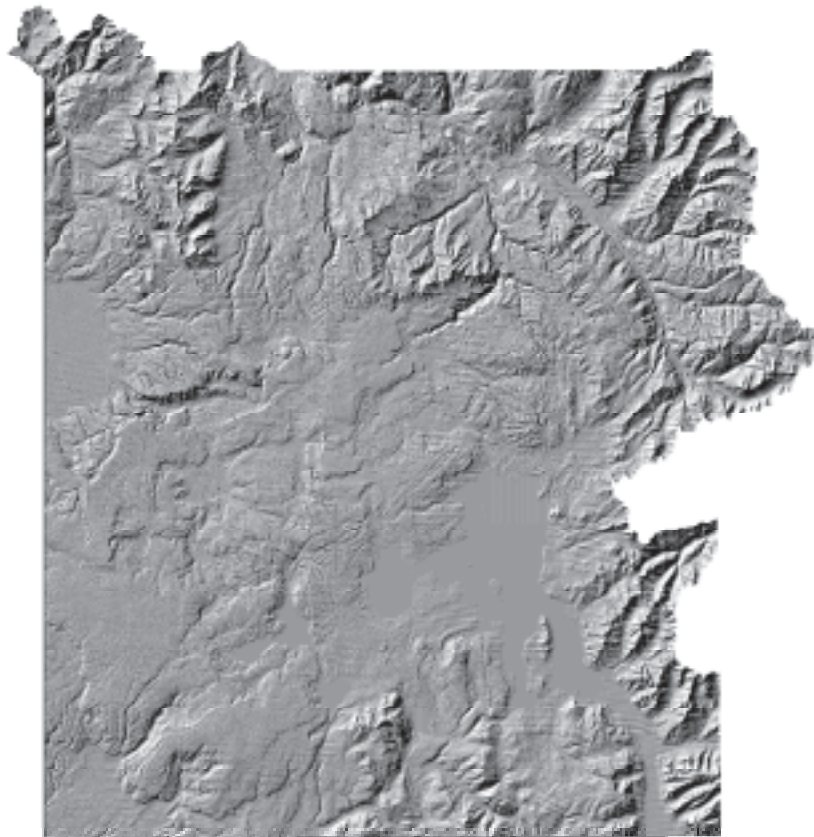


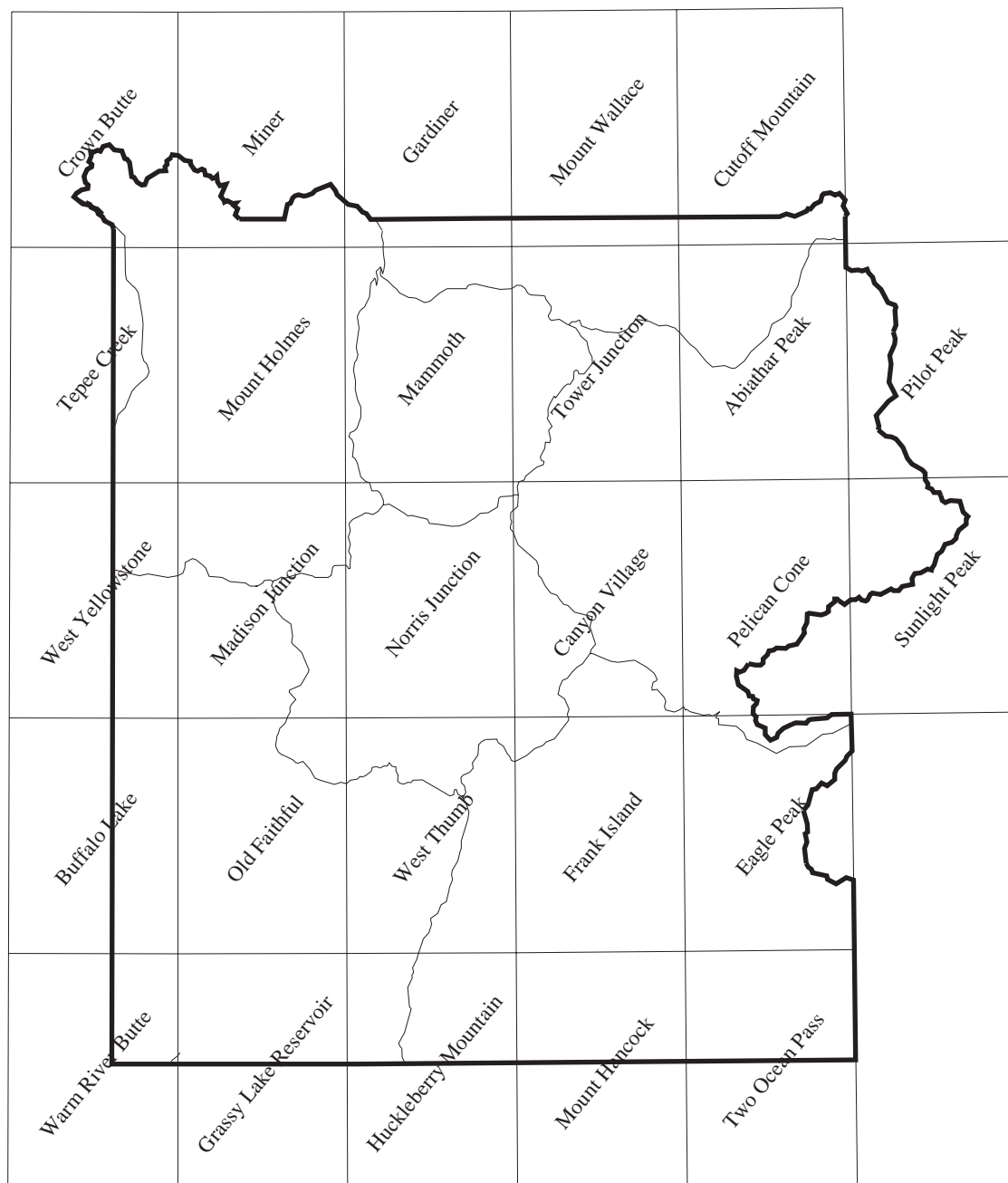
Soils of Yellowstone National Park

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Yellowstone Center for Resources
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1996

INDEX TO MAP SHEETS



Map Sheets are based on USGS 15 minute 1:62,500 quadrangles.

Rodman, A., H.F. Shovic, and D. Thoma. 1996. Soils of Yellowstone National Park.
Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-NRSR-96-2.

HOW TO USE THIS SOIL SURVEY

This survey is divided into two parts. The first part is this document, which includes an introduction, detailed descriptions of the map units, and taxonomic units, tables of information, references, a glossary, and appendices. The second part is a folder containing the detailed map sheets.

To find information about your area of interest:

- Locate the area on the Index to Map Sheets on the inside cover of this document and on the separate sheet included with the maps. Note the name of the map sheet and open up that map.
- Locate your area of interest on the map sheet. Note the map unit symbols that are in that area.
- Look up the symbols in the Index of Map Units, located at the beginning of this document. The symbols are listed alpha-numerically, followed by the number of the page where each map unit is described (Map Unit Descriptions).

The Map Unit Descriptions give detailed information about the main soils in the specified area. For more information about the range of properties of a specific soil, look up the soil name listed alphabetically in the Taxonomic Unit Descriptions. See Table of Contents for other sections of this publication that may address your specific needs.

The information on the map sheets is also available in a digital format from the Spatial Analysis Center, Yellowstone National Park, Wyoming 82190.

How to cite this soil survey.

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Major fieldwork for this soil survey was completed in 1994. Soil names and descriptions were approved in 1996. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1989 through 1995. This survey was done cooperatively by the National Park Service and the Natural Resource Conservation Service (NRCS). The National Park Service was responsible for legend development, fieldwork, mapping methods, legend quality control, and field quality control. The Natural Resource Conservation Service was responsible for taxonomic quality control, consistency of taxonomic and map unit descriptions, and final office correlation. The document was published by the National Park Service in consultation with the Natural Resource Conservation Service.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the mapping detail. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a greater resolution.

Fieldwork and computer analysis were done by: Henry F. Shovic (Party Leader), Eric Bard, Charlie Brankman, Amy Emanuelson, Susan Gregerson, Jill Harting, Alexa Calio Henry, Heidi Himmelberger, Bill Hobbs, John Lane, Bob Lindstrom, Kathy McCurdy, Dean Neprud, Ann Rodman, David Thoma, Christina Biel, Natasha Bleier, Mandi Hardy, Wendy Husk, Kristin Legg, Kathy Noaker, Jennifer Walker, and Nettie White.

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Contents

Introduction	6
Map Units	16
Index of Map Units	17
Classification of the Soils	148
Index of Soils Classifications	149
Literature Cited and References	239
Glossary	244
Index of Glossary	245
Appendices	273

INTRODUCTION

PURPOSE OF THE SURVEY

Yellowstone National Park is a natural laboratory for hundreds of scientific researchers from all over the world. Millions of visitors come to the park every year to view the amazing abundance of wildlife and the landscapes on which they live. Soils provide the underpinnings for those landscapes, a fact brought into focus by the fires of 1988 which underscored the need for reliable soils information. Managers, scientists, and the public were concerned about whether a new Yellowstone would rise from the ashes of hundreds of thousands of burnt over acres. New trees, shrubs, and grass grew not from ashes, but from the reservoir of seeds, bulbs, and roots protected by the nurturing soil environment. This study was commissioned to provide better information about the nature and distribution of that resource.

We undertook this study to provide baseline soil data at an Order IV level, meaning that soils are classified and mapped at a scale suitable for broad resource planning. The information can be used for site-specific work only after field verification. The map units delineate soil bodies that occur together in repeating patterns on the landscape. Rather than making map units with predetermined interpretations in mind, major soil properties were grouped to maximize differences between groups and minimize differences within a group. This type of grouping allows the user flexibility in developing interpretations for specific interests.

Soil properties affect a wide variety of seemingly unrelated phenomena. They influence the mixture of plants that spring up after a fire, partly because coarse textured soils dry more quickly than fine textured soils and may be more susceptible to wildfire damage. Revegeta-

tion of disturbed sites is critically dependent on the preservation of the topsoil and its structure. Soils contain and protect cultural artifacts, while providing clues about the climatic environment present at the time of burial. Erosion and sedimentation are highly affected by soil type. Soils may be sediment sources, or too unstable to be used as a foundation for buildings or roads. Some soils are seasonally wet or subject to flooding, and some are shallow to bedrock. Soil properties influence ecosystem parameters, such as resistance to grazing pressure or predisposition to invasion of exotic or noxious vegetation. Medium textured soils may have a high potential for rodent activity, which affects the prey base for various species. These and many other soil properties that affect land use and potential are described in this document.

Our objectives were to provide basic soils information for use in research, resource management, and interpretive and educational purposes. Resource management planners can use it to determine the effects of different management alternatives. Research personnel can use it to plan site locations, correlate soil properties with existing information, extrapolate site data, and help place site data in a landscape context. Ecologists can better place communities of plants and animals into a landscape setting using soils as a component of the ecosystem. Wildfire personnel can use the information to predict vegetation recovery, potential wildfire soil damage, and suppression hazards. Teachers and students can study patterns of soils and how they relate to wildlife use, vegetation patterns, or visitor impact. Specialists in cultural resources, construction and buried services can use this survey to locate which areas require more intensive field studies.

Because this document is the result of a lengthy process of scientific discovery, it includes considerable technical language. These terms are used because they have well defined and limited meanings in the discipline. Since they are not familiar to most users we have included an extensive glossary.

The location of each map unit is shown on the detailed soil maps. Each map unit and each soil in the survey area is described in detail. Help in using this publication and its digital counterpart is available from the Center for Resources, Yellowstone National Park.

This publication is a benchmark of soils knowledge within Yellowstone National Park in 1996. It will be updated to include the additional soils knowledge or the development of new management or scientific needs.

GENERAL NATURE OF THE SURVEY AREA

The survey area lies within the boundaries of Yellowstone National Park, which is located mostly in northwest Wyoming, and extends into southwest Montana and southeast Idaho (Figure 1). The survey includes 2,196,480 ac (888,915 ha). The park's physiography is primarily a set of high, forested, volcanic plateaus eroded to various degrees by glaciation and stream flow. They are flanked on the north, east, and south by mountains, but terrain to the west and southwest gradually decreases in elevation. Major mountain ranges include the Absaroka, Gallatin, and Washburn. The Continental Divide traverses the park from its southeast corner to its western boundary. The average elevation is 8,000 ft (2,479 m) and ranges from 5,282 ft (1,637 m) in the north, where the Gardner River drains from the park to 11,358 ft (3,521 m) in the east, at the summit of Eagle Peak in the Absaroka Range.

Approximately five percent of the park is covered by water. Major rivers in the area include the Snake, Yellowstone, Gallatin, and Madison, and major lakes are Lewis, Heart, Shoshone, and Yellowstone. Yellowstone Lake lies at 7,730 ft (2,397 m) in elevation, and has an area of 136 square miles (35,259 ha) and a maximum depth of 390 ft (121 m). It is the largest lake at high elevation in North America. There are over 2,000 other lakes ranging from 0.1 ac (0.04 ha) to 7,000 ac (2,800 ha) in size.

The park environment supports seven species of coniferous trees, 1,100 species of vascular plants, and the largest concentration of large and small wild mammals in the lower 48 states. Rare mammals such as the gray wolf (reintroduction in progress), bald eagle, grizzly bear, wolverine, and pine marten make their home in the park, and rare endemic plant species such as Ross' bentgrass and Yellowstone sand verbenas are supported by its soils. Rare thermophilic microorganisms occur in hydrothermal pools and in the surrounding thermogenic soils.

Yellowstone was created as a National Park on

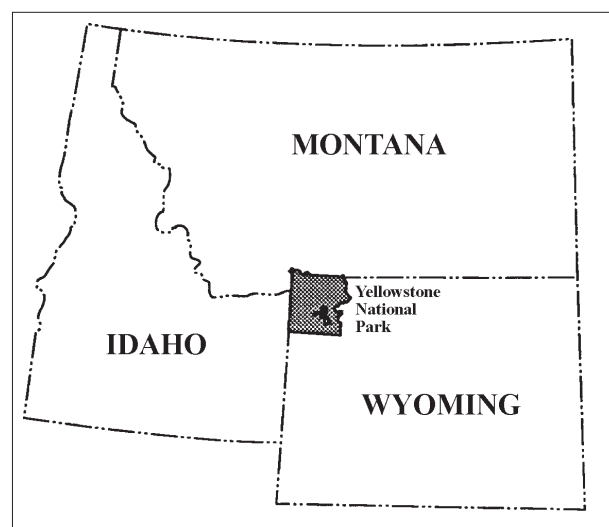


Figure 1. Location of Yellowstone in relation to Montana, Idaho, and Wyoming.

March 1, 1872, accepted as a World Biosphere Reserve in June 1976, and as a World Heritage Site in 1978. Except for relatively small localized areas of development, most of the soils have evolved without the disturbance of human activity. Facilities in the park include restaurants, hotels, various buildings, campgrounds, 370 mi (620 km) of paved roads, 1,210 mi (2,033 km) of trails, 85 trailheads, and 300 backcountry campsites.

Soils of the survey area range from very coarse to fine textured and from very shallow to very deep. Coarse fragment content of the soil can be low to very high. Soils in the high elevation forests are usually acidic, while soils at lower elevations are neutral to alkaline. Soil temperature regimes in most of the park are cryic or frigid. Soils in hydrothermal areas can have mesic, isomesic, thermic, isothermic, hyperthermic or isohyperthermic temperature regimes.

Geology

The geologic history of the study area has been well described in a variety of publications (Keefer 1971, Parsons 1978, Harris 1980, Reid and Foote 1982). The oldest geologic materials in the park are Precambrian gneisses and schists (2.7 billion years before present), which occur in the Black Canyon of the Yellowstone River. Throughout the most of its history (2.7 to 0.6 billion years before present), the Yellowstone region has generally been under large scale tectonic compression. Subsequently, the area was eroded to a flat plain and then flooded by large seas which deposited layers of calcium carbonate, sand, and clay up to 10,000 ft (3,050 m) thick. These Paleozoic and Mesozoic limestones, sandstones, and shales make up parent rocks of the Gallatin Range, the Red Mountains, and Mount Everts. Extensive folding and faulting has occurred in these rock

units. Tectonic compression during the Laramide Orogeny (65 million years before present) formed crustal uplifts of the southern Rocky Mountains with displacement up to approximately 10,000 ft (3,050 m). Eocene Absaroka Volcanics (40 to 50 million years before present) buried the region in thick deposits of andesite lava, ash, mud, and debris flows. These deposits which make up the second most common geologic material in the park, are thousands of feet thick on its east and northwest sides. The mud and debris flows buried forests and formed the petrified or fossil forests common to the park. Isolated Tertiary flows of basalt also occur in the survey area.

The most common geologic materials are rhyolitic ash-flow tuffs and rhyolite flows, mainly of Quaternary age. Over the past two million years, thousands of cubic kilometers of rhyolite lava have been deposited on the surface. During this time, cataclysmic eruptions produced extensive sheets of rhyolitic ash flow tuff and created one of earth's largest calderas, measuring 28 x 47 mi (47 x 79 km).

The weathering products of the two main rock types (rhyolite and andesite) differ distinctly in mineral nutrient content and water-holding capacity, both factors of primary importance to soil development and plant growth. Soils therefore reflect these influences.

The Yellowstone landscape has undergone at least three extensive glaciations that have affected most of the park. Glaciers gouged mountains and valleys, creating the characteristic landforms and surficial deposits which dominate the current topography. Glacial till and glaciofluvial sediments are common throughout the park. These glaciations also left numerous glacial boulders that are prominently displayed in parts of the

park, and discussed in the Appendix (see Glaciation and Erratics).

Magma under the surface provides an active heat source in parts of the park, and may contribute to the high level of seismicity in the area. This heat source gives rise to an unusually high concentration of thermal features, including geysers, hot springs, mudpots and fumaroles. Soil parent materials in these areas vary from extremely acid to basic in reaction. The weathering regime in these areas includes year-round warm temperatures and moist conditions, very different from the rest of the park. Minerals in these areas are hydrothermally altered or dissolved, and the products vary widely in composition and grain size. Unusual minerals are present in soil profiles, and the thermal regions contain unique assemblages of algae and bacteria.

Climate

The climate is characterized by long, cold winters and short cool summers (Dirks and Martner 1982, Despain 1987). The frost-free season is less than five months at all but the lowest elevations. Frost and snowfall can occur anytime of the year at the higher elevations. Yellowstone is within the normal southward excursions of polar fronts and exposed to frequent passage of winter storm systems. Air temperatures vary from lows of -40 through -30 degrees F to highs of 70 through 80 degrees F. The record high was 103 degrees F at Gardiner, Montana, in 1960, and the record low was -66 degrees F at West Yellowstone, Montana, in 1933, both locations at entrances to the park. Surface winds have a wide range of prevailing directions due to topography, though at higher exposed locations they are consistently from the southwest.

Average annual precipitation varies from 10 in

(25.4 cm) at the north boundary to approximately 80 in (204 cm) in the southwest corner. Precipitation peaks in the park interior and large valleys during spring, and in the mountains of the northern and eastern areas during winter. Most of the park's precipitation comes as snowfall. High elevations accumulate deep snow in winter which may linger on the ground into late June. Summer precipitation is dominated by localized showers and thunderstorms. Although the park has no glaciers, permanent snowfields occur on the north sides of some high peaks.

Vegetation

Climate, wildfire patterns, and soil properties determine the distribution of vegetation within the park. Approximately 80 percent of the park is covered by forests. In general, Douglas fir forests dominate in the warm (low elevation) dry areas with medium textured soils; lodgepole pine forests dominate cool dry areas with coarse textured soils; subalpine fir and Engelmann spruce dominate in wetter areas; whitebark pine dominates the high elevation areas; and a mixture of subalpine fir and lodgepole pine cover everything else. Nonforested vegetation is most common in areas with medium and moderately fine textured soils, that weather primarily from andesite and sedimentary rock types (Despain 1990). Willows, sedges and tufted hairgrass dominate the wetter areas. Nonforested sites on plateaus underlain by rhyolite are typically in lake deposits or in areas of loess accumulation. Areas above 10,000 ft (3,100 m) support alpine tundra and scattered conifers.

Humans have introduced exotic plant species such as timothy, Kentucky bluegrass, and Canada thistle. Over 150 introduced species have been found, mainly restricted to road corridors, disturbed areas, and lower elevations

in the northern part of the park.

The Context of the Landscape

The landscapes and soils of Yellowstone National Park fit into a larger context of associations with biotic and abiotic factors. A hierarchical system for classifying these associations has been developed (McNab and Avers 1994), based on increasing uniformity of ecological potentials. The levels of this classification are in decreasing order of size: domain, division, province, section, subsection, landtype association, landtype, and landtype phase. The park is within the “dry” domain, which includes tropical and subtropical steppes, deserts, and temperate mountainous areas. Within this domain, the park is classified in the division of “temperate steppe regime mountains.” It is in the “southern Rocky mountain steppe-open woodland-coniferous forest-alpine meadow” province, and within the “yellowstone highlands” section. This section is described as a series of high plateaus resulting from ancient volcanism. Some areas are strongly glaciated, but most of the section is plateau-like. Subsections, landtype associations and landtypes have not been developed for Yellowstone National Park, but could be mapped from existing information on soils, geomorphology, vegetation, and lithology.

Previous Work

In the first systematic investigation of soil properties completed by Trettin (1986), 67 sites were described and sampled. Extensive chemical and physical analyses are available for these sites. An erosion potential inventory was completed in 1987 for the northern third of the park and surrounding lands. This was used in the analysis of sediment sources for the Yellowstone River and provided initial information on erosive potentials of different

landscapes (Shovic et al. 1988).

A general landscape map of Yellowstone National Park was completed in 1990 (Shovic, H. F., unpublished data) at a scale of 1:125,000. This map identifies general landform/regolith groups for the park. A soils investigation completed for the northwest part of the park (Shovic et al. 1991) includes a map, legend, and classification of soils in the area near Reese Creek, McMinn Bench, and Mammoth Hot Springs. This survey is at a soil family level at a scale of 1:24,000 and includes about 10,000 ac (4,000 ha). An additional analysis was completed to address issues of wildlife grazing and potential restoration of this area (Shovic 1994). Soil survey information is available for part of the area immediately surrounding Yellowstone National Park. About 30 percent of the area has adjoining soil surveys (Davis and Shovic 1984, Rodman et al. 1992, Nordin and Blackwell 1984). Soil investigations for the remainder of the surrounding area are ongoing. We used these studies to develop a perspective on the range of potential soil properties, their relationships to landscapes, and possible interpretative needs.

We concluded from this work that strong relationships exist between soils and the nature of the regolith, landforms, and vegetation. A bedrock geology map covers the entire park at a scale of 1:125,000 (U.S. Geological Survey 1972a). Partial coverage is available at 1:62,500. Surficial geology maps are available at 1:125,000 (U.S. Geological Survey 1972b) and for most of the park’s area at a scale of 1:62,500 (Pierce 1973a, 1973b, 1974a, 1974b; Richmond and Pierce 1971 1972; Richmond 1973a, 1973b, 1973c, 1973d, 1974, 1977; Richmond and Waldrop 1972, 1975; Waldrop, 1975a, 1975b; Waldrop and Pierce 1975). There are many general geological publications

describing various features (e.g., Keefer 1971, Parsons 1978, Harris 1980, Reid and Foote 1982, White et. al. 1988). Some of this information is available in digital form. We used a parkwide landform/regolith map developed at a scale of 1:62,500 (Shovic 1996) and available in digital form. For vegetation characteristics we used existing habitat type and cover type maps at a scale of 1:62,500 (Despain, D., unpublished, available in digital form), which are discussed in Despain (1990).

METHODS

We produced descriptions of soils, their properties and modes of formation, and the maps of soil distribution using a set of systematic methods based on accepted scientific principles and, where needed, an extension of those principles.

Standard Soil Survey Methodology

A relatively standard set of techniques is used in soil surveys which have been developed over the many years soils have been mapped (Soil Conservation Service 1993). These techniques are based on scientific concepts of soil formation as well as pragmatic application during soil surveys. All approved soil surveys must adhere to certain quality standards. Use of language, format, and content are consistent between surveys, yet enough flexibility is allowed to accommodate for variations in survey objectives and the intended audience.

Since soil is three dimensional, and its surface is usually covered with plant material, it is impractical to predict soil spatial patterns by direct observation. However, the soils in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular

segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept or model of how the soils were formed. This model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Individual soils on the landscape commonly merge onto one another as their characteristics gradually change. To construct an accurate map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationships, are sufficient to verify predictions of the kinds of soil in an area and to determine boundaries between soils.

Soil scientists record the characteristics of the soil profiles they study. After describing the soils in the survey area and determining their properties, the soil scientists assign the soils to taxonomic classes or units. Taxonomic classes are concepts to classify soils systematically. Each class has a set of soil characteristics with precisely defined limits. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile.

After locating and identifying the significant combinations of soils occurring in the area, soil scientists begin to delineate them on maps. The traditional process involves transects and traverses across the landscape with field sheet in hand, drawing boundaries between combinations of soils in the field. Many soil pits are examined to verify the mapping process. Map unit descriptions are developed

from notes taken during the traverse or transect process.

Yellowstone Soil Survey Methodology

The methods described above are practical where relatively detailed soil information is needed and there is reasonable access to all map unit delineations. However, access for this survey was difficult, the required level of detail was less than in agricultural or suburban areas, and the survey objectives required a more formal approach. Therefore we developed a modified set of methods for the soil survey of Yellowstone National Park.

We applied models that predicted soil properties over the landscape of an indirect input, using information gained from interpretation of aerial photographs, ground observations, and existing digital resource maps. These models were based on theories of soil development, soil-site relationships observed in the Yellowstone area, and extensive site observations of soil properties on the ground that were made over a seven-year period.

We described more than 1,100 soil profiles, their environment, and their site locations. These sites were selected as representative of the local range of important features that influence soil development and their relative extent in the park. This resulted in a random sampling of soils and a representative sample of the soil-forming conditions that occur in the park (Shovic and Montagne 1985.) Described properties include color, texture, degree and kind of soil aggregation; consistence; location and thickness of horizons; distribution of plant roots; clay films; presence of carbonates; chemical reaction (pH); and volume and character of rock fragments. All horizons have an archived box sample. Extensive site data were collected on vegetation cover, habitat

type, rock types in the soil profile and on the soil surface, features relating to soil drainage, signs of disturbance, regolith characteristics, elevation, slope gradient, aspect, slope shape and position, landform, and location. All relevant data were entered into digital databases that can be linked to geographic information systems and analytical software packages.

We used these observations to make predictive models of soil occurrence on the landscape. The basic premise in these models is that the kind of soil occurring at a given location can be predicted by knowing the quantitative or qualitative values of a set of factors, i.e. the parent material from which the soil is formed, the climate and vegetation under which the soil has developed, the topography, and its age. We used the soil sample and site properties to develop and test these models. Each model is expressed in a quantitative “rule” or If-Then statement with accompanying conditions under which it is valid. We based these conditions on the information we collected, scientific judgement, and previous research data. The rules are dynamic and easily modified as new data or analysis becomes available.

Because each factor was expressed in a digital spatial data base available in a geographic information system (GIS), the rules could be applied in a logical order to predict soils’ spatial occurrence and distribution on a set of digitally produced maps. Most rule conditions were expressed in spatial data layers, though some required manual modification.

Using the GIS and the rule based system, soil maps were produced automatically during the survey process. The draft maps were used as field sheets in ground verification. Each iteration of maps represented a stage of completion. We used the GIS to flag

unmapped areas (places where no rules existed for that particular combination of soil forming factors) and analyze those combinations. We resolved each case by 1) using existing sample points or taking more field samples in those areas to develop new map units, or 2) combining the areas with other map units. The process of mapping was considered complete when 1) all areas were mapped to an appropriate level of quality and detail, 2) concepts represented by the map units were logical and fit into the surrounding landscapes, and 3) map units had adequate background documentation. We edited the final draft maps using manual and computer assisted methods to match ground observations and to meet quality and readability standards. All map unit boundaries were verified on the maps using remote sensing techniques, and a sampling of each map unit was visited on the ground to verify soil occurrence and distribution.

Documentation was supported by spatial analysis using the GIS and associated data bases. We spatially referenced each sample point in a digital format. Therefore sample points could be selected within a particular delineation or based on a wide range of criteria that spatially represented any of the soil-forming factors, e.g., all sample sites in andesitic rock types, wet forest habitat types, alluvial fans, or within soil map unit 1221. We used these techniques for refinement of soil-forming concepts and for descriptions of property ranges within map unit and taxonomic unit descriptions. Each soil taxonomic unit and soil map unit has a documented set of sample sites and an associated digital data base. The conceptual basis for all delineations was also documented through the rule base. Finally, each sample site has an archived reference box sample of horizons.

Each completed draft map was overlain on a spatial model of slopes created from a digital elevation model (DEM). Slope ranges and distributions were developed and analyzed to verify accuracy of mapping, and to help describe ranges of properties.

We also matched our maps with other ongoing and completed soil surveys that border Yellowstone National Park to the extent practicable, given the differing objectives between surveys, their state of documentation, and our map unit definitions. We matched lines on the Gallatin National Forest soil survey, making the best possible correlation with our delineations and soil descriptions. However, because this survey has been completed for some time, we only changed the delineations of Yellowstone National Park map units. The Bridger Teton National Forest also has a completed survey, but it is very broadly mapped and we did not attempt to match it. We matched the soil investigation at Grand Teton National Park (similar to that on the adjoining John D. Rockefeller Jr. Memorial Parkway), using a method similar to the one used with the Gallatin National Forest. The Targhee National Forest has an ongoing survey due to be completed in 1998. Edgematching for this area was treated slightly differently, with the objective of approaching a seamless match on our survey area boundaries. Map unit delineations were intermixed on the boundary. We used either survey's map unit descriptions depending on the best fit on the ground. Targhee National Forest map unit descriptions were used where appropriate, after converting to our map unit format.

The above analysis and documentation reflects our present conceptualization of the soils and their distribution in Yellowstone National Park. We published the maps and documentation now

to provide a benchmark of soils knowledge as of 1996. Though this publication ends an era of pedologic scientific discovery in Yellowstone National Park, the process of mapping soils here has just begun. As the needs of management and science change, this survey of soils can also change. The electronic nature of the survey provides a means for scientific and orderly updating. The digital spatial maps, physical reference samples, and accessory data bases from which the maps and descriptions came are available to provide historical data in a readily modifiable format, helping to assure the fullest possible use and greatest longevity of the information.

SOIL MAP UNITS

Index of Map Units

1267	22	2226	62	513	106
127	23	2246	63	5217F	107
1282	25	2261	65	522	109
1324	26	2514	67	5294	110
1358	28	2522F	68	5419	111
1532	30	2541	70	554	112
1537	31	2543	71	5883	113
1562	33	2546	73	7153	115
1583	34	2561	74	7172F	116
1721F	35	2662	76	7562	118
1752	37	2751	77	7883	119
1759	38	276	79	812	121
1762	40	2765	80	8125	122
1795	41	2915	82	8167	123
182	43	2916	84	8261	125
1865	44	2924	86	8335	127
2025	46	295F	88	835	128
2126	47	2961	89	8357	130
2154	49	2962	91	853Z	131
2159	50	2972	93	8715	134
2167	52	2975	95	8835	136
2195	53	2996	96	8853	138
2207	55	353Z	98	8863	139
2213	57	358Z	101	8883	141
2216	58	3835	103	8886	142
2222	60	423Z	104	9251	144
				9564	146

Introduction

Map units are defined as the description of a combination of soils used in a soil survey (Soil Conservation Service 1993). They are the actual physical expressions of the conceptual taxons defined in the Soil Taxonomic Unit Descriptions Section. Map units include a combination of soils, mapped together to reflect the scale of mapping, standards for purity, survey objectives, and map readability.

A map unit delineation represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the soil family name or taxonomic classification (see Taxonomic Unit Descriptions) of the dominant soils or miscellaneous areas. We have defined a number of different kinds of map units. Most of our map units are soil “complexes,” which are map units with two or more main soil components or miscellaneous areas in such an intricate pattern that it is not practical to map them separately at the selected scale. The pattern and proportion of the soils are somewhat similar in all areas (Soil Conservation Service 1993). There are also some “undifferentiated groups,” which are map units consisting of two or more main soil components or miscellaneous areas that are not consistently associated geographically, and occur in no discernible pattern.

Each map unit delineation has at least one of the major components and may have them all. Each of the components, however need not be in every delineation. Finally, there is one “consociation,” a map unit dominated by a single soil component and similar soils. The kind of map unit is identified in the map unit name at the top of the description.

Each taxonomic class has precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas have the characteristic variability of all natural phenom-

ena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class can rarely, if ever, be mapped without including areas of other taxonomic classes. Consequently, each map unit is made up of the soils or miscellaneous areas for which it is named and some “included” areas that belong to other taxonomic classes.

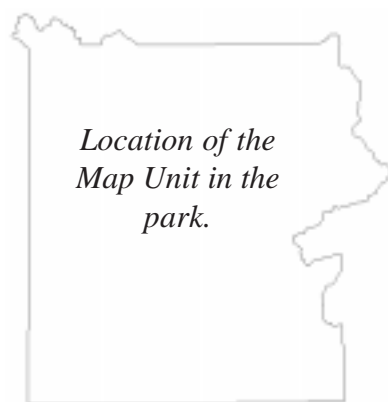
Most included soils have properties very similar to those of the dominant soil or soils in the map unit. These are called “similar inclusions.” However, other included soils and miscellaneous areas, have properties and behavior divergent enough to affect use or to require different management. These are called “dissimilar inclusions.” They are generally in small areas and could not be practically delineated separately at the scale of mapping. In a few areas, the pattern of soils is so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape. Therefore some soils may not have been observed and consequently are not mentioned in the descriptions. These make up a small but unavoidable part of the included soils as defined above.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but to separate the landscape into segments that regularly occur together in a repeating pattern.

The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation to precisely define and locate the soils and miscellaneous areas is needed.

A map symbol comes before the map unit name in each description. This symbol identifies soil map units on the maps. The map unit descriptions include a summary of the environment within which the soils have formed, including landforms, slope ranges, soil parent material, and vegetation. This information is summarized in the Summary of

Map Unit Characteristics Table. Knowing these characteristics helps place soils in an ecological context and aids in locating the map units on the ground. The next section, “Map Unit Format,” explains the format of map unit descriptions. The Identification Legend Table gives the symbol, name, and proportionate extent of each map unit.



MAP UNIT FORMAT

MU# X Family-Y Family Complex

Summary - includes the following:

(1) the most common landform groups within the map unit (see the Glossary for definitions of landform groups and the Landform Appendix for descriptions and oblique photographs of the main groups); (2) the dominant slope gradients, in percent, within the map unit (see the Slope Distribution Table for a graphical distribution of slope gradients); (3) the main type of surficial geologic deposit and

rock type from which the soils are forming; (4) the dominant vegetation and the most common “habitat types” within the map unit (see Habitat Type Groups Appendix for an explanation and Habitat Type Table for a list of habitat types); (5) a list of other important features, such as the presence of bedrock outcrops and soils with aquic conditions; and (6) a brief discussion of the main components and the soil properties that differentiate them.

Components

#% X family and similar inclusions (Y and Z families): *The average percent of the map unit composed of X family and soils that have properties similar to X family*

#% Dissimilar inclusions (Q family): *Soils that have properties significantly different from those of the main soil components*

Soil Description and Distribution

Soil Property Comparison

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
X family Similar inclusions	#1	#2	#3	#4	#5

#1 The weighted average (percent by volume) of rock fragments (> 2mm in diameter) within the control section.

#2 The weighted average of percent clay within the control section.

#3 The range of depths for a root-limiting layer. The “>100” means there is no root-limiting layer between the soil surface and 100 cm. This does not imply that there is a root-limiting layer at depths greater than 100 cm.

#4 An estimate of percent base saturation (%BS) for the whole soil calculated from a relationship between %BS and pH. This is most meaningful in a comparison between soils with similar textures and organic matter content.

#5 A relative number, based on depth of mollic colors, that can be used in comparisons of organic matter accumulations between different soils. Mollic colors have a value of 5 or less when dry and 3 or less when moist. They also have a chroma of 3 or less when moist.

Similar inclusion properties - These are the range of average properties for all the similar inclusions (Y and Z families)

X family: The type of epipedon (mollic, umbric, ochric, or histic) and the presence of important layers (argillic horizons or root-limiting layers) or aquic conditions in the soil family. The range of general textural classes of the soil in this map unit. The distribution of this soil family within the map unit.

Typical Profile: Taxonomic classification (pedon #). All colors are for moist conditions.

A brief description of a typical pedon of the X family that actually occurs in this map unit. The description of each horizon includes depth, moist colors, textures, and pH values. It can also include information about aquic conditions and soil temperatures when appropriate.

Dissimilar inclusions: The properties of each inclusion that make them very different from any of the main components.



1267 Como Family-Bearmouth Family-Oxyaquic Cryochrepts Complex

Summary

This map unit forms on a complex of glaciofluvial plains, kames, and terraces. Slopes are commonly less than 15 percent. The main surficial deposit is glaciofluvial alluvium derived from rhyolite or rhyolitic ash-flow tuff. Small areas of fan alluvium, glacial till, and recent stream alluvium also occur. This is a forested map unit dominated by the ABLA/VASC, ABLA/CACA, and ABLA/CARU habitat types. There are also nonforested inclusions of the

DECE/CAREX habitat type and small marsh areas of *Carex* species. Soils with aquic conditions occur in every delineation and make up approximately 15 percent of the map unit. The main soils are skeletal Inceptisols with coarse textures, skeletal Mollisols with coarse textures, and Inceptisols with aquic conditions.

Components

60% *Como family* and similar inclusions (Billycreek, Bobtail, Shadow, and Trude families)

15% *Bearmouth family* and similar inclusions (McCort, Tomichi, and Jugson families)

15% *Oxyaquic Cryochrepts* and similar inclusions (Cryaquepts and Aquic Cryoborolls)

10% *Dissimilar inclusions* (Rimton, Ripple, and Teton families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Como family	41	6	>100	55 - 85	7
Similar inclusions	20 - 50	3 - 12	>100	35 - 80	2 - 4
Bearmouth family	60	5	>100	55 - 75	32
Similar Inclusions	10 - 55	5 - 15	>100	40 - 80	16 - 30
Oxyaquic Cryochrepts	10	12	>100	70 - 85	1
Similar inclusions	26 - 30	20 - 22	>100	60 - 80	3 - 27

Como family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under the ABLA/VASC habitat type in glaciofluvial alluvium, fan alluvium, and glacial till.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryochrept (pedon 297). All colors are for moist conditions.

0 to 12 cm: dark brown (10YR 3/3) loam; moderately acid (pH 5.8).

12 to 64 cm: dark brown (10YR 3/3) extremely cobbly loamy sand; neutral (pH 6.8).

64 to 93 cm: brown (10YR 5/3) loamy fine sand; neutral (pH 6.8).

93 to 107 cm: very dark grayish brown (10YR 3/2) cobbly coarse sand; neutral (pH 6.8).

Bearmouth family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit under the ABLA/VASC and ABLA/CARU habitat types, in glaciofluvial alluvium, fan alluvium, and glacial till.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryoboroll (pedon 447). All colors are for moist conditions.

0 to 16 cm: very dark grayish brown (10YR 3/2) very gravelly sandy loam; strongly acid (pH 5.4).

16 to 45 cm: very dark grayish brown (10YR 3/2) extremely gravelly loamy fine sand; moderately acid (pH 5.8).

45 to 100 cm: very dark gray (10YR 3/1) extremely gravelly sand; moderately acid (pH 6.0).

Oxyaquic Cryochrepts: These soils have ochric epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the year. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit forming under the nonforested DECE/CAREX habitat type and under the forested ABLA/CACA habitat type in glaciofluvial alluvium and recent alluvium.

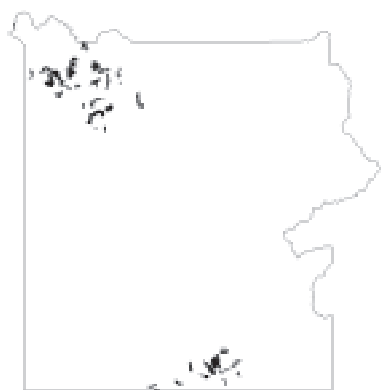
Typical Profile: Oxyaquic Cryochrept (pedon 3126). All colors are for moist conditions.

0 to 6 cm: very dark grayish brown (10YR 3/2) loam; slightly acid (pH 6.2).

6 to 36 cm: dark grayish brown (10YR 4/2) very fine sandy loam; slightly acid (pH 6.4).

36 to 100 cm: grayish brown (10YR 5/2) very fine sandy loam; neutral (pH 6.6).

Dissimilar inclusions: These inclusions all have finer textures than the main components and fewer rock fragments than Como or Bearmouth family soils. Rimton family soils have an argillic horizon and dark-colored surface layers. Ripple family soils have ochric epipedons and Teton family soils have mollic epipedons.



127 Shadow Family-McCort Family Complex

Summary

This complex forms on areas of glacial trough valley bottoms, concave glaciated uplands, and rolling glaciated uplands. The most common slopes are less than 30 percent. The main surficial deposits are glacial till and colluvium derived from sedimentary rocks. Small areas of fan alluvium, glaciofluvial alluvium, and residuum also occur.

The main habitat types in this forested map unit are ABLA/VASC, ABLA/VAGL, and ABLA/THOC. There are also nonforested inclusions of the ARTR/FEID habitat type. Soils with aquic conditions and small areas of bedrock outcrop can occur in this map unit, but do not occur in every delineation. The main soils are skeletal Inceptisols and skeletal Mollisols.

Components

70% *Shadow family* and similar inclusions (Ivywild, Ripple, and Cloud Peak families)

20% *McCort family* and similar inclusions (Greyback and Sula families)

10% *Dissimilar inclusions* (Hobacker family, Cryoboralfs-sh, Aquic Cryoborolls, and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	65	15	>100	55 - 70	2
Similar inclusions	25 - 65	14 - 20	>100	40 - 60	0 - 4
McCort family	40	17	>100	55 - 75	14
Similar inclusions	15 - 50	15 - 20	>100	60 - 75	19 - 22

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately-fine to moderately-coarse textured. They occur throughout the map unit on the steeper slopes, forming under the ABLA/VAGL and ABLA/VASC habitat types, in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 611). All colors are for moist conditions.

5 to 0 cm: litter layer.

0 to 6 cm: dark brown (10YR 3/3) gravelly loam; slightly acid (pH 6.1).

6 to 30 cm: brown (10YR 4/3) very cobbly loam; moderately acid (pH 5.6).

30 to 100 cm: brown (10YR 5/3) extremely cobbly sandy loam; moderately acid (pH 6.0).

McCort family: These soils have weakly developed mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit, forming under forests in glacial till and alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 21). All colors are for moist conditions.

2 to 0 cm: litter layer.

0 to 15 cm: very dark brown (10YR 2/2) very cobbly loam; moderately acid (pH 6.0).

15 to 100 cm: dark brown (10YR 4/3) very cobbly loam; moderately acid (pH 6.0).

Dissimilar inclusions: Hobacker family soils have thick mollic epipedons and form under the ARTR/FEID habitat type. The Cryoboralfs-sh soils have ochric epipedons, argillic horizons, and root-limiting layers within 50 centimeters of the soil surface. They form under inclusions of the drier, nonforested habitat types. Aquic Cryoboroll soils have aquic conditions for some time during the year. Bedrock outcrops are composed of sedimentary rock types and can occupy up to 5 percent of any delineation.



1282 Como Family-Bearmouth Family-Moran Family Complex

Summary

This map unit forms on rolling pluvial uplands, glaciofluvial outwash plains, and a complex of glaciofluvial plains, kames and terraces. Slopes are commonly less than 15 percent. The main surficial deposit is glaciofluvial alluvium derived from rhyolite or rhyolitic ash-flow tuff. Small areas of fan alluvium, glacial till, and recent stream alluvium also occur. This is a forested map unit dominated by the ABLA/VASC and ABLA/CAGE habitat types. Also included are

areas of wet forest habitat types and small inclusions nonforested habitat types. Soils with aquic conditions rarely occur in this map unit, and they are not present in every delineation. The main soils are skeletal Inceptisols with coarse textures, skeletal Mollisols with coarse textures, and skeletal Inceptisols with dark-colored surface horizons.

Components

- 45% *Como family* and similar inclusions (Bobtail and Trude families)
- 25% *Bearmouth family* and similar inclusions (Sula and Tomichi families)
- 15% *Moran Family* and similar inclusions (Jugson and Greyback families)
- 15% *Dissimilar inclusions* (Hobacker family, Ripple family, Cryaquepts, and Cryumbrepts-sh)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Como family	51	5	>100	55 - 95	9
Similar inclusions	20 - 45	4 - 10	>100	45 - 80	3 - 7
Bearmouth family	55	6	>100	55 - 80	31
Similar inclusions	15 - 30	5 - 12	>100	55 - 80	23 - 30
Moran family	53	16	>100	45 - 75	30
Similar inclusions	20 - 55	5 - 18	>100	50 - 75	24 - 30

Como family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under the ABLA/VASC and ABLA/CAGE habitat types in glaciofluvial alluvium, recent alluvium, and glacial till.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryochrept (pedon 788). All colors are for moist conditions.
2 to 0 cm: litter layer.

0 to 9 cm: very dark grayish brown (10YR 3/2) gravelly sandy loam; neutral (pH 6.6).

9 to 26 cm: dark brown (10YR 3/3) gravelly loamy sand; neutral (pH 6.6).
26 to 57 cm: dark yellowish brown (10YR 3/4) loamy sand; medium acid (pH 6.0).
57 to 74 cm: very dark gray (10YR 3/1) very gravelly loamy sand; neutral (pH 7.2).
74 to 100 cm: black (10YR 2/1) very gravelly sand; slightly acid (pH 6.2).

Bearmouth family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit under the ABLA/VASC habitat type in glaciofluvial alluvium.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryoboroll (pedon 3134). All colors are for moist conditions.

8 to 0 cm: Black (10YR 2/1) very gravelly sandy loam; medium acid (pH 5.6).
8 to 20 cm: Very dark grayish brown (10YR 3/2) gravelly coarse sandy loam; medium acid (pH 5.8).
20 to 100 cm: Very dark grayish brown (10 YR 3/2) extremely cobbly loamy very coarse sand; medium acid (pH 6.0).

Moran family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit forming under forests in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryumbrept (pedon 3121). All colors are for moist conditions.

5 to 0 cm: litter layer.
0 to 21 cm: very dark brown (10YR 2/2) very gravelly sandy clay loam; strongly acid (pH 5.4).
21 to 100 cm: very dark grayish brown (10YR 3/2) very gravelly sandy loam; neutral (pH 6.6).

Dissimilar inclusions: Hobacker family soils have thick mollic epipedons and occur under various nonforested habitat types and the forested ABLA/VASC-CARU habitat type. Ripple family soils have finer textures and fewer rock fragments than the main components. Cryaquepts have aquic conditions during the growing season. They form under wet forest habitat types. Cryumbrepts-sh soils have umbric epipedons and root-limiting layers within 50 centimeters of the soil surface.



1324 Como Family-Struggle Family-McCort Family Complex

Summary

This complex forms on glaciated plateaus with some rolling glaciated uplands. Slopes are commonly less than 20 percent. The main surficial deposit is glacial till and colluvium derived from rhyolitic ash-flow tuff. Small areas have andesite or basalt mixed with the tuff. Inclusions of glaciofluvial alluvium, fan alluvium, and loess also occur. This is a forested map unit dominated by the ABLA/VASC-VASC and ABLA/

VASC-PIAL habitat types. Forested inclusions of ABLA/VAGL, ABLA/CARU, and ABLA/CAGE habitat types; along with small inclusions of nonforested habitat types; also occur. Areas of bedrock outcrop and talus are present in this map unit, but do not occur in every delineation. The main soils are skeletal Inceptisols with coarse textures, skeletal Inceptisols with root-limiting layers and coarse textures, and skeletal Mollisols with weakly developed epipedons.

Components

- 45% *Como family* and similar inclusions (Shadow and Bobtail families)
 25% *Struggle family* and similar inclusions (Whitecross, Priestlake, and Granturk families)
 20% *McCort family* and similar inclusions (Greyback, Moran, and Sula families)
 10% *Dissimilar inclusions* (Cryumbrepts-sh, bedrock outcrops, Cloud Peak family, Ripple family, and Hobacker family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Como family	64	4	>100	70 - 95	0
Similar inclusions	25 - 55	6 - 13	>100	65 - 85	0 - 3
Struggle Family	57	5	60 - 90	50 - 70	0
Similar inclusions	30 - 60	4 - 15	30 - 70	45 - 75	0 - 5
McCort family	67	16	>100	60 - 90	14
Similar inclusions	25 - 65	15 - 20	>100	50 - 80	18 - 28

Como family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under forests in glacial till.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryochrept (pedon 765)

- 0 to 14 cm: dark brown (10YR 4/3) gravelly loamy sand; neutral (pH 6.6).
 14 to 31 cm: grayish brown (10YR 5/2) very gravelly loamy sand; neutral (pH 6.8).
 31 to 53 cm: light brownish gray (10YR 6/2) very gravelly loamy sand; neutral (pH 7.0).
 53 to 100 cm: grayish brown (10YR 5/2) very gravelly loamy sand; neutral (pH 7.2).

Struggle family: These soils have ochric epipedons and moderately deep root-limiting layers. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under forests in glacial till.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryochrept (pedon 455)

- 1 to 0 cm: burned litter layer.
 0 to 19 cm: dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) very gravelly sandy loam; strongly acid to moderately acid (pH 5.4 to 5.6).
 19 to 65 cm: light olive brown (2.5Y 5/3) and brown (10YR 5/3) very gravelly loamy sand and extremely gravelly sand; moderately acid (pH 5.8).

65 to 87 cm: paralithic contact with weathered, rhyolitic ash-flow tuff.

87 cm: lithic contact with rhyolitic ash-flow tuff.

McCort family: These soils have weakly developed mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 785)

0 to 13 cm: dark brown (10YR 3/3) very gravelly loam; slightly acid (pH 6.2).

13 to 51 cm: dark brown (10YR 4/3) very gravelly to extremely gravelly loam; slightly acid to neutral (pH 6.4 to 6.6).

51 to 100 cm: dark brown (10YR 4/3) extremely cobbly sandy loam; moderately acid (pH 6.0).

Dissimilar inclusions: Cryumbrepts-sh&r have an umbric epipedon and a root-limiting layer between 30 and 50 centimeters below the soil surface. Bedrock outcrops and talus are composed of rhyolitic ash flow tuff. The Cloud Peak family soils have argillic horizons. Ripple family soils have finer textures and fewer rock fragments than the main components. Hobacker family soils have thick mollic epipedons and occur under inclusions of ABLA/CARU.



1358 Shadow Family-Taglake Family-Bedrock Outcrop Complex

Summary

This complex generally forms on steep or rolling colluvial slopes, or stream breaks. The most common slopes are either less than 30 percent or greater than 50 percent. The main surficial deposit is colluvium derived from rhyolitic ash-flow tuff. About 20 percent of the map unit is underlain by rhyolite flows. This is a forested map

unit dominated by the ABLA/VASC-VASC, ABLA/VAGL, ABLA/VASC-PIAL, and various PSME habitat types. The main soils are skeletal Inceptisols and skeletal Inceptisols with a root-limiting layer.

Components

55% *Shadow family* and similar inclusions (Como, McCort, and Arcette families)

20% *Taglake family* and similar inclusions (Whitecross and Struggle families)

15% *Bedrock outcrop and talus*

10% *Dissimilar inclusions* (Bearmouth and Moran families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	70	17	>100	60 - 90	6
Similar inclusions	55 - 95	5 - 17	>100	50 - 80	0 - 6
Taglake family	71	14	60 - 90	60 - 85	2
Similar inclusions	55 - 75	5 - 15	25 - 80	55 - 85	0 - 3

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in colluvium and glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 774). All colors are for moist conditions.

5 to 0 cm: litter layer.

0 to 11 cm: grayish brown (10YR 3/2) very gravelly sandy loam; neutral (pH 7.0).

11 to 20 cm: dark brown (10YR 3/3) extremely cobbly sandy loam; slightly acid (pH 6.4).

20 to 100 cm: dark grayish brown (10YR 4/2) extremely cobbly loam; slightly acid (pH 6.2).

Taglake family: These soils have ochric epipedons and moderately deep root-limiting layers. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 797). All colors are for moist conditions.

0 to 15 cm: dark brown (10YR 3/3) extremely gravelly sandy loam; neutral (pH 6.6).

15 to 79 cm: brown (7.5YR 5/2) extremely gravelly sandy loam; neutral to slightly acid (pH 6.6 to 6.2).

79 cm: lithic contact with rhyolitic ash-flow tuff.

Bedrock outcrops and talus: These areas are composed of rhyolitic ash-flow tuff or rhyolite. Bedrock outcrops and talus slopes make up from 10 to 35 percent of any delineation. Bedrock outcrops are common between stream valleys.

Dissimilar inclusions: Bearmouth family soils have mollic epipedons, coarse textures and skeletal subsoil layers. Moran family soils have umbric epipedons and skeletal subsoil layers. These inclusions are more common under the ABLA/VASC-PIAL and various PSME habitat types.



1532 Shadow Family-Bedrock Outcrop-Whitecross Family Complex

Summary

This complex forms on rolling glaciated uplands and colluvial slopes, some with high relief. The most common slopes are between 10 and 40 percent. The main surficial deposits are glacial till, glacial rubble, and colluvium derived from dacite and granite. Also included are smaller areas of residuum and glacial till derived from andesite and basalt. This is a primarily a forested map unit dominated by the ABLA/VASC-PIAL, PSME/SYAL, PSME/CARU, and ABLA/

VASC-VASC habitat types. Small areas of other forested habitat types and the nonforested ARTR/FEID habitat type are also included. Soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are skeletal Inceptisols greater than 100 centimeters deep and skeletal Inceptisols less than 50 centimeters deep.

Components

55% *Shadow family* and similar inclusions (McCort and Bobtail families)

20% *Bedrock outcrops and talus*

15% *Whitecross family* and similar inclusions (Cryoboralfs-sh)

10% *Dissimilar inclusions* (Greyback family, Aquic Cryoborolls, and Oxyaquic Cryochrepts)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	53	12	>100	75 - 85	2
Similar inclusions	25 - 55	10 - 15	>100	60 - 85	3 - 15
Whitecross family	54	19	30 - 50	70 - 90	0
Similar inclusions	45	22	30 - 50	60 - 75	0

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forested habitat types in colluvium, glacial rubble, and glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 541) All colors are for moist conditions.

2 to 0 cm: litter layer.

0 to 19 cm: dark brown (10YR 3/3) gravelly loam; medium acid (pH 6.0).

19 to 43 cm: dark yellowish brown (10YR 3/4) very cobbly sandy loam; medium acid (pH 5.8).

23 to 100 cm: dark yellowish brown (10YR 4/4) very cobbly sandy loam; medium acid (pH 5.8).

Bedrock outcrops and talus: These areas are composed of dacite or granite. Bedrock outcrops and talus slopes make up from 5 to 35 percent of any delineation.

Whitecross family: These soils have ochric epipedons and shallow root-limiting layers. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forested habitat types in colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Lithic Cryochrept (pedon 514) All colors are for moist conditions.

4 to 0 cm: litter layer.

0 to 13 cm: dark brown (10YR 3/3) very gravelly sandy loam; slightly acid (pH 6.2).

13 to 35 cm: dark brown (10YR 3/3) very cobbly sandy loam; slightly acid (pH 6.4).

35 cm: lithic contact.

Dissimilar inclusions: Greyback family soils have mollic epipedons and many rock fragments. They form under the nonforested ARTR/FEID habitat type. Oxyaquic Cryaquept and Aquic Cryoboroll soils have aquic conditions. Soils with aquic conditions make up approximately one percent of this map unit.



1537 Shadow Family-Bedrock Outcrop-Taglake Family Complex

Summary

This complex forms on rolling glaciated uplands, glaciated plateaus, glacial trough bottoms, with some rolling pluvial uplands. Slopes are commonly less than 20 percent. The main surficial deposit is glacial till derived from rhyolitic ash-flow tuff. Smaller areas of colluvium, residuum, loess, and recent alluvium are also included.

This is a forested map unit dominated by the ABLA/VASC-VASC and ABLA/VASC-CARU habitat types. There are small inclusions of other forested and nonforested habitat types. The main soils are skeletal Inceptisols and skeletal Inceptisols with root-limiting layers.

Components

50% *Shadow family* and similar inclusions (Como, Trude and Bobtail families)

20% *Bedrock outcrops and talus*

15% *Taglake family* and similar inclusions (Whitecross family)

15% *Dissimilar inclusions* (Josie, Moran, and Cloud Peak families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	60	19	>100	50 - 85	5
Similar inclusions	25 - 65	6 - 15	>100	50 - 80	0 - 5
Taglake family	68	10	50 - 70	50 - 80	4
Similar inclusions	60	13	30 - 50	50 - 80	2

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under the forests in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 251). All colors are for moist conditions.

7 to 0 cm: litter layer

0 to 31 cm: brown (10YR 4/3) very cobbly loam; strongly acid (pH 5.5).

31 to 45 cm: light yellowish brown (10YR 6/4) very gravelly sandy loam; slightly acid (pH 6.5).

45 to 100 cm: pale brown (10YR 6/3) extremely cobbly coarse sandy loam; slightly acid (pH 6.5).

Bedrock outcrops and talus: These areas are composed of rhyolitic ash-flow tuff. Bedrock outcrops and talus slopes make up from 10 to 40 percent of any delineation.

Taglake family: These soils have ochric epipedons and moderately deep root-limiting layers.

In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in colluvium and residuum.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrepts (pedon 796). All colors are for moist conditions.

3 to 0 cm: litter layer

0 to 6 cm: dark brown (10YR 3/3) gravelly loam; moderately acid (pH 5.6).

6 to 22 cm: brown (10YR 4/3) very gravelly fine sandy loam; slightly acid (pH 6.2).

22 to 54 cm: brown (10YR 5/3) very gravelly and extremely gravelly fine sandy loam; slightly acid to neutral (pH 6.4 to 6.6).

54 cm: lithic contact with rhyolitic ash-flow tuff.

Dissimilar inclusions: Josie and Moran family soils have umbric epipedons. They form in areas where loess mantles the underlying glacial till. Cloud Peak family soils have ochric epipedons, argillic horizons, and skeletal subsoil layers.



1562 Shadow Family-Bedrock Outcrop-Cryaquepts Complex

Summary

This complex forms on plateaus and rolling glaciated uplands. All have wet depressions and bedrock outcrops. Slopes are commonly less than 15 percent. The main surficial deposit is glacial till derived from rhyolite and rhyolitic ash-flow tuff. In some areas sedimentary rocks are mixed with rhyolite. There are also small areas of colluvium and alluvium. This is a forested map unit dominated by the ABLA/VASC-VASC and ABLA/VASC-PIAL habitat types, along with various wet forest habitat types. Nonforested inclusions of the DECE/CAREX habitat type, the FEID/AGCA habitat type, and marsh areas of *Carex* species also occur. Soils with aquic conditions make up 15 percent of this map unit. The main soils are skeletal Inceptisols and Inceptisols with aquic conditions.

Components

55% *Shadow family* and similar inclusions (Moran, Como, and McCort families)

15% *Bedrock outcrops*

15% *Cryaquepts* and similar inclusions (Aquic Cryoborolls)

15% *Dissimilar inclusions* (Sula family, Greyback family, and Cryochrepts-sh&s)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	55	8	>100	70 - 90	5
Similar inclusions	45 - 60	5 - 15	>100	50 - 80	3 - 19
Cryaquepts	10	23	>100	55 - 70	10
Similar inclusions	25	22	>100	60 - 70	28

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under forests in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 789). All colors are for moist conditions.

3 to 0 cm: litter layer.

0 to 6 cm: very dark brown (10YR 2/2) very gravelly sandy loam; slightly acid (pH 6.4).

6 to 22 cm: dark brown (10YR 3/3) gravelly sandy loam; slightly acid (pH 6.4). 22 to 100 cm: dark brown (10YR 3/3) extremely gravelly sandy loam; neutral (pH 6.6).

Bedrock outcrops and talus: These areas are composed of rhyolite or rhyolitic ash-flow tuff. Bedrock outcrops and talus slopes make up from 10 to 35 percent of any delineation.

Cryaquepts: These soils have ochric epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming in alluvium under wet forest habitat types, the DECE/CAREX habitat type, and Carex spp. marsh areas.

Typical Profile: Humic Cryaquept (pedon 259). All colors are for moist conditions.

0 to 9 cm: black (10YR 2/1) organic material of intermediate decomposition; strongly acid (pH 5.5); standing water at surface.

9 to 24 cm: very dark brown (10YR 2/2) organic material completely decomposed; strongly acid (pH 5.5).

24 to 100 cm: very dark brown (10YR 4/1) sandy clay loam; strongly acid (pH 5.5).

Dissimilar inclusions: Sula and Greyback family soils have mollic epipedons and form under inclusions of FEID/AGCA. Cryochrept-sh&r soils have ochric epipedons and root-limiting layers within 50 centimeters of the soil surface.



1583 Shadow Family-Bedrock Outcrop-Matcher Family Complex

Summary

This complex generally forms on strongly dissected, rolling glaciated uplands, glacial trough walls, and glacial headslopes. Slopes are between 10 and 60 percent. The main surficial deposits are glacial till, colluvium, and glacial rubble derived from rhyolite and rhyolitic ash-flow tuff. Small areas of loess-mantled glacial till are also

included. This is a forested map unit dominated by the ABLA/VASC-VASC, ABLA/VASC-PIAL, ABLA/VAGL, and ABLA/CAGE habitat types. The main soils are skeletal Inceptisols and skeletal Inceptisols with dark colored surface layers.

Components

50% *Shadow family* and similar inclusions (Como, Bobtail, and Bottle families)

25% *Bedrock outcrop and talus*

15% *Matcher family* and similar inclusions (Moran and Bearmouth families)

10% *Dissimilar inclusions* (Shook and Struggle families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	64	12	>100	40 - 75	1
Similar inclusions	25 - 60	5 - 10	>100	30 - 70	0 - 4
Matcher family	70	8	>100	40 - 75	29
Similar inclusions	50 - 70	6 - 15	>100	40 - 70	23 - 28

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 435). All colors are for moist conditions.

0 to 4 cm: grayish brown (10YR 3/2) very gravelly loam; moderately acid (pH 5.6).

4 to 66 cm: dark grayish brown (10YR 4/2) very gravelly and very cobbly fine sandy loam; moderately acid (pH 5.8 to 6.0).

66 to 100 cm: dark grayish brown (10YR 4/2) extremely gravelly fine sandy loam; slightly acid (pH 6.2).

Bedrock outcrops and talus: These areas are composed of rhyolitic ash-flow tuff or rhyolite. Bedrock outcrops and talus slopes make up from 10 to 30 percent of any delineation.

Matcher family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in colluvium and loess-mantled glacial till.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryumbrept (pedon 429). All colors are for moist conditions.

3 to 0 cm: litter layer

0 to 15 cm: dark brown (10YR 2/2 and 10YR 3/3) sandy loam and very gravelly sandy loam; strongly acid (pH 5.1).

15 to 100 cm: dark yellowish brown (10YR 3/4) extremely stony loamy sand; slightly acid (pH 6.1 to 6.5).

Dissimilar inclusions: Shook family soils have thick mollic epipedons and nonskeletal subsoil layers. These soils form in areas of loess-mantled glacial till. Struggle family soils have coarse textures, skeletal subsoil layers, and root-limiting layers. These soils form in colluvium under the ABLA/VASC-PIAL habitat type.



1721F Gateson Family-Pesowyo Family-Eaglewing Family Complex

Summary

This complex forms on alluvial fans under a frigid temperature regime. Drainage channels and stream courses dissect these fans. Some stream bottoms are also included. Slopes are commonly between 5 and 20 percent. The main surficial deposit is fan alluvium derived from sedimentary rock types. Small areas of

glaciofluvial alluvium, glacial till, and stream alluvium are also included. This is a nonforested map unit dominated by the AGSP/POSA, ARTR/AGSP, and ARTR/FEID habitat types. Small areas of soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are nonskeletal Alfisols, nonskeletal Inceptisols, and skeletal Mollisols.

Components

- 35% *Gateson family*
 35% *Eaglewing family* and similar inclusions (Lamedeer family)
 25% *Pesowyo family* and similar inclusions (Lolo and Roundup families)
 10% *Dissimilar inclusions* (Beartooth family and soils with aquic conditions)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Gateson family	14	28	>100	100	0
Eaglewing family	2	25	>100	100	3
Similar inclusions	37	20	>100	90 - 100	1
Pesowyo family	73	21	>100	80 - 100	20
Similar inclusions	20 - 60	20 - 25	>100	80 - 100	25 - 45

Gateson family: These soils have argillic horizons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. Some of these soils are enriched in calcium carbonate and sodium. They form under warm, dry nonforested habitat types in alluvial fan deposits.

Typical profile: Fine-loamy, mixed, superactive Typic Eutroboralf (pedon 112) All colors are for moist conditions.

0 to 10 cm: dark grayish brown (10YR 4/2) loam; moderately alkaline (pH 8.0); strongly effervescent.

10 to 20 cm: dark grayish brown (10YR 4/2) clay loam; few, thin clay films lining pores; moderately alkaline (pH 8.0); violently effervescent.

20 to 100 cm: dark grayish brown (10YR 4/2) clay loam; common, thin clay films lining pores and ped faces; moderately alkaline (pH 8.0); violently effervescent.

Eaglewing family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit these soils are fine to medium textured. These soils are often enriched in calcium carbonate. They form under warm, dry nonforested habitat types in fan alluvium, stream alluvium, and glaciofluvial kame deposits.

Typical Profile: Fine-loamy, mixed, superactive, frigid Typic Ustochrept (pedon 140) All colors are for moist conditions.

0 to 9 cm: dark brown (10YR 3/3) sandy clay; moderately alkaline (pH 8.0).

9 to 23 cm: very dark grayish brown (10YR 3/2) sandy clay; slightly alkaline (pH 7.5).

23 to 61 cm: brown (10YR 4/3) clay loam; slightly alkaline (pH 7.5); slightly effervescent.

61 to 100 cm: brown (10YR 4/3) sandy clay loam; slightly alkaline (pH 7.8).

Pesowyo family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. Some of these soils are enriched in calcium carbonate. They form under nonforested habitat types in alluvial fan and glaciofluvial kame deposits. These soils are likely to occur close to drainage channels and apex areas of the fans.

Typical profile: Loamy-skeletal, mixed, superactive Typic Haploboroll (pedon 3376) All colors are for moist conditions.

4 to 0 cm: litter layer.

0 to 9 cm: very dark grayish brown (10YR 3/2) gravelly sandy loam; neutral (pH 6.6).

9 to 24 cm: dark brown (10YR 3/3) extremely cobbly sandy loam; neutral (pH 6.6).
 24 to 100 cm: olive brown (2.5Y 4/4) and extremely gravelly coarse sandy loam; slightly acid (pH 6.5).

Dissimilar inclusions: Beartooth family soils have mollic epipedons, argillic horizons, and nonskeletal subsoil layers. Soils with aquic conditions, occurring near stream channels and within small depressions, make up approximately 3 percent of this map unit.



1752 Shadow Family-Ansel Family-Bedrock Outcrop Complex

Summary

This complex forms on areas of rolling glaciated uplands, concave glaciated uplands, and glacial trough valley bottoms; all with areas of bedrock outcrops. Slopes are commonly between 10 and 30 percent. The main surficial deposits are glacial till and colluvium derived from sedimentary rocks. Small areas of fine-textured alluvium also occur. The main habitat types in this forested map unit are the ABLA/VAGL, ABLA/VASC, and ABLA/THOC. There are also nonforested inclusions of the DECE/CAREX, ARTR/FEID, and AGSP/POSA habitat types. Small areas of soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are skeletal Inceptisols and nonskeletal Alfisols.

Components

- 30% *Shadow family* and similar inclusions (Ripple, Ivywild, and McCort families)
- 30% *Ansel family* and similar inclusions (Rimton, Cloud Peak, and Sluice families)
- 20% *Bedrock outcrops and talus*
- 20% *Dissimilar inclusions* (Moran, Sawfork, Passcreek, and Arrowpeak families and Cryaquolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	58	18	>100	60 - 95	0
Similar inclusions	20 - 60	16 - 22	>100	50 - 80	2 - 15
Ansel family	23	30	>100	50 - 95	1
Similar inclusions	15 - 40	25 - 38	>100	50 - 85	0 - 15

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. They occur on steeper slopes throughout the map unit, forming under forested areas, in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 628). All colors are for moist conditions.

5 to 0 cm: litter layer.

0 to 34 cm: dark brown (10YR 3/3) very gravelly loam; moderately acid (pH 5.8).

34 to 68 cm: dark brown (10 YR 3/3) very gravelly loam; moderately acid (pH 6.0).

68 to 100 cm: dark yellowish brown (10YR 3/4) extremely gravelly sandy clay loam; moderately acid (pH 6.0).

Ansel family: These soils have ochric epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are fine to medium textured. They occur throughout the map unit, forming under the ABLA/VAGL habitat type in glacial till.

Typical Profile: Fine-loamy, mixed, superactive Typic Cryoboralf (pedon 3407).

0 to 15 cm: dark brown (7.5YR 4/3) loam; neutral (pH 6.8).

15 to 50 cm: reddish brown (5YR 4/4) gravelly silty clay loam; common, distinct clay films on ped faces; neutral (pH 7.2).

50 to 100 cm: brown (7.5YR 4/4) gravelly loam; neutral (pH 7.0).

Bedrock outcrops and talus: These areas are mainly composed of sedimentary rocks. Bedrock outcrops and talus slopes make up from 10 to 35 percent of any delineation.

Dissimilar inclusions: Moran family soils have umbric epipedons and skeletal subsoil layers. The remaining inclusions all have mollic epipedons. Sawfork and Passcreek family soils have argillic horizons. Passcreek family soils form under the drier, nonforested inclusions. Arrowpeak family soils have a root-limiting layer within 50 centimeters of the soil surface. Cryaquoll soils have aquic conditions during most of the growing season and form under the DECE/CAREX habitat type.



1759 Shadow Family-Cloud Peak Family-Bedrock Outcrop Complex

Summary

This complex forms on areas of glacial head slopes, rolling glaciated uplands, and glacial trough valley walls. A third of the map unit has slopes greater than 50 percent, and the remainder has slopes between 20 and 50 percent. The main surficial deposits are glacial till and colluvium derived from sedimentary rocks. The main habitat

types in this forested map unit are ABLA/VASC-PIAL, ABLA/VASC-VASC, ABLA/VAGL, and ABLA/THOC. There are also nonforested inclusions of alpine meadow areas and the ARTR/FEID and FEID/AGCA habitat types. The main soils are skeletal Inceptisols and skeletal Alfisols.

Components

45% *Shadow family* and similar inclusions (Ivywild, Arcette, and Ripple families)
 25% *Cloud Peak family* and similar inclusions (Ansel and Rimton families)
 15% *Bedrock outcrops and talus*

15% *Dissimilar inclusions* (Sawfork, Greyback, and Sawbuck families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	70	20	>100	55 - 95	0
Similar inclusions	30 - 90	15 - 20	>100	40 - 90	0 - 5
Cloud Peak family	43	27	>100	40 - 70	6
Similar inclusions	20 - 30	22 - 27	>100	45 - 70	5 - 15

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit, forming under forested areas in colluvium and glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 751). All colors are for moist conditions.

8 to 0 cm: litter layer.

0 to 10 cm: dark brown (7.5YR 3/2) gravelly loam; strongly acid (pH 5.2).

10 to 39 cm: dark brown (7.5YR 3/3) gravelly loam; medium acid (pH 6.0).

39 to 100 cm: brown (10YR 4/3) extremely stony loam; neutral (pH 7.2).

Cloud Peak family: These soils have ochric epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are fine to medium textured. They occur throughout the map unit, forming under forested habitat types in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboralfs (pedon 275). All colors are for moist conditions.

1 to 0 cm: litter layer

0 to 5 cm: dark brown (10YR 3/3) loam; very strongly acid (pH 5.0).

5 to 35 cm: brown (10YR 5/3) very stony loam; very strongly acid (pH 5.0).

35 to 70 cm: yellowish brown (10YR 5/4) very stony sandy clay loam; common, prominent clay films on ped faces and few, distinct clay films lining pores; strongly acid (pH 5.5).

70 to 100 cm: grayish brown (10YR 5/2) very stony clay; many, prominent clay films on ped faces and few, distinct clay films lining pores; strongly acid (pH 5.5).

Bedrock outcrops and talus: These areas are mainly composed of sedimentary rocks. Bedrock outcrops and talus slopes make up from 10 to 45 percent of any delineation.

Dissimilar inclusions: The Sawfork and Greyback family soils have mollic epipedons. Sawfork family soils have argillic horizons and form under the nonforested inclusions. Greyback family soils form in areas where andesite is mixed with sedimentary rocks. Sawbuck family soils are similar to Cloud Peak family soils, but form under a warmer temperature regime than the main components.



1762 Shadow Family-Ansel Family-Cryaquepts Complex

Summary

This complex forms on concave glaciated uplands, glacial trough valley bottoms, and rolling glaciated uplands with bedrock outcrops. Smaller plateau areas are also included. Slopes are commonly between 5 and 30 percent. The main surficial deposit is glacial till derived from sedimentary rocks. Small areas of colluvium and alluvium also occur. The main habitat types in this forested map unit are ABLA/VASC-PIAL, ABLA/THOC,

ABLA/VASC-VASC, and ABLA/VAGL. There are also areas of wet forest habitat types and inclusions of the nonforested ARTR/FEID, DECE/CAREX, and ARCA/FEID habitat types. Small areas of bedrock outcrop occur in this map unit, but not in every delineation. Soils with aquic conditions make up approximately 10 percent of this map unit. The main soils are skeletal Inceptisols, nonskeletal Alfisols, and Inceptisols with aquic conditions.

Components

40% *Shadow family* and similar inclusions (Ripple family)

30% *Ansel family* and similar inclusions (Sluice and Rimton families)

10% *Cryaquepts*

20% *Dissimilar inclusions* (Stubbs family, bedrock outcrops, and Gallatin family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	50	20	>100	55 - 75	2
Similar inclusions	25	21	>100	55 - 70	3
Ansel family	12	28	>100	50 - 80	7
Similar inclusions	10 - 25	25 - 38	>100	45 - 75	3 - 15
Cryaquepts	38	15	>100	70 - 90	2

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit, forming under forested habitat types in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 679) All colors are for moist conditions.

4 to 0 cm: litter layer.

0 to 26 cm: dark brown (10YR 3/3) gravelly loam; moderately acid (pH 5.6 to 5.9).

26 to 50 cm: brown (10YR 4/3) gravelly loam; slightly acid (pH 6.2).

50 to 100 cm: brown (10YR 4/3) very gravelly loam; slightly acid (pH 6.1).

Ansel family: These soils have ochric epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under forested habitat types in glacial till and alluvium.

Typical Profile: Fine-loamy, mixed, superactive Typic Cryoboralfs (pedon 281). All colors are for moist conditions.

0 to 8 cm: very dark grayish brown (10YR 3/2) loam; slightly acid (pH 6.5).

8 to 51 cm: brown (10YR 5/3) sandy clay loam; few, distinct, clay films on ped faces and lining pores; strongly acid (pH 5.5).

51 to 100 cm: pale brown (10YR 6/3) clay loam; strongly acid (pH 5.2).

Cryaquepts: These soils have ochric epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under wet forest habitat types and the nonforested DECE/CAREX habitat type.

Typical Profile: Loamy-skeletal, mixed, superactive, nonacid Typic Cryaquept (pedon 3379). All colors are for moist conditions.

3 to 0 cm: litter layer.

0 to 8 cm: very dark grayish brown (2.5Y 3/2) loam; slightly acid (pH 6.2).

8 to 14 cm: very dark grayish brown (10YR 3/2) fine sandy loam with common, small, prominent strong brown (7.5YR 4/6) redoximorphic concentrations; slightly acid (pH 6.2).

14 to 30 cm: very dark gray (10YR 3/1) sandy loam with many, medium, prominent strong brown (7.5YR 4/6) redoximorphic concentrations; slightly acid (pH 6.4).

30 to 100 cm: very dark grayish brown (10YR 3/2) coarse sandy loam; neutral (pH 6.8); water entering pit at 60 cm.

Dissimilar inclusions: Stubbs and Gallatin family soils have thick mollic epipedons and form under nonforested inclusions. Bedrock outcrops are made up of sedimentary rocks and can occupy up to 5 percent of any delineation.



1795 Shadow Family-Cloud Peak Family-Passcreek Family Complex

Summary

This complex forms on earthflows. Slopes are between 10 and 40 percent. The surficial deposits are earthflow debris derived from sedimentary rock types, rhyolite, or rhyolitic ash-flow tuffs. The main habitat types in this forested map unit are ABLA/VASC and ABLA/VAGL. There are also small inclusions of the nonforested FEID/AGCA habitat type. Small areas of soils with aquic conditions occur in this map unit, but not in every delineation. Small inclusions of bedrock outcrop occur throughout the map unit. The main soils are skeletal Inceptisols, skeletal Alfisols, and nonskeletal Mollisols with argillic horizons.

Components

40% *Shadow family* and similar inclusions (Ripple and Ivywild families)

30% *Cloud Peak family* and similar inclusions (Ansel, Sluice, and Rinton families)

15% *Passcreek family* and similar inclusions (Bridger family)

15% Dissimilar inclusions (*Moran family, Hobacker family, Oxyaquic Cryochrepts, and bedrock outcrops*)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shadow family	56	22	>100	50 - 100	6
Similar inclusions	25 - 55	17 - 22	>100	40 - 75	1 - 5
Cloud Peak family	51	28	>100	25 - 90	1
Similar inclusions	20 - 33	22 - 39	>100	35 - 80	0 - 15
Passcreek family	11	31	>100	55 - 80	17
Similar inclusions	15	40	>100	55 - 75	22

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are fine to moderately coarse textured. They form under forested habitat types in earthflow deposits.

Typical profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 608). All colors are for moist conditions.

6 to 0 cm: litter layer.

0 to 13 cm: brown (10YR 4/3) very gravelly loam; very strongly acid (pH 4.6).

13 to 42 cm: brown (10YR 5/3) extremely cobbly sandy loam; moderately acid (pH 5.6).

42 to 100 cm: brown (10YR 5/3) and grayish brown extremely gravelly loamy sand and extremely gravelly sandy loam; strongly acid (pH 5.5).

Cloud Peak family: These soils have ochric epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit these soils are fine to medium textured. They form under forested habitat types in earthflow deposits.

Typical profile: Loamy-skeletal, mixed, superactive Typic Cryoboralf (pedon 612). All colors are for moist conditions.

0 to 4 cm: black (10YR 2/1) loam; neutral (pH 6.6).

4 to 26 cm: brown (10YR 5/3) gravelly loam; strongly acid (pH 5.4).

26 to 50 cm: reddish brown (2.5YR 5/3) gravelly loam; common, distinct clay films on ped faces; strongly acid (pH 5.2).

50 to 100 cm: dark grayish brown (10YR 4/2) very cobbly clay loam; many distinct clay films on ped faces; neutral (pH 6.8).

Passcreek family: These soils have mollic epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are fine to medium textured. They form under forested habitat types in earthflow deposits.

Typical Profile: Fine-loamy, mixed, superactive Argic Cryoboroll (pedon 763). All colors are for moist conditions.

0 to 15 cm: very dark brown (10YR 2/2) gravelly loam; slightly acid (pH 6.4).

15 to 24 cm: brown (10YR 5/3) silty clay loam; common distinct clay films on ped faces; neutral (pH 6.6).

24 to 40 cm: brown (10YR 5/3) gravelly loam; slightly acid (pH 6.2).

40 to 100 cm: yellowish brown (10YR 5/4) very gravelly loam; moderately acid (pH 6.0).

Dissimilar inclusions: Moran family soils have umbric epipedons and skeletal subsoil layers. Hobacker family soils have thick mollic epipedons and skeletal subsoil layers. Oxyaquic Cryochrepts have ochric epipedons and aquic conditions. Soils with aquic conditions make up approximately four percent of the total map unit. Bedrock outcrops are composed of sedimentary rocks, rhyolite, or rhyolitic ash-flow tuff. They can occupy up to 5 percent of any delineation.



182 Como Family-Matcher Family-Bearmouth Family Complex

Summary

This complex forms on glaciofluvial outwash plains near West Yellowstone, Montana. Slopes are less than 5 percent. The main surficial deposit is glaciofluvial alluvium derived from rhyolite. There are also small areas of recent stream alluvium and fan alluvium. This is a forested map unit dominated by the

PICO/PUTR and PICO/CARO habitat types, with nonforested inclusions of the FEID/AGSP habitat type. The main soils are skeletal Inceptisols with coarse textures, skeletal Inceptisols with coarse textures and dark surface layers, and skeletal Mollisols with coarse textures.

Components

75% *Como family* and similar inclusions (Billycreek and Trude families)

15% *Matcher family* and similar inclusions (Jugson family)

10% *Bearmouth family*

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Como family	52	3	>100	50 - 70	5
Similar inclusions	25 - 55	3 - 5	>100	30 - 70	0 - 4
Matcher family	40	3	>100	40 - 60	20
Similar inclusions	28	5	>100	40 - 60	19
Bearmouth family	58	4	>100	70 - 90	20

Como family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under the PICO/PUTR habitat type in glaciofluvial alluvium.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryochrepts (pedon 1033). All colors are for moist conditions.

0 to 4 cm: very dark grayish brown (10YR 3/2) gravelly coarse sandy loam; strongly acid (pH 5.2).

4 to 18 cm: dark brown (10YR 4/3) gravelly coarse sandy loam; strongly acid (pH 5.4).

18 to 39 cm: brown (10YR 5/3) gravelly loamy coarse sand; moderately acid (pH 5.9).

39 to 110 cm: grayish brown (10YR 5/2) very gravelly coarse sand; slightly acid (pH 6.2).

Matcher family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under the PICO/CARO habitat type in glaciofluvial alluvium.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryumbrepts (pedon 697). All colors are for moist conditions.

0 to 21 cm: very dark grayish brown (10YR 3/2), and dark brown (10YR 3/3) gravelly loam and gravelly sandy loam; strongly acid (pH 5.3 to 5.4).

21 to 32 cm: dark yellowish brown (10YR 4/4) very gravelly loamy sand; strongly acid (pH 5.1).

32 to 59 cm: (variegated sand grain colors) gravelly sand; strongly acid (pH 5.3).

48 to 100 cm: (variegated sand grain colors) very gravelly sand; very strongly acid (pH 4.8).

Bearmouth family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit forming under the FEID/AGSP habitat type in glaciofluvial alluvium.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryoborolls (pedon 793). All colors are for moist conditions.

0 to 19 cm: very dark grayish brown (10YR 3/2) extremely gravelly loam; slightly acid (pH 6.2).

19 to 29 cm: dark brown (10YR 3/3) very gravelly sandy loam; slightly acid (pH 6.2).

29 to 67 cm: dark brown (10YR 3/3) extremely gravelly loamy coarse sand; slightly acid (pH 6.2).

67 to 100 cm: (variegated sand grain colors) very gravelly coarse sand; neutral (pH 7.0).



1865 Como Family-Moran Family-Cryaquepts Complex

Summary

This complex forms on glaciated plateaus and concave glaciated uplands with wet depressions. Slopes are commonly less than 10 percent. The main surficial deposit is glacial till derived from rhyolite and rhyolitic ash-flow tuff. There are also smaller areas of colluvium and alluvium. This is forested map unit

dominated by various wet forest habitat types and the ABLA/VASC-VASC habitat type.

Nonforested inclusions of the DECE/CAREX habitat type and marsh areas of *Carex* species also occur. Soils with aquic conditions make up 15 percent of this map unit. The main soils are

skeletal Inceptisols with coarse textures, nonskeletal Inceptisols with dark surface layers and coarse textures, and Inceptisols with aquic conditions.

Components

- 45% *Como family* and similar inclusions (Shadow, Ivywild, and Bobtail families)
 30% *Moran family* and similar inclusions (Jugson, Matcher, and Sula families)
 15% *Cryaquepts* and similar inclusions (Aquic Cryoborolls and Oxyaquic Cryoborolls)
 10% *Dissimilar inclusions* (Cloud Peak family, Histosols, and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Como family	57	7	>100	55 - 70	7
Similar inclusions	30 - 59	4 - 10	>100	40 - 70	0 - 6
Moran family	45	10	>100	45 - 70	15
Similar inclusions	20 - 45	7 - 12	>100	45 - 70	15 - 22
Cryaquepts	5	10	>100	60 - 80	6
Similar inclusions	8 - 20	10 - 16	>100	60 - 80	15 - 25

Como family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under forests in glacial till.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryochrept (pedon 3123). All colors are for moist conditions.

0 to 16 cm: brown (10YR 4/3) gravelly sandy loam; strongly acid (pH 5.4).

16 to 29 cm: dark brown (10YR 3/3) very gravelly loamy sand; medium acid (pH 5.7).

29 to 100 cm: brown (10 YR 5/3) very gravelly loamy sand; medium acid (pH 5.7).

Moran family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under the ABLA/VASC-VASC habitat type, in glacial till and alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryumbrept (pedon 182). All colors are for moist conditions.

0 to 10 cm: black (10YR 2/1) gravelly loam; moderately acid (pH 5.6).

10 to 31 cm: dark yellowish brown (10YR 3/4) very cobbly loam; strongly acid (pH 5.4).

31 to 50 cm: brown (10YR 4/3) cobbly sandy loam; strongly acid (pH 5.4).

50 to 100 cm: brown (10YR 4/3) very gravelly loamy sand; strongly acid (pH 5.4).

Cryaquepts: These soils have ochric or umbric epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are moderately fine to coarse textured. They occur throughout the map unit, forming in alluvium under wet forest habitat types, the DECE/CAREX habitat type, and marsh areas of *Carex* species.

Typical Profile: Typic Cryaquept (pedon 709). All colors are for moist conditions.

0 to 6 cm: black (10YR 2/1) silt loam; medium acid (pH 6.0).

6 to 23 cm: very dark gray (10YR 3/1) silt loam; slightly acid (pH 6.2).

23 to 36 cm: dark gray (10YR 4/1) silty clay loam with few, medium, prominent red (2.5YR 5/6) redoximorphic concentrations; slightly acid (pH 6.4).

36 to 39 cm: dark gray (10YR 4/1) loamy sand; slightly acid (pH 6.4).

39 to 58 cm: light gray (10YR 7/1) silt loam with common, medium, prominent light red (2.5YR 6/8) redoximorphic concentrations; slightly acid (pH 6.4).

58 to 100 cm: gray (10YR 5/1) fine sand; slightly acid (pH 6.4).

Dissimilar inclusions: Cloud Peak family soils have argillic horizons, skeletal subsoil layers, and finer textures than the main components. They form in areas derived from rhyolitic tuff. Histosols are organic soils formed in areas saturated with water for most of the year. Bedrock outcrops are composed of rhyolite or rhyolitic ash-flow tuff.



2025 Hobacker Family Consociation

Summary

This complex forms on concave glaciated uplands. The most common slopes are less than 10 percent. The main surficial deposit is glacial till derived from rhyolitic ash-flow tuff overlain by loess. Smaller areas of colluvium and glacial till derived from basalt are also included. This is a nonforested map unit dominated by the ARTR/FEID, FEID/AGSP, ARTR/AGSP, and FEID/AGCA habitat types. Bedrock

outcrops occur in this map unit, but not within every delineation. The main soils are skeletal Mollisols with thick epipedons.

Components

95% *Hobacker family* and similar inclusions (Greyback and Gallatin families)

5% *Dissimilar inclusions* (bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	42	18	>100	75 - 100	45
Similar inclusions	20 - 40	18 - 20	>100	75 - 100	25 - 45

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under nonforested habitat types in glacial till overlain by loess.

Typical Profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 792) All colors are for moist conditions.

0 to 13 cm: very dark brown (10YR 2/2) silt loam; medium acid (pH 6.0).

13 to 36 cm: dark brown (10YR 3/2) loam to silt loam; slightly acid (pH 6.4).

36 to 58 cm: brown (10YR 4/3) gravelly loam; slightly acid (pH 6.2).

58 to 100 cm: brown (10YR 4/3) very cobbly loam; medium acid (pH 6.0).

Dissimilar inclusions: Bedrock outcrops are composed of rhyolitic ash-flow tuff or basalt. They can occupy up to 5 percent of a delineation.



2126 Greyback Family-Shadow Family-Teton Family Complex

Summary

This complex forms on concave and rolling glaciated uplands. The slopes are commonly less than 25 percent. The main surficial deposits are glacial till, residuum, and colluvium derived from sedimentary rocks. Some areas have andesite mixed with sedimentary rocks. Smaller amounts of frost rubble, fan alluvium, and glaciofluvial alluvium are also included. This is a nonforested map unit dominantly composed of the ARTR/FEID habitat type, areas of alpine meadow, and the FEID/AGCA habitat type. Smaller areas of the DECE/CAREX habitat type, marsh areas of Carex species, and forested inclusions, also occur. Soils with aquic conditions and bedrock outcrops occur in this map unit, but not in every delineation. The main soils are skeletal Mollisols with medium to moderately coarse textures, skeletal Inceptisols with medium to moderately coarse textures, and nonskeletal Mollisols with moderately fine textures.

Components

- 40% *Greyback family* and similar inclusions (McCort family and Sula families)
- 25% *Shadow family* and similar inclusions (Ripple family)
- 20% *Teton family* and similar inclusions (Passcreek family)
- 15% Dissimilar inclusions (*Cloud Peak family*, *Cryaquepts*, *Wallrock family*, *Cryoboralfs-sh*, *Mosroc family*, and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	63	15	>100	65 - 100	23
Similar inclusions	30 - 55	15 - 20	>100	65 - 80	16 - 24
Shadow family	65	19	>100	70 - 85	4
Similar inclusions	29	20	>100	65 - 85	4
Teton family	18	30	>100	75 - 100	28
Similar inclusions	15	28	>100	65 - 75	25

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. Soils forming from limestone parent materials are enriched in calcium carbonate. Greyback family soils occur throughout the map unit, forming under alpine meadows and the ARTR/FEID habitat type in glacial till, colluvium, and frost rubble.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 415). All colors are for moist conditions.

0 to 25 cm: very dark brown (10YR 2/2) gravelly sandy loam; medium acid (pH 6.0).

25 to 100 cm: dark yellowish brown (10YR 4/4) very gravelly very fine sandy loam; medium acid (pH 6.0).

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They form under alpine meadows and forested inclusions in glacial till, frost rubble, and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 3254). All colors are for moist conditions.

0 to 18 cm: Light yellowish brown (10YR 6/4) extremely gravelly loam; medium acid (pH 5.8).

18 to 100 cm: Very pale brown (10YR 8/4) extremely gravelly sandy loam; medium acid (pH 6.0).

Teton family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. Soils weathering from limestone are enriched in calcium carbonate. They form under nonforested vegetation in residuum and glacial till.

Typical Profile: Fine-loamy, mixed, superactive Typic Cryoboroll (pedon 166). All colors are for moist conditions.

0 to 30 cm: dark Brown (7.5YR 3/2) gravelly clay loam; neutral (pH 7.0).

30 to 58 cm: very dark grayish brown (10YR 3/2) cobbly loam; neutral (pH 7.0).

58 to 100 cm: brown (10YR 4/3) very gravelly, sandy clay loam; neutral (pH 7.0).

Dissimilar inclusions: Cloud Peak family soils have ochric epipedons, argillic horizons, and skeletal subsoil layers. Approximately 4 percent of this map unit has soils with aquic conditions, these include Cryaquept soils and Wallrock family soils. Cryoboralfs-sh and Mosroc family soils have argillic horizons and root-limiting layers. Cryoboralfs-sh soils have ochric epipedons and Mosroc family soils have mollic epipedons. Bedrock outcrops can occupy up to 5 percent of any delineation, but makes up only one percent of the total map unit.



2154 Greyback Family-Shadow Family-Sedimentary Bedrock Complex

Summary

This complex forms in glacial trough valley bottoms and glacial headslopes, rolling glaciated uplands with bedrock outcrops, and concave glaciated uplands with bedrock outcrops. The slopes are commonly less than 30 percent. The main surficial deposits are glacial till and colluvium derived from sedimentary rocks. Smaller amounts of glacial rubble and residuum are also included. This is a nonforested map unit dominantly composed of

the FEID/AGCA habitat type and areas of alpine meadows. Smaller areas of the DECE/CAREX and ARTR/FEID habitat types along with forested inclusions also occur. Soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are skeletal Mollisols and skeletal Inceptisols.

Components

- 35% *Greyback family* and similar inclusions (Teton, McCort, and Hobacker families)
- 25% *Shadow family* and similar inclusions (Cloud Peak family)
- 20% *Bedrock outcrops and talus*
- 20% *Dissimilar inclusions* (Jenkinson, Arrowpeak, Whitecross, and Rimton families, Oxyaquic Cryochrepts, and Aquic Cryoborolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	51	27	>100	75 - 100	28
Similar inclusions	23 - 53	22 - 28	>100	70 - 100	16 - 44
Shadow family	62	19	>100	60 - 100	4
Similar inclusions	55	24	>100	60 - 100	3

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. The subsurface layers can be enriched in calcium carbonate. They occur throughout the map unit, forming under meadows and shrublands in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 531). All colors are for moist conditions.

0 to 20 cm: dark reddish brown (5YR 3/3) gravelly loam; slightly acid (pH 6.4).

20 to 34 cm: dark reddish brown (5YR 3/4) very cobbly loam; slightly acid (pH 6.4).

34 to 70 cm: dark reddish brown (5 YR 3/3) very gravelly clay loam; slightly acid (pH 6.4).

70 to 100 cm: dark reddish brown (2.5YR 3/4) gravelly clay loam; slightly acid (pH 6.4).

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. These soils can be enriched in calcium carbonate in the subsurface layers. They form under meadows in glacial till, frost rubble, and colluvium. Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 538). All colors are for moist conditions.

0 to 20 cm: dark brown (10YR 3/3) cobbly loam; slightly acid (pH 6.2).

20 to 37 cm: dark yellowish brown (10YR 4/4) very cobbly loam; slightly acid (pH 6.4); slightly effervescent.

37 to 62 cm: reddish yellow (7.5YR 6/6) very cobbly loam; neutral (pH 7.8); violently effervescent.

62 to 100 cm: yellowish red (5YR 5/6) very cobbly fine sandy loam; neutral (pH 7.2); violently effervescent.

Bedrock outcrops and talus: These areas are mainly composed of sedimentary rocks. Bedrock outcrops and talus slopes make up from 10 to 40 percent of any delineation.

Dissimilar inclusions: Jenkinson, Arrowpeak, and Whitecross family soils have root-limiting layers within 50 centimeters of the soil surface. Jenkinson and Arrowpeak family soils have mollic epipedons, while Whitecross family soils have ochric epipedons. Rinton family soils have dark surface layers and argillic horizons. Oxyaquic Cryochrept soils have ochric epipedons and aquic conditions. Aquic Cryoboroll soils have mollic epipedons and aquic conditions. Approximately 3 percent of this map unit has soils with aquic conditions.



2159 Greyback Family-Shadow Family-Igneous Bedrock Complex

Summary

This complex forms in glacial trough valley bottoms, concave glaciated uplands, and on rolling glaciated uplands; all with areas of bedrock outcrops. Slopes are commonly between 10 and 30 percent. The surficial deposits are glacial till, glacial rubble, and colluvium derived from andesite. Small inclusions

of coarse-textured alluvium also occur. In the northeast area of the park, andesite is mixed with limestone. The main habitat types in this forested map unit are ABLA/VASC-VASC, ABLA/VAGL, and ABLA/VASC-PIAL. There are also nonforested inclusions of the ARTR/FEID, ARTR/AGSP, and FEID/DECE habitat types. Small areas of soils with aquic conditions can occur in this map unit, but do not occur in every delineation. The main soils are skeletal Mollisols and skeletal Inceptisols.

Components

- 50% *Greyback family* and similar inclusions (McCort, Hobacker, Sawfork, and Teton families)
- 20% *Shadow family* and similar inclusions (Ripple and Bobtail families)

20% *Bedrock outcrops and talus*

10% *Dissimilar inclusions* (Arrowpeak family, Mosroc family, and Aquic Cryoborolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	57	15	>100	75 - 100	31
Similar inclusions	15 - 55	14 - 20	>100	65 - 100	16 - 46
Shadow family	54	16	>100	75 - 100	1
Similar inclusions	15 - 30	12 - 19	>100	60 - 100	0 - 3

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. They occur throughout the map unit, forming under forested and nonforested areas, in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 544). All colors are for moist conditions.

6 to 0: litter layer.

0 to 14 cm: dark yellowish brown (10YR 3/2) cobbly loam; moderately acid (pH 5.6).

14 to 32 cm: dark brown (10YR 3/3) very cobbly loam; moderately acid (pH 5.8).

32 to 51 cm: brown (10YR 4/3) very gravelly sandy loam; slightly acid (pH 6.2).

51 to 100 cm: brown (10YR 4/3) very gravelly sandy loam; slightly acid (pH 6.2).

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under the ABLA/VAGL habitat type in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 85). All colors are for moist conditions.

0 to 10 cm: very dark grayish brown (10YR 3/2) loam; moderately acid (pH 5.8).

10 to 100 cm: dark brown (10YR 3/3) very gravelly loam and extremely gravelly loam; moderately acid (pH 5.9 to 6.0).

Bedrock outcrops and talus: These areas are composed of andesite. Bedrock outcrops and talus slopes make up from 10 to 35 percent of any delineation.

Dissimilar inclusions: Arrowpeak and Mosroc family soils have root-limiting layers within 50 centimeters of the soil surface. Aquic Cryoborolls have aquic conditions and mollic epipedons. These soils occur under the FEID/DECE habitat type. Approximately 2 percent of this map unit is made up of soils with aquic conditions.



2167 Hobacker Family-Shadow Family-Cryaquolls Complex

Summary

This complex forms on concave glaciated uplands and also on a few glaciated plateaus. Slopes are commonly between 5 and 20 percent. The main surficial deposit is glacial till derived from andesite. Inclusions of colluvium and fine-textured alluvium, along with small areas derived from rhyolitic ash-flow tuff, also occur. In the northeast area of the park, limestone is mixed with the andesite. The main habitat types in this forested map unit are

ABLA/VASC-VASC, ABLA/VAGL, and ABLA/VASC-PIAL. Smaller areas of wet forest habitat types and nonforested inclusions of the DECE/CAREX and FEID/AGCA habitat types also occur. Soils with aquic conditions make up approximately 10 percent of this map unit. The main soils are skeletal Mollisols with thick epipedons, skeletal Inceptisols, and Mollisols with aquic conditions.

Components

55% *Hobacker family* and similar inclusions (Greyback, Teton, and Sawfork families)

20% *Shadow family* and similar inclusions (Ivywild and Bobtail families)

10% *Cryaquolls*

15% *Dissimilar inclusions* (Oxyaquic Cryochrepts, and the Ansel, Whitecross, and Arrowpeak families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	58	16	>100	60 - 95	53
Similar inclusions	20 - 57	15 - 20	>100	60 - 90	19 - 27
Shadow family	58	21	>100	75 - 95	7
Similar inclusions	28 - 55	15 - 18	>100	50 - 80	0 - 4
Cryaquolls	40	12	>100	80 - 95	35

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forested habitat types in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 420). All colors are for moist conditions.

0 to 4 cm: black (10YR 2/1) sandy loam; very strongly acid (pH 5.0).

4 to 40 cm: dark brown (10YR 3/3) gravelly sandy loam; moderately acid (pH 6.0).

40 to 58 cm: very dark grayish brown (10YR 3/2) very gravelly coarse sandy loam; moderately acid (pH 6.0).

58 to 100 cm: very dark grayish brown (10YR 3/2) very gravelly coarse sandy loam; moderately acid (pH 6.0).

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forested habitat types in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 613). All colors are for moist conditions.

0 to 3 cm: Very dark grayish brown (10YR 3/2) loam; strongly acid (pH 5.2).

3 to 19 cm: Dark brown (10YR 3/3) gravelly loam; slightly acid (pH 6.2).

19 to 33 cm: Dark grayish brown (10YR 4/2) very gravelly loam; slightly acid (pH 6.2).

33 to 100 cm: Yellowish brown (10YR 5/4) extremely gravelly sandy loam; moderately acid (pH 6.0).

Cryaquolls: These soils have mollic epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under the DECE/CAREX habitat type and wet forest habitat types.

Typical Profile: Typic Cryaquoll (pedon 687). All colors are for moist conditions.

0 to 6 cm: black (7.5YR 2/0) silt; medium acid (pH 6.0).

6 to 37 cm: Dark brown (7.5YR 3/2) cobbly loam with few, fine, faint redoximorphic concentrations; slightly acid (pH 6.4).

37 to 43 cm: dark gray (10YR 4/1) sandy loam with many, large, distinct brown (10YR 5/3) redoximorphic concentrations; neutral (pH 6.6).

43 to 100 cm: dark grayish brown (10YR 4/2) extremely gravelly coarse sandy loam with common, large, prominent, dark yellowish brown (10YR 4/6) redoximorphic concentrations; slightly acid (pH 6.2); water entering pit at 46 cm.

Dissimilar inclusions: Oxyaquic Cryochrept soils have ochric epipedons and have aquic conditions for a shorter time than Cryaquolls. They occur under inclusions of wet forest habitat types. Ansel family soils have ochric epipedons, argillic horizons, and finer textures than the main components. Whitecross and Arrowpeak family soils have root-limiting layers within 50 centimeters of the soil surface. Whitecross family soils have ochric epipedons. Arrowpeak family soils have mollic epipedons and form under the FEID/AGCA habitat type.



2195 Greyback Family-Shadow Family-Sawfork Family Complex

Summary

This complex forms on areas of glacial trough valley bottoms, concave glaciated uplands, and rolling glaciated uplands. Slopes are commonly between 10 and 35 percent. The surficial deposits are glacial till and colluvium derived mainly from

andesite, with small inclusions of rhyolitic ash-flow tuff. Small areas of glaciofluvial alluvium, fan alluvium, and residuum also occur. In the northeast area of the park, limestone is mixed with the andesite. The main habitat types in this forested map unit are ABLA/VASC-VASC, ABLA/VAGL, ABLA/VASC-PIAL. There are also nonforested inclusions of alpine meadow areas and the FEID/DECE habitat type. Small areas of bedrock outcrop and soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are skeletal Mollisols, skeletal Inceptisols, and skeletal Mollisols with argillic horizons.

Components

40% *Greyback family* and similar inclusions (McCort, Sula, and Hobacker families)

30% *Shadow family* and similar inclusions (Bobtail and Ivywild families)

15% *Sawfork family* and similar inclusions (Passcreek and Badwater families)

15% *Dissimilar inclusions* (Arrowpeak and Cloud Peak families, bedrock outcrops, and Aquic Cryoborolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	48	17	>100	65 - 100	23
Similar inclusions	25 - 50	15 - 19	>100	60 - 100	16 - 45
Shadow family	54	12	>100	75 - 85	3
Similar inclusions	30 - 55	10 - 12	>100	50 - 75	0 - 3
Sawfork family	46	26	>100	80 - 95	22
Similar inclusions	25 - 40	24 - 28	>100	70 - 100	24 - 50

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. Mollic epipedons are thicker in areas where limestone is mixed with andesite. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under the ABLA/VASC-PIAL habitat type and areas of alpine meadows, in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 856). All colors are for moist conditions.

0 to 23 cm: dark brown (10YR 3/3) gravelly loam; strongly acid (pH 5.2).

23 to 50 cm: brown (10YR 4/3) gravelly sandy loam; strongly acid (pH 5.3)

50 to 100 cm: brown (7.5YR 5/2) very gravelly sandy loam; strongly acid (pH 5.4).

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur on the steeper slopes, forming under ABLA/VASC-VASC and ABLA/VASC-PIAL habitat types in glacial till and colluvium.

8 to 40 cm: Dark grayish brown (10YR 4/2) very gravelly sandy loam; moderately acid (pH 6.0).
 40 to 100 cm: Brown (10YR 4/3) extremely cobbly sandy loam; moderately acid (pH 5.7).

Sawfork family: These soils have mollic epipedons, argillic horizons, and are greater than 100 centimeters deep. Mollic epipedons are thicker in areas where limestone is mixed with andesite. In this map unit they are moderately fine to moderately coarse textured. They occur throughout the map unit, forming under the ABLA/VASC-PIAL and ABLA/LIBO habitat types in glacial till and colluvium. They also form in from the inclusions of rhyolitic ash-flow tuff.

Typical Profile: Loamy-skeletal, mixed, superactive Argic Cryoboroll (pedon 1). All colors are for moist conditions.

0 to 25 cm: dark brown (10YR 3/3) very gravelly loam and gravelly loam; moderately acid (pH 5.8).

25 to 52 cm: brown (10YR 4/3); very gravelly sandy clay loam; common, distinct, clay films on ped faces; slightly acid (pH 6.4).

52 to 100 cm: dark yellowish brown (10YR 4/4) extremely gravelly sandy clay loam; common, distinct, clay films on ped faces; neutral (pH 6.6).

Dissimilar inclusions: The Arrowpeak family soils have mollic epipedons and root-limiting layers within 50 centimeters of the soil surface. They generally form under nonforested inclusions on shoulder and summit slope positions. The Cloud Peak family soils have ochric epipedons and argillic horizons. Bedrock outcrops are composed of andesite, except in the northeast area where bedrock can be limestone or andesite. Outcrops can occupy up to 5 percent of any delineation. Aquic Cryoboroll soils have aquic conditions and occur under the FEID/DECE habitat type. Arrowpeak family soils sometimes have aquic conditions. Approximately 2 percent of this map unit is made up of soils with aquic conditions.



2207 Greyback Family-Bearmouth Family Complex

Summary

This complex forms on alluvial fans. Slopes are commonly less than 20 percent. The main surficial deposit is fan alluvium derived from andesite. Smaller areas of glaciofluvial alluvium and fan alluvium derived from sedimentary rocks are also included. This is a forested map unit dominated by the ABLA/LIBO, ABLA/VASC, and ABLA/CAGE habitat types. The main soils are skeletal Mollisols with medium to moderately coarse textures and skeletal Mollisols with coarse textures.

Components

65% *Greyback family* and similar inclusions (Hobacker and McCort families)

25% *Bearmouth family* and similar inclusions (Tomichi and Shook families)

10% *Dissimilar inclusions* (Cloud Peak and Shadow families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	54	15	>100	75 - 100	28
Similar inclusions	45 - 55	13 - 16	>100	75 - 100	16 - 44
Bearmouth family	64	5	>100	80 - 100	45
Similar inclusions	20 - 30	5 - 8	>100	75 - 100	25 - 40

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forested habitat types in fan alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 810) All colors are for moist conditions.

4 to 0 cm: litter layer.

0 to 25 cm: very dark grayish brown (10YR 3/2) loam; medium acid (pH 8.0).

25 to 60 cm: dark grayish brown (10YR 4/2) very fine sandy loam to loam; slightly acid (pH 6.2).

60 to 100 cm: very dark grayish brown (10YR 3/2) gravelly sandy loam; slightly acid (pH 6.4).

Bearmouth family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under forested habitat types in fan alluvium.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryoboroll (pedon 406) All colors are for moist conditions.

2 to 0 cm: litter layer.

0 to 20 cm: very dark grayish brown (10YR 3/2) very cobbly sandy loam; neutral (pH 7.2).

20 to 66 cm: very dark grayish brown (10YR 3/2) very gravelly sand; neutral (pH 7.2).

66 to 135 cm: very dark grayish brown (10YR 3/2*) very stony loamy sand and very gravelly loamy sand; neutral (pH 7.2).

* Dark color due to dark colored minerals rather than organic carbon.

Dissimilar inclusions: Cloud Peak and Shadow family soils have ochric epipedons and skeletal subsoil layers. Cloud Peak family soils also have argillic horizons. These soils form in fan alluvium derived from sedimentary rocks.



2213 Hobacker Family-Greyback Family-Shadow Family Complex

Summary

This complex forms on concave glaciated uplands and rolling glaciated uplands of the Northern Range area of the park. The slopes are commonly between 5 and 25 percent. The main surficial deposit is glacial till derived from a mixture of rock types. There are also some small areas of colluvium. This is a forested map unit dominated by the PSME/SYAL and PSME/CARU habitat types. Other forested areas of ABLA/THOC and

ABLA/CACA habitat types also occur. Small areas of the nonforested ARTR/FEID and ARTR/AGSP habitat types are included. Areas of rock outcrop and soils with aquic conditions are present in this map unit, but not in every delineation. The main soils are skeletal Mollisols with thick epipedons, skeletal Mollisols, and skeletal Inceptisols.

Components

- 40% *Hobacker family* and similar inclusions (Badwater, Gallatin, and Lolo families)
- 25% *Greyback family* and similar inclusions (Teton, Sula, Moran, and Pesowyo families)
- 15% *Shadow family* and similar inclusions (Ripple family)
- 20% *Dissimilar inclusions* (Jenkinson, Whitecross, and Taglake families, Aquic Cryoborolls, and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	54	22	>100	60 - 100	45
Similar inclusions	20 - 55	22 - 28	>100	60 - 100	42 - 50
Greyback family	46	17	>100	60 - 100	29
Similar inclusions	15 - 50	18 - 22	>100	40 - 100	22 - 28
Shadow family	47	16	>100	60 - 85	1
Similar inclusions	27	19	>100	60 - 75	3

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. They occur throughout the map unit, forming under Douglas fir habitat types in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 3345) All colors are for moist conditions.

0 to 18 cm: black (7.5YR 2/0) gravelly loam; neutral (pH 6.6).

18 to 54 cm: black (7.5YR 2/0) gravelly sandy clay loam; neutral (pH 6.6).

54 to 100 cm: very dark gray (10YR 3/1) extremely gravelly sandy clay loam; neutral (pH 6.8).

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. Some of these soils are enriched in calcium carbonate in the subsurface layers. They occur throughout the map unit, forming under forests and meadows in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoborolls (pedon 365) All colors are for moist conditions.

0 to 24 cm: Very dark brown (10YR 2/2) cobbly and extremely cobbly loam; moderately acid (pH 6.0).

24 to 100 cm: Yellowish brown (10YR 5/4) very gravelly sandy loam; moderately acid (pH 6.0 to 6.2).

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. Some of these soils are enriched in calcium carbonate in the subsurface layers. They occur throughout the map unit, forming under forests in glacial till derived from rhyolite, rhyolitic ash-flow tuff, and basalt.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 481) All colors are for moist conditions.

2 to 0 cm: litter layer.

0 to 20 cm: very dark grayish brown (10YR 3/2) very gravelly loam; moderately acid (pH 5.8).

20 to 100 cm: dark grayish brown (10YR 4/2) very gravelly and extremely gravelly sandy loam; moderately acid (pH 5.6 to 5.8).

Dissimilar inclusions: Whitecross, Taglake, and Jenkinson family soils have root-limiting layers within 100 centimeters of the soil surface. Whitecross and Taglake family soils have ochric epipedons and Jenkinson family soils have mollic epipedons. These soils form in glacial till over residuum. Aquic Cryoboroll soils have mollic epipedons and aquic conditions. They form in depressions and near small streams. Approximately one percent of this map unit is made up of soils with aquic conditions. The bedrock outcrops are composed of rhyolite, andesite, basalt, or sedimentary rocks. They average approximately 4 percent of the map unit, but can occupy up to 10 percent of any one delineation.



2216 Shook Family and McCort Family and Shadow Family Undifferentiated Group

Summary

This map unit forms on rolling pluvial uplands, glaciofluvial outwash plains, terraces, and kames. Slopes are commonly less than 10 percent. The main surficial deposit is glaciofluvial alluvium derived from rhyolite and rhyolitic ash-flow tuff. Small areas of fan alluvium, recent stream alluvium, colluvium, and glacial till also occur. This is a nonforested map unit dominated by the ARTR/FEID, FEID/DECE, and ARCA/FEID habitat types with smaller areas of the DECE/CAREX habitat type and marsh areas of CAREX species. Small inclusions of the forested ABLA/VASC habitat type also

occur in this unit. Soils with aquic conditions can occupy up to 10 percent of any delineation, but do not occur in every delineation. The main soils are nonskeletal Mollisols with thick epipedons, skeletal Mollisols with weakly developed epipedons, and skeletal Inceptisols.

Components

40% *Shook family* and similar inclusions (Hobacker family)
 35% *McCort family* and similar inclusions (Bearmouth and Teton families)
 10% *Shadow family*

15% *Dissimilar inclusions* (Oxyaquic Cryoborolls, Aquic Cryoborolls, Moran, and Stubbs families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shook family	13	11	>100	65 - 100	75
Similar inclusions	45	15	>100	65 - 100	58
McCort family	60	20	>100	65 - 80	15
Similar inclusions	30 - 60	6 - 20	>100	65 - 90	19 - 23
Shadow family	65	12	>100	55 - 90	3

Shook family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. Some of these soils have aquic conditions. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under ARCA/FEID and ARTR/FEID habitat types in glaciofluvial alluvium, recent stream alluvium, and glacial till.

Typical Profile: Coarse-loamy, mixed, superactive Pachic Cryoboroll (pedon 1014). All colors are for moist conditions.

0 to 44 cm: very dark grayish brown (10YR 3/2) sandy loam; strongly acid (pH 5.2).

44 to 100 cm: dark brown (10YR 3/3) fine sandy loam; strongly acid (pH 5.4).

100 to 170 cm: very dark gray (7.5YR 3/0) very gravelly coarse sand; medium acid (pH 5.7).

McCort family: These soils have weakly developed mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit forming under the ARTR/FEID habitat type in glaciofluvial alluvium, glacial till, and recent alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 3385). All colors are for moist conditions.

0 to 11 cm: very dark brown (10YR 2/2) gravelly loam; slightly acid (pH 6.2).

11 to 43 cm: dark yellowish brown (10YR 3/4) very gravelly loam; medium acid (pH 6.0).

43 to 100 cm: dark yellowish brown (10YR 3/4) extremely gravelly sandy loam; slightly acid (pH 6.2).

Shadow family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit forming under the ARTR/FEID habitat type in glaciofluvial alluvium and recent stream alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 618). All colors are for moist conditions.

0 to 18 cm: dark brown (10YR 3/3) very gravelly loam; slightly acid (pH 6.3).

18 to 40 cm: dark yellowish brown (10YR 3/4) extremely gravelly sandy loam; slightly acid (pH 6.4).

40 to 100 cm: dark brown (10YR 3/3) extremely cobbly sandy loam; neutral (pH 6.8).

Dissimilar inclusions: Oxyaquic Cryoboroll and Aquic Cryoboroll soils have aquic conditions for some time during the growing season. They form under the DECE/CAREX habitat type and marsh areas of CAREX species. Three percent of the total map unit is made up of soils with aquic conditions. Moran family soils have umbric epipedons and skeletal subsoil layers. Stubbs family soils have thick mollic epipedons and argillic horizons.



2222 Hobacker Family-Gallatin Family-Bearmouth Family Complex

Summary

This complex forms on alluvial fans. Slopes are commonly less than 15 percent. The main surficial deposit is fan alluvium derived from andesite, rhyolite, or sedimentary rocks. Smaller areas of glaciofluvial alluvium are also included. This is a nonforested map unit dominated by the ARTR/FEID, FEID/

DECE, and FEID/AGCA habitat types. The main soils are skeletal Mollisols with thick epipedons, nonskeletal Mollisols with thick epipedons, and skeletal Mollisols with coarse textures.

Components

35 % *Hobacker family* and similar inclusions (Shook and Greyback families)

30% *Gallatin family* and similar inclusions (Teton family)

25% *Bearmouth family* and similar inclusions (Tomichi family)

10% *Dissimilar inclusions* (McCort, Matcher, and Moran families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	42	20	>100	80 - 90	65
Similar inclusions	23 - 45	16 - 18	>100	75 - 90	27 - 55
Gallatin family	14	26	>100	75 - 100	80
Similar inclusions	18	25	>100	70 - 100	30
Bearmouth family	48	4	>100	90 - 100	50
Similar inclusions	25	6	>100	80 - 100	28

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under nonforested habitat types in fan alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 461) All colors are for moist conditions.

0 to 15 cm: very dark grayish brown (10YR 3/2) very gravelly loam; neutral (pH 6.8).

15 to 43 cm: very dark grayish brown (10YR 3/2) very gravelly loam; neutral (pH 6.8).

43 to 100 cm: very dark grayish brown (10YR 3/2) extremely gravelly loam (pH 6.6).

Gallatin family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under nonforested habitat types in fan alluvium.

Typical Profile: Fine-loamy, mixed, superactive Pachic Cryoboroll (pedon 513) All colors are for moist conditions.

0 to 23 cm: very dark gray (10YR 3/1) silt loam; neutral (pH 6.8).

23 to 59 cm: very dark gray (10YR 3/1) silt loam; neutral (pH 6.8).

54 to 77 cm: very dark grayish brown (10YR 3/2) silt loam; neutral (pH 6.8).

77 to 99 cm: dark brown (10YR 3/3) silt loam; neutral (pH 7.2).

99 to 113 cm: dark brown (10YR 3/3) silt loam; neutral (pH 7.0).

Bearmouth family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. In the Northern Range area of the park, the subsoil can be enriched with carbonates. They occur throughout the map unit, forming under the ARTR/FEID habitat type in fan and glaciofluvial alluvium.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryoboroll (pedon 407) All colors are for moist conditions.

0 to 10 cm: dark brown (10YR 3/3) gravelly loam; neutral (pH 7.2).

10 to 25 cm: dark brown (10YR 3/3) very gravelly sandy loam; neutral (pH 7.2).

25 to 38 cm: dark brown (10YR 3/3) extremely gravelly loamy coarse sand; mildly alkaline (pH 7.4).

38 to 100 cm: very dark grayish brown (10YR 3/2) extremely cobbly coarse sand; mildly alkaline (pH 7.6); slightly effervescent.

Dissimilar inclusions: McCort family soils have weakly developed mollic epipedons and skeletal subsoil layers. Matcher and Moran family soils have umbric epipedons and skeletal subsoil layers. Matcher family soils also have coarse textures. Soils with umbric epipedons form in areas derived from rhyolite.



2226 Sula Family-Teton Family-McCort Family Complex

Summary

This complex forms on dissected lacustrine plains. The most common slopes are less than 20 percent. The main surficial deposits are glacial lacustrine sediments derived from andesite. Some areas include glacial lacustrine sediments derived from basalt or sedimentary rocks. Smaller areas of glacial till and alluvium are also included. This is a forested map unit dominated by the ABLA/VASC-VASC, ABLA/CACA, and ABLA/LIBO habitat types. Small areas of the nonforested DECE/CAREX and FEID/DECE habitat types are also included. Soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are nonskeletal Mollisols and skeletal Mollisols with weakly developed epipedons.

Components

45% *Sula family* and similar inclusions (Shook family)

25% *Teton family* and similar inclusions (Ansel, Rimton, and Passcreek families)

15% *McCort family* and similar inclusions (Greyback family)

15% *Dissimilar inclusions* (Oxyaquic Cryoborolls, Cratermo family, and Sluice family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Sula family	14	13	>100	75 - 90	35
Similar inclusions	15	16	>100	70 - 85	58
Teton family	7	24	>100	85 - 100	25
Similar inclusions	10 - 22	25 - 30	>100	65 - 90	10 - 22
McCort family	68	13	>100	80 - 95	16
Similar inclusions	58	16	>100	75 - 95	22

Sula family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in glacial lacustrine sediments.

Typical Profile: Coarse-loamy, mixed, superactive Typic Cryoboroll (pedon 292) All colors are for moist conditions.

3 to 0 cm: litter layer.

0 to 34 cm: very dark brown (10YR 2/2) and dark brown (10YR 3/3) gravelly loam; strongly to moderately acid (pH 5.4 to 5.6).

34 to 100 cm: dark brown (10YR 3/3) gravelly fine sandy loam; slightly acid (pH 6.2).

Teton family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under forests in glacial lacustrine sediments.

Typical Profile: Fine-loamy, mixed, superactive Typic Cryoboroll (pedon 3094) All colors are for moist conditions.

0 to 26 cm: very dark grayish brown (10YR 3/2) sandy clay loam; slightly acid (pH 6.2).

26 to 56 cm: very dark grayish brown (10YR 3/2) gravelly sandy clay loam; slightly acid (pH 6.4).

56 to 100 cm: dark grayish brown (10YR 4/2) sandy clay loam; slightly acid (pH 6.4).

McCort family: These soils have weakly developed mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in glacial till and glaciofluvial alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 198) All colors are for moist conditions.

0 to 17 cm: Very dark brown (10YR 2/2) very fine sandy loam; moderately acid (pH 5.8).

17 to 29 cm: Dark brown (10YR 3/3) very fine sandy loam; slightly acid (pH 6.4).

29 to 100 cm: Dark grayish brown (10YR 4/2) extremely gravelly very fine sandy loam; slightly acid (pH 6.5).

Dissimilar inclusions: Oxyaquic Cryoboroll soils have mollic epipedons and aquic conditions. They form in depressions under the ABLA/CACA habitat type and under nonforested inclusions. Soils with aquic conditions make up approximately 5 percent of the map unit. Cratermo and Sluice family soils have argillic horizons and form in fine-textured, nonskeletal glacial lacustrine sediments. Cratermo family soils have thick mollic epipedons. They form under nonforested inclusions. Sluice family soils have ochric epipedons.



2246 Greyback Family-Gallatin Family-Lionhead Family Complex

Summary

This complex forms on high ridgetops, concave glaciated uplands, rolling glaciated uplands, and glacial trough valley bottoms. The most common slopes are between 5 and 30 per-

cent. The main surficial deposits are glacial rubble, glacial till, and residuum derived from andesite. Smaller amounts of colluvium and alluvium are also included. In the northeast area of the park, limestone is mixed with the andesite. This is a nonforested map unit dominantly composed of the FEID/AGCA habitat type, areas of alpine meadows, and the ARTR/FEID habitat type. Small areas of the DECE/CAREX habitat type, marshes with CAREX species, and forested habitat types are also included. Soils with aquic conditions occur through out the map unit, but do not occur in every delineation. The main soils are skeletal Mollisols, nonskeletal Mollisols with thick epipedons, and skeletal Mollisols with thick epipedons and root-limiting layers.

Components

40% *Greyback family* and similar inclusions (Sawfork and McCort families)

30% *Gallatin family* and similar inclusions (Hobacker and Stubbs families)

15% *Lionhead family* and similar inclusions (Arrowpeak family)

15% *Dissimilar inclusions* (Shadow family, Aquic Cryoborolls, and Oxyaquic Cryoborolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	64	10	> 100	85 - 95	20
Similar inclusions	45 - 63	10 - 18	>100	70 - 90	17 - 24
Gallatin family	14	30	> 100	70 - 90	50
Similar inclusions	16 - 40	23 - 31	>100	65 - 90	47 - 55
Lionhead family	40	15	60 - 90	70 - 80	50
Similar inclusions	50	15	30 - 45	65 - 80	21

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under meadows in glacial rubble, glacial till, and solifluction deposits.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 812). All colors are for moist conditions.

0 to 18 cm: dark brown (10YR 3/3) loam; slightly acid (pH 6.2).

18 to 30 cm: dark reddish brown (5YR 3/3) very gravelly loam; medium acid (pH 6.0).

30 to 100 cm: dark reddish brown (5YR 3/4) extremely stony sandy loam; medium acid (pH 6.0).

Gallatin family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit. They form under meadows and shrublands in colluvium and glacial till.

Typical Profile: Fine-loamy, mixed, superactive Pachic Cryoboroll (pedon 3344). All colors are for moist conditions.

0 to 33 cm: dark brown (10YR 3/3) silty clay loam; slightly acid (pH 6.2).

33 to 57 cm: dark brown (10YR 3/3) gravelly silty clay loam; slightly acid (pH 6.2).

57 to 100 cm: brown (10YR 4/3) gravelly loam; slightly acid (pH 6.5).

Lionhead family: These soils have thick mollic epipedons and moderately deep root-limiting layers. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under meadows in glacial rubble.

Typical Profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 853). All colors are for moist conditions.

0 to 27 cm: very dark grayish brown (10YR 3/2) loam; moderately acid (pH 5.6).

27 to 50 cm: very dark grayish brown (10YR 3/2) cobbly silt loam; strongly acid (pH 5.4).

50 to 74 cm: brown (10YR 4/3) very gravelly loam; strongly acid (pH 5.2).

74 cm: lithic contact with andesite bedrock.

Dissimilar inclusions: Shadow family soils have ochric epipedons and skeletal subsoil layers. Aquic Cryoboroll soils and Oxyaquic Cryoboroll soils have mollic epipedons and aquic conditions. These soils form under the DECE/CAREX habitat type and marsh areas of CAREX species. Approximately 3 percent of this map unit is made up of soils with aquic conditions.



2261 Gallatin Family and Bearmouth Family and Aquic Cryoborolls Undifferentiated Group

Summary

This map unit forms in stream bottoms. The most common slopes are less than 8 percent, but slopes between 8 and 20 percent also occur. The main surficial deposit is stream alluvium derived from andesite, basalt, or sedimentary rocks.

Smaller areas of fan alluvium and glaciofluvial alluvium also

occur. This map unit is dominated by the nonforested DECE/CAREX and SALIX/CAREX habitat types, various wet forest habitat types, the forested ABLA/LIBO habitat type, and the nonforested ARTR/FEID habitat type. Soils with aquic conditions can occupy up to 15 percent of any delineation. The main soils are nonskeletal Mollisols with thick epipedons, skeletal Mollisols with coarse textures, and Mollisols with aquic conditions.

Components

40% *Gallatin family* and similar inclusions (Silas, Passcreek, and Hobacker families)

35% *Bearmouth family* and similar inclusions (Sula and Greyback families)

15% *Aquic Cryoborolls* and similar inclusions (Cryaquepts and Cryaquolls)

10% *Dissimilar inclusions* (Castlepeak, Como, and Sawfork families, and Histosols)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Gallatin family	19	21	>100	80 - 100	54
Similar inclusions	23 - 45	20 - 25	>100	75 - 100	26 - 52
Bearmouth family	68	7	>100	85 - 95	31
Similar inclusions	28 - 60	10 - 15	>100	70 - 90	20 - 25
Aquic Cryoborolls	45	12	>100	90 - 100	25
Similar inclusions	30 - 50	9 - 18	>100	80 - 100	6 - 25

Gallatin family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. Some of these soils have aquic conditions during the growing season. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under nonforested habitat types in alluvium.

Typical Profile: Fine-loamy, mixed, superactive Pachic Cryoboroll (pedon 3332). All colors are for moist conditions.

0 to 47 cm: very dark brown (10YR 2/2) gravelly loam; slightly acid to moderately acid (pH 6.4 to 5.8).

47 to 60 cm: dark brown (10YR 3/3) very gravelly loam; moderately acid (pH 5.8).

60 to 100 cm: dark grayish brown (10YR 4/2) gravelly loam; moderately acid (pH 5.8).

Bearmouth family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under forested habitat types in alluvium.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryoboroll (pedon 55). All colors are for moist conditions.

3 to 0 cm: litter layer

0 to 27 cm: very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) loam and fine sandy loam; moderately acid (pH 6.0).

27 to 39 cm: dark brown (10YR 3/3*) extremely gravelly loamy coarse sand; slightly acid (pH 6.4).

39 to 100 cm: dark brown (10YR 3/3*) extremely cobbly coarse sand; slightly acid (pH 6.4).

* The dark color is due to dark minerals rather than organic matter.

Aquic Cryoborolls: These soils have mollic epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under DECE/CAREX and SALIX/CAREX habitat types.

Typical Profile: Coarse-loamy / sandy-skeletal, mixed, superactive Aquic Cryoboroll (pedon 3156). All colors are for moist conditions.

0 to 12 cm: very dark brown (10YR 2/2) loam; moderately acid (pH 6.0).

12 to 50 cm: dark grayish brown (10YR 4/2) fine sandy loam with common, medium, prominent strong brown (7.5YR 4/6) redoximorphic concentrations; slightly acid (pH 6.5).

50 to 64 cm: grayish brown (10YR 5/2) loamy sand with few, small, faint brown (7.5YR 5/3) redoximorphic concentrations; slightly acid (pH 6.4).

64 to 118 cm: dark brown (10YR 3/3*) extremely gravelly sand; slightly acid (pH 6.4).

* The dark color is due to dark minerals rather than organic matter.

Dissimilar inclusions: Castlepeak family soils are weakly developed soils with ochric epipedons, many rock fragments, and coarse textures. They form in bare areas of coarse textured alluvium within or adjacent to channels. Como family soils have ochric epipedons, skeletal subsoil layers, and coarse textures. They form under forested habitat types in alluvium derived from sandstones and inclusions of rhyolite. Sawfork family soils have mollic epipedons, argillic horizons, and skeletal subsoil layers. Histosols are organic soils with aquic conditions that form under the SALIX/CAREX habitat type.



2514 Greyback Family-Bedrock Outcrop-Como Family Complex

Summary

This complex forms on stream breaks. The most common slopes are between 30 and 60 percent. The main surficial deposits are colluvium and glacial till derived from rhyolitic ash-flow tuff.

This is a forested map unit composed of the ABLA/CARU habitat type on north-facing slopes and the PSME/SYAL habitat type on south-facing slopes. Nonforested inclusions also occur,

especially on south-facing slopes. The main soils are skeletal Mollisols and skeletal Inceptisols with coarse textures.

Components

40% *Greyback family* and similar inclusions (Hobacker, Moran, and Castan families)

30% *Bedrock outcrops and talus*

20% *Como family* and similar inclusions (Shadow and Lasac families)

10% *Dissimilar inclusions* (Silvercliff family and Cryochrepts-sh&s)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	70	18	> 100	50 - 80	25
Similar inclusions	40 - 60	6 - 19	>100	40 - 80	24 - 45
Como family	66	2	>100	40 - 95	7
Similar inclusions	55 - 60	2 - 11	>100	40 - 90	2 - 5

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit forming under forests in colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 1222b) All colors are for dry conditions.

2 to 0 cm: litter layer

0 to 18 cm: very dark grey (10YR 3/1) very gravelly loam.

18 to 38 cm: very dark grayish brown (10YR 3/2) extremely cobbly sandy loam.

38 to 100 cm: pale brown (10YR 6/3) extremely cobbly loam.

Bedrock outcrops and talus: These areas are composed of rhyolite. Bedrock outcrops and talus slopes make up from 15 to 50 percent of any delineation.

Como family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They form under forests and in colluvium on steep slopes.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryochrept (pedon 775). All colors are for dry conditions.

5 to 0 cm: litter layer.

0 to 7 cm: brown (10YR 5/3) very gravelly loam.

7 to 23 cm: yellowish brown (10YR 5/4) very gravelly loam.

23 to 100 cm: light yellowish brown (10YR 6/4) very gravelly and extremely gravelly loamy sand.

Dissimilar inclusions: Both of these inclusions have root-limiting layers within 100 centimeters of the soil surface. Silvercliff family soils are moderately deep and Cryochrepts-sh&s soils are shallow. Silvercliff family soils have mollic epipedons and Cryochrepts-sh&s have ochric epipedons.



2522F Lolo Family-Bedrock Outcrop-Pesowyo Family Complex

Summary

This complex forms under a frigid temperature regime on stream breaks and areas of rolling glaciated uplands with bedrock outcrops. The surficial deposits are colluvium and glacial till derived from schist and gneiss. There are small areas derived from sedimentary rocks. Slopes are commonly greater than 40 percent. This is a forested map unit made up of various Douglas fir habitat types; primarily PSME/SYAL, PSME/SPBE, and PSME/JUCO. Small areas of nonforested habitat types are also included. The main soils are skeletal Mollisols with thick epipedons and skeletal Mollisols.

Components

- 40% *Lolo family* and similar inclusions (Hobacker family)
 35% *Bedrock outcrop and talus*
 15% *Pesowyo family* and similar inclusions (McCort family)
 10% *Dissimilar inclusions* (Lamedeer and Sawbuck families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Lolo family	47	16	>100	70 - 90	51
Similar inclusions	50	15	>100	65 - 90	47
Pesowyo family	75	26	>100	75 - 80	18
Similar inclusions	60	24	>100	65 - 90	16

Lolo family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They form under Douglas fir habitat types in glacial till and colluvium.

Typical profile: Loamy-skeletal, mixed, superactive Pachic Haploboroll (pedon 3240). All colors are for moist conditions.

0 to 10 cm: very dark brown (10YR 2/2) gravelly loam; slightly acid (pH 6.4).

10 to 50 cm: dark brown (10YR 3/3) gravelly loam and gravelly sandy loam; slightly acid (pH 6.1 to 6.2).

50 to 100 cm: brown (10YR 4/2) very gravelly sandy loam; slightly acid (pH 6.3).

Bedrock outcrops and talus: These area are composed of schist and gneiss. Bedrock outcrops and talus slopes make up from 15 to 70 percent of any one delineation.

Pesowyo family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium textured. They form under Douglas fir habitat types in colluvium.

Typical profile: Loamy-skeletal, mixed, superactive Typic Haploboroll (pedon 520). All colors are for moist conditions.

5 to 0 cm: litter layer.

0 to 15 cm: dark brown (10YR 3/3) very gravelly loam; slightly acid (pH 6.4).

15 to 56 cm: dark grayish brown (10YR 4/2) very gravelly loam; slightly acid (pH 6.3).

56 to 100 cm: dark grayish brown (2.5Y 4/2) extremely gravelly loam; neutral (pH 6.6).

Dissimilar inclusions: Lamedeer family soils have ochric epipedons and skeletal subsoil layers. They form in colluvium derived from sedimentary rocks. Sawbuck family soils have mollic epipedons, argillic horizons, and skeletal subsoil layers.



2541 Greyback Family-Igneous Bedrock-Arrowpeak Family Complex

Summary

This complex forms on glacial head slopes, glacial trough valley walls, glaciated uplands with high relief and bedrock outcrops, and on stream breaks. The most common slopes are greater than 45 percent, but slopes between 15 and 35 percent also occur. The main surficial deposits are colluvium, glacial till, and glacial rubble derived from andesite. Small amounts of residuum and frost rubble are also included. In the northeast area

of the park, andesite is mixed with limestone. This is a forested map unit dominantly composed of the ABLA/VASC-PIAL, ABLA/VAGL, ABLA/VASC-VASC, and PIAL/VASC habitat types. Small areas of alpine meadows and the FEID/AGCA habitat type are also included. The main soils are skeletal Mollisols and skeletal Mollisols with a root-limiting layer within 50 centimeters of the soil surface.

Components

40% *Greyback family* and similar inclusions (Hobacker, Sawfork, and McCort families)

20% *Bedrock outcrops and talus*

25% *Arrowpeak family* and similar inclusions (Jenkinson, Whitecross, and Silvercliff families)

15% *Dissimilar inclusions* (Shadow, Ripple, and Ansel families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	53	18	>100	75 - 95	24
Similar inclusions	43 - 60	16 - 23	>100	70 - 90	16 - 45
Arrowpeak family	51	20	20 - 50	75 - 100	35
Similar inclusions	25 - 63	15 - 22	25 - 70	45 - 95	6 - 27

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. They occur throughout the map unit, forming under forests and alpine meadows in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 176). All colors are for moist conditions.

0 to 24 cm: dark brown (10YR 3/3) very gravelly loam; medium to slightly acid (pH 6.0 to 6.2).

24 to 42 cm: brown (10YR 5/3) gravelly loam; slightly acid (pH 6.3).

42 to 100 cm: yellowish brown (10YR 5/4) extremely cobbly sandy loam; slightly acid (pH 6.5).

Bedrock outcrops and talus: These areas are mainly composed of andesite, except in the northeast area, where bedrock is limestone or andesite. Bedrock outcrops and talus slopes make up from 10 to 40 percent of any delineation.

Arrowpeak family: These soils have mollic epipedons and shallow or very shallow root-limiting layers. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under forests and alpine meadows in colluvium, glacial rubble, and frost rubble. Typical Profile: Loamy-skeletal, mixed, superactive Lithic Cryoboroll (pedon 264). All colors are for moist conditions.

8 to 0 cm: litter layer.

0 to 2 cm: very dark grayish brown (10YR 3/2) loam; medium acid (pH 6.0).

2 to 49 cm: dark brown (10YR 3/3) extremely cobbly loam; medium acid (pH 6.0).

49 cm: lithic contact with andesite conglomerate.

Dissimilar inclusions: Shadow, Ripple, and Ansel family soils have ochric epipedons. Shadow and Ripple family soils form under the ABLA/VASC-VASC habitat type. Ansel family soils have argillic horizons.



2543 Greyback Family-Metamorphic Bedrock-Arrowpeak Family Complex

Summary

This complex forms on concave and rolling glaciated uplands. The most common slopes are less than 35 percent. The main surficial deposits are glacial till, glacial rubble, and colluvium derived from gneiss and schist. Smaller areas of glacial till derive from granite and inclusions of alluvium and residuum also

occur. This is a primarily a forested map unit dominated by the ABLA/THOC, PSME/SYAL, ABLA/VASC, and PSME/JUCO habitat types. Approximately 20 percent of the map unit is nonforested, composed of the ARTR/FEID, FEID/AGSP, and FEID/AGCA habitat types. Soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are skeletal Mollisols that are greater than 100 centimeters deep and skeletal Mollisols with a root-limiting layer within 40 centimeters of the soil surface.

Components

- 55% *Greyback family* and similar inclusions (Hobacker, McCort, Moran, and Bearmouth families)
- 15% *Bedrock outcrops and talus*
- 15% *Arrowpeak family* and similar inclusions (Jenkinson family, Lionhead family, and Cryumbrepts-sh)

15% *Dissimilar inclusions* (Whitecross, Shadow, and Badwater families, and Aquic Cryoborolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	52	15	>100	60 - 90	25
Similar inclusions	42 - 61	6 - 18	>100	40 - 80	16 - 54
Arrowpeak family	42	9	25 - 40	75 - 100	20
Similar inclusions	28 - 50	14 - 18	20 - 80	45 - 100	17 - 45

Greyback family: These soils have a mollic epipedon and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forested and nonforested habitat types in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 3179) All colors are for moist conditions.

4 to 0 cm: litter layer.

0 to 12 cm: very dark grayish brown (10YR 3/2) gravelly loam; medium acid (pH 5.6).

12 to 26 cm: very dark grayish brown (10YR 3/2) gravelly loam; medium acid (pH 5.6).

26 to 55 cm: dark brown (10YR 4/3) very gravelly loam; medium acid (pH 5.8).

55 to 100 cm: yellowish brown (10YR 5/4) very gravelly loam; medium acid (pH 5.6).

Bedrock outcrops and talus: These areas are composed of schist, gneiss, or granite. Bedrock outcrops and talus slopes make up from 5 to 40 percent of any delineation.

Arrowpeak family: These soils have a mollic epipedon and a shallow root-limiting layer. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under Douglas fir habitat types and nonforested areas in colluvium and residuum.

Typical Profile: Loamy-skeletal, mixed, superactive Lithic Cryoboroll (pedon 375) All colors are for moist conditions.

0 to 15 cm: very dark brown (10YR 2/2) very gravelly sandy loam; moderately alkaline (pH 8.0).

15 to 35 cm: very dark grayish brown (10YR 3/2) very gravelly sandy loam; moderately alkaline (pH 8.0).

35 cm: lithic contact.

Dissimilar inclusions: Whitecross family have ochric epipedons and root-limiting layers. Shadow family soils have ochric epipedons and skeletal subsoil layers. They are more common in glacial till derived from granite. Badwater family soils have thick mollic epipedons and argillic horizons. They form under nonforested habitat types. Aquic Cryoboroll soils have mollic epipedons and aquic conditions. Soils with aquic conditions make up approximately 3 percent of this map unit.



2546 Hobacker Family-Bedrock Outcrop-Arrowpeak Family Complex

Summary

This complex forms in glacial headslopes, glaciated uplands with high relief and bedrock outcrops, and concave glaciated uplands with bedrock outcrops. The most common slopes are greater than 50 percent, but slopes between 15 and 35 percent also occur. The main surficial deposits are colluvium, glacial till, and glacial rubble derived from andesite. Small amounts of residuum and alluvium are also included. In the northeast area of the park, limestone is mixed with the andesite. This is a nonforested map unit dominantly composed of the ARTR/FEID and FEID/AGCA habitat types, areas of alpine meadows, and the FEID/AGSP habitat type. Small areas of the DECE/CAREX habitat type and various forested habitat types are also included. Soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are skeletal Mollisols with thick epipedons and skeletal Mollisols with root-limiting layers within 50 centimeters of the soil surface.

Components

- 40% *Hobacker family* and similar inclusions (Sawfork, Greyback, Badwater, and Shook families)
- 20% *Bedrock outcrops and talus*
- 25% *Arrowpeak family* and similar inclusions (Jenkinson, Mosroc, and Silvercliff families)
- 15% *Dissimilar inclusions* (Shadow, Bottle, and Rimton families, and Oxyaquic Cryoborolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	51	15	>100	75 - 100	43
Similar inclusions	30 - 60	12 - 23	>100	60 - 100	23 - 45
Arrowpeak family	48	22	10 - 40	90 - 100	13
Similar inclusions	22 - 63	16 - 28	15 - 80	65 - 85	15 - 20

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under meadows and shrublands in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 392). All colors are for moist conditions.

0 to 6 cm: very dark grayish brown (10YR 3/2) loam; neutral (pH 7.0).

6 to 50 cm: very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) very gravelly loam; neutral (pH 7.0).

50 to 100 cm: dark grayish brown (10YR 4/2) very gravelly coarse sandy loam; neutral (pH 7.0).

Bedrock outcrops and talus: These areas are mainly composed of andesite, except in the northeast area, where bedrock is limestone or andesite. Bedrock outcrops and talus slopes make up from 10 to 40 percent of any delineation.

Arrowpeak family: These soils have mollic epipedons and shallow to very shallow root-limiting layers. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit on summit, shoulder, and upper backslope positions. They form under FEID/AGSP and alpine meadows in colluvium, glacial till, and glacial rubble.

Typical Profile: Loamy-skeletal, mixed, superactive Lithic Cryoboroll (pedon 270). All colors are for moist conditions.

0 to 4 cm: very dark grayish brown (10YR 3/2) very gravelly loam; neutral (pH 6.8).

4 to 10 cm: dark brown (10YR 3/3) very stony sandy loam; neutral (pH 6.6).

10 to 15 cm: paralithic contact with weathered bedrock.

15 cm: lithic contact with andesite bedrock.

Dissimilar inclusions: Shadow, Bottle, and Rimton family soils have ochric epipedons. These soils often form under the forested inclusions. Oxyaquic Cryoboroll soils have aquic conditions and form under the DECE/CAREX habitat type. Soils with aquic conditions make up approximately 1 percent of this map unit.



2561 Teton Family-Bedrock Outcrop-Aquic Cryoborolls Complex

Summary

This complex forms on areas of rolling glaciated uplands and glacial cirque basins. Slopes are commonly between 10 and 25 percent. The main surficial deposit is glacial till derived from andesite. Small areas of fine-textured alluvium are also included. In the northeast area of the park, andesite is mixed with

limestone. The main habitat types in this forested map unit are ABLA/VASC-PIAL, ABLA/VASC-VASC, and wet forest habitat types. There are also areas of ABLA/VAGL and nonforested inclusions of the ARTR/FEID, FEID/DECE, and DECE/CAREX habitat types. Soils with aquic conditions make up approximately 15 percent of this map unit. The main soils are nonskeletal Mollisols and Mollisols with aquic conditions.

Components

50% *Teton family* and similar inclusions (Sula, Passcreek, Greyback, and Ripple families)

15% *Bedrock outcrops and talus slopes*

15% *Aquic Cryoborolls* and similar inclusions (Oxyaquic Cryochrepts and Histosols)

20% *Dissimilar inclusions* (Shadow, Whitecross, Elkner, and Arrowpeak families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Teton family	15	24	>100	75 - 100	26
Similar inclusions	13 - 52	16 - 25	>100	70 - 100	9 - 24
Aquic Cryoborolls	40	20	>100	70 - 85	20
Similar inclusions	2 - 43	5 - 17	>100	55 - 80	7 - 60

Teton family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under both forested and nonforested habitat types in glacial till.

Typical Profile: Fine-loamy, mixed, superactive Typic Cryoboroll (pedon 3213). All colors are for moist conditions.

0 to 16 cm: very dark grayish brown (10YR 3/2) loam; strongly acid (pH 5.4).

16 to 34 cm: dark brown (10YR 3/3) loam; moderately acid (pH 5.6).

34 to 100 cm: brown (10YR 4/3) gravelly loam; moderately acid (pH 5.6).

Bedrock outcrops and talus: These areas are mainly composed of andesite, except in the north-east area, where bedrock is limestone or andesite. Bedrock outcrops and talus slopes make up from 10 to 20 percent of any delineation.

Aquic Cryoborolls: These soils have mollic epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are medium or moderately coarse textured. They form under the wetter, nonforested inclusions in glacial till and alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Aquic Cryoboroll (pedon 59). All colors are for moist conditions.

0 to 20 cm: black (10YR 2/1) silt loam; slightly acid (pH 6.2).

20 to 33 cm: grayish brown (10YR 5/2) very fine sandy loam with common, medium, prominent yellowish brown (10YR 5/6) and greenish gray (5GY 5/1) redoximorphic concentrations; slightly acid (pH 5.4).

33 to 100 cm: dark grayish brown (10YR 4/2) very gravelly loam with common, medium, prominent yellowish brown (10YR 5/6) and greenish gray (5GY 4/1) redoximorphic concentrations; neutral (pH 6.6); water entering pit.

Dissimilar inclusions: Shadow, Whitecross, and Elkner family soils have ochric epipedons. Whitecross, Elkner, and Arrowpeak family soils have root-limiting layers within 100 centimeters of the soil surface. Whitecross family soils form under the nonforested, ARTR/FEID habitat type. Arrowpeak family soils have mollic epipedons and form under the ABLA/VASC-PIAL and ARTR/FEID habitat types.



2662 Gallatin Family and Cryaquolls and Histosols Undifferentiated Group

Summary

This complex forms in alluvial basins. Slopes are commonly less than 10 percent. The main surficial deposits are medium-textured and fine-textured alluvium, along with organic deposits. Small areas of coarse-textured alluvium are also included. This is a nonforested map unit dominated by the DECE/CAREX habitat type and marsh areas composed of *Carex* and *Salix* species. Small inclusions of FEID/DECE, ARTR/FEID, and

forested areas also occur. Soils with aquic conditions make up approximately 50 percent of this map unit and occur within every delineation. The main soils are nonskeletal Mollisols with thick mollic epipedons, Mollisols with aquic conditions, and Histosols.

Components

- 40% *Gallatin family* and similar inclusions (Stubbs, Teton, Silas, and Shook families)
- 40% *Cryaquolls* and similar inclusions (Cryaquepts, Aquic Cryoborolls, and Wallrock family)
- 10% *Histosols*
- 10% *Dissimilar inclusions* (Greyback, Como, and Billycreek families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Gallatin family	12	22	>100	75 - 100	58
Similar inclusions	7 - 20	15 - 26	>100	60 - 95	27 - 80
Cryaquolls	34	17	>100	60 - 95	31
Similar inclusions	15 - 33	13 - 27	>100	45 - 90	8 - 30
Histosols	na	na	>100	na	60

Gallatin family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. Some of these soils have aquic conditions during the growing season. They occur throughout the map unit, forming under the FEID/DECE and DECE/CAREX habitat types in alluvium.

Typical Profile: Fine-loamy, mixed, superactive Pachic Cryoboroll (pedon 295). All colors are for moist conditions.

0 to 14 cm: very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) loam; neutral (pH 6.6 to 6.8).

14 to 45 cm: dark olive brown (2.5Y 3/3) very fine sandy loam; neutral (pH 6.8).

45 to 78 cm: dark grayish brown (2.5Y 4/2) and brown (10YR 4/3) loam; neutral (pH 6.8).

78 to 100 cm: dark yellowish brown (10YR 4/4) extremely gravelly sandy loam; neutral (pH 6.7).

Cryaquolls: These soils have mollic epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are moderately fine to coarse textured. They occur throughout the map unit under marshes of *Salix* species and the DECE/CAREX habitat type.

Typical Profile: Typic Cryaquoll (pedon 51). All colors are for moist conditions.

0 to 20 cm: black (10YR 2/1) silt loam; neutral (pH 7.2).

20 to 34 cm: very dark grayish brown (10YR 3/2) clay loam with few, fine, prominent yellowish brown (10YR 5/6) redoximorphic concentrations; neutral (pH 7.2).

34 to 39 cm: brown (10YR 4/3) fine sandy loam with many, large, prominent reddish brown (5YR 4/4) redoximorphic concentrations; neutral (pH 7.2).

39 to 100 cm: dark gray (10YR 4/1) fine sandy loam and loamy sand, with common medium, prominent, yellowish brown (10YR 5/6) redoximorphic concentrations; neutral (pH 7.2); water entering pit at 80 cm.

Histosols: These organic soils have histic epipedons and are greater than 100 centimeters deep. They have aquic conditions for most of the growing season. In this map unit the average depth of organic materials is 60 centimeters and they can be fibric or hemic. They occur in very wet areas of the map unit under the nonforested DECE/CAREX habitat type and in the *Carex* and *Salix* marsh areas.

Typical Profile: Borohemist (pedon #241). All colors are for moist conditions.

0 to 32 cm: black (10YR 2/1) and very dark brown (10YR 2/2) slightly decomposed organic material; moderately acid (pH 6.0).

32 to 43 cm: very dark grayish brown (10YR 3/2) slightly decomposed organic material; strongly acid (pH 5.5).

43 to 130 cm: black (10YR 2/1), very dark grayish brown (10YR 3/2), and dark brown (10YR 3/3) organic material of intermediate decomposition; moderately acid (pH 6.0); water entering pit at 43 cm.

Dissimilar inclusions: None of these inclusions have aquic conditions. Greyback family soils have mollic epipedons and skeletal subsoil layers. Como family soils have ochric epipedons, coarse textures, and skeletal subsoil layers. They form in glaciofluvial and fan alluvium under forested habitat types. Billycreek family soils have ochric epipedons and coarse textures.



2751 Greyback Family and Rimton Family and Bed-rock Outcrop Undifferentiated Group

Summary

This complex forms on glaciated plateaus. Slopes are commonly less than 15 percent. The main surficial deposits are glacial till and colluvium derived from basalt or a mixture of basalt and rhyolitic ash-flow tuff. Small areas of alluvium are also included. The main habitat types are the forested ABLA/VASC-

VASC, ABLA/VASC-CARU, and ABLA/PIAL habitat types. There are also areas of the nonforested ARTR/FEID and DECE/CAREX habitat types. Soils with aquic conditions occur in

this map unit, but not in every delineation. The main soils are skeletal Mollisols and nonskeletal Alfisols with dark surface layers.

Components

35% *Greyback family* and similar inclusions (Hobacker and Sawfork families)

35% *Rimton family* and similar inclusions (Ansel and Ripple families)

10% *Bedrock outcrops and talus*

20% *Dissimilar inclusions* (Billycreek, Shadow, Jenkinson, and Granmount families, and Cryaquolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	50	20	>100	65 - 90	25
Similar inclusions	47 - 55	21 - 27	>100	65 - 90	24 - 49
Rimton family	15	23	>100	40 - 90	12
Similar inclusions	13 - 26	22 - 26	>100	40 - 80	3 - 5

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit these soils are medium or moderately coarse textured. They form under the forested ABLA/VASC-CARU and the nonforested ARTR/FEID habitat types in glacial till.

Typical profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 161). All colors are for moist conditions.

0 to 29 cm: very dark grayish brown (10YR 3/2) gravelly loam; medium acid (pH 6.0).

29 to 46 cm: very dark grayish brown (10YR 3/2) very gravelly loam; medium acid (pH 6.0).

46 to 100 cm: very dark grayish brown (10YR 3/2) very cobbly loam and extremely cobbly loam; slightly acid (pH 6.2 to 6.5).

Rimton family: These soils have ochric epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. They form under forested habitat types in glacial till and colluvium.

Typical profile: Fine-loamy, mixed, superactive Mollic Cryoboralf (pedon 165). All colors are for moist conditions.

0 to 36 cm: very dark grayish brown (10YR 3/2) gravelly loam; very strongly acid (pH 4.7).

36 to 63 cm: dark brown (10YR 4/3) gravelly coarse sandy loam; slightly acid (pH 6.2).

63 to 81 cm: dark brown (10YR 3/3) gravelly sandy clay loam; common, distinct clay films lining pores and on ped faces; neutral (pH 6.7).

81 to 117 cm: dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/5) loam; common, distinct clay films lining pores and on ped faces; neutral (pH 7.0).

Bedrock outcrops and talus: These areas are mainly composed of basalt and rhyolitic ash-flow tuff. Bedrock outcrops and talus slopes make up from 0 to 40 percent of any delineation.

Dissimilar inclusions: The Billycreek and Shadow family soils have ochric epipedons, but do not have argillic horizons. They form in forested areas where basalt is mixed with rhyolitic ash-flow tuff. Jenkinson family soils have mollic epipedons and root-limiting layers. They form in nonforested areas where the soil is shallow. Granmount family soils have mollic epipedons, argillic horizons, and fine textures. They form on steep colluvial slopes. Cryaquoll soils have mollic epipedons and aquic conditions. Soils with aquic conditions make up approximately one percent of the map unit and occur under the DECE/CAREX habitat type.



276 Sula Family-Ripple Family Complex

This complex forms on lacustrine plains. The most common slopes are less than 15 percent. The main surficial deposits are glacial lacustrine sediments derived from a mixture of rock types. Smaller areas of glacial till and alluvium also occur. This is a nonforested map unit dominated by the ARTR/FEID and ARCA/FEID habitat types. Small inclusions of the DECE/CAREX habitat type also occur. Soils with aquic conditions and

bedrock outcrops occur in this map unit, but not within every delineation. The main soils are nonskeletal Mollisols and nonskeletal Inceptisols.

Components

55% *Sula family* and similar inclusions (Shook and Teton families)

30% *Ripple family* and similar inclusions (Ansel and Bobtail families)

15% *Dissimilar inclusions* (Aquic Cryoborolls, Greyback family, Shadow family, and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Sula family	15	8	>100	85 - 100	24
Similar inclusions	5 - 15	12 - 20	>100	80 - 100	23 - 60
Ripple family	7	20	>100	60 - 95	0
Similar inclusions	6 - 16	10 - 22	>100	60 - 95	0 - 6

Sula family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under nonforested habitat types in glacial lacustrine sediments and alluvium.

Typical Profile: Coarse-loamy, mixed, superactive Typic Cryoboroll (pedon 1024) All colors are for moist conditions.

0 to 20 cm: very dark grayish brown (10YR 3/2) loam; moderately acid (5.8).

20 to 28 cm: dark brown (10YR 3/3) loam; moderately acid (pH 6.0).

28 to 115 cm: dark grayish brown (10YR 4/2) and dark brown (10YR 4/3) gravelly sandy loam, gravelly fine sandy loam, and gravelly coarse sandy loam; moderately to slightly acid (pH 5.8 to 6.2).

Ripple family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under nonforested habitat types in glacial lacustrine sediments.

Typical Profile: Fine-loamy, mixed, superactive Typic Cryochrept (pedon 372) All colors are for moist conditions.

0 to 30 cm: black (10YR 2/1) gravelly loam; neutral (pH 7.2).

30 to 45 cm: very dark brown (10YR 2/2) sandy clay loam; neutral (pH 7.2).

45 to 100 cm: dark grayish brown (10YR 4/2) gravelly sandy loam; neutral (pH 7.2).

Dissimilar inclusions: Aquic Cryoboroll soils have mollic epipedons and aquic conditions. They form under inclusions of DECE/CAREX. Approximately three percent of this map unit is made up of soils with aquic conditions. Greyback and Shadow family soils have skeletal subsoil layers. They form in inclusions of glacial till. Greyback family soils have mollic epipedons and Shadow family soils have ochric epipedons. Bedrock outcrops can occupy up to 5 percent of any delineation, but do not occur in every delineation.



2765 Greyback Family-Cloud Peak Family-Cryaquolls Complex

Summary

This complex forms on areas of concave glaciated uplands and glaciated plateaus. Slopes are commonly less than 20 percent. The main surficial deposit is glacial till derived from andesite. Small areas of colluvium and fine-textured alluvium also occur.

The main habitat types in this forested map unit are various wet forest types, ABLA/CACA, ABLA/VASC, and ABLA/VAGL. There are also nonforested inclusions of the FEID/DECE and DECE/CAREX habitat types. Small areas of bedrock outcrops occur in this map unit, but not in every delineation. Soils with aquic conditions make up approximately 15 percent of this map unit. The main soils are skeletal Mollisols, skeletal Alfisols, and Mollisols with aquic conditions.

Components

40% *Greyback family* and similar inclusions (Teton, Hobacker, and Sawfork families)

25% *Cloud Peak family* and similar inclusions (Rimton and Ansel families)

15% *Cryaquolls* and similar inclusions (Aquic Cryoborolls and Wallrock family)

20% *Dissimilar inclusions* (Shadow family, Arrowpeak family, and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	61	26	>100	65 - 85	20
Similar inclusions	22 - 54	23 - 28	>100	60 - 85	21 - 52
Cloud Peak family	45	25	>100	70 - 85	4
Similar inclusions	17 - 26	24 - 29	>100	70 - 90	3 - 15
Cryaquolls	30	23	>100	85 - 95	41
Similar inclusions	10 - 22	25 - 30	>100	70 - 95	26 - 30

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under forested and nonforested areas, in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 440). All colors are for moist conditions.

1 to 0 cm: litter layer.

0 to 13 cm: very dark grayish brown (10YR 3/2) gravelly loam; strongly acid (pH 5.4).

13 to 21 cm: dark brown (10YR 3/3) gravelly loam; moderately acid (pH 5.6).

21 to 42 cm: dark brown (10YR 3/3) gravelly clay loam; moderately acid (pH 5.8).

42 to 100 cm: dark grayish brown (10YR 4/2) extremely cobbly sandy clay loam; moderately acid (pH 5.8).

Cloud Peak family: These soils have ochric epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under the ABLA/VAGL and ABLA/CACA habitat types in glacial till and alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboralf (pedon 3382). All colors are for moist conditions.

6 to 0 cm: litter layer

0 to 17 cm: dark brown (10YR 4/3) very gravelly loam; strongly acid (pH 5.2).

17 to 42 cm: brown (10YR 5/3) very gravelly loam; common distinct clay films on ped faces and lining pores; medium acid (pH 5.6).

42 to 100 cm: pale brown (10YR 6/3) very cobbly loam; medium acid (pH 5.8).

Cryaquolls: These soils have mollic epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are fine to moderately coarse textured. They occur throughout the map unit, forming under the ABLA/CACA and DECE/CAREX habitat types in glacial till and fine-textured alluvium.

Typical Profile: Argic Cryaquoll (pedon 615). All colors are for moist conditions.

0 to 13 cm: very dark brown (10YR 2/2) loam; slightly acid (pH 6.2).

13 to 29 cm: very dark grayish brown (10YR 3/2) loam; common prominent clay films on ped faces and lining pores; slightly acid (pH 6.2) soil saturated at 23 cm.

29 to 50 cm: black (10YR 2/1) clay loam with few, fine, prominent dark yellowish brown (10YR 3/4) redoximorphic concentrations; common prominent clay films on ped faces and lining pores; slightly acid (pH 6.4); water entering pit at 43 cm.

50 to 67 cm: black (10YR 2/1) clay with common, fine, distinct dark brown (10YR 3/3) redoximorphic concentrations; many distinct clay films on ped faces; slightly acid (pH 6.2).

67 to 100 cm: grayish brown (10YR 5/2) clay loam with common, medium, prominent yellowish brown (10YR 5/6) redoximorphic concentrations; many distinct clay films on ped faces; slightly acid (pH 6.4).

Dissimilar inclusions: Shadow family soils have ochric epipedons and skeletal subsoil layers. Bedrock outcrops are composed of andesite. Arrowpeak family soils have mollic epipedons and shallow root-limiting layers.



2915 Hobacker Family-Sawfork Family-Shadow Family Complex

Summary

This complex forms on earthflows. Slopes are commonly between 10 and 40 percent, though, some areas have slopes greater than 50 percent. The surficial deposits are earthflow debris derived from andesite or a mixture of andesite and sedimentary rock types. The main habitat types in this forested map

unit are ABLA/VASC, ABLA/LIBO, and PSME/SYAL. There are also small inclusions of nonforested areas. Small areas of soils with aquic conditions can occur in this map unit, but they do not occur in every delineation. Small inclusions of bedrock outcrop occur throughout the map unit. The main soils are skeletal Mollisols with thick epipedons, skeletal Mollisols with argillic horizons, and skeletal Inceptisols.

Components

45% *Hobacker family* and similar inclusions (Gallatin and Greyback families)

25% *Sawfork family* and similar inclusions (Passcreek and Granmount families)

15% *Shadow family* and similar inclusions (Cloud Peak family)

15% *Dissimilar inclusions* (Teton family, Oxyaquic Cryoborolls, and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	55	26	>100	70 - 100	48
Similar inclusions	15 - 56	24 - 28	>100	70 - 100	23 - 45
Sawfork family	45	26	>100	75 - 85	21
Similar inclusions	10 - 48	27 - 38	>100	70 - 90	22 - 28
Shadow family	48	23	>100	75 - 85	0
Similar inclusions	45	27	>100	60 - 80	2

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. When limestone is part of the parent material, these soils are effervescent in the subsurface layers. They form under forested habitat types in earthflow deposits.

Typical profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 388). All colors are for moist conditions.

2 to 0 cm: litter layer.

0 to 24 cm: very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) gravelly loam; neutral (pH 6.8 to 7.0).

24 to 54 cm: dark brown (10YR 3/3) very cobbly sandy clay loam; slightly alkaline (pH 7.4).

54 to 100 cm: brown (10YR 5/3) very gravelly sandy clay loam; moderately alkaline (pH 8.0).

Sawfork family: These soils have mollic epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit these soils are moderately fine to moderately coarse textured. They form under moist, forested habitat types in earthflow deposits.

Typical profile: Loamy-skeletal, mixed, superactive Argic Cryoboroll (pedon 855). All colors are for moist conditions.

0 to 9 cm: black (10YR 2/1) silt loam; moderately acid (pH 5.9).

9 to 25 cm: dark brown (10YR 3/3) very gravelly loam; moderately acid (pH 5.7).

25 to 59 cm: dark grayish brown (10YR 3/2) very gravelly sandy loam; few distinct clay films bridging sand grains; moderately acid (pH 5.6).

59 to 100 cm: dark brown (10YR 3/3) very gravelly sandy clay loam; common distinct clay films on ped faces; moderately acid (pH 6.0).

Shadow family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They form under drier, forested habitat types in earthflow deposits.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryochrept (pedon 686). All colors are for moist conditions.

0 to 12 cm: dark brown (10YR 3/3) gravelly loam; strongly acid (pH 5.5).

12 to 34 cm: dark brown (10YR 3/3) very gravelly loam; strongly acid (pH 5.5).

34 to 59 cm: brown (10YR 4/3) very gravelly loam; moderately acid (pH 5.6).

59 to 100 cm: dark grayish brown (10YR 4/2) very cobbly sandy clay loam; moderately acid (pH 5.8 to 5.9).

Dissimilar inclusions: Teton family soils have mollic epipedons and nonskeletal subsoil layers. Oxyaquic Cryoborolls have mollic epipedons and aquic conditions during the growing season. Bedrock outcrops are composed of andesite or sedimentary rock types, and make up between 5 and 15 percent of any delineation.



2916 Sula Family and Cratermo Family and Wallrock Family Undifferentiated Group

Summary

This complex forms on lacustrine plains. The most common slopes are less than 8 percent. The surficial deposits are glacial lacustrine sediments derived from a mixture of rock types. Smaller areas of glacial till and alluvium also occur. This is a nonforested map unit dominated by the DECE/CAREX and

FEID/DECE habitat types. Small marsh areas of *Carex* species and inclusions of forested habitat types also occur. Approximately 10 percent of this map unit is made up of soils with aquic conditions, though the percent within each delineation can vary from 0 to 15 percent. The main soils are Mollisols with medium textures, Mollisols with thick epipedons and fine textures, and Mollisols with argillic horizons and aquic conditions.

Components

60% *Sula family* and similar inclusions (Shook, Teton, and Gallatin families)
 15% *Cratermo family* and similar inclusions (Bridger and Passcreek families)
 10% *Wallrock family*

15% *Dissimilar inclusions* (Cryaquepts, and Bobtail, Como, and Hobacker families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Sula family	1	15	>100	55 - 90	29
Similar inclusions	0 - 15	15 - 20	>100	55 - 90	25 - 54
Cratermo family	3	38	>100	60 - 95	50
Similar inclusions	0 - 8	29 - 43	>100	65 - 95	26 - 32
Wallrock family	3	20	>100	60 - 100	21

Sula family: These soils have a mollic epipedon and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under nonforested habitat types in glacial lacustrine sediments and alluvium.

Typical Profile: Coarse-loamy, mixed, superactive Typic Cryoboroll (pedon 3700) All colors are for moist conditions.

0 to 28 cm: very dark grayish brown (10YR 3/2) fine sandy loam; slightly acid (pH 6.4).

28 to 100 cm: dark brown (10YR 3/2) very fine sandy loam with few, fine, faint mottles below 50 cm; slightly acid (pH 6.4).

Cratermo family: These soils have thick mollic epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are fine to medium textured. They occur throughout the map unit, forming under nonforested habitat types in glacial lacustrine sediments.

Typical Profile: Fine, mixed, superactive Argic Pachic Cryoboroll (pedon 88) All colors are for moist conditions.

0 to 5 cm: black (10YR 2/1) loam; moderately acid (pH 6.0).

5 to 31 cm: black (10YR 2/1) loam; many distinct clay films on ped faces and in pores; slightly acid (pH 6.2).

31 to 55 cm: black (10YR 2/1) sandy clay loam; few distinct clay films in pores; neutral (pH 7.0).

55 to 100 cm: brown (10YR 5/3) silty clay; many distinct clay films on ped faces; neutral (pH 7.2).

Wallrock family: These soils have mollic epipedons and argillic horizons. They are greater than 100 centimeters deep. The soils have aquic conditions for some time during the year. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under the DECE/CAREX habitat type and Carex marsh areas, in glacial lacustrine sediments and alluvium.

Typical Profile: Fine-loamy, mixed, superactive Argiaquic Cryoboroll (pedon 196) All colors are for moist conditions.

0 to 8 cm: very dark brown (10YR 2/2) silt loam; slightly acid (pH 6.2).

8 to 24 cm: very dark gray (10YR 3/1) and black (7.5YR 2/0) silty clay loam; common, distinct clay films in pores and on ped faces; slightly acid (pH 6.3).

24 to 42 cm: black (10YR 2/1) silty clay loam; few, distinct clay films in pores; slightly acid (pH 6.4).

42 to 56 cm: dark grayish brown (2.5Y 4/2) silty clay; common, distinct clay films in pores and on ped faces; neutral (pH 6.8).

56 to 63 cm: olive brown (2.5Y 4/3) clay with common, fine, prominent light olive brown (2.5Y 5/6) mottles; neutral (pH 7.0).

63 to 100 cm: very dark grayish brown (2.5Y 3/2) extremely gravelly loamy sand; neutral (pH 7.2).

Dissimilar inclusions: Cryaquept soils have an ochric epipedon and aquic conditions. These soils are more common than Wallrock family soils in areas where the parent material is derived from rhyolite. Bobtail family soils have moderately coarse textures and an ochric epipedon. They form in lacustrine sediments and glacial till under both forested and nonforested habitat types. Como family soils have many rock fragments and an ochric epipedon. They form under forested inclusions in alluvium. Hobacker family soils have a thick mollic epipedon and many rock fragments. They form in alluvium.



2924 Hobacker Family-Sawfork Family-Greyback Family Complex

Summary

This complex forms in concave glaciated uplands and rolling glaciated uplands of the Northern Range area of the park. Slopes are commonly between 5 and 25 percent. The main surficial deposit is glacial till derived from a mixture of rock types.

There are also some small areas of colluvium. This is a nonforested map unit dominated by the ARTR/FEID, FEID/AGCA, and ARCA/FEID habitat types. Inclusions of the for-

ested PSME/SYAL and PSME/SPBE habitat types and the nonforested DECE/CAREX and AGSP/POSA habitat types also occur. Small areas of bedrock outcrop and soils with aquic conditions are present in this map unit, but do not occur in every delineation. The main soils are skeletal Mollisols with thick epipedons, skeletal Mollisols with argillic horizons, and skeletal Mollisols.

Components

30% *Hobacker family* and similar inclusions (Gallatin and Shook families)

30% *Sawfork family* and similar inclusions (Passcreek and Stubbs families)

25% *Greyback family* and similar inclusions (Teton family)

15% *Dissimilar inclusions* (Haploborolls, Eaglewing family, Taglake family, Emerald family, bedrock outcrops, and Aquic Cryoborolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	57	19	>100	80 - 100	46
Similar inclusions	15 - 27	16 - 24	>100	70 - 100	44 - 53
Sawfork family	57	25	>100	75 - 100	26
Similar inclusions	12 - 26	24 - 28	>100	70 - 100	27 - 54
Greyback family	54	18	>100	70 - 100	24
Similar inclusions	20	24	>100	75 - 100	26

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. Some of these soils have aquic conditions, and some have subsoil enriched of calcium carbonate. They occur throughout the map unit, forming under the ARTR/FEID, ARCA/FEID, and PSME/SPBE habitat types in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 363) All colors are for moist conditions.

0 to 18 cm: very dark brown (10YR 2/2) loam; slightly alkaline (pH 7.5).

18 to 43 cm: very dark brown (10YR 2/2) very cobbly loam; moderately alkaline (pH 8.0).

43 to 100 cm: dark grayish brown (10YR 4/2) very cobbly sandy loam; moderately alkaline (pH 8.0); strongly effervescent.

Sawfork family: These soils have mollic epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. Some of these soils are enriched in calcium carbonate in the subsurface layers. They occur throughout the map unit, forming under the ARTR/FEID and AGSP/POSA habitat types in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Argic Cryoboroll (pedon 464) All colors are for moist conditions.

0 to 31 cm: very dark brown (10YR 2/2) and dark brown (10YR 3/3) gravelly and very cobbly loam; slightly acid (pH 6.4).

31 to 75 cm: brown (10YR 4/3) extremely cobbly sandy clay loam; common distinct clay films on ped faces; slightly acid (pH 6.4).

75 to 100 cm: brown (10YR 4/3) very cobbly loam; slightly acid (pH 6.5).

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. Some of these soils are enriched in calcium carbonate in the subsurface layers. They occur throughout the map unit, forming under ARTR/FEID and FEID/AGCA habitat types in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 465) All colors are for moist conditions.

0 to 30 cm: very dark grayish brown (10YR 3/2) gravelly loam; slightly acid (pH 6.2).

30 to 50 cm: olive brown (2.5Y 4/4) very gravelly sandy clay loam; slightly acid (pH 6.2).

50 to 100 cm: olive brown (2.5Y 4/4) extremely gravelly sandy loam; slightly acid (pH 6.4).

Dissimilar inclusions: Haploboroll soils and Eaglewing family soils form under a warmer temperature regime than the main components. Haploboroll soils have mollic epipedons and Eaglewing family soils have ochric epipedons. Eaglewing family soils form under the AGSP/POSA habitat type. Taglake and Emerald family soils have moderately deep root-limiting layers. Taglake family soils have ochric epipedons and Emerald family soils have mollic epipedons. Bedrock outcrops are composed of rhyolite, andesite, or sedimentary rocks, and can occupy up to 15 percent of any one delineation. Aquic Cryoboroll soils have mollic epipedons and aquic conditions. They make up approximately 3 percent of the total map unit, but can occupy between 0 and 10 percent of any delineation. They form in depressions under the DECE/CAREX habitat type.



295F Pesowyo Family-Sawbuck Family-Beartooth Family Complex

Summary

This complex forms under a frigid temperature regime on concave glaciated uplands and glaciofluvial flood bars and terraces. Slopes are commonly less than 25 percent. The main surficial deposits are glacial till, glaciofluvial alluvium, and flood alluvium derived from a variety of rock types. The flood deposits contain a large proportion of cobbles, stones, and boulders.

Small areas of fan alluvium and colluvium are also included.

This is a nonforested map unit composed mainly of the ARTR/AGSP and ARTR/FEID habitat types. Small areas of AGSP/POSA habitat types and forested Douglas fir habitat types are also included. Areas of bedrock outcrop occur within the map unit, but not in every delineation. The main soils are skeletal Mollisols without argillic horizons, skeletal Mollisols with argillic horizons, and nonskeletal Mollisols with argillic horizons.

Components

45% *Pesowyo family* and similar inclusions (Roundup and Greyback families)

20% *Sawbuck family*

20% *Beartooth family*

15% *Dissimilar inclusions* (Bedrock outcrops and Eaglewing family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Pesowyo family	56	18	>100	70 - 100	28
Similar inclusions	22 - 55	18 - 24	>100	70 - 100	22 - 29
Sawbuck family	45	28	>100	90 - 100	19
Beartooth family	15	26	>100	90 - 100	31

Pesowyo family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. Some of these soils are enriched in calcium carbonate. They form throughout the map unit under nonforested habitat types in glacial till, glaciofluvial alluvium, and flood alluvium.

Typical profile: Loamy-skeletal, mixed, superactive Typic Haploboroll (pedon 109). All colors are for moist conditions.

0 to 17 cm: very dark grayish brown (10YR 3/2) very gravelly loam; mildly alkaline (pH 7.8).

17 to 63 cm: dark brown (10YR 3/3) extremely stony sandy loam; moderately alkaline (pH 8.3); strongly effervescent.

63 to 100 cm: dark grayish brown (10YR 4/2) very stony sandy loam; moderately alkaline (pH 8.0); slightly effervescent.

Sawbuck family: These soils have mollic epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. The subsoil layers are enriched in calcium carbonate. They form under nonforested habitat types in glacial till and flood alluvium.

Typical profile: Loamy-skeletal, mixed, superactive Typic Argiboroll (pedon 107). All colors are for moist conditions.

0 to 6 cm: dark brown (10YR 3/3) loam; slightly alkaline (pH 7.7).

9 to 26 cm: dark brown (10YR 3/3) very bouldery sandy clay loam; common, distinct clay films lining pores; slightly alkaline (pH 7.4).

26 to 62 cm: very dark grayish brown (10YR 3/2) very gravelly sandy loam; moderately alkaline (pH 7.9); strongly effervescent.

62 to 100 cm: dark grayish brown (10YR 4/2) very gravelly sandy loam; slightly alkaline (pH 7.4).

Beartooth family: These soils have mollic epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. The subsoil layers are enriched in calcium carbonate. They form under nonforested habitat types in glacial till and fan alluvium.

Typical profile: Fine-loamy, mixed, superactive Typic Argiboroll (pedon 142). All colors are for moist conditions.

0 to 9 cm: dark brown (10YR 3/3) cobbly sandy loam; mildly alkaline (pH 7.8).

9 to 39 cm: brown (10YR 4/3) cobbly loam; common, distinct clay films on ped faces; mildly alkaline (pH 7.8).

39 to 61 cm: brown (10YR 4/3) very cobbly sandy loam; moderately alkaline (pH 8.0); violently effervescent.

61 to 100 cm: brown (10YR 5/3) sandy loam; moderately alkaline (pH 8.0); violently effervescent.

Dissimilar inclusions: Eaglewing family soils have ochric epipedons and nonskeletal subsoil layers. Bedrock outcrops are mainly composed of sedimentary rocks.



2961 Shook Family-Passcreek Family-Aquic Cryoborolls Complex

Summary

This complex forms on lacustrine plains. The most common slopes are less than 10 percent. The main surficial deposits are glacial lacustrine sediments derived from andesite. Some areas include glacial lacustrine sediments derived from basalt or sedimentary rocks. Smaller areas of alluvium and glacial till are also included. This is a forested map unit dominated by the ABLA/VASC-VASC habitat type, areas of wet forest habitat types, and the ABLA/VAGL habitat type. Small inclusions of the nonforested DECE/CAREX habitat type and marsh areas of *Carex* species are also included. Approximately 15 percent of this map unit is made up of soils with aquic conditions. The main soils are nonskeletal Mollisols with thick epipedons, nonskeletal Mollisols with argillic horizons, and Mollisols with aquic conditions.

Components

- 40% *Shook family* and similar inclusions (Sula, Greyback, and Hobacker families)
 30% *Passcreek family* and similar inclusions (Teton and Ansel families)
 15% *Aquic Cryoborolls* and similar inclusions (Cryaquepts and Oxyaquic Cryoborolls)
 15% *Dissimilar inclusions* (Bobtail, Bearmouth, and Shadow families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shook family	8	16	>100	75 - 90	55
Similar inclusions	12 - 42	15 - 21	>100	65 - 90	23 - 52
Passcreek family	20	27	>100	75 - 95	28
Similar inclusions	5 - 17	26 - 33	>100	55 - 90	5 - 26
Aquic Cryoborolls	25	10	>100	80 - 90	22
Similar inclusions	12 - 36	10 - 21	>100	60 - 90	2 - 21

Shook family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in glacial lacustrine sediments.

Typical Profile: Coarse-loamy, mixed, superactive Pachic Cryoboroll (pedon 80) All colors are for moist conditions.

4 to 0 cm: litter layer.

0 to 53 cm: very dark grayish brown (10YR 3/2) sandy loam and very fine sandy loam; medium to slightly acid (pH 5.6 to 6.2).

53 to 89 cm: very dark grayish brown (10YR 3/2) gravelly loam; medium acid (pH 6.0).

89 to 107 cm: dark grayish brown (10YR 4/2) gravelly sandy loam; medium acid (pH 6.0).

107 to 130 cm: dark gray (10YR 4/1) sandy loam; medium acid (pH 6.0).

Passcreek family: These soils have mollic epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under forests in glacial lacustrine sediments and glacial till.

Typical Profile: Fine-loamy, mixed, superactive Argic Cryoboroll (pedon 422) All colors are for moist conditions.

5 to 0 cm: litter layer.

0 to 16 cm: very dark brown (10YR 2/2) cobbly loam; strongly acid (pH 5.5).

16 to 36 cm: dark brown (10YR 3/3) gravelly loam; few, distinct clay films in pores; strongly acid (pH 5.5).

36 to 100 cm: dark yellowish brown (10YR 3/4) gravelly loam; strongly acid (pH 5.5).

Aquic Cryoborolls: These soils have a mollic epipedon and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming in depressions under wet forest habitat types and nonforested inclusions.

Typical Profile: Aquic Cryoboroll (pedon 82) All colors are for moist conditions.

0 to 21 cm: black (10YR 2/1) silt loam; medium acid (pH 5.8).

21 to 37 cm: very dark grayish brown (10YR 3/2) gravelly sandy clay loam with few, medium, distinct dark

yellowish brown (10YR 4/3) redoximorphic concentrations; medium acid (pH 6.0).
 37 to 100 cm: very dark grayish brown (10YR 3/2) extremely gravelly sandy loam with few, medium, distinct dark yellowish brown (10YR 4/3) redoximorphic concentrations; medium acid (pH 6.0); water entering pit at 37 cm.

Dissimilar inclusions: Bearmouth family soils have coarse textures and skeletal subsoil layers. They form in glacial till and alluvium. Bobtail and Shadow family soils have ochric epipedons. They form within inclusions where rhyolite dominates the soil matrix. Shadow family soils have skeletal subsoil layers.



2962 Gallatin Family-Badwater Family-Oxyaquic Cryochrepts Complex

Summary

This map unit forms on a complex of glaciofluvial plains, kames, terraces, and alluvial fans. Slopes are commonly less than 25 percent. The main surficial deposits are glaciofluvial alluvium and fan alluvium derived from andesite. Small areas of recent stream alluvium and glacial till also occur. This is a forested map unit dominated by wet forest habitat types, and the ABLA/VAGL, ABLA/VASC, and ABLA/LIBO habitat types. There are nonforested inclusions of the DECE/CAREX habitat type and marsh areas of *Carex* species. Soils with aquic conditions make up 15 percent of the map unit and are present in every delineation. The main soils are nonskeletal Mollisols with thick epipedons, skeletal Mollisols with thick epipedons and argillic horizons, and nonskeletal Inceptisols with aquic conditions.

Components

- 45% *Gallatin family* and similar inclusions (Hobacker, Silas, and Teton families)
- 30% *Badwater family* and similar inclusions (Stubbs and Sawfork families)
- 15% *Oxyaquic Cryochrepts* and similar inclusions (Aquic Cryoborolls and Cryaquepts)
- 10% *Dissimilar inclusions* (Ripple, McCort, and Bearmouth families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Gallatin family	15	25	>100	75 - 100	65
Similar inclusions	10 - 47	18 - 25	>100	70 - 100	24 - 82
Badwater family	48	23	>100	55 - 80	60
Similar inclusions	10 - 53	24 - 26	>100	60 - 100	26 - 51
Oxyaquic Cryochrepts	5	16	>100	50 - 70	4
Similar inclusions	10 - 25	15 - 22	>100	55 - 85	6 - 27

Gallatin family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. Some of these soils have aquic conditions for some time during the growing season. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under forested habitat types and the nonforested DECE/CAREX habitat type in alluvium and glacial till.

Typical Profile: Fine-loamy, mixed, superactive Pachic Cryoboroll (pedon 265). All colors are for moist conditions.

0 to 38 cm: very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) loam; moderately to slightly acid (pH 6.0 to 6.5).

38 to 60 cm: very dark grayish brown (10YR 3/2) gravelly loam; neutral (pH 7.0).

60 to 100 cm: very dark grayish brown (10YR 3/2) very gravelly loam; moderately alkaline (pH 8.0).

Badwater family: These soils have thick mollic epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit, forming under forests in glaciofluvial alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Argic Pachic Cryoboroll (pedon 93). All colors are for moist conditions.

0 to 52 cm: dark brown (10YR 3/3) gravelly loam; moderately acid (pH 5.6).

52 to 100 cm: brown (10YR 4/3) very cobbly loam; many, distinct clay films lining pores; moderately acid (pH 6.0).

Oxyaquic Cryochrepts: These soils have ochric epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit forming under wet forest habitat types and nonforested DECE/CAREX habitat type in glaciofluvial and recent alluvium.

Typical Profile: Coarse-loamy, mixed, superactive Oxyaquic Cryochrept (pedon 3220). All colors are for moist conditions.

4 to 0 cm: litter layer.

0 to 7 cm: black (10YR 2/1) silt loam; strongly acid (pH 5.2).

7 to 13 cm: brown (10YR 4/3) fine sandy loam; moderately acid (pH 5.6).

13 to 21 cm: very dark grayish brown (10YR 3/2) very fine sandy loam; moderately acid (pH 5.8).

21 to 100 cm: brown (10YR 4/3) fine sandy loam; moderately acid (pH 5.8).

Dissimilar inclusions: Ripple and Shadow family soils have ochric epipedons. McCort family soils have weakly developed mollic epipedons and skeletal subsoil layers. They form in glacial till and colluvium. Bearmouth family soils have mollic epipedons, coarse textures, and skeletal subsoil layers.



2972 Greyback Family-Stubbs Family-Cloud Peak Family Complex

Summary

This map unit forms on a complex of glaciofluvial plains, terraces, and kames. Slopes are commonly less than 20 percent. The main surficial deposit is glaciofluvial alluvium derived from andesite. In the Mammoth area, travertine and sedimentary rock types are included in the parent material. Small areas of fan alluvium, recent stream alluvium, glacial till, and coarse-textured lacustrine sediments also occur. This is a forested map unit dominated by the ABLA/VASC, ABLA/VAGL, ABLA/LIBO, ABLA/CARU, and wet forest habitat types. There are also inclusions of nonforested habitat types. Small areas of soils with aquic conditions are present in this map unit, but do not occur in every delineation. The main soils are skeletal Mollisols, nonskeletal Mollisols with thick epipedons and argillic horizons, and skeletal Alfisols.

Components

- 60% *Greyback family* and similar inclusions (Bearmouth, Tomichi, and McCort families)
- 15% *Stubbs family* and similar inclusions (Passcreek, Silas, and Badwater families)
- 15% *Cloud Peak family* and similar inclusions (Shadow and Ansel families)
- 10% *Dissimilar inclusions* (Hobacker family and Cryaquepts)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Greyback family	52	10	>100	75 - 100	27
Similar inclusions	22 - 65	3 - 15	>100	60 - 100	15 - 26
Stubbs family	15	20	>100	70 - 100	54
Similar inclusions	13 - 55	22 - 25	>100	70 - 100	25 - 76
Cloud Peak family	43	27	>100	75 - 100	1
Similar inclusions	16 - 53	18 - 22	>100	55 - 90	2

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under the ABLA/VASC, ABLA/CARU, and ABLA/LIBO habitat types in glaciofluvial alluvium, fan alluvium, glacial till, and lake sediments.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 54). All colors are for moist conditions.

0 to 22 cm: very dark grayish brown (10YR 3/2) gravelly loam; strongly acid (pH 5.4).

22 to 36 cm: dark brown (10YR 4/3) very gravelly coarse sandy loam; medium acid (pH 5.6).

36 to 100 cm: dark brown (10YR 4/3) extremely gravelly coarse sandy loam; medium acid (pH 5.8).

Stubbs family: These soils have thick mollic epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit forming under ABLA/CARU and wet forest habitat types in glaciofluvial and fan alluvium.

Typical Profile: Fine-loamy, mixed, superactive Argic Pachic Cryoboroll (pedon 53). All colors are for moist conditions.

0 to 12 cm: black (10YR 2/1) loam; moderately acid (pH 6.0).

12 to 50 cm: very dark grayish brown (10YR 3/2) gravelly loam; few thin clay films on ped faces; moderately acid (pH 5.6).

50 to 65 cm: dark brown (10YR 3/3) very gravelly loam; common thin clay films on ped faces; slightly acid (pH 6.4).

65 to 100 cm: dark brown (10YR 3/3) extremely gravelly sandy loam; slightly acid (pH 6.4).

Cloud Peak family: These soils have ochric epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit forming under forest habitat types in fan alluvium and glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboralf (pedon 300). All colors are for moist conditions.

3 to 0 cm: litter layer.

0 to 12 cm: dark grayish brown (10YR 4/2) gravelly loam; neutral (pH 7.0).

12 to 45 cm: dark grayish brown (10YR 4/2) gravelly loam; few, distinct, clay films on ped faces; neutral (pH 7.0).

45 to 73 cm: dark brown (10YR 4/3) very gravelly loam; common, distinct, clay films on ped faces; mildly alkaline (pH 7.5).

73 to 100 cm: brown (10YR 5.3) very gravelly loam; mildly alkaline (pH 7.5).

Dissimilar inclusions: Hobacker family soils have thick mollic epipedons and skeletal subsoil layers. Hobacker soils form under the nonforested FEID/AGCA and ARTR/FEID habitat types. Cryaquept soils have aquic conditions for some time during the growing season. Soils with aquic conditions occupy approximately 1 percent of the map unit and form under wet forest habitat types and in marsh areas of *Carex* species.



2975 Hobacker Family-Cratermo Family-Ripple Family Complex

Summary

This complex forms on earthflows. Slopes are commonly between 5 and 40 percent. The surficial deposits are earthflow debris derived from andesite or sedimentary rock types. The main habitat types in this nonforested map unit are ARTR/FEID, FEID/AGCA, and DECE/CAREX. There are also inclusions of forested habitat types. Small areas of soils with aquic conditions occur in the map unit, but not in every delineation. Small inclusions of bedrock outcrop occur throughout the map unit. The main soils are skeletal Mollisols with thick epipedons, nonskeletal Mollisols with thick epipedons and argillic horizons, and nonskeletal Inceptisols.

Components

- 40% *Hobacker family* and similar inclusions (Gallatin, Greyback, and Teton families)
- 30% *Cratermo family* and similar inclusions (Sawfork, Badwater, and Passcreek families)
- 20% *Ripple family* and similar inclusions (Shadow and Bobtail families)
- 10% *Dissimilar inclusions* (Aquic Cryoborolls and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	46	27	>100	85 - 100	49
Similar inclusions	13 - 50	23 - 28	>100	80 - 100	26 - 58
Cratermo family	28	44	>100	75 - 100	58
Similar inclusions	20 - 57	24 - 31	>100	75 - 100	25 - 60
Ripple family	5	26	>100	75 - 95	0
Similar inclusions	12 - 45	15 - 20	>100	60 - 90	0 - 4

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They form under nonforested habitat types in earthflow deposits.

Typical profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 637). All colors are for moist conditions.

0 to 21 cm: very dark grayish brown (10YR 3/2) gravelly silty clay loam; slightly acid (pH 6.2).

21 to 40 cm: dark brown (10YR 3/3) silty clay loam; neutral (pH 6.8).

40 to 54 cm: dark yellowish brown (10YR 3/4) silty clay loam; slightly acid (pH 6.4).

54 to 100 cm: dark yellowish brown (10YR 4/4) very gravelly clay loam; slightly acid (pH 6.4).

Cratermo family: These soils have thick mollic epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit these soils are fine to medium textured. They form under nonforested habitat types in earthflow deposits.

Typical profile: Fine, mixed, superactive Argic Pachic Cryoboroll (pedon 65). All colors are for moist conditions.

0 to 8 cm: black (10YR 2/1) loam; neutral (pH 6.8).

8 to 33 cm: very dark grayish brown (2.5Y 3/2) clay; many distinct clay films on ped faces; neutral (pH 7.2).

33 to 56 cm: very dark gray (10YR 3/1) very gravelly clay; common distinct clay films on ped faces; neutral (pH 7.2).

56 to 100 cm: very dark gray (10YR 3/1) very gravelly clay; few distinct clay films on ped faces; slightly alkaline (pH 7.4).

Ripple family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They form under nonforested habitat types in earthflow deposits.

Typical Profile: Fine-loamy, mixed, superactive Typic Cryochrept (pedon 3248). All colors are for moist conditions.

0 to 33 cm: dark brown (7.5YR 4/3) silt loam; slightly acid (pH 6.4).

33 to 100 cm: brown (7.5YR 5/3) loam; slightly acid (pH 6.4).

Dissimilar inclusions: Aquic Cryoborolls have mollic epipedons and aquic conditions during the growing season. Soils with aquic conditions make up approximately 5 percent of the total map unit. Bedrock outcrops are composed of andesite or sedimentary rocks, and make up between 5 and 15 percent of any delineation.



2996 Shook Family-Badwater Family-Passcreek Family Complex

Summary

This map unit forms on a complex of glaciofluvial plains, kames, and terraces. Slopes are commonly less than 20 percent. The main surficial deposit is glaciofluvial alluvium derived from andesite or sedimentary rocks. Small areas of fan alluvium, recent stream alluvium, colluvium, and glacial till also occur. This is a nonforested map unit dominated by

the ARTR/FEID, FEID/AGCA, FEID/AGSP, FEID/DECE, and DECE/CAREX habitat types. Soils with aquic conditions can occupy up to 15 percent of any delineation, but do not occur in every delineation. The main soils are nonskeletal Mollisols with thick epipedons, skeletal Mollisols with thick epipedons and argillic horizons, and nonskeletal Mollisols with argillic horizons.

Components

40% *Shook family* and similar inclusions (Hobacker family)

30% *Badwater family* and similar inclusions (Stubbs family)

15% *Passcreek family* and similar inclusions (Teton family)

15% *Dissimilar inclusions* (McCort family and Aquic Cryoborolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Shook family	16	11	>100	85 - 95	73
Similar inclusions	48	17	>100	75 - 100	53
Badwater family	55	26	>100	80 - 100	77
Similar inclusions	15	25	>100	80 - 100	50
Passcreek family	12	24	>100	80 - 100	28
Similar inclusions	18	22	>100	75 - 100	24

Shook family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under the ARTR/FEID and FEID/AGCA habitat types in glaciofluvial and recent stream alluvium.

Typical Profile: Coarse-loamy, mixed, superactive Pachic Cryoboroll (pedon 3210). All colors are for moist conditions.

0 to 34 cm: very dark grayish brown (10YR 3/2) gravelly loam; medium acid (pH 6.0).

34 to 65 cm: very dark grayish brown (10YR 3/2) gravelly sandy loam; slightly acid (pH 6.2).

65 to 100 cm: dark brown (10YR 3/3) very gravelly sandy loam; slightly acid (pH 6.4).

Badwater family: These soils have thick mollic epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. They occur throughout the map unit forming under the ARTR/FEID, FEID/AGCA, and FEID/AGSP habitat types in glaciofluvial and fan alluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Argic Pachic Cryoboroll (pedon 170). All colors are for moist conditions.

0 to 53 cm: black (10YR 2/1) and very dark brown (10YR 2/2) gravelly loam; slightly acid to neutral (pH 6.5 to 7.0).

53 to 73 cm: dark brown (10YR 3/3) extremely cobbly sandy clay loam; few, distinct clay films in pores; neutral (pH 7.0).

73 to 100 cm: grayish brown (10YR 5/2) very gravelly sandy loam; mildly alkaline (pH 7.5).

Passcreek family: These soils have mollic epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured.

They occur throughout the map unit forming under the ARTR/FEID habitat type in glaciofluvial and fan alluvium.

Typical Profile: Fine-loamy, mixed, superactive Argic Cryoborolls (pedon 3390). All colors are for moist conditions.

0 to 25 cm: black (10YR 2/1) and very dark brown (10YR 2/2) silt loam; neutral (pH 6.6 to 6.8).

25 to 59 cm: dark brown (10YR 4/3) gravelly loam; few, faint clay films bridging sand grains; neutral (pH 6.8).

59 to 100 cm: dark brown (10YR 4/3) clay loam; common, prominent clay films on ped faces; neutral (pH 6.8).

Dissimilar inclusions: McCort family soils have weakly developed mollic epipedons and skeletal subsoil layers. Aquic Cryoboroll soils have aquic conditions for some time during the growing season. These soils form under the FEID/DECE and DECE/CAREX habitat types. Soils with aquic conditions make up approximately 3 percent of the total map unit.



353Z Cryorthents-sh and Hydrothermal Materials and Lithic Eutrochrepts Undifferentiated Group

Summary

This map unit is composed of neutral high-chloride hydrothermal areas and nonthermal areas that have been affected by hydrothermal activity. Approximately 60 percent of the map unit is actively thermal, but not every delineation includes thermal areas.

This undifferentiated group forms mainly on hydrothermal terraces, hydrothermal basins, and rolling glaciated uplands. Some alluvial basins also occur within the unit. Slopes are commonly less than 10 percent. The main surficial deposits are recent alluvium, residuum, glacial till, and colluvium derived from siliceous sinter and altered rhyolite. Small areas of glaciofluvial alluvium, fan alluvium, and lacustrine sediments are also included. Thermal community types are the main vegetation in thermal areas. Forested areas are dominated by wet forest habitat types, the ABLA/VASC-VASC habitat type, and the ABLA/VASC-CARU habitat type. Nonforested, nonthermal areas are dominated by the DECE/CAREX habitat type and marsh areas of *Carex* species. Soils with aquic conditions make up 20 percent of the map unit. Bedrock outcrops occur in this map unit, but not in every delineation. The main soils in thermal areas have mean annual soil temperatures warmer than 8 °C. They are shallow Entisols, shallow Inceptisols, and Inceptisols with aquic conditions. The main soils in nonthermal areas are shallow Entisols and shallow Inceptisols with cryic temperature regimes.

Components

Thermal areas

- 20% *Tropaquepts*
and similar inclusions (Cryaquepts)
- 15% *Hydrothermal materials*
- 15% *Lithic Eutrochrepts*
and similar inclusions (Typic Eutropepts)
- 10% *Lithic Udorthents*

Nonthermal areas

- 15% *Cryorthents-sh*
- 10% *Whitecross family*

15% *Dissimilar inclusions* (Bedrock outcrops, Billycreek family, Lithic Dystrochrepts, and Typic Dystropepts)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Tropaquepts	5	22	>100	55 - 100	10
Similar inclusions	14	16	>100	60 - 100	6
Cryorthents-sh	8	8	5 - 15	90 - 100	0
Lithic Eutrochrepts	37	9	8 - 25	65 - 100	1
Similar inclusions	10	7	>100	65 - 100	2
Lithic Udorthents	34	10	7 - 20	45 - 95	2
Whitecross family	40	8	15 - 25	60 - 90	3

Tropaquepts: These soils have ochric epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. Mean annual soil temperatures range from 8 through 20 °C. In this map unit they are medium or moderately coarse textured. The most common vegetation is the DECE/CAREX habitat type, Carex marsh areas, or thermal communities composed of hydrophyllic plants. The soils form in silica-rich alluvium composed of diatoms, plant opal, quartz, and siliceous sinter.

Typical profile: Histic Tropaquept (pedon 3318). All colors are for moist conditions.

0 to 23 cm: slightly decomposed organic material; neutral (pH 6.6).

23 to 33 cm: grayish brown (2.5Y 5/2) sandy loam; neutral (pH 6.6).

33 to 100 cm: light grey (10YR 7/2) silt loam; neutral (pH 7.2); mean annual soil temperature = 18 °C at 50 cm.

Cryorthents-sh: These soils have ochric epipedons and shallow root-limiting layers. Mean annual soil temperatures are less than 8 °C. In this map unit they are medium to coarse textured. The most common vegetation is scattered stands of Lodgepole pine mixed with nonforested areas. The soils form in glacial till and alluvium over residuum, or from residuum derived from siliceous sinter.

Typical profile: Lithic Cryorthent (pedon 398). All colors are for moist conditions.

0 to 6 cm: dark grayish brown (10YR 4/2) loamy sand; slightly alkaline (pH 7.8).

6 to 17 cm: paralithic contact with siliceous sinter.

17 cm: lithic contact with siliceous sinter.

Hydrothermal materials: These areas are composed of siliceous sinter and thermal pools. They make up from 0 to 50 percent of any delineation.

Lithic Eutrochrepts: These soils have ochric epipedons and very shallow root-limiting layers. Mean annual soil temperatures range from 10 through 25 °C. In this map unit they are medium to coarse textured. The most common hydrothermal communities are composed of grass and forbs or stunted trees and grass. The soils form in residuum derived from siliceous sinter.

Typical profile: Typic Eutrochrept (pedon 3202). All colors are for moist conditions.

3 to 0 cm: litter layer

0 to 5 cm: dark brown (10YR 3/3) gravelly sandy loam; neutral (pH 7.0).

5 to 8 cm: brown (10YR 4/3) very gravelly loamy sand; neutral (pH 7.0).

8 to 13 cm: pale brown (10YR 6/3) gravelly sandy loam; neutral (pH 7.0); mean annual soil temperature = 10 °C at 13 cm.

13 cm: lithic contact with siliceous sinter.

Lithic Udorthents: These soils have ochric epipedons and shallow root-limiting layers. Mean annual soil temperatures range from 10 through 55 °C. In this map unit these soils are medium to coarse textured. The base saturation of the soils is lowest in areas where acid-sulfate processes mix with neutral-chloride processes. The most common hydrothermal communities are composed of moss, grass and moss, or stunted trees and moss. The soils form in residuum derived from siliceous sinter.

Typical profile: Lithic Udorthent (pedon 3320). All colors are for moist conditions.

0 to 16 cm: brown (10YR 5/3) gravelly sandy loam; neutral (pH 7.2).

16 cm: lithic contact with siliceous sinter; mean annual soil temperature = 20 °C at 16 cm.

Whitecross family: These soils have ochric epipedons and shallow root-limiting layers. Mean annual soil temperatures are less than 8 °C. In this map unit they are medium to coarse textured. The most common vegetation is the ABLA/VASC habitat type or various PICO habitat types. The soils form in glacial till and alluvium over residuum derived from siliceous sinter.

Typical profile: Loamy-skeletal, mixed, superactive Lithic Cryochrept (pedon 40). All colors are for moist conditions.

0 to 3 cm: very dark grayish brown (10YR 3/2) very gravelly fine sandy loam; moderately acid (pH 5.8).

3 to 19 cm: brown (10YR 5/3) very gravelly fine sandy loam; slightly acid (pH 6.4).

19 to 36 cm: paralithic contact with siliceous sinter.

36 cm: lithic contact with siliceous sinter

Dissimilar inclusions: Bedrock outcrops, composed of altered rhyolite or siliceous sinter, make up approximately five percent of the map unit. Billycreek family soils are greater than 100 centimeters deep and have nonskeletal subsoil layers with coarse textures. They occur within the nonthermal portions of the map unit. Both of the following soils form within hydrothermal areas, usually adjacent to acid-sulfate areas. Lithic Dystrochrept soils have shallow root-limiting layers and Typic Dystropept soils are greater than 100 centimeters deep.



358Z Cryochrepts-HT&sh and Hydrothermal Materials and Hanks Family Undifferentiated Group

Summary

This map unit is composed of acid-sulphate hydrothermal areas and nonthermal areas that have been affected by hydrothermal activity. Approximately 35 percent of the map unit is actively thermal, though not every delineation includes thermal areas. This undifferentiated group forms on a variety of landforms including rolling glaciated uplands, glaciated plateaus, rolling fluvial uplands, and hydrothermal valleys. Slopes are commonly

less than 25 percent. The main surficial deposits are glacial till, colluvium, residuum, and glaciofluvial alluvium derived from acid-altered rhyolite or siliceous sinter. Smaller areas of fan alluvium are also included. Thermal community types make up the main vegetation in thermal areas. Forested areas are dominated by the ABLA/VASC-VASC habitat type, wet forest habitat types, and the ABLA/CARU habitat type. Soils with aquic conditions occur in this map unit, but not in every delineation. The main soils in thermal areas, Inceptisols and Entisols, have mean annual soil temperatures warmer than 8 °C. The main soils in nonthermal areas are shallow Inceptisols and nonskeletal Inceptisols.

Components

Thermal areas

- 15% *Hydrothermal material*
- 10% *Typic Dystropepts*
- 10% *Typic Troporthents*

Nonthermal areas

- 20% *Cryochrepts-HT&sh* and similar inclusions (*Cryochrepts-sh&s* and *Cryorthents-sh*)
- 20% *Hanks family* and similar inclusions (*Bobtail family*, *Ivywild family*, and *Dystric Cryochrept-HT*)
- 10% *Bedrock outcrops*

- 15% *Dissimilar inclusions* (*Cryaquepts*, *Tropaquepts*, *Ripple family*, *Lithic Udorthents*, and *Lithic Dystrochrepts*)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Cryochrepts-HT&sh	31	18	25 - 45	5 - 40	2
Similar inclusions	30 - 52	7 - 11	10 - 50	15 - 55	1
Hanks family	23	12	>100	35 - 55	0
Similar inclusions	18 - 55	11 - 15	>100	25 - 65	1
Typic Dystropepts	5	9	>100	5 - 60	1
Typic Troporthents	28	8	>100	5 - 65	1

Cryochrepts-HT&sh: These soils have ochric epipedons and shallow root-limiting layers. Mean annual soil temperatures are less than 8 °C. In this map unit these soils are medium or moderately coarse textured. The main vegetation is the ABLA/VASC habitat type or various PICO habitat types. The soils form in glacial till over acid-altered rhyolite or in residuum derived from acid-altered rhyolite or siliceous sinter.

Typical profile: Dystric Cryochrept (pedon 368). All colors are for moist conditions.

0 to 2 cm; brown (10YR 4/3) loam; ultra acid (pH 3.4).

2 to 13 cm; yellowish brown (10YR 5/4) gravelly loam; ultra acid (pH 3.5).

13 to 40 cm; light yellowish brown (10YR 6/4) gravelly sandy clay loam; extremely acid (pH 3.9).

40 to 60 cm; paralithic contact with weathered rhyolite.

60 cm; lithic contact with altered rhyolite.

Hanks family: These soils have ochric epipedons and are greater than 100 centimeters deep. Mean annual soil temperatures are less than 8 °C. In this map unit they are medium or moderately coarse textured. They form under forested habitat types in glacial till, glaciofluvial alluvium and colluvium derived from altered rhyolite and siliceous sinter.

Typical profile: Coarse-loamy, mixed, superactive Dystric Cryochrept (pedon 560). All colors are for moist conditions.

3 to 0 cm; litter layer.

0 to 20 cm; dark brown (10YR 3/3) gravelly sandy loam; moderately acid (pH 5.8).

20 to 100 cm; dark yellowish brown (10YR 4/4) gravelly sandy loam; moderately acid (pH 5.6).

Hydrothermal materials: These areas are composed of acid-altered rhyolite, acid-altered siliceous sinter, and siliceous residue. They make up from 0 to 40 percent of any delineation.

Typic Dystropepts: These soils have ochric epipedons and are greater than 100 centimeters deep. Mean annual soil temperatures range from 11 through 55 °C. In this map unit they are medium to coarse textured. The most common hydrothermal communities are composed of grass and forbs or stunted trees and grass. The soils form in residuum derived from acid-altered rhyolite.

Typical profile: Typic Dystropept (pedon 504). All colors are for moist conditions.

0 to 6 cm; brown (10YR 4/3) loamy sand; extremely acid (pH 4.4).

6 to 50 cm; pale brown (10YR 6/3) and light yellowish brown (10YR 6/4) loamy sand; strongly acid (pH 5.4); mean annual soil temperature = 52 °C at 50 cm.

50 to 64 cm; yellowish red (5YR 5/6) and reddish yellow (5YR 6/6) sandy loam and loamy sand; strongly acid to moderately acid (pH 5.4 to 5.6).

64 to 100 cm; white (5YR 8/1) sand; strongly acid (pH 5.4).

Bedrock outcrops: These areas are mainly composed of altered rhyolite. Bedrock outcrops make up from 0 to 60 percent of any delineation.

Typic Troporthent: These soils have ochric epipedons and are greater than 100 centimeters deep. Mean annual soil temperatures range from 20 through 65 °C. In this map unit they are moderately coarse or coarse textured. The most common hydrothermal communities are composed of moss, grass and moss, or stunted trees and moss. The soils form in residuum derived from acid-altered rhyolite.

Typical profile: Typic Troporthent (pedon 147). All colors are for moist conditions.

1 to 0 cm; dried moss and pine needles

0 to 3 cm; black (10YR 2/1) gravelly sandy loam; extremely acid (pH 3.5).

3 to 100 cm; white (10YR 8/1 and 10YR 8/2) fine sandy loam and gravelly fine sandy loam; extremely acid (pH 3.8 to 4.0); mean annual soil temperature = 23 °C at 50 cm.

Dissimilar inclusions: Cryaquept and Tropaquept soils have aquic conditions. Tropaquept soils occur in thermal areas and Cryaquept soils occur in nonthermal areas. Approximately 7 percent of this map unit is made up of soils with aquic conditions. Ripple family soils are nonthermal and have finer textures than the main components. Lithic Udorthent and Lithic Dystrochrept soils are found within active thermal areas and have shallow to very shallow root-limiting layers. The root-limiting layers are composed of acid-altered rhyolite or siliceous sinter.



3835 Granturk Family-Bottle Family-Cryochrepts-sh&s Complex

Summary

This complex forms on glaciated plateaus with slopes less than 10 percent. The main surficial deposits are glacial rubble and glacial till derived from rhyolite or rhyolitic ash-flow tuff.

Smaller areas of residuum, loess, colluvium, and glaciofluvial alluvium also occur. This is a forested map unit dominated by

the ABLA/VASC-VASC, ABLA/CARO, and ABLA/VASC-PIAL habitat types. Small nonforested areas are also included. Inclusions of bedrock outcrop are present in this map unit, but do not occur in every delineation. The main soils are nonskeletal Inceptisols with root-limiting layers, nonskeletal Inceptisols with coarse textures, and skeletal Inceptisols with root-limiting layers and coarse textures.

Components

30% *Granturk family* and similar inclusions (Cryochrepts-sh&ns and Elkner family)

30% *Bottle family* and similar inclusions (Billycreek, Trude, and Hanks families)

30% *Cryochrepts-sh&s* and similar inclusions (Priestlake and Whitecross families)

10% *Dissimilar inclusions* (Matcher family, Arcette family, and bedrock outcrops)



423Z Arrowpeak Family and Greyback Family and Lithic Eutrochrepts Undifferentiated Group

Summary

This map unit is a mixture of travertine hydrothermal areas, and nonthermal areas that have been affected by hydrothermal activity. Approximately 30 percent of the map unit is thermal, though not every delineation includes thermal areas. This undifferentiated group forms on hydrothermal rolling uplands, hydrothermal terraces, and earthflows. Slopes are commonly less than 20 percent. The main surficial deposits are glacial till, residuum, recent alluvium, and colluvium derived from travertine. There are also small areas of fan alluvium. Various thermal communities make up the main vegetation within hydrothermal areas. Forested areas are dominated by the PSME/SYAL, ABLA/THOC, and ABLA/VASC-CARU habitat types together with areas of Limber pine. Nonforested, nonthermal areas are dominated by the ARTR/FEID habitat type. Soils with aquic conditions and areas of bedrock outcrop occur in this map unit, but not in every delineation. The main soils in thermal areas have mean annual soil temperatures warmer than 8 °C. This includes Inceptisols and Entisols with root-limiting layers. The main soils in nonthermal areas are Mollisols with root-limiting layers and skeletal Mollisols.

Components

Thermal areas

10% *Lithic Eutrochrepts*
 10% *Lithic Udorthents*
 10% *Hydrothermal materials*

Nonthermal areas

25% *Arrowpeak family* and similar inclusions (Mosroc and Jenkinson families)
 25% *Greyback family* and similar inclusions (Sawfork and Hobacker families)

20% *Dissimilar inclusions* (Aquic Cryoborolls, Tropaquepts, bedrock outcrops, and Cryorthents-sh)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Arrowpeak family	50	27	15 - 45	85 - 100	28
Similar inclusions	20 - 49	22 - 28	20 - 45	80 - 100	20 - 30
Greyback Family	45	18	>100	90 - 100	23
Similar inclusions	50 - 55	20 - 26	>100	80 - 100	25 - 60
Lithic Eutrochrepts	10	10	25 - 45	100	3
Lithic Udorthents	20	8	5 - 30	95 - 100	2

Arrowpeak family: These soils have mollic epipedons and shallow root-limiting layers. Mean annual soil temperatures are less than 8 °C. In this map unit the soils are moderately fine or medium textured. They form under the forested ABLA/VASC-CARU and the nonforested ARTR/FEID habitat types in glacial till over travertine or in residuum derived from travertine.

Typical profile: Loamy-skeletal, mixed, superactive Lithic Cryoboroll (pedon 45). All colors are for moist conditions.

0 to 18 cm; very dark grayish brown (10YR 3/2) very dark grayish brown (10YR 3/2) gravelly loam; neutral (pH 7.2).

18 to 38 cm; dark brown (10YR 3/3) very cobbly loam; slightly alkaline (pH 7.8); slightly to strongly effervescent.

38 cm; lithic contact with travertine.

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. Mean annual soil temperatures are less than 8 °C. In this map unit they are medium or moderately coarse textured. They form under forested habitat types in glacial till and colluvium derived from travertine.

Typical profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 28). All colors are for moist conditions.

0 to 18 cm; very dark grayish brown (10YR 3/2) gravelly loam; moderately alkaline (pH 8.0); slightly effervescent.

18 to 50 cm; dark brown (10YR 3/3) very gravelly loam; moderately alkaline (pH 8.0); strongly effervescent.

50 to 100 cm; dark brown (10YR 3/3) very gravelly sandy loam; moderately alkaline (pH 8.0); strongly effervescent.

Hydrothermal materials: These areas are composed of both active and inactive travertine terraces and hydrothermal pools. They can make up from 0 to 40 percent of any delineation.

Lithic Eutrochrepts: These soils have ochric epipedons and shallow root-limiting layers. Mean annual soil temperatures range from 8 through 30 °C. In this map unit they are medium or moderately coarse textured. The most common hydrothermal communities are composed of grass and forbs or stunted trees and grass. The soils form in residuum derived from travertine.

Typical profile: Lithic Eutrochrept (pedon 3319). All colors are for moist conditions.

0 to 10 cm; brown (7.5YR 5/3) silt loam; moderately alkaline (pH 8.4); strongly effervescent.

10 to 18 cm; very pale brown (10YR 7/3) sandy loam; slightly alkaline (pH 7.8); strongly effervescent.

18 to 38 cm; light gray (10YR 7/2) gravelly sandy loam; slightly alkaline (pH 7.8); strongly effervescent.

38 cm; lithic contact with travertine; mean annual soil temperature = 15 °C at 38 cm.

Lithic Udorthents: These soils have ochric epipedons and shallow root-limiting layers. Mean annual soil temperatures range from 8 through 30 °C. In this map unit they are moderately coarse or coarse textured. The most common hydrothermal communities are composed of moss, grass and moss, or stunted trees, grass, and moss. The soils form in residuum derived from travertine.

Typical profile: Lithic Udorthent (pedon 3206). All colors are for moist conditions.

0 to 4 cm; brown (10YR 5/3) sandy loam; moderately alkaline (pH 8.2); violently effervescent.

4 to 14 cm; pale brown (10YR 6/3) gravelly loamy sand; moderately alkaline (pH 8.2); violently effervescent.

14 to 26 cm; paralithic contact with weathered travertine; mean annual soil temperature = 21 °C at 14 cm.

26 cm; lithic contact with travertine.

Dissimilar inclusions: Both Aquic Cryoboroll and Tropaquept soils have aquic conditions for some time during the year. Aquic Cryoboroll soils have mollic epipedons. Tropaquept soils form in thermal areas and have ochric epipedons. Approximately 5 percent of this map unit is made up of soils with aquic conditions. Bedrock outcrops are composed of travertine. Cryorthent-sh soils are weakly developed, and have very shallow root-limiting layers and carbonatic or mixed mineralogy.



513 Bedrock Outcrop-Como Family Complex

Summary

This complex forms on stream breaks, glacial trough valley walls and fluvial bluffs. Slopes are commonly greater than 45 percent. The surficial deposits are mainly colluvium with some glacial till, derived from rhyolite or rhyolitic ash-flow tuff. Smaller areas derived from dacite and granite are also included. Portions of the Grand Canyon of the Yellowstone are included in

this unit. This is a forested map unit made up mainly of ABLA/VASC-VASC, ABLA/VASC-PIAL, and ABLA/VAGL habitat types. There are inclusions of other habitat types, both forested and nonforested. Bedrock outcrops and talus slopes occupy large areas of this map unit. The main soils in the remaining areas are skeletal Inceptisols with coarse textures.

Components

70% *Bedrock outcrop and talus*

20% *Como family* and similar inclusions (Trude family)

10% *Dissimilar inclusions* (Priestlake family, Whitecross family, and Cryochrepts-HT&sh)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Como family	66	4	>100	40 - 95	7
Similar inclusions	60	5	>100	30 - 55	5

Bedrock outcrops and talus: These areas are composed of rhyolite and welded, ash-flow tuff. Bedrock outcrops and talus slopes make up from 40 to 95 percent of any delineation.

Como family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They form under forests in colluvium on steep slopes.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryochrept (pedon 775). All colors are for moist conditions.

5 to 0 cm: litter layer.

0 to 7 cm: dark brown (10YR 3/3) very gravelly loam; moderately acid (pH 6.0).

7 to 23 cm: brown (10YR 4/3) very gravelly loam; neutral (pH 6.6).

23 to 100 cm: dark yellowish brown (10YR 4/4) very gravelly and extremely gravelly loamy sand; neutral (pH 7.0 to 7.2).

Dissimilar inclusions: Priestlake family, Whitecross family, and Cryochrepts-HT&sh soils have ochric epipedons and root-limiting layers. Priestlake family soils are moderately deep and Whitecross family soils are shallow or very shallow. These soils often occur in close association with bedrock outcrops. Cryochrepts-HT&sh soils are formed from altered rhyolite within the Grand Canyon of the Yellowstone.



5217F Bedrock Outcrop-Pesowyo Family-Lamedeer Family Complex

Summary

This complex forms under a frigid temperature regime on stream breaks and glacial trough valley walls. Slopes are commonly greater than 45 percent. The surficial deposits are mainly colluvium with some glacial till, derived from schist, gneiss, or sedimentary rocks. This is a nonforested map unit composed

mainly of the ARTR/AGSP, ARTR/FEID, AGSP/POSA, and FEID/AGSP habitat types. Small areas of forested, Douglas fir habitat types are also included. Bedrock outcrops and talus slopes occupy large areas of this map unit. The main soils in the remaining areas are skeletal Mollisols and skeletal Inceptisols.

Components

40% *Bedrock outcrop and talus*

35% *Pesowyo family* and similar inclusions (Lolo family)

20% *Lamedeer family*

5% *Dissimilar inclusions* (Gateson and Hobacker families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Pesowyo family	70	14	>100	80 - 90	24
Similar inclusions	60	17	>100	80 - 100	46
Lamedeer family	63	30	>100	100	0

Bedrock outcrops and talus: These areas are composed of schists, gneisses, and sedimentary rocks. Bedrock outcrops and talus slopes make up from 15 to 65 percent of any one delineation.

Pesowyo family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse textured. The soils forming from sedimentary rocks are sometimes enriched in calcium carbonate. They form under dry, nonforested vegetation in colluvium.

Typical profile: Loamy-skeletal, mixed, superactive Typic Haploboroll (pedon 521). All colors are for moist conditions.

0 to 27 cm: very dark grayish brown (10YR 3/2) very gravelly fine sandy loam; neutral (pH 6.6).

27 to 100 cm: dark brown (10YR 4/3) very gravelly and extremely gravelly fine sandy loam; slightly acid to neutral (pH 6.5 to 6.6).

Lamedeer family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to coarse textured. The soils forming from sedimentary rocks are sometimes enriched in calcium carbonate. They form under dry, nonforested vegetation in colluvium.

Typical profile: Loamy-skeletal, mixed, superactive, frigid Typic Ustochrept (pedon 3235). Colors are for moist conditions.

0 to 7 cm: black (10YR 2/1), extremely gravelly loamy sand; neutral (pH 7.2).

7 to 36 cm: dark brown (10YR 3/3), very gravelly loamy sand; neutral (pH 6.6 to 6.8).

36 to 100 cm: dark yellowish brown (10YR 4/4) very gravelly and extremely gravelly clay loam; neutral (pH 7.0).

Dissimilar inclusions: Gateson family soils have argillic horizons and form in glacial till. The Hobacker family soils have thick mollic epipedons and form under a colder temperature regime than the main components.



522 Bedrock Outcrop-Hobacker Family Complex

Summary

This complex forms on stream breaks, glacial trough valley walls, and rolling glaciated uplands. The most common slopes are greater than 35 percent. The surficial deposits are colluvium and glacial till. This map unit is forested and consists of Douglas Fir habitat types, primarily PSME/SYAL and PSME/CARU. Mosaics of sparse forest and nonforested habitat types are also included. Bedrock outcrops and talus slopes dominate this map unit. The main soils in the remaining areas are skeletal Mollisols

with thick epipedons.

Components

70% *Bedrock outcrops and talus*

25% *Hobacker family* and similar inclusions (Greyback, Bearmouth, Stubbs, and Lolo families)

5% *Dissimilar inclusions* (Shadow family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	42	11	>100	70 - 90	53
Similar inclusions	20 - 65	6 - 25	>100	60 - 100	24 - 60

Bedrock outcrops and talus: These areas are composed of gneiss, schist, granite, or andesite. Small areas of basalt and sedimentary rocks are also included in this component. Bedrock outcrops and talus slopes make up from 60 to 70 percent of any delineation.

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They form under forests in colluvium and glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 157). All colors are for moist conditions.

4 to 0 cm: litter layer.

0 to 4 cm: black (10YR 2/1) loam; neutral (pH 7.0).

4 to 57 cm: very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) channery very fine sandy loam; slightly acid to neutral (pH 6.5 to 6.7).

57 to 100 cm: dark grayish brown (2.5Y 4/2) very cobbly very fine sandy loam; slightly acid (pH 6.2).

Dissimilar inclusions: The Shadow family soils have ochric epipedons and skeletal subsoil layers.



5294 Bedrock Outcrop-Hobacker Family-Badwater Family Complex

Summary

This complex forms on glacial trough valley walls and areas of rolling glaciated uplands with bedrock outcrops. Slopes are commonly between 25 to 50 percent. The main surficial deposits are glacial till and colluvium derived from andesite. In the northeast area of the park, limestone is mixed with the andesite. This is a nonforested map unit dominated by the FEID/AGCA, ARTR/FEID, and DECE/CAREX habitat types and areas of

alpine meadows. Inclusions of forested habitat types also occur. Most of the map unit is made up of bedrock outcrops and talus slopes. The main soils in the remaining areas are skeletal Mollisols with thick epipedons and skeletal Mollisols with thick epipedons and argillic horizons.

Components

60% *Bedrock outcrop and talus*

15% *Hobacker family* and similar inclusions (Greyback and Gallatin families)

15% *Badwater family* and similar inclusions (Sawfork and Granmount families)

10% *Dissimilar inclusions* (Arrowpeak and Mosroc families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hobacker family	50	20	>100	90 - 100	62
Similar inclusions	23 - 58	19 - 25	>100	85 - 100	26 - 65
Badwater family	57	33	>100	90 - 95	44
Similar inclusions	40 - 55	26 - 46	>100	85 - 95	22 - 30

Bedrock outcrops and talus: These areas are mainly composed of andesite, except in the northeast part of the study area, where bedrock is limestone or andesite. Small areas of other sedimentary rock types are also included in this component. Bedrock outcrops and talus slopes make up from 60 to 70 percent of any delineation.

Hobacker family: These soils have thick mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Pachic Cryoboroll (pedon 3328). All colors are for moist conditions.

4 to 0 cm: litter layer

0 to 45 cm: very dark brown (10YR 2/2) gravelly loam; neutral (pH 6.6).

45 to 68 cm: dark brown (10YR 3/2) very gravelly loam; neutral (pH 6.6).

68 to 100 cm: brown (10YR 4/3) extremely gravelly loam; neutral (pH 6.6).

Badwater family: These soils have mollic epipedons and argillic horizons. In this map unit they are fine or moderately fine textured. They form under the ARTR/FEID habitat type in colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Argic Pachic Cryoboroll (pedon 441). All colors are for moist conditions.

0 to 12 cm: black (10YR 2/1) loam; neutral (pH 6.8).

12 to 27 cm: dark grayish brown (2.5Y 3/2) gravelly clay loam; common, moderately thick clay films on ped faces and common, thin clay films lining pores; neutral (pH 7.2).

27 to 57 cm: dark brown (10YR 3/3) very gravelly sandy clay loam; common, moderately thick clay films on ped faces and common, thin clay films lining pores; slightly acid (pH 6.4).

57 to 100 cm: brown (10YR 4/3) very gravelly sandy clay loam; neutral (pH 7.0).

Dissimilar inclusions: The Arrowpeak and Mosroc family soils have shallow root-limiting layers and mollic epipedons. The Mosroc family soils also have argillic horizons.



5419 Bedrock Outcrop-Silvercliff Family Complex

Summary

This complex forms on glacial trough valley walls and areas of rolling glaciated uplands with bedrock outcrops. Slopes are commonly greater than 35 percent. The surficial deposits are mainly glacial till and colluvium derived from andesite. In the northeast area of the park, limestone is mixed with the andesite. This is a forested map unit dominated by the ABLA/VASC-PIAL, ABLA/VASC-VASC, ABLA/VAGL and PIAL/VASC

habitat types. Inclusions of nonforested habitat types also occur. Bedrock outcrops and talus slopes dominate this map unit. The main soils in the remaining areas are skeletal Mollisols with root-limiting layers.

Components

65% *Bedrock outcrop and talus*

20% *Silvercliff family* and similar inclusions (Arrowpeak and Whitecross families)

15% *Dissimilar inclusions* (Shadow, Rimton, Hobacker, and Sawfork families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Silvercliff family	61	15	55 - 80	75 - 80	28
Similar inclusions	54 - 62	14 - 19	15 - 45	65 - 100	7 - 23

Bedrock outcrops and talus: These areas are mainly composed of andesite, except in the northeast area, where bedrock is limestone or andesite. Some areas of other sedimentary rock types are also included in this component. Bedrock outcrops and talus slopes make up from 60 to 70 percent of any delineation.

Silvercliff family: These soils have mollic epipedons and moderately deep root-limiting layers. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under forests in glacial till and colluvium.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 3340). All colors are for moist conditions.

0 to 24 cm: very dark grayish brown (10YR 3/2) gravelly clay loam; moderately acid (pH 5.8).

24 to 56 cm: brown (10YR 4/3) very gravelly loam; moderately acid (pH 5.8).

56 cm: lithic contact with andesite bedrock.

Dissimilar inclusions: All of these inclusions are greater than 100 centimeters deep. Shadow family soils have ochric epipedons and skeletal subsoil layers. Rimton family soils have argillic horizons and dark surface layers. Hobacker family soils have thick mollic epipedons and skeletal subsoil layers. Passcreek family soils have mollic epipedons, argillic horizons, and nonskeletal subsoil layers.



554 Bedrock Outcrop-Arrowpeak Family Complex

Summary

This complex forms on glacial trough valley walls, glacial cirque headwalls, and landslide scarps. Slopes are commonly greater than 50 percent. The main surficial deposit is colluvium derived from andesite, basalt, sedimentary rocks, or metamorphic rocks. Small inclusions of glacial till also occur. The vegetation in this unit can be forested or nonforested and the habitat types are variable. Bedrock outcrops and talus slopes

dominate this map unit. The main soils in the remaining areas are skeletal Mollisols with root-limiting layers.

Components

70% *Bedrock outcrops and talus*

25% *Arrowpeak Family* and similar inclusions (Jenkinson, Emerald, and Silvercliff families)

5% *Dissimilar inclusions* (Gallatin and Rimton families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Arrowpeak Family	50	22	35 - 50	95 - 100	40
Similar inclusions	20 - 56	17 - 26	25 - 95	80 - 100	19 - 27

Bedrock outcrops and talus: These areas are mainly composed of andesite. Some areas of basalt, sedimentary rocks, and metamorphic rocks are also included in this component. Bedrock outcrops and talus slopes make up from 60 to 95 percent of any delineation.

Arrowpeak family: These soils have mollic epipedons and shallow root-limiting layers. In this map unit they are medium textured. They occur throughout the map unit, forming in colluvium and glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Lithic Cryoboroll (pedon 601). All colors are for moist conditions.

0 to 48 cm: dark brown (7.5YR 3/2) very gravelly loam; slightly acid to neutral (pH 6.6 to 6.8).

48 cm: lithic contact with andesite bedrock.

Dissimilar inclusions: Both of these inclusions are greater than 100 centimeters deep. Gallatin family soils have thick mollic epipedons and nonskeletal subsoil layers. Rimton family soils have ochric epipedons and argillic horizons.



5883 Bedrock Outcrop-Lasac Family-Castan Family Complex

Summary

This complex forms on fluvial bluffs and stream breaks. Slopes are commonly between 10 and 50 percent. The main surficial deposit is colluvium derived from rhyolite. Smaller areas of alluvium are also included. This is a forested map unit composed mainly of the ABLA/VASC-VASC habitat type. There are

also smaller areas of the ABLA/CARU and ABLA/VAGL habitat types. The main soils are skeletal Inceptisols with andic properties and skeletal Andisols with dark surface layers.

Components45% *Bedrock outcrops and talus*40% *Lasac family* and similar inclusions (Trude and Como families)10% *Castan family*5% *Dissimilar inclusions* (Priestlake family)**Soil Description and Distribution**

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Lasac family	65	2	>100	35 - 60	15
Similar inclusions	50 - 65	3 - 6	>100	35 - 65	4 - 10
Castan family	40	10	>100	35 - 75	35

Bedrock outcrops and talus: These areas are mainly composed of rhyolite. Bedrock outcrops occur as level surface exposures and as cliffs.

Lasac family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit forming under forests in colluvium derived from rhyolite.

Typical Profile: Ashy-skeletal, glassy Vitrandic Cryochrept (pedon 1225a) All colors are for dry conditions.

2 to 0 cm: litter layer.

0 to 15 cm: brown (10YR 5/3) gravelly silt loam.

15 to 25 cm: pale brown (10YR 6/3) gravelly silt loam.

25 to 43 cm: pale brown (10YR 6/3) extremely gravelly coarse sandy loam

43 to 150 cm: light brownish gray (10YR 6/2) very gravelly coarse sand.

Castan family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit forming under forests in colluvium derived from rhyolite.

Typical Profile: Ashy-skeletal, glassy Humic Vitricryand (pedon 1225b) All colors are for dry conditions.

2 to 0: litter layer.

0 to 28 cm: brown (10YR 4/3) cobbly silt loam.

28 to 41 cm: brown (10YR 5/3) cobbly loam.

41 to 124 cm: pale brown (10YR 6/3) and very pale brown (10YR 7/3) extremely gravelly sandy loam.

Dissimilar inclusions: Priestlake family soils have a root-limiting layer within 100 centimeters of the soil surface.



7153 Rinton Family and Hanks Family and Bedrock Outcrop Undifferentiated Group

Summary

This complex forms on rolling glaciated uplands. The most common slopes are between 3 and 20 percent. The main surficial deposit is glacial till derived from rhyolite. Smaller areas of colluvium and alluvium are also included. This is a forested map unit composed of the ABLA/VAGL and ABLA/CARU habitat types. Areas of bedrock outcrop are present in this map unit, but not in every delineation. The main soils are

nonskeletal Alfisols with dark colored surface horizons and nonskeletal Inceptisols.

Components

45% *Rinton family* and similar inclusions (Cloud Peak, Ansel, and Oleo families)

35% *Hanks family* and similar inclusions (Ivywild, Bobtail, and Dashiki families)

10% *Bedrock outcrops and talus*

10% *Dissimilar inclusions* (Moran and Taglake families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Rinton family	15	23	>100	20 - 40	13
Similar inclusions	10 - 48	10 - 25	>100	25 - 50	3 - 26
Hanks family	16	9	>100	20 - 50	8
Similar inclusions	10 - 42	5 - 13	>100	25 - 65	2 - 5

Rinton family: These soils have umbric epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit forming under forests in glacial till derived from rhyolite.

Typical Profile: Fine-loamy, mixed, superactive Mollic Cryoboralf (pedon 1580a) All colors are for dry conditions.

5 to 0 cm: litter layer.

0 to 25 cm: brown (10YR 5/3) silt loam.

25 to 78 cm: yellowish brown (5/4) silt loam.

78 to 107 cm: yellowish brown (5/4) and pale brown (6/3) gravelly loam; many, distinct clay films on ped faces.

Hanks family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under the ABLA/VASC-VASC habitat type in glacial till derived from rhyolite

Typical Profile: Coarse-loamy, mixed, superactive Dystric Cryochrept (pedon 1044). All colors are for moist conditions.

0 to 7 cm: very dark grayish brown (10YR 3/2) silt loam; extremely acid (pH 4.4).

7 to 20 cm: dark brown (10YR 3/3) silt loam; very strongly acid (pH 5.0).

20 to 53 cm: yellowish brown (10YR 5/6) gravelly sandy loam; strongly acid (pH 5.1).

53 to 67 cm: light olive brown (2.5YR 5/4) gravelly coarse sandy loam; strongly acid (pH 5.4).

67 to 112 cm: strong brown (7.5YR 5/6) loam; strongly acid (5.3).

Bedrock outcrops and talus: Bedrock outcrops are composed of rhyolite. Bedrock outcrops and talus slopes make up from 0 to 30 percent of any delineation.

Dissimilar inclusions: Moran family soils have umbric epipedons and skeletal subsoil layers. They occur on south-facing slopes under the ABLA/CARU habitat type. Taglake family soils have ochric epipedons and root-limiting layers within 100 centimeters of the soil surface.



7172F Rittel Family-Rombo Family-Beartooth Family Complex

Summary

This complex forms on earthflows under a frigid temperature regime. Slopes are most commonly between 10 and 25 percent. The majority of the surficial deposits are earthflow debris, but there are small areas where glacial till overlies the earthflow deposits. Most of these deposits are derived from sedimentary

rocks. This is a nonforested map unit, dominated by the ARTR/AGSP, ARTR/FEID, AGSP/POSA, and SAVE/AGSM habitat types. Small inclusions of soils with aquic conditions occur within every delineation. The main soils are nonskeletal Alfisols with fine textures, nonskeletal Inceptisols with fine textures, and nonskeletal Mollisols with medium textures. Most soils are enriched in sodium salts and calcium carbonate.

Components

40% *Rittel family* and similar inclusions (Gateson family)

35% *Rombo family* and similar inclusions (Lamedeer family)

10% *Beartooth family*

15% *Dissimilar inclusions* (Lolo family, Pesowyo family, bedrock outcrops, and soils with aquic conditions)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Rittel family	13	50	>100	80 - 100	0
Similar inclusions	10	32	>100	90 - 100	0
Rombo family	8	45	>100	100	0
Similar inclusions	50	24	>100	80 - 100	2
Beartooth family	20	20	>100	100	20

Rittel family: These soils have ochric epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are fine or moderately fine textured. The subsoil layers are commonly enriched in calcium carbonate and sodium. They form under nonforested habitat types in earthflow deposits.

Typical profile: Fine, mixed, superactive Typic Eutroboralf (pedon #2008). All colors are for moist conditions.

0 to 5 cm: brown (10 YR 4/3) gravelly loam; moderately alkaline (pH 8.0).

5 to 43 cm: dark brown (10YR 3/3) and brown (10YR 4/3) gravelly clay; common, distinct clay films on ped faces; moderately alkaline (pH 8.0).

43 to 100 cm: brown (10YR 5/3) gravelly silty clay loam; moderately alkaline (pH 8.0).

Rombo family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit these soils are fine or moderately fine textured. The subsoil layers are commonly enriched in calcium carbonate and sodium. They form under nonforested habitat types in earthflow deposits.

Typical profile: Fine, mixed, superactive, frigid Typic Eutrochrept (pedon #2005). All colors are for moist conditions.

0 to 7 cm: dark brown (10YR 3/3) clay; moderately alkaline (pH 8.0).

7 to 25 cm: brown (10YR 4/3) clay loam; strongly alkaline (pH 8.5).

25 to 58 cm: brown (10YR 5/3) clay; strongly alkaline (pH 8.5); strongly effervescent.

58 to 100 cm: brown (10YR 5/3) and yellowish brown (10YR 5/4) clay; strongly alkaline (pH 8.5); strongly effervescent.

Beartooth family: These soils have a mollic epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. The subsoil layers are commonly enriched in sodium. They form under nonforested habitat types in earthflow deposits mixed with glacial till.

Typical Profile: Fine-loamy, mixed, mixed Typic Argiboroll (pedon #116). All colors are for moist conditions.

0 to 19 cm: very dark grayish brown (10YR 3/2), gravelly sandy loam; moderately alkaline (pH 8.0).

19 to 34 cm: dark grayish brown (10 YR 4/2), gravelly sandy loam; moderately alkaline (pH 8.0).

34 to 45 cm: dark grayish brown (10YR 4/2), gravelly loam; common, distinct clay films lining pores; moderately alkaline (pH 8.0).

45 to 100 cm: very dark grayish brown (10YR 3/2) gravelly sandy loam; moderately alkaline (pH 8.0).

Dissimilar inclusions: Lolo and Pesowyo family soils have mollic epipedons and skeletal subsoil layers. Both of these soils form in deposits of glacial till. Soils with aquic conditions form in wet depressions within the earthflow deposits. Bedrock outcrops are composed of sedimentary rocks and make up approximately 5 percent of the map unit.



7562 Cloud Peak Family-Bedrock Outcrops-Cryaquepts Complex

Summary

This complex forms on areas of rolling glaciated uplands with bedrock outcrops and also within cirque basins. Slopes are commonly between 10 and 30 percent. The main surficial deposit is glacial till derived from sedimentary rocks. Small areas of fine-textured alluvium also occur. The main habitat types in this forested map unit are ABLA/VAGL, ABLA/CACA, ABLA/VASC, and various wet forest habitat types. There are

also nonforested inclusions of the DECE/CAREX habitat type, marsh areas of *Carex* species, and small areas of drier habitat types. Soils with aquic conditions make up approximately 15 percent of this map unit. The main soils are skeletal Alfisols and Inceptisols with aquic conditions.

Components

50% *Cloud Peak family* and similar inclusions (Ansel and Shadow families)

15% *Bedrock outcrops*

15% *Cryaquepts* and similar inclusions (Oxyaquic Cryaquepts and Cryaquolls)

20% *Dissimilar inclusions* (Sawfork, Greyback, and Hanks families, and Cryoboralfs-sh)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Cloud Peak family	44	33	>100	50 - 90	3
Similar inclusions	20 - 59	18 - 26	>100	45 - 100	1 - 4
Cryaquepts	19	18	>100	60 - 80	12
Similar inclusions	23 - 30	17 - 22	>100	65 - 85	8 - 30

Cloud Peak family: These soils have ochric epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under forests in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboralf (pedon 99) All colors are for moist conditions.

0 to 8 cm: dark brown (10YR 3/3) loam; strongly acid (pH 5.4).

8 to 17 cm: brown (10YR 4/3) very gravelly loam; strongly acid (pH 5.4).

17 to 40 cm: yellowish brown (10YR 5/4) very cobbly clay loam with few distinct clay films lining pores; strongly acid (pH 5.4).

40 to 100 cm: yellowish brown (10YR 5/4) very gravelly clay loam with many prominent clay films lining pores; strongly acid (pH 5.4).

Bedrock outcrops: These areas are mainly composed of sedimentary rocks. Bedrock outcrops and talus slopes make up from 10 to 20 percent of any delineation.

Cryaquepts: These soils have ochric epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under wet forest habitat types, the nonforested DECE/CAREX habitat type, and marsh areas of *Carex* species.

Typical Profile: Coarse-loamy, mixed, superactive, nonacid Typic Cryaquept (pedon 3089). All colors are for moist conditions.

9 to 0 cm: litter layer

0 to 20 cm: very dark gray (10YR 3/1) silt loam; strongly acid (pH 5.5); saturated soil.

20 to 40 cm: dark grayish brown (10YR 4/2) silt loam with common, small, prominent strong brown (7.5YR 5/6) redoximorphic concentrations; moderately acid (pH 5.6); saturated soil.

40 to 100 cm: dark gray (10YR 4/1) fine sandy loam, with common, small, prominent strong brown (7.5YR 5/6) redoximorphic concentrations; moderately acid (pH 5.6); free water entering pit at 40 cm.

Dissimilar inclusions: Sawfork and Greyback family soils have mollic epipedons and skeletal subsoil layers. Hanks family soils have ochric epipedons and nonskeletal subsoil layers. They occur on the steep inclinations of colluvium. Cryoboralfs-sh soils have argillic horizons and shallow root-limiting layers. They occur under the drier, nonforested inclusions.



7883 Oleo Family-Lasac Family-Hanks Family Complex

Summary

This complex forms on areas of non-glaciated plateaus with some rolling fluvial uplands. Slopes are commonly less than 10 percent. The main surficial deposits are residuum and colluvium derived from rhyolite. Smaller areas of alluvium are also included. This is a forested map unit composed mainly of the

ABLA/VASC-VASC habitat type. Areas of bedrock outcrop occur throughout the map unit. The main soils are nonskeletal Andisols with argillic horizons, skeletal Inceptisols with andic properties, and nonskeletal Inceptisols.

Components

40% *Oleo family*

30% *Lasac family* and similar inclusions (Trude family)

15% *Hanks family*

15% *Dissimilar inclusions* (Bedrock outcrops and Priestlake family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Oleo family	13	10	>100	40 - 50	5
Lasac family	50	5	>100	35 - 55	15
Similar inclusions	60	4	>100	35 - 50	8
Hanks family	16	9	>100	25 - 50	8

Oleo family: These soils have ochric epipedons and argillic horizons. They are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit forming under forests in residuum and colluvium derived from rhyolite.

Typical Profile: Ashy, glassy Alfic Vitricryand (pedon 1573a) All colors are for dry conditions.

2 to 0 cm: litter layer.

0 to 5 cm: dark grayish brown (10YR 4/2) silt loam.

5 to 25 cm: brown (10YR 5/3) silt loam.

25 to 91 cm: pale brown (10YR 6/3) silt loam; with common distinct clay films on ped faces and lining pores.

91 to 150 cm: pale brown (10YR 6/3) stony silt loam.

Lasac family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit forming under forests in residuum and colluvium derived from rhyolite.

Typical Profile: Ashy-skeletal, glassy Vitrandic Cryochrept (pedon 1573b) All colors are for dry conditions.

0 to 15 cm: brown (10YR 4/3) gravelly silt loam.

15 to 30 cm: light yellowish brown (10YR 6/4) gravelly coarse sandy loam.

30 to 51 cm: very pale brown (10YR 7/3) very gravelly loamy sand.

51 to 150 cm: dark gray (10YR 4/1) very gravelly coarse sand.

Hanks family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under the ABLA/VASC-VASC habitat type in glacial till.

Typical Profile: Coarse-loamy, mixed, superactive Dystric Cryochrept (pedon 1044). All colors are for moist conditions.

0 to 7 cm: very dark grayish brown (10YR 3/2) silt loam; extremely acid (pH 4.4).

7 to 20 cm: dark brown (10YR 3/3) silt loam; very strongly acid (pH 5.0).

20 to 53 cm: yellowish brown (10YR 5/6) gravelly sandy loam; strongly acid (pH 5.1 to 5.4).

53 to 67 cm: light olive brown (2.5YR 5/4) gravelly coarse sandy loam; strongly acid (pH 5.3).

67 to 112 cm: strong brown (7.5YR 5/6) loam; strongly acid (pH 5.3).

Dissimilar inclusions: Bedrock outcrops are composed of rhyolite and make up approximately 9 percent of the map unit. Priestlake family soils have ochric epipedons and root-limiting layers within 100 centimeters of the soil surface.



812 Moran Family-Bobtail Family Complex

Summary

This complex forms on lacustrine plains. The most common slopes are less than 10 percent. The main surficial deposits are glacial lacustrine sediments derived from rhyolite and rhyolitic ash-flow tuffs. There are also smaller areas of glacial till, colluvium, and alluvium. This is a forested map unit dominated by the ABLA/VASC-VASC habitat type, the ABLA/VASC-CARU habitat type, and smaller areas of wet forest habitat types. Nonforested inclusions of the FEID/DECE and FEID/AGCA

habitat types also occur. Soils with aquic conditions occur in this map unit, but not in every delineation. The main soils are skeletal Inceptisols with dark surface horizons and nonskeletal Inceptisols.

Components

55% *Moran family* and similar inclusions (Matcher and Greyback families)

30% *Bobtail family* and similar inclusions (Billycreek family)

15% *Dissimilar inclusions* (Bridger family, Passcreek family, Oxyaquic Cryochrepts, and Oxyaquic Cryoborolls)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Moran family	62	20	>100	40 - 60	26
Similar inclusions	50 - 63	6 - 17	>100	40 - 85	27 - 30
Bobtail family	13	7	>100	40 - 90	2
Similar inclusions	10	5	>100	40 - 85	0

Moran family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. They occur throughout the map unit, forming under forests in glacial lacustrine sediments and glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryumbrepts (pedon 296). All colors are for moist conditions.

0 to 16 cm: very dark grayish brown (10YR 3/2) gravelly sandy loam; strongly acid (pH 5.4).

16 to 65 cm: dark grayish brown (10YR 4/2) very gravelly coarse sand and very gravelly sandy loam; moderately acid (pH 5.6).

65 to 100 cm: dark grayish brown (10YR 4/2) extremely gravelly sandy loam; moderately acid (pH 5.8).

Bobtail family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under the ABLA/VASC-VASC habitat type in glacial lacustrine sediments.

Typical Profile: Coarse-loamy, mixed, superactive Typic Cryochrept (pedon 1038). All colors are for moist conditions.

0 to 2 cm: dark grayish brown (10YR 4/2) loam; strongly acid (pH 5.1).

2 to 20 cm: dark yellowish brown (10YR 4/4) fine sandy loam; strongly acid (pH 5.3).

20 to 41 cm: yellowish brown (10YR 5/4) sandy loam; medium acid (pH 5.7).

41 to 104 cm: light brownish gray (10YR 6/2) sandy loam; medium acid (pH 6.0).

Similar inclusions: The Matcher family soils have coarser textures than Moran family soils. Greyback family soils have mollic epipedons and form under nonforested inclusions. Billycreek family soils have slightly coarser textures than the Bobtail family soils.

Dissimilar inclusions: Bridger and Passcreek family soils have mollic epipedons, argillic horizons, and fine or moderately fine textures. Bridger family soils form under nonforested inclusions. Oxyaquic Cryochrept soils have aquic conditions and ochric epipedons. They form under wet forest habitat types. Oxyaquic Cryoboroll soils have aquic conditions and mollic epipedons. They form under inclusions of the FEID/DECE habitat type. Soils with aquic conditions make up approximately 5 percent of the map unit.



8125 Josie Family-Billycreek Family Complex

Summary

This complex forms on glaciated plateaus with some rolling glaciated uplands. Slopes are commonly less than 15 percent. The main surficial deposit is glacial till and glaciofluvial alluvium derived from rhyolite. Inclusions derived from rhyolitic ash-flow tuff, and tuff mixed with andesite also occur. Smaller areas of colluvium and stream alluvium are included in this map

unit. This is a nonforested map unit dominated by the FEID/AGCA, FEID/DECE, and ARTR/FEID habitat types, with inclusions of the DECE/CAREX habitat type. Soils with aquic conditions and areas of bedrock outcrop and are present in this map unit, but do not occur in every delineation. The main soils are nonskeletal Inceptisols with dark surface layers and nonskeletal Inceptisols with coarse textures.

Components

50% *Josie family* and similar inclusions (Jugson, Moran, Matcher, and Sula families)

40% *Billycreek family* and similar inclusions (Bobtail, Bottle, and Como families)

10% *Dissimilar inclusions* (Bedrock outcrops, Aquic Cryoborolls, and Passcreek family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Josie family	30	4	>100	40 - 70	14
Similar inclusions	15 - 56	5 - 16	>100	35 - 75	20 - 28
Billycreek family	18	3	>100	60 - 90	0
Similar inclusions	15 - 60	4 - 10	>100	40 - 80	0 - 1

Josie family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under the FEID/AGCA and FEID/DECE habitat types in glacial till.

Typical Profile: Coarse-loamy, mixed, superactive Typic Cryumbrept (pedon 310).

0 to 14 cm: dark brown (10YR 3/3); loam; very strongly acid (pH 5.0).

14 to 32 cm: dark yellowish brown (10YR 3/4); gravelly sandy loam; strongly acid (pH 5.5).

32 to 100 cm: dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6); gravelly coarse sandy loam; moderately acid (pH 6.0).

Billycreek family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under nonforested habitat types in glacial till and alluvium.

Typical Profile: Sandy, mixed, superactive Typic Cryochrept (pedon 309).

0 to 26 cm: dark yellowish brown (10YR 4/4), and brown (10YR 4/3); loam; moderately acid (pH 5.8).

26 to 75 cm: yellowish brown (10YR 5/4); gravelly loamy coarse sand; moderately acid (pH 6.0).

75 to 100 cm: pale brown (10YR 6/3); gravelly coarse sand; neutral (pH 6.8).

Dissimilar inclusions: Bedrock outcrops are composed of rhyolite. Aquic Cryoboroll soils have mollic epipedons and aquic conditions. Passcreek family soils have mollic epipedons, argillic horizons, and finer textures than the main components. They form in areas derived from rhyolitic ash-flow tuff.



8167 Jugson Family-Billycreek Family-Oxyaquic Cryochrepts Complex

Summary

This complex forms on lacustrine plains. Slopes are commonly less than 10 percent. The main surficial deposits are glacial lacustrine sediments derived from rhyolite and rhyolitic ash-flow tuffs. There are also small areas of alluvium. This is a forested map unit dominated by the ABLA/VASC-VASC,

ABLA/CACA, and ABLA/CAGE habitat types. Nonforested inclusions of DECE/CAREX also occur. Approximately 15 percent of this map unit is made up of soils with aquic conditions. The main soils are nonskeletal Inceptisols with dark surface layers and coarse textures, nonskeletal Inceptisols with coarse textures, and Inceptisols with aquic conditions.

Components

- 35% *Jugson family* and similar inclusions (Matcher, Tomichi, and McCort families)
 35% *Billycreek family* and similar inclusions (Bobtail, Como, and Bottle families)
 15% Oxyaquic Cryochrepts and similar inclusions (Oxyaquic Cryoborolls and Cryaquepts)
 15% *Dissimilar inclusions* (Ansel, Rimton, and Hobacker families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Jugson family	21	5	>100	45 - 70	26
Similar inclusions	20 - 60	5 - 15	>100	45 - 80	17 - 28
Billycreek family	10	6	>100	50 - 80	4
Similar inclusions	17 - 55	5 - 10	>100	35 - 75	0 - 2
Oxyaquic Cryochrepts	10	8	>100	70 - 80	6
Similar inclusions	18 - 26	12 - 16	>100	60 - 75	2 - 22

Jugson family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under forests in glacial lacustrine sediments.

Typical Profile: Sandy, mixed, superactive Typic Cryumbrept (pedon 453). All colors are for moist conditions.

0 to 6 cm: very dark grayish brown (10YR 3/2) gravelly sandy loam, strongly acid (pH 5.4).

6 to 19 cm: dark brown (10YR 3/3) gravelly sandy loam, medium acid (pH 5.6).

19 to 100 cm: dark grayish brown (10YR 4/2) and brown (10YR 4/3) gravelly loamy sand, medium acid (pH 5.8).

Billycreek family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under forests in glacial lacustrine sediments.

Typical Profile: Sandy, mixed, superactive Typic Cryochrept (pedon 72). All colors are for moist conditions.

5 to 0 cm: litter layer.

0 to 47 cm: dark brown (10YR 3/3) gravelly loamy sand; medium acid (pH 5.6).

47 to 74 cm: dark grayish brown (10YR 4/2) loamy sand; slightly acid (pH 6.4).

74 to 100 cm: dark grayish brown (10YR 4/2) very gravelly coarse loamy sand; slightly acid (pH 6.4).

Oxyaquic Cryochrepts: These soils have ochric epipedons and are greater than 100 centimeters deep.

They have aquic conditions for some time during the growing season. In this map unit they are medium-to coarse-textured. They occur throughout the map unit, forming under the ABLA/CACA habitat type in glacial lacustrine sediments.

Typical Profile: Sandy, mixed, superactive Oxyaquic Cryochrept (pedon 67). All colors are for moist conditions.

0 to 13 cm: very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) coarse sandy loam; slightly acid to neutral (pH 6.2 to 6.6).

13 to 25 cm: dark grayish brown (10YR 4/2) gravelly sandy loam; slightly acid (pH 6.4).

25 to 100 cm: dark brown (10YR 4/3) and dark grayish brown (10YR 4/2) loamy sand; slightly acid to neutral (pH 6.2 to 6.8); water entering pit at 72 cm.

Dissimilar inclusions: Ansel and Rimton family soils have ochric epipedons, argillic horizons, and moderately fine textures. Rimton family soils have darker colored surface layers than Ansel family soils. Ansel family soils form under the ABLA/CACA habitat type and Rimton family soils form under the DECE/CAREX habitat type. Hobacker family soils have thick mollic epipedons and skeletal subsoil layers.



8261 Jugson Family and Tomichi Family and Cryaquolls Undifferentiated Group

Summary

This map unit forms in stream bottoms. The most common slopes are less than 8 percent. The main surficial deposit is stream alluvium derived from rhyolite and rhyolitic ash-flow tuff. Smaller areas of fan alluvium also occur. This map unit is dominated by the forested ABLA/VASC-VASC habitat type,

various wet forest habitat types, the nonforested DECE/CAREX and ARCA/FEID habitat types, and the forested ABLA/CARU habitat type. Soils with aquic conditions can occupy up to 15 percent of any delineation. The main soils are nonskeletal Inceptisols with dark-colored surface layers and coarse textures, nonskeletal Mollisols with coarse textures, and Mollisols with aquic conditions.

Components

- 40% *Jugson family* and similar inclusions (Matcher, Bottle, and Billycreek families)
- 30% *Tomichi family* and similar inclusions (Sula and Greyback families)
- 15% *Cryaquolls* and similar inclusions (Aquic Cryoborolls and Oxyaquic Cryochrepts)
- 15% *Dissimilar inclusions* (Castlepeak and Como families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Jugson family	15	5	>100	45 - 75	30
Similar inclusions	20 - 58	3 - 6	>100	40 - 75	4 - 26
Tomichi family	25	5	>100	65 - 85	30
Similar inclusions	20 - 55	12 - 15	>100	65 - 80	25 - 27
Cryaquolls	15	20	>100	60 - 70	18
Similar inclusions	10 - 30	17 - 26	>100	50 - 90	10 - 30

Jugson family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming forested habitat types in alluvium.

Typical Profile: Sandy, mixed, superactive Typic Cryumbrept (pedon 780). All colors are for moist conditions.

5 to 0 cm: Litter layer.

0 to 29 cm: black (10YR 2/1) and dark brown (10YR 3/3) loam; strongly acid (pH 5.4).

29 to 43 cm: brown (10YR 4/3) loamy sand; slightly acid (pH 6.4).

43 to 100 cm: very dark grayish brown (10YR 3/2) sand; moderately acid to neutral (pH 5.8 to 6.6).

Tomichi family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under nonforested habitat types in alluvium.

Typical Profile: Sandy, mixed, superactive Typic Cryoboroll (pedon 239) All colors are for moist conditions.

2 to 0 cm: litter layer.

0 to 31 cm: dark brown (10YR 3/3) fine sandy loam; medium acid (pH 6.0).

31 to 68 cm: dark yellowish brown (10YR 3/4) loamy sand with common, medium, distinct dark reddish brown (2.5YR 3/4) mottles; slightly acid (pH 6.5).

68 to 100 cm: dark brown (10YR 4/3) very gravelly coarse loamy sand; mildly alkaline (pH 7.5).

Cryaquolls: These soils have mollic epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are medium textured. They occur throughout the map unit forming under wet forest habitat types and the nonforested DECE/CAREX habitat type in alluvium.

Typical Profile: Aquic Cryoboroll (pedon 3386). All colors are for moist conditions.

0 to 16 cm: black (10YR 2/1) sandy clay loam; medium acid (pH 6.0).

16 to 36 cm: very dark gray (10YR 3/1) silt loam with common, medium, prominent strong brown (7.5YR 4/6) redoximorphic concentrations; medium acid (pH 6.0).

36 to 61 cm: very dark brown (10YR 3/1) loam with many, medium, prominent yellowish red (5YR 5/8) redoximorphic concentrations; moderately acid (pH 5.8).

61 to 100 cm: dark gray (10YR 4/1) loam with many, medium, prominent yellowish red (5YR 5/8) redoximorphic concentrations; moderately acid (pH 5.6).

Dissimilar inclusions: Castlepeak family soils are weakly developed soils with ochric epipedons, many rock fragments, and coarse textures. They form in bare areas of coarse textured alluvium that are within or adjacent to channels. Como family soils have ochric epipedons, coarse textures, and skeletal subsoil layers. They form under the forested ABLA/VASC habitat type.



8335 Hanks Family-Struggle Family-Cryochrepts-sh&s Complex

Summary

This complex forms on glaciated plateaus with slopes less than 15 percent. The main surficial deposits are glacial till and residuum derived from rhyolite. Smaller areas of colluvium and alluvium are also included. This is a forested map unit dominated by the ABLA/VASC-VASC and ABLA/VASC-PIAL habitat types. There are also inclusions of the ABLA/VAGL, ABLA/CAGE, and PICO/CARO habitat types. Areas of bed-

rock outcrop are present in this map unit, but not in every delineation. The main soils are nonskeletal Inceptisols, skeletal Inceptisols with moderately deep root-limiting layers, and skeletal Inceptisols with shallow root-limiting layers.

Components

- 50% *Hanks family* and similar inclusions (Bobtail, Bottle, Billycreek families)
- 25% *Struggle family* and similar inclusions (Taglake, Priestlake, and Elkner families)
- 15% *Cryochrepts-sh&s* and similar inclusions (Whitecross and Granturk families)
- 10% *Dissimilar inclusions* (Bedrock outcrops, Matcher family, and Greyback family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Hanks family	18	9	>100	35 - 50	8
Similar inclusions	17 - 24	5 - 11	>100	35 - 65	0 - 4
Struggle family	53	5	55 - 85	60 - 75	2
Similar inclusions	22 - 67	4 - 15	55 - 90	35 - 75	1 - 6
Cryochrepts-sh&s	47	7	30 - 45	20 - 80	2
Similar inclusions	25 - 45	11 - 16	15 - 48	30 - 80	1 - 4

Hanks family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under the ABLA/VASC-VASC habitat type in glacial till.

Typical Profile: Coarse-loamy, mixed, superactive Dystric Cryochrept (pedon 1062). All colors are for moist conditions.

0 to 3 cm: very dark gray (10YR 3/1) fine sandy loam; strongly acid (pH 5.5).

3 to 15 cm: dark brown (10YR 3/3) sandy loam; strongly acid (pH 5.5).

15 to 32 cm: dark yellowish brown (10YR 4/4) gravelly sandy loam; medium acid (pH 5.6).

32 to 83 cm: yellowish brown (10YR 5/4) gravelly sandy loam; medium acid (pH 5.6).

83 to 110 cm: brownish yellow (10YR 6/6) very gravelly loamy sand; slightly acid (pH 6.1).

Struggle family: These soils have ochric epipedons and moderately deep root-limiting layers. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under the ABLA/VASC-PIAL and PICO/CARO habitat types in glacial till and residuum.

Typical Profile: Sandy-skeletal, mixed, superactive Typic Cryochrept (pedon 657). Colors are for moist conditions.

0 to 22 cm: dark brown (10YR 3/3) loam; medium acid (pH 5.6).

22 to 57 cm: dark yellowish brown (10YR 4/6) very gravelly loamy sand; medium acid (pH 5.8).

57 to 82 cm: dark yellowish brown (10YR 4/4) very gravelly loamy sand; medium acid (pH 5.8).

82 cm: paralithic contact with pumice.

Cryochrepts-sh&s: These soils have ochric epipedons and shallow root-limiting layers. In this map unit they are medium to coarse textured. They occur throughout the map unit, most commonly forming under the ABLA/VASC-VASC, ABLA/VASC-PIAL, and ABLA/CAGE habitat types in glacial till and residuum.

Typical Profile: Dystric Cryochrept (pedon 656). Colors are for moist conditions.

0 to 12 cm: dark brown (10YR 3/3) loam; moderately acid (pH 5.6).

12 to 19 cm: dark grayish brown (10YR 4/2) very gravelly loamy sand; moderately acid (pH 5.8).

19 to 47 cm: dark yellowish brown (10YR 4/4) very gravelly loamy sand; moderately acid (pH 5.6).

47 to 65 cm: paralithic contact with weathered rhyolite bedrock.

65 cm: lithic contact with rhyolite bedrock

Dissimilar inclusions: Bedrock outcrops are composed of rhyolite and occur on ridge tops and steep slopes. Matcher and Greyback family soils have dark surface layers. Matcher family soils have umbric epipedons and Greyback family soils have mollic epipedons.



835 Josie Family-Whitecross Family-Bedrock Outcrop Complex

Summary

This complex forms on the Pitchstone Plateau, a glaciated plateau with rounded bedrock ridges. The most common slopes are between 5 and 10 percent. The surficial deposits are glacial rubble, loess, and coarse-textured alluvium derived from rhyolite. The two main types of vegetation in this map unit are a mixture of dry, grassland species and the DECE/CAREX habitat type. There are also smaller areas of the forested, ABLA/CARO habitat type. The main soils are nonskeletal Inceptisols with dark surface layers and skeletal Inceptisols with root-limiting layers.

Components

- 35% *Josie family* and similar inclusions (Moran family)
 30% *Whitecross family* and similar inclusions (Granturk and Elkner families)
 20% *Bedrock outcrops*
 15% *Dissimilar inclusions* (Castlepeak and Hanks families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Josie family	17	12	>100	30 - 55	25
Similar inclusions	55	15	>100	35 - 60	29
Whitecross family	44	15	20 - 30	25 - 35	6
Similar inclusions	20 - 29	10 - 18	15 - 75	40 - 70	3 - 6

Josie family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under nonforested vegetation in loess-capped, glacial rubble.

Typical Profile: Coarse-loamy, mixed, superactive Typic Cryumbrept (pedon 487). All colors are for moist conditions.

0 to 24 cm: dark brown (10YR 3/3) and very dark grayish brown (10YR 3/2) silt loam; extremely acid to very strongly acid (pH 4.4 to 4.8).

24 to 37 cm: dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) gravelly sandy loam; strongly acid (pH 4.8 to 5.4).

37 to 46 cm: light yellowish brown (10YR 6/4) gravelly sandy loam; very strongly acid (pH 4.6).

46 to 55 cm: light brownish gray (10YR 6/2) very gravelly loamy sand; strongly acid (pH 5.4).

55 to 100 cm: light gray (10YR 7/1) gravelly sandy loam; moderately acid (pH 5.8).

Whitecross family: These soils have ochric epipedons, and shallow to very shallow root-limiting layers. In this map unit they are moderately coarse or coarse textured. They form under both forested and nonforested vegetation near areas of bedrock outcrops.

Typical Profile: Loamy-skeletal, mixed, superactive Lithic Cryochrept (pedon 3223). All colors are for moist conditions.

10 to 0 cm: litter layer.

0 to 6 cm: dark brown (10YR 3/3) very gravelly sandy loam; extremely acid (pH 4.2).

6 to 20 cm: brown (10YR 4/3) very cobbly sandy loam; extremely acid (pH 4.4).

20 to 35 cm: paralithic contact with very weathered, rhyolite bedrock.

35 cm: lithic contact with rhyolite bedrock.

Bedrock outcrops and talus: These areas are composed of rhyolite. Bedrock outcrops make up from 10 to 30 percent of any delineation.

Dissimilar inclusions: Castlepeak family soils are weakly developed soils with ochric epipedons, coarse textures, and skeletal subsoil layers. They form in bare areas of coarse textured alluvium that occupy the intermittent drainage channels. Hanks family soils have ochric epipedons, moderately coarse textures, and low percent base saturation.



8357 Trude Family-Whitecross Family-Bedrock Outcrop Complex

Summary

This complex forms on glaciated plateaus and rolling fluvial uplands. Slopes are commonly less than 20 percent. The main surficial deposits are glacial till, glacial rubble, and residuum derived from rhyolite or rhyolitic ash-flow tuff. A loess mantle is common in the western portion of the park. Smaller areas of colluvium and coarse-textured alluvium also occur. This is a forested map unit dominated by the ABLA/VASC-VASC, ABLA/

VASC-PIAL, ABLA/VASC-CARU, and ABLA/THOC habitat types. Smaller areas of ABLA/CARU, PICO/CARO and nonforested habitat types are included. The main soils are skeletal Inceptisols with coarse textures and skeletal Inceptisols with root-limiting layers less than 50 cm deep.

Components

- 35% *Trude family* and similar inclusions (Bottle and Shadow families)
- 30% *Whitecross family* and similar inclusions (Cryochrepts-sh&s and Cryochrepts-sh&ns)
- 20% *Bedrock outcrops and talus*
- 15% *Dissimilar inclusions* (Cryumbrepts-sh, McCort and Cloud Peak families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Trude family	46	6	>100	45 - 55	1
Similar inclusions	22 - 60	5 - 15	>100	35 - 60	0 - 3
Whitecross family	48	9	25 - 45	40 - 75	3
Similar inclusions	19 - 50	7 - 9	30 - 50	30 - 70	0 - 4

Trude family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under forests in glacial till, alluvium, and glacial rubble.

Typical Profile: Sandy-skeletal, mixed, superactive Dystric Cryochrept (pedon 495).

5 to 0 cm: litter layer.

0 to 4 cm: dark brown (10YR 3/3) gravelly loam; strongly acid (pH 5.2).

4 to 30 cm: brown (10YR 4/3) and dark yellowish brown (10YR 4/4) very gravelly sandy loam; strongly acid (pH 5.4).

30 to 100 cm: brown (10YR 4/3) very gravelly loamy coarse sand and very gravelly coarse sand; strongly acid (pH 5.4).

Whitecross family: These soils have ochric epipedons and shallow root-limiting layers. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under forests in glacial rubble, colluvium, and residuum.

Typical Profile: Loamy-skeletal, mixed, superactive Lithic Cryochrept (pedon 474).

0 to 15 cm: dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) gravelly loam; very strongly acid to strongly acid (pH 4.8 to 5.4).

15 to 33 cm: yellowish brown (10YR 5/4) extremely gravelly sandy loam; strongly acid (pH 5.4).

33 cm: lithic contact with rhyolitic ash-flow tuff.

Bedrock outcrops and talus: These areas are composed of rhyolite and rhyolitic ash-flow tuff. Bedrock outcrops and talus slopes make up from 10 to 40 percent of any delineation.

Dissimilar inclusions: Cryumbrepts-sh soils have umbric epipedons and shallow, root-limiting layers. McCort family soils have weakly developed mollic epipedons and form under nonforested inclusions. Cloud Peak family soils have ochric epipedons and argillic horizons.



853Z Ivywild Family and Hydrothermal Materials and Cryochrepts-HT&sh Undifferentiated Group

Summary

This map unit is composed of acid-sulphate hydrothermal areas and nonthermal areas that have been affected by hydrothermal activity. Approximately 35 percent of the map unit is actively thermal, but not every delineation includes thermal areas. This undifferentiated group forms primarily on hydrothermal rolling uplands with some steep breaks, hydrothermal basins, hydrothermal valleys, and glaciated plateaus. Slopes are commonly less than 20 percent. The main surficial deposits are colluvium, glacial till, residuum, and recent alluvium derived from acid-altered rhyolite. Small areas of glaciofluvial alluvium, fan alluvium, and lacustrine sediments are also included. Thermal community types make up the main vegetation in thermal areas. Forested areas are dominated by the ABLA/VASC-VASC habitat type, wet forest habitat types, and the ABLA/VASC-CARU habitat type. Nonforested, nonthermal areas are dominated by DECE/CAREX habitat type. Soils with aquic conditions make up 15 percent of this map unit. Bedrock outcrops occur in this map unit, but not in every delineation. The main soils in thermal areas, Inceptisols and Entisols, have mean annual soil temperatures warmer than 8 °C. The main soils in nonthermal areas are skeletal Inceptisols, shallow Inceptisols, and Inceptisols with aquic conditions.

Components***Thermal areas***10% *Hydrothermal materials*10% *Typic Troporthents*10% *Typic Dystropepts****Nonthermal areas***30% *Ivywild family* and similar inclusions (Shadow family, Dystric Cryochrepts-HT, and Bobtail family)15% *Cryochrepts-HT&sh* and similar inclusions (Cryorthents-sh and Granturk family)10% *Cryaquepts*15% *Dissimilar inclusions* (Bedrock outcrops, Tropaquepts, Lithic Udorthents, and Lithic Eutrochrepts)**Soil Description and Distribution**

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Ivywild family	45	20	>100	40 - 60	2
Similar inclusions	19 - 60	11 - 18	>100	10 - 65	0 - 3
Cryochrepts-HT&sh	19	10	5 - 45	10 - 70	1
Similar inclusions	25 - 30	10 - 18	5 - 45	10 - 65	0 - 2
Cryaquepts	55	10	>100	15 - 50	4
Typic Troporthents	18	14	>100	30 - 65	0
Typic Dystropepts	45	14	>100	25 - 65	0

Ivywild family: These soils have ochric epipedons and shallow root-limiting layers. Mean annual soil temperatures are less than 8 °C. In this map unit these soils are medium or moderately coarse textured. They form under ABLA/VASC habitat types in glacial till and colluvium derived from acid-altered rhyolite.

Typical profile: Loamy-skeletal, mixed, superactive Dystric Cryochrept (pedon 163). All colors are for moist conditions.

0 to 4 cm; dark brown (10YR 3/3) gravelly loam; strongly acid (pH 5.5).

4 to 8 cm; brown (10YR 4/3) gravelly loam; strongly acid (pH 5.5).

8 to 45 cm; dark yellowish brown (10YR 4/4) gravelly and very gravelly loam; strongly acid (pH 5.5).

45 to 100 cm; dark yellowish brown (10YR 4/6) very gravelly clay loam; strongly acid (pH 5.5).

Hydrothermal materials: These areas are composed of acid-altered rhyolite and acid-altered siliceous sinter. They make up from 0 to 40 percent of any delineation.

Cryochrepts-HT&sh: These soils have ochric epipedons and have shallow and very shallow root-limiting layers. Mean annual soil temperatures are less than 8 °C. In this map unit they are medium or moderately coarse textured. They form under forested habitat types in residuum derived from acid-altered rhyolite.

Typical profile: Lithic Cryochrept (pedon 162). All colors are for moist conditions.

0 to 2 cm; very dark grayish brown (10YR 3/2) extremely gravelly loamy sand; ultra acid (pH 2.8).

2 to 8 cm; brown (7.5YR 4/2) gravelly sandy loam; ultra acid (pH 2.6).

8 to 31 cm; pale brown (10YR 6/3) gravelly loamy sand; ultra acid (pH 3.4).

31 to 40 cm; paralithic contact with altered rhyolite.

40 cm; lithic contact with altered rhyolite.

Cryaquepts: These soils have ochric epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. Mean annual soil temperatures are less than 8 °C. In this map unit they are medium or moderately coarse textured. They form under the DECE/CAREX habitat type alluvium derived from silica-rich sediments.

Typical profile: Cryaquept (pedon 3272). All colors are for moist conditions.

0 to 6 cm; light brownish gray (10YR 6/2) gravelly silt loam; extremely acid (pH 3.8).

6 to 30 cm; light gray (10YR 7/2) extremely gravelly coarse sandy loam with few small prominent reddish yellow (7.5YR 6/6) redoximorphic concentrations; strongly acid (pH 5.2); water entering pit at 25 cm.

30 to 100 cm; white (10YR 8/1) extremely gravelly sandy loam; strongly acid (pH 5.5).

Typic Troorthents: These soils have ochric epipedons and are greater than 100 centimeters deep. Mean annual soil temperatures range from 20 through 80 °C. In this map unit they are moderately coarse or coarse textured. The most common hydrothermal communities are composed of moss, grass and moss, or stunted trees and moss. The soils form in residuum derived from acid-altered rhyolite and acid-altered siliceous sinter.

Typical profile: Typic Troorthent (pedon 3402). All colors are for moist conditions.

4 to 0 cm; litter layer of decomposing moss

0 to 5 cm; brown (10YR 4/3) gravelly sandy loam; very strongly acid (pH 4.7); mean annual soil temperature = 50 °C at 5 cm..

5 to 57 cm; light grey (10YR 7/1 and 10YR 7/2) sandy loam and loamy sand; ultra to very strongly acid (pH 3.0 to 4.5); mean annual soil temperature = 80 °C at 50 cm.

57 to 100 cm; white (10YR 8/1) loamy sand; very strongly acid (pH 4.6).

Typic Dystropepts: These soils have ochric epipedons and are greater than 100 centimeters deep. Mean annual soil temperatures range from 10 through 40 °C. In this map unit they are medium to coarse textured. The most common hydrothermal communities are composed of grass and forbs or stunted trees and grass. The soils are forming in residuum derived from acid-altered rhyolite.

Typical profile: Typic Dystropepts (pedon 3323). All colors are for moist conditions.

0 to 10 cm; brown (10YR 4/3) gravelly sandy clay loam; very strongly acid (pH 4.8).

10 to 31 cm; yellowish brown (10YR 5/4) very gravelly sandy loam; extremely acid (pH 4.4).

31 to 62 cm; pale brown (10YR 6/3) very gravelly sandy loam; very strongly acid (pH 4.6); mean annual soil temperature = 12 °C at 50 cm..

62 to 100 cm; white (10YR 8/1) loamy sand; very strongly acid (pH 4.6).

Dissimilar inclusions: Bedrock outcrops, composed of altered rhyolite, make up approximately 7 percent of the map unit. Tropaquept soils have aquic conditions. Tropaquept, Lithic Udorthent, and Lithic Eutrochrept soils all form in active hydrothermal areas. Lithic Udorthent and Lithic Eutrochrept soils have shallow or very shallow root-limiting layers composed of acid-altered rhyolite or siliceous sinter.



8715 Dystric Cryochrepts-HT-Ansel Family-Billycreek Family Complex

Summary

This complex forms on concave glaciated uplands, rolling uplands, and hydrothermal explosion craters. Slopes are commonly less than 15 percent. The main surficial deposits are hydrothermal explosion debris, glacial lake deposits, and colluvium derived from altered rhyolite. Small areas of glacial till

are also included. Forested areas are dominated by the ABLA/THOC habitat type, wet forest habitat types, and the ABLA/VASC-VASC habitat type. Nonforested areas are dominated by the ARTR/FEID and ARCA/FEID habitat types. Soils with hydrothermal conditions and areas of bedrock outcrop are present in this map unit, but not in every delineation. The main soils are nonskeletal Inceptisols, nonskeletal Alfisols, and nonskeletal Inceptisols with coarse textures.

Components

35% *Dystric Cryochrepts-HT* and similar inclusions (Ripple family)

30% *Ansel family* and similar inclusions (Cloud Peak and Rimton families)

20% *Billycreek family* and similar inclusions (Shadow and Hanks families)

15% *Dissimilar inclusions* (Bedrock outcrops, Josie family, and Lithic Eutrochrepts)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Dystric Cryochrepts-HT	20	24	>100	25 - 60	0
Similar inclusions	28	23	>100	55 - 70	3
Ansel family	23	26	>100	35 - 70	0
Similar inclusions	15 - 50	23 - 26	>100	40 - 70	3 - 15
Billycreek family	25	2	>100	55 - 80	3
Similar inclusions	20 - 55	10 - 16	>100	35 - 70	0 - 4

Dystic Cryochrepts-HT: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit these soils are moderately fine or medium textured. They form under the forested ABLA/VASC-CARU and the nonforested ARTR/FEID habitat types in hydrothermal explosion debris mixed with lake sediments.

Typical profile: Fine-loamy, mixed, superactive Dystic Cryochrept (pedon 1052). All colors are for moist conditions.

6 to 0 cm; litter layer

0 to 6 cm; dark grayish brown (10YR 4/2) gravelly clay loam; very strongly acid (pH 4.7).

6 to 23 cm; dark brown (10YR 3/3) loam; strongly acid (pH 5.4).

23 to 40 cm; brown (10YR 5/3) loam; strongly acid (pH 5.6)

40 to 100 cm; pale yellow (2.5Y 7/4) gravelly clay loam; moderately acid (pH 5.7).

Ansel family: These soils have ochric epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They form under forested habitat types in hydrothermal explosion debris mixed with lake sediments.

Typical profile: Fine-loamy, mixed, superactive Typic Cryoboralf (pedon 712). All colors are for moist conditions.

6 to 0 cm; litter layer

0 to 12 cm; dark grayish brown (10YR 4/2) gravelly loam; moderately acid (pH 5.6).

12 to 35 cm; dark brown (10YR 3/3) gravelly loam; moderately acid (pH 5.8).

35 to 68 cm; brown (10YR 5/3) gravelly loam; common distinct clay films lining pores; moderately acid (pH 5.8).

68 to 100 cm; light yellowish brown (10YR 6/4) gravelly clay loam; common, distinct clay films lining pores and on ped faces; moderately acid (pH 5.8).

Billycreek family: These soils have ochric epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They form under forested habitat types in hydrothermal explosion debris mixed with lake sediments.

Typical profile: Sandy, mixed, superactive Typic Cryochrept (pedon 790). All colors are for moist conditions.

0 to 6 cm; very dark brown (10YR 2/2) loam; (pH 6.0).

6 to 18 cm; dark brown (10YR 3/3) gravelly loamy sand; (pH 6.4).

18 to 100 cm; dark grayish brown (10YR 4/2) gravelly loamy sand; (pH 6.6).

Dissimilar inclusions: Bedrock outcrops, composed of rhyolite and acid-altered rhyolite, make up approximately 7 percent of the map unit. Josie family soils have umbric epipedons and nonskeletal subsoil layers. Lithic Eutrochrepts occur in hydrothermal areas, which occupy less than 2 percent of this map unit.



8835 Moran Family-Ivywild Family-Cryumbrepts-sh Complex

Summary

This complex forms on glaciated plateaus and rolling glaciated uplands in the southwestern portion of the park. The most common slopes are between 5 and 10 percent. The main surficial deposit is loess-mantled glacial till, derived from a mixture of basalt and rhyolitic ash-flow tuff. Small areas of colluvium and recent alluvium also occur. This is a forested map unit dominated by the ABLA/VASC-CARU, ABLA/VAGL and PICO/

CARO habitat types. Inclusions of wet forest habitat types and nonforested habitat types also occur. Soils with aquic conditions and areas of bedrock outcrop are present in this map unit, but not in every delineation. The main soils are skeletal Inceptisols with dark surface layers, skeletal Inceptisols, and Inceptisols with dark surface layers and root-limiting layers.

Components

45% *Moran family* and similar inclusions (Josie, Greyback, and Hobacker families)

30% *Ivywild family* and similar inclusions (Hanks and Shadow families)

10% *Cryumbrepts-sh*

15% *Dissimilar inclusions* (Bedrock outcrops, Mosroc family, Aquic Cryoborolls, and Oxyaquic Cryochrepts)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Moran family	45	6	60 - >100	45 - 60	33
Similar inclusions	25 - 58	8 - 15	>100	45 - 70	23 - 47
Ivywild family	40	7	>100	40 - 55	3
Similar inclusions	20 - 60	10 - 15	>100	35 - 60	0 - 4
Cryumbrepts-sh	60	5	35 - 45	45 - 60	20

Moran family: These soils have umbric epipedons and are usually greater than 100 centimeters deep. In a few locations, dense basal till acts as a root-limiting layer between 60 and 100 centimeters below the soil surface. In this map unit these soils are medium to coarse textured. They occur throughout the map unit, forming under forests in loess-mantled glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryumbrept (pedon 698). All colors are for moist conditions.

5 to 0 cm: litter layer.

0 to 34 cm: dark brown (7.5YR 3/2) cobbly silt loam; strongly acid (pH 5.4).

34 to 66 cm: dark brown (7.5YR 3/3) very gravelly silt loam; medium acid (pH 5.6).

66 to 100 cm: dark grayish brown (10YR 4/2) very gravelly fine sandy loam; medium acid (pH 5.6).

Ivywild family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in loess-mantled glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Dystric Cryochrept (pedon 699). All colors are for moist conditions.

3 to 0 cm: litter layer.

0 to 23 cm: dark brown (7.5YR 3/3) silt loam and gravelly silt loam; moderately acid (pH 5.6 to 5.8).

23 to 67 cm: dark yellowish brown (10YR 3/4) very gravelly silt loam; strongly acid (pH 5.4).

67 to 100 cm: dark gray (10YR 4/1) very gravelly sandy loam; strongly acid (pH 5.2).

Cryumbrepts-sh: These soils have umbric epipedon and shallow root-limiting layers. In this map unit they are medium or moderately coarse textured. Dense basal till acts as a root-limiting layer in these soils. They occur throughout the map unit, forming under forests in loess-mantled glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive, shallow Typic Cryumbrept (pedon 701). All colors are for moist conditions.

5 to 0 cm: litter layer.

0 to 19 cm: very dark grayish brown (10YR 3/2) very cobbly silt loam; strongly acid (pH 5.4).

19 to 40 cm: dark brown (7.5YR 3/2) very gravelly silt loam; medium acid (pH 5.7).

40 to 57 cm: dark brown (10YR 3/3) extremely gravelly loamy sand; very hard, very firm; no roots; medium acid (pH 5.6).

Dissimilar inclusions: Bedrock outcrops are made up of rhyolitic ash-flow tuff or basalt. They are not present in every delineation, but can occupy up to 25 percent of any one delineation. Mosroc family soils have mollic epipedons, argillic horizons, and shallow root-limiting layers. Aquic Cryoboroll and Oxyaquic Cryochrept soils have aquic conditions during the growing season. Aquic Cryoboroll soils have mollic epipedons and form under nonforested inclusions. Oxyaquic Cryochrept soils have ochric epipedons and form under wet forest habitat types. Soils with aquic conditions make up approximately 4 percent of the total map unit.



8853 Trude Family-Bottle Family-Bedrock Outcrop Complex

Summary

This complex forms on glaciated plateaus, rolling glaciated uplands and glacial trough valley bottoms, with some rolling fluvial uplands. Slopes are commonly less than 15 percent. The main surficial deposit is glacial till derived from rhyolite. Smaller areas of colluvium, recent alluvium, loess, and residuum are also included. This is a forested map unit dominated by the ABLA/VASC-VASC, ABLA/VASC-PIAL, ABLA/VAGL,

ABLA/CARO, and ABLA/CAGE habitat types. There are small inclusions of other forested and nonforested habitat types. The main soils are coarse-textured Inceptisols, both skeletal and nonskeletal.

Components

- 45% *Trude family* and similar inclusions (Como and Ivywild families)
- 25% *Bottle family* and similar inclusions (Hanks and Billycreek families)
- 20% *Bedrock outcrops and talus*
- 10% *Dissimilar inclusions* (Cryochrepts-sh&s, Matcher family, and McCort family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Trude family	53	4	>100	35 - 55	5
Similar inclusions	55 - 60	4 - 10	>100	30 - 55	1 - 3
Bottle family	25	5	>100	40 - 55	3
Similar inclusions	19 - 24	5 - 10	>100	35 - 60	0 - 2

Trude family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under the ABLA/VASC habitat type in glacial till, colluvium, and alluvium.

Typical Profile: Sandy-skeletal, mixed, superactive Dystric Cryochrept (pedon 493). All colors are for moist conditions.

0 to 6 cm: black (10YR 2/1) loam; strongly acid (pH 5.2).

6 to 29 cm: very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), and dark grayish brown (10YR 4/2) loam and cobbly loam; very strongly acid (pH 4.8 to 5.0).

29 to 62 cm: dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) very cobbly loamy sand and very gravelly loamy sand; strongly to moderately acid (pH 5.4 to 5.6).

62 to 100 cm: grayish brown (10YR 5/2) extremely cobbly loamy sand; moderately acid (pH 5.6).

Bottle family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under the ABLA/VASC-PIAL and ABLA/CARO habitat types in glacial till and alluvium.

Typical Profile: Sandy, mixed, superactive Dystric Cryochrepts (pedon 787). All colors are for moist conditions.

5 to 0 cm: litter layer

0 to 5 cm: dark brown (10YR 3/3) gravelly sandy loam; moderately acid (pH 5.6).

5 to 24 cm: brown (10YR 4/3) gravelly sandy loam; moderately acid (pH 5.6).

24 to 51 cm: grayish brown (10YR 5/2) gravelly loamy sand; moderately acid (pH 5.8).

51 to 100 cm: light grayish brown (10YR 6/2) cobbly loamy sand; moderately acid (pH 5.6).

Bedrock outcrops and talus: These areas are composed of rhyolite. Bedrock outcrops and talus slopes make up from 10 to 40 percent of any delineation.

Dissimilar inclusions: Cryochrepts-sh&s soils have shallow root-limiting layers and skeletal subsoil layers. Matcher family soils have umbric epipedons, skeletal subsoil layers, and coarse textures. McCort family soils have weakly developed mollic epipedons and skeletal subsoil layers. Matcher and McCort family soils form under nonforested inclusions.



8863 Ivywild Family-Jugson Family-Cryaquepts Complex

Summary

This complex forms on plateaus and concave glaciated uplands with wet depressions. Slopes are commonly less than 15 percent. The main surficial deposit is glacial till derived from rhyolite or rhyolitic ash-flow tuff. Andesite rock fragments are mixed with tuff in some areas. Smaller areas of colluvium, fine-textured alluvium, fan alluvium, and glaciofluvial alluvium also occur. This is a forested map unit dominated by the ABLA/VASC-VASC and ABLA/VAGL habitat types along with areas of wet forest habitat type. Nonforested inclusions of the DECE/CAREX habitat type also occur. Bedrock outcrops are present in this map unit, but not in every delineation. About 15 percent of this map unit is made up of soils with aquic conditions. The main soils are skeletal Inceptisols, nonskeletal Inceptisols with dark surface layers and coarse textures, and Inceptisols with aquic conditions.

Components

- 50% *Ivywild family* and similar inclusions (Trude, Shadow, Hanks, and Bobtail families)
- 20% *Jugson family* and similar inclusions (Josie and Matcher families)
- 15% *Cryaquepts* and similar inclusions (Aquic Cryoborolls and Histosols)
- 15% *Dissimilar inclusions* (Ansel family, Priestlake family, Cryochrepts-sh&ns, and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Ivywild family	45	12	>100	25 - 55	5
Similar inclusions	17 - 60	6 - 17	>100	30 - 65	3 - 6
Jugson family	30	5	>100	45 - 60	30
Similar inclusions	25 - 60	6 - 11	>100	35 - 65	22 - 30
Cryaquepts	16	9	>100	50 - 65	9
Similar inclusions	0 - 15	20	>100	55 - 70	28 - 45

Ivywild family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Dystric Cryochrepts (pedon 231). All colors are for moist conditions.

0 to 7 cm: dark brown (10YR 3/3) loam; very strongly acid (pH 5.0).

7 to 21 cm: dark brown (10YR 4/3) gravelly loam; strongly acid (pH 5.5).

21 to 100 cm: dark brown (10YR 4/3) extremely cobbly coarse sandy loam; strongly acid (pH 5.5).

Jugson family: These soils have umbric epipedons and are greater than 100 centimeters deep. In this map unit they are moderately coarse or coarse textured. They occur throughout the map unit, forming under forests in glacial till.

Typical Profile: Sandy, mixed, superactive Typic Cryumbrept (pedon 449). All colors are for moist conditions.

0 to 13 cm: very dark grayish brown (10YR 3/2) sandy loam; strongly acid (pH 5.4).

13 to 30 cm: dark brown (10YR 3/3) gravelly sandy loam; moderately acid (pH 5.8).

30 to 100 cm: dark gray (10YR 4/1) very gravelly loamy sand; moderately acid (pH 5.8).

Cryaquepts: These soils have ochric epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are medium to coarse textured. They occur under the wet forest habitat types and the DECE/CAREX habitat type.

Typical Profile: Typic Cryaquepts (pedon 708). All colors are for moist conditions.

4 to 0 cm: litter layer.

0 to 9 cm: black (10YR 2/1) silt loam; strongly acid (pH 5.2).

9 to 42 cm: very dark gray (10YR 3/1) and black (10YR 2/1) silt and silt loam; moderately acid (pH 5.6 to 5.9).

42 to 100 cm: dark gray (10YR 4/1) very gravelly sand; moderately acid (pH 5.9); water entering pit at 42 cm.

Dissimilar inclusions: Cryochrepts-sh&ns soils and Priestlake family soils have ochric epipedons and root-limiting layers. Cryochrepts-sh&ns are shallow and Priestlake family soils are moderately deep. Ansel family soils have ochric epipedons and argillic horizons. They are more likely to occur where andesite and rhyolitic tuff are mixed together. Bedrock outcrops are composed of rhyolite and rhyolitic ash-flow tuff.



8883 Dashiki Family-Lasac Family-Hanks Family Complex

Summary

This complex forms on areas of glaciated plateaus and glatiated rolling uplands. Slopes are commonly less than 10 percent. The main surficial deposit is glacial till derived from rhyolite.

Smaller areas of colluvium, residuum, and alluvium are also included. This is a forested map unit composed mainly of the ABLA/VASC-VASC habitat type. Areas of bedrock outcrop are present in this map unit, but not in every delineation. The main

soils are nonskeletal Andisols, skeletal Inceptisols with andic properties, and nonskeletal Inceptisols.

Components

45% *Dashiki family*

20% *Lasac family* and similar inclusions (Trude and Ivywild families)

20% *Hanks family* and similar inclusions (Bottle and Billycreek families)

15% *Dissimilar inclusions* (Struggle and Oleo families, and bedrock outcrops)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Dashiki family	15	5	>100	40 - 60	0
Lasac family	55	2	>100	35 - 55	15
Similar inclusions	55 - 63	4 - 10	>100	30 - 55	4 - 6
Hanks family	16	9	>100	35 - 50	8
Similar inclusions	20 - 24	5	>100	40 - 65	0 - 2

Dashiki family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to course textured. They occur throughout the map unit forming under forests in glacial till derived from rhyolite.

Typical Profile: Ashy, glassy Typic Vitricryand (pedon 1570a) All colors are for dry conditions.

2 to 0 cm: litter layer.

0 to 23 cm: brown (10YR 5/3) silt loam.

23 to 79 cm: light yellowish brown (10YR 6/4) gravelly silt loam.

79 to 94 cm: light brownish gray (10YR 6/2) gravelly coarse sandy loam.

94 to 190 cm: gray (10YR 6/1) stratified gravelly coarse sand to extremely gravelly coarse sand.

Lasac family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium textured. They occur throughout the map unit forming under forests in glacial till derived from rhyolite.

Typical Profile: Ashy-skeletal, glassy Vitrandic Cryochrept (pedon 1570b) All colors are for dry conditions.

0 to 15 cm: brown (10YR 5/3) gravelly silt loam.

15 to 30 cm: light yellowish brown (10YR 6/4) gravelly coarse sandy loam.

30 to 51 cm: very pale brown (10YR 7/4) very gravelly loamy sand.

51 to 150 cm: dark gray (10YR 4/1) very gravelly coarse sand.

Hanks family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium to coarse textured. They occur throughout the map unit, forming under forests in glacial till derived from rhyolite.

Typical Profile: Coarse-loamy, mixed, superactive Dystric Cryochrept (pedon 1044). All colors are for moist conditions.

0 to 7 cm: very dark grayish brown (10YR 3/2) silt loam; extremely acid (pH 4.4).

7 to 20 cm: dark brown (10YR 3/3) silt loam; very strongly acid (pH 5.0).

20 to 53 cm: yellowish brown (10YR 5/6) gravelly sandy loam; strongly acid (pH 5.1 to 5.4).

53 to 67 cm: light olive brown (2.5YR 5/4) gravelly coarse sandy loam; strongly acid (pH 5.3).

67 to 112 cm: strong brown (7.5YR 5/6) loam; strongly acid (pH 5.3).

Dissimilar inclusions: Struggle family soils have root-limiting layers and no andic properties. Oleo family soils have andic properties, argillic horizons, and nonskeletal subsoil layers. Bed-rock outcrops are composed of rhyolite and make up approximately 4 percent of the map unit.



8886 Winegar Family-Moran Family-Ivywild Family Complex

Summary

This complex forms on glaciated plateaus with some glaciated rolling uplands. The most common slopes are less than 8 percent. The main surficial deposit is loess-mantled glacial till derived from rhyolite and basalt. Small areas of colluvium and recent alluvium also occur. This is a forested map unit composed of the ABLA/VAGL-VASC, ABLA/VASC-VASC, and ABLA/VASC-CARU habitat types. Inclusions of wet forest habitat types and nonforested habitat types also occur. Soils with aquic conditions and areas of bedrock outcrop are present in this map unit, but not in every delineation. The main soils are nonskeletal Andisols with moderately deep root-limiting layers, skeletal Inceptisols with dark surface layers, and skeletal Inceptisols.

Components

- 45% *Winegar family* and similar inclusions (Elkner family)
 20% *Moran family* and similar inclusions (Cryumbrepts-sh and Jugson family)
 15% *Ivywild family* and similar inclusions (Trude, Bottle, and Lasac families)
 20% *Dissimilar inclusions* (Cryaquepts, Aquic Cryoborolls, bedrock outcrops, and Dashiki family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Winegar family	30	15	55 - 96	25 - 40	10
Similar inclusions	60	11	55 - 75	55 - 70	6
Moran family	45	6	60 - >100	45 - 60	30
Similar inclusions	22 - 40	5 - 10	40 - >100	40 - 70	20 - 27
Ivywild family	43	10	> 100	25 - 55	4
Similar inclusions	24 - 56	2 - 5	>100	35 - 60	0 - 2

Winegar family: These soils have ochric epipedons and moderately deep root-limiting layers. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit forming under forests in loess-mantled glacial till.

Typical Profile: Ashy, glassy Typic Vitricryand (pedon 1516a) All colors are for dry conditions.

2 to 0 cm: litter layer.

0 to 10 cm: dark yellowish brown (10YR 3/4) gravelly silt loam.

10 to 66 cm: yellowish brown (10YR 5/4) loam.

66 to 96 cm: light olive brown (2.5Y 5/3) very gravelly sandy loam.

96 cm: dense basal till.

Moran family: These soils have umbric epipedons and are usually greater than 100 centimeters deep. In some locations, dense basal till acts as a root-limiting layer between 60 and 100 centimeters below the soil surface. In this map unit these soils are medium to coarse textured. They occur throughout the map unit, forming under forests in loess-mantled glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryumbrept (pedon 690). All colors are for dry conditions.

3 to 0 cm: litter layer.

0 to 53 cm: brown (10YR 5/3) silt loam; strongly acid (pH 5.3 to 5.4).

53 to 93 cm: yellowish brown (10YR 5/4) very cobbly silt loam; strongly acid (pH 5.4).

93 to 100 cm: grayish brown (2.5Y 5/2) cobbly loamy sand; strongly acid (pH 5.5).

Ivywild family: These soils have ochric epipedons and are greater than 100 centimeters deep. In this map unit they are medium or moderately coarse textured. They occur throughout the map unit, forming under forests in loess-mantled glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Dystric Cryochrept (pedon 699). All colors are for dry conditions.

3 to 0 cm: litter layer.

0 to 23 cm: brown (10YR 5/3) silt loam and gravelly silt loam; medium acid (pH 5.6 to 5.8).

23 to 67 cm: yellowish brown (10YR 5/4) very gravelly silt loam; strongly acid (pH 5.4).

67 to 100 cm: light gray (10YR 7/1) very gravelly sandy loam; strongly acid (pH 5.2).

Similar inclusions: Elkner family soils do not have andic properties. Cryumbrepts-sh soils have a root-limiting layer at a shallower depth than Moran family soils. Jugson family soils have fewer rock fragments and coarser textures than Moran family soils. Trude family soils have coarser textures than Ivywild family soils. Bottle family soils have fewer rock fragments than Ivywild family soils. Lasac family soils have andic properties.

Dissimilar inclusions: Cryaquept and Aquic Cryoboroll soils have aquic conditions for some time during the year. Cryaquept soils have ochric epipedons and Aquic Cryoboroll soils have mollic epipedons. Approximately nine percent of this map unit is made up of soils with aquic conditions. Bedrock outcrops, composed of rhyolite and basalt, make up approximately seven percent of the map unit. Dashiki family soils have andic properties and nonskeletal subsoil layers.



9251 Sawfork Family and Greyback Family and Bedrock Outcrop Undifferentiated Group

Summary

This complex forms on rolling, fluvial uplands with moderate to high relief. Slopes are commonly between 5 and 40 percent.

The surficial deposits are residuum and colluvium derived mainly from andesite, with small inclusions of rhyolitic ash-flow tuff and dacite. Small areas of glacial till and glaciofluvial

alluvium also occur. The main forested habitat types in this map unit are ABLA/THOC, ABLA/LIBO, and ABLA/VASC-VASC. There are also smaller areas of the nonforested ARTR/FEID and the forested ABLA/VASC-PIAL and ABLA/VAGL habitat types. The main soils are skeletal Mollisols with argillic horizons and skeletal Mollisols without argillic horizons.

Components

40% *Sawfork family* and similar inclusions (Passcreek and Granmount families)

30% *Greyback family* and similar inclusions (McCort and Hobacker families)

10% *Bedrock outcrop*

20% *Dissimilar inclusions* (Cryoboralfs-sh, Shadow family, and Bearmouth family)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Sawfork family	46	25	>100	75 - 90	29
Similar inclusions	15 - 45	23 - 37	>100	70 - 90	24 - 30
Greyback family	65	27	>100	80 - 100	19
Similar inclusions	53 - 62	20 - 23	>100	75 - 100	17 - 52

Sawfork family: These soils have mollic epipedons, argillic horizons, and are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit, forming under forested habitat types in residuum, colluvium, and glacial till.

Typical Profile: Loamy-skeletal, mixed, superactive Argic Cryoboroll (pedon 3800). All colors are for moist conditions.

7 to 0 cm: litter layer.

0 to 37 cm: very dark grayish brown (10YR 3/2) very cobbly loam; strongly acid (pH 5.4 to 5.5).

37 to 70 cm: dark grayish brown (10YR 4/2) very gravelly sandy clay loam; common, distinct clay films lining pores; medium acid (pH 5.6).

70 to 100 cm: very dark gray (10YR 3/1) gravelly loamy sand; medium acid (pH 5.6).

Greyback family: These soils have mollic epipedons and are greater than 100 centimeters deep. In this map unit they are moderately fine to moderately coarse textured. They occur on the steeper slopes, forming under forested habitat types in colluvium and residuum.

Typical Profile: Loamy-skeletal, mixed, superactive Typic Cryoboroll (pedon 641). All colors are for moist conditions.

3 to 0 cm: litter layer.

0 to 7 cm: very dark grayish brown (10YR 3/2) gravelly loam; slightly acid (pH 6.4).

7 to 21 cm: dark brown (10YR 3/3) very gravelly loam; neutral (pH 6.6).

21 to 100 cm: brown (10YR 4/3) extremely gravelly clay loam and extremely gravelly sandy clay loam; slightly acid to moderately acid (pH 6.2 to 6.0).

Bedrock outcrops and talus: These areas are composed of andesite. Bedrock outcrops make up from 0 to 30 percent of any delineation.

Dissimilar inclusions: Cryoboralfs-sh soils have argillic horizons and root-limiting layers within 50 centimeters of the soil surface. They form in colluvium. Shadow family soils have ochric epipedons and skeletal subsoil layers. They are common in areas where the parent materials are influenced by dacite. Bearmouth family soils have mollic epipedons, coarse textures, and skeletal subsoil layers. They form in glaciofluvial alluvium.



9564 Passcreek Family-Bedrock Outcrop-Cryaquolls Complex

Summary

This complex forms on areas of rolling glaciated uplands with bedrock outcrops and glacial cirque basins. The most common slopes are between 5 and 25 percent. The main surficial deposit is glacial till derived from andesite. Smaller areas of frost rubble, colluvium, and fine-grained alluvium are also included. In the northeast area of the park, limestone is mixed with the andesite. This is a nonforested map unit dominantly composed of

the FEID/AGCA, ARTR/FEID, and FEID/DECE habitat types, areas of alpine meadow, and areas of DECE/CAREX. Small inclusions of sparse forest also occur. Bedrock outcrops and soils with aquic conditions occur in every delineation. The main soils are nonskeletal Mollisols with argillic horizons and Mollisols with aquic conditions.

Components

55% *Passcreek family* and similar inclusions (Sawfork, Cratermo, and Teton families)

15% *Bedrock outcrops and talus*

10% *Cryaquolls*

20% *Dissimilar inclusions* (Mosroc, Jenkinson, and Emerald families)

Soil Description and Distribution

Soil Property Comparison (see explanation of column headings on page 20)

Component & Similar inclusions	Rock frag. avg. in CS (%)	Clay Avg. in CS (%)	Root-limiting layer depth (cm)	Base saturation (%)	Mollic colors avg. depth (cm)
Passcreek family	28	28	>100	85 - 100	27
Similar inclusions	14 - 55	23 - 40	>100	80 - 100	20 - 50
Cryaquolls	40	22	>100	85 - 95	20

Passcreek family: These soils have mollic epipedons and argillic horizons. The soils are greater than 100 centimeters deep. In this map unit they are moderately fine or medium textured. They occur throughout the map unit forming under meadows and shrublands in glacial till.

Typical Profile: Fine-loamy, mixed, superactive Argic Cryoboroll (pedon 424) All colors are for moist conditions.

0 to 30 cm: very dark brown (7.5YR 2/2) silt loam; slightly acid (pH 6.2).

30 to 48 cm: brown (10YR 4/3) gravelly loam; few, distinct clay films on ped faces; slightly acid (pH 6.2).

48 to 60 cm: brown (10YR 4/3) very gravelly clay loam with few, medium, prominent yellowish brown (10YR 5/6) mottles; common, distinct clay films on ped faces; slightly acid (pH 6.4).

60 to 100 cm: brown (10YR 4/3) very gravelly clay loam; few, distinct clay films on ped faces; neutral (pH 6.8).

Bedrock outcrops and talus: These areas are mainly composed of andesite, except in the northeast

area, where bedrock is limestone or andesite. Bedrock outcrops and talus slopes can make up from 10 to 20 percent of any delineation.

Cryaquolls: These soils have mollic epipedons and are greater than 100 centimeters deep. They have aquic conditions for some time during the growing season. In this map unit they are moderately fine textured. They occur throughout the map unit forming under DECE/CAREX in glacial till and alluvium.

Typical Profile: Typic Cryaquoll (pedon 3339) All colors are for moist conditions.

0 to 19 cm: black (7.5YR 2/0) silty clay loam; medium acid (pH 6.0).

19 to 100 cm: gray (10YR 5/1) very gravelly sandy clay loam with common, medium, prominent yellowish brown (10YR 5/6) redoximorphic concentrations; slightly acid (pH 6.4); water entering pit at 21 cm.

Dissimilar inclusions: All of these inclusions have mollic epipedons and root-limiting layers. Mosroc and Jenkinson family soils are shallow and Emerald family soils are moderately deep.

CLASSIFICATION OF THE SOILS

Index of Soils Classifications

A

Ansel Family	154
Aquic Cryoborolls	155
Arcette Family	156
Arrowpeak Family	157

B

Badwater Family	158
Bearmouth Family	159
Beartooth Family	160
Billycreek Family	161
Bobtail Family	162
Bottle Family	163
Bridger Family	164

C

Castan Family	165
Castlepeak Family	166
Cloud Peak Family	167
Como Family	168
Cratermo Family	169
Cryaquepts	170
Cryaquolls	171
Cryoboralfs-sh	172
Cryochrepts-HT&sh	173
Cryochrepts-sh&ns	174
Cryochrepts-sh&s	175
Cryorthents-sh	176
Cryumbrepts-sh	177

D

Dashiki Family	178
Dystric Cryochrepts-HT	179

E

Eaglewing Family	180
Elkner Family	181
Emerald Family	182

G

Gallatin Family	183
Gateson Family	184
Granmount Family	185
Granturk Family	186
Greyback Family	187

H

Hanks Family	188
Haploborolls	189
Histosols	190
Hobacker Family	191

I

Ivywild Family	192
----------------------	-----

J

Jenkinson Family	193
Josie Family	194
Jugson Family	195

L

Lamedeer Family	196
Lasac Family	197
Lionhead Family	198
Lithic Dystrochrepts	199
Lithic Eutrochrepts	200
Lithic Udorthents	201
Lolo Family	202

M

Matcher Family	203
McCort Family	204
Moran Family	205
Mosroc Family	206

O

Oleo Family	207
Oxyaquic Cryoborolls	208
Oxyaquic Cryochrepts	209

P

Passcreek Family	210
Pesowyo Family	211
Priestlake Family	212

R

Rimton Family	213
Ripple Family	214
Rittel Family	215
Rombo Family	216
Roundup Family	217

S

Sawbuck Family	218
Sawfork Family	219
Shadow Family	220
Shook Family	221
Silas Family	222
Silvercliff Family	223
Sluice Family	224
Struggle Family	225
Stubbs Family	226
Sula Family	227

T

Taglake Family	228
Teton Family	229
Tomichi Family	230
Tropaquepts	231
Trude Family	232
Typic Dystropepts	233
Typic Eutropepts	234
Typic Troporthents	235

W

Wallrock Family	236
Whitecross Family	237
Winegar Family	238

INTRODUCTION

Soil occurs as a thin mantle over much of Yellowstone National Park. It is a natural body, consisting of organic and mineral materials, in which plants grow. It forms a continuous system, varying from place to place. Because of this variation, the soil continuum is viewed as a collection of individual soil types, each occupying a defined segment of the soil landscape and differing from other soils by a unique set of properties.

Soil Formation

Each soil is a result of soil-forming processes that act through time on mineral matter at the surface of the earth. Since these processes function over a wide range of environmental conditions, they produce soils that varies in appearance, composition, and productivity.

The factors that cause soils to vary are (1) topography and drainage; (2) physical and mineralogical composition of the parent material of the soil; (3) the climate under which the soil material has accumulated; (4) biological activity, including the plant and animal life in and on the soil; and (5) the length of time the forces of formation have acted on the soil material (Soil Survey Staff, 1975). Differences among soils depend largely on these environmental influences. Each soil is affected by all five factors, but the relative effect and importance of each varies from one soil to another.

The surficial material from which the soils have formed are among the strongest influences on the character of soils in the park. Soil formation starts with and results from changes in the parent material. The nature of the changes is strongly influenced by the character of this parent material, particularly its mineralogy and texture. These properties affect various physical and chemical

aspects of the soil-forming environment and are therefore important to essentially all processes of soil development.

Most of the parent material in the park is derived from igneous rocks, primarily rhyolite, rhyolitic tuff, and andesite with smaller amounts of basalt and granite. Rhyolite and granite are high in quartz and potassium feldspars, andesite is high in sodium plagioclase and hornblende, and basalt is high in calcium plagioclase and pyroxene. Sedimentary rock types (sandstone, shale, and limestone) and metamorphic rock types (schist and gneiss) make up the remaining bedrock sources of parent material. In general, soils weathering from shale, limestone, or schist have the highest clay content, followed by andesite, basalt, rhyolitic tuff, sandstone, granite, and rhyolite. Dark surface layers tend to be thickest in the soils forming from andesite, basalt and undifferentiated sedimentary rocks, followed by rhyolitic tuff and rhyolite.

Parent materials can be classified into three broad groups: (1) those formed from rocks weathering in place, (2) those that have been transported from their place of origin and redeposited in a new location, and (3) organic deposits. Most Yellowstone soils are formed from transported materials, including colluvium, fan alluvium, glacial till, glaciofluvial alluvium, lacustrine deposits, landslide debris, loess, and stream alluvium. Soils formed from residual materials make up approximately four percent of the park's area, and organic deposits less than one percent.

One of the park's most visible characteristics is its array of hydrothermal features. These areas create a unique and complicated soil-forming environment. Soil pH can vary from less than 3 to more than 8, and mean annual soil temperatures range from less than 10 to more than 75 degrees

C. Soils forming under these conditions are very different from those that have not been affected by hydrothermal activity. Because of the unique characteristics of these soils, we have given extra attention to their properties and formation. For information about field investigations and cooperative research efforts, see Assumptions for Classification and Hydrothermal Soil Studies in the Appendices.

Soil Properties

During the survey, over 1,000 soil pits were excavated and examined to identify and classify the soils. Soil properties were determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures were followed. These tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

Estimates of soil properties given in map unit descriptions and taxonomic unit descriptions include the physical and chemical characteristics of the major layers of each soil. Some of the important ones are described below.

Andic properties.—Soils forming from volcanic ash have different properties compared to those forming from quartz grains. The weathering ash can increase a soil's water-holding capacity, phosphate retention, cation exchange capacity, and liquid limits, while lowering plastic limits. Soils with andic properties occur along the southwestern edge of the park.

Mollic colors.—The depth of mollic colors measures the thickness of dark surface layers. It can be used, when comparing different soils, as a relative estimate of organic matter in the surface layers. Organic matter can effect soil structure, contribute plant nutrients, and increase the soil's

cation exchange capacity.

Percent base saturation.—This estimate of exchangeable bases as a percent of the cation exchange capacity is used to characterize the exchangeable-ion status of the soil. Comparisons are meaningful only between soils with similar textures and organic matter contents. In general, soils with low percent base saturation have low fertility levels.

Rock fragment content.—This is a volume estimate of the particles larger than 2 mm in diameter. The volume of rock fragments in the soil affects water-holding capacity, root growth, and ease of excavation.

Root-limiting depth.—Refers to the depth at which root growth is strongly inhibited by chemical or physical restrictions (including temperature). This can limit the potential type and amount of vegetative growth. Most root-limiting layers in the park are relatively unweathered bedrock. The exception is in hydrothermal areas where root growth may also be limited by acidity, high temperatures or cemented layers.

Salts and Sodium.—High levels of salts can cause poor seed germination and plant growth. This results from limited water availability due to the high osmotic concentration of salts, or a poor physical or nutritional state due to high levels of exchangeable sodium. A conductivity of 4 mmhos per cm or more indicates high salt concentration and more than 15 percent exchangeable sodium is considered a high level of sodium. Some of the soils between Gardiner and Mammoth in the northwestern part of the park have high levels of salts and sodium.

Texture.—Refers to the proportionate quantities of sand, silt, and clay. Most of the textures reported in this survey were estimated by tactile

methods in the field. The texture of a soil partially controls its ability to transmit and store air and water, its capacity to store plant nutrients (cation exchange capacity), and its susceptibility to erosion. An estimate of clay content is often used as a quick textural comparison between different soils.

Soil Classification

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff 1975, Soil Conservation Service 1994). Beginning with the broadest, these categories are: order, suborder, great group, subgroup, family, and series. Classification is based on soil properties directly observed in the field or laboratory, or indirectly inferred from observations made in the field or laboratory. The categories are defined in the following paragraphs.

Order.—Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in "sol." An example of a common soil order in Yellowstone National Park is Inceptisol.

Suborder.—Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth, or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ochrept, where "Ochr" refers to pale colored surface horizons, and "ept" is from Inceptisol.

Great Group.—Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is

identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Cryochrepts, where "Cry," referring to cryic temperature regime, is added to "ochrept," the suborder of the Inceptisols that have an ochric epipedon.

Subgroup.—Each great group has a "typic" subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. An example is Typic Cryochrept, where "Typic" identifies a subgroup that typifies the Cryochrept great group.

Family.—Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management and plant growth. The properties are mostly those of horizons where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, and depth of the root zone. A family name consists of the subgroup name preceded by terms that indicate soil properties. An example is loamy-skeletal, mixed, superactive Typic Cryochrepts, where "loamy-skeletal" refers to the volume of rock fragments and texture of the soil, and "mixed, superactive" refers to the type of clay minerals and the amount of cation exchange capacity that the clay contributes to the soil.

Series Family.—The final and most detailed category is not included in soil taxonomy proper. A soil series is roughly equivalent to a species in

other taxonomic systems. Because of the nature of this soil survey we use taxonomic classes at higher levels (similar to genus or family in the Linnean system). The most common level is the soil family, which is one class higher than the soil series. Taxonomic family names are quite long and detailed, so to promote ease of communication we substitute a shorter name. An example is the Shadow family, used in this survey to represent all the loamy-skeletal, mixed, superactive Typic Cryochrepts that are deeper than 100 centimeters. Shadow is an arbitrary series name occurring within the family. It does not connote any properties of the Shadow series other than those associated with the family.

The Classification of Soils Table lists every soil taxonomic unit recognized in the survey area. The following section gives a detailed description of

each taxonomic unit arranged in alphabetic order. Characteristics of the soil and the material in which it formed are identified for each unit. A pedon, a small three-dimensional area of soil typical of the unit in the survey area is described. The detailed description of each soil horizon follows soil survey standards. Many of the technical terms used in the descriptions are defined in Soil Taxonomy (Soil Survey Staff, 1975; Soil Conservation Service, 1994) or in the Glossary. Following the pedon description is a range of important characteristics of that soil within the park. The Assumptions in Classification Appendix describes the assumptions that were used to classify the soils in this survey area.

ANSEL FAMILY

The Ansel family soils have ochric epipedons, argillic horizons, and nonskeletal subsoil layers with moderately fine to medium textures. The soils are greater than 100 centimeters deep. These soils form mainly in glacial till derived from andesite, rhyolitic ash-flow tuff, or sedimentary rocks. Soils in this family most often form under the forested ABLA/VAGL and ABLA/VASC habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Cryoboralfs

Typical Pedon

Location: Northwest shore of Heart Lake, Heart Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 540940E/4903520N. Pedon 456.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 10 cm; black (10YR 2/1) silt loam, light brownish gray (10YR 6/2) dry; moderate coarse granular structure; slightly hard, very friable, slightly sticky and slightly plastic; 17 percent clay; slightly acid (pH 6.5); abrupt smooth boundary.

BA 10 to 33 cm; grayish brown (10YR 5/2) very gravelly silt loam, light gray (10YR 7/1) dry; weak coarse subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; 35 percent gravel; 17 percent clay; neutral (pH 6.8); clear smooth boundary.

Bt1 33 to 54 cm; brown (10YR 5/3) very gravelly loam with common medium faint redoximorphic concentrations, very pale brown (10 YR 7/1) dry; moderate coarse angular blocky structure; hard, friable, sticky and slightly plastic; 30 percent gravel and 5 percent cobbles; 23 percent clay; few distinct clay films on ped faces and lining tubular and interstitial pores; slightly acid (pH 6.4); abrupt smooth boundary.

Bt2 54 to 100 cm; brown (10YR 5/3) gravelly clay loam, light gray (10YR 7/1) dry; weak coarse angular blocky structure; very hard, very friable, sticky and plastic; 15 percent gravel; 28 percent clay; common distinct clay films on ped faces and lining tubular or interstitial pores; moderately acid (pH 6.0).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedon range from 5YR through 10YR. Values range from 3 through 7 dry, and from 2 through 5 moist. Chromas range from 1 through 3 moist. The most common textures are loam and silt loam. The pH ranges from 4.5 to 6.8.

Control section: The most common textures are loam, silt loam and sandy clay loam. The weighted average clay content ranges from 22 through 31 percent, and averages 26 percent. The weighted average rock fragment content ranges from 0 through 33 percent and averages 16 percent. The pH ranges from 5.0 through 7.2.

Base saturation: The range for all horizons in all pedons is 31 through 100 percent. The average for all pedons is 71 percent.

AQUIC CRYOBOROLLS

The Aquic Cryoboroll soils have mollic epipedons, and either skeletal or nonskeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 centimeters deep and have aquic conditions some time during the growing season. These soils form in alluvium, lacustrine sediments, and earthflow debris derived from andesite, shale, or rhyolitic ash-flow tuff. They commonly form under the nonforested DECE/CAREX or FEID/AGCA habitat type or marsh areas of *Carex* species.

Taxonomic Classification: Aquic Cryoborolls (includes the coarse-loamy, fine-loamy, loamy-skeletal and sandy-skeletal particle size classes; and the mixed, superactive mineralogy class)

Typical Pedon

Location: Hayden Valley; Crystal Falls 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 539250E/4943150N. Pedon 371. (classified as coarse-loamy, mixed, superactive Aquic Cryoboroll)

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 10 cm; black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; no rock fragments; 17 percent clay; neutral (pH 7.2); abrupt smooth boundary.

A2 10 to 27 cm; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; strong fine granular structure; slightly hard, very friable, sticky and slightly plastic; 5 percent gravel; 20 percent clay; neutral (pH 7.0); abrupt smooth boundary.

Bw1 27 to 37 cm; black (10YR 2/1) loam, gray (10YR 6/1) dry; weak coarse angular blocky structure; soft, friable, nonsticky and slightly plastic; 5 percent gravel; 15 percent clay; neutral (pH 7.0); abrupt smooth boundary.

BC1 37 to 52 cm; dark grayish brown (10YR 4/2) very fine sandy loam, light gray (10YR 7/2) dry; weak coarse angular blocky structure; soft, very friable, nonsticky and nonplastic; 10 percent clay; slightly alkaline (pH 7.5); gradual smooth boundary; water entering pit at 37 cm.

BC2 52 to 100 cm; dark grayish brown (10YR 4/2) loam, white (10YR 8/1) dry with few medium distinct yellowish brown (10YR 5/8) redoximorphic concentrations; weak coarse angular blocky structure; soft, very friable, nonsticky and nonplastic; no rock fragments; 10 percent clay; neutral (pH 7.2).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* to 40 centimeters and averages 28 centimeters. Color hues for the epipedons are 10YR. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas are 1 or 2 moist. The most common textures are silt loam and loam. The pH ranges from 5.4 through 7.2.

Control section: The most common textures are silt loam, loam, and sandy loam. The weighted average clay content ranges from 23 through 42 percent, and averages 30 percent. The weighted average rock fragment content ranges from 0 through 36 percent, and averages 15 percent. The pH ranges from 5.8 through 7.5.

Base saturation: The range for all horizons in all pedons is 53 through 100 percent. The average of all pedons is 78 percent.

* After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Arcette Family

The Arcette family soils have ochric epipedons and skeletal subsoil layers with moderately coarse to coarse textures. They are greater than 100 centimeters deep. These soils form in frost rubble and inactive talus derived from rhyolite, rhyolitic ash-flow tuffs, and andesite. Soils in this family often form under the forested ABLA/VASC-PIAL, PIAL/VASC habitat types; various Douglas fir habitat types; or nonforested alpine meadows.

Taxonomic Classification: Fragmental, mixed, superactive Typic Cryochrepts

Typical Pedon

Location: Near summit of Mount Sheridan, Mt. Sheridan 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 532770E/4901000N. Pedon 784.

Description: (All colors are for moist conditions unless otherwise stated.)

O 5 to 0 cm; litter layer.

A 0 to 6 cm; brown (10YR 4/3) cobbly loam, yellowish brown (10YR 5/4) dry; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; 10 percent gravel and 20 percent cobbles; 20 percent clay; moderately acid (pH 5.8); abrupt wavy boundary.

Bw 6 to 35 cm; dark yellowish brown (10YR 4/4) extremely cobbly loam, light yellowish brown (10YR 6/4) dry; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; 10 percent gravel and 70 percent cobbles; 20 percent clay; slightly acid (pH 6.4); abrupt wavy boundary.

C 35 to 100 cm; brown (10YR 5/3) extremely stony sandy loam, light yellowish brown (10YR 6/4) dry; single grain; loose, nonsticky and nonplastic; 5 percent gravel, 10 percent cobbles, and 80 percent stones; 10 percent clay; slightly acid (pH 6.2).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values are 5 or 6 dry, and are 3 or 4 moist. Chromas are 2 or 3 moist. The textures are loamy sand and loam. The pH ranges from 5.5 through 6.2.

Control section: The most common textures are sand, loamy sand, and sandy loam. The weighted average clay content ranges from 1 through 15 percent, and averages 11 percent. The weighted average rock fragment content ranges from 87 through 95 percent, and averages 91 percent. The pH ranges from 5.8 through 6.4.

Base saturation: All pedons have at least one horizon with a base saturation greater than 60 percent. The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 55 through 89 percent. The average for all pedons is 69 percent.

Arrowpeak Family

The Arrowpeak family soils have mollic epipedons and shallow root-limiting layers. The skeletal subsoil layers have medium to moderately coarse textures. The soils are 10 to 50 centimeters deep, and in some areas have aquic conditions. Soils in this family form in glacial till, colluvium, and residuum derived from andesite, basalt, or rhyolite. These soils most often form under non-forested habitat types or the forested, ABLA/VASC habitat type.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Lithic Cryoborolls

Typical Pedon

Location: Southwest of Republic Pass, Pilot Peak 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 582060E/4977320N. Pedon 2.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 18 cm; dark brown (10YR 3/3) very gravelly sandy loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, friable, slightly sticky and nonplastic; 40 percent gravel; 15 percent clay; moderately acid (pH 5.6); abrupt smooth boundary.

Bw 18 to 27 cm; dark brown (10YR 4/3) very gravelly sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 50 percent gravel; 12 percent clay; moderately acid (pH 5.8); clear smooth boundary.

Cr 27 to 32 cm; paralithic contact with highly weathered andesite conglomerate.

R 32 cm; lithic contact with andesite bedrock.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 10* through 50 centimeters. Color hues range from 7.5YR through 2.5Y. Values are 4 or 5 dry, and 2 or 3 moist. Chromas range from 1 through 3 moist. The most common texture is loam and sandy loam. The pH ranges from 5.0 through 8.0.

Control section: The most common textures are loam and sandy loam. The weighted average clay content ranges from 4 through 29 percent, and averages 17 percent. The weighted average rock fragment content ranges from 38 through 75 percent, and averages 52 percent. The pH ranges from 5.4 through 8.0.

Base saturation: The range for all horizons in all pedons is 60 through 100 percent. The average for all pedons is 85 percent.

Root-limiting layer: Although all pedons have a lithic contact within 50 centimeters of the soil surface, both lithic and paralithic contacts are considered root-limiting layers. The depth to this layer ranges from 10 through 50 centimeters and averages 33 centimeters below the soil surface.

*Thicknesses of less than 18 cm are due to a very shallow root-limiting layer.

Badwater Family

The Badwater family soils have thick mollic epipedons, argillic horizons, and skeletal subsoil layers with moderately fine to medium textures. The soils are greater than 100 centimeters deep. Soils in this family form in glacial till, colluvium, and glaciofluvial deposits derived from andesite, shale, or limestone. These soils form under the nonforested ARTR/FEID and FEID/AGCA habitat types, and also under various Douglas fir and subalpine fir habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Argic Pachic Cryoborolls

Typical Pedon

Location: North of Specimen Creek Trail; Big Horn Peak 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 536100E/4959980N. Pedon 646.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 22 cm; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate very coarse granular structure; hard, very friable, slightly sticky and slightly plastic; 10 percent gravel; 20 percent clay; slightly acid (pH 6.2); abrupt smooth boundary.

A2 22 to 46 cm; dark brown (10YR 3/3) very cobbly silt loam, brown (10YR 5/3) dry; moderate very coarse granular structure; hard, very friable, slightly sticky and slightly plastic; 10 percent gravel and 50 percent cobbles; 20 percent clay; slightly acid (pH 6.2); abrupt smooth boundary.

Bt 46 to 100 cm; dark yellowish brown (10YR 4/4) extremely cobbly loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, very friable, sticky and plastic; 40 percent gravel and 25 percent cobbles; 26 percent clay; common distinct clay films on ped faces; slightly acid (pH 6.2).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 43 through 85 centimeters and averages 57 centimeters. Color hues for the epipedons range from 2.5YR through 2.5Y. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The textures are silt loam, loam, and clay loam. The pH ranges from 5.6 through 8.0.

Control section: The most common textures are loam and sandy clay loam. The weighted average clay content ranges from 23 through 33 percent, and averages 26 percent. The weighted average rock fragment content ranges from 38 through 90 percent, and averages 61 percent. The pH ranges from 5.6 through 8.0.

Base saturation: The range for all horizons in all pedons is 50 through 100 percent. The average for all pedons is 84 percent.

Calcium Carbonate: Subsoil accumulation of calcium carbonate occurs in the Northern Range area of the park, and also in areas where limestone or travertine is part of the parent material.

Bearmouth Family

The Bearmouth family soils have mollic epipedons, and skeletal subsoil layers with coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form in glacial till, alluvium, and glaciofluvial alluviums derived mainly from rhyolite or andesite. Soils in this family most often form under forested ABLA/VASC habitat types, but also form under dry, nonforested habitat types.

Taxonomic Classification: Sandy-skeletal, mixed, superactive Typic Cryoborolls

Typical Pedon

Location: Near Calfee Creek Patrol Cabin, Wahn Springs 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 570150E/4958500N. Pedon 55.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 3 to 0 cm; Litter layer.

A1 0 to 6 cm; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; no rock fragments; 15 percent clay; moderately acid (pH 6.0); abrupt smooth boundary.

A2 6 to 25 cm; dark brown (10YR 3/3) fine sandy loam, dark brown (10YR 4/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 5 percent gravel; 10 percent clay; moderately acid (pH 6.0); abrupt wavy boundary.

Bw 25 to 39 cm; dark brown (10YR 3/3)* extremely gravelly loamy coarse sand, dark yellowish brown (10YR 4/4) dry; weak medium subangular blocky structure; loose, nonsticky and nonplastic; 60 percent gravel and 15 percent cobbles; 3 percent clay; slightly acid (pH 6.4); clear smooth boundary.

C 39 to 100 cm; very dark grayish brown (10YR 3/2)* extremely cobbly coarse sand, dark brown (10YR 3/3) dry; single grain; loose, nonsticky and nonplastic; 45 percent gravel and 25 percent cobbles; 2 percent clay; slightly acid (pH 6.4).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18 through 66** centimeters, and averages 33 centimeters. Color hues for the epipedons are 10YR or 2.5Y. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are loam, sandy loam, and loamy sand. The pH ranges from 5.4 through 8.2.

Control section: The most common textures are sand and loamy sand. The weighted average clay content ranges from 1 through 12 percent and averages 5 percent. The weighted average rock fragment content ranges from 40 through 80 percent, and averages 61 percent. The pH ranges from 5.6 through 8.2.

Base saturation: The range for all horizons in all pedons is 55 through 100 percent. The average for all pedons is 83 percent.

Carbonates: Soils in the Northern Range area of the park can have subsoil layers with calcium carbonate enrichment.

* Dark colors in Bw and C horizons are due to dark colored minerals in the sand fraction.

** This includes soils that have epipedons with textures coarser than loamy fine sand (too coarse for pachic criteria).

Beartooth Family

The Beartooth family soils have mollic epipedons, argillic horizons, and nonskeletal subsoil layers with moderately fine to medium textures. They are greater than 100 centimeters deep. These soils form in fan alluvium, stream alluvium, earthflow debris, and glacial till derived from a mixture of rock types. They form under the nonforested ARTR/AGSP and ARTR/FEID habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Argiborolls

Typical Pedon

Location: Near Reese Creek, Electric Peak 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 516570E/4988710N. Pedon 142.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 9 cm; dark brown (10YR 3/3) cobbly sandy loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; 10 percent gravel, 20 percent cobbles; 15 percent clay; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bt 9 to 39 cm; dark brown (10YR 3/3) cobbly loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 12 percent gravel, 15 percent cobbles; 25 percent clay; common, distinct clay films on ped faces and lining pores; slightly alkaline (pH 7.8); gradual smooth boundary.

Bk1 39 to 61 cm; brown (10YR 4/3) very cobbly sandy loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; 20 percent gravel, 20 percent cobbles; 10 percent clay; moderately alkaline (pH 8.0); accumulation of lime in pores; violently effervescent; abrupt smooth boundary.

Bk 261 to 100 cm; brown (10YR 5/3) sandy loam, light gray (10YR 7/2) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 6 percent gravel, 5 percent cobbles; moderately alkaline (pH 8.0); accumulation of lime in pores; violently effervescent.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 39 centimeters and averages 28 centimeters. Color hues for the epipedons are 10YR. Values are 4 or 5 dry, and are 2 or 3 moist. Chromas are 2 or 3 moist. The most common textures are loam and sandy loam. The pH ranges from 7.5 through 8.0.

Control section: The most common textures are loam and clay loam. The weighted average clay content ranges from 19 through 27 percent, and averages 22 percent. The weighted average rock fragment content ranges from 2 through 27 percent, and averages 16 percent. The pH ranges from 7.8 through 8.2.

Base saturation: The range for all horizons in all pedons is 90 through 100 percent. The average of all pedons is 98 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 30 centimeters. In soils weathering from earthflow debris, calcium carbonates may also accumulate in surface layers.

Salinity and Sodicity: When these soils weather from earthflow debris, they often have an accumulation of sodium salts, with ESPs of 30 to 40 percent, in the subsoil layers. These same layers are slightly to moderately saline with EC measurements of 4 to 13 mmhos/cm.

* After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

BILLYCREEK FAMILY

The Billycreek family soils have ochric epipedons, and nonskeletal subsoil layers with coarse textures. The soils are greater than 100 centimeters deep. These soils form mainly in glacial till, alluvium, and glacial lacustrine beach deposits derived from rhyolite. Soils in this family most often form under forested ABLA/VASC habitat types.

Taxonomic Classification: Sandy, mixed, superactive Typic Cryochrepts

Typical Pedon

Location: North of West Entrance, West Yellowstone 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 493100E/4946700N. Pedon 1043.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 4 cm; very dark gray (10YR 3/1) loamy coarse sand, gray (10YR 5/1) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; 14 percent gravel; 5 percent clay; moderately acid (pH 5.6); abrupt smooth boundary.

Bw 14 to 14 cm; dark grayish brown (10YR 4/2) loamy coarse sand, yellowish brown (10YR 5/4) dry; weak fine granular structure; slightly hard, friable, nonsticky and slightly plastic; 14 percent gravel; 6 percent clay; moderately acid (pH 5.7); clear smooth boundary.

Bw 214 to 42 cm; brown (10YR 4/3) loamy coarse sand, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 12 percent gravel; 5 percent clay; moderately acid (pH 6.0); abrupt smooth boundary.

2C 42 to 110 cm; gray (10YR 5/1) gravelly coarse sand; massive; loose, very friable, nonsticky and nonplastic; 23 percent gravel; 2 percent clay; slightly acid (pH 6.3).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values range from 4 through 6 dry, and from 2 through 4 moist. Chromas range from 1 through 3 moist. The most common textures are sandy loam, loamy sand, and loam. The pH ranges from 5.3 through 6.3.

Control section: The most common textures are sand and loamy sand. The weighted average clay content ranges from 1 through 11 percent, and averages 5 percent. The weighted average rock fragment content ranges from 3 through 32 percent, and averages 20 percent. The pH ranges from 5.7 through 7.0.

Base saturation: All pedons have at least one horizon with a base saturation greater than 60 percent. The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 50 through 91 percent. The average for all pedons is 72 percent.

BOBTAIL FAMILY

The Bobtail family soils have ochric epipedons, and nonskeletal subsoil layers with medium to coarse textures. The soils are greater than 100 centimeters deep. These soils form mainly in glacial till derived from rhyolite. Soils in this family most often form under forested ABLA/VASC habitat types.

Taxonomic Classification: Coarse-loamy, mixed, superactive Typic Cryochrepts

Typical Pedon

Location: Southeast ridge of Dunraven Peak, Mt. Washburn 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 542600E/4957900N. Pedon 1061.

Description: (All colors are for moist conditions unless otherwise stated.)

Oa 2 to 0 cm; litter layer.

A 0 to 8 cm; grayish brown (10YR 5/2) gravelly coarse sandy loam; moderate medium granular structure; slightly hard, friable, nonsticky and slightly plastic; 21 percent gravel; 18 percent clay; moderately acid (pH 5.8); clear wavy boundary.

Bw 8 to 23 cm; brown (10YR 5/3) gravelly coarse sandy loam; moderate fine granular structure; soft, friable, nonsticky and slightly plastic; 19 percent gravel; 18 percent clay; moderately acid (pH 5.7); clear wavy boundary.

BC 23 to 40 cm; yellowish brown (10YR 5/4) gravelly coarse sandy loam; moderate medium subangular blocky parting to fine granular structure; slightly hard, firm, nonsticky and slightly plastic; 17 percent gravel; 15 percent clay; moderately acid (pH 5.9).

C 40 to 110 cm; light yellowish brown (10YR 6/4) gravelly coarse sandy loam; moderate coarse subangular blocky structure; slightly hard, firm, nonsticky and slightly plastic; 17 percent gravel; 10 percent clay; slightly acid (pH 6.2).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons range from 7.5YR through 2.5Y. Values range from 4 through 8 dry, and from 2 through 5 moist. Chromas are 2 or 3 moist. The most common textures are sandy loam and loam. The pH ranges from 4.0 through 6.5.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 3 through 17 percent, and averages 11 percent. The weighted average rock fragment content ranges from 0 through 34 percent, and averages 18 percent. The pH ranges from 5.5 through 7.0.

Base saturation: All pedons have at least one horizon with a base saturation greater than 60 percent. The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 19 through 93 percent. The average for all pedons is 67 percent.

BOTTLE FAMILY

The Bottle family soils have ochric epipedons, and nonskeletal subsoil layers with coarse textures. The soils are greater than 100 centimeters deep. They form mainly in glacial till and alluvium derived from rhyolite. Soils in this family most often form under the forested, ABLA/VASC habitat types.

Taxonomic Classification: Sandy, mixed, superactive Dystric Cryochrepts

Typical Pedon

Location: South of Cub Creek, Frank Island 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 557380E/4925700N. Pedon 446.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 2 to 0 cm; litter layer.

A 0 to 6 cm; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; moderate coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 10 percent gravel; 4 percent clay; moderately acid (pH 5.8); abrupt smooth boundary.

BA 6 to 32 cm; very dark brown (10YR 3/2) loamy sand, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 10 percent gravel; 7 percent clay; strongly acid (pH 5.4); abrupt smooth boundary.

Bw 32 to 49 cm; dark brown (10YR 3/3) loamy sand, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 10 percent gravel; 2 percent clay; moderately acid (pH 5.6); clear smooth boundary.

C 49 to 106 cm; dark brown (10YR 3/3) sand, weak red (2.5YR 5/2) dry; single grain; loose, nonsticky and nonplastic; 10 percent gravel; 2 percent clay; moderately acid (pH 5.6).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons range from 7.5YR through 2.5Y. Values range from 3 through 7 dry, and are 2 or 3 moist. Chromas range from 1 through 4 moist. The most common textures are sandy loam and loam. The pH ranges from 4.7 through 5.8.

Control section: The most common textures are sand and loamy sand. The weighted average clay content ranges from 2 through 8 percent, and averages 5 percent. The weighted average rock fragment content ranges from 0 through 33 percent, and averages 21 percent. The pH ranges from 5.0 through 5.9.

Base saturation: The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 36 through 58 percent. The average of all pedons is 50 percent.

BRIDGER FAMILY

The Bridger family soils have mollic epipedons, argillic horizons, and nonskeletal subsoil layers with fine textures. They are greater than 100 centimeters deep. Soils in this family form in landslide and lacustrine deposits derived from a variety of rock types. These soils form under the nonforested FEID/AGCA and DECE/CAREX habitat types, and also under various forested habitat types.

Taxonomic Classification: Very fine, mixed, superactive Argic Cryoborolls

Typical Pedon

Location: Grebe Lake Service Road, Crystal Falls 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 538690E/4951460N. Pedon 36.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 31 cm; black (10YR 2/1) clay loam, very dark grayish brown (10YR 3/2) dry; strong coarse subangular blocky structure; slightly hard, friable, sticky and plastic; 5 percent gravel; 38 percent clay; slightly acid (pH 6.2); clear wavy boundary.

Bt 131 to 48 cm; dark grayish brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry, very dark brown (10YR 2/2) pores; strong coarse angular blocky structure; slightly hard, friable, sticky and very plastic; 10 percent gravel; 60 percent clay; many moderately thick clay films on ped faces; neutral (pH 6.6); clear wavy boundary.

Bt 248 to 114 cm; brown (10YR 4/3) gravelly clay, pale brown (10YR 6/3) dry, very dark brown (10YR 2/2) ped faces; strong coarse angular blocky structure; hard, firm, sticky and very plastic; 15 percent gravel and 5 percent cobbles; 60 percent clay; many thick clay films on ped faces; neutral (pH 6.8); abrupt wavy boundary.

BC 114 to 161 cm; brown (10YR 5/3) gravelly clay loam, light gray (10YR 7/2) dry; moderate coarse subangular blocky structure; hard, friable, sticky and plastic; 30 percent gravel; 38 percent clay; many thick clay bridges between mineral grains; neutral (pH 6.9); abrupt smooth boundary.

2BC 161 to 196 cm; grayish brown (10YR 5/2) silty clay loam, brownish yellow (10YR 6/8) dry, dark brown (7.5YR 3/2) stains; strong medium platy structure; hard, very firm, sticky and plastic; no rock fragments; 35 percent clay; neutral (pH 7.0).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons range from 18* through 34 centimeters and averages 24 centimeters thick. Color hues for the epipedons are 7.5YR or 10YR. Values range from 3 through 5 dry, and are 2 moist. Chromas range from 1 through 3 moist. The most common textures are clay and silty clay loam. The pH ranges from 5.6 through 6.2.

Control section: The textures are silty clay and clay. The weighted average clay content ranges from 37 through 60 percent, and averages 43 percent. The weighted average rock fragment content ranges from 0 through 18 percent, and averages 8 percent. The pH ranges from 5.6 through 7.0.

Base saturation: The range for all horizons in all pedons is 58 through 91 percent. The average for all pedons is 73 percent.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

CASTAN FAMILY

The Castan family soils have umbric epipedons, and skeletal subsoil layers with medium to coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form in colluvium, loess, or residuum derived from rhyolite. These soils most often form under forests in the ABLA/VAGL habitat type.

Taxonomic Classification: Ashy-skeletal, glassy Humic Vitricryand

Typical Pedon

Location: Southwest of the northeast corner of section 14, T. 14 N., R. 44 E., ID, Targhee National Forest, Idaho. UTM 489387E/4959846N. Pedon T-ca.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 2 to 0 cm; litter layer of needles, twigs and leaves.

A1 0 to 28 cm; dark brown (10YR 3/3) cobbly silt loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure parting to moderate fine granular; soft, very friable, nonsticky and slightly plastic; 10 percent gravel, 10 percent cobbles, trace stones and boulders; moderately acid (pH 5.6); clear smooth boundary.

A2 28 to 41 cm; dark brown (10YR 3/3) cobbly loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many very fine, 10 percent gravel, 10 percent cobbles, trace stones and boulders; moderately acid (pH 5.6); clear wavy boundary.

B/E 41 to 76 cm; dark yellowish brown (10YR 4/4) and brown (10YR 5/3) very gravelly sandy loam, light yellowish brown (10YR 6/4) and very pale brown (10YR 7/3) dry; 80 percent B material and 20 percent E material in a fine (less than 5 mm) irregular matrix; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; 40 percent gravel, 10 percent cobbles and trace stones and boulders; moderately acid (pH 6.0); clear smooth boundary.

2E/B 76 to 96 cm; brown (10YR 5/3) and dark yellowish brown (10YR 4/4) extremely gravelly sandy loam, very pale brown (10YR 7/3) and light yellowish brown (10YR 6/4) dry; 80 percent E material and 20 percent B material in a medium (5 to 15 mm) irregular matrix; weak medium subangular blocky parting to weak fine granular structure; slightly hard, very friable, nonsticky and

nonplastic; 50 percent gravel, 10 percent cobbles and trace stones and boulders; moderately acid (pH 6.0); clear smooth boundary.

2B/E 96 to 124 cm; brown (10YR 4/3) and light brownish gray (10YR 6/2) extremely gravelly sandy loam, pale brown (10YR 6/3) and white (10YR 8/2) dry; 50 percent B material and 50 percent E material in a coarse (greater than 15 mm) irregular matrix; weak fine subangular blocky structure (B portion) and weak fine granular structure (E portion); slightly hard (B portion) and soft (E portion), very friable, nonsticky and nonplastic; 50 percent gravel, 10 percent cobbles; trace stones and boulders; slightly acid (pH 6.2); clear smooth boundary.

2BC 124 to 152 cm; brown (10YR 4/3) extremely gravelly loamy sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; continuous light brownish gray (10YR 6/2) uncoated silt grains capping cobbles stones and boulders; 65 percent gravel, 10 percent cobbles, trace stones and boulders; slightly acid (pH 6.4).

Range of Important Properties

Epipedon: The thickness of these umbric epipedons ranges from 25 through 40 centimeters. Color hues for the epipedons are 10YR. Values are 4 or 5 dry, and 2 or 3 moist. Chromas are 2 or 3 moist. The most common textures are loam, silt loam, and sandy loam. The pH ranges from 5.6 through 6.5.

Control section: The most common textures are silt loam, sandy loam, and loam. The weighted average clay content ranges from 3 through 11 percent, and averages 6 percent. The weighted average rock fragment content ranges from 35 through 65 percent, and averages 40 percent for all pedons. The pH ranges from 5.6 through 6.5.

Andic properties: These properties occur to a depth of 38 to 76 centimeters below the surface. In these soils, andic properties are defined as the following. Phosphate retention is between 35 and 60 percent. Extractable Al + 1/2 Fe is between 0.4 and 1.0 percent. Volcanic glass (0.02 - 2.0 mm in size) is greater than 50 percent.

Castlepeak Family

The Castlepeak family soils have ochric epipedons and skeletal subsoil layers with coarse textures. They are greater than 100 centimeters deep. These soils form in recent alluvium derived from rhyolite or andesite. Soils in this family most often form under the ARTR/FEID or drier, nonforested habitat types.

Taxonomic Classification: Sandy-skeletal, mixed, superactive Typic Cryorthents

Typical Pedon

Location: Next to Slough Creek; Mt. Hornaday 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 561420E/4980800N. Pedon 50.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 10 cm; dark grayish brown (10YR 4/2) very gravelly loamy sand, brown (10YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; 55 percent gravel; 4 percent clay; neutral (pH 6.6); clear smooth boundary.

C1 10 to 50 cm; dark grayish brown (10YR 4/2) extremely gravelly sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and slightly plastic; 75 percent gravel; 1 percent clay; neutral (pH 6.6); clear smooth boundary.

C2 50 to 100 cm; dark grayish brown (10YR 4/2) extremely gravelly sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and slightly plastic; 65 percent gravel; 1 percent clay; neutral (pH 6.6).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values range from 4 through 6 dry and are 3 or 4 moist. Chromas are 2 moist. The most common texture is loamy sand. The pH ranges from 5.4 through 6.6.

Control section: The most common textures are loamy sand and sand. The weighted average clay content ranges from 0 through 3 percent, and averages 2 percent. The weighted average rock fragment content ranges from 42 through 80 percent, and averages 65 percent. The pH ranges from 5.6 through 7.5.

Base saturation: The range for all horizons in all pedons is 50 through 95 percent. The average for all pedons is 82 percent.

Cloud Peak Family

The Cloud Peak family soils have ochric epipedons, argillic horizons, and skeletal subsoil layers with medium textures. The soils are greater than 100 centimeters deep. These soils form mainly in glacial till derived from rhyolite, andesite, or sedimentary rocks. Soils in this family often form under the forested ABLA/VASC or ABLA/VAGL habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Cryoboralfs

Typical Pedon

Location: Northeast of Heart Lake, Heart Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 549670E/4902340N. Pedon 257.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 3 to 0 cm; litter layer.

A 0 to 9 cm; dark brown (10YR 4/3) cobbly loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; 10 percent gravel and 20 percent cobbles; 17 percent clay; moderately acid (pH 5.8); abrupt smooth boundary.

BA 9 to 30 cm; dark yellowish brown (10YR 4/4) cobbly loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; 10 percent gravel and 10 percent cobbles; 23 percent clay; moderately acid (pH 5.8); clear smooth boundary.

Bt 30 to 100 cm; brown (10YR 5/3) very cobbly sandy clay loam, light gray (10YR 7/2) dry; moderate coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; 20 percent gravel and 30 percent cobbles; 27 percent clay; few prominent clay films on ped faces and lining pores; slightly acid (pH 6.5).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons range from 2.5YR through 10YR. Values range from 3 through 7 dry, and from 3 through 5 moist. Chromas range from 1 through 6 moist. The most common textures are loam and sandy clay loam. The pH ranges from 5.0 through 7.0.

Control section: The most common textures are loam and sandy clay loam. The weighted average clay content ranges from 15 through 34 percent, and averages 26 percent. The weighted average rock fragment content ranges from 35 through 76 percent, and averages 53 percent. The pH ranges from 5.2 through 7.5.

Base saturation: The range for all horizons in all pedons is 25 through 100 percent. The average for all pedons is 72 percent.

Como Family

The Como family soils have ochric epipedons, and skeletal subsoil layers with coarse textures. They are greater than 100 centimeters deep. These soils form in alluvium, colluvium, glacial till, and residuum derived from rhyolite. Soils in this family often form under the forested ABLA/VASC or various PICO habitat types.

Taxonomic Classification: Sandy-skeletal, mixed, superactive Typic Cryochrepts

Typical Pedon

Location: Near Deep Creek; Amethyst Mountain 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 551520E/4965780N. Pedon 765.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 14 cm; brown (10YR 4/3) gravelly loamy sand, Light brownish gray (10YR 6/2) dry; weak medium subangular blocky; slightly hard, friable, nonsticky and slightly plastic; 20 percent gravel; 5 percent clay; neutral (pH 6.6); abrupt smooth boundary.

Bw1 14 to 31 cm; grayish brown (10YR 5/2) very gravelly loamy sand, gray (10YR 6/1) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; 35 percent gravel, 5 percent clay; neutral (pH 6.8); clear smooth boundary.

Bw2 31 to 53 cm; grayish brown (10YR 5/2) very gravelly loamy sand, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; 50 percent gravel; 2 percent clay; neutral (pH 7.0); clear smooth boundary.

Bw3 53 to 100 cm; grayish brown (10YR 5/2) very gravelly loamy sand, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; 50 percent gravel; 2 percent clay; neutral (pH 7.2).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons range from 7.5YR through 2.5Y, and N. Values range from 3 through 7 dry and from 2 through 4 moist. Chromas range from 0 through 4 moist. The most common textures are sand, loamy sand, and loam. The pH ranges from 4.6 through 7.5.

Control section: The most common textures are loamy sand and sand. The weighted average clay content ranges from 0 through 9 percent, and averages 5 percent for all pedons. The weighted average rock fragment content ranges from 36 through 90 percent, and averages 58 percent for all pedons. The pH ranges from 4.5 through 8.0.

Base saturation: All pedons have at least one horizon with a base saturation greater than 60 percent. The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 31 through 100 percent. The average for all pedons is 73 percent.

Cratermo Family

The Cratermo family soils have thick mollic epipedons, argillic horizons, and nonskeletal subsoil layers with fine to moderately fine textures. The soils are greater than 100 centimeters deep. Soils in this family form in earthflow debris and glacial lacustrine sediments derived primarily from andesite or sedimentary rocks. These soils often form under the nonforested FEID/AGCA, FEID/DECE, and DECE/CAREX habitat types.

Taxonomic Classification: Fine, mixed, superactive Argic Pachic Cryoborolls

Typical Pedon

Location: East of Flat Mountain, Heart Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 547150E/4910520N. Pedon 65.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 8 cm; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; 10 percent gravel; 19 percent clay; neutral (pH 6.8); abrupt wavy boundary.

Bt1 8 to 33 cm; dusky red (2.5YR 3/2) clay, weak red (2.5YR 5/2) dry; strong coarse subangular blocky structure; very hard, very firm, sticky and very plastic; 10 percent gravel; 52 percent clay; many, prominent clay films on ped faces; neutral (pH 7.2); clear wavy boundary.

Bt2 33 to 56 cm; very dark gray (2.5YR 3/1) very gravelly clay, weak red (2.5YR 5/2) dry; moderate coarse angular blocky structure; very hard, very firm, sticky and plastic; 50 percent gravel; 48 percent clay; common prominent clay films on ped faces; neutral (pH 7.2); gradual smooth boundary.

Bt3 56 to 100 cm; very dark gray (10YR 4/1) very gravelly clay, gray (10YR 5/1) dry; moderate coarse angular blocky structure; very hard, firm, sticky and plastic; 40 percent gravel; 42 percent clay; many faint clay films on ped faces; slightly alkaline (pH 7.4).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 46 through 58 centimeters and averages 54 centimeters. The color hues for the epipedons ranges from 2.5YR through 2.5Y. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas are 1 or 2 moist. The most common textures are silt loam, loam, silty clay, and clay. The pH ranges from 6.0 through 7.4.

Control section: The most common textures are clay and silty clay. The weighted average clay content ranges from 38 through 55 percent, and averages 44 percent. The weighted average rock fragment content ranges from 0 through 29 percent, and averages 13 percent. The pH ranges from 6.2 through 7.4.

Base saturation: The range for all horizons in all pedons is 65 through 100 percent. The average for all pedons is 88 percent.

Cryaquepts

The Cryaquept soils usually have ochric epipedons*, and both skeletal and nonskeletal subsoil layers with medium to coarse textures. The soils are greater than 100 centimeters deep and have aquic conditions for some time during the growing season. These soils form in alluvium derived from a variety of rock types. This includes soils forming from the silica-rich deopsits near active thermal areas. They most often form under wet forest habitat types, the nonforested DECE/CAREX habitat type, or marsh areas of Carex and Salix species.

Taxonomic Classification: Cryaquepts (includes *Typic*, *Aeric*, *Histic*, and *Humic* subgroups)

Typical Pedon

Location: West of High Lake, Sportman Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 50375E/498854N. Pedon 545.

Description: (All colors are for moist conditions unless otherwise stated.)

Oe 0 to 15 cm; partially decomposed organic material; strongly acid (pH 5.4); abrupt smooth boundary; saturated with water at surface.

A 15 to 25 cm; dark gray (10YR 4/1) sandy clay loam, gray (10YR 6/1) dry, with common medium prominent dark brown (7.5YR 3/4) redoximorphic concentrations and oxidized rhizospheres; weak coarse subangular blocky structure; extremely hard, friable, sticky and slightly plastic; 26 percent clay; moderately acid (pH 5.8); clear smooth boundary.

Bg1 25 to 62 cm; very dark grayish brown (10YR 3/2) sandy clay loam, gray (10YR 6/1) dry, with common medium prominent dark reddish brown (5YR 3/3) redoximorphic concentrations and oxidized rhizospheres; weak coarse subangular blocky structure; extremely hard, friable, sticky and slightly plastic; 26 percent clay; strongly acid (pH 5.4); abrupt smooth boundary; standing water at 26 cm.

Bg2 62 to 120 cm; very dark gray (5Y 3/1) sandy clay loam, gray (10YR 6/1) dry, with few medium prominent dark reddish brown (2.5YR 3/4) redoximorphic concentrations; weak coarse subangular blocky structure; extremely hard, friable, slightly sticky and slightly plastic; 12 percent clay; moderately acid (pH 5.6).

Range of Important Properties

Epipedon: Ochric epipedons are the most common in these soils, but mollic and histic epipedons also occur. Color hues for the epipedons are 10YR, 7.5YR, or 2.5Y. Values range from 2 through 8 dry, and from 2 through 6 moist. Chromas range from 1 through 4 moist. The most common textures are silt loam, loam, and sandy clay loam. The pH ranges from 5.2 through 7.5.

Control section: The most common textures are silt loam, sandy loam, and sandy clay loam. The weighted average clay content ranges from 2 through 35 percent, and averages 13 percent. The weighted average rock fragment content ranges from 0 through 85 percent, and averages 17 percent. The pH ranges from 5.0 through 8.0.

Base saturation: The range for all horizons in all pedons is 15 through 100 percent. The average for all pedons is 71 percent.

*See Epipedon section under **Range of Important Properties**.

Cryaquolls

The Cryaquoll soils have mollic epipedons and either nonskeletal or skeletal subsoil layers with fine to moderately coarse textures. Some soils also have argillic horizons. The soils are greater than 100 centimeters deep and have aquic conditions some time during the growing season. Soils in this family form in alluvium derived from a variety of rock types. These soils form under the nonforested DECE/CAREX habitat type, marsh areas of *Carex* species, and under wet forest habitat types.

Taxonomic Classification: Cryaquolls (includes *Typic*, *Cumulic*, *Argic*, and *Histic* subgroups)

Typical Pedon

Location: Mist Creek, Mount Chittenden 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 569160E/4940190N. Pedon 687.

Description: (All colors are for moist conditions unless otherwise stated.)

Ag1 0 to 6 cm; black (7.5YR 2/0) silt loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure; very firm, friable, nonsticky and slightly plastic; no rock fragments; 2 percent clay; moderately acid (pH 6.0); abrupt smooth boundary.

Ag2 6 to 37 cm; dark brown (7.5YR 3/2) cobbly loam, gray (10YR 5/1) dry, with few small faint redoximorphic concentrations; weak coarse subangular blocky structure; hard, friable, nonsticky and slightly plastic; 15 percent cobbles; 16 percent clay; slightly acid (pH 6.4); abrupt smooth boundary.

Bwg1 37 to 43 cm; dark gray (10YR 4/1) sandy loam, white (10YR 8/1) dry, with many large distinct brown (10YR 5/3) redoximorphic concentrations; weak coarse subangular blocky structure; extremely hard, friable, nonsticky and slightly plastic; 5 percent cobbles; 10 percent clay; neutral (pH 6.6); abrupt wavy boundary.

2Bwg2 43 to 100 cm; dark grayish brown (10YR 4/2) extremely cobbly loamy coarse sand, light gray (10YR 7/2) dry, with common small prominent dark yellowish brown (10YR 4/6) redoximorphic concentrations; weak coarse subangular blocky structure; extremely hard, firm, nonsticky and nonplastic; 35 percent gravel and 30 percent cobbles; 5 percent clay; slightly acid (pH 6.2); water entering profile at 46 cm.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* to 60 centimeters and averages 29 centimeters. Some soils have histic epipedons overlying the mollic epipedon. Color hues for the epipedons are 7.5YR, N, or 10YR. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 0 through 2 moist. The most common textures are sandy loam, silt loam, and loam. The pH ranges from 5.4 through 7.5.

Control section: The most common textures are sandy loam, loam, and loamy sand. The weighted average clay content ranges from 5 through 37 percent, and averages 18 percent. The weighted average rock fragment content ranges from 0 through 93 percent and averages 32 percent. The pH ranges from 5.0 through 7.2.

Base saturation: The range for all horizons in all pedons is 53 through 100 percent. The average of all pedons is 77 percent.

*After mixing to 18 cm, the weighted average of the color value and chroma meet mollic requirements.

Cryoboralfs-sh

The Cryoboralfs-sh soils have ochric epipedons, argillic horizons, and shallow root-limiting layers. The skeletal subsoil layers have moderately fine to medium textures. The soils are between 30 and 50 centimeters deep. These soils form mainly in colluvium, till, and residuum derived from andesite or sedimentary rocks. They often form under nonforested habitat types.

Taxonomic Classification: Cryoboralfs (includes the *Lithic* subgroup and the *shallow* depth class of the *Typic* subgroup; the *loamy-skeletal* particle size class; and the *mixed, superactive* mineralogy class)

Typical Pedon

Location: Mirror Plateau, Opal Creek 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 565950E/4959250N. Pedon 471. (classified as Loamy-skeletal, mixed, superactive, shallow Typic Cryoboralf)

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 17 cm; dark grayish brown (10YR 4/2) gravelly sandy clay loam, brown (10YR 5/3) dry; moderate coarse granular structure; soft, very friable, slightly sticky and slightly plastic; 30 percent gravel; 22 percent clay; moderately acid (pH 5.6); clear smooth boundary.

Bt 17 to 40 cm; brown (10YR 4/3) very gravelly sandy clay loam, grayish brown (10YR 5/2) dry; weak coarse subangular blocky structure; hard, friable, sticky and plastic; 40 percent gravel; 27 percent clay; few, distinct clay films on ped faces; moderately acid (pH 5.6); abrupt smooth boundary.

Cr 40 to 69 cm; partially weathered andesitic sandstone.

R 69 cm; lithic contact with andesite bedrock.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR or 2.5Y. Values are 4 or 5 dry, and range from 2 through 4 moist. Chromas range from 1 through 3 moist. The textures are loam and sandy clay loam. The pH ranges from 5.6 through 8.0.

Control section: The most common textures are loam and sandy clay loam. The weighted average clay content ranges from 22 through 30 percent, and averages 27 percent. The weighted average rock fragment content ranges from 35 through 70 percent, and averages 52 percent for all pedons. The pH ranges from 5.6 through 8.0.

Base saturation: The range for all horizons in all pedons is 77 through 100 percent. The average for all pedons is 89 percent.

Root-Limiting Layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. These soils have a root-limiting layer between 30 and 50 centimeters below the soil surface. The average depth to this layer is 37 centimeters.

Cryochrepts-HT&sh

The Cryochrept-HT&sh soils have ochric epipedons and shallow to very shallow root-limiting layers. The soils are between 7 and 45 centimeters deep. The subsoil layers can be skeletal or nonskeletal, though they are usually nonskeletal. These layers have medium to coarse textures. The soils form in nonactive hydrothermal deposits and glacial till, both derived from acid-altered rhyolite and siliceous sinter. They form under the forested ABLA/VASC and PICO/CARO habitat types and under various nonforested vegetation.

Taxonomic Classification: Cryochrepts (includes the *Lithic* Subgroup and the *shallow* depth class of the *Dystric* Subgroup; the *loamy*, *sandy*, *loamy-skeletal*, and *sandy-skeletal* particle size classes; and the *siliceous* mineralogy class)

Typical Pedon

Location: Summit Lake, Summit Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 503240E/4921520N. Pedon 554.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 14 cm; dark brown (10YR 4/3) gravelly loam, pale brown (10YR 6/3) dry; moderate coarse granular structure; slightly hard, friable, slightly sticky and slightly plastic; 25 percent gravel; 20 percent clay; moderately acid (pH 5.6); clear wavy boundary.

Bw 14 to 27 cm; brown (10YR 5/3) loam, very pale brown (10YR 7/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 10 percent gravel; 17 percent clay; strongly acid (pH 5.5); clear smooth boundary.

BC 27 to 34 cm; pale brown (10YR 6/3) loam, very pale brown (10YR 7/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 5 percent gravel; 15 percent clay; moderately acid (pH 5.7); clear smooth boundary.

C 34 to 38 cm; light gray (10YR 7/2) gravelly loam,

white (10YR 8/1) dry, with common medium prominent red (10R 5/6) and reddish gray (10R 6/1) mottles; massive; hard, friable, slightly sticky and slightly plastic; 15 percent gravel; 15 percent clay; moderately acid (pH 5.6); clear smooth boundary.

Cr 38 to 57 cm; paralithic contact with altered rhyolite.

R 57 cm; lithic contact with altered rhyolite bedrock.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 5YR, 7.5YR or 10YR. Values range from 3 through 7 dry, and from 2 through 5 moist. Chromas range from 1 through 3 moist. The most common textures are loam, sandy loam, and loamy sand. The pH ranges from 2.6 through 6.0.

Control section: The most common textures are loamy sand, sandy loam, and loam. The weighted average clay content ranges from 1 through 25 percent, and averages 11 percent. The weighted average rock fragment content ranges from 0 through 37 percent, and averages 23 percent. The pH ranges from 2.6 through 6.3.

Base saturation: The range for all horizons in all pedons is 5 through 70 percent. The average of all pedons is 40 percent.

Root-limiting layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 7 through 45 centimeters and averages 28 centimeters below the soil surface. Layers with pH values less than 3.5 can restrict root growth in these soils.

Cryochrepts-sh&ns

The Cryochrept-sh&ns soils have ochric epipedons and shallow root-limiting layers. The nonskeletal subsoil layers have medium to moderately coarse textures. The soils are between 30 and 45 centimeters deep. These soils form mainly in glacial till over residuum, derived from rhyolite, rhyolitic ash-flow tuff, or sandstone. They form under the forested ABLA/VASC, ABLA/CARO, and ABLA/CAGE habitat types.

Taxonomic Classification: Cryochrepts (includes the *Typic* and *Dystric* subgroups; the *loamy* and *sandy* particle size classes; the *mixed*, *superactive* mineralogy class; and the *shallow* depth class)

Typical Pedon

Location: Summit Lake, Trischman Knob 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 502840E/4912300N. Pedon 659. (Loamy, mixed, superactive, shallow Dystric Cryochrept)

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 19 cm; dark brown (10YR 4/3) gravelly loam, yellowish brown (10YR 5/4) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 15 percent gravel; 17 percent clay; strongly acid (pH 5.2); abrupt smooth boundary.

Bw 19 to 32 cm; dark yellowish brown (10YR 4/4) very cobbly sandy loam, yellow (10YR 7/6) dry; weak coarse subangular blocky structure; soft, friable, nonsticky and nonplastic; 10 percent gravel and 30 percent cobbles; 10 percent clay; strongly acid (pH 5.4); clear wavy boundary.

Cr 32 to 62 cm; paralithic contact with weathered rhyolite.

R 62 cm; lithic contact with rhyolite bedrock.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values range from 3 through 7 dry, and from 2 through 5 moist. Chromas range from 1 through 3 moist. The textures are loamy sand and loam. The pH ranges from 5.0 through 6.0.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 3 through 14 percent, and averages 9 percent. The weighted average rock fragment content ranges from 10 through 34 percent, and averages 21 percent. The pH ranges from 5.0 through 6.8.

Base saturation: The range for all horizons in all pedons is 40 through 90 percent. The average of all pedons is 60 percent.

Root-limiting layer: In these soils a paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 30 through 45 centimeters and averages 39 centimeters below the soil surface.

CRYOCHREPTS-SH&S

The Cryochrept-sh&s soils have ochric epipedons and shallow root-limiting layers. The skeletal subsoil layers have medium to coarse textures. The soils are between 25 and 50 centimeters deep. These soils form in glacial till over residuum, derived from rhyolite or rhyolitic ash-flow tuff. They form under the forested ABLA/VASC-PIAL, ABLA/VASC-VASC, ABLA/CAGE, and PICO/CARO habitat types.

Taxonomic Classification: Cryochrepts (includes the *Typic* and *Dystric* subgroups; the *loamy-skeletal* and *sandy-skeletal* particle size classes; the *mixed*, *superactive* mineralogy class; and the *shallow* depth class)

Typical Pedon

Location: Divide Lookout, Craig Pass 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 521770E/4918460N. Pedon 779. (Sandy-skeletal, mixed, superactive, shallow Typic Cryochrept)

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 4 to 0 cm; litter layer.

A 0 to 20 cm; dark brown (10YR 4/3) gravelly sandy loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; 30 percent gravel; 5 percent clay; strongly acid (pH 5.4); clear wavy boundary.

Bw 20 to 40 cm; Brown (10YR 5/3) very gravelly loamy sand, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; 40 percent gravel; 5 percent clay; moderately acid (pH 5.6); clear smooth boundary.

Cr 40 to 77 cm; paralithic contact with weathered rhyolite.

R 77 cm; lithic contact with rhyolite bedrock.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 7.5YR or 10YR. Values range from 3 through 6 dry, and from 2 through 4 moist. Chromas range from 1 through 4 moist. The most common texture are loam and sandy loam. The pH ranges from 4.6 through 5.6.

Control section: The most common textures are loamy sand, sandy loam, and loam. The weighted average clay content ranges from 1 through 16 percent, and averages 7 percent. The weighted average rock fragment content ranges from 35 through 70 percent, and averages 48 percent. The pH ranges from 4.2 through 6.6.

Base saturation: The range for all horizons in all pedons is 24 through 82 percent. The average of all pedons is 58 percent.

Root-limiting layer: In these soils a paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 29 through 50 centimeters and averages 40 centimeters below the soil surface.

Cryorthents-sh

The Cryorthent-sh soils have ochric epipedons and shallow or very shallow root-limiting layers. The soils are between 5 and 46 centimeters deep. The subsoil layers, which can be skeletal or nonskeletal, have medium to coarse textures. These soils form in nonactive hydrothermal deposits derived from travertine or siliceous sinter; and also in alluvium, glacial till and residuum derived from rhyolite or acid-altered rhyolite. They form under forested PICO habitat types and various nonforested habitat types.

Taxonomic Classification: Cryorthents (includes the *Lithic* subgroup and the *shallow* depth class of the *Typic* Subgroup; the *loamy*, *sandy*, *loamy-skeletal*, and *sandy-skeletal* particle size classes; the *carbonatic*, *siliceous* and *mixed* mineralogy classes; and both the *acid* and *nonacid* reaction classes)

Typical Pedon

Location: Mammoth Hot Springs, Mammoth 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 522580E/4978680N. Pedon 509.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 5 cm; very dark grayish brown (10YR 3/2) sandy loam, light brownish gray (2.5Y 6/2) dry; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; 10 percent gravel; 10 percent clay; slightly alkaline (pH 7.6); violently effervescent; abrupt smooth boundary.

AC 5 to 7 cm; very dark grayish brown (10YR 3/2) gravelly loamy sand, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure parting to moderate medium granular structure; soft, very friable, nonsticky and nonplastic; 20 percent gravel; 5 percent clay; moderately alkaline (pH 8.0); violently effervescent; abrupt smooth boundary.

C 7 to 15 cm; very pale brown (10YR 7/3) very gravelly sand, white (10YR 8/2) dry; single grain; loose, nonsticky and nonplastic; 40 percent gravel; 3 percent clay; slightly alkaline (pH 7.8); violently effervescent; abrupt smooth boundary.

R 15 cm; lithic contact with travertine bedrock.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR or 2.5Y. Values range from 4 through 7 dry, and from 3 through 5 moist. Chromas are 2 or 3 moist. The most common texture are loam, sandy loam, and loamy sand. The pH ranges from 3.6 through 8.1.

Control section: The most common textures are loamy sand and sandy loam. The weighted average clay content ranges from 3 through 25 percent, and averages 10 percent. The weighted average rock fragment content ranges from 12 through 70 percent, and averages 30 percent. The pH ranges from 3.2 through 8.0.

Base saturation: The range for all horizons in all pedons is 5 through 100 percent. The average of all pedons is 63 percent.

Root-limiting layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 5 through 46 centimeters and averages 15 centimeters below the soil surface. Layers with pH values less than 3.5 can restrict root growth above this depth.

Cryumbrepts-sh

The Cryumbrept-sh soils have umbric epipedons and shallow to very shallow root-limiting layers. The subsoil layers have medium to coarse textures, and can be either skeletal or nonskeletal. The soils are between 20 and 50 centimeters deep. These soils form in glacial till over residuum, derived from rhyolite. They form under forested ABLA/VASC and ABLA/VAGL habitat types.

Taxonomic Classification: Cryumbrepts (within the *Typic* subgroup this includes the *loamy*, *loamy-skeletal*, and *sandy-skeletal* particle size classes; the *mixed*, *superactive* mineralogy class; and the *shallow* depth class; and within the *Lithic* subgroup this includes the *loamy*, *mixed*, *superactive* family)

Typical Pedon

Location: Upper Weasel Creek, Dot Island 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 542060E/4926280N. Pedon 73. (classified as sandy-skeletal, mixed, superactive, shallow Typic Cryumbrept)

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 2 to 0 cm; litter layer.

A 0 to 7 cm; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak coars, subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 5 percent gravel; 14 percent clay; strongly acid (pH 5.2); abrupt smooth boundary.

AB 7 to 18 cm; dark brown (10YR 3/3) gravelly sandy loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 25 percent gravel and 5 percent cobbles; 16 percent clay; strongly acid (pH 5.4); clear wavy boundary.

Bw 18 to 48 cm; dark grayish brown (10YR 4/2) extremely gravelly loamy coarse sand, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; loose, very friable, nonsticky and nonplastic; 40 percent gravel, 20 percent cobbles, and 10 percent stones; 8 percent clay; moderately acid (pH 5.6); clear smooth boundary.

Cr 48 to 58 cm; paralithic contact with weathered rhyolite.

R 58 cm; lithic contact with rhyolite bedrock.

Range of Important Properties

Epipedon: The thickness of these umbric epipedons ranges from 18* to 24 centimeters, and averages 19 centimeters thick. Color hues for the epipedons range from 2.5YR through 10YR. Values are 4 or 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The textures are sandy loam and loam. The pH ranges from 4.8 through 5.6.

Control Section: The most common textures are loam, sandy loam, and loamy sand. The weighted average clay content ranges from 4 through 17 percent, and averages 10 percent. The weighted average rock fragment content ranges from 15 through 70 percent, and averages 43 percent. The pH ranges from 5.0 through 6.0.

Base saturation: All pedons have at least one horizon with a base saturation less than 50 percent. The range for all horizons in all pedons is 34 through 79 percent. The average of all pedons is 53 percent.

Root-limiting layer: In these soils a lithic or paralithic contact, or dense basal till is considered a root-limiting layer. The depth to this layer ranges from 24 through 48 centimeters and averages 39 centimeters below the soil surface.

*After mixing to 18 cm the weighted average of the color value and chroma meet umbric requirements.

Dashiki Family

The Dashiki family soils have ochric epipedons, and nonskeletal subsoil layers with medium to coarse textures. The soils are greater than 100 centimeters deep. These soils form mainly in alluvium derived from tephra; and loess over residuum derived from volcanic ash, rhyolite, and obsidian. Soils in this family often form under the forested ABLA/VASC-VASC habitat types.

Taxonomic Classification: Ashy, glassy Typic Vitricryand

Typical Pedon

Location: Northeast of the southwest corner of section 33, T. 12 N., R. 45 E., ID, Targhee National Forest, Idaho. UTM 488570E/4907209N. Pedon T-da.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 2 to 0 cm; litter layer of needles, twigs and leaves; abrupt smooth boundary.

A1 0 to 8 cm; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; soft, very friable, nonsticky and slightly plastic; trace gravel and cobbles; strongly acid (pH 5.5); abrupt smooth boundary.

A2 8 to 23 cm; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; soft, very friable, nonsticky and slightly plastic; 5 percent gravel, trace cobbles; moderately acid (pH 5.7); gradual smooth boundary.

Bw 23 to 79 cm; dark yellowish brown (10YR 4/4) gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate coarse subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; 15 percent gravel and trace cobbles; moderately acid (pH 5.9); clear wavy boundary.

2BC 79 to 94 cm; grayish brown (10YR 5/2) gravelly loamy coarse sand, light brownish gray (10YR 6/2) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; 30 percent gravel, trace cobbles and stones; slightly acid (pH 6.5); clear broken boundary.

2C 94 to 190 cm; dark gray (2.5Y 4/0) stratified

gravelly coarse sand to extremely gravelly coarse sand, gray (2.5Y 5/0) dry; single grain; loose, nonsticky and nonplastic; 20 to 80 percent gravel, 10 percent cobbles, trace stones; slightly acid (pH 6.5).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. The color hues for the epipedons are 7.5YR or 10YR. Values are 4 or 5 dry, and 2 or 3 moist. Chromas range from 2 through 4 moist. The most common texture is silt loam. The pH ranges from 5.1 through 6.0.

Control section: The most common textures are loam, silt loam, and loamy sand. The weighted average clay content ranges from 3 through 10 percent, and averages 5 percent. The weighted average rock fragment content ranges from 0 through 34 percent, and averages 15 percent. The pH ranges from 5.1 through 6.5.

Base saturation: The range for all horizons in all pedons is 10 through 40 percent.

Andic properties: These properties occur to a depth of between 70 and 90 centimeters below the surface. In these soils, andic properties are defined as the following. Phosphate retention is between 35 and 60 percent. Extractable Al + 1/2 Fe is between 0.4 and 1.0 percent. Volcanic glass (0.02 - 2.0 mm in size) is greater than 50 percent by volume of the fine earth fraction.

Dystric Cryochrepts-HT

The Dystric Cryochrept-HT soils have ochric epipedons, and nonskeletal subsoil layers with moderately fine to moderately coarse textures. The soils are greater than 100 centimeters deep. They form mainly in hydrothermal deposits, glaciofluvial outwash, or glacial till derived from acid-altered rhyolite. Soils in this family most often form under the forested, ABLA/VASC habitat type or under various thermal community types.

Taxonomic Classification: Dystric Cryochrepts (includes the *sandy*, *coarse-silty*, and *fine-loamy* particle size classes; with the *siliceous* mineralogy class; and the *fine-loamy*, *mixed*, *superactive* family)

Typical Pedon

Location: Southwest of Little Firehole Meadows, Summit Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 503040E/4922220N. Pedon 561.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 8 cm; brown (10YR 4/3) gravelly sandy loam, light yellowish brown (10YR 6/4) dry; moderate coarse granular structure; soft, very friable, slightly sticky and slightly plastic; 30 percent gravel; 15 percent clay; moderately acid (pH 5.7); abrupt smooth boundary.

Bw 8 to 33 cm; pink (5YR 7/4) gravelly loam, pinkish white (5YR 8/2) dry, with common medium prominent pinkish white (5YR 8/2) mottles; weak coarse subangular blocky structure; soft, very friable, sticky and plastic; 15 percent gravel and 5 percent cobbles; 22 percent clay; moderately acid (pH 5.6); abrupt wavy boundary.

C 33 to 100 cm; white (10YR 8/2) silt loam, white (10YR 8/1) dry, with common medium prominent brownish yellow (10YR 6/8) mottles; weak coarse subangular blocky structure; soft, friable, sticky and plastic; 5 percent gravel; 25 percent clay; strongly acid (pH 5.4).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. The color hues for the epipedons is 10YR. Values are 6 or 7 dry, and 3 through 5 moist. Chromas range from 2 through 4 moist. The most common textures are sandy loam, loam, silt loam, or clay loam. The pH ranges from 3.6 through 5.7.

Control section: The most common textures are loam, sandy loam, loamy sand, and clay loam. The weighted average clay content ranges from 5 through 30 percent, and averages 18 percent. The weighted average rock fragment content ranges from 7 through 33 percent, and averages 19 percent. The pH ranges from 3.7 through 5.8.

Base saturation: The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 10 through 58 percent. The average of all pedons is 35 percent.

Eaglewing Family

The Eaglewing family soils have ochric epipedons, and nonskeletal subsoil layers with moderately fine to medium textures. The soils are greater than 100 centimeters deep. These soils mainly form in fan alluvium and glacial till derived from sandstone, shale, granite, or basalt. Soils in this family form under the nonforested ARTR/AGSP and AGSP/POSA habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive, frigid Typic Ustochrepts

Typical Pedon

Location: East of Reese Creek, Electric Peak 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 518200E/4989310N. Pedon 140.

Description: (All colors are for moist conditions unless otherwise stated.)

Ap 0 to 9 cm; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; soft, very friable, sticky and plastic; 1 percent stones; 39 percent clay; moderately alkaline (pH 8.0); abrupt smooth boundary.

AB 9 to 23 cm; very dark grayish brown (10YR 3/2) silty clay, light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure; slightly hard, very friable, sticky and plastic; 45 percent clay; slightly alkaline (pH 7.5); gradual smooth boundary.

Bw 23 to 61 cm; brown (10YR 4/3) clay loam, pale brown (10 YR 6/3) dry; moderate coarse angular blocky structure; slightly hard, friable, sticky and plastic; 40 percent clay; slightly alkaline (pH 7.5); slightly effervescent; abrupt wavy boundary.

BC 61 to 100 cm; dark brown (10YR 3/3) sandy clay loam, light gray (10YR 7/2) dry; moderate coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 24 percent clay; slightly alkaline (pH 7.8).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR or 2.5Y. Values range from 5 through 7 dry, and are 3 or 4 moist. Chromas are 2 or 3 moist. The most common textures are loam, clay loam, and silty clay loam. The pH ranges from 7.8 through 8.0.

Control section: The most common textures are sandy clay loam, loam and clay loam. The weighted average clay content ranges from 19 through 33 percent, averages 23 percent. The weighted average rock fragment content ranges from 0 through 25 percent, averages 7 percent for all pedons. The pH values range from 7.5 through 8.0.

Base saturation: The range for all horizons in all pedons is 95 through 100 percent. The average of all pedons is 99 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonates to accumulate in the subsoil layers at depths greater than 20 cm. In some soils, calcium carbonates also accumulate in surface layers.

Salinity: Soils forming in fan alluvium derived from sedimentary rocks are very slightly saline, with EC measurements of 2 or 3 mmhos/cm, at depths greater than 50 centimeters.

Elkner Family

The Elkner family soils have ochric epipedons and moderately deep root-limiting layers. The nonskeletal subsoil layers have medium textures. The soils are between 50 and 75 centimeters deep. Soils in this family form in glacial till over residuum derived from rhyolite, andesite, or basalt. These soils form under forested ABLA/VASC, ABLA/VAGL, and ABLA/CARO habitat types.

Taxonomic Classification: Coarse-loamy, mixed, superactive Typic Cryochrepts

Typical Pedon

Location: Northeast of Pelican Creek, Pelican Cone 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 564750E/4950525N. Pedon 246.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 2 cm; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; 5 percent gravel; 12 percent clay; slightly acid (pH 6.5); abrupt smooth boundary.

Bw 2 to 26 cm; brown (10YR 4/3) loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 5 percent gravel; 12 percent clay; strongly acid (pH 5.5); clear smooth boundary.

Bc 26 to 52 cm; yellowish brown (10YR 5/4) cobbly loam, very pale brown (10YR 7/4) dry; weak medium angular blocky structure; soft, very friable, slightly sticky and slightly plastic; 5 percent gravel and 20 percent cobbles; 12 percent clay; moderately acid (pH 5.8); clear smooth boundary.

Cr 52 to 59 cm; paralithic contact with weathered andesite.

R 59 cm; lithic contact with andesite bedrock.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 7.5YR or 10YR. Values are 4 or 5 dry, and are 3 moist. Chromas range from 1 through 3 moist. The most common texture is loam. The pH ranges from 5.4 through 6.5.

Control section: The most common texture is loam. The weighted average clay content ranges from 5 through 15 percent, and averages 11 percent. The weighted average rock fragment content ranges from 10 through 34 percent, and averages 23 percent. The pH ranges from 5.5 through 6.1.

Base saturation: Every pedon has at least one horizon with a base saturation greater than 60 percent. The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 55 through 80 percent. The average of all pedons is 65 percent.

Root-limiting layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 50 through 75 centimeters and averages 60 centimeters below the soil surface.

Emerald Family

The Emerald family soils have mollic epipedons and moderately deep root-limiting layers. The nonskeletal subsoil layers have moderately fine to medium textures. The soils are between 50 and 100 centimeters deep. Soils in this family form in glacial till and colluvium derived from andesite, granite, or sedimentary rocks. These soils form under the nonforested ARTR/FEID, FEID/STRI, or DECE/CAREX habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Cryoborolls

Typical Pedon

Location: Southwest of Mirror Lake, Pelican Cone 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 565050E/4950900N. Pedon 245.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 17 cm; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky and granular structure; soft, very friable, slightly sticky and slightly plastic; 5 percent gravel; 20 percent clay; strongly acid (pH 5.5); gradual wavy boundary.

Bw1 17 to 27 cm; brown (10YR 5/3) loam, light gray (10YR 7/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 10 percent gravel; 20 percent clay; moderately acid (pH 6.0); gradual wavy boundary.

Bw2 27 to 36 cm; brown (10YR 4/3) loam, light gray (10YR 7/2) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 10 percent gravel; 22 percent clay; neutral (pH 7.0); gradual wavy boundary.

Bw3 36 to 51 cm; brown (10YR 5/3) sandy clay loam, light gray (10YR 7/2) dry; weak medium subangular blocky structure; slightly hard, very friable, sticky and plastic; 10 percent gravel; 25 percent clay; neutral (pH 7.0).

R 55 cm; lithic contact with andesite bedrock.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* to 22 centimeters. Color hues for the epipedons are 10YR. Values are 4 or 5 dry, and are 3 moist. Chromas are 2 or 3 moist. The most common texture is loam, but clay loam and clay also occur. The pH ranges from 5.5 through 6.8.

Control section: The most common textures are loam and sandy clay loam. The weighted average clay content ranges from 24 through 30 percent, and averages 27 percent. The weighted average rock fragment content ranges from 10 through 30 percent, and averages 20 percent. The pH ranges from 6.8 through 8.2.

Base saturation: The range for all horizons in all pedons is 77 through 100 percent. The average of all pedons is 90 percent.

Root-limiting layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 50 through 100 centimeters and averages 72 centimeters below the soil surface.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Gallatin Family

The Gallatin family soils have thick mollic epipedons, and nonskeletal subsoil layers with moderately fine to moderately coarse textures. The soils are greater than 100 centimeters deep and in some areas have aquic conditions during the growing season. Soils in this family form mainly in till and alluvium derived from andesite or rhyolite. These soils often form under nonforested habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Pachic Cryoborolls

Typical Pedon

Location: Elk Tongue Creek, Mount Hornaday 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 565280E/4980920N. Pedon 389.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 16 cm; very dark grayish brown (10YR 3/2) loam, brown (10YR 4/3) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; 10 percent gravel; 20 percent clay; neutral (pH 6.8); gradual smooth boundary.

A2 16 to 54 cm; dark brown (10YR 3/3) loam, dark yellowish brown (10YR 4/4) dry; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 5 percent gravel and 5 percent cobbles; 20 percent clay; neutral (pH 6.8); abrupt smooth boundary.

Bw 54 to 100 cm; brown (10YR 4/3) gravelly loam, yellowish brown (10YR 5/4) dry; weak coarse subangular blocky structure; hard, friable, slightly sticky and nonplastic; 15 percent gravel and 10 percent cobbles; 18 percent clay; neutral (pH 6.8).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 40 through 113 centimeters and averages 62 centimeters. Color hues for the epipedons range from 2.5YR through 2.5Y. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common texture is loam. The pH ranges from 5.2 through 8.0.

Control section: The most common texture is loam. The weighted average clay content ranges from 19 through 34 percent, and averages 24 percent. The weighted average rock fragment content ranges from 0 through 31 percent, and averages 19 percent. The pH ranges from 5.4 through 8.0.

Base saturation: The range for all horizons in all pedons is 58 through 100 percent. The average for all pedons is 85 percent.

Gateson Family

The Gateson family soils have ochric epipedons, argillic horizons, and nonskeletal subsoil layers with moderately fine textures. The soils are greater than 100 centimeters deep. Soils in this family form in fan alluvium and glacial till derived from sedimentary rocks or rhyolite. They form under the nonforested AGSP/POSA, ARTR/AGSP, and SAVE/AGSM habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Eutroboralfs

Typical Pedon

Location: West slope of Mt. Everts; Mammoth 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 524840E/4982530N. Pedon 112.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 10 cm; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; strong fine granular structure parting to moderate coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; 5 percent gravel; 22 percent clay; moderately alkaline (pH 8.0); violently effervescent; clear smooth boundary.

Btk1 10 to 30 cm; dark grayish brown (10YR 4/2) clay loam, light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure; slightly hard, friable, sticky and plastic; 10 percent gravel; 34 percent clay; few, distinct clay films lining tubular and interstitial pores; moderately alkaline (pH 8.0); lime accumulation in pores; violently effervescent; diffuse smooth boundary.

Btk2 30 to 100 cm; dark grayish brown (10YR 4/2) clay loam, light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure; hard, friable, sticky and slightly plastic; 10 percent gravel; 34 percent clay; few, distinct clay films on ped faces and lining tubular and interstitial pores; moderately alkaline (pH 8.0); lime accumulation in pores; violently effervescent.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values are 5 or 6 dry, and 3 or 4 moist. Chromas are 2 or 3 moist. The most common texture is loam. The pH ranges from 7.0 through 8.0.

Control section: The most common texture is clay loam. The weighted average clay content ranges from 25 through 34 percent, and averages 30 percent. The weighted average rock fragment content ranges from 5 through 20 percent, averages 14 percent. The pH ranges from 7.3 through 8.6.

Base saturation: The range for all horizons in all pedons is 90 through 100 percent. The average for all pedons is 99 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 20 centimeters. In some soils, calcium carbonates also accumulate in surface layers.

Salinity: Soils forming in fan alluvium derived from sedimentary rocks are very slightly to slightly saline, with EC measurements of 2 to 5 mmhos/cm, at depths greater than 50 centimeters.

Granmount Family

The Granmount family soils have mollic epipedons, argillic horizons, and skeletal subsoil layers with fine to moderately fine textures. The soils are greater than 100 centimeters deep. Soils in this family form in colluvium and earthflow debris derived from andesite or basalt. These soils form under the nonforested ARTR/FEID and FEID/AGCA habitat types, or the forested ABLA/CARU and PSME/SYAL habitat types.

Taxonomic Classification: Clayey-skeletal, mixed, superactive Argic Cryoborolls

Typical Pedon

Location: Oxbow Creek, Blacktail Deer Creek 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 536090E/4978610N. Pedon 516.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 4 to 0 cm; litter layer.

A1 0 to 16 cm; very dark brown (10YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; 20 percent gravel; 25 percent clay; slightly acid (pH 6.4); abrupt smooth boundary.

A2 16 to 37 cm; dark brown (10YR 3/3) very gravelly clay loam, grayish brown (10YR 5/2) dry; weak coarse subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; 30 percent gravel and 5 percent cobbles; 28 percent clay; slightly acid (pH 6.4); clear smooth boundary.

Bt1 37 to 57 cm; brown (10YR 4/3) very gravelly clay loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure; very hard, very firm, sticky and slightly plastic; 35 percent gravel and 5 percent cobbles; 33 percent clay; few distinct clay films line pores; slightly acid (pH 6.5); clear smooth boundary.

Bt2 57 to 100 cm; brown (10YR 5/3) extremely cobbly clay loam, brown (10YR 5/3) dry; moderate, coarse, subangular blocky structure; very hard, very firm, sticky and plastic; 25 percent gravel and 35 percent cobbles; 37 percent clay; common, prominent, clay films in pores and on ped faces; slightly acid (pH 6.5).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 22 through 37 centimeters and averages 29 centimeters. The color hues for the epipedons are 10YR. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are loam and clay loam. The pH ranges from 5.6 through 6.6.

Control section: The most common textures are clay loam and clay. The weighted average clay content ranges from 35 through 40 percent, averages 38 percent. The weighted average rock fragment content ranges from 38 through 60 percent, and averages 49 percent. The pH ranges from 5.6 through 6.6.

Base saturation: The range for all horizons in all pedons is 77 through 95 percent. The average for all pedons is 86 percent.

Granturk Family

The Granturk family soils have ochric epipedons and shallow to very shallow root-limiting layers. The nonskeletal subsoil layers have medium to moderately coarse textures. The soils are between 20 and 45 centimeters deep. Soils in this family form in glacial till, residuum, and colluvium derived from rhyolite or andesite. They most often form under non-forested habitat types, but also occur under the forested ABLA/VASC habitat type.

Taxonomic Classification: Loamy, mixed, superactive Lithic Cryochrepts

Typical Pedon

Location: Ridge between Miller Creek and Calfee Creek, Pilot Peak SW 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 580300E/4957050N. Pedon 267.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi Litter layer.

A 0 to 11 cm; dark yellowish brown (10YR 3/4) cobbly loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 13 percent gravel and 10 percent cobbles; 25 percent clay; moderately acid (pH 6.0); clear smooth boundary.

Bw 11 to 34 cm; dark brown (10YR 3/3) cobbly loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 13 percent gravel and 15 percent cobbles; 25 percent clay; moderately acid (pH 6.0); clear smooth boundary.

Cr 34 to 40 cm; paralithic contact with weathered rhyolitic ash-flow tuff.

R 40 cm; lithic contact with rhyolitic ash-flow tuff bedrock.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 7.5YR or 10YR. Values range from 4 through 7 dry, and are 3 or 4 moist. Chromas range from 2 through 4, moist. The most common texture is loam. The pH ranges from 5.2 through 6.8.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 10 through 25 percent, and averages 18 percent. The weighted average rock fragment content ranges from 10 through 34 percent, and averages 26 percent. The pH ranges from 4.8 through 6.8.

Base saturation: The range for all horizons in all pedons is 39 through 98 percent. The average for all pedons is 70 percent.

Root-limiting layer: Although all pedons have a lithic contact within 50 centimeters of the soil surface, both lithic and paralithic contacts are considered root-limiting layers. The depth to this layer ranges from 12 through 45 centimeters and averages 25 centimeters below the soil surface.

Greyback Family

The Greyback family soils have mollic epipedons, and skeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 cm deep. Soils in this family form mainly in glacial till and colluvium derived from andesite or rhyolite. These soils most often form under the forested ABLA/VASC habitat type, various Douglas fir habitat types, the nonforested ARTR/FEID habitat type, or area of alpine meadows.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Cryoborolls

Typical Pedon

Location: Northeast flank of Two Ocean Plateau, Badger Creek 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 568560E/4897950N. Pedon 858.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 15 cm; very dark grayish brown (10YR 3/2) very gravelly loam, grayish brown (10YR 5/2) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 35 percent gravel and 15 percent cobbles; 14 percent clay; moderately acid (pH 5.8); abrupt smooth boundary.

A2 15 to 32 cm; very dark grayish brown (10YR 3/2) extremely gravelly loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 45 percent gravel and 20 percent cobbles; 14 percent clay; slightly acid (pH 6.1); abrupt smooth boundary.

Bw 32 to 50 cm; dark grayish brown (10YR 4/2) very gravelly sandy loam, weak red (2.5YR 5/2) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 40 percent gravel and 20 percent cobbles; 11 percent clay; moderately acid (pH 5.9); abrupt smooth boundary.

BC 50 to 100 cm; dark grayish brown (10YR 4/2) extremely cobbly sandy loam, light gray (10YR 7/2) dry; moderate medium angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 30 percent gravel and 40 percent cobbles; 15 percent clay; moderately acid (pH 5.8).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18 through 38 centimeters, and average 27 centimeters. Color hues for the epipedons range from 5YR through 2.5Y. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common texture is loam. The pH ranges from 4.8 through 8.0.

Control section: The most common textures are loam and sandy loam. The weighted average clay content ranges from 4 through 30 percent, and averages 16 percent. The weighted average rock fragment content ranges from 35 through 95 percent, and averages 54 percent. The pH ranges from 5.3 through 8.5.

Base saturation: The range for all horizons in all pedons is 53 through 100 percent. The average for all pedons is 82 percent.

Carbonates: Subsoil accumulation of calcium carbonate occurs in the Northern Range area of the park, and also in areas where limestone or travertine is part of the parent material.

Hanks Family

The Hanks family soils have ochric epipedons, and nonskeletal subsoil layers with moderately coarse to coarse textures. The soils are greater than 100 cm deep. These soils form mainly in glacial till, residuum, and glaciofluvial alluvium derived from rhyolite. Soils in this family often form under the forested ABLA/VASC habitat types.

Taxonomic Classification: Coarse-loamy, mixed, superactive Dystric Cryochrepts

Typical Pedon

Location: Phantom Campsite near Pitchstone Plateau, Lewis Canyon 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 521140E/4896880N. Pedon 490.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 7 cm; dark brown (10YR 3/3) loam, yellowish brown (10YR 5/4) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 5 percent gravel; 20 percent clay; very strongly acid (pH 4.8); clear smooth boundary.

AB 7 to 21 cm; dark brown (10YR 4/3) loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 5 percent gravel; 20 percent clay; strongly acid (pH 5.2); abrupt wavy boundary.

2Bw1 21 to 38 cm; dark brown (10YR 4/3) gravelly sandy loam, very pale brown (10YR 7/3) dry; weak coarse subangular blocky structure; soft, friable, slightly sticky and nonplastic; 23 percent gravel; 16 percent clay; strongly acid (pH 5.4); abrupt wavy boundary.

2Bw2 38 to 48 cm; brown (10YR 5/3) gravelly loamy sand, very pale brown (10YR 7/3) dry; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; 30 percent gravel; 5 percent clay; moderately acid (pH 5.8); abrupt irregular boundary.

2Bw3 48 to 59 cm; light yellowish brown (10YR 6/3) sandy loam, yellow (10YR 7/8) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 5 percent gravel; 16 percent clay; moderately acid (pH 5.8); abrupt smooth boundary.

2BC1 59 to 75 cm; light yellowish brown (10YR 6/4) sandy loam, very pale brown (10YR 7/3) dry; massive; soft, very friable, slightly sticky and nonplastic; 10 percent gravel; 13 percent clay; few faint clay films line pores; moderately acid (pH 5.6); abrupt smooth boundary.

2BC2 75 to 100 cm; brown (10YR 5/3) extremely gravelly sandy loam, very pale brown (10YR 5/3) dry; massive; slightly hard, friable, slightly sticky and nonplastic; 65 percent gravel; 10 percent clay; moderately acid (pH 5.6).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. The color hues for the epipedons are 10YR. Values range from 5 through 7 dry, and from 2 through 4 moist. Chromas range from 1 through 3 moist. The most common texture is loam. The pH ranges from 4.8 through 5.5.

Control section: The most common textures are sandy loam and loamy sand. The weighted average clay content ranges from 6 through 17 percent, and averages 12 percent. The weighted average rock fragment content ranges from 0 through 33 percent, and averages 20 percent for all pedons. The pH ranges from 5.2 through 5.8.

Base saturation: The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 34 through 58 percent. The average of all pedons is 53 percent.

Haploborolls

The Haploboroll soils have mollic epipedons, and both skeletal and nonskeletal subsoil layers with medium to moderately coarse textures. They are greater than 100 centimeters deep. These soils form mainly in glacial till, stream alluvium, and glaciofluvial deposits derived from a mixture of rock types. They form under the nonforested ARTR/AGSP and ARTR/FEID habitat types.

Taxonomic Classification: Haploborolls (includes the *Typic*, *Pachic*, and *Aridic* subgroups, but does not include the loamy-skeletal, mixed, superactive *Typic* Haploboroll family)

Typical Pedon

Location: North of Blacktail Pond, Blacktail Deer Creek 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 531781E/4978700N. Pedon 2003. (classified as *Typic* Haploboroll)

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 12 cm; very dark grayish brown (10YR 3/2) gravelly loam, brown (10YR 4/3) dry; weak very fine granular structure; soft, friable, nonsticky and nonplastic; 20 percent gravel; 17 percent clay; slightly alkaline (pH 7.5); clear smooth boundary.

A2 12 to 25 cm; very dark grayish brown (10YR 3/2) gravelly loam, dark brown (10YR 3/3) dry; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; 25 percent gravel; 19 percent clay; slightly alkaline (pH 7.5); clear smooth boundary.

Bw 25 to 43 cm; brown (10YR 4/3) gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; 20 percent gravel; 16 percent clay; moderately alkaline (pH 8.0); clear wavy boundary.

Bk 43 to 60 cm; brown (10YR 5/3) sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; 30 percent gravel; 9 percent clay; moderately alkaline (pH 8.0); lime accumulation in pores; violently effervescent; clear smooth boundary.

BC 60 to 100 cm; pale brown (10YR 6/3) gravelly

sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; 25 percent gravel; 11 percent clay; violently effervescent; moderately alkaline (pH 8.0); abrupt boundary.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 85 centimeters and averages 27 centimeters. The color hues for the epipedons are 10YR. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common texture is loam, but sandy loam, sandy clay loam, and clay loam also occur. The pH ranges from 6.0 through 8.0.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 2 through 69 percent, and averages 18 percent. The weighted average rock fragment content ranges from 0 through 70 percent, and averages 26 percent. The pH ranges from 6.6 through 8.5.

Base saturation: The range for all horizons in all pedons is 67 to 100 percent. The average of all pedons is 93 percent.

Carbonates: The accumulation of calcium carbonates is common in the subsoil layers.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Histosols

The Histosol soils have histic epipedons. Subsoil layers can be organic or mineral in composition. Mineral subsurface layers generally have medium to coarse textures and are nonskeletal. These soils are greater than 100 centimeters deep and have aquic conditions for most of the growing season. Soils with mineral subsurface layers form from alluvium derived from a variety of rock types. All histosols form under the nonforested DECE/CAREX and SALIX/CAREX habitat types or in marsh areas or *Carex* species.

Taxonomic Classification: Histosols (includes *Typic* and *Terric Borohemists*, *Typic* and *Sapric Borofibrists*, and *Typic Borosaprists*)

Typical Pedon

Location: South flank of Channel Mountain, Alder Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 549980E/4901770N. Pedon 98. (Terric Borohemist)

Description: (All colors are for moist conditions unless otherwise stated.)

Oe1 0 to 19 cm; black (10YR 2/1) hemic material, black (10YR 2/1) dry; about 60% fibers rubbed; hard, firm, slightly sticky and slightly plastic; neutral (pH 6.8); abrupt smooth boundary.

Oe2 19 to 35 cm; very dark brown (10YR 2/2) hemic material, black (10YR 2/1) dry; about 50% fibers rubbed; hard, firm, slightly sticky and slightly plastic; neutral (pH 6.6); water entering pit at 35 cm; abrupt wavy boundary.

Oe3 35 to 84 cm; very dark brown (10YR 2/2) hemic material, very dark grayish brown (10YR 3/2) dry; about 35% fibers rubbed; hard, firm, slightly sticky and slightly plastic; neutral (pH 6.6); abrupt smooth boundary.

2C 84 to 130 cm; very dark gray (5Y 3/1) very gravelly loamy sand, gray (N 5/) dry; massive; slightly hard, friable, nonsticky and nonplastic; 35 percent gravel and 5 percent cobbles; 8 percent clay; neutral (pH 7.0).

Range of Important Properties

Epipedon: The thickness of these histic epipedons ranges from 42 centimeters to more than 100 centimeters, and averages 60 centimeters. Organic material can be fibric, hemic, or sapric. Some thin mineral layers of sand, loamy sand, silt loam, or silty clay loam can occur. The pH ranges from 5.0 through 7.8

Control section: Organic material can be fibric or hemic. Mineral layers most commonly have a silt loam, sandy loam, or loamy sand texture. The weighted average percent clay content ranges from 0 through 37 percent, and averages 9 percent. The weighted average percent rock fragment content ranges from 0 through 14 percent, and averages 2 percent. The pH ranges from 5.0 through 7.8.

Hobacker Family

The Hobacker family soils have thick mollic epipedons, and skeletal subsoil layers with medium to coarse textures. The soils are greater than 100 centimeters deep and in some areas have aquic conditions during the growing season. Soils in this family form mainly in glacial till, landslide debris, and colluvium most often derived from andesite. These soils form under both forested and nonforested vegetation. The most common forested habitat types are ABLA/VASC, ABLA/LIBO, and various Douglas fir habitat types. The most common nonforested habitat types are ARTR/FEID and FEID/AGCA.

Taxonomic Classification: Loamy-skeletal mixed, superactive Pachic Cryoborolls

Typical Pedon

Location: South of Cougar Creek, Mount Jackson 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 504470E/4947830N. Pedon 798.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 18 cm; very dark brown (10YR 2/2) gravelly silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; 15 percent gravel; 16 percent clay; moderately acid (pH 6.0); abrupt smooth boundary.

A2 18 to 42 cm; dark brown (10YR 3/3) very gravelly loam, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 30 percent gravel and 10 percent cobbles; 18 percent clay; slightly acid (pH 6.4); abrupt smooth boundary.

Bw 42 to 100 cm; brown (10YR 5/3) very cobbly loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 25 percent gravel and 20 percent cobbles; 18 percent clay; slightly acid (pH 6.2).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 40 through 105 centimeters, and averages 57 centimeters. Color hues for the epipedons range from 7.5YR through 2Y, and N. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 0 through 3 moist. The most common textures are loam and silt loam. The pH ranges from 5.0 through 8.0.

Control section: The most common textures are loam and sandy loam. The weighted average clay content ranges from 5 through 32 percent, and averages 19 percent. The weighted average rock fragment content ranges from 35 through 85 percent, and averages 55 percent. The pH ranges from 5.2 through 8.2.

Base saturation: The range for all horizons in all pedons is 55 through 100 percent. The average for all pedons is 85 percent.

Calcium Carbonate: Subsoil accumulation of calcium carbonate is common in the Northern Range area of the park, and in areas where limestone or travertine is part of the parent material.

Ivywild Family

The Ivywild family soils have ochric epipedons, and skeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 cm deep. These soils form mainly in glacial till, colluvium, and landslide deposits derived from rhyolite, rhyolitic ash-flow tuff or sedimentary rocks. Soils in this family form under the forested ABLA/VASC and ABLA/VAGL habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Dystric Cryochrepts

Typical Pedon

Location: North of Tepee Creek, Richards Creek 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 496220E/4968500N. Pedon 625.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 4 cm; black (10YR 2/1) very gravelly sandy loam, brown (10YR 5/3) dry; moderate coarse granular structure; soft, very friable, nonsticky and slightly plastic; 60 percent gravel; 6 percent clay; moderately acid (pH 5.8); abrupt smooth boundary.

BA 4 to 32 cm; dark brown (10YR 3/3) very gravelly loam, pale brown (10YR 6/3) dry; moderate coarse granular structure; soft, very friable, slightly sticky and slightly plastic; 55 percent gravel; 18 percent clay; strongly acid (pH 5.4); gradual smooth boundary.

Bw1 32 to 62 cm; dark yellowish brown (10YR 3/4) very gravelly loam, light gray (10YR 7/2) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 50 percent gravel; 20 percent clay; moderately acid (pH 5.6); clear smooth boundary.

Bw2 62 to 100 cm; brown (10YR 4/3) very gravelly loam, very pale brown (10YR 7/3) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 60 percent gravel; 20 percent clay; moderately acid (pH 5.8).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 7.5YR or 10YR. Values are 5 or 6 dry, and range from 2 through 4 moist. Chromas range from 1 through 3 moist. The textures are sandy loam and loam. The pH ranges from 4.3 through 5.8.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 4 through 34 percent, and averages 16 percent. The weighted average rock fragment content ranges from 36 through 85 percent, and averages 55 percent for all pedons. The pH ranges from 4.3 through 5.8.

Base saturation: The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 25 through 58 percent. The average of all pedons is 46 percent.

Jenkinson Family

The Jenkinson family soils have mollic epipedons and shallow to very shallow root-limiting layers. The nonskeletal subsoil layers have medium textures. The soils are between 10 and 50 centimeters deep. Soils in this family form in glacial till, residuum, and colluvium derived from andesite or rhyolite. These soils often form under non-forested habitat types.

Taxonomic Classification: Loamy, mixed, superactive Lithic Cryoborolls

Typical Pedon

Location: Northeast of Lamar River on ridge, west of Calfee Creek, Wabab Springs 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 570500E/4961250N. Pedon 378.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 12 cm; very dark brown (7.5YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; 30 percent gravel; 23 percent clay; neutral (pH 6.6); abrupt smooth boundary.

A2 12 to 15 cm; dark brown (7.5YR 3/2) very gravelly loam, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 40 percent gravel; 18 percent clay; neutral (pH 6.6).

R 15cm; lithic contact with andesite breccia bedrock.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 12 through 27 centimeters. Color hues are 7.5YR or 10YR. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. Textures are sandy loam and loam. The pH ranges from 5.4 through 6.6.

Control section: The most common texture is loam. The weighted average clay content ranges from 12 through 34 percent, and averages 22 percent. The weighted average rock fragment content ranges from 12 through 32 percent, and averages 23 percent. The pH ranges from 5.4 through 6.6.

Base saturation: The range for all horizons in all pedons is 60 through 95 percent. The average for all pedons is 78 percent.

Root-limiting layer: Although all pedons have a lithic contact within 50 centimeters of the soil surface, both lithic and paralithic contacts are considered root-limiting layers. The depth to this layer ranges from 12 through 47 centimeters and averages 30 centimeters below the soil surface.

Josie Family

The Josie family soils have umbric or mollic epipedons, and nonskeletal subsoil layers with moderately coarse to coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form mainly in glacial till derived from rhyolite or rhyolitic ash-flow tuff. These soils form under the forested ABLA/VASC, ABLA/VAGL, and ABLA/LIBO habitat types. On the Pitchstone Plateau they also form under the nonforested DECE/CAREX habitat type.

Taxonomic Classification: Coarse-loamy, mixed, superactive Typic Cryumbrepts

Typical Pedon

Location: Pitchstone Plateau, Grassy Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 518920E/4899240N. Pedon 487.

Horizon: (All colors are for moist conditions unless otherwise stated.)

A 0 to 6 cm; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; 3 percent gravel; 22 percent clay; extremely acid (pH 4.4); clear smooth boundary.

AB 6 to 24 cm; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak coarse subangular blocky parting to weak coarse platy structure; slightly hard, friable, slightly sticky and slightly plastic; 8 percent gravel; 22 percent clay; very strongly acid (pH 4.8); abrupt wavy boundary.

Bw1 24 to 33 cm; yellowish brown (10YR 5/4) gravelly sandy loam, brownish yellow (10YR 6/6) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 20 percent gravel; 18 percent clay; strongly acid (pH 5.4); abrupt irregular boundary.

Bw2 33 to 37 cm; dark yellowish brown (10YR 4/4) very gravelly sandy loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 35 percent gravel and 3 percent cobbles; 10 percent clay; very strongly acid (pH 4.8); abrupt irregular boundary.

BC 37 to 46 cm; light yellowish brown (10YR 6/4) gravelly sandy loam, very pale brown (10YR 7/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 15 percent gravel; 10 percent clay; very strongly acid (pH 4.6); clear smooth boundary.

C1 46 to 55 cm; light brownish gray (10YR 6/2) very gravelly loamy sand, light gray (10YR 7/1) dry; weak coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; 40 percent gravel; 5 percent clay; strongly acid (pH 5.4); abrupt smooth boundary.

C2 55 to 100 cm; light gray (10YR 7/1) gravelly sandy loam, white (10YR 8/1) dry; massive; soft, friable, slightly sticky and slightly plastic; 25 percent gravel; 14 percent clay; moderately acid (pH 5.8).

Range of Important Properties

Epipedon: The thickness of these umbric or mollic epipedons ranges from 18* to 35 centimeters, and averages 22 centimeters. Color hues for the epipedons are 10YR or 2.5Y. Values are 4 or 5 dry, and 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are loamy sand, sandy loam, and loam. The pH ranges from 4.4 through 6.0.

Control section: The most common textures are loamy sand and sandy loam. The weighted average clay content ranges from 4 through 15 percent, and averages 9 percent. The weighted average rock fragment content ranges from 8 through 34 percent, and averages 24 percent for all pedons. The pH ranges from 4.6 through 6.0.

Base saturation: All pedons have at least one horizon with a base saturation less than 50 percent. The range for all horizons in all pedons is 30 through 70 percent. The average of all pedons is 54 percent.

*After mixing to 18 cm the weighted average of the color value and chroma meet umbric or mollic requirements.

Jugson Family

The Jugson family soils have umbric or mollic epipedons, and nonskeletal subsoil layers with medium to coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form mainly in lacustrine deposits, glacial till, and alluvium derived from rhyolite. These soils most often form under various forested ABLA habitat types.

Taxonomic Classification: Sandy, mixed, superactive Typic Cryumbrepts

Typical Pedon

Location: Delacy Creek, Craig Pass 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 523910E/4921200N. Pedon 780.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 10 cm; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; moderate coarse granular structure; slightly hard, friable, slightly sticky and slightly plastic; 10 percent gravel; 17 percent clay; strongly acid (pH 5.4); abrupt smooth boundary.

A2 10 to 29 cm; dark brown (10YR 3/3) loam, dark yellowish brown (10YR 4/4) dry; moderate coarse granular structure; soft, friable, slightly sticky and slightly plastic; 10 percent gravel; 17 percent clay; strongly acid (pH 5.4); abrupt smooth boundary.

Bw 29 to 43 cm; brown (10YR 4/3) loamy sand, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky parting to moderate coarse granular structure; soft, friable, slightly sticky and slightly plastic; 10 percent gravel; 8 percent clay; slightly acid (pH 6.4); abrupt smooth boundary.

CB 43 to 59 cm; variegated colors; sand; single grain; loose, nonsticky and nonplastic; 10 percent gravel; 5 percent clay; moderately acid (pH 5.8); abrupt smooth boundary.

C 59 to 100 cm; variegated colors; sand; massive; loose, nonsticky and nonplastic; 10 percent gravel; 3 percent clay; neutral (pH 6.6); abrupt smooth boundary.

Range of Important Properties

Epipedon: The thickness of these umbric or mollic epipedons ranges from 18* through 49 centimeters, and averages 27 centimeters. Color hues for the epipedons are 10YR or 2.5Y. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are sandy loam and loam. The pH ranges from 5.2 through 5.6.

Control section: The most common textures are sand and loamy sand. The weighted average clay content ranges from 3 through 6 percent, and averages 5 percent. The weighted average rock fragment content ranges from 5 through 30 percent, and averages 19 percent. The pH ranges from 5.2 through 6.6.

Base saturation: All pedons have at least one horizon with a base saturation less than 50 percent. The range for all horizons in all pedons is 45 through 82 percent. The average of all pedons is 57 percent.

*After mixing to 18 cm the weighted average of the color value and chroma meet umbric or mollic requirements.

Lamedeer Family

The Lamedeer family soils have ochric epipedons, and skeletal subsoil layers with medium textures. The soils are greater than 100 centimeters deep. They form in earthflow debris, glacial till, and colluvium derived from sandstone, shale, schist, or various volcanic rock types. Soils in this family form under the nonforested ARTR/AGSP and AGSP/POSA habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, frigid Typic Ustochrepts

Typical Pedon

Location: West slope of Mt. Everts; Mammoth 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 525380E/4979760N. Pedon 58.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 19 cm; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; 10 percent gravel; 33 percent clay; moderately alkaline (pH 8.4); slightly effervescent; abrupt smooth boundary.

Bk 19 to 40 cm; dark grayish brown (2.5Y 4/2) very gravelly loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 30 percent gravel and 5 percent cobbles; 23 percent clay; moderately alkaline (pH 8.4); strongly effervescent; lime accumulation in pores; clear smooth boundary.

Bck 40 to 100 cm; dark grayish brown (2.5Y 4/2) extremely stony sandy clay loam, grayish brown (2.5Y 5/2) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 15 percent gravel, 20 percent cobbles, and 30 percent stones; 25 percent clay; moderately alkaline (pH 8.4); slightly effervescent; lime accumulation in pores.

Range of Important Properties

Epipedon: These ochric epipedons usually have color values too high to meet the definition of other epipedons. Color hues range from 2.5YR through 2.5Y. Values are 5 or 6 dry, and range from 2 through 4 moist. Chromas range from 1 through 3 moist. The most common textures are loam or clay loam. The pH ranges from 7.2 through 8.4.

Control section: The most common textures are loam and sandy clay loam. The weighted average clay content ranges from 15 through 28 percent, and averages 23 percent. The weighted average rock fragment content ranges from 39 through 69 percent, and averages 55 percent for all pedons. The pH ranges from 6.8 through 8.4.

Base saturation: The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 82 through 100 percent. The average for all pedons is 97 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: In soils forming from earthflow debris it is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 20 cm.

Salinity: Soils forming in earthflow debris are very slightly to slightly saline, with EC measurements of 2 to 5 mmhos/cm, at depths greater than 20 centimeters.

Lasac Family

The Lasac family soils have ochric epipedons, and skeletal subsoil layers with medium to coarse textures. The soils are greater than 100 cm deep. These soils form mainly in colluvium, alluvium, residuum, loess derived from rhyolite. Soils in this family form under the forested PICO/CARO and PIAL/CARO habitat types.

Taxonomic Classification: Ashy-skeletal, glassy Vitrandic Cryochrepts

Typical Pedon

Location: Southeast of the northwest corner of section 28, T. 12 N., R. 45 E., ID, Targhee National Forest, Idaho. UTM 488020E/4909830N. Pedon T-la.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 8 cm; very dark brown (10YR 2/2) gravelly sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; 15 percent gravel; moderately acid (pH 5.6); abrupt smooth boundary.

A2 8 to 15 cm; dark brown (10YR 3/3) gravelly sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure parting to weak very fine granular; soft, very friable, nonsticky and nonplastic; 15 percent gravel; moderately acid (pH 5.6); clear smooth boundary.

2Bw 15 to 30 cm; dark yellowish brown (10YR 4/4) gravelly coarse sandy loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; 20 percent gravel; moderately acid (pH 5.6); clear wavy boundary.

2BC 30 to 51 cm; dark brown (10Y 3/3) very gravelly loamy sand, very pale brown (10YR 7/3) and yellowish brown (10 Y 5/4) dry; massive; soft, very friable, nonsticky and nonplastic; 30 percent gravel, 5 percent cobbles; slightly acid (pH 6.2); diffuse wavy boundary.

2C 51 to 152 cm; very dark gray (2.5Y 3/1) very gravelly coarse sand, dark gray (2.5 Y 4/1) dry; single grain; loose, nonsticky and nonplastic; 45 percent gravel, 5 percent cobbles, 5 percent stones and trace boulders; neutral (pH 6.8).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values are 4 or 5 dry, and are 2 or 3 moist. Chromas range from 2 through 4 moist. The textures are sandy loam and loam. The pH ranges from 5.1 through 6.0.

Control section: The most common textures are sandy loam, loamy sand, sand, and silt loam. The weighted average clay content ranges from 1 through 3 percent, and averages 2 percent. The weighted average rock fragment content ranges from 35 through 60 percent, and averages 55 percent for all pedons. The pH ranges from 5.1 through 7.3.

Andic properties: These properties occur to a depth of 25 to 35 centimeters below the surface. In these soils, andic properties are defined as [phosphate retention between 35 and 60 percent] and [extractable Al + 1/2 Fe between 0.4 and 1.0 percent] and [volcanic glass (0.02 - 2.0 mm) greater than 30 percent].

Lionhead Family

The Lionhead family soils have thick mollic epipedons and moderately deep root-limiting layers. The skeletal subsoil layers have medium to moderately coarse textures. The soils are between 50 and 80 centimeters deep. Soils in this family form in glacial till over residuum derived from andesite. These soils form under the alpine tundra and the nonforested FEID/AGSP habitat type, or the forested ABLA/VASC habitat type.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Pachic Cryoborolls

Typical Pedon

Location: Northwest flank of Trident Peak, Trident 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 576300E/4895420N. Pedon 853.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 15 cm; very dark grayish brown (10YR 3/2) loam, reddish brown (2.5YR 5/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 5 percent gravel; 11 percent clay; moderately acid (pH 5.6); abrupt smooth boundary.

A2 15 to 27 cm; very dark grayish brown (10YR 3/2) loam, weak red (2.5YR 5/2) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 3 percent cobbles; 15 percent clay; moderately acid (pH 5.6); clear smooth boundary.

A3 27 to 50 cm; very dark grayish brown (10YR 3/2) cobbly silt loam, weak red (2.5YR 4/2) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 3 percent gravel and 15 percent cobbles; 16 percent clay; strongly acid (pH 5.4); clear irregular boundary.

Bw 50 to 74 cm; brown (10YR 4/3) very cobbly sandy loam, light reddish brown (2.5YR 6/4) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 35 percent gravel and 25 percent cobbles; 13 percent clay; strongly acid (pH 5.2).

R 74 cm; lithic contact with andesite bedrock.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 40 through 50 centimeters. Color hues for the epipedons range from 2.5YR through 10YR. Values are 4 or 5 dry, and 3 moist. Chromas are 2 or 3, moist. The most common texture is loam. The pH ranges from 5.4 through 7.0.

Control section: The most common textures are sandy loam, silt loam, and loam. The weighted average clay content ranges from 14 through 16 percent, and averages 15 percent. The weighted average rock fragment content ranges from 38 through 68 percent, and averages 50 percent for all pedons. The pH ranges from 5.2 through 7.5.

Base saturation: The range for all horizons in all pedons is 70 through 100 percent. The average of all pedons is 65 percent.

Root-limiting layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 55 through 80 centimeters and averages 63 centimeters below the soil surface.

Lithic Dystrochrepts

The Lithic Dystrochrept soils have ochric epipedons and very shallow to shallow root-limiting layers. The soils are between 5 and 30 centimeters deep. The nonskeletal subsoil layers have medium to coarse textures. These soils form in acid-sulphate hydrothermal areas, under various thermal community types.

Taxonomic Classification: Lithic Dystrochrepts (includes the *loamy* or *sandy* particle size classes; the *siliceous* mineralogy class; and the *mesic*, *thermic* or, *hyperthermic* soil temperature classes)

Typical Pedon

Location: Norris Geyser Basin, Norris Junction 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 523090E/4951830N. Pedon 148.

Description: (All colors are for moist conditions unless otherwise stated.)

Oe 2 to 0 cm; litter layer

A 0 to 5 cm; grayish brown (10YR 5/2) gravelly loamy sand, light brownish gray (10YR 6/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; 15 percent gravel; 8 percent clay; extremely acid (pH 4.0); MAT = 10 °C at 5 cm; abrupt smooth boundary.

Bw1 5 to 11 cm; light gray (10YR 7/3) very gravelly loamy sand, very pale brown (10YR 8/3) dry; weak medium subangular blocky parting to weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; 35 percent gravel; 3 percent clay; extremely acid (pH 3.8); MAT = 14 °C at 10 cm; abrupt wavy boundary.

Bw2 11 to 17 cm; yellow (10YR 7/8) gravelly loamy sand, very pale brown (10YR 8/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; 20 percent gravel; 3 percent clay; extremely acid (pH 3.8); MAT = 22 °C at 15 cm; clear wavy boundary.

BC 17 to 28 cm; white (10YR 8/2) very gravelly loamy sand, white (10YR 8/1) dry; weak coarse subangular blocky parting to weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; 50 percent gravel; 3 percent clay; ultra acid (pH 3.4); MAT = 30 °C at 20 cm; abrupt smooth boundary.

R 28 cm; lithic contact with hydrothermally altered siliceous sinter; MAT = 36 °C at 28 cm.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. The color hue is 10YR. Values range from 3 through 6 dry, and are 3 or 4 moist. Chromas range from 1 through 4 moist. The most common texture are loam and sandy loam. The pH ranges from 3.6 through 5.6.

Control section: The most common textures are loamy sand and loam. Color hues are 5YR, 7.5YR, 10YR, or 2.5Y. The weighted average clay content ranges from 3 through 16 percent, and averages 9 percent. The weighted average rock fragment content ranges from 0 through 33 percent, and averages 22 percent. The pH ranges from 2.9 through 5.8.

Base saturation: The range for all horizons in all pedons is 5 through 58 percent. The average of all pedons is 37 percent.

Root-limiting layer: Although all pedons have a lithic contact within 50 centimeters of the soil surface, both lithic and paralithic contacts are considered root-limiting layers. The depth to this layer ranges from 5 through 30 centimeters and averages 16 centimeters below the soil surface. High acidity (pH values less than 3.5) can restrict root growth in these soils.

Temperature regime: The mean annual soil temperatures, MAT measured at a lithic or paralithic boundary, range from 8 through 37 °C. This includes soils with mesic, thermic, and hyperthermic soil temperature regimes.

LITHIC EUTROCHREPTS

The Lithic Eutrochrept soils have ochric epipedons and shallow root-limiting layers. The soils are between 5 and 45 centimeters deep. The subsoil layers, which can be skeletal or nonskeletal, have moderately coarse to coarse textures. These soils are common in neutral high-chloride and travertine hydrothermal areas, where they form under various thermal community types.

Taxonomic Classification: Lithic Eutrochrepts (includes the *loamy*, *sandy*, or *sandy-skeletal* particle size classes; the *siliceous* or *carbonatic* mineralogy classes; and the *mesic* and *thermic* soil temperature classes)

Typical Pedon

Location: Smoke Jumpers Hot Springs, Summit Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 50330E/4918000N. Pedon 557.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 4 cm; dark grayish brown (2.5Y 4/2) gravelly loamy sand, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 25 percent gravel; 8 percent clay; slightly acid (pH 6.1); MAT = 10 °C at 3 cm; abrupt smooth boundary.

Bw 4 to 10 cm; light yellowish brown (2.5Y 6/4) very gravelly loamy sand, brownish yellow (10YR 6/6) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 40 percent gravel; 10 percent clay; moderately acid (pH 6.0); abrupt wavy boundary.

Cr 10 to 26 cm; paralithic contact with weathered rhyolite; MAT = 13 °C at 10 cm.

R 26 cm; lithic contact with hydrothermally altered rhyolite bedrock; MAT = 18 °C at 26 cm.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR or 2.5Y. Values range from 3 through 7 dry, and from 2 through 7 moist. Chromas are 2 or 3 moist. The most common texture are sandy loam or sand. The pH ranges from 5.8 through 7.0.

Control section: The most common textures are loamy sand and sandy loam. Color hues are 7.5YR, 10YR, or 2.5Y. The weighted average clay content ranges from 4 through 18 percent, and averages 9 percent. The weighted average rock fragment content ranges from 10 through 60 percent, and averages 37 percent. The pH ranges from 6.0 through 8.4.

Base saturation: All pedons have at least one horizon with a base saturation greater than 60 percent. The range for all horizons in all pedons is 60 through 100 percent. The average of all pedons is 83 percent.

Root-limiting layer: Although all pedons have a lithic contact within 50 centimeters of the soil surface, both lithic and paralithic contacts are considered root-limiting layers. The depth to this layer ranges from 5 through 26 centimeters and averages 12 centimeters below the soil surface.

Temperature regime: The mean annual soil temperatures, MAT measured at a lithic or paralithic boundary, ranges from 8 through 23 °C. This includes soils with mesic and thermic soil temperature regimes.

LITHIC UDORTHENTS

The Lithic Udorthent soils have ochric epipedons and shallow to very shallow root-limiting layers. The soils are between 5 and 35 centimeters deep. The subsoil layers, which can be skeletal or nonskeletal, have moderately coarse to coarse textures. These soils form in all types of hydrothermal areas, under various thermal community types.

Taxonomic Classification: Lithic Udorthents (includes the *loamy*, *sandy*, *loamy-skeletal*, or *sandy-skeletal* particle size classes; the *siliceous*, *carbonatic*, or *mixed* mineralogy classes; both *acid* and *nonacid* reaction classes; and *frigid*, *mesic*, *thermic*, or *hyperthermic* soil temperature classes)

Typical Pedon

Location: Norris Geyser Basin, Norris Junction 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 523080E/4951830N. Pedon 146.

Description: (All colors are for moist conditions unless otherwise stated.)

Oe 4 to 0 cm; litter layer.

A 0 to 6 cm; grayish brown (10YR 5/2) gravelly sandy loam, light brownish gray (10YR 6/2) dry; weak very coarse granular structure; very friable, soft, nonsticky and nonplastic; 30 percent angular gravel; 5 percent clay; extremely acid (pH 3.9); abrupt smooth boundary.

C 6 to 16 cm; white (10YR 8/1) extremely gravelly loamy sand, white (5YR 8/1) dry; single grain; loose, nonsticky and nonplastic; 75 percent angular gravel; 5 percent clay; extremely acid (pH 4.1); MAT = 16 °C at 16 cm; abrupt smooth boundary.

Cr 16 to 18 cm; paralithic contact with weathered siliceous sinter.

R 18 cm; lithic contact with siliceous sinter.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin to meet the definition of other epipedons. Color hues for the epipedons are 10YR or 2.5Y. Values range from 5 through 8 dry, and from 2 through 6 moist. Chromas range from 1 through 6 moist. The most common textures are sandy loam, loamy sand, and sand. The pH ranges from 2.8 through 8.2.

Control section: The most common textures are loamy sand and sandy loam. Color hues are 10R, 5YR, 7.5YR, 10YR, or 2.5Y. The weighted average clay content ranges from 2 through 26 percent, and averages 9 percent. The weighted average rock fragment content ranges from 14 through 75 percent, and averages 38 percent. The pH ranges from 2.8 through 8.2.

Base saturation: The range for all horizons in all pedons is 5 through 100 percent. The average of all pedons is 61 percent.

Root-limiting layer: Although all pedons have a lithic contact within 50 centimeters of the soil surface, both lithic and paralithic contacts are considered root-limiting layers. The depth to this layer ranges from 7 through 35 centimeters and averages 17 centimeters below the soil surface. Temperatures greater than 50 °C and pH values less than 3.5 can limit root growth in these soils.

Temperature regime: The mean annual soil temperatures, MAT measured at a lithic or paralithic boundary, ranges from 9 through 55 °C. This includes soils with mesic, thermic, and hyperthermic soil temperature regimes.

Lolo Family

The Lolo family soils have thick mollic epipedons, and skeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 centimeters deep. Soils in this family most often form in glacial till and colluvium derived from igneous or metamorphic rocks. These soils form under various Douglas fir habitat types and the nonforested ARTR/FEID habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Pachic Haploborolls

Typical Pedon

Location: North of Blacktail Pond, Blacktail Deer Creek 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 531550E/4978550N. Pedon 2004.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 11 cm; very dark grayish brown (10YR 3/2) gravelly loam, dark brown (10YR 3/3) dry; weak fine granular structure; soft, very friable, sticky and plastic; 30 percent gravel; 14 percent clay; moderately alkaline (pH 8.0); clear smooth boundary.

A2 11 to 23 cm; very dark brown (10YR 2/2) gravelly loam, dark brown (10YR 3/3) dry; weak fine subangular blocky structure; soft, very friable, sticky and plastic; 30 percent gravel; 16 percent clay; moderately alkaline (pH 8.0); clear smooth boundary.

Bw 23 to 43 cm; very dark grayish brown (10YR 3/2) gravelly loam, dark brown (10YR 3/3) dry; moderate medium subangular blocky structure; soft, very friable, sticky and plastic; 30 percent gravel; 20 percent clay; moderately alkaline (pH 8.0); clear smooth boundary.

Bk1 43 to 71 cm; brown (10YR 4/3) very gravelly sandy loam, pale brown (10YR 6/3) dry; moderate coarse subangular blocky structure; hard, friable, sticky and plastic; 40 percent gravel; 13 percent clay; moderately alkaline (pH 8.0); accumulation of lime in pores; clear smooth boundary.

Bk2 71 to 100 cm; brown (10YR 4/3) very gravelly sandy loam, light gray (10YR 7/2) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; 40 percent gravel; 13 percent clay; moderately alkaline (pH 8.0); accumulation of lime in pores.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 43 through 55 and averages 47 centimeters. Color hues for the epipedons are 10YR. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common texture is loam. The pH ranges from 6.7 through 8.0.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 9 through 23 percent, and averages 17 percent. The weighted average rock fragment content ranges from 38 through 72 percent, and averages 56 percent for all pedons. The pH ranges from 6.0 through 8.0.

Base saturation: The range for all horizons in all pedons is 67 through 100 percent. The average for all pedons is 92 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 40 cm.

Matcher Family

The Matcher family soils have umbric or mollic epipedons, and skeletal subsoil layers with coarse textures. The soils are greater than 100 cm deep. Soils in this family form mainly in loess capped glacial till and glaciofluvial alluvium derived from rhyolite, rhyolitic ash-flow tuff, or basalt. These soils most often form under the forested ABLA/VASC or PICO/CARO habitat types.

Taxonomic Classification: Sandy-skeletal, mixed, superactive Typic Cryumbrepts

Typical Pedon

Location: Bechler River/ Union Falls Trail, Cave Falls 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 501590E/4891340N. Pedon 711.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 2 to 0 cm; litter layer.

A1 0 to 8 cm; dark brown (7.5YR 3/2) gravelly sandy loam, very dark grayish brown (2.5Y 3/2) dry; moderate coarse granular structure; soft, friable, nonsticky and slightly plastic; 30 percent gravel; 10 percent clay; strongly acid (pH 5.4); abrupt smooth boundary.

A2 8 to 30 cm; very dark grayish brown (10YR 3/2) very gravelly loamy sand, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; 40 percent gravel and 5 percent cobbles; 7 percent clay; moderately acid (pH 5.8); clear smooth boundary.

Bw 30 to 47 cm; dark yellowish brown (10YR 3/4) extremely gravelly loamy sand, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; 60 percent gravel and 6 percent cobbles; 2 percent clay; moderately acid (pH 5.8); clear smooth boundary.

C 47 to 100 cm; brown (10YR 4/3) extremely gravelly sand, very pale brown (10YR 8/3) dry; single grain; loose, nonsticky and nonplastic; 60 percent gravel and 10 percent cobbles; 2 percent clay; strongly acid (pH 5.5).

Range of Important Properties

Epipedon: The thickness of these umbric or mollic epipedons ranges from 18* through 77 centimeters, and averages 29 centimeters. Color hues for the epipedons range from 10YR through 2.5Y. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are sandy loam and loam. The pH ranges from 4.6 through 5.8.

Control section: The most common textures are sand and loamy sand. The weighted average clay content ranges from 2 through 10 percent, and averages 5 percent. The weighted average rock fragment content ranges from 36 through 86 percent, and averages 62 percent. The pH ranges from 4.8 through 6.5.

Base saturation: All pedons have at least one horizon with a base saturation less than 50 percent. The range for all horizons in all pedons is 34 through 79 percent. The average of all pedons is 55 percent.

*After mixing to 18 centimeters the weighted average of the color value and chroma meet umbric or mollic requirements.

McCort Family

The McCort family soils have weakly developed mollic epipedons, and skeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form mainly in glacial till, stream alluvium, and colluvium derived from andesite, rhyolitic ash-flow tuff, or sedimentary rocks. These soils often form under the forested ABLA/VASC and PICO/CARO habitat types. They can also form under the nonforested ARTR/FEID and DECE/CAREX habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Cryoborolls

Typical Pedon

Location: West of Summit Lake, Summit Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 500680E/4918280N. Pedon 663.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 10 cm; dark brown (10YR 3/3) gravelly loam, brown (10YR 5/3) dry; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; 20 percent gravel; 20 percent clay; moderately acid (pH 5.6); abrupt smooth boundary.

A2 10 to 23 cm; brown (10YR 4/3) very gravelly loam, light yellowish brown (10YR 6/4) dry; moderate very coarse granular structure; soft, very friable, slightly sticky and slightly plastic; 40 percent gravel; 20 percent clay; moderately acid (pH 5.6); abrupt smooth boundary.

Bw 23 to 50 cm; dark yellowish brown (10YR 4/4) gravelly loam, very pale brown (10YR 7/4) dry; weak medium subangular blocky parting to moderate very coarse granular structure; soft, very friable, slightly sticky and slightly plastic; 30 percent gravel; 23 percent clay; moderately acid (pH 5.6); clear smooth boundary.

C 50 to 100 cm; yellowish brown (10YR 5/6) extremely gravelly loamy sand, very pale brown (10YR 8/4) dry; massive; loose, nonsticky and nonplastic; 70 percent gravel; 3 percent clay; moderately acid (pH 5.8).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons is 18* centimeters. Color hues for the epipedons are 7.5YR or 10YR. Values range from 3 through 5 dry, and 2 or 3 moist. Chromas range from 1 through 3 moist. The most common texture is loam. The pH ranges from 4.7 through 7.0.

Control section: The most common textures are loam, sandy loam, and loamy sand. The weighted average clay content ranges from 5 through 29 percent, and averages 16 percent. The weighted average rock fragment content ranges from 35 through 79 percent, and averages 54 percent. The pH ranges from 5.0 through 7.0.

Base saturation: The range for all horizons in all pedons is 53 through 97 percent. The average of all pedons is 76 percent.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Moran Family

The Moran family soils have umbric or mollic epipedons, and skeletal subsoil layers with moderately fine to moderately coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form in glacial till, lacustrine sediments, glaciofluvial alluvium, and colluvium derived from rhyolitic ash-flow tuff, rhyolite, or sedimentary rocks. These soils most often form under the forested ABLA/VASC, ABLA/LIBO, and ABLA/CAGE habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Cryumbrepts

Typical Pedon

Location: Flat Mountain Arm, Heart Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 546870E/4912890N. Pedon 296.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 6 to 0 cm; litter layer.

A 0 to 16 cm; very dark grayish brown (10YR 3/2) gravelly sandy loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and non plastic; 15 percent gravel and 10 percent cobbles; 15 percent clay; strongly acid (pH 5.4); abrupt wavy boundary.

Bw1 16 to 36 cm; dark gray (10YR 4/1) very cobbly loamy coarse sand, grayish brown (10YR 5/2) dry; weak coarse subangular blocky structure; loose, loose, nonsticky and nonplastic; 30 percent gravel and 20 percent cobbles; 2 percent clay; moderately acid (pH 5.6); clear smooth boundary.

Bw2 36 to 65 cm; dark grayish brown (10YR 4/2) very gravelly sandy loam, light brownish gray (10YR 6/2) dry; weak, coarse, subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 40 percent gravel and 3 percent cobbles; 17 percent clay; moderately acid (pH 5.6); clear smooth boundary.

C 65 to 100 cm; dark grayish brown (10YR 4/2) extremely gravelly sandy loam, light brownish gray (10YR 6/2) dry; massive; soft, friable, slightly sticky and nonplastic; 65 percent gravel and 2 percent cobbles; 12 percent clay; moderately acid (pH 5.8).

Range of Important Properties

Epipedon: The thickness of these umbric or mollic epipedons ranges from 18* to 57 centimeters, and averages 29 centimeters. Color hues for the epipedons are 7.5YR or 10YR. Values are 4 or 5 dry, and 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are loam and sandy loam. The pH ranges from 4.6 through 5.4.

Control section: The most common textures are sandy loam, loam, and sandy clay loam. The weighted average clay content ranges from 5 through 34 percent, and averages 18 percent. The weighted average rock fragment content ranges from 35 through 76 percent, and averages 56 percent for all pedons. The pH ranges from 5.4 through 7.8.

Base saturation: All pedons have at least one horizon with a base saturation less than 50 percent. The range for all horizons in all pedons is 34 through 100 percent. The average of all pedons is 60 percent.

Root-limiting layer: In these soils dense basal till is considered a root-limiting layer. In map unit 8835, in the southwest portion of the park, dense basal till occurs between 60 and 100 centimeters, and averages 80 centimeters below the soil surface.

* After mixing to 18 cm the weighted average of the color value and chroma meet umbric or mollic requirements.

Mosroc Family

The Mosroc family soils have mollic epipedons, argillic horizons, and shallow to very shallow root-limiting layers. The skeletal subsoil layers have medium textures. The soils are between 20 and 50 centimeters deep. Soils in this family form in glacial till and residuum derived mainly from andesite or sedimentary rocks. These soils often form under nonforested habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Argic Lithic Cryoborolls

Typical Pedon

Location: North peak of the Promontory, Alder Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 556400E/4911960N. Pedon 86.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 16 cm; very dark brown (10YR 2/2) loam, brown (7.5YR 4/2) dry; weak coarse subangular blocky and weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; 4 percent gravel; 16 percent clay; slightly acid (pH 6.5); clear smooth boundary.

Bt1 16 to 33 cm; dark brown (10YR 3/3) very gravelly loam, brown (7.5YR 4/4) dry; moderate medium parting to fine subangular blocky structure; soft, very friable, sticky and slightly plastic; 50 percent gravel and 5 percent cobbles; 24 percent clay; few, distinct clay films lining tubular and interstitial pores; slightly acid (pH 6.5); abrupt wavy boundary.

Bt2 33 to 44 cm; dark brown (10YR 3/3) extremely cobbly loam, yellowish brown (10YR 5/4) dry; moderate coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 40 percent gravel and 30 percent cobbles; 22 percent clay; few, prominent clay films lining tubular and interstitial pores and many, distinct clay films bridging mineral grains; slightly acid (pH 6.5).

R 44 cm; lithic contact with andesite bedrock.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 44 centimeters. Color hues for the epipedons range from 5YR through 10YR. Values are 4 or 5 dry, and 2 or 3 moist. Chromas range from 1 through 3 moist. The most common texture is loam, but silt loam also occurs. The pH ranges from 6.0 through 7.2.

Control section: The most common texture is loam. The weighted average clay content ranges from 21 through 35 percent, and averages 23 percent. The weighted average rock fragment content ranges from 37 through 75 percent, and averages 53 percent. The pH ranges from 6.2 through 7.0.

Base saturation: The range for all horizons in all pedons is 85 through 100 percent. The average for all pedons is 92 percent.

Root-limiting layer: Although all pedons have a lithic contact within 50 centimeters of the soil surface, both lithic and paralithic contacts are considered root-limiting layers. The depth to this layer ranges from 23 through 49 centimeters and averages 35 centimeters below the soil surface.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Oleo Family

The Oleo family soils have umbric epipedons, argillic horizons, and nonskeletal subsoil layers with medium textures. The soils are greater than 100 centimeters deep. These soils form mainly in loess mantled alluvium derived from rhyolite. Soils in this family most often form under the forested ABLA/VASC-VASC and ABLA/VASC-CARU habitat types.

Taxonomic Classification: Ashy, glassy Alfic Vitricryands

Typical Pedon

Location: Southwest of the northeast corner of section 19, T. 14 N., R. 45 E., ID, Targhee National Forest, Idaho. UTM 48S366E/4930387N. Pedon T-ol.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 2 to 0 cm; litter layer of needles, twigs and leaves.

A1 0 to 5 cm; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak coarse platy structure parting to weak very fine granular; soft, very friable, nonsticky and slightly plastic; trace gravel, cobbles and stones; moderately acid (pH 6.0); abrupt smooth boundary.

A2 5 to 25 cm; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure parting to weak very fine granular; slightly hard, very friable, nonsticky and slightly plastic; trace gravel, cobbles and stones; strongly acid (pH 5.5); clear smooth boundary.

B/E 25 to 71 cm; dark yellowish brown (10YR 4/4) and brown (10YR 5/3) silt loam, light yellowish brown (10YR 6/4) and very pale brown (10YR 7/3) dry; 70 percent B material and 30 percent E material in a fine to medium (less than 15 mm) irregular matrix; moderate coarse subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; 5 percent gravel and trace cobbles and stones; moderately acid (pH 5.7); clear wavy boundary.

Bt1 71 to 109 cm; brown (10YR 4/3) gravelly silt loam, pale brown (10YR 6/3) dry; strong coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common distinct clay films on faces of peds and lining pores; many distinct uncoated silt grains on faces of peds; 15 percent gravel, trace cobbles stones; moderately acid (pH 5.8); clear wavy boundary.

Bt2 109 to 152 cm; brown (10YR 4/3) very cobbly silt loam, pale brown (10YR 6/3) dry; strong coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common distinct clay films on faces of peds and lining pores; many distinct uncoated silt grains on faces of peds; 10 percent gravel, 20 percent cobbles and 15 percent stones; moderately acid (pH 5.8).

Range of Important Properties

Epipedon: These umbric epipedons are 25 through 63 centimeters deep. The color hues for the epipedon are 10YR. Values are 4 or 5 dry, and 2 or 3 moist. Chromas are 2 or 3 moist. The most common texture is silt loam. The pH ranges from 5.1 to 6.0.

Control section: The most common textures are loam and silt loam. The weighted average clay content ranges from 5 through 13 percent, and averages 9 percent. The weighted average rock fragment content ranges from 0 through 25 percent, and averages 15 percent. The pH ranges from 5.1 through 6.0.

Base saturation: The average for all pedons is less than 50 percent.

Andic properties: These properties occur to a depth of 70 to 100 centimeters below the surface. In these soils, andic properties are defined as the following. Phosphate retention is between 35 and 60 percent. Extractable Al + 1/2 Fe is between 0.5 and 2.0 percent. Volcanic glass (0.02 - 2.0 mm in size) is greater than 50 percent.

Oxyaquic Cryoborolls

The Oxyaquic Cryoboroll soils have mollic epipedons, and both skeletal and nonskeletal subsoil layers with medium to moderately coarse textures. They are greater than 100 centimeters deep and have aquic conditions for some time during the growing season. These soils form mainly in alluvium, lacustrine deposits, and glacial till derived from a variety of rock types. These soils form under the forested ABLA/VASC and ABLA/CACA habitat types, the nonforested DECE/CAREX habitat type, or marsh areas of *Carex* species.

Taxonomic Classification: Oxyaquic Cryoborolls (includes the *loamy-skeletal* and *coarse-loamy* particle size classes; and the *mixed*, *superactive* mineralogy class)

Typical Pedon

Location: Near Firn Lake Patrol Cabin, Pelican Cone 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 4948000N/559600E. Pedon 253. Coarse-loamy, mixed, superactive Oxyaquic Cryoboroll.

Description: (All colors are for moist conditions unless otherwise stated.)

O 3 to 0 cm; Litter layer.

A 0 to 17 cm; dark brown (10YR 3/3) very stony loam, brown (10 YR 4/3) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; 10 percent gravel and 50 percent stones; 15 percent clay; slightly acid (pH 6.5); clear smooth boundary.

AB 17 to 38 cm; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 10 percent gravel; 18 percent clay; moderately acid (pH 6.0); clear smooth boundary.

Bw 38 to 58 cm; dark gray (10YR 4/1) gravelly sandy loam, dark grayish brown (10YR 4/1) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and slightly plastic; 20 percent gravel; 18 percent clay; moderately acid (pH 6.0); water seeping into pit at 38 cm.

BC 58 to 100 cm; grayish brown (10YR 5/2) very gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak coarse subangular blocky structure; soft, friable, nonsticky and nonplastic; 40 percent gravel; 10 percent clay; moderately acid (pH 6.0); water seeping into pit.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18 through 38 centimeters, and averages 28 centimeters. Color hues for the epipedons are 7.5YR and 10YR. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are silt loam, sandy loam, and loam. The pH ranges from 5.4 to 6.5.

Control section: The most common textures are silt loam, loam, and sandy loam. The weighted average clay content ranges from 11 through 17 percent, and averages 15 percent. The weighted average rock fragment content ranges from 0 through 70 percent, and averages 29 percent. The pH ranges from 5.4 through 6.8.

Base saturation: The range for all horizons in all pedons is 53 through 98 percent. The average for all pedons is 70 percent.

Oxyaquic Cryochrepts

The Oxyaquic Cryochrept soils have ochric epipedons, and both skeletal and nonskeletal subsoil layers with moderately fine to coarse textures. The soils are greater than 100 centimeters deep and have aquic conditions for some time during the growing season. These soils form mainly in alluvium and lacustrine deposits derived from rhyolite or sandstone. They often form under the forested ABLA/CACA and the nonforested DECE/CAREX habitat types.

Taxonomic Classification: Oxyaquic Cryochrepts (includes the *loamy-skeletal*, *clayey-skeletal*, *sandy*, *coarse-loamy*, and *fine-loamy* particle size classes; and the *mixed*, *superactive* mineralogy class)

Typical Pedon

Location: South summit of Flat Mountain, Heart Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 545150E/4908400N. Pedon 298. (loamy-skeletal, mixed, superactive Oxyaquic Cryochrept)

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 8 cm; black (10YR 2/1) loam; very dark grayish brown (10YR 3/2) dry; weak fine granular structure soft, very friable, slightly sticky and slightly plastic; 5 percent gravel; 22 percent clay; slightly acid (pH 6.0); abrupt smooth boundary.

AB 8 to 25 cm; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; 10 percent gravel; 25 percent clay; moderately acid (pH 5.8); abrupt smooth boundary.

Bw1 25 to 58 cm; dark grayish brown (2.5Y 4/2) very gravelly sandy clay loam, very pale brown (10YR 7/3) dry, with few faint brown (10YR 4/3) redoximorphic concentrations; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 40 percent gravel and 20 percent cobbles; 21 percent clay; slightly acid (pH 6.2); abrupt smooth boundary.

Bw2 58 to 100 cm; pale yellow (2.5Y 7/3) gravelly sandy clay loam, pale yellow (2.5Y 7/4) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 30 percent gravel; 23 percent clay; neutral (pH 6.6); water entering pit at 75 centimeters.

Range of Important Properties

Epipedon: These ochric epipedons usually have color values or chromas too high to meet the definition of other epipedons. Approximately half of these soils include a dark colored surface horizon that is too thin to meet the definition of a mollic or an umbric epipedon. The thickness of these dark surface horizons ranges from 6 through 12 centimeters. Color hues for the epipedons range from 10YR through 5Y. Values range from 3 through 7 dry, and from 2 through 5 moist. Chromas range from 1 through 3 moist. The most common texture is loam. The pH ranges from 5.2 through 8.0.

Control section: The most common textures are loamy sand, sandy clay loam, and loam. The weighted average clay content ranges from 5 through 43 percent, and averages 18 percent. The weighted average rock fragment content ranges from 0 through 61 percent, and averages 31 percent. The pH ranges from 5.6 through 8.0.

Base saturation: The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 20 through 100 percent. The average for all pedons is 78 percent.

PASSCREEK FAMILY

The Passcreek family soils have mollic epipedons, argillic horizons, and nonskeletal subsoil layers with moderately fine to medium textures. The soils are greater than 100 centimeters deep. Soils in this family form mainly in glacial till, lacustrine deposits, and earthflow debris derived primarily from andesite or sedimentary rock types. These soils form under the forested ABLA/VASC and nonforested ARTR/FEID habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Argic Cryoborolls

Typical Pedon

Location: West of Harebell patrol cabin, Snake Hot Springs 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 539120E/4890500N. Pedon 676.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 4 cm; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; weak fine granular structure; firm, friable, slightly sticky and slightly plastic; 5 percent gravel; 16 percent clay; slightly acid (pH 6.4); abrupt smooth boundary.

A2 4 to 19 cm; dark brown (10YR 3/3) gravelly loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; firm, friable, slightly sticky and slightly plastic; 18 percent gravel; 18 percent clay; moderately acid (pH 6.0); abrupt wavy boundary.

Bt1 19 to 37 cm; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; strong coarse subangular blocky structure; firm, friable, sticky and slightly plastic; 10 percent gravel; 25 percent clay; many prominent clay films on ped faces; slightly acid (pH 6.1); gradual smooth boundary.

Bt2 37 to 100 cm; dark grayish brown (10YR 4/2) cobbly sandy clay loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 10 percent gravel and 10 percent cobbles; 21 percent clay; many prominent clay films on ped faces; neutral (pH 6.6).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 39 centimeters and averages 25 centimeters. Color hues for the epipedons range from 2.5YR through 2.5Y, and N. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 0 through 3 moist. The most common textures are silt loam and loam. The pH ranges from 5.2 through 7.5.

Control section: The most common textures are loam, sandy clay loam, and clay loam. The weighted average clay content ranges from 18 through 33 percent, averages 24 percent. The weighted average rock fragment content ranges from 0 through 33 percent, averages 16 percent for all pedons. The pH ranges from 5.5 through 8.0.

Base saturation: The range for all horizons in all pedons is 55 through 100 percent. The average for all pedons is 84 percent.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

PESOWYO FAMILY

The Pesowyo family soils have mollic epipedons and skeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form in colluvium and glacial till derived from a variety of rock types. These soils form under various Douglas fir habitat types and the nonforested, AGSP/POSA habitat type.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Haploborolls

Typical Pedon

Location: Near Crevice Creek, Ash Mountain 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 533610E/4985090N. Pedon 521.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 27 cm; very dark grayish brown (10YR 3/2) very gravelly fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; soft, very friable, nonsticky and slightly plastic; 35 percent gravel and 5 percent cobbles; 13 percent clay; neutral (pH 6.6); gradual smooth boundary.

Bw1 27 to 58 cm; dark brown (10YR 4/3) extremely gravelly fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky parting to moderate medium granular structure; soft, very friable, nonsticky and slightly plastic; 60 percent gravel and 15 percent cobbles; 10 percent clay; neutral (pH 6.6); gradual smooth boundary.

Bw2 58 to 100 cm; dark brown (10YR 4/3) extremely gravelly fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, friable, nonsticky and slightly plastic; 50 percent gravel and 20 percent cobbles; 10 percent clay; slightly acid (pH 6.5).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 30 centimeters and averages 20 centimeters. The color hues for the epipedons are 10YR. Values range from 3 through 5 dry, and are 3 moist. Chromas are 2 or 3, moist. The most common textures are sandy loam and loam. The pH ranges from 6.4 through 8.0.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 10 through 27 percent, and averages 19 percent. The weighted average rock fragment content ranges from 60 through 85 percent, and averages 72 percent for all pedons. The pH ranges from 6.3 through 8.0.

Base saturation: The range for all horizons in all pedons is 75 through 100 percent. The average for all pedons is 84 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: In soils forming near the North Entrance of the park, it is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 20 centimeters.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Priestlake Family

The Priestlake family soils have ochric epipedons and moderately deep root-limiting layers. The skeletal subsoil layers have coarse textures. The soils are between 60 and 80 centimeters deep. Soils in this family form in glacial till over residuum, derived from rhyolite or rhyolitic ash-flow tuff. These soils form under the forested ABLA/VASC and ABLA/CAGE habitat types.

Taxonomic Classification: Sandy-skeletal, mixed, superactive Dystric Cryochrepts

Typical Pedon

Location: Solfatara Plateau, Crystal Falls 7.5 minute quadrangle, Yellowstone National Park Wyoming. UTM 532120E/4949980N. Pedon 500.

Description: (All colors are for moist conditions unless otherwise stated.)

O 4 to 0 cm; ash layer.

A 0 to 12 cm; dark brown (10YR 3/3) gravelly sandy loam, light yellowish brown (10YR 6/4) dry; moderate subangular blocky structure; soft, friable, nonsticky and slightly plastic; 20 percent gravel; 18 percent clay; very strongly acid (pH 4.8); abrupt smooth boundary.

Bw 12 to 25 cm; brown (10YR 4/3) very gravelly sandy loam, very pale brown (10YR 7/3) dry; moderate coarse subangular blocky structure; soft, very friable, nonsticky and slightly plastic; 25 percent gravel and 10 percent stones; 18 percent clay; moderately acid (pH 5.6); abrupt wavy boundary.

BC 25 to 63 cm; brown (7.5YR 4/4) extremely gravelly sand, very pale brown (10YR 7/3) dry; single grain structure; loose, nonsticky and nonplastic; 50 percent gravel, 20 percent stones, and 10 percent cobbles; 3 percent clay; strongly acid (pH 5.4); abrupt wavy boundary.

R 63 cm; lithic contact with rhyolite bedrock

Range of Important Properties

Epipedon: These ochric epipedons usually too thin, or have color values or chromas too high, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values are 5 or 6 dry, and are 3 moist. Chromas range from 2 to 4 moist. The most common texture is sandy loam. The pH ranges from 4.5 through 5.5.

Control section: The textures are sand and loamy sand. The weighted average clay content ranges from 2 through 6 percent, and averages 4 percent. The weighted average rock fragment content ranges from 46 through 80 percent, and averages 68 percent. The pH ranges from 5.4 through 5.5.

Base saturation: The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 31 through 58 percent. The average of all pedons is 51 percent.

Root-limiting layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 60 through 80 centimeters and averages 70 centimeters below the soil surface.

Rimton Family

The Rimton family soils have ochric or umbric epipedons, argillic horizons, and nonskeletal subsoil layers with moderately fine to medium textures. The soils are greater than 100 centimeters deep. Soils in this family mainly form in alluvium and glacial till derived mostly from andesite or sedimentary rocks. These soils form under the nonforested DECE/CAREX and FEID/AGCA habitat types and various forested ABLA habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Mollic Cryoboralfs

Typical Pedon

Location: Monument Knob, Alder Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 556450E/4902450N. Pedon 195.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 8 cm; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 10 percent gravel; 25 percent clay; strongly acid (pH 5.4); abrupt smooth boundary.

A2 8 to 16 cm; very dark grayish brown (10YR 3/2) gravelly clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 15 percent gravel and 5 percent cobbles; 30 percent clay; moderately acid (pH 5.6); clear smooth boundary.

BA 16 to 30 cm; very dark grayish brown (10YR 3/2) very cobbly sandy clay loam, light brownish gray (10YR 6/2) dry; weak very coarse platy structure; slightly hard, very friable, slightly sticky and slightly plastic; 15 percent gravel and 20 percent cobbles; 24 percent clay; moderately acid (pH 6.0); clear smooth boundary.

Bt1 30 to 63 cm; dark grayish brown (10YR 4/2) cobbly sandy clay loam, light brownish gray (10YR 6/2) dry; moderate very coarse platy structure; slightly hard, very friable, slightly sticky and slightly plastic; 10 percent gravel and 20 percent cobbles; 33 percent clay; common, distinct, clay films in pores and on ped faces; slightly acid (pH 6.2); clear smooth boundary.

Bt2 63 to 100 cm; dark grayish brown (10YR 4/2) gravelly sandy clay loam, light brownish gray (2.5Y 6/2) dry; strong medium platy structure; slightly hard, very friable, slightly sticky and slightly plastic; 15 percent gravel; 33 percent clay; many, distinct, clay films on ped faces; slightly acid (pH 6.4).

Range of Important Properties

Epipedon: The ochric epipedons have a dark colored surface horizon that is too thin to meet the definition of a mollic or umbric epipedon. The umbric epipedons do not meet the base saturation requirements for a mollic epipedon. The color hues for the epipedons are 5YR, 7.5YR, 10YR, or 2.5Y. Values range from 3 through 7 dry, and from 2 through 5 moist. Chromas range from 1 through 6 moist. The most common textures are loam, silt loam, and clay loam. The pH ranges from 4.7 through 7.0.

Control section: The most common textures are sandy clay loam, silty clay loam, silt loam, and loam. The weighted average clay content ranges from 18 through 34 percent, and averages 26 percent. The weighted average rock fragment content ranges from 4 through 33 percent, and averages 17 percent for all pedons. The pH ranges from 5.5 through 7.0.

Base saturation: The range for all horizons in all pedons is 20 through 100 percent. The average for all pedons is 70 percent.

Ripple Family

The Ripple family soils have ochric epipedons, and nonskeletal subsoil layers with medium textures. The soils are greater than 100 centimeters deep. These soils form mainly in glacial till or landslide debris derived from andesite or sedimentary rocks. Soils in this family often form under the forested, ABLA/VASC habitat type or cool, moist, nonforested habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Cryochrepts

Typical Pedon

Location: Southeast of Bunsen Peak, Mammoth 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 524200E/4974300N. Pedon 1067.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 4 to 0 cm; litter layer.

A 0 to 9 cm; very dark grayish brown (10YR 3/2) gravelly loam, pale brown (10YR 6/3) dry; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; 19 percent gravel; 25 percent clay; neutral (pH 6.6); clear wavy boundary.

Bw1 9 to 23 cm; dark grayish brown (2.5Y 4/2) gravelly loam, brown (10YR 5/3) dry; weak coarse subangular blocky parting to fine, granular, structure; soft, friable, slightly sticky and slightly plastic; 19 percent gravel; 22 percent clay; slightly acid (pH 6.5); clear wavy boundary.

Bw2 23 to 37 cm; dark grayish brown (10YR 4/2) gravelly loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 27 percent gravel; 26 percent clay; neutral (pH 6.6); abrupt wavy boundary.

BC 37 to 51 cm; brown (10YR 4/3) gravelly loam, light olive brown (2.5Y 5/4) dry; moderate medium subangular blocky parting to fine granular structure; hard, very firm, slightly sticky and slightly plastic; 19 percent gravel; 23 percent clay; neutral (pH 6.8); clear wavy boundary.

C 51 to 125 cm; grayish brown (10YR 5/2) gravelly loam, light gray (10YR 7/1) dry; strong coarse subangular blocky structure; hard, very firm, slightly sticky and slightly plastic; 26 percent gravel and 1 percent cobbles; 15 percent clay; neutral (pH 6.9).

Range of Important Properties

Epipedon: These ochric epipedons usually have color values or chromas too high to meet the definition of other epipedons. Approximately 20 percent of these soils include a dark colored surface horizon that is too thin to meet the definition of a mollic or an umbric epipedon. The thickness of these dark surface horizons ranges from 9 through 14 centimeters. Color hues for the epipedons range from 5YR through 10YR. Values range from 5 through 7 dry, and from 2 through 4 moist. Chromas range from 1 through 4 moist. The most common texture is loam. The pH ranges from 6.0 through 6.6.

Control section: The most common texture is loam. The weighted average clay content ranges from 18 through 34 percent, and averages 23 percent. The weighted average rock fragment content ranges from 0 through 31 percent, and averages 19 percent for all pedons. The pH ranges from 5.5 through 7.2.

Base saturation: All pedons have at least one horizon with a base saturation greater than 60 percent. The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 55 through 96 percent. The average for all pedons is 79 percent.

Rittel Family

The Rittel family soils form in a frigid temperature regime. They have ochric epipedons, argillic horizons, and nonskeletal subsoil layers with fine textures. These soils are greater than 100 centimeters deep. Soils in this family form in earthflow debris derived from sedimentary rocks. They form under the nonforested AGSP/POSA, ARTR/AGSP, and SAVE/AGSM habitat types.

Taxonomic Classification: Fine, mixed, superactive Typic Eutroboralfs

Typical Pedon

Location: Near Stephens Creek; Electric Peak 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 518420E/4986080N. Pedon 118.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 7 cm; very dark grayish brown (10YR 3/2) gravelly sandy loam, light grayish brown (10YR 6/2) dry; moderate coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 15 percent gravel; 9 percent clay; neutral (pH 7.1); abrupt smooth boundary.

2Btkn 7 to 33 cm; very dark grayish brown (10YR 3/2) clay, light grayish brown (10YR 6/2) dry; strong coarse angular blocky structure; very hard, friable, sticky and plastic; 10 percent gravel; 58 percent clay; common prominent clay films on ped faces; moderately alkaline (pH 8.1); accumulation of lime in pores; strongly effervescent; gradual smooth boundary.

2Bknz 33 to 55 cm; dark grayish brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) dry; moderate coarse angular blocky structure; hard, very friable, slightly sticky and plastic; 10 percent gravel; 48 percent clay; slightly saline; moderately alkaline (pH 8.4); accumulation of lime in pores; strongly effervescent; gradual smooth boundary.

2BCnz 55 to 100; dark grayish brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; moderate coarse subangular blocky structure; hard, friable, sticky and slightly plastic; 5 percent gravel; 45 percent clay; slightly saline; moderately alkaline (pH 8.4); accumulation of lime in pores; slightly effervescent.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR. Values are 6 or 7 dry, and 3 or 4 moist. Chromas are 2 or 3 moist. The most common textures are sandy clay loam, loam, and sandy loam. The pH ranges from 6.5 through 8.0.

Control section: The most common texture is clay. The weighted average clay content ranges from 40 through 58 percent, averages 50 percent. The weighted average rock fragment content ranges from 10 through 20 percent, and averages 13 percent. The pH ranges from 7.5 through 8.4.

Base saturation: The range for all horizons in all pedons is 80 through 100 percent. The average for all pedons is 95 percent.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 15 cm. In some soils calcium carbonates also accumulate in surface layers.

Salinity and Sodicity: Soils weathering from earthflow debris often have an accumulation of sodium salts, with ESPs of 15 to 25 percent, throughout the soil profile. These same soils are slightly saline, with EC measurements of 4 or 5 mmhos/cm, at depths greater than 35 centimeters.

Rombo Family

The Rombo family soils have ochric epipedons and nonskeletal subsoil layers with fine to moderately fine textures. These soils are greater than 100 centimeters deep. Soils in this family form in earthflow debris derived from sedimentary rock types. These soils form under the nonforested ARTR/FEID, ARTR/AGSP, and AGSP/POSA habitat types.

Taxonomic Classification: Fine, mixed, superactive frigid Typic Ustochrepts

Typical Pedon

Location: West of Gardiner, southwest of cemetery; Gardiner 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 521520E/4986540N. Pedon 2005.

Description: (All colors are for moist conditions unless otherwise stated.)

An 0 to 7 cm; dark brown (10YR 3/3) clay, pale brown (10YR 6/3) dry; weak fine granular structure; slightly hard, friable, sticky and plastic; 44 percent clay; moderately alkaline (pH 8.0); clear wavy boundary.

Bkn 7 to 25 cm; brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; 38 percent clay; strongly alkaline (pH 8.5); lime accumulation in pores; slightly effervescent; gradual wavy boundary.

Bknz 25 to 58 cm; brown (10YR 5/3) clay, light yellowish brown (10YR 6/4) dry; moderate coarse subangular blocky structure; hard, firm, sticky and plastic; 53 percent clay; slightly saline; strongly alkaline (pH 8.5); lime accumulation in pores; strongly effervescent; gradual wavy boundary.

BCnz 58 to 82 cm; yellowish brown (10YR 5/4) clay, light gray (10YR 7/2) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; 50 percent clay; slightly saline; strongly alkaline (pH 8.5), gradual wavy boundary.

C 82 to 100 cm; brown (10YR 5/3) clay, light yellowish brown (10YR 6/4) dry; massive; hard, friable, sticky and plastic; 44 percent clay; strongly alkaline (pH 8.5).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 10YR or 2.5Y. Values are 5 or 6 dry, and are 3 or 4 moist. Chromas are 2 or 3 moist. The most common texture is clay. The pH ranges from 8.0 through 8.9.

Control section: The most common textures are clay loam and clay. The weighted average clay content ranges from 40 through 50 percent, and averages 45 percent. The weighted average rock fragment content ranges from 0 through 19 percent, and averages 7 percent. The pH ranges from 8.0 through 8.8.

Base saturation: The range for all horizons in all pedons is 95 through 100 percent. The average of all pedons is 99 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 25 cm. In some soils, calcium carbonates also accumulate in surface layers.

Salinity and Sodicity: Soils weathering from earthflow debris often have an accumulation of sodium salts, with ESPs of 15 to 25 percent, throughout the soil profile. These same soils are slightly saline, with EC measurements of 4 to 7 mmhos/cm, at depths greater than 35 centimeters.

Roundup Family

The Roundup family soils have mollic epipedons and nonskeletal subsoil layers with moderately fine to medium textures. The soils are greater than 100 centimeters deep. Soils in this family form in glacial till and glaciofluvial alluvium derived from sedimentary rocks and rhyolitic ash-flow tuff. These soils form under the nonforested ARTR/AGSP or ARTR/FEID habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Haploborolls

Typical Pedon

Location: Near Stephens Creek, Gardiner 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 521280E/4985670N. Pedon 13.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 13 cm; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; 10 percent gravel; 24 percent clay; neutral (pH 7.2); abrupt smooth boundary.

A2 13 to 32 cm; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 10 percent gravel; 24 percent clay; slightly alkaline (pH 7.7); abrupt smooth boundary.

AB 32 to 55 cm; dark grayish brown (10YR 4/2) loam, brown (10YR 5/3) dry; moderate medium angular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 10 percent gravel; 21 percent clay; slightly alkaline (pH 7.7); clear smooth boundary.

Bk 55 to 100 cm; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 10 percent gravel; 20 percent clay; moderately alkaline (pH 8.0); lime accumulation in pores; slightly effervescent.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18 through 39 centimeters and averages 29 centimeters. The color hues for the epipedons are 10YR. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3, moist. The most common textures is loam. The pH ranges from 6.0 through 8.0.

Control section: The most common textures are loam and clay loam. The weighted average clay content ranges from 18 through 28 percent, and averages 22 percent. The weighted average rock fragment content ranges from 1 through 17 percent, and averages 11 percent. The pH ranges from 7.5 through 8.5.

Base saturation: The range for all horizons in all pedons is 95 through 100 percent. The average of all pedons is 99 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 25 cm. In some soils, calcium carbonates also accumulate in surface layers.

Sawbuck Family

The Sawbuck family soils have mollic epipedons, argillic horizons, and skeletal subsoil layers with moderately fine textures. The soils are greater than 100 centimeters deep. These soils form in glacial till, fan alluvium, and outwash flood deposits derived from a mixture of rock types. They form under the nonforested ARTR/FEID and AGSP/POSA habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Argiborolls

Typical Pedon

Location: Near Stephens Creek, Electric Peak 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 518240E/4988250N. Pedon 107.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 6 cm; dark brown (10YR 3/3) loam, grayish brown (10YR 5/2) dry; moderate coarse granular structure; soft, very friable, slightly sticky and slightly plastic; 10 percent gravels; 16 percent clay; slightly alkaline (pH 7.7); abrupt smooth boundary.

Bt 6 to 26 cm; dark brown (10YR 3/3) very bouldery sandy clay loam, dark brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, friable, sticky and slightly plastic; 5 percent gravel, 40 percent boulders; 23 percent clay; common, distinct clay films on ped faces; slightly alkaline (pH 7.4); diffuse irregular boundary.

Bk 26 to 62 cm; very dark grayish brown (10YR 3/2) very gravelly sandy loam, light grayish brown (10YR 6/2) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 40 percent gravels; 10 percent clay; moderately alkaline (pH 7.9); lime accumulation in pores; clear smooth boundary.

BC 62 to 100 cm; dark brown (10YR 4/2) very gravelly sandy loam, grayish brown (10YR 5/2) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 30 percent gravels, 15 percent cobbles; 10 percent clay; slightly alkaline (pH 7.4).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 32 centimeters and averages 23 centimeters. Color hues for the epipedons are 10YR. Values are 4 or 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are loam, sandy clay loam, and sandy loam. The pH ranges from 6.7 through 8.0.

Control section: The most common textures are sandy clay loam and clay loam. The weighted average clay content ranges from 11 through 33 percent, and averages 26 percent. The weighted average rock fragment content ranges from 40 through 65 percent, and averages 48 percent for all pedons. The pH ranges from 6.5 through 8.2.

Base saturation: The range for all horizons in all pedons is 79 through 100 percent. The average of all pedons is 93 percent.

Temperature Regime: These soils form in a frigid temperature regime.

Carbonates: It is common for calcium carbonate to accumulate in the subsoil layers at depths greater than 25 centimeters. In some soils, calcium carbonates also accumulate in surface layers.

Salinity: Some these soils are very slightly to slightly saline, with EC measurements of 2 to 4 mmhos/cm, at depths greater than 25 centimeters.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Sawfork Family

The Sawfork family soils have mollic epipedons, argillic horizons, and skeletal subsoil layers with moderately fine to medium textures. The soils are greater than 100 centimeters deep. Soils in this family mainly form in glacial till, colluvium, or earthflow debris derived from andesite or mixed rock types. These soils often form under the forested ABLA/VAGL, ABLA/CACA, and ABLA/VASC habitat types, and also under various nonforested habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Argic Cryoborolls

Typical Pedon

Location: Lamar Ranger Station, Mount Hornaday 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 561020E/4972150N. Pedon 508.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 3 to 0 cm; litter layer.

A 0 to 7 cm; black (10YR 2/1) very gravelly silt loam, dark brown (10YR 3/3) dry; moderate very coarse granular structure; slightly hard, friable, slightly sticky and slightly plastic; 25 percent gravel and 10 percent cobbles; 12 percent clay; neutral (pH 6.8); abrupt smooth boundary.

Bt1 7 to 37 cm; very dark grayish brown (10YR 3/2) very gravelly clay loam, dark brown (10YR 4/3) dry; moderate very coarse granular structure; hard, very friable, sticky and slightly plastic; 40 percent gravel and 10 percent cobbles; 29 percent clay; few, distinct, clay films on faces of peds; neutral (pH 6.6); clear smooth boundary.

Bt2 37 to 81 cm; dark grayish brown (10YR 4/2) extremely gravelly clay loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure; hard, friable, sticky and slightly plastic; 50 percent gravel and 20 percent cobbles; 29 percent clay; common, prominent, clay films on faces of peds; neutral (pH 6.6); clear smooth boundary.

Bt3 81 to 122 cm; dark brown (10YR 3/3) extremely cobbly sandy clay loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 50 percent gravel and 30 percent cobbles, 23 percent clay; common prominent clay films line pores; neutral (pH 6.6); clear smooth boundary.

2C 122 to 138 cm; very dark grayish brown (10YR 3/2) extremely gravelly sand, brown (10YR 5/3) dry; single grain; loose, slightly sticky and nonplastic; 50 percent gravel and 15 percent cobbles, 9 percent clay; neutral (pH 6.6).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 39 centimeters and averages 24 centimeters. Color hues for the epipedons range from 2.5YR through 10YR. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The textures are silt loam, loam, and clay loam. The pH ranges from 5.2 through 8.0.

Control section: The most common textures are loam, clay loam, and sandy clay loam. The weighted average clay content ranges from 15 through 34 percent, averages 25 percent. The weighted average rock fragment content ranges from 39 through 85 percent, averages 55 percent for all pedons. The pH ranges from 5.4 through 8.0.

Base saturation: The range for all horizons in all pedons is 53 through 100 percent. The average for all pedons is 83 percent.

Carbonates: Subsoil accumulation of calcium carbonate occurs in the Northern Range area of the park, and also in areas where limestone or travertine is part of the parent material.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Shadow Family

The Shadow family soils have ochric epipedons, and skeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 centimeters deep. These soils form in glacial till, colluvium, and residuum derived from andesite, welded rhyolite tuff, or sandstone. Soils in this family most often form under the forested ABLA/VASC-VASC, ABLA/VAGL, and ABLA/VASC-PIAL habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Cryochrepts

Typical Pedon

Location: Southwest of Sportsman Lake, Sportsman Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 504800E/4983720N. Pedon 613.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 3 cm; very dark grayish brown (10YR 3/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; no rock fragments; 17 percent clay; strongly acid (pH 5.2); abrupt smooth boundary.

Bw1 3 to 19 cm; dark brown (10YR 3/3) gravelly loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; 25 percent gravel; 17 percent clay; slightly acid (pH 6.2); clear smooth boundary.

Bw2 19 to 33 cm; dark grayish brown (10YR 4/2) very cobbly loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 15 percent gravel and 20 percent cobbles; 17 percent clay; slightly acid (pH 6.2); abrupt wavy boundary.

BC 33 to 100 cm; yellowish brown (10YR 5/4) extremely gravelly sandy loam, very pale brown (10YR 8/3) dry; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 45 percent gravel and 20 percent cobbles; 14 percent clay; moderately acid (pH 6.0).

Range of Important Properties

Epipedon: These ochric epipedons usually have color values or chromas too high to meet the definition of other epipedons. Approximately 30 percent of these soils include a dark colored surface horizon that is too thin to meet the definition of a mollic or an umbric epipedon. The thickness of these dark surface horizons ranges from 2 through 14 centimeters. Color hues for the epipedons range from 5YR through 10YR. Values range from 3 through 8 dry, and from 2 through 4 moist. Chromas range from 1 through 4 moist. The most common texture is loam. The pH ranges from 4.6 through 7.8.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 5 through 34 percent, and averages 16 percent. The weighted average rock fragment content ranges from 35 through 89 percent, and averages 60 percent. The pH ranges from 5.2 through 8.0.

Base saturation: All pedons have at least one horizon with a base saturation greater than 60 percent. The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 30 through 100 percent. The average for all pedons is 78 percent.

Carbonates: Subsoil accumulation of calcium carbonate occurs in the Northern Range area of the park, and also in areas where limestone or travertine is part of the parent material.

Shook Family

The Shook family soils have thick mollic epipedons, and nonskeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 centimeters deep, and in some areas have aquic conditions during the growing season. Soils in this family form mainly in glacial till, glaciofluvial alluvium, and fan alluvium derived from andesite. These soils often form under the nonforested FEID/AGCA, ARCA/FEID, and ARTR/FEID habitat types.

Taxonomic Classification: Coarse-loamy, mixed, superactive Pachic Cryoborolls

Typical Pedon

Location: North end of the Promontory, Alder Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 555070E/4912287N. Pedon 80.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 4 to 0 cm; litter layer.

A1 0 to 13 cm; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; 10 percent clay; moderately acid (pH 5.7); abrupt smooth boundary.

A2 13 to 53 cm; dark grayish brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; 10 percent clay; slightly acid (pH 6.2); clear smooth boundary.

A3 53 to 89 cm; very dark grayish brown (10YR 3/2) gravelly loam, weak red (2.5YR 5/2) dry; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 16 percent gravel; 10 percent clay; moderately acid (pH 6.0); clear smooth boundary.

Bw 89 to 107 cm; dark grayish brown (10YR 4/2) gravelly sandy loam, weak red (2.5YR 5/2) dry; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; 20 percent gravel; 11 percent clay; moderately acid (pH 6.0); abrupt smooth boundary.

BC 107 to 130 cm; dark gray (10YR 4/1) sandy loam, light brownish gray (10YR 6/2) dry; moderate coarse angular blocky structure; very hard, friable, slightly sticky and nonplastic; 8 percent gravel; 15 percent clay; moderately acid (pH 6.0).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 42 through 153 centimeters, and averages 73 centimeters. Color hues for the epipedons are 10YR or 2.5Y. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are sandy loam and loam. The pH ranges from 5.4 through 7.5.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 5 through 17 percent, and averages 12 percent. The weighted average rock fragment content ranges from 0 through 34 percent, and averages 15 percent. The pH ranges from 5.5 through 8.0.

Base saturation: The range for all horizons in all pedons is 58 through 100 percent. The average for all pedons is 83 percent.

Silas Family

The Silas family soils have thick mollic epipedons, and nonskeletal subsoil layers with medium to moderately fine textures. The soils are greater than 100 centimeters deep and can have aquic conditions for short periods of time during the growing season. Soils in this family form in alluvium derived from andesite. These soils form under nonforested DECE/CAREX, FEID/DECE or forested ABLA/VASC habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Cumulic Cryoborolls

Typical Pedon

Location: Mountain Creek, Trident 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 4897880N/570040E Pedon 851.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 26 cm; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; 22 percent clay; moderately acid (pH 5.8); abrupt smooth boundary.

A2 26 to 52 cm; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; 24 percent clay; moderately acid (pH 5.8); clear smooth boundary.

Bt 52 to 75 cm; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; 22 percent clay; moderately acid (pH 5.8); abrupt smooth boundary; few thin clay films lining tubular or interstitial pores and occurring on ped faces.

BC 75 to 100 cm; very dark brown (10YR 2/2) extremely gravelly loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; 70 percent gravel; 18 percent clay; moderately acid (pH 5.8).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 70 through 100 centimeters, and averages 80 centimeters. Color hues for the epipedons are 10YR. Values are 4 or 5 dry, and 2 or 3 moist. Chromas range from 1 through 3 moist. The most common texture is silt loam. The pH ranges from 5.8 to 6.6.

Control section: The most common textures are loam, silty clay loam, and silt loam. The weighted average clay content ranges from 21 through 30 percent, and averages 26 percent. The weighted average rock fragment content ranges from 0 through 23 percent, and averages 13 percent. The pH ranges from 5.8 through 6.6.

Base saturation: The range for all horizons in all pedons is 67 through 95 percent. The average for all pedons is 85 percent.

Silvercliff Family

The Silvercliff family soils have mollic epipedons and moderately deep root-limiting layers. The skeletal subsoil layers have medium to moderately coarse textures. The soils are between 50 and 100 cm deep. Soils in this family form in glacial till and colluvium derived from andesite or dacite. These soils form under the forested ABLA/VASC habitat types and areas of alpine meadow.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Cryoborolls

Typical Pedon

Location: Northeast of Crescent Lake, Sportsman Lake 7.5 minute quadrangle, Yellowstone National Park Montana. UTM 502510E/4991030N. Pedon 546.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 20 cm; dark brown (10YR 3/3) gravelly loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 15 percent gravel and 10 percent cobbles; 15 percent clay; slightly acid (pH 6.2); clear wavy boundary.

A2 20 to 38 cm; dark brown (10YR 3/3) extremely cobbly loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 20 percent gravel and 50 percent cobbles; 15 percent clay; slightly acid (pH 6.2); abrupt wavy boundary.

Bw 38 to 56 cm; brown (7.5YR 4/4) extremely cobbly sandy loam, very pale brown (10YR 7/4) dry; weak coarse subangular blocky structure; hard, friable, nonsticky and nonplastic; 35 percent gravel and 30 percent cobbles; 8 percent clay; slightly acid (pH 6.2); abrupt smooth boundary.

Cr 56 to 77 cm; paralithic contact with weathered dacite.

R 77 cm; lithic contact with dacite bedrock.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 38 centimeters. Color hues for the epipedons are 10YR. Values are 4 or 5 dry, and 3 moist. Chromas are 2 or 3 moist. The most common texture is loam. The pH ranges from 5.3 through 6.2.

Control section: The most common textures are loam and sandy loam. The weighted average clay content ranges from 10 through 26 percent, and averages 15 percent. The weighted average rock fragment content ranges from 40 through 79 percent, and averages 64 percent. The pH ranges from 5.5 through 6.2.

Base saturation: The range for all horizons in all pedons is 75 through 90 percent. The average of all pedons is 80 percent.

Root-limiting layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 52 through 100 centimeters and averages 64 centimeters below the soil surface.

* After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Sluice Family

The Sluice family soils have ochric epipedons, argillic horizons, and nonskeletal subsoil layers with fine to moderately fine textures. They are greater than 100 centimeters deep. These soils form in glacial till, colluvium, landslide debris, and lacustrine sediments derived primarily from sedimentary rocks. Soils in this family most often form under the forested ABLA/VASC habitat type or under a variety of nonforested habitat types.

Taxonomic Classification: Fine, mixed, superactive Typic Cryoboralfs

Typical Pedon

Location: Northwest of Basin Creek Lake, Snake Hot Springs 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 537660E/4895200N. Pedon #754.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 20 cm; dark brown (7.5YR 3/3) silt loam, pale brown (10YR 6/3) dry; strong coarse granular structure; very firm, very friable, slightly sticky and plastic; 2 percent gravel; 25 percent clay; slightly acid (pH 6.2); clear smooth boundary.

Bt1 20 to 49 cm; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/3) dry; strong medium angular blocky structure; very firm, very friable, sticky and plastic; 5 percent gravel; 37 percent clay; common, distinct clay films on ped faces and lining tubular or interstitial pores; neutral (pH 6.8); clear smooth boundary.

Bt2 49 to 100 cm; dark reddish brown (5YR 3/3) gravelly silty clay, reddish brown (5YR 5/3) dry; strong medium angular blocky structure; hard, very friable, sticky and plastic; 15 percent gravel; 43 percent clay; common, prominent clay films lining tubular or interstitial pores and many, prominent clay films on ped faces; neutral (pH 7.0).

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 7.5YR or 10YR. Values are 5 or 6 dry, and 3 or 4 moist. Chromas range from 2 through 4 moist. The textures are silt loam and loam. The pH ranges from 5.5 through 7.2.

Control section: The most common textures are silty clay loam and silty clay. The weighted average clay content ranges from 35 through 48 percent, and averages 39 percent. The weighted average rock fragment content ranges from 2 through 33 percent, and averages 13 percent. The pH ranges from 6.4 through 7.6.

Base saturation: The range for all horizons in all pedons is 55 through 100 percent. The average of all pedons is 79 percent.

Struggle Family

The Struggle family soils have ochric epipedons and moderately deep root-limiting layers. The skeletal subsoil layers have coarse textures. The soils are between 50 and 80 centimeters deep. Soils in this family form in residuum, alluvium, and colluvium; derived from rhyolite, rhyolitic ash-flow tuff, or andesite. These soils form under the forested ABLA/VASC-PIAL habitat type and also under alpine meadows.

Taxonomic Classification: Sandy-skeletal, mixed, superactive Typic Cryochrepts

Typical Pedon

Location: North flank of Cathedral Peak, Cathedral Peak 7.5 minute quadrangle, Yellowstone National Park Wyoming. UTM 571150E/4937680N. Pedon 684.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 12 cm; dark brown (10YR 3/3) cobbly loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 20 percent gravel and 14 percent cobbles; 15 percent clay; moderately acid (pH 5.6); abrupt wavy boundary.

Bw1 12 to 23 cm; brown (7.5YR 4/2) very cobbly sandy loam, very pale brown (10YR 7/4) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; 25 percent gravel and 20 percent cobbles; 12 percent clay; moderately acid (pH 5.8); abrupt wavy boundary.

Bw2 23 to 47 cm; brown (10YR 4/2) extremely cobbly loamy sand, pale brown (10YR 6/3) dry; weak coarse subangular blocky; soft, very friable, nonsticky and nonplastic; 25 percent gravel and 40 percent cobbles; 5 percent clay; slightly acid (pH 6.1); clear wavy boundary.

Bw3 47 to 72 cm; dark grayish brown (10YR 4/2) extremely cobbly loamy sand, light gray (10YR 7/2) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 45 percent gravel and 30 percent cobbles; 4 percent clay; slightly acid (pH 6.2).

R 72 cm; lithic contact with andesite bedrock.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 7.5YR or 10YR. Values are 5 or 6 dry, and are 3 or 4 moist. Chromas are 3 moist. The most common texture is loam. The pH ranges from 5.6 through 6.2.

Control section: The most common texture is loamy sand. The weighted average clay content ranges from 4 through 6 percent, and averages 5 percent. The weighted average rock fragment content ranges from 46 through 70 percent, and averages 61 percent. The pH ranges from 5.8 through 6.6.

Base saturation: Every pedon has at least one horizon with a base saturation greater than 60 percent. The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 58 through 90 percent. The average of all pedons is 80 percent.

Root-limiting layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 53 through 80 centimeters and averages 60 centimeters below the soil surface.

Stubbs Family

The Stubbs family soils have thick mollic epipedons, argillic horizons, and nonskeletal subsoil layers with moderately fine to medium textures. The soils are greater than 100 centimeters deep. Soils in this family form in glacial till, stream alluvium, and fan alluvium derived from andesite or a mixture of rock types. These soils form under the nonforested ARTR/FEID and DECE/CAREX habitat types, and under the forested PSME/SYAL and ABLA/CARU habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Argic Pachic Cryoborolls

Typical Pedon

Location: Lamar River, one mile north of Calfee Creek, Opal Creek 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 569300E/4960150N. Pedon 53.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 12 cm; black (10YR 2/1) loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; 10 percent gravel; 17 percent clay; moderately acid (pH 6.0); abrupt smooth boundary.

Bt1 12 to 50 cm; very dark grayish brown (10YR 3/2) gravelly loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 10 percent gravel and 5 percent cobbles; 20 percent clay; few distinct clay films on ped faces; moderately acid (pH 5.6); clear smooth boundary.

Bt2 50 to 65 cm; dark brown (10YR 3/3) very cobbly loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; 20 percent gravel and 15 percent cobbles; 24 percent clay; common distinct clay films on ped faces; slightly acid (pH 6.4); abrupt wavy boundary.

C 65 to 100 cm; dark brown (10YR 3/3) extremely gravelly sandy loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; 55 percent gravel and 20 percent cobbles; 15 percent clay; slightly acid (pH 6.4).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 40 to 77 centimeters, and averages 55 centimeters. Color hues for the epipedons range from 5YR through 10YR and N. Values range from 2 through 5 dry, and range from 1 through 3 moist. Chromas range from 0 through 3 moist. The most common texture is loam. The pH ranges from 5.2 through 7.9.

Control section: The most common textures are clay loam and loam. The weighted average clay content ranges from 18 through 33 percent, and averages 25 percent. The weighted average rock fragment content ranges from 0 through 27 percent, and averages 13 percent. The pH ranges from 5.2 through 7.9.

Base saturation: The range for all horizons in all pedons is 58 through 100 percent. The average of all pedons is 88 percent.

Carbonates: Subsoil accumulation of calcium carbonate occurs in the Northern Range area of the park, and also in areas where limestone or travertine is part of the parent material.

Sula Family

The Sula family soils have mollic epipedons, and nonskeletal subsoil layers with medium to moderately coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form in glacial till, alluvium, and lacustrine deposits derived from rhyolite or andesite. These soils often form under forested, ABLA habitat types or moist, nonforested habitat types.

Taxonomic Classification: Coarse-loamy, mixed, superactive Typic Cryoborolls

Typical Pedon

Location: Warm Creek Pass, Cutoff Mountain 7.5 minute quadrangle, Yellowstone National Park, Montana. UTM 574700E/4984660N. Pedon 460.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 2 to 0 cm; litter layer.

A 0 to 28 cm; dark brown (7.5YR 3/2) silt loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure; soft, friable, sticky and slightly plastic; no rock fragments; 25 percent clay; moderately acid (pH 5.8); clear smooth boundary.

Bw 28 to 70 cm; brown (7.5YR 4/4) loam, light yellowish brown (10YR 6/4) dry; moderate coarse subangular blocky structure; soft, friable, nonsticky and slightly plastic; no rock fragments; 16 percent clay; moderately acid (pH 5.6); abrupt smooth boundary.

2C 70 to 100 cm; light yellowish brown (10YR 6/3) very gravelly very fine sandy loam, very pale brown (10YR 7/4) dry; weak medium angular blocky structure; soft, friable, nonsticky and slightly plastic; 50 percent gravel; 15 percent clay; neutral (pH 6.8).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 36 centimeters, and averages 25 centimeters. Color hues for the epipedons are 7.5YR through 2.5Y. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are loam, sandy loam, and silt loam. The pH ranges from 5.2 through 7.5.

Control section: The most common textures are sandy loam and loam. The weighted average clay content ranges from 3 through 17 percent, averages 12 percent. The weighted average rock fragment content ranges from 0 through 34 percent, averages 19 percent for all pedons. The pH ranges from 5.3 through 8.0.

Base saturation: The range for all horizons in all pedons is 55 through 100 percent. The average for all pedons is 76 percent.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Taglake Family

The Taglake family soils have ochric epipedons and moderately deep root-limiting layers. The skeletal subsoil layers have moderately fine to moderately coarse textures. The soils are between 55 and 90 centimeters deep. Soils in this family form in glacial till or colluvium over residuum, derived mainly from rhyolitic ash-flow tuff. These soils form under the forested ABLA/VASC-CARU and ABLA/BERE habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Typic Cryochrepts

Typical Pedon

Location: Near the Old Faithful water treatment plant, Old Faithful 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 515010E/4950900N. Pedon 245.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 3 to 0 cm; litter layer.

A1 0 to 10 cm; dark grayish brown (10YR 4/2) loamy very fine sand, grayish brown (10YR 5/2) dry; moderate fine granular structure; loose, nonsticky and nonplastic; 10 percent gravel; 5 percent clay; moderately acid (pH 5.8); clear smooth boundary.

A2 10 to 24 cm; dark grayish brown (10YR 4/2) very fine sandy loam, light brownish gray (10YR 6/2) dry; weak coarse subangular blocky structure; loose, nonsticky and nonplastic; 10 percent gravel; 10 percent clay; slightly acid (pH 6.2); clear smooth boundary.

Bw 24 to 37 cm; grayish brown (2.5Y 5/2) gravelly loamy very fine sand, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; loose, nonsticky and nonplastic; 20 percent gravel; 5 percent clay; slightly acid (pH 6.3); clear wavy boundary.

C 37 to 58 cm; grayish brown (2.5Y 5/2) very gravelly loamy very fine sand, light gray (10YR 7/1) dry; massive; loose, nonsticky and nonplastic; 50 percent gravel; 5 percent clay; slightly acid (pH 6.4); clear wavy boundary.

Cr 58 to 90 cm; paralithic contact with weathered rhyolite.

R 90 cm; lithic contact with rhyolite bedrock.

Range of Important Properties

Epipedon: These ochric epipedons usually have color values or chromas too high to meet the definition of other epipedons. Approximately 30 percent of these soils include a dark colored surface horizon that is too thin to meet the definition of a mollic or umbric epipedon. The thickness of these dark surface horizons ranges from 3 through 6 centimeters. Color hues for the epipedons are 7.5YR or 10YR. Values range from 4 through 6 dry, and are 3 or 4 moist. Chromas are 2 or 3 moist. The most common textures are loam, sandy loam, and loamy very fine sand. The pH ranges from 5.3 through 6.6.

Control section: The most common textures are sandy loam, sandy clay loam, and loamy very fine sand. The weighted average clay content ranges from 3 through 32 percent, and averages 16 percent. The weighted average rock fragment content ranges from 38 through 82 percent, and averages 57 percent for all pedons. The pH ranges from 5.8 through 8.0.

Base saturation: Every pedon has at least one horizon with a base saturation greater than 60 percent. The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 58 through 95 percent. The average of all pedons is 75 percent.

Root-limiting layer: In these soils a lithic or paralithic contact is considered a root-limiting layer. The depth to this layer ranges from 55 through 90 centimeters and averages 60 centimeters below the soil surface.

Carbonates: Subsoil accumulation of calcium carbonate occurs in the Northern Range area of the park, and also in areas where limestone or travertine is part of the parent material.

Teton Family

The Teton family soils have mollic epipedons, and nonskeletal subsoil layers with moderately fine to moderately coarse textures. The soils are greater than 100 centimeters deep. Soils in this family most often form in lacustrine deposits and glacial till derived from andesite. These soils often form under the nonforested ARTR/FEID, DECE/CAREX, and FEID/AGCA habitat types. They also form under dry, forested habitat types.

Taxonomic Classification: Fine-loamy, mixed, superactive Typic Cryoborolls

Typical Pedon

Location: Mt. Everts, Blacktail Deer Plateau 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 531240E/4979110N. Pedon 152.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 12 cm; very dark brown (10YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 20 percent gravel; 17 percent clay; slightly acid (pH 6.5); abrupt smooth boundary.

A2 12 to 37 cm; very dark brown (10YR 2/2) gravelly loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 20 percent gravel; 19 percent clay; neutral (pH 6.9); clear smooth boundary.

BA 37 to 72 cm; dark brown (10YR 3/3) gravelly loam, light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 25 percent gravel; 22 percent clay; slightly alkaline (pH 7.5); clear smooth boundary.

Bk 72 to 82 cm; dark brown (10YR 3/3) gravelly sandy loam; light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 25 percent gravel; 15 percent clay; moderately alkaline (pH 8.1); violently effervescent; lime accumulation in pores; abrupt smooth boundary.

Bck1 82 to 87 cm; light yellowish brown (10YR 6/4) gravelly loamy sand, light gray (10YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; 15 percent gravel; 9 percent clay; strongly alkaline (pH 8.5); violently effervescent; lime accumulation in pores; abrupt smooth boundary.

Bck2 87 to 100 cm; dark grayish brown (10YR 4/2) gravelly sandy loam; light gray (10YR 7/2) dry; massive; soft, very friable, slightly sticky, and slightly plastic; 30 percent gravel; 17 percent clay; moderately alkaline (pH 8.0); strongly effervescent; lime accumulation in pores.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 38 centimeters, and averages 25 centimeters. Color hues for the epipedons range from 2.5YR through 10YR. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common texture is loam. The pH ranges from 5.5 through 8.2.

Control section: The most common textures are loam, clay loam, and sandy loam. The weighted average clay content ranges from 18 through 33 percent, and averages 24 percent. The weighted average rock fragment content ranges from 1 through 28 percent, and averages 19 percent. The pH ranges from 5.6 through 8.5.

Base saturation: The range for all horizons in all pedons is 55 through 100 percent. The average for all pedons is 85 percent.

Carbonates: Subsoil accumulation of calcium carbonate occurs in the Northern Range area of the park, or in areas where limestone or travertine is part of the parent material.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Tomichi Family

The Tomichi family soils have mollic epipedons, and nonskeletal subsoil layers with coarse textures. The soils are greater than 100 centimeters deep. Soils in this family form in stream alluvium, glacial lacustrine deposits (beach sediments), glaciofluvial alluvium, and fan alluvium derived from andesite or rhyolite. These soils most often form under forested habitat types.

Taxonomic Classification: Sandy, mixed, superactive Typic Cryoborolls

Typical Pedon

Location: Natural Bridge Road, Lake 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 544360E/4930500N. Pedon 38.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 10 cm; very dark grayish brown (10YR 3/2) gravelly sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 18 percent gravel; 16 percent clay; moderately acid (pH 5.6); abrupt wavy boundary.

A2 10 to 22 cm; dark brown (10YR 3/3) gravelly sandy loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 18 percent gravel; 16 percent clay; moderately acid (pH 5.8); clear smooth boundary.

Bw1 22 to 50 cm; dark brown (10YR 4/3) gravelly loamy sand, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 20 percent gravel; 10 percent clay; moderately acid (pH 6.0); abrupt smooth boundary.

Bw2 50 cm to 69 cm; brown (10YR 5/3) very cobbly loamy coarse sand, light brownish gray (10YR 6/2) dry; weak coarse subangular blocky structure; loose, nonsticky and nonplastic; 28 percent gravel and 20 percent cobbles; 8 percent clay; slightly acid (pH 6.2); gradual smooth boundary.

BC 69 to 100 cm; dark grayish brown (10YR 4/2) gravelly loamy coarse sand, dark gray (10YR 4/2) dry; weak coarse subangular blocky structure; loose, nonsticky and nonplastic; 28 percent gravel and 5 percent cobbles; 4 percent clay; slightly acid (pH 6.4); clear wavy boundary.

C 100 to 180 cm; black (7.5YR 2/0) very cobbly sand, very dark gray (2.5Y 3/1) dry; single grain; loose, nonsticky and nonplastic; 25 percent gravel and 15 percent cobbles; 2 percent clay; neutral (pH 6.6).

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18 through 48 centimeters, and averages 31 centimeters. The color hues for the epipedons are 10YR. Values range from 3 through 5 dry, and are 2 or 3 moist. Chromas range from 1 through 3 moist. The most common textures are loamy sand and sandy loam. The pH ranges from 5.6 through 6.6.

Control section: The most common textures are loamy sand and sand. The weighted average clay content ranges from 2 through 10 percent, and averages 5 percent. The weighted average rock fragment content ranges from 12 through 32 percent, and averages 21 percent. The pH ranges from 6.0 through 7.5.

Base saturation: The range for all horizons in all pedons is 58 through 100 percent. The average for all pedons is 80 percent.

TROPAQUEPTS

The Tropaquept soils have ochric or histic epipedons. The nonskeletal subsoil layers have medium to coarse textures. The soils are greater than 100 centimeters deep and have aquic conditions for some time during the growing season. They form in alluvium derived from siliceous sinter, diatomaceous sediments, and altered rhyolite. Soils in this family often form under the DECE/CAREX habitat type and in marsh areas of *Carex* species.

Taxonomic Classification: Tropaquepts (includes the *Histic* and *Typic* subgroups; the *fine-loamy* particle size class; the *mixed* and *siliceous* mineralogy classes; and the *isomesic*, *isothermic*, and *isohyperthermic* soil temperature classes)

Typical Pedon

Location: Norris Geyser Basin, Norris Junction 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 522420E/4954190N. Pedon 3316.

Description: (All colors are for moist conditions unless otherwise stated.)

Oe 0 to 5 cm; organic material of intermediate decomposition; neutral (pH 6.8); abrupt wavy boundary; water entering pit at soil surface.

A 5 to 10 cm; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; no rock fragments; 20 percent clay; neutral (pH 6.8); MAT = 12 °C at 10 cm; abrupt smooth boundary.

Bw 10 to 20 cm; light gray (N 7/0) silt loam, white (5Y 8/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; no rock fragments; 20 percent clay; neutral (pH 6.6); abrupt smooth boundary.

C1 20 to 35 cm; light gray (5Y 6/1) fine sandy loam, white (5Y 8/1) dry, with few fine prominent grayish green (5G 5/2) redoximorphic concentrations, and both yellow (5Y 7/6) and dark brown (10YR 3/3) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; no rock fragments; 20 percent clay; strongly acid (pH 5.4); MAT = 17 °C at 35 cm; clear smooth boundary.

C2 35 to 105 cm; greenish gray (5GY 6/1) loam, white (10YR 8/1) dry, with few medium prominent yellow (5Y 8/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; 10 percent gravel; 23 percent clay; moderately acid (pH 5.8); MAT = 21 °C at 50 cm.

Range of Important Properties

Epipedon: The histic epipedons consist of fibric and hemic organic matter. They average 25 centimeters thick. The pH ranges from 6.5 through 7.5. The ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. The color hue for these epipedons is 10YR or 2.5YR. Values range from 5 through 8 dry and from 2 through 7 moist. Chromas range from 1 through 3 moist. The most common textures are loam, silt loam, and sandy loam. The pH ranges from 5.8 through 8.2.

Control section: The most common textures are sandy loam, silt loam, and sand. The weighted average clay content ranges from 10 through 23 percent, and averages 18 percent for all pedons. The weighted average rock fragment content ranges from 0 through 25 percent, and averages 11 percent for all pedons. The pH ranges from 5.4 through 8.2.

Base saturation: The range for all horizons, in all pedons, is 45 through 100 percent. The average for all pedons is 81 percent.

Temperature regime: The mean annual soil temperatures, MAT measured at 50 centimeters, ranges from 8 through 35 °C. This includes soils with isomesic, isothermic, and isohyperthermic soil temperature regimes.

Trude Family

The Trude family soils have ochric epipedons, and skeletal subsoil layers with coarse textures. The soils are greater than 100 centimeters deep. These soils form mainly in glacial till, glacial rubble, colluvium, and glaciofluvial alluvium derived from rhyolite. Soils in this family often form under the forested ABLA/VASC habitat types.

Taxonomic Classification: Sandy-skeletal, mixed, superactive Dystric Cryochrepts

Typical Pedon

Location: Southeast edge of Pitchstone Plateau, Lewis Canyon 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 520950E/4897850N. Pedon 492.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 5 cm; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; 8 percent gravel; 14 percent clay; strongly acid (pH 5.2); abrupt smooth boundary.

BA 5 to 19 cm; dark brown (10YR 3/3) cobbly sandy loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 10 percent gravel and 8 percent cobbles; 14 percent clay; very strongly acid (pH 5.0); abrupt smooth boundary.

Bw1 19 to 41 cm; dark yellowish brown (10YR 4/4) very cobbly loamy coarse sand, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; loose, firm, nonsticky and nonplastic; 38 percent gravel and 20 percent cobbles; 8 percent clay; very strongly acid (pH 4.8); abrupt wavy boundary.

Bw2 41 to 76 cm; yellowish brown (10YR 5/4) very cobbly loamy coarse sand; light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; 30 percent gravel and 25 percent cobbles; 3 percent clay; strongly acid (pH 5.4); abrupt wavy boundary.

C 76 to 100 cm; brown (10YR 5/3) extremely cobbly loamy coarse sand, very pale brown (10YR 7/3) dry; single grain; loose, nonsticky and nonplastic; 40 percent gravel and 30 percent cobbles; 3 percent clay; strongly acid (pH 5.4).

Range of Important Properties

Epipedon: These ochric epipedons usually have color values or chromas too high to meet the definition of other epipedons. Approximately 60 percent of these soils have a dark colored surface horizon that is too thin to meet the definition of a mollic or umbric epipedon. The thickness of these dark surface horizons ranges from 1 through 14 centimeters. Color hues for the epipedons are 7.5YR or 10YR. Values range from 4 through 6 dry, and from 2 through 5 moist. Chromas range from 1 through 4 moist. The most common textures are sandy loam and loam. The pH ranges from 4.5 through 5.8.

Control section: The most common textures are sand and loamy sand. The weighted average clay content ranges from 0 through 10 percent, and averages 5 percent. The weighted average rock fragment content ranges from 40 through 90 percent, and averages 58 percent. The pH ranges from 4.8 through 5.8.

Base saturation: The range for all horizons, between the soil surface and 75 centimeters, in all pedons is 31 through 58 percent. The average of all pedons is 51 percent.

Typic Dystrypepts

The Typic Dystrypept soils have ochric epipedons, and both skeletal and nonskeletal subsoil layers with moderately coarse textures. They are greater than 100 centimeters deep. These soils form in acid-sulphate hydrothermal areas, under various thermal community types.

Taxonomic Classification: Typic Dystrypepts (includes the *coarse-loamy*, *fine-loamy*, *sandy*, or *loamy-skeletal* particle size classes; the *siliceous* mineralogy class; and the *isomesic*, *isothermic*, or *isohyperthermic* soil temperature classes)

Typical Pedon

Location: Solfatara Plateau, south of Norris-Canyon Road; Crystal Falls 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 535400E/4950680N. Pedon 505.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 5 cm; dark brown (7.5YR 4/2) sandy loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; 5 percent gravel; 8 percent clay; extremely acid (pH 4.0); MAT = 15 °C at 5 cm; abrupt smooth boundary.

BA 5 to 11 cm; reddish brown (5YR 5/4) sandy loam, light reddish brown (5YR 6/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; 5 percent gravel; 8 percent clay; extremely acid (pH 4.4); MAT = 18 °C at 10 cm; abrupt smooth boundary.

Bw 11 to 27 cm; light reddish brown (5YR 6/4) gravelly sandy loam, pink (5YR 7/4) dry; weak subangular blocky structure; soft, very friable, nonsticky and nonplastic; 20 percent gravel; 5 percent clay; extremely acid (pH 4.4); MAT = 22 °C at 20 cm; abrupt wavy boundary.

C1 27 cm to 38 cm; light reddish brown (5YR 6/4) gravelly loamy sand, pink (5YR 7/4) dry; massive; soft, very friable, nonsticky and nonplastic; 22 percent gravel; 4 percent clay; strongly acid (pH 5.4); clear wavy boundary.

C2 38 to 56 cm; reddish yellow (5YR 6/6) gravelly loamy sand, pink (5YR 8/3) dry; massive; loose, nonsticky and nonplastic; 25 percent gravel; 2 percent clay; strongly acid (pH 5.4); MAT = 33 °C at 50 cm; abrupt wavy boundary.

C3 56 to 100 cm; white (5YR 8/1) loamy sand, pinkish white (5YR 8/2) dry; massive; loose, nonsticky and nonplastic; 5 percent gravel; 2 percent clay; moderately acid (pH 5.6); MAT = 58 °C at 73 cm.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons are 5 YR, 7.5YR, or 10YR. Values are 6 dry and 3 or 4 moist. Chromas range from 2 through 4 moist. The most common textures are loamy sand and sandy loam. The pH ranges from 3.5 through 5.6.

Control section: The most common texture is sandy loam. Color hues are 10R, 2.5YR, 5YR, 7.5YR, 10YR, or 2.5Y. The weighted average clay content ranges from 2 through 31 percent, and averages 12 percent for all pedons. The weighted average rock fragment content ranges from 0 through 50 percent, and averages 13 percent for all pedons. The pH ranges from 3.2 through 5.6.

Base saturation: All pedons have at least one horizon, between 25 and 100 centimeters, with a base saturation less than 50 percent. The range for all horizons, in all pedons, is 5 through 65 percent. The average for all pedons is 34 percent.

Root-limiting layer: Temperatures greater than 50 °C or pH values less than 3.5 can restrict root growth in these soils.

Temperature regime: The mean annual soil temperatures, MAT measured at 50 centimeters, can range from 10 through 76 °C. This includes soils with isomesic, isothermic, and isohyperthermic soil temperature regimes.

Typic Eutropepts

The Typic Eutropept soils have ochric epipedons, and nonskeletal subsoil layers with medium to coarse textures. They are greater than 100 centimeters deep. These soils form in hydrothermal deposits and alluvium derived from siliceous sinter and altered rhyolite. Soils in this family often form under the nonforested DECE/CAREX habitat type, the forested ABLA/VASC habitat type, and various thermal community types.

Taxonomic Classification: Typic Eutropepts (includes the *sandy, coarse-loamy*, and *coarse-silty* particle size classes; the *siliceous* mineralogy class; and the *isomesic*, *isothermic*, and *isohyperthermic* soil temperature classes)

Typical Pedon

Location: Near Nymph Lake; Obsidian Cliff 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 521960E/4955460N. Pedon 3324.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 4 cm; brown (10YR 4/3) gravelly loamy sand, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; 20 percent gravel; 15 percent clay; moderately acid (pH 6.0); abrupt smooth boundary.

Bw1 4 to 19 cm; yellowish brown (10YR 5/4) very gravelly sandy loam, white (10YR 8/2) dry; weak medium subangular blocky structure; soft, friable, nonsticky and slightly plastic; 40 percent gravel, 10 percent clay; moderately acid (pH 5.8); MAT = 15 °C at 8 cm; clear smooth boundary.

Bw2 19 to 34 cm; pale brown (10YR 6/3) very gravelly sandy loam, white (10YR 8/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; 50 percent gravel; 10 percent clay; moderately acid (pH 5.8); clear smooth boundary.

C 34 to 100 cm; white (10YR 8/1) silt loam, white (N 8/0) dry; massive; slightly hard, friable, slightly sticky and nonplastic; no rock fragments; 5 percent clay; moderately acid (pH 5.7); MAT = 13 °C at 50 cm.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedons include 7.5YR, 10YR, and 2.5Y. Values range from 6 through 8 dry and from 2 through 6 moist. Chromas range from 1 through 3 moist. The most common textures are silt loam and loam. The pH ranges from 5.8 through 8.4.

Control section: The most common textures are sand, sandy loam, silt loam, and loam. The weighted average clay content ranges from 2 through 13 percent, and averages 7 percent. The weighted average rock fragment content ranges from 0 through 21 percent, and averages 7 percent. The pH ranges from 5.7 through 8.2.

Base saturation: The range for all horizons in all pedons is 58 through 100 percent. The average for all pedons is 83 percent.

Temperature regime: The mean annual soil temperatures, MAT measured at 50 centimeters, ranges from 8 through 30 °C. This includes soils with isomesic, isothermic, and isohyperthermic soil temperature regimes.

Typic Troorthents

The Typic Troorthent soils have ochric epipedons, and both skeletal and nonskeletal subsoil layers with moderately coarse to coarse textures. They are greater than 100 centimeters deep. These soils form in both neutral high-chloride and acid-sulphate hydrothermal areas, under thermal community types.

Taxonomic Classification: Typic Troorthents (includes the *coarse-loamy*, *sandy*, or *loamy-skeletal* particle size classes; the *siliceous* mineralogy class; both the *acid* and *nonacid* reaction classes; and the *isothermic* or *isohyperthermic* soil temperature classes)

Typical Pedon

Location: Shoshone Geyser Basin; Shoshone Geyser Basin 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 516290E/4910790N. Pedon 60.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 6 cm; dark brown (10YR 3/3) gravelly sandy loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; soft, loose, slightly sticky and nonplastic; 15 percent gravel and 5 percent cobbles; 15 percent clay; strongly acid (pH 5.4); abrupt smooth boundary.

AC 6 to 14 cm; light brownish gray (10YR 6/2) gravelly sandy loam, white (N 8/0) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 15 percent gravel; 12 percent clay; strongly acid (pH 5.4); MAT = 30 °C at 10 cm; abrupt smooth boundary.

C1 14 to 29 cm; white (10YR 8/1) sandy loam, white (N 8/0) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; 8 percent gravel; 6 percent clay; moderately acid (pH 5.6); MAT = 35 °C at 20 cm; abrupt wavy boundary.

C2 29 to 34 cm; white (10YR 8/1) gravelly loamy sand, white (N 8/0) dry; massive; soft, very friable, nonsticky and nonplastic; 30 percent gravel; 2 percent clay; moderately acid (pH 5.6); MAT = 48 °C at 30 cm; abrupt wavy boundary.

C3 34 to 100 cm; white (N 8/0) gravelly sandy loam, white (N 8/0) dry; massive; loose, slightly sticky and slightly plastic; 30 percent gravel; 14 percent clay; very strongly acid (pH 4.8); MAT = 61 °C at 50 cm.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. Color hues for the epipedon are 7.5YR, N, or 10YR. Values range from 5 through 8 dry and from 2 through 7 moist. Chromas range from 0 through 3 moist. The most common textures are sandy loam and loamy sand. The pH ranges from 3.5 through 5.6.

Control section: The most common textures are sandy loam, loamy sand, and sand. Color hues are 5YR, 7.5YR, 10YR, 2.5Y, and 5Y. The weighted average clay content ranges from 1 through 14 percent, and averages 10 percent for all pedons. The weighted average rock fragment content ranges from 0 through 51 percent, and averages 25 percent for all pedons. The pH ranges from 2.8 through 6.0.

Base saturation: The range for all horizons in all pedons is 5 through 82 percent. The average for all pedons is 42 percent.

Root-limiting layer: Temperatures greater than 50 °C and pH values less than 3.5 can limit root growth in these soils.

Temperature regime: The mean annual soil temperatures, MAT measured at 50 centimeters, ranges from 16 through 80 °C. This includes soils with isothermic and isohyperthermic soil temperature regimes.

Wallrock Family

The Wallrock family soils have mollic epipedons and argillic horizons. The nonskeletal subsoil layers have moderately fine textures. The soils are greater than 100 centimeters deep and have aquic conditions for some time during the growing season. These soils form in glacial lacustrine and stream alluvium derived from andesite, shale, or rhyolitic ash-flow tuff. They commonly form under the nonforested DECE/CAREX or habitat type marsh areas of *Carex* species.

Taxonomic Classification: Fine-loamy, mixed, superactive Argiaquic Cryoborolls

Typical Pedon

Location: Swan Lake Flats; Mammoth 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 521300E/4972470N. Pedon 350.

Description: (All colors are for moist conditions unless otherwise stated.)

A1 0 to 6 cm; black (10YR 2/1) loam, very dark brown (10YR 2/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; no rock fragments; 12 percent clay; moderately alkaline (pH 8.0); clear smooth boundary.

A2 6 to 15 cm; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; no rock fragments; 15 percent clay; neutral (pH 7.0); gradual smooth boundary.

Bt1 15 to 25 cm; very dark gray (10YR 3/1) sandy clay loam, very dark grayish brown (10YR 3/2) dry; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; no rock fragments; 23 percent clay; common prominent clay films on ped faces; neutral (pH 6.8); gradual wavy boundary.

Bt2 25 to 40 cm; very dark grayish brown (10YR 3/2) gravelly sandy clay loam with common, prominent yellowish red (5YR 4/6) redoximorphic concentrations; light brownish gray (10YR 6/2) dry; moderate medium angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 20 percent gravel; 25 percent clay; common prominent clay films on ped faces; slightly acid (pH 6.5); gradual wavy boundary.

BC 40 to 100 cm; dark brown (10YR 3/3) very cobbly sandy loam, light brownish gray (10YR 6/2) dry; weak coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; 25 percent gravel and 20 percent cobbles; 10 percent clay; slightly acid (pH 6.3); water entering pit at 40 centimeters.

Range of Important Properties

Epipedon: The thickness of these mollic epipedons ranges from 18* through 55 centimeters and averages 28 centimeters. Color hues for the epipedons are 10YR. Values range from 2 through 5 dry, and are 2 or 3 moist. Chromas are 1 or 2 moist. The most common textures are silt loam, loam, and sandy clay loam. The pH ranges from 5.0 through 8.0.

Control section: The most common textures are silty clay loam, clay loam, and sandy clay loam. The weighted average clay content ranges from 23 through 33 percent, and averages 30 percent. The weighted average rock fragment content ranges from 0 through 15 percent, and averages 10 percent for all pedons. The pH ranges from 6.3 through 6.8.

Base saturation: The range for all horizons in all pedons is 53 through 100 percent. The average of all pedons is 85 percent.

*After mixing to 18 cm the weighted average of the color value and chroma meet mollic requirements.

Whitecross Family

The Whitecross family soils have ochric epipedons and shallow to very shallow root-limiting layers. The skeletal subsoil layers have moderately coarse textures. The soils are between 10 and 50 centimeters deep. Soils in this family form in glacial till, residuum, and colluvium derived from rhyolite or andesite. These soils often form under the forested ABLA/VASC and PICO/JUCO habitat types.

Taxonomic Classification: Loamy-skeletal, mixed, superactive Lithic Cryochrepts

Typical Pedon

Location: Northeast of Mist Creek Pass in the Pelican Valley, Mt. Chittenden 7.5 minute quadrangle, Yellowstone National Park, Wyoming. UTM 567070E/4940630N. Pedon 682.

Description: (All colors are for moist conditions unless otherwise stated.)

A 0 to 9 cm; dark brown (10YR 4/3) gravelly loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; 20 percent gravel; 14 percent clay; moderately acid (pH 5.6); clear smooth boundary.

Bw 9 to 30 cm; dark brown (10YR 3/3) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; 25 percent gravel, 10 percent cobbles; 14 percent clay; moderately acid (pH 5.6); abrupt smooth boundary.

BC 30 to 40 cm; dark brown (10YR 4/3) very gravelly sandy loam, very pale brown (10YR 8/3) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; 40 percent gravel, 5 percent cobbles; 11 percent clay; moderately acid (pH 5.6).

R 40cm; lithic contact with andesite bedrock.

Range of Important Properties

Epipedon: These ochric epipedons usually have color values or chromas too high to meet the definition of other epipedons. Approximately 50 percent of these soils include a dark colored surface horizon that is too thin to meet the definition of a mollic or an umbric epipedon. The thickness of these dark surface horizons ranges from 2 through 14 centimeters. Color hues for the epipedons are 7.5YR or 10YR. Values range from 4 through 7 dry, and from 2 through 4 moist. Chromas are 2 or 3 moist. Textures include sandy loam, silt loam, and loam. The pH ranges from 4.2 through 7.2.

Control section: The most common texture is sandy loam. The weighted average clay content ranges from 3 through 23 percent, and averages 12 percent. The weighted average rock fragment content ranges from 35 through 70 percent, averages 46 percent. The pH ranges from 4.2 through 7.2.

Base saturation: The range for all horizons in all pedons is 25 through 91 percent. The average for all pedons is 63 percent.

Root-limiting layer: Although all pedons have a lithic contact within 50 centimeters of the soil surface, both lithic and paralithic contacts are considered root-limiting layers. The depth to this layer ranges from 14 through 48 centimeters and averages 33 centimeters below the soil surface.

Winegar Family

The Winegar family soils have ochric epipedons and moderately deep root-limiting layers. The nonskeletal subsoil layers have medium to moderately coarse textures. The soils are between 55 and 100 centimeters deep. These soils form mainly in loess mantled glacial till and alluvium derived from rhyolite and basalt. Soils in this family often form under the forested ABLA/VAGL-VASC habitat type.

Taxonomic Classification: Ashy, glassy Typic Vitricryand

Typical Pedon

Location: Northeast of the southwest corner of section 12, T. 9 N., R. 46 E., ID, Targhee National Forest, Idaho. UTM 492865E/4885174N. Pedon T-wi.

Description: (All colors are for moist conditions unless otherwise stated.)

Oi 2 to 0 cm; litter layer.

A 0 to 10 cm; dark brown (10YR 3/3) gravelly silt loam, dark yellowish brown (10YR 4/4) dry; weak very fine granular structure; soft, very friable, nonsticky and slightly plastic; 15 percent gravel, trace cobbles, stones and boulders; moderately acid (pH 5.6); abrupt smooth boundary.

Bw1 10 to 36 cm; dark yellowish brown (10YR 3/4) silt loam, dark yellowish brown (10YR 4/4) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and slightly plastic; 10 percent gravel, trace cobbles, stones and boulders; moderately acid (pH 5.8); gradual smooth boundary.

Bw2 36 to 66 cm; dark yellowish brown (10YR 3/4) loam, yellowish brown (10YR 5/4) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and slightly plastic; 10 percent gravel, trace cobbles, stones and boulders; moderately acid (pH 6.0); abrupt irregular boundary.

2BC 66 to 96 cm; olive brown (2.5Y 4/4) very gravelly sandy loam, light olive brown (2.5Y 5/4) dry; massive;

soft, very friable; nonsticky and slightly plastic; 50 percent, gray (10YR 5/1) dry cobble-sized fragments of dense basal till that crushes to a very gravelly sandy loam; 25 percent gravel, 10 percent cobbles and trace stones and boulders; slightly acid (pH 6.4); clear irregular boundary.

2Cd 96 to 165 cm; dark grayish brown (10YR 4/2) dense basal till that crushes to a very gravelly sandy loam, gray (10YR 5/1) dry; massive; hard, firm and brittle, nonsticky and nonplastic; 25 percent gravel, 10 percent cobbles, trace stones and boulders.

Range of Important Properties

Epipedon: These ochric epipedons either have color values or chromas too high, or they are too thin, to meet the definition of other epipedons. The color hues for the epipedons are 7.5YR, 10YR, or 2.5Y. Values are 4 or 5 dry, and 2 or 3 moist. Chromas range from 2 through 4 moist. The most common texture is silt loam. The pH ranges from 5.1 through 6.5.

Control section: The most common textures are loam, silt loam, and sandy loam. The weighted average clay content ranges from 8 through 16 percent, and averages 13 percent. The weighted average rock fragment content ranges from 14 through 34 percent, and averages 22 percent. The pH ranges from 5.1 through 6.5.

Base saturation: The range for all horizons in all pedons is 10 through 40 percent.

Root-limiting layer: In these soils dense basal till is considered a root-limiting layer. Dense basal till occurs between 55 and 100 centimeters below the soil surface.

Andic properties: These properties occur between 50 and 100 centimeters below the surface. In these soils, andic properties are defined as the following. Phosphate retention is between 35 and 60 percent. Extractable Al + 1/2 Fe is between 0.5 and 2.0 percent. Volcanic glass (0.02 - 2.0 mm in size) is greater than 50 percent.

LITERATURE CITED AND REFERENCES

- Chorley, R. J. 1972. Spatial analysis in geomorphology. Methuen and Co., London.
- Christiansen, R. L. 1984. Yellowstone magmatic evolution: its bearing on understanding large-volume explosive volcanism. Pages 84-95 in *Studies in geophysics, explosive volcanism: inception, evolution, and hazards*. National Academy Press, Wash., D.C.
- Davis, C., and H. F. Shovic. 1996. Gallatin National Forest Soil Survey. National Resource Conservation Service, USDA.
- Despain, D. G. 1987. The two climates of Yellowstone National Park. Pages 11-20 in *Proc. Mont. Acad. Sci.* 47:11-20.
- Despain, D. G. 1990. Yellowstone vegetation. Roberts Rinehart, Inc., Boulder, Colo.
- Dikau, R. 1989. The application of a digital relief model to landform analysis in geomorphology. Pages 51-79 in J. Raper, ed. *Three dimensional applications in geographic information systems*. Taylor and Francis, London.
- Dirks, R. A., and B. E. Martner. 1982. The climate of Yellowstone and Grand Teton National Parks. National Park Service Occasional Paper No. 6., Wash., D.C.
- Dixon, J. B., and S. B. Weed. 1977. Minerals in soil environments. Soil Sci. Soc. of Amer., Madison, Wis.
- Dorn, R. D. 1992. Vascular plants of Wyoming. 2nd ed. Mountain West Publ., Cheyenne, Wyo.
- Forman, R. T., and M. Godron. 1986. Landscape ecology. John Wiley and Sons, New York, N.Y.
- Fournier, R. O. 1985. The behavior of silica in hydrothermal solutions. Pages 45-61 in Berger, B.R. and P.M. Bethke, eds. *Reviews in economic geology*, Vol. 2: geology and geochemistry of epithermal systems. Soc. of Econ. Geo., Chelsea, Mich.
- Fournier, R. O. 1989. Geochemistry and dynamics of the Yellowstone National Park hydrothermal system. *Ann. Rev. Earth Planet. Sci.* 17:13-53.
- Gary, M. R., C. McAfee, Jr., and R. Wolf, eds. 1974. *Glossary of geology*. American Geological Institute, Wash., D.C.
- Harmon, P. and D. King. 1985. *Expert systems: artificial intelligence in business*. John Wiley and Sons, Inc., New York, N.Y.
- Harris, D. V. 1980. *The geologic story of the national parks and monuments*. John Wiley and Sons, New York, N.Y.
- Hausenbuiller, R. 1972. *Soil science: principles and practices*. Wm. C. Brown, Dubuque, Iowa.
- Jenny, H. 1941. *Factors of soil formation*. McGraw-Hill Book Company, Inc., New York, N.Y.
- Jones, J. B., and E. R. Segnit. 1971. The nature of opal. I: Nomenclature and constituent phases. *J. Geo. Soc. Aust.* 18:57-68.
- Keefer, W. R. 1971. The geologic story of Yellowstone National Park. *U.S. Geol. Surv. Bull.* 1347.
- McNab, W. H., and P. E. Avers. 1994. *Ecological subregions of the United States: section descriptions and map*. U.S.D.A. For. Serv., Wash. D.C.
- Nordin, J., and M. Blackwell. 1984. Soil survey of the Teton National Forest. U.S.D.A., Soil Conserv. Serv., Casper, Wyo.
- Parsons, W. H. 1978. *Field guide: middle Rockies and Yellowstone*. Kendall Hunt, Dubuque, Iowa.
- Pierce, K. L. 1973a. Surficial geologic map of the Mammoth quadrangle, and part of the Gardiner quadrangle, Yellowstone National Park, Wyoming and Montana. Map I-641. U.S. Geol. Surv., Wash., D.C.
- Pierce, K. L. 1973b. Surficial geologic map of the Mount Holmes quadrangle, and parts of the Tepee Creek, Crown Butte, and Miner quadrangles, Yellowstone National Park, Wyoming and Montana. Map I-640. U.S. Geol. Surv., Wash., D.C.

- Pierce, K. L. 1974a. Surficial geologic map of the Abiathar Peak quadrangle, and parts adjacent quadrangles, Yellowstone National Park, Wyoming and Montana. Map I-646. U.S. Geol. Surv., Wash., D.C.
- Pierce, K. L. 1974b. Surficial geologic map of the Tower Junction quadrangle, and part of the Mount Wallace quadrangle, Yellowstone National Park, Wyoming and Montana. Map I-647. U.S. Geol. Surv., Wash., D.C.
- Pierce, K. L. 1979. History and dynamics of glaciation in the northern Yellowstone National Park area. U.S. Geol. Surv. Prof. Paper 729-F. U.S.G.P.O., Wash. D.C.
- Ray, R. G. 1984. Aerial photographs in geologic interpretations and mapping. U.S. Geol. Surv. Prof. Paper 373, Seventh printing, U.S.G.P.O., Wash., D.C.
- Reid, S. G. and D. J. Foote. 1982. Geology of Yellowstone Park area. Wyoming Geological Association, 33rd Annual Field Conference Guidebook. Casper, Wyo.
- Richmond, G. M., and K. L. Pierce. 1972. Surficial geologic map of the Eagle Peak quadrangle, Yellowstone National Park and adjoining area, Wyoming. Map I-637. U.S. Geol. Surv., Wash., D.C.
- Richmond, G. M. 1973a. Surficial geologic map of the Huckleberry Mountain quadrangle, Yellowstone National Park and adjoining area, Wyoming. Map I-639. U.S. Geol. Surv., Wash., D.C.
- Richmond, G. M. 1973b. Surficial geologic map of the Grassy Lake quadrangle, Yellowstone National Park and adjoining area, Wyoming. Map I-644. U.S. Geol. Surv., Wash., D.C.
- Richmond, G. M. 1973c. Surficial geologic map of the Warm River Butte quadrangle, Yellowstone National Park and adjoining area, Idaho and Wyoming. Map I-645. U.S. Geol. Surv., Wash., D.C.
- Richmond, G. M. 1973d. Surficial geologic map of the West Thumb quadrangle, Yellowstone National Park, Wyoming. Map I-643. U.S. Geol. Surv., Wash., D.C.
- Richmond, G. M. 1974. Surficial geologic map of the Frank Island quadrangle, Yellowstone National Park, Wyoming. Map I-642. U. S. Geol. Surv., Wash., D.C.
- Richmond, G. M. 1977. Surficial geologic map of the Canyon Village quadrangle, Yellowstone National Park, Wyoming. Map I-652. U. S. Geol. Surv., Wash., D.C.
- Richmond, G. M. and K. L. Pierce. 1971. Surficial geologic map of the Mount Hancock quadrangle, Yellowstone National Park, and adjoining area, Wyoming. Map I-636. U.S. Geol. Surv., Wash., D.C.
- Richmond, G. M. and H. A. Waldrop. 1972. Surficial geologic map of the Pelican Cone quadrangle, Yellowstone National Park and adjoining area, Wyoming. Map I-638. U.S. Geol. Surv., Wash., D.C.
- Richmond, G. M. and H. A. Waldrop. 1975. Surficial geologic map of the Norris Junction quadrangle, Yellowstone National Park, Wyoming. Map I-650. U.S. Geol. Surv., Wash., D.C.
- Richmond, G. M. and K. L. Pierce. 1971. Surficial geologic map of the Two Ocean Pass quadrangle, Yellowstone National Park and adjoining area, Wyoming. Map I-635, U.S. Geol. Surv., Wash, D.C.
- Rodman, A, D. Thoma, and H. F. Shovic. 1992. John D. Rockefeller, Jr. Memorial Parkway draft soil survey. Yellowstone Center for Resources, Yellowstone National Park, Wyo.
- Ross, C. S., and R. L. Smith. 1960. Ash-flow tuffs: their origin, geologic relations, and identification. Geol. Survey Professional Paper 366. U.S.G.P.O., Wash., D.C.
- Schultz-Lam, S., F. G. Ferris, K. O. Konhauser, and R. G. Wiese. 1995. In situ silicification of an Icelandic hot spring microbial mat: implications for microfossil formation. *Can. J. Earth Sci.* 32: 2021-2026.

- Shepard, J. S. 1971. The influence of geothermal temperature gradients upon vegetation patterns in Yellowstone National Park. Ph.D. thesis. Colo. State Univ., Ft. Collins, Colo.
- Shovic, H. F. 1996. Landforms and associated surficial materials of Yellowstone National Park. Yellowstone Center for Resources, Yellowstone National Park, Wyo.
- Shovic, H. F., A. Rodman, and D. Neprud. 1991. Soils investigation of the Reese Creek-McMinn Bench-Mammoth area: northwestern Yellowstone National Park, Wyoming. Yellowstone Center for Resources, Yellowstone National Park, Wyo.
- Shovic, H. F., J. Mohrman, and R. Ewing. 1987. Major erosive lands in the upper Yellowstone River drainage basin from Livingston, Montana to Yellowstone Lake outlet, Yellowstone National Park. Yellowstone Center for Resources, Yellowstone National Park, Wyo.
- Shovic, H. F. and C. Montagne. 1985. Application of a statistical soil-landscape model to an order III wildland soil survey. *Soil Sci. Soc. Am. Jour.* 49: 961-968.
- Shovic, H. F. 1994. Landscapes of northwestern Yellowstone National Park: soils, landforms, and vegetation characteristics with interpretations for erosion potential and productivity. Pages 273-283 in *Plants and their environments: proceedings of the first biennial scientific conference on the Greater Yellowstone Ecosystem*. Tech. Rept. NPS/NRYELL/NRTR. U.S.D.I., NPS, Nat Res. Pub. Office, Denver, Colo.
- Shovic, H. F., M. Johnson, and H. H. Porter. 1994. A new view of an old land. *Yellowstone Science*. 1(2):2-6. Yellowstone National Park, Wyo.
- Soil Science Society of America. 1987. Glossary of soil science terms. *Soil Sci. Soc. of Am.*, Madison, Wis.
- Soil Conservation Service. 1993. Soil survey manual. U.S. Dept. Agri. Handbook 18, U.S.G.P.O., Wash. D.C.
- Soil Survey Staff. 1994. Keys to soil taxonomy, 6th Ed. SMSS Tech. Monograph No. 19., Natural Resources Conservation Service, U.S.G.P.O., Wash. D.C.
- Soil Conservation Service. 1985. Glossary of landform and geologic terms. *National Soils Handbook* 430-VI. U.S.G.P.O., Wash. D.C.
- Soil Survey Staff. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. *Soil Conserv. Serv.*, U.S. Dept. Agric. Handbook 436, Wash., D.C.
- Thornbury, W. D. 1969. Principles of geomorphology. John Wiley and Sons, New York, N.Y.
- Thornbury, W. D. 1965. Regional geomorphology of the United States. John Wiley and Sons, New York, N.Y.
- Trettin, C. C. 1986. Characterization of soils in Yellowstone National Park- Project Report CX-1200-1B027. Ford Forestry Center, Michigan Tech. Univ., Houghton, Mich.
- U.S. Geological Survey. 1972. Geologic map of Yellowstone National Park. Map I-711. U.S. Geol. Surv., Wash., D.C.
- U.S. Geological Survey. 1972. Surficial geologic map of Yellowstone National Park. Map I-710. U.S. Geol. Surv., Wash., D.C.
- Waldrop, H. A. 1975a. Surficial geologic map of the Old Faithful quadrangle, Yellowstone National Park, Wyoming and Montana. Map I-649. U.S. Geol. Surv., Wash., D.C.
- Waldrop, H. A. 1975b. Surficial geologic map of the West Yellowstone Quadrangle, Yellowstone National Park and adjoining area, Montana, Wyoming, and Idaho. Map I-648. U.S. Geol. Surv., Wash., D.C.
- Waldrop, H. A. and K. L. Pierce. 1975. Surficial geologic map of the Madison Junction Quadrangle, Yellowstone National Park, Wyoming. Map I-651. U.S. Geol. Surv., Wash., D.C.

- Watt, A., ed. 1986. Challinor's dictionary of geology, 6th edition. Oxford Univ. Press, New York, N.Y.
- Way, D. S. 1973. Terrain analysis. Dowden, Hutchinson, and Ross, Stroudsburg, Pa.
- White, D. E., R. A. Hutchinson, and T. E. C. Keith. 1988. The geology and remarkable thermal activity of Norris Geyser Basin, Yellowstone National Park, Wyoming. Prof. Pap. 1456. U.S. Geol. Surv., U.S.G.P.O, Wash., D.C.
- Wolf, P. R. 1974. Elements of photogram-metry (with air photograph interpretation and remote sensing). McGraw-Hill, New York, N.Y.

GLOSSARY

Index of Glossary

A

Acid sulfate	248
Acid-altered rhyolite	248
Actively hydrothermal	248
Alfisols	248
Alluvial basin	248
Alluvial fan	248
Alluvium	248
Alpine	248
Andesite	248
Andic	248
Andic.	248
Andisol	248
Angulate stream drainage pattern	249
Annular drainage pattern	249
Aquic condition	249
Arboreal stream drainage pattern	249
Argillic horizon	249
Ash flow	249
Ashy	249
Association, soil	249
Available water capacity (available moisture capac	249

B

Back slope	249
Basalt	249
Base saturation	249
Bedrock	249
Block glide	250
Boulders	250
Bouldery soil material	250
Boundaries, horizon	250
Braided stream drainage pattern	250
Breakland, break	250
Bull Lake	250

C

Caldera	250
Cambic soil horizon	250
Canyon	250
Cation-exchange capacity	250

Channery soil material	250
Chroma	251
Cirque	251
Cirque basin	251
Cirque headwall	251
Clay	251
Clay film	251
Clay loam	251
Coarse fragments	251
Coarse textured soil	251
Cobble (or cobblestone)	251
Cobbly soil material	251
Colluvial slope	251
Colluvium	251
Complex, soil	251
Component, soil	251
Concave glaciated uplands	251
Concretions	252
Conglomerate	252
Consistence, soil	252
Consociation, soil	252
Control section	252
Correlation, soil	252
Cryic	252

D

Dacite	252
Delineation	252
Dendritic stream drainage pattern	252
Deranged stream drainage pattern	253
Diatomaceous earth	253
Diatoms	253
Diorite	253
Dissimilar soil	253

E

Earthflow	253
Effervescence	253
Eluvial horizon	253
Eluviation	253
Entisols	253
Entrenched stream channel	253
Ephemeral stream	253
Epipedon	253

Erratic	253
Expert System	253
Explosion debris field	254
Extremely gravelly, cobbly, stony	254

F

Family, soil	254
Fertility, soil	254
Fibric soil material (peat)	254
Fine earth fraction	254
Fine textured soil	254
Flagstone	254
Flood plain	254
Fluvial	254
Foot slope	254
Frigid	254
Frost rubble	254

G

Genesis, soil	254
Geographic information system (GIS)	254
Glacial headslope	255
Glacial rubble	255
Glacial till	255
Glacial trough valley bottom ...	255
Glacial trough valley wall	255
Glaciated plateau	255
Glaciated uplands with high relief	255
Glaciofluvial alluvium	255
Glaciofluvial deposits	255
Glaciofluvial flood bars and terraces	255
Glaciofluvial outwash	255
Glaciofluvial outwash plain	255
Glaciofluvial plains, terraces, and kames	255
Glaciolacustrine deposits	256
Gleyed soil	256
Gneiss	256
Granite	256
Gravel	256
Gravelly soil material	256
Ground water	256

H

Habitat type	256
Hemic soil material (mucky peat)	256
High ridgetop	256
Hill	256
Histic epipedon	256
Histosols	256
Holocene	256
Horizon, soil	256
Hue	256
Hydric soils	257
Hydrothermal	257
Hydrothermal basin	257
Hydrothermal breakland	257
Hydrothermal explosion debris field 257	
Hydrothermal material	257
Hydrothermal rolling upland ...	257
Hydrothermal valley	257
Hydrothermally altered	257
Hydrothermally cemented	257
Hyperthermic	257

I

Igneous rock	258
Illuvial horizon	258
Illuviation	258
Inceptisols	258
Inclusion	258
Intermittent stream	258
Isothermic	258

K

Kame	258
------------	-----

L

Lacustrine plain	258
Lake sediments	258
Landform	258
Landscape	258
Landslide	259
Landslide scarp	259
Limestone	259
Liquid Limit	259
Lithic contact	259
Lithified	259
Litter	259
Loam	259
Loamy sand	259

Loess	259
-------------	-----

M

Map unit	259
Mass wasting	259
MAST	259
MAT	259
Medium-textured soil	259
Mesic	260
Metamorphic rock	259
Mineral soil	260
Mineralogy class, soil	260
Miscellaneous areas	260
Mixed rock types	260
Moderately coarse textured soil	260
Moderately fine textured soil ..	260
Mollic colors	260
Mollic epipedon	260
Mollisols	260
Moraine	260
Mottles	261
Mountain	261
Mudstone	261
Munsell notation	261

N

Neutral soil	261
Neutral-high chloride	261
Non-glaciated plateau	261
Non-skeletal	261
Non-thermal	261
Northern range glacial till	261
Nunatak	261
Nutrient, plant	261

O

Obsidian	261
Ochric epipedon	262
Organic matter	262

P

Paralithic contact	262
Parallel drainage pattern	262
Parent material	262
Particle size class, soil	262
Particle size control section	262
Ped, soil	262
Pedon, soil	262
Periglacial	262

pH value	262
Phosphate retention	262
Pinedale	262
Pinnate stream drainage pattern	262
Pitchstone Plateau	262
Plan slope curvature (horizontal slope shape)	263
Plastic Limit	263
Plateau	263
Profile slope curvature (vertical slope shape)	263
Profile, soil	263

Q

Quartzite	263
-----------------	-----

R

Reaction class, soil	263
Reaction, soil	263
Rectangular stream drainage pattern	264
Redoxymorphic concentrations and depletions (mottl)	264
Regolith	264
Relief	264
Residuum (residual soil material)	264
Rhyolite	264
Rhyolite tuff	264
Rock fragments	264
Rock rubble	264
Rock slide	264
Rolling glaciated uplands	264
Rolling pluvial uplands	264
Root limiting layer	265
Rubble veneer	265

S

Saline soil	265
Saline-sodic soil	265
Sand	265
Sandstone	265
Sandy clay	265
Sandy clay loam	265
Sandy loam	265
Sapric soil material (muck)	265
Schist	265
Scree	265
Sedimentary rock	265

Shale	265
Sheet erosion	265
Siliceous sinter	265
Silt	265
Silt loam	266
Siltstone	266
Silty clay	266
Silty clay loam	266
Similar soil	266
Skeletal	266
Slope.	266
Slump	266
Sodic soil	266
Soil	266
Soil classification	266
Soil depth	266
Soil map, generalized	267
Soil profile	267
Soil separates	267
Soil survey	267
Soil taxon	267
Solifluction	267
Stones	267
Stony soil material	267
Stratified	267
Stream bottom	267
Stream break	267
Stream dissection	267
Stream dissection degree	268
Stream drainage pattern	268
Stream drainage spacing	268
Stream terrace	268
Structural	268
Structure, soil	268
Subsoil	269
Subsurface layer	269
Surface layer	269

T

Talus	269
Talus slope	269
Tephra	269
Terrace	269

Texture, soil	269
Thermal	270
Thermic	270
Thermogenic soils	270
Thick mollic epipedon	270
Travertine	270
Trellis stream drainage pattern	270
Tuff	270
Tundra	270

U

Udic	270
Umbric epipedon	270
Undifferentiated group	270
Universal Transverse Mercator (UTM)	271
Upland	271
Ustic	271

V

Valley	271
Value, color	271
Variegation	271
Variety of rock types	271
Varve	271
Very gravelly, cobbly, stony, bouldery soil materi	271
Volcanic glass	271
Volcaniclastic	271

W

Water table	271
Water-holding capacity	271
Weakly developed	272
Weathering	272
Weighted average percent clay	272
Weighted average percent rock fragments	272
Welded tuff	272

Introduction

This glossary was developed to help individuals with the technical and scientific terminology used in this document. It was created from a variety of sources in geology, geomorphology, soils, and vegetation (Chorley 1972; Dikau 1989; Forman and Godron 1986; Gary and McAfee 1974; Harmon and King 1985; Hausenbuiller 1972; Pierce 1979; Soil Conservation Service 1985; Soil Science Society of America 1987; Soil Survey Staff 1975; Soil Survey Staff 1994; Watt 1986; White, Hutchinson, and Keith 1988).

Acid sulfate. One of the three general types of hydrothermal activities or areas in Yellowstone National Park, characterized by relatively low aqueous pH, and high sulfate concentration. Deposition varies with the amount of water present and surrounding surficial materials. Mudpots, bleached bedrock, and white soils may occur. See Neutral-high chloride, Traver-tine.

Acid-altered rhyolite. Rhyolite rock altered by the reaction of hydrothermal water and/or gases. This rock appears bleached with bands of red or yellow, and is poorly consolidated.

Actively hydrothermal. Presently in a hydro-thermal area, with relatively high soil tempera-tures (greater than 20 degrees C), hot pools, geysers, or fumaroles with hydrothermally related erosion or deposition in progress. See Non-thermal, Thermal.

Alfisols. Mineral soils that have umbric or ochric epipedons and argillic horizons.

Alluvial fan. The fan-like deposit of a stream where it issues from a gorge upon a plain or from a tributary stream near or at its junction with its main stream. Profile slope shape is

straight, and plan slope is convex. Stream pattern is fine and braided, with weak dissec-tion.

Alluvial basin. An unusually broad alluvial opening in an otherwise narrow stream valley. Profile and plan slope shape is straight. It has a fine dendritic drainage pattern and weak dissec-tion.

Alluvium. Unconsolidated clastic material, such as sand, gravel, silt, or clay, or various mixtures of these, deposited on land by streams.

Alpine. Characteristic of, or resembling the European Alps, or any lofty mountain or mountain system, especially one so modified by intense glacial erosion as to contain cirques, horns, etc.

Andesite. A fine-grained extrusive igneous rock composed primarily of sodic plagioclase and one or more mafic minerals (eg. biotite, hornblende, or pyroxene). Extrusive equivalent of diorite. In Yellowstone National Park, the rock type includes interbedded conglomerates that have formed from wet volcanic ash flows and andesite rock.

Andic. This soil property results from mainly from the presence, in soils, of significant amounts of allophane, imogolite, ferrihydrite, or aluminum-humus complexes. These materials are relatively amorphous, with low bulk den-sity, as well as some fertility-limiting properties. Their presence is related to the amount of volcanic glass in a soil.

Andisol. Mineral soils having andic soil properties in more than 60 percent of their thickness.

Angulate stream drainage pattern. A drainage pattern similar to a rectangular drainage pattern where streams follow joints or faults that join each other at acute or obtuse angles, rather than right angles.

Annular drainage pattern. A drainage pattern in which subsequent streams follow a roughly circular or concentric path along a belt of weak rocks, resembling in plan a ring-like pattern.

Aquic condition. Soils with aquic conditions are those which currently experience continuous or periodic saturation and reduction. The conditions are indicated by redoximorphic features and can be verified by measuring saturation and reduction.

Arboreal stream drainage pattern. A drainage pattern similar to a trellis pattern, but with a dominating central trunk stream with smaller branching tributaries. It is similar in plan to certain trees, such as pine or spruce.

Argillic horizon. A mineral horizon that is characterized by the illuvial accumulation of layer-lattice silicate clays. The argillic horizon has a certain minimum thickness depending on the thickness of the solum, a minimum quantity of clay in comparison with an overlying eluvial horizon depending on the clay content of the eluvial horizon, and usually has coatings of oriented clay on the surface of pores or peds or bridging sand grains.

Ash flow. A highly heated mixture of volcanic gases and ash, traveling down the flank of a volcano or along the surface of the ground; produced by the explosive disintegration of viscous lava in a volcanic crater, or by the explosive emission of gas-charged ash from a fissure or group of fissures. The solid materials contained in a typical ash flow are generally

unsorted and ordinarily include volcanic dust, pumice, scoria, and blocks in addition to ash. Deposit may create ash flow tuff. See Tuff.

Ashy. Less than 35 percent (by volume); a fine-earth fraction which contains 30 percent or more (by weight) particles between 0.02 and 2.0 mm in diameter which either has andic soil properties or 30 percent or more volcanic glass or related materials.

Association, soil. A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hillsides. Back slopes in profile are commonly steep, linear, and may or may not include cliff segments.

Basalt. A fine-grained extrusive igneous rock primarily composed of calcic plagioclase and pyroxene. Extrusive equivalent of gabbro.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Block glide. A landslide in which the slide mass remains essentially intact, moving outward and downward as a unit, most often along a preexisting plane of weakness. The appearance is of large blocks of relatively undisturbed materials at a variety of angles in repose.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter or > 60 cm in length.

Bouldery soil material. Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened in the indicated size class.

Boundaries, horizon. Description of the lower boundary of each horizon indicating distinctness and general topography.

Distinctness:

- a - abrupt, transition is less than 1 inch (2.5 cm).
- c - clear, transition is 1 to 2.5 inches (2.5 cm to 6 cm) thick.
- g - gradual, transition is 2.5 to 5 inches (6 cm to 12.5 cm) thick.
- d - diffuse, transition is more than 5 inches thick (12.5 cm).

Topography:

- s - smooth, boundary is parallel to the surface of the soil.
- w - wavy, if pockets are wider than their depth.
- i - irregular, if irregular pockets are deeper than their width.
- b - broken, if parts of the horizon are unconnected with other parts.

Braided stream drainage pattern. A drainage pattern characterized by braided streams. These are streams that are divided into or follow an interlacing or tangled network of several small branching and reuniting shallow channels separated by branch islands or channel bars, resembling in plan a complex braid.

Breakland, break. See Stream breakland.

Bull Lake. Pertaining to a time period of glaciation in the Yellowstone area that is thought to have ended about 150,000 years ago. Distinguished from a younger glaciation termed "Pinedale".

Caldera. A large, more or less circular depression formed by explosion and/or collapse, which surrounds a volcanic vent or vents, and whose diameter is many times greater than that of the included vent, or vents.

Cambic soil horizon. A mineral-soil horizon that has a texture of loamy very fine sand or finer, has soil structure rather than rock structure, contains some weatherable minerals, and is characterized by alteration or removal of mineral material as indicated by mottles or gray color, stronger colors, or redder hues than the underlying horizons, or the removal of carbonates. The cambic horizon lacks cementation or induration, and has too few evidences of illuviation to meet the requirements of an argillic horizon.

Canyon. A long, deep, narrow, very steep-sided valley with high, precipitous walls in an area of high local relief.

Cation-exchange capacity. The total amount of exchangeable cations that a soil can absorb, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Channery soil material. Soil material that is 15 to 35 percent, by volume, thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. Very channery soil material is 35 to 60 percent of

these rock fragments, and extremely channery soil material is more than 60 percent. A single piece is called a chanter.

Chroma. The relative purity, strength, or saturation of a color; directly related to the dominance of the determining wavelength of the light and inversely related to grayness.

Cirque. Semicircular, concave, bowl-like areas that have steep faces primarily resulting from glacial ice and snow abrasion.

Cirque basin. The semi-circular bowl-like part of a cirque. Profile and plan slope are concave. Slope gradients are less than 30 percent. Stream pattern is fine and dendritic with weak dissection.

Cirque headwall. The steep face of a cirque basin. Profile and plan slope are concave. Slope gradients are greater than 30 percent. Stream pattern is fine and dendritic with weak dissection.

Clay. As a soil separate, the mineral soil particles less than 0.002 mm in diameter. Also see texture, soil.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Clay loam. See Texture, soil.

Coarse fragments. Mineral or rock particles larger than 2 mm in diameter. A synonym is “rock fragments”.

Coarse textured soil. Texture exhibited by sands, loamy sands, and sandy loams except very fine sandy loam.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 cm) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments in the indicated size class.

Colluvial slope. A steep slope having a mixture of talus with some soil formed by slow downhill movement of material. Slope gradients are greater than 30 percent. Slope profile and plan are straight. Drainage is variable in texture with a parallel pattern. Degree of dissection is variable

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and either on or deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil and/or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Component, soil. The soil(s) formally named and described as comprising the delineations of a map unit and for which the map unit is named. Simple or complex names for the component soils are formed from a class name from some categorical level of the U.S. system of soil taxonomy, with or without an additional phase identification for utilitarian features. See Inclusion and Map unit.

Concave glaciated uplands. Broad, valley-like landforms, not including glacial trough bottoms. They have a large-scale bowl shape, with slightly concave profile slopes and com-

plex plan slopes. They have dendritic drainage patterns.

Concretions. Grains or pellets of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conglomerate. A coarse-grained, clastic rock composed of rounded to subangular rock fragments more than 2 mm in diameter. It commonly has a matrix of sand and finer material. Conglomerate is the consolidated equivalent of gravel.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose - Non-coherent when dry or moist; does not hold together in a mass.

Friable - When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm - When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic - Readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky - Adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard - When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft - When dry, breaks into powder or individual grains under very slight pressure.

Cemented - Hard; little affected by moistening.

Consociation, soil. A kind of soil map unit dominated by a single soil taxon or miscellaneous area and similar soils. At least half of the pedons in each delineation are of the same soil components that provide the name of the map unit. The remainder is largely of similar soils.

Control section. The part of the soil on which a classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches (25 cm) and 40 or 80 inches (100 or 200 cm).

Correlation, soil. The process of quality control used in soil surveys, as well as the process of map-unit concept development and completion. It involves the selection of which soils may be allowed to occur in a map unit, their allowed proportions, and the kinds of inclusions.

Cryic. A soil temperature regime that has mean annual soil temperatures of > 0 degrees C but < 8 degrees C and relatively cool summer temperatures. See Frigid.

Dacite. An extrusive igneous rock with similar composition to andesite, but with less calcic plagioclase and more quartz. The extrusive equivalent of granodiorite.

Delineation. An individual instance of a map unit on a map. A delineation may have only one map unit defining it. See Map unit.

Dendritic stream drainage pattern. A drainage pattern in which the streams branch irregularly in all directions and at almost any angle, resembling the branching pattern of

certain trees (such as oaks or maples), and produced where a consequent stream receives several tributaries which in turn are fed by smaller tributaries.

Deranged stream drainage pattern. A drainage pattern that is distinctively disordered in a recently glaciated area whose former surface has been remodeled and effaced, and in which the new drainage system shows a complete lack of underlying structural and bedrock control. It is characterized by irregular streams that flow into and out of lakes, by only a few short tributaries, and by swampy interstream areas.

Diatomaceous earth. A geologic deposit of fine, grayish, siliceous material composed chiefly or wholly of the remains of diatoms.

Diatoms. Microscopic, single-celled plants growing in marine or fresh water secreting compounds of silica that may accumulate in sediments.

Diorite. A group of plutonic rocks intermediate in composition between acidic and basic, characteristically composed of hornblende, oligoclase or andesine, pyroxene, and sometimes quartz.

Dissimilar soil. A kind of soil that differs sufficiently from the named soil in a map unit that interpretations or major properties are different. The allowed proportion of dissimilar soil is limited to a small part of the map unit.

Earthflow. The depositional parts of a landslide. This results from the relatively rapid downslope movement of a mixture of soil material and rock fragments. Large-scale profile slope is concave. Plan slope is complex. Dissection is variable.

Entrenched stream channel. A channel where the stream has eroded a trench with vertical walls in a relatively level upland.

Effervescence. Reaction of soil to dilute (about 1 normal) HCl.

- e - slightly effervescent- bubbles are readily observed.
- es - strongly effervescent- bubbles form a low foam.
- ev - violently effervescent-thick foam “jumps” up.

Ephemeral stream. A stream or reach of a stream that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other sources and its channel is above the water table at all times.

Epipedon. A soil horizon that has developed directly underneath the soil surface.

Eluvial horizon. A soil horizon that has been formed by the process of eluviation.

Eluviation. The removal of soil material in suspension (or in solution) from a layer or layers of a soil.

Entisols. Mineral soils that have no distinct subsurface diagnostic horizons within 1 m of the soil surface (other than a Cambic horizon).

Erratic. A rock fragment carried by glacial ice or by floating ice, and deposited when the ice melted at some distance from the outcrop from which the fragment was derived. Generally of boulder size, although the fragments range from pebbles to house-sized blocks.

Expert System. A set of rules, usually complex, that simulates the thought process used by an expert in making decisions. Expert systems

are often expressed in “if-then” statements in computer software.

Explosion debris field. An area composed of debris from a hydrothermal explosion, characterized by craters, mounds, and pits made up of rock fragments in a variable matrix.

Extremely gravelly, cobbly, stony, bouldery soil material. Material that is > 60 percent by volume, rounded or angular rock fragments, not prominently flattened in the indicated size class.

Family, soil. In soil classification, one of the categories intermediate between the great soil group and the soil series. Families provide groupings of soils with ranges in texture, mineralogy, temperature, and thickness.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well-preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine earth fraction. That portion of the soil that whose particles are less than 2 mm in diameter.

Fine textured soil. Sandy clay, silty clay, and clay.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 cm) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. In this study, processes that include the effects of precipitation, stream dissection, dispersed runoff, slow weathering in-place and slow down-slope movement of the regolith to stream channels where it is carried off by moving water.

Foot slope. The inclined surface at the base of a hill.

Frigid. A soil temperature regime that has mean annual soil temperatures of > 0 degrees C but < 8 degrees C and relatively warm summer temperatures.

Frost rubble. Cobble-sized rock fragments, usually coarse and angular, shattered by freeze thaw or frost-shattering processes in a fine grained matrix. Usually found on low to flat slopes at higher elevations. Seasonal movement is indicated by sparse or disrupted tundra and shallow soils. See Rock rubble.

Gabbro. A group of basic intrusive igneous rocks composed principally of labradorite or bytownite and augite, with or without olivine and orthopyroxene.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Geographic information system (GIS). A system of computer hardware and software for the creation, storage, analysis, and presentation of spatial data.

Glacial rubble. See Rubble veneer.

Glacial till. Unsorted, nonstratified glacial material consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glacial trough valley bottom. The floor and lower side slopes of a glacially eroded valley. The valley profile is commonly U-shaped. Profile slope is concave and plan slope is straight. Slope gradients are less than 30 percent. Stream pattern is arboreal, with weak dissection.

Glacial trough valley wall. The steep side slopes of a glacially eroded valley. The valley profile is commonly U-shaped. Profile slope is concave and plan slope is straight. Slope gradients are greater than 30 percent. Stream pattern is parallel, with weak to moderate dissection.

Glacial headslope. Valley headslope or valley wall having evidence of glacial scouring and deposition in a direction perpendicular to the valley headslope or wall. Cirque-like features are present, but there is no well-defined basin. Slopes are variable. Profile slope is concave and plan slope is complex. Stream pattern is parallel with moderate dissection and coarse texture.

Glaciofluvial outwash. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Glaciofluvial outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly nearly flat and smooth; where pitted, it is generally low in relief. Slopes are less than

10 percent. Profile slope and plan slope are straight. Stream pattern is absent or dendritic with weak dissection.

Glaciated plateau. A plateau showing evidence of glacial scouring and deposition, but retaining its relatively flat appearance. Regional slope is less than 15 percent. Profile slope and plan slope are straight. Stream pattern is variable.

Glaciated uplands with high relief. Uplands having evidence of glacial molding and deposition. Relief is greater than 1000 ft (300 m). Slopes are greater than 20 percent. Profile slope is convex and plan slope is complex.

Glaciofluvial deposits. Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciofluvial alluvium. See Glaciofluvial deposits.

Glaciofluvial flood bars and terraces. Ridge-like landforms or flat terraces having a mixture of sand, gravel, and boulders. These were formed by catastrophic floods, usually during glacial times. Slopes are less than 25 percent. Profile slope is convex or straight and plan slope is straight. Stream pattern is either absent or parallel with weak dissection.

Glaciofluvial plains, terraces, and kames. Glaciofluvial deposits in the form of terraces, stream bottoms, kames, and small plains. Slopes are less than 25 percent. Profile slope is concave and plan slope is concave or straight. Stream pattern is dendritic or arboreal, with weak dissection.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Gneiss. A foliated rock formed by regional metamorphism, in which bands or lenticles of granular minerals alternate with bands or lenticles of minerals with flaky or elongate prismatic habit.

Granite. A plutonic rock in which quartz makes up 10 to 50 percent of the felsic components and the alkali feldspar/total feldspar ratio is 65 to 90 percent.

Gravel. Rounded or angular rock fragments as much as 3 inches (7.5 cm) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened in the indicated size class.

Ground water. Water filling all the unblocked pores of underlying material below the water table.

Habitat type. A set of environmental conditions that appears repeatedly across a landscape.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

High ridgetop. Broad, convex ridgetops above the elevation limit of the most recent general glaciation of Yellowstone National Park. The most common regolith-forming processes are frost churning and addition of small amounts of loess. Slopes are less than 25 percent. Profile and plan slope are convex. Stream pattern is absent or parallel with weak dissection.

Hill. A natural elevation of the land surface with less than 1000 feet (300 m) relief. It rises above surrounding lowlands, commonly of limited summit area and having a well-defined outline; hillsides generally have slopes of more than 15 percent. See Mountain.

Histic epipedon. A thin organic soil horizon that is saturated with water at some period of the year unless artificially drained, and that is at or near the surface of a mineral soil. The histic epipedon has a maximum thickness depending on the kind of materials in the horizon and the lower limit of organic carbon is the upper limit for the mollic epipedon.

Histosols. Organic soils that have organic soil materials in more than half of the upper 80 cm, or that are of any thickness if overlying rock or fragmental materials that have interstices filled with organic soil materials.

Holocene. Pertaining to the period of time after the last glacial age (the Pleistocene). In Yellowstone National Park, this period is from 8 to 12 thousand years ago to the present.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes.

Hue. One of the three variables of color. It is caused by light of certain wavelengths and changes with the wavelength.

Hydric soils. Soils that are wet long enough to periodically produce anaerobic conditions, thereby influencing the growth of plants.

Hydrothermal. Geological term meaning of or pertaining to hot water, to the action of hot water, or to the products of this action, here taken to refer to water heated beneath the surface of the earth.

Hydrothermal basin. A basin-like landform formed by the erosive and depositional action of hydrothermal waters. Slopes are less than 30 percent. Profile and plan slope are concave. Stream pattern is variable.

Hydrothermal breakland. A stream break-like landform formed or strongly influenced by the weathering, erosive, and depositional action of hydrothermal waters. Slopes are greater than 40 percent. Profile slope is straight, and plan slope is variable. Stream pattern is parallel with moderate dissection.

Hydrothermal explosion debris field. A chaotic, mixed, hummocky area of rock debris and fine material resulting from a subsurface hydrothermal explosion. Drainage patterns are deranged. This includes craters, pits, scarps, and rolling uplands.

Hydrothermal material. Silty, sandy, gravelly or cobbly material of variable composition, resulting from hydrothermal processes modifying pre-existing regolith or bedrock, or deposited by hydrothermal waters or gases. This material is considered non-soil. No living material is present, and it has no apparent soil features such as horizons or structure. Either this material is too geologically young, too hot, too acidic, too infertile, too toxic, or too coarse textured to support plant growth at this time. Reaction of this material may be below pH 3.0.

Mineralogy reflects a degradational environment where bases are leached and weatherable minerals solubilized or altered or a depositional environment rich in either silica or carbonates. This material may be in an active hydrothermal area, in a thermal environment without hydrothermal activity, or in an ambient environment. See Actively hydrothermal, Thermal, Non-thermal.

Hydrothermal rolling upland. A complex of slopes having a rolling, hilly appearance, formed by the erosive and depositional action of hydrothermal processes. Slopes are less than 45 percent. Profile and plan slope are complex. Stream pattern is variable.

Hydrothermal valley. A valley-like landform formed by the erosive and depositional action of hydrothermal waters. Slopes are less than 40 percent. Profile slope is concave and plan slope is variable. Stream pattern is dendritic with weak dissection.

Hydrothermally altered. Rocks or other surficial materials altered by the reaction of hydrothermal water with pre-existing solid phases.

Hydrothermally cemented. Hydrothermally precipitated mineral material has moved into the spaces among the grains of sedimentary rock, thus binding the grains into a rigid mass.

Hyperthermic. A soil temperature regime that has mean annual soil temperatures of >22 degrees C., and the difference between mean summer and mean winter soil temperatures is more than 5 degrees C. at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

Illuviation. The process of deposition of soil material that has moved from another soil horizon. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Illuvial horizon. A soil horizon that has been from which soil materials have been moved, either through solution or physical transport processes.

Inceptisols. Mineral soils that have one or more pedogenic horizons in which mineral materials other than carbonates or amorphous silica have been altered or removed but not accumulated to a significant degree. Under certain conditions, inceptisols may have an ochric, umbric, histic, plaggen or mollic epipedon. Water is available to plants more than half of the year or more than 90 consecutive days during a warm season.

Inclusion. A soil or miscellaneous land area within a delineation of a map unit that is not identified by the map unit name; i.e. is not one of the named component soils or named miscellaneous area components. Such soils or areas are either too small to be delineated separately without creating excessive map or legend detail, occur too erratically to be considered a component, or are not identified by practical mapping methods.

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Isothermic. A soil temperature regime that has mean annual soil temperatures of >15 degrees C. but lower than 22 degrees C., and the difference between mean summer and mean winter soil temperatures is less than 5 degrees C. at a depth of 50 cm from the soil surface or at a lithic or paralithic contact whichever is shallower. See Thermic.

Kame. An irregular, short ridge or hill of stratified glacial drift.

Lacustrine plain. Flat or nearly flat expanse of glaciolacustrine deposits. It is commonly smooth; where pitted, it is generally low in relief. Slopes are less than 10 percent. Profile slope and plan slope are straight. Stream pattern is absent or dendritic with weak dissection.

Lake sediments. See Glaciolacustrine deposits.

Landform. A three-dimensional part of the land surface, formed of soil, sediment, or rock that is distinctive because of its shape, that is significant for land use or to landscape genesis, that repeats in various landscapes, and may have a consistent position relative to surrounding landforms. In this study landforms are differentiated by characteristics of stream dissection, slope curvature and gradient, arrangement of slopes, proportion of exposed bedrock, physical indicators of glaciation, and total relief.

Landscape. a) All the natural features, such as fields, hills, forests, and water, which distinguish one part of the earth's surface from another part. Usually that portion of land or territory which the eye can comprehend in a single view, including all its natural characteristics. b) A heterogeneous land area composed of a cluster of interacting ecosystems (plants,

animals, soils) that is repeated in similar form throughout. A distinct, measurable unit defined by its recognizable and spatially repetitive cluster of interacting ecosystems, geomorphology, and disturbance regimes.

Landslide. A general term meaning the rapid downhill movement of a mass of material (some combination of soil and loose rock), generally when wet or saturated. The speed and distance of movement as well as the amount of soil and rock material vary greatly.

Landslide scarp. The erosional part of an earthflow or other kind of landslide. This is often a very steep scarp or cliff. Slope is greater than 30 percent. Stream pattern is parallel. Dissection is weak.

Limestone. A sedimentary rock consisting chiefly of the mineral calcite with or without magnesium carbonate. Common impurities include chert and clay.

Liquid Limit. The water content at the change between liquid and plastic states. It is measured on thoroughly puddled soil material that has passed a number 40 sieve (0.43 mm) and is expressed on a dry weight basis.

Lithified. The conversion of a newly deposited, unconsolidated sediment into a coherent and solid rock.

Lithic contact. The boundary between soil and coherent underlying material. If consisting of a single material, a hardness by MOHS scale of 3 or more is required. Hand digging with a spade is impractical.

Litter. The surface layer of the forest floor consisting of freshly fallen leaves, needles, twigs, stems, bark, and fruits.

Loam. See Texture, soil.

Loamy sand. See Texture, soil.

Loess. Fine-grained material, dominantly of silt-sized particles, deposited by wind.

MAT. Mean annual temperature of a soil, taken at a given depth. (See MAST)

Mass wasting. A general term describing the dislodgement and down-slope transport of soil and rock material under the direct application of gravity. In contrast to other erosion processes, the debris removed by mass-wasting processes is not carried within, on, or under another medium possessing contrasting processes. It includes slow displacements such as creep and solifluction and rapid movements such as landslides.

MAST. Mean annual soil temperature, taken at 50 cm in depth (See MAT).

Map unit. A conceptual group of one to many delineations identified by the same name in a soil survey that represent similar landscape areas comprised of either: (1) the same kind of component soil, plus inclusions, or (2) two or more kinds of component soils, plus inclusions, or (3) component soils and miscellaneous areas, plus inclusions, or (4) two or more kinds of component soils that may or may not occur together in various delineations but all have similar, special use and management.

Medium-textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Miscellaneous areas. A kind of component used in soil surveys comprised of a landscape unit within which little or no vegetation occurs because there is little or no soil, very unfavorable soil conditions, active erosion, washing by water, or man's activities prevent vegetation growth. Miscellaneous areas are named for the limiting condition, such as hydrothermal deposits, bedrock, beaches, or dumps.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Mesic. Said of a habitat receiving a moderate amount of moisture; also said of an organism or group of organisms occupying such a habitat. Cf.: hydric

Mineralogy class, soil. A class used in soil classification. It refers to the mineralogical composition of selected grain-size fractions of the control section. Classes used in this study are:

Ashy - Less than 35 percent (by volume); a fine-earth fraction which contains 30 percent or more (by weight) particles between 0.02 and 2.0 mm in diameter which either has andic soil properties or 30 percent or more volcanic glass, or related materials.

Mixed - Less than 40 percent by weight of any single kind of mineral other than quartz or feldspars in the 0.02 to 20 mm size fraction.

Siliceous - More than 90 percent by weight in the 0.02 to 20 mm size fraction is some kind of silica mineral.

Carbonatic - More than 40 percent by weight carbonates (expressed as CaCO_3) plus gypsum, with carbonates constituting more than 65 percent of the total weight of carbonates plus gypsum, either in the

fine-earth fraction or in the less-than-20 mm fraction, whichever has a higher percentage of carbonates plus gypsum.

Mixed rock types. A mixture of andesite, rhyolite, tuff, sandstone, and limestone occurring in northern range glacial till.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Mollic colors. These colors are criteria for indicating the presence of a mollic epipedon. Munsell color value is 3 or less when moist and 5 or less when dry, and chroma is 3 or less, moist or dry.

Mollic epipedon. A surface horizon of mineral soil that is dark-colored and relatively thick, contains at least 5.8 g kg⁻¹ organic carbon, is not massive and hard or very hard when dry, has a base saturation of >50 percent when measured at pH 7, has <110 mg P kg⁻¹ soluble in .05 M citric acid, and is dominantly saturated with bivalent cations.

Mollisols. Mineral soils that have a mollic epipedon overlying mineral material with a base saturation of 50 percent or more when measured at pH 7. Mollisols may have an argillic, natric, albic, cambic, gypsic, calcic, or petrocalcic horizon, a histic epipedon, or a duripan, but not an oxic or spodic horizon.

Moraine. A non-stratified accumulation of silt, sand, clay, stones, and other debris deposited by a glacier. It usually contains a wide mixture of these materials, as opposed to glaciofluvial deposits. Some types are terminal, lateral, medial, and ground.

Mottles. Variation in color of sediment, regolith, or rock as represented by localized spots, patches, or blotches of color, or shades of color. This includes colors formed by geologic processes (eg. hydrothermal processes), and excludes colors in soils that are due to changes in redox states from soil-forming processes (see Redoxymorphic concentrations).

Mountain. A natural elevation of the land surface, with high relief. It rises above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides and considerable bare-rock surface. A mountain can occur as a single, isolated mass or in a group forming a chain or range.

Mudstone. An indurated mud having the texture and composition of shale, but lacking its fissility; a blocky fine-grained sedimentary rock in which the proportions of clay and silt are approximately equal.

Munsell notation. A designation of color by degrees of the three simple variables = hue, value, and chroma. For example, a notation of 10YR 6/4 is a color in hue of 10YR, value of 6, and chroma of 4.

Neutral-high chloride. One of the three general types of hydrothermal activities or areas in Yellowstone National Park, characterized by relatively neutral aqueous pH, and high chloride and silica concentration. Deposits are often of siliceous sinter. See Acid sulfate, Travertine.

Northern range glacial till. Glacial till made up of a combination of andesite, rhyolite, granite, limestone, sandstone, and shale. It occurs in the northern one-quarter of Yellowstone National Park in a band stretching from its

source near the Beartooth Plateau to beyond the town of Gardiner, Montana on the northwest edge.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Non-glaciated plateau. A plateau showing no evidence of glacial scouring and deposition, and retaining its relatively planar appearance. Stream drainageways have straight sides, indicating pluvial processes are important to stream pattern formation. Regional slope is less than 15 percent. Profile slope and plan slope are straight. Stream pattern is variable.

Non-skeletal. A particle size-class modifier indicating less than 35 percent of the soil by volume is rock fragments greater than 2 mm in diameter.

Non-thermal. Not having relatively high soil temperatures at the present time, but showing evidence of past thermal regimes, cf. hydrothermally altered materials or landforms.

Nunatak. An isolated hill, knob, ridge, or peak of bedrock that projects prominently above the surface of a glacier and is completely surrounded by glacier ice.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Obsidian. A black or dark-colored volcanic glass, usually of rhyolitic composition, characterized by conchoidal fracture.

Ochric epipedon. A surface horizon of mineral soil that is too light in color, too high in chroma, too low in organic carbon, or too thin to be a plaggen, mollic, umbric, anthropic, or histic epipedon, or that is both hard and massive when dry.

Organic matter. Plant and animal residue in the soil in various stages of decomposition. Organic matter (OM) accumulation. Organic material, excessive of duff, that is in various states of decomposition that has been incorporated into mineral soil.

Paralithic contact. Similar to a lithic contact except that it is softer and can be dug with difficulty with a spade. If a single mineral, has a hardness <3 (Mohs scale) and gravel-size chunks that can be broken out and will partially disperse within 15 hours when shaken in water or sodium-hexametaphosphate solution.

Particle size class, soil. Used to characterize the grain-size composition of the whole soil, including fragments greater than 2 mm in diameter.

Particle size control section. The section of a soil profile that is used in determining a particle size-class for the soil. Its depth varies depending on the presence of diagnostic horizons.

Parallel drainage pattern. A pattern in which the streams and their tributaries are regularly spaced and flow virtually parallel or subparallel to one another over a considerable area, or in a number of successive cases.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped, soil. A naturally occurring soil aggregate, which gives structure to soils exposed in soil profiles.

Pedon, soil. A three-dimensional body of soil with lateral dimensions large enough to permit the study of horizon shapes and relations. It is usually about one meter square and a maximum of two meters deep.

Periglacial. Said of the processes, conditions, areas, climates, and topographic features at the immediate margins of former and existing glaciers and ice sheets, and influenced by the cold temperatures of the ice.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.) The negative logarithm of the hydrogen ion activity of a soil. The degree of acidity (or alkalinity) of a soil as determined by means of a glass, quinhydrone, or other suitable electrode or indicator at a specified moisture content or soil-water ratio, and expressed in terms of the pH scale.

Phosphate retention. The tendency of certain soil materials to retain added phosphorus, which is then unavailable for plant nutrition.

Pinedale. Pertaining to a time period of glaciation in the Yellowstone area that is thought to have ended from 12,000 to 14,000 years ago. Distinguished from an older glaciation termed "Bull Lake".

Pinnate stream drainage pattern. A drainage pattern similar to a dendritic pattern in which the main stream receives many closely spaced, subparallel tributaries that join it at acute angles, resembling in plan a feather.

Pitchstone Plateau. A glaciated plateau with rounded bedrock ridges in the southwest part of Yellowstone National Park.

Plan slope curvature (horizontal slope shape).

Plan curvature is measured along the slope contour or perpendicular to the fall line. It is described for the landform as a whole. This is usually on the order of 300 to 500 m. Local curvature on the order of 10-100 m may be considerably different. For example, a glaciated valley has an overall straight plan slope, but on a local scale may have highly variable curvature due to morainal deposition and post-glacial erosion. "Convex" curvature implies the land surface resembles the curved outside of a sphere, as one moves along a transect on the contour of the surface. "Concave" curvature implies the surface resembles the inside surface of a sphere. "Straight" curvature implies a relatively planar surface. "Complex" curvature implies a repeating sequence of convex and concave slopes. "Variable" curvature implies any combination of slope curvature may occur.

Plastic Limit. The water content at the change between semi-solid and plastic states. It is measured on thoroughly puddled soil material that has passed a number 40 sieve (0.43 mm) and is expressed on a dry weight basis.

Plateau. An extensive upland mass with relatively flat summit area that is considerably elevated (more than 300 ft (100 m)) above adjacent lowlands and separated from them on one or more sides by escarpments.

Profile slope curvature (vertical slope shape).

Profile curvature is a measure of curvature along the fall line or perpendicular to the contour. It is described for the landform as a whole. This is usually on the order of 300 to 500 m. Local curvature on the order of 10-100 m may be considerably different. For example, a glaciated valley has an overall concavity, but on a local scale may have highly variable curvature due to morainal deposition. "Con-

vex" curvature implies slope angle increases as one moves along a transect directly down the fall line. "Concave" curvature implies slope angle decreases. "Straight" curvature implies slope angle stays relatively constant. "Complex" curvature implies a repeating sequence of convex and concave slopes. "Variable" curvature implies any combination of slope curvature is possible.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Quartzite. A granoblastic metamorphic rock consisting mainly of quartz, formed by recrystallization of sandstone by regional or thermal metamorphism.

Reaction class, soil. A classification of the acidity or alkalinity of a soil. This is used in soil classification.

Acid class - The soil has a pH of less than 5.5 in water at a one:one dilution throughout the control section.

Nonacid class - The soil has a pH of 5.5 or greater in water at a one:one dilution throughout the control section.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as pH.

Ultra acid	below 3.5
Extremely acid	3.5 to 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
acid	6.1 to 6.5
Moderately acid	6.6 to 7.0
Slightly alkaline	7.1 to 7.5

Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Rectangular stream drainage pattern. A drainage pattern in which both the main streams and their tributaries display many right-angle bends and exhibit sections of approximately the same length.

Redoxymorphic concentrations and depletions (mottles). Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance = few, common, and many; size = fine, medium, and coarse; and contrast = faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 mm (0.2 inch); medium, from 5 to 15 mm (0.2 to 0.6 inch); and coarse, more than 15 mm (0.6 inch).

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above solid rock.

Relief. The difference between the lowest and highest elevations in an individual landform delineation. Most landforms are differentiated on maximum relief. High relief uplands or "mountains" have relief greater than 1,000 ft (304 m), while other lands have relief less than that amount. A few landforms allow any relief, and some have a minimum due to mapping limitations (e.g., 120 ft (37 m). for breaklands). Breakland-like forms with relief less than that value cannot be reliably mapped at the scale of this study.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered

mineral material that accumulated as consolidated rock disintegrated in place. In Yellowstone National Park, this includes weathered hydrothermally deposited or altered materials.

Rhyolite. A group of extrusive igneous rocks, porphyritic with phenocrysts of quartz and alkali feldspar, in a glassy to cryptocrystalline groundmass. Extrusive equivalent of granite.

Rhyolite tuff. A tuff with rhyolitic composition.

Rock fragments. Rock or mineral fragments having a diameter of 2 mm or more. For size classes, see gravel, stones, cobbles, or boulders.

Rock slide. A landslide involving a downward and usually sudden and rapid movement of newly detached segments of bedrock sliding or slumping over an inclined surface of weakness. The moving mass is greatly deformed and usually breaks up into many small independent units.

Rock rubble. A general term for a loose mass, layer, or accumulation of rough, irregular, or angular rock fragments broken from larger masses, usually by physical forces, coarser than sand, and commonly but not necessarily poorly sorted. See Frost rubble.

Rolling glaciated uplands. A complex of slopes having a rolling, hilly appearance. Slopes are less than 40 percent. Profile slope and plan slope are complex. There is evidence of glacial molding and scouring. Stream drainageways have convex to complex sides, indicating glacial processes dominate over pluvial ones.

Rolling pluvial uplands. A complex of slopes having a rolling, hilly appearance. Slopes are

less than 40 percent. Profile slope and plan slope are complex. There is no evidence of glacial molding and scouring. Stream drainageways have straight sides, indicating pluvial processes are important to stream pattern formation.

Root limiting layer. Layer in which most roots are unable to penetrate. This is often a paralithic or lithic contact.

Rubble veneer. Thin mantle over bedrock of rock rubble in a loose sandy or silty matrix on glaciated uplands. Mostly frost-riven from local bedrock but locally contains glacial erratics and other glacially moved debris. Some areas of shallow glacial till are included.

Saline soil. A non-sodic soil containing sufficient soluble salt to adversely affect the growth of most plants. The lower limit of saturation-extract electrical conductivity (EC) of such soils is set at 0.4 Siemens per meter (4 mmhos per cm).

Saline-sodic soil. A soil containing both sufficient soluble salt and exchangeable sodium to adversely affect the growth of most plants.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 mm in diameter. Most sand grains consist of quartz. Also see Texture, soil.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sandy clay. See Texture, soil.

Sandy clay loam. See Texture, soil.

Sandy loam. See Texture, soil.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Schist. A strongly foliated crystalline rock, formed by dynamic metamorphism, that has well-developed parallelism of more than 50 percent of the minerals present, particularly those of lamellar or elongate-prismatic habit.

Scree. A collective term for an accumulation of coarse rock debris or a sheet of coarse debris mantling a slope. Scree is not a synonym of talus, as scree includes loose, coarse fragmental material on slopes without cliffs.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Siliceous sinter. The lightweight, porous opaline variety of silica deposited as an incrustation by precipitation from the waters of geysers and hot springs.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit

of very fine sand (0.05 millimeter). See Texture, soil.

Silt loam. See Texture, soil.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Silty clay. See Texture, soil.

Silty clay loam. See Texture, soil.

Similar soil. A kind of soil that differs so little from the named soil in a map unit that there are no important differences in interpretations. These soils are not named components in a map unit, but are limited to a brief description of the feature or features by which the soil differs from the soils in the map unit name. See Dissimilar soil.

Skeletal. A particle size-class modifier indicating over 35 percent of the soil by volume is rock fragments greater than 2 mm in diameter.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet (6 m) in 100 feet (30 m) of horizontal distance.

Slump. a) A mass-movement process characterized by a landslide involving a shearing and rotary movement of a generally independent mass of rock or earth along a curved slip surface (concave upward) and about an axis parallel to the slope from which it descends, and by backward tilting of the mass with respect to that slope so that the slump surface often exhibits a reversed slope facing uphill. b) The landform or mass of material slipped down during, or produced by, a slump.

Sodic soil. A non-saline soil containing enough exchangeable (plant available) sodium to adversely affect the growth of most plants. The lower limit of the saturation extract SAR (sodium adsorption ratio) is conventionally set at 13. Another measure of sodicity is percent exchangeable sodium, with a limit of 15 percent.

Soil. The collection of natural material on the earth's surface containing living matter and supporting or capable of supporting plants. Its upper limit is air or shallow water. At its margins it grades to deep water or to barren areas of rock or ice. Its lower limit to the non-soil beneath is perhaps the most difficult to define. Soil includes the horizons near the surface that differ from the underlying rock material, as a result of interactions through time of climate, living organisms, parent materials, and relief. In the few places where it contains thin-cemented horizons that are impermeable to roots, soil is as deep as the deepest horizon. More commonly, soil grades at its lower margin to hard rock or to earthy materials virtually devoid of roots, animals, or marks of other biologic activity. The lower limit of soil is normally the lower limit of biologic activity, which generally coincides with the common rooting depth of native perennial plants.

Soil classification. The systematic arrangement of soils into groups or categories on the basis of their characteristics. Broad groupings are made on the basis of general characteristics and subdivisions on the basis of more detailed differences in specific properties. The soils classification system used in this survey is from the Soil Survey Staff, Soil Conservation Service (1975.)

Soil depth. The thickness of the soil mantle over bedrock or a root-limiting layer; i.e., very

shallow is 4 to 10 inches (5 to 25 cm) thick, shallow is 10 to 20 inches (25 to 50 cm) thick, moderately deep is 20 to 40 inches (50 to 100 cm) thick. If none of these modifiers are used, soil is greater than 60 inches (150 cm) thick. No modifier is defined for soils 40 to 60 inches (100 to 150 cm) thick.

Soil map, generalized. A small-scale soil map which shows the general distribution of soils within a large area and thus in less detail than on a detailed soil map.

Soil profile. The sequence of natural layers, or horizons, in a soil. The profile extends from the surface downward either into the unconsolidated material in which the soil formed (regolith) or to hard bedrock. The unconsolidated material or bedrock is devoid of roots and other living organisms and has not been changed by other biologic activity.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

Separate	mm Diameter
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Soil survey. The systematic examination, description, classification, and mapping of soils in an area. Soil surveys are classified according to the kind and intensity of field examination. Also, the program of the National Cooperative Soil Survey that includes developing and

implementing standards for describing, classifying, mapping, writing, and publishing information about soils of a specific area.

Soil taxon. The particular taxonomic name of a soil.

Solifluction. Slow, viscous, down-slope flow of water-saturated regolith. Rates of flow vary widely. The presence of frozen substrate or even freezing and thawing is not implied in the original definition. However, one component of solifluction can be creep of frozen ground. The term is commonly applied to processes operating in both seasonal frost and permafrost areas.

Stones. Rock fragments 10 to 24 inches (25 to 60 cm) in diameter if rounded or 6 to 15 inches (15 to 38 cm) in length if flat.

Stony soil material. Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened in the indicated size-class.

Stratified. Arranged in or composed of strata or layers.

Stream bottom. Relatively narrow, gently sloping area of recent alluvial deposits, bordering a mountain stream or drainageway. It includes floodplains, low terraces, and small alluvial fans.

Stream break. The steep to very steep broken land at the border of an upland summit that is dissected by ravines. Slopes are greater than 40 percent. Profile slope is straight. Plan slope is variable. Stream pattern is parallel.

Stream dissection. The occurrence of V-shaped valleys and gulches formed from stream

downcutting and associated sideslope development primarily a result of pluvial and fluvial processes. Glacial landforms are not considered dissected unless there is visible evidence of post-glacial stream modification or pre-glacial remnant drainage pattern. Stream drainage pattern type, average density or texture, and degree of dissection are measures of this modification.

Stream dissection degree. A measure of the depth of drainageway bottoms versus adjacent uplands or ridgetops. This and stream drainage spacing are two measures of the degree to which streams have “dissected” or divided a pre-existing landform. “Not dissected” indicates there is no discernible dissection on aerial photos at a magnified scale of 1:24000. “Weakly dissected” refers to stream drainageways that are less than 10 m (ca. 30 ft) below adjacent surface ridges or uplands that are perpendicular to the stream drainageway. “Moderate” dissection is 10 to 30 m (30 to 90 ft). “Strong” dissection is greater than 30 m (90 ft). “Entrenched” dissection is where stream drainageways have steep (>40 percent) slopes and flat bottoms. These are also 30 m (90 ft) or deeper. The degree of stream dissection is related to the influence of running water. Where landforms are weakly dissected, little stream downcutting has occurred since the landform was created (usually in the Pleistocene). Strong dissection implies high stream energy, high stream volume, or an older landform.

Stream drainage spacing. The relative spacing of fluvial (stream) drainageways. This and stream dissection degree are two measures of the degree to which streams have “dissected” or divided a pre-existing landform. Stream drainage spacing (ie. texture) is a measure of average stream drainageway spacing. It does not imply

there is an active stream in each drainage. “Fine” texture means that spacing is <300 m (900 ft). “Medium” texture is 300 m to 700 m (900 ft to 2100 ft). “Coarse” spacing is where drainageways are greater than >700 m (2100 ft) apart. “Fine” spacing typically indicates high levels of surface runoff, impervious bedrock which may be relatively nonresistant, and soils of low permeability. “Coarse” spacing implies there is relatively little runoff, relatively resistant bedrock which may be permeable, and coarse-textured soils. “Medium” spacing implies soils and runoff have intermediate values.

Stream drainage pattern. The pattern of ridges, slopes, and drainageways in an area formed by stream downcutting and associated processes. It is determined by climate, underlying rock type and structure, soil texture, glacial history, and slope. Patterns occurring in Yellowstone National Park are arboreal, dendritic, deranged, angulate, pinnate, parallel, rectangular, or braided.

Stream terrace. One of a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream, and representing the dissected remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of erosion or deposition. Erosional surfaces cut into bedrock and thinly mantled with stream deposits are designated “strath terraces.” Remnants of constructional valley floors thickly mantled with alluvium are termed alluvial terraces.

Structural. In this document, a landform whose shape is primarily determined by the underlying bedrock structure.

Structure, soil. The arrangement of primary

soil particles into compound particles or aggregates. The principal forms of soil structure are = platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Grades of soil structure are expressed as:

Structureless - No observable aggregation or no definite and orderly arrangement of natural lines of weakness. Massive, if coherent; single grain, if non-coherent.

Weak - Poorly-formed indistinct peds, barely observable in place.

Moderate - Well-formed distinct peds, moderately durable and evident, but not distinct in undisturbed soil.

Strong - Durable peds that are quite evident in undisturbed soil, adhere weakly to one another, withstand displacement, and become separated when the soil is disturbed.

Subsoil. The part of the soil beneath the surface horizon(s) or surface layer.

Subsurface layer. A subdivision of the surface layer.

Surface layer. The horizon(s) directly under the soil surface.

Talus. Rock fragments of any size or shape, commonly coarse and angular, derived from and lying at the base of a cliff or very steep, rock slope. The accumulated mass of such loose, broken rock formed chiefly by falling, rolling, or sliding. See scree.

Talus slope. A slope composed of talus or scree, either active (unvegetated, with no soil cover) or inactive (with vegetation and shallow soil cover).

Tephra. A general term for the pyroclastics of a volcano, pertaining to clastic rock material

formed by volcanic explosion or aerial expulsion from a volcanic vent.

Terrace. An old flood plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil, excluding particles greater than 2 mm in diameter. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine." The textural classes may be modified by the addition of suitable adjectives when coarse fragments are present in substantial amounts (eg. gravelly, very stony, extremely cobbly). See Particle size class, soil.

Sand - Soil material that contains 85 percent or more of sand; percentage of silt, plus 1.5 times the percentage of clay, shall not exceed 15.

Loamy sand - Soil material that contains at the upper limit 85 to 90 percent sand, and the percentage of silt plus 1.5 times the percentage of clay is not less than 15; at the lower limit it contains not less than 70 to 85 percent sand, and the percentage of silt plus twice the percentage of clay does not exceed 30.

Sandy loam - Soil material that contains either 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30, and 52 percent or more sand; or <7 percent clay, <50 percent silt, and between 43 percent and 52 percent sand.

Loam - Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and <52 percent sand.

Silt loam - Soil material that contains 50 percent or more silt and 12 to 27 percent clay or 50 to 80 percent silt and <12 percent clay.

Silt - Soil material that contains 80 percent or more silt and <12 percent clay.

Sandy clay loam. Soil material that contains 20 to 35 percent clay, <28 percent silt, and 45 percent or more sand.

Clay loam - Soil material that contains 27 to 40 percent clay and 20 to 45 percent sand.

Silty clay loam - Soil material that contains 27 to 40 percent clay and <20 percent sand.

Sandy clay - Soil material that contains 35 percent or more clay and 46 percent or more sand.

Silty clay - Soil material that contains 40 percent or more clay and 40 percent or more silt.

Clay - Soil material that contains 40 percent or more clay, <45 percent sand, and <40 percent silt.

Thermal. Having relatively high temperatures, usually above 20 degrees C. This may apply to active hydrothermal areas or in soils surrounding them that are warm but not actively hydrothermal.

Thermic. A soil temperature regime that has mean annual soil temperatures of >15 degrees C. but lower than 22 degrees C., and the difference between mean summer and mean winter soil temperatures is more than 5 degrees C. at a depth of 50 cm from the soil surface or at a lithic or paralithic contact whichever is shallower. See Isothermic.

Thermogenic soils. Soils with properties that have been influenced primarily by high temperature as the dominant soil-formation factor; normally developed in subtropical and equato-

rial regions or in areas surrounding active hydrothermal geologic features.

Thick mollic epipedon. >40 cm in thickness.

Travertine. A finely crystalline, massive deposit of calcium carbonate of white, tan, or cream color, formed by chemical precipitation from solution in surface and ground waters, esp. hot springs. One of the three major types of hydrothermal areas in Yellowstone National Park. See Neutral-high chloride, Acid sulfate.

Trellis stream drainage pattern. A drainage pattern characterized by parallel main streams intersected at or near right angles by their tributaries, which in turn are fed by elongated secondary tributaries parallel to the main streams, resembling in plan the stems of a vine on a trellis.

Tuff. A compacted deposit that is 50 percent or more volcanic ash and dust.

Tundra. A level or undulating treeless plain characteristic of arctic regions.

Udic. A soil-moisture regime that is neither dry for as long as 90 cumulative days nor for as long as 60 consecutive days in the 90 days following the summer solstice at periods when the soil temperature at 50 cm below the surface is above 5 degrees C.

Umbric epipedon. A surface layer of mineral soil that has the same requirements as the mollic epipedon with respect to color, thickness, organic carbon content, consistence, structure, and phosphorous content, but that has a base saturation <50 percent when measured at pH 7.

Undifferentiated group. A map unit consisting of two or more kinds of soils and/or miscel-

laneous areas that are not consistently coterminous, and occur in no discernible pattern. Every delineation has at least one of the major components and may have all. Each of the components need not be in every delineation.

Universal Transverse Mercator (UTM). The ellipsoidal Transverse Mercator to which specific parameters, such as central meridians, have been applied. The earth, between 84 degrees N and 80 degrees S is divided into 60 zones each generally 6 degrees wide in longitude. Bounding meridians are evenly divisible by 6 degrees, and zones are numbered from 1 to 60 proceeding east from the 180th meridian with minor exceptions. Each of these quadrangles is further subdivided into grid squares 100,000 meters on a side.

Upland. Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Ustic. A soil moisture regime that is intermediate between the aridic and udic regimes and common in temperate subhumid or semiarid regions, or in tropical and subtropical regions with a monsoon climate. A limited amount of water is available for plants but occurs at times when the soil temperature is optimum for plant growth.

Valley. An elongate, relatively large, externally drained depression of the Earth's surface that is primarily developed by stream erosion or glacial activity.

Value, color. The relative lightness or intensity of color and approximately a function of the square root of the total amount of light.

Variation. Refers to patterns of contrasting

colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Variety of rock types. Dominant rock types may vary widely.

Varve. A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by melt-water streams, in a glacial lake or other body of still water in front of a glacier.

Very gravelly, cobbly, stony, bouldery soil material. Material that is 35 to 60 percent by volume, rounded or angular rock fragments, not prominently flattened, in the indicated size class. See Rock fragments.

Volcanic glass. A natural glass produced by the cooling of molten lava, or a liquid fraction of it, too rapidly to permit crystallization. If ejected into air during eruption, it may contain many small holes or vesicles that hold a large amount of water relative to their volume. See Tephra.

Volcaniclastic. Pertaining to a clastic rock (principally made up of broken fragments derived from pre-existing rocks or minerals) containing volcanic material in whatever proportion, and without regard to its origin or environment.

Water-holding capacity. See Available water capacity.

Water table. The upper surface of ground water or that level in the ground where the water is at atmospheric pressure.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Weighted average percent clay. The proportion of clay-sized particles (by volume) compared to sand and silt sized particles. This is given for the control section as a whole, weighted by horizon depth within that section.

Weighted average percent rock fragments. The proportion of rock fragments (by volume) compared to the proportion of soil particles. This is given for the control section as a whole, weighted by horizon depth within that section.

Weakly developed. A term describing a soil having a mollic epipedon that is thinner than 18 cm, that meets the mollic requirements only after mixing the soil to 18 cm.

Welded tuff. A glass-rich rock that has been indurated by the welding together of its glass shards under the combined action of the heat retained by particles, the weight of overlying material, and hot gases. It is generally composed of silica pyroclasts and appears banded or streaky.

APPENDICES

Glaciation and Erratics

Large icecaps covered more than 90 percent of the park's area and were more than 3,000 ft (914 m) thick in places (Richmond 1977). There is evidence of three major glacial advances (early, middle, and late Pleistocene, respectively). These include the Pre-Bull Lake, Bull Lake, and Pinedale Glaciations, which left numerous glacial erratics in the northern sections of the survey area, especially the northern halves of the Mammoth and Tower Junction 15 minute quadrangles (Pierce 1973, 1974).

Erratics from Pre-Bull Lake glaciations are sparse and are no longer on the soil surface, but Precambrian erratics from the Absaroka Range have been found in Pre-Bull Lake glacial till deposits in the north and northeast sections of the Tower Junction quadrangle. These deposits show that glaciers reached the narrows just northwest of Tower Falls. Glaciers must have extended at least 30 miles from their source in the Absaroka Mountains to leave these deposits.

The Bull Lake Glaciation included two periods of major icecap development within the park, with the earlier stade (stage) beginning about 125,000 years ago. Deglaciation occurred about 45,000 years ago. Valley glaciers flowed west and north from the Absaroka Mountains, forming an icecap in Yellowstone Lake basin. This ice joined another major glacier in the Lamar River drainage. Three large Precambrian granitic erratics are located south of the Washburn Range, indicating that at some point glaciers flowed from the northern sections of the park to south of the Washburn Range. Other northern range erratics associated with the Bull Lake glaciation are located at least 15 miles southwest of the Tower Junction quadrangle.

Pinedale glaciation began about 25,000 years ago. Deglaciation occurred between 8,500 and 13,000 years ago, depending on location. Pinedale Glaciers coalesced into a thick icecap in the Yellowstone Lake basin. To the north, ice formed in the Yellowstone and Lamar River drainages and spread laterally to the southwest. Erratics from this ice are widespread to the north and south of the Grand Canyon of the Yellowstone. These erratics show that the northern glacier flowed over the Canyon area and also across Hayden Valley. A change from granitic erratics to erratics of basalt and andesite in Hayden Valley suggest a confluence of the northern ice with ice from the southeast. Granitic erratics also occur sparingly in a band of drift about 7.5 mi (13 km) wide that extends across the Norris Junction quadrangle.

All three stades of Pinedale glaciation are associated with large glaciers along the east to west trending Lamar and Yellowstone River drainages. These glaciers left the most prevalent and widespread deposit of erratics in the northern section of the park. These are quite evident on the landscape, and range from boulders to the size of small automobiles. Some of the larger boulders provide moist, protected microenvironments on their northern sides. These commonly provide growth sights for individual Douglas fir trees.

Many of these erratics can be seen along the Grand Loop Road from the head of Lava Creek Canyon to Tower Junction, especially on steeper northern slopes, and along the Northeast Entrance Road from Tower Junction and Junction Butte to the east border of the Tower Junction quadrangle. Erratics also occur atop Bunsen Peak, Terrace Mountain, and Mt. Everts, and are probably widespread on the Buffalo Plateau.

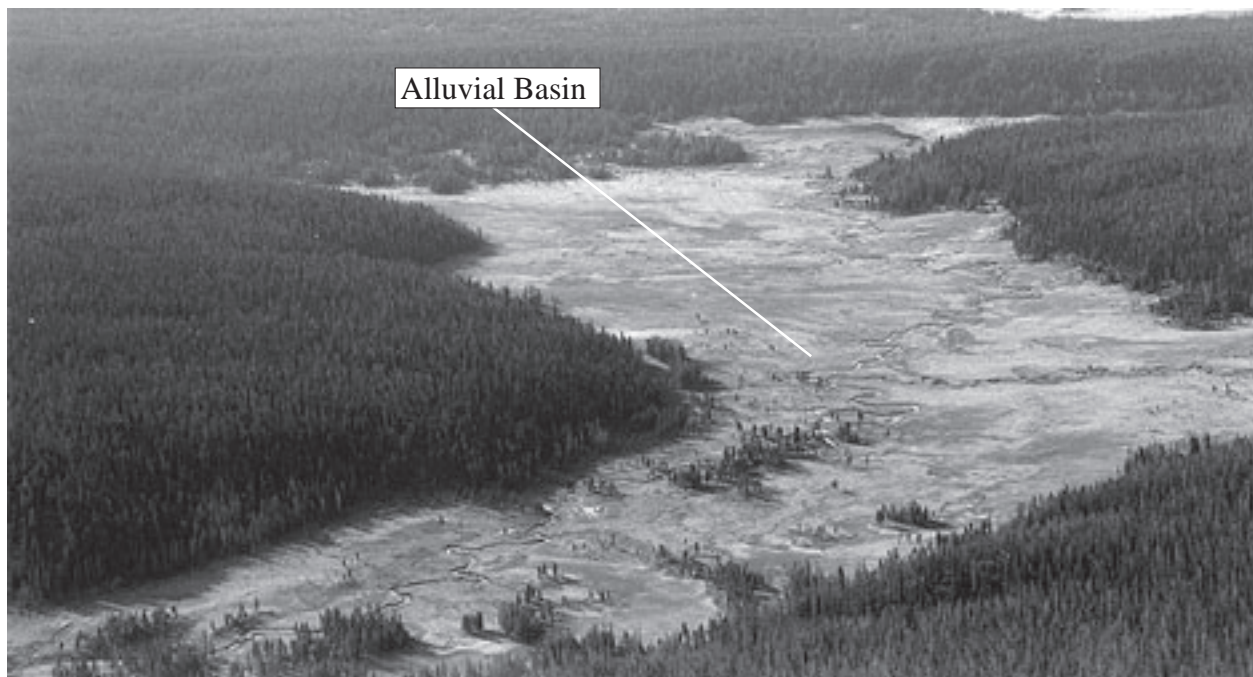


Figure 2. Alluvial Basin. An unusually broad opening in an otherwise narrow stream valley. Map unit 2662 represents this landform throughout the park.



Figure 3. Alluvial Fan. The fan-like deposit of a stream where it issues from a gorge out onto a plain or of a tributary stream near or at its junction with the main stream. Map units 2222 and 1721F are nonforested and can form from a variety of rock types. Map units 2207 and 2962 are forested and form from andesite or sedimentary rocks.

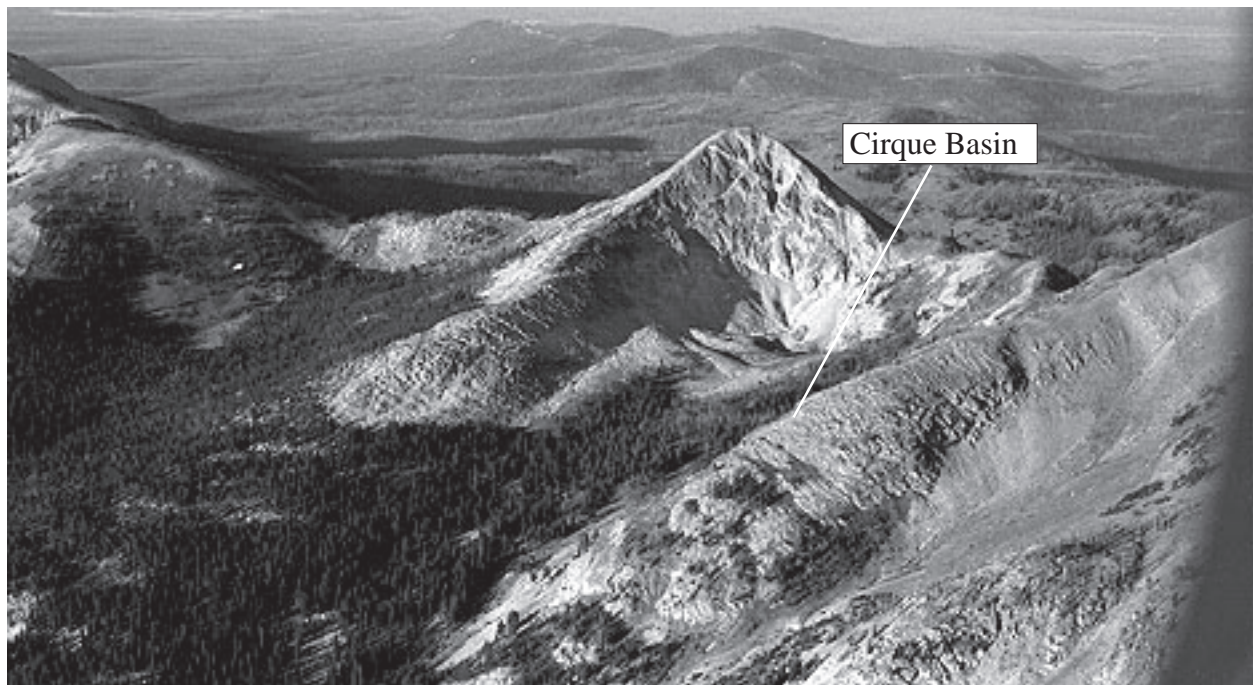


Figure 4. Cirque Basin. The semi-circular part of a cirque that is shaped like a bowl. Map unit 2561 is forested and map unit 9564 is nonforested; both form from andesitic material. Map unit 7562 forms from sedimentary rocks and can be either forested or nonforested.



Figure 5. Colluvial Slopes. A steep slope, having a mixture of talus and soil, formed by the slow downhill movement of material. Map unit 1358 forms from rhyolitic material and 1532 forms from granite or dacite. Both map units are forested.

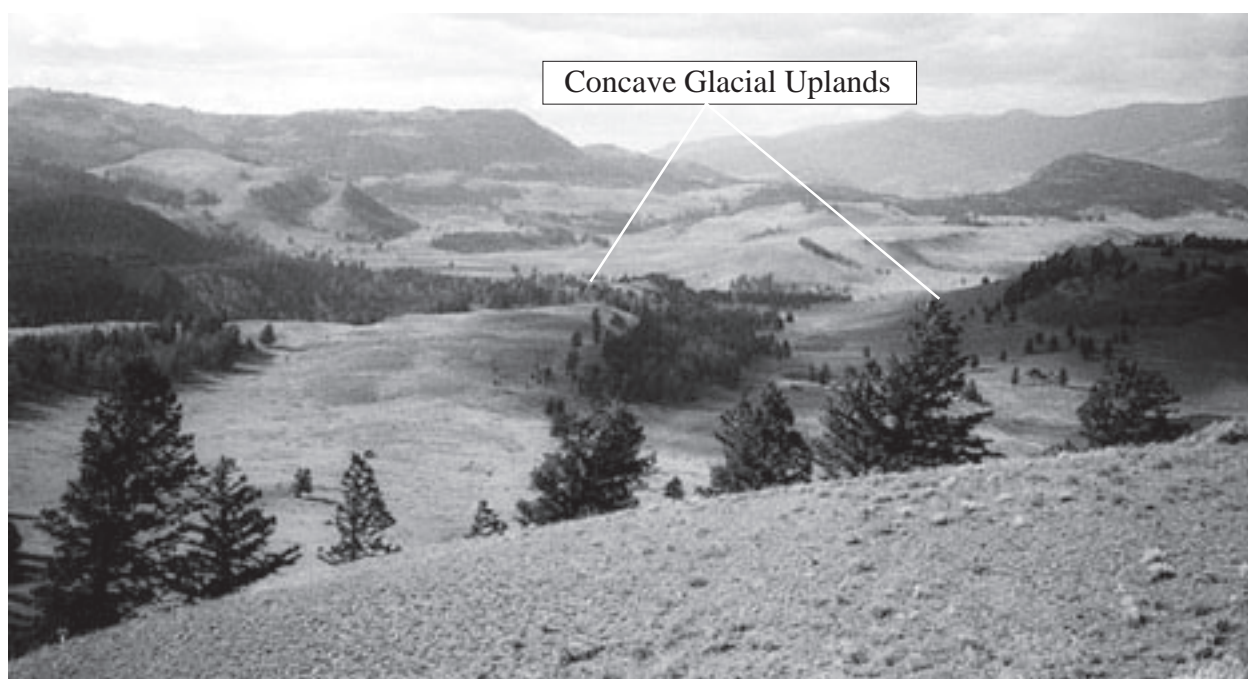


Figure 6. Concave Glaciated Uplands. Broad, valley-like landforms with a large scale "bowl" shape. This landform does not include glacial trough valley bottoms.

	Andesite	Rhyolite or tuff	Sedimentary	Other
Nonforested	2159, 2246, 2546	1865, 2025	2126, 2154	2543, 2924, 295F, 8715
Forested	2159, 2167, 2195, 2765	1865, 8863	127, 1752, 1762	2213, 2543, 295F, 8715

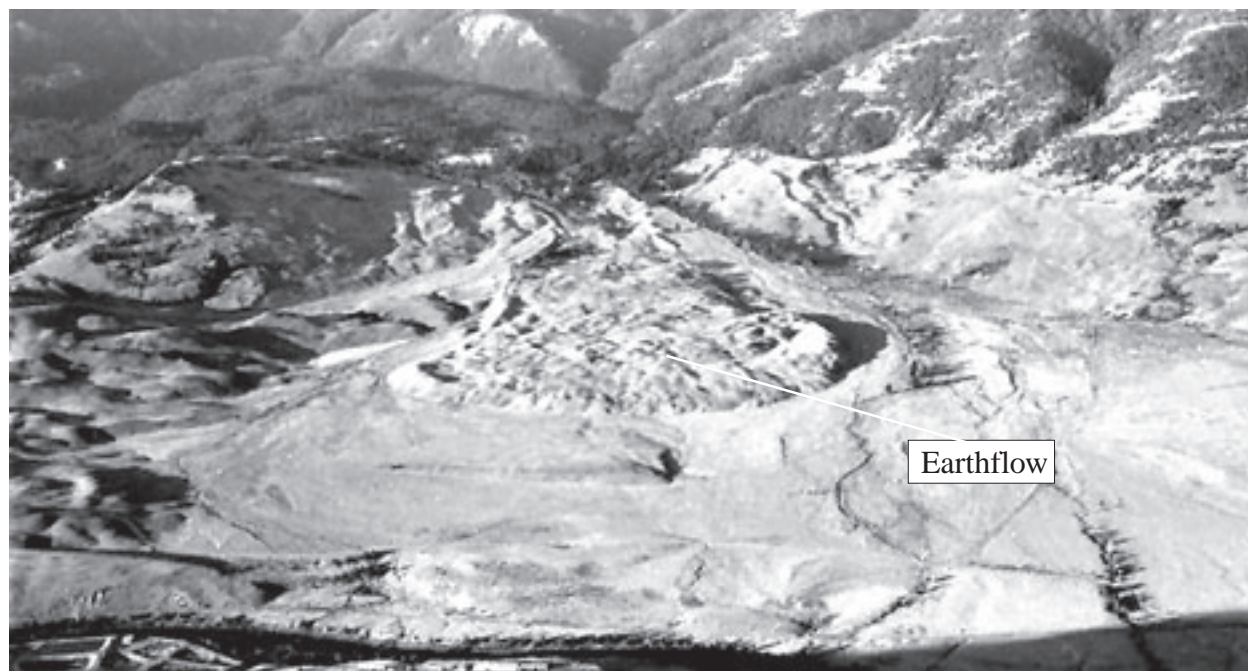


Figure 7. Earthflow. The depositional parts of a landslide which result from the rapid downslope movement of soil and rock fragments.

	Andesite	Rhyolite or tuff	Sedimentary	Travertine
Nonforested	2975	(none)	2975, 7172F	423Z
Forested	2915	1795	1795, 2915	423Z

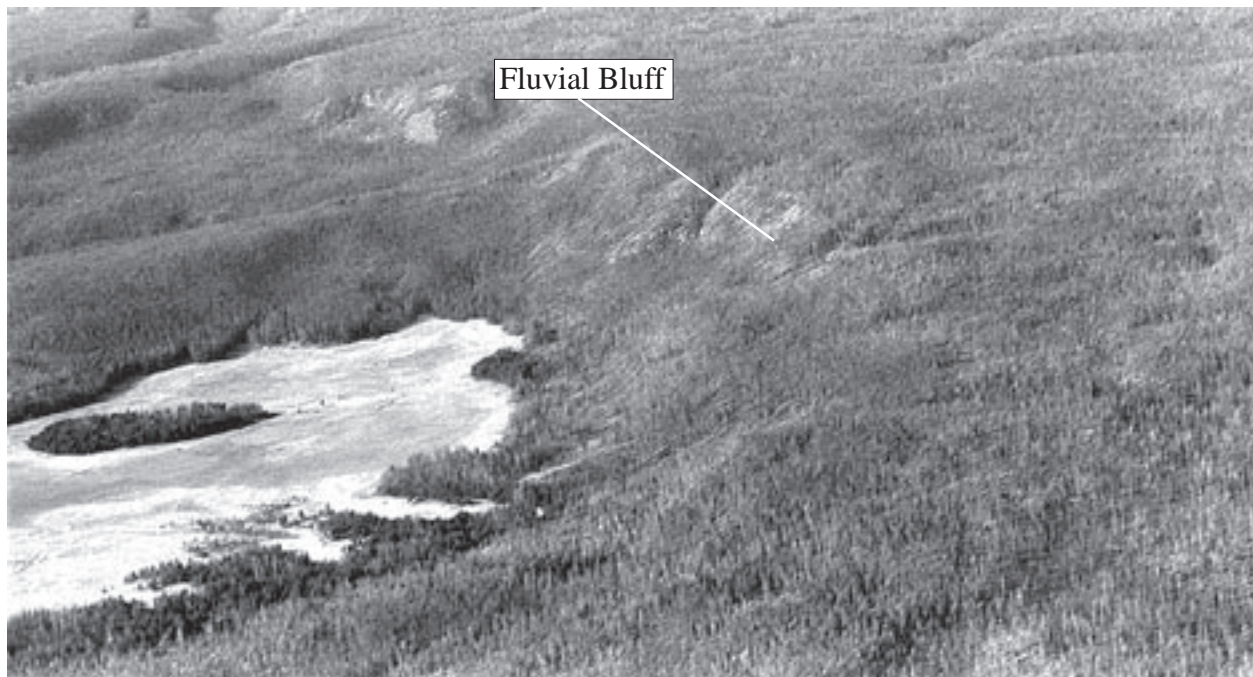


Figure 8. Fluvial Bluff. A convex bluff with a relatively simple slope configuration. The overall shape is a result of rhyolite flow boundaries and colluvial processes rather than glacial processes. Map units 513 and 5883 form from rhyolite or rhyolitic ash-flow tuff.

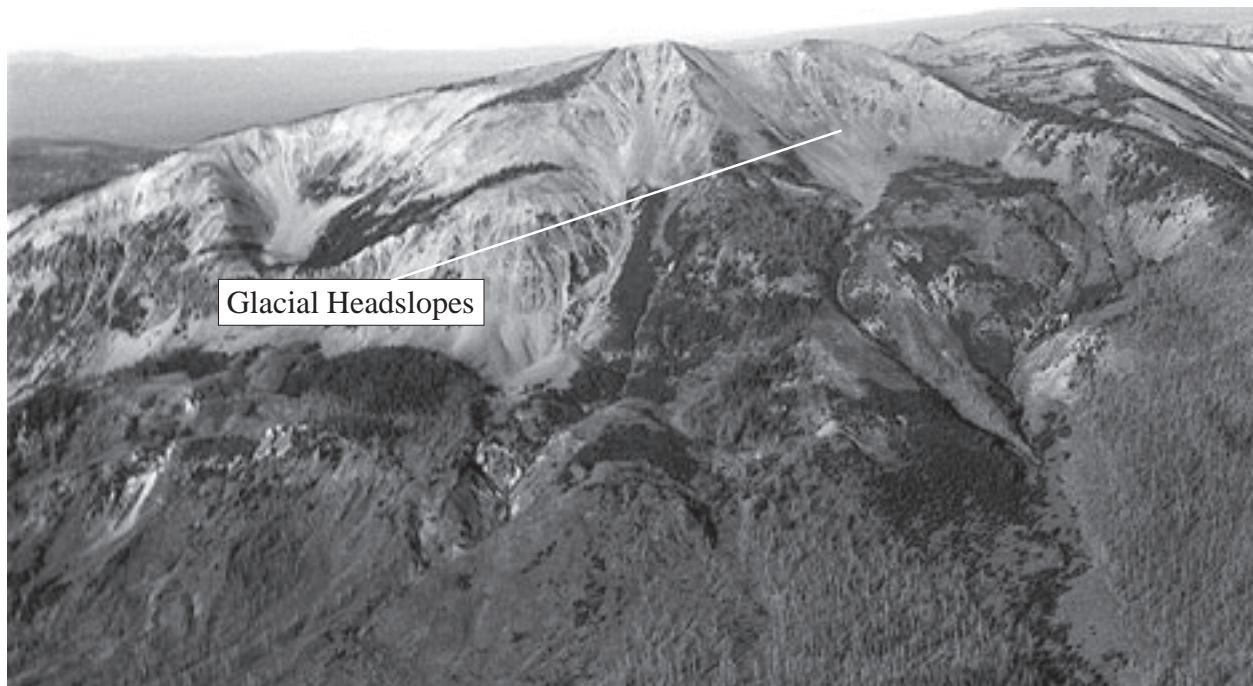


Figure 9. Glacial Headslope. A valley headslope or valley wall that shows evidence of glacial scouring and deposition in a direction perpendicular to the valley headslope or wall. Cirque-like features are present, but lack a well-defined basin.

	Andesite	Rhyolite or tuff	Sedimentary
Nonforested	2541	(none)	2154
Forested	2546	1583	1759

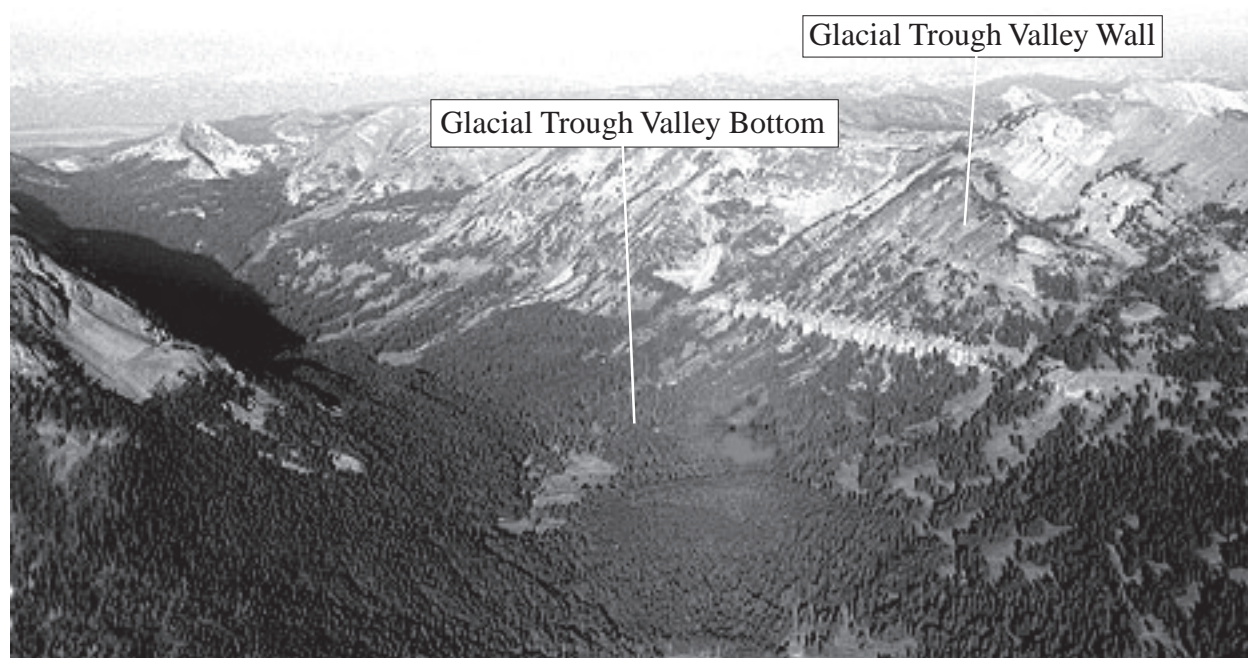


Figure 10. Glacial Trough Valley Bottom and Glacial Trough Valley Wall.

The valley bottom is the floor and lower side slopes of a glacially eroded valley.

	Andesite	Rhyolite or tuff	Sedimentary
Nonforested	2159, 2246	(none)	2154
Forested	2159, 2195	8853	127, 1752, 1762

The valley wall is the steep side slopes of a glacially eroded valley.

	Andesite	Rhyolite or tuff	Sedimentary	Mixed or metamorphic
Nonforested	5294, 554	513	5217F, 554	5217F, 554
Forested	2541, 522, 5419	1583, 513	1759	522



Figure 11. Glaciated, High Relief Uplands. Uplands with evidence of glacial molding and deposition. Maximum relief is greater than 1,000 feet. Map unit 1532 forms from dacite and granite under forested vegetation. Map units 2541 and 2546 form from andesite; 2541 is forested and 2546 is nonforested.



Figure 12. Glaciated Plateau. A plateau showing evidence of glacial scouring and deposition, but retaining its relatively flat, featureless appearance.

	Andesite	Rhyolite or tuff	Basalt or hydrothermal
Nonforested	(none)	1865, 8125, 835	2751, 358Z, 853Z
Forested	2167, 2765	1324, 1537, 1562, 1865, 3835, 7883, 8335, 835, 8357, 8835, 8853, 8863, 8883, 8886	2751, 358Z, 853Z, 8835, 8886



Figure 13. Glaciofluvial Complex. Glaciofluvial deposits in the form of terraces, stream bottoms, kames, and small plains.

	Andesite	Rhyolite or tuff
Nonforested	2996	2216
Forested	2962, 2972	1267, 1282

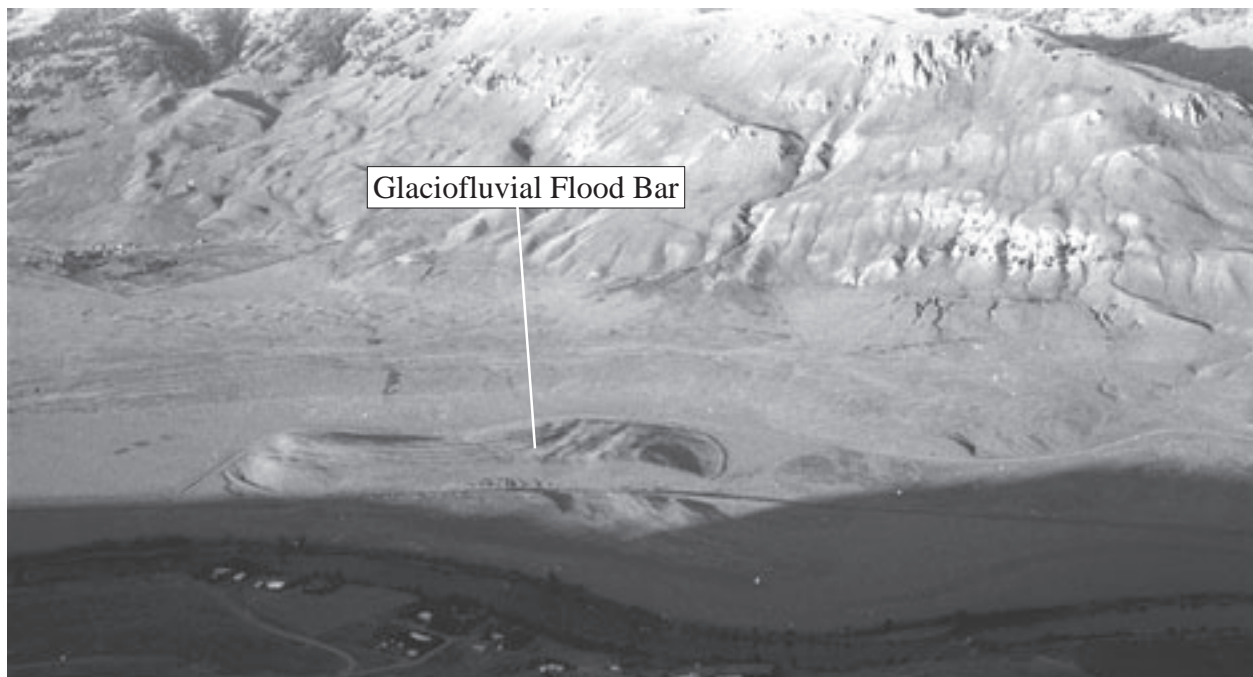


Figure 14. Glaciofluvial Flood Bar. Ridge-like landforms or flat terraces having a mixture of sand, gravel, and boulders. These were formed by large floods associated with glacial melting. Map unit 295F represents this landform in the northern area of the park.



Figure 15. Glaciofluvial Outwash Plain. This landform is commonly smooth and flat. It consists of sand, gravel and cobbles of glaciofluvial origin. Map units 1282, 182, and 2216 form from rhyolite or rhyolitic tuff. Map unit 1282 is forested, 2216 is nonforested, and 182 can be either forested or nonforested.

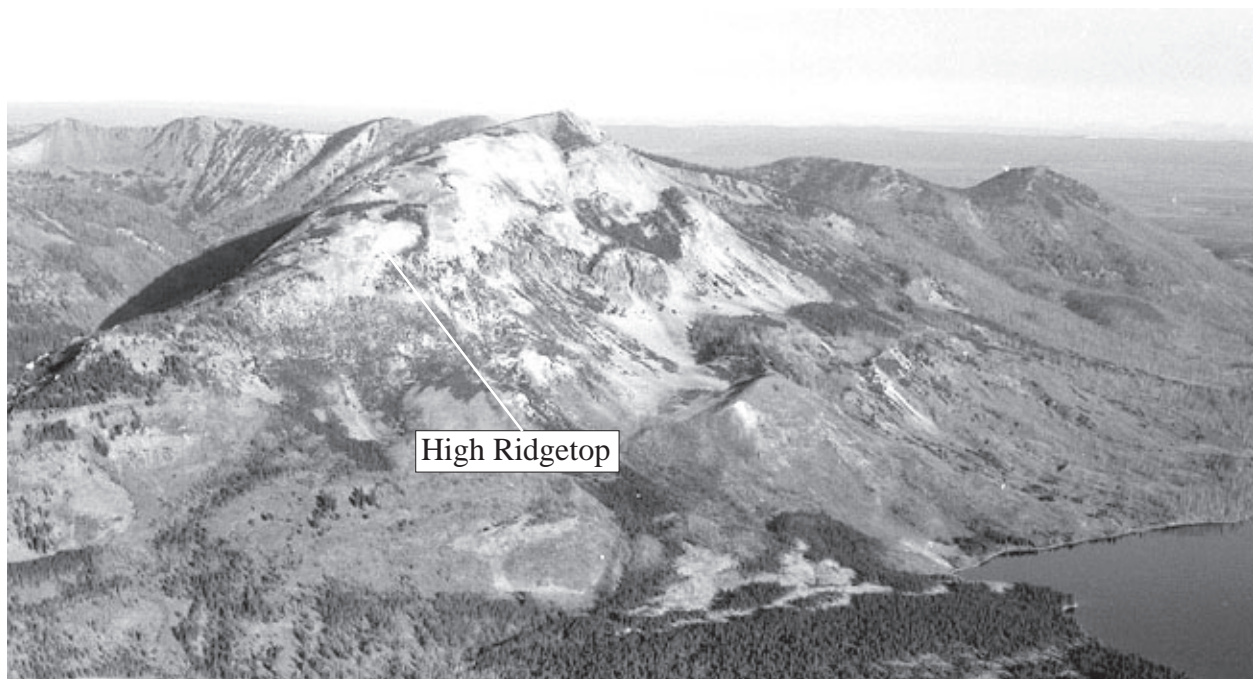


Figure 16. High Ridgetop. Broad, convex ridgetops above the elevation limit of the most recent general glaciation in the park. The most common regolith forming processes are frost churning and the addition of small amounts of loess. Map unit 2246 represents this landform throughout the park.



Figure 17. Lacustrine Plain. Flat and smooth expanse of glaciolacustrine deposits.

	Andesite	Rhyolite or tuff	Sedimentary or basalt
Nonforested	276, 2916	276, 2916	276, 2916
Forested	2961	812, 8167	2226



Figure 18. Pitchstone Plateau. An area of glaciated plateaus with rounded bedrock ridges formed from the most recent lava flows in the park. Map unit 835, in the southwest part of the park, represents this landform.

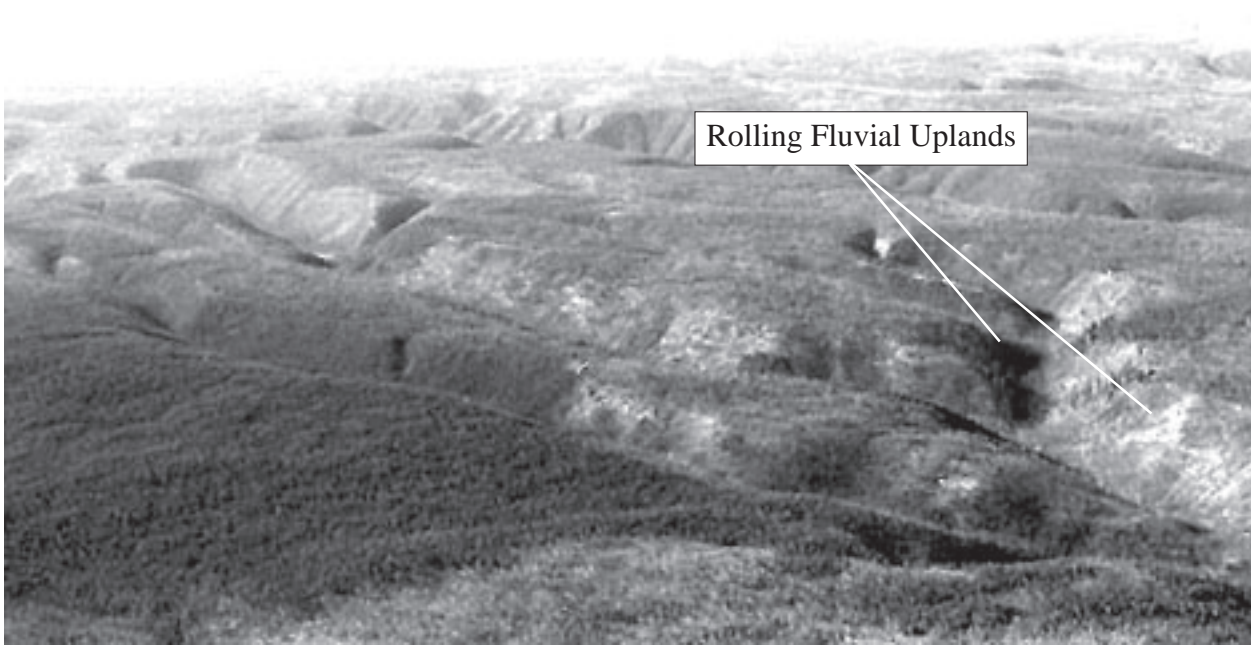


Figure 19. Rolling Fluvial Uplands. A complex of rolling, hilly slopes with no evidence of glacial scouring and deposition.

	Andesite	Rhyolite or tuff	Other
Nonforested	9251	2216	358Z
Forested	9251	1282, 1537, 7883, 8357, 8853	358Z

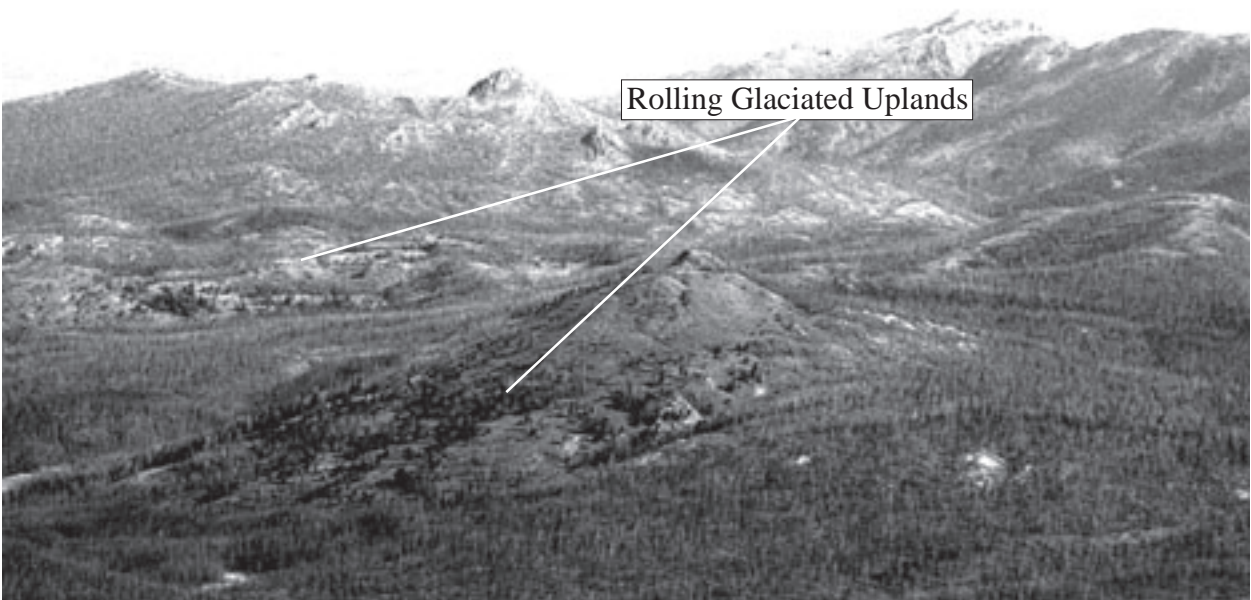


Figure 20. Rolling Glaciated Uplands. A complex of rolling, hilly slopes with evidence of glacial molding and scouring.

	Andesite	Rhyolite or tuff	Sedimentary	Metamorphic or mixed
Nonforested	2159, 2246, 5294, 9564	8125	2126, 2154, 7562	2543, 2924, 353Z, 358Z
Forested	2159, 2195, 2561, 522, 5419	1324, 1537, 1562, 1583, 7153, 8835	127, 1752, 1759, 1762, 7562	1532, 2213, 2522F, 2543, 353Z, 358Z, 522

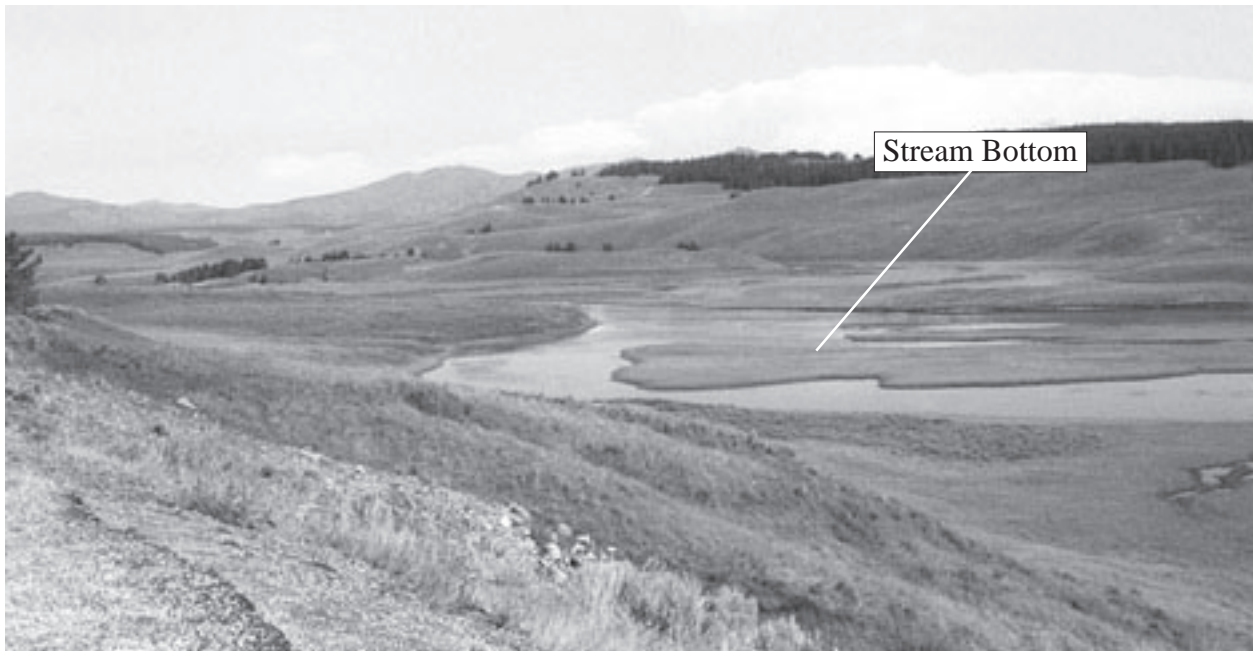


Figure 21. Stream Bottom. A relatively narrow, gently sloping area of active rivers and streams with recent alluvial deposits. This includes floodplains, low terraces, and small alluvial fans. Map unit 2261 forms primarily from andesite sediments and 8261 from rhyolite sediments.

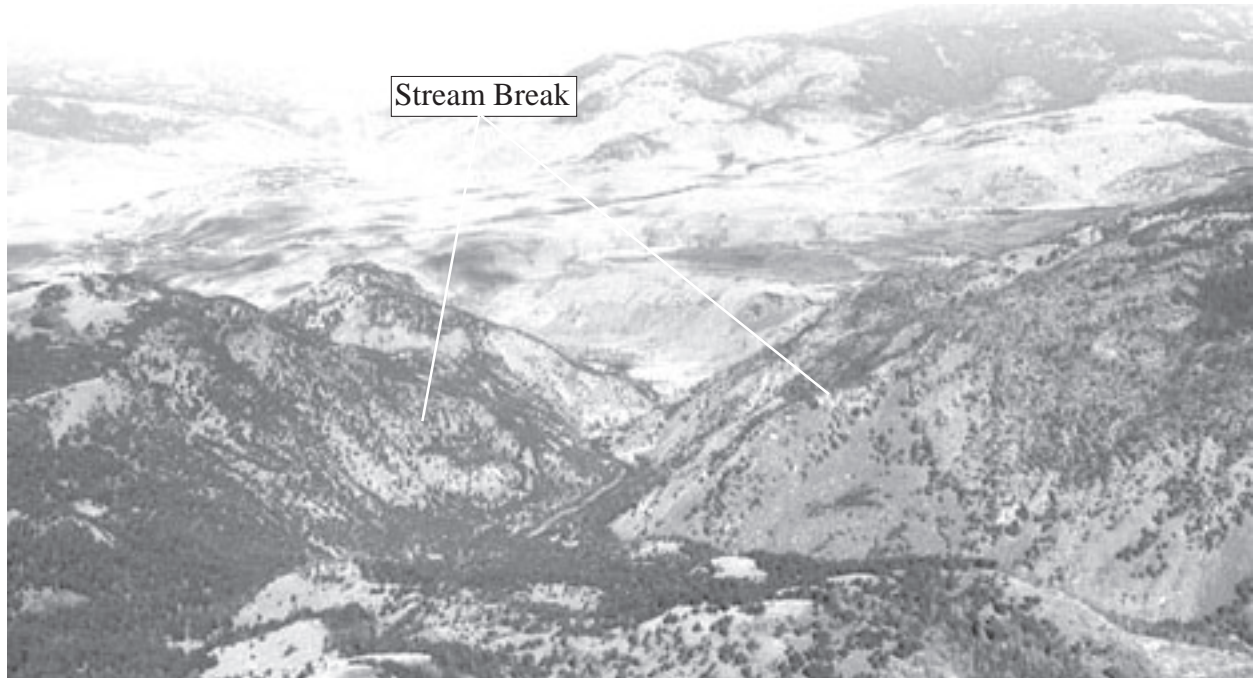


Figure 22. Stream Break. The steep to very steep broken land at the border of an upland summit that is dissected by ravines.

	Andesite	Rhyolite or tuff	Sedimentary	Schist and gneiss
Nonforested	(none)	513	5217F	5217F
Forested	2541, 522	1358, 2514, 5883	(none)	2522F, 522

Habitat Type Groups

Habitat types are considered to be basic ecological subdivisions of landscapes. Each is recognized by distinctive combinations of overstory and understory plant species at climax. They are named for the dominant or characteristic vegetation of the climax community. Habitat types are useful in soil surveys when assessing the combined effects of aspect, slope, elevation, and soil properties on potential plant growth.

The forested and nonforested habitat types used in this survey follow those defined in *Yellowstone Vegetation* (Despain 1990). The Habitat Type Table, which includes the most common habitat types, lists the habitat type abbreviations used in the document along with the corresponding scientific and common names.. Very wet areas, high elevation areas, and thermal areas have vegetation that is too variable, at our scale of mapping, to characterize with habitat type designations. These areas have been grouped and are briefly described below.

Alpine meadows.—a diverse group of habitat types, mainly occurring above 9,500 feet, that are dominated by alpine grasses and forbs.

Hydrothermal communities.—These communities have been divided into temperature zones similar to those used by Shepard (1971).

very hot (>60 °C)	bare ground hydrothermal material
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hot (40 - 60 °C)	moss community (only scattered patches in hotter areas) example - <i>Racomitrium canescens</i> , <i>Polytrichum</i> spp.
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moderate 1 (25 - 35, but up to 50 °C)	moss and grass community (some stunted lodgepole pine trees) example - <i>Agrostis scabra</i> , <i>Panicum</i> spp.
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moderate 2 (15 - 35 °C)	grass and forbs community (some stunted lodgepole pine trees) example - <i>Chrysopsis villosa</i> , <i>Heterotheca</i> spp.
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low (<25 °C)	transition communities (from thermal into nonthermal) forests, meadows, and wet areas
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Marsh areas of Carex species.—very wet areas dominated by various species of sedges (for example, water sedge [*C. aquatilis*] and inflated sedge [*C. vesicaria*]).

Marsh areas of Salix species.—very wet areas, dominated by various species of willow, with sedges and reedgrass growing under willows.

Wet forest habitat types.—habitat types in the Engelmann spruce series, mainly PIEN/EQAR (Engelmann spruce/common horsetail), and the ABLA/CACA (subalpine fir/bluejoint reedgrass) habitat type.

Assumptions in Classification

Cation Exchange Capacity (CEC) Activity Classes for Soil Families

Cation exchange activity classes based on CEC to clay ratio are used to modify mineralogy classes in differentiating families of mineral soils as follows:

CEC/clay > 0.6: superactive

CEC/clay 0.4 to 0.6: active

CEC/clay 0.24 to 0.40: semiactive

CEC/clay < 0.24: subactive

Rock type mineralogy largely determines the type and activity of clay in soils (Dixon and Weed 1977). For this reason, activity classes in the park are based on the most abundant rock type found in the soil profile. This assumes that the clays are weathered from the dominant rock type found in the soil profile with the exception of sedimentary rocks. Because sandstone is more resistant to local weathering processes than siltstone, shale or limestone, it often occurs in the profile yet contributes relatively little to clay activity.

All pedons with laboratory analysis are classified according to the above guidelines. All others are classified as follows, based on analysis of 110 pedons with laboratory data.

Andesite - superactive

Basalt - superactive

Dacite - superactive

Granite - superactive

Rhyolite - mostly superactive, a few active

Limestone - superactive

Mineralogy

Based on complete laboratory analysis, all of the mineral soils classified in Trettin (1986) had mixed mineralogy. This conclusion, combined with results from complete laboratory analysis on 20 additional pedons, supports

our assumption that all mineral soils in the park have mixed mineralogy, with a few exceptions in particular parent materials. For example, in neutral chloride hydrothermal areas many Entisols have siliceous, rather than mixed mineralogy.

Percent Base Saturation

Taxonomic classification of soils is sometimes dependent on percent base saturation (%BS) of soil horizons. The Mollisol order and some Inceptisol subgroups have specific %BS requirements. The high cost of laboratory analysis limited the amount of calculated %BS data available to the soil survey staff. A standard practice used in soil surveys is to use pH values to estimate %BS after correlation with existing data. Until recently, the Gallatin National Forest "pH versus base saturation" curves were used to predict base saturation in Yellowstone National Park (Henry Shovic, Gallatin National Forest Soil Scientist, personal comm.). These were modified for the Yellowstone study area because soil forming factors vary somewhat from those used in the Gallatin area.

Based on these modified relationships, we concluded andesite parent materials have %BS greater than 50% in all horizons. For soils derived from parent materials other than andesite, pH 5.5 and pH 5.9 indicate greater than 50% and 60% base saturations respectively.

Soil Moisture Regime

The moisture regime for most of the park is ustic. This regime was determined through comparison with established regimes in neighboring survey areas adjoining the park. Exception to the ustic moisture regime are in hydro-

thermal areas where the moisture regime is considered udic or moister due to the continual presence of steam and hydrothermal waters.

Soil Temperature Regimes

Based on unpublished weather data, most of the park is assumed to be in a cryic soil temperature regime. A small area in the north is probably in a frigid soil temperature regime. Soils in hydrothermal areas often have soil temperature regimes (mesic, isomesic, thermic, isothermic, hyperthermic, and isohyperthermic) that are warmer than cryic or frigid.

We determined the boundaries between cryic and frigid temperature regimes using relationships developed in the adjoining National Forests. These relationships correlate slope, aspect, and vegetation to soil temperature (unpublished documents on file in Yellowstone National Park). The following guidelines are used to determine cryic and frigid temperatures regimes in the park.

(1) The temperature regime for Yellowstone is assumed cryic in all areas above 7,500 feet.

(2) Between 6,000 feet and 7,500 feet, the temperature regime is assumed frigid if the aspect is south, southeast, or southwest, the

slope is greater than 25 percent, and the habitat type is any of those listed below in (3).

(3) Below 6,000 feet, the temperature regime is assumed frigid on any slope and aspect that has the following habitat types: PSME/SYAL, PSME/CARU, PSME/SPBE, PSME/PHMA, ARTR/FEID, ARTR/AGSP, mudflow mosaic, AGSP/POSA, FEID/AGSP, FEID/AGCA. See the Habitat Type Table for the scientific and common names associated with these abbreviations.

We delineated a frigid temperature regime zone in the northern part of the park based on (2) and (3). All map units within this zone are dominated by soils with frigid soil temperature regimes. Outside of this zone, soils with frigid temperature regimes are treated as inclusions.

Soil temperature data were collected in hydrothermal areas by Yellowstone soil survey staff between 1989 and 1995. Mean annual soil temperatures within thermal areas varied between 10 and 80 degrees C depending on location. We found temperatures at depths less than 40 cm were significantly effected by diurnal variation, and temperatures at greater depths were primarily determined by the relatively constant input of geothermal heat.

Hydrothermal Soil Studies

Hydrothermally-altered volcanic rocks and secondary mineral deposits from magmatically-heated groundwater are parent materials for over 20,000 ha of soils in Yellowstone National Park. These hydrothermal soils form a critical component of the park's fragile thermal ecosystems and support a unique population of plants and other soil biota (Despain 1990). Knowledge of the properties and genesis of these soils is important to ecologists, microbiologists, and other scientists who study, utilize, and seek to preserve these areas.

The purpose of this appendix is to provide a brief overview of the geology, hydrothermal chemistry, and properties of soils in selected acid sulfate and neutral chloride hydrothermal areas. Research on hydrothermal soils is part of an ongoing project in the Yellowstone National Park soil survey. This is a cooperative project between Yellowstone National Park and the USDA, Natural Resources Conservation Service. Mike Wilson, Ph.D. is the principle USDA investigator and contributed this summary paper.

Geology and Hydrothermal Chemistry

Yellowstone National Park is in the Middle Rocky Mountain Province (Thornbury 1965). Hydrothermal soil study sites are located on the Yellowstone Plateau, a 6500 km² volcanic region which has been intermittently active for at least 2.2 million years (Christiansen 1984). The plateau is composed of glaciated volcanic materials, principally rhyolitic ash-flows (tuff) and viscous lava flows, deposited during three cycles of caldera-forming eruptions. Principal surficial stratigraphy in our study area is the 630,000 year old Lava Creek Tuff and numerous younger (<165,000 year old) rhyolite flows.

Tuff is an ash-sized (< 2-mm) pyroclastic deposit, exploded from volcanoes in combination with heated magmatic gases. This mixture is not ejected high in the air, but remains near the ground surface, retaining heat, and undergoing varying degrees of consolidation, "induration" (welding), devitrification, and vapor phase mineralization (Ross and Smith 1960). The latter two processes result in formation of crystalline minerals, principally SiO₂ polymorphs and feldspars in the Lava Creek Tuff. Relative to this tuffaceous unit, rhyolite flow deposits in Yellowstone are less "devitrified" (composed of a greater amount of volcanic glass), but have a similar suite of crystalline minerals.

A system of fractures and tectonic faults within and along the caldera perimeter serve as major conduits for deeply-circulating groundwater. This groundwater is magmatically-heated to temperatures > 200°C (Fournier 1989), solubilizing minerals in contacted geologic units underlying the hydrologic region and absorbing volcanic gases such as H₂S.

Cooling of this groundwater as it reaches the surface results in supersaturation with respect to the solute load. The solute composition, and therefore the elemental composition of any resulting mineral deposit, depends on the traversed geologic units along fracture zones. For example the deposit may be siliceous (e.g., the "geyserite" (siliceous sinter) deposits of Lower and Midway Geyser Basins) or calcareous (e.g., the travertine deposits of the Mammoth Terraces). In Yellowstone National Park, the predominance of rhyolitic stratigraphic units results in a preponderance of silica-rich deposits.

Groundwater reaching the surface is typically near neutral in pH, a favorable condition for deposition of SiO_2 from silica-saturated solutions. These areas are termed neutral chloride, because of the pH and the high concentration of Cl^- in solution.

Depending on the relative abundance of magmatic H_2S in this groundwater, acidification of certain landscapes may result through the oxidation of this gas to H_2SO_4 by *Thiobacillus* and other S-oxidizing bacteria in the soil “vadose” zone (that soil above the water table but moistened by it through capillary action). This results in development of acid sulfate chemistry, precluding the abundant deposition of siliceous sinter found in neutral chloride areas by inhibiting silica polymerization and by the formation of silica-sulfate solution complexes (Fournier 1985).

These two chemistries, acid sulfate and neutral chloride, represent two endpoints in the rhyolite-based hydrothermal areas of Yellowstone. Both chemistries represent accumulations of silica: acid sulfate by the loss of alkali and alkaline earth elements resulting in concentration of remaining siliceous minerals and residue, and neutral chloride from abundant silica precipitation. The exact chemistry which controls an area is variable between these chemical endpoints and may vary over time depending on relative H_2S in groundwater and water table levels of an area.

Study Sites

As a part of the field and laboratory pedon characterization program for the park soil survey, 10 pedons in four hydrothermal areas were sampled. Sample sites represent acid sulfate (Norris Annex and Solfatara Plateau), neutral chloride (Nez Perce Creek), and traver-

tine or CaCO_3 (Mammoth Terraces) chemistries. Ongoing laboratory investigations are currently focused on acid sulfate and neutral chloride areas.

The Norris Annex site is located directly east of Norris Geyser Basin ($44^\circ 43' 41''\text{N}$, $110^\circ 41' 49''\text{W}$). Centered within this site is a small hydrothermal basin. Soils within the basin and surrounding landscape have developed in glaciated Lava Creek Tuff and have undergone acid sulfate alteration. Two pedons were sampled. One pedon is on the basin sideslope where stunted lodgepole pines (*Pinus contorta* Dougl. ex. Loud var. *Latifolia* Engelm. ex Wats.) (Dorn, 1992) and small areas of juniper moss (*Polytrichum juniperinum* Hedw.) are capable of establishment. At lower elevations within the basin, temperature and chemical restriction prevent vegetational growth. The second pedon is on an upland interfluvial position to the south. Lodgepole pine at this location appears similar in size and density to other non-hydrothermal rhyolitic areas in the park, though this site has limited development of understory vegetation. It is estimated at 10–15% coverage and consists of juniper moss and lichen (*Cladina nitida* Sanbst., Hustich).

The Solfatara Plateau site is 12 km east of the Norris Annex along the Canyon-Norris Road ($44^\circ 42' 41''\text{N}$, $110^\circ 33' 11''\text{W}$). Soils in this acid sulfate area have a parent material composed of weathering products from the 110,000 year old Solfatara Plateau Unit, a vitrophyritic rhyolite flow. This hydrothermal area is composed of multiple small basins. Three pedons were sampled along a 4 m pit dug perpendicular to the contour of a selected basin. This pit traversed a landscape boundary represented by a change in soil color and a progressive loss of vegetation downslope.

Vegetation is moss, panicgrass (*Panicum acuminatum* Sw), hairy golden-aster (*Heterotheca* spp.), and other small forbs.

The Nez Perce site is along Nez Perce Creek, located 3 km northeast of the Lower Geyser Basin (44° 34' 19"N, 110° 48' 18"W). This neutral chloride alluvial area contains soils forming in siliceous deposits that are either hard, platy materials or soft, slightly thixotropic deposits. Pedons were sampled to characterize soils developed in both materials. Vegetation is lodgepole pine in moderately well to well drained soils on stream terrace positions, and tufted hairgrass (*Deschampsia cespitosa* L., Beauv.), alkali cordgrass (*Spartina gracilis* Trin.), slender wheatgrass (*Elymus trachycaulus* Link, Gould ex Shinnery.), and Hall's sedge (*Carex parryana* Dewey var. *unica* Bailey) on poorly drained soils.

Properties of Hydrothermal Soils **Acid Sulfate Soils**

Acid sulfate soils are characterized by an extremely acidic pH, ranging from 5.3 to 2.1, and soil temperatures ranging from ambient to 78°C. Acidification and acid leaching are the major processes in these soils, removing bases and other plant nutrients, and accelerating rates of mineral alteration and dissolution relative to non-hydrothermal soils. The most extreme areas of acidity are principally aligned with fracture zones, which serve as conduits of water, heat, and gases. These zones generally coincide with basin floors, which areas of principal water movement and greatest subsidence. Basin floors and sideslopes are characterized by the lack or presence of sparse, stunted vegetation and accelerated rates of erosion. In higher landscape positions, weathering occurs from both acidic water held in pores and vapor phase alteration.

Soils in acid sulfate areas are weakly developed, with most pedogenic (soil forming) activity in the upper 20-30 cm. Hydrothermal alteration continues below the depth where pedogenic processes are active. Soils have ochric surface horizons and cambic subsurface horizons on more stable, less acidic upland landscape positions. Pedons at these sites classify as Typic Trophents or Dysuric Cryochrepts (Soil Survey Staff, 1994), and similar soils in acid sulfate map units include the great groups of Dystropepts and Cryochrepts. Soils are bleached white from loss of Fe oxide coatings on mineral grains, though surface horizons are generally darkened by organic matter. Horizon textures are sandy loams and loamy sands and soils have low water holding capacity. Organic matter is the major source of cation exchange capacity and extractable bases, and greatly increases water retention.

Soils forming from tuff and volcanic flow parent materials have similar suites of minerals in both the sand and clay fractions. The sand fraction is generally composed of quartz, cristobalite, tridymite, volcanic glass, and feldspar. Devitrification occurred to a greater extent in tuff deposits relative to volcanic flow materials at the Solfatera site. This has resulted in lower amounts of glass in hydrothermal soils from tuff.

Feldspars and volcanic glass are most susceptible to hydrothermal alteration in these soils. Other minerals, such as pyroxenes, biotite, or hornblende, if present, would undergo alteration or dissolution as well. These latter minerals exist in very low concentrations in these parent materials and soils.

The clay fraction is composed of cristobalite and kaolinite, with lesser amounts of goethite

and alunite. These terms are defined in Dixon and Weed (1977). Cristobalite is a primary mineral from the original volcanic deposition. Kaolinite, alunite, and goethite are secondary minerals which form through alteration of feldspars. Kaolinite has been identified as both sand-sized pseudomorphs from feldspar and as yellow to red, oriented, laminar deposits in voids associated with Fe oxides. These two secondary minerals are present only in horizons with a pH > 3.2, suggesting the relative instability of these weathering products under hydrothermal alteration at a lower pH.

Neutral Chloride Soils

Silica concentrations in groundwater are often similar in both acid sulfate and neutral chloride areas. While deposition of silica is minor or absent in acid sulfate soils, the near neutral pH of neutral chloride areas favors deposition and accumulation of siliceous organic and inorganic deposits.

Groundwater in neutral chloride areas typically emerges from hot springs. This heated water may flow from the mouth of the spring in a dispersed, fanlike pattern forming a spring apron, or channelized in a narrow flow. Silica precipitates from this groundwater as a non-crystalline mineral, opal-A (Jones and Segnit, 1971). Precipitation initiates on mats of phototropic bacterium which provide nucleation sites (Schultze-Lam et al., 1995), or by homogeneous nucleation in solution (Fournier, 1985). This non-crystalline silica forms hard, platy morphologic forms. These deposits tend to build up slowly along the opening and sides of a hot spring. Deposition results in an increasingly small spring opening, eventually forming a dome and completely encapsulating the spring.

Along the stream terraces of Nez Perce Creek, older hot spring deposits are weathering into shallow, skeletal soils, with channery siliceous rock fragments. These soils classify as Lithic Cryochrepts. The great group classification of other similar soils included in these map units are Udorthents and Eutrochrepts. Textures in the sampled pedon are loamy sands and sand loams, and the soil pH ranges from 5.0 at the surface to 6.9 in the Cr horizon at 19 cm. Mineralogy and micromorphology of these soils suggest that alluvial or colluvial deposits from non-hydrothermal rhyolitic soils are mixed with the original parent material in the fine earth fraction.

Behind and on the sides of existing hot springs, and overlying former hot spring deposits, are hydric soils saturated with groundwater at ambient temperature. Scanning electron microscope observations suggest that both inorganic and biogenic silica deposits accumulate, combining to form soft, low density aggregates of diatoms, plant opal, and inorganic flakes of opal-A. The matrix of this soil is white in color, with upper horizons darkened by organic matter accumulation. The sampled pedon has a solum depth of 36 cm, contacting an R horizon at 51 cm. This R horizon is a white, platy siliceous material suggesting this present soil overlies a former hot spring deposit.

This pedon classifies as a Typic Cryaquept, and other similar soils in the map unit are Tropaquepts. The texture of upper horizons is silty clay loam or silty clay. The pH ranges from 6.6 to 6.8 and the NH_4OAc -base saturation is at or near 100% for all horizons. The mineralogy is predominantly opal-A in the clay and sand fractions, though small amounts of

quartz and feldspar are found in the sand fraction, probably due to alluvial deposits originating from non-hydrothermal soils.

Conclusions

Hydrothermal soils in Yellowstone National Park are complex entities with diverse origins and properties. This diversity of properties is principally related to the surficial stratigraphy, the geologic strata through which the magmatically-heated groundwater travels, the inclusion and subsequent oxidation of H_2S , and

the differences in landscape position within a particular area.

Examples of this diversity are clearly exhibited in comparing acid sulfate and neutral chloride soils. Both groups of soils represent silicification, but by different processes. Acid sulfate soils form in existing geologic deposits undergoing acid degradation with little to no secondary mineral deposition, while neutral chloride soils form in silica minerals deposited from groundwater.