	21.81	ACADIA NATIONAL PARK (1919)	
(Acres)	(Sq. Miles)	(Name of Area)	
		Maine Coast	Hancock
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: Granite mountains on Mt. Desert Island and a bold point on opposite mainland across Frenchmans Bay.

GEOLOGY: This topographically prominent area, which includes the Lafayette (Acadia) National Park on our Atlantic coast, presents many interesting problems in igneous, metamorphic, and physiographic geology. The ancient Ellsworth schists and the later Bar Harbor sediments, 700 to 800 feet (the lower Cambrian age will be discussed in a later paper) and related agglomerates have been severely brecciated and much altered by a series of plutonic rift injections. Revising previously published reports, first in order came a dioritegabbro, then a hornblende granite, which forms the bulk of the island, and a commercial biotite granite not hitherto outlined. Probably associated with the first and last of the abyssal intrusions, came, respectively basic sills and flows now much changed and acid rhyolite-dacite dikes, sills, and flows. All formations have been extensively cut by two sets of trap dikes, probably of Triassic age. The bold relief of this region, produced by differential erosion in rocks of widely varying resistance, gives abundant opportunity to study the igneous and metamorphic history. The fiord coast shows many fine examples of shoreline features and in the high marine fossiliferous clays proofs of post-glacial uplift.

Charles Wilson Brown: Bull. Geol. Soc. Am., vol. 40, 1929, p. 108.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

(10315

1,222,000 (Acres) | (Sq. Miles) | BIG BEND NATIONAL PARK (PROPOSED) (Name of Area)

(C.C.C. Camps) | (Period) | Texas (State) | Brewster (County)

DESCRIPTION OF AREA: The establishment of Big Bend National Park gives the first opportunity to set up an area that will contain a complete biological unit. In the Chisos mountains the Service has the only complete mountains in a national park. The park also contains a variety of geological phenomena not found in an area of similar size in the United States. The area is also important as a part of an international park, a long-horn cattle ranch, and is replete with the colorful border history of this section.

GEOLOGY: The Big Bend area offers the happy combination of geologic problems that appeal alike to the experienced professional and the amateur. The variety of geologic phenomena is so great that illustrations can be found of almost every phase of the science. The simple examples of geologic phenomena which are apparent to all are combined in more and more intricate associations so that the student may progress from simple to complex, until at last he reads the geology as he would a printed page.

After the Rio Grande leaves Santa Helena Canyon it flows in a southeast direction parallel to the direction of the Rocky Mountain folding. At the Big Bend it changes its course and flows in a northeast direction parallel to the folding of the Marathon Basin which is a part of the Appalachian Mountain Orogeny. There is no other region in the United States where these two great systems of mountain building are superimposed upon each other and it is interesting that the Rio Grande, in outlining the Big Bend, should be controlled by these lines.

-----------After Wegemann.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

(10315F

SOLITARIO UPLIFT AND BIG BEND

AGE		FORMATION	THICKNESS	CHARACTER
Recent		Alluvian		
Tertiary		Chisos volcanics	2,000±	Lava flows and tuffs in thin even beds, with thin strata of clay, conglomerate, and cross-bedded, ripple-marked sandstone. Considerable bentonite.
		Unconformity		
UPPER CRETACEOUS	Navarro	Tarnillo clay	600±	Green, blue, yellow, brown and black clays with thin hard sandstone lentils; weathered surfaces covered with iron-stone and other concretions.
	Navarro / Taylor	Aguja formation	600±	Composed of coarse-grained fossiliferous sandstone; lustrus to dull black, non-marine, carbonaceous lignite-bearing shales with purple, vermillion and greenish-gray shales at top; and massive shelly clays weathering yellowish-brown.
	Taylor / Austin	Terlingua clay	1250	Thin to medium-bedded laminated, slightly shaly flags, breaking into diamond shaped blocks. Upper part a typical marl. Fossiliferous. Siliceous limestone at base.
	Eagle Ford	Boquillas flags	600	Contains a few ammonites, fish remains, and other fossils.
	Woodbine			
		Unconformity		
LOWER CRETACEOUS	Washita	Buda Limestone	50-60?	Dense, hard, fine-grained buff to light gray limestone, with a smooth conchoidal fracture. Clayey and nodular in some portions.
	Washita	Grayson (Del Rio)	23-30	Thin, calcareous, and siliceous flagstones, with large numbers of large arenaceous foraminifera, <u>Haplostiche texana</u>. Ripple marked.
	Washita	Georgetown	500-800	Entire formation composed of reef limestone facies in Big Bend area.
	Fredericksburg			
	Fredericksburg	Edwards	800+	Crystalline, calcitic, and flint-bearing limestone; caprinids, <u>Eoradiolits</u>, and other radiolites.
	Fredericksburg	Comanche Peak	2-12	Nodular limestone, fossiliferous in places.
	Fredericksburg	Walnut	50-100	Marls, sandy marls, and thin limestones.
	Trinity	Shafter (Glen Rose)	700	Thin to medium-bedded, but mostly massive limestone with some marly beds.
	Trinity	Presidio (Travis Peak)	400	Sandstone, sand, clay, sandy clay, and conglomerates, with "Mortar rocks" throughout. Indurated gray marl and clayey limestone with a few calcareous and organic fragments at base.
		Unconformity		
PENNSYLVANIAN ? MISS.?		Tensus	3,000-7,000	Largely dark green to black shales and fine-grained green sandstones, including arkose and graywacke.
DEVONIAN	upper	Percha (?) shale	100+	
DEVONIAN	middle	Caballos novaculite	200-600	Lenses and thin beds of white, buff, or dull green novaculite and chert containing radiolaria, lingula.
		Unconformity		
ORDOVICIAN		Marivillas formation	100-400	Thin-bedded black chert in upper part; thin beds of bituminous limestone and shale in middle; locally conglomeratic at base; very fossiliferous.
CAMBRIAN		Dagger Flat formation	300+	Mostly sandstone in ledges 4-5' thick, passing into flaggy and thinly laminated micaceous beds, with shale predominant at the top. Sparingly fossiliferous.

Compiled from: The Geology of Texas: Vol I, Univ. of Texas Bull. 3232, 1932.

(Acres)	(Sq. Miles)	Boulder Dam National Recreational Area (Name of Area)		
(C.C.C. Camps)	(Period)	Nevada (State)	(County)	

DESCRIPTION OF AREA: - Rampart Cave

Environment of Fauna - In summary, the environment of Rampart Cave during the period of accumulation of fossil remains seems to have been essentially that of today. The climate may have been somewhat cooler but not enough so to affect the flora to a noticeable degree. The presence of marmot and goat is best explained perhaps by the favorable topographic conditions which for a time overshadowed the unfavorable climatic state. In this regard, it should be pointed out that due to the considerable topographic relief in the Grand Canyon area, life zones range from lower Sonoran at the river to Transition on the Colorado Plateau. The relatively mobile goat need not have habitually occupied the area immediately sorrounding the cave, but could have lived in cooler environs during the summer months.

GEOLOGY:

Age of Fauna - In the course of time, a satisfactory chronology for late Pleistocene-post Pleistocene faunas probably will be developed. At present, however, exact determination of the age of the Rampart Cave fauna hardly is possible. The physical features of the cave deposit and its fauna give a supervicial impression of material a few hundred years old. However, the occupation of the cave by extinct genera and species, and an animal that no longer lives in the region, is prima-facie evidence of antiquity. Except possibly Equus, these animals must have been rather common in view of the small size of the test pits. It is reasonable to assume that the deposit at Rampart Cave is post-Pleistocene in age. A rough estimate in years might be made of between a few thousand and 20,000 years.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

35,240.08 (Acres) | 55.06 (Sq. Miles) | BRYCE CANYON NATIONAL PARK (Name of Area)

(C.C.C. Camps) | SIXTH (Period) | UTAH (State) | GARFIELD (County)

DESCRIPTION OF AREA:

Bryce Canyon is located in Southwestern ~~Colorado~~ UTAH in Township 37 South, Range 3 West. The canyon is in the form of an amphitheater which has been cut into the Paunsaungunt Plateau. It is about three miles in length and two miles wide, presenting many pinnacles, domes, spires and grotesque forms. There are many canyons within the park showing some of the most highly colored sections of geologic formations in the world.

GEOLOGY:

Bryce Canyon, having an elevation from 8000 feet to 9000 feet, is in the northeastern part of the Colorado plateau region. Tertiary sediments of the plateau area include the Wasatch formation of Eocene Age. They consist of highly colored beds of limestone, shale and sandstone resting unconformably on the Cretaceous. The most conspicuous part of the Wasatch formation is the vari-colored "Pink Cliffs" member which gives scenic interest to the various canyons. In most places the Wasatch formation is only 400 or 500 feet in thickness. Cretaceous and Jurassic formations are exposed in the Paria river valley to the East. The main structural feature in the vicinity is the Paunsaungunt fault which together with two other master displacements cut the plateaus into north-south trending blocks. Displacement on the Paunsaungunt fault is estimated at 2000 feet with downthrown block on the west side.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

of the Grand Canyon. It is predominantly a gray or buff cherty fossiliferous arenaceous limestone with some interbedded sandstone and locally gypsum at the base (Harrisburg gypsiferous

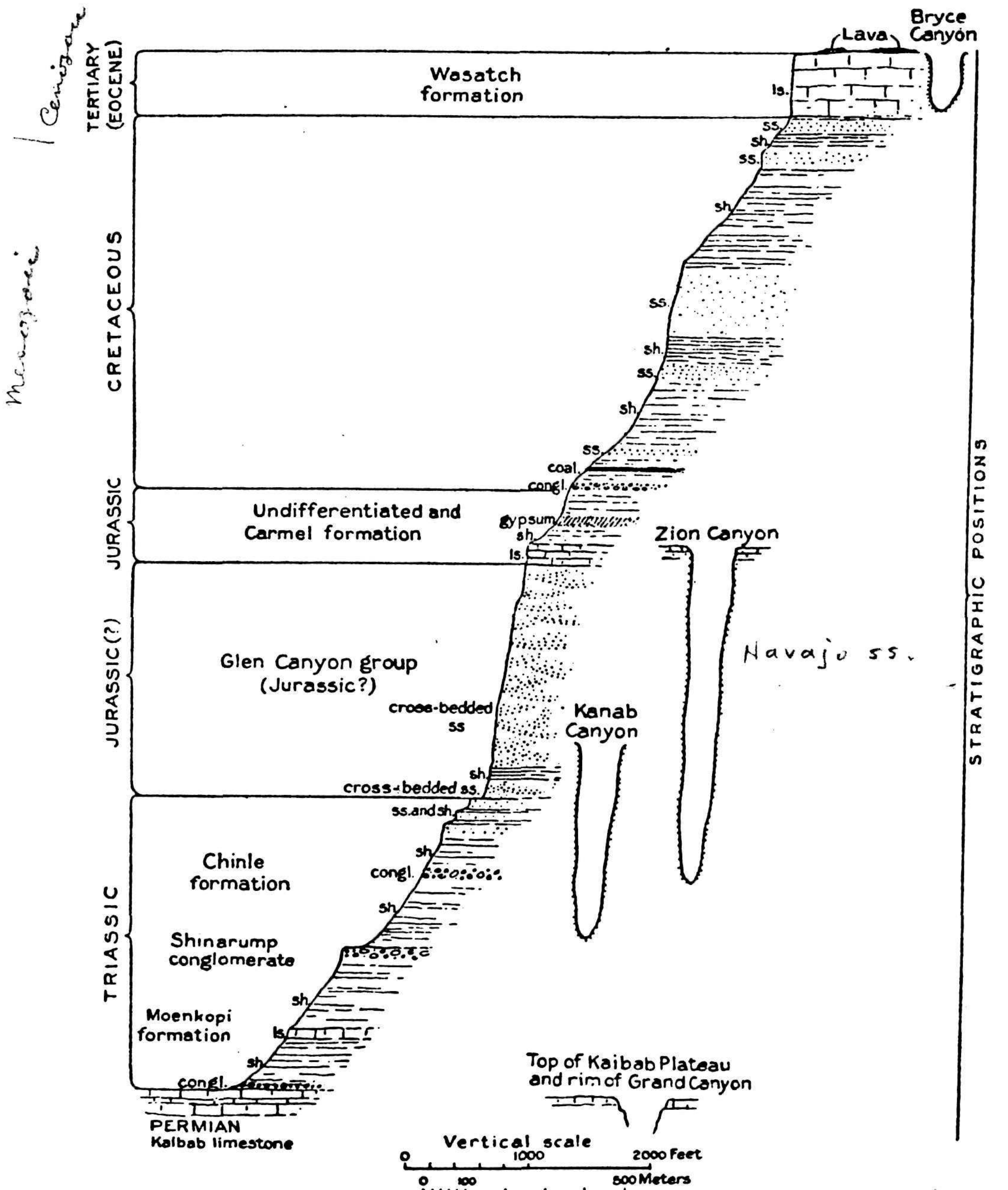

FIGURE 3.—Generalized section of sediments along the rim of the High Plateaus

member, "*Bellerophon* limestone"). In outcrops the Kaibab limestone forms ragged, nearly vertical cliffs with recessed grooves along the edges of the less resistant beds. The Per-

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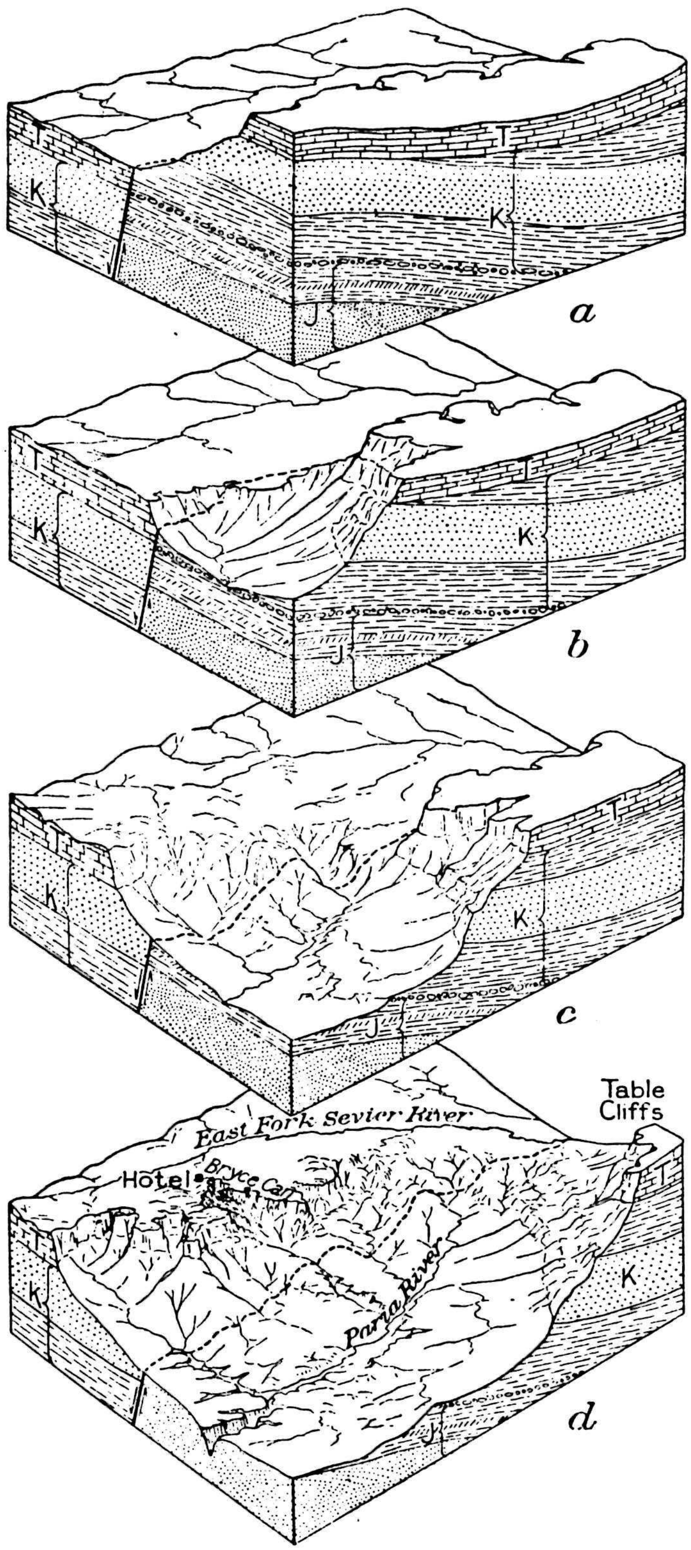
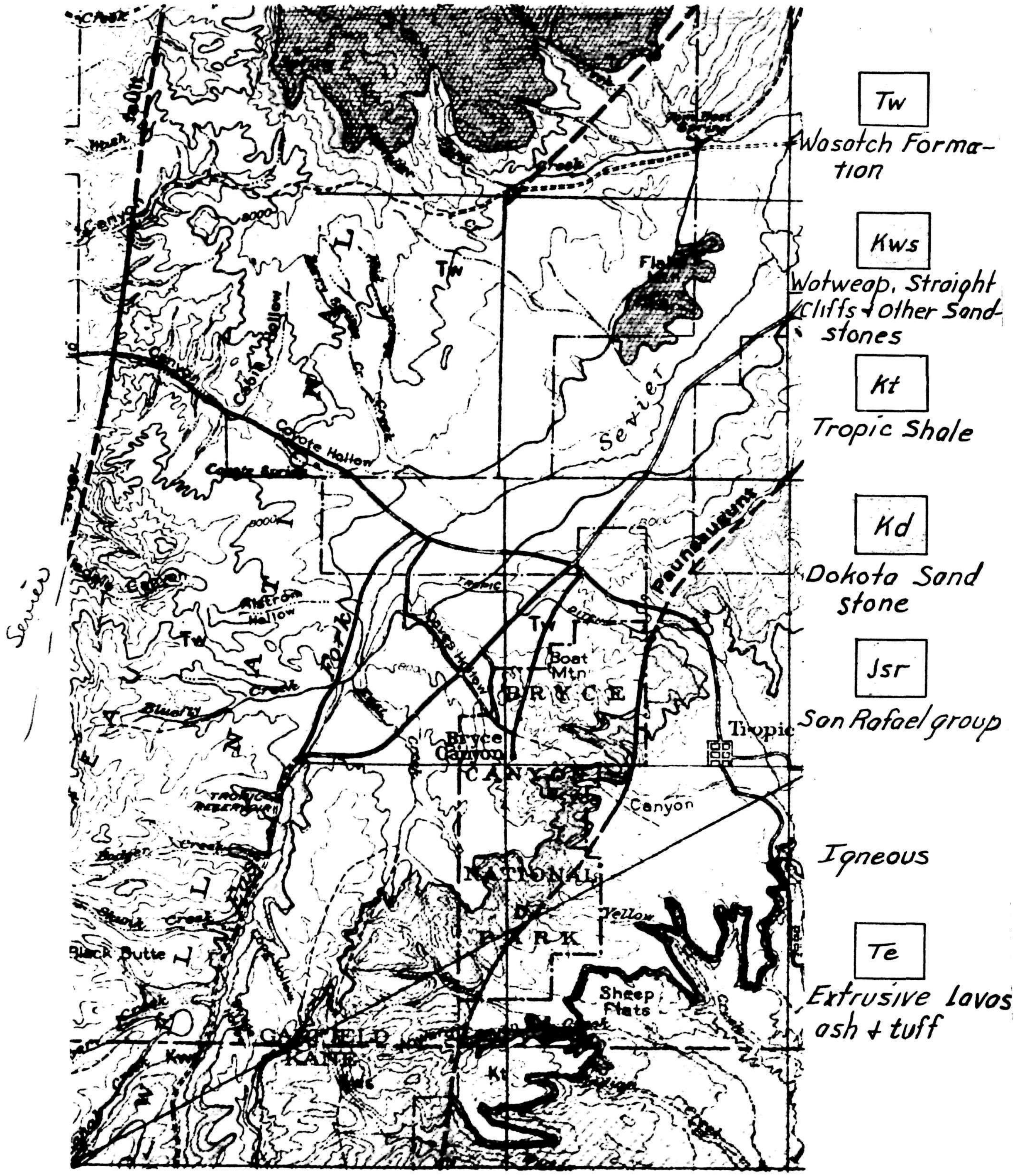
XVI International Geological Congress, Guidebook 18, 1932.



GENERALIZED BLOCK DIAGRAM SHOWING
STAGES OF EROSION AT BRYCE CANYON

XVI International Geological Congress, Guidebook 18, Opp. p. 20, 1932.

BRYCE CANYON



U. S. Geol. Survey Prof. Paper 164, Pl. 2, 1931.

9,959.16	15.56	CARLSBAD CAVERNS NATIONAL PARK	
(Acres)	(Sq. Miles)	(Name of Area)	
	SIXTH	NEW MEXICO	EDDY
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA:

The famous Carlsbad Caverns are located in Southeastern New Mexico about 20 miles southwest of Carlsbad, in the rugged east slope of the Guadalupe Mountains. The region is a semi-desert country containing an interesting cactus vegetation. The size of this series of connected caverns has not yet been determined although new areas are continually being explored. The entrance to the caverns is on the mountainside, 300 feet above the valley, forming a natural arch in which a broad stairway descends into a deep chamber giving access to the three main levels at 750, 900, and 1320 feet. The distance to be traversed in the caverns is approximately seven miles. Temperature is 56°F. at all times. Particularly notable are the large chambers and variety of depositional forms.

GEOLOGY:

Carlsbad Caverns are openings made by percolating ground waters in the massive Carlsbad limestone of Permian Age. The Guadalupe Mountains near Carlsbad are outliers of the Great Rocky Mountain system being uplifted and folded during the Mesozoic and early Tertiary. The repeated folding and faulting in the region has produced numerous joint cracks or fissures in the Carlsbad limestone, thus giving easy access to percolating ground waters to form the caverns. This limestone is approximately 900 feet in thickness and is underlain by gypsum. Undermining by solution of these gypsum beds has been influential in the formation of the very large rooms in the caverns. The most exceptional room is 4000 feet by 625 feet and 350 feet in height. The caverns are profuse with beautiful products of lime deposition throughout. Fossils of the Guadalupian fauna (Capitan limestone) occur in the Carlsbad limestone near the cave entrance.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

160,333	250.5	CRATER LAKE NATIONAL PARK		
(Acres)	(Sq. Miles)	(Name of Area)		
		Oregon	Klamath	
(C.C.C. Camps)	(Period)	(State)	(County)	

DESCRIPTION OF AREA: Hidden away in the volcanic rocks of the Cascade Range of southern Oregon is the record of Mount Mazama, an ancient volcanic cone that grew to great height and later disappeared entirely, leaving a giant caldera in which the deep-blue waters of Crater Lake have since accumulated. The story of this mysterious mountain is recorded in the rocks of the region. Like leaves in a book, the alternating layers of lava and glacial material in the rim surrounding Crater Lake tell the story of the late monarch of the Cascade Range.

GEOLOGY: Alternating layers of lava and glacial material in the rim surrounding Crater Lake record the history of an intermittently active volcano on the slopes of which glaciers formed during periods of dormancy, to be destroyed when igneous activity resumed. The position of buried moraines and the pumice character of material mantling the glacial topography indicate that Mount Mazama disappeared as the result of collapse. The glacio-volcanic sequence discovered at Crater Lake is particularly significant in that it throws light upon the history of the volcanoes of the Northwest which may be similar to that of Mount Mazama before its destruction.

-- After Atwood, Wallace W. Jr., The glacial history of an extinct volcano, Crater Lake National Park: The Jour. Geology, vol. XLIII, no. 2, February-March, 1935.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

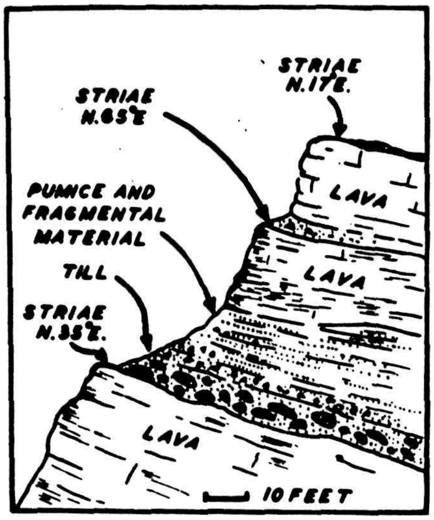


FIG. 12.—Three stages of glaciation at Glacier Point. Locality 2

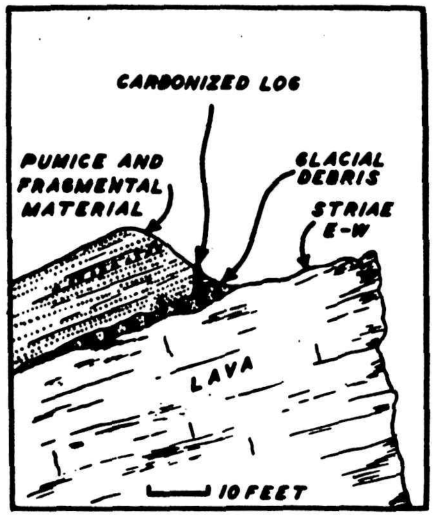


FIG. 13.—A carbonized log buried beneath pumice and fragmental material. Locality 3.

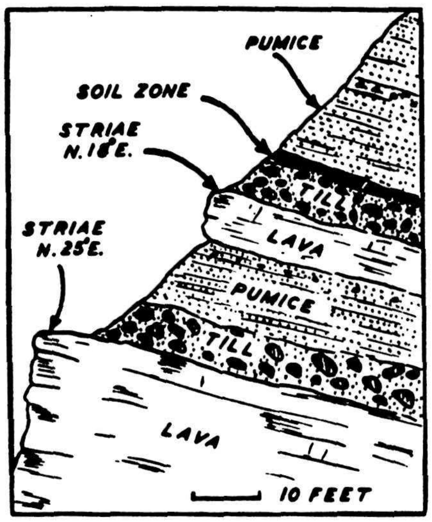


FIG. 18.—Two glacial stages at Pumice Point. A soil zone appears in the upper portion of the younger till layer. Locality 8.

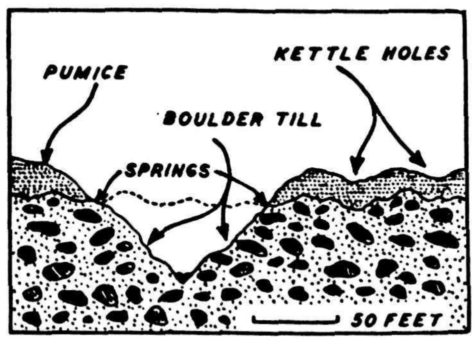


FIG. 20.—Buried kame and kettle topography on the Middle Fork of Annie Creek. Locality 18.

Atwood, Wallace W. Jr., The glacial history of an extinct volcano, Crater Lake National Park: Jour. Geol., Vol. XLIII, pp. 152, 153, 157, and 161, 1935.

FIG. 1.—The youthful Mount Mazama as it may have looked during the early stages of its growth. Continued volcanic activity gradually produced a mountain.

FIG. 2.—A later stage in the growth of the volcano. The cone is dormant and small glaciers are present. Successive stages of vulcanism and glaciation followed.

FIG. 3.—Mount Mazama during one of its last periods of volcanic activity. A secondary cone, Little Mazama, is situated on the western slope.

FIG. 4.—The last glacial landscape. The *U*-shaped valleys which notch the present rim were produced during this final ice invasion. The dotted line indicates the location of the rim.

FIG. 5.—The present Crater Lake located in the giant caldera, formed by the collapse and engulfment of Mount Mazama. The Wizard Island cinder cone developed after the disappearance of the mountain.

FIG. 6.—A generalized cross section of the region today. The alternating layers of till and volcanic material record the story of the growth of Mount Mazama. The dotted lines mark the several stages represented in the preceding drawings.

Atwood, Wallace W. Jr., The glacial history of an extinct volcano, Crater Lake National Park: Jour. Geol., Vol. XLIII, pp. 143-145, 1935.

1,300,000		EVERGLADES NATIONAL PARK (PROPOSED)	
(Acres)	(Sq. Miles)	(Name of Area)	
		Florida	Collier, Boward, Monroe and Dude.
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: A vast area on the extreme southern tip of Florida, a great lowland of swamps, beaches, grassland, and forests, the habitat of rare birds, reptiles, and other forms. It is an area of the Recent in geology, with rock formations in the process of deposition, entombing in the marls, sands, and clays, thousands upon thousands of the invertebrate and vertebrate forms that abound there.

GEOLOGY: The Everglades form a level, grassy plain that slopes gently southward from an altitude of about 18 feet above sea level near Lake Okeechobee and merges into the mangrove-covered keys in Florida Bay. This plain is floored with Pliocene shell marl and limestone (Caloosahatchee marl), which is generally covered by 6 or 8 feet of peaty muck or by a thin layer of Pleistocene limestone. Before their artificial drainage was undertaken the Everglades were usually flooded, but now so much of their water is carried off by canals that their higher parts stand above normal water level.

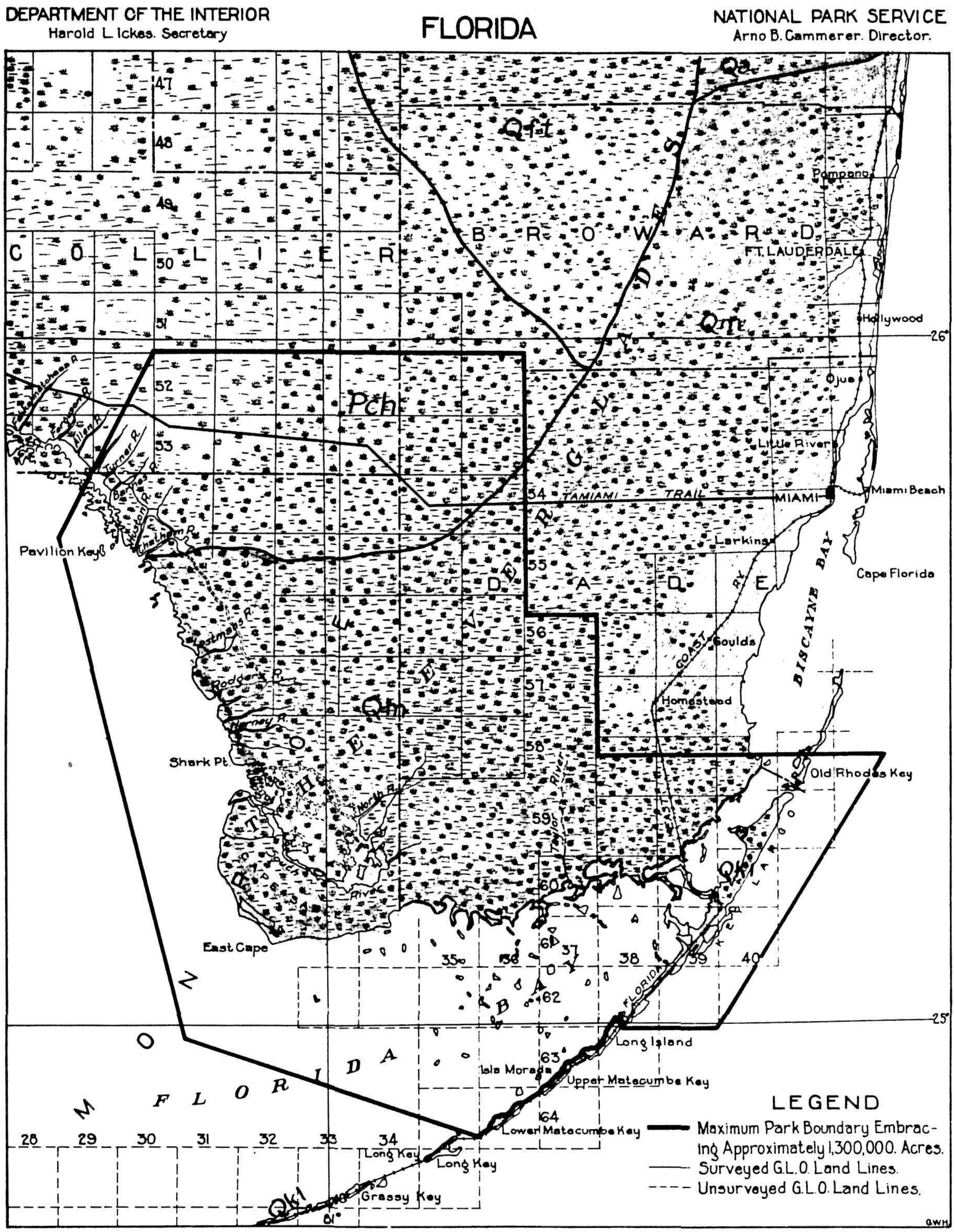
The Florida Keys comprise a long fringe of islands that curves southwestward along the edge of the Straits of Florida from Key Biscayne Bay to Key West and that includes outlying islands as far west as the Dry Tortugas. The keys of the outer line of this fringe as far as Bahia Honda Channel differ from the other keys in that they are parts of an old coral reef (Key Largo limestone), whereas the others are composed of the same rock as the mainland (Miami oolite), of which they are the partly submerged extension. The foundation of all the keys is limestone, but on many of the smaller keys in Florida Bay the rock is covered by mangrove swamps.

--- After Cooke and Mossom, Florida Geol. Survey 20th Ann. Rept., p.43, Sept. 1927-28.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

AGE	FORMATION	THICKNESS	CHARACTER
PLEISTOCENE (?)	Undifferentiated and Recent		Chiefly sand; overlaps most of the older formations
PLEISTOCENE	Fort Thompson formation	10 ±	Limestone and marl, containing fresh and brackish water, and marine shells.
	Key Largo limestone	130	Coral reef limestone
	Miami - Anastasia	24 ±	Miami white oolitic limestone and the Anastasia, a coquina, shell marl and sandy limestone.
PLIOCENE (Largely contemporaneous)	Citronelle formation	100 ±	Chiefly fluvial and littoral sand and gravel.
	Bone Valley gravel	50-	Sand, clay, and pebble phosphate
	Alachua formation	75-100	Sand, clay, and hard-rock phosphate, chiefly residual; contains Pliocene vertebrates.
	Caloosahatshee formation	25-30	Sandy marine shell marl and limestone
MIOCENE	Choctawatchee formation	25+	Shell marl, dark clay, and limestone

Adapted from Geol. Map of Florida: U.S.G.S., 1929.



PROPOSED EVERGLADES NATIONAL PARK

Qft — Fort Thompson formation

Qa — Anastasia formation

Qm — Miamioolite limestone

QKl — Key Largo Limestone

Pch — Caloosahatchee formation

981,681 (Acres) | 1534 (Sq. Miles) | GLACIER NATIONAL PARK (Name of Area)

(C.C.C. Camps) | Sixth (Period) | Montana (State) | (County)

DESCRIPTION OF AREA: Rugged mountain region of alpine character, 250 glacier-fed lakes of great beauty; 60 small glaciers, precipices thousands of feet deep; sensational scenery of marked individuality; fine trout fishing.

GEOLOGY: The Algonkian rocks of western Montana, deposited on Archean schists and gneisses, form an extraordinarily thick group of clastic sediments known as the Belt series. Originally clays, sands, and marls, they have been metamorphosed into slates, argillites, and quartzites and impure marbles and limestones. Paleozoic sediments are not found within the park area although they occur a short distance to the southeast.

The rocks of the Belt series have been thrust over the Mesozoic(Cretaceous) sediments by the Lewis Overthrust, a low angle thrust fault having an average dip of 7^{o}. This fault has a maximum vertical displacement of 40,000 feet and a horizontal movement of at least 12 miles along the fault plane. The trace of this fault forms an irregular line just east of the Continental Divide. Two conspicuous outliers composed of Belt rocks resting on Mesozoic shales are found in Chief and Divide Mountains; near the headwaters of Ole Creek there is a fenster exposing these shales.

The Belt rocks are cut by dikes and sills of diorite and gabbro. Similar rocks known as the Purcell lava are interbedded with the Belt near the Canadian Border.

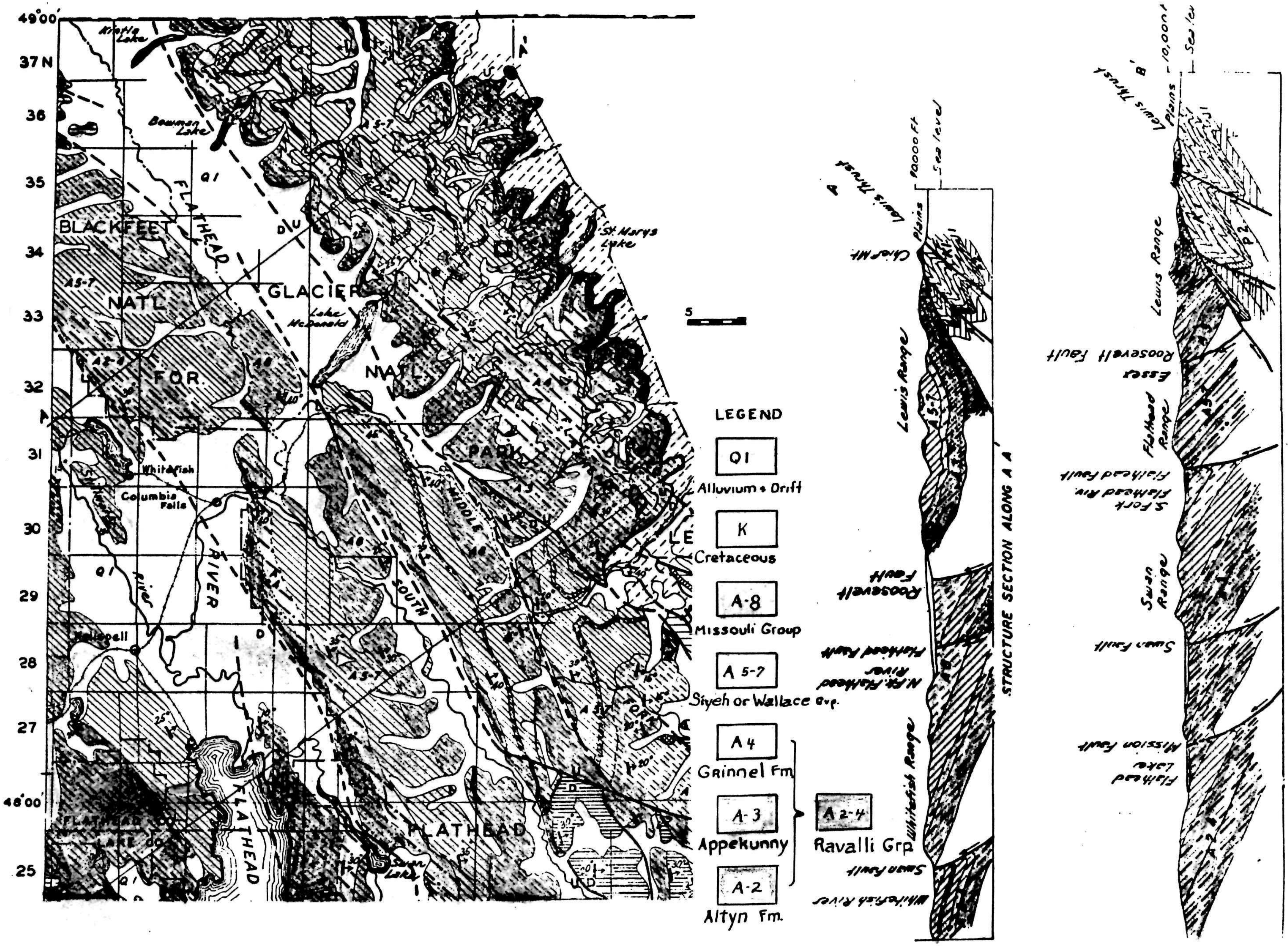
-----Adapted from: Clapp, C. H., Geology of a portion of the Rocky Mountains of northwestern Montana: Montana Bu. Mines and Geol., Memoir 4, 1932.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

AGE			FORMATION		THICKNESS	CHARACTER
CENOZOIC	QUARTERNARY			Alluvium and Glacial Drift		Flood-plain, delta, alluvial-fan, alluvial-cone, and talus-slope deposits of gravel, sand, and clay
				Unconformity		
MESOZOIC	CRETACEOUS	Upper	Montana group	Horsethief sandstone Bearpaw shale Two Medicine Virgelle sandstone	1500-3000	Gray sandy shales, yellow-brown sandstones, and clays; some carbonaceous members, and minor coal seams.
MESOZOIC	CRETACEOUS	Middle		Colorado	1500-2500	Dark gray to black shales, green-gray sandstones, and minor limestones.
MESOZOIC	CRETACEOUS	Lower		Kootenai	1000-2500	Red and reddish brown sandstones and shales, minor conglomerates and limestones, and local coal seams.
				Unconformity		
PROTEROZOIC	ALGONKIAN	Belt Series		Missoula group	10,000-18,000	Red, purple, green, and gray qtz., argillites, and sandstones; minor impure carbonate beds and limestone
PROTEROZOIC	ALGONKIAN	Belt Series	Siyeh or Wallace group			Thin bedded, siliceous, argillaceous, and sideritic limestone, and calcareous argillite; minor magnesian limestone. All buff weathering, some beds show molar tooth structure
PROTEROZOIC	ALGONKIAN	Belt Series	Siyeh or Wallace group	Spokane	500-6000	Red and green argillites and quartzites; lower portion green-gray and dolomitic and sideritic, forming Grayson "shale" in the vicinity of Helena.
PROTEROZOIC	ALGONKIAN	Belt Series	Siyeh or Wallace group	Newland	2500-5000	Impure argillitic, dolomitic, and sideritic limestone and calcareous argillite; dark on fresh fracture, weathers buff.
PROTEROZOIC	ALGONKIAN	Belt Series	Ravalli group	Grinnell	2000-3500	Red with some green argillite, sandstone, and sandy quartzite.
PROTEROZOIC	ALGONKIAN	Belt Series	Ravalli group	Appekunny	3500-10,000	Green-gray to light to dark gray argillitic and sandy quartzite and quartzitic argillite; some massive nearly white quartzite.
PROTEROZOIC	ALGONKIAN	Belt Series	Ravalli group	Altyn (Not exposed west of Continental Divide)	1400	Impure siliceous, argillaceous to sandy uniform pebbly limestone; some beds essentially calcareous pebbly sandstone.
PROTEROZOIC	ALGONKIAN	Belt Series		Prichard	8000 +	Rusty weathering, micaceous, quartzitic argillites.

Clapp, C. H., Geology of a portion of the Rocky Mountains of northwestern Montana: Bu. Mines and Geol., Memoir 4, pp. 21-22, 1932.

Glacier



49°00'
37N
36
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29
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27
48°00'
25
Kintla Lake
Bowman Lake
St. Marys Lake
Lake McDonald
BLACKFEET
NATL
FOR
GLACIER
NATL
PARK
FLATHEAD
RIVER
MIDDLE
SOUTH
FLATHEAD
Whitefish
Columbia Falls
Kalispell
Swan Lake
FLATHEAD CO.
LAKE CO.
LEGEND
Q1
Alluvium + Drift
K
Cretaceous
A-8
Missouli Group
A 5-7
Siyeh or Wallace Grp.
A 4
Grinnel Fm
A-3
Appekunny
A-2
Altyn Fm.
A 2-4
Ravalli Grp
STRUCTURE SECTION ALONG A A'
Lewis Thrust
Lewis Range
Roosevelt Fault
Flathead Fault
N. Fk. Flathead River
Whitefish Range
Swan Fault
Whitefish River
Essex
Roosevelt Fault
Flathead Range
S. Fork Flathead Riv.
Swan Range
Swan Fault
Mission Fault
Flathead Lake

645,808.79	1009.08	GRAND CANYON NATIONAL PARK	
(Acres)	(Sq. Miles)	(Name of Area)	
	SIXTH	ARIZONA	
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA:

Grand Canyon National Park is located in Northern Arizona. The Park includes some 56 miles of the Grand Canyon and the Colorado River traverses it for 105 miles. The canyon within the park varies from 4 to 18 miles in width and is over a mile in depth at the North Rim. Grand Canyon National Park contains the most spectacular section of the Canyon. This vari-colored canyon is the world's greatest example of stream erosion.

GEOLOGY:

Geologic history is probably more clearly observed in the walls of the Grand Canyon than any other place in the world. It is located in the south-western portion of the broad, almost circular Colorado Plateau whose eastern boundary is the Rocky Mountains and western boundary is the Great Basin. This plateau has had a persistent positive history and the strata are only slightly deformed. The canyon has been formed by the stream erosion of the Colorado River. Within the walls of the canyon beds ranging in age from Permian to Cambrian are present. They consist of limestone, sandstones and shales comprising some 4000 feet of section. Below these Paleozoic rocks in the "Granite Gorge" occurs the Algonkian snadstones and shales with some limestones followed by the Archean gneisses and schists. Great unconformities are in evidence at the close of the Archean, Algonkian, and Cambrian periods. While lesser unconformities mark the close of the Mississippian and Permian. The Paleozoic formations contain fossil evidence of animal and plant life.
Cambrian begins with L. Cambrian, no upper Miss and no. Penn. Devonian is probably upper. Entire Uncompahgran of Algonkian missing - only Beltian present. Vishnu may be either Laurentian or Keewatin. Kaibab = Leonard (EDMcK 1/37)

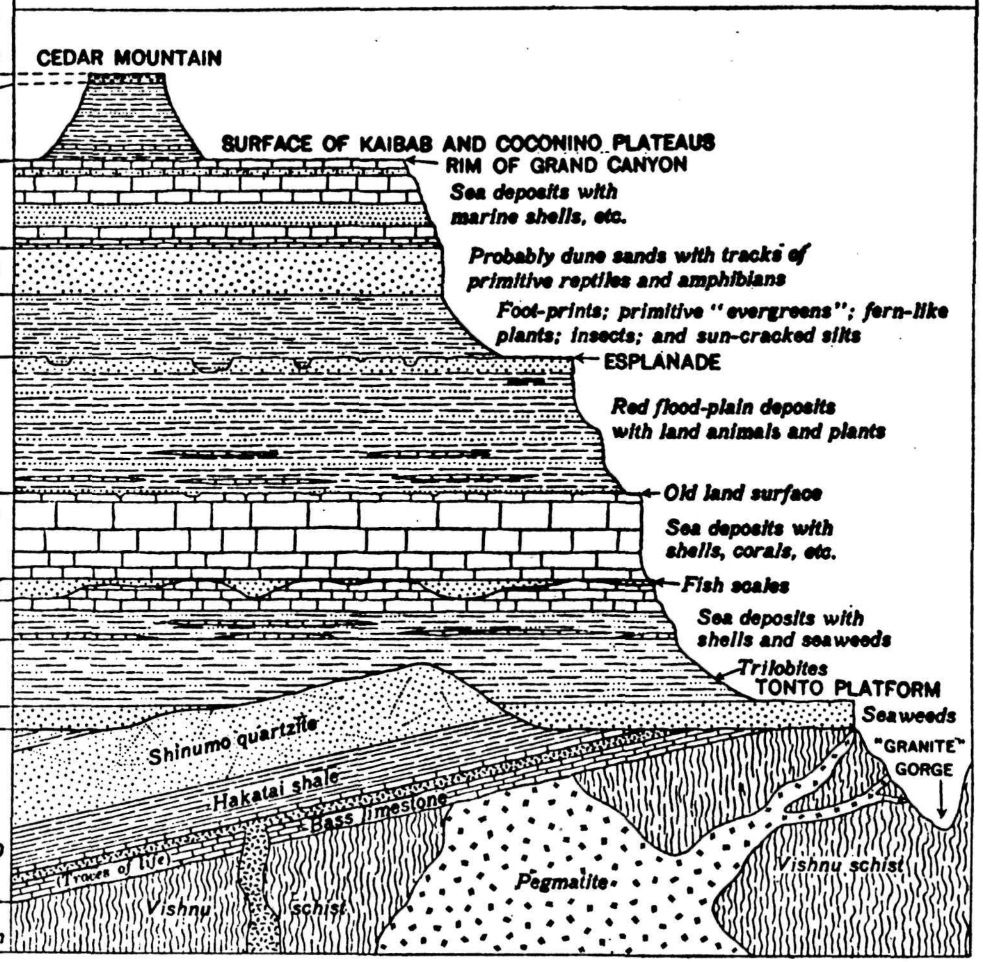
~~RECOMMENDATIONS FOR FUTURE DEVELOPMENT:~~

Excerpt from May 1939 Monthly Narrative Report of the Superintendent:

Drs. Fraser and Maxson and Park Naturalist McKee made a pack trip to the mouth of Monument Canyon on May 13-15 for the purpose of examining the so-called "ripple marks" in the Archean quartzite. It was determined that these are pressure folds instead of ripples as originally reported by Maxson and Campbell and a retraction is to be prepared by Dr. Maxson for publication in the American Journal of Science.

ERA	PERIOD and EPOCH	GROUP AND FORMATION	KIND OF ROCK	PREVAILING COLOR	THICKNESS IN FEET
MESOZOIC	TRIASSIC	*Shinarump congl.*	Conglomerate	Brown	25
		Moenkopi fm	Shale and sandstone	Red	480
		UNCONFORMITY			
PALEOZOIC	CARBONIFEROUS — PERMIAN	Kaibab limestone	Limestone and sandstone	Gray, buff, and red	525
		Coconino sandstone	Sandstone	Light buff	350
		Hermit shale	Sandy shale	Red	225
		Supai formation	Sandstone and shale with some limestone	Red and gray	825
		UNCONFORMITY			
	CARBONIFEROUS — MISS.	Redwall limestone	Limestone	Gray stained red	450 to 500
	DEVONIAN	Temple Butte ls.	Limestone and sandstone	Pale purplish	0-36
		GREAT UNCONFORMITY			
	CAMBRIAN (Tonto group)	Muav limestone	Sandy shale and limestone	Gray	100
		Bright Angel shale	Sandy shale	Greenish gray	450 to 650
		Tapeats sandstone	Sandstone	Brown	225
		GREAT UNCONFORMITY			
PROTEROZOIC	ALGONKIAN	Unkar and Chuar groups of Grand Canyon series	Sandstone and shale with some limestone; contains sheets and dikes of lava	Mostly red	0 to 12000
		GREAT UNCONFORMITY			
	ARCHEAN	Vishnu schist	Schist, granite, and gneiss	Dark gray	Not known

DIAGRAMMATIC PROFILE



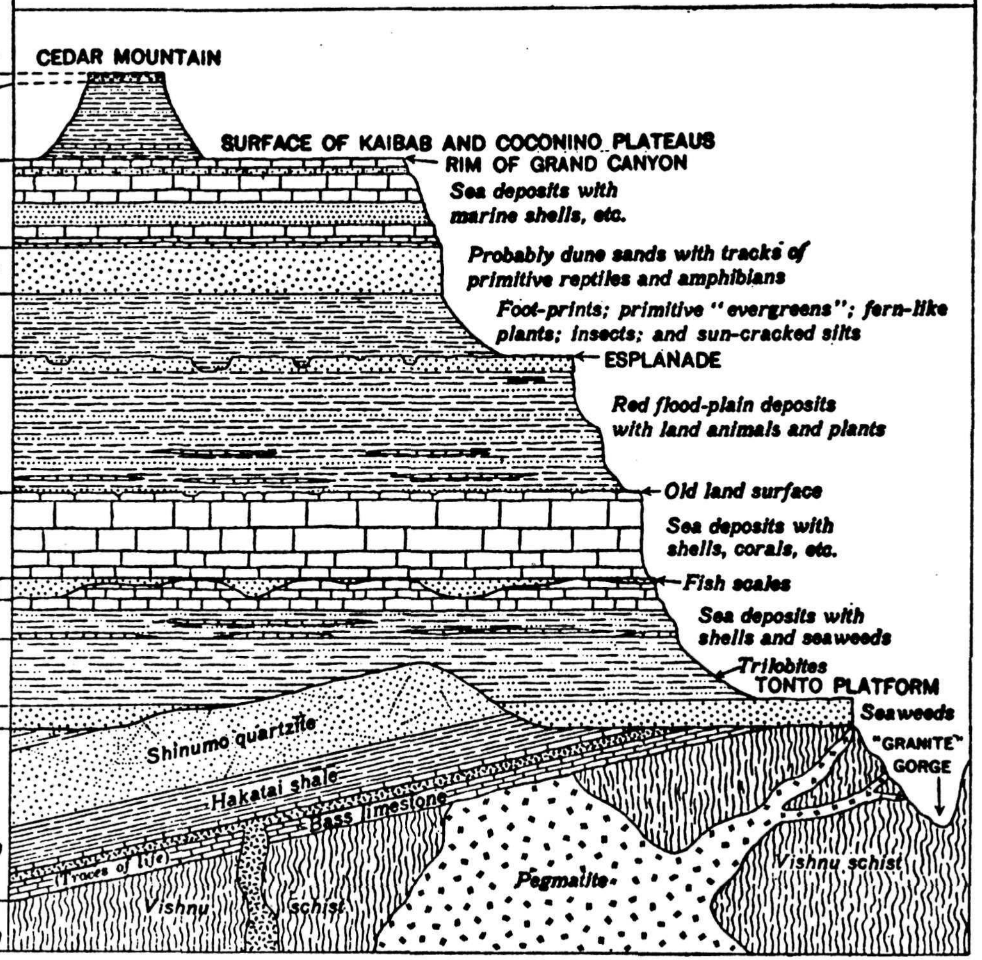
GENERALIZED COLUMNAR SECTION OF ROCKS FORMING THE WALLS OF THE GRAND CANYON

After L. F. Noble.

XVI International Geological Congress, Guidebook 18, Opp. p. 12, 1932.

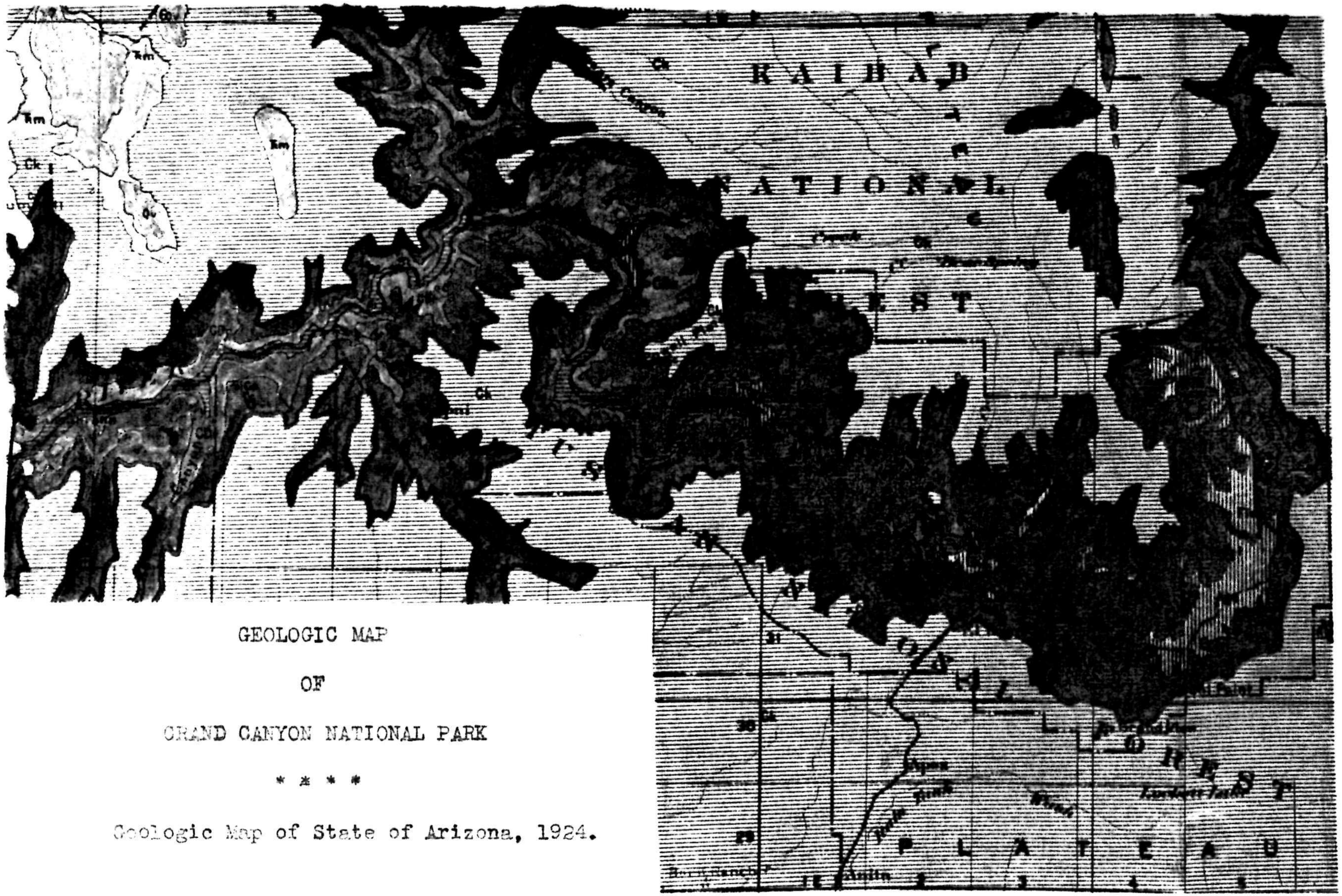
ERA	PERIOD and EPOCH		GROUP AND FORMATION	KIND OF ROCK	PREVAILING COLOR	THICKNESS IN FEET
MESOZOIC	TRIASSIC		*Shinarump congl.*	*Conglomerate*	*Brown*	25
MESOZOIC	TRIASSIC		*Moenkopi fm*	Shale and sandstone	Red	480
			UNCONFORMITY			
PALEOZOIC	CARBONIFEROUS	PERMIAN	*Kaibab limestone*	Limestone and sandstone	Gray, buff, and red	525
PALEOZOIC	CARBONIFEROUS	PERMIAN	Coconino sandstone	Sandstone	Light buff	350
PALEOZOIC	CARBONIFEROUS	PERMIAN	*Hermit shale*	Sandy shale	Red	225
PALEOZOIC	CARBONIFEROUS	PERMIAN	*Supai formation*	Sandstone and shale with some limestone	Red and gray	825
			UNCONFORMITY			
PALEOZOIC	CARBONIFEROUS	MISS.	*Redwall limestone*	Limestone	Gray stained red	450 to 500
PALEOZOIC	DEVONIAN		*Temple Butte ls.*	Limestone and sandstone	Pale purplish	0-36
			GREAT UNCONFORMITY			
PALEOZOIC	CAMBRIAN	Tonto group	*Muav limestone*	Sandy shale and limestone	Gray	100
PALEOZOIC	CAMBRIAN	Tonto group	*Bright Angel shale*	Sandy shale	Greenish gray	450 to 650
PALEOZOIC	CAMBRIAN	Tonto group	*Tapeats sandstone*	Sandstone	Brown	225
			GREAT UNCONFORMITY			
PROTEROZOIC	ALGONKIAN		*Unkar and Chuar groups of Grand Canyon series*	Sandstone and shale with some limestone; contains sheets and dikes of lava	Mostly red	0 to 12000
			GREAT UNCONFORMITY			
PROTEROZOIC	ARCHEAN		*Vishnu schist*	Schist, granite, and gneiss	Dark gray	Not known

DIAGRAMMATIC PROFILE



GENERALIZED COLUMNAR SECTION OF ROCKS FORMING THE WALLS OF THE GRAND CANYON

After L. F. Noble.



GEOLOGIC MAP

OF

GRAND CANYON NATIONAL PARK

* * * *

Geologic Map of State of Arizona, 1924.

(Legend on Back)

GRAND CANYON

SEDIMENTARY ROCKS

Trm

Moenkopi formation

Ck

Kiabab limestone

Cc

Coconino sandstone

Cs

Supai formation and
Hermit shale

CDr

Redwall and Temple
Butte limestone

Ꞓt

Tonto group
Mauv limestone, Bright
Angel shale, Tapeats sandstone

Agc

Grand Canyon series
Chuar and Unkar groups

Sch

Vishnu schist

IGNEOUS ROCKS

Qv

Younger Tertiary volcanic
rocks, mostly basaltic lava
flows

394,088.35 (Acres) | 615.76 (Sq. Miles)

(C.C.C. Camps) | (Period)

GREAT SMOKY MOUNTAINS NATIONAL PARK
(Name of Area)

North Carolina and Tennessee. (State) | (County)

DESCRIPTION OF AREA: This park covers a great scenic area of wooded mountains in the southern Appalachian Mountain Region.

GEOLOGY: A considerable area of the Great Smoky Mountains National Park is covered by Cambrian sediments in various stages of metamorphism; conglomerates, quartzites, slates, and schists. Small areas of Ordovician limestone and unaltered Cambrian sediments are found near the western edge of the park. A small body of pre-Cambrian granite and gneiss is found on the Qualls Indian Reservation and the area immediately north of it along Raven Fork.

The Cambrian strata were deposited upon the uneven floor of pre-Cambrian granite, gneiss and schist along the eastern shore of the sea which covered the region. As the land was lowered by erosion the sediments became finer and finer until, during the Ordovician the Knox dolomite shows little trace of near shore sediments. Deposition continued until late Carboniferous, or until the Appalachian Revolution which formed the Great Smoky Mountain overthrust.

---- After Mackay.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

TABLE OF FORMATION NAMES

	According to the Knoxville Folio (#16) U. S. Geological Survey				According to unpublished notes on the Mt. Guyot Quadrangle, by Arthur Keith.			
Period	Formation Name	Columnar Section	Thickness in feet	Character of the rocks	Formation Name	Columnar Section	Thickness in feet	Character of the rocks
ORDOVICIAN	KNOX DOLOMITE		3500	Magnesian limestone with chert nodules	Knox Dolomite		3500±	Magnesian limestone--chert nodules
CAMBRIAN	Nolichucky Shale		450-550	Calcareous Shale, Ls. beds	Nolichucky Shale		400	Calcareous Shale, Ls. bec
	Maryville Limestone		350-550	Massive dark-blue Limestone	Hopaker Limestone (Sequence broken)		100+	Massive blue Limestone
	Rogersville Shale		180-220	Green clay-shales, Ls. bed				
	Rutledge Limestone		350-450	Massive dark blue Limestone	Watauga Shale ?		600+	Purple, reddish brown shales, yellow sandy shales and thin s.s.
	Rome Formation " " s.s.		250 500-700	Red, green, brown shales and s.s.				
	Beaver Limestone		300	Massive blue Limestone				
	Apison Shale		900+	Green, red, and brown shales	Shady Limest.		800-950	Limestones - with chert
	Hesse Sandstone *		500+	Fine, white massive s.s.	Hesse Quartzite		700-1200	Massive white Quartzite & ss.
	Murray Shale *		300	Sandy shale	Murray Slate		300-450	shales, slate and s.s.
	Nebo Sandstone *		500	Massive white sandstone	Nebo Quartzite		350-1700	Massive white quartzite & ss
	Nichols shale*		500-800	Gray-blue sandy shale	Nichols Slate NANTAHALA *		750-1800	sandy shale & sandstone
	Cochrane Conglomerate		1200+	Sandstone, sh. & conglomerate	Cochrane Conglomerate			
	Sandsuck shale		1000+	Argil. shale				
	CLINGMAN CONGLOMERATE		1000+	Gray s.s. and conglomerate	GREAT SMOKY CONGLOMERATE		5500-6000	Massive beds of quartz & feldspar conglomerate and s.s. with quartzite, slate and schist.
	HAZEL SLATE		600-800	Black slate, s.s. & congl.				
	THUNDERHEAD CONGLOMERATE		3000+	Gray ss. and conglomerate				
	CADES CONGLOMERATE		2400+	Gray ss. and conglomerate				
	PIGEON SLATE		1300-1700	Slate and sdy. slate, & s.s.	HIWASSEE SLATE		900-1500	Banded slate and mica schist; some sandstone, quartzite & conglomerate
	CITICO CONGLOMERATE		50-800	conglomerate & sandstone				
	WILHITE SLATE		0-1000	Argillaceous & calc. slate				
	No equivalent unless some Wilhite may prove to be Snowbird.				SNOWBIRD FORMATION		0-5000	Quartzite sandstone, slate, and conglomerate
				-unconformity-				
PRE-CAMBRIAN	None-according to Folio Map				GRANITE & GNEISS (Max Patch)			Coarse biotite granite, porphyritic-

TABLE ALSO SHOWS TENTATIVE CORRELATIONS——FORMATIONS OF THE PARK AREA ARE INDICATED IN THE TABLE BY CAPITAL LETTERS——FORMATIONS WHICH BARELY TOUCH THE WESTERN EDGE OF THE PARK ARE DESIGNATED BY *.

TABLE 1.

1,008.99	1.58	HOT SPRINGS NATIONAL PARK	
(Acres)	(Sq. Miles)	(Name of Area)	
		Arkansas	Garland
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: The Hot Springs National Park is located near the center of the State of Arkansas and includes Hot Springs Mountain, North Mountain, West Mountain, and Sugarloaf Mountain, all of which are part of the Zigzag Mountains of the Quachita Range. This area was set aside so that the waters from the hot springs, of which there are 49, could be available to all at a nominal cost.

GEOLOGY: The accompanying columnar section is a generalized section of the sedimentary rocks exposed in the vicinity of the park. There are also some igneous rocks exposed near the park area which take the form of dikes and sills. The sedimentary beds were compressed into folds during the Pennsylvanian epoch so that now these beds lie in a series of folds. The Zigzag Mountains are really a series of plunging anticlines and synclines which alternately interlock. After being truncated the more resistant beds form the high ridges and the less resistant ones the valleys. The springs issue from the Hot Springs sandstone. The origin of the high temperature is still a disputed question--some authors advocating a meteoric and others a juvenile hypothesis.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

COLUMNAR SECTION

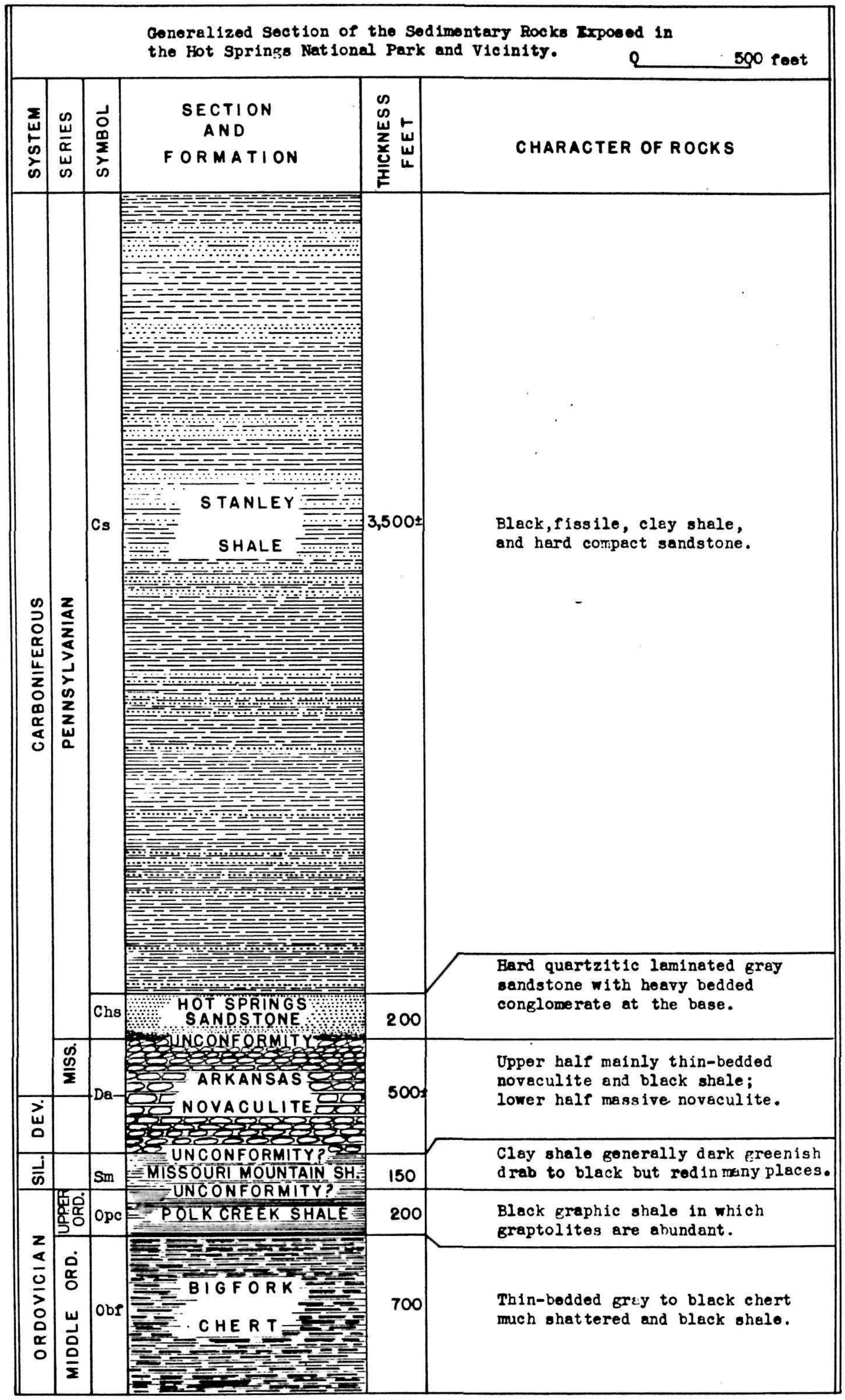


Figure 3. - Columnar Section of the Sedimentary Rocks of Hot Springs National Park and Vicinity.

131,000		ISLE ROYALE NATIONAL PARK(Proposed)	
(Acres)	(Sq. Miles)	(Name of Area)	
		Michigan	Keweenaw
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: Isle Royale is the largest island in Lake Superior with shore line of great beauty. Archaeological remains. Fine forests and game preserve, large numbers of moose.

GEOLOGY: The formations exposed on Isle Royale belong to the Keweenawan series of Upper Algonkian age. This series, possibly 5 miles thick, is made up of a series of sandstones with intercalated shales and conglomerates. In the lower part occur large quantities of extrusive lavas and intrusive laccoliths and sills. They have characteristic colors of red, yellow, and purple and exhibit evidences that they were essentially continental deposits formed under semi-arid conditions.

Although the Keweenawan is pre-Cambrian in the sense of preceeding the Upper Cambrian transgression, having structural and igneous affiliations with the pre-Cambrian and being non-fossiliferous, it may in part be Cambrian in the sense that its deposition probably contimued into the time when Middle and Lower Cambrian sediments were being laid down in approaching Cambrian seas.

The youngest rocks, of lower Upper Keweenawan age and possibly Cambrian in part, is a thick series of conglomerates, sandstones, arkoses, and shales. The lower series, of lower Middle Keweenawan age, is largely basic intrusions with minor amounts of sedimentary rocks.

---- After U. S. Geol. Survey, Prof. Paper 184.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

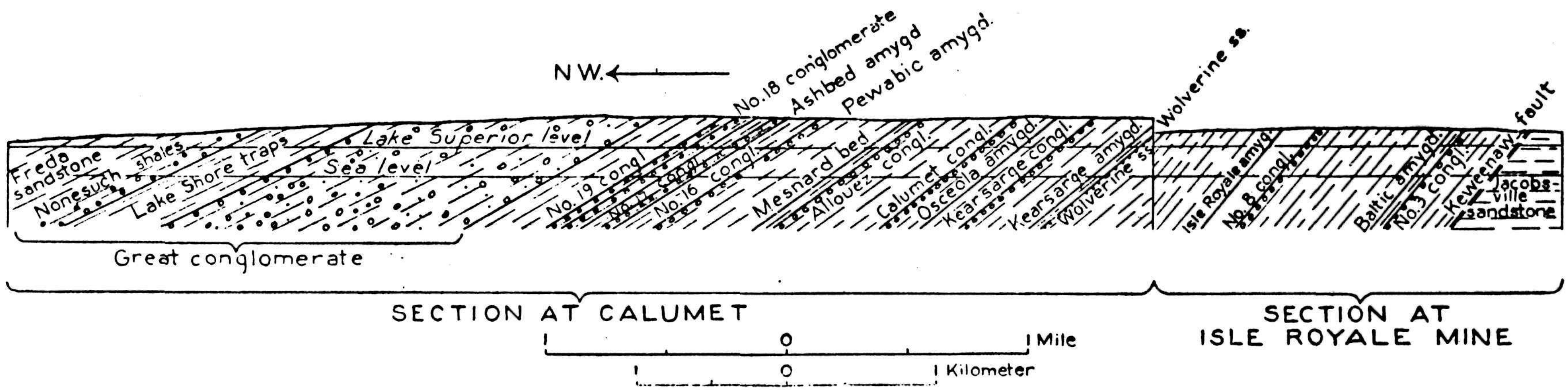


FIGURE 7.—Cross section through Copper Range. (From Min. Cong. Jour., October, 1931, p. 480)

XVI International Geological Congress, Guidebook 27, p. 31, 1932.

104,526.61	163.32	LASSEN VOLCANIC NATIONAL PARK	
(Acres)	(Sq. Miles)	(Name of Area)	
		California	
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: Lassen Volcanic National Park is located near the southern end of the Cascade Mountains of northeastern California. Lassen Peak, which has an altitude of 10,453 feet, is the most recently active (eruptions, 1914-1917) volcano in the United States, exclusive of Alaska and the Hawaiian Islands. In addition to Lassen Peak, other interesting volcanic cones are Prospect Peak, 8,342 feet high; Cinder Cone, 6,913 feet; and Harkness Peak, 8,039 feet. The park also contains smaller volcanic peaks and fantastic lava fields, fumaroles, hot springs, mud volcanoes, and other interesting phenomena characteristic of a volcanic region.

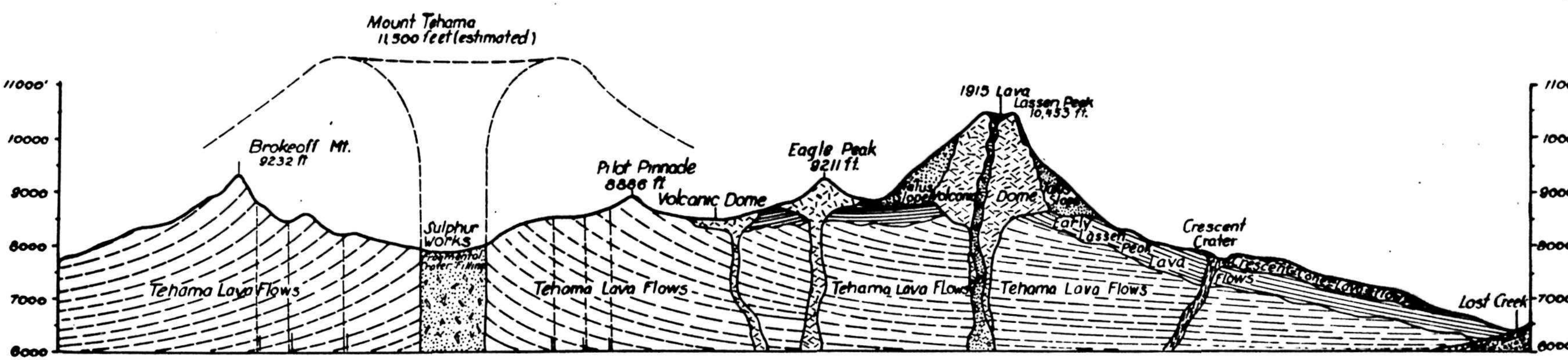
GEOLOGY: The Cascade Mountains are volcanic in origin and are dotted with numerous volcanic peaks, now inactive. The character and arrangement of the older rocks of the Cascades (probably late Mesozoic or Tertiary in age) indicate that earlier mountains once occupied the region. After these were worn down great lava flows issued from many vents and fissures and accumulated, flow upon flow, to depths of several thousand feet. These flows were then arched upward along the line of the Cascades. Later eruptions were localized and produced the magnificant series of volcanic peaks for which the region is now famous.

During the Glacial period the park was heavily glaciated,--the valley and much of the Central Plateau are now mantled by a thick blanket of glacial drift. Since the volcanic activity has been so recent, there has been only slight modification of these features by erosion. Glaciation has been the greatest modifying agent, but even its effects are concealed in areas where volcanic activity has continued after the close of the Glacial period.

--- After Lewis, J. Volney, and Anderson, S. M.

Prof Chas. Anderson, U. of Calif., states that source of lava for Subway Cave is a vent 2½ mi. N. of Badger mountain.

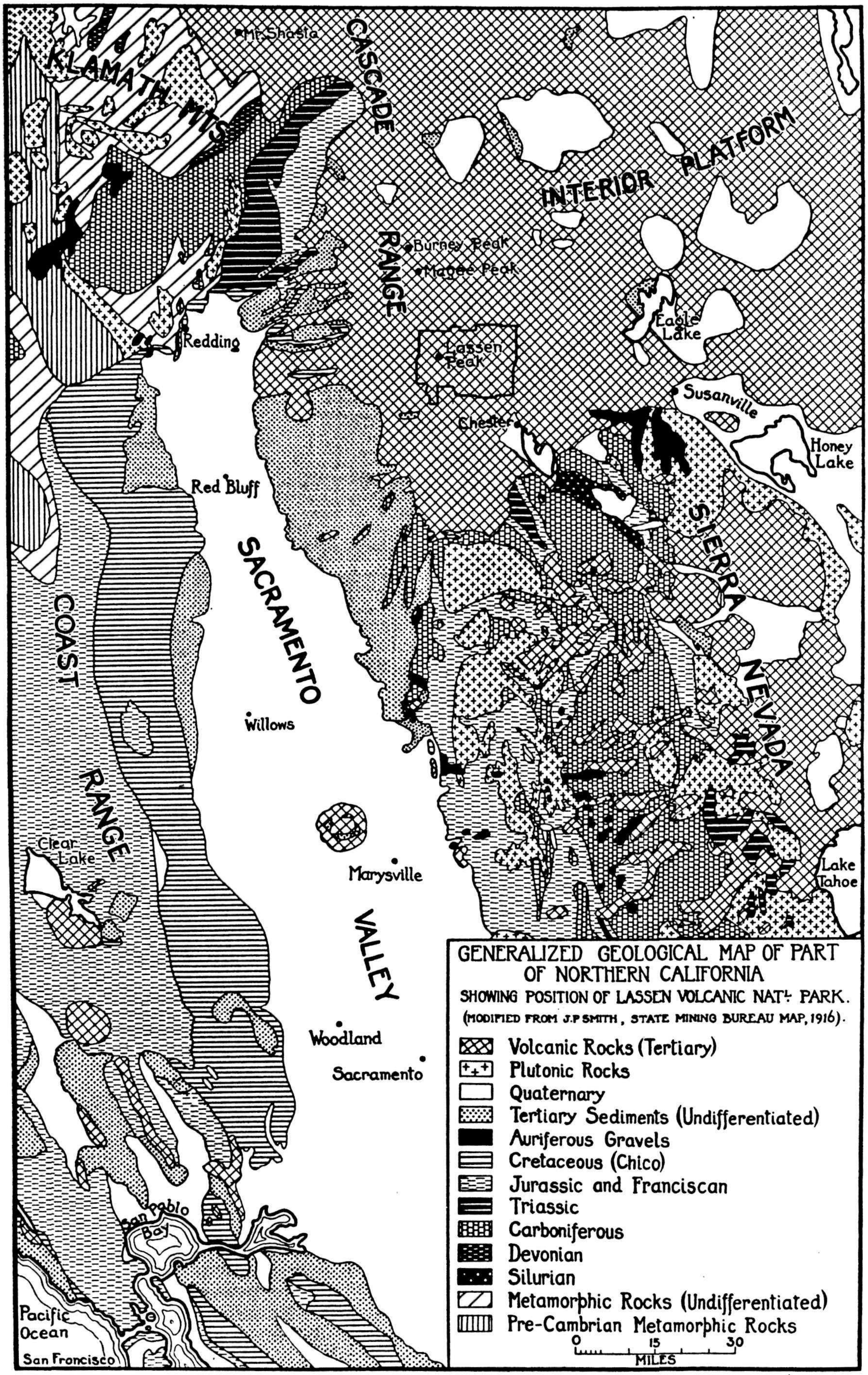
RECOMMENDATIONS FOR FUTURE DEVELOPMENT:



Lassen Peak and Mount Tehama Generalized Cross Section
Vertical Scale 4 times the horizontal

after Lewis - williams?

Williams, Howell, Geology of the Lassen Volcanic National Park: Univ. of Calif. Pub., Bull., Dept. Geol. Sci., vol. 21, no. 8, fig. 1, 1932.



45,310		MAMMOTH CAVE NATIONAL PARK (Proposed))	
(Acres)	(Sq. Miles)	(Name of Area)	
		Kentucky	Principally Edmonson.
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: The Mammoth Cave National Park (proposed) lies in the central-southern park of Kentucky. Physiographically it is located near the east center of the Interior Lowlands. The area contains ninety caves, many of which are of great linear extent and are decorated with fine gypsum incrustations, flowers, or twisted helectite.

GEOLOGY: The geologic section of the park includes formations of higher Mississippian and lower Pennsylvanian rocks as shown on the accompanying geologic section. The major caves of the park have been formed in the St. Genevieve and Gasper limestones by groundwater dissolving out the limestone with resultant solution channels. Associated with these caves are two features of primary uniqueness. "First is their great linear extent, and second, the presence of an exceptional quantity and quality of two rare cave growths or deposits--gypsum and helectite."

----After Pohl, E. R.

Total relief in park is 480'.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

(10315

AGE	FORMATION	THICKNESS	CHARACTER
PENN.	Pottsville Series Trade Water	250	Mainly a coarse, thick-bedded and sometimes foreset sandstone usually with a heavy, rounded quartz pebble conglomerate near the base. Some arenaceous shale irregularly present. Plant remains often present, especially in sandstone in lower portion. Most commonly <u>Siglillaria</u> and <u>Lepidodendron</u>. Limonite concretions frequent. Nearly restricted to northwestern part of park.
MISSISSIPPIAN (Chester Series)	Leitchfield	~~40~~ 100' Pohl	Predominantly a dark green to black clay-shale, thin-bedded and friable, weathering to a dark gray, sticky clay. Thin laminations of calcareous shale sparingly present. Unfossiliferous. Restricted to extreme southeast portion of park. Absent from rest of area due to post-Mississippian scour.
	Glen Dean	~~60~~ 50' Pohl	Predominantly a massive, thick-bedded, fossiliferous, medium gray-blue limestone with some partings of light green clay-shale. Formation weathers to deep red clay. Characteristic fossils: <u>Pentremites</u> <u>brevis</u>, <u>Spiriferina</u> <u>spinosa</u>. Nearly restricted to north and west portions of park. Upper portion frequently denuded or cut out by pre-Pennsylvanian scour.
	Hardinburg	~~50~~ 60' Pohl	Mostly massive, thick- and thin-bedded, often foreset, uniformly medium-grained, moderately resistant, white sandstone. Weathers to dark brown and red sand. Frequently caved into Golconda formation below. Unfossiliferous. Mostly present in north and west portions of park. Sometimes absent due to pre-Pennsylvanian scour.
	Golconda	40 ✓	Composed of a basal light gray clay shale, sometimes with a 0-2 inch impure coal bed; 0-2 ft. band of highly indurated, fine, sandstone, often containing both marine and land plant remains; and an upper 10 to 20 foot bed of medium gray, heavy-bedded, compact, crinoidal, moderately fossiliferous limestone, which is extremely soluble and cavernous where present. Characteristic fossils: <u>Agassizocrinus</u> <u>conicus</u>, <u>Eupachycrinus</u> sp., <u>Archimedes</u> <u>laxus</u>. Present throughout entire area, but in southeastern portion only basal section remaining.
	Cypress	60 ✓	Uniformly medium-grained, pure white, thick- and thin-bedded, frequently highly foreset, barren, resistant sandstone. Present throughout park area.
	Gasper	130 ✓	Massive, thick-bedded, crinoidal limestone and oolite with occasional thin partings of light clay shale, often with a 0-3 ft. bed of green clay shale at the top. Sparingly fossiliferous. Characteristic fossils: <u>Campophyllum</u> <u>gasperense</u>, various species of <u>Talarocrinus</u>, <u>Productus</u> <u>inflatus</u>. Present through most of park, especially in southeastern portion.
	St. Genevieve	~~150~~ 150' Pohl	Thick-bedded, loosely and heavily compacted oolite; thick-bedded, dense light gray, cryptocrystalline, barren limestone with some chert, and loosely compacted, white, highly fossiliferous, crinoidal, limestone. Major caves of the park have been excavated in this and the above formation. Characteristic fossil: <u>Platycrinus</u> <u>penicillus</u>. Restricted to central, south, and east portions of park.

After-- E.R. Pohl.

51,333.62	80.21	MESA VERDE NATIONAL PARK	
(Acres)	(Sq. Miles)	(Name of Area)	
	Sixth	COLORADO	MONTEZUMA
(C.C.C. Camps)	(Period)	(State)	(County)

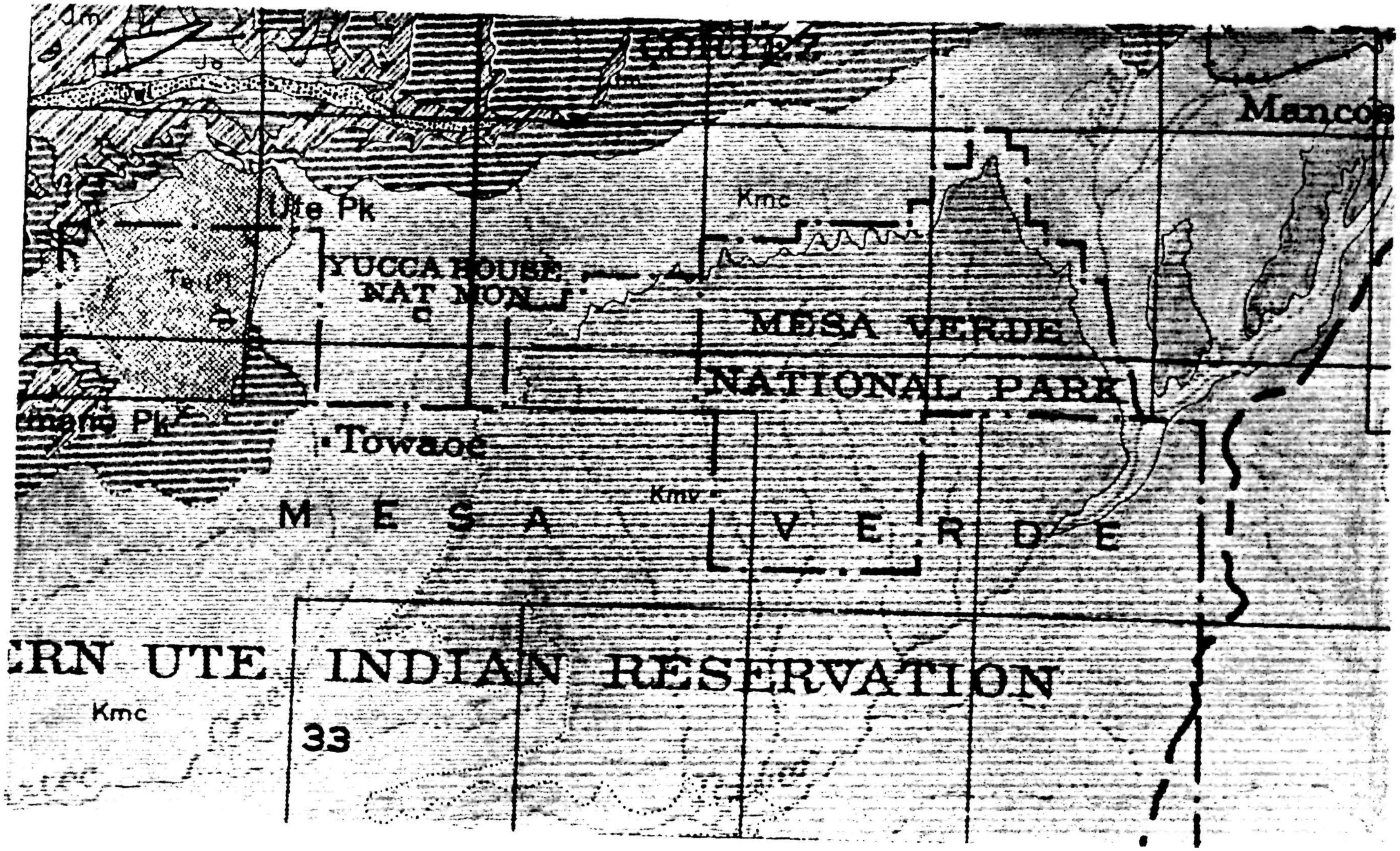
DESCRIPTION OF AREA: Mesa Verde, probably so called by Spanish Explorers, is located on the north rim of the San Juan Basin in Southwestern Colorado about 35 miles west of Durango. It is 15 miles long and 8 miles wide and is one of the largest mesas in the region. The northern edge of the mesa terminates in a bluff some 2000 feet above the valley. The main interest in Mesa Verde is in the fact that it contains the ruined homes of Pueblo Indians (possibly of various stocks and many tribes) who inhabited them some thousand years or so ago.

GEOLOGY: The northern escarpment of Mesa Verde rises from 1500 to 2000 feet above the Colorado plateau to the north, and its highly dissected surface slopes southward with the underlying formations to the lower plateaus of Northwestern New Mexico. At the northeastern edge of the mesa the top of the escarpment is formed by Point Lookout Sandstone the lower marine formation of the Mesa Verde group. In the northern part of Mesa Verde the beds are dipping southward at a greater rate than the surface of the mesa so that the overlying Menefee formation and Cliff House sandstone succesisvely constitute the surface formations down the slope of the mesa. These formations are all of Upper Cretaceous Age. The Mesa Verde structure has had its origin in the forces that caused the uplift of the San Juan Mountains and the down warping of the San Juan Basin. The physiographic effects have been produced by the headward erosion of many of the southward-leading canyons and southward retreat of its northern escarpment by the weaving away of the soft underlying shales of the marine Mancos shales. The Mancos shales and Cliff House sandstone contain invertebrates.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

CRETACEOUS & TERTIARY FORMATIONS OF THE WESTERN PART OF THE SAN JUAN BASIN IN COLORADO

AGE	FORMATION		THICK-NESS	CHARACTER
Eocene	Wasatch formation		1000'±	Massive gray to brown conglomerate sandstone interbedded with variegated shale Fluviatile. Contains remains of mammals and plants.
	Torrejon and Puerco formations and undifferentiated		0-1450	Lenticular gray to brown conglomeratic sandstone interbedded with shale. Fluviatile. Contains remains of mammals, reptiles, fish, and plants.
	---Unconformity---			
Eocene (?)	Animas formation		0-2670	At base, coarse beds with weathered and waterworn andesitic debris and pebbles of siliceous rocks. Remainder of formation shale and sandstone with andesitic debris and beds of fine conglomerate. Fluviatile. Dinosaur and plant remains.
	---Unconformity---			
Upper Cretaceous (?)	McDermott formation		0-300	In the north, andesitic tuff and tuffaceous sandstone and shale, with some conglomerate of siliceous rocks. Proportion of volcanic material decreases southward. Contains plants and reptilian remains.
	--Local Unconformity--			
Upper Cretaceous	Kirtland shale		565-1325	Consists of upper and lower shale members, and middle sandstone member. Fluviatile. Contains reptilian and fish fossils and plants.
	Fruitland formation		340-530	Gray sandy shale, gray-white cross-bedded sandstone, brown indurated sandstone, carbonaceous shale, and coal. Fresh and brackish water origin. Reptilian, fish, & invertebrate fossils & plants.
	Pictured Cliffs sandstone		125-240	Buff to light-yellow & gray sandstone interbedded in the lower part with thin gray shale. Marine. Invertebrate fossils.
	Lewis shale		1710-2290	Greenish-gray and dark-gray sandy shale with a few lenses of brown sandy limestone & buff concretions. Marine. Invertebrate fossils.
	Mesa Verde Group	Cliff House sandstone	90-390	Yellow to red-brown sandstone with some sandy shale. Some beds massive, cliff-forming. Marine invertebrates.
	Mesa Verde Group	Menefee formation	270-360	Gray shale with some sandst. & coal. Of fresh & brackish water origin, with a few marine beds.
	Mesa Verde Group	Point Lookout sandstone	60-270	Massive buff or cleam-col. to red-brown sandstone. Marine.
	Mesa Verde Group	Mancos shale	1800-2000	Dark gray and drab sandy shale, with a few sandstone lenses. Contains marine invertebrates.
	Dakota (?) sandstone		200-250	Brown sandstone with some shale lenses & coal; cherty conglomerate at base.



GEOLOGIC MAP OF MESA VERDE NATIONAL PARK AND YUCCA HOUSE NATIONAL MONUMENT

Geologic Map of Colorado, 1935.

(Legend on Back)

Qal

Alluvium

Kmv

Mesa Verde group

Kmc

Mancos shale

Kd

Dakota (?) sandstone

Jm

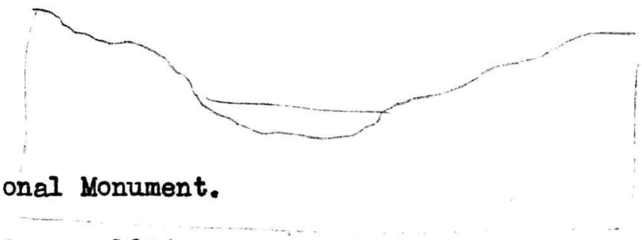
Morrison formation

Jo

Older Jurassic and
Jurassic (?) undivided

Tei (?)

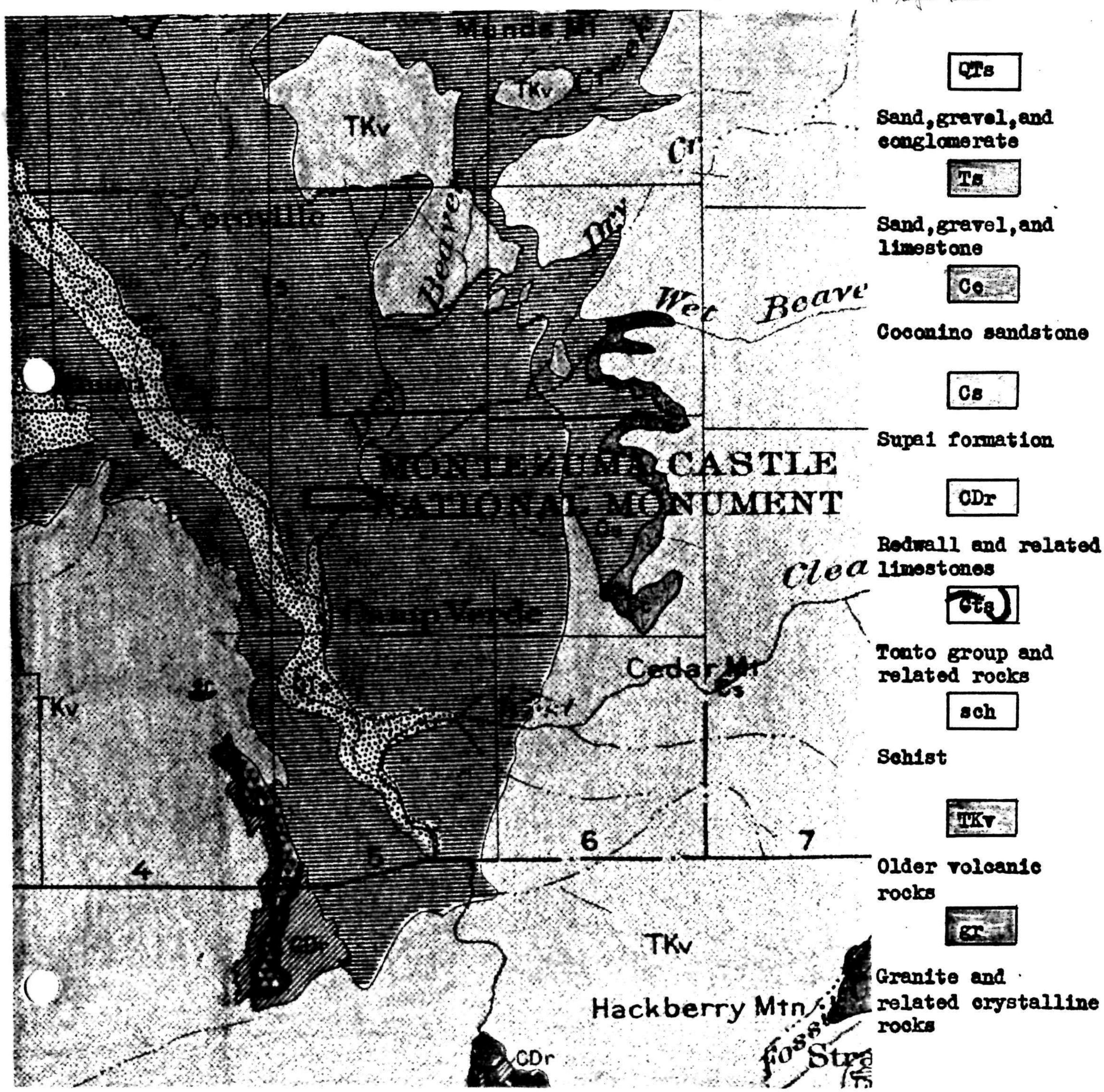
Early Tertiary
intrusive rocks

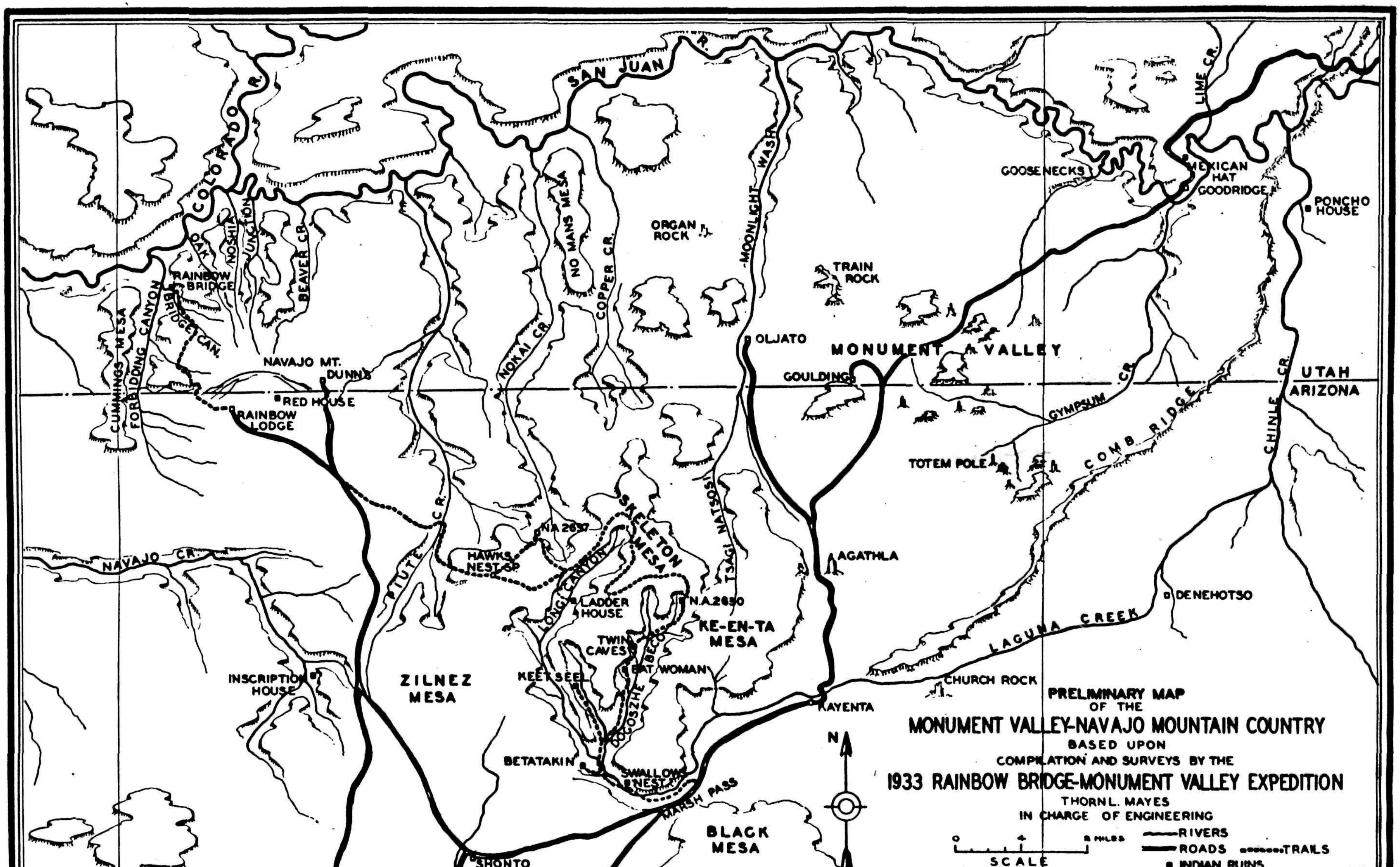


Geologic Map of Montezuma Castle National Monument.

From Geologic Map of the State of Arizona, 1924.

X Sec
See museum plan
" topo sheet





MONUMENT VALLEY

377.78	MOUNT RAINIER NATIONAL PARK (1899)
(Acres)	(Sq. Miles)	(Name of Area)

		WASHINGTON	
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: Mount Rainier National Park is located in the northern part of the Cascade Mountains in the west-central part of Washington. The region is a land of rugged mountains and heavily forested valleys. Mount Rainier, which is an extinct volcano, has a glacier system far exceeding any other in continental United States.

GEOLOGY: The character and arrangement of the older rocks of the Cascades (probably late Mesozoic or Tertiary in age) indicate that earlier mountains once occupied the region. After these were worn down great lava flows issued from many vents and fissures and accumulated, flow upon flow, to depths of several thousand feet. These flows were then elevated by a gradual buckling or upwarping along the line of the present Cascades. Later eruptions were localized and produced the magnificent series of volcanic peaks for which the region is now famous.

During the Glacial Period the area was heavily glaciated, and since the volcanic activity has been so recent, glaciation has been the greatest modifying agent of erosion. The cliffs have begun to crumble and talus slopes are forming at their bases, and the streams are altering the valley floors, yet on the whole the region still exhibits the characteristic forms imparted to it by the ice. There still remains, on the slopes of Mount Rainier, the most extensive glacier system of any single peak in the United States, outside of Alaska.

After -- Matthes, F. E., The Mount Rainier National Park, Washington, U. S. Geological Survey Topographic Sheet, 1934.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

848.31	1-1/3	PLATT NATIONAL PARK	
(Acres)	(Sq. Miles)	(Name of Area)	
		Oklahoma	Murray
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: Platt National Park is located in the south-central portion of Oklahoma in the Arbuckle Mountains and adjacent to the town of Sulphur. The area was set aside because of the mineral properties of the springs of which there are 32 of major importance within the park.

GEOLOGY: The accompanying generalized columnar section gives a brief description of the rocks exposed in the vicinity of the park. The major crustal movement which formed the Arbuckle Mountains took place in Pennsylvanian time, and the beds were compressed into anticlines and synclines and were highly faulted. The accompanying hypothetical cross-section shows a probable explanation for the fresh and mineral springs of the area. The fresh water springs come from the coarse, porour sands and conglomerates of the Pontotoc series while the waters in the mineral springs rise from the asphalt-impregnated beds of the Simpson group from which they have taken some of the minerals into solution.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

COLUMNAR SECTION

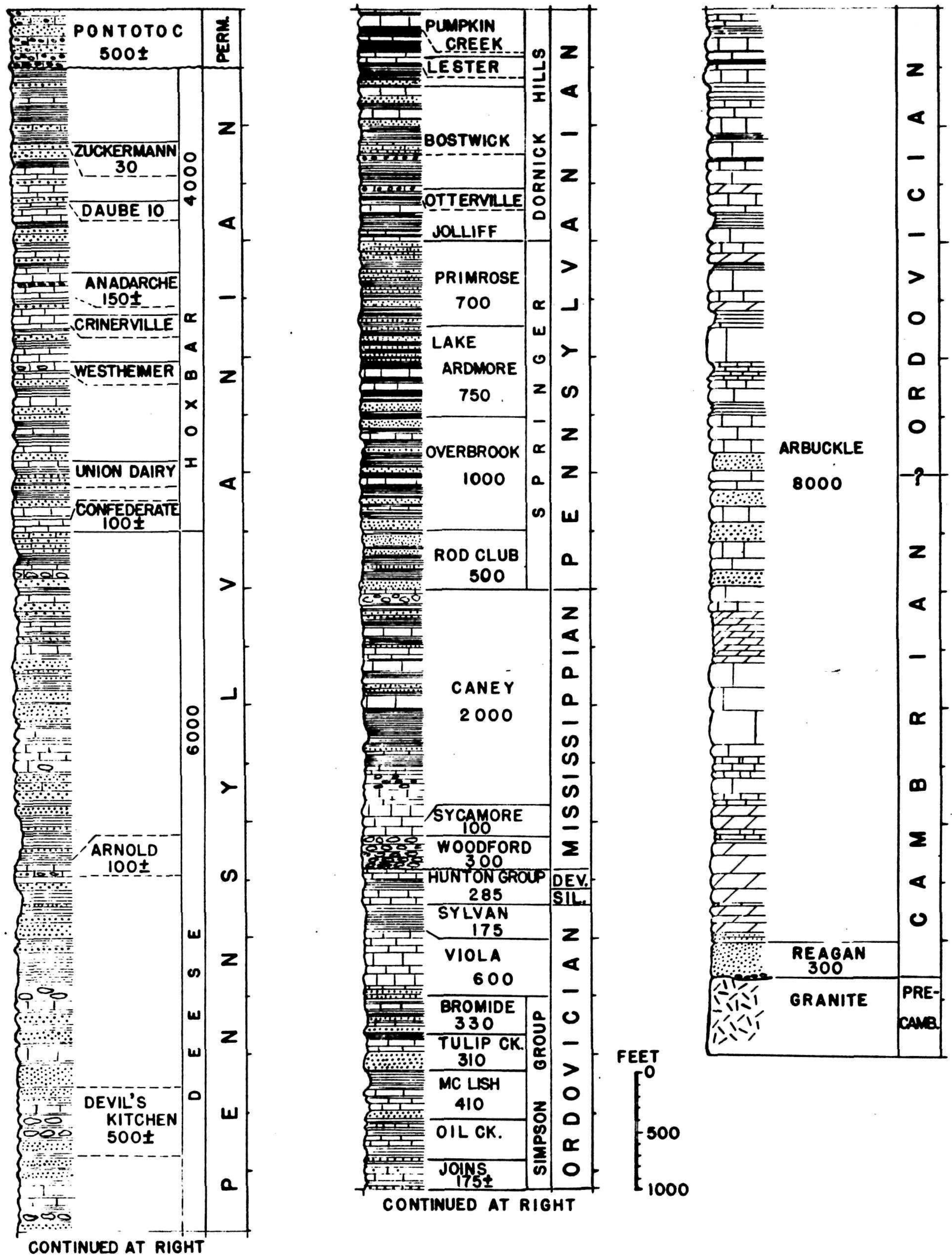


FIGURE 2.– COLUMNAR SECTION OF THE ROCKS EXPOSED IN PLATT NATIONAL PARK AND VICINITY.

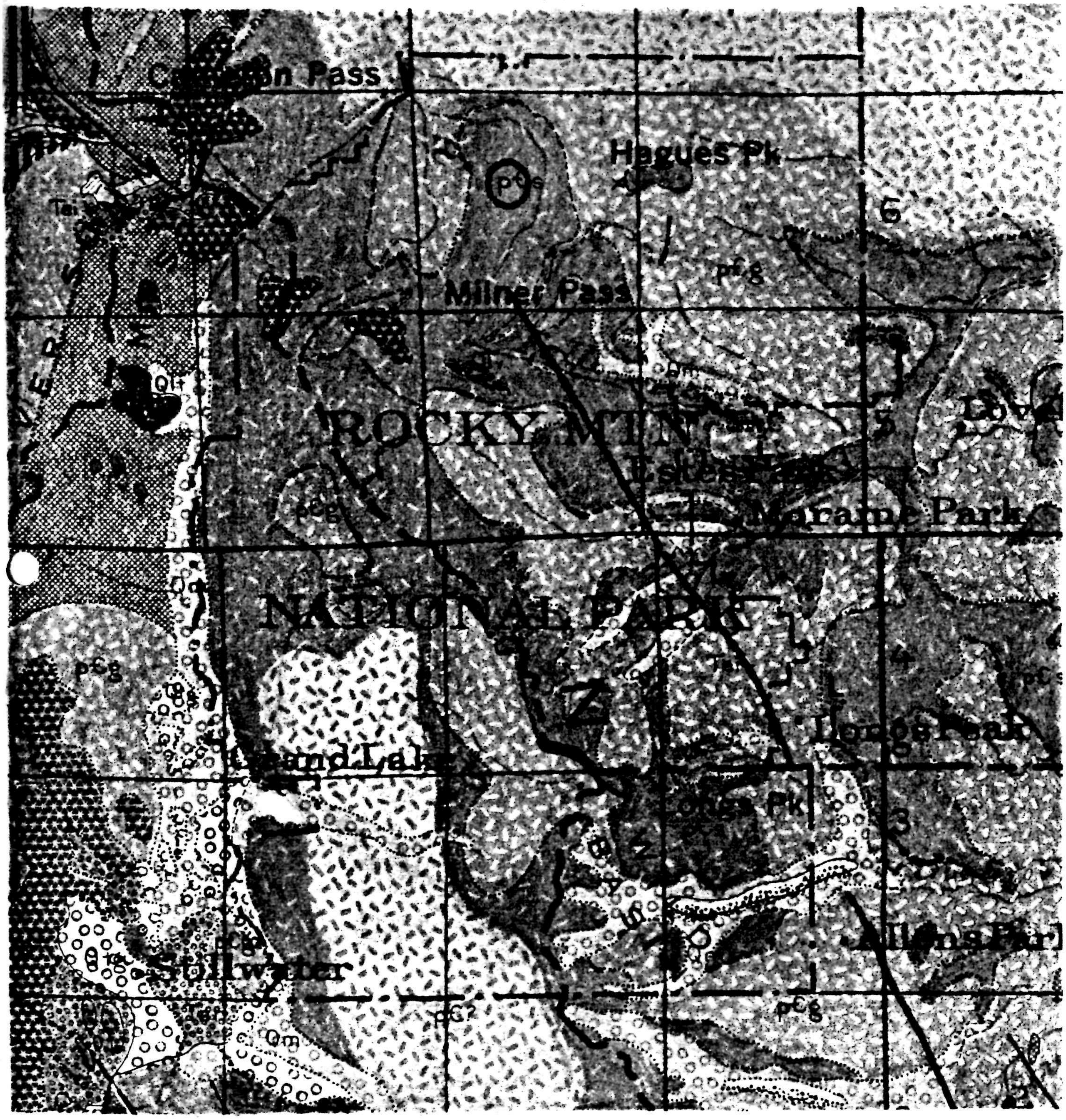
	405.33	ROCKY MOUNTAIN NATIONAL PARK (1915)		
(Acres)	(Sq. Miles)	(Name of Area)		
		COLORADO		
(C.C.C. Camps)	(Period)	(State)	(County)	

DESCRIPTION OF AREA: A snowy range forming the Heart of the Rockies; peaks 11,000 to 14,225 feet in altitude; remarkable glacial record.

GEOLOGY: Over most of the park area is exposed preCambrian metamorphosed sediments and igneous intrusives. The oldest rocks, the Idaho Springs formation, composed of metamorphic schists and gneisses, have been extensively intruded by a number of pre-Cambrian granites and related rocks. Among these are the Pikes Peak, Sherman, Silver Creek, and Mount Rosa granites.

The Quaternary is represented by Pleistocene ice sculptured valleys and morainal deposits, and Recent alluvium and terrace deposits.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:



GEOLOGIC MAP OF ROCKY MOUNTAIN NATIONAL PARK

Geologic Map of Colorado, 1935.

(Legend on Back)

386,560.00	604.00	SEQUOIA NATIONAL PARK	
(Acres)	(Sq. Miles)	(Name of Area)	
		California	Tulare
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: The Sequoia National Park includes a portion of the western slope of the Sierra Nevada, the longest and highest mountain range in the United States. In this area the finest of the remaining stands of the Big Trees (*Sequoia gigantea*) are protected. Other attractions which invite visitors to the park are the magnificant panoramas of mountain, stream, and forest, and an excellent climate.

GEOLOGY: In the table accompanying the description of Yosemite National Park the major events in the geologic history of the Sierra region are given in chronologic order. During the latter half of the Tertiary period this region was the scene of repeated disturbances and minor mountain-building movements. The present Sierra Nevada assumed its present height and form at the beginning of the Quaternary.

In the east central part of the park there is an area of Triassic rocks, (heavy thick-bedded gray limestones; and thick masses of dark, siliceous slates). All the other exposed rocks of this area are granitic and are part of a great batholith-- the sedimentary rocks which once formed the roof of the batholith have been worn away.

During the great Ice Age (early Quaternary) the Sierra Nevada was a center of snow accumulation separate from the vast continental ice sheet which covered most of Canada and the northern United States east of the Rocky Mountains.

Since the end of the Ice Age the cliffs have been subjected to the destructive action of the elements, and masses of rock waste are collecting at their base. Exfoliation is the predominant type of weathering effecting the massive granitic rocks of this area.

---After Matthes, Francois E., Geologic history of the Yosemite Valley: U. S. Geol. Survey Prof. Paper 160, p. 23, 1930.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

176,429 (Acres) | (Sq. Miles) | SHENANDOAH NATIONAL PARK (~~PROPOSED~~) (Name of Area)

(C.C.C. Camps) | (Period) | Virginia (State) | (County)

DESCRIPTION OF AREA: The Shenandoah National Park, located in the Blue Ridge Mountains, contains the famous Skyline Drive which affords unusual vistas of Virginia's finest scenery. From the crest of the mountains a panorama extends for many miles over the Piedmont Region to the east and the Shenandoah Valley Massanutten Mountain and the Valley Ridges on the west.

GEOLOGY: The early history of the area was one of igneous activity forming the pre-Cambrian complex of batholithic intrusions, fissure flows, and surface extrusions. Upon the eroded surface of these igneous rocks the lower Cambrian seas deposited a succession of sedimentary rocks which have since been metamorphosed by mountain uplifts and later intrusions. There is no record in the park area of the period between the Cambrian and Permian. The major structural features were produced during the Appalachian Revolution in the Permian. Triassic intrusions of diabase dikes occurred next followed by the erosion of the area and the development of the present Shenandoah drainage system. The Upland peneplain was formed in early Jurassic followed later by the Kittatinny. Later uplifts formed the Weverton and Shenandoah (Harrisburg) peneplains. Shortly after, the greater part of the present drainage system assumed the form it now has.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

(10315F

AGE	FORMATION	THICKNESS	CHARACTER
TRIASSIC	Dike rocks	-	Moderately fine-grained augite-diabase in intrusive dikes.
LOWER CAMBRIAN	Tomstown	1800	Coarse-grained massive dolomite, deeply weathered to sandy and cherty clay.
	Antietam	500	Hard, thick-bedded pink, gray, or white quartzite, with inter-bedded sandstone. Typically contains tubes of Scolithus.
	Harpers shale	400	Alternating sandy shales and slates with interbedded thin sandstone.
	Weverton	200-1000	Dark ferruginous arkosic sand, sandstone, and quartzite, with interbedded slaty sandstone
	London	100	Red, purple, and greenish or gray conglomerate, shale, arkosic sandstone and quartzite. In places metamorphased to schists and slates.
	Cambrian (?)	100	Red or purple volcanic tuff, agglomerate, breccia, and slate and amygdaloidal flows.
PRE-CAMBRIAN	Air Point granite	?	Pink to green orthoclase- microcline-quartz granite, with albite and epidate.
	Catoctin	?	Fine-grained, often amygdaloidal basalt, altered to a quartz-epidate-hornblende greenstone in thick flows and occasional dikes.
	Old Rag granite	?	Fine- to coarse-grained quartz-feldspar granite with biotite granodiorite.
	Hypersthene granodiorite		Coarse-grained greenish to gray intrusive of feldspar and pyroxene, with quartz.

11,818.94	18.47	WIND CAVE NATIONAL PARK	
(Acres)	(Sq. Miles)	(Name of Area)	
	Sixth	South Dakota	
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: The name of this park was suggested by the strong currents of air that blow alternately in and out of the mouth of the cave, believed to be caused by changes in the atmospheric temperature and pressure. The explored portions of the cavern are about 10 miles in extent. The formations in Wind Cave are unusual, in that they are of a boxwork and frostwork type instead of the usual stalactite, stalagmite, and drapery types. It is generally believed the caves were first discovered by Tom Bingham in 1881 while hunting.

GEOLOGY: The cave is dissolved from the Pahasapa limestone of lower Mississippian age, which, in the Black Hills region is 300-600 feet thick. The solution of this limestone has been influenced by three sets of joints formed when the rocks in this area were folded and faulted during the uplift of the Rocky Mountains and the Black Hills in late Cretaceous and early Tertiary. The most prominent set of joints trends in a northwest direction parallel to the mountain folds. The limestone beds dip 18° to the southeast.

The "box work" is due to the deposition of calcite in the fractures and joints of the limestone; later solution of the limestone leaving a network of vein calcite projecting from the surface.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

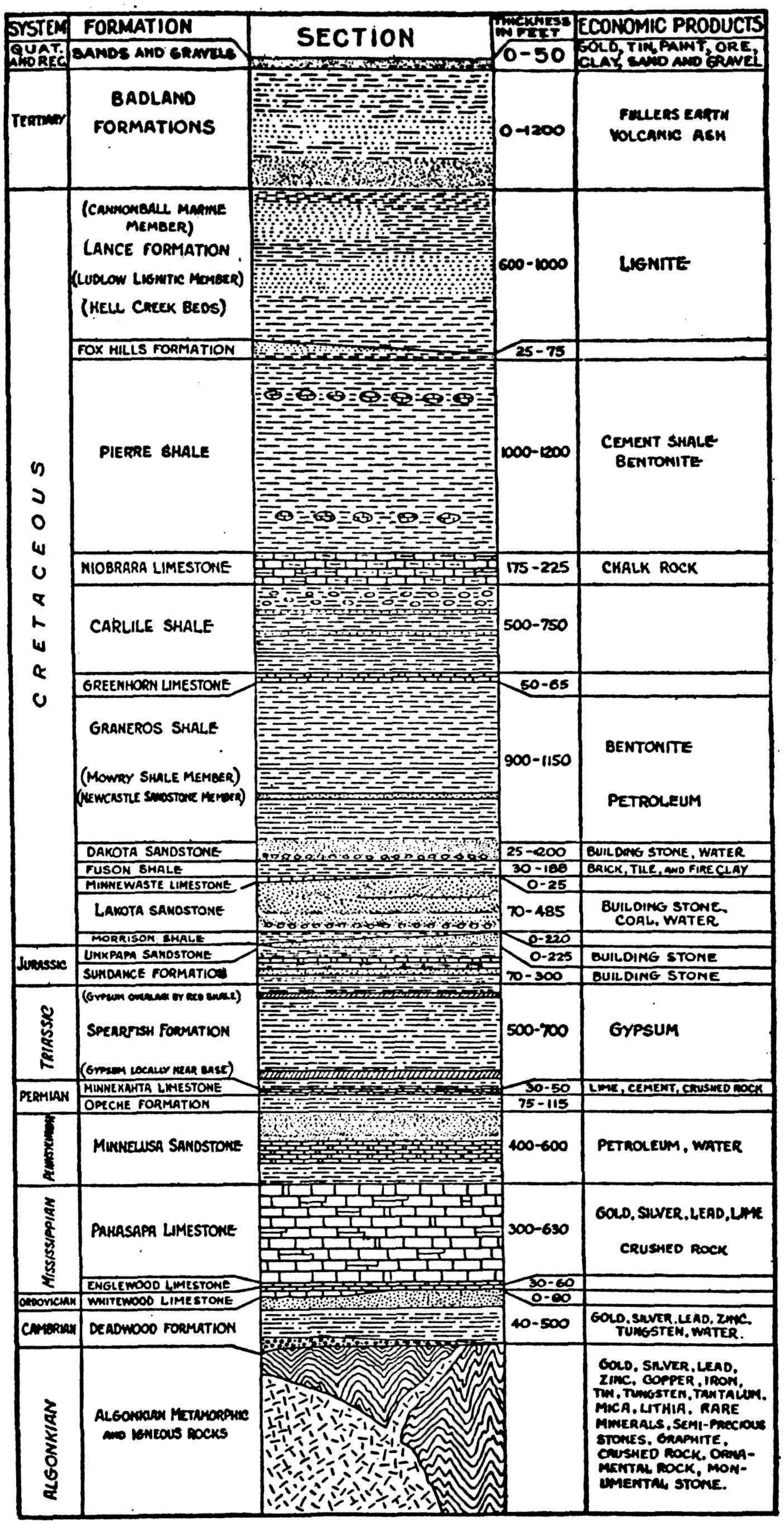


FIGURE 2.—Generalized columnar section of the Black Hills

XVI International Geological Congress, Guidebook 25, p. 3, 1932.

COLUMNAR SECTION

GENERALIZED SECTION OF THE SEDIMENTARY ROCKS OF THE CENTRAL BLACK HILLS, SOUTH DAKOTA.

SCALE: 1 INCH = 500 FEET.

System.	Series or group.	Formation.	Symbol.	Section.	Thickness in feet.	Character of rocks.	Character of topography and soil.
TERTIARY	OLIGOCENE / WHITE RIVER GROUP	Brule clay and Chadron formation undifferentiated.	Tw		0-600	Sand, gravel, clay, fuller's earth, sandstone, and limestone.	Valleys and saddles among the ridges and plateaus, with badlands.
		UNCONFORMITY					
CRETACEOUS	UPPER CRETACEOUS / MONTANA GROUP	Pierre shale.	Kp		[illegible]	Principal horizon of limestone lenses giving rise to tepee buttes. Dark-gray shale containing scattered concretions. Widely scattered limestone masses giving rise to small tepee buttes. Black fissile shale containing cone-in-cone and other concretions.	Small rocky, sharply conical hills or tepee buttes. Wide, rolling plains with shallow valleys. Clay soil, in greater part sodded.
	UPPER CRETACEOUS / COLORADO GROUP	Niobrara formation.	Kn		[illegible]	Impure chalky limestone or calcareous clay, containing many shells of *Ostrea congesta*.	Valleys or flat areas with fertile soil.
		Carlile shale.	Kc		[illegible]	Light-gray shale containing numerous large concretions and sandy layers. Dark-gray shale.	Rolling plains and valleys. Clay soil.
		Greenhorn limestone.	Kg		[illegible]	Impure slabby limestone which weathers light buff and contains many shells of *Inoceramus labiatus*.	Low ridges with thin soil.
		Graneros shale. (Mowry shale member.)	Kgn (Kmr)		[illegible] ([illegible])	Dark-gray shale. Shale that weathers light gray and contains numerous fish scales. Sandstone locally at base. Dark fissile shale.	Wide rolling plains. Clay soil. Wooded ridges. Rolling plains and valleys. Clay soil.
		Dakota sandstone.	Kd		[illegible]	Massive sandstone, weathering brown, thinner-bedded at top. Conglomerate locally at base.	Rocky slopes and cliffs. Sandy soil.
	LOWER CRETACEOUS	Fuson shale.	Kf		10-100	Massive gray to purple shale or clay.	Slopes with clay soil, partly bare.
		OVERLAP					
		Minnewaste limestone.	Kmw		[illegible]	Massive gray limestone; present only in extreme southeastern part.	Outer slope of hogback ridges.
		Lakota sandstone.	Kk		[illegible]	Coarse hard cross-bedded sandstone, mostly buff to gray. Conglomerate at base.	Hogback ridges, sloping plateaus, cliffs, and canyons. Thin sandy soil.
		OVERLAP SOUTHWARD					
CRETA-CEOUS?		Morrison shale.	Km		[illegible]	Greenish to maroon shale and thin limestone. Absent in southern part.	Inner slope of hogback ridges. Clay soil.
		UNCONFORMITY					
JURASSIC	UPPER JURASSIC	Unkpapa sandstone	Ju		[illegible]	Soft massive fine-grained sandstone. Absent in western and northwestern parts.	Steep slopes, mostly covered by talus.
		Sundance formation.	Jsd		[illegible]	Sandstone, shale, and thin fossiliferous limestone.	Inner slopes of hogback ridges, mostly covered by talus.
		UNCONFORMITY					
TRIASSIC ?		Spearfish formation.	Tis		[illegible]	Gypsum overlain by red shale. Red sandy shale, soft red sandstone, and gypsum beds. Gypsum locally near base.	Wide valley with thin barren red soil except where covered by alluvium.
(?)	(?)						
CARBONIFEROUS	PERMIAN ?	Minnekahta limestone.	Cmk		30-50	Massive gray, thinly laminated limestone.	Rocky slopes and canyon walls. Thin soil.
		Opeche formation.	Co		75-115	Red shale and red slabby sandstone.	Slopes of limestone ridges, mostly covered by talus.
	PENNSYLVANIAN	Minnelusa sandstone.	Cml		[illegible]	Massive granular sandstone, slabby sandstone, and limestone of reddish, buff, and white colors. Red shale and white concretionary limestone at base.	Rocky ridges, mountain slopes, and canyon walls. Sandy soil.
	MISSISSIPPIAN	Pahasapa limestone.	Cp		[illegible]	Mostly massive light-colored limestone weathering dove-colored	High ridges, plateaus, and cliffs. Thin fertile soil
		Englewood limestone	Ce		30-60	Pale-pink to buff slabby limestone, with shale locally at base.	Slopes, mostly covered by talus.
		UNCONFORMITY					
ORDOVICIAN	UPPER ORDOVICIAN	Whitewood limestone	Ow		0-60	Massive buff limestone. Present only in northwestern part.	Cliff or bench in canyon wall
		UNCONFORMITY					
CAMBRIAN	UPPER CAMBRIAN	Deadwood formation.	Cd		[illegible]	Massive buff to brown sandstone at top locally overlain by green shale. Greenish glauconitic shale, flaggy dolomite, and flat-pebble limestone conglomerate. Sandstone and locally quartz conglomerate at base	Wide high plateaus, ridges, slopes, and canyon walls. Sandy soil
		UNCONFORMITY					
PRE-CAMBRIAN		Schist, slate, grit, granite, and other igneous rocks.				Micaceous, quartzitic, garnetiferous, calcareous, and other schists, slate, quartzite, and arkosic grit, intruded by granite, amphibolite, monzonite, and other igneous rocks in laccoliths, sills, and dikes.	High rocky ridges and valleys. Fertile soil in parts of intervening valleys.

U. S. Geol. Survey, Folio 219.

2,200,240.00	3,437.88	YELLOWSTONE NATIONAL PARK	
(Acres)	(Sq. Miles)	(Name of Area)	
		Mostly in Wyoming.	
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA: The Yellowstone National Park occupies the northwest corner of Wyoming, slightly overlapping Montana and Idaho. It is the most celebrated of the national parks owing to its hot springs and geysers.

GEOLOGY: The rocks of the park are largely volcanic, including one of the most extensive known exposures of acid flows, as well as a great series of volcanic agglomerates, of Tertiary Age. The Tertiary and Quaternary stratigraphy and physiography are not only unique in North American geology but also bear an important relation to the contiguous areas.

--- Internat. Geol. Congress, Guidebook 24.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

Geologic history of Yellowstone Park

Quaternary.	Recent.	Removal of major portion of valley basalts and lake sediments. Reexcavation of the Grand Canyon of the Yellowstone and Lamar Valley. Local valley glaciation.		
		Erosion		
Quaternary.	Pleistocene.	Glaciation, piedmont type. Till and glacial-lake deposits (Bull Lake epoch?).		
Quaternary.	Pleistocene.	Basalt "valley" flows and associated lake sediments. Canyon filled to brim; rim conglomerate.		
		Erosion		
Quaternary.	Pleistocene.	"Trachytic rhyolite" flows and associated lake sediments and canyon conglomerates.		
		Erosion		
Quaternary.	Pleistocene.	Basalt "valley" flows and associated lake sediments and canyon conglomerates.		
Quaternary.	Pleistocene.	Intrenchment of Yellowstone River. The Grand Canyon cut to approximately present depth of the Yellowstone.		
Quaternary.	Pleistocene.	Uplift and rejuvenation.		
Tertiary.	Pliocene.	Development of local base-level. Removal of 600± feet (183 meters) of rhyolite.		
Tertiary.	Miocene.	Extrusion of rhyolite and associated acid flows and volcanic rocks.		
Tertiary.	Oligocene.	Extensive erosion. Development of mature surface. Mount Washburn a monadnock.		
Tertiary.	Eocene.	"Basic" breccias and agglomerates. Pinyon conglomerate.		Andesitic breccias with basic intrusives and flows.
Tertiary.	Eocene.	"Acid" volcanic breccias.		Andesitic breccias with basic intrusives and flows.
Mesozoic.	Upper Cretaceous.	Montana group undivided. Thick sandstone above and shale below.		
Mesozoic.	Upper Cretaceous.	Colorado group undivided; 2,000 feet (610 meters) of shale with some limestone.		
Mesozoic.	Lower Cretaceous.	Kootenai formation; 250± feet (76 meters). Shale, quartzite, and sandstone. Mapped under color for Cloverly formation on Wyoming State map.		
Mesozoic.	Jurassic.	Ellis formation; 500± feet (152 meters). Limestone, marl, and shale.		
Mesozoic.	Jurassic.	(?)		
Mesozoic.	Triassic.	Teton formation; 200–400 feet (61–122 meters). Shale, sandstone, and cherty limestone.	(?)	
Mesozoic.	Triassic.	Teton formation; 200–400 feet (61–122 meters). Shale, sandstone, and cherty limestone.	Limestone.	
Mesozoic.	Triassic.	Teton formation; 200–400 feet (61–122 meters). Shale, sandstone, and cherty limestone.	Red sandy shale.	800 feet (244 meters).
Mesozoic.	Triassic.	Teton formation; 200–400 feet (61–122 meters). Shale, sandstone, and cherty limestone.	Shaly brown limestone.	800 feet (244 meters).
Paleozoic.	Permian.	Teton formation; 200–400 feet (61–122 meters). Shale, sandstone, and cherty limestone.	Phosphoria formation; 100–340 feet (30–104 meters). Shale, quartzite, chert, and phosphate rock.	
Paleozoic.	Pennsylvanian.	(?)		
Paleozoic.	Pennsylvanian.	Quadrant quartzite; 200–425 feet (61–130 meters). Quartzite, sandstone, some limestone, and shale.		
Paleozoic.	Mississippian.	(?)		
Paleozoic.	Mississippian.	Madison limestone; 1,300–1,600 feet (396–488 meters). White or cream-colored limestone above; dark-colored limestone below.		
Paleozoic.	Upper Devonian.	Threeforks limestone; 170–250 feet (52–76 meters). Gray cherty limestone.		Darby formation in Teton Range.
Paleozoic.	Middle Devonian.	Jefferson limestone; 110–300 feet (34–91 meters). Dark crystalline limestone.		Darby formation in Teton Range.
Paleozoic.	Upper Ordovician.	Big Horn dolomite; 200–300 feet (61–91 meters). Massive white to buff dolomite.		
Paleozoic.	Upper and Middle Cambrian.	Gallatin limestone; 110–400 feet (34–122 meters).	Massive limestone, shale, and "edgewise" conglomerates.	
Paleozoic.	Upper and Middle Cambrian.	Gallatin limestone; 110–400 feet (34–122 meters).	Calcareous and argillaceous shale.	
Paleozoic.	Upper and Middle Cambrian.	Gallatin limestone; 110–400 feet (34–122 meters).	Dark mottled limestone; 100–500 feet (30–46 meters).	
Paleozoic.	Middle Cambrian; 700–750 feet (213–229 meters).	Gros Ventre formation. Shale and thin limestone near top.		
Paleozoic.	Middle Cambrian; 700–750 feet (213–229 meters).	Flathead quartzite. Conglomerate at base.		
Algonkian.		Sheridan quartzite.		
Archean.		Granite and gneiss.		

104787—32. (Face p. 8.)

Sedimentary formations exposed in the Yellowstone-Beartooth-Big Horn region

[By John G. Bartram]

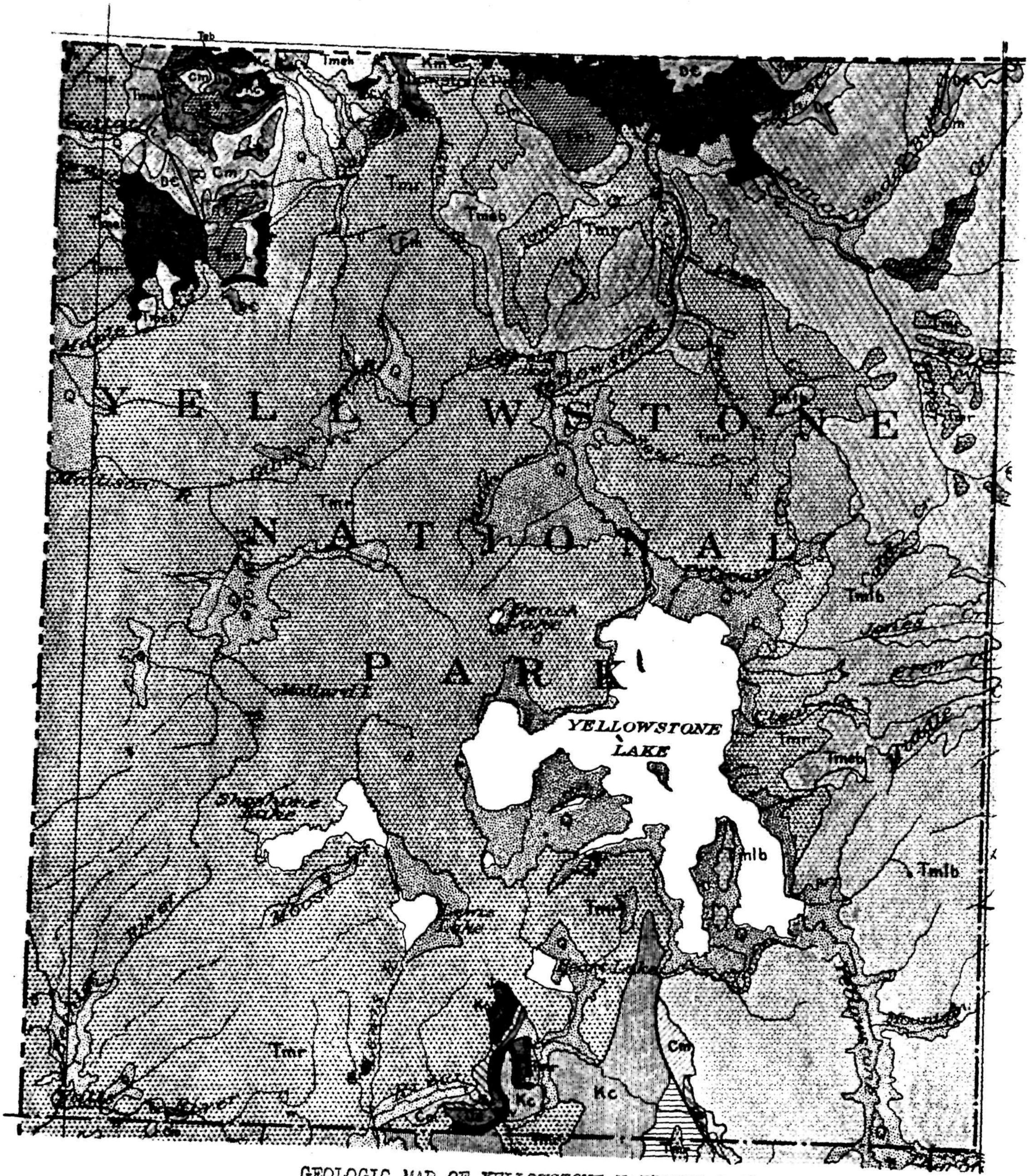
Age		Formation: Billings area		Formation: Cody area (with thickness)	Character	Origin
Tertiary.					Andesitic tuffs and flows.	Deposits that spread from the Yellowstone Park volcanic center.
	Eocene.[a]			Wind River and Wasatch, 1,000 feet (305 meters).	Red and drab clay, buff and white sandstone, and gravel beds. Strong angular unconformity near basin margins.	Flood-plain and stream deposits formed after a period of major deformation. Contains mammalian vertebrates, leaves, and invertebrate fresh-water fossils.
	Paleocene.[b]	Fort Union.		Fort Union, 3,600 feet (1,097 meters).	Buff and white sandstone, with drab and green clay; some gravel beds and seams of coal. Some angular unconformity at base near basin margins.	Fresh-water sediments deposited in flood plains, swamps, etc.
Mesozoic.	Upper Cretaceous.	Lance.[a, b]		Lance,[a] 700 feet (213 meters).	White and buff sandstone with large concretions and yellow, green, and gray clay.	Fresh-water sandstones and clays locally, with abundant dinosaur remains and fossil leaves.
		Lennep.		Meeteetse, 1,100 feet (335 meters).	Soft gray and brown shale, with gray and buff sandstone and some coal.	Marine shale rapidly grading to sandy nonmarine beds farther west.
		Bearpaw.				
		Judith River.		Mesaverde, 850 feet (259 meters).	Prominent gray and white sandstone, with gray and brown shale and coal beds near base.	Sandstone and coal series, partly marine, partly brackish water. Source in the west; thins eastward.
		Claggett.				
		Eagle.		Cody, 2,200 feet (670 meters).	Gray and black marine shale, with Eagle sandstone near top.	Marine beds deposited not far from western shore line.
		Telegraph Creek.				
		Niobrara.				
		Carlile.				
		Frontier.		Frontier, 550 feet (168 meters).	Two or more beds of gray and buff sandstone with gray and brown shale and some bentonite.	Wedges from a thicker sandstone formation to the west; thin and disappear eastward.
		Mowry.		Mowry, 200 feet (61 meters).	Hard gray siliceous shale with fish scales. Breaks in thin rectangular fragments.	Peculiar character probably due to admixed volcanic material.
		Thermopolis.		Thermopolis, 450 feet (137 meters).	Gray to black shale with one sandstone (the "Muddy") and several bentonite beds.	Marine shale and altered pyroclastic rocks derived from west.
	Lower Cretaceous.	Cloverly.		Cloverly, 128 feet (39 meters).	Upper hard sandstone, variegated shale, and lower conglomeratic sandstone, containing abundant pebbles of black chert.	Upper bed of Cloverly is basal sandstone of invading interior Cretaceous sea.
		Morrison.		Morrison, 400 feet (122 meters).	Gray to reddish or purplish shale, white sandstone, and one or more thin beds of gray limestone.	Fresh-water material that in places contains dinosaur bones and gastroliths.
	Jurassic.	Sundance.		Sundance, 575 feet (175 meters).	Blue-green shale, yellow and green sandstone, fossiliferous sandy limestone, reddish shale, and some gypsum.	Deposited in a Jurassic sea that lay mostly to the north and west of this area. Sandstones increase to south.
	Triassic.	Chugwater.		Chugwater, 975 feet (297 meters).	Bright-red sandy shale and shaly sandstone. Some gypsum beds and thin limestones.	The "Red Beds" contain few fossils. Evenly deposited material that grades into nonred marine deposits farther west. Disappears to north.
Paleozoic.	Permian.	Big Horn Mountains.	Beartooth region.	Embar, 150 feet (46 meters).	Hard, cherty limestone and one interbedded sandstone.	Permian sea was largely to west, and limestone grades rapidly into red shale and gypsum to east.
		Embar.	Phosphoria.			
	Pennsylvanian.	Tensleep.	Tensleep.	Tensleep, 180 feet (55 meters).	Quartzitic sandstone, calcareous in some layers.	Very widespread cross-bedded marine and eolian sandstone that covers large areas in the Rocky Mountains.
		Amsden.	Amsden and Quadrant (probably).	Amsden, 200 feet (61 meters).	Cherty and sandy limestone, red and purple shale, and purple sandstone.	A catch-all formation that probably contains marine beds representative of several Pennsylvanian and perhaps upper Mississippian formations.
	Mississippian.	Madison.	Madison.	Madison, 1,200 feet (366 meters).	Buff, white, or grayish limestone with some chert.	Deposited over most of the Rocky Mountain area.
	Devonian.		Three Forks.		Gray shale and limestone.	Present in western Montana and absent in eastern Wyoming and Montana.
			Jefferson.		Brownish-buff, more or less crystalline thin-bedded limestone.	
	Ordovician.	Bighorn.	Bighorn.	Bighorn, 350 feet (107 meters).	Hard, massive light-colored dolomite and limestone.	Marine limestone, difficult to distinguish from the Madison. Characteristically shows pitted weathering.
	Cambrian.	Deadwood.	Gallatin. Gros Ventre. Flathead.	Deadwood, 1,150 feet (350 meters).	Light-colored limestone, green and red shale, and a basal arkosic sandstone or quartzite.	Deposited during progressive eastward marine transgression during Middle and Upper Cambrian time.
	Pre-Cambrian.	Granite.		Granite, schist, etc.		

[a] As proposed by [illegible] the Mesozoic-Tertiary boundary was placed beneath the Lance formation.—R. M. F.
[b] The United States Geological Survey classifies Fort Union formation as Eocene and Lance formation as Tertiary (?).

104787—32. (Face p. 2.) No. 1

XVI International Geological Congress, Guidebook 24, Opp. p. 2, 1932.

YELLOWSTONE



GEOLOGIC MAP OF YELLOWSTONE NATIONAL PARK
U. S. Geol. Survey Geologic Map of Wyoming, 1925.
Legend on Back.

SEDIMENTARY ROCKS

Km

Montana Group

Kc

Colorado Group

Kcv

Cloverly formation

Js

Sundance, Ellis, Beckwith, Twin Cr., Nugget

Trc

Chugwater formation

Cm

Mississippian

D Є

Devonian to Cambrian

gr

Granite, gneiss, schist, and quartzite.

IGNEOUS ROCKS

Tmr

Rhyolite lava flows

Tmlb

Late basaltic and acidic breccia

Tmeb

Early basaltic breccia and lava flows

Teb

Early acidic breccia and lava flows

752,744632	1,176.16		YOSEMITE NATIONAL PARK	
(Acres)	(Sq. Miles)		(Name of Area)	
	Sixth		California	
(C.C.C. Camps)	(Period)		(State)	(County)

DESCRIPTION OF AREA: The Yosemite National Park includes a portion of the west slope of the Sierra Nevada, the longest and highest mountain range in the United States. The famous Yosemite Valley, through which Merced River flows, is only one of a great many features of the park which also includes innumerable lakes and waterfalls, lofty granite domes, and ice-sculptured canyons. In addition, the park contains three groves of sequoias, the celebrated "Big Trees of California", and one of the best groves outside of Sequoia National Park.

GEOLOGY: In the accompanying table of geologic time divisions the major events in the geologic history of the Sierra region are given in chronologic order. During the later half of the Tertiary period this region was the scene of repeated disturbances and minor mountain-building movements. The present Sierra Nevada assumed its present height and form at the beginning of the Quaternary period.

The exposed rocks of this region are all granitic and are part of a great batholith. It is from these granitic rocks that the magnificent sculptural features of the region are carved,--the sedimentary rocks which once formed the roof of the batholith have been worn away.

During the great ice age (early Quaternary) the Sierra Nevada was a center of snow accumulation separate from the vast continental ice sheet which covered most of Canada and the northern United States east of the Rocky Mountains. Where the rocks were well jointed glacial quarrying was effective; but where the granite was massive and aparsely jointed the ice could do little more than rasp and polish. The V-shaped canyons were transformed into U-shaped troughs with hanging valleys from which now pour magnificant waterfalls.

Since the end of the Ice Age some of the glacial lake basins in the valley have been filled by the forward-growing deltas which the streams have built with their loads of sand and gravel, forming level valley floors. The cliffs have been subjected to the destructive action of the elements, and masses of rock waste are collecting at their base. Exfoliation is the predominant type of weathering effecting the massive granitic rocks in this area.

--After Matthes, Francois E., Geologic history of the Yosemite Valley: U.S.G.S. Prof. Paper 160, p.23, 1930.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

1939 E. B. Blackwelder and Walter Buss of Stanford Univ. suggests that the El Portal stage of the ice advance in Yosemite valley extended at least 4 miles below El Portal.

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Sequence of mountain-building events in Sierra region.

ERA	PERIOD	EPOCH	NATURE OF EVENTS
CENOZOIC	QUATERNARY.	Recent.	Postglacial time. Return to normal climatic conditions.
		Pleistocene.	The great ice age. The higher parts of the range are repeatedly mantled by glaciers. Renewed vigorous tilting, accompanied by strong faulting movements along its eastern margin, cause the Sierra Nevada to stand forth as a lofty block range with steep eastern front. Period of relative stability. Occasional minor crustal movements and volcanic outbreaks. The region is tilted to the west and assumes mountainous height at its eastern margin. Volcanic eruptions begin anew, and the northern half of the region is covered by successive flows of andesitic lava and mud. Prolonged interval marked by minor warpings of the earth's crust, up and down. The land is subject to continued erosion and the rhyolitic materials are mostly worn away. The region, together with the country to the east of it, is slowly upwarped to moderate heights. Volcanoes burst forth in the northern part and cover the land repeatedly with rhyolitic lava, mud, and ash. The mountain ranges are worn down gradually and the region as a whole is reduced to a lowland. The bulk of the sedimentary rock, several thousand feet in thickness, is carried away by the streams, and the granite is uncovered over large areas. The new sediments, together with remnants of the old, are folded and crumpled into parallel, northwestward-trending mountain ranges. Molten granite invades the folds from below. More sediments are laid down as the sea bottom progressively sinks.
	TERTIARY.	Pliocene.	
		Miocene.	
		Oligocene.	
		Eocene.	
MESOZOIC	CRETACEOUS.		
	JURASSIC.		
	TRIASSIC.		The mountains are slowly worn down to hills. The land finally sinks below the sea and new sediments are deposited.
PALEOZOIC	CARBONIFEROUS.	Permian.	The sediments are uplifted and folded into the form of mountain ranges.
		Pennsylvanian. Mississippian.	Sediments, mainly outwash from the continent, accumulate to thicknesses of thousands of feet on the floor of the Pacific Ocean.
	DEVONIAN.		
	SILURIAN.		
	ORDOVICIAN.		
	CAMBRIAN.		
PROTEROZOIC	ALGONKIAN.		Nothing definite known.
	ARCHEAN.		

Read up

Matthes, Francois E., Geologic history of the Yosemite Valley: U.S.G.S. Prof. Paper 160, p.23, 1930.

94,887.73	148.26	ZION NATIONAL PARK
(Acres)	(Sq. Miles)	(Name of Area)

	SIXTH	UTAH	WASHINGTON
(C.C.C. Camps)	(Period)	(State)	(County)

DESCRIPTION OF AREA:

The Zion National Park is situated in Southwestern Utah in the Colob plateau region. The vividly colored and carved sandstone cliffs bordering a deep valley rise abruptly from 2000 to 4000 feet. These gorgeous sandstone cliffs present an extraordinary spectacle of erosion. However, it is probable that the startling color displays are most amazing. The Gorge was known to the Mormons in the late fifties and was first explored in 1862.

GEOLOGY:

The Gorge has been formed by the erosion of the North Fork of the Virgin River. The oldest sedimentary rocks exposed are the variegated shales, arkosic sandstones and cherty limestone conglomerates defined as the Chinle formation of Triassic Age. This formation ranging in thickness from 400 to 1000 feet, contains fossil wood as well as species of fossil fish and reptilian teeth. The Glen Canyon group (Jurassic?) above, consists mainly of sandstone with some shale and is characterized by cross-bedding on an exceptional scale. This group is the outstanding maker of cliffs and canyon walls. On the high plateaus its thickness exceeds 2000 feet. The Carmell formation (Jurassic) conformably overlies the Glen Canyon group. This series of hard gray limestones and shales range in thickness from 100 to 250 feet. The limestone beds contain fossils. They also form the rim of Zion Canyon.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT:

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of the Grand Canyon. It is predominantly a gray or buff cherty fossiliferous arenaceous limestone with some interbedded sandstone and locally gypsum at the base (Harrisburg gypsiferous

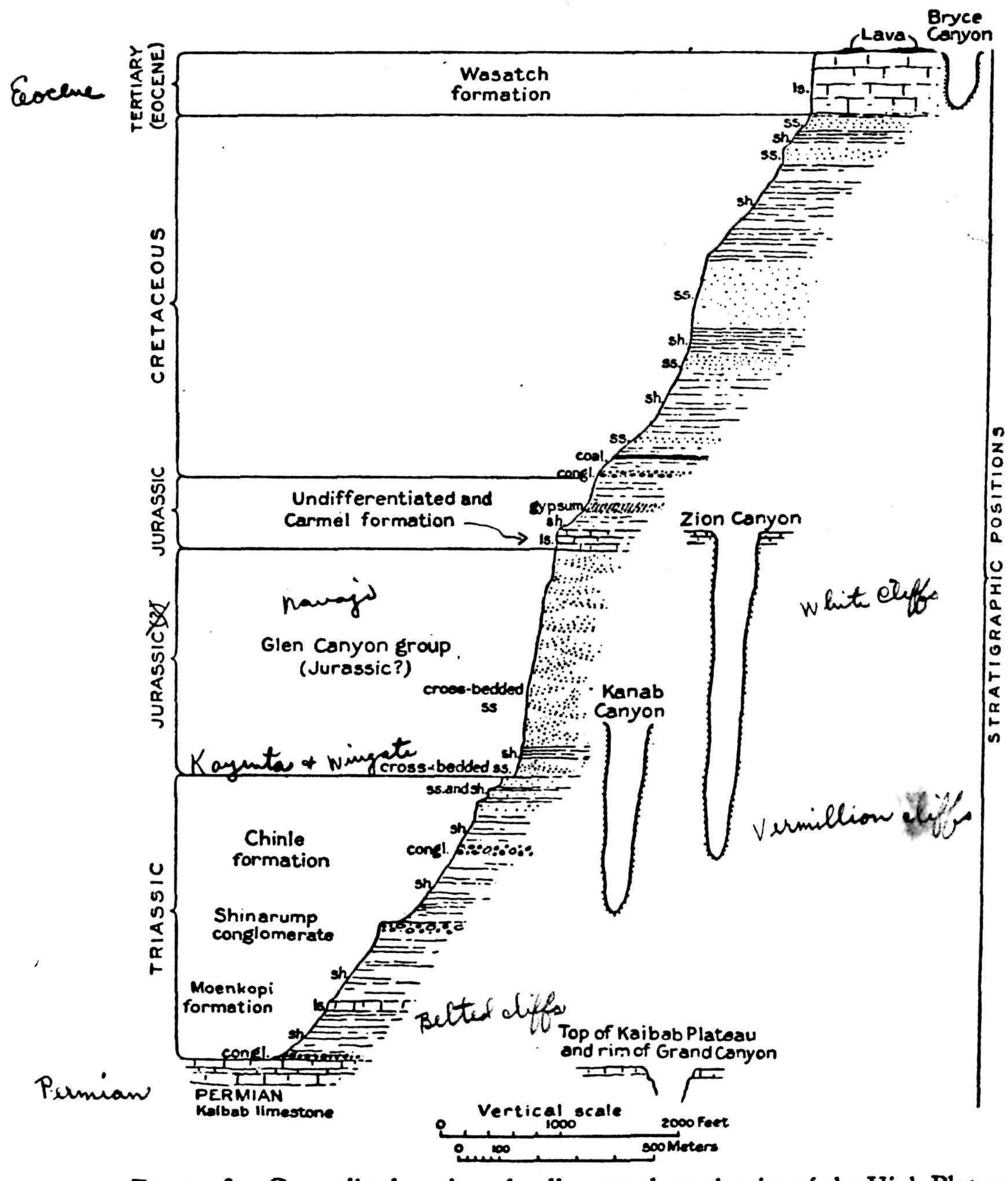

FIGURE 3.—Generalized section of sediments along the rim of the High Plateaus

member, "*Bellerophon* limestone"). In outcrops the Kaibab limestone forms ragged, nearly vertical cliffs with recessed grooves along the edges of the less resistant beds. The Per-

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Geologic formations of southwestern Utah and northwestern Arizona.

System.	Series.	Formation.	Member.	Character of rocks.	Thickness (feet).
Quaternary.				Alluvium, dune sand, etc.	
Tertiary(?).				Basalt flows with associated boulder beds and cinder cones.	
				Massive yellow sandstone with some pink staining, separated by soft sandstone, much of it red, and red shale. The series as a whole is pink.	1,800+
Cretaceous(?).				Buff sandstones with some intercalated shale.	1,000±
				Variegated shale, with a little thin limestone in upper part and some platy limestone in lower part.	140
Jurassic.				Greenish-gray, cream-colored, and brown fossiliferous marine limestone, underlain by brick-red sandstone, shale, and gypsum.	400±
				Massive cross-bedded sandstone, red in lower part and white above, the boundary between the colored parts varying in position from a level near the middle to the top.	2,100
Triassic.	Upper Triassic.	Chinle formation.		Brick-red to deep-red shale and sandstone.	300
				Massive medium-grained mauve sandstone, cross-bedded and ripple-marked.	90
				Brick-red sandstone and shale.	420
				Variable coarse arkosic cross-bedded sandstone, banded with gray, white, and mauve and containing fossil wood. Locally known as the "Silver Reef sandstone."	25
				Variegated "gumbo" clay shale, bluish gray, greenish gray, mauve, red, and rarely brown; contains fossil wood.	300
	Upper Triassic(?).	Shinarump conglomerate.		At top 20 feet of gray platy sandstone, underlain by 20 feet of gray and green shale with some fossil wood; at base 75 feet of brown sandstone, with lines and lenses of pebbles of chert, quartz, silicified wood, and rarely igneous rock; fossil logs abundant.	115
	Lower Triassic.	Moenkopi formation.		Brick-red to deep-red and brown shale and sandstone; upper part very dark; locally contains massive beds of yellow medium-grained sandstone.	475±
			Shnabkaib shale member.	Gray to white sandy shale and soft sandstone, with some pink layers and much gypsum.	300–600
				Red beds similar to those underlying the Virgin limestone member.	425±
			Virgin limestone member.	Three layers of earthy yellow limestone separated by yellow and red calcareous shale.	11–100
				Red to brown shale and sandstone, with soft tan sandstone near base and layers, streaks, and veinlets of gypsum throughout.	300±
			Rock Canyon conglomeratic member.	Variable assemblage of shale, limestone, gypsum, conglomerate, and a minor amount of sandstone.	0–200
Carboniferous.	Permian.	Kaibab limestone.	Harrisburg gypsiferous member.	Gypsum, shale, and limestone, with platy chert. Locally the "*Bellerophon* limestone" at top.	0–300±
				Massive cliff-forming cherty gray limestone, with locally a thick limestone breccia in lower part.	185–455
				Soft beds resembling basal member.	80–285
				Massive gray limestone with much chert.	150–220
				Gypsum, gray and yellow shale, soft gray sandstone, and some thin-bedded dark-drab limestone.	0–100
	Permian (?).	Coconino sandstone.		Deep-yellow to buff sandstone at top locally; massive white friable sandstone in middle; pale-yellow sandstone below.	90±
	Pennsylvanian (?).	Supai formation.		Brick-red sandstone and shale in the southeastern part of the region, changing northwestward into a yellow massive sandstone with only patches of pink color.	1,200–1,500
	Pennsylvanian. / Mississippian.	Redwall limestone.		Dense siliceous gray limestone, with some sandstone layers; mostly heavy bedded; light gray on fresh surface, dark gray and brown on weathered surface.	1,500±

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