A PRELIMINARY ASSESSMENT OF PALEONTOLOGICAL RESOURCES AT BIGHORN CANYON NATIONAL RECREATION AREA, MONTANA AND WYOMING

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ABSTRACT - Paleontological resources occur throughout the Paleozoic and Mesozoic formations exposed in Bighorn Canyon National Recreation Area. Isolated research on specific geologic units within Bighorn Canyon has yielded data on a wide diversity of fossil forms. A comprehensive paleonotological survey has not been previously undertaken at Bighorn Canyon. Preliminary paleontologic resource data is presented in this report as an effort to establish baseline data.

INTRODUCTION

Bighorn Canyon National Recreation Area (BICA) consists of approximately 120,000 acres within the Bighorn Mountains of north-central Wyoming and south-central Montana (Figure 1). The northwestern trending Bighorn Mountains consist of over 9,000 feet of sedimentary rock. The predominantly marine and near shore sedimentary units range from the Cambrian through the Lower Cretaceous. Many of these formations are extremely fossiliferous. The Bighorn Mountains were uplifted during the Laramide Orogeny beginning approximately 70 million years ago. Large volumes of sediments, rich in early Tertiary paleontological resources, were deposited in the adjoining basins.

This report provides a preliminary assessment of paleontological resources identified at Bighorn Canyon National Recreation Area.

STRATIGRAPHY

The stratigraphic record at Bighorn Canyon National Recreation Area extends from the Cambrian through the Cretaceous (Figure 2). The only time period during this interval that is not represented is the Silurian. Brief descriptions of the stratigraphic units exposed in Bighorn Canyon are provided below.

GROS VENTRE FORMATION & GALLATIN LIMESTONE (Cambrian)

Cambrian strata are poorly exposed in the deepest cuts into Bighorn Canyon. The lack of paleontological specimens has led to the Gros Ventre and Gallatin Formations being mapped as one unit. The Gallatin is a gray limestone unit with a mud-cracked gray-green shale and beds of flat-pebble limestone conglomerate. Identification of these units is based upon lithologic correlation with similar strata exposed in the Bighorn Basin.

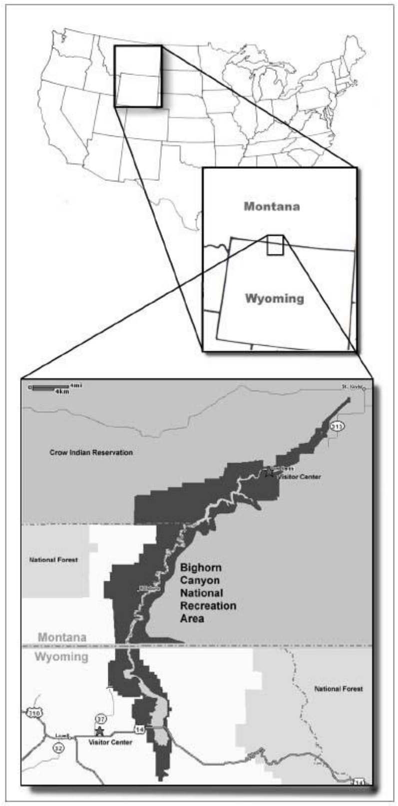

Figure 1— Map showing the location of Bighorn Canyon National Recreation Area, Montana and Wyoming.

BIGHORN DOLOMITE (Upper Ordovician)

The Ordovician Bighorn Dolomite is appoximately 400 feet thick in Bighorn Canyon. The unit consists of a lower massive dolomitic limestone member and an upper thin-bedded dolomite and limestone member. The lower member forms a distinct continuous cliff through the Bull Elk Basin section of the canyon. Darton (1906) reported the Bighorn Dolomite to be Upper Ordovician in age. An archaeogastropoda is reported from the Bighorn Dolomite in Bighorn Canyon.

THREE FORKS SHALE & JEFFERSON LIMESTONE (Devonian)

Devonian age rocks, believed to correlate to the Three Forks Shale and the Jefferson Limestone, are exposed in Bighorn Canyon along Big Bull Elk Creek and in Devils Canyon. The Big Bull Elk Creek section is approximately 220 feet thick and the Devils Canyon section is approximately 180 feet thick. Brachiopods of the genus Atrypa sp. were collected from this unit at about 60 feet below the contact with the Madison Limestone in Devils Canyon. Atrypa sp. and the coral Amplexiphyllum sp. were collected from the limestones between 40 to 60 feet below the contact with the Madison Limestone in the Big Bull Elk Creek area (Richards, 1955).

MADISON LIMESTONE (Mississippian)

The Madison Limestone consists of approximately 700 feet of limestone and dolomite and forms the rim of Bighorn Canyon for its entire length. An abundance of marine invertebrates, including bryozoans, corals, brachiopods, and crinoids are preserved in the Madison Limestone. Crushing teeth of the cochliodont *Hybodus* also occur in this unit.

AMSDEN FORMATION (Pennsylvanian)
The Amsden Formation consists of interbedded sandstone, limestone, siltstone and shale. The unit ranges from 230 to 280 feet in the Bighorn Mountains. Marine invertebrate fossils were collected from the Amsden Formation by L.G. Henbest of the U.S. Geological Survey (Richards, 1955). The following fossils are reported from the Amsden: *Bradyina sp., Climacammina sp., Profusulinella sp., Pseudostaffella sp., Tetrataxis sp.*, and sponge spicules.

TENSLEEP SANDSTONE (Pennsylvanian)
The Tensleep Sandstone is a light-gray to yellow-gray, cross-bedded sandstone. This unit ranges between 75 and 110 feet thick in the Bighorn Mountains. L.G. Henbest of the U.S. Geological Survey collected *Bradyina sp.*, *Climacammina sp.*, *Fusulina rockymontana*, *Pseudostaffella sp.*, *Wedekindellina euthysepta*, and *W. excentrica* from the Tensleep Sandstone (Richards, 1955).

EMBAR FORMATION (Permian)
The Embar Formation consists of a series of limestones, dolomites, shales, siltstones and sandstones. The unit is up to 100 feet thick in the Bighorn Mountains. No fossils are reported from the Embar Formation (Richards, 1955).

CHUGWATER FORMATION (Permian/Triassic)
The Chugwater Formation forms red bluffs around the Bighorn and Pryor Moutains. This fine-grained red sandstone unit ranges from 450 to 650 feet thick. The only fossils from this unit occur in the gray chert pebbles within the basal conglomerate. These are reported to be Pennsylvanian fauna eroded from the Tensleep Sandstone or Amsden Formation (Richards, 1955).

PIPER FORMATION (Jurassic)
The Piper Formation is a red sandstone and siltstone unit with beds of gray limestone and gypsum. This unit is between 150 and 200 feet thick in the Bighorn Mountains. No fossils are reported from the Piper Formation.

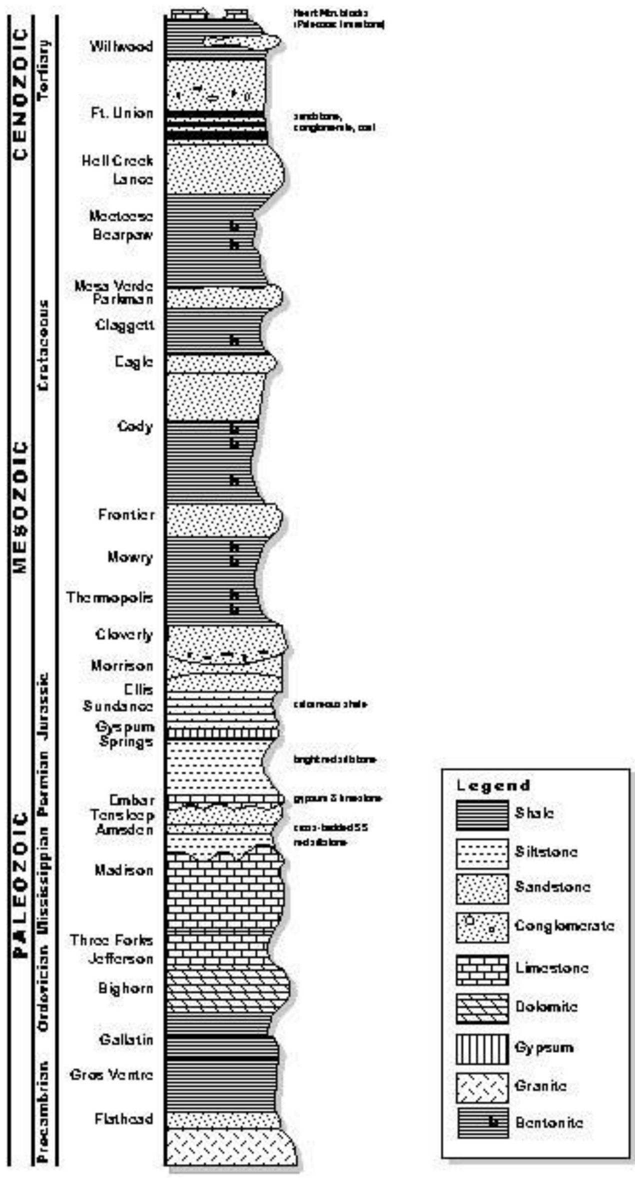

Figure 2— Stratigraphic column for Bighorn Canyon National Recreation Area, Montana and Wyoming.

SUNDANCE FORMATION (Jurassic)
The Sundance Formation, previously referred to as the Rierdon and Swift Formations, is a series of fossiliferous marine sandstones and shales. The total thickness of this unit is about 500 feet on the eastern flank of the Bighorn Mountains. The lower section contains numerous Belemnites sp., Gryphaea sp., and the star-shaped crinoid columnals Pentacrinus sp.. The upper section contains a lenticular fossiliferous sandstone bed at the top of the unit (Richards, 1955).

MORRISON FORMATION (Jurassic)
The Morrison Formation is a gray-green siltstone and sandstone unit that ranges in thickness between 140 to 280 feet in the Bighorn Mountains. Fragmentary dinosaur bones are preserved in

the non-marine Morrison Formation. A sauropod track locality was identified on the west side of Sykes Mountain in the upper portion of the Salt Wash Member (Engelmann and Hasiotis, 1999).

CLOVERLY FORMATION (Early Cretaceous)
The Early Cretaceous Cloverly Formation was first described by Darton for exposures on the east flank of the Bighorn Mountains (Darton, 1904). The formation is exposed in the northern and eastern portions of the Bighorn Mountains and ranges between 300 to 400 feet thick. This formation consists of a basal conglomeratic sandstone member, a middle variegated shale member, and upper shale, siltstone, and sandstone member. Fossils have not been reported from this formation in the Bighorn Mountains.

THERMOPOLIS SHALE (Early Cretaceous)
A section of the Thermopolis Shale was measured in the Bighorn Mountains on the east side of Soap Creek dome (Rogers, et al., 1948). This unit consists of approximately 425 feet of dark-gray shale with many bentonite beds and ironstone concretions. The unit is crosscut by fine-grained sandstone dikes. Fossils are not reported from this unit in the Bighorn Mountains.

MOWRY SHALE (Early Cretaceous)
The Mowry Shale lies conformably over the Thermopolis Shale in the Bighorn Mountains. This unit is exposed on the eastern edge of the Bighorns and ranges in thickness between 350 and 400 feet. The Mowry consists of dark-gray shale and light-gray siltstone and sandstone. Fish scale impressions are abundant in the Mowry Shale (Richards, 1955).

FRONTIER FORMATION (Late Cretaceous)
The Late Cretaceous Frontier Formation consists about 260 feet of dark-gray concretionary, sandy shale with interbedded bentonite (Richards, 1955). This unit contains a few lenses of cherty sandstone in the Bighorn Mountains and in the Bighorn Basin. Fossils are not reported from this unit in the Bighorn Mountains.

CODY SHALE (Late Cretaceous)
The Cody Shale is approximately 2000 feet thick and is composed of seven members (Thom, et al., 1935). All of the members are fossiliferous except for the lowest member of the Cody Shale. Identification of the fossil material was made by W.A. Cobban (Richards, 1955).

Greenhorn Calcareous Member: *Allocrioceras annulatum, Mytiloides labiatus, Ostrea sp., Plicatula sp., Pseudaspidoceras sp., Quitmaniceras sp., Scaphites delicatulus, Vascoceras catinus, Watinoceras reesidei,* and fish bones.

Carlile Shale Member: *Baculites besairiei, Crassatellites reesidei, Inoceramus altus, I. flaccidus, Membraniporina sp., Nucula sp., Ostrea congesta, Placenticeras stantoni, Prionocyclus wyomingensis, Scaphites corvensis, S. nigricollensis, Tritonium kanabense,* and *Veniella goniophora*.

Niobrara Shale Member: *Anomia sp., Baculites codyensis, B. mariasensis, B. sweetgrassensis, Clioscaphites vermiformis, Inoceramus deformis, Ostrea congesta, Pteria nebrascana, Scaphites* *impendicostatus, Veniella sp.* and indeterminant nautiloids, gastropods, pelecypods, echinoid spines, and fish scales.

Telegraph Creek Member: Baculites sp., Ostrea sp., and *Scaphites hippocrepis*.

Shale Member equivalent to the Eagle Sandstone: This unit is considered equivalent to the Eagle Sandstone based upon the fossil assemblage including: *Anomia sp., Baculites aquilaensis, B. haresi, B. minerensis, B. thomi, Callista pellucida, Capulus microstriatus, Cardium whitei, Corbulamella gregaria, Crenella elegantula, Cymbophora sp., Cymella montanensis, Drepanochilus evansi, Glyptoxoceras novimexicanus, G. rubeyi, Goniochasma crockfordi, Inoceramus barabini, I. saskatchewanensis, I. subdepressus, Leptosolen conradi, Lima sp., Lithophaga sp., Pholadomya subventricosa, Pinna dolosoniensis, Placenticeras meeki, P. planum, Scaphites aquilaensis, S. hippocrepis, S. stantoni, Spironema tenuilineata, Syncyclonema halli, Tellina scitula, Volsella meeki*, crustacean remains, fish scales and reptilian bones.

Claggett Shale Member: *Baculites aquilaensis, B. asperiformis, B. haresi, Caprinella coraloidea, Inoceramus barabini, I. sagensis, I. saskatchewanensis, I. vanuxemi, Jeletzkytes brevis, Pteria notukeuensis,* and *Yoldia sp.*

PARKMAN SANDSTONE (Late Cretaceous)

The Parkman Sandstone is a sandy shale and sandstone approximately 250 feet thick in Bighorn Canyon. Darton, who first described this unit, made a small collection of fossils from the Parkman Sandstone (Darton, 1906). These fossils were identified by T.W. Stanton as being Late Cretaceous marine organisms. The beds above the basal sandstone of the Parkman Sandstone, that occur northwest of Hardin, have been suggested to be a continuation of the fresh-water and brackish-water beds of the Judith River Formation (Hancock, 1920; Thom et al., 1935).

BEARPAW SHALE (Late Cretaceous)

The Bearpaw Shale is a fossiliferous, dark-gray marine shale that is exposed in the Ninemile area. The unit is approximately 850 feet thick. Richards (1955) divides the Bearpaw Shale into three members.

Upper Member: *Baculites compressus, B. grandis, Cymbophora cf. gracilis, Chlamys nebrascensis, Discoscaphites nicolletti, Inoceramus altus, I. barabini, Jeletzkytes nodosus, Lucina occidentalis, L. subundata, Nucula planimarginata, Ostrea sp., Placenticeras meeki, P. planum, Polinices concinna, Protocardia subquadrata, Pteria linguaeformais,* and *Yoldia evansi.*

Bentonitic Member: *Acmaea? occidentalis, Baculites compressus, Cuspidaria moreauensis, C. ventricosa, Cymbophora gracilis, Cymella meeki, Dentalium pauperculum, Drepanochilus evansi, D. nebrascensis, Ellipsoscapha occidentalis, E. subcylindrica, Fasciolaria gracilenta, Gervillia recta, Inoceramus vanuxemi, I. tenuilineatus, Jeletzkytes brevis, J. nodosus, J. quadrangularis, Lucina subundata, Ostrea subalata, Placenticeras intercalare, P. meeki, Polinices concinna, Pteria parkensis, Syncyclonema halli, Yoldia evansi,* and *Y. ventricosa.*

Lower Member: *Baculites compressus, Didymoceras nebrascense, Inoceramus barabibi, I. cf. palliseri, I. sagensis, I. saskatchewanensis, I. tenuilineatus, Lucina sp., Ostrea sp., Placenticeras meeki,* and *Yoldia sp*.

Tertiary and Quaternary gravels and alluvium are present on the flanks of the Bighorn Mountains. Six principal terraces are associated with the Bighorn River and its tributaries. No fossils have been reported from the terraces.

PALEONTOLOGICAL RESOURCE PROTECTION

Two case incident reports related to the unauthorized collecting of paleontological resources were produced in 1994. Both incidents documented park visitors involved with the illegal collection of invertebrate fossils from Mesozoic rock units, possibly the Sundance Formation, within BICA. In both cases, the unauthorized fossil collecting occurred in the Sykes Mountain area.

PALEONTOLOGICAL RESOURCE INTERPRETATION

The Bighorn Canyon Visitor Center in Lovell has paleontological displays titled "Rocks Reveal the Past". The following specimens are included in this interpretive exhibit.

CAMBRIAN
- algal stromatolite
- trilobite

ORDOVICIAN
- sponge
- coral (honeycomb and large vesicles)
- mollusk

MISSISSIPPIAN
- brachiopod casts and molds
- coral

TRIASSIC
- coral

JURASSIC
- dinosaur bone fragments
- gastroliths
- oysters (Gryphea)
- pelecypods
- belemnites

CRETACEOUS
- ammonites, baculites, and scaphites
- bivalves _ pelecypods
- shark's teeth
- crocodile teeth

PALEONTOLOGICAL RESOURCES NEAR BIGHORN CANYON

The remains of an *Allosaurus* were collected from Morrison Formation on BLM land about 20 miles south of Bighorn Canyon National Recreation area.

Bighorn Basin: A thick sequence of fossiliferous Paleocene and Eocene strata, including the Polecat Bench, Fort Union, and Willwood Formations, occurs in the Bighorn Basin. The fossil-bearing strata have been divided into thirteen different mammal zones including: two Torrejonian zones, five Tiffanian zones, one Clarkforkian zone, and 5 Wasatchian zones (Woodburne, 1987).

Natural Trap Cave: Natural Trap Cave is a karst sinkhole feature developed within the Mississippian Madison Limestone on the western slope of the Bighorn Mountains in north-central Wyoming. Late Pleistocene paleontological resources have been excavated from stratified sediments within Natural Trap Cave (Anderson, 1974).

ACKNOWLEDGEMENTS

Thanks to the Bighorn Canyon National Recreation Area staff including Rick Lasko, Theo Huggs, and Superintendent Daryl Cook for support of this project. Additional thanks to Dr. Bill Cobban (U.S.G.S.), Lindsay McClelland (NPS), Shawn Duffy, and Kris Thompson for technical review of this report.

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