SOUTH DAKOTA GEOLOGICAL SURVEY

DUNCAN J. McGREGOR, STATE GEOLOGIST.

STATE OF SOUTH DAKOTA

NILS BOE, GOVERNOR

GEOLOGY of the SHARPS CORNER QUADRANGLE SOUTH DAKOTA

EXPLANATION

QUATERNARY

PLEISTOCENE-RECENT

Qal — Alluvium
(Floodplain deposits of silt, sand, and gravel in valleys of present streams; local low terraces.)

Qe — Eolian Deposit
(Wind-blown deposits of quartz sand, and loess in dunes and blowouts on upland.)

Qtl — Quarternary Terrace Deposit (lower)
(Stream deposits of gravel and finer materials including volcanic ash, at several levels above present stream valleys.)

Qtm — Quarternary Terrace Deposit (middle)
(Silts and gravels high above present stream channels.)

PLIOCENE

Qttu — Tertiary Terrace Deposit (upper)
(Upper unit; poorly sorted, sub-rounded sands and gravels. Lower unit; grayish-buff to brown-gray sands, silts, and clays.) 50+ feet represented.)

TERTIARY

Tpah — Ash Hollow Formation
(Grayish, highly indurated, poorly sorted, cross-bedded, gritty marls with some volcanic ash and abundant remains of plant roots; caps small buttes. Maximum thickness 15 feet.)

Tmr — Rosebud Formation
(Reddish-buff to brown inter-bedded sands, silts, and clays; concretions abundant and varied in size and shape; light-pink clayballs of montmorillonite present; siliciously cemented puffy, reddish-buff clays at various levels. Maximum thickness 250 feet.)

MIOCENE

Tmh — Harrison Formation
(Massive gray moderately consolidated silty fine to very fine sands; layers of concretionary material and grayish-white bedded marl; upper contact exhibits three distinct facies; maximum thickness 160 feet.)

Tmmc — Monroe Creek Formation
(Compact, massive, grayish-buff sandy silts and clays, some fossilized rootlets thoughout and thin bone breccias at higher elevations; cliff-forming tendencies; maximum thickness 115 feet.)

Tms — Sharps Formation
(Massive, poorly consolidated, compact, pinkish-tan silt; many scattered, small, gray, calcareous, "potato - ball" concretions; local lenses of impure limestone; clastic and chalcedony dikes; channel sands and gravel at several levels; Rockyford Ash Member at base; maximum thickness 366 feet.)

OLIGOCENE

Brule Formation

Tobp — Poleslide Member
(Series of pinkish to grayish-brown and buff sands, silt, clays and volcanic ash. Lower portion weathers to typical "step and riser" profile while upper portion is a vertical-weathering prominently bedded ashy silt, greenish channels with *Protoceras* are present in the medial portions of the member, maximum thickness 170 feet.)

Tobs — Scenic Member
Series of pinkish, greenish, and buff sands, silts, and clays; weathers to typical "step and riser" profile and contains the channel with *Metamynodon* sandstone; maximum thickness 140 feet.)

Geologic Contact (dashed where approximately located)

Gravel Pit

x BM 3026 Bench Mark (monument showing exact altitude above sea level)

x 3026 Spot Altitude

△ READ Triangulation Station (monument marking exact geographic location)

House, School, and Church

SHARPS CORNER QUADRANGLE

Geology by J. C. Harksen, 1963
Assisted by Joseph Kulik and George W. Shurr

Vertical and horizontal control surveyed from triangulation and level lines of Federal surveys

Drafted by Bruno C. Petsch, 1965

APPROXIMATE MEAN DECLINATION, 1959

Scale 1:62500

Vermillion South Dakota
1965

■ Quadrangle Location

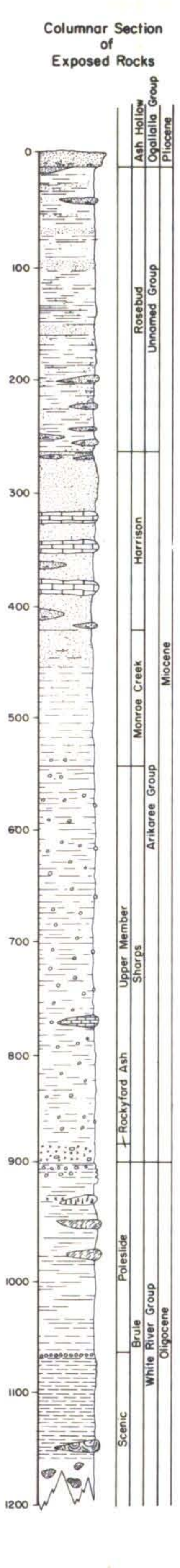
GEOLOGY OF THE SHARPS CORNER QUADRANGLE

SECOND EDITION

by

J. C. HARKSEN

Columnar Section of Exposed Rocks



INTRODUCTION

The Sharps Corner quadrangle was mapped during the summer of 1963 with the assistance of Joseph Kulick and George W. Shurr. Mapping was accomplished under the direction of Dr. Allen F. Agnew, former State Geologist, and Dr. J. R. Macdonald, Curator of Vertebrate Paleontology at the Los Angeles County Museum.

Geologic mapping of this area was supported by funds from both the National Science Foundation and the South Dakota Geological Survey. The State Geological Survey furnished jeep transportation, gas, air photos, and supported publication, and the National Science Foundation (grants G-6582 and GB-3) provided for the hiring of field personnel and for miscellaneous expenses.

The purpose for mapping this area is fivefold: (1) to provide accurate stratigraphic descriptions of fossil collecting sites for J. R. Macdonald and his associates, (2) to continue the South Dakota Geological Survey's program of geological mapping, (3) to map geological sediments which may have an economic potential to the Pine Ridge Indian Reservation, (4) to map an area which contains many features important to the correct interpretation of Tertiary geology elsewhere in this region, and (5) to augment the study of ground water being conducted by the U. S. Geological Survey on the Pine Ridge Indian Reservation.

The western one-half of this 15-minute quadrangle, the Sharps Corner and Malone 7½-minute quadrangles, was originally mapped in 1959 (Harksen, 1960). This publication served as a companion publication to J. R. Macdonald's work (1963a) on the mammalian fauna of the lower Miocene of South Dakota.

ACKNOWLEDGMENTS

The author would like to express thanks to Allen F. Agnew and James Reid Macdonald for their assistance in the field and for generously imparting their knowledge of the continental Tertiary. Thanks are also due to Lynn Huenemann and Harry Haywood for the excellent job they did with the jeep-mounted drill. To Marion, Walter, and the late Grover Sharp the author is indebted for the hospitality extended to him and to the members of the field party.

LOCATION AND TOPOGRAPHY

The Sharps Corner quadrangle contains about 218 square miles in the south-central part of Shannon County, Pine Ridge Indian Reservation, South Dakota. The area is in the Tertiary Tablelands subdivision of the Missouri Plateau section of the Great Plains; however, the northern part of the quadrangle is in the awesome White River Badlands, a region of indescribably rugged topography.

The major drainage is Porcupine Creek which crosses the area from southeast to northwest. The western part of the quadrangle is drained by Wounded Knee Creek, while the eastern part is drained by Three Mile Creek and other smaller tributaries of Medicine Root Creek. The first three creeks, as well as many smaller drainages along the northern edge of the quadrangle, drain northward into the White River, just north of the quadrangle boundary.

The Rosebud and Sharps Formation weather to a rolling topography. The Monroe Creek Formation forms sheer cliffs and the Harrison Formation weathers either into sheer cliffs or steep slopes. This weathering phenomenon produces an upper rolling highland formed on the Rosebud in the southeastern part of the area, a rolling lowland formed on the Sharps, separated by steep slopes and cliffs of the Harrison and Monroe Creek. The Brule Formation, exposed along the northern edge of the quadrangle, has a characteristic rugged "step and riser" topography.

Local relief averages 200-300 feet along the cliffs formed by the Monroe Creek and Harrison Formations and also along the wall of the Badlands. Altitudes above sea level range from 2,615 feet along Porcupine Creek at the northern edge of the quadrangle to a maximum of 3,710 feet in the southeast corner of the quadrangle.

The mapped area is sparsely populated. Sharps Corner (pop. 9) is the only settlement. While the stream valleys are clustered with Indian habitations and ranches, the uplands are quite barren of dwellings.

Two asphalt roads cross the quadrangle. One follows the valley of Porcupine Creek across the area from north to south. The second extends east from Sharps Corner to the edge of the quadrangle.

Only one gravel road is present. This road follows the valley of Wounded Knee Creek along the western edge of the quadrangle. The road leaves the area near the center of the map and re-enters it again in the northwest corner.

The remainder of the area is traversed by a discontinuous network of graded roads and fire-trails, which are impassable when wet due to the clay content of the soil.

The climate of this region is generally considered inhospitable as there is an extreme annual temperature fluctuation. The average precipitation for the southwest corner of the State is 16.5 inches and strong winds are common.

HISTORY OF GEOLOGICAL EXPLORATIONS

Ever since the first fossils were collected by the early fur traders and army expeditions, the White River Badlands of South Dakota has proved to be a mecca for geologists and paleontologists. Even before the turn of the century many tons of fossils had been collected and sent to many of the world's major museums. This collecting was mainly exploited to the north of this general area and very little collecting was done south of the White River.

In 1906, W. D. Matthew, Albert Thompson, and W. K. Gregory, of the American Museum of Natural History, spent a summer collecting vertebrate fossils from the Miocene outcrops along Wounded Knee and Porcupine Creeks (Matthew, 1907). The route taken by the party was such that they collected southward along Wounded Knee Creek until they reached the vicinity of the town of Wounded Knee (formerly called Brennan), 7 miles south of the quadrangle. At this point they crossed the divide into the Porcupine Creek drainage and then collected northward along Porcupine Creek. When they came to the siliceously cemented area of the Sharps Formation west of Mahtowakpa Paha (Bear Creek Hill), they believed that they were at the top of the Brule Formation. Actually, they were over 200 feet above the top of the Brule.

This mistake was repeated by H. F. Osborn (1918) in his work on the Equidae of North America. The area from figure 7 of Osborn's work was again photographed and is printed here as figure 1. This figure shows the geological interpretations of Mahtowakpa Paha as of 1918. Figure 2 shows a picture of the same hill with the current geological interpretations.

Modern paleontological and geological work began in this area in 1953 when J. R. Macdonald, Curator of Paleontology at the Los Angeles County Museum (then associated with the South Dakota School of Mines and Technology) began a systematic collection of fossil vertebrates along the Wounded Knee and Porcupine drainages. His findings have revamped the geological section of this area. Many of the modern interpretations of the Tertiary in southwestern South Dakota have been as a result of the research and collecting that he and his associates have done.

EXPOSED SEDIMENTARY ROCKS

The area of the Sharps Corner quadrangle is entirely underlain by Tertiary bedrock sediments. These sediments from oldest to youngest are the White River Group, the Arikaree Group, the Rosebud Formation, and the Ogallala Group. These strata are partially covered by unconsolidated Quaternary deposits that were mapped only in those areas where their thickness and geographic extent warranted mapping.

White River Group

Meek and Hayden 1858

The White River Group, commonly known as the White River Oligocene, was named from exposures along the White River in southwestern South Dakota. Although no standard type section has been designated for this group, the generally accepted type area is in the Big Badlands, in and near the Badlands National Monument. The White River Group is composed of the Chadron (lower) and Brule Formations. (Not shown on map.)

Darton (1899) divided the White River Group into the Chadron Formation and the Brule Clay while describing the geology of western Nebraska. Osborn (1929) designated the type section for the Chadron Formation along Bear Creek in Pennington County, South Dakota. Schultz and Stout (1961) while referring to the different stratigraphic terminology applied to the White River Group in regions outside of Nebraska state: "This practice is questioned by the writers because it appears to ignore completely the fact that the type localities of the Chadron and Brule are in northwestern Nebraska." Schultz and Stout, however, have completely ignored the fact that Darton (1899) while referring to the Nebraska section of the White River Group stated: "The White River beds in their extension from South Dakota into Nebraska present some differences in stratigraphic range and relations. They expand considerably and include, at their top, beds which appear not to be represented in the typical regions." Therefore, while Darton first used the terms Chadron and Brule in a report on the geology of Nebraska, he designated that the type area was elsewhere--undoubtedly South Dakota.

The Brule is the only formation in the White River Group found in the Sharps Corner quadrangle. Nearly the complete section is represented as only the lower 20 feet are covered. The Peanut Peak Member (Clark, 1954) of the Chadron Formation crops out along Porcupine Creek one-half mile north of the northern limit of this quadrangle.

Brule Formation

Darton 1899

The Brule Clay was named by Darton in 1899 but previously this sequence of strata had been termed the "turtle and oreodon" beds by Hayden in 1857 and the "oreodon" beds by Hayden in 1867. In 1893 Wortman divided the Brule into the oreodon beds (lower) and Protoceras beds. Schultz and Stout (1938) were the first to propose geographic place names for the Brule Members when they coined the terms Orella (oreodon beds) and Whitney (Protoceras beds). However, their work was invalid as they merely tacked geographic place names on the old faunal zones without regard for lithology.

Bump (1956) was the first to divide the Brule into member units on the basis of lithology when he split the Brule into the Scenic (lower) and Poleslide Members. The type sections for these members are on and near Sheep Mountain Table some 20 miles north of this quadrangle. Due to a printing error, both of the legal descriptions of these members, as published by Bump, are incorrect. The type section for the Scenic Member is in the SW¼ sec. 27, T. 3 S., R. 13 E., not the SW¼ sec. 23, T. 3 S., R. 13 E. While the type section for the Poleslide Member is also incorrect, the correct legal description has not been determined at this time.

Scenic Member

Bump 1956

In the Sharps Corner quadrangle, the Scenic Member of the Brule Formation is composed of about 140 feet of reddish, greenish, and buff sands, silts, and clays which weather to the typical "step and riser" profile. The entire thickness of this member is not exposed in this quadrangle; however, most of it is exposed along Porcupine Creek one-half mile north of the area boundary.

The sequence of strata comprising the Scenic Member has four distinct units. The lowermost unit is composed of 34 feet of grayish-brown silty clays which contain an abundance of large, highly calcareous, gray silty concretions. The unit above this differs only in a change of color to light brown or buff and by a lack of concretionary material. The combined thickness of the two lower units is as much as 64 feet.

The third unit is about 60 feet thick and is composed of gray silty clays with an abundance of silty or sandy bedding planes. This sequence of bedding planes is quite variable in thickness and can only be traced for short lateral distances. This third unit contains the slabby, reddish, coarse sandstones that are called the Metamynodon channel sandstones. Good outcrops of these sandstones occur northwest of Chimney Butte, in close proximity to the Rockyford-Manderson road.

The upper unit of the Scenic Member is a six foot band of light cream colored silty clays. In the interval are many small, wormy appearing, silty, calcareous nodules up to six inches in diameter. This six foot interval was taken to be the upper nodular zone, the uppermost unit in the Scenic Member. From a distance, the light zone will appear as the lower of the two light-weathering zones which appear in the Brule.

Poleslide Member

Bump 1956

That portion of the Brule Formation that lies above the upper nodular zone has been designated the Poleslide Member (Bump, 1956). In the Sharps Corner quadrangle it attains a thickness of 170 feet, which is appreciably less than the 299 foot thickness measured at the type section some 20 miles to the north.

In the Chimney Butte area, in the northwestern corner of the Sharps Corner quadrangle, the lower zone of the Poleslide Member is as much as 65 feet thick. This unit consists of massive, near vertical weathering, brownish silts and clays with some scattered, small, worm-like calcareous concretions. The top 5 feet appears from a distance as a light-colored band. The light band is the prominent light-weathering zone which has been mentioned by Wanless (1923) and others.

The middle unit consists of as much as 70 feet of banded, brown to buff silts and clays. There are many calcareous, silty, worm-like concretions found throughout the unit. The most common is a small variety (2-6 inches) which lies in bedding planes.

The upper unit is composed of as much as 65 feet of vertical weathering, grayish-brown to buff ashy silt which has a very prominent horizontal bedding. The surface has a washboard appearance due to a succession of hard and soft beds. The unit occurs only in the Chimney Butte area of this quadrangle. Outside of the quadrangle the only other known exposures are on Cedar Butte and on Sheep Mountain Table. This unit is believed to be a channel deposit, but its relationship to the remainder of the Brule Formation is yet to be determined.

Arikaree Group

Darton 1899

The Arikaree was originally assigned formational rank by Darton (1899). Hatcher (1902) divided the Arikaree into the Harrison and Monroe Creek Formations. These two formations plus the Gering Formation (Darton, 1899) make up the present Arikaree Group in Nebraska.

The Arikaree Group in the Sharps Corner quadrangle consists of three formations: the Sharps, Monroe Creek, and Harrison. The Monroe Creek and Harrison Formations are lithologically similar to the deposits of the type section areas in western Nebraska. The Sharps Formation is in part a time equivalent of the Gering Formation, the lowermost Arikaree in Nebraska. The entire Arikaree Group in the Sharps Corner quadrangle attains an average thickness of 610 feet.

Sharps Formation

Harksen, Macdonald and Sevon 1961

The Sharps Formation was named from exposures near the community of Sharps Corner. No single outcrop shows a complete section of the formation, consequently, a split type section was made. The lower type section is located 8 miles northeast of Sharps Corner in sec. 31, T. 41 N., R. 42 W. The upper type section is located 5 miles southwest of Sharps Corner in sec. 20, T. 39 N., R. 43 W. The Sharps Formation is composed of two members: a distinctive lower unit, the Rockyford Ash Member, and an unnamed upper member.

Rockyford Ash Member

Nicknish and Macdonald 1962

The Rockyford Ash of the Sharps Formation was named from exposures surrounding the now defunct post office-general store of Rockyford. The prominent outcrops of this member are located at Cedar Pass, the Pinnacles in the Badlands National Monument, Sheep Mountain Table, Cedar Butte, Chimney Butte, and along the cliffs south of the White River east of the mouth of Porcupine Creek. The type section of this member is located along the south rim of Sheep Mountain Table in sec. 32, T. 43 N., R. 44 W.

The Rockyford Ash is the basal Miocene. In South Dakota the base of the ash bed is used to mark the boundary between the Oligocene and Miocene.

The Rockyford Ash has proved to be a very tricky unit with which to work. Nicknish (1957) reported a disconformity at the base of the Rockyford. This statement was possibly made because the Rockyford is underlain by both Division 2 and Division 3 of the upper Brule (Wanless, 1923). However, this was corrected by Harksen (1960) and accepted by Nicknish and Macdonald (1962). Sevon (Harksen, Macdonald, and Sevon, 1961) in making the stratigraphic section of the Sharps Formation went one ash too low in his section and described an isolated upper Brule ash as the Rockyford Ash. The actual Rockyford was described by Sevon (Harksen, Macdonald, and Sevon, 1961) as being a silt (bed three of the description).

The Rockyford Ash in this quadrangle consists of up to 21 feet of light-weathering, light-tan to buff, silty, very fine ash, well consolidated and containing some scattered gray nodular concretions. The concretions weather to a brownish tinge. The ash has gradational contacts with the formations above and below.

Upper Member

The upper unnamed member of the Sharps Formation consists of 345 feet of massive, poorly consolidated, compact, pinkish-tan silt with many randomly scattered, small, gray, nodular, calcareous concretions. These small (2-4 inches) concretions are very abundant and cover most outcrops in profusion.

Most continental deposits are quite varied in lithology. While variation is present in this unit, the lithology is remarkably consistent throughout. Clays, limestones, and channel deposits are found at various levels and localities.

Several beds of impure limestone are found in this unit. However, these limestones have only a short lateral range and none can be used for correlation. The limestones often contain gastropods and other invertebrate fossils and usually are partially replaced by silica.

Clastic and chalcedony dikes are present throughout the unit, but not as abundantly as in the White River Group.

The following is a listing of genera and species of Mammalia (Macdonald, 1963a, 1963b) which have been collected from the Sharps Formation of this general area. (From Macdonald, 1963a, p. 151-153)

MARSUPIALIA

Peratherium spindleri

INSECTIVORA

Ocajila makpiyahe
Domnina greeni
Domninoides evelynae
Arctoryctes terrenus

PRIMATES

Ekgmowechashala philotau

LAGOMORPHA

Palaeolagus hypsodus
Palaeolagus philoi
Megalagus primitivus

RODENTIA

Prosciurus dawsonae
Meniscomys hippodus
Pleurolicus leptophrys
Pleurolicus clasoni
Grangerimus dakotensis
Heliscomys sp.
Proheteromys fedti
Proheteromys gremmelsi
Proheteromys bumpi
Hitonkala andersontau
Florentiamys agnewi
Tamias sp.
Palaeocastor nebrascensis
Capatanka cankpeopi
Capacikala gradatus
Cutimus blacki
Cutimus woodi
Scottimus sp.

CARNIVORA

Hesperocyon leptodus
Nothocyon roii
Nothocyon geismarianus
Nothocyon lemur
Cynodesmus cooki
Mesocyon robustus
Sunkahetanka geringensis
Sunkahetanka pahinsintewakpa
Enhydrocyon crassidens
Palaeogale dorothiae
Ekgmoiteptecela olsontau

PERISSODACTYLA

Miohippus near equinanus
Miohippus equiceps
Hyracodon apertus
Diceratherium cf. gregorii
Diceratherium armatum

ARTIODACTYLA

Leptochoerus sp.
Agriochoerus sp.
Mesoreodon megalodon cf. sweeti
Desmatochoerus hatcheri geringensis
Desmatochoerus wyomingensis
Cyclopidius schucherti
Cyclopidius simus
Arretotherium sp.
Oxydactylus cf. wyomingensis
Nanotragulus cf. loomisi
Nanotragulus intermedius
Leptomeryx sp.

Monroe Creek Formation

Hatcher 1902

The Monroe Creek Formation was named from exposures along Monroe Creek Canyon in Nebraska, some 70 miles to the southwest. In the Sharps Corner quadrangle it consists of 90-115 feet of compact, massive, grayish-buff, sandy silts and clays. Many gray, calcareous, nodular concretions are found near the base of the formation, while small irregular concretions and calcified rootlets are found throughout. Celtis seeds are present locally, but never in abundant quantities.

In the Sharps Corner quadrangle, the Monroe Creek Formation thickens by 25 feet going eastward. Collins (1960b) has reported a thickness of approximately 350 feet of Monroe Creek in the Patricia quadrangle, 25 miles to the east. It is possible but not plausible that the section measured by Collins is entirely Monroe Creek. It is believed that further study of the Tertiary of southwestern South Dakota will show Collins' section to contain not only the Monroe Creek but also some additional strata.

In the east central part of the Sharps Corner quadrangle, thin bone breccias are found in the upper Monroe Creek. These layers are very thin (approximately one-fourth inch) and are composed of small, mostly rounded, fragments of bones and teeth. Harvester ant mounds built near these layers are completely covered with tiny teeth and osteological fragments.

The cliff-forming tendencies of the Monroe Creek tend to form vertical escarpments wherever this formation is exposed. This characteristic weathering makes the formation distinguishable from a distance and also furnishes one of the best means of differentiating it from the underlying Sharps Formation.

Between Sharps Corner and the type area in Nebraska, the Monroe Creek Formation has undergone some change in lithology. The most notable change is the complete lack of "pipey" concretions in the Sharps Corner area. Some "pseudopipes" are present in this area but they generally occur in the overlying Harrison Formation.

In the SW¼ sec. 34, T. 39 N., R. 43 W. (fig. 3), a series of fossil geysers is found in the upper Monroe Creek. These fossil geysers form an east-west line about 200 yards long with the major geyser being located in the center.

The largest structure has been named the "Gieser Geyser" after my field assistant in 1959, Darold G. Gieser. This structure is 22 feet high, 12 feet in diameter and is composed of concentric rings of calcareous silts which have abundant calcified rootlets imbedded in the walls. Figure 3 is a picture of the "Gieser Geyser" as viewed from the south.

Both the upper and lower contacts of the Monroe Creek are gradational with the overlying and underlying formations.

The following is a listing of the genera and species of Mammalia (Macdonald, 1963a, 1963b) that have been collected from the Monroe Creek Formation of this general area.

INSECTIVORA

Proscalops sp.

RODENTIA

Allomys harkseni
Meniscomys sp.
Promylagaulus cf. riggsi
Pleurolicus dakotensis
Palaeocastor simplicidens*
Capatanka brachyceps*
Grangerimus oregonensis

CARNIVORA

Nothocyon geismarianus
Nothocyon near latidens*
Neocynodesmus delicatus*
Enhydrocyon crassidens*
Mammacyon obtusidens*
Promartes gemmarosae
Nimravus sectator*

PERISSODACTYLA

Miohippus equinanus*
Parahippus pristinus*

ARTIODACTYLA

Promerycochoerus montanus pinensis*
Nanotragulus ordinatus*

* Collection data unsatisfactory

Harrison Formation

Hatcher 1902

In the Sharps Corner quadrangle the Harrison Formation is represented by 160 feet of gray, massive, noncalcareous, moderately consolidated, fine to very fine, silty sands. Calcareously cemented channels, concretionary ledges, and bedded marls dot the section giving the outcrops a bedded appearance. As the contact with the underlying Monroe Creek Formation is gradational and as areas of Harrison lithology appear in the Monroe Creek and vice versa, the contact is rather hard to spot without a great deal of leg work. However, the Harrison is less inclined towards the cliff-forming tendency of the Monroe Creek and there is less of a lichen covering on the Harrison. These characteristics make the contact readily discernible from a distance while it may be obscured at closer observation.

The limestone zones so prevalent in the Harrison are composed of a soft, grayish-white, massive or bedded marl which in typical outcrops has a worm-like appearance. These beds range to 3 feet in thickness in this quadrangle and can be traced for only short distances laterally.

The marls and the intervening sediments often show a cyclic pattern. The pattern is exemplified by a massive section of silty gray sands which grade upward into a greenish-gray clay. The clay in turn grades upward through a series of laminated marls into a massive, worm-like, grayish-white marl. Above the marl is another series of sand, clay and marl. The sand lies unconformably upon the marl. The upper surface of the marl has a jagged surface and pieces of marl are included with the overlying sand. These cycles, as many as three to an outcrop, may be interpreted as reflecting orogenic pulsations or some closely related phenomenon.

The top of the Harrison is marked by one of three different lithologies: (1) a series of several concretionary ledges which are gray and are composed of calcareously cemented sandy silts; (2) a zone of randomly spaced, ivory-colored, small (up to 5 inches), highly calcareous, coprolite shaped concretions which have a unique desiccation surface; (3) a series of grayish-green to green siliceously cemented sandstone ledges. The first lithology is the most common. The last, the siliceously cemented zone, furnishes some insights which may apply, in principle at least, to the entire Tertiary section of southwestern South Dakota.

Wanless (1923) gives reference to vertical pipe-like concretions with tapering ends and small hollow tubes averaging from 1/16 to 1/8 inch in diameter. He states that these concretions are found only in ash and most commonly in the white ash layer at the base of the Rosebud. Concerning their mode of formation he writes:

> "Therefore, the cylindrical pipes filled with these tubular concretions may have been formed by gas explosions or the upward escape of imprisoned water, CO_2, or even air, and the zeolites produced by crystallization of material derived from the ash."

Bump (1951, p. 43) states:

> "Present in the White Ash Layer are abundant round, pipe-like concretions with tapering terminations and with small central hollow tubes less than one-eighth inch in diameter. The hollow tubes are lined with minute zeolite crystals of several varieties. The length of the concretions varies from one to 12 inches. The average diameter is about one inch, but the concretions grade downward to less than a quarter of an inch and may be as large as 3 inches. They exist only in the ash beds and their manner of origin has not been determined."

Harksen (1960) was the first to report these concretions above the white ash layer in describing them from the siliceously cemented zone of the Sharps Formation. At that time the cemented zone was thought to be confined only to the Sharps and Brule Formations. However, field work in 1963 has shown that these concretions, in the area near St. John's Church and southeastward, extend up through the Monroe Creek Formation and through the Harrison.

Macdonald (1963a) has described the areal extent of the cemented area. This area is shown in outline on the face of this map. The most southeasterly area of cementation is a unique area. Here the top of the Harrison is composed of a series of stream channels and intervening sediments which are very highly cemented and are colored various shades of green. Lying conformably on the Harrison, the Rosebud shows no indication of cementation.

Therefore, it is proposed that the tubular concretions and the siliceously cemented zone in the Harrison, Monroe Creek, Sharps, and Brule were formed by downward percolating ground waters near the close of Harrison time in this area. The downward percolation was aided by faults and joints, now represented by clastic and chalcedony dikes, and by the partially mineralized remains of plant roots.

This form of cementation may well be related to that which formed the Bijou Facies of the Ogallala Group. Further investigation of this problem is needed before any conclusions can be drawn.

In the northeastern part of the mapped area there is a unique bed of limestone. This bed is a pinkish white, silicified, varved bed of very dense limestone which ranges up to 1 foot in thickness.

Small (up to 8 inches) fossil fish, of the perch family, are found in abundance in this bed. A number of specimens were collected and sent to the Los Angeles County Museum.

The following is a listing of the genera and species of Mammalia (Macdonald, 1963a) which have been collected from the Harrison Formation of this general area.

RODENTIA

Pleurolicus dakotensis*
Gregorymus formosus
Gregorymus curtus
Palaeocastor simplicidens*
Capatanka brachyceps*
?Capacikala sciuroides

CARNIVORA

Hesperocyon gregorii
Nothocyon near latidens*
Cynodesmus vulpinus
Neocynodesmus delicatus*
Mesocyon robustus
Enhydrocyon crassidens
Mammacyon obtusidens*
Promartes gemmarosae*
Nimravus sectator*

PERISSODACTYLA

Miohippus equinanus
Miohippus cf. gemmarosae

Parahippus pristinus

ARTIODACTYLA

Promerycochoerus carrikeri
Promerycochoerus barbouri
Promerycochoerus minor pygmyus
Promerycochoerus montanus pinensis
Desmatochoerus curvidens gregorii
Desmathyus pinensis
Arretotherium leptodus

Nanotragulus ordinatus

* Collection data unsatisfactory

Rosebud Formation

Gidley 1904

The Rosebud Formation is exposed over a wide area in southwestern South Dakota and northwestern Nebraska. Outcrops are known in Shannon, Washabaugh, Bennett, Mellette, Todd, Tripp, and Gregory Counties, South Dakota, and Cherry County, Nebraska. The unit is early Hemingfordian (mid-Miocene) in age and, in places, lies conformably on the Harrison Formation. The Rosebud is unconformably overlain by unnamed later Miocene deposits, by the Pliocene Ogallala Group, and by the Pleistocene Sandhills Formation.

The name Rosebud was first used by Gidley (1904) to delimit a series of beds on the Rosebud Indian Reservation, Todd County, South Dakota. He stated:

> "The lower formation above mentioned, for which we propose the local term Rosebud beds, is best exposed along the Little White River and in the vicinity of the Rosebud Agency. These beds closely resemble portions of the upper Oligocene beds, both in character and general appearance, except that they contain a little more sand. In certain exposures an examination of the fossils contained in the beds is necessary to determine their horizon."

Unfortunately, Matthew (1907) applied the name Rosebud to deposits along the Porcupine Creek drainage, Shannon County, South Dakota, in a manner which was not consistent with Gidley's usage. Matthew differentiated the strata along Porcupine Creek into "Upper Rosebud" and "Lower Rosebud." The Upper Rosebud included all of the Rosebud of Gidley, as well as the upper part of the Harrison Formation. The Lower Rosebud of Matthew included the lower part of the Harrison Formation, the Monroe Creek Formation, and the upper part of what is now the Sharps Formation. The basal 300 feet of the Sharps Formation was placed in the Brule Formation.

Osborn (1909, 1918) adopted Matthew's interpretation of the Porcupine Creek section (see figure 1) and furthermore Wanless (1923) stated that the type section for the Rosebud was along Porcupine Creek.

Simpson (1933), in his correlation of the Miocene of the mid-continent, reviewed the work of Gidley (1904) and Matthew (1907). He accepted Matthew's work and correlated the Rosebud of South Dakota with the Gering, Monroe Creek, and Harrison of Nebraska. The interpretation of Cook and Cook (1933) agreed with that of Simpson.

Wilmarth (1938) cited Gidley (1904) and Osborn (1909) and stated that the Rosebud is an equivalent of the Arikaree and that the name Arikaree has priority. Schultz (1938) described the Miocene of western Nebraska and referred to the Rosebud as "...a generalized, indefinite name for deposits in the vicinity of the Rosebud Agency in South Dakota." Wood (1941) included the Rosebud within the Arikaree Group and Gregory (1942) agreed with this interpretation in his description of the Big Spring Canyon fauna, Bennett County, South Dakota. Gregory considered both the Rosebud Formation and the younger "Flint Hill Channel" to be within the Arikaree Group.

In 1956 Allen F. Agnew initiated geologic mapping in the Tertiary of southwestern South Dakota under the supervision of E. P. Rothrock, the State Geologist. Agnew encouraged graduate students at the University of South Dakota to do mapping theses in this area. In his first publication on the Tertiary, Agnew (1957) named a new formation, the Mellette Limestone. The Mellette has since been shown to be a facies of the Rosebud Formation.

Subsequent work in Gregory and Tripp Counties, South Dakota (Stevenson, 1958, 1959; Schoon, 1958; Schoon and Sevon, 1958; Collins, 1958, 1960a) resulted in mapping many small outcrops of the Rosebud Formation as either Brule or White River.

Macdonald (1957) had clearly stated that the Miocene Rosebud Formation occurred in Todd County, South Dakota, and Toohey (1959) was quite emphatic in stating that a study of the Rosebud should begin along the Little White River. Sevon (1959, 1960a, b) mapped the Rosebud Formation, in and near the type area, as Arikaree Undifferentiated. He stated (Sevon, 1961) that east of the town of Vetal, South Dakota, the lithologies of the Sharps, Monroe Creek, and Harrison become so similar that they could not be differentiated on the basis of lithology. Collins (1959, 1960b) agreed in principle with Sevon on the problem of differentiation of the Arikaree Group in Bennett County. Actually, much of what these workers mapped as the Harrison Formation is the Ash Hollow Formation.

The first paper to use the term Rosebud in the original sense (Gidley, 1904) was written by Macdonald (Matthew and Macdonald, 1960). This paper served as the forerunner for Macdonald's paper (1963a) on the faunas and stratigraphy of the Wounded Knee Area which described the lithology, fauna, and stratigraphic relationship of the Rosebud Formation.

In the Sharps Corner quadrangle the Rosebud consists of 250 feet of interbedded pinkish sands, silts and clays. The lower contact may be expressed in a number of ways (see the section on the Harrison), but the upper contact is marked by a well-defined unconformable contact with the overlying Ash Hollow Formation.

Concretions are abundant and assume a variety of shapes. In general they are gray and calcareous, but have few other characteristics in common.

The most characteristic, but not the most prevalent, lithology found is a series of beds of reddish-buff, puffy to vesicular, siliceously cemented silty clays which are to be found throughout the section. These beds are nonfossiliferous. To the east these beds apparently become less prevalent; however, in this same easterly direction there is an increase in small "peaballs" of pink clay. This pink clay is apparently of secondary origin as it often assumes the shape of rootlets and tabular masses.

The following is a listing of the genera and species of Mammalia (Macdonald, 1963a, b) which have been collected from the Rosebud Formation of this general area.

INSECTIVORA

Arctoryctes terrenus

LAGOMORPHA

Archaeolagus primigenius
Archaeolagus macrocephalus

RODENTIA

Promylagaulus riggsi*
Mylagaulodon cf. angulatus
Pleurolicus leptophrys
Gregorymus formosus
Gregorymus curtus*
Grangerimus oregonensis
Proheteromys matthewi
Dikomys matthewi

CARNIVORA

Tomarctus thomsoni
Cynodesmus minor
Promartes lepidus
Megalictis ferox

ARTIODACTYLA

Phenacocoelus stouti
Promerycochoerus minor pygmyus
Merycochoerus matthewi
Merychyus minimus
Oxydactylus exilis
Oxydactylus lacota
Blastomeryx primus
Blastomeryx advena

PERISSODACTYLA

Parahippus coloradensis praecurrens
Parahippus texanus
Diceratherium gregorii

* Collection data unsatisfactory

Ogallala Group

Darton 1899

The Ogallala was designated a formation by N. H. Darton in 1899. This formation was to include the sequence of strata that had been referred to as the "Mortar beds," "Tertiary grit," or "Magnesia beds." Although there is little doubt to which beds Darton referred, he did fail to designate a type locality or a type area, and he did not define the limits of the formation. Darton (1920) did attempt to correct these omissions by giving the type area (near Ogallala Station in western Nebraska) and limiting the questioned upper boundary of the formation (Frye and others, 1956, p. 10).

Lugn (1939) gave the unit group status. The group contains four formations in ascending order: Valentine, Ash Hollow, Sidney, and Kimball.

Of the four formations comprising the Ogallala Group in Nebraska, only two, Valentine and Ash Hollow, have been reported in South Dakota. Of these two formations, only the Ash Hollow occurs in the Sharps Corner quadrangle.

Ash Hollow Formation

Englemann 1876

Redefined by Lugn 1939

The Ash Hollow Formation was first described by Henry Englemann (1876) from exposures in Ash Hollow Canyon near Lewellen, Nebraska, 130 miles south of this quadrangle. Englemann did not give a type section nor clearly define the limits of the formation. Lugn (1939) initiated the modern usage of the Ash Hollow when he designated a type section in Ash Hollow Canyon, Nebraska.

In the Sharps Corner quadrangle, the Ash Hollow Formation is found only as a prominent, highly dissected cap rock on several buttes in the southeastern corner of the area. This cap rock is as much as 15 feet thick and is composed of poorly sorted, cross-bedded, gritty marls with some volcanic ash and abundant calcified plant root remains. The Ash Hollow lies unconformably on the Rosebud and in relation to the Rosebud is highly resistant to erosion. Some variations in the consolidation of the cap rock brings out many recesses and hollows within the ledge itself. The size of the constituent particles ranges from clay to clay-silt concretions up to 3 inches in diameter. Lying above the ledges, but unmapped, is up to 45 feet of loess.

Johnson (1938) and others have commented upon an Ash Hollow bed known as the Cap Rock Bed. While no correlation between these two can be made at this time, further work in the field may show this unit to be an equivalent of that found in Nebraska.

No fossil mammals have been found in the Ash Hollow of this quadrangle.

SURFICIAL DEPOSITS

A large part of the mapped area is covered by Recent unconsolidated deposits. These deposits are divided into alluvium, eolian deposits, and terrace deposits.

Alluvium

Alluvium deposits consist of gravel and finer materials that are confined to present stream valleys. This material was derived in Recent time by the reworking of older surficial deposits and bedrock sediments.

Quaternary Eolian Deposits

The eolian deposits included in this category are found at all elevations. However, as a general rule of thumb the higher the relative elevation, the finer the constituent particles will be.

The most unusual deposits of this unit are the sand dunes found on top of Castle Buttes. The base of these dunes may entirely cover the top of the butte on which they rest. This form of deposition has been explained by White (1960) who attributes their formation to winds sweeping up the face of the butte. These winds will dislodge small fragments of rock and carry them to the top of the butte. The reduction in the force of the wind at the top allows for deposition of the particle.

This seemingly slow method of deposition has formed some loess dunes in this quadrangle, which are over 45 feet thick.

Quaternary Terrace Deposits (lower)

The Quaternary lower terrace deposits consist of volcanic ash, gravel, and smaller sized sediments laid down by Quaternary streams with the help of wind. These deposits record the greater width of earlier streams. The several levels show that the present streams are in their fourth or fifth cycle of erosion.

Quaternary Terrace Deposits (middle)

The Quaternary middle terrace deposits consist of silts and gravels high (at least 75 feet) above the present stream channels. These channels have no economic importance as the gravel contained in these deposits is much too silty to have any economic use.

Quaternary-Tertiary Terrace Deposits (upper)

Dotting the higher elevations in and along the southern edge of the Big Badlands is a series of terrace deposits which are in part late Pliocene and in part Pleistocene in age. These deposits can be found in a discontinuous string from eastern Custer to western Washabaugh Counties. They represent remnants of one of the major Black Hills drainages during the late Pliocene and early Pleistocene time.

These terraces, along with a short section on stream piracy of the early Pleistocene, are mentioned by Todd (1902). Wanless (1923) and Sevon (1960a) make some comments on the later Pleistocene stream piracies involving the Minnechaduza River. Todd and Wanless state that in late Pliocene times the major drainage of this area was a river which connected the present Battle Creek and the Minnechaduza River.

In the Sharps Corner quadrangle these upper terrace deposits are composed of an upper unit and a lower unit. The lower unit is composed of grayish-buff to brownish-gray sands, silts and clays. Consolidation is poor, cross bedding is common, and calcareous ledging is abundant. Thin (up to 2 mm) layers are common and a small percentage of material in the layers is magnetite. Excellent exposures of this unit can be found along the east rim of Cuny Table (5 miles west of the northwest corner of this quadrangle) and in the northeastern part of this quadrangle in the SW¼ sec. 16, T. 40 N., R. 42 W. This lower unit is as much as 30 feet in thickness, and fossils are rare.

The upper unit consists of coarser materials than the lower unit. Poorly sorted, subrounded, sedimentary, igneous, and metamorphic rocks are represented. The sedimentary rocks include limestone, conglomerate, sandstone, siltstone, and concretions. The concretions represent several types including cone-in-cone, septarian, ironstone, and chert. The major constituents of igneous origin are granite porphyries, feldspars, quartz, and coarse-grained fragments which probably represent pegmatites.

The size range of the constituent particles in the upper unit is great. The smallest particles are clays, while the largest is a brown, orthoquartzite boulder which measures 3½ by 2½ by 1½ feet. A boulder of this size would require more than simple stream transport to move it 80 miles away from the Black Hills. Ice rafting and mud flows are possibilities for transportation.

The lower unit was formed during Pliocene time. With the advent of the Pleistocene and the greater flow of water the river began transporting coarser materials. After a period of deposition, stream piracy by the Cheyenne River diverted the major supply of water and deposition ceased. Since the beginning of the Pleistocene the drainage pattern of the southwestern part of South Dakota has been completely changed.

SUBSURFACE ROCKS

The only accurate subsurface information is provided by the Amerada #1 Govt.-Red Eagle oil test drilled in 1945 (NE¼ sec. 25, T. 36 N., R. 48 W.), 25 miles southwest of this quadrangle. Samples and electric log correlations for this well show the following:

Depth (feet)	Formations
0- 405	Niobrara Marl and Carlile Shale.
405- 980	Greenhorn Limestone, Belle Fourche Shale, Mowry Shale.
980-1331	Newcastle Sandstone and Skull Creek Shale.
1331-1688	Fall River Sandstone and Fuson Shale.
1688-2104	Morrison Shale and Sundance Sandstone.
2104-2345	Spearfish Shale.
2345-2475	Minnekahta Limestone and Opeche Shale.
2475-3358	Minnelusa Formation.
3358-3367	Precambrian Granite. Elevation of surface - 3344 feet.
3367	Total depth.

ECONOMIC GEOLOGY

Of the many potential economic deposits in the Sharps Corner quadrangle, only the sand, gravel, and water have been utilized. Potential deposits of volcanic ash, sandstone, and limestone are present but have never been quarried. Petroleum and other hydrocarbons may be present in the subsurface.

Sand and gravel of good quality and of great quantity for road surfacing and concrete aggregate have been obtained from both the Quaternary terraces and the Quaternary-Tertiary terraces. These terrace deposits have a high content of western derived igneous and metamorphic rocks. There is too high a percentage of fine materials present for direct utilization as road materials so the material is screened to remove the finer materials and then the larger fragments are crushed to the desired size.

Ground water of excellent quality and in good quantity is available in nearly all parts of this area. The primary aquifer is the Rockyford Ash. One well situated in the ash, at Sharps Corner, has been pumping 10,000 gallons per day for over a year with a drawdown of less than 4 inches.

The Huron, South Dakota, office of the U. S. Geological Survey, Ground Water Division, is conducting a ground-water survey of Shannon County (Ellis and Adolphson, in prep.).

Limestone in moderate quantity and of poor quality is available from scattered outcrops. In general, the quality is too poor or the overburden is too great for any large-scale mining operations.

Volcanic ash of limited quantity is present in the Brule and Sharps Formations. While the quality is poor and the overburden is generally great, portions may be used for road construction or some other noncritical use.

Clay materials from the Rosebud Formation could be used in the manufacture of brick or pottery.

Petroleum and uranium may occur in this area, but as yet no discoveries have been made. Joseph Kulick and Harry C. Haywood, under the supervision of the author, conducted small radiological surveys, but found little more than background count.

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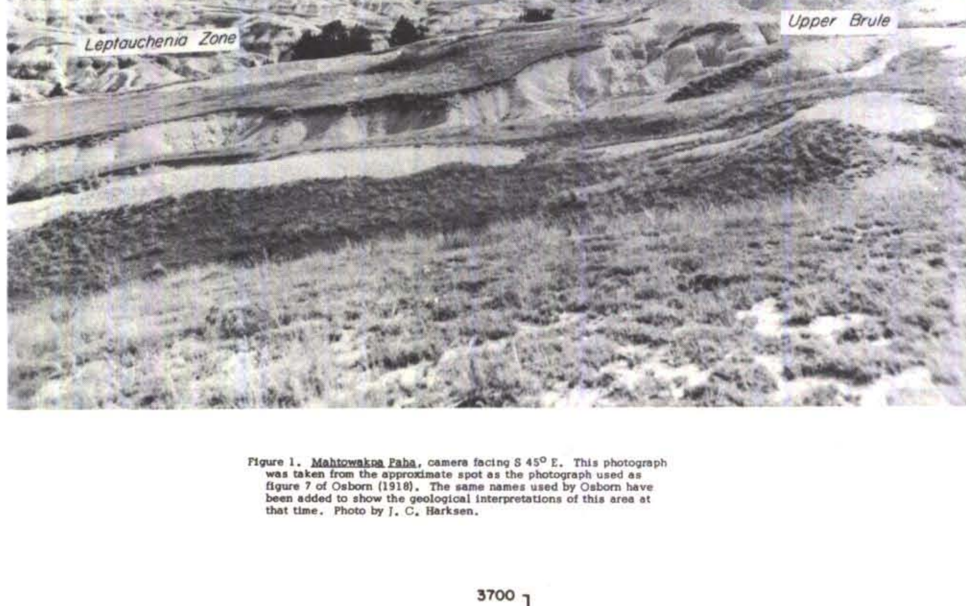
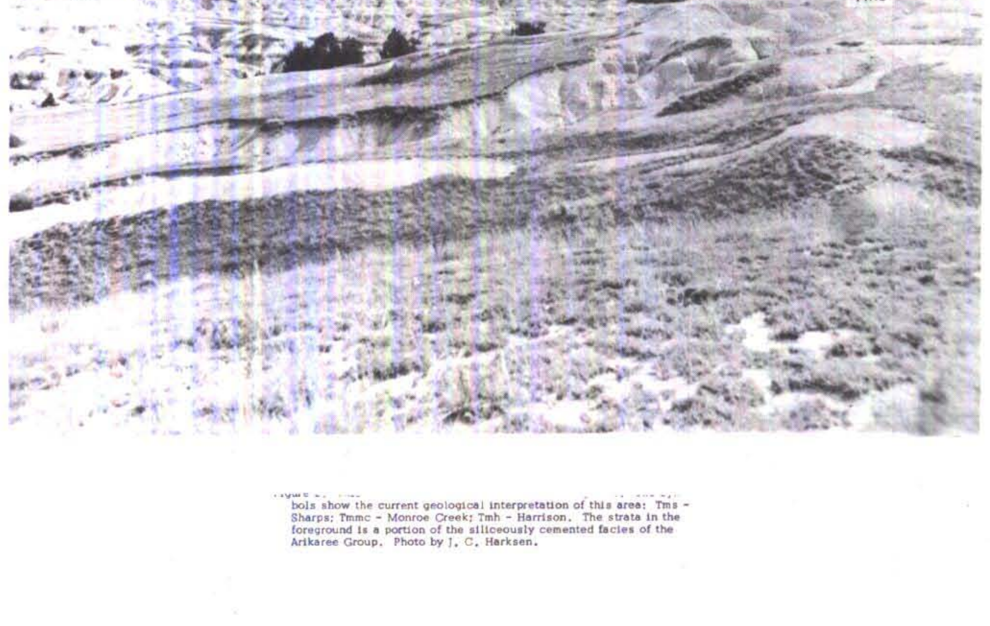


Figure 1. Mahtowakpa Paha, camera facing S 45° E. This photograph was taken from the approximate spot as the photograph used as figure 7 of Osborn (1918). The same names used by Osborn have been added to show the geological interpretations of this area at that time. Photo by J. C. Harksen.



... bols show the current geological interpretation of this area: Tms - Sharps; Tmmc - Monroe Creek; Tmh - Harrison. The strata in the foreground is a portion of the siliceously cemented facies of the Arikaree Group. Photo by J. C. Harksen.

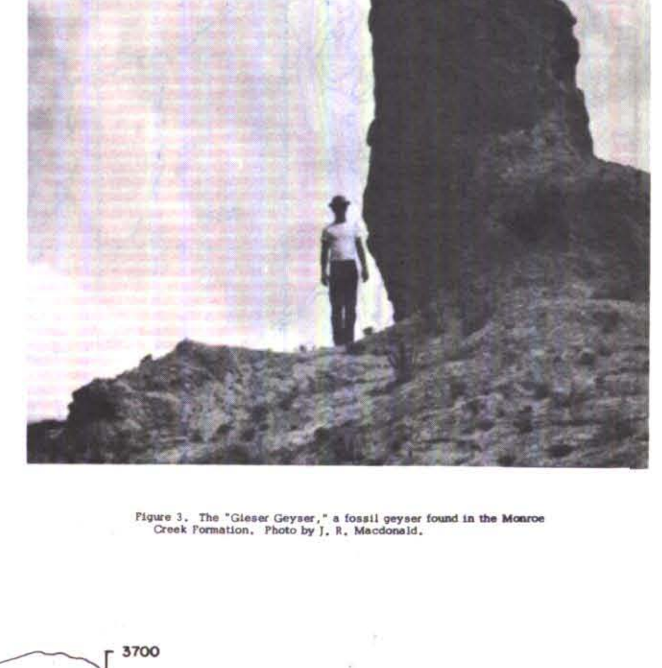


Figure 3. The "Gieser Geyser," a fossil geyser found in the Monroe Creek Formation. Photo by J. R. Macdonald.