

GEOLOGY OF THE PORCUPINE BUTTE QUADRANGLE SOUTH DAKOTA

J.C. Harksen

Columnar Section of Exposed Rocks 100--=== 200 300-**-----**500 - A **5** 600-**1** ---_______ 900 -0----_q __o__ 0 0 1000-

Columnar Section Silt Clay ---Limestone Calcareous XXXXX Volcanic Ash Concretions 8 1

INTRODUCTION

INTRODUCTION

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

The geologic mapping of the 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; grants G-6582 and GB-3 of the National Science Foundation provided funds for the hiring of the field personnel and miscellaneous expenses.

The purpose for mapping

expenses.

The purpose for mapping this area was: (1) to provide stratigraphic control for the Miocene mammal collecting sites of J. R. Macdonald, (2) to continue the donald, (2) to continue the geologic mapping program initiated by the South Dakota Geological Survey, (3) to map geologic sediments which may be economically utilized by the Pine Ridge Indian Reservation, (4) to attempt to correlate certain stratigraphic units with Tertiary deposits of adjacent states, and (5) to augment the United States Geological Survey's study of the ground water of the Pine Ridge Indi-

water of the Pine Ridge Indian Reservation.

The northwestern quarter of this 15-minute quadrangle, the Manderson 7½-minute quadrangle, was mapped in 1959 (Harksen, 1960). Although this area was not remapped, the road system was brought up to date and some changes were made in the geological interpretations.

ACKNOWLEDGMENTS

I wish to express my thanks I wish to express my thanks to Allen F. Agnew, J. R. Macdonald, and Morris F. Skinner for their assistance in the field and in the writing of this report. The administrative branch of the Pine Ridge Indian Reservation is lauded for the cooperation extended during all phases of this project. I am indebt-ed to Walter, Marion, and the late Grover Sharp for the hospitality which was ex-tended myself and the mem-bers of my party.

The Porcupine Butte quadrangle contains about 220 square miles of the south-central part of Shannon County, Pine Ridge Indian Reservation, South Dakota, A thin strip of land south of latitude 43 degrees North and north of the Nebraska border was included in this quadrangle. The Porcupine Butte quadrangle is in the Missouri Plaleau section of the Great Plains physiographic Province, and is within the region of Tertiary continental deposits. Four small settlements are located within the limits of this quadrangle; Manderson, Porcupine, Wounded Knee (called Brennan on older maps), and Denby. A very good system of all-weather roads covers the area. U. S. Highway 18 traverses the southern section from east towest. Manderson, Porcupine, and Wounded Knee are connected by a network of Bureau of Indian Affairs asphalt roads which extends south to connect with U. S. Highway 18. The remainder of the area is served by a network of graded roads and firetrails which are ungraveled and are generally impassable in times of wet weather.

Topography of the quadrangle is quite varied. In the southern part sand dunes predominate; in the northern part dissected High Plains remannts are characteristic;

remnants are characteristic; and in the central part a rolling midland typifies the topography. Maximum topographic relief is approximately 700 feet and is found
between Porcupine Butte,
(elevation 3690), and the
junction of Wounded Knee
Creek and the northern edge
of the quadrangle (elevation
2980). Local relief is greatest in the northern part of the
mapped area where 200 feet
of relief may be found in a
few hundred feet of lateral
distance. Porcupine Butte
is the dominant topographic
feature and can be seen from
Sheep Mountain Table (36
mules to the north)

The southern part of the quadrangle is drained by Wolf and Spring Creeks. Wolf Creek has its originin Nebraska, enters the mapped area in the south-central part, flows west and joins White Clay Creek near the town of Pine Ridge. Spring Creek, with headwaters in Nebraska, is fed by numerous springs as it flows northward through the Sand Hills to join

numerous springs as it flows northward through the Sand mins to join Wounded Knee Creek near Denby.

The quadrangle is diagonally bisected, from southeast to northwest, by Wounded Knee Creek. The drainage begins near Walk Upon Me Lake (three miles east of the southeastern corner of the quadrangle) and empties into the White River northwest of the quadrangle limits.

White Horse Creek, which drains the west-central part of the quadrangle, empties into Wounded Knee Creek near Manderson. The northeast part of the manned area is drained by Porcuring Creek.

White Horse Creek, which drains the west-central part of the quadrangle, empties into Wounded Knee Creek near Manderson. The northeast part of the mapped area is drained by Porcupine Creek.

All of the named creeks in this area, with the exception of White Horse Creek, are perennial streams. The stream valleys are filled with the typical riparian community of deciduous trees. These trees furnish the local residents shade in the summer and windbreak and firewood in the winter. These factors plus the availability of water are the reasons that most of the permanent habitations are found adjacent to these streams. Very few cabins are found along the coniferous-covered ridges.

No large natural lakes are found within the mapped area. Many small stock dams are situated back in the draws and one large dam, Denby Reservoir, has been constructed. Denby Reservoir furnishes limited camping and fishing facilities.

HISTORY OF GEOLOGIC INVESTIGATIONS

Southwestern South Dakota has long been a favorite research area for persons interested in the geological and paleontological sciences. However, the majority of their activities have been conducted to the north of White River and very few actually studied the area within the confines of this quadrangle.

this quadrangle.

Matthew (1907) reported on the geology south of the White River in the Wounded Knee area. To the sequence of strata found there, Matthew applied the names "Upper Rosebud" and "Lower Rosebud." These names are an incorrect lithologic extension of the Rosebud Beds of Gidley (1904). The name Rosebud was first applied to beds along the Little White River some 60 miles east of the Porcupine Butte quadrangle.

Green (1956) collected and studied the Pliocene fauna from Wolf Creek n South Dakota and Nebraska. In conjunction with Green's study, Wismer wrote a master's thesis on the stratigraphy of the Wolf Creek area.

Macdonald (1963) and Toohey (1959) wrote papers which combined vertebrate paleontology with a review of the stratigraphy of southwester South Dakota. Schultz (1961) and Dunham (1961) described the clays and shales and uranium occurrences of parts of the Pine Ridge Indian Reserva-

EXPOSED SEDIMENTARY ROCK

Tertiary System

The Tertiary rocks of southwestern South Dakota are all continental in origin. Strata representing the Oligocene, Miocene, and Pliocene are present and lie unconformably on marine deposits of the Cretaceous System. Most deposits are remnants of a vast blanket of sediments which spread eastward from the Rocky Mountains during much of Tertiary time. The Rocky Mountains and Black Hills served as the source area for all sediment. Regional and local orogenic pulsations controlled the deposition and are responsible for many unconformities having a relatively small geographic area. Only in isolated areas can a section be found that is free of depositional breaks for any length of geologic time. One of the most complete lower Miocene sections in North America is found directly north of this quadrangle in the Sharps Corner 15-minute quadrangle.

Within the Porcupine Butte quadrangle are exposures representative of the Miocene and Pliocene Series of rocks. The greatest areal extent is exhibited by the Miocene Rosebud Formation.

(Darton, 1899)

Redefined Hatcher, 1902 and Schultz, 1938

Strata of the Arikaree Group are found in the northern half of the mapped area. This group in South Dakota is broken down into the Sharps, Monroe Creek, and Harrison Formations. The Sharps Formation is considered to be in part a time equivalent of the Gering Formation of western Nebraska. The Monroe Creek and Harrison Formations of the Porcupine Butte quadrangle are considered to be both time and lithologic equivalents of the type section areas of western Nebraska.

Sharps Formation

Harksen, Macdonald, and Sevon, 1961

At the type section location, the Sharps Formation attains a thickness of 350 feet. In the Porcupine Butte quadrangle only the upper 200 feet are exposed in the valleys of Porcupine, Wounded Knee, and White Horse Creeks. Throughout the remainder of the quadrangle the Sharps Formation is buried under younger sediments.

The Sharps Formation is composed of massive, poorly consolidated well compacted, pinkish tan silts with many randomly spaced, small (2" 4"), gray, nodular concretions. In some areas freshwater limestones and channel deposits interrupt or deviate from the massive character of the Sharps. Some channels have been referred to as time equivalents of the Gering Formation of western Nebraska (Collins, 1960). Althoughmany Tertary channel cuts are wide and deep (Clark, 1937; Macdonald, 1963) very few can be traced for more than a few miles. Therefore, the channel deposits in the Sharps Formation should be treated as phenomena common to most of the continental Tertiary and not as distinct stratigraphic units.

The naming of the Sharps Formation has created some controversy concerning the validity of the term (Schultz and Stout, 1961). After reading Darton (1899) and Condra and Reed (1959) and visiting exposures of Gering in Nebraska it would appear that the statements made by Schultz and Stout (1961) are in error and results in confusion regarding the usage of "time units" and "rock units" (Maerican Commission on Stratigraphic Nomenclature, 1961). McKenna (1965) also presents the status of this confusion. The Sharps Formation has now produced the largest, best, and most fully documented early Miocene mammalian fauna in North America. The Sharps Formation is a large fauna representative of almost all of the orders of North American, discone mammalism, This fauna contains many distinctive species and also contains many species which either carry through into this fauna or carry on out which, until the Sharps fauna was known, were considered to be either Oligocene or Miocene.

Macdonald (1963 and personal com

DELTATHERIDIA
**Hyaenodon brevirostrus Peratherium spindleri CARNIVORA INSECTIVORA CARNIVORA

Hesperocyon leptodus
Nothocyon roli
N. geismarianus
N. lemus
Cynodesmus cooki
Sunkahetanka geringensis
S. pahinsintewakpa
**Brachyrhynchocyon douglasi
Enhydrocyon crassidens
Palaeogale dorothiae
Pp. cf. dorothiae
Pp. sp.
**Dinictis elleenae
Nimravus brachyops
Ekgmolteptecela olsontau INSECTIVORA

Ocajila makpiyahe

**Quadrodens wilsoni
Domnina greeni
D. dakotensis
Domninoides evelynae
Proscalops sp.

**Palaeoscalopus pineridgensis
Taipidee, gen. indet,
Arctoryctes terrenus Ekgmowechashala philotau

Palaeolagus hypsodus
P. philoi
Megalagus cf primitivus
Palaeolaginae, gen. indet.

PERISSODACTYLA
Miohippus near equinanus
M. equiceps
Hyracodon apertus
7H. sp.
Diceratherium gregorii
D. cf. gregorii
D. armatum

RODENTIA
Prosciurus dawsonae
?P. dawsonae
?P. dawsonae
**Xenomys chadwicki
**Allomys sharpi
Meniscomys hippodus
**M. milleri
Tamias propertion
Tamias propertion
Entoptychus minor
Pleurolicus clasoni
P. leptophrys
Grangerimus dekotensis
Heliscomys schlaikjeri
Proheteromys fedti
P. gremmelsi
P. bumpi
Sanctimus stuartae
Hitenkals RODENTIA ARTIODACTYLA Leptocheerus sp.
Agriccheerus sp.
Agriccheerus sp.
Mesoreodom megalodon of, sweeti
Promerycocheerus montanus pinensi
Desmatocheerus curvidens gregoryi
D. hatcheri geringensis
D. wwomingensis

. wyomingensis yclopidius schucherti C. simus
**Flomeryx garbanii
Arrototherium sp.
Oxydactylus cf. wyomingensis Sanctimus stuartae
Hitonkala andersontau
Florentiamys agnewi
Palaeocastor nebrascensis **Manuscript name

Eutypomys cf. montar
Eumys blacki
E. woodi
Scottimus sp.
*Paciculus mcgregori Monroe Creek Formation Hatcher, 1902

The Monroe Creek Formation was named from outcrops in Monroe Creek Canyon, Nebraska, 55 miles southeast of the Porcupine Butte quadrangle, Condra and Reed (1959) give the Monroe Creek a combined thickness of 285 feet to 370 feet in western Nebraska. In the Porcupine Butte quadrangle the Monroe Creek is 120 feet thick, However, gradational contacts with both the underlying Sharps and overlying Harrison Formations make any statement of thickness an arbitrary matter.

In the Porcupine Butte quadrangle the Monroe Creek Formation is composed of a massive series of pinkish to grayish buff clayey to sandy silts. It is well compacted and weathers to a light buff. The Monroe Creek weathers vertically into steep or vertical exposures. Such exposures are conducive to the growth of lichens, particularly in the upper half of the formation.

formation.

The Monroe Creek Formation is remarkably uniform in texture. Concretions are abundant only in the lower 20-30 feet and only one limestone or marl bed was found within this quadrangle. This marl is directly to the west of Porcupine in the SE\$ sec. 19, T. 38 N., R. 42 W.

The Monroe Creek Formation thins from 370 feet in western Nebraska 120 feet in this quadrangle. Collins (1960) reports 350 feet in the Patricia quadrangle. The great variation in thickness reported for the Monroe Creek may be indicative of a gentle upwarping of this area during Miocene Time.

In the Porcupine Butte quadrangle the Monroe Creek Formation is best exposed along the valleys of Porcupine, Wounded Knee, and White Horse Creeks. Macdonald (1963 and personal communications) lists the following genera and species of Mammalia as having been collected from the Monroe Creek Formation of the Wounded Knee area.

ARNIVORA

*Nothocyon geismarianus

*N. nr. latidens
N. sp.
*Neocynodesmus delicatus
Tennocyon percussor
Enhydrocyon crassidens
*Mammacyon obtusidens
Plesictus sp. Peratherium spindleri P. sp.

INSECTIVORA
**Palaeoerinaceus horncloudi
Proscalops sp. LAGOMORPHA RODENTIA Allomys harkseni A. ?harkseni

**Gregorymus downsi

downsi formosus La tormosus
Grangermus sp. indet.
*Heliscomys woodi
*Proheteromys ironcloudi
*Sanctimus tiptoni
Palaeocastor simplicidens
*Capatanks brachyceps
*Eumys gloveri

Harrison Formation

In the Porcupine Butte quadrangle the Harrison Formation is represented

son Formation, similar to the Monroe Creek, has thinned

The Harrison Formation, similar to the Monroe Creek, has thinned northward from the type section area in western Nebraska. However, the thinning has amounted to less than 50 feet, an amount not unusual considering the variability of continental deposits.

The Harrison Formation of this quadrangle contains few good pipey concretions. Schultz (1941) reported finding pipey concretions in the Arikaree of this quadrangle with an axial trend of north-northeast. No Daimonelix have been found, but Barbour (1903) reports finding two varieties on Eagles Nest Butte (35 miles to the northeast of this quadrangle) and one variety on White Clay Butte (90 miles to the northeast of this quadrangle). Therefore, it is reasonable to assume that Daimonelix may be found within the limits of this quadrangle.

Therefore, it is reasonable to assume that Daimonelix may be found within the limits of this quadrangle.

In the Sharps Corner quadrangle (Harksen, 1965) the marls of the Harrison were reported to range up to three feet in thickness. In the Porcupine Butte quadrangle these freshwater limestones attain a greater thickness. One bed, nine feet thick, is found in the SE ½ sec. 23, T. 37 N., R. 43 W. This bed is just below the series of calcareous concretionary ledges which mark the top of the Harrison. The cyclical nature of the marls and the intervening sediments was noted in the text of the Sharps Corner quadrangle.

gle.

In the Sharps Corner quadrangle, the top of the Harrison Formation was marked by three distinct lithologies. Of the three, the one most prevalent in the Sharps Corner quadrangle and the only one present in the Porcupine Butte quadrangle is a series of gray concretionary ledges. These ledges may be upwards of five feet in thickness but are generally one foot in thickness. The ledges grade upward into the overlying Rosebud Formation and the contact is placed at the color change where the gray sands of the Harrison merge with the buff, clay-bedded sands and silts of the Rosebud Formation.

Formation.

In the area north of the Wounded Knee Battlefield Store, in addition to the ledges, there are found a number of small concretions. These concretions may represent poor sand crystal development.

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

RODENTIA Gregorymus formosus *G. curtus *Heliscomys woodi *Capatanka brachyceps ?C. sciuroides CARNIVORA

ARTIO DACTYLA Hesperocyon gregorii
*Nothocyon nr. latidens
Tomarctus sp.
Cynodesmus yulpinus
*Necynodesmus delicatus
Mesocyno robustus
Enhydrocyon crassidens
*Mammacyon obtusidens

PERISSODACTYLA ERISSODACTYLA
*Miohippus equinanus
M. cf. gemmarosae
Parahippus pristinus
*P. coloradensis praecurrens
Diceratherium gregorii

Miotapirus harrisonensis Miohippus equinanus Diceratherium sp.

? Oreodontoides curtus

*Collection data unsatisfactory **Manuscript name

ARTIODACTYLA

P. barbouri
P. minor pygmyus
P. montanus pinensis
Desmatochoerus curvidens gregoryi
Nanotragulus ordinatus

Rosebud Formation

Gidley, 1904

The Rosebud Formation was named from outcrops along the Little White River near the Agency Headquarters, Rosebud Indian Reservation, Todd County, South Dakota, The areal extent of the formation is undefined, Preliminary work (Macdonald, 1957) indicates that the Rosebud is present along the Niobrara River at Fort Niobrara, Nebraska. Matthew had considered the beds to be Miocene (Stirton and McGrew, 1935) and Johnson (1938) assigned them to the Brule Formation.

Although the type area of the Rosebud Formation is in the Rosebud Indian Reservation, Matthew (1907) applied the terms "Upper Rosebud" and "Lower Rosebud" in the Wounded Knee area in a manner which is not consistent with that of the type area (Gidley, 1904). Matthew's "Upper Rosebud" included the Rosebud of Gidley plus the upper part of the Harrison Formation, the entire Morroe Creek Formation, and the upper part of the Sharps Formation.

Osborn (1918) made several references to the "Upper Rosebud" and "Lower Rosebud." He continued the use of the names and included in his monograph a section taken near Porcupine Butte. Osborn's monograph possibly led Wanless (1923) to make the misstatement that the type section of the Rosebud Formation was along Porcupine Creek.

Schultz (1938) called the Rosebud "a generalized, indefinite name for deposits in the vicinity of Rosebud Agency in South Dakota," He further stated, "It (Rosebud) appears to include deposits of more varied age than the Arkaree." The following year Lugn (1939) stated that the Rosebud could be traced southward from the type locality into the Gering, Monroe Creek, Harrison, and Rosebud Formations, Generally speaking, these formations are in part time equivalents of lithologic equivalents of the Sharps, Monroe Creek, Harrison, and Rosebud Formations, Lugn's comment would be substantially correct if the type locality of the Rosebud Formation were along Porcupine Creek and contained the "Upper Rosebud" and "Lower Rosebud" of Matthew (1907).

Sevon (1960) applied Lugn's statement to the s

Lugn's comment would be substantially correct if the type locality of the Rosebud Formation were along Porcupine Creek and contained the "Upper Rosebud" and "Lower Rosebud" of Matthew (1907).

Sevon (1960) applied Lugn's statement to the strata along the Little White River and mapped the Rosebud Formation near the type area as Arikaree undifferentiated. Sevon included the Mellette Formation, named by Agnew (1957) as part of his Arikaree.

Throughout the last 60 years the Rosebud Formation has been subject to controversy. This is equally true today. While many geologists insist that the Rosebud of this report in no way correlates with the Rosebud of Gidley (1904), the author feels that lithically they are one and the same. Only future work will prove or disprove this hypothesis.

The Rosebud Formation, as used in this report, refers to the series of pinkish, sandy clays and silts, middle Miocene in age, which in this quadrangle conformably overlain by the Ash Hollow Formation.

In the Forcupine Butte quadrangle the Rosebud Formation is approximately 235 feet thick. The clastic sediments of the Rosebud range in size from clay to medium sand; however, the major constituent is silt. Cementation, in some instances, gives the Illusion of larger grain size than is actually present. The color ranges from cream to reddish-buff with some local occurrences of green. The formation weathers to a pinkish-buff. The most common lithology is a series of alternating beds of silt and clay. Although the thickness of any bed or sequence of beds in the continental Tertiary varies greatly over short lateral distances, it may be said that the silt beds range to several feet in thickness, and the clay beds rarely exceed one foot in thickness. The clays are generally considered indicative of the Rosebud.

Concretions, ranging from small randomly scattered calcareous masses the sits are not.

A series of reddish-tan, silicified, and vesicular clay beds occur at various levels, but generally are in the upper part of the formation, These b

Invertebrate remains, Macdonald (1963 and personal communications) lists the following genera and species of Mammalia as having been collected from the Rosebud Formation of the Wounded Knee area. Parahippus texanus P. nr. cognatus

LAGOMORPHA ARTIO DACTYLA Archaeolagus primigenius A. macrocephalus Desmathyus pinensis
Phenacocoelus stouti
Merycochoerus matthewi
Merychyus minimus
Oxydactylus exilis
Q. lacota
2.0 acc RODENTIA
Promylagaulus riggsi
Mylagaulodon of, angulatus
Pleurolicus leptophrys
Gregorymus curtus
Grangerimus oregonensis
**G. harkseni
Dikomys matthewi
Proheteromys matthewi Blastomeryx primus
B, advena
B, sp.

*Collection data unsatisfactory **Manuscript name

Ogallala Group

Darton, 1899

Darton, 1899

The period of time from late early Hemingfordian to early late Clarendoman is represented in the Porcupine Butte quadrangle by an unconformity. The amount of deposition and erosion that took place in this span of time is open to speculation.

The Ogalilala Group contains strata, found at the level of the High Plains, which has been broken down into a variety of units. Some names which have been given to the Ogalilala Group, or portions thereof, are magnesia beds. Tettary grit, mortar beds, Oak Creek Formation, Niobrara River Formation, Devils Gulch Formation, and Burge Formation, The controversy over the nomenclature of this group reached its apex in 1938 when a flurry of papers appeared in the American Journal of Science. Since this time the Ogalilala Group has generally been considered to contain the Valentine, Ash Hollow, Sidney, and Kimbail Formations.

In the early thirties, Dr. M. K. Ellias conducted a study of the fossil seeds of the rate Tertiary. He found that the best method for correlating the beds of this region was through the collection and study of fossil seeds. Ellas (1935) states, "The succeeding horizons, which contain the same leading types of herbs, constitute natural stratigraphic zones. The thickness of these zones is measured in scores of feet. The succession of these floral zones proves to be the same everywhere within the studied areas in western Nebraska, northwestern Kansas, and adjacent parts of Colorado. The same assemblages of plant remains were also found on reconnissance trips to south-orentral South Dakota and north-central Texas."

Very little work on the fossil seeds of the South Dakota and north-central Texas."

as."
Very little work on the fossil seeds of the South Dakota Tertiary has been published. Other than Sevon (1960) who reported <u>Stipidium</u> from the Ash Hollow Formation of the Spring Creek quadrangle and Gregory (1942) who reported <u>Stipidium</u> and <u>Lithospermum</u> from the Big Spring Canyon area, the majority of recent papers only mention random findings of hackberry seeds. A study of the fossil seeds from the Ogallala of South Dakota is needed to show the time correlation between the Ogallala of South Dakota and adjacent areas.

and adjacent areas.

Of the four formations in the Ogallala Group only the Ash Hollow and Valentine Formations have been reported from South Dakota. Of these two only the Ash Hollow Formation occurs in the Porcupine Butte quadrangle.

Ash Hollow Formation

The Ash Hollow Formation was first described by Henry Englemann 6) from exposures in Ash Hollow Canyon near Lewellen, Nebraska about

The Ash Hollow Formation was first described by Henry Englemann (1876) from exposures in Ash Hollow Canyon near Lewellen, Nebraska about 100 miles south of the Porcupine Butte quadrangle.

In the Porcupine Butte quadrangle, the Ash Hollow Formation is best exposed along the southern edge of the quadrangle, where it attains an estimated thickness of 200 feet. Accurate thickness could be obtained only through drilling, as good outcrops are few and any distinguishable bed can be traced laterally for only short distances. The Sand Hills Formation, vegetation, and slumpage of unconsolidated beds tend to cover most of the Ash Hollow.

In general, the Ash Hollow of this quadrangle consists of white to gray volcanic ash, white consolidated freshwater limestone, and many beds of brownish unconsolidated to calicareously-cemented sandstones and silt-stones. The sandstones range from fine grained with a high percentage of silt, to medium grained with some included pebbles of calcareous cemented materials. The coloration varies; gray, green, brown, and white are present with brown being the most prevalent.

materials. The coloration varies; gray, green, brown, and white are present with brown being the most prevalent.

Porcupine Butte is capped with 25 feet of Ash Hollow. The base of the Ash Hollow is marked by an unconformity some feet below a bed of fine gray volcanic ash. The ash averages 2-3 feet in thickness and grades upward within a foot into "typical" Ash Hollow.

The Ash Hollow on Porcupine Butte is very much like that of the Sharps Corner quadrangle, a whitish to brownish gray marly medium to coarse-grained sandstone, with local crossbedding, small concretions, mineralized rootlets and volcanic ash. Consolidation of this unit is quite variable and differential erosion gives it a ledge-like appearance. This unit is responsible for "holding up" Porcupine Butte as the Ash Hollow is much more resistant to erosion than the underlying Rose solud Formation.

Although only scattered Celtis seeds and mineralized rootlets were

more resistant to erosion than the underlying Rosebud Formation.

Although only scattered <u>Celtis</u> seeds and mineralized rootlets were found on Porcupine Butte additional prospecting may reveal <u>Krynitzkia</u> coronoformis. If they are found, it would substantiate the belief that this outcrop is an equivalent of the Cap Rock bed of the Nebraskan Ash Hollow.

Green (1956) studied the geology and paleontology along the Wolf Creek drainage in the southern part of the quadrangle. He chose to call the beds Ogallala undifferentiated, stating, "The beds are here considered part of the Ogallala Group. No attempt was made to discern formations as most of the stream channels are not connected and the exposures themselves too small for such determination," In regard to age and correlation of the unit, Green further states, "Therefore, the Ogallala-Wolf Creek local fauna is late Clarendonian in age, most closely correlative with the Big Spring Canyon local fauna and the Ogallala-Mission local fauna of South Dekota,"

Green (1956 and written communication) lists the following genera and species of Mammalia as having been collected from the Ogallala of the Wolf Greek area.

Wolf Creek area. PERISSODACTYLA Nannippus cf. gratus INSECTIVORA Domninoides riparensis sp. echipparion occidentale sp. liohippus (Astrohippus) martini . pernix Hypolagus sp. Leporidae gen, indet. P. sp.
Tapiridae gen. indet.
Teleoceras cf. fossiger RODENTIA Mylagaulus sp.
Pliosaccomys cf. dubius
Eucastor planus
E. sp. T. sp.
Peraceras sp.
Phinocerotidae gen. indet.

CARNIVORA RRNIVORA
cf. Pliocyon sp.
Tomarctus sp.
Brachypselis pristinus
Pliogale manka
Pseudaelurus sp.
Felis sp. PROBOSCIDEA

?Amebelodon sp.

ARTIODACTYLA TTIODACTYLA
Procamelus dakotensis
P. cf. occidentalis
Pliauchenia cf. magnifontis
Paracamelus sp.
Camelidae gen. indet. Parablastomeryx sp. Longirostomeryx wellsi Cranioceras cf. dakotensis Palaeomerycidae gen. indet. Merycodus ?furcatus Antilocapridae gen. indet.

Sand Hills Formation

Lugn, 1934

Lugn, 1934

In the southern portion of the Porcupine Butte quadrangle the Tertiary strata is unconformably overlain by the Quaternary Sand Hills Formation. This unit consists mainly of fine sands derived from the Ogallala Group and Rosebud Formation with some endemic loessial material. The Sand Hills Formation attains a thickness of 50-100 feet.

In mapping, the Sand Hills were differentiated from the underlying Tertiary primarily on the basis of topography. The distinctive dune topography makes this unit discernible from a distance even in grassy areas.

There is no drainage system developed on the Sand Hills. Rainfall is absorbed and percolates directly to the water table. The water table is quite high and the land surface often bisects it and forms small lakes, Because of map scale, all of the lakes thus formed were too small to permit mapping.

Grasses cover the surface of the dunes and restrict further migration.

Collins (1959) states that only a small decrease in the annual rainfall would allow the dunes to resume active migration.

SURFICIAL DEPOSITS

A large part of the mapped area is covered by Recent and Pleistocene unconsolidated deposits that are separated into terrace deposits, eolian deposits, alluvium, and undifferentiated Quaternary deposits.

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.

Eolian deposits are mixtures of dune sand and loess which cap some of the buttes and hills in the northwest part of the quadrangle. This material was derived from older sediments during the late Pleistocene and Recent Time.

Undifferentiated Quaternary Deposits

Undifferentiated Quaternary deposits occur in the southern part of the quadrangle. These deposits are a combination of alluvium, colluvium, lake deposits, and dune sands which were undifferentiated in mapping either because of the smallareas of outcrop or because the various lithologies merge in a manner that would make differentiation impractical.

The lower terrace deposits consist of gravel and smaller material which was laid down by Pleistocene streams with the help of wind. These deposits record the greater width of these ancient stream valleys when compared to the modern stream. Quaternary Terrace Deposits (upper)

The middle terrace deposits consist of gravel and finer material, laid on by Pleistocene streams, which are at least 75 feet above the present stream channels.

SUBSURFACE ROCKS Accurate subsurface information is obtained from the samples and electric log of one nearby oil test. The Amerada #1 Red Eagle (NE $\frac{1}{4}$ sec. 25, T. 36 N., R. 48 W.), located 20 miles west of the quadrangle, furnishes the following information.

Elevation of surface: 3344 feet.

Depth

Formations Niobrara Marl and Carlile Shale Greenhorn Limestone, Belle Fourche Shale, Mowry Greenhorn Limestone, Belle Fourche Shale, Shale
Newcastle Sandstone and Skull Creek Shale Fall River Sandstone and Fuson Shale Morrison Shale and Sundance Sandstone Spearfish Shale
Minnekahta Limestone and Opeche Shale Minnelusa Formation Precambrian Granite Total Depth

STRUCTURE Because of gradational and unconformable contacts between all forma-

Because of gradational and unconformable contacts between all formations in the mapped area and the lack of any continuous traceable horizon, any statement on regional dip would be little more than hearsay. Areas to the north and east have a reported maximum regional dip of less than 20 feet per mile away from the Black Hills Uplift.

The beds within this quadrangle appear to be essentially flat lying with the exception of the extreme southern part. Structure within the quadrangle is appearently controlled by the Black Hills, the Chadron Arch, faulting, and possibly by other regional and local phenomena.

Along the southern edge of the mapped area the beds dip steeply to the north. One measurement of beds in the Ash Hollow Formation (NE ½ NE½ sec. 21, T. 35 N., R. 44 W.) indicates that over short distances the dip is of the magnitude of 550 feet per mile.

The White Clay Fault, named and mapped by Dunham (1961), continues eastward from his mapped area. The fault enters Nebraska near White Clay, Nebraska (2½ miles west of this quadrangle) and then extends in an easterly direction. Near Nebraska Highway 27 the fault becomes obscured by the Sand Hills Formation. Terrace deposits along the Nebraska-South Dakota border are to the south of present streams and some indication of drainage reversal suggests the possibility that some crustal movement has taken place within Recent time. Unconformities in the Slim Butte and White Clay areas give indications of crustal movements throughout the late Tertiary.

ECONOMIC GEOLOGY

Of the many potential economic deposits in the Porcupine Butte quadrangle, only the sand, gravel, and water have been utilized. Potential deposits of volcanic ash and limestone are present but have never been quarried. Oil and gas may be present in the subsurface. Ground Water

Ground water in sufficient quantities for domestic and stock use is available throughout the quadrangle. The quality of the water is good as is generally true throughout the region of Tertlary sediments. Wells in the mapped area range from a few feet below surface to 275 feet in depth. The shallowest wells produce from the alluvium and the deepest are those drilled through the Rosebud Formation.

Sand and Gravel

Sand is abundant throughout the quadrangle at all levels in the stratigraphic column. However, only in the Ogailala Group is it of a quality to be utilized for construction purposes. The grain size is generally too small for effective use as road metal; however, it is excellent for use in plasterand concrete aggregate. Locally derived gravel can be found in the SW 4 sec. 32, T. 36 N., R. 42 W, and in secs. 24 and 25, T. 38 N., R. 44 W. Both of these deposits are poorly-sorted gravels that have a very limited use. Deposits of relatively pure volcanic ash are present on Porcupine Butte and along Wolf Creek. Preliminary analysis of this ash (Bruce Hodson, personal communication) indicates that its high iron content would limit its use in glass manufacture to such products as beer bottles. However, its possible use as an abrasive, as road metal, or as a "popped" ingredient in lightweight building blocks are yet to be investigated.

Oil and Gas The structure present along the southern part of the mapped area indi-cates excellent possibilities for future discoveries of oil and gas accumu-lations.

REFERENCES CITED Agnew, A. F., 1957, Geology of the White River quadrangle, South Dakota:
S. Dak. Geol. Survey map and text.
American Commission on Stratigraphic Nomenclature, 1961, Code of stratigraphic nomenclature: Am. Assoc. Petroleum Geologists Bull., v. 45,

p. 645-665.
Barbour, E. H., 1903, Present knowledge of the distribution of <u>Daimonelix</u>;

Science, new series, v. 18, p. 304-505.

Clark, J., 1937, The stratigraphy and paleontology of the Chadron formation of the Big Badlands of South Dakota: Annals of the Carnegie Mus., v. 25, p. 261-350.

Collins, S. G., 1959, Geology of the Martin quadrangle, South Dakota: S. Dak, Geol, Survey map and text, 1960, Geology of the Patricia quadrangle, South Dakota: S. Dak. Geol. Survey map and text.

Geol. Survey map and text.

Condra, G. E., and Reed, E. C., 1959, The geological section of Nebraska: Lincoln, Univ. of Nebr., 82 p.

Darton, N. H., 1899, Preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian: U. S. Geol, Survey 19th Ann. Rept., pt., 4, p. 719-814,

Dunham, R. J., 1961, Geology of uranium in the Chadron area, Nebraska and South Dakota: U. S. Geol. Survey Open-File Rept.

Elias, M. K., 1935, Tertiary grasses and other pratire vegetation from High Plains of North America: Am. Jour. Sci., v. 29, p. 24-33.

Engelmann, H., 1876, Report on the geology of the country between Fort Leavenworth, Kanass and the Sierra Nevada, near Carson Valley: p. 243-335, in Simpson, J. H., Report of explorations across the Great Basin of the Territory of Utah for a direct wagon-route from Camp Ployd to Genoa, in Carson Valley, in 1859, Washington, G.P.O., 518 p. Gidley, J. W., 1904, Geological notes, in Matthew, W. D., and Gidley, J. W., New or little known mammals from the Miocene of South Dakota, American museum expedition of 1903: Am. Mus. Nat. Hist. Bull., v.

American museum expedition of 1903: Am. Mus. Nat. Hist. Bull., v. American museum expedition of 1905; nm, museum 20, p. 241-288.

Green, M., 1956, The lower Pliocene Ogallala-Wolf Creek fauna, South Dakota: Jour, Paleontology, v. 30, p. 146-169.

Gregory, J. T., 1942, Pliocene vertebrates from Big Spring Canyon, South Dakota: Univ. Calif. Pubs., Bull. Dept. Geol. Sci., v. 26, p. 307-

Harksen, J. C., 1960, The geology of the Sharps Corner, Malone, and Manderson 7½ minute quadrangles, South Dakota: S. Dak. Geol. Survey

Harksen, J. C., 1960, The geology of the Sharps Corner, Malone, and Manderson 7½ minute quadrangles, South Dakota: S. Dak. Geol. Survey map and text.

1965, Geology of the Sharps Corner quadrangle, South Dakota: S. Dak. Geol. Survey map, text, and auxiliary sheet.

Harksen, J. C., Macdonald, J. R., and Sevon, W. D., 1961, New Miocene formation in South Dakota: Am. Assoc. Petroleum Geologists Bull., v. 45, p. 674-678.

Hatcher, J. B., 1902, Origin of the Oligocene and Miocene deposits of the Great Plains: Am. Philos. Soc. Proc., v. 41, p. 113-131.

Johnson, F. W., 1938, Further comments on the usage of "Valentine:" Am. Jour, Sci., v. 36, p. 215-219.

Lugn, A. L., 1934, Outline of the Pleistocene geology of Nebraska: Univ. Nebr. State Museum Bull., v. 1, p. 319-356.

1939, Classification of the Tertiary system in Nebraska: Geol. Soc. Am. Bull., v. 50, p. 1245-1276.

Macdonald, J. R., 1957, The "Rosebud Formation" of western South Dakota: S. Dak. Acad. Sci. Proc. (1956), v. 36, p. 113-114.

1963, The Miocene faunas from the Wounded Knee area of South Dakota: Am. Mus. Nat. Hist. Bull., v. 125, p. 139-238.

McKenna, M. C., 1965, Stratigraphic nomenclature of the Miocene Hemmingford group, Nebraska: Am. Mus. Novitates 2228, 21 p.

Matthew, W. D., 1907, A lower Miocene fauna from South Dakota: Am. Mus. Nat. Hist. Bull., v. 23, p. 169-219.

Osborn, H. F., 1918, Equidae of the Oligocene, Miocene, and Pliocene of North America: Iconographic type revision: Am. Mus. Nat. Hist. Mem., new series, v. 2, p. 1-330.

Schultz, C. B., 1938, The Miocene of western Nebraska: Am. Jour. Sci., v. 35, p. 441-444.

Mem., new series, v. 2; p. 1-330.

Schultz, C. B., 1938, The Miocene of western Nebraska: Am. Jour. Sci., v. 35, p. 441-444.

1941, The pipey concretions of the Arikaree: Univ. Nebr., State Mus. Bull., v. 2, p. 69-82.

Schultz, C. B., and Stout, T. M., 1961, Field conference on the Tertiary and Pleistocene of western Nebraska, Guidebook for the ninth field conference of the Society of Vertebrate Paleontology: Lincoln, Univ. Nebr. State Mus. 55.9.

conference of the Society of Vertebrate Paleontology: Lincoln, Univ. Nebr. State Mus., 55 p.

Schultz, L. G., 1961, Preliminary report on the geology and mineralogy of the clays of the Pine Ridge Indian Reservation, South Dekota: U. S. Geol. Survey Open-File Rept.

Sevon, W. D., 1960, Geology of the Spring Creek quadrangle, South Dekota: S. Dek, Geol. Survey map and text.

Stirton, R. A., and McGrew, P. O., 1935, A preliminary notice on the Miocene and Pilocene mammelian faunas near Valentine, Nebraska: Am. Jour. Sci., v. 29, p. 125-132.

Toohey, L., 1959, The species of Nimravus (Carnivora, Felidae): Am. Mus. Nat. Hist. Bull., v. 118, p. 71-112.

Wanless, H. R., 1923, The stratigraphy of the White River beds of South Dekota: Am. Philos. Soc. Proc., v. 62, p. 190-269.

Wismer, R., M.S., The stratigraphy of the Wolf Creek area, Shannon County, South Dekota: Unpublished thesis, Department Geological Engineering, South Dekota School of Mines and Technology, Rapid City, South Dekota.

