

# GEOLOGY OF THE FAITH QUADRANGLE

# Rene E. Fournier

Generalized Columnar section

100 000 000 0,010,000 75777777 300 200-===-(3) **6**3= 50 A -

> ==== clay-silt sand > (11,1,1) bentonitic clay oo o o o pisolites cross-bedded manganese-iron shale @ @ calcite concretion - lignite vertebrata

summer of 1965 under the direction of State Geologist Duncan J. McGregor. Mapping of this area is part of the South Dakota Geological Survey's continuing program of mapping and exploring the mineral resources of the State.

INTRODUCTION

#### **ACKNOWLEDGMENTS**

The Faith Quadrangle was mapped during the

The author would like to express thanks to D. Emmett Faulkner for assistance in the field. Earl J. Cox and Merlin Tipton of the South Dakota Geological Survey staff were most helpful in orientation and advice in field and administrative matters. Robert E. Stevenson of the University of South Dakota aided in determination of field relationships and fauna identification. Also, Lange, was helpful in identification. Alan Lange was helpful in conversing with the author in regard to field

Robert Larimer and John Moore determined the elevations in the southern half of the mapped area. Ranchers and business people of the Faith area are commended for their interest and cooperation. Special appreciation is extended to Mr. and Mrs. Bill Mason for their

#### LOCATION AND TOPOGRAPHY

The Faith Quadrangle is located in Meade and Perkins Counties of northwestern South Dakota. The mapped area includes approximately 30 square miles in northeastern Meade County and 180 square miles in southeastern Perkins County and is located approximately 100 miles northeast of Belle Fourche and 135 miles northwest of Pierre.

The quadrangle is in the Cretaceous Tableland subdivision of the Missouri Plateau division of the Great Plains physiographic province. Topography is composed of gently rolling hills in the southern portion of the mapped area, highly dissected badlands topography in the west-central portion, broad dissected terraces along the Moreau River, and several prominent buttes in the east-central area. The highest elevation, 2,664 feet, is located on Arrowhead Butte and the lowest elevation, 2,200 feet, occurs at the junction of the Moreau River, at the auditangle. 2,200 feet, occurs at the junction of the Moreau River and the eastern border of the quadrangle. The maximum relief is 464 feet; in areas not adjacent to the Moreau River the local relief is about 50 feet.

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Drainage in the Faith quadrangle is controlled by two major streams; the Moreau River, which crosses the quadrangle from west quadrangle. Only the extreme southern portion of the quadrangle is drained by the Cherry Creek – Cheyenne River system.

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quadrangle. Only the extreme southern portion of the quadrangle is drained by the Cherry Creek—Cheyenne River system.

Moreau River carries water most of the year, but Rabbit Creek, Deep Creek, and Flint Rock Creek carry water for no more than six months of the year. Gradient of the Moreau River through the quadrangle is 3.3 feet per mile, which is considerably less than the 8.5 feet per mile reported for the Moreau in the Signal Buttes quadrangle immediately west of the mapped area (Lange, 1962). Moreau River originates near the South Dakota—Montana border, approximately 100 miles to the west. At the river gauging station on the Moreau just east of Highway 73, available records indicate that the greatest discharge occurs in June and the least discharge occurs in January (U. S. Geological Survey, 1963). In recent years the greatest discharge (26,000 cfs) occurred April 9, 1944. At that time the recorded height was 20.9 feet above the level of the channel.

The Moreau River channel has a meander wavelength of approximately one mile, and the stream valley has a meander wavelength of approximately two miles. The present stream valley and its attendant tributaries exhibit mature age modified by the incised meander. Terrace remnants found along the Moreau River and the greater valley meander wavelength indicate that the Moreau once flowed at a higher level. In some areas the terraces are fills of alluvium, but in other areas the terraces have bedrock surfaces. At the present time the Moreau is not actively cutting through bedrock.

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Terraces do occur along Rabbit Creek, Flint Rock Creek, and Deep Creek, but are better Terraces do occur along Rabbit Creek, Flint Rock Creek, and Deep Creek, but are better developed along the Moreau River. Adjacent to the Moreau River, the terraces occur principally on the north side of the valley at approximately 150 feet above the present stream channel. Well-defined terrace remnants are present along the north side of Rabbit Creek and coalesce with the terraces of the Moreau. At the point of confluence of Rabbit Creek and the Moreau, several large terraces occur on the south side of the Moreau, especially in secs. 5 and 8, T. 14 N., R. 16 E.

Gravel deposits ranging in thickness from less than 1 foot to over 10 feet occur on most terraces. In some areas the gravel is covered by older alluvium which appears from a distance to be Hell Creek strata.

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Flat, alluvial floodplains occur along the length of the Moreau River and Rabbit Creek, and less extensively along Flint Rock Creek and Deep Creek. Moreau River floodplain is about one-half mile wide, but in secs. 3 and 10, T. 14 N., R. 16 E., the floodplain abruptly widens to about a mile. The wider floodplain continues east for two miles and then narrows once again. The floodplain usually lies 10 to 20 feet above the stream channel. The surface is relatively flat, but long, curving natural levees mark previous channels. Because of the richness of the soil and the shallow water table the floodplain serves as rich farmland.

Of the three major tributaries to the Moreau River, Flint Rock Creek is the only one that does not join the Moreau in the quadrangle, but it crosses the quadrangle from west to east south of the Moreau. Deep Creek and Rabbit Creek empty into the Moreau within the quadrangle boundaries. Rabbit Creek drains the largest area as it extends northwest to the Slim Buttes area, a distance of 40 miles. Gradient of Rabbit Creek is about six feet per mile. Flint Rock Creek, which originates about 5 miles west of the mapped area and joins the Moreau about 5 miles east of the mapped area, has a gradient of about 15 feet per mile.

Deep Creek enters the Moreau less than a mile inside the western border of the quadrangle. West of the quadrangle Deep Creek has beheaded Flint Rock Creek by means of Flint Creek, a tributary of Deep Creek. Lange (1962) states that Deep Creek has a gradient of 20 feet per mile and is in the process of being beheaded by the larger Moreau River. In the Faith quadrangle several minor tributaries of Deep Creek and the Moreau River. This process is apparent in secs. 25, 26, and 30, T. 14 N., R. 16 E. The tributaries of Deep Creek have dissected the divide into deep ravines. In

A small area in parts of secs. 3 and 4, T. 14 N., R. 16 E., is overlain by a thin deposit of dune sand. Dunes are stabilized by vegetation, but they are easily recognized on aerial photographs as long, low ridges with a northwest-southeast orientation.

# CULTURE

The Faith Quadrangle is inhabited by about 650 people, including the population of Faith. Usta is the only other village in the mapped area, but Meadow lies 15 miles to the north, Maurine 15 miles to the west and Dupree 20 miles to the east.

U. S. Highway 212 and State Highway 73 are the only paved roads in the quadrangle. Highway 212 crosses the southern portion of the quadrangle in an east-west direction. State Highway 73 crosses the central portion of the quadrangle from north to south. U. S. Highway 212 connects the area with Newell, 72 miles to the west and Dupree, 20 miles to the east, while State Highway 73 connects the quadrangle with Philip to the south and Bison to the north. An improved county road extends north from Faith to about a mile from the Moreau and turns west to intersect with Highway 73. Several unimproved section line roads and a number of fire lanes and trails account for the remaining accessibility routes. Secondary routes become impassible with inclement weather.

Principle business of the population of the Faith area is raising beef cattle and sheep. Faith is the financial and business center of the quadrangle area and is the western terminus of the Chicago, Milwaukee and St. Paul Raifroad's Mobridge division.

Climate in the quadrangle is semi-arid and subject to abrupt temperature changes during the fall and spring. The area may experience severe blizzards in the winter and relative drought in the summer.

# PREVIOUS INVESTIGATIONS

According to Searight (1934a), the earliest geologists to investigate the Perkins County area were Winchell and Willis during the late 1870's. Todd, the State Geologist, visited the region in 1885 and again in 1900 and 1902. During 1911 and 1912 the area to the northwest of the Faith quadrangle was investigated for lignite by Winchester and other U. S. Coologies Supres accounted.

Geological Survey personnel.

Searight (1934a, b) visited areas to the northwest and southwest of the Faith area in 1932 and again in 1933 to investigate lignite and coal deposits.

Moulton (1923) and Russell (1925) made detailed studies and mapped structures in two areas along the Moreau River. Wilson (1925) mapped the structural geology of an area to the southwest and reported the presence of a large anticline.

Numerous investigators have studied the Hell Creek—Fox Hills stratigraphy and mention is made in many reports of observations in the Faith area.

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Latest published information on the geology of the area is by Cox (1962) who studied the geology along a portion of U. S. 212 in the southeast corner of the quadrangle.

# EXPOSED SEDIMENTARY ROCKS\*

Exposed sedimentary rocks in the Faith quadrangle range in age from late Cretaceous to Recent. Late Cretaceous rocks are the only consolidated sedimentary rocks exposed in the mapped area. Succession of Cretaceous rocks represents various depositional environments ranging from fluviatile and lacustrine to estuarial, lagoonal and marine

# Fox Hills Formation, Meek and Hayden, 1862

The Fox Hills Formation was named for exposures of marine sediments that are present about 40 miles east of the Faith quadrangle at the eastern end of Fox Ridge in southwestern Dewey County. This general region serves as the type area of the Fox Hills. The Fox Hills Formation is widespread throughout the upper Great Plains, occurring at the foot of the Big Horn Mountains, along the Moreau River, the North and South Platte Rivers and the Missouri River. In the Faith quadrangle the Fox Hills Formation crops out along the Moreau River. The maximum width of outcrop is about one-half mile and the maximum thickness of exposed strata is about 55 feet.

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At the type location, four members have been described: the Trail City, a bluish-green, coarse to fine-grained sand; the Timber Lake, a yellow-brown glauconitic, massive, fine-grained graywacke sandstone; the Bullhead, thin alternating layers of brown to gray clayey shale containing lenses of silt; and the Colgate, calcareous and siliceous crossbedded fine to very coarse-grained graywacke sandstone.

Although two lithologic units in the Fox Hills can be locally recognized, these units are not shown as mappable entities. The lower unit is composed of 15-20 feet of alternating, gray, black, and buff thinly bedded shale, graywacke, and carbonaceous material. The lower unit is similar in lithology to the Bullhead member that has been reported to occur in the Sienal Butte quadrangle (Lange, 1962).

unit is similar in lithology to the Bullhead member that has been reported to occur in the Signal Butte quadrangle (Lange, 1962).

The upper unit is composed of 35-40 feet gray to buff, medium to fine-grained massive sandstone and graywacke. The Colgate in the Faith area is represented by the upper lithologic unit noted above. Lange did not recognize the Colgate Member in the Signal Butte quadrangle, but it can be recognized in the Faith Quadrangle. The thicknesses of the upper and lower lithologic units vary from location to location because of depositional conditions and local structure. However, a series of stratigraphic sections measured along Deep Creek and the Moreau River show that the two units can be recognized throughout the region.

The upper unit also contains occasional sandstone ledges which contain Melania sp., a fauna associated with the Colgate in other areas. Although these features are not present

and the Moreau River show that the two units can be recognized throughout the region.

The upper unit also contains occasional sandstone ledges which contain Melania sp., a fauna associated with the Colgate in other areas. Although these features are not present throughout the area of outcrop, the lithologic distinction remains; however, the upper unit varies in thickness. In the eastern area of the quadrangle this unit contains a large Ostrea glabra reef which is typical of the Colgate Member as described by previous authors.

Environment of deposition of the Fox Hills Formation has been discussed by Waage (1961, p. 238). In particular, Waage believes the marine character of the strata in the type locality gives way "into a sandy sequence of predominantly brackish and freshwater beds in which none of the members of the type area are discernible."

Occurrence of Ostrea and Melania suggests that "the area of deposition was probably close to a source of fresh water" (Mickel, 1962, p. 42). Previous geologic investigations indicate that the mapped area was near the shoreline during Fox Hills time.

An extensive Ostrea reef occurs in parts of secs. 2, 3, 10, 11, T. 14 N., R. 17 E. In places the reef exceeds 25 feet in thickness. The reef disappears further to the west, Ostrea are found in graywacke above the alternating strata of the Bullhead Member. Much of the graywacke associated with the Ostrea also contains glauconite. Where the reef crops out the surface is littered with oyster shells and local ranchers have used the shells as grit for chickness.

Contact between the overlying Hell Creek Formation and the Fox Hills Formation is gradational through an interval of about 50 feet. The traditional method of picking the contact has been to use the appearance of the first red carbonaceous shale. This criteria is apparently the only method one can employ in delineating the contact because both formations are lithologically very similar. In the western two-thirds of the Faith Quadrangle the carbonaceous shale was used to determine the Fox Hills—Hell Creek contact.

Fossils noted in the Fox Hills sediments appear to be limited to those found near an ancient shoreline. Such fauna as Ostrea and Melania are typical of sublittoral environments and the presence of wood fragments and plant fragments also supports the near-shore environment. The following list shows that only mollusks are present; pelecypods are numerous. List of fossils collected from the Fox Hills Formation of the Faith Quadrangle is as follows:

as follows:
Pelecypoda
Callista sp.
Ostrea glabra Corbicula sp.

> Gastropoda Melania insculpta Melania wyomingensis Fasciolaria sp.

### Hell Creek Formation, Brown, 1907, redefined, Thom and Dobbin, 1924

The Hell Creek Formation is named for exposures of "sombre" colored massive sandstones and shales that crop out along Hell Creek, Garfield County, Montana. The type area is approximately 250 miles northwest of the Faith quadrangle. The Hell Creek was originally placed in the upper Cretaceous by Brown for strata lying above the Fox Hills sandstones and below the Tullock Member of the Lance: the Colgate Member of the present Fox Hills was included as the basal portion of the Hell Creek. The present usage of Hell Creek was defined by Thom and Dobbin (Agnew and Tychsen, 1965).

In the mapped area, the Hell Creek strata are found over almost the entire quadrangle. The formation is thickest in the vicinity of Arrowhead Butte, where it is approximately 360 feet thick. The Hell Creek consists of a sequence of brown and red carbonaceous shales, brown and gray salt and pepper sandstones, and an occasional laterally discontinuous lignite bed. Various units within the Hell Creek strata contain abundant manganese-iron concretions and nodules. Bentonitic clay, ironstone and claystone, ledges of calcite and marcasite concretions are also present. Several red carbonaceous shale beds occur at the base of the Hell Creek, but are lenticular in nature.

In several areas badland topography is well developed in the argillaceous sandstones. The areas are interesting because they afford excellent exposures and exhibit fascinating miniature land forms.

Fossil remains of animals and plants are present throughout the Hell Creek, but significant numbers of fossils are limited to the lower portion of the formation in secs. 1 and 2, T. 14 N., R. 16 E. In this area vertebrate fossils and tree remains are very common. The fossils are very fragile and are not easily collected.

#### SURFICIAL DEPOSITS

Surficial rocks of the Faith Quadrangle have been deposited by the action of wind and water. There are sand dunes, alluvial floodplain deposits and residual boulders. Age of these deposits is not accurately known, but they are presumed to range from Pleistocene to Recent.

#### Alluvium

Alluvial deposits occur along the Moreau River and several of the tributary creeks. In general the alluvium consists of gravel and sand which has been deposited on the floodplain of the attendant stream. Alluvium can be found at two levels above the stream channel. The lower level is the present floodplain, but the higher level represents an earlier floodplain lying 10 to 20 feet above the present stream channel. Thickness of the alluvium varies from several inches to 30 and 40 feet. The thinner deposits occur at the level of the present floodplain and the thicker deposits occur as remnants of the earlier floodplain.

Alluvial deposits in the mapped area are easily mistaken because they weather similarly to the Hell Creek deposits. Presence of gravel in the outcrop serves to verify the presence of alluvium rather than Hell Creek strata.

#### Terrace Deposits

Terrace deposits are present along the Moreau River, Rabbit Creek, and Flint Rock Creek. These terraces consist of sand and gravel-size fragments of conglomerate, iron-manganese concretions, claystone, quartz and chert. Many of the deposits are well sorted as individual deposits are composed of entirely fine or pebble-sized gravel. A gravel deposit of pebble-sized material occurs in SE½SW½SW¼ sec. 6, T. 14 N., R. 16 E.

The largest terrace deposits along the Moreau occur on the north side of the river valley, usually 125 to 130 feet above the present floodplain. Terrace deposits above or below this level have not been recognized in the quadrangle, although they are reported in other areas adjacent to the Moreau.

The size of the terraces vary from several acres to some which are about one source with

The size of the terraces vary from several acres to some which are about one square mile in area. The largest terrace occurs in secs. 2 and 3, T. 14 N., R. 16 E., and secs. 34 and 35, T. 15 N., R. 16 E.

#### Residual Boulders

Two types of residual material occur on the surface in the mapped area. Highly polished buff to tan and gray boulders are present in the quadrangle but they are not sufficiently concentrated to warrant mapping. These appear in greater quantities on the north side of the Moreau River. Huge boulders of conglomerate occur in secs. 17 and 22, T. 14 N., R. 16 E. The tan boulders are derived from silicified portions of the Tongue River Formation and the conglomerate originates from the White River Group. Rocks occur on the surface through a process of erosion in which the material beneath the rocks is eroded, but the rock is not. Over a period of time, the rocks are let down.

### Sand Dunes

Stabilized sand dunes occur on the floodplain of the Moreau River in secs. 1, 2, 3, 4, 9, 11, 12, T. 14 N., R. 16 E., and secs. 4 and 5, T. 14 N., R. 17 E. These eolian deposits are composed of well-sorted gray sand and silt. Sand is apparently derived from floodplain material and the Hell Creek Formation. The deposits have a northwest-southeast orientation and at the present time are stabilized by vegetation. Dunes are recognizable on aerial photographs by their hummocky appearance.

photographs by their hummocky appearance.

Age of the sand dunes is unknown because no one has attempted to establish the date of these specific deposits. Sand dunes cover much of the area north and west of the Faith quadrangle. In that area the sand dunes are assigned to the Recent age. Sand dunes also occur over much of western Nebraska where they are known as the Sand Hills Formation (Lugn, 1934) and are assigned to the Pleistocene and Recent. It is possible that the dunes within the Faith quadrangle are Pleistocene in age; however, they appear to be deposited on the Moreau River floodplain.

# STRUCTURAL GEOLOGY

Faith Quadrangle is situated near the axis of the Williston Basin and, therefore, the structural geology apparent in the area; the regional dip of the strata and the local structure.

Regional dip of the strata is difficult to ascertain for several reasons: (1) it is very low, (2) there are no continuous key horizons for plotting purposes, and (3) most of the outcrops in the region are grass covered. Examination of several minor tributaries to the outcrops in the region are grass covered. Examination of several minor tributaries of the Moreau reveal a stream pattern similar to that expected for strata dipping to the north. Most of the tributaries on the north side of the Moreau are short obsequent streams while their counterparts on the south side of the Moreau are long, consequent streams. If the top of the Niobrara Formation in oil tests in the area is used as a datum, a regional dip of 12 feet per mile to the northwest is revealed. Three oil tests used to determine the attitude of the strata

Faults and folds are present along the Moreau River and Rabbit Creek. Minor faults occur in the SW4 sec. 23, T. 15 N., R. 15 E., and the SE¼SE¼NW4 sec. 29, T. 15 N., R. 16 E. These faults have a small displacement of about 5 to 10 feet and are usually marked by beds of calcareous graywacke which show evidence of plastic flow. Faults in adjacent areas have been noted by Russell (1925), Moulten (1923) and Lange (1962). Folds in the mapped area are minor and local. Indications of a dome can be observed in a badlands area in sec. 23, T. 15 N., R. 15 E. The entire structure is contained in an area of very little over an acre. Several small folds occur along the Moreau River. In SE¼SE¼SW4, sec. 5, T. 14 N., R. 17 E., at a point where the Moreau River has cut through the floodplain deposits, the Colgate Member dips gently to the east and about one mile to the northwest the same strata appears to dip to the west. Contact between the Colgate and the Hell Creek appears to disappear below the south side of the stream channel between sec. 6, T. 14 N., R. 17 E., and sec. 9, T. 14 N., R. 16 E., over a distance of approximately five miles. Character of the Moreau River valley also changes between these two locations as the valley widens at this point and remains about two miles wide over the same distance. These two features suggest the presence of a shallow syncline. It is possible, however, that the Colgate Member thins in this presence of a shallow syncline. It is possible, however, that the Colgate Member thins in this

Joints are not very well preserved in the Hell Creek or Fox Hills. In a number of areas, however, sandstone dikes occur at the surface. The dikes generally occur as red calcareous sandstone ridges about one inch to two feet wide and one-half to a foot above the surface. Sufficient data are not available to explain the origin of these dikes in the Faith area, but it is possible that these dikes are joint fillings.

# SUBSURFACE GEOLOGY

Formations not exposed at the surface but known to be present in the subsurface from data obtained from the Evans No. 1 Querbes Trust-Capp oil test (NW¼NW¼ sec. 9, T. 13 N., R. 16 E.) are summarized in Table 1.

# Economic Geology

At the present time there is no large mineral or aggregate production from the Faith quadrangle. At times in the past local residents recovered lignite from outcrops of the Hell Creek and local ranchers and various governmental agencies have recovered gravel and sand from the terrace deposits. Because the region's economy is primarily based on beef cattle and sheep raising, ground water is an important commodity. Commercial quantities of oil and gas accumulations have not been discovered, although four oil tests have been drilled in the region and nearby the area.

# Ground Water

Ground water is available in all areas of the Faith quadrangle. Water collected for analysis Ground water is available in all areas of the Patth quadrangle, water collected for analysis came from wells drilled into the Fox Hills. Quality and quantity of water appears to be adequate for domestic and stock use. As the accompanying table shows, there is no particular depth into the Fox Hills one must drill to obtain water. Flowing wells do not occur in the quadrangle, but attempts to obtain flowing wells have been made along the lower reaches of the Moreau River.

Table 2 lists the results of chemical analyses of water samples collected in the Faith Quadrangle. These results are compared to standard values issued by the U. S. Public Health Service.

Gravel deposits occur on the terraces along the Moreau River, Rabbit Creek and Flint Rock Creek. The quality of the gravel varies from deposit to deposit as well as within individual deposits. Many of the deposits contain poorly-sorted gravels composed of chert, manganese-iron claystone and siliceous fragments of Tertiary conglomerates. These aspects of the deposits make them unsuitable for concrete and road metal.

A gravel pit which meets the requirements for road metal is located on a terrace in sec. 6, T. 14 N., R. 16 E. Gravels are located in the present stream channel and floodplains but have not been

An abundant amount of sand is located in the Faith Quadrangle. The sand occurs as massive cross-bedded fine- to medium-grained graywacke in the Hell Creek and Fox Hills Formations, in the sand dunes along the Moreau River, and the floodplains along the major streams. Quartzoes sand occurs in the lower Hell creek and is easily recognized by its bright white color. Much of the Fox Hills sand is friable and easily obtained from the ground. Hell Creek sand is more argillaceous and tends to be very hard during the dry seasons. Some friable sand units occur near the top of the Hell Creek.

# Other Potential Mineral Resources

Iron-manganese concretions and iron claystone occur in the Hell Creek; however, the volume in any one area does not warrant commercial exploitation of these rocks. Gypsum occurs sporadically in the Hell Creek, but never in abundance. Lignite has been used by local Although in other areas of northwestern South Dakota uranium has been located in lignite deposits, none has been reported in the lignites of the Faith Quadrangle. Capmic clay has not been located in the Faith Quadrangle, but it is possible that good ceramic clay has present locally in the Hell Creek. Although bentonite occurs in the Hell Creek, it is very located in the Hell Creek.

#### OIL AND GAS POSSIBILITIES

The Faith Quadrangle lies on the southwestern flanks of the Williston Basin. The nearest The Faith Quadrangle lies on the southwestern flanks of the williston basin. The flanks of lifed is the Buffalo Field, approximately 75 miles to the northwest of Faith. Several oil tests have been drilled in the Faith area; however, none encountered commercial accumulation of oil or gas. The only test in the quadrangle was drilled to basement rock to a depth of 7,318 feet from the surface. Table 1 shows the thickness and lithology of rocks encountered in the oil tests in the Faith Quadrangle.

That oil and gas exist in the subsurface of the Faith Quadrangle will have to be proven by further test drilling.

# Table 1.-Stratigraphic section of rocks penetrated in the Evans No. 1 Querbes Trust-Capp oil test located in NW¼NW¼ sec. 9, T. 13 N., R. 16 E.

System	stem Group Formation Depth		Depth	Thickness	Lithology				
		Hell Creek Formation	0-350?	350?	Somber colored beds of sandstones and shales				
Cretaceous		Fox Hills Formation	350?-750?	250± or 400±	Fossiliferous sandstone and clays				
		Pierre Shale	?-1870	1520±	Light to dark-gray bentonitic shale with minor amounts of siltstone.				
		Niobrara Chalk	1870-2230 360		Light to medium-gray, white speckled argillaceous chalk				
		Carlile Shale	2230-2645	415	Medium to dark-gray shale. Codell Sandstone Member occurs near the top of the formation.				
		Greenhorn Limestone	2645-2770	125	Fragmental limestone composed pre- dominantly of Inoceramus shells. Interbedded with gray calcareous shale.				
		Belle Fourche Shale	2770-3070	300	Dark-gray, slightly calcareous shale.  Medium-gray siliceous shale. Marked at top by consistant bentonite bed.				
		Mowry Shale	3070-3185	115					
		Dakota Formation	3185-3330	145	Light-gray fine to medium grained micaceous sandstone.				
		Skull Creek Shale	3330-3485	155	Medium- to dark-gray shale. Consistant zone of glauconite near middle of formation.				
	Inyan Kara Group	Fall River Sandstone Fuson Shale Lakota Sandstone	3485-3830	345	Fine to very coarse sandstone at the top and light-gray calcareous siltstone at base. Separated by 140 feet shaly interval.				
Triassic		Spearfish Formation	3830-4095	265	Reddish anhydrite and dolomitic silt- stone and clay. Anhydrite and dolomite increases baseward.				
Permian		Minnekahta	4095-4135	40	Limestone, pale to moderate red with some white, granular anhydrite.				
		Opeche Shale	4135-4195	60	Dark reddish-brown clay and siltstone.				
		Cassa Formation	4195-4230	35	Moderate red-orange sandstone and siltstone.				
		Broom Creek Formation	4230-4410	180	White to pale-red anhydrite and dolomit with minor amounts of sandstone.				
u		Wendover-Meek Formation	4410-4610	200	Light-colored sandstone, anhydrite and dolomite. Red marker shale at top.				
		Hayden Formation	4610-4680	70	Medium-gray dolomite and black radio- active shale.				
Pennsylvanian		Roundtop Formation	4680-4790	110	Varicolored (red, yellow, green) with thin dolomite beds increasing baseward.				
Pennsy		Reclamation Formation	4790-4890	100	Light- to dark-gray limestone interbedde with varicolored shale.				
		Fairbank Formation	4890-4965	75	Very fine to medium-grained calcareous sandstone.				
Mississippian		Charles Formation	4965-5150	185	Light-colored anhydrite and fine to very fine limestone				
	Madison Group	Mission Canyon Formation	5150-5290	140	Light-colored, fine oolitic and fossil- iferous limestone.				
	Mad	Lodgepole Formation	5290-5800	510	Light-gray and light-brown, fine to medium limestone in part oolitic and fossiliferous.				
		Englewood Formation	5800-5870	70	White, poorly sorted sandstone and reddish shale.				
Devonian		Duperow Formation	5870-6030	160	Pale-brown and light-gray limestone and dolomite.				
Silurian		Interlake ? Formation	6030-6190	160	White to light-gray limestone and gray shale.				
Ordovician	p p	Stony Mountain Formation	6190-6280	90	Light-gray limestone and medium-gray shale.				
	Big Horn Group	Red River Formation	6280-6790	510	Light- to medium-gray and light-brown limestone and dolomite in part vuggy.				
		Winnepeg Shale	6790-6865	75	Light-gray, fine grained, calcareous sandstone and greenish-gray shale that contains black phosphatic nodules.				
Cambrian		Deadwood Formation	6865-7300	435	White to pale-orange, fine-grained sandstone in part very glauconitic and dolomitic.				
		Precambrian	7300		Igneous and metamorphic rocks.				

# Table 2.--Chemical analyses of selected water samples

	Location	Depth feet	Chemical Constituents in Parts Per Million							
Owner			Total Hardness	Cl	SO <sub>4</sub>	Ca	Fe	Mg	рН	Total Solids
W. Mason	NW¼ sec. 32, T. 15 N., R. 17 E.	?	40	88	830	Trace	Trace	Trace	7.8	2450
G. Jones	SE¼ sec. 23, T. 15 N., R. 15 E.	80	40	98	252	Trace	4.0	Trace	7.8	1395
R. Mason	SW¼ sec. 11, T. 14 N., R. 17 E.	156	38	73	648	Trace	Trace	Trace	7.8	2250
H. Escott No. 1	NE¼ sec. 19, T. 14 N., R. 17 E.	177	Trace	59	180	Trace	Trace	Trace	7.8	1330
H. Escott No. 2	NE¼ sec. 19, T. 14 N., R. 17 E.	150	32	Trace	288	Trace	0.48	Trace	8.0	1400
J. Escott	SW¼ sec. 21, T. 15 N., R. 16 E.	158	Trace	Trace	216	Trace	0.16	Trace	8.0	802
G. Escott	NW¼ sec. 18, T. 14 N., R. 17 E.	138	36	50	372	Trace	Trace	Trace	8.0	1415
D. Jones	NW¼ sec. 25, T. 15 N., R. 15 E.	320	Trace	278	85	Trace	Trace	Ттасе	7.9	1435
D. Lutz	SE¼ sec. 4, T. 13 N., R. 17 E.	100	Trace	59	228	Trace	Trace	Trace	8.1	1290
V. Squires	NE¼ sec. 12, T. 14 N., R. 15 E.	180	23	400	396	Trace	0.16	Trace	7.6	2160

# REFERENCES CITED

Agnew, A. F., 1963, Geology of the Mission quadrangle: S. Dak. Geol. Survey, Geol. quad. map and text.

Agnew, A. F., and Tychen, P. C., 1965, A guide to the stratigraphy of South Dakota: S.

Dak. Geol. Survey Bull. 14, 195 p.

Brown, Barnum, 1907, The Hell Creek beds of the Upper Cretaceous of Montana: Amer.

Mus. Nat. Hist. Bull., v. 23, p. 823-845.

Creek, E. J. 1962, Cappeng of selected bighway strips in South Dakota: S. Dak. Geol. Survey.

Cox, E. J., 1962, Geology of selected highway strips in South Dakota: S. Dak. Geol. Survey Rept. Inv. 93, 180 p.
Dobbin, C. E., and Reeside, J. B., 1929, The contact of the Fox Hills and Lance Formations: U. S. Geol. Survey Prof. Paper 158-B, p. 9-25.
Lange, A. U., 1962, Geology of the Signal Buttes quadrangle: S. Dak. Geol. Survey, Geol.

Quad, map and test.

Lugn, A. L., 1934, Outline of Pleistocene geology of Nebraska, In The geology and Mammalian fauna of the Pleistocene of Nebraska, In Nebraska State Museum, Preliminary report on the Nebraska State Museum, Bull. 1, v. 1, p. 319-351.

Meek, F. B., and Hayden, F. V., 1861, Descriptions of New Lower Silurian (Primordial), Jurrassic, Cretaceous, and Tertiary fossils, collected in Nebraska territory, with some remarks on the rocks from which they were collected: Acad. Nat. Sci., Philadelphia Proc. p. 415-447 (1862).

p. 415-447 (1862).
Meek, F. B., and Hayden, F. V., 1862, Descriptions of new Cretaceous fossils from Nebraska Terr.: Phila. Acad. Nat. Science Proc., v. 13, p. 419-427.
Mickel, C. J., 1962, Gastropoda of the Fox Hills Formation in its type area: Unpub. M. A. thesis, University of South Dakota, 85 p.
Moulten, G. F., 1923, Oil and gas prospects in southern Perkins County, South Dakota. Geol. and Nat. Hist. Survey, Circ. 14, 12 p.
Russell, W. L., 1925, The possibilities of oil in western Ziebach County. S. Dak. Geol. and Nat. Hist. Survey, Circ. 20, 25 p.
Searight, W. V., 1934a, The geology of central Perkins County: S. Dak. Geol. Survey, Rept. Inv. 21, 52 p.

Inv. 21, 52 p.

1934b, The Stoneville coal area: S. Dak. Geol. Survey, Rept. Inv. 22, 24 p.

Thom, W. T., and Dobbin, C. E., 1924, Stratigraphy of Cretaceous-Eocene transition beds in eastern Montana and the Dakota: Geol. Soc. Amer. Bull., v. 35, p. 381-506.

U. S. Dept. of Interior, Geological Survey, 1963, Surface water records for North Dakota and South Dakota: Washington, D. C., p. 255.

Waage, K. M., 1961, The Fox Hills Formation in its type area, central South Dakota: Wyo. Geol. Assoc. Guidebook, Symposium on Late Cretaceous Rocks of Wyoming, p. 229-240.

1969, The type Fox Hills Formation Cretaceous (Maestrichtian) South Dakota, Part 1 Stratigraphy and Paleoenvironment: Peabody Mus. Nat. History Bull. 27, Yale University, New Haven, Conn.
Wilson, R. A., 1925, Oil and gas possibilities in northeastern Meade County: S. Dak. Geol.

and Nat. Hist. Survey, Circ. 23, 14 p.

\*Geologic mapping in the Faith Quadrangle was completed before Waage, K. M., 1969, was published. Therefore, Waage's terminology used in subsequent quadrangles is not used in