THE GEOLOGICAL SURVEY OF WYOMING

DANIEL N. MILLER, JR., State Geologist

PRELIMINARY REPORT NO. 15

Structural Geology of the Arlington-Wagonhound Creek Area, Carbon County, Wyoming A Revision of Previous Mapping

BY

D. L. BLACKSTONE, JR.

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D. L. BLACKSTONE, JR.

BOX 3008, UNIVERSITY STATION
LARAMIE, WYOMING 82071
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ABOUT THE COVER: THIS PHOTO LOOKS NORTHEAST ACROSS THE ROCK CREEK VALLEY AT ARLINGTON, WYO.

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CARBON COUNTY, WYOMING

A REVISION OF PREVIOUS MAPPING

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STRUCTURAL GEOLOGY OF THE ARLINGTON-WAGONHOUND CREEK AREA

CARBON COUNTY, WYOMING

A REVISION OF PREVIOUS MAPPING

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D. L. BLACKSTONE, JR.*

INTRODUCTION

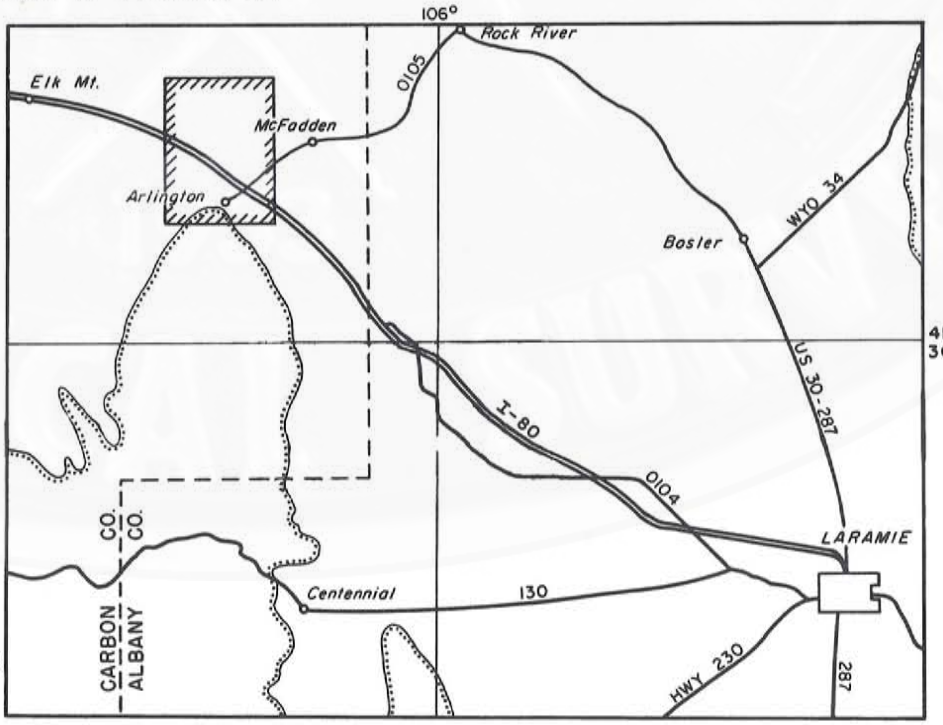
The writer investigated the structural geology of the Laramie Basin for several years. In the course of geologic mapping of the Arlington fault, it became apparent that existing mapping is inadequate and in need of revision. Construction of U.S. Highway Interstate 80 created new exposures in areas of critical relationships which were not previously available.

In the vicinity of the Wagonhound Creek exit from I-80, T L Ranch quadrangle, Hyden and McAndrew (1967) incorrectly identified the Steele Shale as Frontier Formation, thereby complicating the interpretation of the geologic structure. The presence of oil saturated sandstone in the Hanna Formation, in the same locality, has not been previously reported. This sandstone poses an intriguing problem in regard to the source of the hydrocarbons.

The Upper Cretaceous stratigraphic nomenclature includes revisions suggested by Gill and others, 1970 and Blackstone, 1973.

LOCATION

The map presented in this report (Plate I) covers approximately the area of a 7½ minute quadrangle centered at lat. 106°15'W and long. 41°37'30"S which is the common corner of four U. S. Geological Survey 7½ minute topographic quadrangles -- McFadden (northeast), T L Ranch (northwest), White Rock Canyon (southwest) and Arlington (southeast). New mapping is concentrated along the Arlington fault and the Wagonhound anticline. The area includes parts of Ts 19 and 20N, and Rs 78 and 79W, all lying in Carbon County, Wyoming. Figure 1 is an index map and provides necessary geographic reference points.



Post Cambrian rocks

Area of Precambrian rocks

Area of Report

FIG. 1 INDEX MAP - Preliminary Report No. 15

*Professor of Geology
University of Wyoming

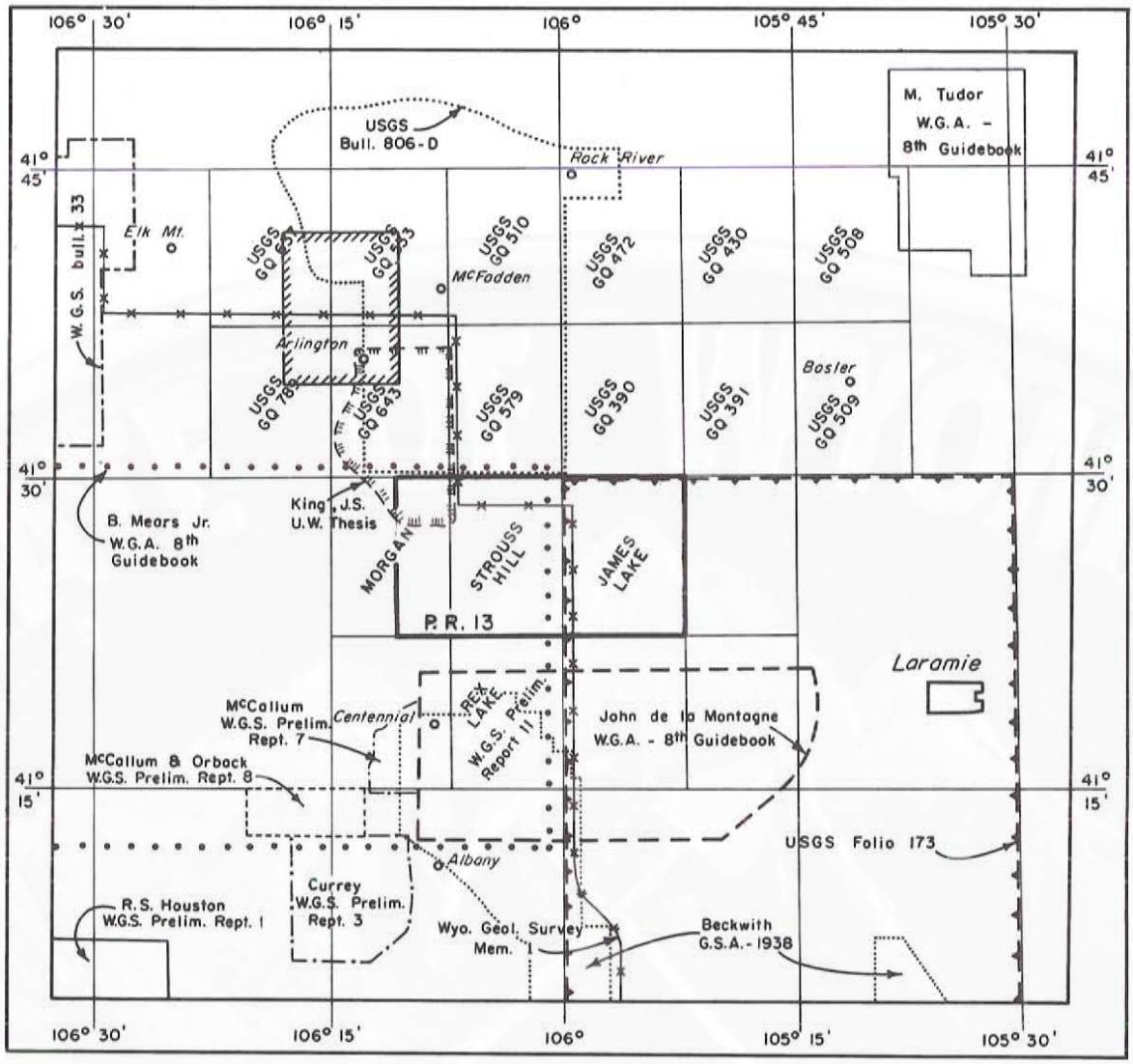


FIG. 2

Index to Geologic Mapping

Wyo. Geol. Survey Prelim. Rept. No. 15

PREVIOUS GEOLOGIC INVESTIGATIONS

Geologic maps in and adjacent to the area of study are presented, at various scales, in investigations by Darton and Siebenthal (1909), Dobbin and others (1929a, 1929b), Neely (1934), Bauer (1952), Love (1955), King (1964), Hyden (1966), Hyden and McAndrew (1967), Hyden and others (1967), Hyden and others (1968), Houston and others (1968) and Blackstone (1973).

The most recent published geologic maps are the quadrangle geologic maps of the U.S. Geologic Survey GQ series. This report presents revision of previous mapping.

STRATIGRAPHY

The major aspects of the area's stratigraphy are presented here in tabular form (Table 1). This report deals with structural geology, therefore no lengthy discussion of stratigraphy is presented. The stratigraphic units critical to the structural interpretation are the Steele Shale, Rock River Formation, Lewis Shale, Medicine Bow Formation and the Wind River Formation. The thickness of some units has been obtained from the mechanical logs of test holes drilled in oil and gas exploration. Details concerning most of the units can be obtained from papers dealing specifically with stratigraphy. Of particular use is the report on the Cretaceous and Early Tertiary by Gill and others (1970).

Table 1. Stratigraphic units in the Wagonhound Creek Area, Carbon County, Wyoming.

Age			General Lithology	Thickness
CENOZOIC	Quaternary	Recent	Alluvium, colluvium, landslide debris.	
		Pleistocene	Pediment gravels, landslide debris.	0-100'
	Tertiary	Eocene	Wind River Formation - Variegated claystone, sandstones.	400'+
		Paleocene	Hanna Formation - Basal conglomerate with quartzite boulders, arkosic sandstones, brown claystones, carbonaceous shales.	1000'±
			Major Unconformity	
MESOZOIC	Cretaceous		Medicine Bow Formation - Sandstones, shales, carbonaceous shale, coals, ironstones. Pelecypod fauna. Only basal part present.	400'+
			Fox Hills Sandstone - Sandstone, gray, fine grained. Mapped with Lewis shale.	
			Lewis Shale - Shale, gray, marine, containing fine grained light gray to white sandstone, local concretion zones.	2200-2600'
			Rock River Formation - Pine Ridge sandstone member at top (coal bearing). Sandstones brown, siltstones, and gray shales. Thick, yellow weathering sandstones near base.	1700-1900'
			Steele Shale - Shale, gray, marine, several sandstones have been locally called "Shannon" sandstone.	2200-2500'
			Niobrara Formation - Calcareous shale with three well defined marlstones.	800-900'
			Frontier Formation - Wall Creek Sandstone Member at top, "salt and pepper," sandstone, chert pebbles and shark teeth (at base). Shale gray, changing to black at base. Septarian concretions in basal shale.	20'

MESOZOIC	Cretaceous	Mowry Shale - Shale, siliceous, weathers silver gray. Fish scales common. Numerous bentonite layers.	200'+
		Muddy Sandstone - Sandstone, clean, medium grained.	20'
	Jurassic	Thermopolis Shale - Shale, black, marine containing thin lenticular olive green sandstone layers.	110'
		Cloverly Formation - Tripartite unit. Limonitic yellow sand at top, pink siltstone in middle, and sandstone cross-bedded white, locally conglomeratic, at base.	150'
		Morrison Formation - Claystone, variegated, purple, green, maroon. Green chert and calcareous nodules.	300'
		Sundance Formation - Sandstone, yellow at top, green shale in lower part.	25-50'
	Permo-Triassic	Jelm Formation - Sandstones characterized by orange, pink, and lavender coloration. Lenses of clay pellet and limestone pellet conglomerate.	165'
		Chugwater Formation - Siltstones and sandstones, red, thinly bedded.	550'
PALEOZOIC	Permian	Forelle Limestone - Limestone, thinly laminated often "crinkled" or with algal bed structure. Lavender in color.	20'
		Satanka Shale - Shale or siltstone, red with local limestone layers.	120-160'
	Pennsylvanian-Permian	Casper Formation - Three units, upper yellowish sandstone, cross-bedded; middle hard red siltstone; lower sandstone, cross-bedded, white.	250'
	Precambrian	Granite, granite gneiss, and variable metamorphic rock types. See Wyoming Geological Survey Memoir No. 1 for complete discussion.	

STRUCTURAL GEOLOGY

General

The area under consideration lies at the northeast corner of the northern Medicine Bow Mountains and includes the termination of the Arlington fault and related structures. The major structural aspect is a northwest plunging, major fold with rocks of Precambrian age exposed in the core of the fold. The basic structural pattern is presented by Houston and others (1968).

Folds

Rock Creek Anticline

The Rock Creek anticline and an oil field of the same name lie just east of the mapped area. The crest of the structure is located in sec. 35, T20N, R78W. The Lewis Shale, Medicine Bow Formation and the Hanna Formation crop out in the northeast corner of the map area, on the west flank of the Rock Creek anticline. These strata strike N30°W and dip 25° west.

The strata that dip west and form the western limb of the Rock Creek anticline are inferred to reappear along the mountain front, adjacent to the trace of the Arlington fault (Cross-section C-C').

Arlington Syncline

The exposures along the mountain front are very poor, except for the conglomerate beds in the Hanna Formation. The Hanna For-

mation definitely dips east, away from the mountain front, with the result that it occupies a syncline between the Rock Creek anticline and the mountain front. The name Arlington syncline was applied to this feature by Blackstone (1973).

Wagonhound Creek Anticline

Bauer (1952) named the prominent, northwest trending, asymmetrical anticline, extending from sec. 27, T19N, R79W to the Medicine Bow River in sec. 11, T20N, R80W, the Wagonhound Creek anticline. Subsequently in 1957, oil was discovered in the Pan American-UPRR Anschutz Ranch No. 1 test hole (sec. 23, T20N, R80W), drilled on a local closure on the axis of the major fold. The producing area was named the Elk Mountain field for the community of Elk Mountain, about four miles southwest.

The southern part of the Wagonhound Creek anticline is related to the West Foote Creek fault. The fold is asymmetrical with the steeper dips on the northeast flank. Dips on the steep limb of the fold range from 20° northeast to 70° southwest overturned. The plunge of the fold axis is northwest and varies from 5° to 15°.

The surface axis of the fold has three distinct trends, when viewed in its entirety. The southern part of the fold core, in the area of exposed Precambrian age rocks, trends N50°W for a distance of about six miles to approximately the SW¼ sec. 1, T19N, R80W. There the trend changes to N30°W and continues for three miles to the NE¼ sec. 27, T20N, R80W. At this point the axis changes, trending sharply to N20°E and continues for about two and one-half miles to the Medicine Bow River.

The anticline is bounded by a fault along part of the northeast flank. This bounding fault is separate from the fault in the axial region, at the south end of the fold.

Unnamed Syncline

A well defined, north plunging syncline extends through secs. 15, 16, 21 and 22, T19N, R79W. The fold is asymmetric with a steep west limb. The youngest formation exposed in the trough of the syncline is the Niobrara. The folded strata in the syncline pass unconformably beneath the Hanna Formation, near the west end of Sheepherder Hill.

Folds in the West Flank of the Wagonhound Creek Anticline

Folds of low structural relief in the Chugwater Formation are found between the east and west forks of Wagonhound Creek. The folds plunge generally west, away from the axial region of the major fold. They are essentially symmetrical in cross-section.

Folds in the Hanna Formation

A series of anticlines and synclines, trending approximately N60°W, extend across the area from Arlington to Wagonhound Creek, north of I-80. The folds are open, with dips ranging from 5° to 25°, and are limited to the Hanna Formation. In the map area, the Hanna Formation overlies the older rocks with angular unconformity.

The angularity of the contact (up to 90°) indicates that the folds in the Hanna are not the reflection of deeper folds in the older rocks. The low relief folds above the unconformity may have been produced by interstratal movements between the near-vertical resistant units. The folded Hanna strata lie near the Arlington and Wagonhound faults (see section following) where maximum deformation on the footwall would be expected.

Faults

Arlington Fault

The Arlington fault was named by Darton and Siebenthal (1909) who considered it as a single fracture, bounding the east side of the northern Medicine Bow Mountains and extending from the Big Laramie River, in the vicinity of Woods Landing, to Arlington.

The mapping of Beckwith (1938), Houston and others (1968) and Blackstone (1973) has added details and shown that the fault system is more complex than originally visualized.

South of Arlington, in sec. 30, T18N, R78W, the fault trace trends about N55°W and, from the topographic relations, appears to be a high angle reverse fault. Rocks of Precambrian age in the hanging wall are in fault contact with the Casper and Chugwater formations, which are, in turn, in fault contact with Upper Cretaceous rocks.

The Arlington fault bifurcates in sec. 24, T19N, R79W and continues in a northerly direction, roughly parallel to I-80. Along this section of the fault trace the sedimentary section strikes approximately N70°E and dips 35° northwest down the north plunge of the Medicine Bow Mountains. The fault trace is approximately normal to the strike of the sedimentary strata and units from the Casper Formation to the Frontier Formation are truncated by the fault.

The footwall relationships in this area are not clear. Exposures are poor and the Hanna Formation unconformably overlies and conceals the Upper Cretaceous rocks. Local areas of Wind River Formation further conceal the older rocks in critical areas.

The writer believes that the strata in the footwall of the northern part of the Arlington fault are Cretaceous Rock Creek Formation or younger. The reason for this

conclusion is that, about four miles east of and parallel to the Arlington fault trace, a major fold -- the Rock Creek anticline -- is present. Cretaceous Steele Shale is exposed along the crest of the fold, with Rock Creek Formation, Lewis Shale and Medicine Bow Formation exposed in the west limb, dipping 15° to 30° west. These rocks are unconformably overlain by the Hanna Formation that occupies a syncline between the mountain flank and the Rock Creek anticline (see Fig. 3). The writer believes that the Upper Cretaceous rocks are also folded into this syncline, along the axis of the Arlington syncline. A similar situation exists between the Seven Mile anticline and the Arlington fault trace in T17N, R77 and 78W (Blackstone, 1973).

Near Arlington, the basal conglomerate of the Hanna Formation crops out in a prominent hogback and dips 30° to 40° east, suggesting similar or greater dips in the underlying rocks. About 2000 feet northwest of the I-80 Arlington interchange, shales and sandstones of unknown age crop out in a west facing highway cut. These strata strike N45°W and dip 45° or greater. The writer believes that these strata are part of the Lewis Shale on the west limb of the Arlington syncline. On the geologic map (Plate 1), they are designated Ku (Cretaceous undivided).

Neely (1934) mapped a small area of red sediments in the NW¼, sec. 24, T19N, R79W, along the old county road from Arlington to Wagonhound Creek, as Wind River Formation. The outcrops were re-examined and are believed to be red siltstones of the Chugwater Formation, along with another small outcrop of red siltstones and thin white sandstones (½" to 2" thick) which crop out in a tributary of Foote Creek, about 1000 feet northwest.

The Chugwater Formation, in these exposures, is in fault contact with gray shales of an unidentified Cretaceous unit. The red siltstones are in a fault slice similar to that occurring south of the town of Arlington (Houston and others, 1968).

The Arlington fault trace and the subthrust slice trace continue north from the Arlington interchange, with a N20°W trend, until they are covered by the steeply dipping Hanna Formation in secs. 13 and 14, T19N, R79W.

Wagonhound Creek Fault

The Wagonhound Creek anticline is bounded on the northeast flank by a major, south-dipping, reverse fault. The fault trace trends N60°W in the area mapped and is well exposed in sec. 8, T19N, R79W. The fault trace relation is shown on cross-section A-A'. The fault trace is concealed, in part, by the overlapping Hanna Formation.

Strata in the hanging wall, south of the fault trace, are in a normal stratigraphic sequence, strike N60° to 70°W and dip 25° to 45° north with the steeper dips nearest the fault trace. The youngest strata exposed in the hanging wall, adjacent to the fault trace, are parts of the Frontier and Niobrara formations.

The strata in the footwall are Steele Shale. They are overturned so that the recumbent dips are 40° to 60° south. Cross-laminated sandstones identify the top of the beds. The assigned age of the strata is based on a fossil collection made at the point labeled on the geologic map (sec. 8, T19N, R79W).*

The Baculite zones referred to by Cobban occur in the O'Brien Springs Member of the Haystack Formation, along the west side of the Hanna Basin. The equivalent position in the Steele Shale of the Laramie Basin is in the lower third of the formation.

The stratigraphic separation on the Wagonhound Creek fault (Cross--section A-A') is approximately 2400 feet. The overturned lower part of the Steele Shale in the footwall is in fault contact with the upper part of the Frontier Formation. The Frontier Formation is in normal stratigraphic order.

The structural relationships (Cross-section A-A') may reflect two episodes of movement. Evidence is the overturned strata observed in the Hanna Formation, immediately north of the fault trace. The problem will be discussed under the section on Chronology of Events (p. 11).

It appears that the Wagonhound Creek fault must intersect the Arlington fault in sec. 11 or 14, T19N, R79W, beneath the Hanna

*NOTE

The age of these strata as given by Hyden and McAndrew (1967) is in error. The following discussion is intended to clarify the matter.

Hyden and McAndrew (1967) mapped these strata as Frontier Formation in normal stratigraphic order and reported fossils from essentially the same spot as that reported by the writer. The fossil locality was reported as D4348 -- U.S. Geological Survey Mesozoic fossil locality (Denver catalogue). W. A. Cobban of the U.S. Geological Survey reported on the fossil collection made by the author as follows:

"The pelecypod Veniella sp. from locality D4348 has no close stratigraphic significance. Your collection, however, is important. The Inoceramid is Inoceramus subcompressus Meek and Hayden, and the Baculite species is either the early form of Baculites obtusus Meek or the slightly older unnamed species referred to as "Baculites sp. (weak flank ribs)". For the stratigraphic position of these species, see Table 1 of Professional Paper 667 (Stratigraphy and nomenclature of some Upper Cretaceous and Lower Tertiary rocks in south-central Wyoming). The collection is from the Steele Shale."

Formation.

Foote Creek Fault

A poorly defined, normal fault extends from about the center of the west line of sec. 24, T19N, R79W, N50°W for about two and one-half miles. The fault trace can be defined on vertical aerial photographs and by aligned springs. The displacement on the fault must be small, probably less than 50 feet.

West Foote Creek Fault

The name West Foote Creek fault is applied to the normal fault that appears to originate in the area of Precambrian rocks near the northwest corner of sec. 26, T19N, R79W. The fault trends N40°W, is nearly vertical in dip and is downthrown to the northeast. The fault cannot be traced to the northwest beyond the Wick Brothers Ranch (Wyoming Game and Fish Range Station).

The fault roughly follows the crest of the Wagonhound Creek anticline, but does not control the location of the fold itself. Maximum displacement on the fault is approximately 500 feet.

Detached Allochthonous Masses

The eastern edge of a thin detached mass of Precambrian rock is exposed, about one-half mile southwest of the Arlington townsite, in sec. 30, T19N, R78W. This mass of allochthonous Precambrian rock was first noted by King (1964). It was further exposed in excavations made during the construction of I-80. The mass lies approximately a thousand feet east of the trace of the Arlington fault and appears to have been emplaced by gravity movement downslope.

Another small allochthonous mass of Precambrian rock (largely hornblende schist) is exposed north of the Arlington interchange in a large road cut. The mass is completely brecciated and crops out as rubble slope. It appears to have been detached from the hanging wall of the Arlington fault and to have been emplaced downslope by gravity movement.

CHRONOLOGY OF STRUCTURAL EVENTS

The Arlington-Wagonhound Creek area at the northern end of the Medicine Bow Mountains is an excellent place to document the structural history of the area. The post-Precambrian tectonic events, from older to younger, are presented in the following section.

Paleozoic

The age of the Precambrian rocks in the northern end of the Medicine Bow Mountains ranges from 2.4 to 1.5 million years (my) (Houston and others, 1968).

The oldest sedimentary rocks that overlie the Precambrian basement are assigned to the Mississippian (Hyden and others, 1967; Hyden and others, 1968), were not given a formal stratigraphic designation and were mapped with the lower part of the Pennsylvanian Casper Formation. The time interval represented by the nonconformity between the Precambrian and the Mississippian age rocks is about 250 my.

The tectonic events represented by this unconformity are not well documented. Chronic and others (1964) reported that kimberlitic diatremes, near the Wyoming-Colorado border in the Precambrian core of the northern front range and the southern Laramie Range, contain blocks of fossiliferous limestone of Late Ordovician and Early, Middle, and Late Silurian age. Chronic (1972) presents a geologic history for the emplacement of the diatremes. A period of extensive uplift and erosion took place by Late Devonian time and the formerly widespread deposits of Ordovician and Silurian age were removed by erosion. The region then subsided in Early Mississippian time allowing deposition of carbonates.

The ancestral Rocky Mountains of Colorado came into existence during Late Mississippian time and, a short distance south in the central and southern Medicine Bow Mountains, Pennsylvanian age rocks rest upon the Precambrian basement.

Mesozoic

Tectonic activity during the Mesozoic era in this area was limited to slow subsidence, with minor disconformities between some units reflecting short periods of emergence. Such activity continued through Late Cretaceous time (Lancian provincial age). The youngest Mesozoic strata deposited in nearby basins are those now assigned to the Medicine Bow and Ferris Formations (Gill and others, 1970).

The Medicine Bow Formation varies from 400 feet to 4,000 feet in thickness and contains distinctive yellow siltstones, mudstones and some coals. The marked variation in thickness results from erosional trunca-

tion of the top of the formation.

The Ferris Formation is limited to the Hanna and Carbon basins. It contains conglomerates from a remote source and is coal bearing. The thickness is approximately 4,000 feet, at a maximum.

Cenozoic

The withdrawal of marine waters from the region, in Early Maestrichian time (Blackstone, 1974), marked the end of a long interval of relative crustal stability. Immediately thereafter, the region was the site of major differential movement of the crust that defined most of the present uplifts and intermontane basins.

North of the Medicine Bow Mountains, an elongate basin was defined in Late Cretaceous time. It continued to deepen during Paleocene time and, in the axial region, received 6,888 feet of sediment, now known as the Hanna Formation. The formation is a classic example of an intermontane basin deposit in the Rocky Mountain region. In the central and deeper part of the structural basin, the formation conformably overlies strata of Late Cretaceous age, but, on the basin margins, the formation overlaps onto the older rocks with marked angular unconformity.

The area under consideration is on the south margin of the Hanna Basin. The geologic map (Plate 1) depicts the overlapping relationship of the Hanna Formation upon rocks as old as the Triassic Chugwater Formation. An excellent locality to view the unconformity between the Hanna Formation and the Late Cretaceous rocks is in sec. 36, T20N, R80W, near Barrel Springs, T L Ranch Quadrangle, as mapped by Hyden and McAndrew (1967). The Mesaverde Formation, including the Pine Ridge Sandstone Member, is well exposed, strikes N40°W, and is slightly overturned with a dip of 80° southwest. The overlying Hanna Formation strikes N10°W and dips 5° to 8° northeast, creating an angular unconformity of about 90°.

At the old Wick Ranch in sec. 8, T19N, R79W, just east of Wagonhound Creek, the situation is more complex. A special map of the geology at a scale of 1:12,000 has been prepared (Fig. 3).

The phases of tectonic movement are well documented here and will be discussed in order from older to younger time periods.

First Phase

The initial upward movement of the Precambrian basement in the northern Medicine Bow Mountains (Blackstone, 1974) tilted the entire stratigraphic section east, northeast and northwest, away from the mountain core. During uplift, beveling of the Cretaceous rocks was initiated on the mountain flank.

At the Wick Ranch, this beveling is documented by a thin, iron-cemented, quartz-quartzite pebble conglomerate of the Hanna Formation that lies on the Steele Shale. The attitudes of the Steele Shale and the conglomerate are essentially parallel, indicating a very low angle of beveling across the Steele. The conglomerate is, in turn, overlain by yellow sandstones and claystones with thin conglomerate lenses.

Second Phase

The Steele Shale and the overlying Hanna Formation were then deformed causing the Wagonhound Creek anticline and the associated fault of the northeast flank of the fold. The Steele Shale and the Hanna Formation were overturned in the footwall of the Wagonhound Creek fault so that the overturned units now dip 40° to 75° southwest. Slip on the fault was about 3,000 feet (see Plate 1 and Cross-section B-B').

Third Phase

During the initial stage of general uplift in the northern Medicine Bow Mountains and the contemporaneous depression of the adjacent intermontane areas, sediment continued to accumulate in the surface depressions, coincident with the structural downwarp. Coarse clastic debris, derived from the core of the Medicine Bow Mountains, filled the depressions and local fans built back to the source areas, overlapping the previously deformed beds around the flanks of the basin. At the Wagonhound Creek area, deposition of the Hanna Formation must have continued during and after the initial folding and faulting.

Deposition continued after the cessation of fault movement as shown by the overlapping of the trace of the Wagonhound Creek fault by younger units of the Hanna (Fig. 3).*

Fourth Phase

Deformation continued, probably contemporaneously with the continued subsidence of the Hanna Basin. This is evidenced by the folding of the Hanna Formation in the area north of the Sheepherder Hill ridge. (Also north of I-80, Fig. 3). In these elongated, northwest trending, fairly well defined folds, the dips in the Hanna Formation are as much as 40 degrees.

*NOTE

Blackstone (1973) reported that the age of the Hanna Formation, at the Cooper Cove anticline a few miles south of Arlington, is youngest Paleocene and, there, overlies the Lewis Formation unconformably with a very low angle of discordance.

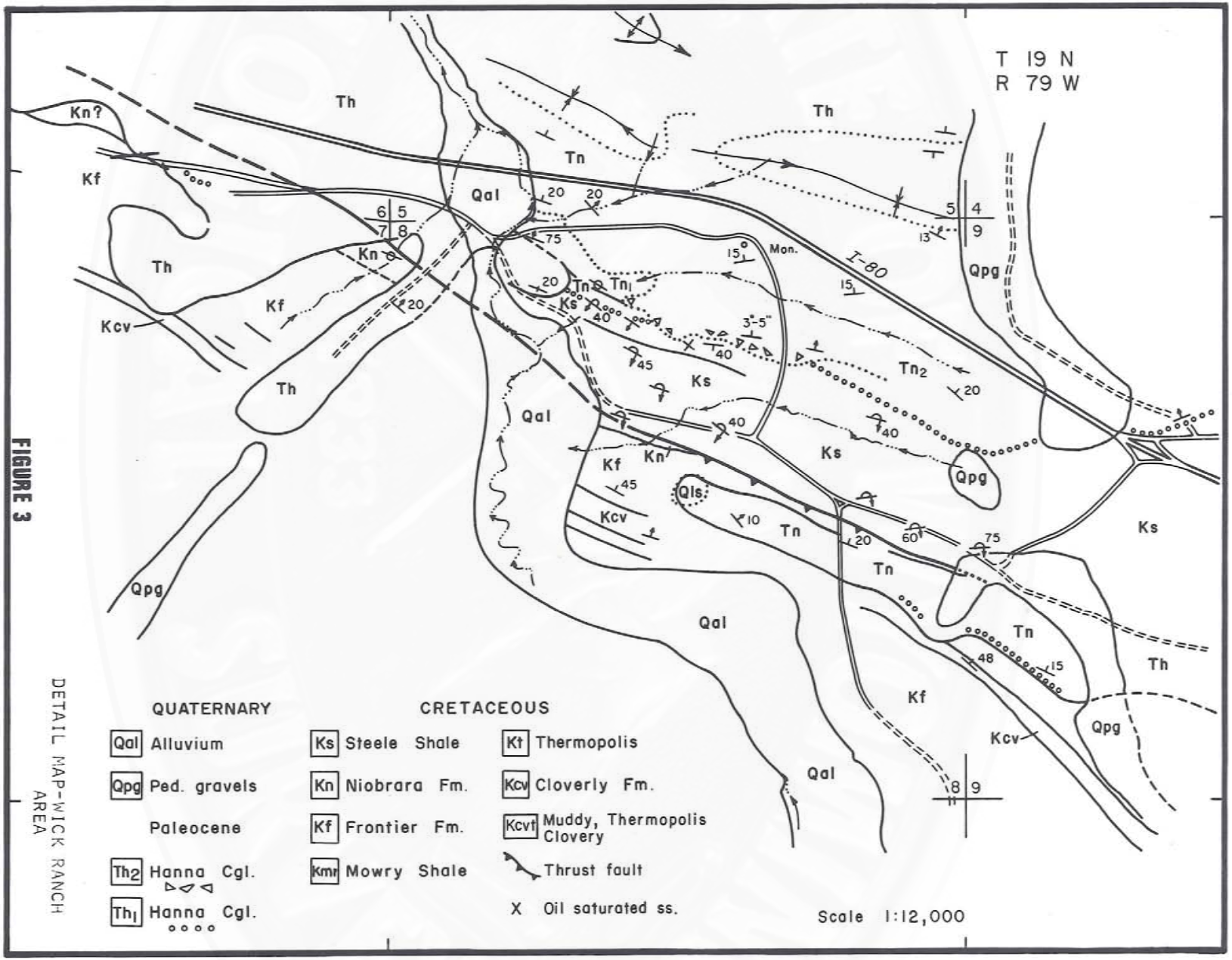


FIGURE 3

DETAIL MAP-WICK RANCH AREA

Fifth Phase

The Wind River Formation crops out extensively in the central part of the Cooper Creek basin, a few miles southeast of Arlington, and unconformably overlaps the Hanna Formation. Within the mapped area, the Wind River Formation is poorly exposed but does underlie part of the Arlington pediment. The same relationship can be observed at a few nearby localities.

The Wind River Formation, in the Cooper Creek basin, has been dated as lower Eocene (Graybullian provincial age) by Princhinello (1971). The Wind River Formation is gently folded and locally offset by normal faults, indicating that deformation continued after lower Eocene time.

No strata younger than the Wind River Formation are known in the area under consideration so no conclusions can be drawn about the continuation of deformation. In the Medicine Bow Mountains, Oligocece and possibly younger rocks are known.

Blackstone (1974) has reviewed the Cenozoic history of the area and the reader is referred to that publication for further details.

The Arlington pediment surface has not been definitely dated, but is believed to be early Pleistocene in age. The surface is not deformed.

OIL & GAS POSSIBILITIES

The Laramie basin contains a number of oil fields which produce from several pay zones, ranging in age from Pennsylvanian to Upper Cretaceous. The field with the greatest cumulative production is the Rock River or Rock Creek field. The nearest production to the area under consideration is the Elk Mountain field in secs. 14 and 23, T20N, R80W. The field produces from the Jurassic Sundance Formation, has only one producing well and, through 1974, has produced 677,195 barrels of oil. The Elk Mountain field is a local closure upon the major Wagonhound Creek anticline. Steele Shale crops out at the surface.

Oil saturated sands in the Hanna Formation are reported to drop out in the T L Ranch and McFadden quadrangles (Hyden and McAndrew, 1967; Hyden, 1966). A search of the limited outcrops in sec. 10, T19N, R79W by the writer failed to locate the outcrops which Hyden (1966) described as follows:

> "Small quantities of liquid hydrocarbons were distilled from a sample of oil-soaked sandstone of the Dutton Creek Formation that crops out near the center of sec. 10, T19N, R79W. The extracted oil is brownish black, is napthenic with API gravity of 19.7° and is presumed to have migrated into the Dutton Creek Formation from adjacent beds in the Frontier Formation."

From the general description of the occurrence, the writer is convinced that the outcrops referred to are near the center of sec. 8, T19N, R79W, where oil saturated sandstone of the Hanna Formation crops out. The formation name, Dutton Creek, has been abandoned (Gill and others, 1970; Blackstone, 1973) and these rocks are now considered to be a part of the Paleocene Hanna Formation.

Hyden and McAndrew (1967) also reported that outcrops of the Cloverly Formation and the Muddy Sandstone Member of the Thermopolis Shale are oil stained in the southern part of the T L Ranch quadrangle.

The writer found blocks of oil stained sandstone from the Hanna Formation lying in the borrow pits south of I-80. These had been derived from excavations for I-80 across secs. 5 and 8, T19N, R79W.

It is readily apparent from the known producing areas that both source beds for hydrocarbons and reservoir rocks exist in the region. The oil saturated sandstone in the Hanna Formation undoubtedly is derived from previous accumulation in either the Sundance, Cloverly or Muddy Sandstone member of the Thermopolis Shale. Migration into the Hanna may have occurred either by direct contact across the unconformity or by migration along fractures related to the Wagonhound Creek fault.

The possibility of hydrocarbon accumulation in the footwall of the Wagonhound Creek fault is an interesting possibility.

COAL POSSIBILITIES

Coal occurs within the mapped area and immediately west in three formations. Hyden and McAndrew (1967) reported coal in the Pine Ridge Sandstone Member of the Mesaverde Formation, the Medicine Bow Formation and the Hanna Formation.

PINE RIDGE SANDSTONE MEMBER

A coal seam six feet thick crops out in the SW¼ sec. 25, T20N, R80W. A few hundred feet northwest of the outcrop the thickness decreases to only 1.2 feet. The coal outcrops are vertical and, within 1,000 feet

south, they pass beneath several hundred feet of unconformable Hanna Formation.

MEDICINE BOW FORMATION

Coal occurs in secs. 21 and 25, T20N, R79W in this formation. The attitude of the coal is approximately horizontal. The seam varies from 1.2 to 2.0 feet thick.

HANNA FORMATION

The Hanna Formation contains one thin coal seam ranging from 1 to 2.3 feet thick in secs. 5, 8, and 10, T19N, R79W. The coal only underlies a small part of these sections and occurs in east-west trending, shallow folds.

REFERENCES

Blackstone, D. L., Jr., 1970, Structural geology of the Rex Lake quadrangle, Laramie basin, Wyoming: Geological Survey of Wyoming Preliminary Report 11, p. 17.

_____, 1973, Structural geology of the eastern half of the Morgan quadrangle, the Strouss Hill quadrangle, and the James Lake quadrangle, Albany and Carbon counties, Wyoming: Geological Survey of Wyoming Preliminary Report 13, p. 45.

_____, 1974, Late Cretaceous and Cenozoic history of the Laramie basin region, southeast Wyoming: in Bruce F. Curtiss (editor), Geological Society of America Memoir 144, Cenozoic history of the Southern Rocky Mountains.

Bauer, Edward J., 1952, Geology of the Wagonhound Creek area, Carbon County, Wyoming: University of Wyoming Masters thesis.

Beckwith, R. H., 1938, Structure of the southwest margin of the Laramie basin, Wyoming: Bulletin of the Geological Society of America, vol. 49, p. 1515-1544.

Chronic, John, M. E. McCallum, C. S. Ferris, Jr., and D. H. Eggler, 1964, Lower Paleocene rocks in diatremes, southern Wyoming and northern Colorado: Geological Society of America Bulletin, vol. 80, p. 149-156.

Chronic, John, 1972, Middle Paleozoic kimberlitic diatremes in Colorado and Wyoming: Colorado School of Mines Quarterly, vol. 67, p. 63-75.

Darton, N. H., and C. E. Siebenthal, 1909, Geology and mineral resources of the Laramie basin, Wyoming: U. S. Geological Survey Bulletin 364, p. 81.

Dobbin, C. E., C. F. Bowen, and H. W. Hoots, 1929a, Geology and coal and oil resources of the Hanna and Carbon basins, Carbon County, Wyoming: U.S. Geological Survey Bulletin 804.

Dobbin, C. E., H. W. Hoots, C. H. Dane, and E. T. Hancock, 1929b, Geology of the Rock Creek oil field and adjacent areas, Carbon and Albany counties, Wyoming: U.S. Geological Survey Bulletin 806-D.

Ferris, C. S, Jr., and H. W. Kreuger, 1964, New radiogenic dates on igneous rocks from the southern Laramie Range, Wyoming: Geological Society of America Bulletin 75, p. 1051-1054.

Gill, J. R., E. A. Merewether, and W. A. Cobban, 1970, Stratigraphy and nomenclature of some Upper Cretaceous and Lower Tertiary rocks in south-central Wyoming: U.S. Geological Survey Professional Paper 667, p. 53.

Houston, R. S., and others, 1968, A regional study of rocks of Precambrian age in that part of the Medicine Bow Mountains lying in southeastern Wyoming -- with a chapter on the relationship between Precambrian and Laramide structure: Geological Survey of Wyoming Memoir No. 1.

Hyden, Harold J., Harry McAndrew, and R. H. Tschudy, 1965, The Foote Creek and Dutton Creek Formations, two new formations in the north part of the Laramie basin, Wyoming: U.S. Geological Survey Bulletin 1194-K.

Hyden, Harold J., 1966, Geologic map of the McFadden quadrangle, Carbon County, Wyoming: U.S. Geological Survey Map GQ 533.

Hyden, Harold J., John S. King, and R. S. Houston, 1967, Geologic map of the Arlington quadrangle, Carbon County, Wyoming: U.S. Geological Survey Map GQ 643.

Hyden, Harold J., and Harry McAndrew, 1967, Geologic map of the T L Ranch quadrangle, Carbon County, Wyoming: U.S. Geological Survey Map GQ 637.

Hyden, Harold J., Robert S. Houston, and John S. King, 1968, Geologic map of the White Rock Canyon quadrangle, Carbon County, Wyoming: U.S. Geological Survey Map GQ 789.

King, John S., 1964, Cooper Hill -- A gravity slide in the northeastern Medicine Bow Mountains, Wyoming: Contributions to Geology, vol. 3, no. 1, p. 33-37.

Love, J. D., J. L. Weitz, and R. K. Hose, 1955, Geologic map of Wyoming, U. S. Geological Survey, Scale 1:500,000.

Neely, Joseph, 1934, Geology of the north end of the Medicine Bow Mountains: Geological Survey of Wyoming Bulletin 25, p. 15.

Princhinello, Kathryn A., 1971, Earliest Eocene mammalian fossils from the Laramie basin of southeast Wyoming: Contributions to Geology, vol. 10, p. 73-89.