THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

STRATIGRAPHY OF RED PEAK FORMATION, ALCOVA LIMESTONE, AND CROW MOUNTAIN MEMBER OF POPO AGIE FORMATION (TRIASSIC) OF CENTRAL WYOMING

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STRATIGRAPHY OF RED PEAK FORMATION, ALCOVA LIMESTONE, AND CROW MOUNTAIN MEMBER OF POPO AGIE FORMATION (TRIASSIC) OF CENTRAL WYOMING

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Dr. G. G. Huffman supervised the project and gave freely of his time and energy in discussing the results. Dr.

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In addition to the above, Mr. Ronald R. West identified the algae of the Alcova Limestone and critically read the manuscript and Mr. Ted Gard accompanied the writer to the field and provided stimulating discussions of the stratigraphic relationships.

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INTRODUCTION

Location of Area

Location of the area investigated for this study is shown on the Index Map (Fig. 1). The study involves a regional stratigraphic investigation of Triassic sediments of part of the Chugwater Group in central and north-central Wyoming. More specifically, the investigation was conducted throughout the entire Big Horn and Wind River basins and the western part of the Powder River basin. The area extends from Range 77 West on the east to Range 109 on the west, and from Township 21 North on the south to the Montana-Wyoming state line (Township 58 North) on the north. It covers an approximate area of 34,500 square miles.

Purpose and Scope of Study

This investigation is an original, detailed reconnaissance study of the Triassic of central Wyoming. Prior to

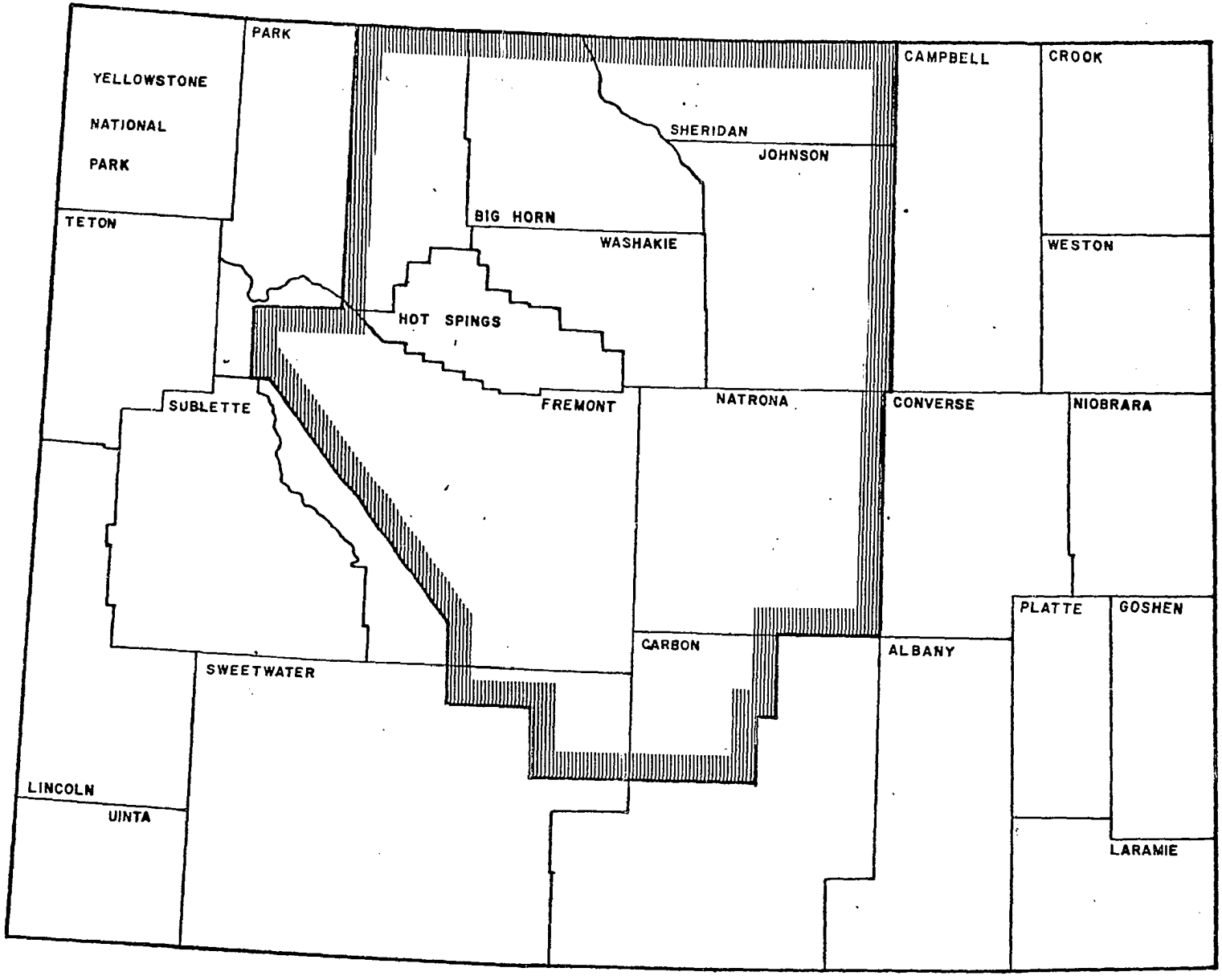


Fig. 1.—Index map of Wyoming showing area of investigation.

this investigation no such study has been undertaken. Due to the lack of previous regional investigations the writer undertook this study with no pre-conceived ideas as to what might be found concerning stratigraphic relationships.

The investigation has provided data concerning the areal extent, lithologic nature, and the thickness and lateral relationships of the upper portion of the Red Peak Formation, Alcova Limestone and the Crow Mountain Member of the Popo Agie Formation. In addition, the writer was able to determine the nature of the unconformity separating Triassic and Jurassic sediments and to map the subcrop relationships existing below that unconformity. An attempt, although inconclusive, was made to establish the position of the Lower Triassic-Upper Triassic boundary. In addition, the writer has attempted to establish the source of sediment for the Crow Mountain Member and the environment of deposition for all of the Triassic rock units studied in the area of this report.

Method of Investigation

During the summers of 1961, 1962, and 1963 the writer conducted field investigations of Triassic rock units throughout central Wyoming. During this time, 27 well-exposed sections were measured, described and sampled by normal standard

field procedures. In the fall of 1963 the writer was allowed to use subsurface data provided by Texaco, Inc., Casper, Wyoming. A total of 207 well logs was analyzed by projecting lithic units found on the surface into the subsurface to determine their extent, thickness and stratigraphic relationships. Laboratory studies were conducted later on the samples collected. The samples were first described using a binocular microscope and then certain of the samples were subjected to thin-section examination to determine gross mineralogy, cementation characteristics and grain-size relationships of the rock units involved.

Previous Investigations

Prior to 1904 the redbed series of Wyoming had received no formal nomenclatorial status and was referred to simply as "red beds." The first attempt at distinguishing various stratigraphic units was done informally by S. H. Williston (1904, p. 688). Williston, at the suggestion of N. H. Brown, first applied the term "Popo Agie beds" to a series of beds containing vertebrate remains, "forty to eighty feet thick about two hundred feet below the top and six hundred feet above the base of the red beds along the Popo Agie River." No further description of the beds was

provided, but Williston was able to assign a Triassic age to the beds on the basis of the contained vertebrate fauna.

In the same year Darton (1904, p. 397) applied the name "Chugwater" for the extensive series of red beds along Chugwater Creek in the vicinity of Iron Mountain, Wyoming. As originally defined, the name "Chugwater" was applied to all red sediments between the top of the Pennsylvanian Tensleep Sandstone and the base of the Jurassic Sundance Formation.

Two years later, Darton (1906, p. 36) specifically applied the term "Chugwater" to a series of red beds extending along the base of the steeper portions of the slopes of the Big Horn Mountains. He described the rocks as "mainly soft, massive red, fine-grained sandstones, merging into red shales, but extensive gypsum deposits and a few thin limestones are also included." He believed the lower portion of the Chugwater to be of Permian age, but the upper portion was placed in the Triassic. Darton modified his earlier beliefs on the lower boundary, proposing the term Embar (now rejected) for the lower marine shales, limestones and gypsums above the Tensleep but below the unfossiliferous Chugwater.

Darton (1906, p. 18) extended the term "Chugwater" to the region of the Owl Creek Mountains. This paper

provided a description of the Chugwater sediments. Of particular interest is the fact that Darton noticed the lateral persistence of various stratigraphic units, particularly a "widespread sheet of limestone about 2 feet thick (now known as the Alcova) . . . 100 to 150 feet below the top of the formation." He also realized that there had been a period of uplift and erosion prior to the deposition of the Jurassic Sundance. From the description of the Chugwater provided in this paper, one who is familiar with the series can quite easily discern to which of the present named stratigraphic units Darton was referring.

Speculation on the origin of the red beds began shortly after the formation was formally named. The first record in print on the origin is given by Branson in 1915. Branson noted the texture, color and persistence of individual units over "long distances" and believed that the abundance of data suggests that the red beds are of "subaqueous origin."

For the next ten years not much information filtered into the literature. Berry (1924) discussed the significance of some fragmentary plant remains found in the Popo Agie beds from several locations southwest of Lander, Wyoming. These beds are at about the same stratigraphic horizon as those in

which the vertebrate fossils described by Williston were obtained. Berry concluded that the plant and molluscan remains indicated a Keuper or Rhaetic age (Upper Triassic), because of the associated vertebrate remains.

Lee (1927, p. 13-14) provided the next subdivision of the Chugwater. He applied the name "Alcova Limestone" to an 8-foot limestone bed that is 335 feet below the top of the "Red Beds" near Alcova, Wyoming. He described the Alcova as a hard, resistant, purplish limestone which forms conspicuous ledges at the outcrop. Lee stated that the Alcova should probably be regarded as Lower Triassic in age because the only other marine Triassic rocks anywhere near central Wyoming are recognized as Lower Triassic.

Brainerd and Keyte (1927) seemingly were the first to recognize that the upper part of the Chugwater as defined by Darton is in error. They found fossils of definite Sundance (Jurassic) age in the upper portion of the Chugwater, which had previously been considered as Triassic. They postulated an unconformity in the upper part of Darton's Chugwater. In order to remedy the error they proposed that the Triassic-Jurassic contact be moved down in the Chugwater Formation and be placed at the level of the Alcova Limestone because of its convenience as a marker.

The first attempt at correlation of the red beds with rocks of areas outside Wyoming was provided by Branson (1927, p. 610, Fig. 3). In this significant paper, Branson attempted to give some idea of the age and regional distribution of Triassic-Jurassic red beds of the Rocky Mountains and the Colorado Plateau. Two years later, Reeside (1930, p. 50, Fig. 1) replied to Branson's correlations with criticisms. He provided a correlation chart in which his ideas were expressed. The controversy which developed is not of great importance, but the fact that some attempt at regional correlation was made is quite significant in that it provided some information on the age and distribution of Triassic sediments.

Love (1939, p. 42) applied the term "Chugwater" to "all strata lying between the Dinwoody and Sundance formations." In the same paper, he named and described three new lithostratigraphic units to be included in the Chugwater Formation. He applied the name "Gypsum Springs Member" to a 250-foot section of cliff-forming gypsum, variegated shale, sandstone, and limestone exposed at the gypsum spring on Red Creek and in the Maverick Springs oil field. The term "Crow Mountain Member" was defined by Love as a sandy sequence which is "conspicuous because of the contrast in color and hardness

with the overlying soft variegated clays (Popo Agie) and the underlying bright red soft shales and sandstones." The type section of the Crow Mountain Member was named after Crow Mountain near the southeastern end of the Washakie Range. "Red Peak Member" is a term applied by Love to the series of bright-red, soft shales and sandstones lying below the Crow Mountain Member. The Red Peak Member is named after Red Peak, a few miles east of the type section on Red Creek.

Branson and Branson (1941, p. 133-136) provided brief descriptions of the Triassic redbeds along the eastern flank of the Wind River Mountains of Wyoming. Basically they used the classifications proposed by Love in 1939. However, they proposed that the Chugwater be given the status of a group and the earlier named members be given formational status. In addition they added two formational names: Wyopo was applied to the massive cliff-forming sandstones lying above the Popo Agie Formation and below the Gypsum Springs Formation; the Dinwoody was regarded by them as lying above the Permian Phosphoria Formation and below the Red Peak Formation.

In 1945, Love published a report containing several cross-sections and isopach maps. This represented the first attempt to utilize available surface and subsurface data to establish some type of regional picture.

The most recent attempt to clarify Triassic nomenclature and stratigraphy of central Wyoming is a monumental work by McKee et al. (1959). This piece of research presents lithofacies, isopach, paleotectonic and correlation information not only of central Wyoming, but of all Triassic rocks in the United States.

In addition to the above works, numerous other articles have appeared in various journals, bulletins, and theses. As most of them have not played a significant part in the development of the nomenclature they were not discussed here, but will be discussed in the sections of this work where they are most appropriate.

STRATIGRAPHIC ANALYSIS OF THE CHUGWATER GROUP

Introduction

Figure 2 is a summary of stratigraphic nomenclature used in the area of investigation. The classification used by the writer is essentially the same as that proposed by Branson and Branson (1941, p. 133) except that Crow Mountain is given the status of a member of the Popo Agie Formation and the Wyopo and Gypsum Springs formations are excluded. It is believed by the writer that the Chugwater legitimately should be given group status on the basis of thickness (approximately 400 to 2,500 feet) and because of the persistence of definite mappable units throughout the area of study (approximately 34,500 square miles). The formations proposed are definitely mappable units throughout the area and possess lithologies sufficiently distinct to provide easy recognition in the field by future investigators.

Red Peak Formation

General Considerations.--Love (1939, p. 44) proposed the name Red Peak for a unit of interbedded red shales,

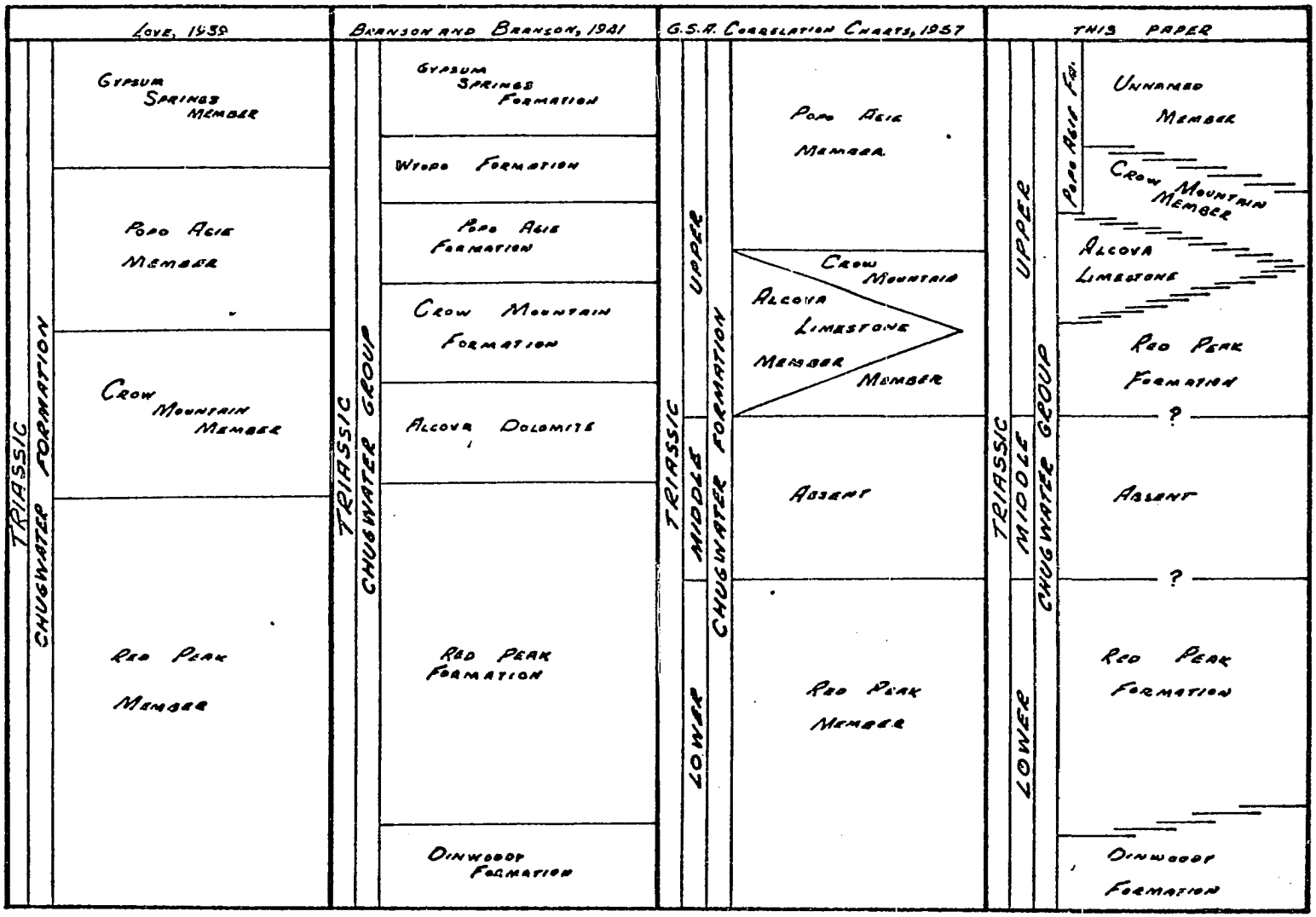
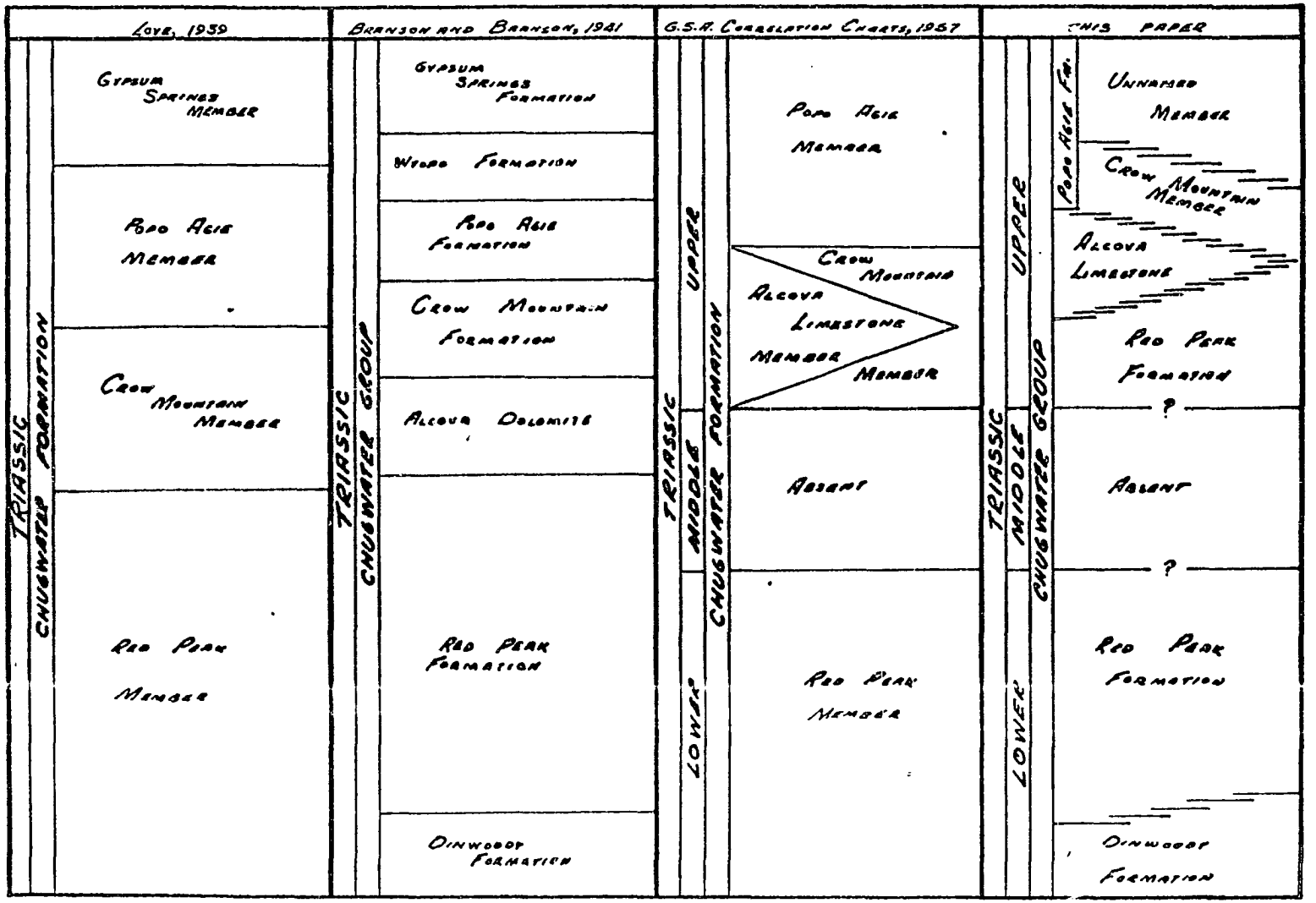


Fig. 2.--Chart showing Triassic nomenclature used in area of investigation.


LOVE, 1939
TRIASSIC
CHUGWATER FORMATION
GYPSUM SPRINGS MEMBER
POPO AGIE MEMBER
CROW MOUNTAIN MEMBER
RED PEAK MEMBER
BRANSON AND BRANSON, 1941
TRIASSIC
CHUGWATER GROUP
GYPSUM SPRINGS FORMATION
WOODD FORMATION
POPO AGIE FORMATION
CROW MOUNTAIN FORMATION
ALCOVA DOLOMITE
RED PEAK FORMATION
DINWOODY FORMATION
G.S.A. CORRELATION CHARTS, 1957
TRIASSIC
UPPER
MIDDLE
LOWER
CHUGWATER FORMATION
POPO AGIE MEMBER
CROW MOUNTAIN MEMBER
ALCOVA LIMESTONE MEMBER
ABSENT
RED PEAK MEMBER
THIS PAPER
TRIASSIC
UPPER
MIDDLE
LOWER
CHUGWATER GROUP
POPO AGIE FM.
UNNAMED MEMBER
CROW MOUNTAIN MEMBER
ALCOVA LIMESTONE
RED PEAK FORMATION
?
ABSENT
?
RED PEAK FORMATION
DINWOODY FORMATION

sandstone, and siltstones of Triassic age along Red Creek on the south flank of the Absaroka Range. As there defined the Red Peak included all strata between the base of the Crow Mountain Member and the top of the Dinwoody Formation.

Branson and Branson (1941, p. 134) apparently recognizing that the Alcova Limestone occurs between the Crow Mountain and the Red Peak, proposed that the Red Peak be defined as strata lying below the Alcova Limestone, or in places where the Alcova is missing the Red Peak is that series of strata lying below the Crow Mountain Member. They also proposed that the Red Peak be given a formational rank.

Strata of the Red Peak are normally expressed topographically as a slope-forming unit on the dip slope of the underlying strata or as part of the escarpment face of hogbacks held up by the more resistant Alcova Limestone or by the Crow Mountain Member.

Lithology.--Most writers in the past (Branson and Branson, 1941, p. 134; Mills, 1956, p. 14; Burk, 1956, p. 27) described the lithology as a series of red or salmon-red siltstones and red and maroon shales. Generally this description has proven true. The writer can offer little else in the way of description except for local examples. The writer did not measure a single section of the lower part of the

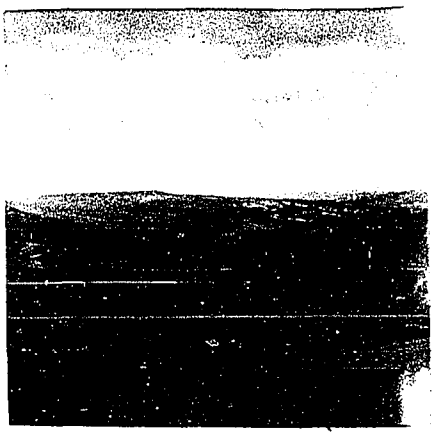
PLATE I

PHOTOGRAPHS OF REPRESENTATIVE OUTCROPS OF THE CHUGWATER GROUP

A. Outcrop photograph showing an almost complete section of the Chugwater Group (Measured section V). The hogback in the center is held up by the Alcova Limestone. Below the Alcova is the interbedded siltstone and silty shale of the Red Peak Formation. Above the Alcova Limestone is a slope-forming unit comprising the Popo Agie Formation. The scarp-forming sandstones in the background are part of the Nugget (Wyopo) Sandstone.

B. Outcrop photograph of Red Peak Formation (Measured section G). Note interbedded siltstone and silty shale sequence which is typical of the upper part of the Red Peak Formation. Very top of hogback is capped by the resistant Alcova Limestone.

PLATE I



A.

B.

formation. However, in order to obtain a more accurate picture of regional relationships, numerous of the measured sections include from 50 to 250 feet of the Red Peak in the description. In addition, samples were collected for description and a total of 8 thin-sections from 8 measured sections were analyzed to determine gross mineralogy. The samples analyzed were not taken from the same stratigraphic units but were taken at random from the various beds to determine what minerals were the more common constituents present in the Red Peak Formation.

Quartz was the most abundant mineral present in all samples analyzed. It exhibits a constant percentage ranging between 84 and 87.5 percent of the total terrigenous fraction. Empirically, quartz grains with straight extinction and few vacuoles and no microlites are the more abundant types. Second in abundance is quartz with straight extinction and numerous vacuoles. The third empirical quartz type consists of composite grains with straight to strongly undulose extinction.

In the samples examined, feldspar is the second most common and important constituent. In all sections examined, it comprises 6.5 to 10.5 percent of the total terrigenous material. It may be present as fresh, angular grains or may

exhibit all stages of alteration as shown by the amount of vacuolization and sericitization.

Mica is a common constituent, more so than in other Chugwater sediments. It comprises 1 to 4 percent of the total terrigenous fraction. Commonly it is altered and has a "dog-eared" appearance.

Chert is a rather uncommon constituent in all samples examined, being present in quantities from a trace to 2 percent. Where present, the grains are generally subangular to subround and of medium- to coarse-grained silt-size. In many cases the chert has a brown-stained appearance in plane polarized light.

Rock fragments and heavy minerals are present in all samples and may comprise up to 4 percent of the total terrigenous fraction. The rock fragments may be either of igneous or metamorphic origin, each normally being present in about subequal proportions. Heavy minerals were not studied in detail but those present are generally opaque minerals such as magnetite and ilmenite and members of the ultrastable group such as tourmaline, zircon, and garnet.

In all samples examined, the most common cementing agent is calcite which is present as a void filling and quartz-feldspar replacement. Clay cement is common, as is

overgrowth cement. Not enough data are available to discern cementation history.

Regional Distribution and Thickness.--The Red Peak Formation is the most widely distributed of all of the rock units of the Chugwater Group. It is found throughout Wyoming, parts of Colorado, Montana, Nebraska, and South Dakota, and possibly in the Williston basin to the north.

In the area investigated by the writer, the Red Peak has a maximum thickness in excess of 1,200 feet in the present Wind River basin and more than 1,300 feet just northwest of the Wind River basin area.

In the southern part of the present Big Horn basin the Red Peak maintains a rather constant thickness of 700 to 800 feet. Northward, the formation shows a rather constant rate of thinning due to truncation during pre-Gypsum Springs time.

Similarly the same features are duplicated in the Powder River basin. Here there is a general eastward thinning developed by pre-Sundance erosion and truncation.

Thickness studies, as shown by the isopach map (Plate VII) of this formation, reveal that a large, semi-rectangular basin was developed during the time of Red Peak deposition in almost the same location as what is now called the Wind

River basin. Here, the sediments thicken at a rather uniform rate of 20 to 30 feet per mile toward the center of the basin.

South of this major depositional basin, another basin developed in about the present site of the Red Desert basin. Here the sediments thicken at about 20 to 40 feet per mile into the basin.

The upper and lower boundaries of the Red Peak are seemingly conformable with the units above and below. This has previously been pointed out by Love (1939, p. 46), Branson and Branson (1941, p. 134).

Correlation and Age.--While doing subsurface studies it was noted that correlation of units between the top of the Dinwoody Formation and the base of the Alcova is easily facilitated by persistent electrical log patterns which allow good correlations from one region to another. However, about 150 to 300 feet below the Alcova Limestone, correlation is hampered by the seeming disappearance of some units and by the appearance of additional units. Regionally as much as 600 to 800 feet of section may be added to the Red Peak Formation. This is strongly suggestive of an unconformity, one which conceivably separates the Lower from the Upper Triassic. Field relations suggest that the unconformity may also be

seen on the surface. About 150 to 250 feet below the base of the Alcova Limestone is a subtle but noticeable color change. The sediments composing the upper Red Peak generally have a brick-red or salmon-red appearance, while the sediments below have a reddish-maroon color. In two places, measured section M and measured section AA, the writer found what appeared to be a calcareous zone in which siltstones of pebble size were present with a random orientation.

Other writers have assumed that the lower part of the Chugwater was Lower Triassic whereas the sediments above and including the Alcova Limestone were of Upper Triassic age (Faulkner, 1956, p. 38; Mills, 1956, p. 14). It is suggested here that the unconformity between the Upper and Lower Triassic occurs somewhere within the Red Peak Formation, possibly some 150 to 300 feet below the Alcova and not at the base of the Alcova Limestone where it is now placed by the United States Geological Survey.

Cyclic Sedimentation.--Branson and Branson (1941, p. 135) and Burk (1953, p. 30) have previously noted the uniformity of thickness and lithologic character of Red Peak sediments both along the outcrop and as shown by electric log data in the subsurface. The same uniformity was noted throughout the area of investigation. Moreover, the writer

was able to establish a definite vertical sequence in the upper part of the Red Peak which suggests that the sediments were deposited in a cyclic, repetitive manner. This repetitive sequence can be well established throughout the entire Big Horn basin and the northern and eastern portion of the Wind River basin. Detailed measured section data are not sufficient to establish the repetitive nature of Red Peak deposits along the east flank of the Wind River Mountains but the data available strongly suggest that the same general relationships hold true.

Directly below the Alcova Limestone and grading conformably into the base of that unit is a thin zone of grayish-white to maroonish-white, coarse-grained siltstone or very fine-grained sandstone. Typically this unit is rather massive-bedded with micro-cross-laminations. At many places the bed appears massive and structureless at the outcrop but in thin section the bedding appears to be swirled and disrupted. The thickness of this bed ranges from 2 to 13 feet, but invariably it shows a fairly constant lithologic character.

Lying below the sandy, silty unit is a reddish-maroon to brick-red, thin-bedded siltstone. Typically this is a slope-forming unit which, where well-exposed, can be seen to

grade conformably upward and downward into the overlying and underlying units. Usually this unit appears to be composed of very fine silt-size particles, is micaceous, and averages about 8 to 10 feet in thickness.

Below the overlying silt slope is found a thin, medium- to coarse-grained siltstone. This siltstone is massively bedded with micro-cross-laminations and is brick-red to maroonish-brick-red. It has a calcareous cement and is more resistant to erosion than either of the overlying and underlying units with which it is conformable and gradational. This siltstone maintains a rather constant and uniform thickness of 2 to 7 feet.

Lying below the thin massive siltstone is an interbedded succession of reddish-maroon to brick-red, thin-bedded, quartzose siltstones and clayey siltstones. Typically the unit forms a slope from which the more resistant siltstones protrude as slight ledges. About 7 to 12 feet above the base of the slope-forming unit is a massive-bedded, coarse-grained siltstone about 2 feet thick. The thickness of the entire unit varies from section to section but averages 25 feet.

Directly underlying the interbedded siltstones and shaly siltstones is a brick-red to reddish-maroon, medium- to coarse-grained siltstone. Typically this unit forms a

rather prominent ledge and is well cemented with calcareous cement. It is massive bedded and micro-cross-laminated. The thickness of this particular unit is variable. It ranges from 5 to 30 feet, but is generally less than 10 feet in thickness.

Directly below the massive siltstone unit is another slope-forming unit composed of reddish-maroon to brick-red, thin-bedded, clayey siltstones. The upper and lower contacts are seemingly gradational with the overlying and underlying siltstones. The unit is composed of very fine-grained, micaceous siltstones and is, at many places, grass-covered. Thickness ranges from 12 to 38 feet.

At the base of the above slope-forming unit is a persistent, white to grayish-white, medium- to coarse-grained, thin-bedded, clay-cemented, quartzose siltstone. With the exception of the Alcova Limestone, it is the most prominent and most useful marker horizon the writer found in the entire Chugwater Group. It was found in all sections examined and has been traced visually and by walking in the prominent red cliffs all around the Big Horn basin, western Powder River basin, and the northern and eastern parts of the Wind River basin. It is remarkable in that it shows no lithologic variation, it is laterally persistent over wide areas and it

maintains a constant thickness of only 2 to 3 feet.

Directly below the prominent, white marker horizon is a brick-red to reddish-maroon, medium- to coarse-grained, massive-bedded siltstone. This unit was found at all of the measured sections. It seemingly is gradational with units above and below.

Data are not available to describe in detail the underlying sedimentary units. Data were not gathered nor sections measured to any extent below this unit because the outcrops are generally grass covered, poorly exposed and at the level of most alluvial-filled valleys. However, from the data available there is a strong suggestion that a cyclical pattern of sedimentation is to be found in the underlying rock units.

From the paucity of information available it is difficult, if not impossible, to determine the significance of this repetitious type of sedimentation. It suggests possibly that the above units were deposited during a transgression, with minor regressive oscillations, from a basin located in central Wyoming during Upper Triassic time. This transgression culminated with the deposition of the Alcova Limestone after which deposition of the Popo Agie ensued.

Alcova Limestone

General Considerations.--Lee (1927, p. 14) was the first to name the Alcova Limestone, although Darton had obviously recognized this unit prior to 1904. The name was applied to an 8-foot limestone 335 feet below the top of the "Red Beds." It was defined as a "hard, resistant limestone which forms conspicuous ledges at the outcrop." Lee assigned a Lower Triassic age to the Alcova because "the only marine Triassic rocks anywhere near central Wyoming are recognized as Lower Triassic." As formally proposed by Lee, the Alcova was regarded as a member of the Chugwater Formation. No specific location of a type section was given and the only location provided was "at Alcova, Wyoming."

Several features may be regarded as typical and characteristic of the Alcova Limestone. One of the more characteristic features is the manner of topographic expression. The Alcova is a conspicuous ledge-former holding up massive hogbacks. Even where it does not cap the hogbacks it is normally found high above adjacent subsequent valleys near the crest of a hogback. Another characteristic feature of the Alcova is the bedding. In all but one outcrop visited the Alcova shows massive bedding in the lower part, grading upward into bedding which has a thin, wavy-bedded appearance

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PLATE II

REPRESENTATIVE OUTCROP PHOTOGRAPHS OF THE ALCOVA LIMESTONE FORMATION

A. Alcova Limestone Formation at Measured section N. Note lower massive bedded and upper thinly, "crinkly" bedded portions of limestone bed.

B. Detailed close-up of Alcova Limestone Formation at Measured section N. Thickness of limestone is 4.5 feet.

PLATE II

A.

B.

which has been referred to by many as "crinkly" bedding.

Lithology.--Many authors have provided local descriptions of the Alcova (Mills, 1956; Burk, 1956; Faulkner, 1956), but have merely described it on the basis of color, crystallinity, and average thickness.

During the course of this investigation the writer examined the lithology in 76 thin-sections. The amount of control available is not sufficient to allow a detailed petrographic study but is sufficient to provide a reasonably qualitative lithologic evaluation. The classification scheme used to describe the limestone is basically that proposed by Folk (1959) with two minor exceptions. The term bondstone (term proposed by Dunham, 1962) is used in the same sense as the term biolithite used by Folk; the term limestone pebble conglomerate is used in preference to the term calclithite proposed by Folk.

The lithology of the Alcova Limestone is uniform. From all the outcrops visited and the number of thin-sections analyzed one wonders at the lack of lithologic diversity. In all the samples the writer was able to distinguish only the following carbonate types, each of which is described in some detail on the following pages.

Microsparite is by far the most common lithology

present in the Alcova Limestone. It is light in color--buff, light rose, pink, light brown, or light gray. Calcite crystals which comprise the limestone range in size from about 0.006 to 0.06 mm, normally averaging about 0.01 to 0.02 mm. Fine silt-size, angular quartz grains are present in varying amounts. No regional pattern in the amount of this terrigenous admixture is discernible. Where quartz grains are present they are distributed along fine laminae which are normally stained red. The writer believes that the presence of detrital quartz in such arrangement may represent "dust" blown into the environment by the wind. Commonly pyrite is disseminated throughout the section. As normally expressed, this constituent appears as grains around which altered pyrite has been spread into the matrix. This particular rock is interpreted as having originally been deposited as micrite or lime mud and after deposition subjected to grain growth through recrystallization.

At only one locality, measured section Z, a limestone pebble conglomerate occurs in the same stratigraphic position as the Alcova. Here the Alcova consists of granule- to pebble-size, angular pieces of brown limestone. Texturally, the limestone fragments may be classified as being of a microsparite with a few fragments showing a pelmicrite texture.

Coarse, well-rounded quartz grains are common in the void spaces between the limestone fragments. The entire rock is loosely cemented with sparry calcite. This lithology is interpreted as having been deposited in an environment of relatively high energy--possibly beach or shallow water adjacent to a beach. Because the fragments are angular, extensive transport is unlikely. Quite possibly this rock type represents a lithology in the transition zone between the micrite environment of the adjacent Big Horn region to the north and that of a positive area in the vicinity of the present Owl Creek-Bridger area to the south.

Algal bondstone is almost omnipresent. As typically seen in the field, the Alcova Limestone has an abundance of cabbage-head size "algal heads" resembling cryptozoon colonies. These are especially common and well expressed by differential erosion in the lower, massive-bedded portion of the unit. In thin-section the limestone appears as microspar in which no detail of cell structure can be found due to subsequent recrystallization. Possibly the original algal framework served as a baffle to trap lime mud or micrite. The writer has the impression that several types of algae are present. In one of the less highly recrystallized samples there is a trace of cell structure. In this type the

PLATE III

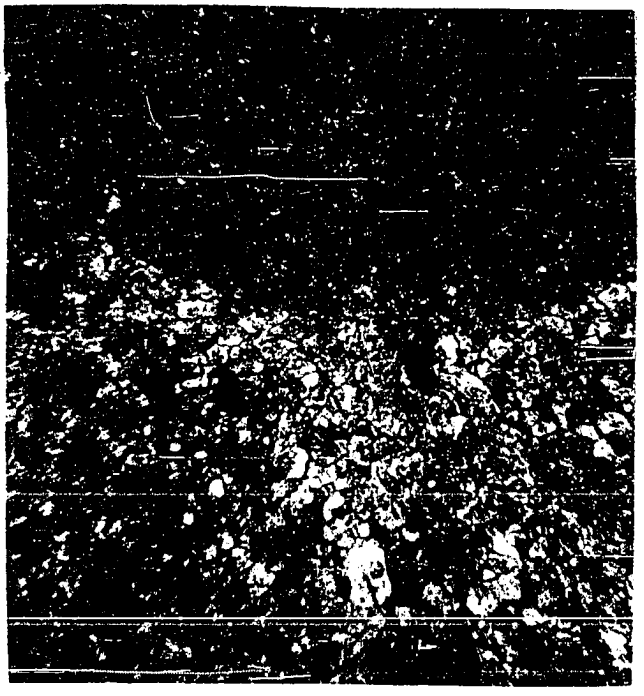
REPRESENTATIVE PHOTOMICROGRAPHS OF THE

ALCOVA LIMESTONE FORMATION

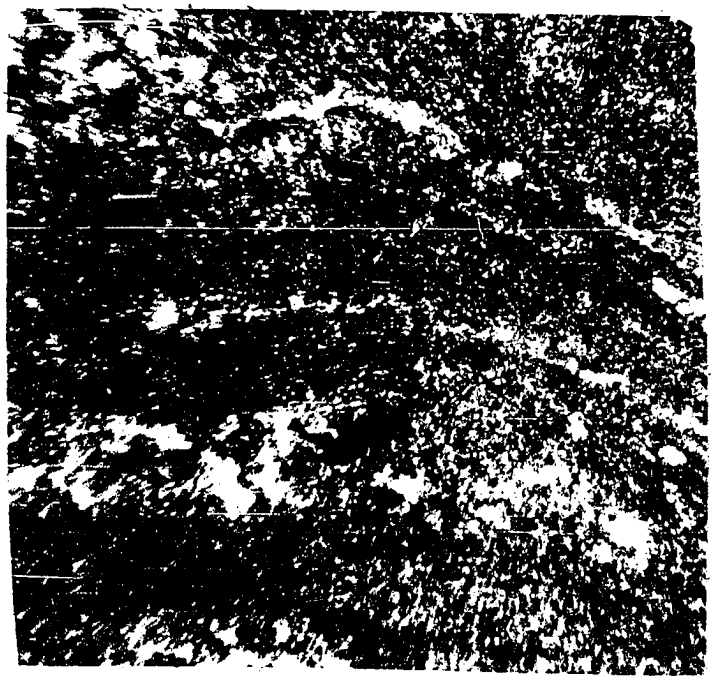
A. Measured section A. Lower portion coarse microsparite; upper portion fine to medium sparite. Sample is typical of the lower more massive-bedded part of the Alcova Limestone. Magnification 37.5X.

B. Measured section AB. Algal bondstone, showing typical recrystallized nature of upper thinly, "crinkly" part of the Alcova Limestone. Magnification 37.5X.

PLATE III



A.



B.

PLATE IV

REPRESENTATIVE PHOTOMICROGRAPHS OF THE ALCOVA LIMESTONE FORMATION

A. Measured section E. Partially recrystallized ostracode biomicrosparite. Internal part of carapace filled with coarse sparry calcite. Shell partially obliterated by subsequent recrystallization of microspar matrix. Magnification 37.5X.

B. Measured section E. Very finely silty algal bondstone. Algal stromatolite about the size and shape of a man's thumb. Magnification 37.5X.

PLATE IV

A.

B.

individual cells are arranged in parallel rows stacked one on top of another. This particular type has been tentatively identified by Mr. Ronald R. West (verbal communication, 1964) as belonging to the family Solenoporacea. The other type represented appears to be another type of colonial algae. This type forms thumb-size, thumb-shaped colonies much resembling those made by the genus Collenia. However, no attempt is made here to assign the type discussed to that genus.

The fourth limestone type represented in the Alcova Limestone is classified as a pelmicrite. This type is particularly common in the section measured on the north end of the Rawlins Uplift. In this rock type, spherical to elliptical brown pellets average about 0.003 mm in diameter. Most samples show pellets having a smeared appearance strongly resembling the grumeleuse structure illustrated by Cayeux (1935, plate XVIII). Here, at least, it can be clearly established that the "grumeleuse structure" is due to some type of smearing process to which the pellets have been subjected during subsequent recrystallization.

Dolosparite or dolomicrosparite is the last major carbonate rock type found in the Alcova Limestone. In this type the individual crystals comprising the rock range in size from about 0.009 to 0.4 mm. Invariably former textures

and structure has been destroyed during dolomitization. However, in some cases differential weathering of the outcrop hints that the rock type possibly was an algal bondstone. Seemingly there is no discernible relationship of dolomitization to local faulting or folding, although all of the Triassic outcrops are located along the flanks of mountain ranges.

Because sampling was done over an extensive area with scattered control, there is a possibility that other rock types might have been found had the outcrop control been closer. Detailed description of rock types from selected localities is in Appendix B.

Paleontology.--One of the more impressive facets of this unit is the sparsity of fossils in such a persistent and widespread limestone unit. During the course of three summers of field investigation the writer was able to find only two small, unidentifiable gastropods and the aforementioned algae. Subsequent investigations of thin section samples revealed that small ostracodes were present in two localities.

Pipiringos (1957, p. 14) has provided a summary of the fossil forms known or postulated to have come from the Alcova Limestone. He thought that the invertebrate fauna indicated an Early Triassic age. Most other investigators

(Mills, 1956, p. 14; Burk, 1956, p. 27; McKee, 1959, p. 16) are prone to assign a Middle or Upper Triassic age to the Alcova; most seem to feel that Upper Triassic age is most likely.

In 1936, Case described the nothosaur species Corosaurus alcovensis, which was found earlier in a quarry in the Alcova Limestone along the Casper to Alcova highway. Zangerl (1963, p. 117-123) has recently published the preliminary results of a restudy of the species. He interpreted Corosaurus alcovensis as being the "most advanced member of the Nothosauria so far known." With this in mind and with known Upper Triassic forms known from the Popo Agie above, Zangerl stated that an Upper Triassic age is strongly suggested.

The writer believes that the facies relationships of the Alcova with the Crow Mountain and, in turn, the Crow Mountain with the upper Popo Agie indicate a genetic relationship. He would conclude that the regional relationships suggest that the Alcova is of Upper Triassic age.

Regional Distribution and Thickness.--An isopach map (Plate VII) showing the thickness and distribution was constructed for the Alcova Limestone. The map shows the Alcova to be present throughout much of central Wyoming. However,

there are several areas where the Alcova is absent because of removal by pre-Middle Jurassic erosion along a line extending eastward from the vicinity of Northwest Little Buffalo Basin oil field eastward across the Big Horn basin toward Tensleep, Wyoming. About 5 miles north of Tensleep, Wyoming, where the Alcova Limestone is absent, a massive, white gypsum assigned to the Gypsum Springs Formation rests unconformably upon the Red Peak Formation. Farther north, in the vicinity of Hyattville, the Alcova is again present along the outcrop as far north as Shell Canyon near Shell, Wyoming, where it has also been removed by erosion. In the subsurface along the eastern flank of the Big Horn basin the Alcova is truncated by the pre-Middle Jurassic unconformity.

Love (1957, p. 1483) has previously noted that the Alcova Limestone is locally absent in the northwestern Wind River basin and along the south flank of the Owl Creek Mountains. A similar condition exists along the north flank of the Owl Creeks in the vicinity of Duncan anticline and Embar anticline. It is believed that the absence here is due to non-deposition. In this region the Crow Mountain Member is the lateral facies equivalent of the Alcova. This fact is substantiated by bore hole logs of this interval in the subsurface of the adjacent basins. This indicates that at the

time the Alcova Limestone was being deposited in the Wind River and Big Horn basins, sandstones and siltstones of the Crow Mountain were being deposited on a peninsular-like positive area located along the present area of the Owl Creek Mountains.

Along the Triassic outcrop on the east flank of the Big Horn Mountains, Love (1957, p. 1484) has reported the Alcova to be absent by apparent non-deposition. Here the Crow Mountain Member is the lateral equivalent of the Alcova Limestone. This report of a facies change was substantiated by the writer. It occurs about five miles north of Barnum along the Barnum-Mayoworth road.

Burk (1953, p. 31) reported the same relationship with the Alcova in his study of Triassic correlations of southeastern Wyoming.

For a considerable period of time, various authors have proposed that the Alcova Limestone is a tongue of the Thaynes Limestone (Pipiringos, 1957, p. 14; Burk, 1953, p. 31; Pipiringos, 1953, p. 38). Love (1948, p. 99; 1958, p. 1482) suggested that the Alcova is younger than Thaynes; that Thaynes interfingers with Red Peak; that Thaynes is of Lower and Middle (?) Triassic age, and that the Alcova is of Late Triassic age.

The zero-isopach line on the Alcova Limestone Isopach map (Plate VII) is significant for outlining the western margin of Alcova deposition. This line coincides with part of the eastern flank of the present Wind River Mountains. Deep wells drilled by Mountain Fuel Supply at Baxter Basin on the Rock Springs uplift penetrate no limestone at the stratigraphic position of the Alcova. Here, at least the lateral equivalent of the limestone is also a sandstone--the Higham Grit. Northward along the west flank of the Wind River Mountains there are no Triassic outcrops until one reaches the Jackson Hole country. Alcova Limestone has been reported as being present (Love, 1957, p. 1483) in this region. This writer has seen limestone of presumed Triassic age along the Gros Ventre River above Lower Slide Lake and Goosewing Anticline. However, a cursory examination indicates that they are not like "typical Alcova" of central Wyoming, although it is possible.

Age and Correlation.--The Alcova has been dated as Lower, Middle, and Upper Triassic. The Geological Society of America Correlation Charts and the correlation charts included in the Triassic Paleotectonic Maps folio assign the Alcova to the Upper Triassic. From available faunal evidence and from the regional relationships the writer is inclined

to agree and to include it in the Upper Triassic.

Regionally, the Alcova interfingers with the Crow Mountain Member and is considered a lateral equivalent of the basal Crow Mountain. On the Rock Springs uplift the Higham Grit occurs in the same stratigraphic position and therefore is assumed to be stratigraphically equivalent.

Farther to the west the writer hesitates to correlate because he is unfamiliar with the stratigraphic relationships. Reeside, and others (1957) correlate the Higham Grit with the basal part of the Ankareh Formation and the Shinarump Conglomerate of the basal Chinle Formation.

Environment of Deposition.--Deposition of the Alcova Limestone is envisioned as having taken place at the height of a transgression caused by the areal enlargement of a large basin located in central Wyoming during Upper Triassic time. Isopach data (Plate VIII) indicate that the Alcova is thickest in central Wyoming, near Casper and in the vicinity of the present Wind River basin. Apparently, during Upper Triassic time, the present trend of the Wind River Mountains was a positive area separating the basin in central Wyoming from the geosyncline to the west. This possibly caused a ponding effect on the shelf east of the Rocky Mountain geosyncline and isolated the basin of central Wyoming in which

the Alcova Limestone was deposited.

The waters of this isolated basin may have become concentrated. If sufficient concentration occurred, the Alcova Limestone may have been deposited as a chemical precipitate. If this possibility is considered valid it may explain the generally micritic (microspar) nature of the limestone and may also explain why fossils are few. If the waters of this basin were highly saline, possibly only the adaptive green algae, gastropods, pelecypods and ostracodes could persist.

Crow Mountain Member, Popo Agie Formation

General Considerations.--Sandstones of the Crow Mountain Member are rapidly becoming a major oil-producing horizon in central Wyoming. Oil production was first established in this horizon at the Hamilton Dome field in 1918. The name "Curtis Oil Sand" was applied as a driller's term for a sandstone unit 420 feet below the top of the Chugwater Formation. This sand was named for Herman D. Curtis, past President of Empire Oil and Gas Company.

In 1939, Love (p. 44) named and described the Crow Mountain Member for exposures along the south flank of the Absaroka Range in the northwestern part of the Wind River

basin. Love stated that "this member is conspicuous because of the contrast in color and hardness with the overlying soft variegated clays and the underlying bright red soft shales and sandstones." As defined, it included all the strata from the top of the Red Peak to the base of the Popo Agie Formation. At the type section, the Alcova Limestone is absent, although it is present a few miles to the east and a few miles to the west. Where the Alcova Limestone is present the Crow Mountain conformably overlies the Alcova.

The topographic expression of the Crow Mountain Member seemingly is variable and depends on the lithology for its mode of expression. Where the Crow Mountain Member is a sandstone it is typically expressed as a slight scarp on the dipslope of hogbacks held up by the Alcova Limestone. However, where the Crow Mountain is siltstone the topographic expression is that of a bold cliff with a smooth, somewhat rounded appearance on the escarpment face. In the latter case, the Crow Mountain Member supports massive hogbacks, forming some of the more spectacular scenery in the foothills of the various mountain ranges of Wyoming. This is particularly true in the southeastern part of the Big Horn basin between Tensleep and Big Trails, Wyoming.

Lithology.--A total of 34 thin-sections from 17

measured sections was analyzed to determine gross mineralogical characteristics, nature of cementing agents, size of terrigenous detritus, gross horizontal and vertical variations of individual components and, if possible, the nature and location of the probable source from which the sediment was derived.

The grain size and shape of all constituents varies from section to section throughout the region of investigation and within any given measured section there is a tendency toward grain-size variation. Within a given measured section the grain size typically decreases upward. Regionally a definite trend in grain-size is evident. Along the flanks of the Owl Creek and Bridger Mountains the lower 30 to 60 feet of the Crow Mountain Member is a fine-grained sandstone. The grain size shows a progressive decrease laterally into the adjacent Big Horn and Wind River basins where the same interval is represented by medium- to coarse-grained siltstones. At most places the upper few feet of the Crow Mountain Member is composed of medium- to coarse-grained siltstones. Along the east flank of the Wind River Mountains the Crow Mountain is represented by medium- to coarse-grained siltstones. Similarly, the Crow Mountain Member consists of medium- to coarse-grained siltstone along the

east flank of the Big Horn basin and the west flank of the Powder River basin. Fine-grained sandstone occurs locally at the outcrop in only two other localities. At Bessemer Mountain just southwest of Casper, Wyoming, and at Alcova, Wyoming, the member consists of interbedded, fine-grained sandstones and coarse-grained siltstones. Similarly, on the north end of the Rawlins uplift the Crow Mountain Member is a fine- to medium-grained sandstone. At both of the latter localities the mineralogy is significantly different to indicate that the sediment was derived from a different source than were the sandstones of this interval in the vicinity of the Owl Creek Mountains.

In all of the thin-sections examined, quartz is the most common constituent. Empirically, only three quartz types are significant quantitatively. By far the most common type present in all sections consists of single grains with straight extinction, few vacuoles, and no microlites. The second most abundant quartz type is that in which the individual grains have numerous vacuoles and exhibit straight extinction. The third quartz type present in any significant quantity consists of composite grains with straight to strongly undulose extinction. Although the three quartz types listed above comprise most of the quartz present, all

of the empirical types proposed by Folk (1961, p. 71) are present in minor quantities.

Feldspar is the second most common constituent present in the Crow Mountain Member. The most common feldspar is orthoclase or untwinned microcline. It forms 2 to 22 percent of the terrigenous fraction in the member. It is generally fresh and angular but subequal amounts show all degrees of alteration in the form of sericitized and vacuolized grains. Plagioclase feldspars (var. albite) are commonly found throughout the member and form 2 to 11 percent of the total feldspar content. The individual plagioclase grains are normally angular and appear quite fresh. Microcline is the poorly represented third member of the feldspars. It is normally present in less than 5 percent of the feldspar fraction.

Mica is an uncommon constituent in all of the sections examined and was found to be present in measurable quantity in only 11 sections. It occurs in quantity from a trace to 5.5 percent, normally being present in quantities of 1 percent or less. Both biotite and muscovite micas are present, but muscovite is the more common of the two. Seemingly mica is present in quantity in the member where it has the characteristic siltstone aspect. Generally the micas

present are somewhat altered. The alteration manifests itself by expansion of the flakes in the direction perpendicular to that of the basal pinacoid so that the flakes give the appearance of being "dog eared." In many cases the mica flakes appear to be wrapped around other detrital grains but most commonly the grains show a strong tendency toward parallelism.

Chert is the third prominent constituent present in this member. It forms 1 to 7 percent of the terrigenous fraction but commonly represents only 2 to 4 percent of the total fraction. The most common type of chert consists of subrounded to rounded grains of microcrystalline quartz which normally give the appearance of being stained brown or black when seen in plane polarized light.

For the convenience of sample description such constituents as heavy minerals and rock fragments were "lumped" under the term of miscellaneous transported detritus. Rock fragments commonly form 1 to 3 percent of the total fraction. The most common rock fragments are igneous in which several grains of quartz and feldspar are intimately intergrown. Metamorphic rock fragments are relatively rare in all sections examined except thin section number 458 taken from measured section E on the Rawlins uplift. Here metamorphic

rock fragments form 11 percent of the total terrigenous fraction. The metamorphic rock fragments consist of rounded and squeezed grains of low grade metamorphics, possibly slate or phyllite fragments. Sedimentary rock fragments were found to be common in only one locality. Limestone fragments, strongly resembling the Alcova Limestone, were found in a zone about 3 feet thick lying directly on top of the Alcova Limestone at measured section M.

Two general groups of heavy minerals are present in the Crow Mountain Member. These are opaque minerals such as magnetite and ilmenite, and members of the ultrastable group such as zircon and tourmaline. In most samples the heavy mineral suite comprises about 1 percent quantitatively of the total fractions present. Magnetite and ilmenite are generally most common in the Crow Mountain where it is a siltstone and may be absent where it is a fine sandstone. There is a direct correlation of color with the presence of magnetite and ilmenite. Where magnetite and ilmenite are present, the Crow Mountain generally has a brick-red or salmon-red color and where absent it has a buff to grayish-white color. Generally the ultrastable heavy mineral group is present in all sections examined. Invariably these minerals are subrounded to rounded, seemingly indicating recycling and/or extensive

transport.

A general statement can be made concerning horizontal and vertical variation of the individual components present in the Crow Mountain Member. However, it must be emphatically emphasized that control is not sufficiently dense vertically or horizontally to allow a detailed study and therefore only gross generalizations can be made. In 11 sections examined where there were several samples taken in a vertical sequence, quartz quantity increases whereas feldspar quantity decreases. Moreover feldspar grains increase in roundness vertically and the intensity of alteration increases vertically. Similarly, samples taken near the west end of the Owl Creek Mountains have a higher feldspar content than those taken at the east end of the same range or those examined along the west flank of the Big Horn Mountains. For example, at measured section D, the most westerly measured section along the north flank of the Owl Creek Mountains, the feldspar content is 15 percent, whereas at measured section N, the measured section at the eastern end of the Owl Creek and Bridger Mountains, the equivalent interval has a feldspar content ranging from 8.5 to 10 percent. On the east side of the Big Horn basin, as at measured section C, the feldspar content ranges from 2 to 7 percent. The regional

variation of chert is difficult, if not impossible to discern. However, there is an apparent vertical variation. The lower few feet and the upper few feet have a lesser quantity of chert than does the middle portion of the same unit.

Four types of binding or cementing media are present in the Crow Mountain Member. These are: overgrowth cement, calcite, microcrystalline quartz, and unidentified clay minerals (Plate V, Figs. A, B, C). Only gross details of cementation history can be deciphered. Clay-mineral cement is present in all samples to a greater or lesser extent. It is probably primary in that the grains cemented by it were originally deposited contemporaneously with the clay matrix. Overgrowth cement can at places be seen to enclose and surround the clay matrix indicating that it developed after the clay cementation. Microcrystalline quartz cement, not necessarily chert, seemingly is the third stage in cementation. Although it is relatively rare, where present it is invariably found cementing previous developed overgrowth cemented patches. The last cement to develop was calcite. Calcite is present as both a void filling and as a replacement of quartz, feldspar and all previously developed cementing agents. Calcite replacement is most common and most severe in the fine-grained clastics; particularly it is severe in

PLATE V

PHOTOMICROGRAPHS OF SELECTED SAMPLES ILLUSTRATING THE VARIOUS CEMENTING AGENTS OF CHUGWATER GROUP SEDIMENTS

A. Measured section AB. Immature, clay cemented, subarkosic siltstone. Red Peak Formation. Magnification 150X.

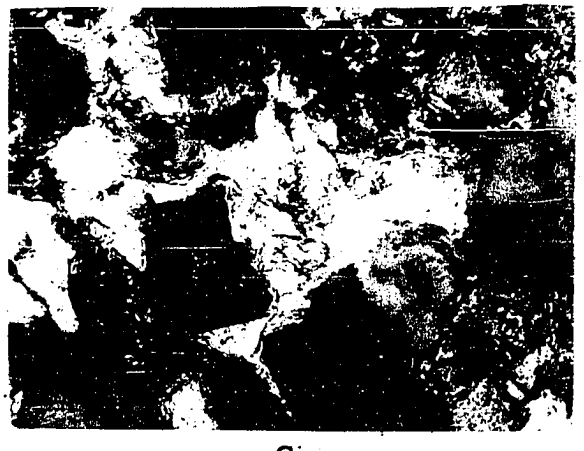
B. Measured section A. Immature subarkosic siltstone. Calcite cement present as pore filling and as a replacement for quartz and feldspar. Crow Mountain Member. Magnification 150X.

C. Measured section X. Immature subarkosic siltstone. Calcite cement present as pore filling and as a replacement for quartz and feldspar. Red Peak Formation. Magnification 150X.

PLATE V

A.

B.



C.

the more highly vacuolized constituents.

Dispersal Centers.--Cross-stratification dip directions were recorded only where the individual cross-stratified sets were cleanly exposed and the axis of cross-stratified units clearly expressed. Data were recorded only at the localities where the Crow Mountain Member or its considered equivalent was present. A total of 78 observations was recorded from 11 localities. Of the 11 localities, 6 are in the Big Horn basin, 4 in the Wind River basin, and 1 in the Powder River basin.

Data obtained from these observations were statistically analyzed to find the mean, mode, and standard deviation for both the local section and for the grand total. The results of this analysis are in Appendix C in graphical form and in the rosette diagram, Fig. 3. Since the data indicate a bi-modal distribution, the two predominant modes were isolated into 90° quadrants and the data further statistically analyzed to find the mean, mode, and standard deviation of each of the two predominant modes. This was done to insure greater accuracy and not convey the impression that the mean, mode, and standard deviation of the total were indicative of either of the two predominant modes.

The data obtained for any individual outcrop are

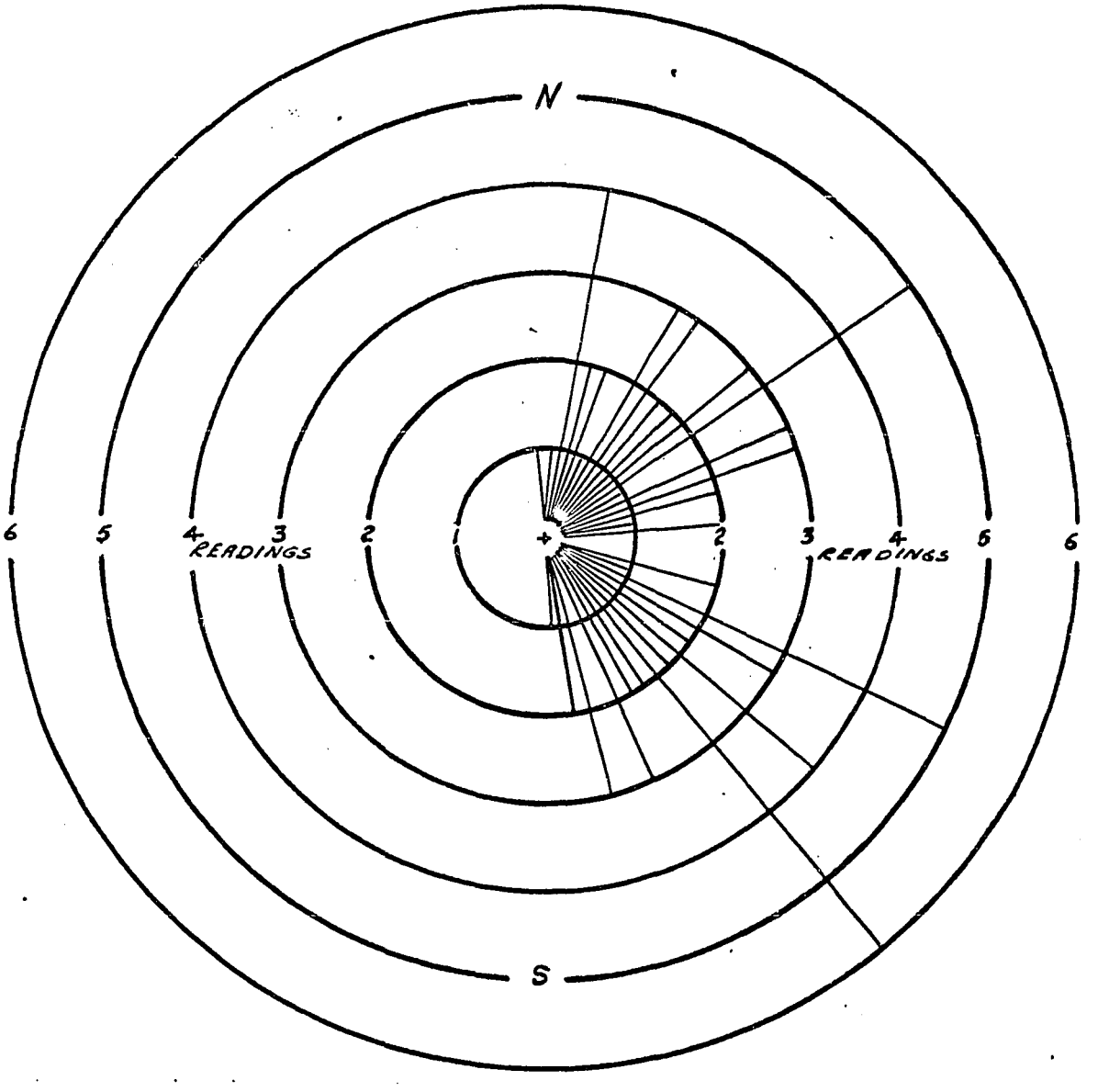


Fig. 3.--Bull's-eye diagram showing dispersal centers of Crow Mountain Member.

considered to be accurate. It is not felt by this writer that enough data were taken nor that critical, reliable outcrops were always available to do justice to a complete dispersal study. There are several reasons for this paucity of good data. First and most obvious, is the fact that the Crow Mountain Member or its equivalent was not present at many of the localities where sections were measured due to post-Triassic erosion and truncation. Secondly, at several localities, the Crow Mountain Member was present but was either not cross-stratified or the cross-stratification so ill-defined that it was not considered practical to record observations.

Even with the paucity of data, several interesting observations can be made on the data available. Even a cursory observation of the rosette diagram of Fig. 3 reveals that the direction of sediment transport in all localities where cross-stratification was observed was either in a northeast or southeast direction. At no place was there any indication that sediment was transported in a westerly direction, nor that the paleoslope was inclined in any direction other than an easterly direction. Also, the data indicate that the source for these sediments was both to the southwest and the northwest of the area involved. This

further suggests that the sources for the sediments were probably Paleozoic structures undergoing erosion during Upper Triassic time--although this is admittedly conjectural.

Regional Distribution and Thickness.--An isopach map of the Crow Mountain Member (Plate IX) was prepared to show the thickness and distribution of the member. Thickness studies reveal that this member retains a relatively uniform thickness of 100 to 200 feet in the area of the present Big Horn basin. Regionally the Crow Mountain is truncated by pre-Gypsum Springs erosion along a line extending east-west across the present Big Horn basin. Only locally is there significant variation in the thickness of this member in the Big Horn basin.

South of the present Owl Creek and Bridger Mountains the Crow Mountain thickness increases at a rate of 8 to 10 feet per mile to a maximum thickness of 250 feet. Thickness studies reveal that at the time of deposition of this member there was a gently subsiding basin almost at the same site as that occupied by the present Wind River basin.

The Crow Mountain Member is truncated along a line extending in a north-south direction along the western flank of the present Powder River basin.

A conspicuous regional thinning of this member occurs

in two localities. One of the thin areas occurs over the region now occupied by the Big Horn Mountains southward along the Casper Arch. The other area of thinning occurs over the area of the present Granite Mountains.

The sandstones of the lower part of the Crow Mountain have a rather restricted distribution. Those sandstones which are typical Crow Mountain as shown at the type section, occur as a fringe around the present Owl Creek and Bridger Mountains. Laterally these sands undergo a change in size into the adjacent basins where the equivalent rock units have a siltstone aspect. The regional limit of the lower sandstones of the Crow Mountain Member are shown by the dashed line on the isopach map.

As previously mentioned by the writer (p. 34) and by Love (1957, p. 1484) the lower part of the Crow Mountain is a facies equivalent of the Alcova Limestone. This facies relationship is well shown along the north and south flanks of the Owl Creek and Bridger Mountains and along the east flank of the Big Horn Mountains.

Sources of Sediment.--One of the more speculative tasks that can be undertaken by a geologist is that of trying to determine the source of the sediments which are being studied and this case is no exception. However, several

lines of evidence are available for making a few interpretations and drawing some conclusions.

Dispersal centers, previously discussed, seem to indicate that sandstones and siltstones in the vicinity of the Owl Creek Mountains were derived from a western source. At no place is there any indication other than that of an easterly direction of transport.

Further evidence of a western source is found in the regional distribution of feldspar and quartz. It was found that feldspar was most abundant in the westernmost sections and that the quantity decreased progressively eastward. Similarly quartz is less abundant in the western measured sections and the quantity increases progressively in an eastward direction.

Similar evidence for a western source is found in a progressive change from fine-grained sandstone to medium- to coarse-grained siltstone in a westward to eastward direction. The lower portion of the Crow Mountain Member is a fine-grained sandstone around the Owl Creek and Bridger Mountains whereas equivalent intervals have a siltstone aspect in the adjacent Big Horn and Wind River basins.

It is postulated that the sediments of the Crow Mountain Member in the vicinity of the Owl Creek Mountains

were derived from a positive area in the vicinity of the present Owl Creek and Absaroka ranges on the basis of the previously stated evidence.

However, another source must be postulated to explain the origin of the Crow Mountain sediments in the southernmost portion of the region investigated. Sandstones occur in the Crow Mountain interval near Casper and Alcova, Wyoming, and on the Rawlins uplift. These sandstones are significantly different in composition from those in the vicinity of the Owl Creek and Bridger Mountains. In the southeastern portion of the region investigated the sandstones have a high percentage of igneous and metamorphic rock fragments as well as a generally higher percentage of feldspar fragments than those in the vicinity of the Owl Creek Mountains. Between the two areas of sandstone deposition, the Crow Mountain interval is composed mainly of medium- to coarse-grained siltstones. Enough detail is not available to make a reasonable assumption as to what served as a source for the sediments in the southeastern portion of the area. Quite possibly they were derived from Paleozoic structures in south-central Wyoming and northern Colorado.

Environment of Deposition.--The determination of depositional environment of sedimentary bodies is almost as

tenuous an undertaking as that of determination of sediment source. However, several rather logical but perhaps speculative deductions can be made.

It was earlier postulated that the underlying Alcova Limestone was deposited as a result of an outwardly directed transgression from a gradually expanding, isolated basin located in central Wyoming. It is postulated that the sediments of the Crow Mountain Member were deposited as a regressive unit and represent the infilling stage of the pre-existing basin. Possibly the regression was initiated by the uplift of the area to the west which served as one of the sources for sediments of the Crow Mountain Member.

If the above deductions are considered as possible or probable, then possible environments of deposition may also be postulated. It is here proposed that the sandstones of the Crow Mountain Member probably represent a regressive beach-dune complex developed around the margins of the basin of deposition. Folk (1961, p. 117) stated that subarkoses are a characteristic rock type of beach-dune complexes. The siltstones were probably deposited in fluvial, deltaic, or shallow-water environments present in the basin of deposition. Seemingly, it would be impossible to assign an environment of deposition to any single one of the individual rock units.

Upper Member, Popo Agie Formation

"Popo Agie Beds" was the first recognized subdivision of the Chugwater red beds in Wyoming. This name was applied by Williston (1904, p. 688) to a series of beds containing vertebrate remains "forty to eighty feet thick about two hundred feet below the top and six hundred feet above the base of the red beds along the Popo Agie River."

In 1939, Love (p. 45) recognized that the term "beds" has no definite stratigraphic rank and he proposed that the Popo Agie be raised to the rank of a member of the Chugwater Formation. No type locality was specified.

The writer is not familiar enough with the Popo Agie Formation to offer any definite conclusions or suggestions on stratigraphic relationships of the part of the formation lying above the Crow Mountain Member of this formation. However, it seems reasonable to assume that conditions of deposition of the Crow Mountain persisted through the remainder of Popo Agie time and that the sediments found therein represent the culmination of basin infilling. Probably the conditions of deposition changed from that of shallow-water sedimentation to sedimentation characteristic of fluvial, paludal, flood plain and piedmont environments.

ORIGIN OF RED COLOR

It has been noticed by the writer from thin-section examination that invariably the red color is intimately associated with those rock units containing an abundance of magnetite and ilmenite. Generally the magnetite and ilmenite grains are of very fine silt-size and they occur most prominently in the siltstone beds. Where the rock units have a sandstone aspect there is a definite paucity of magnetite and ilmenite and the color of the unit is buff or grayish-white. Where the rock units have a siltstone aspect there is an abundance of magnetite (up to as much as 3 percent) and the rock units have a brick-red or reddish-maroon color.

An examination of the individual magnetite and ilmenite grains in the rock units reveals that, in all of the sections examined, grains in all stages of alteration may be found. That is, grains may have a fresh, rounded aspect or they may have a highly altered aspect with all variations and stages of alteration between the two extremes.

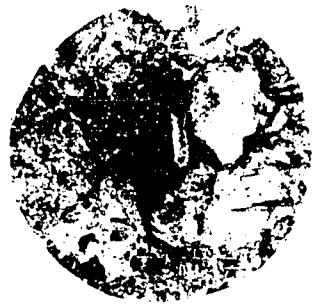
A series of photomicrographs (Plate VI) illustrates

PLATE VI

PHOTOMICROGRAPHS SHOWING INDIVIDUAL MAGNETITE-ILMENITE GRAINS UNDERGOING ALTERATION AND THE RED COLOR IN THE MATRIX CAUSED BY SUCH ALTERATION. ALL PHOTOMICROGRAPHS TAKEN FROM THIN SECTION NUMBER A-O.

PLATE VI

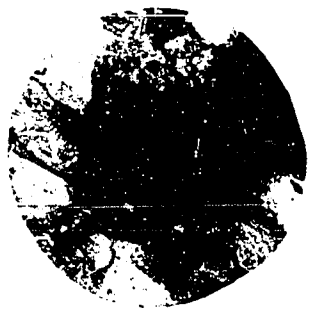
A.



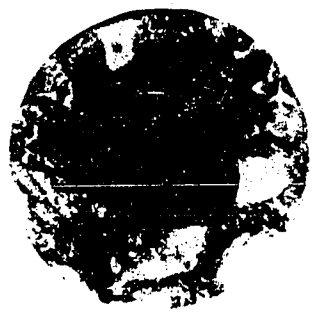
B.

C.

D.



E.



F.

that when the individual grains are fresh and unaltered there is no red color associated in adjacent matrix. As magnetite and ilmenite begin to alter to hematite the grains boundaries begin to become blurred and hematite stains begin to occur as a staining halo in the adjacent matrix. Further alteration causes the red, staining halo to enlarge and stain a greater volume of the matrix, whereas at the same time the size of the original grain decreases. Finally a point is reached at which the original grain is completely obliterated and all that remains is a red "cloud" of hematite stain, in many cases with a ghost structure remaining showing the original position of the nucleus from which the stain was derived.

The above described phenomenon seems to indicate that in the case of red color in the Chugwater sediments the red color was developed after deposition and after cementation had occurred.

DISCUSSION OF ISOPACH MAPS

General Statement

Most of the data discussed in this portion of the text have been dealt with more extensively under distribution and thickness discussions of individual lithostratigraphic units. However, for the purpose of completeness and summary the data are again presented, at the risk of boring repetition, to give the reader some idea of the evolution of the basins of sedimentation.

Isopach Map of Red Peak Formation

The isopach map of the Red Peak Formation (Plate VII) reveals the presence of a pear-shaped basin in almost the same position as the present Wind River basin. Sediments thicken toward this basin at a rate of approximately 15 to 20 feet per mile until a thickness in excess of 1,200 feet is reached in the center of this basin.

In the area now covered by the present Big Horn basin, the Red Peak is about 700 feet thick. However, sediments comprising the Red Peak Formation thin northward due to post-

Popo Agie erosional truncation. Only locally, as in the western portion of the Big Horn basin, is there deviation from the average thickness. Here, a small, nearly circular basin accumulated a thickness of sediment in excess of 1,100 feet. Just a few miles to the southwest of this circular basin is located another basin which accumulated in excess of 1,300 feet of sediment.

To the east the original thickness and distribution is undiscernible due to truncation of the sediments which took place during post-Popo Agie erosion. Here the Red Peak sediments show a general eastward thinning. How far east the thinning continues is not determinable from this study.

In the southernmost portion of the region of study the Red Peak sediments thicken into a northeast-southwest trending basin. Sediments thicken toward the axis of this basin at a rate of 15 to 25 feet per mile until a maximum thickness in excess of 1,100 feet is reached. The size and shape of this basin is unknown from the present study.

Isopach Map of Alcova Limestone

During the time of deposition of the Alcova Limestone, the shape of certain of the structural elements present during the time of the deposition of the underlying Red

Peak were modified or disappeared. A basin was still present in about the same location as the present Wind River basin. However, this basin was not as extensive as it was during Red Peak time, although the general shape is similar.

For the first time during deposition of the Alcova Limestone an essentially east-west trending positive element appeared in about the present position of the Owl Creek and Bridger Mountains. A similar phenomenon is shown by the presence of the zero isopach line encircling an area roughly coinciding with the present position of the Big Horn Mountains.

In the area of the present Big Horn basin the thickness of the Alcova Limestone is uniform and averages about 5 feet. It is interesting to note the prominent northwest-southeast areas of thinning. In every case these thin areas coincide with the position of present day anticlines. These are considered by most geologists to be Laramide features.

The Alcova Limestone is absent throughout the northern part of the Big Horn basin. It was truncated along an essentially east-west line extending from Little Buffalo basin eastward toward Tensleep, Wyoming, by post-Popo Agie erosion.

The western limit of the Alcova Limestone is shown by the zero contour line in the western part of the area of

investigation. This line coincides with the approximate position of the Wind River Mountains. It is suggested that possibly the ancestral Wind River Mountains existed during the time of deposition of the upper part of the Red Peak Formation and during the time of Alcova deposition and served as a barrier which essentially isolated a basin in central Wyoming in which Red Peak and Alcova deposition took place.

In the southernmost part of the area of investigation the basin present during preceding Red Peak time evidently disappeared or more possibly shifted slightly eastward and was reoriented in a northwest-southeast direction. Here the Alcova Limestone is present in excess of 25 feet in thickness.

The eastward extent of the Alcova Limestone is not determinable from the data analyzed by the writer. In the western portion of the present Powder River basin, the Alcova attains a thickness of at least 30 feet, indicating the presence of a basin of deposition similar in position to that of the present Powder River basin. The shape and size of this basin cannot be determined from this study.

Isopach Map of Crow Mountain Member, Popo Agie Formation

Studies of the isopach map of the Crow Mountain Member (Plate IX) show that essentially the same features

persisted during the time of deposition of the Crow Mountain as were present during the time of deposition of the Alcova Limestones.

A basin of deposition of similar size and extent to the one of Alcova and Red Peak time existed in about the same location as the present Wind River basin.

In the present area of the Big Horn basin, sediments of the Crow Mountain Member average about 100 feet in thickness. Only locally is there a significant deviation from this average as in the eastern portion of the Big Horn basin where locally as much as 250 feet of sediment accumulated in a small semi-rectangular syncline. In the central portion of the Big Horn basin, Crow Mountain sediments are truncated by post-Popo Agie erosion.

The regional distribution of the Crow Mountain Member is of some significance. Seemingly the original western, southern, and eastern limits were of not much greater extent than the present subsurface extent of the member at the present time. This part suggests that the general basinal nature of central Wyoming did not persist long after deposition of the Crow Mountain sediments and that the Crow Mountain sediments were responsible for the infilling of this basin.

Isopach Map of Red Peak, Alcova Limestone, and Popo Agie Formations

An isopach map showing the total thickness of Red Peak, Alcova Limestone, and Popo Agie Formations is shown in Plate X.

This map reveals a general southwestward thickening of the Chugwater Group at a rate of about 5 to 40 feet per mile.

Many of the thickness features shown by the detailed isopach maps of individual rock units are not shown on the total thickness isopach map. Several reasons may be postulated to explain this apparent anomaly. First, post-Popo Agie erosion has modified and reduced the thickness of the upper units of the Chugwater Group causing an apparent thickening of all units toward the southwest and thinning toward the northeast. A second reason for the anomaly is attributed to a lateral shift in position of an ancestral Wind River basin during the time of deposition of sediments comprising the Chugwater Group.

Only locally are abnormal thicknesses present in the generally westward thickening succession of rock units. In the western part of the present Big Horn basin a local area of subsidence occurred in which an excess of 1,300 feet of

sediment accumulated in a small, nearly circular synclinal basin. A similar locally thick accumulation is an elongate area in the southeastern part of the present Big Horn basin.

In the southernmost part of the area of investigation is an area in which Red Peak, Alcova and Popo Agie sediments accumulated to a thickness in excess of 2,000 feet.

Pre-Gypsum Spring, Pre-Sundance Subcrop Map

The writer observed that a regional unconformity was present at the top of the Chugwater Group. In order to substantiate the presence of this unconformity and delimit the subcrop relationships the writer collected data to construct the subcrop map (Plate XI). This map was prepared by noting what formation was penetrated by drilled wells directly below the Gypsum Springs or the Sundance formations.

A study of the pre-Gypsum Springs, pre-Sundance subcrop map reveals several interesting relationships. In general the strike of the sedimentary units is roughly northwest-southeast. This direction in turn is parallel with regional thickening to the southwest. The rate of truncation of the rock units varies from place to place but averages 15 to 20 feet per mile. Regionally across the Big Horn basin from south to north at least 800 feet of sediment of the

Chugwater Group have been removed by pre-Gypsum Springs erosion. This reflects an uplift to the north and northeast or a downwarp in the south and southwest involving a minimum vertical displacement of at least 800 feet.

Of great interest is the arcuate subcrop pattern present in the central part of the present Big Horn basin. The only possible manner in which such an arcuate pattern could develop is by anticlinal folding and erosional truncation of the sediments along the flank of such a feature. It is postulated that the present area of the Big Horn basin was subjected to broad anticlinal folding after deposition of the Popo Agie Formation and before the deposition of the Jurassic Gypsum Springs Formation.

The exact time of erosional truncation and gentle folding cannot be accurately determined. It is suggested here that it took place after the deposition of the Nugget Sandstone (Wyopo) which is of either late Triassic or early Jurassic age, but prior to deposition of the Middle Jurassic Gypsum Springs Formation.

CONCLUSIONS

1. On the basis of the distinctiveness of lithology, lateral persistence of lithostratigraphic units and their mappability both along the outcrop and in the subsurface it is concluded that sediments comprising the Red Peak, Alcova Limestone and the Popo Agie should be given the ranks of formations which comprise the Chugwater Group. Although the Dinwoody was not included in this study it is believed by the writer that it, likewise, should be included as the lowest formation of the Chugwater Group. Because the top of the Crow Mountain is gradational with overlying units and is not entirely satisfactory as a mappable unit is is deemed advisable to assign it the rank of a member of the Popo Agie Formation.

2. Within the upper portion of the Red Peak Formation is a definite succession of strata deposited in a cyclical or repetitive manner. It is inferred that this succession of strata was deposited during a transgression with minor regressive oscillations from a basin of deposition located in

central Wyoming. The transgression culminated with the deposition of the Alcova.

3. At no place is there evidence of an unconformity at the base of the Alcova Limestone as had previously been postulated. It is suggested that the unconformity is somewhere below the base of the cyclically deposited sequence in the upper part of the Red Peak Formation. This would place the Lower Triassic-Upper Triassic boundary somewhere between 150 and 300 feet below the base of the Alcova Limestone, in the Red Peak Formation.

4. Isopach and distribution studies of the Alcova Limestone reveal that the Alcova is limited in distribution to central Wyoming, and does not extend westward much beyond the present Wind River Mountains. It is therefore impossible to correlate it with any part of the Thaynes, especially as the Thaynes is considered to be of Lower Triassic age and the Alcova of Upper Triassic age. This would make an interesting correlation problem for subsequent investigation.

5. On the basis of gross lithology it is concluded that the Alcova was deposited primarily as a lime mud or ooze. The individual grains were enlarged by recrystallization so that at present the Alcova Limestone has a microspar appearance. From the paucity of organic remains it seems

likely that organisms played a minor role in its deposition and that it is instead a deposit resulting from hypersaline conditions which existed in a large isolated basin located in central Wyoming during Upper Triassic time.

6. Following the deposition of the Alcova Limestone, the Crow Mountain Member of the Chugwater Formation was laid down as a regressive beach-dune complex. This continuum of deposition represents the beginning of basin infilling. Basin infilling continued throughout Popo Agie time.

7. On the basis of regional change in mineralogy, grain-size and cross-bed orientation it is reasonably apparent that the source of sediments comprising the Crow Mountain Member came from a northwestern and southwestern direction. At no place is there any indication of transport from any other direction nor are there any indications that the paleoslope was inclined in any direction other than an easterly direction.

8. From the data studied by the writer it seems that virtually all of the red color, which is so prominent in the Chugwater sediments, was derived by the alteration of magnetite and ilmenite after cementation had taken place. The red color is well shown as a stain in the matrix surrounding individual magnetite and ilmenite grains.

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APPENDIX A

MEASURED SECTIONS

A. NORTH FLANK OF THERMOPOLIS ANTICLINE

SW¼ sec. 19, T. 43 N., R. 94 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Grayish-white, finely crystalline, massive-bedded gypsum with interbedded red, thinly laminated, clay shales. Thickness not measured.		
Triassic:		
Popo Agie:		
Covered interval	102	0
Sandstone, buff- to salmon colored, very fine- to fine-grained, subrounded, poorly sorted, cross-laminated, very silty, occurs in beds 1" to 5' thick. See detailed description A-15	15	0
Shale, reddish-maroon, clayey, silty, micaceous, fissile to powdery, thinly laminated	2	0
Siltstone, red, weathering same, medium- to coarse-grained, subrounded, fairly well-sorted, somewhat clayey, thin-bedded with micro-cross-laminations	1	3

Covered interval	4	0
Siltstone, reddish-maroon, weathering same, medium- to coarse-grained, subrounded, fairly well-sorted, somewhat clayey, thin-bedded	0	4
Shale, red to maroon, clayey, silty, somewhat micaceous, very powdery, thinly laminated	1	0
Sandstone, buff, weathering same, fine-grained, subrounded, fairly well-sorted, somewhat silty, thinly cross-laminated	1	0
Shale, reddish-maroon, clayey, very silty, thinly laminated, slope former	13	0
Crow Mountain:		
Sandstone, buff, fine- to very fine-grained, subangular to rounded, well-sorted, quartzose, calcareous-cemented, thin-bedded, ledge former	11	6
Shale, grayish-green, clayey, very silty, platy to thinly laminated, slope former	3	6
Sandstone, buff, fine- to very fine-grained, subangular to rounded, well-sorted, quartzose, calcareous-cemented, occurs in beds 4" to 1' thick, cross-laminated. See detailed description A-10	20	10
Sandstone, buff, fine- to very fine-grained, subangular to rounded, well-sorted, quartzose, calcareous-cemented, occurs in beds 1' to 3' thick. See detailed description A-4	15	7
Alcova:		
Limestone, buff, weathering gray, finely crystalline to almost cryptocrystalline, dense, brittle, thinly wavy- to "crinkly" bedded		

in upper 2' while the lower 1' is a massive bed. See detailed descriptions A-1, A-2, and A-3	3	2
Red Peak:		
Sandstone, brownish-gray, very fine-grained, very silty, subangular, quartzose, massive-bedded with micro-cross-laminations. See detailed description A-0	2	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, calcareous-cemented, massive-bedded with micro-cross-laminations	4	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, calcareous cemented, thin-bedded, ledge former	3	0
Shale, reddish-maroon, clayey, very silty, thinly laminated, slope former	5	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, calcareous-cemented, massive-bedded with micro-cross-laminations	3	0
Shale, reddish-maroon, clayey, very silty, thinly laminated, slope former	13	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, calcareous-cemented, thin-bedded, ledge former	7	0
Shale, reddish-maroon, clayey, very silty, thinly laminated, slope former	38	0
Siltstone, grayish-white, medium- to coarse-grained, quartzose, calcareous-cemented, thin-bedded, slope former	2	0
Siltstone, reddish-maroon, medium- to coarse-grained, quartzose, somewhat micaceous, massive-bedded with micro-cross-laminations	8	0
Lower portion of section covered and not measured. No estimate of thickness.		

B. NORTH FLANK OF THERMOPOLIS ANTICLINE

Measured in drainages in secs. 19 and 20, T. 43 N., R. 95 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Grayish-white, finely crystalline, massive-bedded gypsum, with interbedded maroon, thinly laminated, clay shales. Thickness not measured.		
Triassic(?):		
Popo Agie (?):		
Interval mostly covered except locally where maroon, clayey shales with interbedded siltstones crop out	108	0
Triassic:		
Popo Agie:		
Sandstone, grayish-white, very fine-grained, angular to subrounded, poorly sorted, very silty, calcareous-cemented, quartzose, ledge former. See detailed description B-14	4	0
Shale, reddish-maroon, clayey, thinly laminated with several reddish-maroon, medium-grained, quartzose, micaceous, thin-bedded siltstones	66	0
Crow Mountain:		
Sandstone, buff, very fine-grained, subrounded, fairly well-sorted, quartzose, with some muscovite and feldspar, calcareous-cemented, occurs in beds 3 to 5 inches thick	5	3

Shale, reddish-maroon, clayey, very silty, somewhat micaceous, thinly laminated	6	0
Sandstone, buff, very fine- to fine-grained, subrounded to rounded, fairly well-sorted quartzose with some fresh appearing pink feldspar, ledge former. See detailed description B-11	26	0
Covered interval	2	0
Sandstone, buff, very fine- to fine-grained, subangular to subrounded, well-sorted, quartzose with some fresh appearing pink feldspar. See detailed description B-7	2	0
Covered interval	9	0
Sandstone, buff, very fine- to fine-grained, subangular to subrounded, fairly well-sorted, quartzose with some fresh appearing pink feldspar, ledge former	8	4
Covered interval	14	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, somewhat micaceous, calcareous-cemented, slope former	2	9
Alcova:		
Limestone, white, weathering to a variegated gray, sugary crystalline, thin-bedded, somewhat dolomitic, upper 2 feet thin- , wavy-bedded and becoming increasingly silty, grades into overlying unit conformably. See detailed descriptions B-1, B-2, and B-3	5	6
Red Peak:		
Sandstone, grayish-white, very fine-grained, silty, quartzose, massive-bedded with micro-cross-laminations, slight ledge former .	4	9
Lower portion poorly exposed and not measured. No reasonable estimate of thickness.		

C. ACROSS THE ROAD WEST FROM THE ROBERT ORCHARD RANCH

W½ W½ sec. 21, T. 42 N., R. 88 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Grayish-white, finely crystalline, massive-bedded gypsum with interbedded red, thinly laminated, clay shales. Thickness not measured.		
Triassic(?):		
Popo Agie(?):		
This portion of section very poorly exposed on low dip slope. Interval not measured. Estimate a thickness of 75 feet.		
Triassic:		
Popo Agie:		
Sandstone, buff to grayish-white, very fine-grained, fairly well-rounded, well-sorted, quartzose ..	1	6
Covered interval, appears to be predominantly interbedded shales and silty shale	17	0
Sandstone, buff to grayish-white, very fine-grained, fairly well-rounded, well-sorted, quartzose. See detailed description C-18	13	0
Shale, reddish-maroon, clayey, very silty, thinly laminated	1	0
Sandstone, buff to grayish-white, very fine-grained, fairly well-rounded, well-sorted, quartzose ..	1	6
Shale, reddish-maroon, clayey, very silty, thinly laminated	1	0

Sandstone, buff to grayish-white, very fine-grained, fairly well-rounded, well-sorted, quartzose ..	1	6
Covered interval, appears to be predominantly of interbedded red, medium- to coarse-grained siltstones and red to maroon clayey, silty shales	40	0
Crow Mountain:		
Sandstone, buff, very fine-grained, with scattered grains of fine- and medium-grain size, generally well-sorted and grains subrounded but becoming somewhat silty, very friable, thin-bedded. See detailed description C-15	10	0
Sandstone, buff, weathering same, very fine- to fine-grained, angular to subrounded, fairly well-sorted, quartzose with minor amounts of chert and fresh pink feldspar, massive-bedded but friable, ledge former. See detailed description C-12	15	8
Sandstone, buff, very fine-grained, with scattered grains of fine- and medium-grain size, generally well-sorted, grains subrounded, very friable, thin-bedded with small scale cross-lamination	12	0
Sandstone, buff, weathering same, very fine- to subrounded, fairly well-sorted, quartzose with minor amounts of chert and fresh pink feldspar, massive-bedded but friable, ledge former	8	6
Sandstone, buff, very fine-grained, with scattered grains of fine- and medium-grain size, generally well-sorted, grains subrounded, very friable, thin-bedded with small scale cross-lamination	3	6

Sandstone, buff, weathering same, very fine- to fine-grained, angular to subrounded, fairly well-sorted, quartzose with minor amounts of chert and fresh pink feldspar, massive-bedded but friable, ledge former. See detailed description C-5 ..... 7 6

Alcova:

Limestone, variegated gray, weathering light gray, very finely crystalline, sugary, dolomitic, lower 2½ feet massive-bedded with numerous stylolites, upper 4½ feet very thin-, wavy-bedded. See detailed descriptions C-1, C-2, C-3, and C-4 ..... 7 0

Red Peak:

A well exposed Red Peak section occurs in a vertical cliff below where the upper part of this section was measured. It was deemed inadvisable to measure this portion because of steepness. No estimate of thickness made.

D. MEASURED ALONG MUD CREEK DRAINAGE

Center of the S½ sec. 33, T. 8 N., R. 3 E.

Formational Description	Thickness of Unit in Feet and Inches

Triassic:

Popo Agie:

Upper portion unmeasurable because of cover and gentle slope over excessive horizontal distance.

Siltstone, white, medium- to coarse-grained, calcareous-cemented, quartzose, massive-bedded, ledge former, has a 6 inch red silty shale bed in center of unit	3	0
Shale, maroon, clayey, slightly silty, thinly laminated, slope former	4	0
Siltstone, white, medium- to coarse-grained, quartzose, calcareous-cemented, massive-bedded, ledge former	3	0
Shale, maroon, clayey, silty, slightly micaceous, thinly laminated, slope former	7	0
Siltstone, white, medium- to coarse-grained, quartzose, calcareous-cemented, massive-bedded, ledge former	0	9
Shale, maroon, clayey, silty, micaceous, thinly laminated, slope former	22	6
Crow Mountain:		
Sandstone, salmon-pink, fine- to very fine-grained, well-rounded, well-sorted, quartzose with minor amount of feldspar, calcareous-cemented, thin-bedded, slope former	3	6
Sandstone, buff to white, fine-grained, well-sorted, sub-angular to rounded, quartzose with finely disseminated black material, massively cross-laminated, ledge former, cross-lamination dip directions of S 35° E, S 40° E, S 70° E. See detailed description D-11	11	2
Sandstone, buff to white, fine-grained, well-rounded, subangular to rounded, quartzose, calcareous-cemented, thin-bedded. See detailed description 456.	2	9

Sandstone, buff, fine-grained, well-sorted, angular to rounded, quartzose, calcareous-cemented, massive-bedded, structureless, ledge former	5	3
Sandstone, buff, fine-grained, well-sorted, well-rounded, subangular to rounded, quartzose, calcareous-cemented, thin-bedded	5	0
Sandstone, buff, fine-grained, well-sorted, subangular to rounded, quartzose, calcareous-cemented, massive bedded with micro-cross-laminations. See detailed description 457	18	0
Alcova:		
Limestone, buff, weathering gray, finely crystalline, unfossiliferous, lower 1 foot massive-bedded, upper 1 foot 4 inches crinkly- to wavy-bedded, ledge former. See detailed descriptions D-1, D-2, and D-3	2	4
Red Peak:		
Sandstone, gray with maroon bands, fine- to very fine-grained, quartzose, calcareous-cemented, massive-bedded with micro-cross-laminations, ledge former	12	0
Lower portion very poorly exposed in anticlinal core. Not measured and no estimate of thickness made.		

E. NORTH END OF RAWLINS UPLIFT

Sec. 22, T. 23 N., R. 88 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Sundance:		
Sandstone, buff, fine- to coarse-grained, poorly sorted, subangular to subrounded, quartzose, calcareous-cemented, thinly bedded. Prominent ledge former. No estimate of thickness.		
Triassic:		
Popo Agie:		
Covered interval	243	0
Sandstone, buff weathering to reddish-brown, medium- to fine-grained, poorly sorted, subangular to rounded, cherty, quartzose, calcareous-cemented, thin-bedded and cross-laminated, slight ledge former	4	6
Covered interval	3	6
Sandstone, buff weathering to reddish-brown, medium- to fine-grained, poorly sorted, subangular to rounded, cherty, quartzose, calcareous-cemented, thin-bedded and cross-laminated, slight ledge former. See detailed description 458	5	0
Covered interval	22	6
Alcova:		
Limestone, light gray, very fine- to fine crystalline, unfossiliferous, thin- to massive-bedded, prominent ledge former. See detailed descriptions E-1, E-2, E-3, E-4, E-5, E-6, E-6-A, and E-7	12	6

Red Peak:
Red Peak section is fairly well exposed here but was not measured. No estimate of thickness.

F. IN DRAINAGE ON EAST SIDE OF WYO. HIGHWAY 220

C W½ W½ sec. 22, T. 32 N., R. 81 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Sundance:		
Sandstone, buff, weathering same, fine-grained with abundant medium-size grains of well-rounded, frosted quartz, abundant grains of fresh looking, pink feldspar and black chert, lower 43 feet form an imposing, unscalable cliff, upper 13 feet thin-bedded and cross-laminated. See detailed description 462	56	0
Sandstone, reddish-maroon, fine-grained, very silty, calcareous-cemented, quartzose, thin-bedded, slight slope former, cross-bed dip direction of N 55° E	8	0
Sandstone, buff, weathering same, fine-grained, well-sorted, well-rounded, calcareous-cemented, quartzose, thin-bedded	2	0
Covered interval	8	0
Triassic:		
Popo Agie:		
Sandstone, buff, weathering same, fine- to medium-grained, angular to subrounded, fairly well-sorted,		

well-cemented, quartzose, thin-bedded, ledge former. See detailed description 461	1	6
Sandstone, buff, weathering same, fine-grained with abundant medium-size grains of well-rounded, frosted quartz, abundant grains of fresh-looking pink feldspar and black chert, upper 3 feet massive-bedded, lower 2½ feet somewhat silty and thin-bedded	5	6
Sandstone, brownish-red, very fine-grained, silty, subangular to sub-rounded, fairly well-sorted, quartzose with some fresh-looking pink feldspar and black chert, moderately well-cemented, thin-bedded, slight ledge former	3	0
Shale, reddish-maroon, clayey, somewhat silty, micaceous, thinly laminated, slope former	2	0
Sandstone, buff, weathering same, fine-grained with abundant medium-size grains of well-rounded, frosted quartz, abundant grains of fresh-looking, pink feldspar and black chert, thin-bedded and cross-laminated, cross-bed dip directions of N 20° E, N 45° E, and N 55° E, massive-bedded, ledge former	9	6
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, calcareous-cemented, thin-bedded, slope former	2	0
Sandstone, buff, weathering same, fine-grained with abundant medium-size grains of well-rounded, frosted quartz, abundant grains of fresh-looking, pink feldspar and black chert, massive-bedded and cross-laminated with cross-bed dip direction of N 65° E, ledge former	14	0

Shale, reddish-maroon, clayey, micaceous, slightly silty, thinly laminated	1	0
Sandstone, buff, weathering same, fine- to medium-grained, fairly well-rounded, well-sorted, quartzose, some pink feldspar and dark brown to black chert with trace of other dark minerals, very friable and massive-bedded with small scale cross-laminations, cross-bed dip directions of N 15° E. See detailed description 460 .	22	6
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, calcareous-cemented, thin-bedded	1	3
Sandstone, buff, weathering same, fine- to medium-grained, fairly well-rounded, well-sorted, quartzose, some pink feldspar and dark brown to black chert with trace of other dark minerals, very friable and massive bedded. See detailed description 460	6	3
Covered interval	1	6
Sandstone, reddish-buff, very fine- to medium-grained, poorly sorted, rounded to subangular, quartzose, some fresh pink feldspar and gray to black chert grains, well-cemented	2	0
Shale, reddish-maroon, clayey, micaceous, slightly silty, thinly laminated	1	6
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, calcareous-cemented, thin-bedded, slope former. See detailed description 459	17	0
Sandstone, buff, weathering same, fine- to medium-grained, fairly well-sorted, quartzose, some pink feldspar and dark brown to black		

chert with trace of other dark minerals, very friable and massive-bedded, ledge former	3	0
Alcova:		
Limestone, gray, weathering grayish-white, finely crystalline, slightly dolomitic, lower 14 feet massive-bedded with numerous hematite stained quartz silt laminae, upper 18 feet thin-, wavy-bedded with large algal structures, upper surface of limestone wavy-bedded and mud cracked, prominent ledge former. See detailed descriptions F-1, F-2, F-3, F-4, F-5, and F-6	32	0
Red Peak:		
No good exposures at this locality. Not measured and no estimate of thickness.		

G. JUST SOUTHWEST OF ALKALI CREEK FENCE AND CATTLE GUARD

SW¼ SW¼ sec. 1, T. 50 N., R. 90 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Grayish-white, finely crystalline, massive-bedded gypsum, with interbedded red, thinly laminated, clay shales. Thickness not measured.		
Jurassic--Triassic(?):		
Undivided:		
Covered interval	17	0

Triassic:		
Alcova:		
Limestone, gray, unfossiliferous, very fine-crystalline with numerous hematite-stained quartz grains, upper 4½ feet thin-, wavy-bedded, lower 5 feet massive-bedded with abundant "algal heads".	9	6
Red Peak:		
Sandstone, grayish-white, very fine- to fine-grained, subrounded, well-sorted, quartzose, massive-bedded .	2	0
Sandstone, reddish-gray, very fine- to fine-grained, subrounded, well-sorted, quartzose, massive-bedded, grades vertically into the unit above	3	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, massive-bedded, prominent ledge former	19	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, very argillaceous, thin-bedded, slope former	7	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	2	0
Shale, reddish-maroon, clayey, somewhat silty, thinly laminated, slope former	9	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded, slight ledge former	3	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, very argillaceous, thin-bedded, slope former	2	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose,		

massive-bedded with micro-cross-laminations, ledge former	3	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, very argillaceous, thin-bedded, slope former	4	0
Shale, grayish-green, clayey, somewhat silty, very thinly laminated	0	6
Siltstone, salmon-red, medium- to coarse-grained, slightly micaceous, very argillaceous, thin-bedded, slope former	15	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	5	6
Shale, brick-red, clayey, slightly silty, thinly laminated	1	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded with micro-cross-laminations, prominent ledge former	19	0
Lower portion of Red Peak section covered and not measured. No estimate of thickness.		

H. CIRCLE RIDGE ANTICLINE. JUST NORTH OF WELL 29

N½ SE¼ sec. 26, T. 7 N., R. 3 W.

Formational Description	Thickness of Unit in Feet and Inches	
Triassic(?):		
Nugget:		
Sandstone, grayish-white, fine- to medium-grained, well-sorted, subangular to subround, quartzose, thin-bedded, ledge former	15	0

Triassic:		
Popo Agie:		
Covered interval. Appears to be primarily an interval composed of reddish-maroon, silty, clay shale, slope former	29	0
Claystone, brownish-yellow, blocky- to thin-bedded, with pea-size, ovoid concretions, plant remains rare, ledge former	3	0
Shale, reddish-maroon, clayey, silty, thinly laminated, slope former	4	0
Claystone, brownish-yellow, blocky- to thin-bedded, with pea-size, ovoid concretions, plant remains rare, ledge former	8	0
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, quartzose, massive-bedded, ledge former	4	0
Claystone, brownish-yellow, blocky- to thin-bedded, with pea-size, ovoid concretions, plant remains fairly common, ledge former	10	0
Shale, reddish-maroon, clayey, silty, somewhat micaceous, thinly laminated, slope former	4	0
Covered interval	36	0
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, quartzose, massive-bedded, ledge former	4	0
Covered interval	15	0
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, quartzose, massive-bedded, ledge former	1	6
Covered interval	14	6
Crow Mountain:		
Sandstone, grayish-white, fine- to very fine-grained, well-sorted, subangular to subrounded, quartzose, upper 3 to 6 inches is a		

limestone pebble conglomerate, unit has two one-foot shale layers near the top, thin to massive-bedded and cross-stratified, numerous cross-bed dip directions of N 85° E	26	6
Siltstone, reddish-maroon with white bands, medium- to coarse-grained, quartzose, thin-bedded, slope former	5	3
Sandstone, grayish-white, fine- to very fine-grained, well-sorted, subangular to subrounded, quartzose, massive-bedded, ledge former .	22	4
Siltstone, grayish-white, coarse-grained to arenaceous, well-sorted, subrounded, quartzose, thin-bedded, lower 4 feet has same description but is reddish-maroon in color, slope former	13	0
Sandstone, grayish-white, fine- to very fine-grained, well-sorted, subangular to subrounded, quartzose, massive-bedded, ledge former .	19	6
Shale, greenish-gray, clayey, slightly silty, calcareous, thinly laminated. This unit may be equivalent to the Alcova Limestone Member	1	6
Shale, reddish-maroon, clayey, silty, somewhat micaceous, calcareous, thinly laminated	3	3
Red Peak:		
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, quartzose, thinly-bedded, ledge former	15	0
Lower portion of Red Peak section not exposed at this locality. No estimate of thickness.		

I. SOUTH LIMB OF CIRCLE RIDGE ANTICLINE, 150 YARDS WEST OF MAIN ROAD

SW¼ sec. 7, T. 6 N., R. 2 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Grayish-white, finely crystalline, massive-bedded gypsum, with interbedded red, thinly laminated, clay shales. Thickness not measured.		
Triassic(?):		
Popo Agie(?):		
Covered interval. Interval appears to consist primarily of reddish-maroon, clayey, silty shales	65	0
Claystone, brownish-yellow, blocky- to thin-bedded, with pea-size, ovoid concretions, plant remains rare, ledge former	33	0
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, quartzose, massive-bedded ledge former	6	0
Claystone, brownish-yellow, blocky- to thin-bedded, with pea-size, ovoid concretions, plant remains rare, ledge former	18	0
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, quartzose, massive-bedded, ledge former	5	0
Claystone, brownish-yellow, blocky- to thin-bedded, with pea-size, ovoid concretions, plant remains fairly common, ledge former	11	0

Shale, reddish-maroon, clayey, silty, thinly laminated, slope former	41	0
Siltstone, reddish-maroon with white bands, medium- to coarse-grained, somewhat micaceous, thin-bedded, ledge former	15	0
Covered interval. Lower 6 feet definitely consist of green, silty shale, while the upper part appears to consist of red, silty shale, slope former	23	6
Mudstone, grayish-white, fine-grained, calcareous-cemented, thin-bedded, weathering blocky, ledge former	4	0
Covered interval	27	0
Crow Mountain:		
Sandstone, grayish-white, fine- to very fine-grained, well-sorted, subangular to subrounded, quartzose, upper 3 to 6 inches is a limestone pebble conglomerate, unit has two one foot shale layers near the top, thin- to massive-bedded, ledge former, outcrop well saturated with petroleum residue	25	6
Covered interval	6	6
Siltstone, grayish-white, medium- to coarse-grained, slightly micaceous, quartzose with numerous dark minerals, thin-bedded and micro-cross-laminated, ledge former	5	0
Sandstone, grayish-white, very fine-grained with some medium size grains, fairly well-sorted, subrounded to angular, quartzose, massive-bedded with micro-cross laminations, ledge former. See detailed description 464	44	0
Siltstone, grayish-white, medium- to coarse-grained, slightly		

micaceous, quartzose with numerous dark minerals, very thin-bedded, slope former	14	0
Siltstone, grayish-white, medium- to coarse-grained, slightly micaceous, quartzose with numerous dark minerals, very thin-bedded and micro-cross-laminated, outcrop saturated with petroleum residue, ledge former	51	0
Red Peak:		
Shale, reddish-maroon, clayey, slightly silty, thinly laminated, weathering to small, angular chunks, slope former	5	4
Mudstone, grayish-white, very fine-grained, calcareous-cemented, very thin-bedded, slight ledge former .	10	6
Shale, reddish-maroon, clayey, slightly silty, thinly laminated, weathering to small angular chunks, slope former	23	6
Lower portion not exposed at location where this section was measured. No estimate of thickness.		

J. SECTION MEASURED IN CLIFFS ON SOUTH SIDE OF RED BASIN

W½ W½ sec. 14, T. 7 N., R. 2 W.

Formational Description	Thickness of Unit in Feet and Inches
Jurassic:	
Gypsum Springs:	
Grayish-white, finely crystalline, massive-bedded gypsum and interbedded reddish-maroon, clayey, silty shales. Thickness not measured.	

Triassic:		
Popo Agie:		
Covered interval	55	0
Siltstone, brownish-maroon, medium- to coarse-grained, somewhat micaceous, very argillaceous, quartzose, thin-bedded	6	0
Shale, reddish-maroon, clayey, micaceous, rubbly weathering, thinly laminated, slope former ...	8	0
Siltstone, brownish-maroon, medium- to coarse-grained, somewhat micaceous, slightly argillaceous, quartzose, well-cemented, massive-bedded, ledge former	22	0
Shale, maroon, clayey, slightly silty, rubbly weathering, thinly laminated, slope former	10	0
Sandstone, greenish-gray, very fine-grained, well-sorted, subangular to subrounded, quartzose, calcareous-cemented, thin-bedded	4	0
Shale, maroon, clayey, slightly silty, rubbly weathering, thinly laminated, slope former	25	0
Conglomerate, variegated gray, particles of granite to pebble-size composed of limestone, calcareous-cemented, base shows evidence of channeling, cross-laminated, ledge former	8	0
Shale, maroon, clayey, slightly silty, rubbly weathering, thinly laminated, slope former	25	0
Sandstone, grayish-white, very fine- to fine-grained, fairly well-sorted, subangular to subrounded, quartzose, friable, thin-bedded ..	3	0
Shale, maroon, clayey, slightly silty, rubbly weathering, thinly laminated, slope former	15	0
Sandstone, grayish-white, very fine- to fine-grained, fairly well-sorted, subangular to subrounded, quartzose, friable, thin-bedded ..	3	0

Siltstone, reddish-maroon with white bands, medium- to coarse-grained, micaceous, quartzose, well-cemented, thin-bedded	3	6
Conglomerate, variegated gray, particles of granule to pebble-size composed of limestone, calcareous-cemented, averages about 2 feet in thickness but locally channels out lower units to a depth of 8-10 feet, ledge former .	2	0
Shale, reddish-maroon, clayey, very silty, micaceous, rubbly weathering, thinly laminated	4	0
Sandstone, grayish-white, very fine-grained, well-sorted, subangular to subrounded, quartzose, well-cemented with calcareous cement, thin-bedded, ledge former	8	0
Shale, reddish-maroon, clayey, very silty, micaceous, rubbly weathering, thinly laminated	2	0
Siltstone, grayish-white, fine- to medium-grained, quartzose, well-cemented with calcareous cement, massive-bedded	0	6
Shale, reddish-maroon, clayey, very silty, slightly micaceous, rubbly weathering, thinly laminated, slope former	8	0
Siltstone, reddish-maroon, medium- to coarse-grained, somewhat micaceous, quartzose, well-cemented, massive-bedded with micro-cross-laminations, ledge former	1	6
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, very argillaceous, quartzose, thin-bedded	5	0
Siltstone, reddish-maroon, medium- to coarse-grained, somewhat arenaceous, slightly micaceous, quartzose, well-cemented, along		

the outcrop this unit varies from 1-4 feet in thickness but locally forms a channel 20-25 feet deep into underlying units, ledge former	2	0
Siltstone, reddish-maroon, medium- to coarse-grained, somewhat micaceous, very argillaceous, quartzose, thin-bedded, slope former	25	0
Crow Mountain:		
Sandstone, buff to grayish-white, fine- to very fine-grained, fairly well-sorted, subangular to subrounded, quartzose, calcareous-cemented, massive-bedded, ledge former. See detailed description 468	13	0
Covered interval	3	0
Sandstone, lower and upper 2 feet grayish-white, grading to salmon-red in central part, fine- to very fine-grained, fairly well-sorted, subangular to subrounded, quartzose, well-cemented with calcareous cement, massive-bedded with medium-scale cross-laminations, ledge former. See detailed description 467	14	0
Siltstone, white, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded	0	6
Shale, reddish-maroon, clay, slightly silty, thin-bedded	4	0
Siltstone, brick-red, medium- to coarse-grained, arenaceous, slightly micaceous, quartzose, well-cemented, massive-bedded, ledge former	5	6
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, argillaceous, quartzose, thin-bedded, slope former	22	0

Sandstone, salmon-red, fine- to very fine-grained, fairly well-sorted, subangular to subrounded, slightly micaceous, quartzose, well-cemented, massive-bedded, ledge former. See detailed description 466	7	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, well-cemented, thin-bedded	12	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded, slope former	15	0
Sandstone, grayish-white, fine- to medium-grained, fairly well-sorted, subangular to subrounded, quartzose, thin-bedded and cross-laminated with cross-bed dip directions of N 85° E, N 65° E, S 75° E, S 40° E, S 50° E, S 45° E, ledge former. See detailed description 465	10	0
Red Peak:		
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded, slope former	17	6
Siltstone, grayish-white, fine- to medium-grained, quartzose, calcareous-cemented, thin-bedded, possibly Alcova equivalent, ledge former	5	2
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded, slope former	17	6
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, well-cemented with calcareous cement, massive-bedded with micro-cross-laminations, ledge former	6	6

Shale, reddish-maroon, clayey, silty, slightly micaceous, thinly laminated, rubbly weathering, has a few gypsum stringers, slope former	21	0
Gypsum, grayish-white, fine- to medium-crystalline, massive-bedded with maroon shale partings.	1	0
Shale, reddish-maroon, clayey, somewhat silty, thinly laminated	1	3
Siltstone, grayish-white, fine- to medium-grained, quartzose, calcareous-cemented, thin-bedded	0	10
Shale, reddish-maroon, clayey, slightly silty, somewhat micaceous, thinly laminated	0	6
Sandstone, brick-red, fine- to medium-grained, well-sorted, subangular to subrounded, quartzose, micro-cross-laminated	0	4
Shale, reddish-maroon, clayey, slightly silty, somewhat micaceous, thinly laminated	3	0
Covered interval, probably shale	65	0
Shale, reddish-maroon, clayey, slightly silty, somewhat micaceous, thinly laminated	3	0
Siltstone, light gray, fine- to medium-grained, quartzose with several very thin beds of fibrous gypsum, fairly massive-bedded, ledge former	6	8
Shale, reddish-maroon, clayey, slightly silty, thinly laminated	2	9
Shale, light green, clayey, slightly silty, thinly laminated	0	2
Gypsum, grayish-white, fine- to medium-crystalline, thin-bedded	0	1
Shale, light green, clayey, slightly silty, thinly laminated	0	6
Limestone, medium-gray, very fine- to fine-crystalline, unfossiliferous, thin-bedded. See detailed description J-1	0	4

Lower portion of Red Peak not well exposed. No estimate of thickness.

K. NORTH FLANK OF MADDEN ANTICLINE

SE¼ SW¼ SW¼ sec. 19, T. 7 N., R. 1 E.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Grayish-white, fine- to medium-grained, massive-bedded gypsum and interbedded reddish-maroon clayey, slightly silty shales. Thickness not measured.		
Shale, reddish-maroon, clayey, somewhat silty, slightly micaceous, thinly laminated, slope former	4	0
Triassic:		
Popo Agie:		
Siltstone, reddish-maroon, medium- to coarse-grained, well-cemented, massive-bedded with micro-cross-laminations, ledge former	3	0
Claystone, yellow-brown, fine- to medium-grained, silty with a few scattered plant remains, slope former	14	0
Shale, reddish-maroon, clayey, somewhat micaceous, thinly laminated, slope former	5	0
Sandstone, grayish-white, fine- to very-fine-grained, well-sorted, subrounded, quartzose, calcareous-cemented, thin-bedded, ledge former	12	0

Shale, reddish-maroon, clayey, slightly silty, somewhat micaceous, thinly laminated, slope former	6	0
Sandstone, grayish-white, very fine- to fine-grained, well-sorted, subangular to subrounded, quartzose, calcareous-cemented, massive-bedded, ledge former	2	0
Shale, reddish-maroon, clayey, slightly silty, very thinly laminated	2	0
Sandstone, grayish-white, very fine- to fine-grained, well-sorted, subangular to subrounded, thin-bedded, slight ledge former. See detailed description 471	3	6
Shale, reddish-maroon, clayey, slightly silty, thinly laminated .	3	6
Siltstone, brick-red, medium- to coarse-grained, micaceous, thin-bedded, prominent ledge former ...	16	0
Shale, reddish-maroon, silty, slightly micaceous, thinly laminated	2	0
Crow Mountain:		
Sandstone, grayish-white, fine- to very-fine-grained, fairly well-sorted, subangular to subrounded, quartzose with calcareous cement, massive-bedded with small scale cross-laminations having dip directions of N 50° E, N 55° E, N 70° E, N 60° E, ledge former	8	0
Sandstone, brick-red, fine- to very-fine-grained, fairly well-sorted, subangular to subrounded, quartzose, well-cemented with calcareous cement, thin-bedded	2	0
Sandstone, grayish-white, fine- to very fine-grained, fairly well-sorted, subangular to subrounded, quartzose, calcareous-cemented,		

massive-bedded with small scale cross-laminations having dip directions of N 70° E, N 85° E, N 65° E, ledge former	13	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, thin-bedded .	4	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, slightly calcareous-cemented, massive-bedded, ledge former	10	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded, slope former	7	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, somewhat argillaceous, quartzose, rubbly weathering, thin-bedded, ledge former	25	0
Shale, reddish-maroon, clayey, thinly laminated	0	2
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, quartzose, massive-bedded with micro-cross-laminations	0	3
Shale, reddish-maroon, clayey, thinly laminated	0	2
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, thin-bedded, ledge former	5	0
Shale, reddish-maroon, clayey, thinly laminated	0	3
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, massive-bedded .	0	3
Shale, reddish-maroon, clayey, thinly laminated	0	3
Sandstone, fine- to very fine-grained, fairly well-sorted, subangular to subrounded, quartzose, massive-bedded, ledge former. See detailed description 470	13	0

Red Peak:		
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, well-cemented, massive-bedded	1	0
Shale, reddish-maroon, clayey, somewhat silty, thinly laminated, slope former	14	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, thin-bedded	1	6
Shale, reddish-maroon, clayey, somewhat silty, thinly laminated	1	6
Siltstone, grayish-white, very fine-grained, quartzose, calcareous-cemented, massive-bedded, probable Alcova equivalent	6	0
Shale, reddish-maroon, clayey, slightly micaceous, thinly laminated	1	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, somewhat argillaceous, quartzose, thinly laminated, slope former	25	0
Shale, reddish-maroon, clayey, very thinly laminated	0	8
Siltstone, grayish-white, fine-grained, quartzose, calcareous-cemented, thin-bedded	0	6
Shale, reddish-maroon, clayey, slightly silty, thinly laminated ..	3	0
Sandstone, grayish-white, very fine-grained, well-sorted, subangular to subrounded, well-cemented, quartzose, massive-bedded, ledge former	16	0
Shale, reddish-maroon, clayey, slightly silty, thinly laminated ..	3	0
Siltstone, reddish-maroon, medium- to coarse-grained, slightly micaceous, quartzose, massive-bedded with micro-cross-laminations, ledge former	31	0
Shale, reddish-maroon, clayey, slightly silty, thinly laminated ..	1	6

Siltstone, reddish-maroon, medium- to coarse-grained, slightly micaceous, quartzose, well-cemented, massive-bedded with micro-cross-laminations, prominent ledge former	46	0
Lower portion of Red Peak is not exposed in the center of the anticline. No estimate of thickness. Upper portion of Popo Agie section locally faulted and difficult to measure.		

L. MEASURED WHERE PAVEMENT ENDS WEST OF KAYCEE, WYOMING

NE¼ sec. 2, T. 42 N., R. 83 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Sundance:		
Buff, medium- to coarse-grained, well-sorted, subrounded, calcareous-cemented, thin-bedded. At very base of Sundance there is a prominent zone of reworked Chugwater. Thickness not measured.		
Triassic:		
Popo Agie:		
Shale, reddish-maroon, clayey to slightly silty, somewhat micaceous, thin-bedded with occasional 4-6 inch grayish-white, fine-grained quartz sandstone interbedded, slope forming unit	25	0

Siltstone, reddish-maroon, medium- to coarse-grained, slightly micaceous, well-cemented, quartzose, massive-bedded, ledge former	12	0
Shale, reddish-maroon, clayey to slightly silty, thinly laminated .	3	0
Sandstone, reddish-maroon, very fine-grained, silty, slightly micaceous, massive-bedded, ledge former	2	0
Shale, reddish-maroon, clayey to slightly silty, thinly laminated .	3	0
Sandstone, grayish-white, very fine-grained, silty, quartzose, massive-bedded	0	3
Shale, reddish-maroon, clayey, silty, thinly laminated	1	6
Siltstone, reddish-maroon, medium- to coarse-grained, somewhat micaceous, micaceous quartzose, well-cemented, massive-bedded, ledge former	4	6
Siltstone, reddish-maroon, medium- to coarse-grained, slightly micaceous, argillaceous, thin-bedded, slope former	11	0
Sandstone, brick-red, fine- to very fine-grained, fairly well-sorted, subangular to subrounded, quartzose, calcareous-cemented, massive-bedded	0	10
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, well-cemented, massive bedded	1	6
Shale, reddish-maroon, clayey, silty, thinly laminated	0	6
Sandstone, grayish-white, very fine-grained, silty, slightly micaceous, quartzose, well-cemented ..	0	5
Shale, reddish-maroon, clayey, slightly silty, thinly laminated .	3	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, calcareous-		

cemented, thin-bedded, slope former	17	6
Crow Mountain:		
Sandstone, brick-red, very fine-grained, well-sorted, subangular to subrounded, quartzose, well-cemented with calcareous-cement, massive-bedded	3	6
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, quartzose, calcareous-cemented, thin-bedded, slight slope former	12	0
Shale, reddish-maroon, clayey, silty, slightly micaceous, thinly laminated	0	6
Sandstone, brick-red, fine- to very fine-grained, well-sorted, sub-angular to subrounded, quartzose, with abundant fresh pink feldspar grains, calcareous-cemented, massive-bedded with small scale cross-laminations having dip directions of S 10° E, S 5° E, S 25° E, S 50° E, S 25° E, S 15° E, S 15° E, S 15° E, massive cliff former	47	0
Alcova:		
Limestone, light gray, fine- to medium-crystalline, lower 3' 6" massive-bedded with numerous silt lamina, upper 3' 9" thin- , wavy-bedded and slightly argillaceous, ledge former. See detailed descriptions L-3, L-4	7	3
Red Peak:		
Siltstone, brick-red with grayish-white bands, medium- to coarse-grained, slightly arenaceous, quartzose, well-cemented with calcareous cement, massive-bedded	11	0

Shale, reddish-maroon, clayey, somewhat silty and micaceous, thinly laminated	0	6
Lower portion of Red Peak section is well exposed in cliffs throughout this region. It was deemed inadvisable to measure this portion of Red Peak because of the steepness of the cliff faces.		

M. RED ROCKS REGION EAST OF DUBOIS, WYOMING

S½ SE¼ sec. 13, T. 5 N., R. 6 W.

Formational Description	Thickness of Unit in Feet and Inches	
Triassic(?):		
Nugget(?):		
Sandstone, buff, medium- to coarse-grained, well-sorted, subrounded, quartzose with some fresh pink feldspar, calcareous-cemented, massive-bedded, ledge former	125	0
Siltstone, bluish-gray, medium- to coarse-grained, slightly micaceous, quartzose, thin-bedded, slope former	7	0
Triassic:		
Popo Agie:		
Covered interval	63	0
Sandstone, grayish-white, medium- to coarse-grained, poorly sorted, subangular to subrounded, quartzose with abundant grains of pink feldspar and gray to black chert, thin-bedded, ledge former	5	6
Covered interval	107	0

Shale, reddish-maroon, clayey, silty with a 2 foot quartz-limestone pebble conglomerate at very top ..	11	6
Sandstone, grayish-white, very fine-grained, silty, slightly micaceous quartzose with several 6-10 inch reddish-maroon, silty, clay shales interbedded	5	0
Siltstone, grayish-white, medium- to coarse-grained, micaceous, quartzose, thin-bedded	0	6
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, quartzose, calcareous-cemented, massive-bedded	1	6
Shale, reddish-maroon, clayey, becoming silty in upper 1 foot, thinly laminated	5	6
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, quartzose, calcareous-cemented, massive-bedded. See detailed description 474	1	6
Shale, reddish-maroon, clayey, silty, micaceous, thinly laminated	2	6
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, argillaceous, quartzose, slope former	6	0
Siltstone, reddish-maroon, medium- to coarse-grained, slightly micaceous, quartzose, well-cemented with calcareous cement, massive-bedded with micro-cross-laminations, ledge former	5	0
Siltstone, reddish-maroon, medium- to coarse-grained, micaceous, argillaceous, quartzose, thin-bedded, slope former	16	6
Siltstone, reddish-maroon, medium- to coarse-grained, slightly micaceous, quartzose, well-cemented with calcareous cement, massive-bedded with micro-cross-		

laminations; angular limestone granules, apparently derived from underlying Alcova are abundant throughout, but are particularly abundant in lower 3 feet; lower contact shows good evidence of channeling into underlying limestone. Prominent ledge former. See detailed descriptions 473, 474	11	6
Alcova:		
Limestone, light-gray-stained, reddish maroon, finely crystalline, silty, vuggy porosity, dolomitic, lower 1 foot massive-bedded, upper 13 inches very wavy- and "crinkly"-bedded. See detailed descriptions M-2 and M-4	2	1
Red Peak:		
Siltstone, reddish-maroon, medium- to coarse-grained, slightly micaceous, quartzose, well-cemented, massive-bedded with a few 6 inch beds of reddish-maroon, clayey, silty shales. See detailed description 472	33	6
Lower portion of Red Peak section is well exposed here but was not measured. No estimate of Red Peak thickness.		

N. ALONG ROAD THROUGH WATERGAP

South Line sec. 20, T. 42 N., R. 98 W.

Formational Description	Thickness of Unit in Feet and Inches
Jurassic:	
Gypsum Springs:	
Grayish-white, fine-crystalline, massive-bedded gypsum, with	

interbedded maroon, thinly laminated, clay shales. Thickness not measured.		
Triassic:		
Popo Agie:		
Covered interval. Unit appears to be composed of red to maroon, very silty, clay shales and siltstones, slope former	83	0
Sandstone, grayish-white, very fine-grained, somewhat silty, quartzose, calcareous-cemented, massive-bedded, ledge former	1	0
Covered interval. Unit appears to be composed of red to maroon, very silty, clay shales and siltstones, slope former	68	0
Sandstone, reddish-maroon, very fine-grained, very silty, quartzose, calcareous-cemented, thin-bedded, slight ledge former .	11	0
Shale, reddish-maroon, silty, clayey, thinly laminated, slope former	16	0
Sandstone, grayish-white, very fine-grained, somewhat silty, quartzose, calcareous-cemented, massive-bedded, ledge former	3	6
Shale, reddish-maroon, silty, clayey, thinly laminated, slope former	4	0
Sandstone, reddish-maroon with white banding, very fine-grained, quartzose, calcareous-cemented, massive-bedded, ledge former	1	6
Shale, reddish-maroon, silty, clayey, thinly laminated, slope former	3	0
Crow Mountain:		
Sandstone, grayish-white, very fine- to fine-grained, subangular to subrounded, fairly well-sorted, quartzose, cross-stratified with		

dip directions of N 5° E, N 5° W, N 10° E, N 10° E, N 10° E, N 15° E, N 10° E, ledge former. See detailed description 477	18	6
Shale, reddish-maroon, clayey, somewhat micaceous, thinly laminated, slope former	1	0
Sandstone, grayish-white, very fine- to fine-grained, quartzose, friable, thin-bedded, ledge former ..	1	4
Shale, reddish-maroon, clayey, silty, somewhat micaceous, thinly laminated, slope former	0	8
Sandstone, grayish-white, very fine- to fine-grained, quartzose, friable, thin-bedded, ledge former ..	1	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, thin-bedded, quartzose, slope former	11	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, argillaceous, interval somewhat poorly exposed on grass covered slope	16	0
Sandstone, buff to grayish-white, very fine- to fine-grained, subangular to subrounded, fairly well-sorted, quartzose, thin-bedded, ledge former	7	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, unit somewhat poorly exposed on grass covered slope	10	0
Sandstone, buff to grayish-white, very fine- to fine-grained, subangular to subrounded, fairly well-sorted, quartzose, occurs in beds 4" to 4' thick, basal 8" somewhat silty and calcareous-cemented, prominent ledge former. See detailed description 476	38	0

Alcova:		
Limestone, grayish-white, weathering same, finely crystalline, slightly dolomitic, lower 2' massive-bedded with some "algal heads," upper 2' feet thin and wavy-bedded, ledge former. See detailed descriptions N-100-T, N-100-BC, N-100-TM, N-100-MM, and N-100-BM	4	6
Red Peak:		
Sandstone, grayish-white with maroon bands, very fine-grained, somewhat silty, well-cemented with calcareous cement, quartzose, massive-bedded, contact with overlying limestone very sharp, ledge former	9	6
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, argillaceous, quartzose, thinly laminated, slope former	8	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	1	6
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, artillaceous, quartzose, thinly laminated, slope former	13	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	1	6
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, argillaceous, quartzose, thinly laminated, slope former	7	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	2	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous,		

argillaceous, quartzose, thinly laminated, slope former	9	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, calcareous-cemented, quartzose, massive-bedded with micro-cross-laminations, ledge former	3	0
Shale, reddish-maroon, clayey, silty, micaceous, thinly laminated, blocky weathering, slope former ...	15	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, calcareous-cemented, quartzose, massive-bedded with micro-cross-laminations, ledge former	12	0
Shale, reddish-maroon, clayey, silty, micaceous, thinly laminated, blocky weathering, slope former	4	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, calcareous-cemented, quartzose, massive-bedded with micro-cross-laminations, ledge former	11	0
Siltstone, greenish-gray, fine- to medium-grained, quartzose, calcareous cemented	0	3
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, argillaceous, quartzose, thinly laminated, slope former	22	0
Siltstone, grayish-white, medium- to coarse-grained, quartzose with carbonaceous (?) streaks, thin-bedded	2	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, calcareous cemented, quartzose, massive-bedded, ledge former	7	3
Lower portion of Red Peak very poorly exposed and unmeasurable. No estimate of thickness.		

O. MEASURED ALONG WILD HORSE BUTTE ROAD

NW¼ sec. 15 and SW¼ sec. 10, T. 42 N., R. 98 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
White massive-bedded gypsum with interbedded red clay shale. Thickness not measured.		
Triassic:		
Popo Agie:		
Shale, maroon, clayey, thinly laminated with a few intercalated siltstones, unit predominantly a covered slope	67	0
Siltstone, brick-red, medium- to coarse-grained quartzose, micaceous, massive-bedded with micro-corss-laminations, ledge former ..	9	0
Shale, red-maroon, silty, clayey, thinly laminated, interval primarily a partially covered slope ...	54	0
Crow Mountain:		
Sandstone, white, very fine-grained to silty, quartzose, well-cemented, massive-bedded with micro-cross-laminations	2	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, massive-bedded with micro-cross laminations, ledge former	14	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, thin-bedded, slight slope former	6	0

Sandstone, white, very fine- to fine-grained, well-rounded, well-sorted, quartzose, calcareous, massive-bedded	1	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, thin-bedded, slight slope former	9	0
Sandstone, white, very fine- to fine-grained, well-rounded, well-sorted, quartzose, calcareous-cemented, massive-bedded	1	3
Shale, red-maroon, silty, clayey, micaceous, thinly laminated, slope former	3	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, massive-bedded with micro-cross-laminations, ledge former ...	9	0
Shale, red-maroon, silty, clayey, micaceous, thinly laminated, predominantly a slope former, generally poorly exposed	13	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, massive-bedded, grading upward into very fine-grained, white, well-rounded, well-sorted quartz sandstone in upper 18 inches, ledge former	8	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, massive-bedded, cliff former	17	0
Shale, pinkish-red with gray streaks, silty, clayey, thinly laminated, slope former	2	6
Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded in lower 12 feet, becoming somewhat thin-bedded in upper 16 feet, ledge former. See detailed description 478	28	0

Alcova:		
Limestone, gray, finely crystalline, lower 2 feet massive bedded, upper 2'2" thin-, wavy-bedded. See detailed description 0-100-BM, 0-100-MM, 0-100-TM, 0-100-BC, 0-100-MC, and 0-100-TC	4	2
Red Peak:		
Sandstone, grayish-white with maroon band, very fine- to fine-grained, quartzose, slightly silty, massive-bedded, upper 1 foot slightly shaly, grades upward into Alcova, ledge former	13	0
Shale, grayish-pink, thinly laminated, clayey, weathering blocky, slope former	0	8
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, massive-bedded, ledge former	2	0
Shale, reddish-maroon, thinly laminated, clayey, slightly silty, slope former	2	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, massive-bedded, ledge former	2	0
Shale, reddish-maroon, clayey, silty, thinly laminated with several reddish-maroon, medium- to coarse-grained, micaceous, quartzose, thin-bedded siltstones	16	0
Sandstone, buff with red laminations, very fine to fine-grained, poorly sorted, subangular to subrounded quartzose, massive-bedded	3	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, massive-bedded with micro-cross-laminations, grades upward into overlying sandstone ...	2	6
Shale, reddish-maroon, clayey, silty, thinly laminated, slope former	13	0

Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, massive-bedded with micro-cross-laminations, ledge former	5	0
Shale, reddish-maroon, clayey, silty, thinly laminated, slope former	18	0
Siltstone, greenish-white, medium- to coarse-grained, well-cemented, quartzose with thin wavy laminations	2	0

P. MEASURED ALONG ROAD SOUTH OF NOWOOD RIVER

NE¼ of sec. 14, T. 47 N., R. 89 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Massive-bedded gypsum alternating with beds of red shale. Thickness not measured.		
Triassic (?)		
Popo Agie (?)		
Shale, red-maroon, thinly laminated with interbedded medium- to coarse-grained, red, quartzose siltstones; slope former, interval poorly exposed	9	0
Crow Mountain:		
Sandstone, brick- to salmon-red, very fine-grained to silty, subangular to rounded, friable, quartzose, massive-bedded with small scale cross-laminations.		

Cross-stratification dip directions S 30° E, S 23° E, S 35° E, S 25° E, S 15° E, S 30° E, S 25° E, S 25° E, apparently conformable with unit below. See detailed descriptions 479, 480, and 491	42	0
Alcova:		
Limestone, gray, weathering whitish-gray, finely crystalline, massive-bedded throughout, prominent ledge former. See detailed description P-100-A, P-100-B, P-100-C, and P-100-D	4	0
Red Peak:		
Siltstone, brick-red, slightly arenaceous, medium- to coarse-grained, quartzose, massive-bedded, ledge former	18	0
Shale, red, silty, clayey, thinly laminated, slope former	2	0
Siltstone, brick-red, medium- to coarse-grained, slightly arenaceous, quartzose, massive-bedded in lower portion becoming thin-bedded in upper few feet, ledge former	37	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, argillaceous, thin-bedded, slope former ..	3	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded, ledge former	23	0
Shale, reddish-maroon, silty, clayey, thinly laminated, blocky weathering, slope former	17	0
Siltstone, grayish-green, fine- to medium-grained, calcareous, thin-bedded quartzose, ledge former	0	5
Shale, brownish-red, silty, blocky weathering, thinly laminated, slope former	9	0

Siltstone, brownish-red, medium- to coarse-grained, somewhat micaceous, massive-bedded with micro-cross-stratification, ledge former	40	0
Lower portion of section poorly exposed because of talus cover.		

R. MEASURED IN BLUFF ON WEST SIDE OF HYATTVILLE-TENSLEEP ROAD

NE¼ sec. 16, T. 48 N., R. 89 W.

Formational Description	Thickness of Unit in Feet	Inches
Jurassic:		
Gypsum Springs:		
Grayish-white, finely crystalline, massive-bedded gypsum, with interbedded red, thinly laminated, clay shales. Thickness not measured.		
Triassic(?):		
Red Peak(?):		
Covered interval. Interval appears to be a massive, red siltstone	8	0
Triassic:		
Red Peak:		
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous calcareous-cemented, quartzose, massive-bedded, ledge former	1	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, calcareous-cemented, quartzose, thin-bedded	0	6

Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	1	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, calcareous-cemented quartzose, thin-bedded	0	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	1	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, calcareous-cemented, quartzose, thin-bedded	0	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	1	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, calcareous-cemented, quartzose, thin-bedded	0	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	0	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, calcareous-cemented, quartzose, thin-bedded	0	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded, ledge former	0	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, calcareous-cemented, quartzose, thin-bedded	0	6

Siltstone, reddish-maroon, emdium- to coarse-grained, clayey, micaceous, calcareous-cemented, quartzose, massive-bedded, prominent ledge former	14	0
Siltstone, greenish-gray, medium-grained, somewhat argillaceous, quartzose, calcareous-cemented, thin bedded	0	4
Siltstone, reddish-maroon, medium- to coarse-grained, clayey, micaceous, calcareous-cemented, quartzose, massive-bedded, prominent ledge former	21	0
Siltstone, greenish-gray, medium- to coarse-grained, somewhat argillaceous, quartzose, calcareous-cemented, thin-bedded	0	3
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, calcareous-cemented, quartzose, thin-bedded, slope former	13	0
Siltstone, reddish-maroon, medium- to coarse-grained, slightly micaceous, calcareous-cemented, quartzose, massive-bedded with micro-cross-laminations, scarp former. See detailed description 482	36	0
Siltstone, reddish-maroon mottled with gray, medium- to coarse-grained, argillaceous, micaceous, calcareous-cemented, slight slope former	3	0
Shale, reddish-maroon, clayey, slightly silty, thinly laminated, slope former	11	0
Siltstone, greenish-gray, medium- to coarse-grained, somewhat argillaceous, quartzose, calcareous-cemented, thin-bedded	0	6
Lower portion of Red Peak section covered and unmeasured. No estimate of thickness.		

S. MEASURED ALONG PROMINENT CLIFF ON NORTHSIDE OF PAINT ROCK CREEK

SW¼ SE¼ sec. 29, T. 50 N., R. 89 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Grayish-white, fine crystalline, massive-bedded gypsum, with interbedded maroon, thinly laminated, clay shales. Thickness not measured.		
Triassic (?):		
Popo Agie (?):		
Interval mostly covered. Seems to be a reddish-maroon shale with interbedded siltstones	78	0
Triassic:		
Alcova:		
Limestone, gray, fine-crystalline, unfossiliferous, lower 3 feet massive-bedded, middle 4 feet nodular to somewhat massive-bedded, upper 2 feet thinly bedded, middle part contains "algal heads." See detailed descriptions S-3-BM, S-3-TM, S-3-MB, S-3-MMM, S-3-TMM, S-3-A, S-3-B, and S-3-C	9	0
Red Peak:		
Siltstone, grayish-white with maroon bands, coarse-grained to finely arenaceous, quartzose, ledge former, grades upward into overlying limestone unit	4	6

Siltstone, salmon-red, medium- to coarse-grained, quartzose, somewhat micaceous, prominent cliff former	23	0
Lower portion of the Red Peak section is beautifully exposed in a prominent cliff which was deemed to be too steep to be measured.		

T. TRAPPERS CANYON SOUTHEAST OF SHELL, WYOMING

S½ sec. 29, T. 52 N., R. 93 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Grayish-white, fine crystalline, massive-bedded gypsum, with interbedded red, thinly laminated clay shales. Thickness not measured.		
Triassic(?):		
Popo Agie (?):		
Covered interval. Unit appears to be composed of reddish-maroon, clayey, somewhat silty shales; slope former	8	0
Triassic:		
Alcova:		
Limestone, gray weathering to grayish white, finely crystalline, unfossiliferous. Lower 3 feet massive-bedded; upper 1½ feet thinly, wavy bedded, ledge former	4	6

Triassic:		
Red Peak:		
Siltstone, reddish-gray, coarse-grained, arenaceous, quartzise, calcareous-cemented, massive-bedded, ledge former	5	0
Siltstone, brick red, medium- to coarse-grained, slightly micaceous, quartzose, massive-bedded with micro-cross-laminations, ledge former	13	0
Shale, reddish maroon, clayey, slightly silty, thinly laminated .	1	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded, slope former	21	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, massive-bedded, ledge former	2	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded, slope former	27	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, massive-bedded, ledge former	6	6
Shale, reddish-maroon, clayey, slightly silty, thinly laminated .	1	6
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, calcareous-cemented, massive-bedded, ledge former	8	0
Shale, reddish-maroon, clayey, slightly silty, thinly laminated .	2	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, quartzose, calcareous-cemented, massive-bedded, ledge former	4	6

Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded; slope former	11	0
Lower portion of Red Peak section poorly exposed and unmeasurable. No estimate of thickness.		

U. MUDDY GAP. ABOUT ¼ MILE EAST OF CHEVRON STATION

E½ sec. 34, T. 23 N., R. 89 W.

Formational Description	Thickness of Unit in Feet and Inches	
Triassic:		
Popo Agie:		
Upper portion of Popo Agie section is poorly exposed and unmeasurable. No estimate of thickness.		
Siltstone, grayish-white, medium- to coarse-grained, quartzose, calcareous-cemented, massive-bedded, ledge former	13	0
Covered interval	42	0
Shale, maroon, clayey, slightly silty, somewhat micaceous, thinly laminated; slope former	6	0
Siltstone, grayish-white, medium- to coarse-grained, quartzose, calcareous-cemented, massive-bedded with micros-cross-laminations; slight ledge former	6	0
Shale, purplish-maroon, clayey, thinly laminated, slope former	8	0
Siltstone, grayish-white, medium- to coarse-grained, quartzose, calcareous-cemented, massive-bedded with micro-cross-laminations, ledge former	3	5

Siltstone, reddish-maroon, medium- to coarse-grained, somewhat micaceous, quartzose, calcareous-cemented, thin-bedded; slight slope former	48	5
Siltstone, maroon, medium- to coarse-grained, micaceous, quartzoze, calcareous-cemented, artillaceous, thin-bedded; slope former .	3	6
Siltstone, reddish-maroon, thin-bedded, medium- to coarse-grained, clayey, quartzose, calcareous-cemented; slope former	1	6
Siltstone, greenish-gray, medium- to coarse-grained, calcareous-cemented, quartzose, thin-bedded; slope former	1	6
Siltstone, reddish-maroon, medium- to coarse-grained, clayey, quartzoze, calcareous-cemented, thin-bedded; slope former	18	0
Siltstone, gray, medium- to coarse-grained, quartzose, calcareous-cemented, massive-bedded with micro-cross-laminations; ledge former	2	0
Siltstone, reddish-maroon, medium- to coarse-grained, argillaceous, quartzose, calcareous-cemented, thin-bedded	38	0
Siltstone, grayish-green, medium-grained, calcareous-cemented, quartzose, thin-bedded; slight slope former. See detailed description U-2	12	6
Alcova:		
Limestone, gray, weathering whitish-gray, fine crystalline, slightly dolomitic, thin-bedded throughout, section has a nodular chert bed about the middle of the unit and another nodular chert bed about 4		

feet from top of unit; ledge former. See detailed description U-1-a, U-1-b, U-1-c, and U-1-d ...	22	0
Lower portion of Alcova not exposed. Estimate total limestone thickness of 24 feet. No red Peak exposed well enough to be measured. No estimate of Red Peak thickness.		

V. SOUTH PASS, MEASURED ALONG HIGHWAY U.S. 28

Beginning in sec. 1, T. 30 N., R. 2 E., and extending Northward into sec. 36, T. 31 N., R. 2 E.

Formational Description	Thickness of Unit in Feet and Inches	
Triassic (?):		
Nugget:		
Upper portion not measured.		
Sandstone, white to buff, medium- to fine-grained, quartzose with siliceous cement, thin-bedded	1	6
Covered interval	13	0
Sandstone, buff, medium- to fine-grained, quartzose with siliceous cement, thin-bedded	7	0
Triassic:		
Popo Agie:		
Covered interval	18	0
Siltstone, red to maroon, shaly, medium- to coarse-grained, micaceous, calcareous, micro-cross-laminated	2	0
Shale, pinkish-maroon, clayey, thinly laminated	4	0
Siltstone, reddish-pink, medium- to coarse-grained, shaly, thin-bedded	8	0

Siltstone, white, medium- to coarse-grained, calcareous, thin-bedded, forming slight ridge	1	0
Covered interval	193	0
Siltstone, orange-red, medium- to coarse-grained, quartzose, slightly micaceous, thin-bedded with micro-cross-laminations, calcareous cements, slight ledge former	7	0
Shale, red-maroon, thinly laminated, silty	3	6
Siltstone and shale, interbedded. Siltstone, reddish-maroon, medium- to coarse-grained, quartzose, calcareous-cemented, thin-bedded. Shale reddish-maroon, thinly laminated and somewhat silty, slight ledge former	23	0
Shale, red-maroon, thinly laminated and silty, slope former	3	6
Siltstone, reddish-maroon, medium- to coarse-grained, slightly micaceous, calcareous-cemented, massive-bedded, ledge former	9	0
Siltstone and shale, interbedded. Siltstone, reddish-maroon, medium- to coarse-grained, quartzose, calcareous-cemented, thin-bedded. Shale, reddish-maroon, thinly laminated and somewhat silty, slight ledge former	21	6
Shale, reddish-maroon, thinly laminated, silty, slope former ...	3	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, slightly calcareous, thin-bedded with micro-cross-laminations, slight slope former. See detailed description 485	23	6

Alcova:

Limestone, lower 1 foot gray weathering same, slightly dolomitic and wavy-bedded. Upper 5 feet		

reddish-gray, silty and massive-bedded. See detailed description V-14-A, V-14-B, and V-14-D	6	0
Red Peak:		
Sandstone, white with maroon bands, very fine- to fine-grained, subangular to subround, quartzose, slightly feldspathic with calcareous cement, ledge former. See detailed description 484	9	6
Shale, brick-red, thinly laminated, silty, slope former	13	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, slightly calcareous, thin-bedded, ledge former	24	0
Shale, brick-red, thinly laminated, rubbly weathering, somewhat silty, slope former	11	0
Siltstone, brick-red, medium-grained, quartzose, slightly micaceous, calcareous-cemented, massive-bedded with micro-cross-laminations, ledge former	9	0
Shale, brick-red, thinly laminated, very silty, micaceous, slope former	2	6
Siltstone, brick-red, medium- to coarse-grained, quartzose, slightly micaceous, calcareous-cemented, massive-bedded, with micro-cross-laminations, ledge former	13	0
Shale, brick-red, thinly laminated, very silty, micaceous, slope former	1	6
Siltstone, brick-red, medium- to coarse-grained, quartzose, micaceous, slightly calcareous, massive-bedded with micro-cross-laminations, ledge former. See detailed description V-5	8	0
Shale, brick-red, thinly laminated, silty, micaceous, slope former ...	1	6

Siltstone, brick-red, medium- to coarse-grained, quartzose, slightly micaceous, slightly calcareous, massive-bedded with micro-cross-laminations, ledge former	10	6
Shale, brick-red, thinly laminated, somewhat silty, slope former, has a 4 inch siltstone bed about middle of unit	4	6
Siltstone, brick-red, medium- to coarse-grained, quartzose, slightly micaceous, massive-bedded with numerous shale partings, ledge former	37	0

W. MIDDLE POPO AGIE RIVER

N½ sec. 3, T. 32 N., R. 100 W.

Formational Description	Thickness of Unit in Feet and Inches	
Triassic (?):		
Nugget:		
Sandstone, buff to variegated, very fine- to medium-grained, quartzose, massively cross-laminated, entire section not measured, no thickness estimate.		
Triassic:		
Popo Agie:		
Covered interval. All slope. Lower 30 to 40 feet appear to be interbedded siltstone and silty shale, upper part of section appears to be maroon shale	234	0
Alcova:		
Limestone, gray, fine crystalline,		

unfossiliferous, lower 1 foot massive-bedded and silty, upper portion crinkly- to wavy-bedded with algal stromatolites	4	6
Red Peak:		
Sandstone, white with red banding, fine- to very fine-grained, angular to rounded, quartzose, massive-bedded with micro-cross-laminations, grades upward into overlying limestone	3	6
Basal portion of Red Peak poorly exposed and not measured, no estimate of thickness.		

X. MEASURED ALONG WILLOW CREEK ROAD

S½ sec. 19, T. 32 N., R. 99 W.

Formational	Thickness of Unit in Feet and Inches	
Triassic (?):		
Nugget:		
Sandstone, salmon-pink, fine-grained, well-cemented, massively cross-laminated. Section not measured.		
Triassic:		
Popo Agie:		
Shale, maroon, silty to sandy, micaceous, thinly laminated, slope former	19	0
Claystone, mauve to ochre, blocky, oolitic, large ovoid concretions, carrying plant remains and bone fragments about 5 feet from top, ledge former	17	0

Shale, maroon, clayey, thinly laminated, slope, mostly covered	48	0
Sandstone, white, very fine-grained to silty, calcareous, massive-bedded with micro-cross-laminations, ledge former	3	3
Covered interval	138	0
Shale, brick-red, clayey, silty, thinly laminated, partially covered slope	5	6
Siltstone, white with red banding, medium- to coarse-grained with interbedded reddish maroon, silty, clay shale, somewhat of a ledge former. See detailed description 489	27	6
Alcova:		
Limestone, gray, fine- to medium-crystalline, dense, lower 3 feet massive-bedded, upper 2½ feet thin-, wavy-, to "crinkly"-bedded, prominent scarp former. See detailed descriptions X-7-A, X-7-C, X-7-E, and X-7-F	5	6
Red Peak:		
Sandstone, red with white banding, very fine- to fine-grained, poorly sorted, angular to rounded, quartzose, feldspathic, ledge former	4	0
Shale, reddish-maroon, clayey, silty, thinly laminated slope former	13	0
Siltstone, brick-red, medium- to coarse-grained, massive-bedded with micro-cross-laminations, ledge former. See detailed description X-4	4	6
Shale, reddish-maroon, clayey, silty, weathering blocky, thinly laminated, slope former	17	0

Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded with micro-cross-laminations, ledge former	18	0
Shale, reddish-maroon, clayey, silty, thinly laminated with several interbedded brick-red medium- to coarse-grained siltstones, slope former. Base of unit covered	25	0

Y. EAST FLANK OF DALLAS DOME IN PROMINENT DRAINAGE

Center E½ sec. 18, T. 32 N., R. 98 W.

Formational Description	Thickness of Unit in Feet and Inches	
Triassic:		
Popo Agie:		
Upper part of section not measured because of poor exposure. No estimate of thickness.		
Sandstone, brick-red, fine-grained, quartzose, thin-bedded, ledge former, few interbedded red, thinly laminated, silty shales ...	35	6
Alcova:		
Limestone, gray, fine crystalline, dense, lower 3 feet in massive bed with thin laminations, upper 6 feet thin-, wavy-bedded with large algal (?) stromatolites. See detailed descriptions Y-5-C and Y-5-E	9	0
Red Peak:		
Sandstone, grayish-white, with maroon banding, very fine-grained, well-rounded, quartzose, slightly		

silty, calcareous-cemented, micro-cross-laminated; ledge-former. See detailed description 490	4	6
Shale, brick-red, thinly laminated, somewhat silty and micaceous, grades upward into overlying sandstone; slope former	7	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, micaceous, slightly calcareous, thin-bedded; ledge former	29	0
Shale, maroon, thinly laminated, somewhat blocky, slightly silty; slope former	15	0
Lower portion of Red Peak section faulted and poorly exposed. Not measured and no estimate of thickness.		

Z. MEASURED IN MAJOR DRAINAGE NORTH OF ROADSIDE PARK

W½ W½ sec. 17, T. 42 N., R. 94 W.

Formational Description	Thickness of Unit in Feet and Inches	
Jurassic:		
Gypsum Springs:		
Grayish-white, fine crystalline, massive-bedded gypsum, with interbedded red, thinly laminated, clay shales. Thickness not measured.		
Triassic:		
Popo Agie:		
Shale, maroon, clayey, thinly laminated and reddish-maroon, medium- to coarse-grained, thin-bedded siltstones; slope former ..	64	0

Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, well-cemented, quartzose, massive-bedded with micro-cross-laminations; ledge former	6	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous quartzose, thin-bedded; slope former	16	0
Siltstone, brick-red, medium- to coarse grained, somewhat micaceous, well-cemented, quartzose, massive-bedded with micro-cross-laminations; ledge former	17	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded; slope former, interval partially covered	135	0
Sandstone, white, very fine- to fine-grained, subangular to subrounded, fairly well-sorted, well-cemented, quartzose, massive-bedded with calcareous nodules; ledge former	7	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded; slope former	16	0
Sandstone, white, very fine- to fine-grained, subangular to subrounded, fairly well-sorted, well-cemented, quartzose, massive-bedded; ledge former	4	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded, slope former	27	0
Sandstone, white, very fine- to fine-grained, subangular to subrounded, fairly well-sorted, well-cemented, quartzose, massive-bedded; ledge former	2	0

Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded; slope former	22	0
Sandstone, white, very fine- to fine-grained, subangular to subrounded, fairly well-sorted, well-cemented, quartzose, massive-bedded; ledge former. See detailed description 491	2	0
Covered interval. Appears to be thin-bedded red siltstone	57	0
Crow Mountain:		
Siltstone, brick-red, medium- to coarse-grained, somewhat arenaceous, slightly micaceous, calcareous-cemented, quartzose, massive-bedded; cliff former	37	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded; slope former	8	0
Alcova:		
Limestone, variegated to buff, fine- to medium-crystalline, slightly dolomitic, pseudo-brecciated, unfossiliferous; ledge former. See detailed description Z-109	2	4
Red Peak:		
Shale, grayish-maroon, clayey, arenaceous, thinly laminated; slope former	9	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, massive-bedded; ledge former	7	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, argillaceous, quartzose, thin-bedded; slope former	1	6
Shale, reddish-maroon, clayey, somewhat silty, thinly laminated; slope former	4	0

Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, argillaceous, quartzose, thin-bedded, slope former	15	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, massive-bedded; ledge former	6	0
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, argillaceous, quartzose, thin-bedded; slope former	12	0
Siltstone, greenish-gray, medium-grained, well-cemented, quartzose, calcareous matrix; ledge former ..	2	0
Shale, reddish-maroon, clayey, slightly silty, thinly laminated; slope former	21	0
Siltstone, grayish-white, medium-grained, quartzose, calcareous-cemented, thin-bedded; slight ledge former	2	0
Siltstone, brick-red, medium- to coarse-grained, slightly micaceous, calcareous-cemented, massive-bedded; ledge former	11	0
Lower portion of Red Peak section very poorly exposed and unmeasurable. No estimate of thickness.		

AA. BLUFF ON WEST SIDE OF ROAD

SE½ sec. 28, T. 41 N., R. 91 W.

Formational Description	Thickness of Unit in Feet and Inches
Triassic:	
Crow Mountain:	
Top few feet covered and thickness not determinable.	

Sandstone, buff, weathering same, fine- to very fine-graoued, poorly sorted, angular to sub-rounded, quartzose with minor amount of chert, somewhat argillaceous, friable with some calcite cement, thin-bedded (beds 2-3 inches), slope former. See detailed description 493	31	6
Alcova:		
Limestone, gray, fine crystalline, unfossiliferous; lower 3 feet massive-bedded, upper 3 feet crinkly-, wavy-bedded, lower 1 foot maroon colored and somewhat arenaceous, ledge former. See detailed description AA-17-A; AA-17-C	6	0
Red Peak:		
Sandstone, white with maroon-red bands, very fine- to fine-grained, quartzose; massive-bedded with micro-cross-lamination; ledge former	5	0
Covered interval	10	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, argillaceous; thinly laminated; slight ledge former	3	0
Covered interval	6	6
Siltstone, brick-red, medium- to coarse-grained, quartzose, argillaceous, thinly laminated; slight ledge former	3	0
Covered interval	24	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, somewhat wavy-bedded, ledge former ...	6	0
Shale, reddish-maroon, becoming white in upper 1 foot, clayey, slightly silty and micaceous, thinly laminated; slope former ...	6	0

Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded with micro-cross-laminations, ledge former ..	7	0
Shale, reddish-maroon, clayey, silty, micaceous, thinly laminated, slope former	56	0
Mudstone, white, very fine-grained, somewhat silty, thinly laminated; slope former	2	6
Siltstone, reddish-maroon, medium- to coarse-grained, quartzose, slightly micaceous, massive-bedded, structureless, ledge former	2	6
Shale, reddish-maroon, clayey, silty, micaceous, thinly laminated, slope former	15	0
Siltstone, reddish-maroon, medium- to coarse-grained, quartzose, slightly micaceous; massive-bedded; ledge former	3	0
Shale, reddish-maroon, clayey, silty, thinly laminated, weathering blocky; slope former	6	0
Siltstone, maroon-red, coarse-grained, arenaceous, quartzose, slightly micaceous; massive-bedded with micro-cross-laminations, prominent scarp former	21	0
Basal portion covered and unmeasurable. No estimate of thickness.		

AB. MEASURED IN THE GENERAL VICINITY OF THE TYPE SECTION OF THE ALCOVA LIMESTONE

Measured in prominent drainage above dump in sec. 30, T. 30 N., R. 82 W.

Formational Description	Thickness of Unit in Feet and Inches	
Triassic:		
Popo Agie - Crow Mountain undifferentiated:		
This part of section very poorly exposed on dip slope. Mostly covered and extending over ½ mile horizontally. Lithology primarily very fine- to fine-grained, silty, white to red, massive-bedded sandstone. Estimated thickness of 50-70 feet.		
Alcova:		
Limestone, gray, weathering same, fine-crystalline, slightly silty, crinkly-bedded. See detailed description AB-35-VT	5	0
Mudstone, gray, silty, calcareous, massive-bedded with very small unornamented gastropods. See detailed description AB-35-T	7	0
Siltstone, brick-red, medium-grained, micaceous, quartzose, massive-bedded with micro-cross-laminations. See detailed description AB-35	4	0
Limestone, gray with maroon laminae, fine- to medium-crystalline, thin-bedded. See detailed description AB-35-A	5	0
Red Peak:		
Shale, reddish-maroon, clayey, somewhat silty, thinly laminated, slope former	9	0

Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded with micro-cross-laminations, ledge former	4	0
Shale, reddish-maroon, clayey, very silty, micaceous, thinly laminated, slope former	7	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded, structureless, ledge former	2	6
Shale, reddish-maroon, clayey, silty, thinly laminated, weathering blocky, slope former	3	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded with micro-cross-lamination, ledge former	3	0
Shale, reddish-maroon, clayey, very silty, thinly laminated, slope former	6	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, thin-bedded, ledge former	7	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded with micro-cross-laminations, ledge former	14	0
Siltstone, brick-red, medium to coarse-grained, micaceous, quartzose, thin-bedded, slight ledge former	12	0
Shale, reddish-maroon, clayey, very silty, micaceous, thinly laminated, slope former	13	0
Siltstone, brick-red with gray banding, medium- to coarse-grained, quartzose, calcareous-cemented, massive-bedded, ledge former	1	0
Shale, reddish-maroon, clayey, slightly silty, thinly laminated; slope former	8	0

Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded, structureless, ledge former	3	0
Shale, reddish-maroon, clayey, silty, micaceous, thinly laminated, slope former	7	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded, structureless, ledge former	3	0
Shale, reddish-maroon, clayey, slightly silty, thinly laminated, slope former	4	6
Siltstone, brick-red, medium- to coarse-grained, somewhat micaceous, quartzose, massive-bedded with micro-cross-laminations, ledge former	6	0
Shale, reddish-maroon, clayey, silty, thinly laminated, blocky weathering, slope former	13	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, massive-bedded with micro-cross-laminations, ledge former	3	0
Shale, reddish-maroon, clayey, silty, micaceous, thinly laminated, slope former	7	0
Siltstone, brick-red, medium- to coarse-grained, micaceous, quartzose, massive-bedded, structureless, ledge former	2	0
Shale, reddish-maroon, clayey, silty, micaceous, thinly laminated, slope former	7	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, slightly micaceous, well-cemented, massive-bedded with micro-cross-laminations, scarp former	46	0
Shale, reddish-maroon, clayey, slightly silty, micaceous, thinly laminated, slope former	6	0

Siltstone, brick-red, medium- to coarse-grained, quartzose, micaceous, thin-bedded, ledge former .	1	6
Shale, reddish-maroon, clayey, silty, somewhat micaceous, thinly laminated, slope former	17	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, thin-bedded, ledge former	1	6
Shale, reddish-maroon, clayey, silty, micaceous, thinly laminated, slope former	16	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, micaceous, massive-bedded, structureless, ledge former	1	0
Shale, reddish-maroon, clayey, silty, slightly micaceous, thinly laminated, slope former	9	0
Siltstone, brick-red, medium- to coarse-grained, quartzose, micaceous, massive-bedded with micro-cross-laminations, ledge former ..	5	6
Siltstone, brick-red, medium- to coarse-grained, quartzose, micaceous, thin-bedded, slope former .	3	6
Siltstone, white with black carbonaceous (?) streaks, medium-grained, quartzose, calcareous-cemented; thin-, wavy-bedded, slope former	2	6
Siltstone, maroon, medium- to coarse-grained, massive-bedded with micro-cross-laminations, ledge former	3	0
Lower part of section very poorly exposed and not measured; no estimate of thickness.		

APPENDIX B

DETAILED PETROLOGIC DESCRIPTIONS OF SELECTED LITHOLOGIES FOUND IN THE VARIOUS MEASURED SECTIONS

Measured Section A (page 74)

Crow Mountain:

Sandstone, buff to salmon-red. Very fine-grained, silty. Grains angular to subrounded. Poorly sorted. Immature to almost submature. Subarkose. Mineralogy: 88% quartz, 7% feldspar, 1% chert, 4% miscellaneous transported detritus. Cement primarily calcite as void filling and as quartz-feldspar replacement; moderate amount of clay in matrix. Red color restricted to vacuoles and irregularities in grain boundaries and in matrix. Outcrop thin- to massive-bedded in beds 1 inch to 5 feet thick. Total thickness 15 feet. Sample taken 77.0 feet above top of Alcova Limestone. Thin section number A-15.

Sandstone, buff, weathering the same. Fine-grained. Grains angular to subangular. Moderately sorted. Submature to mature. Subarkose. Mineralogy: 71% quartz, 22% feldspar, 7% chert. Cement primarily calcite as pore filling and as quartz-feldspar replacement; overgrowth cement sparse and poorly developed; clay cement in small localized patches. Minor amounts of red hematite stain around grain boundaries and in calcite matrix and in vacuolized areas of quartz and feldspar grains. Outcrop massive-bedded in beds 1-3 feet thick. Sample taken 33 feet above top of Alcova Limestone. Thin section number A-10.

Sandstone, buff, weathering the same. Fine-grained. Grains angular to subangular. Submature to mature. Subarkose. Mineralogy: 75% quartz, 21% feldspar, 4% chert, trace mica. Cement primarily calcite as pore

filling; overgrowth cement sparse and poorly developed. Feldspars fresh to vacuolized and sericitized. Minor amounts of red hematite stain in calcite matrix. Outcrop massive-bedded in beds 1-3 feet thick. Sample taken 3.0 feet above top of Alcova Limestone. Thin section number A-4.

Alcova Limestone (Thickness 2.2 feet):

Limestone, gray to white, coarse microsparite to very fine sparite. Crystals vary from 0.03 mm to 0.6 mm averaging 0.05 mm. Local recrystallized patches with crystals averaging 0.13 mm. Unfossiliferous. Minor amounts of fine silt-size quartz and few rounded grains of magnetite of ilmenite averaging 0.02 mm. Hand specimen dense, brittle and showing a wavy- or "crinkly-bedded" nature. Sample taken at very top of limestone unit. Thin section number A-3.

Limestone, gray to white, coarse microsparite to very fine sparite. Crystals vary from 0.02 mm to 0.05 mm, averaging 0.03 mm. Unfossiliferous. Trace of rounded magnetite or ilmenite grains. Hand specimen dense, brittle and wavy- or "crinkly-bedded." Sample taken 1.2 feet from top of limestone unit. Thin section number A-2.

Limestone, gray to white, coarse microsparite to very fine sparite. Crystals vary from 0.01 mm to 0.07 mm, averaging 0.03 mm. Unfossiliferous. Local red staining of red hematite. Outcrop contains "algal heads." Sample taken 6 inches above base of limestone unit. Thin section number A-1.

Red Peak:

Siltstone, brick- to salmon-red. Grains subangular to subround. Moderate to poorly sorted. Submature to immature. Subarkose. Mineralogy: 84% quartz, 7% feldspar, 2.5% mica, 3% chert, 2.5% miscellaneous transported detritus. Well-cemented with calcite, minor amounts of microcrystalline quartz cement locally. Red hematite stain locally developed around magnetite grains which are altering to hematite. Outcrop massive-bedded. Micro-bedding has a "swirled" or disrupted appearance. Thickness of unit 12.0 feet. Sample taken 3.0 feet below the base of the Alcova Limestone. Thin section number A-0.

Measured Section B (page 77)

Crow Mountain:

Sandstone, buff weathering the same. Very fine- to fine-grained, very silty. Grains angular to rounded. Poorly to moderately sorted. Submature to immature. Subarkose. Mineralogy: 85.5% quartz, 9% feldspar, 3.5% chert, 1% mica, 1% miscellaneous transported detritus. Cement consists of microcrystalline quartz; abundance of calcite as pore filling, quartz-feldspar replacement and replacement of microcrystalline quartz cement; sparse and patchy overgrowth cement. Feldspars fresh to highly vacuolized and sericitized. Outcrop thinly cross-laminated in beds 3-5 inches thick. Thickness of unit 5.2 feet. Sample taken 71.0 feet above top of Alcova Limestone. Thin section number B-14.

Sandstone, buff weathering same. Fine-grained. Grains angular to subround. Moderately sorted. Submature. Subarkose. Mineralogy: 80.5% quartz, 11% feldspar, 7% chert, 1.5% miscellaneous transported detritus. Cement consists of minor amounts of microcrystalline quartz, poorly developed and patchy overgrowth, minor amounts of calcite as void fillings, and traces of clay minerals. Feldspars relatively fresh and angular. Some red hematite stain contained in quartz and feldspar vacuoles. Outcrop thin-bedded in beds 3-6 inches thick. Sample taken 54 feet above top of Alcova Limestone. Thin section number B-11.

Sandstone, buff weathering the same. Very fine- to fine-grained. Grains angular to rounded. Poorly to moderately sorted. Immature to submature. Subarkose. Mineralogy: 81.5% quartz, 12.5% feldspar, 4% quartz, 2% miscellaneous transported detritus. Cement primarily microcrystalline quartz, patchy overgrowth cement, and calcite as pore filling and quartz-feldspar replacement. Feldspars relatively fresh and only very slightly altered. Outcrop thin-bedded in beds 1-3 inches thick. Unit 2.0 feet thick. Sample taken 35.0 feet above top of Alcova Limestone. Thin section number B-7.

Alcova Limestone (Thickness 5.5 feet):

Limestone, gray to white, coarse microsparite to very fine sparite. Crystals vary from 0.03 mm to 0.06 mm,

averaging from 0.04 mm. Unfossiliferous. Dense, compact and brittle. Outcrop wavy to "crinkle-bedded." Thin section shows bedding to be disrupted with a "swirled" appearance. Sample taken at top of limestone unit. Thin section number B-3.

Limestone, gray to white, coarse microsparite to very fine sparite. Crystals vary in size from 0.01 mm to 0.07 mm, averaging 0.03 mm. Unfossiliferous. Has an abundance of fine silt size quartz in laminae one grain thick distributed about 1 mm apart throughout the slide, giving the slide almost a "varved" appearance. Laminae also stained red by hematite. Outcrop brittle, massive-bedded. Sample taken 3.5 feet above base of unit. Thin section number B-2.

Limestone, gray to white, coarse microsparite to very fine sparite. Crystals vary in size from 0.01 mm to 0.06 mm, averaging 0.03 mm. Some patches of coarse sparry calcite as vein fillings. Unfossiliferous. Slide has about 1% fine silt size quartz grains distributed uniformly throughout. Outcrop massive-bedded with "algal heads" showing up by differential weathering. Sample taken 6 inches above base of limestone unit. Thin section number B-1.

Measured Section C (page 79)

Crow Mountain:

Sandstone, buff-stained red. Very fine-grained, somewhat silty. Grains subangular to angular. Moderately to poorly sorted. Submature. Subarkose. Mineralogy: 87.5% quartz, 7% feldspar, 1% mica, 0.5% chert, 4% miscellaneous transported detritus. Cement consists primarily of microcrystalline quartz; moderately well developed overgrowth cement; minor amounts of pore filling calcite cement. Few patches of red hematite stain restricted to the vacuolized areas of quartz grains. Outcrop massive-bedded and cross-laminated. Thickness of unit 13.0 feet. Thin section number C-18.

Sandstone, buff weathering same. Fine- to very fine-grained, somewhat silty. Grains angular to rounded. Moderately sorted. Submature. Subarkose. Mineralogy: 90% quartz, 6% feldspar, 2% chert, 2% miscellaneous transported detritus. Moderately cemented

with microcrystalline quartz; minor amount of pore filling calcite; quartz overgrowth poorly developed. Minor amount of red stain in matrix associated with magnetite-ilmenite grains. Outcrop thin-bedded and cross-laminated. Sample taken 53.0 feet above top of Alcova Limestone. Thin section number C-15.

Sandstone, buff weathering the same. Fine- to very fine-grained. Grains subangular to subround. Moderately sorted. Submature. Orthoquartzite. Mineralogy: 91% quartz, 2% feldspar, 3% chert, 4% miscellaneous transported detritus. Moderately cemented with microcrystalline quartz; minor amounts of calcite as pore fillings; overgrowth cement poorly developed. Minor trace of red hematite stain in matrix and in the highly vacuolized quartz grains. Outcrop massive and cross-laminated. Sample taken 38.0 feet above top of Alcova Limestone. Thin section number C-12.

Sandstone, buff weathering to salmon-red. Fine- to very fine-grained with a few medium sized grains. Grains angular to rounded. Poorly to moderately sorted. Submature. Orthoquartzite. Mineralogy: 85% quartz, 4% feldspar, 1% mica, 5.5% chert, 1.5% rock fragments, 3% miscellaneous transported detritus. Moderately cemented with calcite; minor amounts of microcrystalline quartz and clay minerals; overgrowth cement very poorly developed. Outcrop massive-bedded. Sample taken 3.0 feet above top of Alcova Limestone. Thin section number C-5.

Alcova Limestone (Thickness 7.0 feet):

Limestone, yellow-gray weathering white. Coarse microsparite to fine sparite. Crystals vary in size from 0.01 mm to 0.1 mm, averaging 0.06 mm. Unfossiliferous. Minor amount of angular silt size quartz desiminated throughout. Outcrop thinly wavy- to "crinkly bedded." Sample taken 6 miles from top of unit. Thin section number C-4.

Limestone, yellow gray weathering white. Coarse microsparite to very fine sparite. Crystals vary in size from 0.006 mm to 0.03 mm, averaging 0.01 mm. Few patches of very coarse sparry calcite. Minor amounts of fine- to medium-silt size, angular to rounded quartz grains. Quartz grains occur in thin laminae,

1 or 2 grains wide. Trace of red hematite as detrital grains and void filling. Outcrop thinly wavy- to "crinkly bedded." Sample collected 2 feet below top of limestone unit. Thin section number C-3.

Limestone, yellowish-gray weathering gray. Coarse microsparite to very fine sparite. Crystals vary in size from 0.007 mm to 0.03 mm, averaging 0.02 mm. Unfossiliferous. Minor amounts of fine silt-sized, angular quartz. Silt grains occur in thin alternating, evenly spaced laminae. Outcrop thinly wavy-bedded to "crinkly bedded." Sample taken 4.0 feet from top of limestone unit. Thin section number C-2.

Limestone, yellowish-gray weathering gray. Coarse microsparite to very fine sparite with "stringers" and pathces of coarse sparrh calcite. Crystals very in size from 0.009 mm to 0.02 mm, averaging 0.01 mm. Unfossiliferous. Minor amount of angular, fine silt-size quartz dessiminated throughout. Outcrop massive-bedded with numerous stylolites and "algal heads." Sample taken 1 foot from bottom of unit. Thin section No. C-1.

Measured Section D (page 81)

Crow Mountain:

Sandstone, buff weathering same. Fine- to very fine-grained. Grains very angular to subrounded. Poorly sorted. Immature to submature. Subarkose. Mineralogy: 78% quartz, 15% feldspar, 7% miscellaneous transported detritus. Quartz overgrowth cement moderately well developed; calcite present as void filling and quartz replacement; minor amount of microcrystalline quartz and clay cement. Feldspars fresh to highly vacuolized; vacuolized feldspars stained reddish brown. Magnetite present in all stages of alternation to hematite. Hematite stain present in calcite matrix locally. Thin section shows micro-cross-laminations. Outcrop thin-bedded in beds 1½-2 inches thick. Sample taken 17.0 feet above top of Alcova Limestone. Thin section number D-7.

Sandstone, buff weathering same. Very fine- to fine-grained. Grains subangular to subrounded. Moderately

to poorly sorted. Submature. Subarkose. Mineralogy: 75% quartz, 19% feldspar, 6% miscellaneous transported detritus. Cement primarily calcite as void filling and as quartz replacement; quartz overgrowth cement poorly to moderately developed, minor amounts of microcrystalline quiartz and clay minerals as cement. Feldspars generally highly vacuolized. Minor amount of magnetite present in all stages of alteration to hematite. Locally hematite stains calcite matrix. Outcrop massive-bedded in beds 1½-2 feet thick. Thin section number D-4.

Alcova Limestone (Thickness 2.3 feet):

Limestone, yellow gray to buff, weathering gray. Coarse microsparite to very fine sparite with "stringers" or thin bands of gray micrite. Crystals vary in size from 0.01 mm to 0.04 mm, averaging 0.02 mm. Unfossiliferous. Numerous areas of red hematite stain radiating outward from a center. Outcrop dense, compact and thinly wavy-bedded to "crinkly bedded." Sample taken at very top of unit. Thin section number D-3.

Limestone, gray weathering same. Coarse microsparite to very fine sparite. Crystals vary in size from 0.009 mm to 0.03 mm, averaging 0.02 mm. Unfossiliferous. Trace of fine silt size, angular quartz. Some red hematite staining around detrital nuclei. Fractures filled with drusy calcite. Outcrop thinly wavy-bedded to "crinkly bedded." Sample taken 1.1 feet from top of limestone unit. Thin section number D-2.

Limestone, gray weathering same. Coarse microsparite to very fine sparite. Crystals vary in size from 0.003 to 0.03 mm, averaging 0.02 mm. Unfossiliferous. Some red hematite staining radiating outward from local dark centers. Outcrop massive-bedded with "algal heads." Sample taken 6 inches from base of limestone unit. Thin section number D-1.

Measured Section E (page 84)

Crow Mountain:

Sandstone, tan stained red. Fine- to medium-grained. Grains very angular to subrounded. Sorting poor to moderate. Immature. Subgraywacke. Mineralogy: 53%

quartz, mostly composite type, 10% orthoclase; 5.5% plagioclase; 5.5% mica; 1.5% chert; 6.5% igneous rock fragments; 12% metamorphic rock fragments; 5.5% miscallaneous transported detritus. Cement consists of a pasty matrix of clay minerals; quartz overgrowths moderately to poorly developed. Micas show strong parallelism and are slightly altered. Feldspars fairly fresh and unaltered. Metamorphic rock fragments rounded and "squeezed." Igneous rock fragments angular to subrounded. Matrix stained red due to alteration of magnetite to hematite. Outcrop thin-bedded and cross-laminated. Sample taken 25½ feet above top of Alcova Limestone. Thin section number 458.

Alcova Limestone (Thickness 14.0 feet):

Limestone, gray weathering same. Fine- to medium-crystalline microsparite. Crystals averaging about 0.003 mm. Unfossiliferous. Trace of angular medium silt-size, angular quartz grains. Sample contains about 1% subangular pyrite grains which show slight alteration to hematite. Outcrop thin-bedded with beds 2-3 inches thick. Sample collected 14 feet above base. Thin section number E-7.

Limestone, red weathering to reddish-gray. Algal bondstone. Sample shows algal stromatolites measuring approximately ½-¾ inches wide by 1½ inches in height. Recrystallization has obliterated most of detail but remains of algal "branches" appear to be marked by medium size crystals of sparry calcite. Minor amounts of fine silt-size angular quartz fragments scattered throughout sample. Sample taken from a 2½ inch bed about 12.5 feet from base of limestone unit. Thin section number E-6-A.

Limestone, gray weathering same. Fine- to medium-crystalline microsparite. Crystals averaging about 0.003 mm. Unfossiliferous. Trace of fine- to medium silt-size angular quartz grains. Sample contains about 1% subangular to rounded fine silt-size magnetite or ilmenite grains which show slight alteration to hematite. Evenly spaced micro-laminations present. Outcrop thin-bedded in beds 2-3 inches thick. Sample taken 12 feet above base of unit. Thin section number E-6.

Limestone, brown weathering gray. Pelmicrite recrystallized to pelmicrosparite. Crystalline calcite varies in size from 0.003 mm to 0.01 mm. Unfossiliferous. Pellets recrystallized. Now expressed as dark brown cloudy masses but still retaining a ghost nucleus. Local patches of coarse sparry calcite. Minor amount of fine silt size, angular quartz scattered throughout sample. Sample taken 10 feet above base of limestone unit. Thin section number E-5.

Limestone, brown weathering gray. Pelmicrite recrystallized to pelmicrosparite. Crystalline calcite varies in size from 0.003 mm to 0.01 mm. Unfossiliferous. Pellets recrystallized. Now expressed as dark brown cloudy masses but still retaining a ghost nucleus. Pellet patches interrupted throughout by "stringers" of medium-crystalline sparry calcite. Trace of fine silt-size, angular quartz and fine silt-size, subrounded magnetite or ilmenite grains. Sample taken 8 feet above base of limestone unit. Thin section number E-4.

Limestone, brown weathering gray. Partially recrystallized ostracode biomicrite. Calcite crystals average 0.01 mm. Contains an abundance of inarticulated ostracode carapaces from 1.2 to 2.5 mm in length and showing no preferred orientation. Ostracode carapaces filled with highly twinned medium crystalline sparry calcite. Grumeleuse structure quite prominent. Fairly clear evidence that the grumeleuse structure originated from the destruction of pellets during recrystallization. Minor amount of fine silt-size, angular quartz grains scattered throughout slide. Locally a minor accumulation of some type of "blady" algae. Outcrop thin-bedded in beds 2-3 inches thick. Sample taken 6 feet above base of unit. Thin section number E-3.

Limestone, gray weathering same. Microsparite. Calcite crystals averaging about 0.01 mm. Unfossiliferous. Thinly and uniformly laminated. Brown microsparite laminae separated by very thin laminae of medium crystalline sparry calcite. Brown microsparite laminae contain minor amounts of fine silt-size, angular quartz fragments. Outcrop thin-bedded in beds 2-3 inches thick. Sample taken 4 feet above base of limestone unit. Thin section number E-2.

Limestone, gray with faint red streaks. Microsparite. Crystals averaging about 0.01 mm. Unfossiliferous except for the trace of a small curved shell fragment which is preserved as a ghost structure. Very pure in that there is no terreginoir fraction. Outcrop thin-bedded in beds 2-3 inches thick. Sample taken 2.0 feet above base. Thin section number E-1.

Measured Section F (page 85)

Sundance:

Sandstone, buff weathering same. Fine-grained. Grains subangular to rounded. Moderately to well-sorted. Mature. Orthoquartzite. Mineralogy: 91% quartz, 4.5% feldspar, 2.2% chert, 2.2% miscellaneous transported detritus. Cement primarily moderately to well-developed quartz overgrowths; minor amount of void filling calcite cement. Outcrop a massive cliff forming unit 56.0 feet thick. Sample taken at very top of unit. Thin section number 462.

Crow Mountain:

Sandstone, buff weathering same. Fine-grained. Grains subangular to subrounded. Moderately well-sorted. Submature to mature. Orthoquartzite. Mineralogy: 88.5% quartz, 4% feldspar, 2% chert, 5.5% miscellaneous transported detritus. Cement primarily moderately well-developed quartz overgrowths; minor amount of calcite as void filling. Outcrop thinly bedded in beds 1-3 inches thick. Unit 11.5 feet thick. Sample taken 5.0 feet below top of unit. Thin section number 461.

Sandstone, buff weathering same. Fine-grained. Grains subangular to subrounded. Submature to mature. Subarkose. Mineralogy: 78% quartz, 13% feldspar, 2% chert, 6% miscellaneous transported detritus, trace of mica. Cement primarily calcite as a void filling with some as quartz replacement; quartz overgrowth cement moderately developed. Feldspars fresh to highly vacuolized. Very minor trace of red hematite stain in calcite matrix. Outcrop massive-bedded in beds 2-4 feet thick and with small scale cross-laminations. Thickness of unit 22.5 feet. Sample

taken 44 feet above top of Alcova Limestone. Thin section number 460.

Siltstone, brick red weathering same. Medium- to coarse-grained. Poorly to moderately sorted. Submature. Subarkose. Mineralogy: 75.5% quartz; 14% feldspar; 3% mica; 7.5% miscellaneous transported detritus. Cement primarily calcite as a void filling and as replacement for quartz and feldspars. Micr-bedding has a "swirled" or disrupted appearance. Red hematite stain present in calcite matrix due to alteration of magnetite to hematite. Outcrop thin-bedded in beds 1-2 inches thick. Unit 17.0 feet thick. Thin section number 450.

Alcova Limestone (Thickness 32.0 feet):

Limestone, white weathering gray. Coarse microsparite to very fine sparite. Crystals vary in size from 0.01 to 0.04 mm, averaging 0.03 mm. Unfossiliferous. Trace of fine-silt size angular quartz fragments scattered throughout. Outcrop thin-bedded with conspicuous red silt streaks. Top surface is conspicuously ripple marked. Sample taken 30 feet above base of unit. Thin section number F-6.

Limestone, dark gray weathering medium gray. Coarse microsparite to very fine sparite. Calcite crystals vary in size from 0.01 mm to 0.08 mm, averaging 0.04 mm. Unfossiliferous. Very thin red laminae composed of fine silt size quartz grains common throughout. Laminae bearing grains stained red by hematite. Outcrop somewhat wavy and irregularly bedded in beds 2-4 inches thick. Sample taken 20 feet above base of limestone unit. Thin section F-3-T.

Limestone, gray-brown weathering gray. Coarse microsparite to very fine sparite. Calcite crystals average 0.01 mm. Medium-crystalline sparry calcite alternate with bands of microspar. Sparry calcite bands have a high content of fine- to medium-silt size, angular quartz fragments. Outcrop thin-bedded with beds averaging 4-6 inches in thickness. Sample taken 15 feet above base of unit. Thin section number F-3-B.

Limestone, grayish brown, weathering same. Coarse microsparite to very fine sparite. Calcite crystals average 0.01 mm. Unfossiliferous. Very thin laminae of medium-crystalline sparry calcite alternate with

microspar laminae. Trace of fine silt size, angular quartz fragments. About 1% very fine silt size, subrounded magnetite or ilmenite grains partially altered to hematite. Outcrop thin, wavy-bedded. Sample taken 10 feet above base of unit. Thin section number F-2.

Limestone, grayish-brown weathering same. Coarse microsparite to fine sparite. Calcite crystals average about 0.04 mm. Unfossiliferous. Sample contains about 5% fine silt size, angular quartz fragments and about 1-2% subrounded magnetite or ilmenite grains in various stages of alteration to hematite. Outcrop massive-bedded. Sample taken 2.0 feet above base of limestone unit. Thin section number F-1.

Measured Section H (page 90)

Crow Mountain:

Siltstone, grayish-white, weathering same. Medium- to coarse-grained, finely arenaceous. Grains angular to subangular. Poorly to moderately sorted. Submature. Subarkose. Mineralogy: 82.5% quartz, 9% feldspar, 4% mica, 0.5% chert, 4% miscellaneous transported detritus. Cement primarily calcite as void filling and as replacement of quartz and feldspar. Outcrop thin-bedded and micro-cross-laminated. Saturated with petroleum residue. Sample taken 10 feet above top of Red Peak. Thin section number 463.

Measured Section I (page 93)

Crow Mountain:

Sandstone, grayish white weathering same. Fine-grained. Grains angular to subrounded. Moderately well-sorted. Submature. Subarkose. Mineralogy: 87% quartz, 8% feldspar, 1% chert, 4% miscellaneous transported detritus. Cement primarily calcite as replacement of quartz and feldspar and as a void filling; quartz overgrowths poorly developed and patchy; petroleum residue also bonding agent. Outcrop massive-bedded with micro-cross-laminations. Sample taken 87.0 feet above base of Crow Mountain Sandstone. Thin section number 464.

Measured Section J (page 95)

Crow Mountain:

Sandstone, buff to grayish-white. Very fine- to fine-grained. Grains angular to subround. Poorly to moderately sorted. Submature. Subarkose. Mineralogy: 87% quartz, 8% feldspar, 0.5% mica, 0.5% chert, 4% miscellaneous transported detritus. Cementing agent primarily calcite as quartz-feldspar replacement and as void filling; minor patches of quartz overgrowth. Minor amount of red hematite stain in calcite matrix. Outcrop massive-bedded. Thickness of unit 13.0 feet. Sample taken in middle. Thin section number 468.

Sandstone, lower and upper 2 feet grayish-white, grading to salmon-red in center. Fine- to medium-grained. Grains angular to rounded. Moderately well-sorted. Submature to mature. Orthoquartzite. Mineralogy: 84% quartz, 5.5% feldspar, 5% chert, 5.5% miscellaneous transported detritus. Cement primarily quartz overgrowth; minor amounts of calcite as void filling. Chert fragments well rounded. Outcrop very massive-bedded with medium-scale cross-laminations. Unit 14.0 feet thick. Sample taken from middle. Thin section number 467.

Siltstone, salmon-red. Medium- to coarse-grained, finely arenaceous. Grains angular to subround. Poorly sorted. Immature to submature. Subarkose. Mineralogy: 83% quartz, 9% feldspar, 1% mica, 3.5% chert, 4% miscellaneous transported detritus. Cement primarily calcite replacing quartz and as a void filling; minor patches of quartz overgrowth cement and microcrystalline quartz. Red stain in calcite matrix due to alteration of magnetite to hematite. Outcrop massive-bedded. Unit 7.5 feet thick. Sample taken in middle of unit. Thin section number 466.

Sandstone, grayish-white. Fine-grained. Grains subangular to rounded. Moderately well-sorted. Mature. Orthoquartzite. Mineralogy: 85.5% quartz, 5.5% feldspar, 5% chert, 4% miscellaneous transported detritus. Cement primarily moderately well developed quartz overgrowth. Minor amounts of microcrystalline quartz and calcite as cement. Outcrop thin-bedded and cross-laminated. Thickness of unit 10.0 feet. Sample taken 5.0 feet above basal contact. Thin section number 465.

Red Peak:

Limestone, medium gray weathering same. Coarse microsparite to very fine sparite. Crystals average about 0.01 mm. Grumeleuse structure prominent. Grumeleuse patches separated from each other by patches of fine sparry calcite. Outcrop thin-bedded. Thickness 4 inches. Thin section J-1.

Measured Section K (page 101)

Popo Agie:

Siltstone, grayish-white. Medium- to coarse-grained. Grains angular to subround. Moderately to poorly sorted. Submature. Subarkose. Mineralogy: 84.5% quartz, 10% feldspar, 1% mica, 1% chert, 3% miscellaneous transported detritus. Cement primarily calcite as void filling and quartz replacement; minor amount of microcrystalline quartz as cement; quartz overgrowths poorly developed. Outcrop thin-bedded. Thickness of unit 3.5 feet. Sample taken in middle of unit. Thin section number 471.

Crow Mountain:

Sandstone, buff weathering same. Very fine-grained, silty. Grains angular to subrounded. Moderately to poorly sorted. Submature. Subarkose. Mineralogy: 86% quartz, 9% feldspar, 2% chert, 3% miscellaneous transported detritus. Cementing agent primarily calcite as void filling with minor amount as quartz replacement; quartz overgrowths patchy and poorly developed. Outcrop massive-bedded. Thickness of unit 13.0 feet. Sample taken from middle of unit. Thin section number 470.

Red Peak:

Siltstone, grayish-white. Medium- to coarse-grained, very finely arenaceous. Grains angular to subangular. Poorly to moderately sorted. Submature. Subarkose. Mineralogy: 87% quartz, 7% feldspar, 3% mica, 3% miscellaneous transported detritus. Cementing agent primarily calcite as quartz replacement and as void filling; quartz overgrowth patchy and poorly developed. Minor amount of red hematite stain in calcite

matrix. Micro-bedding has a "swirled" or disrupted appearance. Outcrop massive-bedded. Unit thickness is 16.0 feet. Sample taken in middle. Thin section number 469.

Measured Section L (page 105)

Alcova Limestone (Thickness 7 feet 3 inches):

Limestone, gray weathering same. Coarse microsparite to very fine sparite. Calcite crystals average about 0.01 mm with streaks of very fine sparry calcite common. Unfossiliferous. Trace of fine silt size, angular quartz fragments distributed along laminae of hematite stained very finely-crystalline sparry calcite. Outcrop very thin, wavy to "crinkly" bedded. Sample taken 7 feet above base of unit. Thin section number L-4.

Limestone, yellow-gray weathering gray. Coarse microsparite to very fine sparite. Calcite crystals averaging about 0.01 mm. Unfossiliferous A minor trace of fine silt size, angular quartz fragments. Local spots of hematite staining. Outcrop massive-bedded with "algal heads" common. Sample taken 1 foot 6 inches above base. Thin section number L-3.

Measured Section M (page 108)

Crow Mountain:

Siltstone, reddish-maroon weathering same. Medium- to coarse-grained. Grains angular to subround. Moderately sorted. Submature. Subarkose. Mineralogy: 85.5% quartz, 10% feldspar, 2% mica, trace chert, 2.5% miscellaneous transported detritus. Cement primarily calcite as void filling and quartz-feldspar replacement; minor amounts of patchy overgrowth cement. Abundance of red hematite stain in matrix. Outcrop thin-bedded and micro-cross-laminated. Sample taken 27.5 feet above top of Alcova Limestone. Thin section number 474.

Siltstone, reddish-maroon. Medium- to coarse-grained. Grains subangular to subround. Moderately well-sorted. Submature. Subarkose. Mineralogy: 83%

quartz, 10% feldspar, 1% chert, 3.5% limestone fragments, 3.5% miscellaneous transported detritus. Cement primarily calcite as a void filling and as quartz replacement; minor, poorly developed patches of overgrowth cement. Abundant red hematite staining in matrix due to alteration of magnetite to hematite. Outcrop massive-bedded. Sample taken 3.0 feet above top of Alcova Limestone. Thin section number 473.

Alcova Limestone (Thickness 2.0 feet)

Dolostone, gray weathering reddish-gray. Coarse dolomicrosparite to fine dolosparite. Crystals average 0.01 mm, but has numerous patches of very coarse dolospar as void filling and recrystallization spar. Unfossiliferous. Very good vuggy porosity. Red hematite stain prominent around pore-filled areas and lining vuggy areas. No terrigenous material. Outcrop thin-, wavy- to "crinkly" bedded. Sample taken 2 feet above base of unit. Thin section number M-4.

Dolostone, gray weathering reddish-gray. Coarse dolomicrosparite to fine dolosparite. Crystals average 0.01 mm, but has numerous patches and laminae of coarse dolospar. Unfossiliferous. Red hematite present as subrounded grains and as intracrystal staining. No terrigenous material. Outcrop thin-, wavy- to "crinkly" bedded. Sample taken 1 foot above base of unit. Thin section number M-2.

Red Peak:

Sandstone, reddish-maroon. Very fine-grained with a few medium-size grains. Grains subangular to subrounded. Moderately sorted. Submature to mature. Subarkose. Mineralogy: 87% quartz, 7% feldspar, 1% mica, 2% chert, 3% miscellaneous transported detritus. Cement primarily calcite as void filling and as quartz replacement; quartz overgrowth very poorly developed and patchy. Micro-bedding appears to be "swirled" or disrupted. Outcrop thin-bedded. Thin section number 472.

Measured Section N (page 110)

Crow Mountain:

Sandstone, grayish-white weathering same. Fine-grained. Grains subangular to round. Sorting moderate to good. Mature to submature. Subarkose. Mineralogy: 87.5% quartz, 8.5% feldspar, 2% chert, 2% miscellaneous transported detritus. Cement primarily moderately developed quartz and feldspar overgrowth; minor amount of calcite as void filling and quartz-feldspar replacement. Feldspars generally highly vacuolized. Micro-cross-laminations conspicuous in thin section. Outcrop massive-bedded. Unit 18.5 feet thick. Sample taken 86.0 feet above top of Alcova Limestone. Thin section number 477.

Sandstone, buff weathering the same. Fine-grained sandstone. Grains angular to rounded. Moderately sorted. Submature. Subarkose. Mineralogy: 83.5% quartz, 10% feldspar, 1% mica, 1% chert, 4% miscellaneous transported detritus. Cement primarily calcite replacing quartz and feldspar and as a void filling; overgrowth cement common; trace of microcrystalline quartz as a cement. Micas are highly altered. Feldspars vacuolized and sericitized. Red hematite stain common in calcite matrix around detrital magnetite grains. Outcrop massive-bedded with beds ranging in thickness from 4 inches to 4 feet. Sample taken 0.5 feet above top of Alcova Limestone. Thin section number 476.

Alcova Limestone (Thickness 5.5 feet):

Limestone, buff weathering gray. Pelmicrite. Crystals too small to be measured. Dark brown pellets set in fine-grained matrix. Pellets average about 0.01 mm in diameter. Locally the micrite matrix converted to microspar. Outcrop thin-, wavy-bedded. Sample taken at very top of unit. Thin section number N-100-T.

Limestone, buff weathering gray. Coarse microsparite to very fine sparite. Crystals average about 0.01 mm. Unfossiliferous. Stylolitic. Very fine hematite stained laminae of fine sparry calcite alternating with microspar laminae. Trace of very fine silt size quartz distributed along the fine sparry calcite laminae. Outcrop thin-, wavy- to "crinkly"

bedded. Sample taken 2.5 feet above base of unit. Thin section number N-100-BC.

Limestone, buff weathering gray. Coarse microsparite to very fine sparite. Crystals average about 0.008 mm. Unfossiliferous. Minor amount of altered muscovite and very fine silt size, angular quartz. Reddish-brown subrounded, fine silt size pyrite grains common. Outcrop massive-bedded. Sample taken at the top of the massive unit 2.0 feet above the base. Thin section number N-100-TM.

Limestone, buff-gray weathering gray. Coarse microsparite to very fine sparite. Crystals average about 0.01 mm. Unfossiliferous. Very minor trace of fine silt size muscovite. No quartz. Sample taken in middle of massive bed 1.0 foot above base of unit. Thin section number N-100-MM.

Limestone, buff-gray weathering gray with red stain. Coarse microsparite to ver fine sparite. Crystals average about 0.04 mm. Unfossiliferous. Minor amount of very fine- to fine-silt size, subangular quartz fragments. Appears to be micro-cross-laminated. Small "algal heads" common. Outcrop massive-bedded. Sample taken from very base of unit. Thin section number N-100-BM.

Measured Section O (page 115)

Crow Mountain:

Sandstone, brick-red weathering same. Very fine-grained, very silty. Grains angular to subround. Poorly to moderately sorted. Submature. Subarkose. Mineralogy: 75% quartz, 19% feldspar, 2% chert, 4% miscellaneous transported detritus. Cement primarily moderately developed quartz and feldspar overgrowths; minor amounts of calcite as void fillings and quartz-feldspar replacement. Feldspars moderately to highly vacuolized. Outcrop very massive in lower 12 feet becoming thin-bedded in upper part. Unit 28.0 feet thick. Sample taken 5.0 feet above top of Alcova Limestone. Thin section number 478.

Alcova Limestone (Thickness 4 feet 4 inches):

Limestone, reddish-gray weathering gray. Coarse microsparite to fine sparite. Calcite crystals average

0.02 mm. Has a few inarticulated ostracode valves. Thin microspar laminae alternate with thin laminae of medium crystalline sparry calcite which is highly twinned. No quartz present. Slide contains about 1% subrounded, fine silt size magnetite or ilmenite grains which are partially altered to hematite. Red stain restricted to edges of sparry calcite laminae. Sample taken at the very top of the unit. Thin section number 0-100-TC.

Limestone, reddish-gray weathering gray. Coarse microsparite to fine sparite. Calcite crystals average 0.02 mm. Unfossiliferous. Thin microspar laminae alternate with thin laminae of medium crystalline sparry calcite. Coarse sparry calcite present as void fillings. No quartz. About 1% subrounded, fine silt-size magnetite or ilmenite which is partially altered to hematite. Red stain restricted to margins of spar filled voids or edges of sparry calcite laminae. Sample taken in middle of wavy-bedded part of unit, 3.2 feet from base of unit. Thin section number 0-100-MC.

Limestone, reddish-gray weathering gray. Coarse microsparite to fine sparite. Calcite crystals average 0.01 mm. Unfossiliferous. Thin microspar laminae alternate with thin laminae of finely crystalline sparry calcite. No quartz present. Slide contains about 1% subrounded, fine silt size magnetite or ilmenite grains which are partially altered to hematite. Red stain restricted to edges of fine sparry calcite laminae. Sample taken at base of wavy-bedded part of unit 2 feet 1 inch above base of unit. Thin section number 0-100-BC.

Limestone, reddish-gray weathering gray. Coarse microsparite to fine sparite. Calcite crystals average 0.04 mm. Unfossiliferous. A few unevenly spaced medium-crystalline sparry calcite laminae alternate with the microspar laminae. No quartz present. Has about 1% magnetite or ilmenite in all stages of alteration to hematite. Outcrop massive-bedded with numerous large "algal heads." Sample taken from very top of massive-bedded unit 2.0 feet from base of unit. Thin section number 0-100-TM.

Limestone, buff weathering gray. Coarse microsparite to very fine sparite. Calcite crystals average about 0.03 mm. Unfossiliferous. A very few unevenly

spaced medium-crystalline sparry calcite laminae alternate with the microspar laminae. No quartz present. Has about 1% magnetite or ilmenite in all stages of alteration to hematite. Outcrop massive-bedded with numerous large "algal heads." Sample taken from the middle of massive-bedded unit 1.0 feet from base. Thin section number 0-100-MM.

Limestone, reddish-gray weathering gray. Coarse microsparite to very fine sparite. Calcite crystals average about 0.06 mm. Unfossiliferous. Numerous evenly spaced laminae of medium crystalline sparry calcite laminae alternate with the microspar laminae. Minor amounts of fine silt size, angular quartz fragments present. Slide contains about 1% of magnetite or ilmenite in various stages of alteration to hematite. Outcrop massive-bedded. Sample taken from very base of unit. Thin section number 0-100-BM.

Measured Section P (page 118)

Crow Mountain:

Siltstone, salmon-red weathering same. Medium- to coarse-grained, finely arenaceous. Grains angular to subround. Poorly to moderately sorted. Submature. Subarkose. Mineralogy: 88.5% quartz, 7% feldspar, 1% chert, 3.5% miscellaneous transported detritus. Cement primarily moderately developed quartz-feldspar overgrowths; minor amount of calcite and clay as void fillings. Red stain in vacuolized areas of quartz and feldspars and as stain in the clay-calcite matrix. Outcrop massive-bedded with micro-cross-laminations. Sample taken 42 feet above top of the Alcova Limestone. Thin section number 481.

Sandstone, salmon-red weathering same. Very fine-grained very silty. Grains angular to rounded. Moderately well-sorted. Mature to submature. Subarkose. Mineralogy: 88.5% quartz, 7% feldspar, 2.5% chert, 2% miscellaneous transported detritus. Cement primarily moderately developed quartz-feldspar overgrowths, trace of calcite and clay as void fillings. Red hematite staining around grain boundaries in vacuoles and in grain irregularities. Outcrop massive-bedded with small scale cross-laminations. Sample taken 21.0 feet above top of Alcova Limestone. Thin section number 480.

Sandstone, salmon-red weathering same. Very fine-grained, very silty. Grains angular to subround. Moderately sorted. Submature. Subarkose. Mineralogy: 83.5% quartz, 11% feldspar, 1.5% chert, 4% miscellaneous transported detritus. Cement primarily quartz and feldspar overgrowths; very minor amount of calcite as void filling; minor amounts of clay as a matrix. Red stain common in vacuolized feldspars and in clay and calcite matrix. Outcrop massive-bedded. Sample taken 3.0 feet above top of Alcova Limestone. Thin section number 479.

Alcova Limestone (Thickness 4.0 feet):

Limestone, medium gray weathering light gray. Coarse microsparite to very fine sparite. Crystals average about 0.02 mm. Unfossiliferous. Very minor amounts of medium crystalline calcite present as a filling material in small vuggy pores. No terrigenine admixture. Outcrop massive-bedded. Sample taken from very top of limestone unit. Thin section number P-100-D.

Limestone, medium gray weathering to light gray. Coarse microsparite to very fine sparite. Calcite crystals average 0.01 mm. Unfossiliferous. Thin section shows parallel laminations of brown microsparite. Very minor amount of very fine silt size, angular quartz fragments. Outcrop massive-bedded. Sample taken 3.0 feet above base of unit. Thin section number P-100-C.

Limestone, medium gray weathering light gray. Coarse microsparite to very fine sparite. Calcite crystals average 0.01 mm. Unfossiliferous. Stylolitic. Very minor amount of very fine silt size, angular quartz fragments present. Outcrop massive-bedded. Sample taken 1.0 feet above base of unit. Thin section number P-100-B.

Limestone, pinkish-gray weathering gray. Coarse microsparite to very fine sparite. Calcite crystals average 0.01 mm. Unfossiliferous. Numerous fine sparite "stringers" appear throughout the microspar. Abundant fine silt size quartz fragments scattered along the fine sparite laminae. Thin section shows good micro-cross-lamination. Outcrop massive-bedded. Sample taken at very base of limestone unit. Thin section number P-100-A.

Measured Section R (page 120)

Red Peak:

Siltstone, brick-red weathering the same. Medium- to coarse-grained, finely arenaceous. Grains angular to rounded. Poorly to moderately sorted. Submature. Subarkose. Mineralogy: 86% quartz, 8.5% feldspar, 2% chert, 3.5% miscellaneous transported detritus. Cement primarily poorly to moderately developed quartz-feldspar overgrowths; minor amount of calcite as void filling and as replacement of quartz, feldspar and microcrystalline quartz cement. Red hematite stain confined to vacuoles, grain boundary irregularities and calcite matrix. Outcrop massive-bedded with small scale cross laminations. Thickness of unit 36 feet. Thin section number 482.

Measured Section U (page 126)

Popo Agie:

Limestone, slightly greenish-gray weathering gray. Micrite. Crystals too fine to be measured. Unfossiliferous. About 20-25% of slide composed of very fine silt size, angular quartz fragments. Trace of mica. Numerous silt size grains of hematite which are undergoing destruction and clouding the adjacent matrix. Outcrop thin-bedded in beds 1-3 inches thick. Slope former. Sample taken 25 feet above base of unit. Thin section number U-2.

Alcova Limestone (Thickness 22.0 feet):

Limestone, gray weathering same. Micrite. Individual crystals too small to measure. Unfossiliferous. Trace of fine silt size quartz which is partially to entirely replaced by fine sparry calcite. Outcrop thin-bedded in beds 2-4 inches thick. Sample taken 10 feet above exposed base of unit. Thin section number U-1-C.

Limestone, gray weathering same. Micrite. Individual crystals too small to measure. Unfossiliferous. Minor amount of fine silt size quartz which is partially to entirely replaced by fine sparry calcite. Outcrop thin-bedded in beds 2-4 inches thick. Sample

taken 5 feet above exposed base of unit. Thin section number U-1-B.

Limestone, gray weathering same. Micrite. Individual grains too small to be measured. Unfossiliferous. Trace of fine silt size, angular quartz fragments which are partially or wholly replaced by calcite. Outcrop thin-bedded in beds 2-4 inches thick. Sample taken at very base of unit. Thin section number U-1-A.

Measured Section V (page 128)

Crow Mountain:

Siltstone, reddish-maroon weathering same. Medium- to coarse-grained. Grains angular to subround. Poorly to moderately sorted. Immature. Subarkose. Mineralogy: 86% quartz, 9.5% feldspar, 3% mica, 2% miscellaneous transported detritus. Cement primarily calcite as void filling and quartz-feldspar replacement: clay matrix common; overgrowth cement rare. Red color due to hematite stain in clay-calcite matrix. Outcrop thin-bedded. Unit thickness 23.5 feet. Sample taken 10.0 feet above top of Alcova Limestone. Thin section number 485.

Alcova Limestone: (Thickness 6.0 feet):

Dolostone, variegated maroon gray weathering same. Dolosparite. Individual crystals average 0.09 mm. Unfossiliferous. Minor amount of silt size hematite grains. Some red hematite staining. Small vugs partially filled with coarse dolospar. Outcrop massive-bedded. Sample taken at very top of unit. Thin section number V-14-D.

Dolostone, variegated maroon-gray weathering same. Dolosparite. Individual crystals average 0.09 mm. Unfossiliferous. Stylolitic. Minor amounts of silt size hematite grains distributed along thin red stained dolospar laminae. Outcrop massive-bedded. Sample taken at base of massive-bedded part 1.1 feet above base of unit. Thin section number V-14-B.

Dolostone, gray weathering same. Dolomicrosparite. Unfossiliferous. Trace of fine silt size hematite grains distributed along thin red stained laminae.

Outcrop thin-bedded in beds 1-2 inches thick. Sample taken 3 inches above base of limestone unit. Thin section number V-14-A.

Red Peak:

Siltstone, white with red laminae. Medium- to coarse-grained. Grains angular to subround. Poorly to moderately sorted. Immature. Subarkose. Mineralogy: 86% quartz, 6.5% feldspar, 4% mica, trace chert, 3.5% miscellaneous transported detritus. Cement primarily calcite as quartz-feldspar replacement and as void filling; clay matrix common; overgrowth cement rare. Red hematite stain abundant in matrix due to alteration of magnetite to hematite. Outcrop massive-bedded with micro-cross-laminations. Sample taken 5.0 feet below base of Alcova Limestone. Thin section number 484.

Measured Section W (page 131)

Alcova Limestone (Thickness 4.5 feet):

Limestone, gray weathering same. Fine sparite. Crystals average 0.04 mm. Unfossiliferous. Slightly dolomitic. No quartz. Trace of silt size, red hematite grains, many undergoing disintegration and clouding adjacent matrix. Outcrop thin,- wavy-bedded in beds 1-2 inches thick. Sample taken at very top of unit. Thin section number W-2-E.

Limestone, gray weathering same. Coarse microsparite to very fine sparite. Individual crystals averaging 0.01 mm. Unfossiliferous. Stylolitic. No quartz. Minor amount of silt size red hematite grains undergoing alteration and clouding adjacent matrix. Outcrop massive-bedded with large "algal heads." Sample taken 3 feet above base of unit. Thin section number W-2-D.

Limestone, gray weathering same. Coarse microsparite to very fine sparite. Crystals average about 0.02 mm. Unfossiliferous. Stylolitic. Very thin laminations of fine sparite alternate with microspar laminations. Some red hematite staining along stylolite zones. Outcrop massive-bedded. Sample taken 2.0 feet above base of unit. Thin section number W-2-C.

Limestone, gray weathering same. Sparite. Individual crystals average about 0.06 mm. Unfossiliferous. Stylolitic. Dolomitic. No quartz. Minor amounts of red, silt size hematite grams scattered throughout. Red staining most prominent adjacent to stylolites. Outcrop massive-bedded. Sample taken 1.0 foot above base of unit. Thin section number W-2-B.

Limestone, gray weathering same. Coarse microsparite to very fine sparite. Crystals average about 0.02 mm. Unfossiliferous. Slightly dolomitic. No quartz. Minor amount of red, silt size hematite grains. Very thin laminations of fine sparite alternate with thin microspar laminae. Outcrop massive-bedded. Sample taken at very base of unit. Thin section number W-2-A.

Red Peak:

Siltstone, white with red laminae. Medium- to coarse-grained. Grains angular to subround. Poorly to moderately sorted. Immature. Subarkose. Mineralogy: 86.5% quartz, 7.5% feldspar, 1.5% mica, 1% chert, 4% miscellaneous transported detritus. Cement primarily calcite replacing quartz and feldspar and as a void filling; clay matrix common; overgrowth cement rare. Abundant red hematite stain in matrix due to alteration of magnetite to hematite. Outcrop massive-bedded with micro-cross-laminations. Unit 3.5 feet thick. Sample taken 2.5 feet below base of Alcova Limestone. Thin section number 486.

Measured Section X (page 132)

Crow Mountain:

Siltstone, brick-red weathering the same. Coarse-grained, finely arenaceous. Grains angular to rounded. Moderately sorted. Submature. Subarkose. Mineralogy: 80% quartz, 13.5% feldspar, trace mica, 1% chert, 5% miscellaneous transported detritus. Cement primarily calcite as quartz-feldspar replacement and as void filling; minor amount of clay and microcrystalline quartz as cement. Red hematite stain in streaks and patches; color restricted to calcite matrix. Outcrop consists of 27.5 feet of interbedded red silty shale

and red and white siltstones. Sample taken 15.0 feet above top of Alcova Limestone. Thin section number 489.

Alcova Limestone (Thickness 5.5 feet):

Limestone, gray weathering same. Coarse microsparite to very fine sparite. Crystals average 0.03 mm. Unfossiliferous. Stylolitic. No quartz. Minor amount of red, very fine silt-size hematite partially disintegrated. Outcrop thin-, wavy-bedded. Sample taken 4.5 feet above base of unit. Thin section number X-7-F.

Limestone, gray weathering gray. Coarse microsparite to very fine sparite. Crystals average 0.03 mm. Unfossiliferous. Trace of quartz. Minor amount of red, very fine silt-size grains of hematite undergoing disintegration. Outcrop thin-, wavy-bedded. Sample taken 3.1 feet above base of unit. Thin section number W-7-E.

Dolostone, white weathering grayish-white. Finely crystalline dolosparite. Crystals average about 0.02 mm. Fossiliferous, but fossil fragments unidentifiable because of extensive recrystallization. Central portion of fossils filled with medium-crystalline dolospar. Outcrop massive-bedded. Sample taken 2.0 feet above base of unit. Thin section number X-7-C.

Limestone, gray weathering same. Coarse microsparite to fine sparite. Crystals average 0.02 mm. Unfossiliferous. Stylolitic. Slightly dolomitic. No quartz. Minor amounts of red, very fine silt size-hematite grains. "Stringers" of fine sparry calcite alternate with laminae of microspar. Outcrop massive-bedded. Sample taken 1.0 foot above base of unit. Thin section number X-7-B.

Limestone, gray weathering same. Coarse microsparite to fine sparite. Slightly dolomitic. No quartz. Minor amount of red, very fine siltsize hematite scattered along fine sparite laminae. Outcrop massive-bedded. Sample taken at very base of unit. Thin section number X7-A.

Red Peak:

Siltstone, brick-red weathering same. Medium- to coarse-grained. Grains angular to subround. Poorly to

moderately sorted. Immature. Subarkose. Mineralogy: 87.5% quartz, 7.5% feldspar, 1.5% mica, 1% chert, 2.5% miscellaneous transported detritus. Cement primarily calcite as quartz-feldspar replacement and as void filling; moderate amount of clay cement. Red color confined to grain boundaries and matrix. Outcrop massive-bedded with micro-cross-laminations. Thickness of unit 4.5 feet. Thin section number 487.

Measured Section Y (page 134)

Alcova Limestone (Thickness 9.0 feet):

Limestone, gray weathering same. Coarse microsparite to very fine sparite. Crystals average about 0.02 mm. Unfossiliferous. Slightly dolomitic. No terrigenous fraction. Thin laminae of finely crystalline sparite alternate with microspar laminae. Outcrop thin-, wavy-to "crinkly" bedded. Sample taken 1.5 feet below top of limestone unit. Thin section number Y-5-E.

Limestone, gray weathering same. Coarse microsparite to very fine sparite. Crystals average about 0.02 mm. Unfossiliferous. Slightly dolomitic. No terrigenous admixture. Thin laminae of finely crystalline sparite alternate with microspar laminae. Outcrop massive-bedded. Sample taken 3.0 feet above base of unit. Thin section number Y-5-C.

Red Peak:

Siltstone, whitish-gray weathering same. Medium- to coarse-grained. Grains angular to subround. Poorly to moderately sorted. Submature to immature. Subarkose. Mineralogy: 86.5% quartz, 10% feldspar, 2% mica, 3.5% miscellaneous transported detritus. Cement primarily calcite as quartz-feldspar replacement and as a void filling; overgrowth cement patchy and poorly developed. Feldspars fresh to highly vacuolized and sericitized. Micro-cross-laminations conspicuous. Outcrop massive-bedded. Unit 4.5 feet thick. Sample taken 2.0 feet below base of Alcova Limestone. Thin section number 490.

Measured Section Z (page 135)

Crow Mountain:

Siltstone, buff weathering same. Medium- to coarse-grained, finely arenaceous. Grains angular to subround. Poorly to moderately sorted. Immature to submature. Subarkose. Mineralogy: 86% quartz, 11% feldspar, trace mica, 2% chert, 2% miscellaneous transported detritus. Cement primarily calcite replacing quartz, feldspar and as a void filling; minor patches of clay matrix, patches of overgrowth cement rare and poorly developed. Feldspars fresh to altered. Outcrop thin-bedded. Thickness of unit 2.0 feet. Thin section number 491.

Alcova Limestone (Thickness 2.3 feet):

Limestone, light brown weathering gray. Limestone pebble conglomerate (calclithite). Fragments range in size from very fine sand to coarse pebbles. Sand fraction consists primarily of angular to well-rounded quartz, chert and feldspar fragments. Pebble material consists of angular to subrounded, brown micrite and microsparite limestone fragments very similar to those of the Alcova elsewhere in the vicinity. Cementing material medium-crystalline sparry calcite as a void filling. Outcrop massive-bedded. Scarp former. Sample taken from middle of unit. Thin section number Z-109.

Measured Section AA (page 138)

Crow Mountain:

Sandstone, grayish-white weathering same. Very fine-grained, very silty. Grains angular to subround. Moderately to poorly sorted. Submature to immature. Subarkose. Mineralogy: 83.5% quartz, 11.5% feldspar, 1% mica, 0.5% chert, 3.5% miscellaneous transported detritus. Cement primarily calcite as quartz-feldspar replacement and as void filling; minor patches of clay matrix; overgrowth cement poorly developed and patchy. Outcrop massive-bedded. Thickness of unit 30.0 feet. Thin section number 493.

Alcova Limestone (Thickness 6.0 feet):

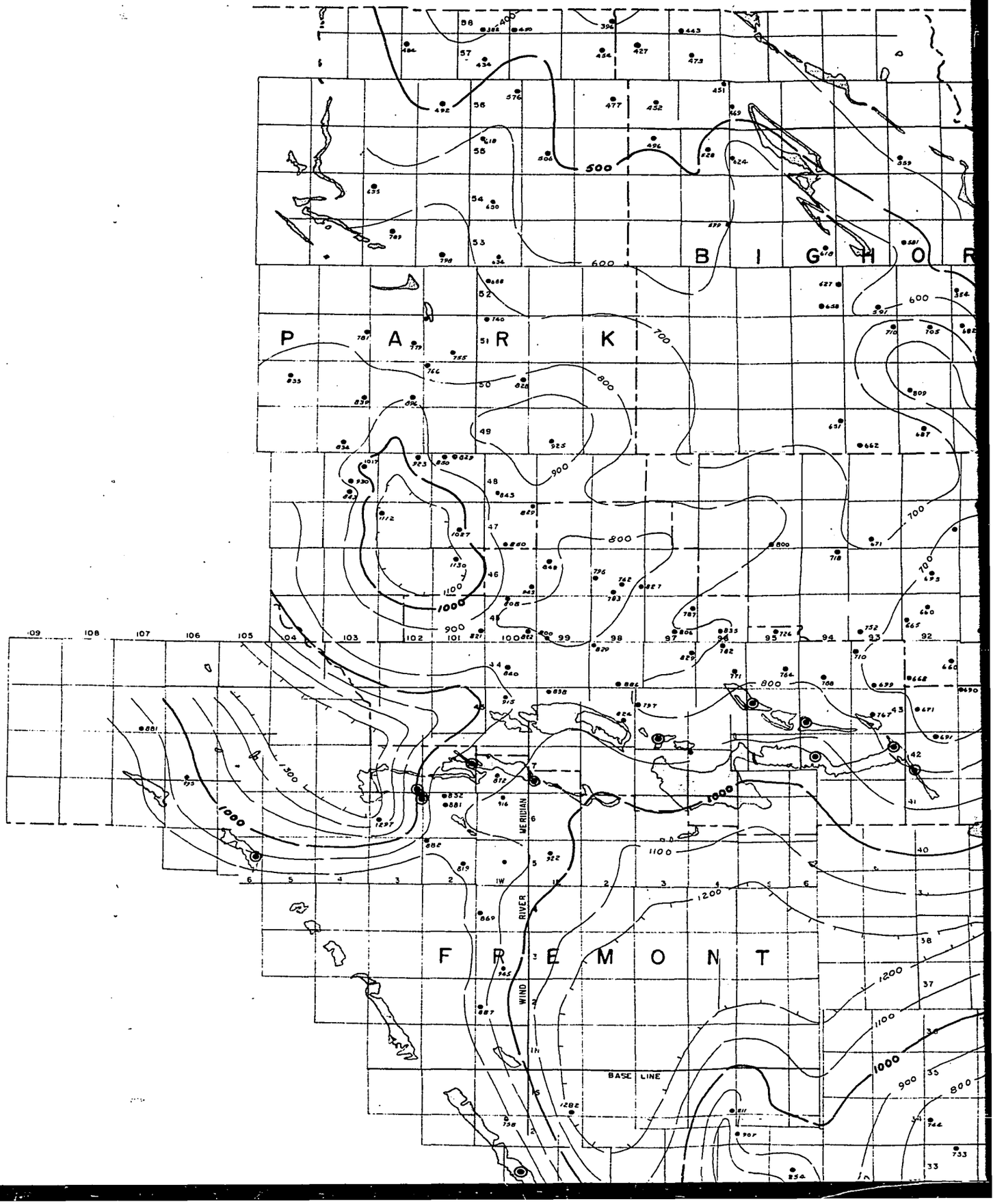
Limestone, buff weathering gray. Coarse microsparite to very fine sparite. Unfossiliferous. Trace of fine silt size, angular quartz fragments. Very thin laminae of fine sparry calcite interspersed between micrite laminae. Quartz fragments scattered along sparry laminae. Outcrop thin, wavy-bedded. Sample taken at very top of unit. Thin section number AA-17-C.

Limestone, reddish-buff weathering gray. Coarse microsparite. Crystals averaging 0.02 mm. Unfossiliferous. Minor amount of fine silt size angular quartz fragments which are partially replaced by calcite. Abundant hematite fragments and hematite staining. Outcrop massive-bedded. Sample taken at very base of limestone unit. Thin section number AA-17-A.

APPENDIX C

SUMMARY OF CROSS-STRATIFICATION DIP DIRECTION DATA

Measured Section	No. of Readings	Mean	Mode	Standard Deviation (Degrees)
A	6	S 35° E	S 30° E	11
B	7	S 51° E	S 40° E	23
C	9	N 62° E	N 75° E	19
D	5	S 51° E	None	14
E	8	N 34° E	N 30° E	5
F	7	N 44° E	N 55° E	19
J	7	S 66° E	S 40° E	30
K	7	N 65° E	N 70° E	12
L	8	S 30° E	S 15° E	14
N	7	N 8° E	N 10° E	8
P	8	S 26° E	S 25° E	6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P A R K
F R E M O N T
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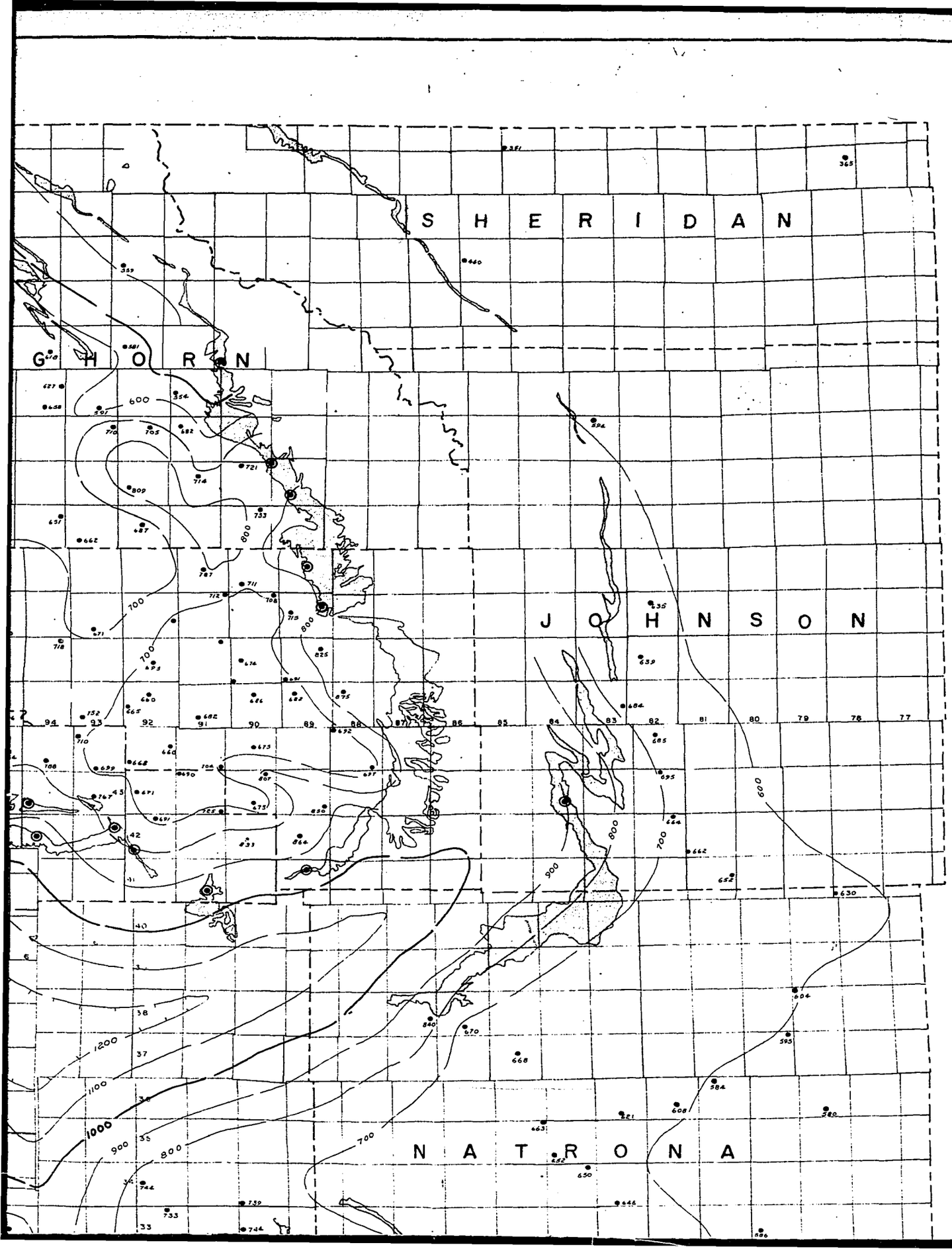
700
800
900
1000
1100
1200
1300
WIND RIVER
BASE LINE
MERIDIAN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HORN
JOHNSON
NATRONA
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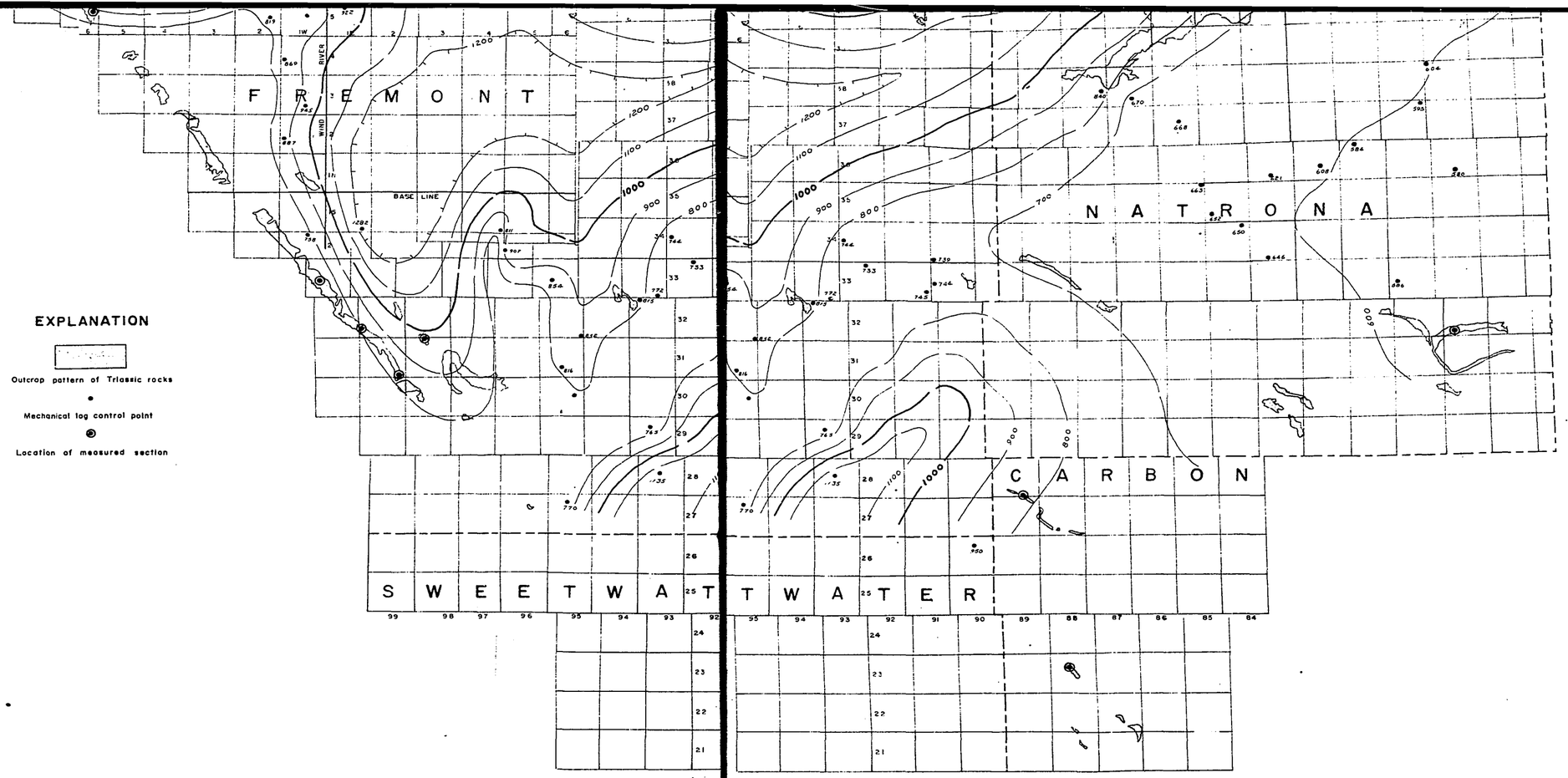
700
800
900
1000
1100
1200



EXPLANATION

Outcrop pattern of Triassic rocks

Mechanical log control point

Location of measured section

PLATE VII

PLATE VII

ISOPACH MAP SHOWING APPARENT THICKNESS OF RED PEAK FORMATION

CENTRAL WYOMING

Contour Interval: 100'

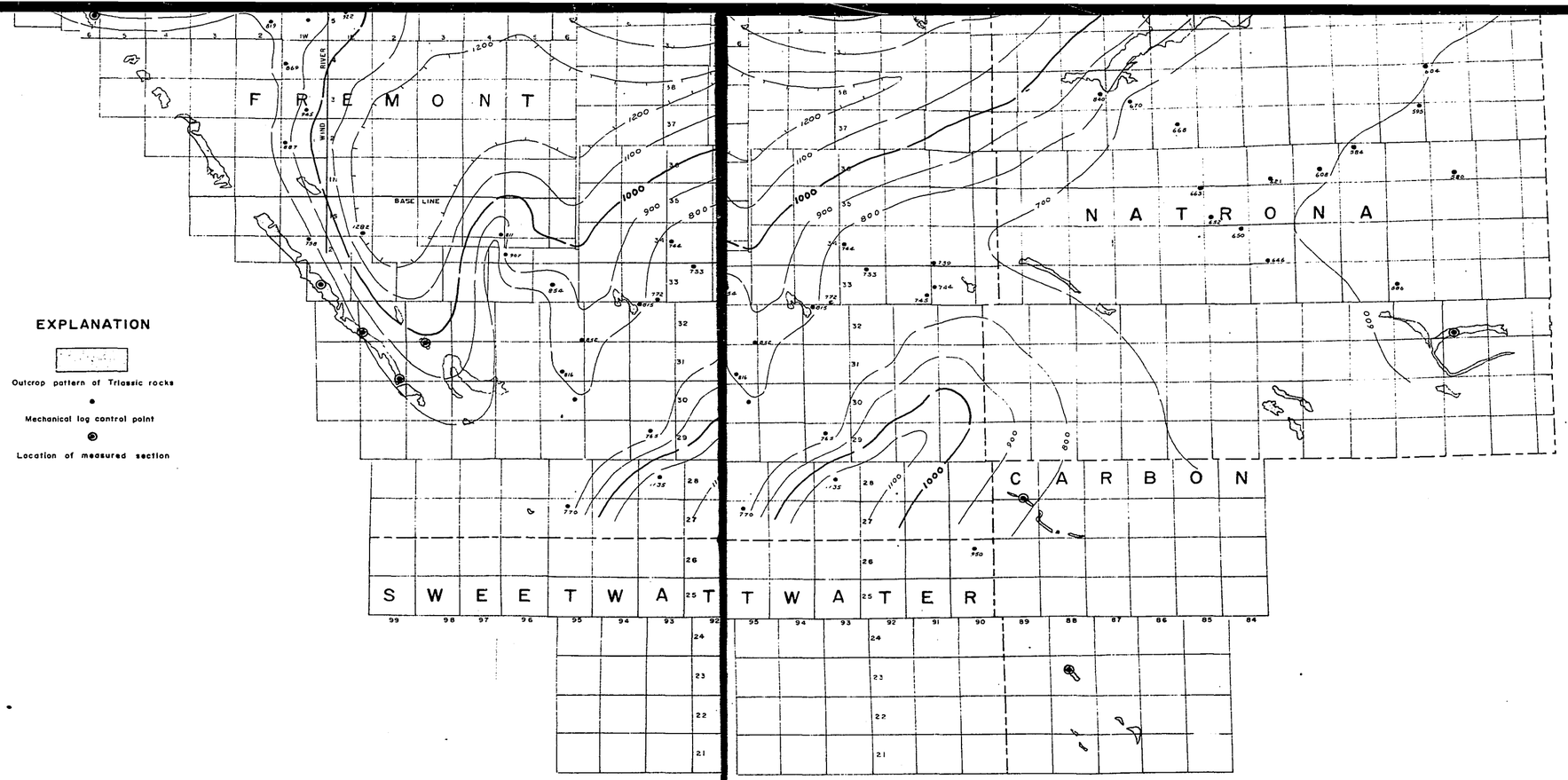
0 10 20 30 MILES

Contour Interval: 100'

20 30 40 50 MILES

Richard R. Bower, Ph.D.

Richard R. Bower, Ph.D. April, 1964



EXPLANATION

Outcrop pattern of Triassic rocks

Mechanical log control point

Location of measured section

PLATE VII

PLATE VII

ISOPACH MAP SHOWING APPARENT THICKNESS OF RED PEAK FORMATION

ISOPACH MAP SHOWING APPARENT THICKNESS OF RED PEAK FORMATION

CENTRAL WYOMING

CENTRAL WYOMING

Contour Interval: 100'

Contour Interval: 100'

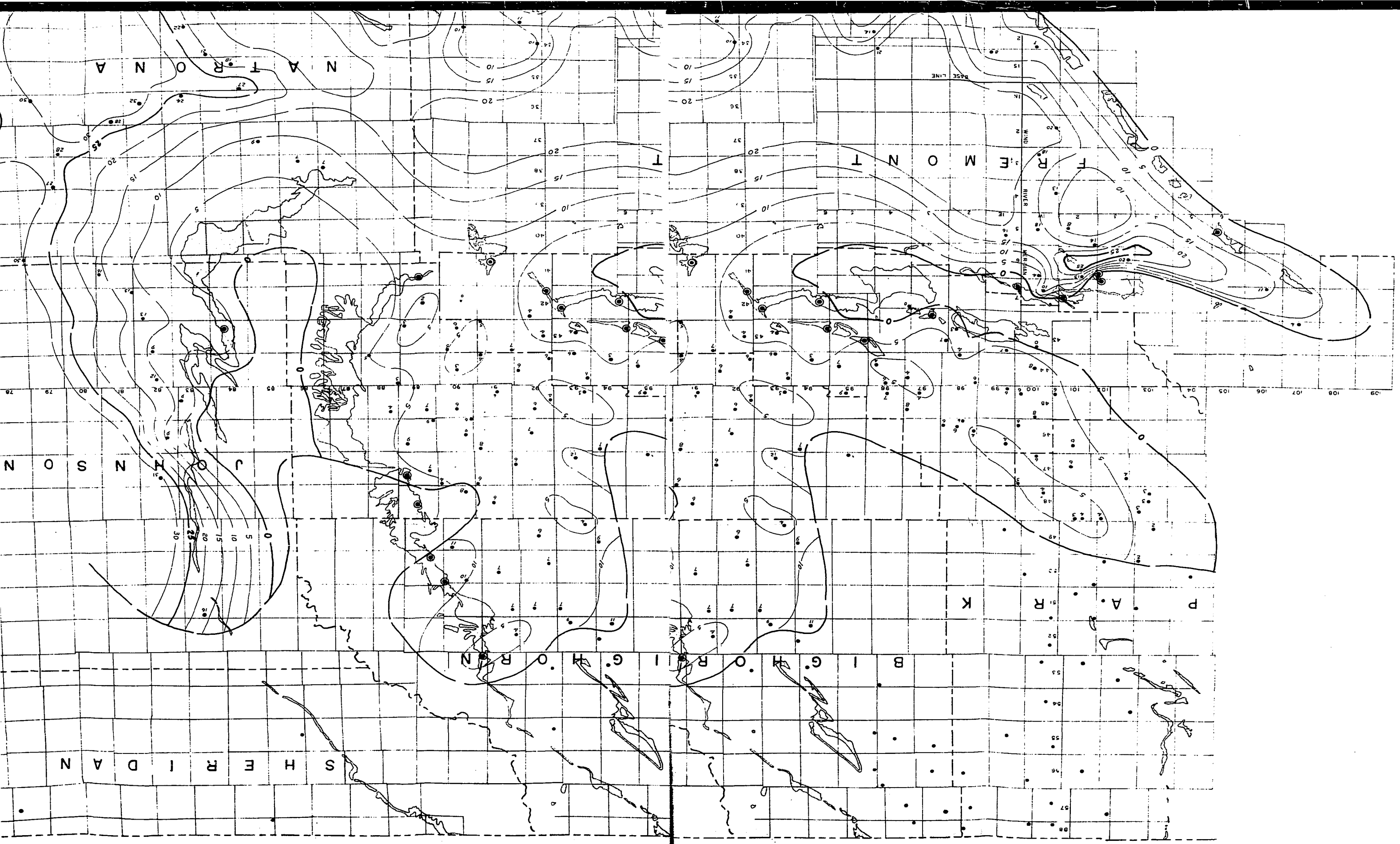
0 10 20 30 MILES

20 30 40 50 MILES

Richard R. Bower, Ph.D.

R. Bower, Ph.D.

April, 1964


JOHNSON
NATRONA
CONVERSE
NIOBRARA
WESTON
CROOK
CAMPBELL
SHERIDAN
SWEETWATER
FREMONT
BIG HORN
PARK
BASE LINE
MERIDIAN
WIND RIVER

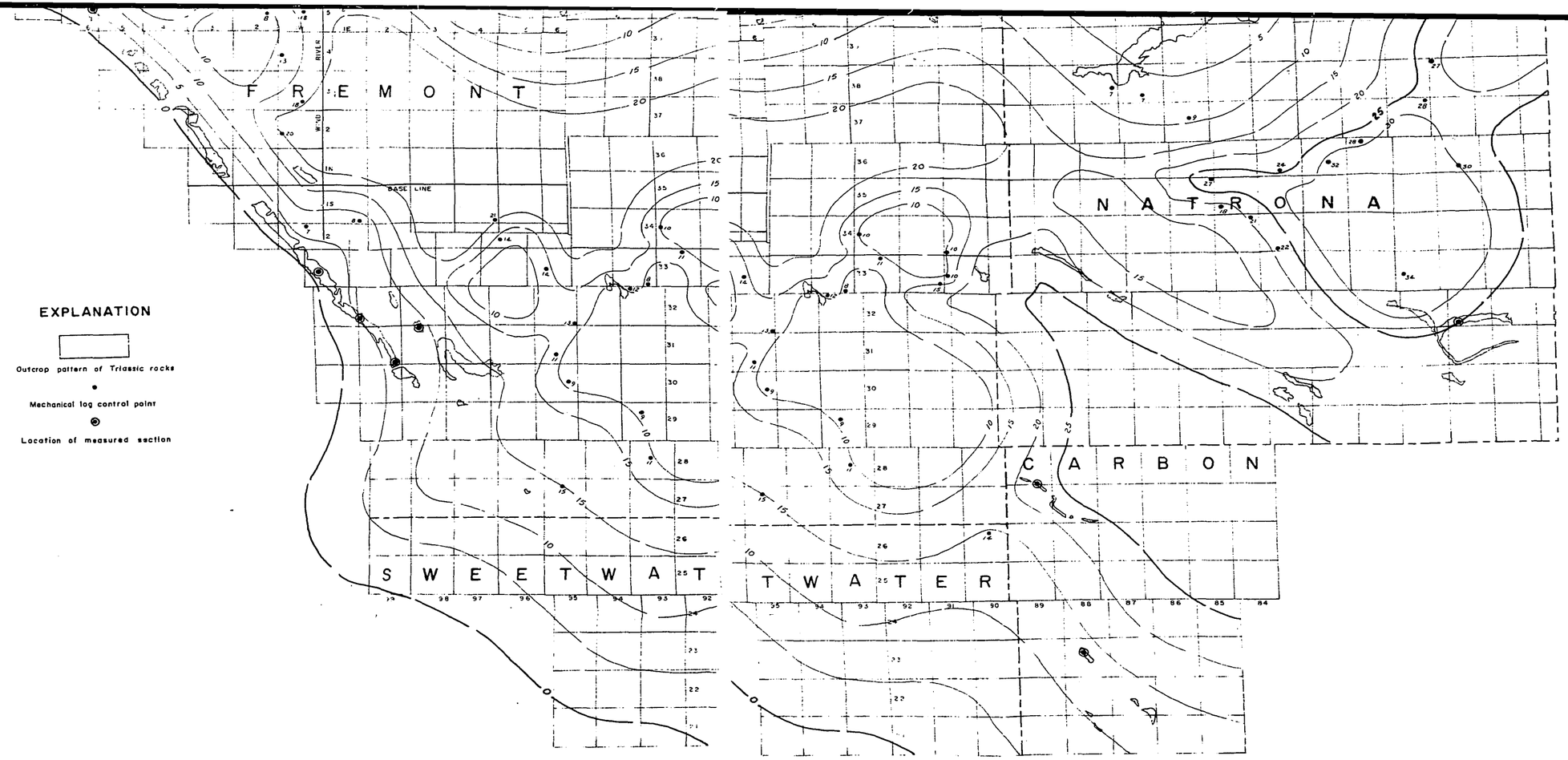


PLATE VIII

ISOPACH MAP SHOWING APPARENT THICKNE

CENTRAL WYOMIN

Contour Interval: 5'

0 10 20 30

MILES

Richard R. Bower Ph.D. Ap

PLATE VIII

ARENT THICKNESS OF ALCOVA LIMESTONE

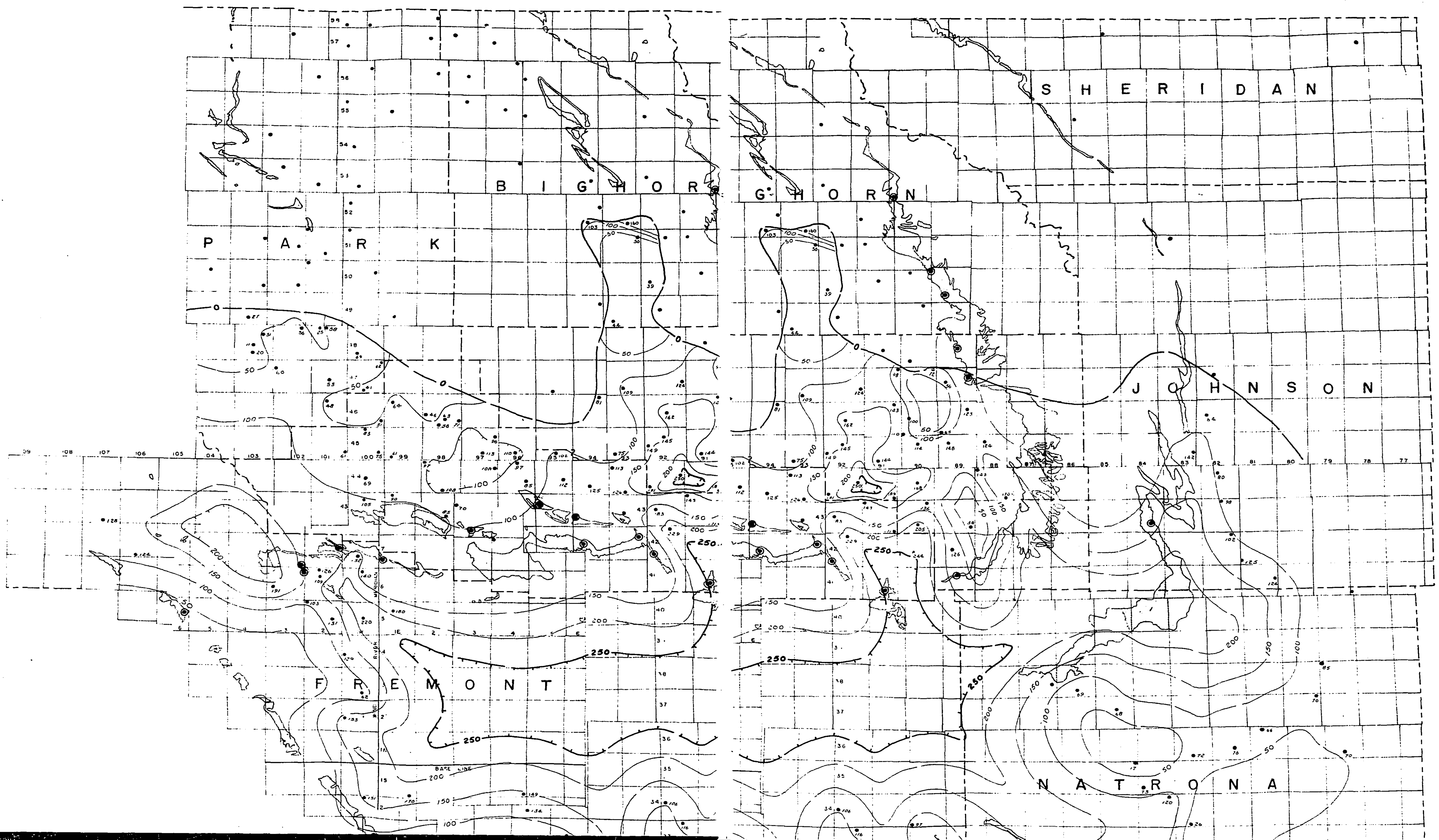
ENTRAL WYOMING

Contour interval: 5'

20 30 40 50

MILES

R. Bower Ph.D. April, 1964


SHERIDAN
BIG HORN
PARK
JOHNSON
FREMONT
NATRONA
BASE LINE

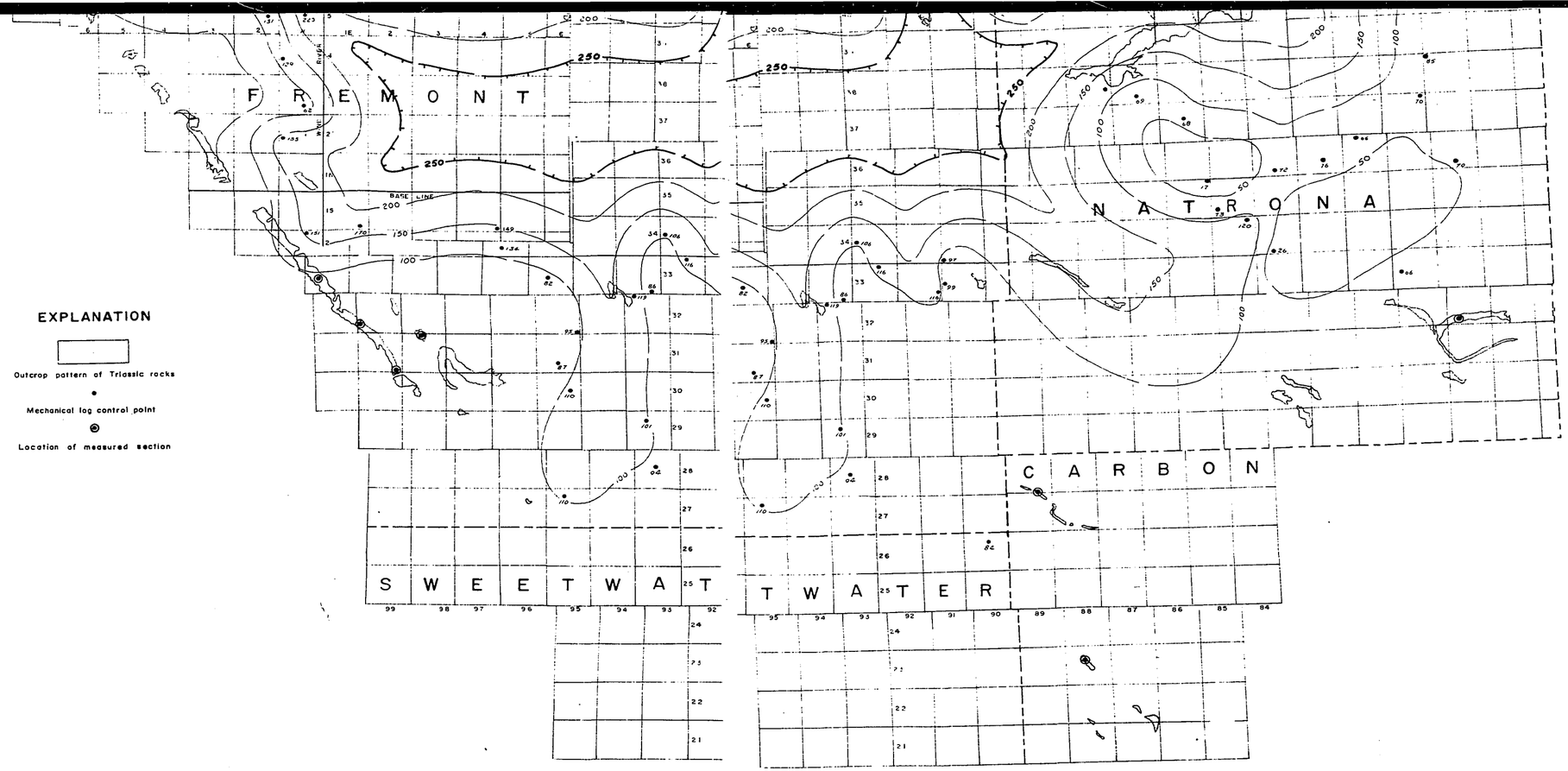


PLATE IX

PLATE IX

ISOPACH MAP SHOWING APPARENT THICKNESS OF POPO AGIE FORMATION, CENTRAL WYOMING

ISOPACH MAP SHOWING APPARENT THICKNESS OF CROW MOUNTAIN MEMBER, POPO AGIE FORMATION, CENTRAL WYOMING

Contour Interval: 50'

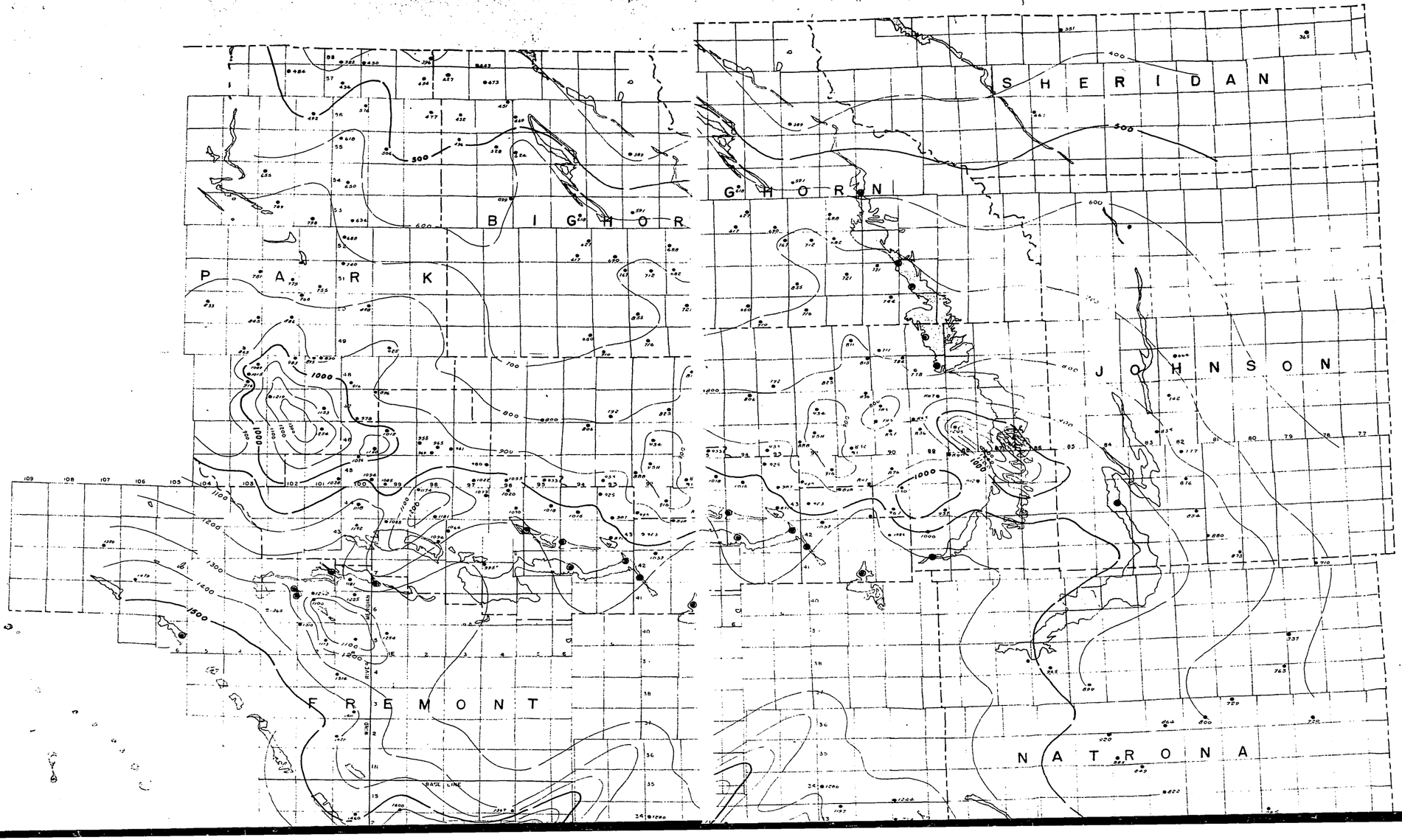
0 10 20 30 MILES

Richard R. Bower Ph.D. April, 1964

Contour Interval: 50'

20 30 40 50 MILES

R. Bower Ph.D. April, 1964


SHERIDAN
GOSHEN
BIGHORN
PARK
JOHNSON
FREMONT
NATRONA
BASE LINE

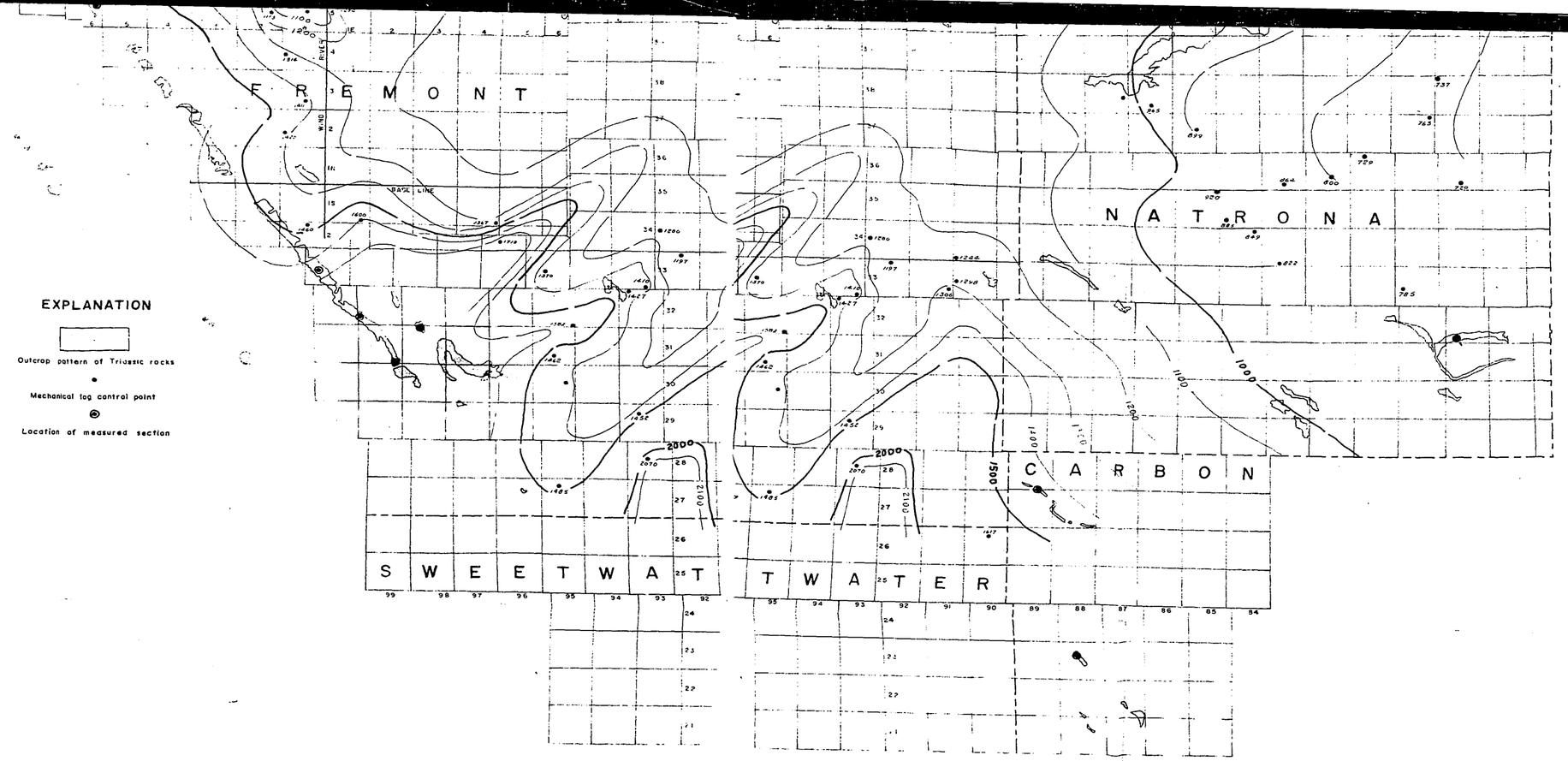


PLATE X

PLATE X

ISOPACH MAP SHOWING APPARENT THICKNESS OF RED PEAK FORMATION, ALCOVA LIMESTONE, CROW MOUNTAIN MEMBER, POPO AGIE FORMATION

CENTRAL WYOMING

CENTRAL WYOMING

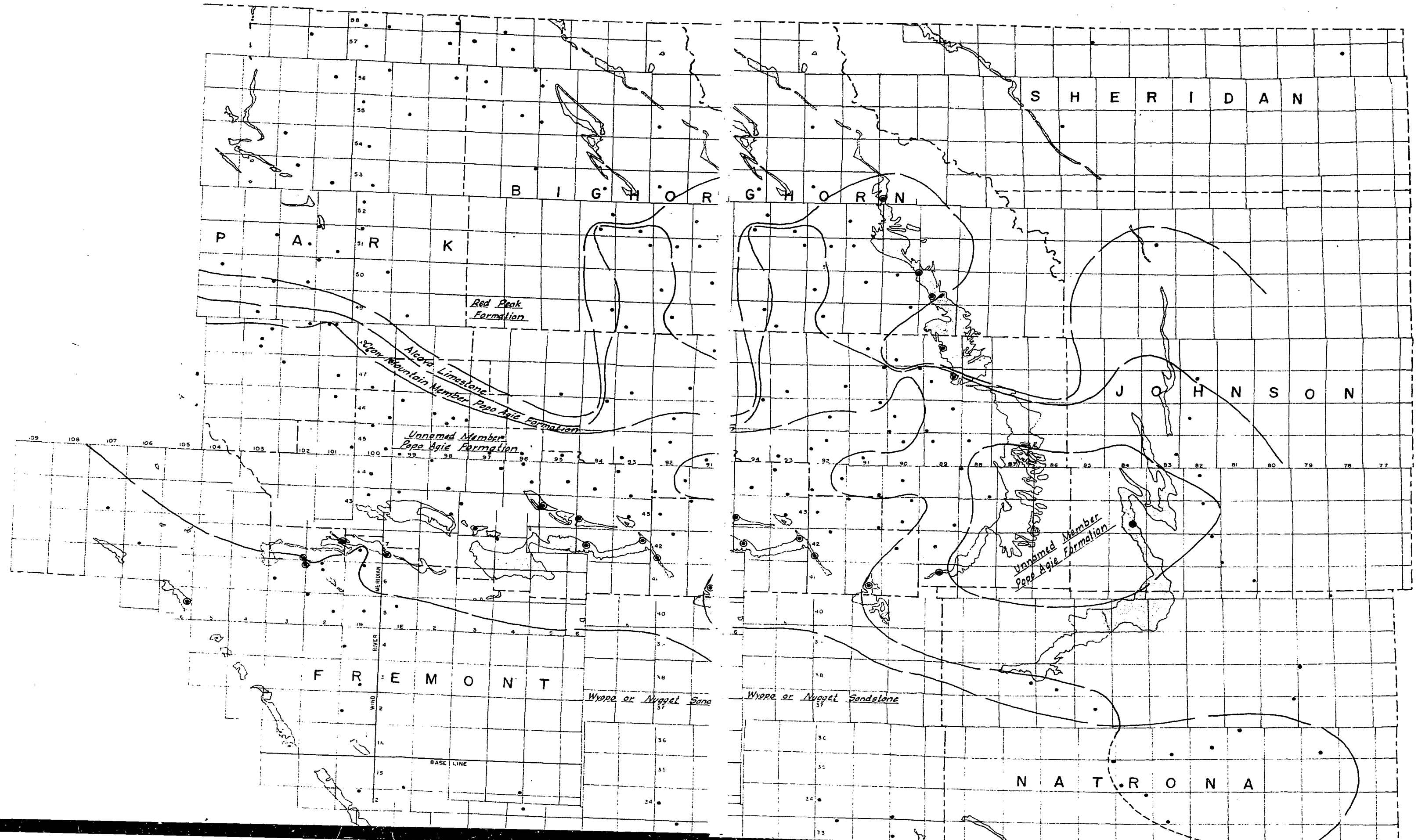
Contour Interval: 100'

Contour Interval: 100'

Richard R. Bower Ph.D.

R. Bower Ph.D.

April, 1964


SHERIDAN
BIG HORN
PARK
JOHNSON
FREMONT
NATRONA
Red Peak Formation
Alcova Limestone
Grey Mountain Member, Pope Agie Formation
Unnamed Member Pope Agie Formation
Wyope or Nugget Sandstone
Wyope or Nugget Sandstone
Unnamed Member Pope Agie Formation
WIND RIVER
BASE LINE

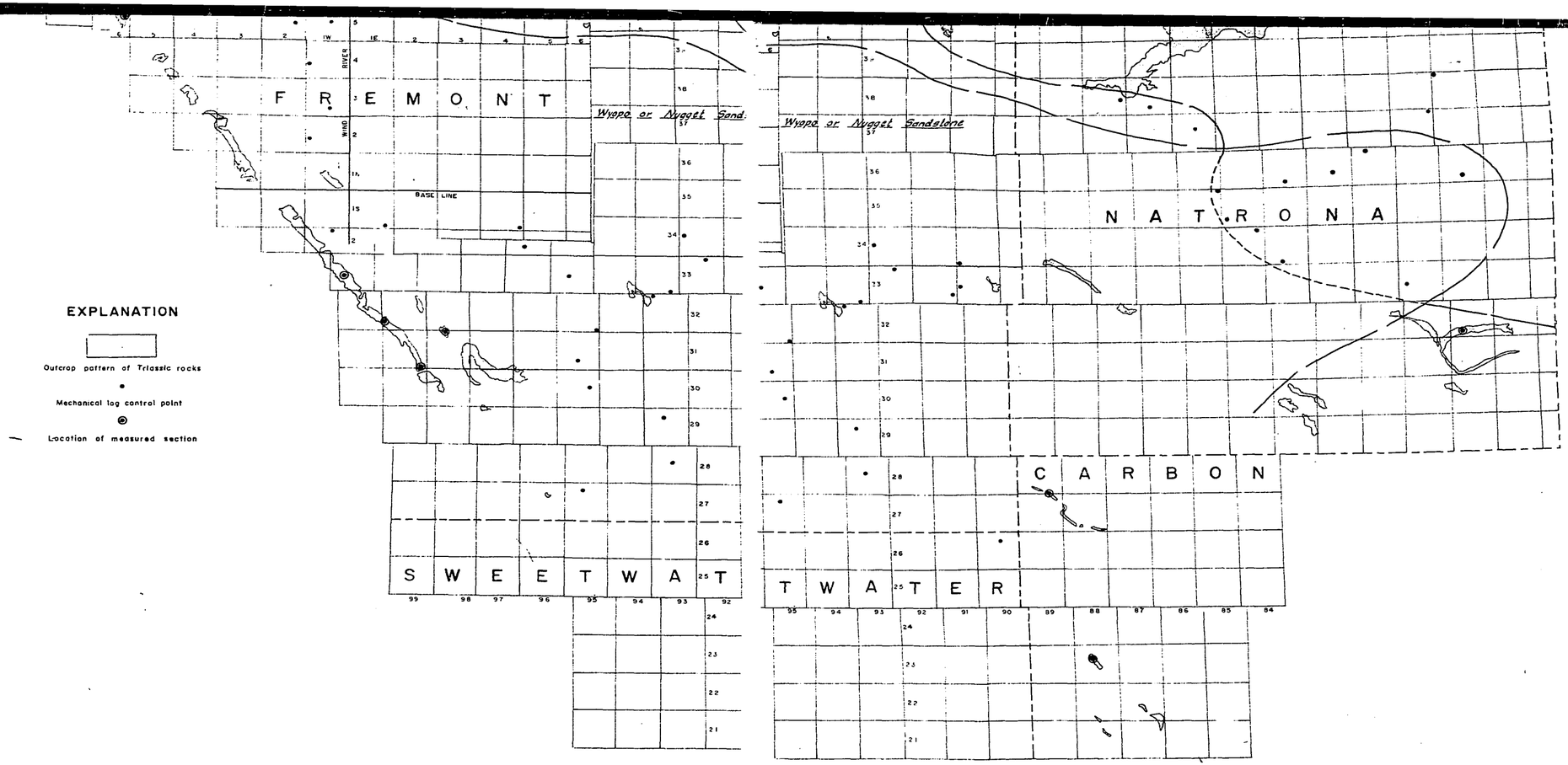


PLATE XI

PLATE XI

PRE-GYPSUM SPRINGS, PRE-SUND..GS, PRE-SUNDANCE SUBCROP MAP

CENTRAL WYOMIN... CENTRAL WYOMING

0 10 20 30 MILES

20 30 40 50 MILES

Richard R. Bower Ph.D. A...

...Bower Ph.D. April, 1964