THE GEOLOGY OF AN AREA IN THE NORTHERN HOBACK RANGE, WYOMING

by
Lyman E. Galbraith

1949

Dear Ken,

This thesis of Lyman Galbraith has been critically read and rewritten and I now believe it is worthy of acceptance. According to Galbraith he has completed the other requirements for the M.A. degree. Will you kindly check, and with your approval, kindly inform the Grad. School to award the degree. Gene is writing a note below.

Armand

I have read this thesis and approve its acceptance

E.H. Walker

Nov. 20. '48

The Geology of an Area in the Northern Hoback Range, Wyoming

A Thesis Submitted
in Partial Requirement
for the Masters Degree
by

Lyman E. Galbraith

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ILLUSTRATIONS

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INTRODUCTION

This report is based on field work carried out in the summer of 1946 in the northern Hoback Range which there lies directly south of the Gros Ventre Mountains (Plate #1). The northern boundary of the area extends from Jackson for a distance of about seven miles up the Cache Creek valley. The area is bounded on the west by Jackson Hole from which the Hoback Range in this region rises abruptly. The southern boundary of the area extends from a point on Highway #187 about four miles due south of Jackson first northerly, then easterly to the headwaters of Game Creek, and then northeasterly to the peak designated on the map as 9284 feet, near the headwaters of Horse Creek. The eastern end of the area is in the headwaters of Cache Creek.

The geological work was undertaken for the purpose of obtaining (1) a geological map of the area (Plate #2), (2) a description and interpretation of the structural geology, and (3) a knowledge of the history of the area.

The writer wishes to express his deep appreciation to Professor Armand J. Eardley of the Geology Department of the University of Michigan for his kind and capable supervision and invaluable assistance. The writer is also indebted to Arthur Bergren and William Smith for their assistance in the field.

STRATIGRAPHY

Introduction

Since the structural study is the primary concern of this paper, the stratigraphy of the area has been dealt with only sufficiently for structural purposes. The data on the formations are those used by the University of Michigan Geology Field Station at Camp Davis, Wyoming, unless otherwise noted.

The oldest formation in the small area of this report is the Madison limestone (Mississippian), but older beds have been reported nearby[1]. Because they occur at depth in the local area, their descriptions are here included. The Upper Jurassic formations and Cretaceous Aspen and Bear River formations are not exposed, but they are known to occur in the Hoback Range to the south, and for the sake of completeness their descriptions are also included.

As is true of the geosynclinal ranges of the Middle Rockies, the crystalline basement complex is not exposed in this area, but it is exposed in the nearby Gros Ventre Mountains and is described by Nelson and Church[2] as consisting of gneisses and schists intruded by granite.

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1. Nelson, V.E. & Church, V., Critical Structures of the Gros Ventre and Northern Hoback Ranges, Wyoming, The Journal of Geology, Vol. LI, No. 3, April-May, 1943, p.159.

2. Ibid., pp. 145 and 154.

Cambrian System

Flathead quartzite: The Flathead quartzite is a buff to light grey orthoquartzite and sandstone. It is massive and medium to coarse grained. It weathers brownish with iron stains. There is a pebbly basal conglomerate. It has a thickness of about 250 feet.

Gros Ventre formation: The Gros Ventre formation contains two shale units and an intermediate limestone. It overlies the Flathead quartzite conformably. The basal shale is green to yellow, chloritic and glauconitic, fissile and friable. It is about 75 feet thick. The middle limestone is the "Death Canyon" member. It is a fine grained to sub-lithographic grey limestone which weathers rusty and has lenses of a flat pebble limestone conglomerate. It is about 250 feet thick. The upper shale is a calcareous, grey-green shale with units of intraformational breccia and pebbly limestone. It is about 400 feet thick.

Boysen formation: The Boysen formation is a dark blue to blue-grey massive limestone which contains pockets of yellow calcite and interbedded calcareous shale. It lies unconformably on the Gros Ventre formation and is about 250 feet thick.

Ordovician System

Bighorn formation: The Bighorn formation is a cream to buff to grey, massive dolomite. It is characterized by a rough, pitted surface where exposed to weathering. It is about 300 feet thick and rests unconformably on the Boysen limestone. A milk-white dolomite 40 feet thick lies above the pitted Bighorn. It is thin, dense, and flaggy and weathers to a smooth surface. It is known as the Leigh dolomite and may be a separate formation, although until now has been considered a member of the Bighorn.

Devonian System

Darby formation: The Darby formation unconformably overlies the Ordovician formations. It is a sequence of mouse-coloured dolomites and shales. It is incoherent and has a pitted structure. It has an approximate thickness of 350 feet.

Mississippian System

Madison-Brazer limestones: The Madison-Brazer limestones in the area form the crest and north slope of the ridge paralleling the area, but the boundary between them is not clearly defined and since they form a convenient mapping unit, the hyphenated term is here used. The two formations differ somewhat in lithology. The Madison is grey to blue in color, coarser grained and less massive, particularly in the upper one-third of the formation, than the Brazer. It weathers light grey and forms a yelloworange coating on exposure.

The Brazer formation is a dark grey, almost lithographic, limestone. It has numerous calcite veins and considerably more black chert nodules than the Madison. It weathers light grey to buff.

The Madison contains many small cup corals associated with spiriferoid brachiopods. The Brazer contains large cup corals and compound corals. The formations together are about 1000 feet thick. They share a conformable relationship and rest unconformably on the underlying Darby formation.

Pennsylvanian System

Wells formation: The Wells formation is here used to include the Amsden and Tensleep formations. These two formations, when considered together, are convenient units in mapping, so they are here lumped as the Wells formation.

The Amsden formation lies conformably on the Brazer. It is a series of interbedded shales, limestones, and sandstones. The basal member is a red shale, "the Lower Amsden Red", which is gypsiferous. Above this red shale there is a dark grey limestone which closely resembles the Brazer limestone. Above this limestone is the Darwin sandstone which is hard and pink and forms a distinctive unit. Above the Darwin sandstone is another red shale unit known as "the Upper Amsden

Red". The uppermost unit is a dolomitic limestone which has chert nodules or bands in its lower part.

The upper dolomitic limestone of the Amsden grades imperceptibly into the Tensleep formation, and the most distinctive point of separation between the Amsden and Tensleep is where the Tensleep becomes the typical grey to pink orthoquartzitic sandstone. This sandstone is fine-grained and is somewhat calcareous in spots. Throughout the Tensleep there are units of limestone, dolomite, and gypsum. The combined thickness of the Amsden and Tensleep is about 1300 feet.

Permian System

Phosphoria formation: The Phosphoria formation, which lies conformably on the Wells formation, is a series of phosphatic shales ranging in color from grey to brown to black. In the shales are numerous phosphorites which are nodular to oolitic. These shales are not resistant and form slopes on which can be found phosphatic float. At the top of the formation there is a 40 foot bed of very cherty limestone known as the "Rex Chert". This cherty limestone is poorly developed in the area under discussion. The Phosphoria formation is about 150 feet thick.

Triassic System

Dinwoody formation: The Dinwoody formation, which is considered the basal member of the Woodside formation, is here mapped separately because of its ready recognizability and persistence in outcrop. It shares an unconformable relationship with the Phosphoria.

It is a thin-bedded calcareous sandstone or siltstone, grey to grey-green on the fresh surface but weathers to a characteristic light brown. It weathers into rectangular pieces about six inches long or smaller. A characteristic brachiopod genus occuring in this formation is Lingula.

Woodside-Thaynes formation: The Woodside and Thaynes formations were not separated but mapped together as a unit. The present status of the Triassic formations is very much in doubt, so this term was used to indicate the series of red shales and interbedded limestones that overlie the Dinwoody and underlie the Nugget sandstone. The outcrops in the area were poor, and the formation was usually recognized by the red soil formed by disintegration of the shales. However, this soil, plus some outcrops, enabled the writer to map the unit with considerable confidence. The thickness of the Woodside-Thaynes here is about 500 feet.

Jurassic System

Nugget sandstone: The Nugget sandstone is a buff to red, fine-grained, quartzitic sandstone. In the area, it is well exposed along Game Creek, and due to its resistance to erosion it forms the highest points immediately in front of the Game Creek Thrust. It rests unconformably on the Woodside-Thaynes formation and is about 350 feet thick.

Twin Creek formation: The Twin Creek formation rests unconformably on the Nugget sandstone and in this area occurs as remnants in folds. Three units may be recognized in this formation: a lower limestone member, a middle shaley limestone, and an upper oolitic limestone. The thickness of the complete Twin Creek is about 550 feet.

Stump and Preuss formations: Beds of the Stump and Preuss formations are not exposed in the area but are found elsewhere in the northern Hobacks. They are a series of calcareous sandstones: the Preuss is a shaley red, non-resistant sandstone series; and the Stump is a characteristic greenish, glauconitic, resistant sandstone.

Gannett formation: The Gannett formation does not crop out in the area of this report. It is a series of interbedded sandstones, shales, and limestones, and is about 600 feet thick where found to the south.

Cretaceous System

Bear River formation: The Bear River formation and the Aspen formation are not exposed in the area. Where found to the south, the Bear River formation is composed of a basal unit of four tan sandstones interbedded with black shales. Over this unit there is a black, carbonaceous shale with a few thin sandstones and limestones. This formation is about 300 feet thick.

Aspen formation: The Aspen formation is usually about 1000 feet thick. It has a basal 100 foot unit of "salt and pepper" sandstones and an upper unit of interbedded shales, sandstones, coal, and porcelainite beds.

Frontier formation: The valley of Cache Creek in this area is cut in the Frontier formation. It is a grey to buff arkosic sandstone with some shales and thin coal beds. It has a thickness of 5000 feet in the southern Hoback Range (St. John and Ross, 1945)[3] and about 3000 feet to the north in the Gros Ventre Range (Foster, 1946)[4].

Tertiary Formations

Camp Davis formation: The only Tertiary formation in this area is represented by the Camp Davis conglomerate. It forms scabs of red conglomerates which are evidently erosion-

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3. St. John, Jack and Ross, Alex, Geology of the Southern Hoback Range, Masters Thesis, University of Michigan, 1945.

4. Foster, Helen L., Paleozoic and Mesozoic Stratigraphy of Northern Gros Ventre Mountains and Mount Leidy Highlands, Teton County, Wyoming, Bull. Amer. Assoc. Pet. Geol., Vol. 31, No. 9, Sept., 1947.

al remnants of a more extensive deposit. Its age is Miocene. The thickness of a complete section is 2250 feet, but, as stated, a complete section is not found in the area.

STRUCTURE

General

The Hoback Range exhibits the features which Horberg[5] states belong to the western orogenic belt of the Middle Rockies. The belt is one of highly deformed geosynclinal sediments. Its principal features are low-angle thrust faults in which large scale horizontal compression occurred. Several folds were recognized within the thrust sheets.

Thrust Faults of the Area

Jackson thrust: The northern margin of the area under consideration is marked by the southwest-dipping Jackson thrust (Plate #3, Fig. A-A'). It can be traced from the western border of the Hoback Range along Jackson Hole eastward on out of the area. The average strike of the thrust is about S 60° E. The plane of the Jackson thrust was nowhere exposed along the south wall of Cache Creek valley, but it may be assumed that the plane dips at a relatively low angle to the southwest in common with other low-angle thrusts of the western orogenic belt of the Middle Rockies. Along the fault, the stratigraphic relations show the Madison-Brazer limestones, dipping from nearly vertical to

5. Horberg, Leland, Structural Geology and Physiography of the Teton Pass Area, Wyoming, Augustana Library Publication No. 16 (1938), pp. 53-55.

60° SW, resting on the Frontier formation of Upper Cretaceous age which dips from 60° SW and 60° NE to vertical. The southwest dips in the Frontier formation occur in proximity to the Jackson thrust, and the northeast dips occur in proximity to the Cache thrust. The vertical dips were found at the head of Cache Creek midway between the opposing Cache and Jackson thrusts (Plate #3, Fig. B-B'). The vertical dips demonstrate that at this point the thrust forces were equal in their effect on the Frontier formation.

Some faulting of the imbricate type must be associated with the Jackson thrust since the Madison-Brazer limestones and the Wells formation are far too thick to represent normal thicknesses. Minor faults to substantiate this contention were not found, but these conditions are often found associated with thrusts and the theory is not untenable.

Game Creek thrust: South of the Jackson thrust about three miles, the front of a second thrust sheet is encountered (Plate #3, Fig. A-A'). This is the Game Creek thrust, so-named because the plane of the fault is well exposed on the valley sides of Game Creek. Along the walls of this re-entrant of the thrust sheet the grey Madison-Brazer limestones rest on the Triassic beds and form a striking contrast in color with the reds and browns of the Woodside-Thaynes formation.

The Game Creek thrust roughly parallels the Jackson. It may be traced from the eastern margin of Jackson Hole southeastward out of the area. The valley of Game Creek affords an excellent opportunity to study the stratigraphic relations along the fault plane. It shows relatively flat-lying Madison-Brazer limestones resting on closely folded Nugget and Woodside-Thaynes beds. The thrust plane in the Game Creek valley is essentially horizontal for about one mile from its front and then dips steeply to the southwest probably because of drag on a normal fault which cuts the thrust sheet. South of this normal fault the plane of the thrust is below the surface.

Folds of the Area

There are numerous folds throughout the area. They are associated with the thrusts. The largest single fold is an anticline, a mile south of the Jackson thrust, which exposes the Dinwoody formation in its core. The north flank of the fold dips steeply into a small sharp syncline. The south flank dips gently into a broad synclinal fold.

The Game Creek thrust sheet is a series of broad folds which expose the Wells formation in the downwarps and the Madison-Brazer limestones in the upwarps.

The dips in the Madison-Brazer limestones at the front of the Jackson thrust sheet are to the southwest except east of the head of Horse Creek. There the Madison-Brazer limestones are folded into a large anticline.

High Angle Faults

There are several high angle faults in the area. The greatest one is the Hoback fault (Plate #3, Fig. A-A') which forms the western margin of the Hoback Range. The fault plane itself cannot be seen in the area, but the sudden termination of the steeply dipping sedimentary beds of the Hoback Range and the scarp-like appearance of the Hoback Range along the eastern margin of Jackson Hole indicate the presence of the fault.

There is a high angle normal fault paralleling the Jackson thrust (Plate #3, Fig. A-A'). It was traced from its western limit, where it has been clipped off by another high angle fault, to the divide between Horse and Cache Creeks where it disappears beneath the conglomerates of the Camp Davis formation. Along most of the fault the Phosphoria formation has been displaced against the Wells formation. However, at the head of Game Creek the Woodside-Thaynes formation is in contact with the Madison-Brazer along the fault. The beds on the north or upthrown block have a steep dip to the southwest ranging from about 60° to 70°. The younger beds on the downthrown side show dips of 50° to 55° to the southwest, but the dips are due to the fact that the beds are on the flanks of a tight syncline.

Another high angle fault, a mile south of the Jackson thrust (Plate #3, Fig. A-A'), has its western limit at Jackson Hole where it has been clipped off by the Hoback fault. It was traced east about two or three miles where it dies out in an anticline in the core of which the Dinwoody formation is exposed. The observable stratigraphic displacements along the fault show the Madison-Brazer limestones on the upthrown block against the Wells formation; and as the displacement is traced eastward, Wells is found against Wells, and finally Wells is found against Phosphoria, Dinwoody, and Woodside-Thaynes at which point the fault dies out.

GEOLOGICAL HISTORY

Laramide Diastrophism

There is no evidence in the area of major diastrophism prior to that associated with the Laramide Revolution. Deformation began after the deposition of the Frontier formation. The many tight folds in the area are probably indications of the beginnings of the geosynclinal disturbances.

The thrusts of the area cannot be dated exactly by evidence within the area. However, thirty miles south of Granite Creek in the Hoback Basin the age of the Jackson thrust is established. In the Hoback Basin the Pass Peak formation, Middle Eocene in age, rests with an angular unconformity upon the Hoback formation, Lower Eocene in age. The Jackson thrust overrides the Hoback formation and is in turn overlain by the Pass Peak formation.[6] Thus, the Jackson thrust can be dated as developing after Lower Eocene time but before Middle Eocene.

The Game Creek thrust resting on the Jackson thrust sheet must be younger than the Jackson thrust. However, with similar characteristics and similar direction of movement as those of the Jackson thrust, it seems logical to conclude that it is also a product of Laramide diastrophism.

6. A. J. Eardley, oral communication, 1946.

Following the period of folding and thrusting directly connected with the Laramide movements, a tensional strain was developed within the compressed beds. Relief from the tension was obtained by the development of the high angle faults across the thrust plates. These faults cannot be dated with exactitude except that they pre-date the Hoback fault and the Camp Davis conglomerates. This is shown by their sudden termination against the Hoback fault and disappearance under the Camp Davis formation at the divide between Horse and Cache Creeks. The faults are thus dated as pre-Miocene and post-Laramide. However, if the faults are tensional in origin as believed, they are probably slightly younger than the thrusts with which they are associated.

Miocene Faulting

After the Laramide Revolution there was a period of erosion. Erosion continued to the Miocene when there was another period of high angle faulting during which the Hoback fault came into existence. Although the Hoback fault cannot be dated exactly, it probably coincides in time with the period of Miocene faulting in the Teton Range. The Laramide features of the area terminate against the fault indicating a later date for it than that of Laramide time.

When the period of Miocene faulting was completed, the area was uplifted. Subsequent erosion of the uplifted parts supplied material which made up the Camp Davis formation.

Late Tertiary and Recent Movements

The latest history of the area is one of epeirogenic uplift which caused stream rejuvenation and led to the carving of the present topography. Erosion also stripped the Camp Davis conglomerates from the higher parts of the area and left only scabs as an indication that the formation was more extensive than is presently seen.

DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

PLATE NO. I

WYOMING
JACKSON QUADRANGLE

Topography by T. F. Murphy, Bishop Moorhead, R. K. Lynt, and U. S. Forest Service
Control by U. S. Geological Survey
Surveyed in 1927 and 1929-1931

Scale 1/125000

Contour interval 100 feet
Datum is mean sea level

APPROXIMATE MEAN DECLINATION, 1931

Polyconic projection. North American datum
5000 yard grid based upon U.S. zone system, F

HARD IMPERVIOUSLY SURFACED ROADS
OTHER MAIN TRAVELED ROADS
1934

JACKSON, WYO.
Edition of 1935

MASTER
GAILBRATH

THE TOPOGRAPHIC MAPS OF THE UNITED STATES

The United States Geological Survey is making a standard topographic atlas of the United States. This work has been in progress since 1882, and its results consist of published maps of more than 42 per cent of the country, exclusive of outlying possessions.

This topographic atlas is published in the form of maps on sheets measuring about 16½ by 20 inches. Under the general plan adopted the country is divided into quadrangles bounded by parallels of latitude and meridians of longitude. These quadrangles are mapped on different scales, the scale selected for each map being that which is best adapted to general use in the development of the country, and consequently, though the standard maps are of nearly uniform size, they represent areas of different sizes. On the lower margin of each map are printed graphic scales showing distances in feet, meters, and miles. In addition, the scale of the map is shown by a fraction expressing a fixed ratio between linear measurements on the map and corresponding distances on the ground. For example, the scale $\frac{1}{62,500}$ means that 1 unit on the map (such as 1 inch, 1 foot, or 1 meter) represents 62,500 similar units on the earth's surface.

Although some areas are surveyed and some maps are compiled and published on special scales for special purposes, the standard topographic surveys for the United States proper and the resulting maps have for many years been divided into three types, differentiated as follows:

1. Surveys of areas in which there are problems of great public importance—relating, for example, to mineral development, irrigation, or reclamation of swamp areas—are made with sufficient accuracy to be used in the publication of maps on a scale of $\frac{1}{31,680}$ (1 inch = one-half mile), with a contour interval of 1, 5, or 10 feet.

2. Surveys of areas in which there are problems of average public importance, such as most of the basin of the Mississippi and its tributaries, are made with sufficient accuracy to be used in the publication of maps on a scale of $\frac{1}{62,500}$ (1 inch = nearly 1 mile), with a contour interval of 10 to 25 feet.

3. Surveys of areas in which the problems are of minor public importance, such as much of the mountain or desert region of Arizona or New Mexico, are made with sufficient accuracy to be used in the publication of maps on a scale of $\frac{1}{125,000}$ (1 inch = nearly 2 miles), with a contour interval of 25 to 100 feet.

A topographic survey of Alaska has been in progress since 1898, and nearly 43 per cent of its area has now been mapped. About 10 per cent of the Territory has been covered by reconnaissance maps on a scale of $\frac{1}{625,000}$, or about 10 miles to an inch. Most of the remaining area surveyed in Alaska has been mapped on a scale of $\frac{1}{250,000}$, but about 4,000 square miles has been mapped on a scale of $\frac{1}{62,500}$ or larger.

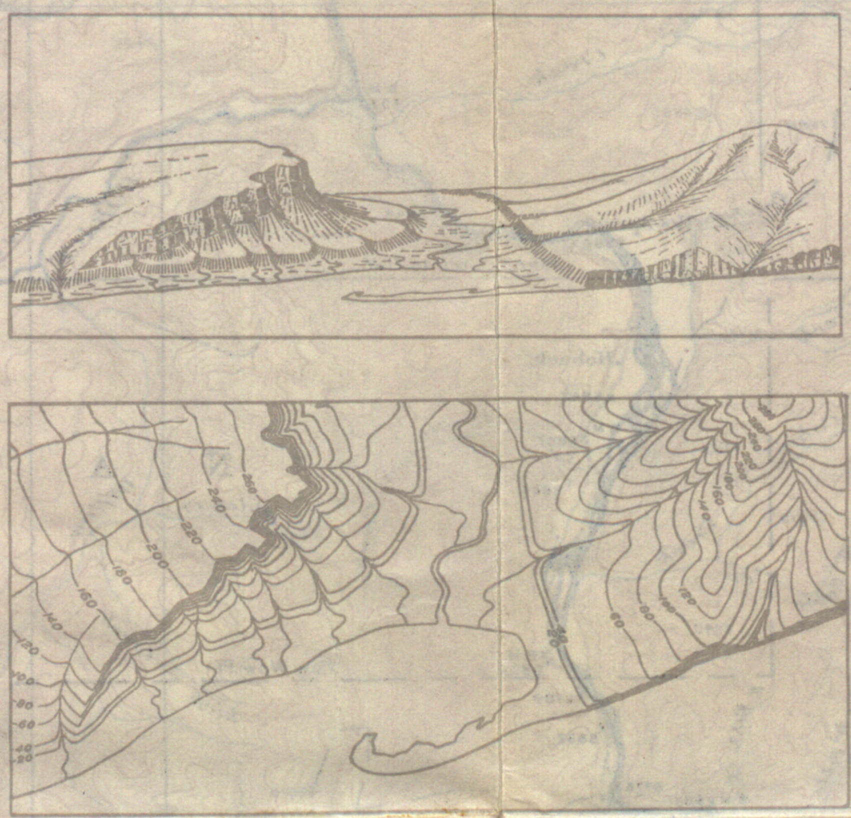
The Hawaiian Islands, with the exception of the small islands at the western end of the group, have been surveyed, and the resulting maps are published on a scale of $\frac{1}{62,500}$.

The features shown on these maps may be arranged in three groups—(1) water, including seas, lakes, rivers, canals, swamps, and other bodies of water; (2) relief, including mountains, hills, valleys, and other features of the land surface; (3) culture (works of man), such as towns, cities, roads, railroads, and boundaries. The symbols used to represent these features are shown and explained below. Variations appear on some earlier maps, and additional features are represented on some special maps.

All the water features are represented in blue, the smaller streams and canals by single blue lines and the larger streams, the lakes, and the sea by blue water lining or blue tint. Intermittent streams—those whose beds are dry for a large part of the year—are shown by lines of blue dots and dashes.

Relief is shown by contour lines in brown, which on some maps are supplemented by shading showing the effect of light thrown from the northwest across the area represented, for the purpose of giving the appearance of relief and thus aiding in the interpretation of the contour lines. A contour line represents an imaginary line on the ground (a contour) every part of which is at the same altitude above sea level. Such a line could be drawn at any altitude, but in practice only the contours at certain regular intervals of altitude are shown. The line of the seacoast itself is a contour, the datum or zero of altitude being mean sea level. The 20-foot contour would be the shore line if the sea should rise 20 feet. Contour lines show the shape of the hills, mountains, and valleys, as well as their altitude. Successive contour lines that are far apart on the map indicate a gentle slope; lines that are close together indicate a steep slope; and lines that run together indicate a cliff.

The manner in which contour lines express altitude, form, and grade is shown in the figure below.



The sketch represents a river valley that lies between two hills. In the foreground is the sea, with a bay that is partly inclosed by a hooked sand bar. On each side of the valley is a terrace into which small streams have cut narrow gullies. The hill on the right has a rounded summit and gently sloping spurs separated by ravines. The spurs are truncated at their lower ends by a sea cliff. The hill at the left terminates abruptly at the valley in a steep scarp, from which it slopes gradually away and forms an inclined table-land that is traversed by a few shallow gullies. On the map each of these features is represented, directly beneath its position in the sketch, by contour lines.

The contour interval, or the vertical distance in feet between one contour and the next, is stated at the bottom of each map. This interval differs according to the topography of the area mapped: in a flat country it may be as small as 1 foot; in a mountainous region it may be as great as 250 feet. Certain contour lines, every fourth or fifth one, are made heavier than the others and are accompanied by figures showing altitude. The heights of many points—such as road corners, summits, surfaces of lakes, and bench marks—are also given on the map in figures, which show altitudes to the nearest foot only. More exact altitudes—those of bench marks—as well as the geodetic coordinates of triangulation stations, are published in bulletins issued by the Geological Survey.

Lettering and the works of man are shown in black. Boundaries, such as those of a State, county, city, land grant, township, or reservation, are shown by continuous or broken lines of different kinds and weights. Good motor or public roads are shown by fine double lines, poor motor or private roads by dashed double lines, trails by dashed single lines.

Each quadrangle is designated by the name of a city, town, or prominent natural feature within it, and on the margins of the map are printed the names of adjoining quadrangles of which maps have been published. Over 3,300 quadrangles in the United States have been surveyed, and maps of them similar to the one on the other side of this sheet have been published.

The topographic map is the base on which the geology and mineral resources of a quadrangle are represented, and the maps showing these features are bound together with a descriptive text to form a folio of the Geologic Atlas of the United States. More than 220 folios have been published.

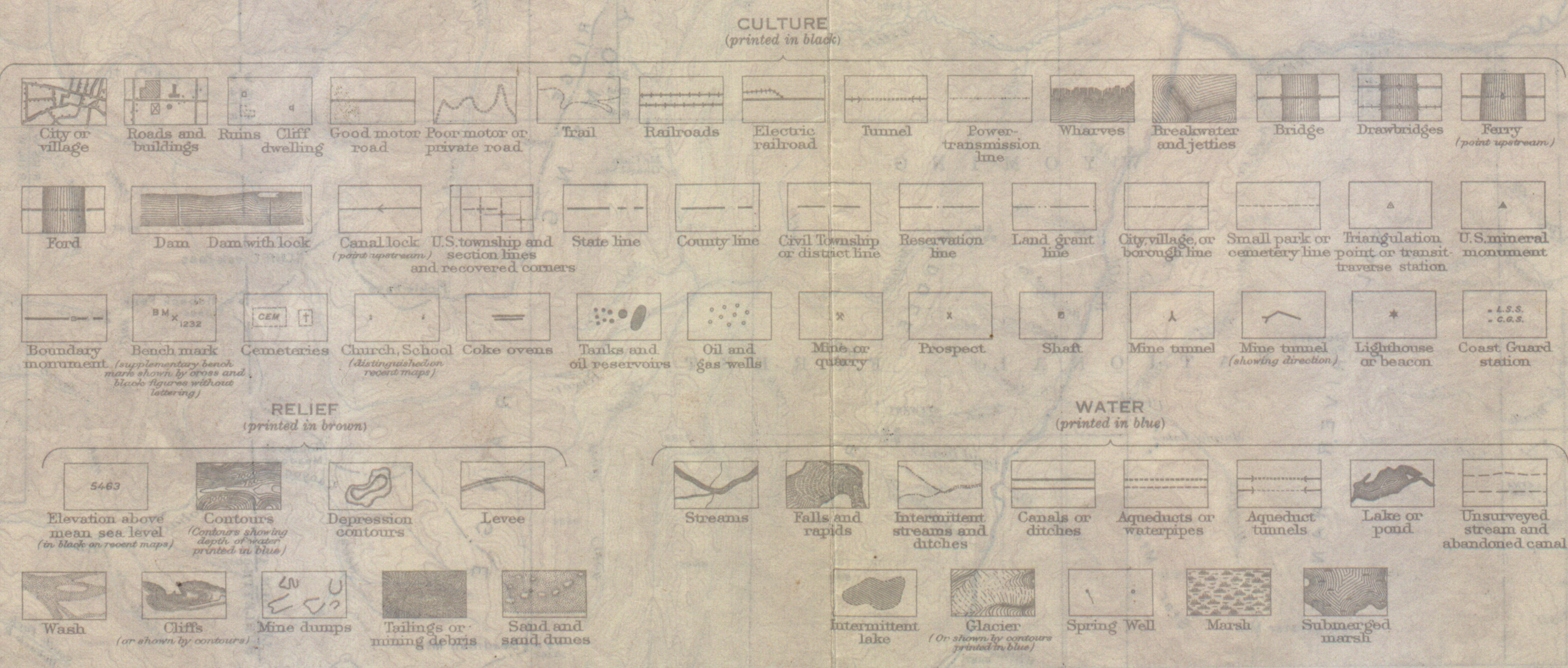
Index maps of each State and of Alaska and Hawaii showing the areas covered by topographic maps and geologic folios published by the United States Geological Survey may be obtained free. Copies of the standard topographic maps may be obtained for 10 cents each; some special maps are sold at different prices. A discount of 40 per cent is allowed on an order for maps amounting to $5 or more at the retail price. The geologic folios are sold for 25 cents or more each, the price depending on the size of the folio. A circular describing the folios will be sent on request.

Applications for maps or folios should be accompanied by cash, draft, or money order (not postage stamps) and should be addressed to

THE DIRECTOR,
United States Geological Survey,
Washington, D. C.

September, 1928.

STANDARD SYMBOLS



WOODS
(when shown, printed in green)

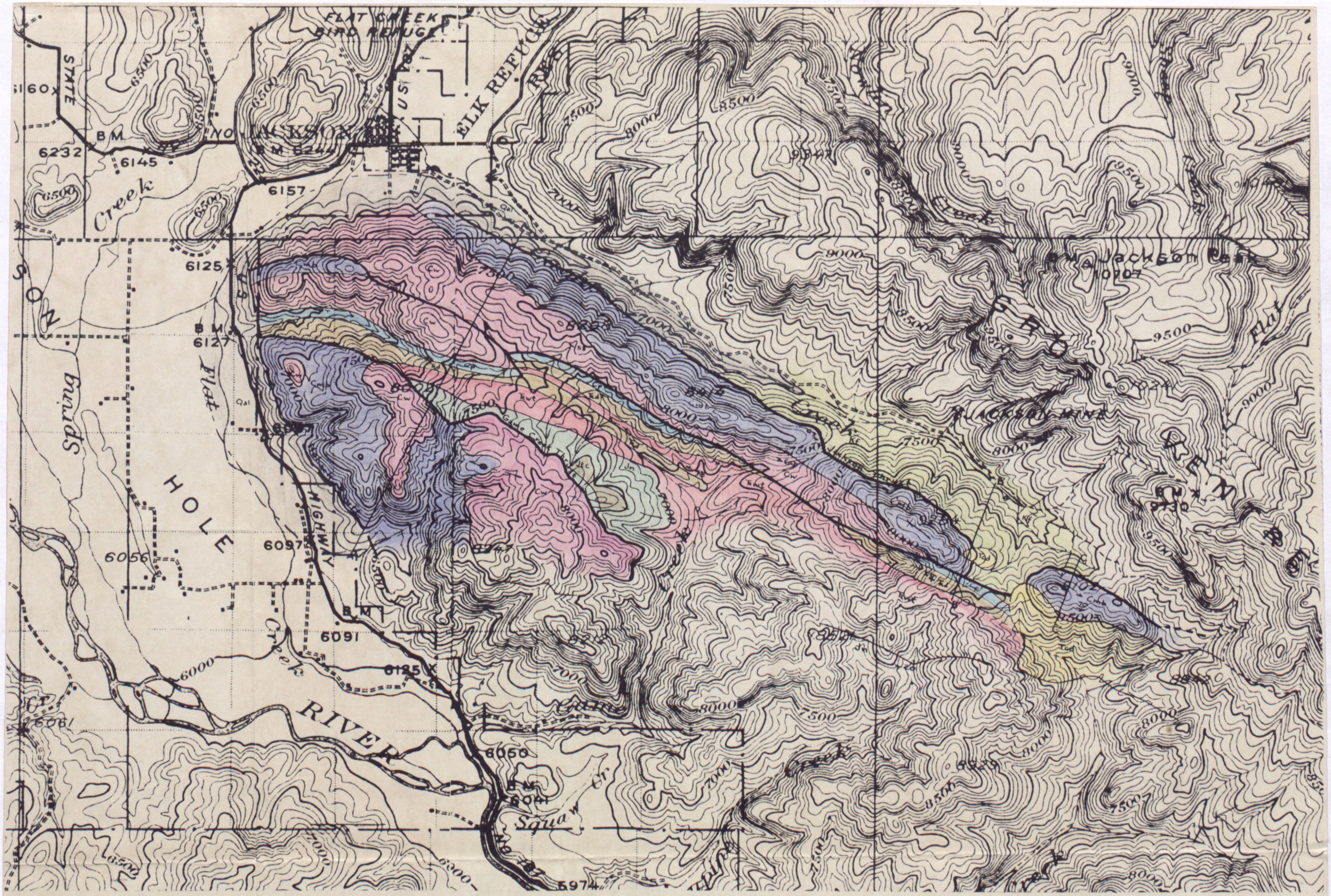


PLATE NO.2

LEGEND

Recent	Qal	Alluvium
Miocene	Tcd	Camp Davis
Mesozoic – Cretaceous	Kf	Frontier
Mesozoic – Jurassic	Jsp	Stump & Preuss
	Jtc	Twin Creek
	Jn	Nugget
Mesozoic – Triassic	Trwt	Woodside-Thaynes
	Trd	Dinwoody
Paleozoic – Permian	Cp	Phosphoria
Paleozoic – Pennsylvanian	Cw	Wells
Paleozoic – Mississippian	Cmb	Madison-Brazer
Paleozoic – Silurian & Devonian	Dd	Dinwoody
Paleozoic – Ordovician	Ob	Bighorn

SCALE

1 INCH = 1 MILE

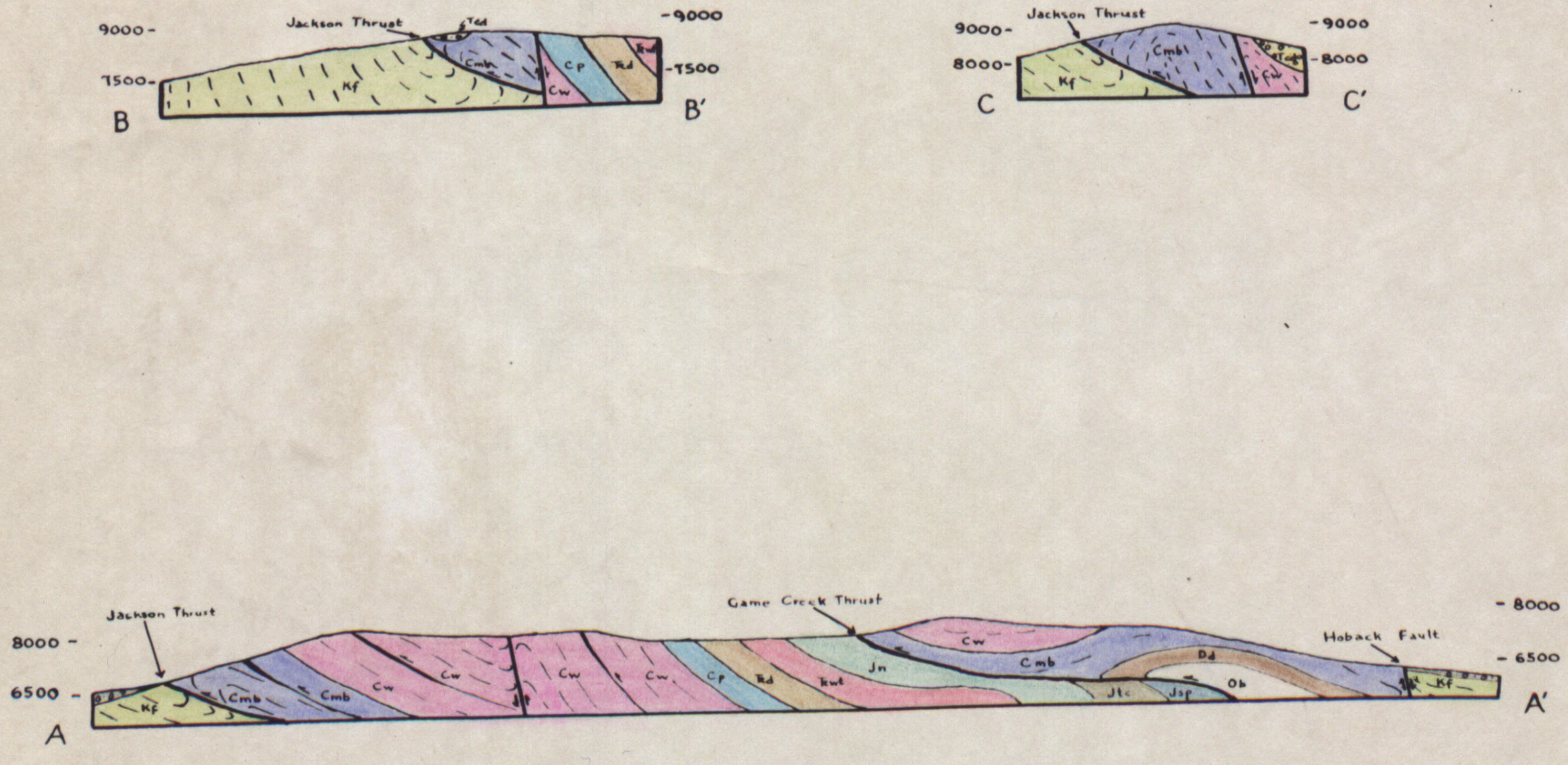


PLATE NO.3

SCALE

Horizontal : 2 inch = 1 mile

Vertical : 1 inch = 500 ft.