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GEOLOGY OF FREEZEOUT MOUNTAIN-BALD MOUNTAIN  
AREA, CARBON COUNTY, WYOMING

BY

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Contribution from the Geological Survey of Wyoming  
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GEOLOGY OF FREEZEOUT MOUNTAIN-BALD  
MOUNTAIN AREA, CARBON COUNTY,  
WYOMING<sup>1</sup>

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ABSTRACT

The Freezeout Mountain-Bald Mountain area constitutes the southeastern end of the Freezeout Hills between the Laramie Range on the east, the Medicine Bow Range on the south, and the Wind River Range on the northwest. The main structural features of this area are two northeastward-trending anticlines and the intervening syncline. The northwest flank of the southeastern anticline is cut by a southeastward-dipping thrust. It is believed that the folds and the thrust were formed under northwest-southeast compressive stresses.

INTRODUCTION

*Location.*—This report describes the geology of the southeastern part of the Freezeout Hills. The area is located 15 miles northwest of the town of Medicine Bow, Carbon County, Wyoming (Fig. 1). The mapped area includes approximately 43 square miles of the northeastern part of Carbon County in Ts. 24 and 25 N., Rs. 78, 79, and 80 W. The Shirley Mountains are 5 miles west of the northwestern part of the area, and the Little Medicine Bow River is 8 miles east of the eastern boundary. The southern boundary is 2 miles north of the Medicine Bow River, and the northern boundary is 8 miles south of Muddy Creek.

*Purpose.*—The geologic work was undertaken for the purpose of (1) obtaining an accurate geologic map, (2) describing and interpreting the structural geology, (3) measuring in detail the stratigraphic sections, and (4) investigating the possible mineral deposits and ground-water resources of the area.

*Field work.*—The mapping was done with a plane table and telescopic alidade on the scale of 1 inch = 1,000 feet. Section and quarter section corners were used for orientation and base-line points. Stratigraphic sections were measured normal to strike and downdip, with the aid of the Brunton compass and a steel tape. The field work was begun July 24, 1939, and was completed on September 1, 1939.

*Acknowledgments.*—The writer wishes to express his thanks to S. H. Knight, State geologist, who supervised the field work and made possible the completion of this report through the facilities of the Geo-

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logical Survey of Wyoming. R. H. Beckwith's assistance in drafting procedure is greatly appreciated. Acknowledgment is due Reid Bryson of Denison University, Ohio, for his valuable assistance in the field. The coöperation and hospitality of Denver Miller and John Ellis, and the other ranchers in the region are acknowledged.

*Previous geological investigations.*—No previous detailed geological investigations involving this area have appeared in print. W. C. Knight (8)<sup>3</sup> published a stratigraphic section of the Jurassic rocks of the area. W. N. Logan (10) published a paper which deals with the stratigraphy and invertebrate paleontology of the Freezeout Hills area. W. T. Lee (9) made a stratigraphic survey and described the rock sequences of the Difficulty area (Fig. 1). C. E. Dobbin, C. F. Bowen, and H. W. Hoots (5) mapped the area south of Freezeout Mountain. J. E. Ferren (6) made a reconnaissance survey of the Shirley Mountain area (Fig. 1). Sections 12, 13, and 24, T. 24 N., R. 80 W., mapped by Ferren, were remapped for greater detail. A. F. Peterson (13) made a reconnaissance survey of the Shirley Basin and Bates Hole region 6 miles northwest of the area. H. J. Giddings (7) made a reconnaissance survey of a portion of the Laramie Basin north of Como anticline 3 miles east of the T. B. Ranch. C. H. Crickmay (4) measured a Jurassic section at the east end of Freezeout Hills. Joseph Neely (12) measured a Sundance section south of the T. B. Ranch in T. 24 N., R. 78 W. O. P. Brown (3) made a detailed survey of the Difficulty-Little Shirley Basin area adjoining that described in this paper on the west (Fig. 1).

*Accessibility.*—A graded road passes within  $\frac{1}{2}$  mile east of the eastern margin of the area. This road begins at Medicine Bow and continues to Casper, Wyoming. An improved road extends from the Medicine Bow-Casper road to the T. B. Ranch. This is the only road within the area. Trails and almost impassable wagon roads are scattered throughout the region.

#### TOPOGRAPHY AND DRAINAGE

The topography of the area is controlled by two northwest-trending anticlines and an intervening syncline. In general, the anticlines form ridges which increase in height and width southwestward, and the syncline forms a valley which increases in depth and decreases in width southwestward. The core of West Freezeout anticline, in the northwestern part of the area, stands out as a ridge 50-500 feet high and 2,000 feet to 1 mile wide. The core of Freezeout Mountain anti-

<sup>3</sup> Numbers in parentheses refer to list of references at end of article. A number following a colon in parentheses gives the page in the reference cited.

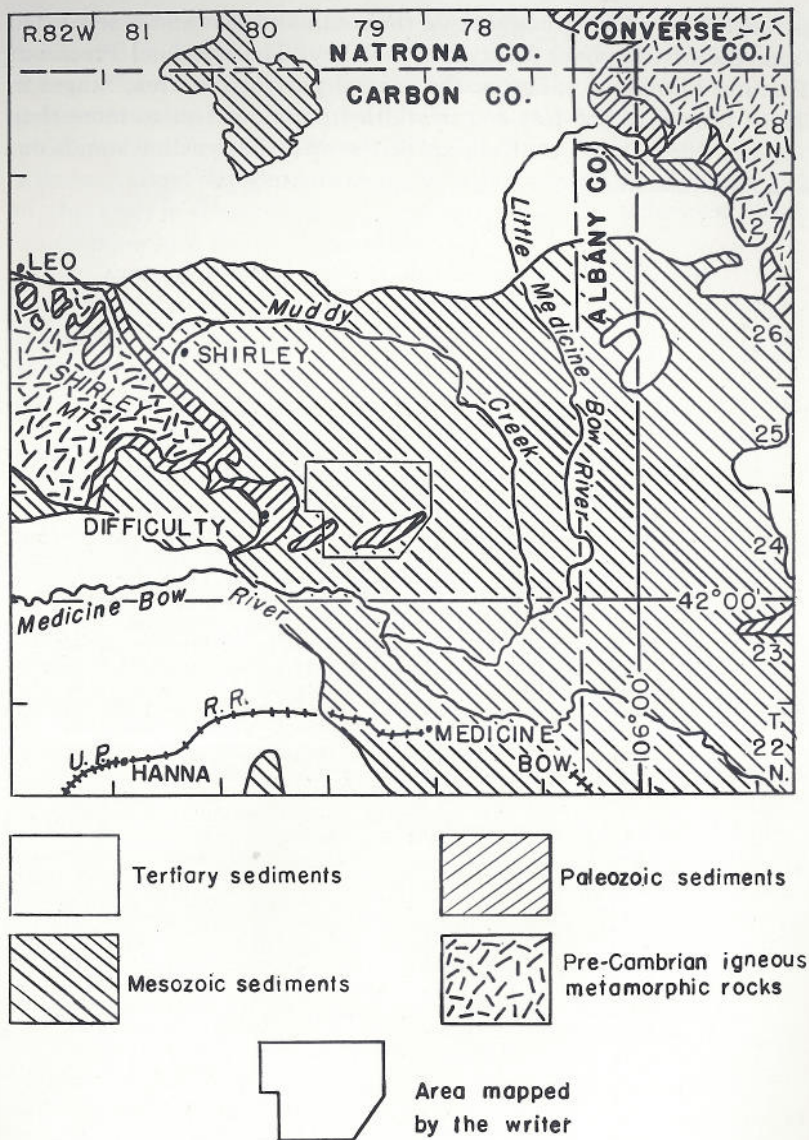


FIG. 1.—Index map of northeastern part of Carbon County, Wyoming.

cline, in the southeastern part of the area, stands out as a ridge 50-700 feet high and approximately 1 mile wide. A broad valley parallels this ridge on the south, east, and north and in turn is paralleled by a hogback which has an approximate height of 100 feet. This hogback is

paralleled by a higher hogback on the south and east and is separated from the first hogback by a narrow valley. The syncline, Freezeout Pasture, forming a valley in the central part of the area, ranges in depth from 0 to 800 feet and in width from 1,000 feet to more than 2 miles. In the north-central part of the area the syncline stands out as a mountain and has a height of approximately 500 feet.

TABLE I  
STRATIGRAPHY OF FREEZEOUT MOUNTAIN-BALD MOUNTAIN AREA

Age	Unit Mapped	Thickness in Feet	Description
Upper Cretaceous	Frontier formation		Black shale with ferruginous concretions
	Mowry shale	117	Black to gray fine-bedded siliceous shale weathering to silver-gray with ferruginous discoloration
	Thermopolis shale	97	Black shale
Lower Cretaceous	Dakota group	260	Light brown medium-grained slabby quartzitic sandstone. Black and brown shales and sandy shales. Light brown to dark brown massive, fine-grained ferruginous quartzitic sandstone. White and brown thin-bedded gray shales. White to gray massive medium-grained sandstone with basal conglomerate that is quartzitic in places
Upper Jurassic	Morrison formation	216	Black shale. Light green shale with clay seam 3 feet thick. Maroon and green shale. Green, red, and maroon sandy shale
	Sundance formation	335	Gray to white thick-bedded sandstone. Purple fossiliferous limestone. Buff to gray sandstone with <i>Belemnites densus</i> . Red and gray shale and shaly sandstone. Greenish gray massive to thin-bedded cross-bedded sandstone
Triassic	Jelm formation	93	Red and green shales and sandstones with purple shale at top. Red sandstones and shales capped by greenish gray platy shaly sandstone. Greenish gray to pink fine-grained massive cross-bedded friable sandstone capped by slabby sandstone
	Alcova limestone	10	Crenulated ribbon limestone with small pelecypods
	Chugwater formation	689	Greenish gray fine-grained thin-bedded sandstone. Red sandy shale. Greenish gray sandstone. Alternating red and gray shales and sandy shales. Light orange shale. White gypsum with red and pink streaks
	Permian	Embar group	338
Pennsylvanian Pre-Pennsylvanian	Tensleep sandstone	325	Brown to gray medium-grained cross-bedded sandstone Gray massive limestone

The Freezeout Mountain-Bald Mountain area lies in the drainage basin of the Medicine Bow River, a tributary of the North Platte River. There are no permanent streams in the area. However, the gulches draining the eastern part of the area empty into Muddy Creek, which in turn empties into the Little Medicine Bow River, the main tributary of the Medicine Bow River in this region. The western part of the area is drained by gulches emptying into Difficulty Creek, which flows into the Medicine Bow River.

STRATIGRAPHY

*General statement.*—The stratigraphic succession of the area (Table I) was assembled from exposures throughout Ts. 24 and 25 N. Thicknesses were measured with a Brunton compass and a steel tape with corrections for slope angles. Thicknesses were also computed from plane-table sheets by the formula:

$$T = WO \times \sin \phi$$

*T* being the thickness, *WO* being width of outcrop, and  $\phi$  being the dip. The thickness of the succession compares favorably with that measured in the Difficulty-Little Shirley Basin area by Brown (3: 6).

*Special notes on nomenclature.*—The name “Embar group” is herein applied to the entire sequence between the Tensleep sandstone and the Chugwater formation. This is in agreement with the nomenclature of Brown (3: 7).

The term “Jelm formation” is here applied to the entire sequence between the Alcova limestone and the Sundance formation. This is a deviation from the nomenclature of Neely (12: 743). These distinctions were made in order to provide readily mappable units.

STRATIGRAPHIC SECTION OF MOWRY SHALE, THERMOPOLIS SHALE, AND DAKOTA GROUP, MEASURED SOUTHEAST OF FREEZEOUT MOUNTAIN IN SECS. 18 AND 19, T. 24 N., R. 78 W.

	Feet	Inches
<i>Frontier formation</i>		
Black shale with ferruginous concretions		
<i>Mowry shale</i>		
Black to gray fine-bedded siliceous shale weathering to silver-gray with ferruginous discoloration	117	
<i>Thermopolis shale</i>		
Black shale	96	6
<i>Dakota group</i>		
Light brown medium-grained slabby quartzitic sandstone	107	1
Brown fine-bedded sandy shale with worm tracks and gypsum. Black shales at base	32	4
Light brown to dark brown massive fine-grained ferruginous quartzitic sandstone	21	2

	Feet	Inches
White to brown fine-grained thin-bedded shaly sandstone with thin-bedded gray shales.....	19	7
White to brown sandy shale and brown quartzitic sandstone.....	28	8
White to brown sandy shale. Brown medium-grained quartzitic sandstone.....	15	3
Brown medium-grained quartzitic sandstone.....	14	5
White to gray massive medium-grained sandstone weathering to brown. Quartzitic in places with basal conglomerate.....	21	7
	260	1
<i>Morrison formation</i>		
STRATIGRAPHIC SECTION OF MORRISON FORMATION, SUNDANCE FORMATION, JELM FORMATION, AND ALCOVA LIMESTONE, MEASURED NORTHWEST OF FREEZEOUT MOUNTAIN IN SEC. 32, T. 25 N., R. 78 W.		
	Feet	Inches
<i>Dakota group</i>		
<i>Morrison formation</i>		
Black shale.....	39	
Black shale. Brown sandstone with siliceous stringers and clay seam 3 feet thick. Light green shale.....	43	10
Dark green to light green shale.....	43	10
Dark green shale. Maroon and green shale.....	48	6
Green, red and maroon shales. Red sandy shale. Green sandy shale.....	40	8
	215	10
<i>Sundance formation</i>		
Brown massive ferruginous sandstone. Green and red shales. Gray thick-bedded sandstone.....	49	11
Gray and brown sandstone.....	53	9
Gray and brown thin-bedded cross-laminated sandstone.....	15	3
Buff to gray sandstone with numerous <i>Belemnites</i> . Purple dense fossiliferous limestone 1 foot thick. Green fissile shales. Brown thin-bedded cross-laminated ferruginous sandstone. Coquina formed of pelecypods present in brown sandstone.....	37	9
Gray to green sandstone with <i>Belemnites</i> very abundant.....	24	3
Gray to buff medium to thin irregularly bedded cross-laminated sandstone. Worm trails and calcite stringers very common.....	6	11
Green to gray massive cross-bedded sandstone. Green to red fissile shales. Red and green sandy shales.....	40	6
Covered interval.....	43	10
Covered interval. <i>Belemnites</i> very common.....	32	7
Covered interval.....	18	3
Greenish gray massive to thin-bedded cross-laminated medium-grained sandstone.....	12	3
	335	4
<i>Jelm formation</i>		
Red and green shales and sandstones with purple shales at top. Red sandstones and shales capped by greenish gray platy shaly sandstone. Greenish gray to pink fine-grained massive cross-bedded friable sandstone capped by slabby red sandstone.....	48	6
Covered interval.....	22	11
Red shale.....	21	
	92	5
<i>Alcova limestone</i>		
Crenulated ribbon limestone with small pelecypods. Stands out as cliff	10	
<i>Chugwater formation</i>		

FREEZEOUT MOUNTAIN-BALD MOUNTAIN AREA 889

STRATIGRAPHIC SECTION OF CHUGWATER FORMATION, EMBAR GROUP, AND TENSLEEP SANDSTONE, MEASURED SOUTH OF FREEZEOUT MOUNTAIN IN SECS. II AND 14, T. 24 N., R. 79 W.

	Feet	Inches
<i>Chugwater formation</i>		
Greenish gray fine-grained thin-bedded sandstone. Greenish gray sandy shale.....	25	
Red and white fine-grained thin-bedded sandstone. Red sandstone. Red sandy shale.....	71	11
Red and white fine-grained thin-bedded sandstone. Red sandy shale. Red sandy shale and greenish gray fine-grained thin-bedded sandstone.....	58	10
Red and white fine-grained platy sandstone. Red sandstone. Red sandy shale. Greenish gray fine-grained thin-bedded sandstone. Red sandy shale.....	58	10
Red sandy shale. Greenish gray thin-bedded sandstone.....	42	4
Light orange sandy shale.....	42	4
Covered interval.....	270	11
Light orange sandy shale.....	20	10
Covered interval.....	42	5
Orange shale. White gypsum with red and pinkish streaks.....	17	5
Light orange shales. Greenish gray porous sandy marly limestone.....	12	3
Dirty gray gypsum; very soft and has hollow sound when walked on. Red shales. White gypsum with green and pinkish streaks.....	25	11
	689	
<i>Embar group</i>		
Pale orange shale. Dirty gray dense dolomitic limestone.....	45	
Pale orange shale.....	63	4
Dirty gray dense crenulated ribbon limestone with jasper concretions. Orange-red shale.....	15	9
Maroon shale. Maroon color seems to be on weathered surface. On fresh fracture has orange-red color.....	10	
Maroon polka-dot sandy shale. Dots are greenish gray. Weathers very commonly to small pebbles.....	22	6
Red and purple shale.....	35	1
Red and purple shale. Red to purple fine-grained platy shaly sandstone with numerous white specks.....	14	10
Red shale covered with white sandy shale pebbles.....	19	6
Red shale.....	29	3
Reddish and greenish gypsum.....	19	
Gray to reddish gypsum. Red clay and reddish and green gypsum. Has ferruginous appearance on weathered surface and dirty white on fresh fracture.....	5	3
Gray gypsum on weathered surface. Almost pure white on fresh fracture. Has very hollow sound when walked over.....	7	11
	49	11
	337	4
<i>Tensleep sandstone</i>		
Brown to gray medium-grained cross-bedded sandstone with numerous calcite stringers.....	325	
<i>Pre-Pennsylvanian</i>		
Gray massive limestone		

STRUCTURE

*General structural relations.*—East of the area mapped by the writer, and north of Como anticline, the axial planes of the folds dip south (7: 37). Northwest of the mapped area the Shirley anticline and



Austin dome have axial planes dipping northeast and north, respectively (14: 42-44). In the area south of the Shirley Mountains (Fig. 1) the axial planes dip southeast (6: 25). In the Difficulty area (Fig. 1) the axial planes of the folds dip south or southeast with the exception of the Beer Mug anticline, which dips west (3: 17). South of the Freezeout Hills, in T. 23 N., R. 79 W., the axial plane of the Flat Top anticline dips south (5: 30). These relations show the direction of dip of the axial planes of the folds surrounding the area under discussion.

*Structure of area mapped.*—In order to facilitate a more detailed discussion of the structure, the area has been divided into three parts, corresponding with the topographic subdivisions used on page 884.

#### FREEZEOUT MOUNTAIN AREA

The Freezeout Mountain anticline extends across the entire southeastern part of the area. It is an asymmetric fold with steep dips on the northwest flank and more gentle dips on the southeast flank. It consists of a Tensleep core paralleled on the southeast flank by an Alcova-capped hogback, which in turn is paralleled by a higher Dakota-capped hogback. The axial plane of the fold dips  $80^{\circ}$ - $85^{\circ}$  SE. The axis plunges northeast and north. The trend of the fold from Sec. 19 to Sec. 1, T. 24 N., R. 79 W., is northeast. North of Sec. 1, the trend changes from northeast to north. This anticline dies out a few miles north of the area.

The Tensleep sandstone is exposed in the core of the anticline and the outcrop varies in width from a few hundred feet in Sec. 19, T. 24 N., R. 79 W., to more than 5,000 feet in the SW.  $\frac{1}{4}$  of Sec. 2, and the NW.  $\frac{1}{4}$  of Sec. 12, T. 24 N., R. 79 W. The dip of the Embar bed, in contact with the Tensleep core on the southeast flank, varies from  $24^{\circ}$  in Sec. 21, to  $2^{\circ}$  in Sec. 1, T. 24 N., R. 79 W. On the northwest flank the Embar has a dip of  $2^{\circ}$  in Sec. 1, and  $45^{\circ}$  in Sec. 10, T. 24 N., R. 79 W. The Embar group is separated from the Alcova-capped hogback by a broad valley. This valley is cut into the soft Chugwater shales and varies in width from approximately 1,000 feet in Sec. 19, T. 24 N., R. 79 W., to more than 2 miles in Secs. 31 and 36, T. 25 N., R. 79 W. The valley is paralleled on the southeast and east by the Alcova-capped hogback. The dip of the Alcova limestone decreases from  $22^{\circ}$  in the SW.  $\frac{1}{4}$  of Sec. 19, T. 24 N., R. 79 W., to  $9^{\circ}$  in Sec. 32, T. 25 N., R. 78 W. A much narrower valley occurs between the Alcova and Dakota hogbacks. In general it parallels the larger valley, but merges into a broad plain immediately north of the area. These structural relations are shown in structure section AA' (Fig. 2).

The northwest flank of the Freezeout Mountain anticline is cut by

the Freezeout Mountain fault, which strikes approximately N. 65° E., and is a southeast-dipping thrust (Fig. 2). This fault is covered by alluvium in Sec. 24, T. 24 N., R. 80 W., and in Sec. 11, T. 24 N., R. 79 W. In Secs. 19, 18, 17, 16, 9 and 10, T. 24 N., R. 79 W., the fault was traced with little difficulty. Thus the fault has a minimum length of 5½ miles. Pennsylvanian and pre-Pennsylvanian sediments are exposed southeast of the fault contact, and Permian and Triassic sediments are exposed northwest of the fault contact. In Secs. 18, 19, the western parts of Secs. 10 and 17, and the extreme southeastern part of Sec. 9, the Tensleep sandstone is in contact with the basal gypsum of the Chugwater formation. In Secs. 10 and 11, the Tensleep sandstone is in contact with the upper Embar group. In Secs. 9, 16, and 17, pre-Pennsylvanian limestone is in contact with the basal gypsum of the Chugwater formation. This is the only locality in the area in which the pre-Pennsylvanian limestone is exposed. The maximum stratigraphic displacement is not more than 700 feet. This is in Secs. 9, 16 and 17, where the pre-Pennsylvanian limestone is in contact with the basal gypsum of the Chugwater formation. The relations of the Freezeout Mountain fault to the associated anticline are shown in structure section *BB'* (Fig. 2).

About 2 miles south of the southwestern corner of the area there is a marked left offset in the Dakota and Alcova hogbacks. This area was not investigated in detail, but it is the writer's belief that the Freezeout Mountain fault continues southward passing into a fault intermediate between a reverse fault and a tear. The tendency for a thrust fault to pass laterally into a fault intermediate between a reverse fault and a tear is not uncommon in Wyoming. Such structure has been mapped and explained, in the southwest margin of the Laramie Basin, Wyoming, by R. H. Beckwith (1: 1526-1542).

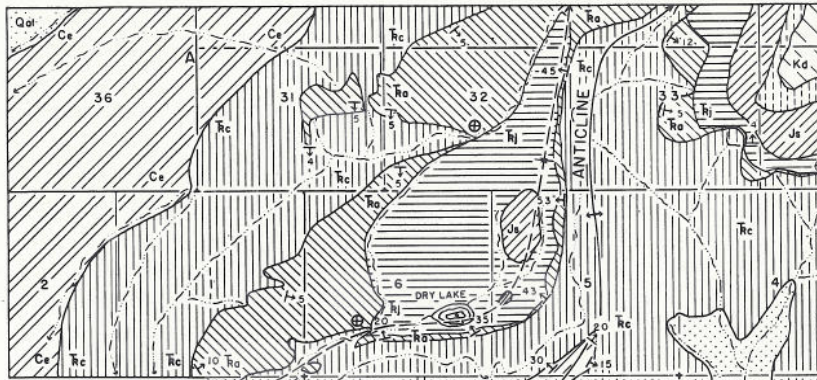
#### WEST FREEZEOUT ANTICLINE AREA

The West Freezeout anticline is located in the northwestern part of the area (Fig. 2). Like the Freezeout Mountain anticline it is asymmetric with steeper dips on the northwest flank than on the southeast flank. The axis of the fold trends approximately northeast from the NE. ¼ of Sec. 13, T. 24 N., R. 80 W., to the central part of the S. ½ of Sec. 5, T. 24 N., R. 79 W. From here to the NW. ¼, NW. ¼ of Sec. 33, T. 25 N., R. 79 W., the axis trends north. From Sec. 33, to the northern part of the area the axial trend is again northeast. The dip of the axial plane, where the trend is northeast, is approximately 85° SE., and 75° E. where the axial plane trends north.

The Tensleep sandstone forms the core of the anticline and is ex-

R 80 W

R 79 W

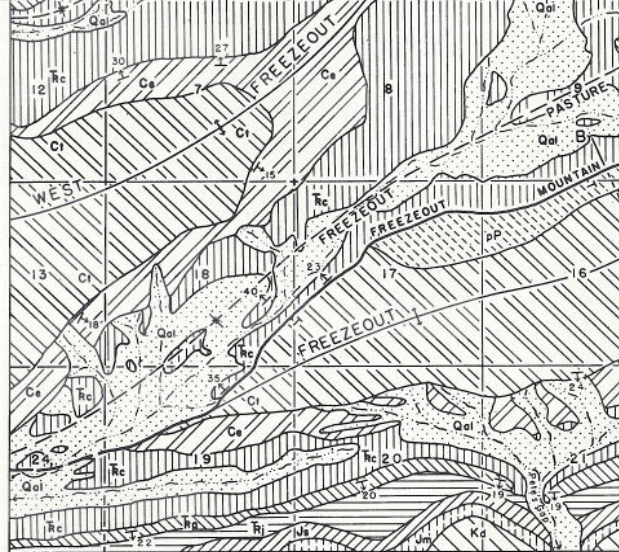
T  
25  
N

## SEDIMENTARY ROCKS

Quaternary	Qal	Quaternary alluvium
Cretaceous	Kt	Frontier formation
	Km	Mowry shale
	Kt	Thermopolis shale
	Kd	Dakota group
Jurassic	Jm	Morrison formation
	Js	Sundance formation
Triassic	Rj	Jelm formation
	Ra	Alcova limestone
	Rc	Chugwater formation
Permian	Ce	Embar group
Pennsylvanian	Ci	Tensleep sandstone
pre-Pennsylvanian	pP	limestone

## CONVENTIONAL SYMBOLS

	Improved road
	Ranch
	Lake
	Spring
	Intermittent stream
	Formation boundary
	Horizontal beds
	Strike and dip of beds
	Axis of anticline
	Axis of syncline
	Direction of plunge of fold
	Thrust fault. T is on block above fault
	Known fault covered by later deposits

T  
24  
N

R 80 W

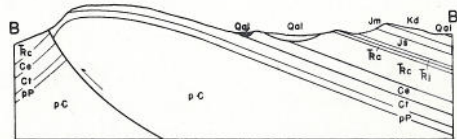
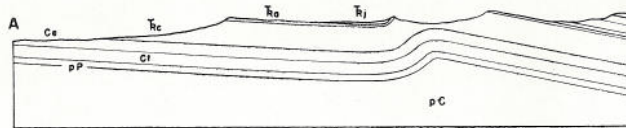
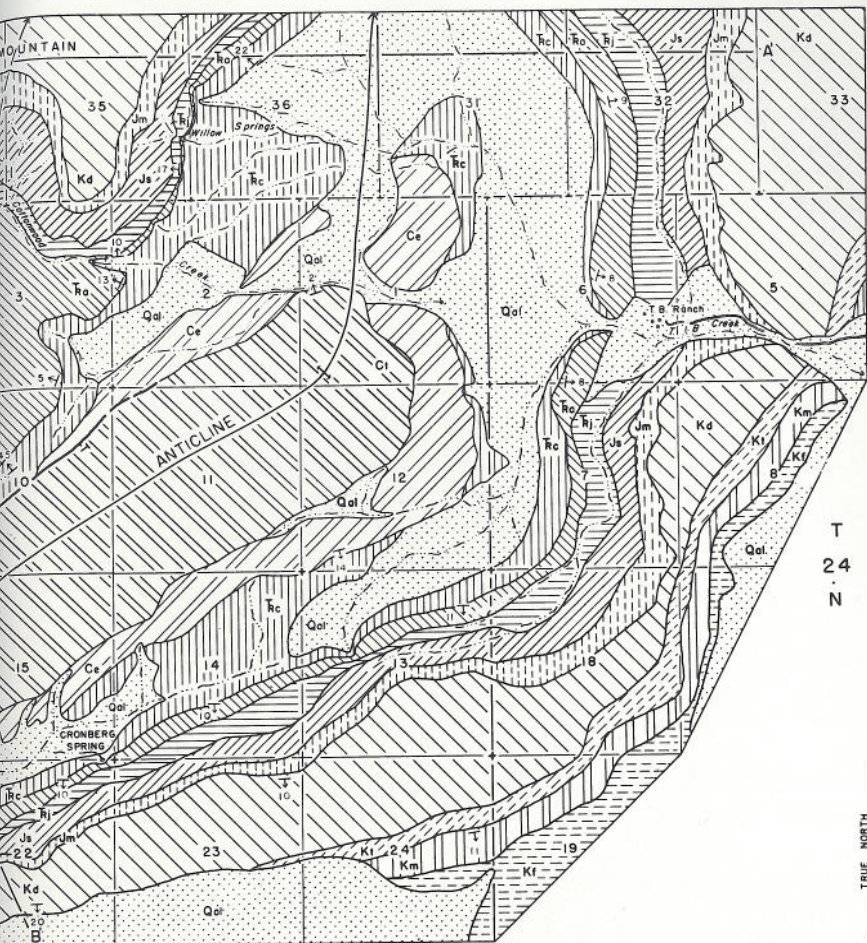


FIG. 2.—Geologic map and structure sections of Freezeout Mountain-Bald Mountain Area, Carbon County, W

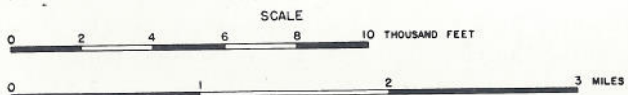
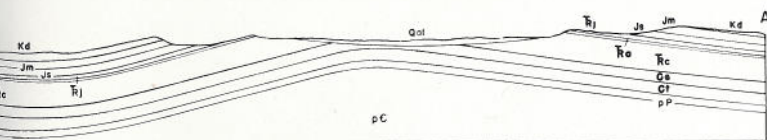
R 78 W



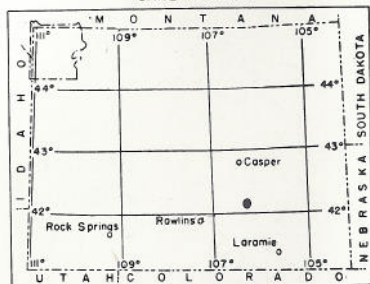
T 25 N

T 24 N

R 78 W



INDEX MAP OF WYOMING  
● AREA MAPPED



posed in Secs. 12 and 13, T. 24 N., R. 80 W., and in Secs. 7 and 18, in T. 24 N., R. 79 W. On the southeast limb, the dip of the Embar is  $18^\circ$  in Sec. 13. The dip of the Embar, on the northwest limb, in Sec. 7, is  $30^\circ$ . In the central part of the S.  $\frac{1}{2}$  of Sec. 5, the Embar, forming the nose of the anticline, dips  $15^\circ$  on the southeast flank,  $30^\circ$  on the northwest flank, and  $20^\circ$  northeast at the nose.

On the east limb of the West Freezeout anticline, in Sec. 33, the Alcova limestone forms a north-trending hogback in which the beds dip between  $5^\circ$  and  $12^\circ$  E. The Alcova is also a hogback on the northwest limb of the anticline. In the SW.  $\frac{1}{4}$  of Sec. 1, NE.  $\frac{1}{4}$  of Sec. 12, T. 24 N., R. 80 W., the S.  $\frac{1}{2}$  of Sec. 6, SW.  $\frac{1}{4}$  of Sec. 5, T. 24 N., R. 79 W., the Alcova strikes northeast and dips northwest between  $20^\circ$  and  $43^\circ$ . There is a marked change in strike from northeast to approximately due north from the central part of the W.  $\frac{1}{2}$  of Sec. 5, to the SE.  $\frac{1}{4}$ , NE.  $\frac{1}{4}$  of Sec. 32, T. 25 N., R. 79 W. From the SE.  $\frac{1}{4}$ , NE.  $\frac{1}{4}$  of Sec. 32, to the northern part of the area the strike changes again to northeast. Northward from the NW.  $\frac{1}{4}$  of Sec. 5, the dip of the Alcova varies from  $50^\circ$  to  $30^\circ$ . The relations of this anticline to the Freezeout Mountain anticline are shown in structure section AA' (Fig. 2).

The Alcova forming the northwest flank of the West Freezeout anticline is the southeast flank of a small doubly plunging syncline. This syncline is completely closed by the Alcova limestone. The trend of this fold is approximately parallel with the strike of the Alcova limestone on the northwest flank of the West Freezeout anticline. The axial plane dips southeast and east. The fold plunges southwest from the NE.  $\frac{1}{4}$ , NE.  $\frac{1}{4}$  of Sec. 32, T. 25 N., R. 79 W., and northeast from the NE.  $\frac{1}{4}$  of Sec. 12, T. 24 N., R. 80 W. The fold axis is approximately horizontal in the W.  $\frac{1}{2}$  of Sec. 5. The dip of the Alcova on the northwest limb varies from  $10^\circ$  to  $5^\circ$ , toward the north. In the W.  $\frac{1}{2}$  of Sec. 5, there are two Sundance buttes in the trough of the syncline. The larger of these is approximately 1,000 feet wide, 2,000 feet long, and 50 feet high. Both consist mainly of horizontal beds of basal Sundance sandstone.

The lowest part of the syncline is in the SE.  $\frac{1}{4}$  of Sec. 6, T. 24 N., R. 79 W., and is known as Dry Lake. Water is present in this lake only during thaws and for short periods after heavy rains.

#### FREEZEOUT PASTURE AREA

The Freezeout Pasture area is the intervening syncline between Freezeout Mountain and West Freezeout anticlines (Fig. 2). The dip of the axial plane and the plunge of the axis of this fold closely parallels

that of the Freezeout Mountain anticline (page 890). This syncline varies in width from approximately 1,000 feet in the NW.  $\frac{1}{4}$  of Sec. 17, T. 24 N., R. 79 W., to more than  $2\frac{1}{2}$  miles in Secs. 33, 34, 35 and 36, T. 25 N., R. 79 W. The central part of the trough, from the SW.  $\frac{1}{4}$  of Sec. 4, to the southwestern part of the area, is covered by alluvium. Scattered throughout the alluvium-filled trough are numerous small outcrops of Chugwater. These small remnants ordinarily consist of the upper sandy part of the formation. The flanks of the syncline, southwest of the SW.  $\frac{1}{4}$  of Sec. 4, are made up of the lower Chugwater shales, and the entire syncline immediately north, east, and west of the SW.  $\frac{1}{4}$  of Sec. 4, is cut in these shales.

A large mesa, capped by Alcova limestone, occurs in Sec. 3, the E.  $\frac{1}{2}$  of Sec. 4, and the NW.  $\frac{1}{4}$  of Sec. 10, T. 24 N. The Alcova is horizontal on the western edge of this mesa. The dips on the eastern edge vary from  $13^\circ$  in the northern part to  $20^\circ$  in the southern part (Fig. 2).

Immediately north and northwest of the Alcova-capped mesa, in Secs. 33, 34, 35, and 36, T. 25 N., the Freezeout Pasture syncline is topographically expressed as a synclinal mountain and is known as "Bald Mountain" (Fig. 2). The Alcova limestone occurs at the base of the mountain and rests on the Chugwater formation. The top of the mountain is made up of the lower part of the Dakota group. The beds on the east flank of the mountain dip west and northwest between  $17^\circ$  and  $22^\circ$ . The dips on the western flank vary from  $5^\circ$  E. to  $12^\circ$  SE., and the dips of the beds on the south face of the mountain are between  $4^\circ$  and  $10^\circ$  N. Immediately north of the area this syncline flattens and merges into a broad plain. The relation of this syncline to the flanking anticlines is shown in structure section AA' (Fig. 2).

#### ECONOMIC RESOURCES

There are no economic resources of commercial value in this area. The gypsum in the Embar group and Chugwater formation is of good quality and extensive, but the remoteness of the exposures from graded roads and railroads prohibits the commercial production of this mineral.

The possibility of finding oil or gas in the folds exposed in the area is slight. The only formation which is not extensively exposed either in the cores or on the flanks of the anticlines and which might be a producer is the pre-Pennsylvanian limestone. The nature of this limestone is such that it is highly improbable that any oil is present. No exploration for oil and gas has been carried on in this area.

## UNDERGROUND WATER

Due to the fact that the water needs of the ranchers have been generally served by springs, no wells have been dug or drilled in this area. Hence, the lack of data on which to base a detailed underground-water discussion.

There are numerous springs throughout the area, but most of these were not flowing during the writer's stay in the vicinity.

The source bed for the few flowing springs is either the upper sandy Chugwater beds or the basal Dakota sandstone. The two most important springs are in the SE.  $\frac{1}{4}$ , NE.  $\frac{1}{4}$  of Sec. 3, T. 24 N., and the NE.  $\frac{1}{4}$ , SE.  $\frac{1}{4}$  of Sec. 35, T. 25 N., R. 79 W. The first spring is in the upper sandy Chugwater beds and furnishes water for Cottonwood Creek. The latter spring is in the basal Dakota sandstone and furnishes water for Willow Springs. Both creeks dry up within a mile or two of their source.

There are two additional flowing springs in the area and both are in the upper sandy Chugwater beds. The domestic water supply for the T. B. Ranch comes from a small spring in the NW.  $\frac{1}{4}$ , SE.  $\frac{1}{4}$  of Sec. 6, T. 24 N., R. 78 W., while water for livestock comes from the Cronberg Spring, in the NE.  $\frac{1}{4}$ , NE.  $\frac{1}{4}$  of Sec. 22, T. 24 N., R. 79 W.

The Tensleep sandstone is exposed in the cores of the Freezeout Mountain and West Freezeout anticlines. Steep-walled gorges have been cut in these Tensleep cores, but no springs or seeps were observed. The extent to which the Tensleep may yield water in the synclinal troughs can only be determined by drilling.

## CONCLUSIONS

Available evidence indicates that the mountain-making folding of the Laramie Basin area began in late Cretaceous time and continued intermittently to early Eocene time. There are no data within the area covered in this report whereby it is possible to date the disturbance which produced the Freezeout Mountain anticline, other than that it is post-Frontier in age. The forces applied to the area took the form of intense northwest-southeast compressive stresses.

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