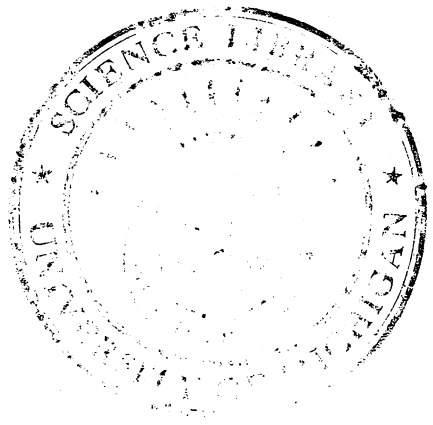
THE PERMIAN PHOSPHORIA FORMATION IN NORTHWESTERN WYOMING AND EASTERN IDAHO

Lily Marie Carter Kruseкopf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Lily Marie Carter Krusekopf

Thesis
Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Arts in Geology
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ILLUSTRATIONS

ABSTRACT

The Phosphoria formation in northwestern Wyoming and eastern Idaho is 150 to 250 feet thick. The lower phosphatic shale member is 50 to 100 feet thick, and the upper Rex chert member is 100 to 150 feet thick. Phosphorite deposits are widespread in the lower member but restricted in the upper. The upper phosphorite is limited approximately to the northeastern part of the area which had been a shelf zone for the older Paleozoic formations. The lower phosphorite beds spread over both the shelf and the adjacent geosyncline, but as far as the Phosphoria formation itself is concerned, it reflects inappreciably the two sedimentary provinces in its thickness. The lithologic sequence, in ascending order, is phosphatic shales comprising the lower member, and (1) limestone and dolomite, (2) phosphatic shale, and (3) chert in the upper member.

Laramide thrusting to the southwest in the shelf area and to the northeast in the trough area have brought within the local area of study sections of the Phosphoria that were deposited considerable distances apart. As the formation is traced from the thrust sheet in the shelf area to those in the trough area, the formation thickens only about 40 feet. The stratigraphic sequence in the trough area is phosphatic shales in the lower member, and (1) limestone and dolomite, (2) chert, and (3) shale in the upper

member. The phosphatic shale in the middle of the upper member in the shelf area has wedged out and a shale unit, not present in the shelf area, is at the top of the formation. The thickening of the formation is thought to be due chiefly to the presence of the upper shale unit in the trough area. Thus, the stratigraphic succession and the thickness of the formation relate only in minor ways to the structural belts.

The thickening of the formation from the shelf area to the trough area is too slight to indicate a trough facies of the Phosphoria within the area of study.

The thickest bed of phosphorite is less than 3 feet thick; it is doubtful if the deposits are of commercial value.

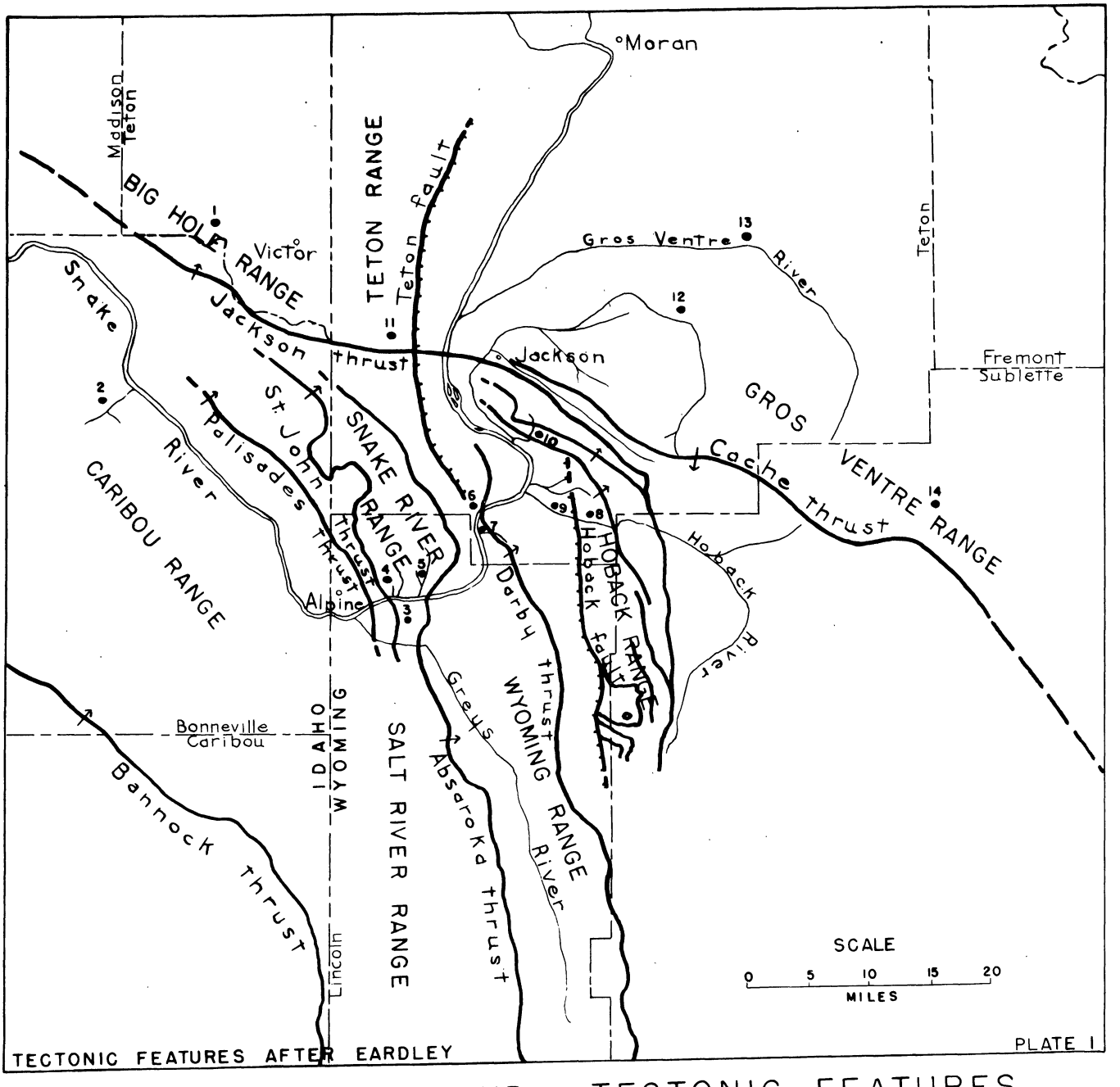
INTRODUCTION

Object of study

The Phosphoria formation was studied in order to locate beds of commercially important phosphorite, to discover the lithologic divisions and their distribution, to establish any relationship between the sections and the thrust sheets, and between the formation and the Paleozoic geosyncline.

Location of area

The area of investigation is northwestern Wyoming and the adjacent eastern part of Idaho. Parts of Teton, Lincoln,



PHYSIOGRAPHIC AND TECTONIC FEATURES AND LOCATION OF SECTIONS

and Sublette Counties, Wyoming, and Teton and Bonneville Counties, Idaho, are included in the area. See index map, Plate 1.

Structure

The Rocky Mountains in Wyoming and Idaho have been divided into an eastern belt of ranges representing the foreland, and a western belt of ranges representing the geosyncline (Horberg, 1938, pp. 24, 25). The structures characteristic of the shelf area are, for the most part, broad open folds. The sedimentary cover is relatively thin and the pre-Cambrian rocks are exposed in the cores. Overthrusting locally is prominent. In the belt of geosynclinal structures, the thick sedimentary series has been complexly folded and overthrust to the northeast without exposures of the pre-Cambrian. The deformation is part of the Laramide orogeny.

The Gros Ventre Range is typical of the shelf belt; the Snake River, Salt River, and Wyoming Ranges are included in the geosynclinal belt.

The Hoback and Teton Ranges were formed in part by later high-angle normal faulting.

Relation of sections to the thrust sheets

The northwest-southeast trending overthrusts of the Laramide orogeny cut the area into structural units. The

overthrusting to the southwest in the foreland belt and to the northeast in the geosynclinal belt have brought into proximity sections from the outer and inner parts of the geosyncline.

Sections were measured in each thrust sheet to determine the characteristics of the formation in each structural belt.

Acknowledgments

The field work was directed by Dr. Harold R. Wanless of the University of Illinois to whom the writer is indebted for the photographs used in this paper and for the identification of the fossils collected from the Phosphoria. Assistance in the field also was given by Henry Hamilton Gray, Alice King Gray, and John Chivers. The writer is particularly indebted to Professor A. J. Eardley of the University of Michigan who gave many suggestions and much of his time to the supervision of the manuscript.

STRATIGRAPHY

Type locality of the Phosphoria formation

The Phosphoria formation was named from Phosphoria Gulch in southeastern Idaho by Richards and Mansfield (1912, p. 684). There it is composed of two members: a lower phosphatic shale, 175 feet thick, and an upper cherty member, 240 feet thick.

The lower member consists of yellow to brown phosphatic sandstones, dark brown to black phosphatic shales, brown to black limestones, and one to three valuable beds of dark-colored, oolitic phosphorite.

The upper member is named the Rex chert from Rex Peak in the Crawford Mountains, Rich County, Utah. According to Richards and Mansfield (1912, p. 684), "This locality has been described by Gale [1910, p. 513] and the selection of the name for the member was originally made by him." The Rex chert member in Phosphoria Gulch is composed, in ascending order, of 100 feet of light gray, fossiliferous limestone, 60 feet of massive, light to dark gray, non-fossiliferous chert, and 80 feet of dark-colored, flinty shale.

The total thickness of the formation is 415 feet.

Lithology of the Phosphoria in northwestern Wyoming and southeastern Idaho

The two members comprising the Phosphoria in the type locality were distinguished in the area of this report: a lower phosphatic shale, and an upper Rex chert.

The lower member consists of thin beds of soft, black shale which become brown on weathering. Phosphorite occurs interbedded with the shale. Some beds immediately above the phosphorite are oolitic to pisolitic, weakly consolidated, and resemble a rock intermediate between shale and rock phosphate. The phosphorite, which marks the base of the formation in places, is bluish-black, pisolitic, compact; the weathered rock has a distinctive blue-white "bloom." The phosphorite, when struck, gives off a strong petroliferous odor which Mansfield describes as "fetid" (1927, p. 76; p. 208). The phosphorite beds are thin and occur near the base and top of the member. Nowhere are the units as thick as the commercially important deposits in southeastern Idaho which are as much as 10 feet thick (Mansfield, 1940-B, pp. 6-7). Interbedded with the shale and phosphorite are thin beds of limestone, dolomite, and siltstone. In almost all the sections in the Hoback and Gros Ventre Ranges, some chert occurs in the lower member. With the exception of the chert and the few thin calcareous beds, the lower member is soft and nonresistant, weathering into dark soil zones that stand out between the underlying, light-colored, resistant ledges of the Pennsylvanian Tensleep formation, and the overlying Rex chert beds.

The lower member is about 80 feet thick.

The Rex chert member consists of light and dark chert, light gray, tan, and black limestone and dolomite, dark shale, and a few sandstone and siltstone beds.

The chert is white, gray, tan, and black. It is generally well-stratified with beds ranging in thickness from 2 inches to 3 feet. Some of the stratification is irregular and wavy which gives the chert a nodular appearance. A few beds are bluish-black and have a petroliferous odor when struck. Most of the chert is uniform in color, but black and white banded beds are found in many sections. The thickest unit of chert is 50 feet in the Flat Creek section. There are many variations in color, thickness, and stratification, but few of the more distinctive features carry through from one section to another.

Near the base of the upper member are light-colored dolomites and limestones: a few are massive beds; others have geodes of calcite; many contain nodules, stringers, or thin bands of chert, or are interbedded dolomite and chert.

Phosphatic shale, similar to that in the lower member, occurs near the middle of the Rex in the Hoback and Gros Ventre Ranges. Brown, hard, non-phosphatic shale is at the top of the member in the sections near the Wyoming-Idaho border. The shale units form dark-colored slopes, but the other beds stand out as prominent ledges which can be traced for long distances.

The upper member is about 140 feet thick, and throughout the area of study the entire Phosphoria formation is approximately 200 feet thick.

Sections

The base of the formation was placed at the beginning of the dark phosphatic shale zone. The base of the Rex chert member was put at the top of the dark shales and phosphorites. The upper limit of the formation is marked by slabby, calcareous siltstone of the Triassic Dinwoody formation which overlies the Phosphoria unconformably. Lithology rather than paleontology was used to correlate the major divisions of the formation as fossils are not abundant nor sufficiently diagnostic to use in local correlation.

Big Hole Range, Idaho, T. 4 N., R. 44 E., S. 26.--This section was measured on the north side of Patterson (?) Creek, 4.6 miles northwest and 3 miles north of Victor, Idaho. The area is included in the Gardner map of the Big Hole Mountains (1944, Plate 2).

The beds of the lower member are seldom exposed, but form characteristic dark-colored slopes. On this basis, a large concealed interval is interpreted as the phosphatic shales and siltstones of the lower member.

The Rex chert member consists of cherty dolomites and coarse reddish-tan sandstone, very similar lithologically to that of the Derbya zone in the Martin Creek section.

The upper contact was not observed but is estimated to be 15 to 20 feet higher.

Unit	Thickness in feet	Total
Dinwoody formation not measured		
Phosphoria formation:		150.0
Rex chert member:		112.0
14. Concealed interval estimated	15.0	
13. Sandstone, quartzitic, light pink to tan, massive	15.0	
12. Concealed interval estimated	25.0	
11. Sandstone, reddish-tan, medium to coarse grained, similar to the Derbya zone	33.0	
10. Dolomite, light gray, with numerous small chert nodules, probably in place	16.0	
9. Concealed	17.0	
8. Limestone with white chert nodules and calcite geodes	6.0	
Lower member:		38.0
7. Concealed, probably phosphatic shale	37.0	
6. Phosphorite, dark blue, pisolitic	1.0	
Tensleep formation:		
5. Dolomite, light gray, with some dark gray chert	6.3	
4. Chert, dark gray to black	0.3	
3. Chert, medium gray	0.6	
2. Chert, dark gray to black	0.4	
1. Dolomite, light gray	15.0	

An observation was made along the Victor-Swan Valley highway on the north side of Piney Creek, about one mile east of the St. John thrust. The lower member of the formation was not exposed, but 50 feet of the upper Rex chert

were inspected. The lowerpart consists of interbedded light-colored chert and dolomite. The upper part is light tan, quartzitic sandstone. The Triassic contact was not observed.

Caribou Range, Idaho, T. 1 N., R. 43 E., S. 17.--This section was measured on the north side of Fall Creek opposite Little Currant Hollow.

The lower member was poorly exposed but float blocks of phosphorite and dark-colored dolomite were present.

The Rex chert member includes some limestone and dolomite but is chiefly massive, dark gray chert. Immediately below the uppermost chert bed is a thick limestone unit with concretionary structures that resemble the pipestems at the top of the formation at Flat Creek and the Gros Ventre River.

The upper contact was not observed.

Unit	Thickness in feet	Total
Dinwoody formation not measured		
Phosphoria formation:		197.1
Rex chert member:		134.7
28. Concealed interval	15.0	
27. Chert, light and dark gray, weathers mottled, oolitic appearance, very uneven lower surface	30.0	
26. Limestone, light gray, weathers buff, cylindrical gray chert bodies at right angles to bedding--may be equivalent to the pipestems at Flat Creek	8.9	

Unit		Thickness in feet	Total
25.	Limestone, light gray, weathers gray with irregular, pitted surface; calcite veins and some dark chert nodules; fossiliferous (?)	14.0	
24.	Chert, black, wavy stratification, beds 1 inch to 1 foot thick	9.0	
23.	Chert(?), shaly, weak zone	0.6	
22.	Chert, black, nodular appearance, wavy stratification, beds 1 inch to 1 foot thick; lenses of medium gray limestone in upper 12 feet; wavy laminae of interbedded chert and black chert and limestone near top	20.0	
21.	Chert, medium gray, evenly bedded	4.2	
20.	Conglomerate of dark chert pebbles in a limestone matrix	0.3	
19.	Limestone, medium gray, weathers tan and reddish, massive, very fossiliferous: resembles Derbya zone	1.5	
18.	Dolomite, dark gray, weathers tan, dense	4.8	
17.	Dolomite, dark gray, weathers dark tan; small chert and calcite nodules; poorly preserved pelecypods	8.0	
16.	Chert, black, nodular, irregularly bedded	3.7	
15.	Phosphorite (?), dark brown, slightly calcareous, more or less oolitic	0.2	
14.	Dolomite, dark gray; gray chert nodules	3.2	
13.	Chert, dark gray near base becoming light near top; massive	11.3	
Lower member:			62.4
12.	Concealed interval, probably phosphatic shale and phosphorite	62.4	
Tensleep formation:			
11.	Dolomite, dull gray, medium-grained, compact	17.0	
10.	Chert, black, interbedded with black limestone	5.0	

Unit		Thickness in feet	Total
9.	Limestone, poorly exposed	1.4	
8.	Chert, black	0.5	
7.	Limestone, light tan, fossiliferous	3.0	
6.	Dolomite, yellow-brown, irregularly bedded, platy	16.2	
5.	Concealed by slump of unit 6.	21.0	
4.	Sandstone, calcareous, light gray, weathers with pitted surface, massive	4.0	
3.	Sandstone, quartzitic, light gray	2.0	
2.	Concealed interval	27.7	
1.	Sandstone, quartzitic, white, weathers reddish, massive	4.5	

Bradley Mountain, Salt River Range, Wyoming, T. 37 N., R. 118 W.--This section was measured in a divide between Greys River and the Snake River, and about one-quarter mile southwest at the head of the west branch of Skull Creek.

The lower member is this and chiefly siltstone and shale with two thin phosphorite units. Slickensides were found on some beds and the thinness of the member is probably due to faulting. The uppermost phosphorite bed is overlain by a blue-black conglomerate that marks the base of the Rex chert member.

The Rex consists of cherty dolomite and limestone, and thick, bedded cherts. Two white chert beds with abundant Euphemites and Schizodus occur about 30 feet from the top. The uppermost units are dark, cindery sandstones that, together with the fossiliferous chert beds, have been involved in a fault passing through the upper member. These beds are repeated.

Unit	Thickness in feet	Total
Dinwoody formation:		
41. Siltstone, calcareous, tan, slabby	4.0	
Phosphoria formation:		209.2
Rex chert member:		179.2
40. Siltstone and shale, dark blue-gray and brown	23.0	
39. Sandstone, dark blackish-brown, weathers bluish, nodular, hard	2.0	
38. Sandstone, brown to dark gray, weathers mottled, medium- to coarse-grained, fossiliferous (?)	2.0	
37. Sandstone, conglomeratic, with light chert fragments	0.2	
36. Sandstone, brown to dark gray, weathers mottled, medium- to coarse-grained, fossiliferous, may be the Derbya zone	0.7	
35. Chert, white well-bedded	2.4	
34. Chert, white, well-bedded, with Euphemites, asphaltic	0.4	
33. Chert, white, well-bedded, zone with Schizodus and other pelecypods about one foot below top, fossils nearly all one one bedding plane	2.7	
32. Limestone, light gray, with light gray chert bands; chert increasingly prominent toward the base	16.1	
31. Concealed interval, probably leached cherty limestone	3.0	
30. Chert, dark blue-gray, large nodules	4.2	
29. Limestone, with equal amount of chert, light gray and tan	3.6	
28. Chert, dark gray to black. See Plate 2.	5.0	
27. Dolomite, light gray to tan, well-bedded, with light gray chert bands; 1.5 feet from base is black and white laminated chert layer 0.4 feet thick	23.3	
26. Chert, dark blue, weathers blue-white	9.2	

Unit		Thickness in feet	Total
25.	Dolomite, light gray, with small white chert geodes	42.0	
24.	Dolomite, brown, dense, well-bedded	14.6	
23.	Sandstone, cherty, blue-gray, massive, hard, ledge forming	9.5	
22.	Chert, black, at base of covered interval	7.0	
21.	Dolomite, light gray, with small white chert geodes	5.8	
20.	Sandstone, phosphatic, more or less calcareous and cherty, blue-black, nodular with small white chert nodules; unconformities at top and base. See Plate 2.	1.5-2.5	
Lower member:			30.0
19.	Phosphorite, black, pisolitic	0.4	
18.	Shale, phosphatic	0.6	
17.	Phosphorite, black, weathers brown, pisolitic	0.4	
16.	Shale, brown	0.2	
15.	Shale, "coaly" appearance, very soft, slickensided	6.9	
14.	Shale, black to brown, massive	1.2	
13.	Shale, very soft, "coaly" appearance, slickensided	0.7	
12.	Siltstone, black, concretionary	0.1	
11.	Shale, brown, similar to unit 14, but very soft	2.0	
10.	Shale, brown, slightly calcareous, massive	1.0	
9.	Dolomite, light gray, hard, dense	4.0	
8.	Shale, brownish-black, slightly calcareous, soft, looks "coaly", slickensided	0.9	

A. Bedded dark gray chert with a tan weathered surface.

B. The base of the Rex chert member at the contact of the dark-colored phosphatic shale and the overlying sandstone.

REX CHERT BEDS AT BRADLEY MOUNTAIN

Unit		Thickness in feet	Total
7.	Dolomite, light gray, hard, dense	0.3	
6.	Shale, brownish-black, slightly calcareous, soft, "coaly" appearance, slickensided	1.2	
5.	Siltstone, brownish-black, compact, massive, petroliferous	1.3	
4.	Shale, brownish-black, slightly calcareous, soft, "coaly" appearance, slickensided	0.4	
3.	Siltstone, slightly calcareous, brownish-black, a few thin shale partings, petroliferous	8.0	
2.	Shale, phosphatic, pisolitic, soft	0.4	
Tensleep formation:			
1.	Limestone, white	5.0	

Little Red and Red Creeks, Snake River Range, Wyoming, T. 37 N., R. 119 W.--Most of this section was measured at the head of Little Red Creek.[1] The upper units, however, were well exposed at the head of Red Creek and measured there by Dr. H. R. Wanless and H. H. Gray.

The lower shale member was covered with slump and exposed in one place only. It was measured, therefore, as a single unit to the base of the Rex chert member.

The Rex forms prominent ledges of arenaceous dolomite and chert. Near the top of the formation there is a white chert bed with abundant Euphemites and Plagyoglypta, with

1. Dr. L. B. Kellum of the University of Michigan supervised the measurement of this section.

asphaltic material in the cavities. One foot lower is a zone containing numerous Schizodus and other pelecypods. The fossiliferous chert beds are overlain by some 15 feet of sandstone and siltstone. The Derbya zone is included in this uppermost 15 feet.

Unit	Thickness in feet	Total
Dinwoody formation not described here; measured by Wanless and Gray. Unconformity at base.		
Phosphoria formation:		267.3
Rex chert member:		147.3
28. Siltstone, argillaceous, dark gray to black, massive, fetid.	3.2-3.7	
27. Concealed interval, probably dark carbonaceous shale	5.5	
26. Sandstone, dark bluish-gray, weathers brown	2.4	
25. Sandstone, calcareous, brownish-gray, nearly a coquina of Derbya and Spiriferina pulchra	0.6	
24. Sandstone, slightly calcareous, dark brownish-gray, weathers brownish	3.0	
23. Chert, white, with abundant Euphemites and Plagyoglypta; some asphaltic material in the cavities	1.0	
22. Chert, white, with numerous Schizodus and other pelecypods on a bedding plane 1 foot below the top	2.0	
21. Chert, gray, weathers tan, interbedded with slightly sandy dolomite, large white irregular chert beds near top	30.1	
20. Dolomite, sandy, light gray, with light gray chert at the top	9.0	

Unit		Thickness in feet	Total
19.	Dolomite, light gray, brecciated appearance	12.8	
18.	Dolomite, light gray, weathers light tan, fine-grained, massive, blocky	27.0	
17.	Dolomite, sandy, dark gray, weathers buff, with interbedded chert bands up to 18" thick, banded black and white chert at the base	21.9	
16.	Dolomite, slightly sandy, light gray, weathers white with a pitted surface, a few white chert nodules	18.2	
15.	Sandstone, light gray, weathers chalky, many white calcite geodes and vugs, a few black chert nodules	10.1	
Lower menber:			120.0
14.	Phosphorite at the base of a dark soil zone; includes units 13 and 12	120.0	
Tensleep formation:			
11.	Dolomite, sandy, gray, weathers, white, medium-grained, slabby	6.1	
10.	Sandstone, tan, weathers yellow-brown, with reddish iron stains, slabby	9.3	
9.	Dolomite, gray, weathers chalky, with blue-gray chert nodules	5.1	
8.	Dolomite, slightly sandy, medium gray, weathers light tan, rather slabby, with white chert nodules 3" in diameter, and gray chert nodules 6" to 2' in diameter	12.8	
7.	Dolomite, sandy, dark gray, weathers light gray, dense	3.7	
6.	Dolomite, sandy, light gray, weathers chalky, finely crystalline, massive	7.0	
5.	Concealed interval	38.8	
4.	Sandstone, calcareous, white to buff, weathers tan, irregularly bedded	14.5	
3.	Sandstone, light buff, weathers gray, coarse-grained, massive, friable	10.2	

Units 2 and 1 omitted

Wolf Creek, Snake River Range, Wyoming, T. 38 N., R. 118 W.--

This section was measured by Dr. H. R. Wanless and Donald Ferguson along the east bank of the north fork of Dry Fork just above the falls over the upper Tensleep limestone.

The lower member consists of dark phosphatic shale and thin limestone and dolomite units. The upper member is composed of light gray chert and dolomite. The Phosphoria-Dinwoody contact was not observed.

Unit	Thickness in feet	Total
Dinwoody formation:		
26. Siltstone, brownish-gray, not measured		
Phosphoria formation:		237.4
Rex chert member: 111.3		145.6
25. Concealed interval	2.0	
24. Chert, light gray, with some limestone	12.0	
23. Limestone, light gray, with numerous chert nodules and lenses	16.0	
22. Chert, light to medium gray, highly jointed	13.0	
21. Limestone, argillaceous, light gray, highly jointed	3.0	
20. Chert, dark gray to black, splintery fracture	8.0	
19. Limestone, bituminous, abundant calcite geodes and nodules	1.2	
18. Shale(?)bituminous, dull brown, with chert geodes	9.5	
17. Dolomite, brownish-gray, massive	4.5	

Unit		Thickness in feet	Total
16.	Dolomite, light gray, calcite in joints and cavities, massive	6.0	
15.	Shale parting	0.5	
14.	Dolomite, light to medium gray, massive	12.0	
13.	Shale, dull gray, hard	0.2	
12.	Dolomite, medium gray, rough weathered surface, massive	3.6	
11.	Chert, gray, calcite in cavities and along joints, massive, irregular surface at top and bottom	2.0	
10.	Chert, blue-gray, lighter toward top, somewhat calcareous	23.8	
Lower member:			91.8
9.	Shale, phosphatic, black, with shiny luster that resembles that of coal	28.7	
8.	Limestone, phosphatic, bituminous, black	2.0	
7.	Dolomite, light gray, dense and massive	12.0	
6.	Shale, phosphatic, black	2.0	
5.	Limestone, light gray, with geode-like chert nodules	1.6	
4.	Shale, phosphatic, dark gray to black	15.6	
3.	Limestone, light gray	1.2	
2.	Shale, phosphatic, black	28.7	
Tensleep formation:			
1.	Dolomite, forming prominent cliff	30.0	

Johnny Counts Flat, Snake River Range, Wyoming, T. 39 N., R. 116 W.--This section was measured by Dr. H. R. Wanless along the Snake River about 4 miles southwest of the

junction with the Hoback River. See Plate 3.

The base of the formation is marked by cherty phosphorite overlain by chert beds two to three feet thick. The phosphatic shales are interbedded with phosphorite and limestone.

The Rex member is marked by a conglomerate of chert pebbles in a phosphorite matrix. The member is composed of light gray and tan cherty limestone and massive chert. The uppermost unit is dark brown shale over which are the calcareous siltstones of the Dinwoody.

The upper units were only estimated because the exposures along the Snake River were precipitous and inaccessible.

Unit	Thickness in feet	Total
Dinwoody formation:		
55. Sandstone, brownish	2.0	
Phosphoria formation:		177.4
Rex chert member:		103.8
54. Shale, dark brownish-gray	4.0	
53. Chert, light brownish-gray, massive, weak near center	8.0	
52. Shale, dark gray to black, phosphatic, may include phosphorite	2.0	
51. Chert, light to medium gray, bedded	10.0	
50. Chert, black, upper part interbedded with tan limestone	8.0	
49. Limestone, light gray, weathering chalky, massive, dense	16.0	

Unit		Thickness in feet	Total
48.	Limestone, weathered, interbedded with black chert	8.0	
47.	Limestone, light gray, chalky	21.0	
46.	Limestone, cherty, medium gray, pitted surface	1.0	
45.	Limestone, light brownish-gray, weathering chalky, some beds harder than others	7.0	
44.	Limestone, dark brown; slight unconformity	5.5	
43.	Limestone, cherty, brown	3.5	
42.	Limestone, brownish-gray	5.0	
41.	Chert, medium blue-gray, massive	4.0	
40.	Chert, dark gray,	2.0	
39.	Chert conglomerate; some black phosphorite fragments; unconformity	0.8	
Lower member:			73.6
38.	Phosphorite, black, weak	0.8	
37.	Limestone, brownish gray	2.0	
36.	Phosphorite, black, weak	0.3	
35.	Limestone, brownish, hard	3.0	
34.	Phosphorite, dark brown to black	0.4	
33.	Limestone, brownish-gray, fetid, well jointed	5.3	
32.	Phosphorite, black, with sulphate efflorescence	1.0	
31.	Limestone, brownish-gray, fetid	1.7	
30.	Shale, phosphatic, black	1.7	
29.	Limestone, dark brownish-gray	2.8	
28.	Phosphorite, dark brown	0.4	
27.	Shale, phosphatic, black	2.6	
26.	Chert, medium gray	1.8	

Unit		Thickness in feet	Total
25.	Shale, phosphatic, black	5.4	
24.	Limestone, dark brown to black, fetid, large, flattened, oval concreations	0-2.0	
23.	Number not used		
22.	Shale, phosphatic, black, probably with thin phosphorite beds	7.3	
21.	Phosphorite, black, weak	0.5	
20.	Shale, phosphatic, black	0.2	
19.	Siltstone, dark brown, fetid	2.4	
18.	Siltstone, dolomitic, black	1.0	
17.	Shale, phosphatic, dark brown to black	3.9	
16.	Siltstone, black, hard	0.6	
15.	Phosphorite, black, and phosphatic shale, loose particles	3.0	
14.	Shale, phosphatic, hard, brittle	1.8	
13.	Number not used		
12.	Phosphorite, black, pisolitic, uncemented	0.9	
11.	Shale, phosphatic, brown	0.8	
10.	Phosphorite, bluish, weak, pisolitic	0.6	
9.	Phosphorite, blue-black, hard	1.3	
8.	Dolomite, light gray, dense	5.5	
7.	Chert, black	0.4	
6.	Chert, dolomitic, light gray	3.5	
5.	Sandstone, light blue-gray, hard	5.0	
4.	Chert, black	2.7	
3.	Shale, phosphatic, dark brown	0.3	
2.	Chert or phosphorite, black	1.7	
Tensleep formation:			
1.	Limestone, light blue-gray, dense		8.0

A. The section opposite Johnny Counts Flat showing the massive ledges of the Pennsylvanian Tensleep formation, the lower and upper members of the Phosphoria formation, and the siltstones of the Triassic Dinwoody formation.

B. Cherty limestone and dolomite in the lower part of the Rex chert member at Flat Creek.

Martin Creek, Wyoming Range, Wyoming, T. 38 N., R. 116 W.--Good exposures were found along a ridge on the west side of the first large ravine to the north of Martin Creek, one-quarter mile above the junction with the Snake River plain.

The base of the formation is marked by fairly thick phosphorite which, with an overlying dark soil zone, was measured as the lower member.

The Rex chert member consists of dolomite, limestone, and several calcareous sandstones including an exceptional exposures of the Derbya zone about 30 feet from the top of the section.

The contact with the Triassic Dinwoody formation was not observed.

Unit		Thickness in feet	Total
Dinwoody formation:			
51.	Siltstone, calcareous, light gray, weathers tan	not measured	
Phosphoria formation:			230.8
Rex chert member:			
50.	Concealed interval; includes Triassic contact	42.7	
			173.3
49.	Shale, Brownish-black, soft	2.0	
48.	Chert, black, weathers tan, iron-stained, massive, blue-white fossil casts; caps knob	3.0	
47.	Sandstone, dark brownish-gray, weathers dark gray, massive, coarse-grained	13.8	

Unit		Thickness in feet	Total
46.	Limestone, medium gray, weathers tan, abundant calcite veins, fossiliferous; 3 units, each 3-4 feet thick separated by thin brown soil zones	14.7	
45.	Sandstone, tan, weathers brown and reddish, slightly calcareous, irregular thin beds ½-1 inch thick; numerous Derbya, Composita, Spiriferina, and bryozoa: the Derbya zone	5.0	
44.	Sandstone, light yellow-brown, weathers brown, 2 inch beds	2.0	
43.	Limestone, dark gray, weathers tan, medium to coarse grained, hard, massive and blocky	25.5	
42.	Shale, slightly calcareous, black, weathers brown, petroliferous, massive	0.2	
41.	Sandstone, dark gray, weathers brown with red iron stains, coarse grained, slightly calcareous	4.7	
40.	Conglomerate of ½inch dolomite pebbles in a dark gray dolomite matrix	2.0	
39.	Limestone, very light gray to white, weathers chalky, finely laminated with dark calcite veins	6.2	
38.	Chert, white, brittle, much fractured	3.1	
37.	Limestone, silty, light gray, weathers light gray, massive	7.6	
36.	Limestone with interbedded chert, light gray to white, weathers chalky	14.2	
35.	Dolomite, light gray, massive	9.4	
34.	Dolomite, light gray, massive, numerous calcite geodes, ½-2 inches in diameter	6.0	
33.	Concealed interval	2.0	
32.	Limestone,gray, with black chert nodules, massive	3.7	

Unit		Thickness in feet	Total
31.	Concealed interval	2.2	
30.	Dolomite, thin-bedded, platy, with abundant small geodes	1.3	
29.	Limestone with black chert nodules	5.0	
28.	Chert, black	1.0	
27.	Limestone, light gray,	1.8	
26.	Chert, light and dark gray, mottled appearance	0.6	
25.	Limestone, light gray, fine grained	1.0	
24.	Chert, dark gray, with small white geodes	0.6	
23.	Concealed interval	3.1	
22.	Sandstone, black, weathers dark tan, blocky	1.0	
21.	Concealed interval	2.0	
20.	Limestone tan, weathers dark tan, coarsely crystalline	2.0	
19.	Concealed interval	0.5	
18.	Limestone, dolomitic, light gray, weathers light tan	3.0	
17.	Concealed interval	2.5	
16.	Dolomite, light gray, weathers buff, large blue-gray chert nodules	3.4	
15.	Concealed interval	11.0	
14.	Dolomite, light gray, weathers tan, irregularly bedded with small red chert nodules and calcite veins and geodes	2.5	
13.	Limestone, light gray, weathers light tan, finely laminated	3.0	
Lower member:			57.5
12.	Shale, phosphatic and slightly calcareous, black, oolitic, at base of large concealed interval	54.9	

Unit		Thickness in feet	Total
11.	Phosphorite, pisolitic, lavender fluorine (?) stains and iron stains	2.6	
Tensleep formation:			
10.	Dolomite, blue-gray, weathers light gray, white calcite nodules, dense, much fractured	5.2	
9.	Dolomite, buff, weathers yellow-tan	9.5	
8.	Dolomite, light gray, weathers gray, dense, with tiny calcite veins and 2 persistent beds of black chert 3 inches thick, one at top of unit and the other 2 feet from the top	5.0	
7.	Dolomite, tan, weathers yellow-tan, irregular, massive	5.4	
6.	Conglomerate of dolomite pebbles in light gray limestone	0.5	
5.	Limestone, light gray	1.9	
4.	Conglomerate of tan dolomite pebbles 1/8-1 inch in diameter in light gray limestone, weathers light gray	0.3	
3.	Dolomite, light gray	1.3	
2.	Sandstone, calcareous, light gray, weathers buff, massive at base, irregular beds 1-4 inches thick at top	19.2	
1.	Limestone, dolomitic and siliceous, light gray	2.0	

Creampuff Mountain, Hoback Range, Wyoming, T. 39 N., R. 115 W.--A complete section was measured along a spur on the west side at an elevation of approximately 8,400 feet.

The lower member was trenched and measured in detail. Several phosphorite units are interbedded with the phosphatic

shale. A few siltstone units and two thin dark-colored dolomite beds are the only resistant beds in the member.

The phosphatic shales are overlain by a thick series of dolomites and thin chert beds which comprise the upper member. There are phosphatic shales and phosphorite about 30 feet from the top that are overlain by the uppermost unit of the formation, a dark calcareous, non-phosphatic shale. This unit is succeeded by the calcareous siltstones of the Dinwoody.

Unit	Thickness in feet	Total
Dinwoody formation:		
85. Siltstone, calcareous, dark gray, weathers tan, with 0.8' conglomerate at the base	2.0	
Phosphoria formation:		202.1
Rex chert member:		148.6
84. Shale, slightly calcareous, gray-black, weathers tan, thin-bedded and well-bedded, a few harder, more massive beds	27.6	
83. Phosphorite, black, weathers brown	1.3	
82. Shale, phosphatic, brown, hard	1.7	
81. Shale, soft, brownish-black, flaky	2.0	
80. Shale, phosphatic, brownish-black, fairly massive	3.0	
79. Phosphorite	0.3	
78. Shale, phosphatic, brownish-black	4.4	
77. Phosphorite, pisolitic	0.3	
76. Phosphorite, black to dark blue, somewhat nodular, "cindery" appearance	0.8	

Unit		Thickness in feet	Total
75.	Sandstone, calcareous, purplish-gray, weathers dark tan, massive, with Derbya and bryozoa, equivalent to Derbya zone of Martin Creek	1.6	
74.	Number not used		
73.	Dolomite, light gray, weathers tan, a few calcareous nodules, slightly fossiliferous: large cross sections of gastropods, Euphemites (?); may be equivalent to white chert bed with Euphemites at Red Creek and Bradley Mt.	8.7	
72.	Conglomerate, phosphatic, brownish	0.3	
71.	Limestone, dolomitic, light brownish-gray, lower 6 inches slightly conglomeratic and phosphatic	1.8	
70.	Dolomite, very light gray, weathers white, a few large blue-white chert nodules 2 inches long	10.2	
69.	Dolomite, light gray, weathers chalky	11.0	
68.	Chert, mottled white and gray, oolitic appearance	0.8	
67.	Dolomite, arenaceous, light gray, weathers buff, massive, conchoidal fracture	12.6	
66.	Dolomite, argillaceous, light gray, weak	0.6	
65.	Limestone, dolomitic, light gray	5.2	
64.	Dolomite, light gray, abundant chert nodules and geodes, massive	1.8	
63.	Dolomite, light gray, massive	3.5	
62.	Dolomite, light gray, weathers buff; in lower part are a few flattened quartzitic sandstone pebbles 1 inch by 8 inches; upper part is irregularly bedded and contains abundant geodes	12.4	

Unit		Thickness in feet	Total
61.	Dolomite, light yellowish-gray, weathers tan, thin-bedded near top with a few quartzitic sandstone pebbles	3.8	
60.	Sandstone, calcareous, light brownish-gray, massive, with geodes of calcite	5.8	
59.	Dolomite, gray, weathers tan, medium gray chert geodes	2.3	
58.	Chert, white	0.3	
57.	Dolomite, light gray, with wavy bands of gray and white chert; thin-bedded	3.8	
56.	Dolomite, light gray, with large white chert and calcite masses	3.6	
55.	Sandstone, slightly calcareous, gray, weathers tan, large white chert and calcite geodes	2.2	
54.	Chert, light gray to white	0.8	
53.	Dolomite, light gray, weathers buff, a few small chert nodules	1.3	
52.	Sandstone, calcareous, light gray, weathers tan, massive, a few blue-gray chert nodules	0.6	
51.	Dolomite, light gray, weathers chalky	1.6	
50.	Sandstone, calcareous, light gray, weathers tan, medium-grained, massive	3.8	
49.	Chert, black, flinty	0.5	
48.	Chert, blue-gray, rather coarse grained, quartz geodes, nodular structure	1.5	
47.	Chert, blue-gray and white, thin, wavy banding	1.4	
46.	Chert, blue, large calcite geodes	0.8	
45.	Dolomite, light gray, slightly fossiliferous	0.7	

Unit		Thickness in feet	Total
44.	Chert, phosphatic, blue, fetid	0.8	
43.	Limestone, dolomitic, light gray	0.6	
Lower member:			53.5
42.	Phosphorite, siliceous	0.7	
41.	Phosphorite, pisolitic, soft	0.4	
40.	Shale, phosphatic, brown, hard	2.5	
39.	Siltstone, dark brown, weathers tan, fine-grained, dense, hard	1.3	
38.	Phosphorite, pisolitic, soft	0.3	
37.	Shale, phosphatic, brownish-black, weathers dark brown, hard	1.3	
36.	Siltstone, 1.2' at base is tan, 1.0' in the middle is black, the top 3' are tan; weathers tan, dense, hard, with some surfaces showing large, concentric spherules	5.2	
35.	Shale, phosphatic, black, pisolitic, soft	1.2	
34.	Siltstone, slightly calcareous, brown, weathers dark gray, hard	1.9	
33.	Phosphate rock, brown, hard, dense, non-pisolitic	1.6	
32.	Shale, black, soft, oolitic	1.3	
31.	Shale, brown, weathers dark gray, hard	2.2	
30.	Shale, phosphatic, hard, massive	1.5	
29.	Shale, phosphatic	2.8	
28.	Shale, phosphatic, black, pisolitic, weakly consolidated	1.9	
27.	Shale, phosphatic	0.8	
26.	Chert, light gray mottled with dark gray	0.3	

Unit		Thickness in feet	Total
25.	Shale, phosphatic, pisolitic, weak	2.0	
24.	Shale, phosphatic	0.3	
23.	Shale, phosphatic, fairly hard	0.5	
22.	Dolomite, dark gray, weathers brown, somewhat phosphatic	0.9	
21.	Shale, phosphatic, black, weathers brown, fairly hard	0.8	
20.	Dolomite, dull brownish-gray, weathers light gray, fairly dense	1.6	
19.	Shale, phosphatic, soft	3.5	
18.	Shale, phosphatic and argillaceous, dark brown, fetid, massive, fairly hard	1.6	
17.	Shale, phosphatic, brown	5.3	
16.	Phosphate rock, light brownish-gray, minute white oolites in black matrix, dense, weathers smooth black	0.3	
15.	Shale, phosphatic, brown	1.8	
14.	Phosphorite, loose pisolites	0.5	
13.	Phosphorite, dark gray, weathers with white coating, oolitic to dense, hard	1.6	
12.	Phosphorite, loose pisolites	0.4	
11.	Shale, phosphatic, brown, weathers dark brown	2.6	
10.	Phosphorite, loose pisolites, soft	1.2	
9.	Phosphorite, blue-black, weathers blue-white, large pisolites; lower 4 inches includes pebbles of underlying dolomite	1.8	
Tensleep formation:			
8.	Dolomite, brownish-gray, weathers gray, massive, a discontinuous chert stringer in lower part	4.5	

Unit		Thickness in feet	Total
7.	Siltstone, slightly calcareous, brown, weathers gray, laminated, dense	0.3	
6.	Dolomite, light gray	0.7	
5.	Dolomite, light buff, weathers rusty brown	1.1	
4.	Sandstone, light yellow-gray	1.9	
3.	Dolomite, buff, weathers buff, looks like sandstone	4.2	
2.	Sandstone, quartzitic, light yellow-gray, massive, with chert and dolomite pebbles in lower 5"	6.6	
1.	Sandstone, quartzitic, light yellow-gray, weathers tan, massive	8.3	

Little Horse Creek, Wyoming, T. 39 N., R. 115 W.--A partially exposed section was measured along a small tributary about one-quarter mile north of Little Horse Creek. This section is estimated to be one-quarter mile east of the Hoback fault.

The measurements of the lower member are based on dark soil exposures only. The Rex chert units form prominent ledges of sandy limestone and dolomite with two thin chert bands. The upper contact was not observed.

Unit		Thickness in feet	Total
Phosphoria formation:			194.0 seen
Rex chert member:			80.0 seen
9.	Dolomite, medium gray, weathers tan, massive, calcite nodules and geodes	52.0	
8.	Limestone, slightly sandy, medium gray, weathers tan, massive	2.0	

Unit		Thickness in feet	Total
7.	Limestone, sandy, medium gray, weathers gray with rough surface, medium-grained	5.0	
6.	Sandstone, calcareous, light gray, weathers tan, fine grained, white chert nodules and bands	4.0	
5.	Sandstone, calcareous, light gray, weathers tan, crenulated bands, quartz geodes	6.0	
4.	Chert, white to light gray, weathers light gray	2.0	
3.	Limestone, siliceous, medium gray, weathers light gray, fine- to medium-grained	4.0	
2.	Chert, light to medium gray, weathers buff, massive, iron stains	5.0	
Lower member:			114.0
1.	Largely covered, with phosphatic shale and phosphorite in lower part	114.0	

Tensleep formation not measured

Game Creek, Wyoming, T. 40 N., R. 116 W., S. 26--

This section was measured along the west side of Game Creek one and one-half miles above the right angle bend of the creek to the north. The best exposures were found at the anticline which brings up the Tensleep sandstone.

With the exception of a phosphorite unit at the base of the formation, the shales and other units of the lower member are poorly exposed and measured, therefore, as a single unit.

The Rex chert member is predominantly limestone and sandy dolomite, overlain by phosphatic shale. The uppermost unit is a reddish, coarse grained sandstone.

Unit	Thickness in feet	Total
Dinwoody formation:		
28. Siltstone, calcareous, light tan, weathers tan	3.0 seen	
Phosphoria formation:		207.1
Rex chert member:		134.2
27. Sandstone, reddish-brown, weathers brown, yellow, and red, medium-to coarse-grained, small blue phosphate (?) nodules; at top of unit sandstone is darker and coarser	40.0	
26. Concealed interval; a dark-colored slope--probably shale	35.0	
25. Shale, phosphatic, black, weathers brown	4.0	
24. Conglomerate of phosphorite pebbles in limestone, grades into units 25 and 23	0.4	
23. Limestone, light gray, weathers tan, thick calcite coating on weathered surfaces, brecciated appearance	3.0	
22. Dolomite, medium gray, weathers tan, massive, dense	1.7	
21. Dolomite, medium gray, weathers tan, massive, coarsely crystalline	1.7	
20. Limestone, light gray, weathers chalky, slabby	6.0	
19. Chert, light gray and limestone, light gray, calcite veins, vugs and geodes	2.5	
18. Dolomite, light gray, weathers tan, light gray chert bands 3 inches thick, and numerous chert nodules 1-4 inches in diameter, massive, forms ledge	6.5	
17. Dolomite, siliceous, dark gray, weathers dark tan, with white calcite nodules	4.7	
16. Limestone, dolomitic, light gray, weathers tan, calcite nodules, massive	5.3	

Unit		Thickness in feet	Total
15.	Dolomite, light tan, weathers tan, dark gray limestone bands and small white calcite and chert nodules	1.4	
14.	Dolomite, light tan, weathers tan and red, irregularly bedded, many calcite vugs	4.8	
13.	Dolomite, siliceous, light gray, weathers tan, blocky	3.0	
12.	Limestone, gray, weathers tan, massive, many calcite veins and geodes, brecciated appearance	6.9	
11.	Dolomite, siliceous, gray, weathers light tan, irregularly bedded to nodular, abundant white calcite nodules, less resistant than unit 12	1.3	
10.	Dolomite, light gray, weathers light gray, finely crystalline, many calcite nodules, base concealed	0.8	
Lower member:			82.9
9.	Concealed interval, light-colored slope	60.0	
8.	Concealed interval, dark-colored slope, probably phosphatic shale	20.0	
7.	Phosphorite, brownish-black, pisolitic	1.0	
6.	Shale, phosphatic, black, pisolitic grades into unit 7	1.4	
5.	Phosphorite, black, weathers blue-white, blocky, hard	0.5	
Tensleep formation:			
4.	Dolomite, siliceous, medium gray, weathers tan, massive, forms prominent ledge	2.3	
3.	Limestone, siliceous, gray, weathers light gray, thin-bedded, much fractured	5.7	
2.	Sandstone, dark gray, weathers tan, compact	2.0	
1.	Sandstone, gray, weathers tan, massive, blocky, base concealed	9.2	

Teton Pass, Teton Range, Wyoming, T. 41 N., R. 118 W.

This section was measured along a roadcut 0.3 miles below the Pass on the west side. There is much faulting in the area and the marked thinness of the lower member may be due to elimination of some beds by faults.

The lower member includes several phosphorite units interbedded with shale that resembles coal in appearance. There are two thin black chert beds near the top.

The Rex chert member consists of a series of chert and calcareous rocks overlain by phosphatic shale. The highest unit of the formation is a massive black chert bed.

Unit	Thickness in feet	Total
Dinwoody formation:		
48. Siltstone, calcareous, light yellow-brown, slight unconformity at base	10.0	
Phosphoria formation:		145.4
Rex chert member:		120.9
47. Chert, black, iron stains on weathered surface, a few white chert veins; upper 6.7' contains concretions that may be the pipestems found at Flat Creek	19.8	
46. Chert, black, thin-bedded with shaly partings	12.0	
45. Shale, dark brown, weathers brown, thin-bedded	20.1	
44. Phosphorite, dense, non-pisolitic	1.0	
43. Sandstone, calcareous	3.4	
42. Sandstone, calcareous, light blue-gray, well-bedded, medium-grained, fossiliferous: bryozoa and brachiopods (?); may be Derbya zone	3.6	

Unit		Thickness in feet	Total
41.	Dolomite, slightly arenaceous, light gray, coarsely crystalline	8.0	
40.	Siltstone, calcareous, tan to gray, massive	5.6	
39.	Siltstone, shaly, yellow-brown, massive, a few light gray chert nodules	9.7	
38.	Dolomite, light gray, dense, dark gray and white chert nodules	4.2	
37.	Chert, dark gray	0.4	
36.	Dolomite, light gray, dense, gray chert nodules, lower part shattered	6.3	
35.	Shale, light yellow-brown, very soft	2.7	
34.	Dolomite, light gray, weathers gray, very finely crystalline	1.6	
33.	Sandstone, tan	2.6	
32.	Dolomite, light gray, with gray chert bands	4.7	
31.	Shale, yellow-brown, soft, earthy	2.2	
30.	Chert, light and dark gray, weathers tan, shattered, dark green stains	7.7	
29.	Chert, dark gray with light gray and white chert nodules	1.2	
28.	Chert, black	1.3	
27.	Shale, siliceous, thin-bedded, platy	0.8	
26.	Chert, gray, white, and black in thin bands, interbedded with thin beds of gray, arenaceous dolomite	2.0	
Lower member:			24.5
25.	Phosphorite, cherty, black, non-pisolitic, Orbiculoidea	1.0	
24.	Siltstone, yellow-brown	0.7	

Unit		Thickness in feet	Total
23.	Phosphorite, black	0.2	
22.	Chert black, with siliceous black dolomite	0.8	
21.	Shale, brown, very soft	0.5	
20.	Siltstone, yellow-tan, black chert partings	0.4	
19.	Phosphorite, black	0.1	
18.	Shale, greenish	0.5	
17.	Sandstone, white, fine-grained, friable, very porous; a leached zone (?)	1.0	
16.	Chert, dark gray to black, shattered	1.9	
15.	Shale, brown, massive, fairly soft	1.8	
14.	Chert, black, nodular, massive	0.9	
13.	Shale, siliceous, dark gray, weathers brown	1.0	
12.	Shale, brownish-black, weathers brown, soft, probably phosphatic	6.7	
11.	Phosphorite, non-pisolitic, looks like soft coal	0.2	
10.	Shale, phosphatic, black	1.1	
9.	Phosphorite, black, pisolitic, unconsolidated	0.7	
8.	Shale, phosphatic, black	0.6	
7.	Phosphorite, black, pisolitic, unconsolidated	0.7	
6.	Shale, phosphatic	0.2	
5.	Phosphorite, black, pisolitic, unconsolidated	0.3	
4.	Phosphorite, black, consolidated, hard	0.6	

Unit	Thickness in feet	Total
3. Shale, phosphatic, dark brown to black, hard, massive	1.6	
2. Phosphorite, black, non-pisolitic, partly unconsolidated	1.0	
Tensleep formation:		
1. Dolomite, light gray	4.0	

An observation was made in an unnamed branch of Trail Creek 1.3 miles west of Coal Creek. Numerous float blocks of dark, blue-gray sandstone were found with Orbiculoidea, fish teeth, and other fish material. There were also curious cylindrical concretions in the sandstone that may the the pipestems of the Flat Creek section. This sandstone is probably unit 42 of the above section.

Flat Creek, Gros Ventre Range, Wyoming, T. 41 N., R. 115 W.--A complete section was obtained on the north side of Flat Creek about one mile east of the dam.

The lower contact was marked by a basal conglomerate of rounded chert, limestone, and dolomite pebbles in a sandstone matrix of the Tensleep type. Immediately over this unit was a thin conglomerate of pebbles in a phosphorite matrix. There units werenot observed at other localities. Interbedded with the shale units of the lower member are beds of light and medium gray chert.

The Rex chert member consists of massive dolomite, shale, and a 50 foot unit of bedded black chert. The upper

contact at the top of the chert is marked by pipestems overlain by a basal Dinwoody conglomerate of dark chert pebbles in a siltstone matrix. See Plate 4. The pipestems are irregular cylinders of black chert, one to three inches in diameter, and about one and one-half feet in length. They are inclined at a low angle above the chert and are prominently exposed since the material in which they formed has been weathered away.

Conularia kaibabensis McKee was found 8 feet from the top of the massive dolomite measured as unit 29.

Unit		Thickness in feet	Total
Dinwoody formation:			
39.	Conglomerate of dark chert pebbles in a tan siltstone matrix, calcite veins	2.0	
38.	Conglomerate of flat pebbles of reworked chert	1.0	
Phosphoria formation:			188.0
Rex chert member:			124.3
37.	Chert, dark gray to black, weathers tan with deep red iron stains, hackly to brittle, beds 1-3 inches thick, minute shale partings; a massive 4' zone near the middle; beds become thicker and nodular near the top; cylindrical black chert concretions 1-3 inches in diameter, bent about 60° above chert just below Dinwoody contact: pipestem zone	50.0	
36.	Chert, black, and interbedded black paper shale; chert increases toward top	3.1	
35.	Shale, dark gray to black, paper-thin layers	9.2	

Unit		Thickness in feet	Total
34.	Dolomite, black, massive	2.5	
33.	Shale, black, thin-bedded, soft	9.0	
32.	Dolomite, black, massive, fetid	1.5	
31.	Shale, black, thin-bedded, soft	2.8	
30.	Phosphorite, blue-black, oolitic, interbedded with phosphatic black shale, somewhat banded	4.0	
29.	Dolomite or dolomitic limestone, medium gray, weathering tan with irregularly rounded and pitted surface, massive, cliff-forming, more thinly bedded 16.5' above base, somewhat darker and finer grained near top; fossiliferous zone near top: calcite casts of large pelecypods (Pecten ?) and gastropods (Euphemites?); a fine specimen of Conularia kaibabensis McKee was found 8' from the top.	40.0	
28.	Dolomite, light gray with a string of light blue-gray chert nodules 2.5' above the base, some iron stains and calcite veins and geodes. See Plate 3.	10.3	
Lower member:			63.7
27.	Shale, siliceous, buff to yellow, buff	5.0	
26.	Siltstone, siliceous, irregular thin bedding, platy, weathers tan	3.0	
25.	Siltstone or shale, buff, weathers buff, string of milky white chert nodules 2.3' above base; bedding 1-2 inches thick at base, more massive near middle, light gray chert nodules at top	8.2	
24.	Conglomerate of chert pebbles in sandstone	0.8	
23.	Chert, light tan-gray, weathering tan, some shaly partings, calcite along joint surfaces, brecciated appearance	11.7	
22.	Dolomite, medium gray, weathering tan, massive, upper surface pitted and eroded, unconformity?	0.1	

Unit		Thickness in feet	Total
21.	Chert, flattened nodules poorly cemented, light to medium gray	1.0	
20.	Shale, light gray, oval greenish-gray chert nodules in upper part	2.0	
19.	Shale, olive green, soft, weak	5.0	
18.	Chert, calcitic, thin, wavy bedding in lower 2', more massive at top	4.5	
17.	Dolomite, dark gray, with an equal amount of chert; brittle, dense, slifhtly petroliferous	1.0	
16.	Claystone, siliceous, brown, laminated, thin, platy beds, a few calcite nodules	5.2	
15.	Dolomite, dark gray, weathers tan, brittle, dense, petroliferous, siliceous	0.6	
14.	Claystone, dolomitic, dirty greenish-brown, weathers tan	1.0	
13.	Limestone, siliceous, yellow-brown, weathers reddish,	0.5	
12.	Dolomite, light to medium gray, dense, hard	1.0	
11.	Shale, phosphatic, brown, loose pisolites	0.3	
10.	Phosphorite, glauconitic (?), greenish, pisolitic	0.2	
9.	Shale, phosphatic and glauconitic, green, weathers tan	0.8	
8.	Limestone, phosphatic, light gray at base, darker near top	0.3	
7.	Shale, phosphatic, brownish-gray	0.3	
6.	Phosphorite, brownish-gray, weathers bluish, pisolitic	0.2	
5.	Limestone, phosphatic, light-colored, pisolitic, grades into dark-colored phosphorite	1.3	

A. Pipestems at the top of the Phosphoria overlain by a basal conglomerate of the Triassic Dinwoody formation.

B. Pennsylvanian Tensleep sandstone overlain by a basal conglomerate of chert and quartzite pebbles in a matrix of (a) sandstone and (b) phosphorite.

FORMATIONAL CONTACTS AT FIAT CREEK

Unit		Thickness in feet	Total
4.	Phosphorite, black, weathers bluish-white, pisolitic, blocky	1.1	
3.	Chert, light to medium blue-gray, weathers tan, bedded, with suggestion of breccia in lower 1-2'; cavities and veins filled with milky white calcite; ledge forming	5.5	
2.	Conglomerate of rounded pebbles of limestone, chert and quartzite, ½-2" in diameter in a phosphorite matrix	0.6	
1.	Sandstone, conglomeratic, with rounded pebbles of chert, quartzite and limestone in a sandstone matrix of the Tensleep type. See Plate 4.	1.6	
Tensleep formation:			
	Sandstone, slightly calcareous, light gray, weathers light yellow-brown, very fine-grained, massive, calcite vugs and geodes with dog-tooth spar crystals, unconformity with relief of a few inches at top, base concealed	5.0	

Gros Ventre River, Gros Ventre Range, Wyoming, T. 42 N., R. 115 W.--Two partial sections which included the lower and upper contacts were measured along the Gros Ventre River. The lower part of the formation was measured on the Gros Ventre River bluff just south of the cattle gate on the National Forest boundary. The upper units were observed about 2 miles east of the cattle gate on the north side of the road. The unmeasured interval between the two sections is estimated to be about 60 feet by comparison with the Flat Creek section.

The lower contact is marked by a chert conglomerate or breccia beneath which the beds are pitted and eroded. The phosphorite zones near the base of the member include light-colored pisolitic phosphorite as well as the more usual dark-colored variety. The chert units in this lower member are light pink and red.

The Rex chert member is predominantly black chert and coarse, fossiliferous sandstone. One unit was brecciated but no other evidence of faulting was observed. A chert bed about 25 feet from the top may be the pipestem zone. The upper contact was not marked by a prominent unconformity.

Unit	Thickness in feet	Total
Dinwoody formation:		
30. Siltstone, calcareous, tan, no prominent unconformity at base	2.6	
Phosphoria formation:		199.5
Rex chert member:		106.2 seen
29. Chert, medium gray and tan, unevenly bedded	3.3	
28. Sandstone, calcareous, tan, with some gray chert bands, massive, cross-bedded, bryozoa and other fossils	9.3	
27. Sandstone, quartzitic, dark gray, weathers dark gray, fossiliferous	1.0	
26. Chert, dark gray to black, thin, irregular, nodular beds, pipestems?	4.0	
25. Chert, tan to dark gray with some black and white banded beds, massive, brecciated	5.6	

Unit		Thickness in feet	Total
24.	Chert, gray to pink to white,	5.2	
23.	Concealed interval	6.0	
22.	Chert, gray, and banded black and white beds	2.0	
21.	Concealed interval.	16.0	
20.	Shale, black, weathers tan, fissile	5.0	
19.	Claystone, siliceous, black, massive	0.4	
18.	Concealed interval, probably dark shale	11.0	
17.	Concealed interval	7.0	
16.	Chert, light gray, irregularly bedded	7.0	
15.	Concealed interval	12.0	
14.	Sandstone, slight calcareous, gray, weathers tan, irregular wavy bedding; lower 4' very calcareous, beds 1-3' thick, weathers more or less rounded with a rough, pitted surface, shale breaks, fossiliferous (brachiopods)	8.8	
13.	Estimated interval between measured sections, includes base of upper member		60.0
Lower member			33.3 seen
12.	Siltstone, slightly calcareous, slabby, nodular beds 1" thick, one fish tooth found; not definitely in place	1.3	
11.	Chert, pink to red, brecciated, calcite cement	1.7	
10.	Shale, siliceous, variegated tan and pink, slabby	21.0	
9.	Phosphorite, dark gray	0.1	
8.	Shale, light greenish-brown, soft	1.0	
7.	Phosphorite, light gray, pisolitic	0.8	

Unit		Thickness in feet	Total
6.	Phosphorite, light-colored, pisolitic, poorly cemented	0.9	
5.	Phosphorite, a band of dark gray between the light-colored phosphorite of units 4 and 6	0.1	
4.	Phosphorite, light-colored, pisolitic; white pisolites in a tan matrix, highly calcareous	1.0	
3.	Chert, light and dark gray and pink, massive	4.7	
2.	Conglomerate or very coarse sandstone, calcareous cement, dark gray, weathers tan	0.7	
Tensleep formation:			
1.	Dolomite, buff, weathers buff, unconformity at the top		

Tosi Creek, Gros Ventre Range, Wyoming, T. 39 N., R. 111 W.--This section was measured on the north side of Tosi Creek by Dr. H. R. Wanless and Gerald Cooley in August, 1945.

The formation consists of chert, sandstone, and limestone units without exposures of the phosphatic shales.

Unit		Thickness in feet	Total
Dinwoody formation:			
24.	Sandstone, light brownish-gray, massive	20.0	
Phosphoria formation:			154.5
Rex chert member:			75.0
23.	Limestone, phosphatic, brownish-gray	2.0	
22.	Concealed interval	6.0	

Unit		Thickness in feet	Total
21.	Limestone, brownish-gray, unevenly bedded, may be phosphatic	3.0	
20.	Concealed interval	10.0	
19.	Chert, light tan to blue-gray, distinctly but unevenly bedded, some beds 6" thick	11.0	
18.	Concealed interval with chert talus	20.0	
17.	Chert, bluish-gray, much fractured, "grained" appearance	7.0	
16.	Concealed interval	5.0	
15.	Chert, purplish-gray, much fractured, caps bench	11.0	
Lower member:			79.5
14.	Sandstone, calcareous, light greenish-gray, small limestone fragments	5.0	
13.	Concealed interval	5.0	
12.	Limestone, light gray, capping principal bench	8.0	
11.	Sandstone, calcareous, light tan	6.0	
10.	Limestone, light gray	1.3	
9.	Sandstone, calcareous, tan, medium-grained, ledge forming	12.0	
8.	Chert, buff to blue-gray, weathers brownish to white, looks like a pile of boards	11.5	
7.	Concealed interval; much geode-bearing chert and black phosphatic chert blocks	5.0	
6.	Chert, light gray to white, abundant geodes	4.0	
5.	Concealed interval	3.0	
4.	Limestone, siliceous, tan	7.5	

Unit		Thickness in feet	Total
3.	Chert, light gray to white, many geodes, may be slightly oolitic	4.0	
2.	Concealed interval	5.0	
1.	Sandstone, calcareous, light gray, small chert pebbles $\frac{1}{4}$" in size	2.0	
Tensleep formation: Limestone, sandy, brownish-gray, weathers pinkish		1.5	

Correlation of sections

At Phosphoria Gulch in southeastern Idaho, the Phosphoria formation is composed of a lower phosphatic shale member, 175 feet thick and an upper member, 240 feet thick that is divided into (1) a cherty limestone unit at the base, (2) a chert unit in the middle, and (3) a shale unit at the top. The total thickness of the formation is 415 feet. About 70 miles north and northeast of Phosphoria Gulch in the area of this study, the same sequence of beds is found west of the Absaroka thrust. See Plate 1. East of the Absaroka fault in the Darby thrust sheet, the sequence is similar but the cherty limestones and dolomites at the base of the upper member are much thicker, the chert is very thin, and a few phosphatic shales are present. The average thickness of these sections is 220 feet, the lower member being about 70 feet thick, and the upper member about 150 feet thick. North and east of the Darby thrust, phosphatic beds are found in the middle of the upper member as

well as in the lower, and the uppermost shale unit is absent. The Big Hole section at the northwest end of the area includes cherty limestone and dolomite and thick sandstone beds above the lower phosphatic shale member. Eastward in the Teton Pass area, several chert beds are present in the lower member, and in the upper member are (1) a cherty limestone unit at the base, (2) a phosphatic shale unit in the middle, and (3) a chert unit at the top. At the eastern limit of the area, at Tosi Creek, the lower member is predominantly calcareous sandstone, and the upper member is chert with some thin phosphatic limestone. The thickness of these sections is about 185 feet: the lower member is about 70 feet thick, and the upper member 115 feet thick.

The beds of the lower member are composed in large part of nonresistant, thin-bedded phosphatic shale, and details of the lithology cannot be secured without trenching. As a result, incomplete information was obtained and correlations within the member were not made.

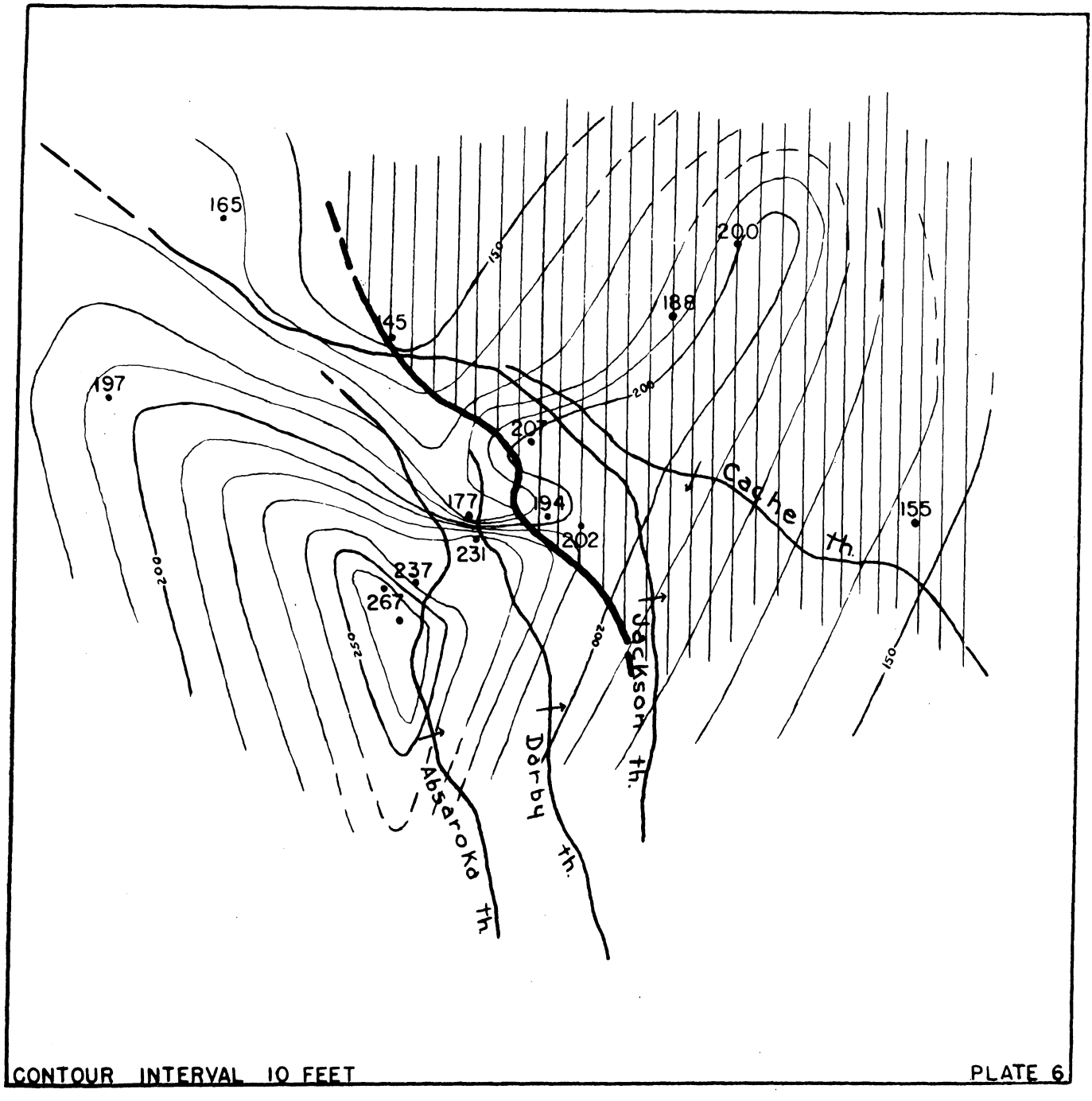
The units of the upper member have been correlated as shown in Plate 5. At the base of the upper member in all sections is a unit of limestone and dolomite. Above this in the sections west of the Darby thrust are a chert unit and a shale unit. North and east of the thrust, the calcareous rocks are overlain by phosphatic shale and chert.

The phosphatic shale is interpreted as wedging out to the west, and the chert unit at the top of the member is correlated with that in the middle of the member in the sections to the west. The uppermost shale in the western sections is not represented to the east.

CONCLUSIONS

The Phosphoria thickens from about 185 feet north and east of the Darby thrust to about 220 feet west of the thrust. If the correlations are correct, the thickening is due chiefly to the presence of the upper shale only in the western sections. It is absent in the Teton Pass area, and at the eastern limit of the area, the shale unit and the underlying chert unit are both absent. The interpretation in this paper is that the upper units were not deposited in the outer parts of the Phosphoria sea; hence, the thinning to the north and east, and thicker deposits to the southwest.

As shown in Plate 6, however, the thickening of the formation relates only in a general way to the shelf and trough belts. The difference in thickness is so small that it is reasonable to assume that the formation over the entire area represents deposition in a shallow shelf sea. The varying extent of the sea is reflected somewhat by the stratigraphic succession and the thickness.



Isopach map of the Phosphoria formation in northwestern Wyoming and eastern Idaho. The thrust faults are also shown. The area extent of the phosphorite beds in the upper member is shown by vertical ruling. The phosphorite beds of the lower member extend over the entire area.

Although no commercial deposits of phosphorite were found, the distribution shows widespread deposition in the lower member, and minor deposition in the upper member that was restricted to the relatively shallow northeastern parts. A sharply defined basin is not indicated within the area of this study.

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BRADLEY MOUNTAIN

CARIBOU RANGE

LITTLE RED AND RED CREEKS

BIG HOLE RANGE

WOLF CREEK

JOHNNY COUNTS FLAT

MARTIN CREEK

CREAMPUFF MOUNTAIN

LITTLE HORSE CREEK

GAME CREEK

TETON PASS

FLAT CREEK

GROS VENTRE RIVER

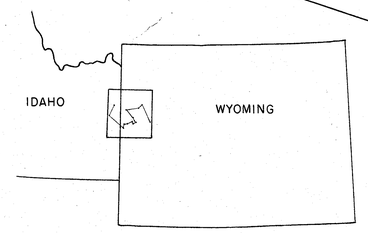
TOSI CREEK

EXPLANATION

CONGLOMERATE		SHALE	
QUARTZITIC SANDSTONE		PHOSPHORITE	
CHERTY SANDSTONE		CHERTY DOLOMITE	
CALCAREOUS SILTSTONE		SANDY DOLOMITE	
SANDSTONE		DOLOMITE	
CALCAREOUS SANDSTONE		CHERTY LIMESTONE	
SILTSTONE		SANDY LIMESTONE	
SILICEOUS SHALE		LIMESTONE	
CALCAREOUS SHALE		CHERT	
PHOSPHATIC SHALE		COVERED INTERVAL	

SCALE

30
20
10
5
0
FEET



LOCATION OF AREA

CORRELATION OF PHOSPHORIA SECTIONS IN NORTHWESTERN WYOMING AND EASTERN IDAHO

PLATE 5