Geology of the Dry Valley Quadrangle Idaho

GEOLOGICAL SURVEY BULLETIN 1015-I

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By EARLE R. CRESSMAN *and* ROBERT A. GULBRANDSEN

A CONTRIBUTION TO ECONOMIC GEOLOGY

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By Earle R. Cressman and Robert A. Gulbrandsen

ABSTRACT

The 7½-minute Dry Valley quadrangle in southeastern Idaho was mapped by the U. S. Geological Survey as a part of an investigation of the phosphate deposits of the western United States. The mapping was undertaken to outline in greater detail the distribution of the Phosphoria formation and to define the structures in which it is involved.

Only sedimentary rocks ranging from Mississippian to Recent in age are exposed in the quadrangle. Rocks of Paleozoic age are represented by the Brazer limestone of Mississipian age, the Wells formation of Pennsylvanian age, and the Phosphoria formation of Permian age. Strata of Mesozoic age are represented only by the Dinwoody and Thaynes formations of Triassic age. Unnamed Tertiary and Quarternary strata overlie formations of Paleozoic and Mesozoic age with profound unconformity.

The area is characterized by generally open folds striking north-northwest, by a few large faults of similar trend, and by many short faults of small displacement that are commonly transverse to the major structural trend. The Schmid syncline, a relatively simple, open fold, is the most prominent structural feature of the quadrangle. Most of Dry Ridge is underlain by the moderately dipping strata forming the east limb of the Dry Valley anticline. These beds overturn abruptly to form the east limb of the nearly isoclinal Georgetown syncline.

No mineral deposits other than phosphate rock are known to occur in the quadrangle. The phosphate mineral, cryptocrystalline carbonate-fluorapatite, occurs in quantity in the phosphatic shale member of the Phosphoria formation. Two zones of phosphate rock in this member are suitable for mining and processing: one zone is near the base of the member, and the other is about 20 feet below the upper contact.

INTRODUCTION

The Dry Valley quadrangle includes part of the Preuss Range, one of several minor ranges in the western part of the Middle Rocky Mountain province (fig. 38). The Preuss Range includes the ridges and valleys from about 3 miles east of the quadrangle west to Bear Lake Valley, a breadth of 16 miles, and from the Blackfoot River just north of the quadrangle to south of Montpelier, a total length of 47

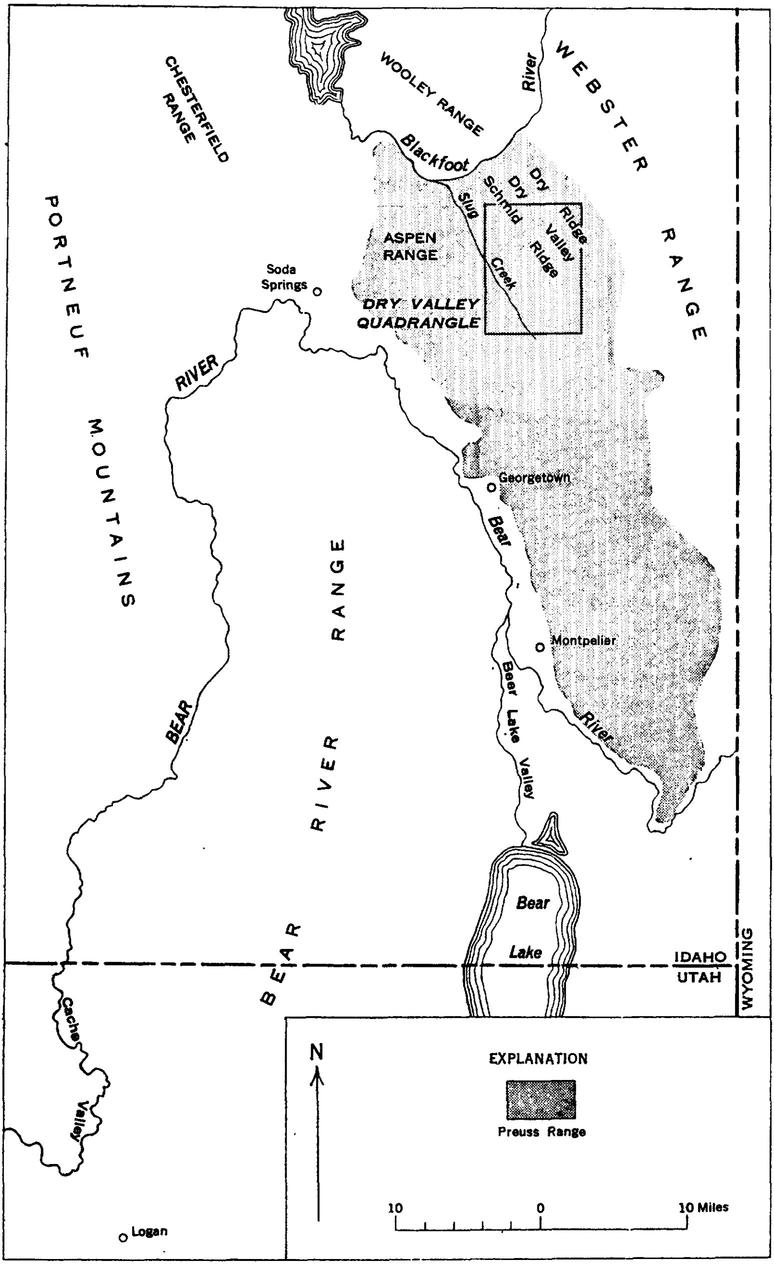

FIGURE 38.—Index map showing location of Dry Valley quadrangle and principal physiographic features of southeastern Idaho.

miles. Parts of the 3 component ridges that form the northern part of the Preuss Range—Dry Ridge on the east, Schmid Ridge in the middle, and the Aspen Range on the west—are included in the quadrangle, although by far the greater parts of both Dry Ridge and the Aspen Range are in adjoining quadrangles. Just south of the quadrangle the ridges join to form the main mass of the Preuss Range.

The small streams in the quadrangle drain into the Columbia River by way of the Blackfoot and Snake Rivers.

North and east slopes are generally forested with both mixed and pure stands of aspen and conifers. South and west slopes and valley floors are covered with grasses and sagebrush. Part of the Slug Creek valley is cultivated.

The quadrangle is accessible by gravel roads from Montpelier, Georgetown, and Soda Springs and is traversed by a few secondary roads and dry-weather trails. A paved highway (U. S. 30N) and the main line of the Union Pacific Railroad from Chicago and Portland pass through these same towns.

The area is mountainous and the winters are fairly severe with a deep snowfall, making it almost inaccessible during the winter months. There are no permanent residents, but a few ranches are occupied during the summer.

The Dry Valley quadrangle, Caribou County, Idaho (pl. 27), is one of seven 7½-minute quadrangles in southeastern Idaho being remapped by the U. S. Geological Survey with the cooperation of the Division of Raw Materials of the Atomic Energy Commission, as part of an investigation of the phosphate deposits of the western United States. The principal objective of the program is to make detailed geologic maps of the areas in which important phosphate deposits in the Phorphoria formation occur. It is hoped that the maps will serve both as an aid in selecting possible sites for mining and as a basis for calculating reserves. The quadrangle was mapped on a 1:12,000 topographic base in 1950–51 by E. R. Cressman and R. A. Gulbrandsen, assisted at various times by K. B. Krauskopf, K. Lutz, J. W. Hill, R. G. Waring, and M. A. Warner. The Dry Valley quadrangle is the NE¼ of the Slug Creek 15-minute quadrangle that was mapped by Mansfield (1927, pl. 6) at a scale of 1:62,500, as part of his classic study of southeastern Idaho.

STRATIGRAPHY

Only sedimentary rocks are exposed in the quadrangle. They range in age from Mississippian to Recent, but all the strata of Mesozoic age except the formations of Early Triassic age have been stripped off by erosion. The formations have been divided into members for convenience in mapping, but with the exception of the Rex chert and phosphatic shale members—both in the Phosphoria formation—the member designation is informal and may not have any regional significance.

CARBONIFEROUS SYSTEMS

BRAZER LIMESTONE

The Brazer limestone of middle and late Mississippian age is the oldest formation exposed in the quadrangle. Mansfield (1927, p. 63) reported the thickness of the Brazer as greater than 1,130 feet at Wells Canyon, 6 miles southeast of the Dry Valley quadrangle. A recent measurement at the same locality by T. M. Cheney, of the Geological Survey, indicates a thickness in excess of 1,900 feet. Only the upper 800 feet of the formation is exposed in the Dry Valley quadrangle. The lower 400 feet includes interbedded dense limestone, medium- to coarse-grained crinoidal limestone, poorly sorted oolitic limestone, calcareous quartz siltstone, and well-sorted medium-grained quartz sandstone. The upper 400 feet consists mostly of thick-bedded to massive light- to dark-gray dense limestone and medium-grained crinoidal limestone. Large horn corals are common.

WELLS FORMATION

The Wells formation is Pennsylvanian in age. It has been mapped as two units, a lower member that corresponds approximately to the "lower sandy and cherty facies" of Mansfield (1927, p. 72), and an upper member that includes both the "middle sandy facies" and the "upper siliceous limestone."

The lower member consists mostly of interbedded limestone and sandy limestone, but it contains some very fine grained to fine-grained calcareous quartz sandstone. Some of the limestones are composed largely of flattened oolites and are diagnostic of the member. Crinoid plates are present in small amounts in many of the limestones; chert nodules and stringers are common, especially in the upper half of the member. The thickness of the lower member within the quadrangle ranges from 700 to 1,200 feet. In the southwest corner of the quadrangle and just south of it in sec. 22, T. 9 S., R. 44 E., the lower member is about 700 feet thick. On Dry Ridge at the east side of the quadrangle it is 1,200 feet thick, and 1 mile west of the quadrangle in the NE¼ sec. 36, T. 9 S., R. 45 E., it is 1,500 feet thick. Mansfield (1927, p. 73) noted the variation in thickness of the lower member and suggested that it was due to deposition on an unconformity at the top of the Brazer limestone. An erosional unconformity at the same stratigraphic position near Logan, Utah, has been suggested by Williams (1948, p. 1143–1144) and Parks (1951, p. 186). It is possible, however, that much of the variation in thickness within the quadrangle is caused by structural repetition or omission. No structural thickening has been detected in the thick and fairly well exposed section on Dry Ridge, but the upper member of the Dinwoody formation is also anomalously thick in the same locality.

The upper member ranges in thickness from 1,300 feet on the west side of the quadrangle to 1,500 feet on the east side. It consists of calcareous quartz sandstone with subordinate limestone and chert. The sandstone, which ranges from very fine grained to fine-grained, is commonly crossbedded and brecciated, particularly in the upper part. It is light gray to weak yellowish orange, but many beds in the uppermost 500 feet are reddish brown. Most of the sandstone in the reddish-brown interval is poorly sorted, containing well-rounded medium-grained sand in a very fine to fine-grained sand matrix. A distinctive dense light-gray limestone 50 to 100 feet thick that typically contains silicified *Squamalaria* (brachiopod) shells and crinoid plates occurs at the top of the member and is extremely useful as a guide to the phosphatic shale member of the Phosphoria formation. Mansfield (1927, p. 73) states that the upper limestone is absent locally, suggesting an unconformity at the top of the formation, but the limestone is present throughout this quadrangle and does not change greatly in thickness or character. It has been suggested by Williams (1943, p. 615–616) and McKelvey (1949, p. 273) that the upper part of the Wells formation is Permian in age and correlative with the lower member of the Park City formation of the northern Wasatch Mountains. At present, however, the faunas have not been studied sufficiently to define the age of the Wells with accuracy.

PERMIAN SYSTEM

PHOSPHORIA FORMATION

The Phosphoria formation consists of two members, a lower phosphatic shale member and an upper Rex chert member.

The phosphatic shale member, which is composed of interbedded black mudstone, phosphatic mudstone, limestone and oolitic phosphate rock, is 180 to 200 feet thick. Usually, the member is not exposed in outcrop but is eroded to form a swale between the underlying Wells formation and the overlying Rex chert member.

The Rex chert member consists of about 300 feet of bedded dark-gray and black chert and cherty mudstone, the cherty mudstone usually occurring in the upper half of the member. Much of the chert weathers brown and reddish brown. In places the bedded chert crops out in massive ledges, but in others it is indicated only by float. In places a thin bed of nodular phosphate rock at the top of the member crops out.

TRIASSIC SYSTEM

DINWOODY FORMATION

The Triassic strata overlying the Phosphoria formation that were mapped as the Woodside shale by Mansfield (1927) are here referred to as the Dinwoody formation. This change in nomenclature is based in large part on unpublished studies by Bernhard Kummel, Jr., who has made an examination of Triassic strata in this region in conjunction with the current study of the western phosphate field.

The lower member consists of thin-bedded to fissile light-grayish-brown to olive-brown calcareous siltstone and shale with a few thin interbeds of light-gray limestone and is 850 to 1,000 feet thick. At the top of the member is 100 to 150 feet of thick-bedded olive-gray and olive-brown silty limestone and calcareous siltstone that weather moderate brown to shiny black. These uppermost beds contain in many places truncated "rolls" or "slump structures."

The upper member consists of prominent beds of gray limestone intercalated with thin-bedded olive-brown to light-grayish-green siltstone and thick-bedded black-weathering pale-olive-brown calcareous siltstone similar to the siltstones in the lower member. Some limestone beds contain much coarse silt whereas others are composed dominantly of fossil fragments. Crossbedding is common in the limestone. The average thickness is about 900 feet, but the range is from 700 to 1,500 feet. On the moderately dipping east flank of the Dry Valley anticline the abnormal thickness of 1,500 feet may be caused by small-scale adjustment of the incompetent interbeds to the eastward thrusting. Mapping in adjacent quadrangles indicates that the thickness of both members of the Dinwoody formation is very different in different structural environments.

THAYNES FORMATION

Mansfield (1916) elevated the Thaynes formation of Early Triassic age to group rank in the Fort Hall region, dividing it into three formations. In most of southeastern Idaho south of the Fort Hall region, however, he referred to the Thaynes as "group" but found it impractical to differentiate the component formations (Mansfield, 1927, p. 87). Kummel (1943, p. 316) later concluded that the breakdown could not be used in the Bear Lake region. Because Mansfield's three formations cannot readily be mapped in the Dry Valley quadrangle and are evidently distinct only in the Fort Hall region, the Thaynes is here considered to be of formation rank.

The base of the formation is placed at the base of a 5- to 15-foot thick limestone bed containing abundant cephalopods of the *Meekoceras* fauna. The *Meekoceras* zone is in the upper third of a thick-bedded to massive gray limestone 50 to 100 feet thick. Although Kummel (1950, p. 31) included the entire 50 to 100 feet of limestone in the Thaynes formation, the limestone just below the *Meekoceras* zone is here included in the Dinwoody formation because of its lithologic similarity to limestone lower in the Dinwoody formation and because in places the underlying siltstone grades upward into the limestone.

Overlying the *Meekoceras* beds is 650 to 850 feet of poorly exposed black and gray shale containing two units of extremely fine-grained thin-bedded limestone, each probably not more than 100 feet thick. Platy black siltstone is exposed at the top of the dark shale in many localities.

The beds from the base of the *Meekoceras* zone to the top of the platy black siltstone are mapped as the lower black shale member.

The black shale is overlain by 500 feet of thin-bedded brownish-gray silty limestone and calcareous siltstone that are in turn overlain by about 200 feet of medium-bedded brownish-gray calcareous siltstone. The thin-bedded limestone and siltstone weathers into large flat plates. These strata are mapped as the platy siltstone member.

The platy siltstone member is overlain by the nodular siltstone member which is about 900 feet thick. The latter is composed predominantly of thin irregularly bedded brownish-gray calcareous siltstone that contains many small nodules and lenses of dense gray limestone. Some gray and black shale and limestone are present in the lower third of the member. The uppermost 50 to 100 feet consists of medium-bedded light-brownish-gray calcareous siltstone and very fine grained calcareous sandstone containing some interbeds of very fossiliferous gray limestone. The member is poorly exposed within the quadrangle.

About 600 feet of interbedded limestone, siltstone, and sandstone that immediately overlie the nodular siltstone member is exposed in the axis of the Georgetown syncline. These rocks are mapped as the gray limestone member. The limestone, which is light gray and very fossiliferous, crops out in beds from 10 to 50 feet thick; but the interbedded light-brownish-gray calcareous siltstone and sandstone is very poorly exposed. The youngest beds of this member exposed in the quadrangle are probably about 700 feet below the top of the Thaynes formation.

TERTIARY AND QUATERNARY(?) SYSTEMS

SEDIMENTARY DEPOSITS

The deposits here included in a single unit were mapped as two formations by Mansfield (1927, p. 110–114, pl. 6), the Salt Lake formation of Pliocene(?) age and older alluvium and hillwash of Quaternary age. Mansfield described the Salt Lake formation as consisting of light-gray or buff conglomerate with light-colored calcareous matrix, white marl, calcareous clay, sandstone, and grit. The Tertiary sediments, however, are considerably more complex than Mansfield indicated, and it is considered unwise to subdivide them until the Tertiary rocks of the region have been studied more thoroughly. All Tertiary and Quaternary deposits rest on formations of Mesozoic and Paleozoic age with profound unconformity.

Consolidated Tertiary strata similar in lithology to the Salt Lake formation as described in the Bear River Valley near Soda Springs (Armstrong, 1953) and in Cache Valley near Logan, Utah (Williams, 1948, p. 1147), crop out on the west side of upper Slug Creek valley (secs. 16 and 21, T. 9 S., R. 44 E.). They are composed of very light gray oolitic limestone, calcareous tuff, calcareous and tuffaceous pebble and cobble conglomerate. The pebbles and cobbles have been derived mostly from the Dinwoody formation with which the Tertiary strata are in contact, but 2 miles south of the quadrangle where the beds are in contact with the Wells formation and the Rex chert member of the Phosphoria formation, the cobbles and pebbles are derived from those units. On the basis of mollusks Yen (1947) dated similar beds in Cache Valley as late Pliocene. The Salt Lake formation in Bear River Valley southwest of Soda Springs has been assigned provisionally to the Pliocene-Pleistocene on the basis of gastropods (Teng-Chien Yen in written communication to F. C. Armstrong, 1951) and to the Pliocene(?) on the basis of diatoms (K. E. Lohman in written communication to F. C. Armstrong, 1951). Although it might be possible to map beds of the Salt Lake type in the Dry Valley quadrangle as a unit, the local derivation of the pebbles makes it extremely difficult in the absence of good exposures to distinguish the Salt Lake formation from other Tertiary deposits or even from Recent talus and hillwash.

Several apparently unconsolidated boulder deposits have evidently been formed under physiographic conditions different from those now existing. There are several scattered deposits of boulders of the Rex chert member at an altitude of 7,000 feet on north Schmid Ridge. The boulders are as much as 5 feet in diameter and so little worn that some slickenside surfaces are preserved. Scattered patches of boulders derived from the Rex and Wells occur on the west side of northern Dry Valley. These deposits and the boulders on north Schmid Ridge are out of adjustment with the present topography and probably represent remnants of old valley fill.

According to Mansfield (1927, p. 18–19), the alluvial slopes in Dry Valley are partly dissected fans that were deposited during the late Pleistocene. The presence of sandstone and chert boulders on the west side of the valley and the size of the fans compared to the size of the drainage basin probably indicate that the bulk of the deposits are not Recent. Instead of being Pleistocene in age, the fans may be in large part the remnants of the Tertiary valley fill believed to be represented by the boulder deposits on north Schmid Ridge.

Many of these older deposits are veneered in some degree by Quaternary hillwash and fan material.

QUATERNARY SYSTEM

ALLUVIUM

The deposits on the flood plains of the present stream system have been mapped as alluvium. Included are minor amounts of hillwash and alluvial fan deposits.

STRUCTURE

The area is characterized by generally open folds striking north-northwest, by a few large faults of similar trend, and by many short faults of small displacement that are commonly transverse to the major structural trend. The structure in the more complex areas is poorly defined because of the scarcity of outcrops. This is particularly true west of Slug Creek. Dips of most faults as shown on the geologic map and in the structure sections are interpretive.

The area of this quadrangle, as well as that of all the Aspen Range, was believed by Mansfield (1927) to be part of the upper plate of the Bannock overthrust, and a small window in the thrust plate was mapped on the west side of upper Slug Creek valley in E½ (unsurveyed) sec. 20 and N½ (unsurveyed) sec. 28, T. 9 S., R. 44 E. Recent mapping along the front of the Aspen Range by members of the U. S. Geological Survey has revealed no evidence of the trace of the Bannock overthrust as shown by Mansfield. The small window in upper Slug Creek valley apparently was mapped on the basis of a contact exposed immediately south of the quadrangle between the Rex chert member of the Phosphoria formation and an overlying conglomerate of probable Tertiary age that was mistaken for the Wells formation. Because the work has cast some doubt on the existence of the Bannock overthrust as mapped by Mansfield, it is not shown in the structure sections. Before the major features of Mansfield's interpretation can adequately be appraised, the critical area of low-angle thrusting in Georgetown Canyon, 8 miles south of the quadrangle, will have to be re-examined.

The most conspicuous structural feature of the quadrangle is the Schmid syncline, a relatively simple, open fold with both the north and south ends plunging gently toward the center. The beds that are turned around the south end are broken by many small transverse faults and the west side is complicated by several west-dipping longitudinal faults, both normal and reverse, with dip-slip displacements as much as 500 feet.

A fault, probably westward-dipping and normal, occurs along the east side of Dry Valley and is nearly coincident with the Dry Valley anticlinal axis. Where the fault enters the east side of the quadrangle, its stratigraphic displacement is about 1,000 feet and the dip-slip displacement is probably about the same. There are several minor folds on the west flank of the anticline. Both the fault and the minor folds die out to the north.

Most of the Dry Ridge area within the quadrangle is underlain by the moderately dipping strata forming the east limb of the Dry Valley anticline. About 2 miles east of the Dry Valley anticlinal axis these moderately dipping formations are overturned very abruptly and dip 65° westward to form the west limb of the isoclinal Georgetown syncline. About 700 feet east of the Georgetown synclinal axis, the dip abruptly flattens from about 65° west to 15° west. The unusually large thicknesses of the lower member of the Wells formation, the upper member of the Dinwoody formation, and the lower black shale member of the Thaynes formation on the moderately dipping east limb of the Dry Valley anticline may indicate the presence of faults or minor folds not detected in mapping the area. More probably, the increased thickness of the latter two units, both of which are quite incompetent, resulted from adjustment to the unusual folding.

The only readily apparent major structural feature west of Slug Creek valley is a tightly folded anticline, in part overturned to the east and in part fan shaped, that exposes the Brazer limestone along its axis (secs. 1 and 12, T. 9 S., R. 43 E.). Although the anticline is much faulted, mapping in the Johnson Creek quadrangle to the west indicates that the anticline was originally a continuous arcuate fold convex to the west. In the extreme southwest corner of the quadrangle, the faulted east flank of this anticline is bordered on the east by the Dairy syncline, in part overturned to the east, with a gently dipping east limb.

To the east of the Dairy syncline the structure has been interpreted as the result of tear faults and westward-dipping arcuate thrusts, roughly paralleling the overturned anticline and in places intersected by high-angle normal faults. Neither the dips nor the position of most of the faults in this part of the quadrangle is known with accuracy. Nevertheless, at least some of the major discontinuities seem to indicate faults with curvilinear traces similar to those represented, which, together with the associated overturned folds, makes thrusting from the west the most plausable interpretation.

The interpretation of structural conditions in NE¼ sec. 6, T. 9 S., R. 44 E. is highly speculative because it is difficult to distinguish bedding from jointing in the Rex chert member of the Phosphoria formation.

The structural features of the rocks bordering Slug Creek Valley are too complex to project under the valley alluvium. However, some of the westward-dipping beds of Tertiary age on the west side of the valley evidently have been displaced downward by relatively late rotational block faulting.

The complexity of structural features west of Slug Creek Valley as compared with those in the rest of the quadrangle may be due to their location at a point of major change of regional structural trend. From the south edge of the quadrangle north to the Snake River plains the structural trend is approximately N. 45° W. Regional strike from the quadrangle south to Georgetown Canyon, a distance of 8 miles, is about N. 15° E. From Georgetown Canyon south to Utah the regional strike is approximately north, with some deviation near Georgetown Canyon (Mansfield, 1927, pl. 1). The overturned folds and the thrusts west of Slug Creek may represent crumpling in the elbow of the changing structural trend.

Study of the quadrangle area alone yields insufficient data on which to base a detailed discussion of the age and sequence of deformation. Mansfield's regional study (1927) revealed two periods of compressive stress, one apparently minor episode in middle Cretaceous time (see also Spieker, 1946, p. 151) and a major orogeny in Late Cretaceous or early Tertiary time. Normal faulting occurred at least as late as Pliocene, as shown by the faulted beds in Slug Creek valley which show the lithologic character of the Salt Lake formation. Recent work by Armstrong (oral communication, 1952) has revealed Quaternary faulting in the Bear River valley near Soda Springs.

PHOSPHATE DEPOSITS

No mineral deposits other than phosphate rock occur in the quadrangle. The phosphate mineral, cryptocrystalline carbonate-fluorapatite, occurs in quantity in the phosphatic shale member of the Phosphoria formation. Two zones of the phosphate rock in the phosphatic shale member are suitable for mining and processing; one zone is near the base of the member, and the other is about 20 feet below the upper contact (fig. 39). The phosphatic shale member has been sampled by the U. S. Geological Survey at 7 localities within the quadrangle (lots 1208, 1210, 1211, 1212, 1260, 1277, and 1278). The basic stratigraphic and analytical data for these lots have been published by the Survey (McKelvey, Armstrong, and others, 1953; McKelvey, Davidson, and others, 1953; and O'Malley, Davidson, and others, 1953). These data are summarized in the table below.

The table indicates that, although both phosphate zones are present in all complete sections, the thickness and grade of the zones show considerable variation. Observations indicate that weathering increases grade and decreases thickness by removing carbonates and organic matter. Differences due to different degrees of weathering in different trenches are added to original sedimentary variations.

Thickness, in feet, of minable[1] phosphate rock at Dry Valley quadrangle sample localities[2]

Lot no.	Name and location	Thickness for indicated zone and grade (percent P_2O_5)					
		Upper phosphate zone			Lower phosphate zone		
		31.0	25.0	20.0	31.0	25.0	20.0
1208	West Dairy; sec. 19, T. 9, S., R. 44 E.	--------	10.6 8.1	29.5	9.0	9.2 22.5	55.0
1210	Maybe Canyon; NW¼NE¼ sec. 10, T. 8 S., R. 44 E.	--------	17.1	29.2	6.4	4.4 4.3 19.2	39.1
1211	South Dry Valley; W½SE¼ sec. 14, T. 9 S., R. 44 E.	3.6	10.2 12.4	39.8	8.1	5.8 25.1	49.8
1260	Caldwell Canyon;[3] sec. 1, T. 8 S., R. 43 E.	--------	4.9	12.2	6.0	17.7	31.6
1277	Drill hole 6; sec. 30, T. 8 S., R. 44 E.	--------	(4)	--------	7.1	22.0	28.0

[1] A minimum mining thickness of 3 feet is assumed.
[2] Lot 1212 (North Dairy) is not included because the section is complicated by faulting.
Lot 1278 (drill hole 7) is not included because of poor core recovery.
[3] Although at least parts of both phosphatic zones are present, faulting has reduced the total thickness of the phosphatic shale member from nearly 200 to 116 feet.
[4] Not sampled.

The phosphatic shale member is an incompetent unit, and in many localities trenching has revealed faults of too small a displacement to be detected by surface mapping. At Caldwell Canyon no faults were mapped, but several small ones—one cutting out nearly all the upper phosphate zone—were exposed by trenching. The variations in thickness and grade and the small-scale faulting make it imperative to investigate thoroughly by trenching and drilling in any locality seriously considered for mining.

Although some promising outcrops of the phosphatic shale in the quadrangle have been trenched extensively by private companies, no phosphate rock has yet been mined. The only mining activity at present is on Dry Ridge where the Western Fertilizer Association has driven a short exploratory adit into the north side of Maybe Canyon and is removing overburden on the ridge immediately south of the canyon preparatory to stripping.

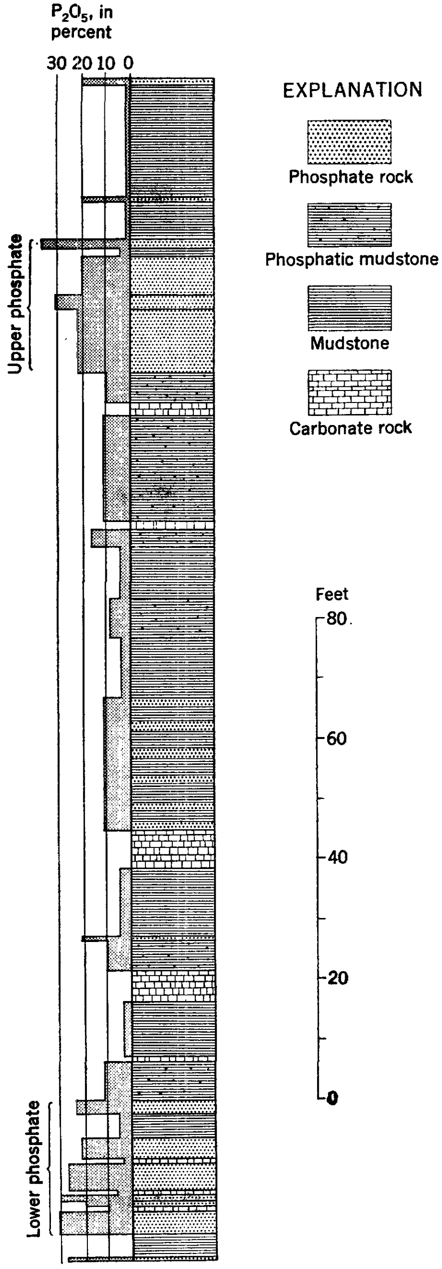

FIGURE 39.—Generalized stratigraphic section and P_2O_5 content of the phosphatic shale member of the Phosphoria formation at Maybe Canyon, Caribou County, Idaho.

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[The letters in parentheses preceding the titles are those used to designate the papers for separate publication]