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Structural Geology of the Oxford Peak Area, Bannock Range, Idaho

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STRUCTURAL GEOLOGY OF THE OXFORD PEAK AREA,

BANNOCK RANGE, IDAHO

by

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Larry C. Raymond

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ABSTRACT

Structural Geology of the Oxford Peak Area,

Bannock Range, Idaho

by

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The mapped area, in southeastern Idaho, includes part of the Bannock Range, on the west, and Cache Valley, on the east. It is centered about 13 miles northwest of Preston, Idaho, and measures 12 miles in the north-south direction and 8.5 miles in the east-west direction.

The Bannock Range, in the western part of the mapped area, consists of Precambrian and Cambrian stratigraphic units. The Precambrian units are as follows: (1) lower Precambrian argillite, (2) Precambrian quartzite, and (3) upper Mutual Formation. The Brigham Formation, which overlies the Mutual, is probably of Cambrian age; however, the lower part may be Precambrian. The Langston, Ute, Blacksmith, Bloomington, and Nounan Formations, all of Cambrian age, crop out locally. The Wasatch and Salt Lake Formations of Tertiary age overlap older rocks near the western margin of the area. The Salt Lake Formation overlaps older rocks in the foothills along the western side of Cache Valley. It is separated from Precambrian argillite, on the west, by a major north-south gravity fault.

Amphibolite plutons intrude the Precambrian argillite at three localities in the Oxford Peak area; basalt flows and volcanic breccia are also present in the Precambrian argillite. The amphibolite represents

metamorphosed diabase. Both the metamorphism of the plutons and the presence of extrusive igneous rocks in the Precambrian argillite indicate that the plutons formed during Precambrian time.

Two major thrust faults are present in the Bannock Range. The Oxford Peak thrust fault places the Brigham Formation of Cambrian age, as well as Precambrian quartzite and the Mutual Formation of Precambrian age, over Precambrian argillite. The Clifton thrust fault places carbonate formations of Cambrian age and also a lower Paleozoic undifferentiated unit on various older rocks. Near the northwestern corner of the mapped area, however, the Clifton thrust fault underlies the Brigham Formation. Both thrust faults dip westward except where locally folded; the direction of movement was presumably eastward. The thrust faulting is probably related to the Laramide orogeny which occurred during the Cretaceous Period and the early part of the Tertiary Period.

A major gravity fault extends along the eastern side of the Bannock Range. It places Salt Lake Formation of Tertiary age, on the east, against Precambrian argillite, on the west. A relatively short gravity fault, also down on the east, offsets the two major thrust faults east of Oxford Peak. The relative collapse of Cache Valley, during the Tertiary Period, produced great relief and, as a consequence, a major landslide formed northeast of Oxford Peak. It transported Precambrian argillite and overlying Brigham Formation down over Precambrian argillite.

(57 pages)

INTRODUCTION

Purpose and Scope

The purpose of this investigation of the Oxford Peak area, Bannock Range, Idaho, is to improve understanding of the structural features and events. Detailed geologic mapping (Plate 1) provided a basis for subsequent interpretations.

Location and Accessibility

The mapped area is located in southeastern Idaho in the Bannock Range (Figure 1). The southern boundary of the area is about 12 miles north of the Idaho-Utah State Line. The area is 12 miles long in the north-south direction and 8.5 miles wide in the east-west direction. It is represented on the Pocatello, Idaho, and Preston, Idaho-Wyoming, topographic maps of the Geological Survey of the United States Department of Interior. These maps are on a scale of 1:250,000.

Much of the eastern part of the mapped area is readily accessible from roads. The western side of the Bannock Range, however, requires extensive walking.

Physiographic Features

The mapped area includes part of Cache Valley on the east and part of the Bannock Range on the west. It is located along the northern part of the western edge of Cache Valley. Cache Valley trends north-south and is about 50 miles long and 10 miles wide. It is bordered on the east by

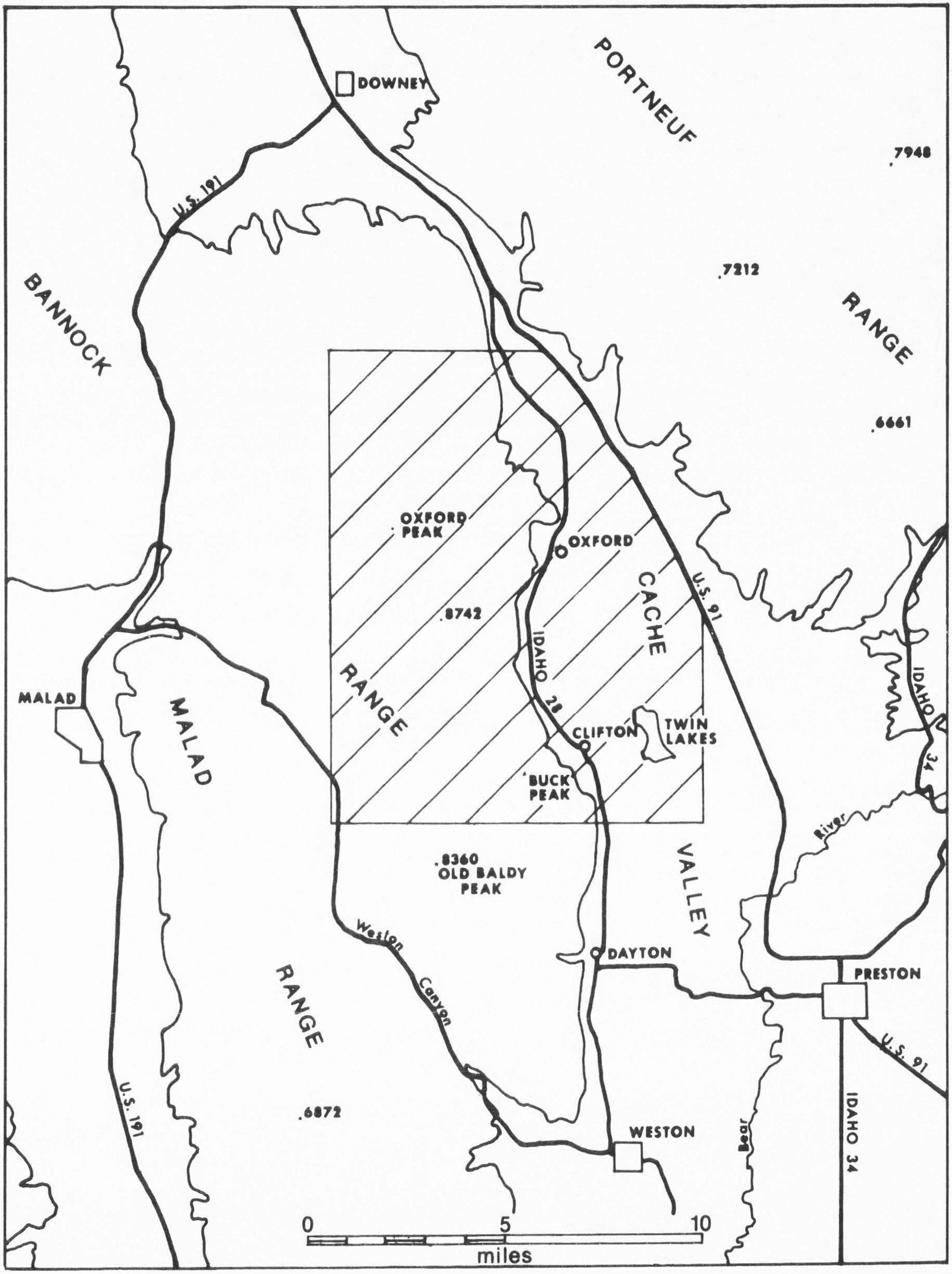

Figure 1. Index map of part of southeastern Idaho showing location of Oxford Peak area.

the Bear River Range. The lowest elevation of Cache Valley, in the mapped area, is about 4,750 feet. Oxford Peak, in the Bannock Range, has an elevation of 9,282 feet. Within the Oxford Peak area, the mountains rise as much as 4,500 feet above the valley. Twin Lakes Reservoir, retained by two dams, is within the mapped area.

Field Work

Field investigations were conducted during part of the summers of 1967, 1968, and 1969. Geologic features were mapped in the field on aerial photographs, and the information was later transferred to a base map at a scale of 1:24,000.

One stratigraphic section of Precambrian rocks was measured by means of a tape and a Brunton compass. Representative samples were collected for thin section petrographic description. Rock colors were determined by using the Rock-Color Chart distributed by The Geological Society of America.

Previous Investigations

No previous geologic mapping has been done in the Oxford Peak area as limited in this report. Prospectors have searched the Precambrian rocks for mineralization; however, no record of their work remains.

STRATIGRAPHIC UNITS

General Statement

The Bannock Range, in the western part of the Oxford Peak area, consists of Precambrian and Cambrian stratigraphic units that are complexly faulted (Table 1). The Salt Lake Formation of Tertiary age forms foothills along the eastern side of the range. It rests unconformably on older rocks and is faulted down against a unit of Precambrian argillite on the west. The Wasatch Formation of probable Eocene age overlaps older rocks on the western side of the mountain ridge in the west-central part of the mapped area. The younger Salt Lake Formation of Tertiary age overlaps older rocks of the mountain ridge in the southwestern part of the mapped area. Undifferentiated Quaternary deposits overlap the Salt Lake Formation and, in places, they also overlap older units in Cache Valley.

Numerous formations of Paleozoic age, younger than those preserved in the Oxford Peak area, and also formations of Mesozoic age were deposited in the area. They were removed by erosion before the deposition of the Wasatch Formation.

Precambrian Units

Precambrian argillite

The oldest stratigraphic unit, exposed in the Oxford Peak area, is referred to as Precambrian argillite. It consists mostly of green-gray to brown-gray argillite; however, phyllite and schist occur locally. Volcanic rocks are present in the lower part of the Precambrian argillite, and conglomeratic argillite characterizes the upper part. The Precambrian

Table 1. Stratigraphic units of Precambrian and Paleozoic age, Oxford Peak area

Unit	Lithology	Thickness (feet)
Cambrian System		
Nounan Formation	Dark-gray dolomite	886[a]
Bloomington Formation	Medium-gray limestone Green shale with limestone interbeds	431[a]
Blacksmith Formation	Medium-gray oolitic limestone	444[b]
Ute Formation	Limestone and green shale	745[c]
Langston Formation	Dark-gray limestone Black and brown shale Dark-gray limestone	133[a]
Brigham Formation	Quartzite and shale Quartzite	4,000[d]
Precambrian rocks		
Mutual Formation	Purple argillite Purple quartzite	1,000[e]
Precambrian quartzite	White quartzite	2,000[d]
Precambrian argillite	Green and brown argillite Basalt, felsite, and volcanic breccia	

[a]Two Mile Canyon, Malad Range, Idaho (Axtell, 1967).
[b]Malad Range, Utah (Hanson, 1949).
[c]High Creek, Bear River Range, Utah (Maxey, 1958).
[d]Huntsville, Utah (Crittenden, 1968).
[e]Oxford Peak area (this report).

argillite probably represents an argillite unit, 2,000 feet thick, that underlies quartzite in the area near Huntsville, Utah (Crittenden, 1968, p. 413). It also probably represents the Bannock Volcanic Formation and the Pocatello Formation, which are known from the area east of Pocatello, Idaho (Ludlum, 1942, p. 88-92).

The Bannock Volcanic Formation was first described by Weeks and Heikes (1908, p. 178-179); however, they thought that it was of Ordovician age. Ludlum (1942, p. 89) later recognized that it underlies the Pocatello Formation of Precambrian age. Trimble and Schaeffer (1965) have concluded that the Bannock is a lens which underlies the Pocatello Formation and overlies older metasedimentary rocks. The Bannock Volcanic Formation, according to Ludlum (1942, p. 88), consists of metamorphosed lavas, tuffs, and volcanic breccias. The lava is mostly dark green and purple. The tuffs and breccias are green and brown.

The Pocatello Formation, where it overlies the Bannock Volcanic Formation, consists of a lower "tillite" unit, 1,100 feet thick, and an upper "varved slate" unit, 350 feet thick (Ludlum, 1942, p. 89). The "tillite" unit includes quartzitic sandstone, carbonaceous slate, intraformational limestone conglomerate, thin-bedded limestone, and argillite, as well as the "tillite." Blackwelder (1932, p. 294-297) described similar rocks in northern Utah and concluded that they represent glacial till. Eardley and Hatch (1940, p. 833) accepted a glacial origin for such rocks. Later, Dott (1959) suggested that some tillitic rocks formed by a process of subaqueous sliding. Misch, Hazzard, and Turner (1957) indicated that the tillitic rocks of the Deep Creek Range of western Utah were formed by ice rafting. Because of uncertainty as to the origin of these rocks, they will be described as conglomeratic argillite in this paper.

The Precambrian argillite is exposed on the east-facing slope of the Bannock Range nearly from the southern edge to the northern edge of the mapped area. A major gravity fault limits this outcrop on the east and places the Salt Lake Formation of Tertiary age against the Precambrian argillite. It is bounded on the west by thrust faults above which a unit of Precambrian quartzite, quartzite of the Brigham Formation of Cambrian age, and lower Paleozoic undifferentiated rocks rest.

The argillite, in the unit of Precambrian argillite, is a fine-grained detrital rock that is more firmly indurated than mudstone. It consists mostly of clay and silt particles; however, some recrystallization of micaceous minerals is evident. The argillite is mostly green gray to brown gray. Yellow-brown beds are present in the lower part of the exposed section. Bedding fissility is marked but it is not as pronounced as in shale. Individual beds are generally less than 3 inches thick and form units 6 to 18 inches thick. The thinner beds are relatively more phyllitic.

Volcanic rocks, which occur in the lower part of the Precambrian argillite, crop out immediately south of Clifton Basin. Northward, the outcrop is limited by stratigraphically higher parts of the Precambrian argillite. A stratigraphic section, measured in the cliff immediately south of Clifton Basin, represents the upper part of the volcanic component of the Precambrian argillite:

Unit	Description	Thickness (feet)
6.	Sandstone, arkosic, pale yellowish brown, weathers moderate yellowish brown, medium-coarse grained, clasts of angular to subrounded quartzite 1/4-1/2 in. across, beds 3-6 in. thick.	30.7
5.	Volcanic breccia, covered, greenish gray, weathers moderate yellowish brown, felsite fragments, as large as 1 cm across, in quartzose matrix, abundant sericite, epidote, amphibole, and chlorite, highly sheared, like Unit 4 but higher percentage of matrix.	63.9
4.	Volcanic breccia, greenish gray, weathers brownish gray, felsite fragments in quartzose matrix, secondary amphibole and chlorite, beds 4-18 in. thick, slightly phyllitic, sheared.	24.4
3.	Felsite, moderately porphyritic, like Unit 2, sheared lenticular masses of volcanic breccia like Unit 4, felsite fragments predominate over matrix.	17.3
2.	Felsite, somewhat porphyritic, greenish gray, weathers grayish olive, modified subtrachitic texture, phenocrysts of pyroxene, secondary hornblende, chlorite, and sericite, somewhat phyllitic.	25.7
1.	Basalt, porphyritic, greenish gray, weathers light olive gray to moderate yellowish brown, subtrachitic texture, rounded masses of pyroxene, secondary hornblende and chlorite, slightly phyllitic.	50.7
	Total	212.7

The porphyritic basalt of Unit 1 has a subtrachitic groundmass that becomes finer upward. The texture was somewhat modified by the development of phyllitic foliation. Rounded masses of pyroxene, 1 to 2 mm in diameter, resemble vesicle fillings; however, the pyroxene indicates that they must be phenocrysts. Fine needles of hornblende are pervasive, chlorite replaces biotite, and sericite is also pervasive. The basalt contains blebs of plagioclase, which seem to have a composition of An 30-35, and also thin quartz veins. It is sheared into lens-shaped masses and sheets that are 3 to 3 1/2 inches thick. The unit represents a basalt which was metamorphosed and sheared.

Unit 2 is a somewhat porphyritic felsite. The composition seems to be that of andesite or dacite with An 30. An original subtrachitic texture has been modified by the development of phyllitic foliation. The scattered phenocrysts consist mainly of pyroxene and are less than 0.5 mm in diameter. Secondary hornblende, chlorite, and sericite are disseminated throughout the rock. Surfaces of foliation tend to wrap around feldspathic and quartzose masses. The felsite is moderately sheared.

Unit 3 is a felsite that is moderately porphyritic. The rock consists mostly of felsite fragments in a dark-green matrix. The felsite of the fragments is similar to that of Unit 2; however, it contains more abundant pyroxene phenocrysts. The matrix consists of a relatively coarsely crystalline sutured intergrowth of feldspar, quartz, hornblende, pyroxene, chlorite, and sericite. Shearing is essentially confined to the matrix.

Unit 4 is a volcanic breccia. The fragments are felsite that is similar to that of Unit 3. The matrix is predominant. It is possibly more quartzose than that of Unit 3. Secondary hornblende needles are common. Chlorite and sericite occur both in the matrix and in the felsite fragments. The breccia is cut by closely spaced shears. Major shears have a spacing of 4 to 18 inches.

Unit 5 is also a volcanic breccia. It contains scattered felsite fragments, as large as 1 cm across, in a coarse-grained quartzose matrix.

The matrix consists of andesine, quartz, and pyroxene. The grains are sutured in a roughly interlocking pattern. Secondary chlorite is common throughout. Sericite is abundant in places in the felsite fragments and is common throughout the matrix as relatively coarse isolated flakes. The sericite content increases upward. Biotite is altered to chlorite along cleavage surfaces. The quartz in the matrix seems to have been introduced. The matrix is interpreted to have been basalt or perhaps andesite.

The upper part of the Precambrian argillite, in the Oxford Peak area, contains green-gray to brown-gray conglomeratic argillite. The matrix consists of silt and clay particles. The clasts are quartzite. They range in size from a quarter of an inch to 6 inches across and are angular to subrounded. Individual beds are 1 inch to 2 feet thick and form units 6 to 8 feet thick.

Conglomeratic argillite is exposed at two localities in the west-central part of the mapped area. It crops out about a quarter of a mile southwest of the main mass of Precambrian amphibolite and also in a prospect pit located about a mile west of the Precambrian amphibolite. Another exposure is located about 2 miles northwest of Oxford Peak.

The occurrence and stratigraphic position of the volcanic rocks and conglomeratic argillite suggest a correlation of the Precambrian argillite with the Bannock Volcanic Formation and the lower part of the overlying Pocatello Formation of the Pocatello area. "Varved slate," present in the upper part of the Pocatello Formation, was not found in the Oxford Peak area. The Blackrock Limestone, which overlies the Pocatello Formation, in the region east of Pocatello, is not present in the Oxford Peak area.

The Precambrian argillite also crops out in a limited area northwest of Oxford, Idaho (Plate 1). It is surrounded by deposits of Tertiary and Quaternary age. Within this area, exposures are poor. Thus, it is difficult to determine the relationship between the Precambrian argillite and a quartzite that is mapped as the Brigham Formation. It was assumed that the same relationship prevails as on the ridge to the west; namely, quartzite of the Brigham Formation is thrust over the Precambrian argillite.

The hills, west and south of Twin Lakes Reservoir, also consist mostly of the Precambrian argillite (Plate 1). In the area immediately west of Twin Lakes Reservoir, younger rocks have been thrust over the Precambrian argillite. The Precambrian argillite of this area contains conglomeratic argillite (Figure 2). The hills, southeast of Twin Lakes Reservoir, consist entirely of Precambrian argillite.

Precambrian quartzite

A major unit of white quartzite, identified as Precambrian quartzite, overlies the Precambrian argillite along a thrust fault. It represents a quartzite unit of the Huntsville area, Utah, which overlies an argillite unit and underlies a unit of purple quartzite that is regarded as the Mutual Formation of Precambrian age (Crittenden, 1968, p. 413).

Northwest of Oxford Peak and also near the northwestern corner of the mapped area, the Precambrian quartzite is thrust over Precambrian argillite. At both localities, the Mutual Formation of Precambrian age overlies the Precambrian quartzite with apparent conformity. The Mutual consists largely of purple quartzite.

Figure 2. Conglomeratic argillite in upper part of Precambrian argillite near northern end of southern dam of Twin Lakes Reservoir; view northwest. White clasts are quartzite.

The Precambrian quartzite consists almost entirely of white quartzite with sand-size grains; however, occasional thin beds of argillite are present. A few beds of quartzite are light brown, light gray, and very pale green. Individual quartzite beds are generally 8 to 18 inches thick and form units 2 to 4 feet thick. Some beds contain particles of feldspar. At one locality, a bed of light-brownish-gray dolomite, 6 inches thick, crops out approximately 100 feet below the top of the Precambrian quartzite. The exposed thickness of the Precambrian quartzite is about 795 feet.

Mutual Formation

A stratigraphic unit, characterized by purple quartzite and purple argillite, overlies the Precambrian quartzite and underlies the Brigham Formation of Cambrian age. It probably represents the Mutual Formation of the Huntsville area, Utah, which is lithologically similar (Crittenden, 1968, p. 413).

The Mutual Formation seems to be conformable with the underlying unit of Precambrian quartzite. The base is taken at the bottom of the lowest purple quartzite. Interbedded purple and white quartzite, about 20 feet thick, forms the basal unit. The top of the Mutual is placed at the top of a bed of reddish-purple argillite, which is about 50 feet thick. The contact with the overlying Brigham Formation seems to be conformable. Basalt flows and boulders, which occur above the Mutual in the Huntsville area (Crittenden, 1968, p. 413), Utah, are not present in the mapped area.

The Mutual Formation underlies Oxford Peak. This outcrop, which is about 2 miles long, is terminated northward and southward by faults.

The Mutual is also present, above a major thrust fault, near the northwestern corner of the mapped area. Two small outcrops of purple quartzite, believed to represent the Mutual, are present southwest of Clifton, Idaho. They are surrounded by the Salt Lake Formation of Tertiary age; contacts with the underlying and overlying formations are not exposed.

The Mutual Formation of the Oxford Peak area consists mostly of dusky-red-purple quartzite with an occasional pale-red bed. The quartzite is medium to coarse grained. Beds are generally 1 to 3 feet thick. Cross-bedding is common. Well-rounded pebbles, a quarter of an inch to 1 inch across, are locally abundant along bedding planes. They consist almost entirely of white quartzite; however, occasionally jasper pebbles are present. The Mutual of the Oxford Peak area is approximately 1,000 feet thick.

Cambrian System

Brigham Formation

The Brigham Formation was named by Walcott (1908, p. 8-9) with reference to exposures in the Wasatch Mountains, northeast of Brigham City, Utah. The base of the formation, however, is not exposed at the type locality. Crittenden (1968, p. 413) reported a thickness of 3,300-4,000 feet in the area northeast of Huntsville, Utah.

In the Oxford Peak area, all outcrops of the Brigham Formation are limited at either the top or the bottom by thrust faults. Thus, immediately east of Oxford Peak, the Brigham overlies the Mutual Formation; however, down the slope to the east, it is thrust over the Precambrian argillite. This thrust relationship prevails both northward and southward nearly to the margins of the mapped area. West of Oxford, Idaho, the Brigham is also apparently in thrust contact with the underlying Precambrian argillite. This same relationship is also evident on the small hill immediately west of Twin Lakes Reservoir. Only at one locality, near the northern end of the mapped area, is the upper contact of the Brigham Formation preserved. Elsewhere, the top has either been broken by a thrust fault or destroyed by erosion.

The Brigham, in the mapped area, rests with apparent conformity on the Mutual Formation of Precambrian age. It is gradational upward into the Langston Formation of earliest Middle Cambrian age. The Brigham is probably of Early Cambrian age; however, the lower part may be Precambrian.

The Brigham Formation, in the Oxford Peak area, consists almost entirely of white quartzite, which weathers light brown; however, thin beds of argillite are common in the upper part of the formation. The particles, comprising the quartzite, are sand size. Beds of purple and red quartzite are present in the lower part of the Brigham; beds of brown, gray, and green quartzite, with occasional interbeds of light-brown and light-green argillite, are present in the upper part. Quartzite beds are generally 1 to 3 feet thick; argillite beds are 1 to 3 inches thick and form units 4 to 8 inches thick. The quartzite displays abundant cross-bedding. Quartzite pebbles, a sixteenth of an inch to 1 inch across, are occasionally present along the bedding planes. The Brigham is commonly broken by thrust faults and generally displays abundant slickensides and fault breccia; therefore, no attempt was made to determine the thickness in the Oxford Peak area.

Langston Formation

The Langston Formation was named by Walcott (1908, p. 8) with reference to exposures at Langston Creek in southeastern Idaho. He, nevertheless, designated Blacksmith Fork Canyon, in the Bear River Range south of Logan, Utah, as the type locality. The Langston, as now defined, consists of three members: (1) Naomi Peak Limestone, (2) Spence Shale, and (3) upper member (Maxey, 1958, p. 654-655). At Two Mile Canyon, in the Malad Range south of Malad, Idaho, the Langston is 133 feet thick (Axtell, 1967, p. 11). The Langston is of Middle Cambrian age (Maxey, 1958, p. 671).

In the Oxford Peak area, only one occurrence of the Langston Formation was noted with certainty. The outcrop is near the northwestern corner of the mapped area where it overlies the Brigham Formation and underlies the Ute Formation. A small unmapped outcrop of limestone, about a mile south of Oxford Basin, seems to be closely associated with the Brigham Formation, and may be the Naomi Peak Limestone Member of the Langston.

The three members of the Langston Formation are present in the outcrop near the northwestern corner of the mapped area. The lower Naomi Peak Limestone Member, about 35 feet thick, is finely crystalline medium-gray to medium-dark-gray limestone that weathers medium gray to medium light gray. The beds are 1 to 4 inches thick and contain abundant sponge spicules and trilobite fragments. The lower part of the Spence Shale Member consists of greenish-black to black schistose shale. Intense deformation evidently destroyed the trilobites that are generally abundant in this unit. The upper part of the Spence Shale and the upper member of the Langston do not crop out. The total thickness of the Langston is approximately 125 feet.

Ute Formation

The Ute Formation was named by King (1876). Walcott later restricted the Ute with reference to Blacksmith Fork Canyon in the Bear River Range, south of Logan, Utah (Walcott, 1908, p. 7-8). The Ute consists of thin-bedded limestone with interbeds of green shale. It is 745 feet thick at High Creek in the Bear River Range, about 30 miles southeast of Oxford Peak (Maxey, 1958, p. 653-654). The Ute is of Middle Cambrian age (Maxey, 1958, p. 672).

In the Oxford Peak area, the Ute is recognized only at one locality which is near the northwestern corner of the mapped area. There, thin-bedded limestone and green shale, characteristic of the Ute, are present above the Langston Formation and below the Blacksmith Formation. The interval is only about 100 feet thick; however, the thickness may have been reduced by thrust faulting.

Blacksmith Formation

Walcott (1908, p. 7) named the Blacksmith Formation with reference to exposures in Blacksmith Fork Canyon in the Bear River Range, south of Logan, Utah. At High Creek in the Bear River Range, about 30 miles southeast of Oxford Peak, it is 485 feet thick (Maxey, 1958, p. 672). The Blacksmith is of Middle Cambrian age (Maxey, 1958, p. 673).

The Blacksmith Formation was identified at two localities in the Oxford Peak area. It crops out south of Clifton Basin, near the southern margin of the mapped area, where it is in thrust contact with the underlying Precambrian argillite. At this locality, the Bloomington Formation conformably overlies the Blacksmith. The Blacksmith also caps a hill near the northwestern corner of the mapped area. There, it apparently lies conformably on the Ute Formation.

In the Oxford Peak area, the Blacksmith is finely crystalline dark- to medium-gray oolitic limestone. Individual beds are 1 to 6 inches thick and form units that are 1 to 2 feet thick. No estimate of the total thickness was obtained because of incomplete sections as explained above.

Bloomington Formation

The Bloomington Formation was defined by Walcott (1908, p. 7) with reference to a stratigraphic section in the Bear River Range, west of Bloomington, Idaho. At High Creek in the Bear River Range, about 30 miles southeast of Oxford Peak, Maxey (1958, p. 660) recognized three members in the Bloomington: (1) Hodges Shale, 595 feet thick, (2) thin-bedded limestone, 720 feet thick, and (3) Calls Fort Shale, 180 feet thick. The total thickness at High Creek is 1,495 feet. At Two Mile Canyon, in the Malad Range south of Malad, Idaho, the Bloomington is only 431 feet thick (Axtell, 1967, p. 16). This reduced thickness, probably also characteristic of the Oxford Peak area, may be due to thrust faulting. The Bloomington is regarded as of late Middle Cambrian age (Maxey, 1958, p. 678).

The Bloomington Formation is recognized only near the southern boundary of the mapped area. Southwest of Clifton Basin, it is in thrust contact with the underlying Brigham Formation and underlies and Nounan Formation. South of Clifton Basin, it overlies the Blacksmith Formation and underlies the Nounan Formation.

The Bloomington Formation, in the Oxford Peak area, consists of olive-green shale with thin beds of gray limestone, in the lower part, and thin-bedded coarsely crystalline medium-gray limestone, in the upper part. The shale crops out only immediately above the Clifton thrust fault where it has been tectonically metamorphosed to greenish-black schist. The exposed thickness of the Bloomington is about 300 feet.

Nounan Formation

The Nounan Formation was first described by Walcott (1908, p. 6-7) with reference to a type locality on the eastern slope of Soda Peak, south of Soda Springs, Idaho. In Two Mile Canyon in the Malad Range, south of Malad, Idaho, it is 886 feet thick (Axtell, 1967, p. 20).

In the Oxford Peak area, the Nounan Formation is present south of Clifton Basin where it overlies the Bloomington Formation. It consists of highly brecciated coarsely crystalline light-gray dolomite with occasional beds of dark-gray dolomite. The brecciation generally obscures the bedding.

Lower Paleozoic Undifferentiated Unit

In places, it is difficult to recognize and to map carbonate units directly above thrust faults. These masses are brecciated and are almost certainly broken by internal thrust faults. West of the ridge, between Oxford Peak and Buck Peak, the thrust mass of carbonate rock is unusually thin and the trace of the fault displays an intricate pattern. Thus, a unit of lower Paleozoic undifferentiated rocks was recognized for mapping purposes. Probably most of the outcrops mapped in this way consist of rocks of Cambrian age; however, rocks of Ordovician age may be present.

Tertiary System

Wasatch Formation

The Wasatch Formation was recognized in north-central Utah by Williams (1948, p. 1144). In western Wyoming, the Wasatch was mostly deposited under alluvial conditions (Oriel and Tracey, 1970, p. 28). There, it is of early Eocene age (Oriel and Tracey, 1970, p. 27).

The Wasatch Formation crops out west of Oxford Peak. It consists of pebble and cobble conglomerate with a red fine-grained matrix. It is well bedded. The Wasatch lies unconformably on Precambrian rocks as well as on Brigham Formation and the unit identified as lower Paleozoic undifferentiated. It also overlaps two major thrust faults. The Salt Lake Formation unconformably overlaps the Wasatch near the southern end of the outcrop.

Salt Lake Formation

The Salt Lake Formation has been identified in the southern part of Cache Valley, Utah, by Williams (1948, p. 1147; 1962, p. 133-135). The Salt Lake of the northern part of Cache Valley, Idaho, was described by Keller (1952, p. 13-16) and Adamson, Hardy, and Williams (1955, p. 14-18). Three members have been recognized in the Cache Valley area: (1) lower conglomerate, (2) tuffaceous member, and (3) upper conglomerate (Adamson, Hardy, and Williams, 1955, p. 1; Keller, 1963, p. 41-52). The Salt Lake Formation of the southern part of Cache Valley is of Miocene and Pliocene age (Adamson, Hardy, and Williams, 1955, p. 2).

In the Oxford Peak area, the Salt Lake Formation is faulted against Precambrian argillite along the eastern side of the Bannock Range. East of this fault, it unconformably overlies older rocks of Precambrian and Paleozoic age. In the southwestern part of the mapped area, the Salt Lake unconformably overlaps the Brigham Formation and lower Paleozoic undifferentiated rocks. West of Oxford Peak, it overlies the Wasatch Formation of probable early Eocene age. The nature of this relationship is not evident; however, it is presumed to be unconformable. Elsewhere, the Salt Lake Formation overlaps the Wasatch unconformably (Adamson, Hardy, and Williams, 1955, p. 4).

The Salt Lake Formation, in the Oxford Peak area, consists of interbedded tuffaceous sandstone, conglomerate, and arenaceous limestone. The conglomerate consists of pebbles and cobbles of quartzite, limestone, dolomite, and tuffaceous sandstone in beds 1 to 3 feet thick. The pebbles of tuffaceous sandstone were derived from older beds of the Salt Lake Formation. The Salt Lake of the Oxford Peak area represents the lower part of the formation as recognized in the Cache Valley area (Adamson, Hardy, and Williams, 1955, p. 1; Keller, 1963, p. 41-52). The upper conglomerate member is not present.

Quaternary System

Boulder deposits

Several boulder deposits are present in the lower part of Clifton Basin. The boulders consist exclusively of quartzite and are mostly light brown. Individual boulders are as large as 3 feet across. They were probably derived from the Brigham Formation which is present to the north and west beyond an outcrop of the Salt Lake Formation. The Salt

Lake Formation probably underlies the boulders. The boulder deposits are presumed to be of Quaternary age.

Another boulder area is located about 0.8 mile south of the northern boundary of the mapped area. The boulders consist entirely of purple quartzite and are as large as 3 feet across. They seem to rest on Precambrian argillite, on the western side, and on the Salt Lake Formation, on the eastern side. The upper part of the valley, in which the outcrop is located, is surrounded by quartzite of the Brigham Formation. An adequate source for purple boulders is not present within the valley; therefore, the deposit may represent a remnant of an ancient landslide. The deposit is, nevertheless, regarded as of Quaternary age.

Glacial till

A deposit of glacial till is present northwest of Oxford Peak. The upper part of the valley, west of Oxford Peak, contains a small cirque from which a glacier extended west and northwest to the area of the till deposit.

Alluvial deposits

Alluvial deposits are present in small isolated areas in the Bannock Range. In the eastern part of the mapped area, they are included in a unit which is identified as Tertiary and Quaternary undifferentiated. These deposits consist mostly of fine-grained material, deposited along streams; however, some relatively coarse-grained material of alluvial fans is included. They are of Holocene age.

Tertiary and Quaternary Undifferentiated Unit

In the eastern part of the Oxford Peak area, below the level of the highest shoreline of Lake Bonneville, Tertiary rocks and Quaternary deposits are mapped as an undifferentiated unit. This unit, Tertiary and Quaternary undifferentiated, generally overlaps the Salt Lake Formation from the southern boundary of the mapped area to the northern boundary. In places, it also overlaps rocks of Precambrian and Paleozoic age. It consists largely of the deposits of Lake Bonneville of Quaternary age; however, unmapped outcrops of the Salt Lake Formation are included. Locally, it contains alluvial deposits of Quaternary age.

STRUCTURAL FEATURES

Regional Setting

The Oxford Peak area, in southeastern Idaho, displays notable thrust faulting and gravity faulting. It is located west of the Bannock thrust zone of southeastern Idaho (Armstrong and Cressman, 1963). It is within the Basin and Range Province, which is characterized by gravity faults.

The Paris thrust fault, which is the westernmost thrust fault of the Bannock thrust zone, crops out about 30 miles east of the center of the mapped area (Armstrong and Cressman, 1963, p. 7-8). It extends along the eastern side of the Bear River Range. Northwest of Nounan, Idaho, the Brigham Formation is thrust over the Triassic Thaynes Formation. There, the stratigraphic throw is about 20,000 feet. The Paris thrust fault dips westward. The amount of displacement is uncertain but is presumably great. The western extent of the Paris thrust fault underground is also uncertain. Presumably it is more or less parallel to stratification in the Precambrian succession. Movement was eastward.

Cache Valley, which includes the eastern part of the Oxford Peak area, trends northward and is bounded by major gravity faults along which the valley block has dropped relative to the mountains. The eastern fault, or fault zone, parallels the western margin of the Bear River Range in Utah and Idaho. Near Mink Creek, Idaho, about 20 miles east of Oxford Peak, the upper part of the Salt Lake Group of Keller, on the west, is faulted against the Brigham Formation of Cambrian age, on the east (Keller, 1963, Plate 1). A major gravity fault also extends along the western side of the southern part of the Portneuf Range about 6 miles east of the mountain front of the Oxford Peak area (Keller, 1963, Plate 1). The Portneuf Range occupies an intermediate location between the high Bear River Range on the east and the Bannock Range on the west. It is separated from the Bannock Range of the Oxford Peak area by the relatively narrow northern end of Cache Valley.

Plutons

Amphibolite plutons, which intrude the Precambrian argillite, crop out at three localities within the Oxford Peak area. The largest pluton is located about midway between Oxford Peak and Buck Peak. It is represented by a central outcrop that measures 0.7 miles in the east-west direction and 0.9 miles in the north-south direction. Six related outcrops are recognized. Small plutons are present about 3 miles northeast of Oxford Peak and on the hill immediately west of Twin Lakes Reservoir.

The rock of the largest pluton is amphibolite with hornblende crystals that range in size from submicroscopic to 20 mm across and 30 mm long. The texture is porphyroblastic.

The central outcrop of the largest pluton is evidently discordant with the Precambrian argillite. Apophyses, in the form of sills, project northward and southward from the eastern part of the central outcrop. These are located just east of the north-south ridge of the Bannock Range. Numerous small dikes intrude the Precambrian argillite in the vicinity of the central outcrop. A thrust fault cuts off the central outcrop on the northwestern side. It places lower Paleozoic undifferentiated rocks over the pluton and also over Precambrian argillite in the immediate vicinity.

The amphibolite evidently represents metamorphosed diabase. The original rock consisted of plagioclase, pyroxene, amphibole, and quartz with accessory pyrite, magnetite, ilmenite, and possibly biotite. The original texture was probably ophitic. The rock now consists of at least 50 percent hornblende. Other metamorphic minerals include epidote, chlorite, leucoxene, sericite, hematite, and clay. This mineral assemblage indicates metamorphism of the diabase to the albite-epidote-amphibolite facies. Metamorphism of the diabase pluton resulted from regional metamorphism that affected the unit of Precambrian argillite; however, some autometamorphism may have occurred during cooling and solidification.

The small mass of amphibolite, exposed about 3 miles northeast of Oxford Peak, also intrudes the Precambrian argillite. It is cut off at the southern end by a thrust fault that places lower Paleozoic undifferentiated rocks over the amphibolite and the argillite unit.

The amphibolite, which crops out on the hill immediately west of Twin Lakes Reservoir, likewise intrudes the Precambrian argillite. It is cut by a thrust fault that places quartzite of the Brigham Formation over the amphibolite.

The igneous rocks that intrude the Salt Lake Formation along the eastern side of Cache Valley, about 20 miles east of the Oxford Peak area, are significantly different from the amphibolite plutons. They are virtually unmetamorphosed and, in this respect, contrast notably with the amphibolite plutons. Apatite is present in the intrusive rocks of the eastern side of Cache Valley; it evidently is not present in the amphibolite of the Oxford Peak area.

Thrust Faults

Thrust faults are well exposed in the western part of the Oxford Peak area. The oldest stratigraphic unit, Precambrian argillite, is truncated by thrust faults except where it is overlapped by either the Salt Lake Formation of Tertiary age or by younger deposits. Two major thrust faults are recognized. The Oxford Peak thrust fault places the unit of Precambrian argillite, the Mutual Formation, and the Brigham Formation on the Precambrian argillite. The Clifton thrust fault places Cambrian formations and lower Paleozoic undifferentiated rocks on the Precambrian argillite and on the Brigham Formation.

A segment of the Clifton thrust fault extends from near the southern margin of the mapped area northward to Clifton Basin (Figure 3). The Blacksmith Formation of Cambrian age is thrust over the Precambrian argillite. This segment terminates southward at a gravity fault; northward it is covered by alluvial deposits. The Clifton thrust fault dips westward. A fault, presumably part of the Clifton thrust fault, crops out 2 miles south of Clifton, Idaho. It places lower Paleozoic undifferentiated rocks on the Brigham Formation and dips 40° SE. to 45° SE.

The Oxford Peak thrust fault crops out in the Buck Peak area (Figures 3 and 4). It places quartzite of the Brigham Formation over Precambrian argillite. This segment is covered at both the southern and northern ends by Salt Lake Formation. In this area, the thrust fault dips westward. On the hill immediately west of Twin Lakes Reservoir, the Oxford Peak thrust fault also places the Brigham Formation over Precambrian argillite. There, it dips westward at a low angle.

Figure 3. Clifton and Oxford Peak thrust faults west of Clifton, Idaho; aerial view southwest. Clifton thrust fault, at left, places Blacksmith Formation (Ꞓbl) over Precambrian argillite (pꞒa). Segments of Oxford Peak thrust fault, in center and at right, connect behind ridge. Oxford Peak thrust fault places Brigham Formation (Ꞓb) on Precambrian argillite (pꞒa).

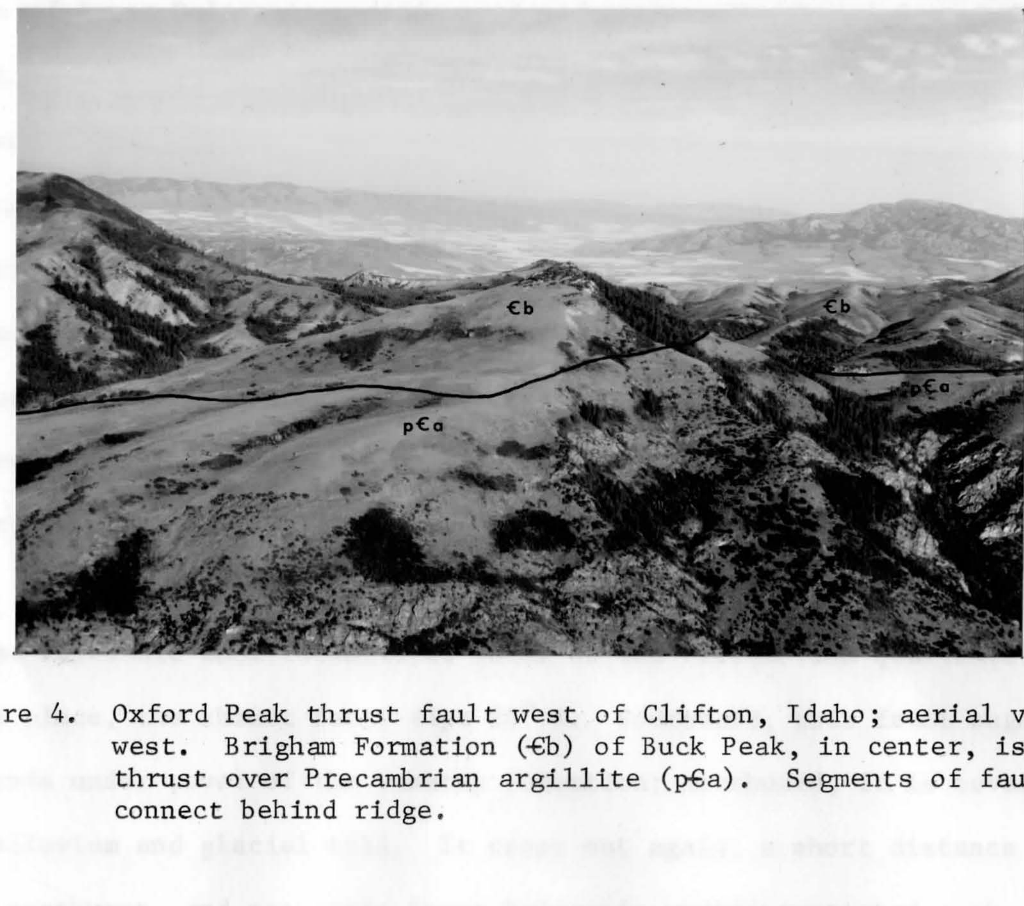

Figure 4. Oxford Peak thrust fault west of Clifton, Idaho; aerial view west. Brigham Formation (Єb) of Buck Peak, in center, is thrust over Precambrian argillite (pЄa). Segments of fault connect behind ridge.

East of Oxford Peak, the Oxford Peak thrust fault places quartzite of the Brigham Formation on the Precambrian argillite. Southward, this fault is covered by a displaced mass of lower Paleozoic undifferentiated rocks that rests on the higher Clifton thrust fault. A short distance to the south, within a mile, four relatively small isolated masses of quartzite of the Brigham Formation rest on the Oxford Peak thrust fault and are truncated by the Clifton thrust fault. Thus, they extend under a mass of lower Paleozoic undifferentiated rocks. Northward from Oxford Peak, the Oxford Peak thrust fault successively underlies the Mutual Formation and the Precambrian quartzite. It disappears westward under glacial till but again crops out, under an isolated mass of Precambrian quartzite, near the western edge of the mapped area. It then extends under cover of the Wasatch Formation of Tertiary age. The Oxford Peak thrust fault is evidently present in the foothills west of Oxford, Idaho, where field relations indicate that the Brigham Formation has been thrust over the Precambrian argillite.

West of Oxford Peak, a segment of the Clifton thrust fault places lower Paleozoic undifferentiated rocks on the Precambrian quartzite. At this place, the thrust fault dips 25° W. Southward, this fault segment extends under cover of the Wasatch Formation; northward, it is covered by alluvium and glacial till. It crops out again, a short distance to the northwest, and separates lower Paleozoic undifferentiated rocks from both Precambrian argillite and an isolated block of Precambrian quartzite. Northwestward, the Clifton thrust fault is covered by the Wasatch Formation.

South of Oxford Peak, the trace of the Clifton thrust fault is intricate due to erosion. Again lower Paleozoic undifferentiated rocks rest on Precambrian argillite and Brigham Formation. The westward termination is at a gravity fault; southward, this segment of the Clifton thrust fault is covered by the Salt Lake Formation.

In the west-central part of the mapped area, both the Oxford Peak and Clifton thrust faults dip distinctly westward on the western side of the mountain and eastward on the eastern side. The minor eastward dip, on the eastern side, could have resulted from downward flexing in association with the collapse of Cache Valley along a major north-south gravity fault.

In the northwestern corner of the mapped area, the Oxford Peak thrust fault places, successively northward, the Precambrian quartzite, the Mutual Formation, and the Brigham Formation on the Precambrian argillite. Two main segments of the Oxford Peak thrust fault are recognized in this area. The southwestern segment extends northeastward from the western edge of the map to where it is truncated by the Clifton thrust fault. The northeastern segment extends from a mass of lower Paleozoic undifferentiated rocks, above the Clifton thrust fault, northward to a termination at a small east-west gravity fault. Two isolated masses of quartzite, thought to be the Brigham Formation, crop out at the eastern edge of the block of lower Paleozoic undifferentiated (Figure 5). These, of course, are believed to rest on short segments of the Oxford Peak thrust fault. The Oxford Peak thrust fault, in this area, dips westward.

The block above the Clifton thrust fault, in this area, is divided into two parts by a north-south gravity fault. The western part consists of Brigham Formation, immediately above the thrust fault, with overlying Langston, Ute, and Blacksmith Formations of Cambrian age. The eastern

Figure 5. Truncation of Oxford Peak thrust fault by Clifton thrust fault about 3 miles north of Oxford Peak; aerial view northwest. Oxford Peak thrust fault underlies Brigham? Formation (Єb?); Clifton thrust fault underlies lower Paleozoic undifferentiated (lPu) and is exposed on both sides of the outcrop.

part is represented only as lower Paleozoic undifferentiated rocks. The Clifton thrust fault of this area dips westward.

Strike-slip Faults

A zone of four vertical faults, which strikes about N. 75° E., is present 2,200 feet south of Oxford Peak. The fault zone is about 3,000 feet wide. It probably terminates eastward at the Oxford Peak thrust fault. Westward, it is covered by the Wasatch and Salt Lake Formations of Tertiary age. Strike-slip movement is implied by the apparent drag immediately south of the fault zone.

The southern fault is entirely within quartzite of the Brigham Formation. Folding, adjacent to this fault on the southern side, suggests that the southern block moved eastward. The northern fault offsets the Clifton thrust fault, as well as formation contacts, eastward on the northern side. Differential strike-slip movement along the fault zone may have taken place at different times.

Gravity Faults

A major gravity fault trends northward along the eastern front of the Bannock Range from the southern margin of the mapped area to the northern margin (Figure 6). The exact location of the fault is uncertain; however, it generally separates outcrops of Precambrian argillite, on the west, from Salt Lake Formation, on the east. The strike is N. 2° W. from the southern boundary of the mapped area northward for 5.0 miles, N. 19° W. from 5.0-7.9 miles, N. 10° E. from 7.9-9.6 miles, and approximately N. 3° W. for 2.6 miles to the northern boundary of the mapped area.

Figure 6. Gravity fault along eastern side of Oxford Peak area, Bannock Range; view west. Cache Valley block, in foreground, is down relative to Bannock Range along north-south gravity fault. Salt Lake Formation overlies older rocks in foothills east of fault; Precambrian argillite forms lower part of mountain front west of fault.

The area of Cache Valley collapsed along this fault relative to the Bannock Range on the west. At the southern margin of the mapped area, lower Paleozoic undifferentiated rocks that underlie the Salt Lake Formation, east of the fault, oppose a fault block of lower Paleozoic undifferentiated on the west. Generally, Precambrian argillite on the west opposes Salt Lake Formation on the east. At the northern boundary of the mapped area, Salt Lake Formation, on the east, opposes a fault block of quartzite of the Brigham Formation, on the west. Rock units and thrust faults, present in the Bannock Range at high elevation, are also recognized in Cache Valley, at relatively low elevations, in isolated outcrops. Thus, the Oxford Peak thrust fault is identified in the hill west of Twin Lakes Reservoir and also in the area west of Oxford, Idaho. This fault is covered by alluvial deposits northwest of Clifton, Idaho, and by a small boulder deposit of Quaternary age near the northern border of the mapped area. The large landslide, northeast of Oxford Peak, also covers the fault. A gravity fault, indicated by a gravity survey (Peterson and Oriel, 1970, p. 118), extends along the eastern side of the hill that is located immediately west of Twin Lakes Reservoir.

A gravity fault also parallels the high ridge of the Bannock Range in the west-central part of the mapped area. It generally separates lower Paleozoic undifferentiated rocks, on the east, from Salt Lake Formation, on the west. The fault strikes N. 25° W. and, therefore, nearly parallels a segment of the eastern boundary fault. At the southern end, it is covered by the Salt Lake Formation. Northward, it extends beyond the western edge of the mapped area. Near the boundary of the mapped area, it truncates the Clifton thrust fault where the Brigham

Formation, under the thrust fault, opposes the Salt Lake Formation on the west. A small landslide covers part of this fault.

Four gravity faults, in the higher part of the Bannock Range, trend northward and offset thrust faults. They all have the same relative movement, down on the east, as the major gravity fault that parallels the eastern side of the mountain. Two of these faults extend northward from the southern margin of the mapped area. The eastern one opposes Salt Lake Formation, on the east, and Brigham Formation, on the west, near the northern end. The western one is probably covered by Salt Lake Formation at the northern end. The north-south fault, which extends through Oxford Basin, displaces two thrust faults relatively downward on the eastern side (Figure 7). A gravity fault, at the northern margin of the mapped area, has offset the trace of the Oxford Peak thrust fault. There, Brigham Formation, on the east, has dropped relative to Precambrian argillite, on the west.

A number of gravity faults of east-west trend are also present in the Oxford Peak area. They have relatively small displacement. The east-west fault, west of Clifton Basin, seems to be overlapped by the Salt Lake Formation. An inferred fault, 2 miles south of Clifton, Idaho, evidently cuts the Salt Lake Formation. At this locality, the contact between lower Paleozoic undifferentiated rocks and the Salt Lake Formation dips 60° N. to 70° N.

The north-trending fault, near the northwestern corner of the mapped area, is evidently confined to the rocks above the Clifton thrust fault. It is, therefore, believed to have formed either before or during the thrust faulting.

Figure 7. Offset of thrust faults by gravity fault east of Oxford Peak; view west. Oxford Peak thrust fault places Brigham Formation (€b) on Precambrian argillite (p€a). Clifton thrust fault places lower Paleozoic undifferentiated (lPu) on Brigham Formation (€b). North-south gravity fault, down on east, offsets trace of Oxford Peak thrust fault.

Folds

The Precambrian argillite dips westward, at a low angle, from the southern margin of the mapped area northward to the plutons of Precambrian amphibolite. Pronounced eastward and westward dips, in the vicinity of the larger pluton, indicate moderate local deformation due to intrusion. North of Oxford Peak, scattered attitude determinations suggest that the Precambrian argillite is folded with axes striking about N. 15° W. A syncline, anticline, and syncline may be present from west to east.

A broad anticline, which strikes east-west and plunges westward, is present in the quartzite units of Oxford Peak. This anticline involves the unit of Precambrian quartzite, the Mutual Formation, and the Brigham Formation. It is above the Oxford Peak thrust fault.

A broad north-trending arch extends along the higher parts of the Bannock Range in the Oxford Peak area. In the southwestern part of the mapped area, the Salt Lake Formation, which overlaps older rocks, dips generally westward. East of the mountain ridge, between Buck Peak and Oxford Peak, the Oxford Peak and Clifton thrust faults, which dip generally westward, have been turned down to the east. This folding is believed to be related to the collapse of the valley on the west, between the Bannock Range and the Malad Range, and Cache Valley on the east.

The Salt Lake Formation is intensely folded, on a small scale, in a gully located a quarter of a mile south of Twin Lakes Reservoir (Figure 8). The folds are overturned to the west. They probably formed before consolidation as a result of sliding into a relatively low area that formed during the collapse of Cache Valley.

Figure 8. Folds in Salt Lake Formation a quarter of a mile south of Twin Lakes Reservoir; view south. Exposure is along vertical side of gully.

Landslides

A major landslide is present about 2 miles northeast of Oxford Peak on the eastern slope of the Bannock Range. The slide mass consists of Precambrian argillite, at the lower eastern end, and overlying Brigham Formation, at the upper western end. These rock units are separated by a displaced segment of the Oxford Peak thrust fault. The mass measures about 5,600 feet in the east-west direction and 2,300 feet in the north-south direction. It overlaps the major gravity fault that parallels the mountain front. The slide rests mostly on Precambrian argillite, west of the gravity fault; however, the toe is on the Salt Lake Formation east of the fault. This landslide moved about 6,000 feet downslope as evidenced by the displacement of the segment of the Oxford Peak thrust fault in the slide. The relatively uneroded hummocky topography of the slide indicates a late Pleistocene or Holocene age.

Two smaller landslides are present on the eastern side of the Bannock Range. One, located about 0.8 mile northeast of Oxford Peak, places quartzite of the Brigham Formation on Precambrian argillite below the Oxford Peak thrust fault (Figure 9). The Brigham, on the ridge above, dips about 26° E. South of Clifton Basin, near the southern margin of the mapped area, a mass of Nounan Formation slid down to the northeast over the underlying Bloomington Formation.

On the western side of the Bannock Range, between Buck Peak and Oxford Peak, a mass of Paleozoic undifferentiated slid down to the southwest over the gravity fault that parallels the mountain front. The lower part of the slide rests on the Salt Lake Formation west of the fault.

Figure 9. Landslide of Brigham Formation 0.8 mile northeast of Oxford Peak; aerial view west. Oxford Peak thrust fault places Brigham Formation (-€b) over Precambrian argillite (p€a).

Another small landslide is located about 1.3 miles southwest of Clifton, Idaho. A mass of quartzite of the Brigham Formation moved down into a valley. The stream was diverted westward at the toe of the slide.

MINERALIZATION

Several quartz veins, an eighth of an inch to 3 feet wide, cut Precambrian rocks in the Oxford Peak area. They strike about N. 20° W. Some mining for gold was attempted in these veins about 40 years ago. The veins, examined by the writer, were barren of sulphide minerals.

Quartz and chalcopyrite veins are present in a dike of Precambrian amphibolite on the western side of the ridge between Buck Peak and Oxford Peak. This outcrop was explored, at an unknown date, to a depth of 12 feet by means of a shaft. Another outcrop of the dike, located about 300 feet north, is stained green by copper minerals.

STRUCTURAL EVENTS

Precambrian Event

Basalt flows and associated volcanic breccia, in the Precambrian argillite of the Oxford Peak area, are evidence of igneous activity during Precambrian time. This volcanic activity was probably associated with near-by plutonic activity.

The plutons of amphibolite, in the Oxford Peak area, intrude a rock unit identified as Precambrian argillite. The amphibolite was formed from diabase as a result of regional metamorphism. This metamorphism evidently occurred before the deposition of the Precambrian quartzite, which overlies the Precambrian argillite, as argillite beds within the Precambrian quartzite are relatively unmetamorphosed. Ludlum (1942, p. 93) reached the same conclusion for an area near Pocatello, Idaho. Thus, it is concluded that the plutons of the Oxford Peak area formed during Precambrian time.

Laramide Event

The two major thrust faults of the Oxford Peak area are closely related. The Oxford Peak thrust fault places quartzite of the Brigham Formation on Precambrian argillite. This fault dips generally westward, except where locally deformed, and the direction of movement is presumed to have been eastward based on evidence from the region of southeastern Idaho (Armstrong and Cressman, 1963, p. 19). The Clifton thrust fault places carbonate rock of Cambrian age, as well as lower Paleozoic undifferentiated carbonate rocks, over the Brigham Formation and also over

Precambrian argillite. It seems evident that the two thrust faults formed at the same time or at nearly the same time; however, the Clifton thrust fault truncates the Oxford Peak thrust fault.

Strike-slip faults of east-west trend, in the Bannock Range south of Oxford Peak, offset the Clifton thrust fault; they probably do not displace the lower Oxford Peak thrust fault. It seems most reasonable to conclude that they formed in association with movement on the Clifton thrust fault.

The Oxford Peak area does not provide complete evidence for dating of the thrust faulting. The Wasatch Formation of probable early Eocene age overlaps both thrust faults in the area west of Oxford Peak. Thrust faulting began, in the Bannock thrust zone of southeastern Idaho, as early as latest Jurassic or earliest Cretaceous and may have continued into Paleocene (Armstrong and Cressman, 1963, p. 14). The thrust faults represent the Sevier orogeny of Armstrong (1968).

Basin and Range Events

Early gravity faulting

Valleys, in which initial deposition of Salt Lake Formation took place, are thought to have existed before Miocene time (Adamson, Hardy, and Williams, 1955, p. 21). They undoubtedly formed as a consequence of collapse, relative to the mountains, along marginal gravity faults. Such depositional basins are represented, in the Oxford Peak area, by Cache Valley and by the valley west of the Bannock Range. Gravity faulting is thought to have started in western Wyoming as early as Eocene time (Armstrong and Oriel, 1965, p. 1862). The intense folding of the Salt

Lake Formation, in the area south of Twin Lakes Reservoir, probably formed before consolidation and resulted from slumping into a down-faulted area.

In the Oxford Peak area, movement on some gravity faults predated deposition of at least part of the Salt Lake Formation. Thus, the marginal fault, southwest of Oxford Peak, is overlapped at the southern end by Salt Lake Formation. The northern end of the north-south gravity fault, west of Buck Peak, also seems to extend beneath the Salt Lake. It is appropriate, therefore, to recognize early and late gravity faulting as more or less distinct events.

Late gravity faulting

In the Oxford Peak area, major gravity faults cut the Salt Lake Formation. Thus, the gravity fault, which extends along the eastern side of Bannock Range, opposes Salt Lake Formation, on the east, against Precambrian argillite, on the west. The great difference in elevation between Cache Valley and the Bannock Range resulted from relative collapse of the valley block. This fault probably formed at the time of the inception of gravity faulting.

The great relief, which resulted from gravity faulting, produced slope instability along the mountain fronts. Numerous landslides formed of which the most notable example is northeast of Oxford Peak.

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PLATE 1

EXPLANATION

Quaternary	Qal	Alluvial deposits
	Qgt	Glacial till
	Qb	Boulder deposits
Tertiary-Quaternary	TQu	Tertiary-Quaternary undifferentiated
Tertiary	Tsl	Salt Lake Formation
	Tw	Wasatch Formation
Paleozoic	lPu	Lower Paleozoic undifferentiated
	€n	Nounan Formation
	€bo	Bloomington Formation
	€bl	Blacksmith Formation
	€u	Ute Formation
	€l	Langston Formation
	€b	Brigham Formation
Precambrian	p€m	Mutual Formation
	p€q	Precambrian quartzite
	p€a	Precambrian argillite
	p€am	Precambrian amphibolite

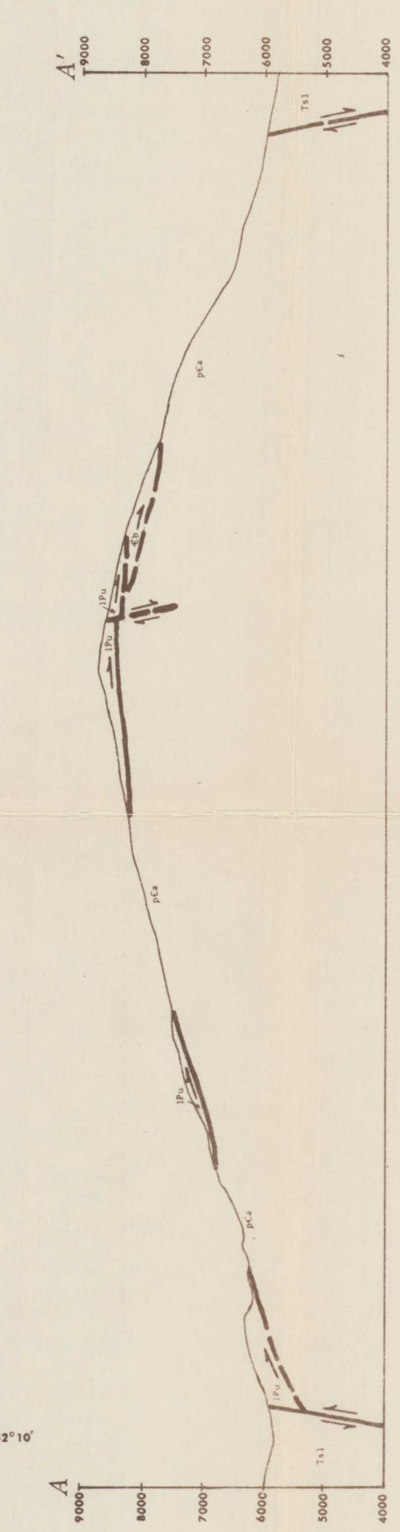
contact
approximately located
inferred

thrust fault
approximately located
inferred
covered

gravity fault
approximately located
inferred
covered

strike-slip fault
inferred

landslide surface



Base taken from U.S. Geological Survey
1:24,000 and 1:250,000 maps

by LARRY C. RAYMOND-1971

GEOLOGIC MAP OF THE OXFORD PEAK AREA, BANNOCK RANGE, IDAHO

1 1/2 0 1 MILE

0 1000 2000 3000 4000 5000 6000 FEET