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**GEOLOGY OF THE MINK CREEK
REGION, IDAHO**

ALLEN S. KELLER

UTAH STATE UNIVERSITY

1952

GEOLOGY OF THE MINK CREEK REGION, IDAHO

by

Allen S. Keller

A thesis submitted to the faculty of the
University of Utah in partial fulfillment
of the requirements for the degree of

MASTER of SCIENCE

Department of Geology

University of Utah

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Approved:

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INTRODUCTION

Location and access

The Mink Creek region is centered 14 miles northeast of Preston in Franklin County, Idaho (see Index Map, Figure 1). The area of this report comprises approximately 70 square miles. It is bounded on the north and south by parallels $42^{\circ}17'$ and $42^{\circ}11'$ North Latitude and on the east and west by meridians $111^{\circ}37'$ and $111^{\circ}49'$. The easternmost part of the area is located in the Bear River Range and is part of Cache National Forest.

The region is readily accessible. A paved Idaho State Highway goes through the center of the area and State Highway 34 skirts the northwest corner. Numerous dirt roads, jeep roads, and cattle trails traverse the area.

Relief and drainage

Topographically the region may be divided into two major divisions. The western two-thirds is composed of rounded hills and valleys with the exception of the Oneida Narrows, the steep gorge cut by the Bear River. The eastern third is part of the Bear River Range and has a higher more rugged topography, characterized by high ridges and steep narrow canyons. Elevations range from 4500 feet on the Bear River to 8750 feet on the ridge east of the head of Birch Creek.

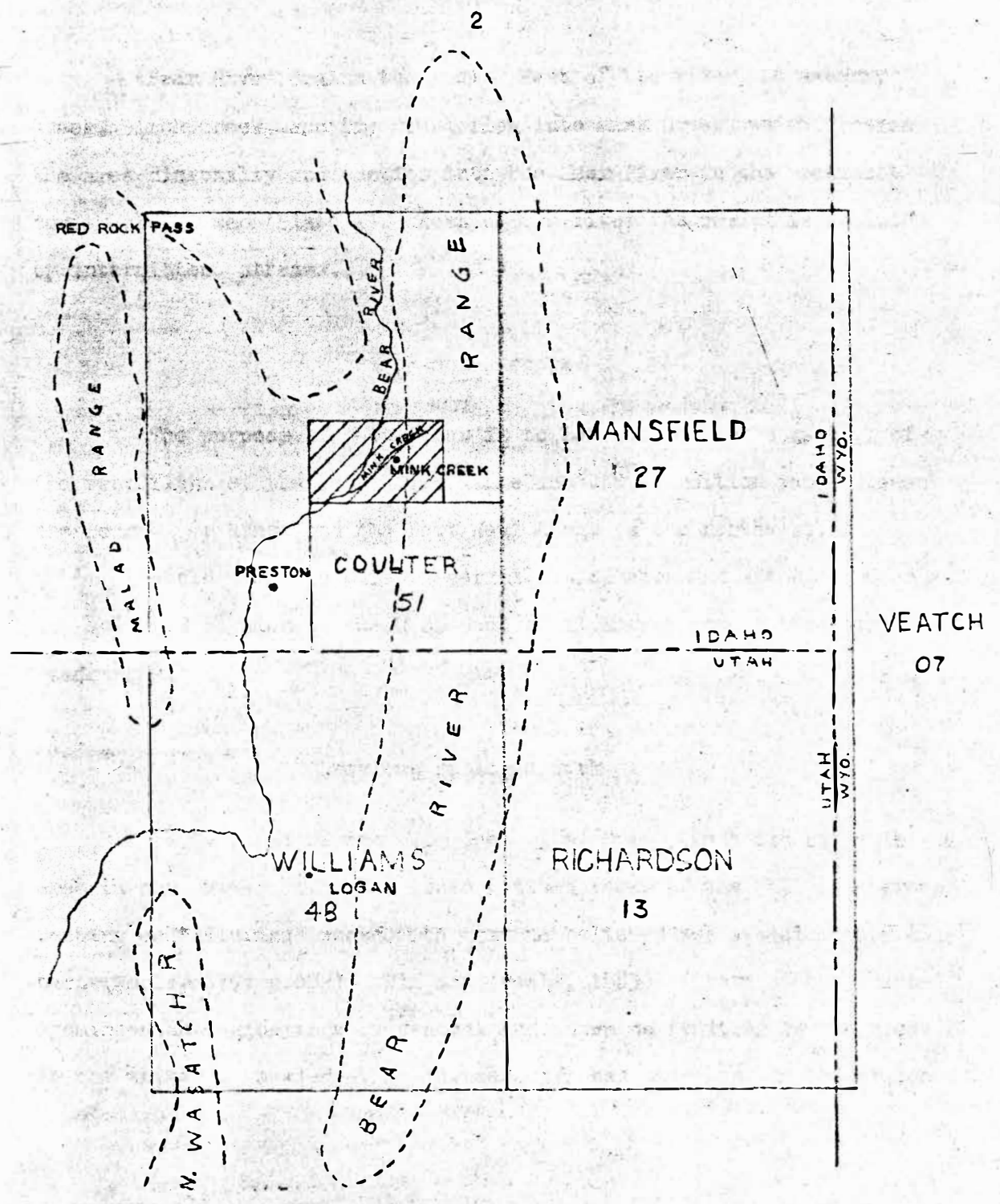


Figure 1. - INDEX MAP

Bear River drains the area. East of the river, Strawberry Creek, Birch Creek, and Dry Creek flow into Mink Creek, which crosses the area diagonally and empties into the Bear River in the southwest corner of the map (Plate I). West of the river the region is drained by intermittent streams.

Purpose and scope

The purpose of this paper is to contribute to the geology of the west flank of the Bear River Range and the transition zone between the Bear River Range and the Port Neuf Range to the northwest.

Field work was done on aerial photographs and transferred to an enlarged portion of the U.S. Geological Survey map of the Preston quadrangle.

Previous geologic work

A.C. Peale of the U.S. Geological Survey made two stops in the area in the summer of 1877. Peale noticed rocks of the Salt Lake group resting on "Silurian" rocks with what he believed was a sedimentary contact (Peale, 1879, p.602). His map (Peale, 1883) of part of the Idaho-Wyoming-Utah region is very general and shows no faulting in the area. To the writer's knowledge, no further work has been done in the region.

SEDIMENTARY ROCKS

Cambrian system

General statement: A northward trending geosyncline existed in northeastern Utah and southeastern Idaho in Paleozoic time. A thick Cambrian section of quartzites, limestones, dolomites and shales was deposited in the geosyncline in its early stages. In 1908 C.D. Walcott studied the Cambrian section in Blacksmith Fork Canyon (Logan Quadrangle, Utah) and named the formations exposed there. Other geologists later accepted Walcott's formations, but their sections, measured in nearby areas, revealed differences in lithology, thickness, and resistance to weathering from one area to another.

The Cambrian section in the Mink Creek area is about 11,000 feet thick. Formations exposed are the Brigham, Langston, Ute and Blacksmith, Bloomington, Nounan, and St. Charles. Some changes in lithology and thickness with respect to neighboring areas are explained in the following pages.

Brigham quartzite: The Brigham quartzite was named by C.D. Walcott in 1908 from its exposure northeast of Brigham, Utah. It is the oldest formation exposed in the Mink Creek region, and is composed of grey, pink, red, purple and greenish-brown quartzite with some layers of quartzite conglomerate.

Near the top of the formation are several olive and brown micaceous shales, and about 50 feet of thin-bedded purple argillite

occurs near the base of the thick sections on both sides of Strawberry Creek and Mink Creek.

In South Canyon the Brigham occurs in three faulted segments. One of these, the area around Hill 7836 (see Plate I), is the end of a long frontal ridge that extends southward into the Logan Quadrangle. A belt of Brigham begins near the head of Birch Creek Canyon, where it is folded and cut off by the Birch Creek fault, and continues northwestward on the upthrown side of the fault to the vicinity of Hill 6468 west of the Bear River. Three smaller exposures crop out along the fault, one on each side of Mink Creek, and one south of Hill 5950. In the vicinity of Rocky Peak a large area of Brigham is exposed.

Maximum thickness of the formation is 6000~~7~~ feet and its base is not exposed. Quartz veins and iron stained fracture zones are common in the outcrops and some thickness may be due to faulting, but no linear zone of fracture was found within the formation.

As yet no diagnostic fossils have been found in the Brigham. Its apparently conformable relationship to the Langston formation of early Middle Cambrian age led Williams and Maxey (1941) to assign a Lower Cambrian age to the Brigham.

Langston formation: The Langston formation was named by Walcott in 1908 from its occurrence at Langston Creek, Logan Quadrangle, Utah. As used by Walcott it denoted the limestone above the Brigham quartzite and below the Spence shale. This usage was followed by Richardson(1913) and Mansfield (1927) but was modified by Williams and Maxey (1941) who, using fossil criteria, placed the Spence shale and an overlying series of limestone and tan-weathering dolomite in the

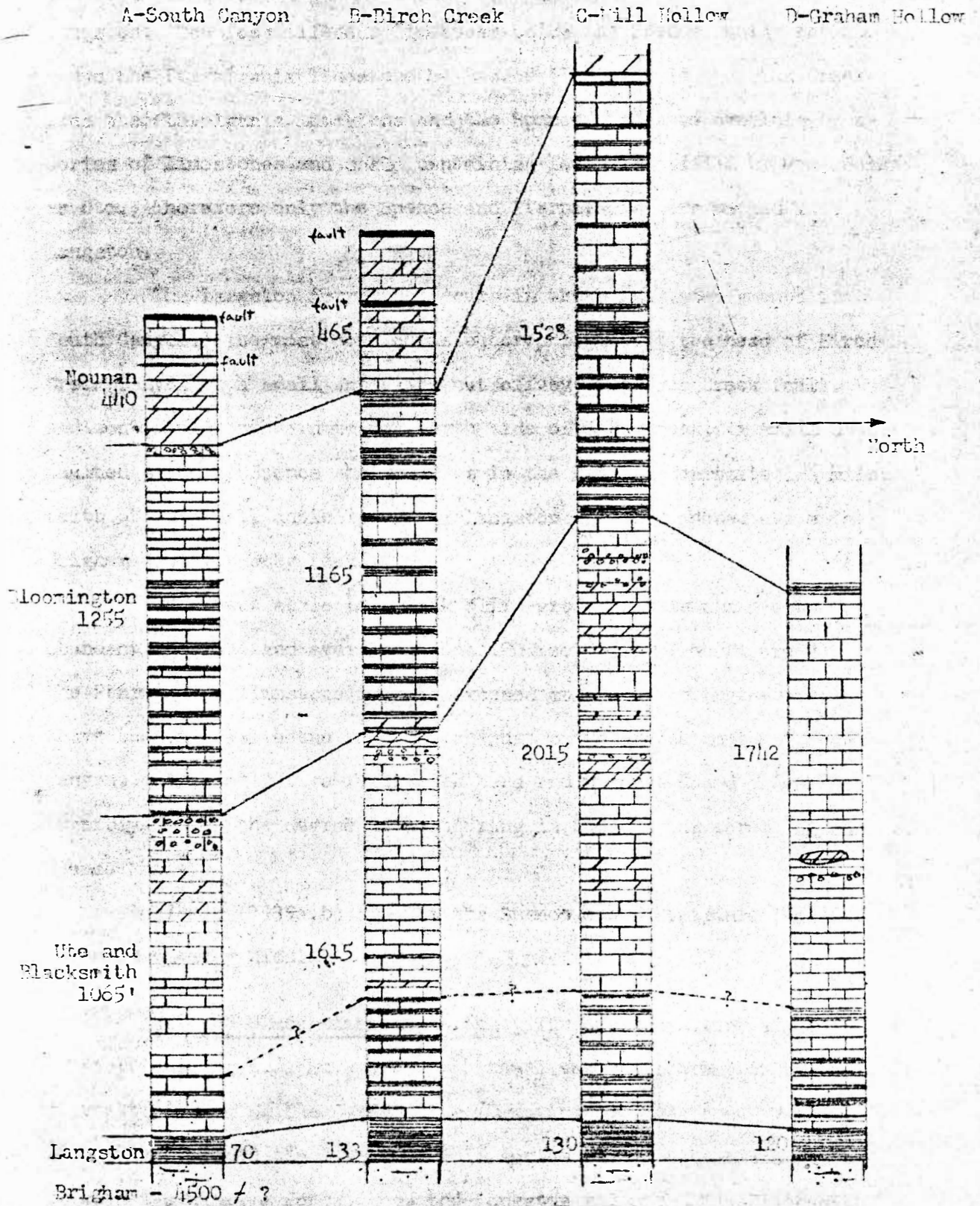


Figure 2 - Cambrian Sections

Langston. The fossiliferous limestone below the Spence shale was named the Ptarmigania limestone by Resser (1939b). In the Mink Creek area the Ptarmigania limestone and the Spence shale are overlain by a series of limestones and shale containing fauna identified by Mrs. Balk as Ute. Therefore only the Spence and Ptarmigania were mapped as Langston.

The Langston formation occurs in three faulted segments in South Canyon. The most continuous outcrop begins at the head of Birch Creek Canyon in a small anticline cut off by the Birch Creek fault, and continues northward to the north side of Mink Creek. A small down-faulted slice of Spence shale occurs in the Brigham quartzite 1/4 mile north of the small anticline. The Langston is also exposed above the Brigham east of Rocky Peak.

The Spence shale is a dark olive-green fissile shale with abundant fossils, and averages about 100 feet thick (see Figure 2). The Ptarmigania limestone is only exposed at one place in the area, above the Brigham in the fault block just north of the mouth of South Canyon. It is only five feet thick here and was not found elsewhere, possibly due to the degree of weathering in the saddles formed by the Spence shale.

Resser (1939a,b) studied the Spence and Ptarmigania fauna and found them early Middle Cambrian.

Ute and Blacksmith formations: The Ute formation was used by the Fortieth Parallel Survey for all the limestone above the Brigham quartzite including the Garden City (Ordovician) limestone. Walcott in 1908 restricted the formation to a series of limestones and shales between two massive formations, the Langston below and the Blacksmith

above. Walcott's Ute contained the Spence shale member at its base, but Williams and Maxey (1941) put the Spence shale and some overlying limestones and dolomites in the Langston formation, leaving the Ute as the limestones and shales above the highest dolomite of their Langston.

The Blacksmith formation was named by Walcott in 1908 for its occurrence in Blacksmith Fork Canyon, Logan Quadrangle, Utah. As described by Walcott it was a distinct lithologic and topographic (cliff forming) unit lying between the soft beds of the Ute below and the shale of the Bloomington above. Deiss (1938) later pointed out that dolomite is abundant in the Blacksmith Fork section.

In the Mink Creek region the topographic expression is similar to that described by Walcott for the Ute and Blacksmith formations. Above the Spence shale and occupying the same depression in the ridges is a series of shale and limestone and above them are cliff forming limestones and dolomite beds. See Figure 2. However, the dolomites thin rapidly northward (Figure 2) and fossils collected from well up into the cliff forming limestones in the Mink Creek area were identified by Mrs. Balk as Ute. Because of the difficulty in drawing a contact between the two formations they were mapped together as the Ute and Blacksmith formations.

The lower beds consist of silty, blue-grey limestone with many oolitic and pisolitic layers, interbedded with olive and brown micaceous shales that weather light brown and red. The upper beds are composed of blue-grey silty limestones often laced with calcite veins, with some beds of massive grey dolomite.

The Ute and Blacksmith formations occur in three faulted segments in South Canyon and above the Brigham east of the town of Mink Creek. They occur in a continuous belt from the head of Birch Creek Canyon to north of Mink Creek near Hill 6713. East of Rocky Peak part of the formation crops out above the Brigham and is cut off by the Cave Mountain fault. In the Oneida Narrows they are exposed in the faulted core of an anticlinal fold and also in a northwesterly belt that extends from west of Hill 5879 to west of Hill 6352.

Thickness of the two formations combined varies from 1165 to 1943 feet, increasing northward (see Figure 2). It is possible that parts of A and B, Figure 2, have been faulted out.

The following fossil collections were identified by Mrs. Balk as belonging to the Ute formation:

#1 - Middle ridge South Canyon #2 - Ridge at mouth of South Canyon

Nisusia
Elrathina Permulta
Aloskitare
Glyphaspis
Solenopleura
Tonkinella
Ogygopsis
Kootenia

Kootenia
Solenopleura
Glyphaspis
Helcionella
 cf. Aloskitare

#3 - Fossil Hollow, Oneida Narrows

Ogygopsis
Peronopsis
Elrathina
Triplagnostus
Acroteida
Lingulella

Bloomington formation: The Bloomington formation was named by Walcott in 1908 for its occurrence about 6 miles west of Bloomington, Idaho. The basal shale part of the formation was named the Hodges shale by Richardson in 1913 from Hodges Creek near Garden City, Utah. In the Mink Creek area shale is present throughout the section, and although shale predominates at the base and limestone predominates near the center of the section, there is no distinct topographic or lithologic break and the Hodges shale has not been mapped separately. See Figure 2.

The Bloomington is a series of light blue-grey limestones, with grey and yellow silt partings, and light olive shales. The beds usually weather as light red, green, and tan shale chips with nodular pieces of light blue silty limestone.

The Bloomington is exposed in two faulted sections in South Canyon and east of the town of Mink Creek above the Ute and Blacksmith formations. It crops out in a wide band from east of the head of Birch Creek Canyon to north of Mink Creek, and in a small faulted segment beneath the Nounan formation at the head of Mink Creek. It is found in the vicinity of Hill 5879 at the mouth of the Oneida Narrows and in a continuous belt northward to Hill 6352. It is repeated by faulting and occurs as part of a fold that crosses the Bear River near B.M. 4681, and also crops out below the Nounan west of Hill 6459.

The maximum thickness of Bloomington in the Mink Creek region is 1528 feet. (See Figure 2). The following collection was identified by Mrs. Balk as latest Middle Cambrian, somewhere in the Thomsonaspis (or Deissella) zone near the top of the Bloomington.

#5 - Gravel pit, Oneida Narrows, below Hill 5879.

Deissella
Thomsonaspis

Nounan formation: The Nounan formation was named by Walcott in 1908 from its occurrence west of Nounan, Idaho. It is an easily recognizable cliff forming series of limestone and dolomite that lie between the softer Bloomington formation below and the Warm Creek quartzite member of the St. Charles formation above.

The limestone is a dark blue-grey limestone with numerous red and yellow silt partings. The dolomite is a massive, light grey dolomite with numerous pisolitic layers.

The Nounan is exposed in two places in South Canyon and also above the Bloomington east of the town of Mink Creek. It forms a continuous band of cliffs that extends from east of the head of Birch Creek Canyon northward to the head of Mink Creek, where it is displaced and repeated by two faults. It also forms a small knob cut off by a fault 1/2 mile southeast of Hill 7767. In the mouth of the Oneida Narrows the Nounan is part of a fold that crosses the Bear River and has a small faulted overthrust on Hill 5879. It is also found on Hill 6352 and a small outcrop believed to be Nounan occurs in T13S R39E S35. The Nounan occurs as a continuous band which starts on Hill 5762 and continues northward across the Bear River to the vicinity of Hill 6459, where it is repeated by faulting. Williams and Maxey (1941) found the Nounan to be Upper Cambrian. In the Mink Creek area it is about 900 feet thick.

St. Charles formation: The St. Charles formation was named by Walcott in 1908 from its occurrence west of St. Charles, Idaho. The Worm Creek quartzite member at its base was named by Richardson in 1913 from its occurrence along Worm Creek in the Bear River range 10 miles north of the Randolph Quadrangle, Utah.

The Worm Creek quartzite is a massive light grey and pink quartzite, and is usually tightly cemented with silica and calcite. Locally a thin dolomite from 10-30 feet thick composed of dense light grey dolomite occurs within the formation. The total thickness ranges from 100 to 150 feet. The Worm Creek seldom is a cliff maker but sometimes is found capping ridges and forming extensive dip slopes.

Above the Worm Creek quartzite is a very fossiliferous, limonitic, blue-grey limestone that weathers light blue and red. It is followed by a series of light grey dolomites speckled with white blebs. Some fairly thick white, coarsely crystalline dolomite and some light grey limestone beds are interbedded with the speckled dolomite. The maximum thickness in the area is about 900 feet. Two collections of fossils, one from the head of Mink Creek just above the Worm Creek quartzite, and another from pebbles in the Mink Creek conglomerate, were identified by Mrs. Balk as belonging to the middle or upper part of the Ptychaspis-Prosaugia zone of the St. Charles formation.

Tertiary system

General statement: The Salt Lake group was named by Hayden in 1869 from its occurrence in the Weber River Valley near Morgan, Utah.

As defined by Hayden it included all the light colored beds, sands, sandstones, and marls, found along the margin of Salt Lake Valley. A.C. Peale (1879) found similar beds around Cache Valley, Bear Lake Valley, and others in Utah and Idaho. Mansfield (1929, p. 110), although he found both Eocene(?) and Pliocene (?) fossils, also concluded that the beds were Pliocene(?) and thought they were both lacustrine and fluvial in origin. A.J. Eardley (1941) later found vertebrate remains of Oligocene age in the Norwood tuff (Salt Lake group) in Hayden's Type area.

In the lower part of Cache Valley the beds are Late Miocene to Early Pliocene (Yen, 1947) and have been divided into three formations by J. Stewart Williams (personal communication): a lower conglomerate, a middle limestone, marl, and tuff, and an upper conglomerate. In the Mink Creek region, the Salt Lake group does not correlate too well with the Cache Valley section and a new formation, the Mink Creek, consisting of a lower tuff member and an upper conglomerate member is herein described.

Mink Creek formation: (new name) The Mink Creek formation is a series of tuffs, limestones and conglomerates that are well exposed near the town of Mink Creek, Franklin County, Idaho. The formation has been divided into two mappable members: a lower tuff member and an upper conglomerate member. At some places where the contact between the lower tuffs and the underlying Cambrian formations is a sedimentary one, an erosional surface is found on which a basal conglomerate has been developed 10 to 30 feet thick, that weathers red-brown.

The lower tuff member has a thick succession of massive-bedded green tuff at its base followed by a series of light colored, medium- to thin-bedded tuffs and limestones.

The light-colored tuffs usually form soft, crumbling exposures and have some thin conglomerate layers with well rounded pebbles and granules of Cambrian quartzite and limestone. The green tuffs are more compact and weather into massive, rounded outcrops and small chips with sharp edges. The limestone beds are interlayered with the tuffs and are of three types: (1) a massive medium-bedded white limestone that weathers into irregular rounded oblong blocks, (2) a thin-bedded, light grey, dense, petroliferous limestone usually containing plant remains, and (3) a light brown limestone that contains abundant irregular patches of light tan opaline chert.

The upper conglomerate member consists of conglomerate composed mainly of Cambrian quartzite, limes, and shale fragments and a few thin tuff layers. The conglomerates are of three main types: (1) a conglomerate with a compact, fine grained lime matrix and well rounded pebbles ranging in size from 1mm to 8 cm in diameter, (2) a poor to well cemented conglomerate composed of layers of heterogeneous boulders, cobbles and pebbles and well sorted layers of pebbles of different sizes in a marly matrix; a few thin tuff beds are included, and (3) a boulder and cobble conglomerate very loosely cemented in a light yellow-brown silty calcareous matrix. All three types of conglomerates are interbedded with each other, but in general become finer near the top.

The Mink Creek formation makes up the hills south and west of the town of Mink Creek. It also forms a large outcrop west of the Bear River southwest of the Power Plant, and north and east of Rocky Peak. (See Plate I). Three isolated outcrops near the Siphon are probably part of a belt that extends northward to just south of Rocky Peak.

The formation also outcrops in place beneath the conglomerate east of the town of Mink Creek. The thickness of a section measured along the north side of Mink Creek is about 5600 feet (see section below).

Some pelecypods, gastropods, and ostracods were collected from a thin-bedded petroliferous limestone about 500 feet from the base of the section but have not yet been identified.

WESTON CANAL SECTION (1 mile west of the town of Mink Creek, Idaho)
Section of Tertiary strata measured along the Weston Canal cut on the north side of Mink Creek, 1 mile west of the town of Mink Creek.

UPPER CONGLOMERATE MEMBER

Unit	Description	Feet
Top not exposed		
19	Conglomerate, poor to well cemented, composed of boulders, cobbles, and pebbles (not measured)	1000 4
18	Tuff, white, and limestone, white	18
17	Conglomerate, boulders and cobbles in marly matrix	1093
16	Conglomerate, yellow-brown matrix, alternating layers of boulders and cobbles	314
15	Conglomerate, cobbles and boulders poorly sorted	260
14	Limestone, white, massive bedded	85
13	Conglomerate, boulders in loosely cemented red-brown matrix	60
12	Tuff, white, and conglomerate, thin, tuffaceous	70
11	Conglomerate interbedded with green tuff	253
10	Conglomerate, quartzite and limestone cobbles, marly matrix	144
9	Conglomerate, quartzite and limestone pebbles, marly matrix	133

Total thickness upper conglomerate member 3435~~4~~

LOWER TUFF MEMBER

Unit	Description	Feet
8	Float, covered. Limestone and tuff fragments	2208
7	Limestone, thin bedded, petroliferous, and tuff, soft, white	162
6	Covered with Bonneville silt	108
5	Tuff, soft, white, and conglomerate, 4mm diameter	43
4	Limestone, thin-bedded, petroliferous, and tuff, white, thin-bedded	290
3	Covered. Tuff and limestone float	501
2	Tuff, green, massive, medium to thin-bedded	82
1	Conglomerate, cobbles and pebble in red-weathering matrix	20
Total thickness lower tuff member		<u>2208</u>

Strawberry fanglomerate: (new name) The Strawberry fanglomerate is a widespread alluvial fan deposit composed generally of boulders and angular pebbles (see Plate IVa) deposited at the foot of the rising block of the Birch Creek and allied faults in post-Mink Creek time. Good exposures are found east of the mouth of Strawberry Creek in the town of Mink Creek, Franklin County, Idaho.

Most of the boulders are composed of Brigham quartzite but some limestone fragments are found. No fresh cuts into the fanglomerate reveal its characteristics, but the boulder debris, the topography, and the areal relations lead Dr. A.J. Eardley to believe that it is a deposit similar to the Camp Davis fanglomerate of the Hoback Range and Grand Valley areas to the north in Idaho and Wyoming. (Eardley, 42, p.1800).

The Strawberry fanglomerate is found in South Canyon and west of Hill 7836. It covers the hills east and northeast of the town of Mink Creek.

An extensive, thick deposit is found north of Hill 6459, and patches are found southeast of Hill 6459. A flat area east of the Power Plant and a small hill south of Hill 4681 are composed of the fanglomerate. Its thickness can only be estimated but is believed to be several hundred feet in places.

Quaternary system

Quaternary alluvium: Quaternary deposits include Bonneville silt, valley alluvium, and stream terrace gravels. Pink Bonneville silt was laid down extensively below 5135 feet, the highest level of Lake Bonneville. After the lake withdrew, vigorous downcutting by Bear River and Mink Creek removed a great amount of the silt so that, with the exception of the thick deposits of the Bear River delta west of the Siphon, (see Plate I), only patches remain against the mountain sides. The silt unconformably overlaps all older rocks in horizontal layers, and some filled stream channels cut the silt. Terraces containing rounded boulders are found along the sides of the Oneida Narrows at elevation 4800. Stream terraces are common along Mink Creek, and an extensive alluvial cover has filled the valleys and covered the lower slopes with alluvium.

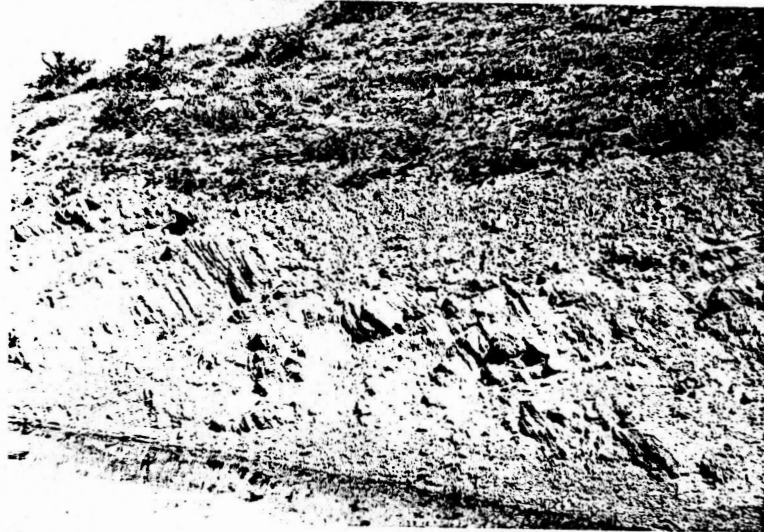
IGNEOUS ROCKS

Basic intrusion

Just south of the southwest corner of the map (Plate I), a basic igneous rock rich in hornblende and plagioclase is intruded into

the Mink Creek tuff. It may be the conduit of an old volcano. Irregular dikes of the same basic rock also cut through the tuff. A chilled zone about one foot thick is present on the edge of the igneous rock, and the intruded tuff has been bleached from one to six feet from the contact, and calcite and silica introduced.

Locally the intrusion has caused doming and faulting of the tuff, but its effect in the Mink Creek area to the north is not apparent. The intrusion may have been the source of some of the later tuffs, although no flows or other evidences of extrusion were found, and the basic composition of the rock contrasts sharply with the composition of the light colored tuffs.



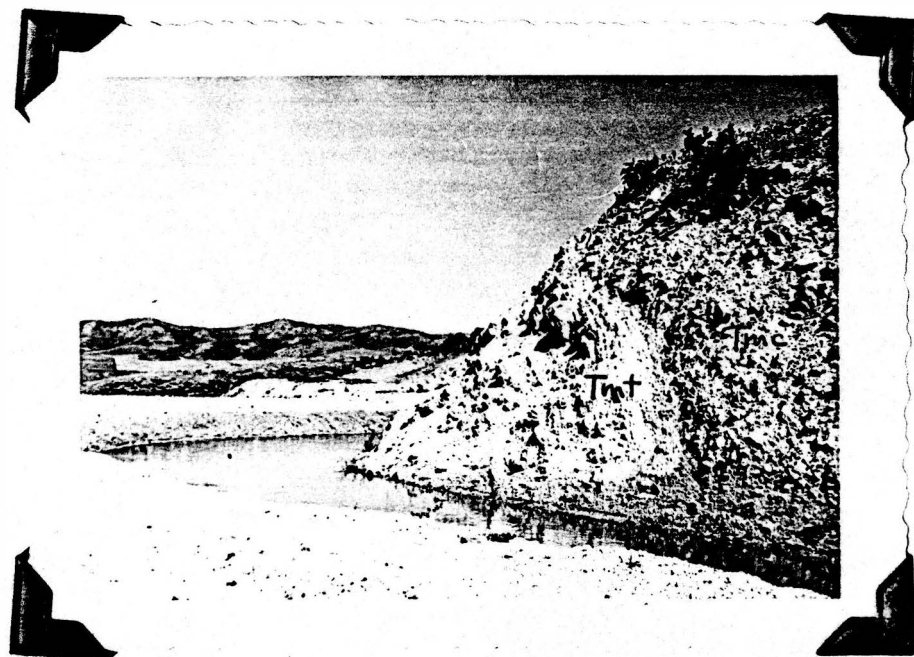
a. Mink Creek tuff overlain by remnant of Bonneville silt



b. Basal conglomerate of the Mink Creek formation



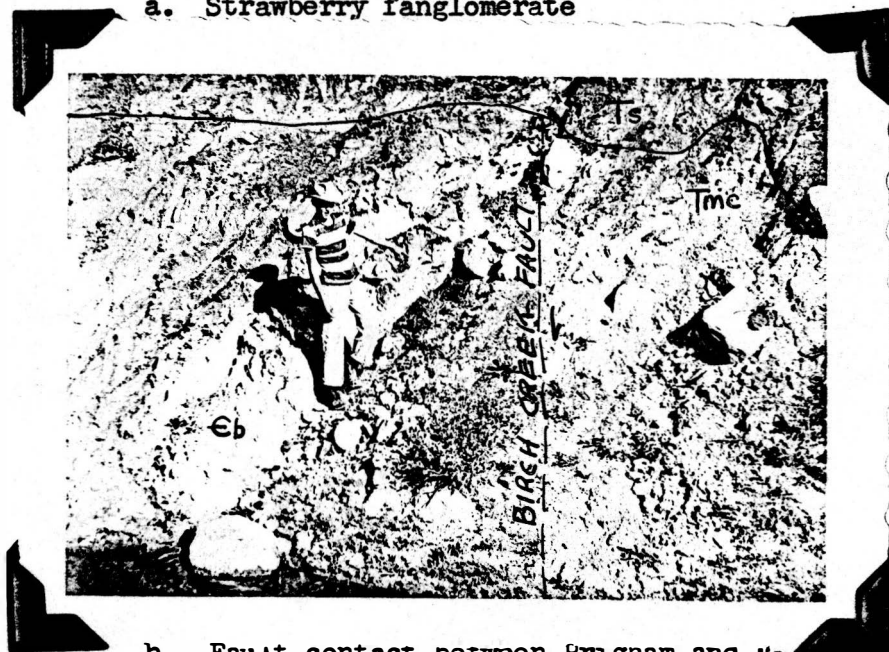
a. Well cemented Mink Creek conglomerate



b. Contact between Mink Creek tuff and conglomerate Tmt tuff, Tmc conglomerate



a. Strawberry fanglomerate



b. Fault contact between Brigham and Mink Creek formations overlain by Strawberry fanglomerate - Eb Brigham, Tmc Mink Creek conglomerate, Ts Strawberry fanglomerate



a. Oneida Narrows cut in McKensie Flat surface



b. St. Charles formation overlain unconformably by Mink Creek limestone
Esc St. Charles, Tmt Mink Creek, limestone bed of Mink Creek tuff

STRUCTURE

Laramide (?) folds

The Bear River Range in the Mink Creek area is part of the west limb of an elongate north-trending syncline that has its axis approximately at the crest of the range to the east. This syncline is probably the northward continuation of the Logan Peak syncline in the Logan Quadrangle, Utah, which is overlain unconformably by Tertiary Wasatch (Eocene) beds and was deformed by Laramide forces before the Wasatch was laid down (Williams, 1948, p. 1148).

The Cambrian rocks in the Oneida Narrows have been folded, and since the fold axis trends discordantly to later faults of the Basin and Range system, the fold is presumed to be Laramide. It is now exposed as two half-anticlines.

The presence of great sections of similarly tilted Cambrian beds cannot be easily explained by later fault displacement. Seemingly a prior period of folding and/or thrusting must have preceded the deposition and faulting of the Salt Lake beds. Evidence of prior disturbance is shown in the cross section, Plate I, east of Mink Creek and Plate V, b, which show an angular unconformity between the Cambrian and Mink Creek strata. Any other evidence is concealed below the Mink Creek formation and alluvium.

It is possible that part of this folding occurred in post-Mink Creek time, since the Mink Creek beds are curved along similar lines as the Cambrian. This may be due, however, to deposition of the Mink Creek in basins controlled by underlying structures.

Laramide (?) faults

A small low angle thrust is exposed in South Canyon with Brigham quartzite thrust over beds of the Langston and Brigham formations. The extent of the thrust is not known, as it is truncated by a high angle reverse fault that extends from a pass between Hills 7805 and 7836 down into the canyon. Both of the thrusts are probably cut off by a later transverse fault.

At Cave Mountain (Hill 5879) in the Oneida Narrows a slice of Nounan has been thrust westward in such a manner as to cut off a portion of the Bloomington, and the small thrust is probably contemporaneous with the folding already mentioned in the Oneida Narrows.

Tertiary faults

Pattern: The faults in the area align themselves into two general directions, northeast and northwest. The faults form a mosaic pattern indicative of the action of differential vertical forces (see Figure 3).

Displacements: Stratigraphic displacements along the faults range from a few feet to a maximum of 3500~~4~~ feet. The amount of brecciation varies with each fault and is apparently not proportional to the displacement. Brecciation, gouge, and calcite veins are very common along the faults.

Age: Most of the faults either displace the Mink Creek formation or are cut by faults that do. See Plate I. A master fault, the

Birch Creek, is covered by the Strawberry fanglomerate and hence it and associated faults are believed to pre-date the Strawberry formation. (See cross section, Plate I, and Figure 4).

The age of the Mink Creek beds has not yet been established, but since they are undoubtedly post-Wasatch, the faulting must be of Basin and Range age and category. The entire system is a large scale fault mosaic (see Figure 4), and all faults that compose it probably came about simultaneously. (See Eardley, 1941, p.106). Most of the displacement occurred in post-Mink Creek time but its inception may be marked by the deposition of the Mink Creek conglomerate.

Faults in the Bear River Range and the Oneida Narrows that affect only Cambrian rocks are similar in direction and displacement to those that cut the Tertiary beds and are probably the same age.

Mansfield (1927, p.239) and Williams (1948, p. 1161) both concluded that the major faulting in their areas and the development of high erosion surfaces came before the deposition of the Salt Lake group. Although steep dips are common in the Salt Lake beds in both Mansfield's and William's areas, they believed them due to minor local disturbances and along previous lines of major faulting.

It seems impossible for any surface to remain stable during a strong period of deformation. The extreme tilting and faulting that has displaced the Mink Creek formation in the Mink Creek area point strongly to the conclusions that the major period of faulting and the development of all erosion surfaces came after the deposition of the Mink Creek formation.

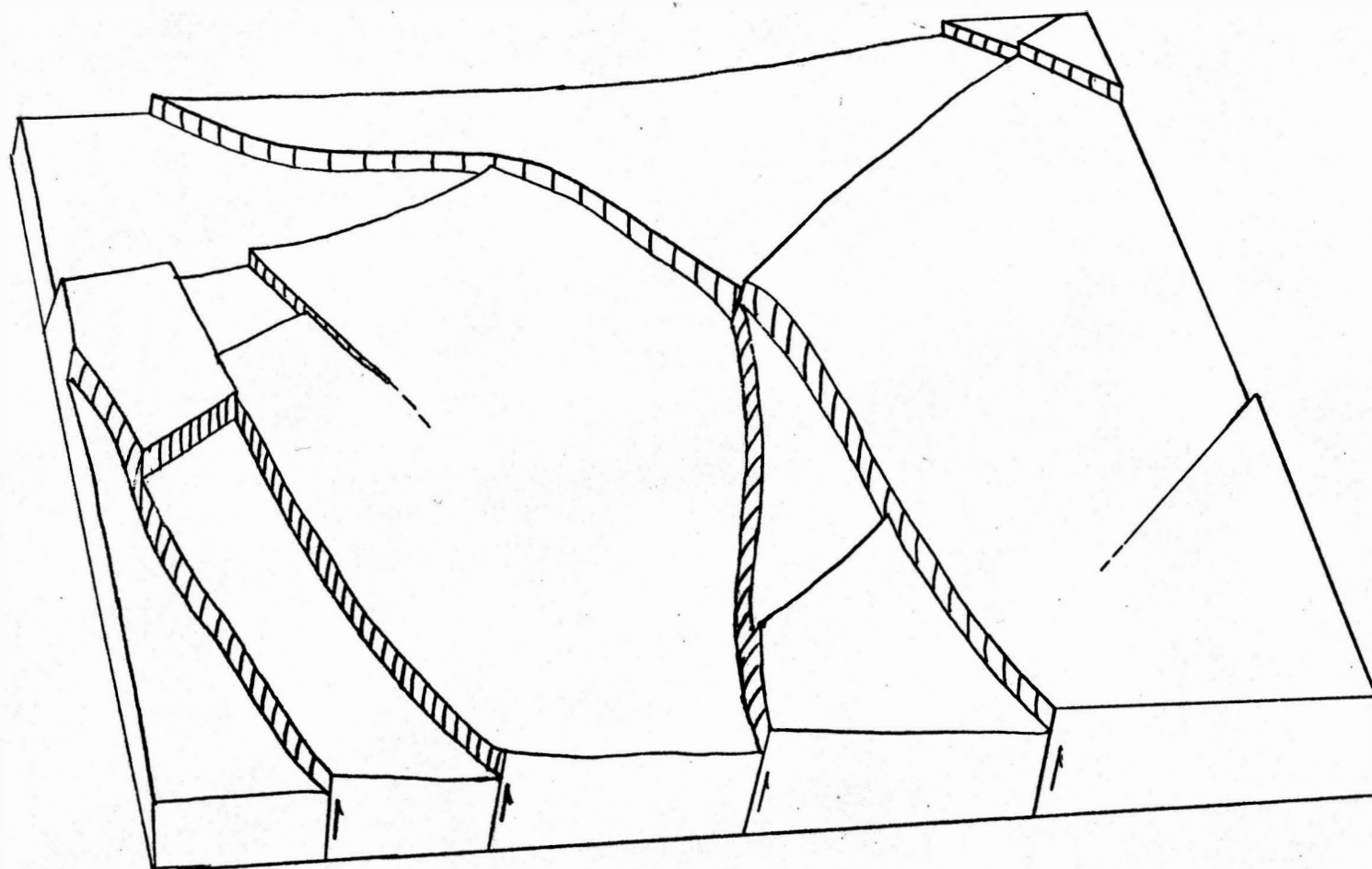


Figure 3 - Diagram of Mink Creek region showing relations of fault blocks in fault mosaic.

Relation to Basin and Range fault systems: The boundary between the Basin and Range and Middle Rocky Mountain provinces is regarded as the Bear River by Mansfield(1927, Plate 15). However, the presence of Basin and Range type faults in the Bear River Range (see Plate I) shows that this is only an arbitrary line and there is a transition zone between the two provinces.

Detail of major faults: In Birch Creek Canyon the Brigham quartzite is faulted up against upper Cambrian beds, with 3500 or more feet of stratigraphic displacement. The fault, the Birch Creek, continues northward, cutting diagonally across the beds, to the south side of Mink Creek, where the Brigham lies in contact with the Mink Creek conglomerate(see Plate I).

The northwestward extension of the Birch Creek fault, the Power Plant fault, may be only a branch, the main fault continuing northward within the Brigham and causing an abnormally thick quartzite section northward(see page 4, p2). The Power Plant fault begins on the north side of Mink Creek and continues northwestward across the Bear River to the vicinity of Hill 6468, where it becomes lost beneath Tertiary formations.

Mink Creek Canyon follows the trace of the Mink Creek fault, which brings older Cambrian beds on the south side of the canyon up against younger beds on the north. The displacement is about 500 feet. The Mink Creek fault or a parallel zone of faults may continue southeastward, for from the mouth of the canyon a straight line may be drawn from the head of Mink Creek to its junction with the Bear River. At

this point the river turns abruptly and follows the same line for ten miles out into Cache Valley before turning south.

At the head of Mink Creek a northwest fault of small displacement cuts the Mink Creek fault and repeats part of the section on both sides of the canyon.

A fault similar to the Mink Creek fault occurs south and east of Hill 7767 and a shorter one is also found that extends between the mouth of South Canyon and Birch Creek canyon.

The Cave Mountain fault begins east of Rocky Peak and continues southeastward past Cave Mountain (Hill 5879) and across the Bear River south of Hill 5762, where it brings Cambrian up against Mink Creek tuff. The fault is well exposed in a much fractured outcrop of St. Charles formation and again in a road cut next to Mink Creek, where it dips 55° southwest and brings green tuff up against white limestone (both of the Mink Creek formation). It probably continues to the southeast but is concealed beneath alluvium. West of Hill 6459 a thick calcite zone marks the northwest trending Calcite Mine fault that repeats part of the Nounan and dies out the southwest.

The Oneida fault is concealed beneath alluvium derived from the Mink Creek conglomerate south of Rocky Peak but as it goes southeast it is exposed in a wide fracture zone between the St. Charles and the Ute-Blacksmith formations, and between the Mink Creek tuff and the Bloomington and Nounan formations. At the mouth of the Narrows the St. Charles reappears faulted against the Nounan, and the fault probably continues across the Bear River beneath the alluvium.

Two northeast trending faults southeast of Rocky Peak form the southern boundary of two fault blocks. Stratigraphic displacements indicate one of these, the Rocky Peak block, came up about 3000

feet while the block east of it went down about 1000 feet (see Figure 3).

A fault just north of Rocky Peak brings the Brigham up against Mink Creek tuff, and as the fault is traced eastward the Cambrian and then the lower part of the Mink Creek is faulted up against Mink Creek conglomerate. The fault probably joins the Power Plant fault in the vicinity of the Power Plant.

In the vicinity of Cave Mountain (Hill 5879) are a number of small faults that cut the Cambrian formations and have small displacements.

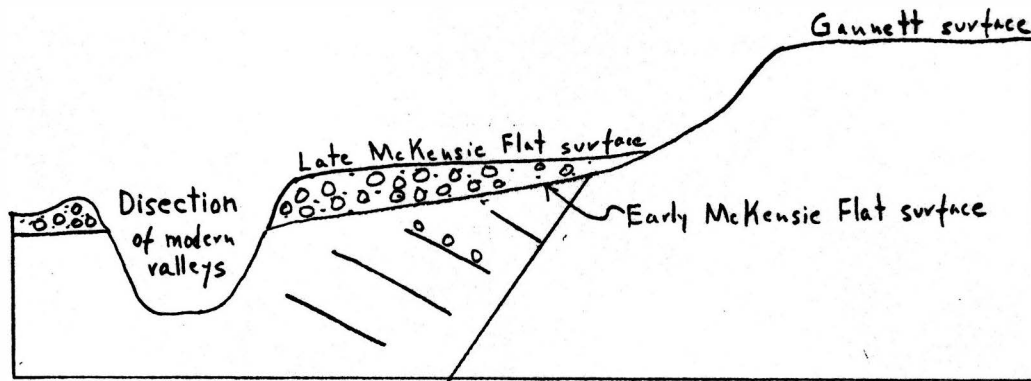
At the mouth of the Oneida Narrows are several small faults. The one on the east side of the river has displaced the upper Cambrian beds and on the west a fault brings the St. Charles against the Mink Creek tuff. Two more inferred faults displace the Mink Creek formation, and the Nounan and St. Charles formations.

GEOMORPHOLOGY

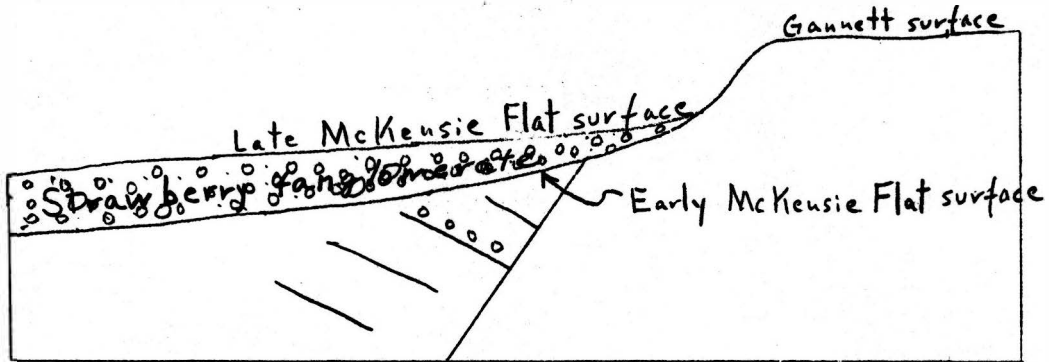
The high ridge on the east margin of the area, with elevations from 8000 to 8750 feet, is continuous north and south, and viewed from a distance is a level surface. This is probably equivalent to Mansfield's Gannett erosion surface.

Whether or not this surface formed before or after the deposition of the Mink Creek formation is not known, as Mink Creek deposits do not reach this elevation. However, the extreme tilting and faulting that have displaced the Mink Creek seemingly make it impossible for such a surface to remain stable during such a period of deformation. The surface is probably post-Mink Creek.

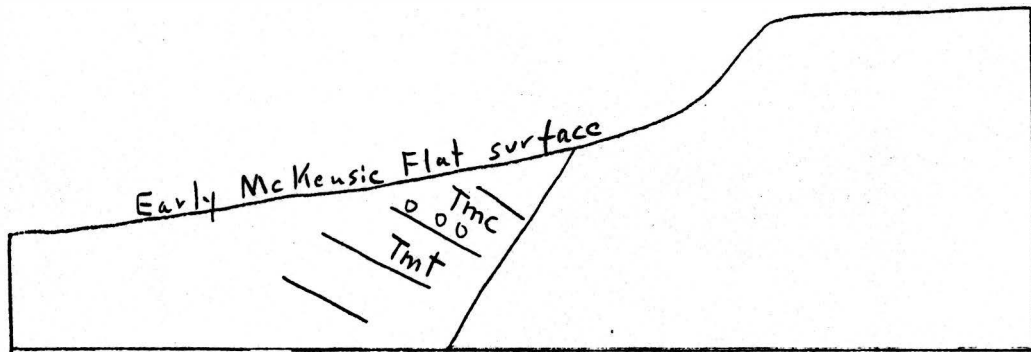
The next surface is developed from 5500 to 6500 feet, and corresponds to William's McKensie Flat surface (Williams, 1948, p.1161). Long level benches are developed in the Brigham quartzite and the Mink Creek formation. The top of the Strawberry fanglomerate is a conspicuous bench at this level, but it could not be ascertained whether this is a depositional or erosional surface. If an erosional surface on the Strawberry, then the surface post-dates the fanglomerate; if a depositional surface then the deposit is either contemporaneous or younger. Possibly two surfaces exist. (See Figure 4). An erosion surface, the early McKensie Flat, developed on the beveled Brigham and Mink Creek beds, and then either due to renewed movement along the faults or encroaching aridity (Figure 4b), the Strawberry fanglomerate spread out over the early McKensie Flat surface and covered the fault trace. The late McKensie Flat surface (Figure 4b) is then an aggradational surface on the top of the fanglomerate. The modern cycle of valley cutting



C. Modern cycle of downcutting



B. Deposition of Strawberry conglomerate and formation of Late McKensie surface



A. Development of Early McKensie surface

Figure 4 - Development of late Tertiary geomorphology

completed the sequence (Figure 4c), leaving the Strawberry conglomerate exposed as perched remnants on the hills and benches.

In the Oneida Narrows region the McKensie Flat surface is a mature surface of valleys and hills developed at the same average elevation as the benches. In the modern cycle of valley cutting the Bear River has cut a deep trench, the Oneida Narrows, into the mature surface.

The Bear River is a youthful stream in the Oneida Narrows but has cut a wide valley into the soft silts of the delta and is a late mature meandering river after leaving the Narrows. Some lower stream terraces are present in the Narrows and along Mink Creek. Remnants of Bonneville terraces are prominently exposed at the mouth of the Narrows.

The Tertiary and Quaternary formations usually weather into gentle, rounded forms. The Cambrian shales also form smooth slopes, but the quartzites and limestones generally make rugged topography. Below the 6000 level the land is in a stage of maturity, and is composed mainly of rounded hills and mature valleys, with the exception of the Oneida Narrows. From 6000 to 8000 feet the topography is more rugged, especially in the Bear River Range.

GEOLOGIC HISTORY

Paleozoic history

The Paleozoic was a period of shallow geosynclinal deposition accompanied by intermittent gentle epeirogeny. A thick (23,000 feet) section of sandstone, shale, limestone, and dolomite accumulated in the Logan Quadrangle and probably covered the Mink Creek area as well.

Mesozoic history

The nearest exposures of Mesozoic rocks are too far from the Mink Creek area to indicate what, if any, deposition took place in the area. Orogeny possibly began in the area in late Jurassic or early Cretaceous time (Eardley, 1951, p.325), and continued into the early Tertiary. It resulted in the folding of the Bear River Range and some folding and otherwise obscure deformation in the Mink Creek area.

Cenozoic history

A long period of erosion followed the late Mesozoic and early Tertiary deformation, and broad valleys, probably controlled by the previous structures, were formed. A period of vulcanism followed, filling the intermontane valleys in places with several thousands of feet of ash to form the Mink Creek tuff, which is partly of lacustrine origin. As the ash fall decreased in magnitude, vertical movements began and fault blocks were raised which furnished large quantities of conglomerate, the Mink Creek conglomerate, to the basins. The

faulting continued extensively after the conglomerate had been deposited. The Strawberry fanglomerate was then laid down at the foot of the rising blocks in places. The relation of the fanglomerate to the highest and oldest erosion surface (the Gannett surface) is not known, but the Gannett surface and the early McKensie Flat surface probably predate the formation of the fanglomerate (see Figure 4) and the late McKensie Flat surface post-dates it. After the late McKensie Flat surface was developed, a period of rejuvenation and erosion then removed much of the old surface and the present incised valleys of the modern topography resulted. Lake Bonneville rose, laid down a thick blanket of silt, and withdrew. The streams cut down through the Bonneville deposits and the present surfaces developed.

MINERAL RESOURCES

The dump of a small mine developed on the thrust fault in South Canyon yielded quartz, barite, specularite, and pyrite, and some malachite was found along a fault at the head of the canyon. A calcite mine on the Calcite Mine fault exposes a thickness of 30 or more feet of milky calcite for some distance. No mines are being worked at present.

Much of the limestone interbedded with the tuffs of the lower member of the Mink Creek formation has a petroliferous odor. The complex faulting, nearby intrusion, and lack of any anticlinal structures seem to preclude, however, the possibility of oil accumulation.

Gravel beds along the Bear River have been utilized for road building.

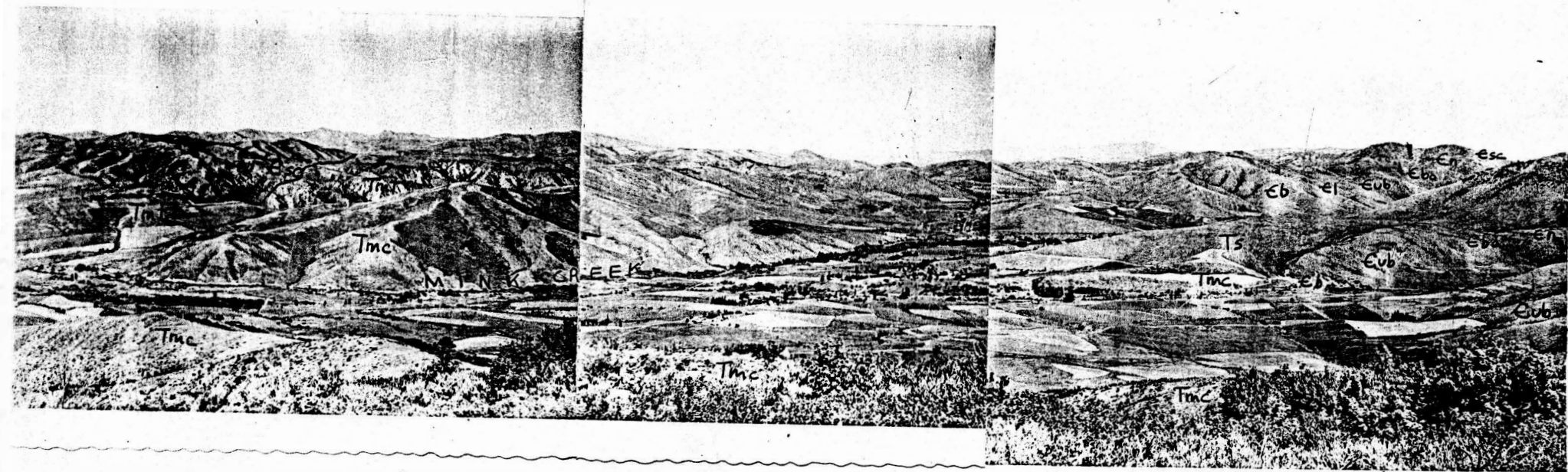


Plate VI. - Panorama of the Mink Creek region, Idaho .a, McKensie Flat surface, Cb Brigham, Sub Ute-Blacksmith, Cbo Bloomington, En Nounan , Esc St. Charles, Tmt Mink Creek tuff, Tmc, Mink Creek conglomerate, Ts Strawberry fanglomerate

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