GEOLOGY OF THE CALAMITY POINT AREA, SNAKE RIVER RANGE, IDAHO

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ILLUSTRATIONS

ABSTRACT

The Calamity Point area lies in Grand Valley and on the west flank of the Snake River Range in Idaho. Strata from the Cambrian Gros Ventre formation through the Triassic Dinwoody formation are exposed. The late Miocene or early Pliocene Camp Davis formation is also present. Laramide structures are the St. John, Blowout, Needle Peak, and Ferry Peak thrusts, which are branches of the well-known Absaroka thrust. The late Miocene structures present are the Snake River and Grand Valley normal faults, which formed a graben in which the Camp Davis formation accumulated. Deposition of the Camp Davis formation filled the graben and buried both fault scarps and also portions of the Laramide thrusts. Three cycles of erosion have trenched the graben fill about 2500 feet below the surface of maximum aggradation and have exhumed the Snake River fault scarp, but have not uncovered the Grand Valley scarp to any extent.

INTRODUCTION

Location of area

The Calamity Point area of Bonneville County, Idaho, lies partly in the Snake River Range and partly in Grand Valley of the Snake River. (See index map, plate 1) The Snake River Range is bounded on the north by the Teton Range, on the east by the Wyoming Range, on the south by the Salt River Range, all in Wyoming, and on the south and west by the Caribou Range in Idaho. The Idaho portion of the Snake River Range is in the Irwin topographic quadrangle, and the Wyoming portion in the Jackson topographic quadrangle.

Calamity Point is a prominent topographic feature in Grand Valley, on the Snake River, 16 miles northwest of the village of Alpine on the Idaho-Wyoming boundary. The specific area mapped extends from Elk Creek (see geologic map, plate 2) five miles northwest to a line midway between Sheep Creek and Palisades Creek, and from the Snake River northeast six miles into the Snake River Range.

The Snake River is the master stream of the Calamity Point area and the chief tributaries in the area are Elk, Little Elk, and Sheep Creeks. The extreme northeastern portion of the area is drained by Waterfall Canyon Creek, a tributary of Palisades Creek, which also flows into the Snake River.

Purpose of study

The purpose of the study is to decipher the structural geology of the Calamity Point area. Similar studies around Camp Davis, the Rocky Mountain Field Station of the University of Michigan, are parts of a major geologic project sponsored by the staff of the camp. The present report on the Calamity Point area is intended as a Master's

SCALE IN MILES

0 25 50 75 100

INDEX MAP

of the Calamity Point area

thesis for the author at the University of Michigan.

Acknowledgements

The field work for this report was done during the month of August, 1946. The base camp was on Indian Creek, 10 miles southeast of Calamity Point. A. J. Eardley, Professor of Geology, University of Michigan, supervised the field work and the writing of the report. J. A. McIntosh, graduate student of the University of Michigan, was the author's assistant in the field and M. V. Denny, Department of Mineralogy, University of Michigan, gave the author valuable information in the interpretation of the igneous rocks in the area.

STRATIGRAPHY

General

Although all formations listed in the following stratigraphic column (Table 1) are not present in the Calamity Point area, a complete section of the surrounding area, including the Snake River Range, the Teton Range, the Wyoming Range, and the Hoback Mountains, is given. In the Calamity Point area only the formations from the Cambrian Upper Gros Ventre shales to the Carboniferous Wells formation, and the Miocene Camp Davis formation are exposed.

Pre-Cambrian rocks

Pre-Cambrian rocks are not exposed in the Calamity Point area, but crop out in the Teton Range to the north, where they consist mostly of steeply dipping schists and gneisses with pegmatite, granite and basic intrusions. In addition to the crystalline rocks, metaconglomerates and metaquartzites occur in scattered localities (Horberg, 1938, p. 13).

Table 1

Stratigraphic Column of the Snake River, Teton and Hoback Mountains

Age	Formation	Thickness in feet
Quaternary	Alluvium	Unknown
Upper Miocene	Camp Davis formation	5500-6300 ±
Middle Eocene	Pass Peak conglomerate	3000
Lower Eocene	Hoback formation	15000
Upper Cretaceous	Frontier formation	645-5200
Upper Cretaceous	Aspen formation	2015
Lower Cretaceous	Bear River formation	880
Lower Cretaceous	Gannett group	940
Upper Jurassic	Stump sandstone	140
Upper Jurassic	Preuss sandstone	55
Middle to Upper Jurassic	Twin Creek formation	685
Middle Jurassic	Gypsum Spring formation	285
Lower Jurassic	Nugget sandstone	340
Middle to Upper Triassic	Ankareh shale	550
Lower Triassic	Thaynes limestone	1000
Lower Triassic	Woodside formation	1130
Lower Triassic	Dinwoody formation	760
Permian	Phosphoria formation	176
Pennsylvanian	Tensleep sandstone	1140
Upper Mississippian to Lower Pennsylvanian	Amsden formation	710
Upper Mississippian	Brazer formation	265
Lower Mississippian	Madison formation	1160
Devonian (?)	Darby formation	570
Silurian to Devonian	Leigh formation	40
Ordovician	Bighorn dolomite	400
Upper Cambrian	Boysen limestone	145
Middle Cambrian	Gros Ventre formation	1090
Middle Cambrian	Flathead quartzite	240
Pre-Cambrian	Schists and gneisses	Unknown

Cambrian system

Flathead quartzite.—The Flathead quartzite, although not exposed in the Snake River Mountains, lies unconformably over the pre-Cambrian rocks in the Teton Range to the north (Horberg, 1938, p. 12). There the formation consists of white to tan, medium-bedded, orthoquartzites with a well-developed basal conglomerate. The formation is 240 feet thick. Peale (1893, p. 20-21) described the Flathead formation as a persistent quartzite or sandstone, 125 feet thick, with interlaminated beds of reddish brown siltstone, in which the cementing material is partly an iron oxide, overlain by the Flathead shales, 290 feet thick, which have since been placed into the Gros Ventre formation. The Flathead was named from exposures in Flathead Pass in the northeast corner of the Three Forks quadrangle, Montana, and is Middle Cambrian in age.

Gros Ventre formation.—The upper 150 feet of the Gros Ventre formation is exposed along Elk Creek in a small anticline in the three thrust sheets northeast of the Snake River. (See geologic map, plate 2) The Gros Ventre is divided into three members. The upper member consists of green non-resistant shale, with a gray to yellow-gray, calcitic limestone and intraformational breccia. It is 240 feet thick.

The middle member has been called the Death Canyon limestone by Miller (1936, pp. 119-120) after the type locality at the head of Death Canyon in the Teton Range. This member consists of a bluish-gray, thin-bedded to massive, coarse-grained, cliff-forming limestone, with irregular yellow partings and mottlings. It is 450 feet thick.

The lower member is exposed in the Teton Range as a series of green and red, glauconitic, chloritic and hematitic shales. It is 400 feet thick.

The Gros Ventre formation lies conformably on the Flathead quartzite and was named by Blackwelder (1918, p. 417) from exposures on the west slope of Doubletop Peak, in the Gros Ventre Range, Wyoming, where the section is 796 feet thick. Horberg (1938, pp. 13-14) placed the Gros Ventre in the Middle Cambrian.

Boysen limestone.--The Boysen limestone is well exposed in the three thrust sheets northeast of the Snake River. See geologic map, plate 2. The Boysen is a blue to brownish-gray limestone with many silty, green partings and yellow to brown mottled areas. It weathers tan with pitted surfaces, is thick to thin-bedded, locally oolitic, and 145 feet thick. It lies disconformably on the Gros Ventre formation. The Boysen (Deiss, 1938, pp. 1104-1105) was originally the Gallatin limestone as described by Peale (1893, pp. 22-25) from exposures in the Gallatin Range in the southeast part of the Three Forks quadrangle, Montana. The Boysen is Upper Cambrian in age (Deiss, 1938, pp. 1104-1105).

Ordovician system

Bighorn dolomite.--The Bighorn dolomite is exposed in cliffs in the three sheets of thrusts northeast of the Snake River. The Bighorn is a light gray to dark gray or cream dolomite, generally fine-grained and massive. There is some pink to gray irregular banding or mottling. It weathers characteristically to a rough, pitted surface. Gardner (1944, p. 10) has described the upper 150 feet on the south slope of Baldy Mountain to the northwest of the Calamity Point area as a red to brown sandstone, siltstone, shale and conglomerate, giving way in short distances to the predominating massive gray dolomite. The total thickness is 400 feet, and it lies disconformably on the Boysen limestone. Darton (1904, pp. 394-395) named the Bighorn from exposures on the east side of the Bighorn Mountains, Wyoming, and described it as an impure limestone, 200-300 feet thick, light gray to buff in color, with reticulating networks of silica which gives the typical pitted surface. The Bighorn dolomite in the Snake River Range is believed to be Ordovician in age, but fossils have not yet been found in it.

Silurian or Devonian system

Leigh formation.--The Leigh formation was mapped as a unit with the Bighorn dolomite over which it appears conformable. The Leigh is typically a finely crystalline, brittle, white dolomite, that weathers to a pitted surface. It is 40 feet thick in the Teton Range. The Leigh formation was formerly the Leigh member of the Bighorn dolomite, but was recognized as a formation by Blackwelder (1918, p. 419), who named it from exposures in Leigh Canyon on the West slope of the Teton Range. It has been tentatively placed in the Silurian or Devonian due to the presence of a few plates found on Glory Mountain in the Teton Range by members of the staff of Camp Davis (personal communication, Professor Claude Hibbard, University of Michigan).

Devonian (?) system

Darby formation.--The Darby formation is exposed in several places along stream cuts near the base of the St. John thrust sheet. Gardner (1944, p. 10) has divided the Darby into two members, the upper of which is a yellow, purplish-red and brown, calcareous and sandy shale, siltstone and sandstone that weathers yellow, brown, dark gray olive and red. It contains some bright red partings and a few layers of silty dolomitic limestone. The upper member is 210 feet thick.

The lower member is a dark gray to sooty black limestone and dolomite, that weathers a dark gray. A few beds of light gray limestone, yellowish-brown siltstone, and gray to brown sandstone are intercalated. A discontinuous five foot bed of yellow pebbly quartzite is present at the base. This member is 360 feet thick. The Darby rests unconformably on the Leigh formation.

In the Camp Davis area the Darby is typically a brownish-gray massive dolomite, that weathers to a yellowish-brown. Gray and black shales are interbedded. Blackwelder (1918, p. 420) named the formation from exposures in Darby Creek on the west slope of the Teton Range and placed it in the Devonian (?). It has not yet been correlated with the Jefferson or Three Forks formations

Mississippian system

Madison formation.--Generally, the Madison is not readily distinguishable from the Brazer, and for this reason, the two formations are mapped as a single unit. The Madison formation is typically a blue-gray, partly thin-bedded, dominantly massive, coarse-grained limestone, with many calcite veins. It is very fossiliferous, with corals and brachiopods abundant. It weathers light gray to somewhat tan and is an important cliff-former. It is 1160 feet thick. Peale (1893, pp. 33-39) named the Madison formation from exposures in the Madison Range, in the central part of the Three Forks quadrangle, Montana. The Madison lies unconformably on the Darby formation. The Madison is Lower Mississippian in age (Mansfield, 1927, p. 60).

Brazer formation.--The Brazer formation consists of a light to dark gray, thin-bedded, almost shaly limestone. It is generally fine-grained to sub-lithographic, with calcite veins abundant. It is 265 feet thick and lies conformably on the Madison. The Brazer was named from exposures in Brazer Canyon, Rich County, N.E. Utah, and is Upper Mississippian in age.

Pennsylvanian system

Amsden formation.--The Amsden formation was mapped together with the overlying Tensleep sandstone as the Carboniferous Wells formation after the practice of Horberg (1938, pp. 16-17). It is exposed in the tops of the mountains in the Calamity Point area. The Amsden consists of a variable succession of sandstones, shales, and limestones, with brown, pale yellow and yellowish rocks predominating. The basal member, a light yellow sandstone was an excellent aid in mapping. The Amsden is 710 feet thick and lies conformably on the Brazer formation. Darton (1904, p. 398, 401) described the Amsden from exposures on the Amsden Branch of the Tongue River west of Dayton, Wyoming. There the basal member was a red sandy shale of fine-grained sandstone from 50 to 100 feet thick, increasing in thickness to the southward. In the type locality the formation is 150 to 350 feet thick. The Amsden is transitional from Upper Mississippian to Lower Pennsylvanian in age (Bachrach, 1945).

Tensleep sandstone.--The Tensleep sandstone forms the peaks in the Calamity Point area. Gardner (1944, p. 9) divided the formation into three members. The upper member, 300 feet thick, is a gray cherty dolomite and limestone and a gray to yellow sandstone, quartzite, and siltstone. The middle member is a pale yellow to brown quartzite and sandstone 390 feet thick. The lower member is a white to gray quartzite and sandstone 450 feet thick. The Tensleep has a total thickness of 1140 feet and lies conformably on the Amsden formation. Darton (1904, p. 397) named the Tensleep from exposures of a white sandstone, 50-200 feet thick in the lower Canyon of Tensleep Creek in the Bighorn Mountains, Wyoming and placed it in the Pennsylvanian.

Permian system

Phosphoria formation.--The Phosphoria formation is exposed along faults and in a shallow syncline in the northeast corner of the Calamity Point area. Gardner (1944, pp. 10-10), who did extensive work in the Snake River and Bighole Mountains, described the following section: The upper Rex chert member is a dark gray to black dolomite and gray, blue and brown limestone. It is silty and cherty with some layers of sandstone and shale and contains fossils. This member is 147 feet thick. The lower phosphatic member is a gray to brown phosphate rock with alternating beds of gray to brown calcareous and phosphatic mudstones, shales and limestones. This member is 29 feet thick. The Phosphoria totals 176 feet in thickness and lies conformably on the Tensleep sandstone. (Krusekopf, personal communication) The Phosphoria was described by Richards and Mansfield (1912, pp. 684-689) from exposures in Phosphoria Gulch, north of Meade Peak, Idaho. It is Permian in age. (Richards and Mansfield, 1912, 684-689)

Triassic system

Dinwoody formation.--The Dinwoody formation is exposed in areas adjacent to the Calamity Point area. The Dinwoody consists of a thin-bedded and fine-grained dull, olive-green to brownish-gray mudstone and shale. These beds contain about equal parts of sand, clay, and calcium carbonate. A few layers of gray impure resistant limestones are present in the lower part. The section is 760 feet thick (Gardner, 1944, p. 8) and lies unconformably over the Phosphoria. Blackwelder (1918, p. 425) named the Dinwoody for exposures in the canyon of Dinwoody Lakes, in the Wind River Range, where the formation consists of greenish-gray shales with many thin layers of dense calcareous sandstones or argillaceous shale that weather brown, tawny, and even black. Newell and Kummel (1942, p. 941, 947) restrict the

Dinwoody at the type locality to include only dominantly silty strata between the Phosphoria and the top of the resistant siltstones midway to the summit of the original Dinwoody. They also place the Dinwoody in the lower Triassic as the time equivalent of the lower part of the red-beds section of the type Woodside formation.

Woodside formation.--The Woodside formation is poorly exposed between Palisade and Trail Creeks north of the Calamity Point area. There it consists of brick red shales and sandstones, thin-bedded and non-resistant. The Woodside is 1130 feet thick (Gardner, p. 8) and lies conformably on the Dinwoody formation. Boutwell (1907, p. 446) named the Woodside for exposures in Woodside Gulch, in the Park City District, Utah. There the Woodside consists of over 1000 feet of fine-grained, thinly bedded dark-red shales, barren of fossils. Newell and Kummel (1942, p. 947) say that the red beds between the Dinwoody formation and Thaynes limestone should be considered as a northeastern tongue of the Woodside, and that they belong to the same facies as the type Woodside but equivalent stratigraphically to the upper half of the type Woodside, which is Lower Triassic in age.

Thaynes limestone.--The Thaynes limestone is exposed on a ridge between Palisades and Trail Creeks north of the Calamity Point area. Gardner (1944, p. 8) has divided the Thaynes into three members. The upper member, 625 feet thick, is a dull gray, sandy limestone, that weathers yellowish-gray. Some gray to brown very calcareous sandstones are also present. The middle member, 265 feet thick is known only from fragments of red siltstone, red shaly sandstone, and gray sandy limestone in a covered interval. The lower member is 80 feet thick and consists of a dull brown to gray limestone or calcareous sandstone, that weathers dark brown. The Thaynes limestone has a total thickness of 1000 feet and lies conformably on the Woodside formation. Boutwell (1907, p. 448-452) named the formation after Thaynes Canyon in the Park City District, Utah. The Thaynes limestone is Lower Triassic in age. (Newell and Kummel, 1942, p. 947-948).

Ankareh shale.--The Ankareh shale is exposed on a ridge between Palisades and Trail Creeks north of the Calamity Point area. There the Ankareh consists of a deep red, nonresistant shale, and gray quartzite and red sandstone. The Ankareh is 550 feet thick and lies conformably over the Thaynes limestone. Boutwell (1907, p. 452-54) named the Ankareh, consisting of 1300 feet of red siliceous detrital deposits with a prominent upper white sandstone member for Ankareh Ridge, Park City District, Utah. Five years later, Boutwell (1912, p. 58-59) redefined the Ankareh, calling the upper white sandstone member the Nugget sandstone. The Ankareh shale is Middle to Upper Triassic in age. (Mansfield, 1927, p. 374).

Jurassic system

Nugget sandstone.--The Nugget sandstone is exposed on a ridge between Palisades and Trail Creeks north of the Calamity Point area. There the formation is a resistant and massive, dull, reddish-brown sandstone, with 6 inches of pale, greenish-gray, highly calcareous sandstone at the base. Aeolian cross bedding is locally conspicious. The Nugget is 340 feet thick (Gardner, 1944, p. 8) and lies unconformably on the Ankareh shale. Veatch (1907, p. 56) named the Nugget from outcrops of yellow, pink, and red sandstones near Nugget Station, on the Oregon Short Line, southwest Wyoming. Mansfield (1920, p. 52) restricted the use of the name Nugget to the upper member of the Nugget as defined by Veatch. The Nugget is Lower Jurassic in age. (Mansfield, 1927, p. 27)

Gypsum Spring formation.--The Gypsum Spring was not differentiated by Gardner (1944, p. 7) but is probably present on a ridge between Palisades and Trail Creeks north of the Calamity Point area. There are 250 feet of light gray limestone that weathers to small splinters and plates. It is fossiliferous in some localities. This is overlain by 35 feet of red, nonresistant shales, poorly exposed. The total thickness of the Gypsum Spring is 285 feet, and it lies unconformably on the Nugget sandstone. The type section of the Gypsum Spring is in the Wind River Basin, where it consists of a basal red, blocky siltstone, a middle gypsum member, and an upper alternating sequence of limestones, shales, and dolomites of Middle Jurassic age (Love, et al., 1945).

Twin Creek formation.--The Twin Creek formation is exposed on a ridge between Palisades and Trail Creeks north of the Calamity Point area. It consists of a brittle, light gray limestone, that weathers to a dull gray splintery and platy fragments, with fossils abundant at some localities. The Twin Creek is 685 feet thick and is disconformable on the Gypsum Spring formation. In the Camp Davis area Gryphea are abundant in the upper 300 feet. (Dobrovolny, 1940, p. 431) Veatch (1907, p. 56) named the Twin Creek from excellent exposures on Twin Creek between Sage and Fossil in S. W. Wyoming. There the formation consists of black and gray, calcareous shales and thin-bedded shaly limestones with a few beds of yellow sandstone. The Twin Creek is Middle to Upper Jurassic in age. (Imlay, 1945, pp. 1019-1022)

Preuss sandstone.--The Preuss sandstone is exposed on a ridge between Palisades and Trail Creeks north of the Calamity Point area. There the Preuss consists of a red, shaly sandstone, poorly exposed through a red sandy soil. It is 55 feet thick (Gardner, 1944, p. 7) and lies conformably on the Twin Creek formation. Mansfield and Roundy (1916, pp. 76,81) named the formation for Preuss Creek, northeast of Montpelier, Idaho, where the formation is a very fine, even-grained, siltstone, gray to deep dull red, usually calcareous, and more or less argillaceous. The beds are shaly in places and are generally less than 6 feet thick. The Preuss sandstone is Upper Jurassic in age (Mansfield, 1927, p. 99).

Stump sandstone.--The Stump sandstone is exposed on a ridge between Palisades and Trail Creeks north of the Calamity Point area. There it consists of a brownish-gray to greenish-gray sandstone and sandy limestone, with a dark bluish-gray limestone near the top. Gardner (1944, p. 7) measured a thickness of 140 feet. The Stump rests conformably on the Preuss sandstone. Mansfield and Roundy (1916, pp. 76, 81) named the Stump sandstone for Stump peak at the head of the north fork of Stump Creek. There it is a resistant, thin-bedded, gray to greenish-gray, fine-grained siltstone that weathers into platy fregments. At the base is a bed of grit or coarse-grained sandstone that contains marine Jurassic fossils. Mansfield (1927, p. 101) has assigned an Upper Jurassic age to the Stump sandstone.

Cretaceous system

Gannett group.--The Gannett group is exposed on a ridge between Palisades and Trail Creeks north of the Calamity Point area. Gardner (1944, p. 7) has recognized four formations in the Gannett. The upper formation is the dark green Draney limestone that weathers gray to brown. A lavendar, calcareous shale is present in the middle of the section. The Draney is 245 feet thick. The Bechler shale, next descending, is poorly exposed and consists of a few stringers of red shale and mudstone 35 feet thick. The Peterson limestone, next descending, is a dark-gray, resistant limestone, massive to thin-bedded, that weathers white, gray, and purplish-gray. The Peterson is 125 feet thick. The lowest formation is the Ephraim conglomerate. The Ephraim is a discontinuous deposit of vari-colored shales, quartzite, conglomerate, and pebbly sandstones and is 535 feet thick. The total thickness of the Gannett group, which rests apparently conformable on the Stump sandstone, is 940 feet. Mansfield and Roundy (1916, pp. 76-83) sub-divided the Gannett group descending into the Tygee sandstone, the Draney limestone, the Bechler conglomerate, the Peterson limestone and the Ephraim conglomerate. They named the Gannett group for Gannett Hills in Bannock County, Idaho, and Lincoln County, Wyoming. Mansfield (1927, pp. 101-105) has placed the Gannett group in the Lower Cretaceous.

<u>Bear River formation</u>.--The Bear River formation is exposed on a ridge between the forks of Palisades Creek north of the Calamity Point area. Gardner (1944, p. 7) described the upper 450 feet of the Bear River as a black nonresistant shale, poorly exposed. The middle 280 feet consist of black shales, olive green siltstones and quartzites, and gray sandstones, cross-bedded and calcareous. The lower 150 feet is a rusty brown, thin-bedded quartzite with some black shale. The Bear River totals 880 feet in thickness and lies unconformably on the Gannett group. The Bear River formation was first recognized as the Bear River group by Hayden in 1869 for coal bearing strata exposed at Bear River City, Wyoming. Veatch (1907, p. 63) placed the Bear River at the base of the Upper Cretaceous, but Aurelle La Rocque, a graduate student of the University of Michigan, after extensive collecting in the Camp Davis area in the summer of 1946, has tentatively placed the Bear River in the Lower Cretaceous.

Aspen formation.--The Aspen formation is exposed on a ridge between the forks of Palisades Creek north of the Calamity Point area. Gardner (1944, p. 6) measured a total thickness of approximately 2,015 feet of sediments. The lower 360 feet is an olive-green, calcareous shale and siltstone, with interbedded sandstone, which in the Camp Davis area is a gray-green salt and pepper sandstone. One thin bed of limestone is found near the base. The remainder of the Aspen is an olive-green, siliceous shale and siltstone, with many beds of a pale green to gray porcelainite, which is a vitreous rhyolite tuff. The porcelainite in the upper 350 feet is mottled gray, green and pink. The Aspen lies conformably on the Bear River formation. Veatch (1907, p. 64-65), who placed the Aspen in the Colorado epoch of the Upper Cretaceous, named the formation from exposures near Aspen Station, Wyoming.

Frontier formation.--The Frontier formation is exposed on a ridge between the forks of Palisades Creek north of the Calamity Point area. There it consists of olive brown to greenish-gray sandstone and shale, with interbedded olive-brown conglomerates and quartzites. The basal member has discontinuous beds of gray and rusty quartzite and conglomerate. Gardner (1944, p. 6) reports an incomplete section of 645 feet, the top removed by erosion. The type locality is at Frontier, Wyoming, where the Frontier is 2000± feet thick, with coal beds present, and lies conformably on the Aspen. In the Camp Davis area, the Frontier is 3000± feet thick, with a few coal beds seams (Dobrovolney, 1940, p. 441). Ross and St. John, graduate students at the University of Michigan, measured a section on Deadman Mountain in the Wyoming Range (see Index Map, Plate 1) during the summer of 1946 and found the Frontier there to be 5290 feet thick with the upper part cut out by the Darby Thrust, a prominent thrust fault in that area. Veatch (1907, p. 69) has placed the Frontier formation in the Colorado epoch of the Upper Cretaceous.

Eocene series

Hoback formation.--The Hoback formation is exposed in the Hoback Basin 30 miles to the east of the Calamity Point area. It consists of interbedded gray sandstones and shales. Several conglomerate lenses and impure freshwater limestone beds are also present. The Hoback is estimated to be 15,000 feet thick (Eardley, et al, 1944). It is unconformable on the lower formations and is lower Eocene in age.

Pass Peak conglomerate.--The Pass Peak conglomerate is exposed in the Hoback Basin 30 miles to the east of the Calamity Point area. It consists of coarse red to gray conglomerates grading upward to sandstones and shale. Percussion marks are characteristic of the conglomerate pebbles. The Pass Peak is 3000 feet thick, lies conformably on the Hoback formation, and has been assigned to the middle Eocene (Eardley, et al, 1944).

Miocene series

Camp Davis formation.--The Camp Davis formation is exposed along the front of the Snake River Mountains in the Calamity Point area. It extends toward the northeast from the Snake River for a distance of approximately 3 miles with an isolated exposure six miles from the Snake River up the north fork of Indian Creek, immediately south of the Calamity Point area. In the Calamity Point area, the Camp Davis formation consists of four members. They are, in ascending order, the lower andesite, the compacted silt, the upper andesite, and the tan and gray conglomerate.

The lower andesite member is a zeolitic hypersthene augite andesite, typically massive and dark gray in color (Mielenz, 1946, p. 3). The andesite contains microphenocrysts of hypersthene, augite, and labradorite in a groundmass of microcrystalline labradorite, augite, and magnetite with interstitial glass and chabazite. Fractures are common, usually filled with calcite. The andesite contains secondary minerals of the montmorillonite group. The andesite body is sometimes slightly vesicular, but in view of the fact that it has indurated the overlying sediments to a maximum distance of 8 feet from the contact and trangresses the bedding planes of the sediments in places (Mielenz, 1946, p. 4), the andesite has been called a sill. It is approximately 1200 feet thick. The age of the intrusion could not be determined, but due to the similarity to the upper andesite member, it is assumed to be post-gray conglomerate and pre-tan conglomerate. It rests unconformably on Triassic formations along the west side of the Snake River.

The compacted silt member, approximately 800 feet thick, lies between the lower and the upper andesite members in a conformable relationship. The silt member is well stratified and composed of comparatively soft or hard silts, clays, and sands (Mielenz, 1946, p. 1) with some tuffs. The contacts of the silts are indurated, as much as 8 feet from the contacts, at some places and some are partially recrystallized and fused. The fluidity of the partially fused sandstone was so great in one place that the material flowed and intruded the surrounding sediments. (Mielenz, p. 4) In the only exposures that could be seen, in cuts made by the Bureau of Reclamation, the andesites and the silts are dipping northeast at the same angle.

The upper andesite is composed of the same minerals as the lower andesite and is 300-1000 feet thick, the variation being due to apparent thinning of the sill. The gray conglomerate seems to rest conformably on the upper andesite, and since the tan conglomerate appears to rest unconformably on the gray conglomerate, it is probable that the andesites were intruded toward the end of the deposition of the gray conglomerate or at least the pre-tan conglomerate.

The lower part of the conglomerate member that weathers light to dark gray is firmly cemented and consists of rounded to sub-angular Madison-Brazer fragments. The gray conglomerate is 2-300 ± feet thick. The bottom appears to rest conformably on the upper andesite member.

The upper part of the conglomerate member is composed of pebbles of the following formations in the approximate percentages: 66% Madison-Brazer, 24% Wells, 4% Darby, 4% Bighorn, and 2% Boysen. The fragments ranged from 1 mm. to 1 foot in diameter, the finer fragments acting as the cementing material. Efforts were made to restrict the count to pebbles approximately ½ inch in diameter. In the larger fragments, Boysen and Bighorn occurred more frequently. The tan conglomerate weathers buff to light tan and in exposures in Sheep Creek, a dull red, which was a noted exception. The tan conglomerate was measured graphically and found to be 3000 ± feet thick. It is separated from the underlying gray conglomerate by an erosional interval, and is unconformable in the immediate area of the Snake River, but farther northeast, it appears to be disconformable.

The total thickness of the Camp Davis formation is 5500-6300 ± feet. It rests unconformably on Triassic formations along the west side of the Snake River and along the west slope of the Hoback Range, which is the type locality of the Camp Davis formation. The Camp Davis is also unconformable on the underlying formations.

The Camp Davis formation was described by Eardley (1944). In the past it has been referred to as the Almy conglomerate of Paleocene age by Veatch (1907, p. 76-87) and Schultz (1914, p. 30). Kirkham (1924,

FORMATIONAL DESIGNATIONS

Qal— Quaternary alluvium

Tc	Camp Davis formation	conglomerate
Tua		upper andesite
Ts		silts, compacted
Tla		lower andesite

Ћd— Dinwoody formation

Pp— Phosphoria formation

Cw— Amsden formation & Tensleep sandstone

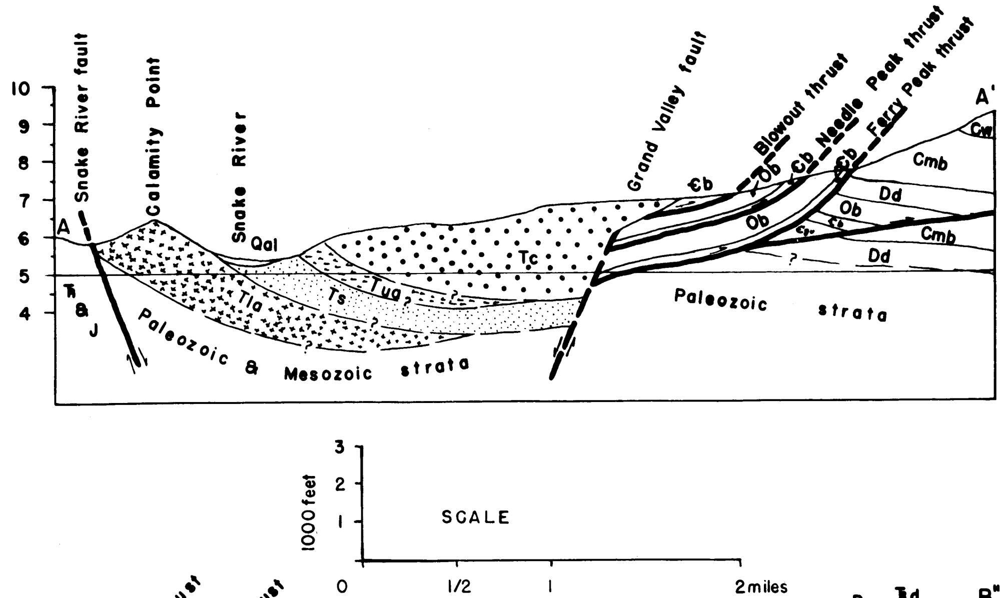
Cmb- Madison- Brazer formations

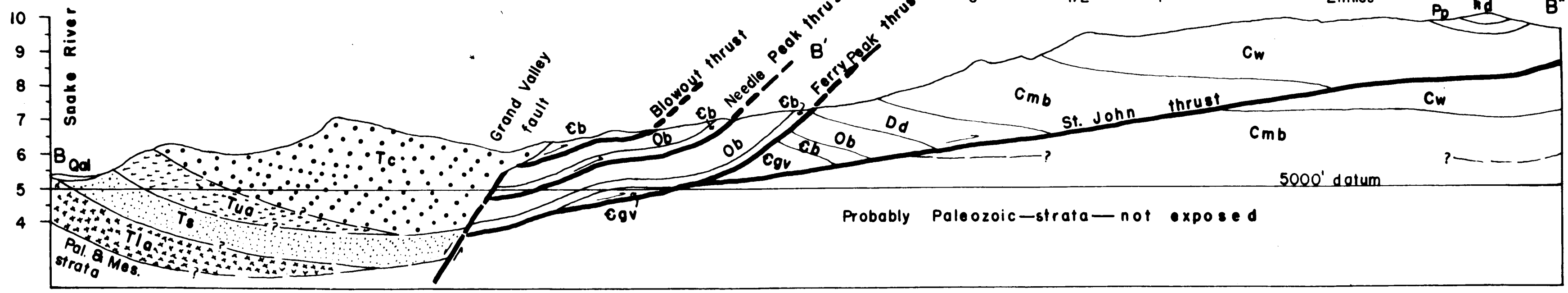
Dd— Darby formation

Ob— Bighorn dolomite & Leigh formation

Єb— Boysen limestone

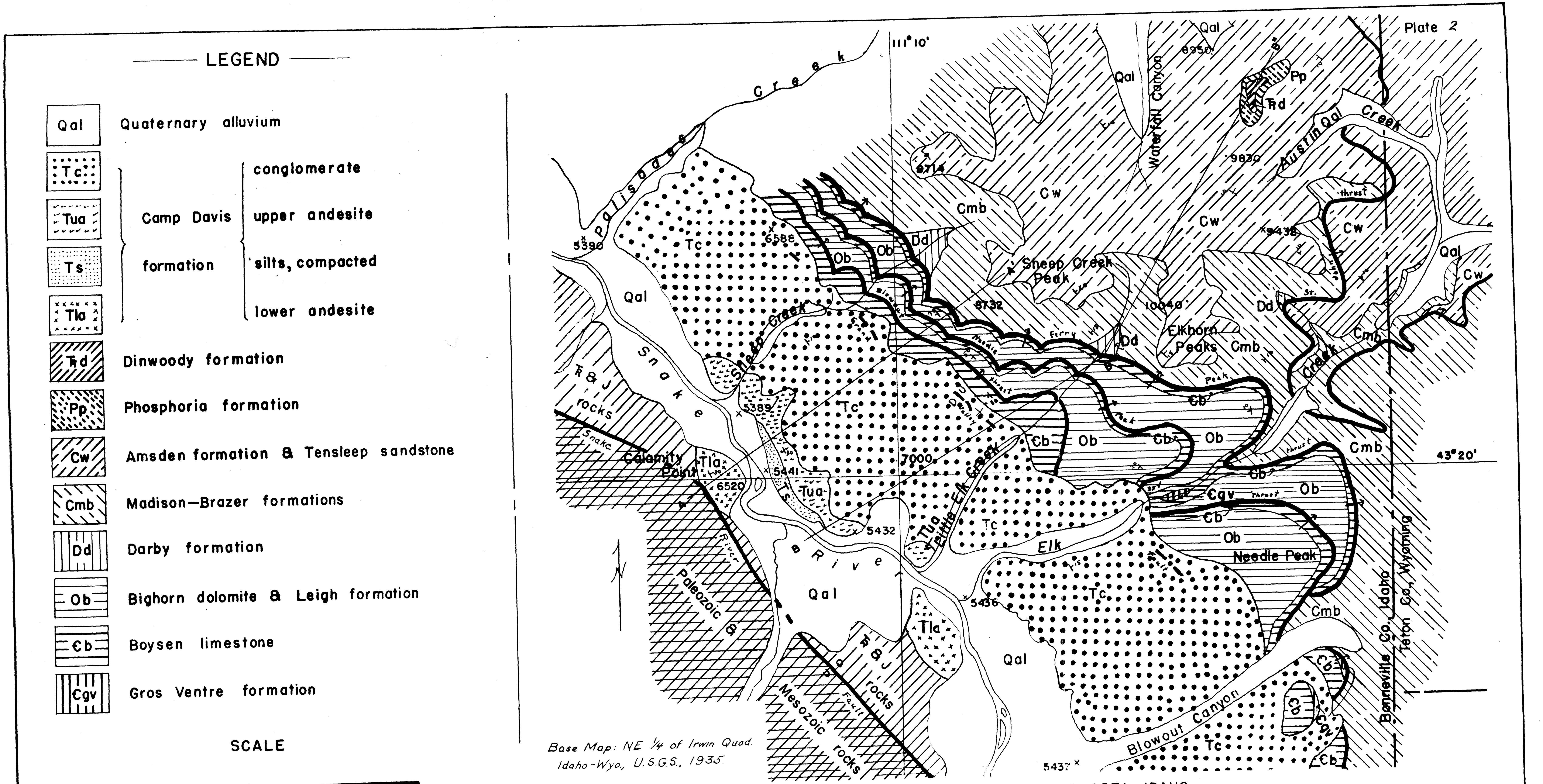
Єgv— Gros Ventre formation





CROSS SECTIONS, CALAMITY POINT AREA, IDAHO

Plate 2



GEOLOGIC MAP, CALAMITY POINT AREA, IDAHO pp. 29-30) has referred to this formation as the Salt River formation in the Snake River area. In the type locality there is a lower gray conglomerate, 200± feet thick, a light gray freshwater limestone and tuff 50 feet thick, and an upper red or tan conglomerate, 2000 feet thick. Eardley (1942, p. 1800) described the manner of deposition as follows: initial folding and thrusting in Laramide time, followed by high angle normal faulting; the high angle fault formed the trough in which the Camp Davis conglomerate accumulated. As the escarpment was dissected by erosion, it contributed to subsequent deposition which finally buried the fault scarp. A fossil horse's tooth in the fresh-water limestone near the base of the Camp Davis proved to be upper Miocene or lower Pliocene in age (Eardley, 1942, p. 1800)

Folding and thrusting in Laramide time is well displayed in the Snake River Range. The folds and thrusts were later cut by a high angle fault, which like the one in the type Camp Davis area, resulted in a depression in which coarse conglomerate accumulated. Because of similar lithology and similar structural relations to the type Camp Davis, which is upper Miocene or lower Pliocene, a similar age is assigned.

STRUCTURAL GEOLOGY

General features

The various structures of the Calamity Point area may be divided into two categories according to type and according to age, namely; the Laramide structures and the Mid-Tertiary structures. The Laramide structures are huge thrust sheets and broad, gentle folds, whereas the mid-Tertiary structures are high angle normal faults and a fold caused by drag on one of these faults. The high angle faults parallel the main Snake River Valley and are partly responsible for it.

Laramide structures

Blowout thrust sheet.--All that is exposed of the Blowout thrust sheet in the local area of the report is the Boysen formation of Cambrian age. The Camp Davis formation overlaps the upper and southwestern contact, and the lower part of the thrust sheet rests on the Bighorn dolomite of the Needle Peak thrust sheet. The Blowout thrust sheet was named for its exposures in Blowout Canyon, south of the Calamity Point area. See geologic map and cross sections, plates 2 and 3. The fault can be traced from Blowout Canyon northwestward except in the area between Elk Creek and Blowout Canyon where the trace is covered by the Camp Davis formation, to the edge of the Calamity Point area, and southeastward from Blowout Canyon to Indian Creek, where it disappears beneath the overlap of the Camp Davis formation. The sheet dips southwest at an average of 20° in the vicinity of Little Elk Creek, but in the vicinity of Sheep Creek, it dips nearly 50°.

Needle Peak thrust sheet.--The Needle Peak thrust sheet was named from exposures in Needle Peak where Boysen and Bighorn beds rest on the Ferry Peak thrust sheet. See geologic map and cross sections, plates 2 and 3. The Needle Peak thrust fault can be traced from Needle Peak in a northwestwardly direction to the south side of Elk Creek, where it disappears under the Camp Davis formation. The trace reappears north of Elk Creek and extends northwestward to the northern limits of the Calamity Point area, a total distance of 10 miles. The Needle Peak thrust sheet generally is in contact with the Bighorn dolomite of the Ferry Peak thrust sheet below, except in the area of Needle Peak, where it is in contact with the Madison formation of the St. John thrust sheet. The Needle Peak thrust sheet dips at an average of 50° to the southwest except in the vicinity of Elk Creek where the dip decreases to about 20°.

Ferry Peak thrust sheet.--The Ferry Peak thrust sheet (see geologic map and cross sections, plates 2 and 3) was named from exposures in Ferry Peak, 10 miles southeast of the Calamity Point area. It is composed of the Gros Ventre, Boysen and Bighorn formations, and dips at an average of 50° to the southwest, except in the vicinity of Elk Creek, where the dip decreases to about 20°. The upper contact is the Boysen of the Needle Peak thrust sheet. The Ferry Peak sheet rests on the Madison of the St. John thrust sheet, which dips gently to the northeast. The Ferry Peak thrust can be traced from the northern limits of the Calamity Point area southeastward for 10 miles to Blowout Canyon where it disappears beneath the Needle Peak thrust sheet. To the south of Blowout Canyon it reappears and can be traced at least 8 miles further southeast to the Snake River.

St. John thrust sheet.--The St. John thrust sheet (Schultz, p. 35-36) as shown on the geologic map and cross sections, plates 2 and 3, is made up chiefly of the Darby, Madison-Brazer, and Wells formations. In addition, the Phosphoria and Ankareh formation are exposed in a gentle syncline northwest of Austin Creek. At the contact with the Ferry Peak thrust the beds dip northeast at 15°. Within a short distance the dip becomes 10° southeast and remains so as far as Austin Creek, where it changes to 10° southwest. The St. John fault can be traced from Neeley Basin south to Elk Creek from where it trends northward, then eastward and southeastward through Ferry Peak to the Snake River, a total distance of approximately 20 miles. The southern contact of the St. John thrust sheet is the Boysen formation of the Ferry Peak thrust sheet. In the Elk Creek area the Darby, Madison-Brazer, and Wells formations form the northern contact with an unnamed thrust sheet below (Gardner, 1944, plate 2), which is composed of the

Madison-Brazer and Wells formations. The St. John thrust sheet slices up and northeastward at a gentle dip across this unnamed thrust sheet. According to Kirkham (1929, p. 33), the St. John thrust is probably a west branch of the Absaroka thrust.

Elk Creek anticline.--A small anticline in the Ferry Peak, Needle Peak, and Blowout thrust sheets parallels the general strike of beds in the Calamity Point area. It is exposed best in Elk Creek one mile north of the Camp Davis contact. The south limb dips about 10° to the southwest and the north limb dips about 5° to the northeast. A broad synclinal cross fold with small dips is parallel to and west of Elk Creek. The folding probably occurred at the time of thrusting.

Austin Creek syncline.--A broad symmetrical syncline whose axis trends northwest in the vicinity of Austin Creek involves the beds of the St. John thrust sheet and in an unnamed underlying thrust sheet. The limbs of the fold dip about 10°. The formations involved in the fold are the Madison-Brazer, Wells, Phosphoria and the Ankareh. The folding probably took place at the time of major thrusting.

Sheep Creek fold.--A drag fold in the Madison-Brazer and Wells formations is present at the head of Sheep Creek in the top of an unnamed mountain peak northwest of Sheep Creek Peak (see plate 2). The northern limb of the fold dips 10° to the northeast, and the southern limb is vertical. When the Ferry Peak thrust sheet road over the underlying Madison-Brazer and Wells formations, they were dragged to a vertical position.

Mid-Tertiary structures

Grand Valley fault.—The presence of the Grand Valley fault is based on the indirect evidence of calcareous spring deposits and the alignment of fresh-water springs along the front of the Snake River Range, approximately 2 to 2½ miles north and east of the Snake River. It is probably a high angle normal fault that trends northwest, with the southwest side down. The Camp Davis formation was deposited against the fault scarp as a fanglomerate. A similar relation is present in the Camp Davis area where the type Camp Davis formation was deposited as a fanglomerate against the scarp of the Hoback fault.

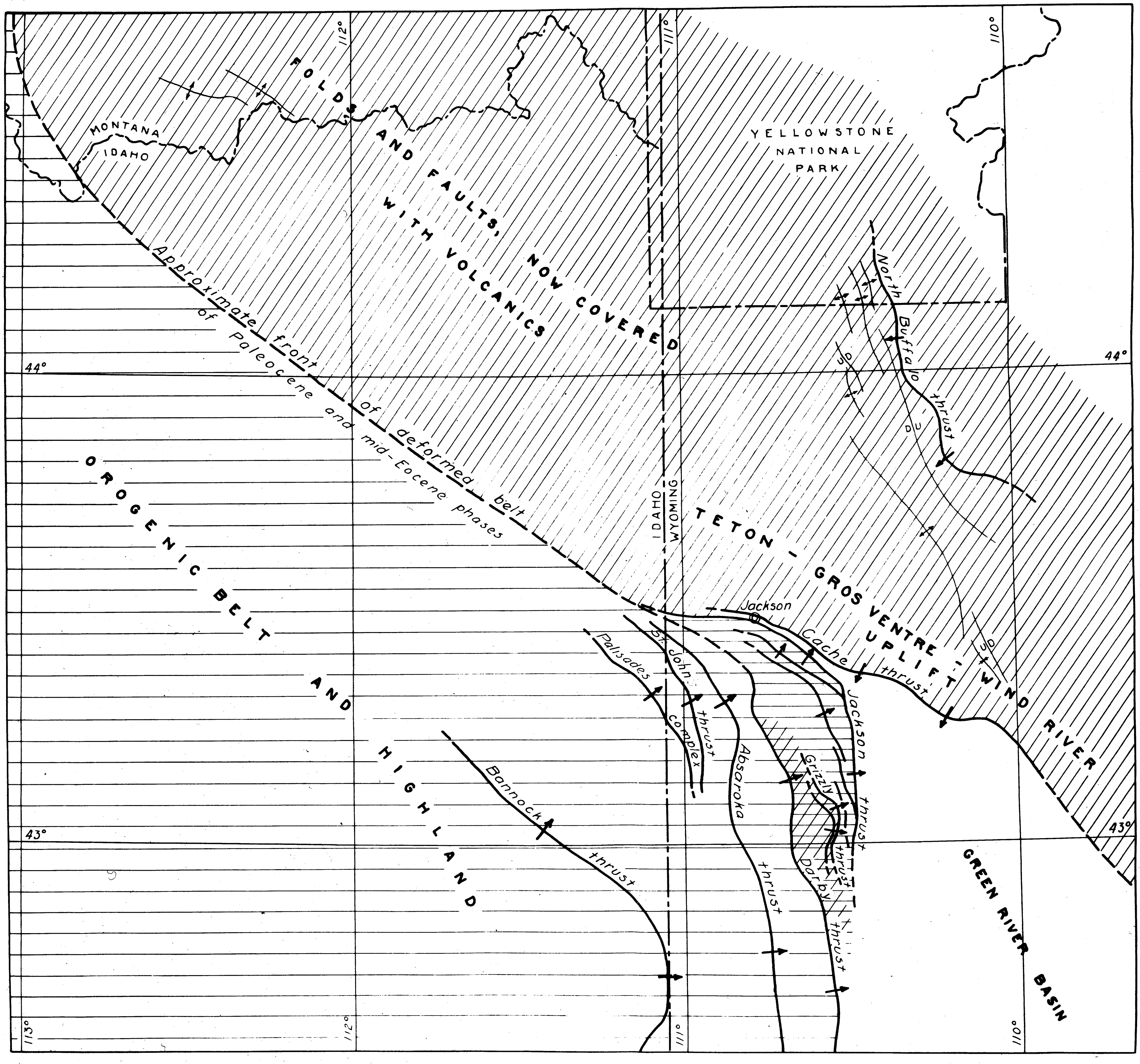
The Hoback fault is believed by Eardley (personal communication) to have created the trough in which the Camp Davis conglomerate accumulated, and the fault may have continued active during the early stages of accumulation of the conglomerate. Eventually the conglomerate covered the scarp and overlapped the surface back of it. If this relation of conglomerate to faulting is true, then the fault is essentially the same age as the conglomerate. A horse's tooth found near the base of the type Camp Davis conglomerate proved to be uppermost Miocene or lowermost Pliocene in age (Eardley, 1942, p. 1800). As far as can be determined, the Grand Valley fault is similar to the Hoback. It is evident from examination of the cross sections that the conglomerate accumulated at least to an elevation of 1700 feet above the present valley floor, and completely buried the fault scarp. In the erosional cycle that followed very little of the fault scarp has been exhumed, and the contact of the conglomerate with the older rocks as mapped (see geologic map, plate 2) is a sedimentary one, and in detail irregular, but overall fairly straight, and in this respect revealing of the fault scarp below. The andesite intrusions of the

Camp Davis formation may have issued along the Swan Valley fault.

Camp Davis fold.--The Camp Davis fold is a gentle fold only known to exist in the Camp Davis formation. Near the Snake River, the beds dip about 30° to the northeast. Further northeast, the dip decreases rapidly at first, and finally about 2 miles northeast of the Snake River the beds become nearly horizontal. See cross section, pl. 2. In the vicinity of Alpine, Idaho, the Camp Davis formation dips between 10° and 15° northeast. The fold could have been produced by renewed movement on the Grand Valley fault with the northeast side moving upward. A more logical explanation is that when the southwest side of the Snake River fault went up, the Camp Davis formation in the vicinity of the fault was dragged to its present position. If the Snake River faulting occurred during deposition of the Camp Davis formation, and the conglomerates banked up against and over the fault scarp, primary dips of 15° to the northeast could be accounted for. This dip could have been increased to its present 30° by further movement on the Snake River fault. Therefore, the age of the Camp Davis folding can be determined as upper Miocene or later.

Snake River fault.--The Snake River fault (see geologic map and cross sections, plates 2 and 3) unlike the Grand Valley fault, is marked by a prominent escarpment along the west side of Grand Valley. Numerous hot springs along the base of the scarp confirm its presence. The Snake River fault was first mapped by Kirkham (1924, plate 5) with Paleozoic and Mesozoic rocks on the upthrown and southwest side, and the Camp Davis formation together with Mesozoic rocks on the downthrown and northeast side of the fault.

The following sequence of events are more fully explained under the heading "Pre- and Post- Camp Davis surfaces." After formation of the Union Pass (?) surface in pre-Camp Davis time, movement on the



113°
112°
111°
110°
44°
43°
MONTANA
IDAHO
FOLDS AND FAULTS, NOW COVERED WITH VOLCANICS
YELLOWSTONE NATIONAL PARK
North Buffalo thrust
Approximate front of deformed belt of Paleocene and mid-Eocene phases
OROGENIC BELT AND HIGHLAND
IDAHO
WYOMING
TETON - GROS VENTRE - WIND RIVER UPLIFT
Jackson
Cache thrust
Palisades complex
St. John thrust
Absaroka thrust
Jackson thrust
Grizzly thrust
Darby thrust
Bannock thrust
GREEN RIVER BASIN

Grand Valley fault occurred, forming a trough in which the Camp Davis silts and gray conglomerates accumulated. During the deposition of the gray conglomerate sill-like dikes were intruded and movement on the Snake River fault occurred, dragging the beds to their present attitude. Further erosion headward in the canyons contributed the sediments for the tan conglomerate which eventually buried the Grand Valley scarp completely and the Snake River scarp to some extent. The Black Rock erosion cycle, which is post-Camp Davis partially exhumed the Snake River escarpment and left an erosion surface at about 7500 feet on both sides of the Snake River in Grand Valley. See diagrams 2-5, plate 5. The Snake River fault can then be said to be upper Miocene or lower Pliocene in age.

Spatial relations

In general, two distinct structural provinces, the shelf and the geosynclinal, exist in western Wyoming (Horberg, 1938, p. 28). The Teton, Gros Ventre, and Wind River ranges (see index and tectonic maps, plates 1 and 4) are located in the shelf zone of sedimentation and the Snake River, Wyoming, Hoback, and other ranges mentioned in this report in the geosynclinal. Characteristic of the shelf zone are large, asymmetrical folds. West of the shelf zone are thrust sheets involving Paleozoic and Mesozoic beds of geosynclinal thicknesses. The thrust sheets and geosynclinal thicknesses of strata typify the structure in the Snake River, Wyoming, Hoback and Salt River ranges.

From east to west the thrusts already well known of the geosynclinal province are the Darby, Absaroka, and Bannock. See tectonic map, plate 4. The Darby and Absaroka thrusts are both present in the Snake River Range but the Bannock lies further south and west in

Idaho. In addition to these thrusts others described on previous pages are present. The great province of geosynclinal sediments and thrust sheets extends from the Idaho batholith southeastward to the Snake River Range, and thence southward along the Idaho-Wyoming boundary into Utah.

A series of long and prominent fault scarps and intermontane structural valleys extend from north-central Utah northward along the Idaho-Wyoming boundary to Grand Valley (the Snake River and Grand Valley faults) and Jackson Hole (the Teton and Hoback faults), and appear like a rift zone. They are generally discordant with the Laramide structures, but since all relations have not yet been worked out in this long zone, little more than the mention of the rift theory is possible at the moment. The zone of rifting may be an extension of the Basin and Range province northward into western Wyoming and eastern Idaho (A.J. Eardley, personal communication).

Age relations

The Darby and Absaroka thrusts in the Snake River Range were active during the Laramide orogeny with overriding sheets moving from west to east. This fact has been noted by several students of the area, notably Schultz, Mansfield and Kirkham. During the summer of 1946, Ross and St. John, (M.A. thesis, University of Michigan, 1947), graduate students at the University of Michigan, pointed out that the Darby thrust sheet has overidden the entire Mesozoic and Paleozoic section including 5,000 feet of Frontier formation in the Wyoming Range. See index map, plate 1. Also in the Wyoming Range the Darby thrust is covered by the Camp Davis formation of upper Miocene to lower Pliocene age. Therefore, it is seen that in the immediate region around the Calamity Point area the age of the Darby thrust is post-

Colorado and pre-upper Miocene. Evidence noted by Eardley (personal communication) in north-central Utah and southwest Wyoming shows the Darby and Absaroka thrust to be covered by the Almy conglomerate of upper Paleocene age. It is thought that the Darby and Absaroka thrust sheets furnished the sediments for the Hoback formation of lower Eocene age in the Hoback Basin 30 miles east of the Calamity Point area. Therefore, it is concluded that the Darby and Absaroka thrusts together with the branching thrusts, the St. John and Palisades complex, represent the first stage of Laramide thrusting in the region. The activity occurred in Paleocene time.

North and east of the Darby thrust are the Jackson, Cabin, and Clause thrusts (see tectonic map, plate 4) which moved toward the east in a similar fashion to the Darby and Absaroka. The Jackson, Cabin, and Clause thrusts cut the Hoback formation of lower Eocene age but are overlapped by the Pass Peak conglomerate in the Hoback Mountains. Since the Pass Peak is middle Eocene in age, the Jackson, Cabin, and Clause thrusts are post-lower Eocene and pre-middle Eocene in age, and represent the second stage of thrusting in the region.

Also in the Hoback Mountains are the Grizzly fault thrust toward the northeast, and in the Gros Ventre Range the opposing Cache Creek thrust. See tectonic map, plate 4. The Pass Peak conglomerate of middle Eocene age is cut by these thrusts and the Cache Creek thrust is covered by the Camp Davis formation of upper Miocene to lower Pliocene age. From the above evidence it is concluded that the post-Pass Peak thrusts represent the third and final stages of the Laramide orogeny in the geosynclinal province of which the Calamity Point area is a portion.

PRE- AND POST-CAMP DAVIS EROSION SURFACES

High surfaces in the Grand Valley area

Scattered throughout the Snake River Range in the vicinity of Grand Valley are graded spurs and isolated peaks and ridges that approach concordantly a high imaginary surface, and suggest a possible old erosion surface. These features are at a general elevation of 8700-9500 feet, and the surface that they presumably represent cuts folded and faulted Paleozoic and Mesozoic strata. In the Caribou Range are long ridges parallel to the Snake River and isolated peaks that have a general elevation of 8700-9200 feet. The trellis drainage and accordant semi-level-topped ridges produce a topography similar to that of the Appalachian region. The surface in this area also cuts folded Paleozoic and Mesozoic strata.

In the Snake River Range a lower surface that bevels the Camp Davis formation can be established at an elevation of 7500 feet by the presence of flat benches that extend from south of Indian Creek to Little Elk Creek. Long graded spurs that terminate at 7400 feet are present in the Caribou Range. This represents a second surface. A flat north of Little Elk Creek at an elevation of 7000 feet, and two remnants in the Caribou Range do not seem to be related to the slightly higher surface. Therefore, it is thought that the scanty evidence is not sufficient to establish a surface at 7000 feet, and only one surface is present at a general elevation of 7500 feet.

On either side of Sheep Creek are well defined remnants of a surface at an elevation of 6500-6700 feet. Benches and graded spurs are numerous along the east side of the Caribou Range at 6400-6500 feet. These features on either side of the Snake River valley seem sufficient and definite enough to establish a third surface at the 6400-6700 foot elevation.

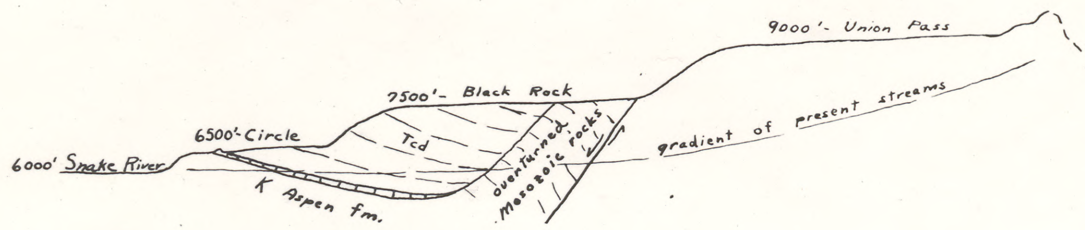


Fig. 1 – Erosion surfaces of Hoback Range, Wyoming

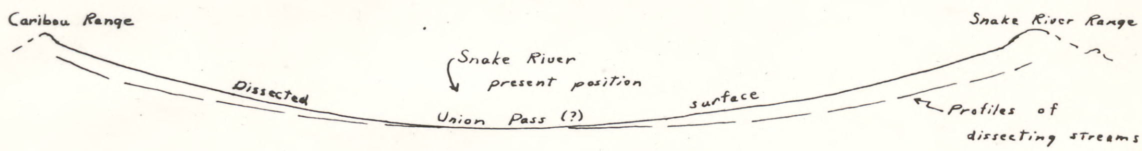


Fig. 2 – Stage I – Formation of Union Pass (?) surface, Grand Valley, Idaho

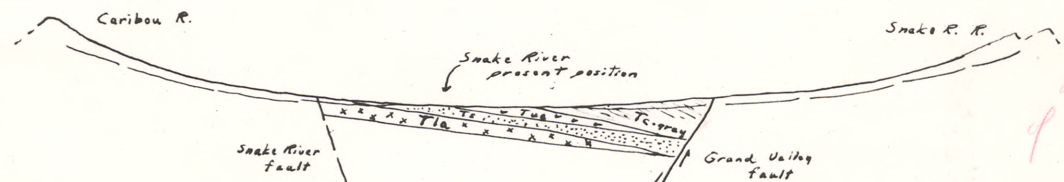


Fig. 3 – Stage 2 – Deposition of Camp Davis silts, gray conglomerate, intrusion of dikes

Must show dissection of Union Pass surface

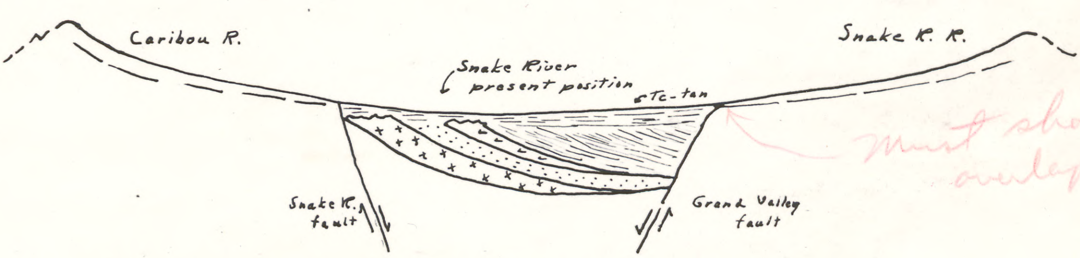


Fig. 4 – Stage 3 – Culmination of valley fill – deposition of tan conglomerate

Must show more overlap of Tc

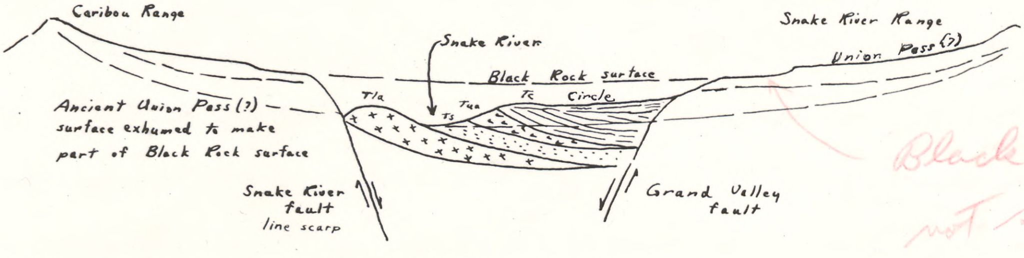


Fig. 5 – Stage 4 – Erosion cycle of Black Rock surface
Stage 5 – Present erosion cycle

Black Rock not sufficiently lower than U.P.

Relation to high surfaces in the Hoback and Gros Ventre ranges

Three surfaces have been recognized in the Hoback and Gros Ventre ranges 20-30 miles to the northeast by Blackwelder (1915, pp. 310-319) and the staff of Camp Davis. They are shown in diagram 1, plate 5. The highest which cuts folded Paleozoic racks is at 8500-9500 feet and is called the Union Pass surface. Next at 7500 feet is the Black Rock surface which cuts the Camp Davis formation. At an elevation of 6500 feet are broad pediments, now dissected, which are known as the Circle surface. These surfaces correlate in number, elevation, and apparently in kind, with those of Grand Valley, and therefore the same sequence of events occurred in both places. The chronology postulated by the staff members of Camp Davis has influenced the writer in establishing one for the Grand Valley area, and the results, briefly stated, follow.

Although the Union Pass surface is thought by some geologists to be Pliocene in age, there are several objections to the theory, and the cumulative regional evidence supports an early or middle Miocene age (A. J. Eardley, personal communication). Therefore, in this report, the Union Pass surface will be considered pre-Camp Davis in age. Since the other surfaces cut the Camp Davis formation, they are post-Camp Davis or post-early Pliocene.

Graben faulting and culmination of deposition

After the formation of the Union Pass (?) surface in the Snake River and Caribou ranges, movement on the Grand Valley fault occurred. A trough was formed in which the Camp Davis silt and gray conglomerate accumulated. During deposition of the gray conglomerate, igneous activity occurred, at which time the sills of the Camp Davis formation were intruded. Further movement on the Grand Valley fault combined with dislocation of the Snake River fault completed the graben structure along the Snake River Valley. Movement on the Snake River fault caused the drag fold in the Camp Davis formation. After a period of erosion, the tan conglomerate was deposited in the deepened trough. Since the tan conglomerate extends up to an elevation of 7790 feet in the Grand Valley area, the culmination of valley fill was at an elevation of at least 8000 feet. At this time the Camp Davis formation probably extended well into the canyons of, or cut into, the Union Pass (?) surface and covered both fault scarps. Later cycles of erosion have exhumed the Snake River escarpment but have not uncovered the Grand Valley scarp to any extent.

Black Rock erosion cycle

Since the Camp Davis formation was deposited to an elevation of at least 8000 feet, it can be seen that the erosion of the Black Rock cycle cut down at least 500 feet below the maximum level of aggradation. Presence of the Camp Davis formation only on the northeast side of the Snake River leads to the conclusion that during Black Rock time the Snake River was west of its present position and eroded more on the west side of the valley than on the east. The Black Rock erosion cycle began in early Pliocene and continues through the Pliocene into the Pleistocene. In the Teton and Gros Ventre ranges to the north and northeast Illinoian (?) drift is present on the Black Rock surface and therefore the cycle was completed by mid-Pleistocene. Relationship of the Black Rock surface to the culmination of valley fill is shown in figure 5, plate 5.

Post-Black Rock erosion cycle

As presented on previous pages, remnants of the Circle erosion surface are present on either side of Grand Valley at an elevation of 6400-6700 feet. Since the elevation of the Black Rock surface is about 7500 feet, the valley was deepened more than 1000 feet during the Circle cycle of erosion. Figure 5, plate 5, shows the relationship of the Circle surface to other surfaces in the area. Later cycles of erosion have cut down through another 1000 feet of strata and have brought the Grand Valley area to its present topographic state.

Exhuming of the Snake River fault scarp

After graben faulting and burial of the Snake River and Grand Valley faults, the Black Rock and later cycles of erosion have exhumed the Snake River escarpment but have not uncovered the Grand Valley scarp to any extent. If these conclusions are true, the Snake River escarpment is a fault-line scarp.

SUMMARY OF EVENTS

After deposition of geosynclinal thicknesses of Paleozoic and Mesozoic rocks in the Calamity Point area, the strata were thrust in imbricate sheets toward the north and east in the first stage of the Laramide orogeny. The first stage of thrusting is represented in the Calamity Point area by the St. John thrust and the Palisades thrust complex which includes the Blowout, Needle Peak, and Ferry Peak thrusts. These are branches of the Absaroka thrust of Paleocene age.

The Darby and Absaroka thrust sheets of Paleocene age furnished the sediments of the Hoback formation of lower Eocene age. In the second stage of thrusting of the Laramide orogeny, the eastward moving Jackson, Cabin, and Clause sheets of the Hoback Range cut the Hoback formation. They were overlapped by the Pass Peak conglomerate of middle Eocene age.

The third and final stage of the Laramide orogeny is represented by the eastward moving Grizzly thrust in the Hoback Range and the southwestward moving Cache Creek thrust in the Gros Ventre Range. Both cut the Pass Peak conglomerate, and are,therefore, middle or late Eocene in age.

After the third stage of thrusting a long erosion cycle established the Union Pass (?) surface in the Calamity Point area. Then, in late Miocene time, the Grand Valley and Snake River faults broke the terrane to form a graben in which the Camp Davis formation accumulated. Aggradation went on to an elevation of at least 8000 feet and both fault scarps were buried. Streams of the Black Rock and later cycles or erosion have deepened the valley more than 2500 feet, mostly in the Camp Davis formation that filled the graben, and have exhumed parts of the Snake River escarpment.

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