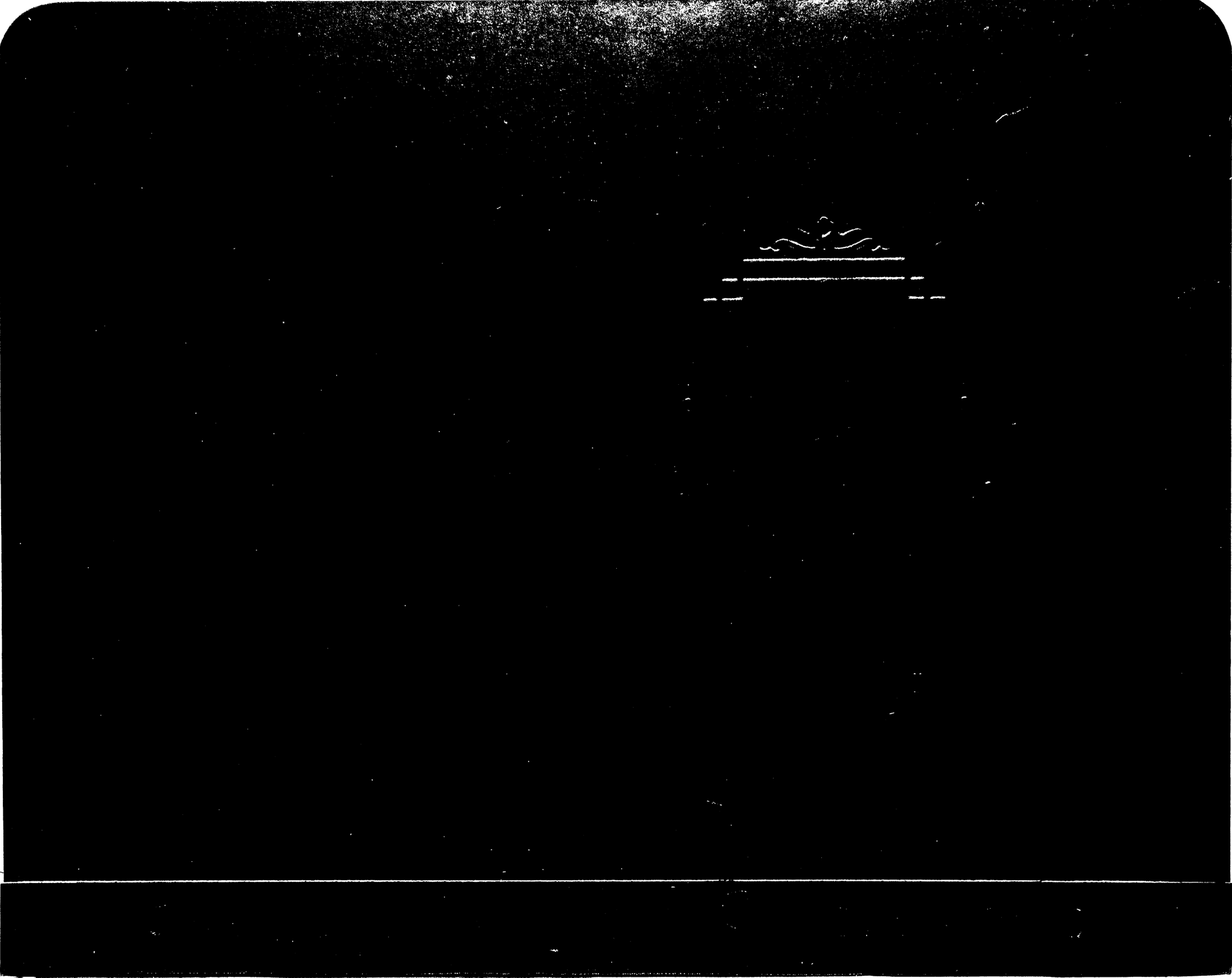
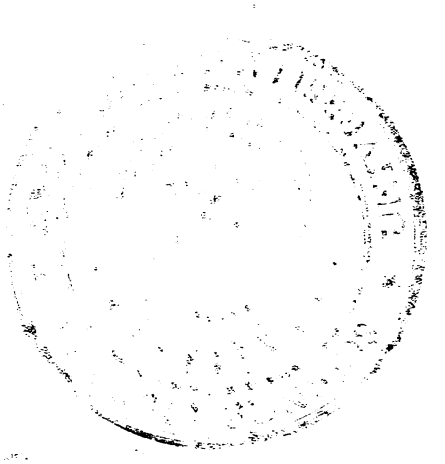
GEOLOGY OF THE BLOWOUT CANYON AREA, SNAKE RIVER RANGE, IDAHO

J.A.McIntosh





GEOLOGY OF THE BLOWOUT CANYON AREA, SNAKE RIVER RANGE, IDAHO

Joseph A. McIntosh

Submitted in partial fulfillment
of the requirements for the degree
of Master of Science in Geology,
University of Michigan, 1947

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INTRODUCTION

Location of area

The Blowout Canyon area, as shown on plate 1, is part of the Snake River Range of Idaho and Wyoming. The Snake River Range is bounded on the north by the Teton Range and on the south by the Snake River Canyon and the Salt River Range. Grand and Swan Valleys, Idaho, lie at the western front of the Snake River Range and separate it from the Carabou Range. The Snake River Range trends northwest-southeast and is cut diagonally by the Idaho-Wyoming state line.

The Blowout Canyon area is on the east side of the Irwin Quadrangle of Idaho. The south side of the area is bounded by Indian Creek, the west by the Snake River, the north by Elk Creek, and the east by a north-south line through Powder Peak.

Blowout Canyon is located on the west side of the area and midway between Elk and Indian Creeks. Because it is the most striking physiographic feature, it has been chosen as a suitable name for the area.

Purpose of study

The purpose of the report is twofold; first, to partially fulfill the requirements for a Master of Science Degree in Geology, and second, to contribute to the geology of western Wyoming and eastern Idaho, specifically of the Snake River Range.

Acknowledgements

The geological mapping and field work for this report was done during the summer of 1946 under the direction of A. J. Eardley of the staff of Camp Davis. In the field, Richard Enyert and Orhan

SCALE IN MILES

0 25 50 75 100

INDEX MAP

Baykal, graduate students at Camp Davis, accompanied the author most of the time and assisted him in the work. To these men the author is especially grateful.

STRATIGRAPHY

Cambrian system

Flathead quartzite.-The Flathead quartzite is not exposed in the Blowout Canyon area, but it is believed to exist below the surface. It is found to the north in the Teton Range at the base of the Paleozoic lying unconformably on pre-Cambrian rocks. It is a resistant, orthoquartzite with a well developed basal conglomerate. The siliceous grains of the quartzite are uniform in size and cemented in a siliceous matrix. In the Teton Pass area its thickness is 240 feet (Horberg, 1938, p. 12). The type locality for this Middle Cambrian quartzite is at Flathead Pass, Montana where its thickness is 125 feet (Peal, 1893, p. 20).

Gros Ventre formation.-The Gros Ventre formation has three members. The lowest of the three is a grayish-green, soft, micaceous shale with some interbedded chloritic and hematitic shales. The member, measured by Blackwelder (1918, p. 417) in the Gros Ventre Range, was 400 feet thick. It may be more in the Blowout Canyon area because of a general westward thickening of Paleozoic and Mesozoic sediments in the Rocky Mountain geoshycline.

The middle member is known as the Death Canyon limestone which is thin-bedded, dark gray, and mottled with rust color. It is fine-grained with some brecciated beds. It was described and named by Miller (1936, pp. 119-120). Gardner (1944, p. 10) found the middle member of the Gros Ventre formation to be 450 feet thick in Palisades Creek a few miles to the north of the area of this report.

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
Permain	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

The upper member is a grayish-green, paper-thin shale with some flat pebble conglomerates, pebbly limestones, and algae reefs. Gardner (1944, p. 10) found its thickness to be 240 feet. This member is the only part of the Gros Ventre formation exposed in the Blowout Canyon area. It crops out on Indian Creek above the trace of the St. John thrust. Horberg (1938, pp. 13-14) placed the Gros Ventre formation in the Middle Cambrian.

Boysen limestone.- The Boysen limestone is found as the bottom formation in the Needle Peak and Ferry Peak thrust sheets. It is a thin-bedded, bluish-gray, fine-grained, locally oolitic limestone that weathers to a pitted surface with a typical rust colored mottling. It lies unconformably on the Gros Ventre formation. The Boysen limestone, as measured by Gardner (1944, p. 10), is 240 feet thick. Originally this formation was named the Gallatin limestone by Peal (1893, p. 22-25). Deiss (1938, p. 1104) correlated it with the upper Cambrian Boysen in the Wind River Canyon, Wyoming, and Gardner has followed Deiss in the use of the term in the Snake River Range.

Ordovician system

Bighorn dolomite.- The Bighorn dolomite is found in the Blowout Canyon area as the upper formation in the Needle Peak and Ferry Peak thrust sheets. See geologic map, plate 3. It is massive, light gray to cream colored and weathers to a dark gray with a pitted surface. It is resistant and a cliff former. The upper and lower sections are impure, and some red to brown sandstones and shales are found in the upper. The thickness of the Bighorn dolomite in this area is 400 feet. Darton (1908, p. 395) described the Bighorn as found in its type locality on the east side of the

Bighorn Mountains where he measured 200-300 feet of it. In the Tetons 300 feet are reported. The Bighorn dolomite in the Snake River Mountains is believed to be Ordovician in age, although no fossil evidence has been found.

Devonian system

Darby formation.-The Darby formation is found in the St. John thrust sheet on Indian Creek and in Dry Canyon. See geologic map, plate 2. It is a massive to thin-bedded, brown to gray dolomite with a high iron sulfide content. Some gray to black shales and sandstones are present. The thickness in the Snake River Range is 570 feet (Gardner, 1944, p. 10). Blackwelder (1918, p. 420) described this formation in Darby Creek in the Tetons and placed it in the Devonian.

Mississippian system

Madison formation.- The Madison formation, which makes up most of the upper surface of the St. John thrust sheet in the area, is also found under the sheet on Indian and Elk Creeks (see geological map, plate 3). It is a massive to thin-bedded, bluish-gray limestone. It is coarse to fine-grained with chert concretions in the upper part and is a cliff former. The thickness of the Madison in the Snake River Range is approximately 1160 feet (Gardner, 1944, p. 9). In its type locality in the Madison Range, Montana, it is 1250 feet thick (Mansfield, 1927, p. 60). Mansfield placed it in the Lower Mississippian.

Brazer limestone.- The Brazer limestone was mapped along with the Madison formation in the area and crops out in the St. John thrust sheet (see geologic map, plate 2). It is a massive, lithographic, dark gray limestone with many calcite veinlets. It has

interbedded breccias and locally some gypsum near the top. Gardner (1944, p. 9) found the formation to be 265 feet thick just north of the Blowout Canyon area. Richardson (1913, pp. 407-413) described the Brazer limestone in its type locality in Brazer Canyon, Utah, and found it to be 800 to 1400 feet thick. It is Upper Mississippian in age (Mansfield, 1927, p. 71).

Pennsylvanian system

Amsden formation.- The Amsden formation was mapped along with the Tensleep sandstone as the Wells formation. In the area covered by this report, the Amsden,as the lower part of the Wells, is exposed on Indian Creek underlying the fault trace of the St. John thrust and conformably overlying the Madison-Brazer formation. It is also the upper formation of the St. John thrust sheet in the area of Powder Peak (see geological map, plate 2). The Amsden is a gray to yellow sandstone and quartzite together with gray, cherty limestone and dolomite. The type locality is the Amsden Branch of the Tongue River, Wyoming. Bachrach (1945) states that the Amsden is possibly transitional from Upper Mississippian to Lower Pennsylvanian.

Tensleep sandstone.-The Tensleep sandstone, mapped as a member of the Wells formation, is exposed in the St. John thrust sheet in the area of Powder Peak (see geological map, plate 2). The Tensleep has three members. The lowest is a white to gray quartzite and sandstone. The middle member is a yellow to brown quartzite and sandstone. The upper member is interbedded, gray to yellow sandstone, dolomite and limestone. The quartzites and sandstones are even grained, well cemented and cliff formers. The weathered surfaces are gray to black and form distinctive talus slopes. The Tensleep is 1140 feet thick in the Snake River Range (Gardner, 1944,

p. 9). Darton (1904, pp. 394-401) described this sandstone in its type locality in Tensleep Canyon, Wyoming, where he found exposures of it 200 feet thick and Pennsylvanian in age.

Permian system

Phosphoria formation.-The Phosphoria formation crops out on Indian Creek in the eastern end of the area under the St. John thrust sheet (see geological map, plate 2) where the Phosphoria is found in the Camp Davis area, it consists of a lower 29 feet of black phosphatic shale and an upper 147 feet of cherty fossiliferous limestone. The top 40 feet of the upper member is the Rex chert. In Phosphoria Gulch, Idaho, its type locality, it was found by Richards and Mansfield (1912, pp. 683-80) to be absent in places and in others to range up to 627 feet thick. It was placed in the Permian.

Triassic system

Dinwoody formation.-The Dinwoody formation is the only Triassic formation exposed in the Blowout Canyon area. It crops out in southeastern corner of the area under the St. John thrust sheet (see geologic map, plate 2). The Dinwoody formation is a thin-bedded, grayish-green lime siltstone, 760 feet thick (Gardner 1944, p. 8). It weathers tan, has a few resistant limestone beds, and contains some phophatic and calcareous shales. Blackwelder (1918, p. 425) named the formation for its exposure in Dinwoody Creek in the Wind River Range, Wyoming, where he measured 200+ feet of it. Newell and Kummel (1942, p. 41) placed this formation in the Lower Triassic.

Woodside formation.-The Woodside formation, not exposed in the area, is a thin-bedded, fine-grained, red shale and 1130 feet

thick (Gardner, 1944, p. 8). Boutwell (1907, pp. 439-458) measured the Woodside in Woodside Gulch of the Park City district Utah, and found 1180 feet of it. Newell and Kummell (1942, p. 941) placed it in the Lower Triassic.

Thaynes limestone.-The Thaynes limestone, not exposed in the area, is thin-bedded, silty, blue-gray in color, weathers to a buff color, and is interbedded with gray to brown calcareous sandstone. Gardner (1944, p. 8) measured 1000 feet of the Thaynes and Gray (1944, p. 22) found 970 feet of it in the Snake River Range. Boutwell (1907, p. 448-452) named the Thaynes formation from Thaynes Canyon in the Park City district, Utah. Newell and Kummell (1942, pp. 447-448) placed the Thaynes in the Lower Triassic.

Ankareh formation.-The Ankareh formation is not exposed in the Blowout Canyon area. It is a red shale interbedded with a fine-grained, red sandstone and gray quartzite. Just to the north of the Blowout Canyon area, Gardner (1944, p. 8) measured 550 feet of this formation. Boutwell (1907, p. 439), who first described the Ankareh formation, measured 1300 feet of it on Ankareh Ridge, Park City district, Utah. Mansfield (1927, p. 374) placed it in the Middle to Upper Triassic.

Jurassic system

Nugget sandstone.-The Nugget sandstone, not exposed in the area, is massive to thin-bedded, white to tan to red and locally quartzitic. In that area there are 350 feet of the Nugget sandstone (Gray, 1946, pp. 21-26). North of the Blowout Canyon area Gardner (1944, p. 7) measured 340 feet of the Nugget. Veatch (1907, p. 56) described 1900 feet of this formation at Nugget Station, Wyoming. Mansfield (1920, p. 52) restricted the name Nugget to the upper

member as defined by Veatch. Mansfield (1927, p. 87) placed the Nugget in the Lower Jurassic.

Gypsum Springs formation.- The Gypsum Springs formation does not crop out in the area. It is a splintery, shaley, gray limestone and limy shale with some interbedded red shale and is 285 feet thick (Gardner, 1944, p. 7). Preliminary Chart 14, U.S.G.S. (Love, et al., 1945) gives the latest information on the distribution and detailed lithology of the Gypsum Springs formation and places it in the Middle Jurassic.

Twin Creek formation.- The Twin Creek formation is an Upper Jurassic (Imlay, 1945, pp. 1019-1022) limestone not exposed in the Blowout Canyon area. The lower member of the Twin Creek formation in the Camp Davis area is a splintery, gray, calcareous shale and shaley limestone and is 615 feet thick. The top 300 feet of the lower member have abundant Gryphea nebraskensis. The upper member is a massive, oolitic, gray limestone that is 50 feet thick. Gardner (1944, p. 7) measured 685 of the Twin Creek formation north of the Blowout Canyon area. Veatch (1907, p. 56) first described the formation in Twin Creek, Wyoming,and measured 3,500 feet of it. Imlay (1945, pp. 1019-1022) placed it in the Middle to Upper Jurassic.

Preuss sandstone.- The Preuss sandstone is not exposed in the Blowout Canyon area. In the Camp Davis area, it is a thin and cross-bedded, fine-grained, red to green to white, calcareous sandstone and 120 feet thick. To the north, Gardner (1944, p. 7) measured 55 feet of a poorly exposed outcrop of the Preuss. Mansfield and Roundy (1916, pp. 76-81) recorded 1,300 feet of it in Preuss Creek, Idaho. Mansfield (1927, p. 99) placed the Preuss sandstone in the Upper Jurassic.

Stump formation.- No outcrops of the Stump formation exist in the area. In the Camp Davis area, to the east, the Stump formation is a thin-bedded, fine-grained, green to green-gray sandstone with some calcareous sandstone near the base. It contains an abundance of glauconite, and Belemites and Pentacrimes columnals are present, and is 100 feet thick. Gardner (1944, p. 7) measured 140 feet of the Stump sandstone. Mansfield and Roundy (1916, pp. 76-81) measured up to 600 feet of the stump in Stump Creek, Idaho. Mansfield (1927, p. 101) placed the Stump formation in Upper Jurassic.

Cretaceous system

Gannett formation.-Though not exposed in the Blowout Canyon area, the Gannett formation crops out in the Snake River Canyon just east of the Absoraka Fault. It is composed of three members; the lower is a light gray sandstone and red shale; the middle is a massive, light gray, lithographic limestone; the upper is gray shale and limestone. In the Snake River Range it is 940 feet thick (Gardner, 1944, p. 7). Mansfield and Roundy (1916, pp. 76-83) named this formation for Gannett Hills, Idaho and Wyoming, and placed it in the Lower Cretaceous.

Bear River formation.- The Bear River formation, though not outcropping in the area, is exposed at other locations in the Snake River Range. It is composed of a basal, brown quartzite, a mid-section of interbedded black shales and tan sandstones, which are cliff makers and an upper section of interbedded black shales, then sandstones and limestones. Some of the black shale partings contain numerous mollusca. Gardner (1944, p. 7) measured 800 feet of the Bear River formation. Dobrovolny (1938, p. 47) reported 970 feet

of the formation in the Camp Davis area. Veatch (1907, p. 63) placed the Bear River formation in the Upper Cretaceous. Aurelle La Rocque, a University of Michigan graduate student, after collecting in the Camp Davis area during the summer of 1946, tentatively places this formation in the upper part of the Lower Cretaceous.

Aspen formation.- No exposure of the Aspen formation is present in the area. In the Camp Davis area, the formation has two members, a lower gray-green, salt and pepper sandstone that is interbedded with black shales and an upper gray-green porcellaneous, vitrified, rhyolite tuff interbedded with tuffaceous siltstones. The total thickness in the Camp Davis area is 960 feet. Gardner (1944, p. 7) measured 2,015 feet of the Aspen north of the Blowout Canyon area. Veatch (1907, p. 64-65) named the Aspen formation for exposures near Aspen Station, Wyoming and placed it in the Upper Cretaceous.

Frontier formation.- The Frontier formation is not exposed in the area of this report. As described by Dobrovolny (1940, p. 441-442), it consists of interbedded gray to buff, arkosic sandstones and buff siltstones. Several coal seams are present in the middle of the Frontier formation. In the Wyoming Range, the Frontier was measured by Ross and St. John, graduate students at Camp Davis, during the summer of 1946 and found to be over 5,200 feet thick.

Eocene series

Hoback formation.-The Hoback formation, not exposed in the Blowout Canyon area, is found in the Hoback Basin 30 miles to the east. It consists of interbedded gray sandstones and shales with lenses of conglomerate and impure freshwater limestone beds. The Hoback formation is approximately 15,000 feet thick (Eardley,et al,

1944). Its base is not exposed. It is Lower Eocene in age (Eardley, et al., 1944).

Pass Peak formation.- The Pass Peak conglomerate is exposed in the Hoback Basin where it rests unconformably on the Hoback formation. It is a coarse red to gray conglomerate with sandstones and shales in its upper part. Percussion marks are characteristic of the conglomerate pebbles. The Pass Peak is about 2000 feet thick and is Middle Eocene in age (Eardley, etal., 1944).

Miocene series

Camp Davis formation.-The Camp Davis formation is exposed along the western front of the Snake River Range in the Blowout Canyon area. Its lateral extent is from Grand Valley, two miles northeast onto the mountain front with an isolated exposure six miles up the North Fork of Indian Creek. In Grand Valley, the Camp Davis formation is composed of four members; a lower andesite, a compacted silt, an upper andesite, and a tan and gray conglomerate. Only the conglomerate is exposed in the Blowout Canyon area.

The lower andesite is a massive and dark gray zeolitic hypersthene augite andesite (Mielenz, 1946, p. 3). Fractures are common and usually filled with calcite. The andesite is slightly vesicular, but because it has indurated the overlying sediments to a maximum of eight feet and transgresses the bedding planes of the sediments in places, the andesite has been called a sill (Mielenz 1944, p. 4). It is approximately 1,200 feet thick and rests unconformably on the Triassic on the west side of the Snake River. The age of the intrusion could not be determined, but due to the similarity to the upper andesite, it is assumed to be post-gray conglomerate and pre-tan conglomerate (Enyert, 1947, p. 18).

The compacted silt member lies conformably between the lower and upper andesites. The silt member is well stratified and composed of comparatively soft or hard silts, clays, sands, and lenses of tuffs (Mielenz, 1946, p. 1). In cuts made by the Bureau of Reclamation, the andesites and silts all have a dip to the northeast at the same angle. The silt member is approximately 800 feet thick.

The upper andesite member is the same lithologically as the lower andesite and is 300-1000 feet thick. The gray conglomerate rests conformably on the upper andesite, and because the tan conglomerate rests unconformably on the gray conglomerate, it is probable that the andesites were intruded toward the end of the deposition of the gray conglomerate (Enyert, 1947, p. 18).

The conglomerate is divided into two parts, a lower gray and an upper tan. The gray conglomerate is firmly cemented and consists of rounded to sub-angular Madison-Brazer fragments. Its thickness, measured graphically is 2-300 feet.

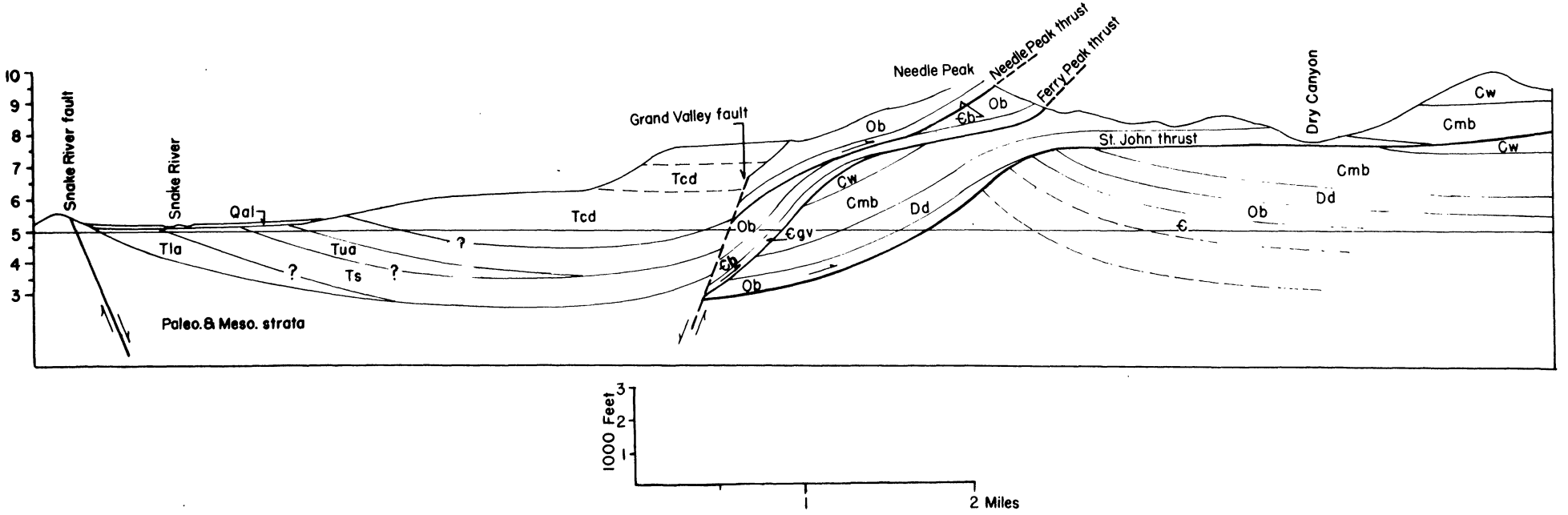
The upper tan conglomerate is composed of fragments of the following formations in the approximate percentages: 66% Madison-Brazer, 24% Wells, 4% Darby, 4% Bighorn, and 2% Boysen. The diamenter of the fragments varied from 1 mm to 1 foot with the finer fragments acting as the cementing material. Pebbles of approximately $\frac{1}{2}$ inch diameter were used in making the count. Measured graphically the tan conglomerate was found to be 3000 $\pm$ feet thick. It is separated from the gray conglomerate by an erosion interval and is unconformable on the gray in the area of the Snake River, but to the northeast it appears to be disconformable.

The total thickness of the Camp Davis formation is 5,500 - 6300 $\pm$ feet. It rests unconformably on Triassic formations along

the west side of the Snake River, as it does in its type locality along the west slope of the Hoback Range.

Veatch (1907, pp. 76-87) originally referred to the Camp Davis as the Almy conglomerate, Paleocione in age, and Kirkham (1927, pp. 29-30) called it the Salt River formation. (Eardley, et al., 1944) described it as the Camp Davis formation of upper Miocene or lower Pliocene age. The manner of deposition according to Eardley (1942, p. 1800) is as follows: initial folding and thrusting during Laramide time, followed by high angle normal faulting; the high angle faulting formed the trough in which the Camp Davis was accumulated. As the escarpment was dissected by erosion, it contributed to the deposition which buried the fault scarp. The age of the Camp Davis was determined after the finding of an upper Miocene or lower Pliocene horses tooth in the fresh-water limestone which is near the base of the formation in its type locality (Eardley, et al., 1942, p. 1800).

This conglomerate formation in the Blowout Canyon area is similar lithologically and structurally to the Camp Davis in its type locality. Laramide thrusts cut by a later high angle fault that formed a trough for the accumulation of the conglomerate are in evidence. The age assigned is upper Miocene or lower Pliocene.



Cross-section, along line A A', of geologic map, pl. 3, of the Blowout Canyon area, Snake River Range, Wyoming — Formations — €gv, Gros Ventre formation; €b, Boysen limestone; Ob, Bighorn dolomite & Leigh formation; Dd, Darby formation; Cmb, Madison–Brazer formation; Cw, Amsden formation & Tensleep sandstone; Camp Davis formation: Tcd, conglomerate, Tua, upper andesite, Ts, compacted silts, Tla, lower andesite; Qal, alluvium.

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PLATE 3

STRUCTURE

Laramide structures

Palisades thrust complex.- The Palisades thrust complex, as found in the Blowout Canyon area, is composed of three thrust sheets (see plates 2 and 3). The upper two are believed to be branches that originate at depth from the main thrust. The three thrust sheets have been given the following names from top to bottom; the Blowout thrust; the Needle Peak thrust, and the Ferry Peak thrust. This complex forms the west side of the Snake River Range in the Blowout Canyon area. The trend of the Palisades complex is northwest, and the dip is approximately 55° for the upper two thrust and 20° for the lower one. The northern limit of the complex is not known, but it was traced to Palisades Canyon six miles north of Elk Creek.

The Blowout fault can be traced northwest from Elk Creek (see geologic map, plate 2) and south from the southside of Blowout Canyon to the junction of the North and South Forks of Indian Creek. Between Elk Creek and Blowout Canyon and south of Indian Creek it is covered by the Camp Davis conglomerate. The Boysen limestone is the only erosional remnant exposed in the Blowout thrust sheet, and it overlies the Bighorn dolomite in the Needle Peak thrust sheet. This gives a stratigraphic throw of just the thickness of the Bighorn which is 400 feet. The minimum dip slip, however, is undoubtedly much greater.

The Needle Peak thrust is the middle sheet in the Palisades complex, and its fault can be traced north-westward from Needle Peak and south from the junction of the North and South Forks of

Indian Creek (see geologic map, plate 2). Between Needle Peak and Indian Creek it has been overridden and covered by the Blowout thrust sheet. The Needle Peak thrust sheet, in all of its exposures, is composed of two formations, the Boysen limestone and the Bighorn dolomite. The Boysen, being the lower of the two, overlies the Bighorn dolomite, which is the upper formation of the Ferry Peak thrust sheet, so that the stratigraphic throw is 400 feet. The minimum breadth of the thrust sheet in the Blowout Canyon area is approximately two miles.

The Ferry Peak thrust sheet is the lowest one in this complex. It can be traced northward from the north side of Blowout Canyon at the base of Needle Peak (see geologic map, plate 2). South of its exposure in Blowout Canyon, the Ferry Peak sheet is overridden and covered by the Blowout Canyon thrust sheet. Like the sheet above it, the Ferry Peak sheet is composed of the Boysen limestone and the Bighorn dolomite. It lies disconformably on the Madison formation so that the stratigraphic throw is approximately 2,300 feet. The minimum breadth of the Ferry Peak thrust is approximately two miles.

St. John thrust.- Below and extending to the east of the Palisades complex is the St. John thrust sheet. The trend of this structure is northwest, and the dip at the root zone varies from 40° southwest on the North Fork of Indian Creek (see geologic map, plate 2), to nearly horizontal at the junction of Elk Creek and Dry Canyon. The trace of the St. John thrust can be followed from Indian Creek northeastward to the east boundary of the area. It can also be followed from Elk Creek northeastward to the boundary of the area.

The lowest formation exposed in the St. John sheet is the upper Gros Ventre shale; the upper most is the Wells (Amsden-Tensleep) sandstone. The thrust sheet, at its lowest exposure on Indian Creek overlies the Madison formation, giving a stratigraphic throw of 2,600 feet. On Elk Creek at the lowest exposure of the St. John thrust, the Madison formation is basal member of the thrust sheet, and it overlies Madison below the thrust.The minimum breadth of the thrust is approximately 12 miles.

Indian Creek fold.-Along Indian Creek below the St. John thrust sheet (see geologic map, plate 2) and truncated by it is a folded series of formations ranging from Madison to Triassic. They dip 15° east near the root zone of the overlying thrust and flatten eastward. The strike of this structure is north-south. On Elk Creek near the northeast corner of the Blowout Canyon area the Indian Creek fold was found to lessen in dip as shown by the slight east dip of the Madison and Wells (Amsden-Tensleep) formations, under the St. John thrust sheet. The Indian Creek fold probably originated during the stage of folding which preceeded the thrusting of the St. John fault.

Mid-Tertiary structures

The Grand Valley fault.-The existence of the Grand Valley fault was postulated from the presence of calcareous spring deposits and the alignment of fresh water springs along the front of the Snake River Range. It is thought to be a normal high angle fault trending northwest with the down thrown side on the southwest. From erosional products of the upthrown block a fanglomerate was deposited at the base of the fault scarp and against it. This same relationship is present in the Camp Davis area where the scarp

of the Hoback fault has been covered by the Camp Davis formation, mostly a fanglomerate. The Camp Davis formation accumulated in a trough formed by the Hoback fault, and the fault may have been active during the initial stages of accumulation of the conglomerate (Eardley, personal communication). As in the Blowout Canyon area, the conglomerate overlapped the fault scarp. If this interpretation of the relation of faulting to conglomerate is correct, the ages of the two occurrences are practically the same. The age of the conglomerate was established after the finding of an upper Miocene or lower Pliocene horse tooth (Eardley, 1942, p. 1800). From all observations, the Grand Valley fault in the Blowout Canyon area is similar to the Hoback fault. The conglomerate overlapped and buried the fault scarp, and at no point in the area has erosion exposed it. The probable position of the fault is shown on the geologic map (plate 2)

The Snake River fault.- The Snake River fault (see geologic map and cross section, plates 2 and 3) is evidenced by a prominent escarpment along the west side of Grand Valley. Calcareous hot springs deposits near the base of the escarpment mark its presence. Kirkham (1924, plate 5) first mapped the Snake River fault with Paleozoic and Mesozoic strata on the upthrown or southwest side, and the Camp Davis formation with Mesozoic strata on the downthrown side.

Camp Davis fold.- The Camp Davis fold is a gentle fold existing only in the Camp Davis formation. The dip near the Snake River is approximately 30° east but it decreases northeastward. Along the front of the Snake River Range the beds are horizontal (see cross section, plate 3). Two explanations for this fold are

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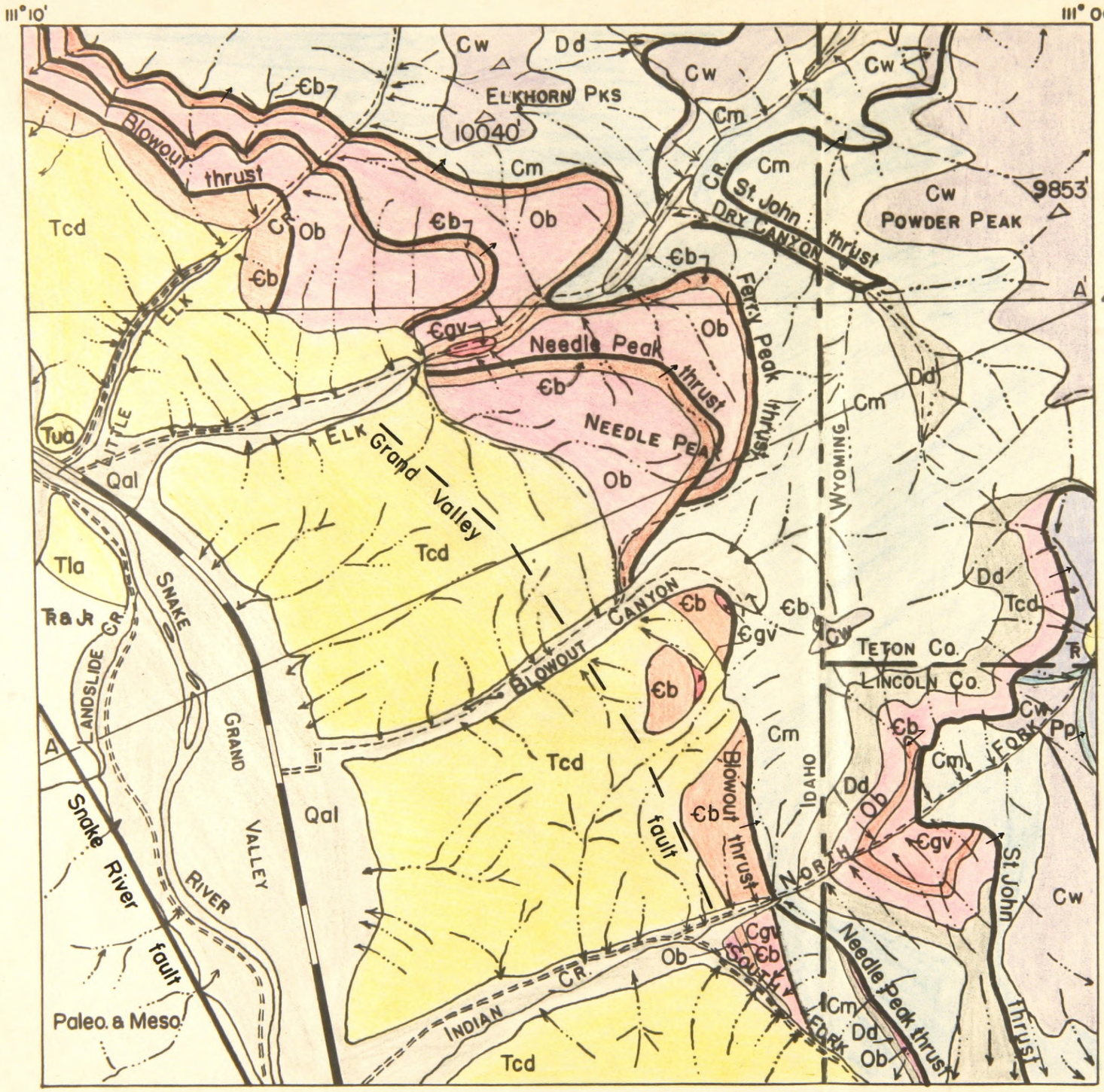


Base Map: NE 1/4 of Irwin Quad.
Idaho–Wyo., U.S.G.S., 1935.

GEOLOGIC MAP, BLOWOUT CANYON AREA, IDAHO

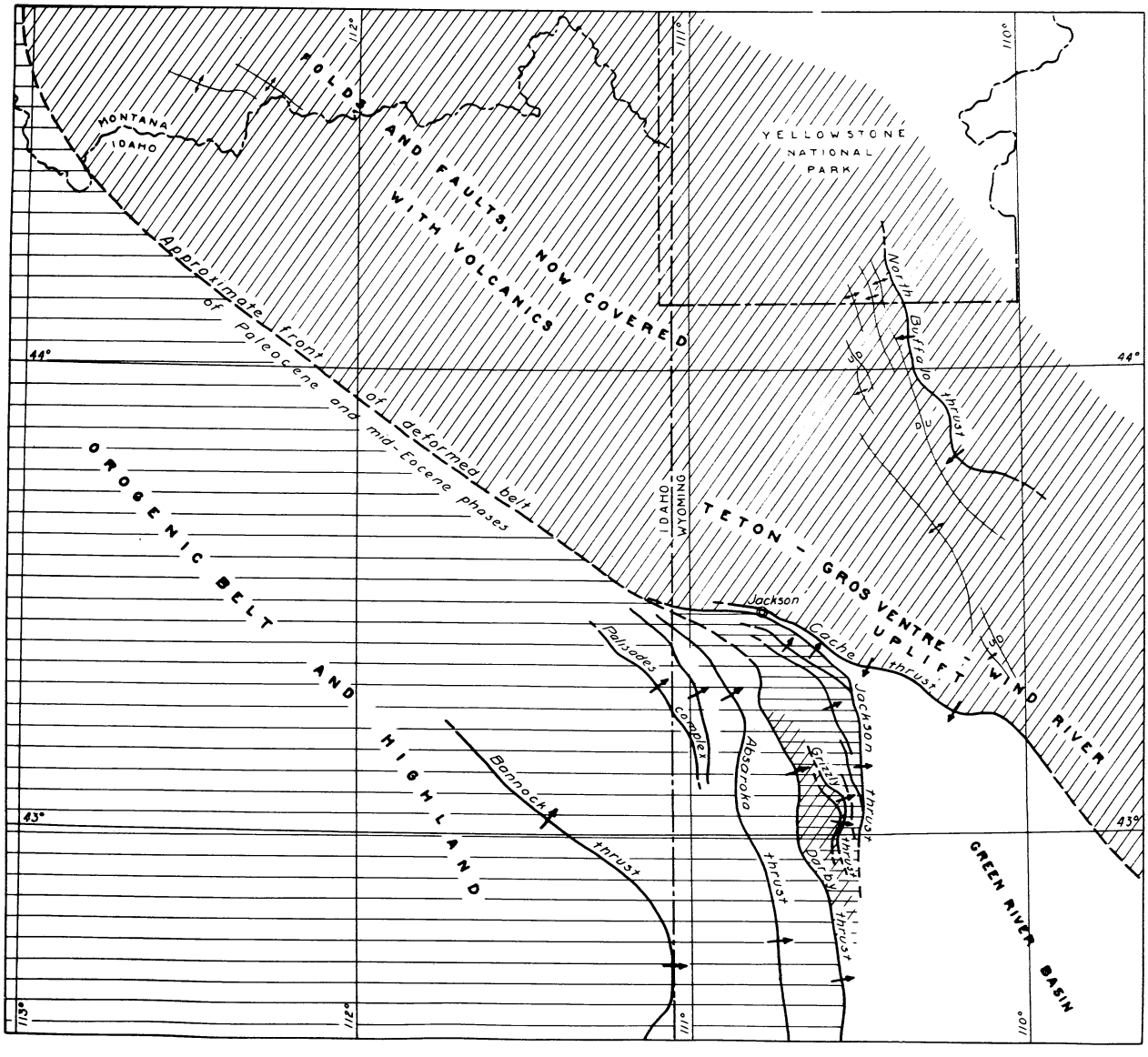
–LEGEND–

Tcd	Camp Davis conglomerate	Tertiary
Trd	Dinwoody formation	Triassic
Pp	Phosphoria formation	Permian
Cw	Wells formation	Carboniferous
Cmb	Madison–Brazer limestone	Carboniferous
Dd	Darby formation	Devonian
Ob	Bighorn dolomite	Ordovician
€b	Boysen formation	Cambrian
€gv	Gros Ventre formation	Cambrian

SCALE

0 1 2 Miles

PLATE 2.



AFTER EARDLEY

possible; first the Snake fault could have had renewed movement with the northeast side moving up; second, and more logical explanation, renewed normal movement along the Snake River fault with southwest side dragging the Camp Davis formation up with it.

Relation of local structures to regional

In western Wyoming and eastern Idaho two structural provinces exist; a shelf zone and a geosynclinal zone, both deformed by compressional forces (Horberg, 1938, p. 28). The Gros Ventre, Wind River, and Teton Mountains were developed from the shelf zone strata. The ranges are all characterized by broad asymmetrical folds, and are all to the north and east of the Blowout Canyon area. To the southwest the Snake River, Wyoming, and Salt River Ranges were formed in the zone of geosynclinal sediments. Large overthrust sheets of Paleozoic and Mesozoic strata characterize these ranges (see tectonic map, plate 4). Two of the well known thrusts that developed in the geosynclinal zone are the Darby and Absaroka. In this system of thrusts are the St. John and Palisades Complex, all passing through the Blowout Canyon area.

A system of high angle faults forming rift-like intermontaine structural valleys extend northward from the Basin and Range Province into eastern Idaho, western Wyoming (Eardley, personal communication). The structures transgress the folds and thrusts in both the geosynclinal and shelf zones and are of a younger age. In the Blowout Canyon area, Grand Valley, bounded by the Grand Valley and Snake River faults, is one of these rift type (see cross-section and geological map, plates 2 and 3). To the east, the Jackson Hole area, along with the Teton and Hoback high angle faults, is another of these intermintaine structural valleys (Eardley, personal

communication).

Age of thrusting

The Laramide orogeny, of which the thrusts in the Blowout Canyon area are a portion, has been divided into three stages (Eardley, personal communication). In north central Utah the Darby and Absaroka thrusts were observed to be overlapped by the lower Paleocene Almy conglomerate. In the Camp Davis area, the upper-Paleocene Hoback formation was formed of sediments from the Darby and Absaroka thrust sheets. Therefore, the first stage of the Laramide thrusting which includes the St. John and Palisades Complex in the Darby and Absaroka system, is pre-Hoback or pre-upper Paleocene. The second stage of the Laramide orogeny is found in the Jackson thrust (see tectonic map, plate 4) which cut the Hoback formation. Overlapping the Jackson thrust is the Pass Peak conglomerate. This deposit developed of sediments eroded from the highlands along the Jackson thrust front. The Pass Peak conglomerate of middle Eocene age post-dates the second stage of the Laramide orogeny. The third stage occurred with the movement of the cache and Grizzly thrusts. (see tectonic map, plate 4). The two thrusts cut the Pass Peak conglomerate and are overlapped by the Camp Davis conglomerate which is of upper Miocene or lower Pliocene age (Eardley, personal communication). Therefore, the final stage of Laramide thrusting can be dated as from post-middle Eocene to pre-upper Miocene. From this description of age relations it is seen that only the initial stages of the Laramide orogeny are in evidence in the Blowout Canyon area.

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