Spring 1-1-1930

Geological Report of the Shoshone Region, Idaho

Eldred R. Harrington

GEOLOGIC REPORT OF THE SHOSHONE REGION, IDAHO

HARRINGTON

GEOLOGIC REPORT

OF THE

SHOSHONE REGION, IDAHO.

By

Eldred R. Harrington

A Thesis Submitted For The Degree

Of Master Of Arts In Geology

University Of New Mexico

1930

Abstract

This report sets forth the results of a five year study of the Shoshone region, Idaho. The region is situated in south-central Idaho on both sides of the Snake River. The southern and larger part of the region lies in the Columbia River Plateau province while the northern and smaller part of the area lies in the Northern Rocky Mountain province.

The greater part of the region is a plain built up of lake beds and basalt flows. The Snake River has cut a deep canyon across this built-up plain. The region is partially covered by a loess-like soil and about one-fifth of the area is under cultivation. The un-irrigated portion is mostly covered with sagebrush.

Geologic history of the area begins with a long period of sedimentation followed by regional metamorphism and erosion in pre-Cambrian times. Sedimentation was the dominant feature in the Paleozoic. The Mesozoic was a period of intense folding and erosion with batholithic intrusions near its close. Peneplanation during the Eocene was followed by crustal movements which dammed the Snake River forming the ancient Lake Payette. The Miocene period was marked by the filling of this lake by sedimentary beds and lava flows. The earlier rhyolite flows were followed by numerous basalt flows which continued almost to the present.

The rocks exposed in the region consist of Miocene rhyolites and andesites, Miocene (?) granite, Miocene lake beds, Pliocene and Pleistocene basalt, and Quaternary alluvium. More than half of the region is covered with the basalt. A number of basalt cones rise from three hundred to eight hundred feet above the plain. Black Butte, one of these cones, is the point of origin for one of the youngest lava flows in the State. This flow contains many caves, one large one being partially filled with ice all the year round. A new and original hypothesis for existence of ice caves is presented.

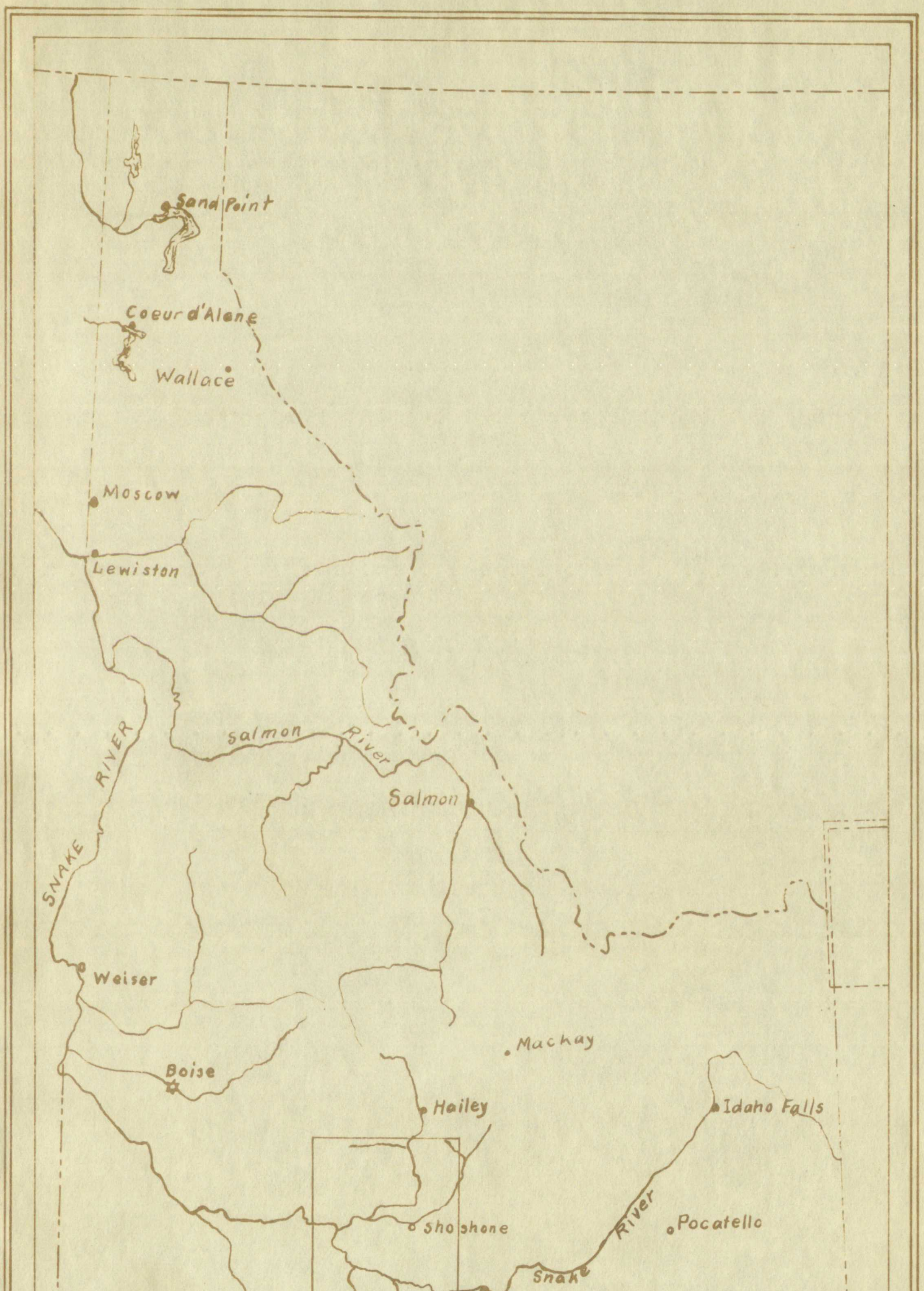
The district is supported by farming and stock raising. There is a little dry farming among the mountain foothills to the north but the larger part of the farmers is dependent upon irrigation. Some placer mining was done in the region at one time but was abandoned after several unsuccessful trials.

The Snake River canyon offers scenic attractions such as water-falls, rapids, alcoves, and very large canyon springs. The canyon offers ideal sites for hydro-electric plants. About 30,000 horse power is generated in the region at present,- this being only one-fourth of the possible total.

Shoshone Falls deserves special mention as a scenic attraction. The height of the falls is 219 feet which is more than fifty feet higher than Niagara.

An areal geology map and several cross-sections accompany the report which is further illustrated by numerous photographs.

CONTENTS



SKETCH MAP SHOWING THE LOCATION AND APPROXIMATE EXTENT OF THE DISTRICT DESCRIBED

INTRODUCTION

Scope of the Report

This report sets forth the results of the writer's study of the Shoshone region. This study has been pursued over a period of five years. Surrounding regions have been studied and an effort made to correlate the formations of this district with surrounding districts. The area has first been treated as a unit in order to bring out the broad relationships it bears to surrounding districts. The various sections have then been taken up separately. Such an arrangement involves certain repetitions which are thought to be justifiable. At the end of the report, special attention has been given to the treatment of erosional phenomena, economic problems, and scenic attractions of the region.

Acknowledgements

No report, to the writer's knowledge, has ever been prepared on this region. Reports on surrounding regions in Idaho and Oregon have been examined and the works of Clyde P. Ross, Joseph B. Umpleby, Virgil R. D. Kirkham,

Harold T. Stearns, Israel C. Russell, and G. H. Girty have been of special value. The geologic map of the region was prepared from a base map of the Idaho State Highway. Technical assistance was received from the Idaho State Bureau of Mines and Geology and from Dr. F. B. Laney, Head of the Geology Department of the University of Idaho. Valuable personal assistance was given the writer by A. B. Ashline, S. T. Baer, Lynn Crandall, C. M. Mangun, S. H. Chapman, and Robert Scanlan. The last two names are the originators of the theory of ice formation in caves which is given under the discussion of Black Butte.

GEOGRAPHY

Situation and Access

The Shoshone region as herin described is in the south-central part of Idaho on both sides of the Snake River. It incloses parts of Blaine, Camas, Gooding, Jerome, Lincoln, and Twin Falls Counties. Shoshone is approximately the geometric center of the district. The Oregon Short Line Railroad crosses the district from east to west passing through Deitrich, Shoshone, Bliss, and Gooding. Wendell, Jerome, and Eden are served from a branch line through Bliss. A similar branch line from

Minidoka goes through Murtaugh, Kimberley, Twin Falls, Filer, and Buhl. Two lines leave from Shoshone. One goes through Richfield, Fairfield, and Hill City. The other runs through Richfield, Picabo, and Gannett, and on to the north to Hailey and Ketchum. All of the above-mentioned branch lines are operated by the Oregon Short Line Railroad.

An automobile stage makes daily trips between Shoshone and Twin Falls. Large motor busses run twice daily between Twin Falls and Boise by way of the paved highway through Buhl, Hagerman, and Bliss. An excellent system of roads is maintained in this territory, especially when one considers the surface over which the road must pass. The main traveled roads are gravelled and are kept open all winter even though the snow is often heavy. The Snake River canyon is the greatest obstruction to north and south travel. Rim to rim bridges cross it near Kimberley and Twin Falls. Crossings can be made at Hagerman, Clear Lakes, and Blue Lakes over bridges in the bottom of the canyon. These bridges are reached by roads which have been blasted out of the steep basalt walls of the canyon. A similar road, or grade as they are commonly called, drops down the canyon wall at Shoshone Falls. Here the crossing is made by a ferry.

[illegible] through [illegible], Kimberley, Twin Falls, Filer, and [illegible]. [illegible] line [illegible] Shoshone. One branch through Shoshone, Fairfield, and Hill City. The other runs through Gooding, Wendell, [illegible], and [illegible] the north to Jerome and [illegible]. All of the above-mentioned branch lines are [illegible] of the Oregon Short Line Railroad.

An automobile stage [illegible] daily [illegible] following [illegible] and [illegible]. [illegible] are daily between Twin Falls and [illegible] by [illegible] highway [illegible], [illegible], and [illegible]. An excellent system of roads is maintained in this territory. Especially when one considers the surface over which the road must pass. The main traveled roads have been [illegible] kept open all winter even though the snow is [illegible]. The Snake River canyon is the greatest obstruction to north and south travel. [illegible] bridges [illegible] Kimberly and Twin Falls. Crossings can be made at Hagerman, [illegible], and [illegible] over bridges in the bottom of the canyon. These bridges are reached by roads which are [illegible] out of the [illegible] walls of the canyon. [illegible] are [illegible] Shoshone Falls. [illegible]

The Snake River is swift and deep. It offered a great barrier to the early settlers of Oregon who made their entrance to the country over the Old Oregon Trail. The Oregon Trail made its old crossing by means of a ford near the present town of Hagerman.

Settlements

The southern part of the area is, for Idaho, a rather thickly settled rural district. The city of Twin Falls with a population of over 12,000 people ranks as the largest settlement of the district as well as the third city in the state. Buhl is next with a population of 4,000. Jerome and Gooding each pass the 2,000 mark while Shoshone, Filer, Wendell, and Kimberley have approximately 1,500 inhabitants. The remaining villages have populations of less than 500.

Shoshone is the oldest town in the district. It was a stage station on the old freight road out of the mining regions to the north several years before the Oregon Short Line Railroad was built. The region south of the old station was just a sagebrush desert until about 1900. Large irrigation projects have given this territory a phenomenal growth in the last quarter of a century.

Climate

The average yearly precipitation of this area is less than twelve inches. The greater part of the moisture comes in the winter and early spring and not in the growing season, hence dry farming is not practiced except in the higher localities such as Hill City and Fairfield.

The summers are short and hot, temperatures of 100 degrees * being common and 110 not unknown. The summers are marked by a monotonous occurrence of wind and dust storms. Temperatures, though high during the day, may fall as much as fifty degrees in six hours and the nights are generally cool.

The winters are long and cold, the temperature often falling twenty degrees below zero. Snowfalls of over two feet sometimes occur on the plain but such storms are uncommon. Though extremely low temperatures are a common occurrence, it is not often that a cold wave has a long duration. Snow does not lie for long on the plain and usually but a few days in the Sanke River Valley. The mean annual temperature is about forty-three degrees.

---

* All weather temperatures are Fahrenheit.

Climate [illegible]

The average [illegible] less than twelve inches. [illegible] are [illegible] in the [illegible] except [illegible] Fairfield.

The summers are [illegible] 100 degrees [illegible] summers are [illegible] and damp [illegible] day, [illegible] and the [illegible]

The winters are long [illegible] often falling [illegible] over the [illegible] storms are [illegible] are a common occurrence [illegible] wave has [illegible] the [illegible] Valley. The mean annual [illegible] degrees.

---

* All weather [illegible]

The prevailing winds are from the west and are usually heavily laden with dust, thus accounting for the fine yellow soil which mantles the lava plain and even extends far up on the mountain slopes. These winds will be mentioned again when the subject of soils is taken up.

Life

In late years few antelope or deer have been seen in this part of the state. The plains, however, abound with sage hens and China pheasant, making this locality very popular with the hunter. Coyotes and small animals such as marmots and ground squirrels are quite common while jack rabbits are so thick as to become a serious pest to the farmers. Rabbit drives netting catches of 2,000 or more have been made near Shoshone.

Only seven per cent of the total area of Idaho is under cultivation. This is partly due to lack of water, but scarcity-or even total absence-of soil is also an important factor. Vegetation over such barren regions must, therefore, be of an extremely hardy variety. Sagebrush (Artemesia tridentata) covers most of the plain that is not under cultivation. This bush grows grows in the cracks of the lava where no soil covers

The prevailing winds are from the west and are usually heavily laden with dust. This accounts for the fine yellow soil which mantles the Snake plain and even extends far up on the mountain slopes. These winds will be mentioned again when the subject of soils is taken up.

Life

In late years few antelope or deer have been seen in this part of the state. The prairie, however, abound with sage hens and Chinese pheasant, making this a locality very popular with the hunter. Coyotes and small animals such as marmots and ground squirrels are quite numerous, while jack rabbits are so numerous as to become a serious pest to the farmers. Rabbit drives netting catches of 2,000 or more have been made near Aberdeen.

Only seven per cent of the total area of Idaho is under cultivation. This is partly due to lack of water, but scarcity--or even total absence--of soil is also an important factor. Vegetation over such barren regions must, therefore, be of an extremely hardy variety. Sagebrush (*Artemesia tridentata*) covers most of the plain that is not under cultivation. Rabbit brush grows in the drier parts of the land where soil is

the surface, acting as a windbreak and thus aiding in further deposition of soil. The sagebrush gives color, or rather lack of color, to the plain, smoothing its harsh surface and enhancing its monotony. Cottonwood and poplar trees grow along the stream banks, their dark green foliage standing out sharply against the light greenish gray of the sage. Gramma grass and bunch grass, once common on the plain, are giving way to a hardier variety known as "cheet grass". This makes an excellent feed for sheep early in the spring but soon becomes dry and hard as hot weather comes on, making it necessary to drive the sheep to the grazing reserves in the mountains.

PHYSIOGRAPHY

Provinces

The Shoshone region lies in the Columbia Plateau and Rocky Mountain (North) provinces *. About three-fourths of the total area lies in the former. The dividing line between these two provinces * is formed by the contact between the basalt and the rhyolite some ten miles north of Shoshone.

---

* Fenneman, Nevin, Annals of the Association of American Geographers. Volume XV111, No.4. pp 335-338.

the surface, [illegible] and [illegible] [illegible] [illegible] [illegible]

further [illegible] [illegible]. The [illegible] [illegible]

or rather [illegible] [illegible] [illegible] [illegible], [illegible] the

marsh surface and [illegible] [illegible] [illegible] [illegible],

and [illegible] [illegible] [illegible] the [illegible] [illegible]. [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

light [illegible] [illegible] of [illegible] [illegible] [illegible] [illegible]

grass, since [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] known as "[illegible] [illegible]". [illegible] [illegible]

excellent [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

become dry and [illegible] [illegible] not [illegible] [illegible], [illegible] [illegible]

necessary to [illegible] the [illegible] [illegible] [illegible] [illegible] [illegible]

the [illegible].

[illegible]

[illegible]

The [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

and [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] line [illegible] [illegible] the [illegible] [illegible] [illegible]

by the contact between the [illegible] [illegible] [illegible] [illegible]

ten miles north of [illegible].

---

* [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]
[illegible] [illegible]

General Relief

A marvelous view of a large part of the territory can be obtained from the top of Notch Butte which rises about 500 feet above the surrounding plain. To the east stretches the monotonous sagebrush-covered plain until it fades into the desert haze. A similar plain extends to the south and west except where it is broken by the brilliant green, checkerboard effect imparted to the landscape by the fields of grain and alfalfa. The North Side Canal from Milner Dam has turned much of this section from a desert to a prosperous farming country. To the northwest the plain is broken by a knobby-topped ridge of rhyolite which rises 2,000 feet above the lava sea at its base. This ridge attains its maximum height (5,800 feet) near the City of Rocks. From there it slopes gently to the east, disappearing below the plain a few miles west of Kinsey Butte.

The plain to the northeast is broken by the great, squat bulk of Dietrich Butte. This butte is not so high as Notch Butte but is more than fifteen miles in diameter at the base. Its gently sloping sides are capped by a broad, flat top which, on closer observation, will be found to be a crater a mile in diameter and three hundred feet deep. To the left of Dietrich Butte rise

Notch Butte

A marvelous view of a large part of the Mohave can be obtained from the top of Notch Butte which rises about 500 feet above the surrounding plain. To the east stretches the sparsely-growing creosote-covered plain until it fades into the desert haze. The plain extends to the south and west almost where it is [illegible] brilliant [illegible] landscape [illegible] of [illegible]. The north side [illegible] the hills [illegible] of this section from a desert to a prosperous [illegible]. To the northeast the plain is [illegible] of granite which rises [illegible] above the [illegible] its base. This [illegible] feet, resembles [illegible] to the east. [illegible] west of Notch Butte.

The [illegible] is [illegible] of [illegible] south of Notch Butte. [illegible] is [illegible] as Notch Butte but [illegible] at the base. Its [illegible] broad. [illegible] which [illegible] found to be a crater [illegible] hundred feet deep. On the [illegible]

Figure 1. Snake River plains looking south from the summit of Notch Butte.

Figure 2. Snake River plains east of Notch Butte. Picture taken from summit of the butte.

Marley, Burns, and Kinsey Buttes. The two strips of green running between Dietrich and Kinsey Buttes mark the courses of Big Wood and Little Wood Rivers which run parallel to each other for twenty miles before uniting to form the Malad River. To the left of Kinsey Butte the low, broken top of Black Butte is visible, surrounded by its black, barren flow of lava. This flow is the most recent, as well as the most extensive, of the region. It lies like a huge black snake along the side of Big Wood River and reaches a distance of thirty miles from its source.

Farther to the north, the Sawtooth Mountains rise from the purple haze of the desert, their snow-capped peaks gleaming in the sun. From a closer view they appear like a rugged coast line being lapped by the waves from a great, gray-green sea of sage-covered lava.

In the heat of the day the desert haze smoothes the relief of the desert. One looks out over a harsh, desolate, wind-swept, and sun-parched plain. Whirlwinds form over the shimmering areas and carry their plumes of gray dust over a grayer plain. The Sawtooth Mountains to the north and the Raft River Mountains to the south swim in the heat waves and disappear in the desert haze. Even the great rhyolite ridge to the northwest is indistinct

Marlow, Thomas' [illegible] the [illegible] green running between [illegible] and [illegible] the courses of Big Wood and Little Wood Rivers which run parallel to each other [illegible] before uniting to form the Malad River. To the left of these Buttes the lava [illegible] of [illegible] surrounded by [illegible]. This Flow is the most recent, as well as the most extensive of the region. It [illegible] the side of Big Wood River and [illegible] a distance of thirty miles [illegible].

Farther to the north, the [illegible] from the purple haze of the desert, their [illegible] peaks gleaming in the sun. From a distance they appear like a jumbled coast line [illegible] by the waves from a vast, storm-[illegible] sea of [illegible].

In the heat of the day the desert [illegible] the relief of the [illegible] over a [illegible], wind-swept, and sun-parched [illegible] over the [illegible] of dust over [illegible] The [illegible] north and the [illegible] the [illegible] the desert [illegible] the [illegible]

as it seemingly crouches closer to the sea of lava which partly engulfs it.

As the sun goes down, the desert begins to take shapes not before visible. Each low flow, dome and pressure-ridge casts a long shadow, bringing its contour out in strong relief. The desert haze turns from gray to purple. The last rays of the setting sun strike the northern mountain peaks painting them a beautiful golden color. The rhyolite ridge seems to take on height. Its dark, knobby crest changes into orange domes set in a purple sea. The ever-present dust in the air gives a brilliance to the sunset such as is seldom seen outside of desert regions. The desert, which for six hours has been sleeping in the stifling heat, is now awake and teeming with life. The brown marmot appears from his rocky burrow. The jackrabbit leaves the shelter of a sagebrush and starts in search of food, avoiding the predatory coyote who is on a similar errand.Night owls and a few bats fly overhead. The animals of the plain are taking advantage of the cool night, obtaining their food before the day dawns and the sweltering heat begins anew.

so it seemingly crosses closer [illegible] which partly engulfs it.

As the sun goes down, the desert begins to take shapes not before visible. Each [illegible] view, [illegible] pressure-ridge quite a long [illegible], [illegible] out in [illegible] relief. The desert here [illegible] purple. [illegible] of the [illegible] northern [illegible] color. The [illegible] to [illegible]. dark, stubby [illegible] purple sea. The ever-present [illegible] the sky gives a brilliance to the [illegible] of desert regions. The desert, [illegible] been sleeping in the [illegible], is now awake and teeming with life. The [illegible] its rocky burrow. The [illegible] of a sagebrush and starts its [illegible] predatory coyote who is on a [illegible]. [illegible] and a few bats fly overhead. The animals of the plain are taking advantage of the cool night, obtaining their food before the day dawns and the scorching heat arrives anew.

Maximum Variation

The greatest elevation (5,800 feet) is five miles north of the City of Rocks. The lowest point of the region is approximately 2,600 feet above sea level. This is the canyon of the Snake River five miles west of Bliss.

Drainage

The northwest part of the mapped area (Plate 1) is drained by Camas Creek which flows into Big Wood River just above Magic Reservoir. The northeastern part of the region is drained by Silver Creek which joins the Little Wood River north of Richfield. Big Wood and Little Wood Rivers unite near Gooding forming the Malad River which empties into Snake River. The Malad River has the distinction of being the only tributary to reach the Snake River from the north for a distance of three hundred miles. The mountains to the north receive a heavy fall of snow but the streams flowing south from these mountains must cross the basalt plains for a distance of fifty miles or more. The basalt is full of cracks and crevices through which the water easily seeps downward. The seepage water is conducted towards the Snake River by pervious strata more than three hundred feet below the ground surface. The Snake River has cut through

Maximum Variation

The greatest elevation (6,800 feet) is five miles north of the City of [illegible]. The lowest point of the region is approximately 2,600 feet above sea level. This is the canyon of the Snake River five miles west of Bliss.

Drainage

The northwest part of the mapped area (Plate 1) is drained by Camas Creek which flows into Big Wood River just above Magic Reservoir. The northeastern part of the region is drained by Silver Creek which joins the Little Wood River north of Richfield. Big Wood and Little Wood Rivers unite near Gooding forming the Malad River which empties into Snake River. The Malad River has the distinction of being the only tributary to reach the Snake River from the north for a distance of three hundred miles. The mountains to the north receive a heavy fall of snow but the streams flowing south from these mountains must cross the basalt plains for a distance of fifty miles or more. The basalt is full of cracks and crevices through which the water easily seeps downward. The seepage water is conducted towards the Snake River by pervious strata more than three hundred feet below the ground surface. The Snake River has cut through

these water-bearing beds between Shoshone Falls and Hagerman. Many large springs flow out of the north side of the canyon wall. (See Plate 4)

Rock Creek and the Little Salmon River empty into Snake River from the south. Some springs flow from the canyon wall on the south side of the Snake River but they are few in number and small in volume.

All the water in Rock Creek, Salmon River, and the Wood Rivers, is often used for irrigation. These streams then, are usually dry in the irrigating season, for a part of their length at least. Malad River may be completely dry eight miles from its mouth and yet pick up 3,000 second feet of water before it reaches the Snake River. The water comes from large springs in the deep canyon. The inflow from springs between Milner Dam and Bliss amounts to more than 6,000 second feet of water. It is not reasonable to imagine that such a flow of water could be derived from the lost streams alone. Snake River was crowded from its old bed in Miocene times, but the old channel-now buried by sedimentary beds and lava flows-still receives part of the flow of the river. A loss of about 1,500 second feet of water occurs north of Idaho Falls, evidently marking a connection between the old channel and the new. Part of the flow from the

these [illegible] have been [illegible] Hagerman. Many large [illegible] of the canyon wall. (See Plate [illegible].)

Rock Creek and the [illegible] Snake River from the south. [illegible] canyon wall on the south side of [illegible] are few in number and small in volume.

All the water in Rock Creek, [illegible] Wood Rivers, is often used for irrigation. [illegible] them, are usually dry [illegible] part of their length at least. [illegible] pletely dry eight miles [illegible] 3,000 second feet of water [illegible] River. The water comes from large springs in the [illegible] canyon. The inflow [illegible] Bliss amounts to more than [illegible] It is not reasonable to [illegible] could be derived from the lost streams [illegible] River was crowded from its old bed [illegible] the old channel--now buried by [illegible] flows--still receives part of [illegible] loss of about 1,500 second feet [illegible] Idaho Falls, evidently [illegible] old channel and the new. [illegible]

Figure 1. Springs from the north wall of Snake River canyon near Hagerman.

Figure 2. Springs from the north wall of Snake River canyon near Thousand Springs power plant.

canyon springs evidently comes from such losses.

GENERAL GEOLOGY

Outline

From looking at the relief map of Idaho (Plate 5) it will be seen that the Snake River Plains form a rude crescent surrounded by rugged mountains. As the Shoshone region includes part of the plain and part of the mountain foothills it will be necessary to give a brief resume of the geologic history of central Idaho before treating this particular area.

The earlier geologic history of central Idaho comprises a long-continuous sedimentation followed by strong regional metamorphism and erosion in pre-Cambrian times. In the Paleozoic, again, sedimentation was the dominant feature, and some time after its close great dynamic movements developed folds whose limbs commonly dip about forty-five degrees away from a general north-south axis. Erosion was the dominant feature of the Mesozoic but near its close great batholithic intrusions entered beneath the area. Their invasion is believed to have been expressed at the surface by a pronounced elevation, which, during the Eocene, was planed well toward the base-level of erosion. The ancient representative of the Snake

canyon springs at their respective [illegible].

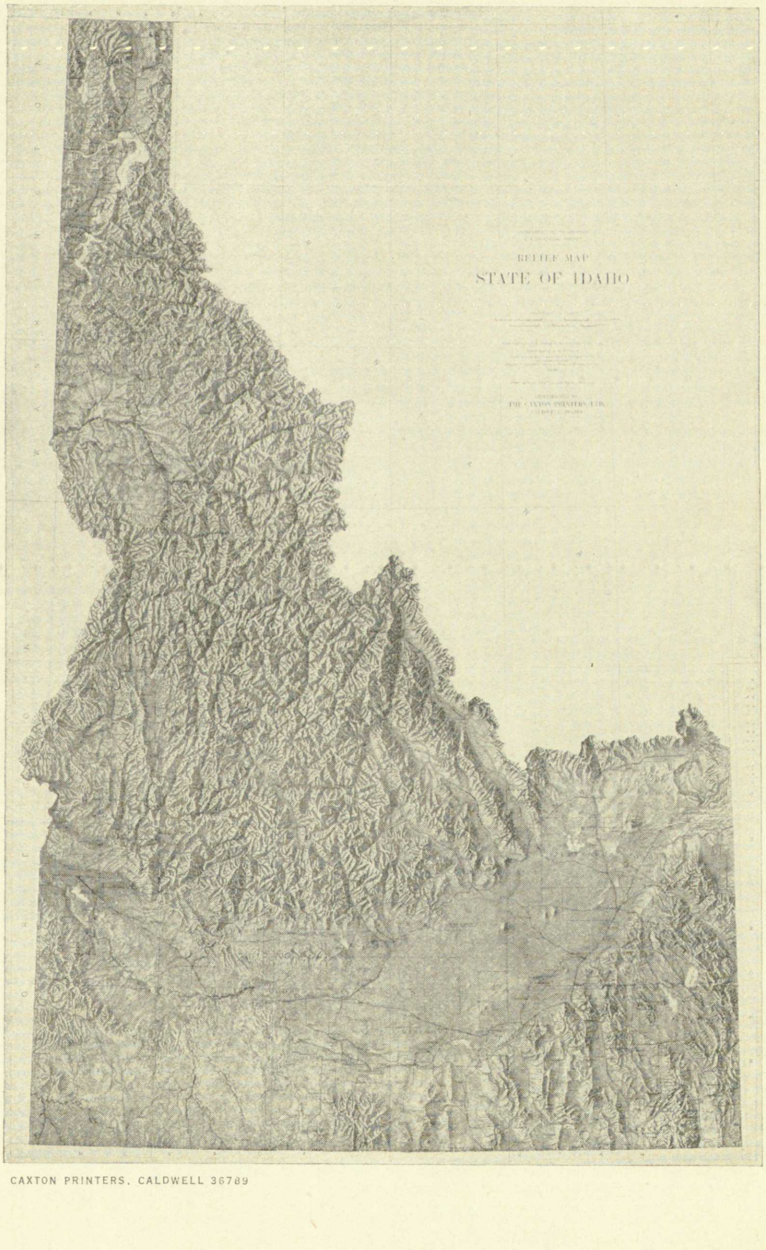
[illegible]

[illegible]

From looking at the geologic map of [illegible] it will be seen that the [illegible] crescent surrounded by [illegible] region includes part of the plain [illegible] of the [illegible] foothills it will be [illegible] of the geologic history [illegible] this particular area.

The earlier geologic history of [illegible] comprises a long-continued [illegible] regional metamorphism and erosion in pre-Cambrian time. In the Paleozoic era, [illegible] feature, and some time after [illegible] movements developed [illegible] forty-five degrees [illegible]. Erosion was the dominant feature [illegible] near its [illegible] across [illegible] beneath the area. [illegible] is believed [illegible] expressed at the surface by [illegible] during the [illegible] of erosion. The general [illegible]

Plate 5



CAXTON PRINTERS, CALDWELL 36789

River became broad and had many tributary valleys opening from it and extending far into the bordering mountains. The sharp-crested mountain spurs between lateral valleys were, in some instances, prolonged far into the main depression.

After the topography had passed maturity, the main stream was obstructed, possibly by a lava flow, but- as seems more probable- by an upward movement of rock athwart its course in the region now included in western Idaho and eastern Oregon. A lake was thus formed reaching over the greater portion of what is now known as the Snake River plains. This water body,named by Lindgren "Lake Payette", received the sediment brought in by tributary streams and the dust blown out by volcanoes, and became deeply filled. These sediments with a known depth of 1,000 feet are well exposed near the towns of Boise and Weiser. In places they contain impressions of leaves, shells of fresh water mollusks, and the bones of land mammals. The fossils record a Miocene age.

Before Lake Payette came to an end, the vast lava flows which form such a conspicuous feature of the Snake River plains began to be poured out. In fact the lava and the sediments of Lake Payette and a later lake in

the same region were contemporaneous, the lava and the lake beds being interbedded. Good examples of such interbedding are seen near Hagerman.

Some of the lava flows entered the lake and the occurrence of thick beds of volcanic fragments and of scoriaceous, glassy lava, and torn and slag-like structure at the base of thick sheets of usually compact basalt, record the energy of the steam explosions which followed. Highly liquid lava continued to be poured out at various intervals from a large number of volcanic vents, and spread out in the previously formed basins forming lakes of molten rock. These highly liquid basalt flows took place in Miocene times and continued almost to the present.

Besides the processes of sedimentation and the pouring out of lava, a third process,- the washing of debris from the uplands- occured. In this manner much gravel, sand, and silt were deposited in the valleys. In addition, widespread aeolian deposits were formed. The volcanic eruptions continued after the lakes were either filled or drained so that by far the greater portion of the Snake River plains is directly underlaid by sheets of lava. Alluvial fans are found interbedded between lava sheets thus aiding water to flow from the

the same region were continuously [illegible]

lake beds being interstratified [illegible] evidences of in-

terbedding are [illegible].

Some of the lava flows [illegible] and the

occurrence of thin beds of [illegible]

scoriaceous, [illegible]

ture at the base of an [illegible]

basalt, record the [illegible]

followed. [illegible]

at various intervals [illegible]

vents, and spread out in the [illegible]

forming lakes of molten rock. [illegible]

flows took place in [illegible]

to the present.

Besides the processes [illegible] the

pouring out of lava, a third process [illegible]

debris from the [illegible]

gravel, sand, and silt were deposited [illegible]

In addition, widespread [illegible]

The volcanic [illegible]

either filled or [illegible] the greatest

portion of the [illegible]

by sheets of lava. [illegible]

between lava sheets [illegible]

mountains to the water-table beneath the plain without appearing at the surface.

The mountains to be seen from the Snake River plains are folded and rugged, presenting a sharp and serrate sky line. The main range in south-central Idaho, known as the Sawtooth Mountains, expresses by its name the salient features and characteristics of the mountain crests throughout the state.

The oldest exposed rocks in the Shoshone region belong to the Miocene period, though it is reasonable to imply that Mesozoic intrusions lie beneath the northern part of the territory described. Therefore the Idaho batholith, commonly classed as Cretaceous, will be included in the descriptions of the other formations. The various series will now be treated in their order,-the oldest first.

The Idaho Batholith

This great, granite mass is thought to be of Cretaceous age since it intrudes the youngest of the Paleozoic beds and is cut by the Eocene erosion surface. Umpleby *, who has written several reports on regions

*Umpleby, J. B. Some Ore Deposits of Northwestern Custer County, Idaho. U. S. G. S. Bulletin 539, Pages 21-23.

mountains to the water-table topography which makes its appearing at the surface.

The mountains to be seen from the Stanley Basin are folded and riven, presenting a disordered set sky line. The main range is saw-toothed in form, as seen in the Sawtooth Mountains, expressed in the same type of features and characteristics of the mountains found throughout the state.

The oldest exposed rocks in the [illegible] belong to the Miocene period. Though it is reasonable to imply that Paleozoic intrusions like [illegible] part of the lar... described, and, although the Idaho batholith, commonly classed as Cretaceous, will be included in the descriptions of the Tertiary formations. The various series will now be treated in their order,—the oldest first.

The Idaho Batholith

This great, granitic mass is thought to be of Cretaceous age; although it intrudes the strongly folded Paleozoic beds and is cut by the Eocene erosion surface. Umpleby *, who has written several excellent discussions

*Umpleby, J. B. Some Ore Deposits in Northwestern Custer County, Idaho. U.S.G.S. Bulletin 539, pp. 21-22.

to the north, assigns this intrusion to a late Cretaceous or an early Eocene age.

The writer has observed this granite in the mining region west of Mackay. It is a fine-grained, gray granite in which orthoclase, quartz, hornblende, and biotite can be readily distinguished. The composition is said to vary considerably in a short distance. This is probable as it is certain that it varies in texture a few miles to the west. A porphyritic phase of this granite intrudes the Carboniferous limestones west of Mackay forming contact deposits of copper minerals.

The writer has assumed that this intrusion underlies the north section of the Shoshone region since some of the later flows have brought unaltered blocks of a similar granite to the surface. The writer found such a block or "inclusion" in an andesite flow fifteen miles north of Gooding. Stearns * records a number of similar occurrences in the Craters of the Moon region forty miles northeast of Richfield. The blocks of granite have not been altered in any noticeable manner, probably due to the fact that basalt does not require an extremely high temperature to keep it in a molten condition.

---

* Stearns, Harold T. Craters of the Moon National Monument of Idaho. Published by Idaho Bureau of Mines and Geology, Bulletin Number 13. Pages 7-8.

to the north, besides this [illegible] with [illegible]

or an early Eocene age.

The writer has observed [illegible] in the region west of Mackay. It is a [illegible]-crushed zone in which [illegible] can be readily distinguished. The [illegible] considerably [illegible] a short distance [illegible] is certain that it [illegible] west. A [illegible] phase of [illegible] Carboniferous limestone, west of [illegible] deposits of copper minerals.

The writer has assumed that this intrusion [illegible] the north end of the [illegible] the later flows have [illegible] lar granite to the surface. [illegible] or "inclusion" [illegible] Gooding. Stearns * reports a [illegible] in the Craters of the Moon [illegible] of Richfield. [illegible] in [illegible] basalt does not [illegible] keep it in a molten condition.

* Stearns, Harold T., [illegible] of the [illegible] ment of Idaho. [illegible] Geology, Bulletin [illegible]

Miocene Rhyolites and Andesites

The northern part of the Shoshone area contains the greatest exposure of these rocks. They are also found in the canyon of the Snake River near Shoshone Falls and Blue Lakes. The flows near Magic Reservoir and the City of Rocks dip gently to the south and west lending weight to the theory that the Snake River plains are a gentle downwarp.

Three distinct flows can be identified at the City of Rocks, twenty miles north of Gooding. The top flow is a light grayish white rhyolite. It is platy in structure, the plates usually being about an inch in thickness. At a distance the rock resembles a thinly bedded limestone. A few small crystals of quartz are visible but, as a whole, the rock is stony and in some places almost glassy. Flow structure is clearly visible. The rock is hard and resistant to decay but its platy structure makes it an easy prey to erosion by frost, as water can readily percolate into the crevices. This flow is only about twenty feet in thickness in some places and has evidently cooled rapidly which accounts for the absence of crystals.

Underlying the platy rhyolite is another flow of much darker color. This flow has a thickness of about eighty feet where it was first observed fifteen miles

Figure 1. Rhyolite flow overlying andesite flow twenty miles north of Gooding.

Figure 2. Columnar jointing in andesite flow twenty miles north of Gooding.

north of Gooding. At another locality five miles away it was not more than fifteen feet in thickness. A similar flow is found in the Snake River canyon north of the city of Twin Falls, over forty miles from the City of Rocks. The flow is dark gray in color. It contains small white crystals of plagioclase feldspar set in a glassy, black groundmass. Dr. F. B. Laney has classed this rock as an andesite. It is softer than the rhyolite overlying it as can be seen from Figure 1, Plate 6. The overhanging bed in this picture is the platy rhyolite mentioned in the preceding paragraph. Figure 2 of Plate 6 shows the columnar jointing of the andesite flow.

Underlying the andesite flow is a thick flow of rhyolite. This rock is mostly a brownish gray in color, though in the vicinity of the City of Rocks it is more highly colored- blues, purples, and reds being also found. Headwater erosion of City Creek and Clover Creek has been largely responsible for the formation of the City of Rocks. The action of water removed the platy rocks in small pieces leaving the more resistant parts standing in columns and curious looking spires. (See Figure 1, Plate 7) The wind has aided this work by its grinding and polishing action.

What is known as the City of Rocks covers about one square mile. The same curious forms occur at a number of

north of [illegible]. [illegible]
it was not more than fifteen feet [illegible]. A simi-
lar flow is found in the [illegible] of the
city of Twin Falls [illegible]
Rocks. The flow is dark gray to black, [illegible]
white crystals of plagioclase [illegible]
black groundmass. [illegible]
as an andesite. [illegible]
it as can be seen from Figure [illegible]. The overly-
ing beds in this plateau [illegible]
in the preceding paragraph. [illegible]
the columnar jointing of the andesite [illegible]

Underlying the andesite [illegible]
rhyolite. This rock is [illegible]
church in the vicinity of the city [illegible]
highly colored-brown, [illegible]
found. Sedimentary strata [illegible]
has been largely responsible for the [illegible]
City of Rocks. The action of [illegible]
rocks in small [illegible]
situation [illegible]
Figure [illegible]
grinding and [illegible] action.

[illegible]
[illegible]

Figure 1. Rhyolite flows carved by water and wind. City of the Rocks north of the town of Gooding.

Figure 2. Andesite flow fifteen miles north of the town of Gooding. The horizontal andesite flow is surmounted by a remnant of a younger rhyolite flow at the center of the picture.

places in the same formation, though not over such a large area as at the City of Rocks.

Five miles east of the City of Rocks, the above-mentioned flow contains a bed of spherulitic material. The spherulites are a dark brick red in color and are sometimes the size of walnuts. Small crystals of quartz and feldspar set in a gray, glassy groundmass make up the rest of the rock. A distinct flow structure is shown, indicating that this spherulitic rhyolite is a flow rock rather than a rock of a fragmental nature. Underlying this bed there is a deposit of lapilli and volcanic dust, the lapilli resembling the spherulites in the bed above. The bed was evidently roughly stratified at one time. It now is folded in several places, the folding evidently taking place before the flow covered it, as the flow now rests unconformably upon the fragmental bed.

The spherulitic rhyolite is also found some twenty miles to the east of the City of Rocks. It is evidently the same rock except for the fact that the spherulites are much smaller in size. The spherulitic flow has been almost eroded away at this locality, only a few fragments remaining.

Five miles west of Kinsey Butte, the rhyolite ridge disappears beneath the later basalt. The last remnant on

the eastern end appears very much like granite to one walking over its surface. It has the same reddish color of the Sherman granite in Wyoming, but, on breaking off a fresh sample, one finds that the interior is not completely crystallized but consists of a few well-defined crystals of quartz and feldspar set in a glassy groundmass. The interior is also much darker in color. The red of the exterior extends only a quarter of an inch into the interior. Evidently the glassy groundmass contains some iron, and the red color is due to the oxidation of this element. The crystals are more resistant than the groundmass in which they are set, thus they stand out clearly on an oxidized surface though they are not clearly visible in a fresh sample. The Idaho Bureau of Mines and Geology classified this rock as a porphyritic rhyolite, or a quartz porphyry. This rock has been subjected to considerable exfoliation. Little decay is visible, though the rock has been disintegrating and the slopes are mantled with a talus of crystals. The finer material has been removed by the wind.

Rhyolite also occurs to the east of Magic Reservoir and to the east of Picabo. To the east of the reservoir the rock is almost white in color. It is light in weight and filled with very fine pores like a pumice stone.

the eastern end [illegible]

walking over [illegible]

of the [illegible] is [illegible]

a fresh sample [illegible]

pletely [illegible]

crystals of quartz and feldspar [illegible]

mass. The interior [illegible]

of the exterior [illegible]

the interior [illegible]

some iron, and the red color [illegible]

this element. [illegible]

groundmass [illegible]

clearly [illegible]

ly visible [illegible]

and Cooley [illegible]

lite or a quartz porphyry. [illegible]

to considerable [illegible]

though the rock [illegible]

are mottled [illegible]

has been [illegible]

Rhyolite also occurs [illegible]

and to the east [illegible]

the rock is [illegible]

and filled with [illegible]

At this place the flow contains no crystals and is of a glassy nature. Evidently when the flow occured, this particular portion was heavily charged with gases which puffed the rock up almost into a pumice stone. Pieces of the rock can be ground between the teeth almost like a piece of chalk. A hundred yards to the south this glassy rock makes a marked change. Its creamy white color changes to a slate blue and the rock becomes partly crystalline. The well developed crystals of orthoclase sometimes attain a length of more than half an inch. Quartz crystals are also present but they are smaller in size. To the south and east this flow becomes darker in color and stonier in texture.

The rhyolite northeast of Picabo is a light brick red in color. Crystals of quartz and feldspars are visible in fresh samples. This rhyolite is softer than most of the flows and shows unmistakable signs of decay. It contains a few stringers of quartz, evidently a later deposit. In the Yankee Fork district eighty miles to the north, the gravels surrounding a similar flow are worked for gold. The gold is supposed to be derived from the quartz veins in the rhyolite. The presence of these veins may be due to hot solutions coming from below. The decay of the rock could be aided in this manner also.

At this place the [illegible] occurs [illegible] glassy masses. [illegible] many [illegible] particular portion [illegible] that [illegible] which puffed the rock [illegible] of the rock [illegible] a piece of [illegible] glassy [illegible] color [illegible] crystallites. [illegible] sometimes [illegible] Quartz crystals [illegible] size [illegible] color and [illegible]

The [illegible] is [illegible] red in color. [illegible] visible in [illegible] most of the [illegible] It contains [illegible] quartz, [illegible] deposit. In the [illegible] north, the [illegible] for gold. The [illegible] is supposed to [illegible] quartz [illegible] in the rhyolite. [illegible] veins may be [illegible] decay of the [illegible]

The appearance of the rock is much similar to that of the flow cut by the Yellowstone Canyon in Yellowstone National Park. No hot springs are found in the immediate vicinity of Picabo but two do occur near Hailey, a few miles to the north.

Miocene (?) Granite

Along the bank of the Big Wood River northeast of Magic Reservoir, there is an exposure of pink granite. The rock is dense and medium-grained. It is made up mostly of orthoclase and quartz with some hornblende and biotite. This granite is much coarser than the samples the writer has seen from the Idaho batholith near Mackay. It is also lighter in color and shows little sign of decay. The rock cuts a flow similar to the soft, red rhyolite near Picabo. Perhaps a similar intrusion may occur east of Picabo, accounting for the quartz stringers and the decayed nature of the rock. A similar intrusion has been noted by Ross* who found it cropping out over an area of 250 square miles near the Middle Fork of the Salmon River. The exact age of the intrusion is not known. Perhaps it may be younger than the Miocene lake beds which will be mentioned shortly. If so, this intrusion might account for the

---

* Ross, Clyde P. Ore Deposits in Tertiary Lavas in the Salmon River Mountains, Idaho. Idaho State Bureau of Mines and Geology, Pamphlet Number 25. Page 10.

The appearance of the rock is the [illegible] of the flow unit [illegible] the following [illegible] Batholith [illegible] vicinity of Idaho [illegible] miles to the north.

Miocene [illegible]

Along the bank of the [illegible] Magic Reservoir, there is an [illegible] The rock is dense and medium-grained [illegible] of orthoclase and quartz with [illegible] This granite [illegible] has seen from the Idaho batholith near [illegible] lighter in color and shows little sign of [illegible] cuts a flow similar to the north, [illegible] Perhaps a similar intrusion [illegible] accounting for the [illegible] of the rock. A similar intrusion [illegible] who found it [illegible] miles near the [illegible] age of the intrusion is not [illegible] younger than the [illegible] shortly [illegible]

---

* [illegible] Salmon River [illegible] Mines and [illegible]

movements, which in late Miocene times caused the Snake River downwarp.

Miocene Lake Beds

At the same time, or at least shortly following the Miocene rhyolite flow, a great folding movement in western Idaho and eastern Oregon dammed the Snake River, forming a lake which, according to Russell* extended almost to the Teton Mountains in Wyoming. Mud, sand, and gravel were washed into the lake and interstratified with thick beds of volcanic dust and lapilli cast out by the still active volcanoes on the lake shores. Shortly following this time, the great Columbia River basalt flow was poured out over more than 200,000 square miles of land. This flow, contrary to popular opinion, did not reach far into Idaho and did not form any part of what is known as the Snake River plains. It is, however, intimately associated with the lake beds near Stein Mountain in the state of Oregon**.

These lake beds are exposed in the western and southwestern parts of the Shoshone region. Loosely

* Russell, Israel C. Geology and Water Resources of the Snake River Plains. U. S. G. S. Bulletin 199. P 15.

** Russell, Israel C. Preliminary Report on Artesian Basins, Southwestern Idaho and Southeastern Idaho. U. S. G. S. Water Supply and Irrigation Paper 78. PP 21-23.

consolidated sandstones, soft, calcareous, white shales, loose gravel, sand, dark brown and yellow lapilli, and white volcanic dust make up these beds.

Examples of the beds of lapilli and volcanic dust can readily be seen in the Snake River canyon a mile to the east of Blue Lakes ranch. Here a bed of fine, white volcanic dust is exposed along the canyon wall for several miles. This dust bed has a maximum thickness of more than forty feet. It rests upon a coarse bed of ash and lapilli which in turn rests upon the eroded surface of an andesite flow,- apparently the same kind of a flow that occurs between the rhyolite flows near the City of Rocks. The so-called bed of lapilli is, in most places, too coarse for such a classification. It is made up of ash, lapilli, and a number of dark-colored bombs of rhyolite. Some of the bombs are a foot or more in diameter. Evidently they were not in a plastic state when they fell as they show no signs of adhering to one another. Some rounded boulders, similar to the underlying andesite flow, are also present. They were evidently washed in during the deposition of the beds as they are not of the same composition as the bombs and lapilli, These fragmental beds are not well consolidated. The dust can be easily cut by a knife while the coarser beds

consolidated [illegible] sand,

loose gravel, sand, [illegible]

white volcanic [illegible]

Examples of [illegible]

can readily be seen in [illegible]

the east of [illegible]

volcanic dust is [illegible]

eral miles), [illegible]

more than [illegible]

and lapilli which [illegible]

of an andesite flow - [illegible]

that occurs between [illegible]

Rocks. The so-called [illegible]

too coarse for such a classification. [illegible]

ash, lapilli, [illegible]

rhyolite, some of the [illegible]

ter. Evidently [illegible]

they fell [illegible]

ther. Some rounded [illegible]

andesite flow, [illegible]

washed [illegible]

not of the same [illegible]

These fragmental [illegible]

dust can be [illegible]

Figure 1. Lake beds south of Hagerman .

Figure 2. Beds of volcanic ash and dust lying upon a coarser bed of fragmental material. Snake River canyon north of the city of Twin Falls.

will not offer much resistance to an attack with pick and shovel.

In some places the beds of dust have been covered by a flow of basalt which has partially fused the bed for several feet below the contact. These fused portions are more resistant to erosion than the rest of the same bed.. (See Plate 9)

Light-colored, calcareous shales and loosely consolidated beds of white sand occur across the Snake River from Hagerman. (Figure 1, Plate 8) These loosely consolidated beds, interstratified with volcanic dust and basalt flows, extend many miles over into southwestern Idaho. Erosion has dissected these beds forming well-defined bad land topography. Two basalt flows are interbedded with the sediments near Hagerman. These flows are older than the ones that cover the greater part of the Snake River plains,- possibly dating back as far as the great Columbia River flow.

An interesting fact in connection with the lake beds mentioned above is that they contain the bones of animals which are now extinct, but which formerly lived in large numbers in and about the ancient lake in which the sand, clay, volcanic dust, and other material was deposited. In the beds of fine silt and sand, fossil leaves are

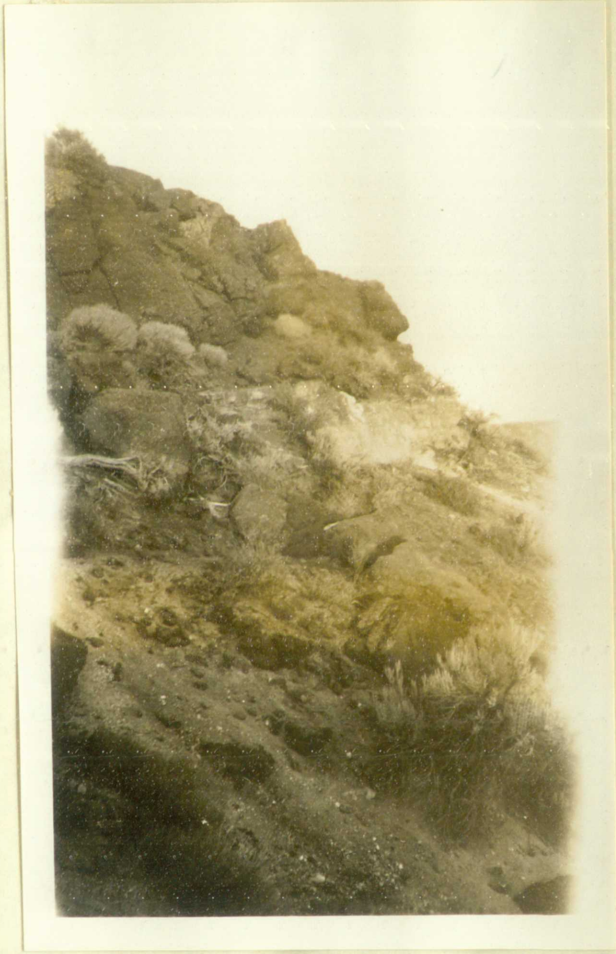
will not [illegible]

and gravel.

In some places the [illegible] have been covered by a flow of basalt which [illegible] for several feet before [illegible] are more resistant to erosion [illegible] bed.. (See Plate [illegible])

Light-colored, [illegible] located [illegible] from Emmett [illegible] [illegible] [illegible] Idaho. [illegible] derived [illegible] bedded with the [illegible] other [illegible] Snake River [illegible] great [illegible] flows.

In [illegible] [illegible] [illegible] [illegible] In the [illegible]



Basalt flows overlying beds of volcanic dust near hagerman.

The basalt flow has partially fused the bed for several feet below the contact. The fused portion appears to be white in the above photograph but it is of a brick red in color. The bed of dust here is about thirty feet thick, but the fused portion is the only part resistant enough to stand in a vertical position.

found, showing that luxurious vegetation once grew in what is now a desert. By the record of leaves, bones, and shells of fresh water mollusks, the age of the formation (known as the Payette formation) is placed as late Miocene or early Pliocene*. Mr. Harold T. Stearns of the U. S. Geological Survey is now hunting fossils in this region. He states that the beds of fine sand contain many bones of animals which mired down in the quicksand when they came to drink. Dr. J. W. Gidley of the Smithsonian Institute is also conducting a similar expedition north of Bliss. Up to date it has been reported that skeletons of giant sloths, elephants, camels, and bison have been found. The excavations have just commenced and the writer has nothing but newspaper accounts to go by up to date. An account of the findings in the region will probably be published within the next two years.

The sedimentary beds, to which attention has been directed, are in many instances open-textured and of such a nature that water would readily percolate through them, while others have the consistency of clay and tend to retain the water in the porous bed if any is present between them. These conditions indicate that wherever

---

* Russell, Israel C. Preliminary Report on Artesian Basins in Southwestern Idaho and Southeastern Oregon. U. S. G. S. Water Supply and Irrigation Paper Number 78. PP 16-18.

found, showing that invertebrate [illegible]
what is now a desert. In the course of [illegible]
and shells of fresh water molluscs [illegible]
ation (known as the [illegible]
Miocene or early Pliocene". Dr. [illegible]
the U. S. Geological Survey, [illegible]
this region, [illegible]
many bones of animals [illegible]
when they came to drink. [illegible]
sonian Institution is also [illegible]
north of Bilma. Up to date it has [illegible]
skeletons of [illegible]
have been found. The expedition [illegible]
the writer has [illegible]
up to date. [illegible]
will probably be published [illegible]

The sedimentary beds, [illegible]
directed, are in [illegible]
a nature that [illegible]
while others [illegible]
retain the water [illegible]
between them. [illegible]

* Russell, [illegible]
in [illegible]
C. [illegible]

these beds have been displaced or bent so as to form basins, there is a probability of obtaining flowing wells by deep drilling. The country south and west of the City of Rocks would seem to be a good place for a trial well as the beds have a pronounced dip in toward the Snake River.

Pliocene and Pleistocene Basalt

A description of any one specimen of the Snake River basalt would not apply to anh the specimens of the region. However, in general, the basalts of the area are all heavy, fine-grained, stony rocks ranging in color from dark gray to black. Some are stony throughout but others may contain a few crystals of dark minerals such as pyroxene or olivine. Most of the basalts are of a vesicular nature. The flow from Black Butte contains many gas pockets a foot or more in diameter. Much of this flow is also scoriaceous. Some of the lava streams are platy in structure, the plates giving out a ring like phonolite. The thick, compact flows usually show a columnar jointing and break with what might be calle a conchoidal fracture on a very large scale.

By far the largest part of the basalt of the region is of the smooth, ropy type known as "pahoehoe." In some

these beds have been displaced [illegible] to [illegible] basins, there is a probability of obtaining [illegible] wells by deep drilling. The country south and east of the City of Pocatello would seem to be a [illegible] place for a trial well as the beds have a pronounced dip toward the Snake River.

Pliocene and Pleistocene Basalt

A description of any one area of the Snake River basalt would apply equally to any [illegible] the equivalents of the region. However, in general, the basalts of the area are all heavy, fine-grained, [illegible] from dark gray to black. Some are [illegible] others may contain a few crystals [illegible] as pyroxene or olivine. [illegible] vesicular nature. [illegible] many gas [illegible] this flow is also [illegible]. Some of the [illegible] are platy in structure, [illegible] like phonolite. [illegible] columnar jointing [illegible] conchoidal fracture [illegible].

By far the [illegible] part of [illegible] is of the [illegible]

cases these pahoehoe flows have broken up like slush ice on a river in spring and the rough, jagged lava known as "aa" has originated. Illustrations of these two types of flows are shown on Plate 10.

About two thirds of the Shoshone district has been covered with these comparatively recent flows of basalt. The flows came from a few well-defined craters and a large number of fissures which left low, smooth domes and ridges to mark the spot from which the flow came. Some of the fissures were no doubt obliterated entirely. The whole plain has been built up by numerous flows and no effort has been made to ascertain how many flows occurred in the region.

The eruptions of basalt in southern Idaho have all been of the quiet type, no indications being present to indicate that any great explosions ever occurred. The liquid material evidently rose to the surface almost as fluid as water. Mr. E. D. Campbell* of the University of Michigan states that such a lava as the Snake River basalt would melt at a temperature of about 2,250 degrees (F) and yield a highly fluid rock. This statement is borne out, in part at least, by the fact

---

* Russell, Israel C. Geology and Water Resources of the Snake River Plains. U. S. G. S. Bulletin 199. P 88.

Figure 1. Aa flow east of the Ice Cave.

Figure 2. Close-up view of the cracked surface of a billowy pahoehoe flow. Taken three miles north of Shoshone. This is also a good example of a pressure ridge.

that many flows are more than twenty miles in length. Lindgren* records finding an old flow more than fifty miles in length in the Boise region. The fluidity of the lava is shown by the fact that the cones have gently sloping sides which make as low an angle as four degrees with the plain.

Composition of the Basalt

The pahoehoe and aa lavas are of the same composition. The analysis given below is from a sample taken from the Cinder Buttes forty miles to the east of the town of Richfield.**

$Si\ O_2$	51.14 Per cent.
$Ti\ O_2$	2.41
$Al_2\ O_3$	13.95
$Fe_2\ O_3$	2.15
$Fe\ O$	12.97
$Ca\ O$	6.57
$Mg\ O$	2.21
$K_2\ O$	2.33

* Russel, Israel C. Geology and Water Resources of the Snake River Plains. U. S. G. S. Bulletin 199. PP 64-66.

** Analyst, W. F. Hillebrand. Table from U. S. G. S. Bulletin 199. Page 87.

that many flows are more than twelve miles in length. Lindgren* records flows [illegible] miles in length in the Boise region. The fluidity of the lava is shown by the fact that the flows have really sloping sides which make as low an angle as four degrees with the plain.

Composition of the Basalt

The pahoehoe and aa lavas are of the same composition. The analysis given below is from a sample taken from the Cinder Buttes forty miles to the west of the town of Richfield.**

Si O_2	47.21 Per cent.
Ti O_2	3.41
Al_2 O_3	13.05
Fe_2 O_3	3.15
Fe O	12.97
Ca O	9.57
Mg O	8.21
K_2 O	2.35

* Russel, Israel C. Geology and Water Resources of the Snake River Plains. U. S. G. S. Bulletin 199, Pp 64-[illegible]

** Analyst, W. F. Hillebrand. Table from I. C. R. U. S. G. S. Bulletin 199. Page 87.

Analysis (Cont.)

Na_2O	. . . . 3.59	Per cent.
P_2O_5	. . . . 1.59	
MnO_2	. . . . 0.44	
BaO	. . . . 0.25	
H_2O	. . . . 0.34	
FeS	. . . . 0.15	
	100.08	

Specific gravity 2.907

It will be noticed that the basalt is a little more than half silica. Analysis of a rhyolite from near Challis, Idaho * shows that rock contains 80.47 per cent of SiO_2 . These compositions would not be the same for the various localities but they will serve as comparisons between the lava flows of the region.

Relief of the Lava Plain

The built-up Snake River plain, at a distance, appears rather smooth. Its surface, however, is broken by a number of lava cones and many small domes and ridges. Kinsey, Marley, Burns, Dietrich, Jerome, Notch

---

* Umpleby, Joseph B. Some Ore Deposits of Northwestern Custer County, Idaho. U. S. G. S. Bulletin Number 539. Page 26. Analyst, R. C. Wells.

Analysis (Cont.)

Na_2O	2.59 Per cent.
P_2O_5	1.59
MnO_2	0.44
BaO	0.28
H_2O	0.24
FeS	0.18
	100.08

Specific gravity 2.907

It will be noticed that the basalt is a little more than half silica. Analysis of a rhyolite from near Challis, Idaho * shows that rock contains 80.47 per cent of SiO_2. These compositions would not be the same for the various localities but they will serve as comparisons between the lava flows of the region.

Relief of the Lava Plain

The built-up Snake River plain, at a distance, appears rather smooth. Its surface, however, is broken by a number of lava cones and many small low and ridges. Kinsey, Marley, Torrance, Bietrich, Gannon, Hotch

---

* Umpleby, Joseph B. Some Ore Deposits of Northwestern Custer County, Idaho. U. S. G. S. Bulletin Number 539. Page 26. Analyst, G. E. Wells.

and Black Buttes are the prominent elevations. There are also numerous vents which are now marked by small mounds and ridges. It is not meant to imply by this, however, that all such mounds mark the positions from which lava once flowed. This is far from the case. The greater part of the domes and ridges were caused by pressure, while the flow was molten a few feet below its surface. The surface of the flow, in most cases, was solid enough to break across the top of the ridge instead of bending. Figure 2 of Plate 10 gives an illustration of a low pressure ridge.

Symmetrical domes (Figure 1, Plate 11) have also been formed by pressure. The writer has visited one such dome which looked like an Eskimo igloo and was even hollow like one. The shell of the dome was about three feet thick. The inside diameter of the dome was over twenty feet and its height about ten feet. The wall was broken at one place affording an entrance. The pressure dome illustrated on Plate 11 is about thirty feet in diameter at the base. Some of them are over three hundred feet across at the base.

The basalt flows usually harden on the top but continue flowing a few feet beneath the surface, the underground lava streams following definite channels.

and Black Buttes are two prominent volcanoes. There are also numerous vents which are now marked by small mounds and ridges. It is not meant to imply by this, however, that all such mounds were the positions from which lava once flowed. This is far from the case. The greater part of the domes and ridges were caused by pressure, while the flow was molten a few feet below the surface. The surface of the flow, in most cases, was solid enough to break across the top of the ridge instead of bending. Figure 2 of Plate 10 gives an illustration of a low pressure ridge.

Symmetrical domes (Figure 1, Plate 11) have also been formed by pressure. The writer has visited one such dome which looks like an Eskimo igloo and was even hollow like one. The shell of the dome was about three feet thick. The inside diameter of the dome was over twenty feet and its height about ten feet. The wall was broken at one place affording an entrance. The pressure dome illustrated on Plate 11 is about thirty feet in diameter at the base. Some of them are over three hundred feet across at the base.

The basalt flows usually cooled on the top but continue flowing a few feet beneath the surface. The underground lava streams followed definite courses.

Figure 1. Pressure dome north of Black Butte.

Figure 2. Notch Butte from the south.

When these underground streams are drained, the hardened lava roof usually remains standing and an underground cavern is formed. A part of the roof may fall in forming an entrance to the cave. A cavern ten miles north of Shoshone is the largest known in the region. This cave (Gwin Cave) is about half a mile in length with a height and width of over forty feet in some places. Most of the original ceiling has shelled off from the gracefully arched roof but near the floor the flow lines or terraces are still visible. Notch Butte Cave and Mabbut Cave are also old channels for underground flows. Such channels and cavern are sometimes struck when wells are being drilled. In such cases, a distinct flow of cold air may be encountered, showing that there is a definite circulation of air through the porous lava.

Some of the underground caverns collapsed completly when the liquid lava was drawn off from beneath. Such occurrences are marked by the reverse of a pressure ridge,- a jagged trench through the lava. Such trenches have been referred to as "depression cracks" in this report.

Lava Cones

Several lava cones are found in the region. They

When these [illegible] fissures are [illegible] [illegible] lava tubes [illegible] [illegible] the [illegible] a [illegible] cavern is formed. [illegible] [illegible] the [illegible] entrance [illegible] cave, a [illegible] of [illegible] is the [illegible] cave (Bulb Cave) [illegible] [illegible] stalactites [illegible] [illegible] [illegible] or overhanging [illegible] [illegible] of the [illegible] [illegible] gracefully [illegible] [illegible] the [illegible] or terraces are still [illegible] [illegible] Mabbur Cave are also [illegible] Such [illegible] are being drilled. In [illegible] cold air [illegible] [illegible] definite [illegible] [illegible]

Some of the [illegible] when the [illegible] lava [illegible] [illegible] [illegible] occurrence [illegible] ridge, - a [illegible] have been referred to [illegible] report.

[illegible]

[illegible]

will be taken up in what is believed to be the order of their age,- the oldest first.

Dietrich Butte

This is a squat, flat-topped cone with gently sloping sides. It rises approximately four hundred feet above the plain and has a diameter at the base of at least fifteen miles. Its flat top contains a crater a mile in diameter and over three hundred feet in depth. The floor of the crater is deeply covered with a fine, white, sandy soil which is clearly an aeolian deposit. If any craters of the region have been of the explosive type, Dietrich Butte has been the best example. No fragmental material is to be found on the slopes of the crater but this is not surprising since its sides are well-covered with soil. This cone is clearly the oldest of any now at the surface. It cannot compare, however, in age with the great Columbia River flow. This great flow has decayed to a depth of forty feet or more while the flow from Dietrich Butte shows no sign of decay. The soil of the Snake River plains is not a product of decay, it being a transported rather than a residual soil. The thick aeolian soil inside of the Dietrich Butte crater is typical of the soils of the region.

will be taken up in what is believed to be the order of their age,- the oldest first.

Dietrich Butte

This is a great, flat-topped cone with gently sloping sides. It rises approximately four hundred feet above the plain and has a diameter at the base of at least fifteen miles. Its flat top contains a crater a mile in diameter and over three hundred feet in depth. The floor of the crater is nearly covered with a fine, white, sandy soil which is clearly an aeolian deposit. If any craters of the region were blown out by the explosive type, Dietrich Butte has been the best example. No fragmental material is to be found on the slopes of the crater but this is not surprising since the slopes are well-covered with soil. This cone is clearly the oldest of any now at the surface. It cannot be stated, however, it age with the recent Snake River flows. This great flow has decayed to a depth of few inches while the flow from Dietrich Butte shows no sign of decay. The soil of the Snake River plains is not a residual decay, it being a transported rather than a residual soil. The thick aeolian soil inside of the Dietrich Butte crater is typical of the soils of the region.

Burns, Marley, and Jerome Buttes

These buttes from similar general appearances have been taken as approximately the same age. Their slopes are gentle and well-covered with soil. They are formed from the same black, vesicular basalt as Dietrich Butte. Small depressions in their tops are the only indications of a crater-like formation.

Kinsey and Notch Buttes

These cones are not well-covered with soil and perhaps are younger than the ones mentioned in the preceding paragraph. The flows from them are scoriaceous in places and of a highly vesicular nature. The gas pockets often make up a quarter of the volume of the rock. Kinsey Butte is the highest lava cone in the region, reaching perhaps eight hundred feet above the plain. It contains a small crater which is partially filled with water in a rainy season. Notch Butte was once surmounted by a well-defined crater which was partially destroyed by a later flow. This cone, like that of Kinsey Butte, was built from a more viscous type of basalt which formed steeper sides and thinner walls. As a later flow filled the crater it broke down the thin wall on the south side

Hume, Harkey, and Jerome Buttes

These buttes from similar [illegible] appear to have been taken as approximately the same age. Their slopes are gentle and well-covered with soil. They are made from the same black, vesicular basalt as Dietrich Butte. Small depressions in their tops are the only indications of a crater-like formation.

Kinney and Notch Buttes

These cones are not well-covered with soil and perhaps are younger than the ones mentioned in the preceding paragraph. The flows from them are vesicular in places and of a highly vesicular nature. The gas pockets often make up a quarter of the volume of the rock. Kinney Butte is the highest lava cone in the region, standing perhaps eight hundred feet above the plain. It contains a small crater which is partially filled with water in a rainy season. Notch Butte was once surrounded by a well-defined crater which was partially destroyed by a later flow. This cone, like that of Kinney Butte, was built from a more viscous type of basalt which formed steeper slopes and [illegible] as well. The [illegible] flow [illegible] the crater it broke down the [illegible] wall on the [illegible] side

Big Wood River canyon one mile below the Magic Reservoir.

The canyon has been cut in a basalt flow resting on an older flow of andesite. The prominent ridge in the background is the rhyolite to the east of the reservoir.

leaving only a part of the original crater standing. This break, or notch, has given the butte its name.

The flow to the west of Magic Reservoir is about the same age as those from Notch and Kinsey Buttes. This flow probably came from a vent five miles southwest of the reservoir near the contact with the rhyolite. The flow laps up around the rhyolite hills both to the east and west of the reservoir. The Big Wood River has cut a canyon two hundred feet in depth across this flow. Near the bottom of the canyon there is an older flow, probably a latite or an andesite.

Black Butte

The flow from Black Butte is the most recent in the district as well as one of the youngest in the state. It is probably but little older than the flows in the Craters of the Moon region fifty miles to the east. Stearns* estimates the age of the Cinder Butte flows to be between 250 and 1000 years in age. It is reasonable to suppose, then, that the Black Butte flow has an age of less than a thousand years.

The Black Butte lava followed the old course of

---

* Stearns, H. T. Craters of the Moon National Monument of Idaho. Idaho Bureau of Mines and Geology Bulletin Number 13. Page 21.

leaving only a part of the original crater standing. This break, or notch, [illegible] gives the butte its name.

The flow to the west of [illegible] reservoir is about the same age as those from [illegible] and [illegible] Buttes. This flow probably came from a vent five miles north-west of the reservoir near the contact with the rhyolite. The flow laps up around the rhyolite inlier both to the east and west of the reservoir. The Big Wood River has cut a canyon two hundred feet in depth out of this flow. Near the bottom of the canyon there is an older flow, probably a latite or an andesite.

Black Butte

The flow from Black Butte is the most recent in the district as well as one of the youngest in the state. It is probably but little older than the flows in the Craters of the Moon region fifty miles to the east. Stearns* estimates the age of the Craters of the Moon flows to be between 200 and 1000 years. It seems reasonable to suppose, then, that the Black Butte flow has an age of less than a thousand years.

The Black Butte lava flowed [illegible]

* Stearns, H. T., "Craters of the Moon [illegible] of Idaho. Idaho Bureau of Mines and Geology [illegible] Number 13, Page 21.

the Big Wood River crowding it from its former bed and forcing it to cut a trench along the edge of the flow. (See Plate 13) The Big Wood River has taken advantage of cracks in the basalt and has cut its channel rapidly downward. This channel is at places more than fifty feet in depth though it may not be more than four feet across at the top. The lava, through which the river cuts, is a rough, ropy, black basalt upon which little soil has collected as yet. Sagebrush grows in the cracks of the rocks where a little soil has been deposited by the wind, otherwise the flow is without vegetation. It could well have been this region which Irving* sums up with the words, " An area where nothing meets the eye but a desolate and awful waste, where no grass grows nor water runs and where nothing is to be seen but lava". It is thought that Irving was speaking of the Cinder Buttes area but the same would apply to the Black Butte flow.

The lava from this flow is of a scoriaceous and vesicular nature. Gas pockets more than two feet in diameter are not uncommon. The Big Wood River has made use of these gas pockets in cutting its bed downward.

---

* Irving, Washington, The Adventures of Captain Bonneville, U.S.A. Hudson Edition, Page 203. New York, 1868.

Figure 1. Big Wood River north of Black Butte. Notice "pot hole" erosion and the vesicular nature of the lava.

Figure 2. Big Wood River north of Black Butte. This channel has a carrying capacity of more than 3,000 second feet of water.

The stream fills these pockets with gravel which, when whirled by the swift current, grinds out large "pot holes" in the bed of the channel.

Black Butte itself does not rise more than four hundred feet above the plain. Its broken top is capped by an irregular crater a quarter of a mile wide and a mile in length. The crater has been formed by a subsidence of lava. Its flat pahoehoe floor is broken by a few small necks of black lava. (See Figure 1, Plate 14)

The north rim of the crater is broken by a perfect U-shaped ditch twenty feet wide and six feet in depth. A small flow coursed through this channel before the lava level in the crater subsided. Several other small flows have slopped over the north rim but most of the lava flowed to the south. The rim of the crater is made up partially of red scoria and a thin, platy form of gray lava giving out a ring like phonolite. Two parasitic cones lie on the eastern slope of the main crater but no great amount of lava ever flowed through them.

The largest flow, or flows, went to the south, passing through a channel below the surface. This lava tube has now fallen in forming a wide, ragged ditch which can be followed for several miles. At one point

The stream fills these [illegible] whirled by the [illegible] holes in the end of the channel.

Black Butte [illegible] hundred feet above the plain, [illegible] by an irregular [illegible] crater [illegible] mile in length. [illegible] ence of lava. [illegible] few small [illegible]

The [illegible] rim of the crater [illegible] U-shaped [illegible] twenty feet [illegible]. A small [illegible] through [illegible] lava level in the crater [illegible] flows have [illegible] the north rim [illegible] lava flowed to the south. The rim [illegible] made up partially [illegible] of gray lava [illegible] parasitic cones lie on the eastern [illegible] of the crater but no great amount of lava [illegible] them.

The largest [illegible] passing through [illegible] ture has now fallen [illegible] which can be [illegible]

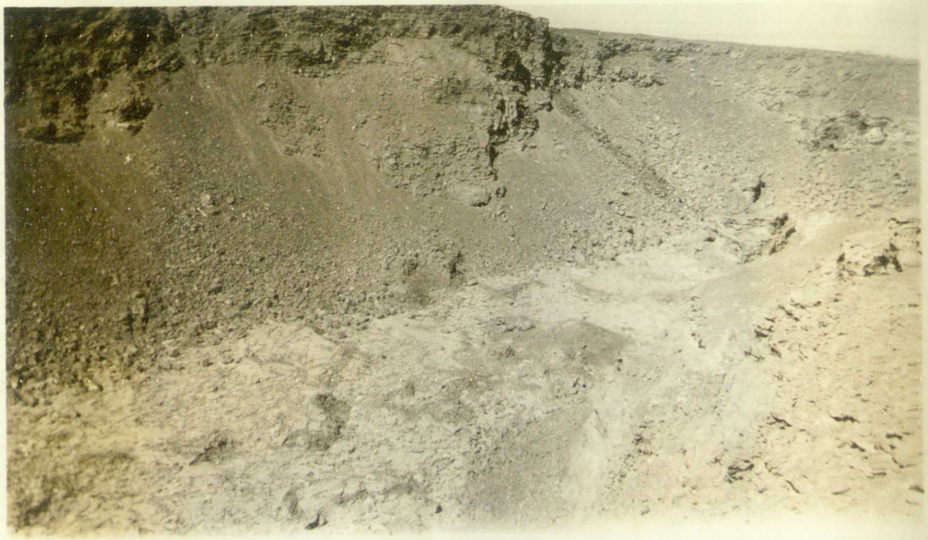


Figure 1. View across part of Black Butte crater. Depth of crater is about 200 feet.

Figure 2. Lava ditch which breaks the north wall rim of Black Butte crater.

a mile from the crater, a portion of the channel roof has remained in place, forming a natural bridge over the depression crack. It is reasonable to suppose that this channel was the outlet which drained the Black Butte crater. The subsidence of lava was accompanied by large rocks sliding down over the pasty sides of the crater wall, cutting grooves in the soft lava and forming polished faces resembling slickensides. (See Figure 1, Plate 15)

A number of underground channels existed. The caves that are now found in the district owe their origin to the draining of such channels. The writer has visited three such caves within two miles of Black Butte. The Shoshone Ice Cave, now a national monument, is the most interesting one of the region and will be described below in detail.

The writer who has made eight visits to this cave, believes it to be part of the same tunnel which drained Black Butte crater. The cave runs in an approximately north-south direction, its entrance being to the south where a portion of the roof has fallen in. Descent is made over a pathway of large basalt boulders for a vertical distance of about seventy feet. Ice is encountered under a projecting lava ledge hardly out of the

a mile from the crater, a [illegible] of the [illegible] has remained in place, [illegible] the depression [illegible]. It is reasonable [illegible] this channel was the outlet which [illegible] the Black Butte crater. The subsidence [illegible] by large rocks sliding down over the [illegible] portion of the crater wall, cutting grooves in the [illegible] lava forming polished faces resembling slickensides. (See Figure 1, Plate [illegible].)

A number of underground channels exist [illegible] caves that are now found [illegible] their [illegible] origin to the draining of such channels. The writer has visited three such caves within two miles of Black Butte. The Shoshone Ice Cave, now a National [illegible], is the most interesting one of the region and will be described below in detail.

The writer who has made [illegible] visits to this cave believes it to be part of the same channel which drained Black Butte crater. The cave [illegible] [illegible] north-south direction. Its [illegible] [illegible] where a portion of the roof has fallen in, [illegible] made over a pathway of large basalt blocks for a vertical distance of about seventy feet. The [illegible] area under a [illegible] lava [illegible]

Figure 1. Grooved and polished surfaces on the inside of the Black Butte crater.

Figure 2. Wrinkled pahoehoe flow on the north slope of Black Butte. This older flow supports some sagebrush and a few lichens though no soil covers its surface.

direct rays of the sun. The visitor crawls on hands and knees over this ice floor for a distance of perhaps fifty feet. Here the lava ledge dips in toward the ice leaving only a hole four feet across leading onward. Through this hole, one's light shows him a steep downward pitch of ten feet and a widening room below. One descends this ice-covered pitch by means of a ladder and a rope and finds himself on a ledge of ice which, ten feet farther on, pitches downward at an angle of forty five degrees to a level ice floor ten feet below. This ice floor is covered by a few inches of water in summer but is frozen solid the rest of the year.

The cave has a maximum width of over sixty feet and a maximum height of over thirty feet. The roof and walls are covered with large ice crystals in winter and the floor is covered with a thick coating of ice the year round. One may walk along this ice pavement for a distance of more than two hundred feet before his way is barred by a wall of solid ice which completely fills the tunnel. (See Plate 21) Drill holes several feet into this ice have failed to encounter anything but more ice. Holes chopped in the ice wall seal themselves in a few weeks and no difference in volume is shown. Ice is found in two other small caves near the larger

one but none is found in the other large caves such as Mabbut Cave and Gwin Cave.

Numerous theories have been advanced for explaining the origin of ice in caves. Most of the theories are far from plausible. To begin with, a cave without ventilation or circulation of air will not have a freezing temperature in either winter or summer. A cave with excellent ventilation such as the Gwin Cave will get cold enough in winter to freeze ice, but the temperature in summer, while cool, is not cool enough to preserve any of the ice. Too much ventilation must then be avoided in advancing a theory. Stearns*, who examined similar occurrences of ice in the Craters of the Moon region, dismisses the question with the statement that "the water is frozen by cold circulating air". This statement, while undoubtedly true, does not answer the question of why there should not be an equal circulation of warmer air in the summer which would melt this ice. The mean temperature of the region is about 43 degrees (F). Therefore if the circulation is the same in winter and summer such as it is in the Gwin Cave, no ice would hold over through the summer. Notice will here be called to the diagram on Plate 16 and the following theory will be advanced:

one but none is found in the other large caves such as Rabbit Cave and Twin Caves.

Numerous theories have been advanced for explaining the origin of ice in caves. Most of the theories are far from plausible. To begin with, a cave without ventilation or circulation of air will not have a freezing temperature in either winter or summer. A cave with excellent ventilation such as the Twin Caves will get cold enough in winter to freeze ice, but the temperature in summer, while cool, is not cool enough to preserve any of the ice. Too much ventilation must then be avoided in advancing a theory. Stearns, who examined similar occurrences of ice in the Craters of the Moon region, dismissed the question with the statement that "the water is frozen by cold circulating air". This statement, while undoubtedly true, does not answer the question of why there should not be an equal circulation of warmer air in the summer which would melt this ice. The mean temperature of the region is about 45 degrees (F). Therefore if the circulation is the same in winter and summer such as it is in the Twin Caves, no ice would hold over through the summer. Notice will here be called to the diagram on Plate 12 and the following theory will be advanced:

The known entrance of the cave is at D. The letter A marks a small air entrance which comes from a far distant place. In the beginning the writer wishes it to be understood that the exact location and length of this tube, or tubes, cannot be determined. It is the writer's belief that the air connection is made through the collapsed tube, or depression ditch, running south from Black Butte. Letter B represents the basin through which entrance is made to the cave. This depression faces to the south and the winter sun strikes a large part of it. This basin is more than fifty feet in depth. Its sheltered position gives it a temperature, in winter, a number of degrees warmer than other higher places such as point A. Let us say that the temperature on a certain winter day is 20 degrees* below zero at A and zero degrees at B. In such a case an air circulation would be set up from A, through the cave, and out at B. When water freezes to ice, heat is liberated so if water froze in the cave the heat liberated would help warm the air passing out through entrance D. Such a circulation would freeze ice in the winter and would draw the cave full of very cold air. Now let is take a

* All temperatures are Fahrenheit.

The above [illegible] *g* [illegible]

A [illegible] the [illegible]

distant place. [illegible]

be understood that the exact [illegible]

tube [illegible]

belief that the [illegible]

[illegible]

[illegible] *B* [illegible]

which [illegible]

[illegible] to the [illegible] and [illegible] water [illegible]

part of it. [illegible]

Its [illegible]

a number of [illegible]

as point *g*. [illegible]

tain [illegible]

zero degrees at *g*. [illegible]

would be [illegible] *g* [illegible]

When water [illegible]

water [illegible] in the [illegible]

warm the air [illegible]

circulation [illegible]

draw the [illegible]

* All temperatures [illegible]

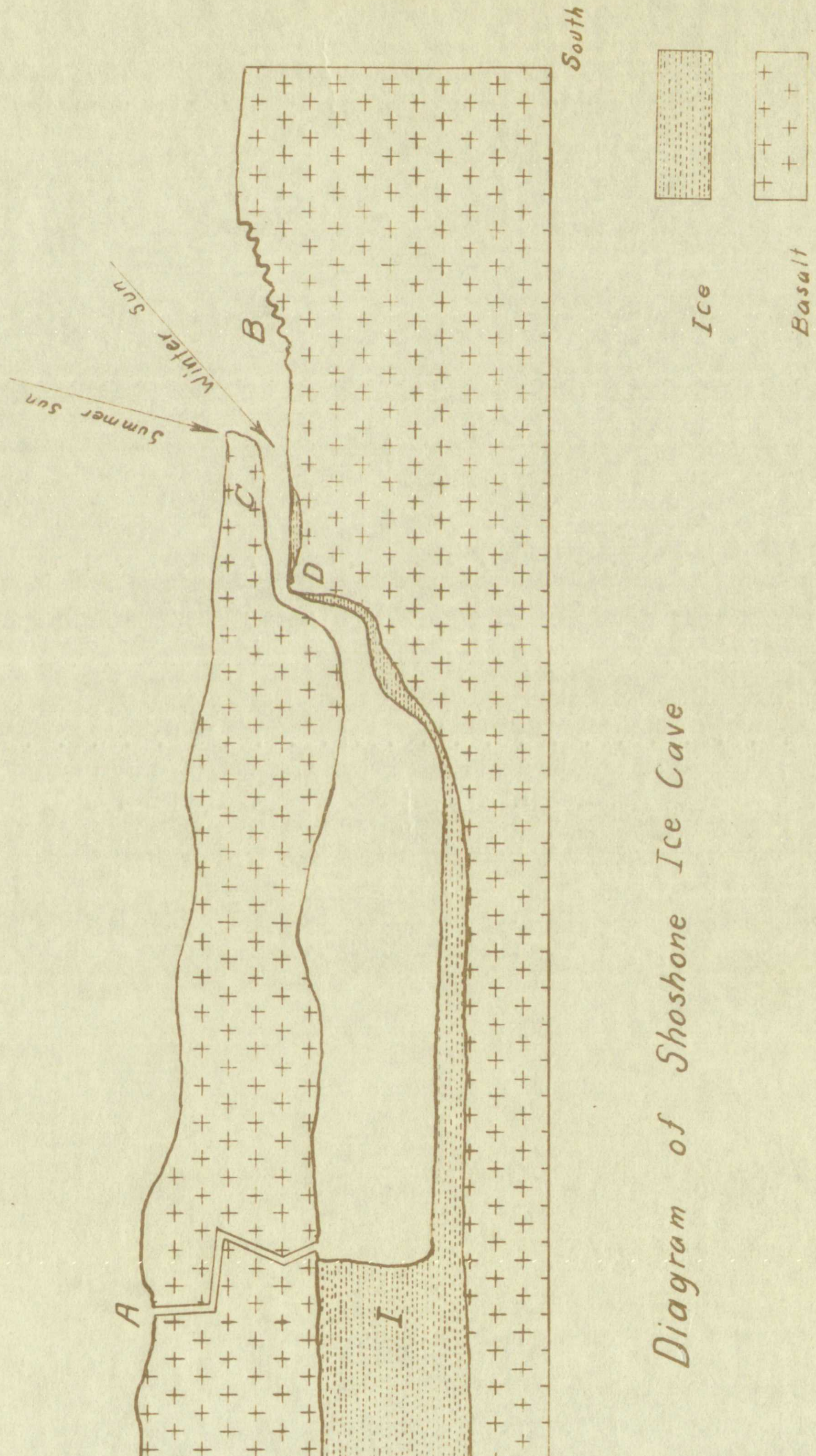


Diagram of Shoshone Ice Cave

summer day and apply the same situation. The summer sun is now more nearly in a vertical position and part of the basin B is sheltered from the direct rays. On the other hand vent A is exposed to the full ray of the sun for a longer part of the day. At this particular day the temperatures of A and B would probably be nearly the same with A being the warmer perhaps. At any rate the difference is not so great as exists during the winter. Suppose, then, air started to circulate through the cave from B to A. As the temperatures at the two points are almost the same, the circulation would be much slower than in winter. The warmer air, entering from B , comes in contact with the ice at D, melting some of this ice by a process of giving up its heat to change the ice into water. In this manner the incoming air is chilled nearly to the freezing point. This cold air collects in the cave and has a marked tendency to remain there since there is no colder air outside to force it out through any of the vents. In this way it can be seen that the circulation in summer is much slower than the circulation in winter. This change in circulation, coupled with the fact that the mean temperature outside is only 43 degrees, gives the best explanation that the writer has ever heard for the

normal decrement of the same typical [illegible]. [illegible]
is the more [illegible] [illegible] [illegible] in the [illegible] of
the earth. E_0 is a [illegible] from the [illegible] [illegible]
alike, and what E_y [illegible] to the [illegible]
sun for a longer [illegible] [illegible] [illegible]
day the temperature of E_0 [illegible] [illegible]
nearly the same [illegible] [illegible]
any only the difference [illegible] [illegible]
the winter. [illegible], E_0 and [illegible]
through the same from E_0 to E_1 [illegible] temperature
the two solstices phase. The [illegible] variation
would be much closer than it is [illegible]. [illegible] with
entering from E_1, comes [illegible] [illegible]
months some of this [illegible] [illegible]
heat to [illegible] into the [illegible]. In this [illegible] the
[illegible] [illegible] to the [illegible].
This cold and [illegible] in the [illegible] tend-
ency to [illegible] there after [illegible] [illegible] win-
able to force [illegible] the [illegible]. In this
way it can be shown [illegible] [illegible]
much [illegible] the [illegible] is [illegible]. This [illegible]
[illegible], [illegible] [illegible] the
temperature [illegible] [illegible]
explanation [illegible] [illegible]

origin of ice in caves. This circulation theory is borne out by the writer's visits to the cave at all seasons of the year. In winter the temperature of the cave is below the freezing point while in summer it is slightly above. In summer some of the ice melts for a distance of perhaps 150 feet from the entrance but the ice in the back of the cave always remains solid.

Quaternary Deposits

Thick deposits of Quaternary gravel occur in the northeastern part of the region near Picabo. The highlands to the east and north of Picabo were glaciated in Pleistocene times and much of the morainal material has been transported southward by streams and deposited in the basin below. The gravel has been transported some distance as it is well rounded. Beds of sand and a chalk-colored marl, locally known as "hard pan" are also found here. The marl contains some clay but the greater part of it is calcium carbonate. Underneath this "hard pan", a very resistant conglomerate is sometimes found. It is made up of a fine gravel and coarse sand set in calcium carbonate. It has the appearance and durability of a good grade of concrete.

The water table of the Picabo area is very near

origin of ice in caves. This circumstance is borne out by the writer's visits to the cave in all seasons of the year. In winter the temperature [illegible] cave is below the freezing point while in summer it is slightly above. In summer also the ice melts for a distance of perhaps 150 feet from the entrance but the ice in the back of the cave always remains solid.

Quaternary Deposits

Thick deposits of Quaternary gravel occupy the northeastern part of the region near Lincoln. The table-lands to the east and north of Lincoln were formed in Pleistocene times and much of the material has been transported southward by streams and deposited in the basin below. The gravel has been transported some distance as it is well rounded. Beds of a light gray chalk-colored marl, locally known as "lime pan" are also found here. The marl contains some clay, but the greater part of it is calcium carbonate. Underneath this "marl pan" a very resistant bed is sometimes found. It is made up of a fine gravel and coarse sand set in calcium carbonate and has the appearance and durability of good hard concrete.

the surface of the ground. Large springs rise and combine to form Silver Creek which has a mean flow of about one hundred second feet of water. These springs are directly dependent upon the flow of Big Wood River. When the flow in this river is low and little water is used in irrigating the country north of Picabo, a material decrease of flow is noted in Silver Creek. Big Wood River is separated from Silver Creek by a low gravel divide a few miles in width. The writer believes this to be outwash from a glacier. Probably , at one time, Big Wood River did not turn west toward what is now Magic Reservoir but continued south and flowed through the gap now occupied by Silver Creek.

Basalt flows underlie the gravel three miles south of Picabo, while a few miles farther south a later flow covers the gravel. Similar gravel wedges between basalt flows all along the mountain sides have made excellent places for the water to be conducted far down below the ground surface. This is also aided by the fact that the basalt is filled by joints, cracks, and caverns. Ten miles south of Picabo, out on the lava plains, it is necessary to drill more than two hundred feet for water. Wells along the Oregon Short Line farther to the south have average depths of approximately four hundred feet.

the surface [illegible] ground. [illegible] it [illegible] possible [illegible] bine to [illegible] silver [illegible] about one hundred feet [illegible] are directly dependent upon the flow of the [illegible] river. When the flow in this river [illegible] used in irrigating the country south of [illegible] ial decrease in flow is noted [illegible] River is [illegible] during a few [illegible] water [illegible] to be obtained from [illegible] Big Wood River did not [illegible] Magic Reservoir [illegible] the [illegible] now [illegible] Silver Creek.

Basalt [illegible] gravels [illegible] of [illegible] surface [illegible] covers the gravel. [illegible] flows [illegible] the [illegible] places for the water to [illegible] ground surface. [illegible] basalt [illegible] miles south of [illegible] necessary to drill [illegible] [illegible] have [illegible]

Soil

The soils, with the exception of the gravels near the mountains and streams, are of aeolian and lacustrine origin. They are mostly volcanic dusts, calcareous clays, and a very fine yellow sand. Russell* screened several samples of soil and found that approximately eighty per cent of the material would pass through a two hundred mesh sieve. An analysis* of a sample of soil from near Shoshone Falls is given below.

$Si O_2$	52.48 per cent.
$Al_2 O_3$	7.10
$Fe_2 O_3$	2.63
$Ca O$	14.60
$K_2 O$	1.70
$Na_2 O$	0.93
$Mg O$	2.93
$C O_2$	12.40
$H_2 O$	4.96
$Ti O_2$	0.38
$P_2 O_5$	0.20
	100.31

* Russell, Israel C. Geology and Water Resources of the Snake River Plains. U. S. G. S. Bulletin 199. PP 136-37. Analyst, W. F. Hillebrand.

Eighty-two per cent of this analyzed soil would pass through a two hundred mesh sieve. The material retained by the sieve was mostly vegetable fibres and small sand grains cemented by calcium carbonate.

The soil of the region is similar to the loess of China except that the deposits in China are thicker and over a larger territory. In the Shoshone region the deposits do not have a maximum thickness of more than forty feet. The talus slopes of the nearby mountains (see Plate 17) furnish an ample supply of material and the prevailing winds do the rest. The wind storms are of almost daily occurrence, especially during the summer time when the mountain slopes are the driest and the rock flour most easily transported. As an example of the transporting power of winds, Cleland* cites the storm on the Sahara Desert which transported two million tons of dust to Europe in two days.

It will be noticed from the analysis of soil on the preceding page, that there is considerable material that would tend to make the soil of an alkaline nature if the ground water level was near the surface. However, drainage of the soil is not a great problem in the region,

---

* Cleland, H. F. Geology, Historical and Physical. American Book Company, 1916. Page 52.

View of the Big Lost River Mountains .

This picture was taken from the west side of the valley looking out over the town of Mackay. The prominent peak in the background is Mount Mc Caleb which is over 11,500 feet in height.

Special attention is directed to the talus slopes and alluvial fans between the town and the mountains. The mountains are formed from the steeply tilted beds of Paleozoic rocks.

even though some of the land receives more than four acre-feet of water during the irrigating season. The water from irrigation, together with that from melting snows on the plain, quickly percolates downward through crevices in the lava, eventually reaching the permanent ground water level some four hundred feet below. An engineer of the Twin Falls Canal Company (Mr. Hayes) reports striking one such underground flow which he estimated as flowing about forty second feet. Probably many similar channels conduct the water downward to the permanent ground water level.

SPECIAL TOPICS

Farming and Irrigation

Only seven per cent of the state of Idaho is under cultivation. About twenty per cent of the Shoshone district, however, is being farmed. The Camas Creek valley near Fairfield and Hill City receives more rainfall than the rest of the district and dry farming is practiced,- wheat being the main crop. The other areas depend upon irrigation from the Big and Little Wood Rivers, Silver Creek, Magic Reservoir, Little Salmon

River and Snake River. The main crops are alfalfa, potatoes, grain of various kinds, and fruit. Therr cuttings of alfalfa are often raised, even though the growing season is short. The soils are fertile and large crops are usually raised when water is plentiful.

The Milner Dam is located above the deep canyon of the Snake River, and it is from here that the large canals of the North Side and South Side projects take out. The Snake River has a mean flow of about 6,000 second feet at Milner during the irrigating season. The South Side Canal, with a maximum capacity of 3,000 second feet, reclaims almost 300,000 acres of land. The North Side Canal is smaller and furnishes water to something less than 200,000 acres of land. This company uses Wilson's Lake as a regulating basin. When this lake is full it loses about 400 second feet of water each day by leakage through the lava. A number of years ago a storage reservoir was built eight miles southeast of Shoshone. It was filled by the North Side Canal from Milner Dam but the loss was tremendous and the reservoir was abandoned.

Silver Creek and Big and Little Wood Rivers irrigate over 100,000 acres of land. The flow of these streams varies a great deal and there is often a lack

of water on the project. To remove this uncertainty, a canal is being constructed from Milner Dam which will empty into the Big and Little Wood River irrigation system near Shoshone. The point of diversion will be Milner Dam, but the water will be storage drawn from the American Falls Reservoir some thirty miles up the river from Milner Dam. This new canal involves some heavy cutting, some of it through solid lava. Part of the canal will be lined with concrete where it passes over the rough, jagged, and cracked surface of Black Butte flow.

A very fertile region is found in the narrow valley near Hagerman. The growing season, here, is longer than it is outside of the Snake River valley, and an abundant supply of water is derived from the large springs which come out of the canyon wall.

Before leaving the subject of irrigation, it might be well to mention the reservoirs of the district. The one constructed southeast of Shoshone leaked almost as fast as the water could be led into it. Its abandonment gave a costly illustration that basalt is not the rock to have for the bottom of a reservoir. Wilson's Lake is a similar example, except that here the lava has a heavy covering of soil which has partially sealed the

of water on the project. To remedy [illegible] canal is being constructed [illegible] Milner [illegible] empty into the Big and Little Wood River irrigation system near Shoshone. The water of [illegible] Milner Dam, but the water will be stored [illegible] the American Falls Reservoir [illegible] river from Milner Dam. While part of this [illegible] heavy cutting, some of it through [illegible] the canal will be lined with concrete [illegible] over the rough [illegible] and crossed [illegible] Butte flow.

A very fertile region is found by the [illegible] near Hagerman, the [illegible] It is outside of the Snake River Valley [illegible] supply of water is derived from the [illegible] come out of the canyon wall.

Before leaving the [illegible] be well to mention the reservoirs of this district. [illegible] one constructed southeast of [illegible] fast as the water could be led into it [illegible] gave a costly illustration that resulted [illegible] to have for the [illegible] a similar example, [illegible] heavy covering [illegible]

bottom. Even with this covering of soil the loss is a serious problem as enough water is lost in the growing season to reclaim twenty thousand acres of land.

The Magic Reservoir, on the other hand, has practically no seepage loss as it has a rhyolite bed. Basalt beds lie to the west of the reservoir but they are thin and are underlaid by a bed of sand resting on a rhyolite base. Not only is there no loss in the reservoir, but there is really a gain as the springs in the reservoir bottom contribute approximately twenty acre-feet of water per day.

Stock Raising

Several large sheep companies have their headquarters in Shoshone, Jerome, and Twin Falls. The sheep range through the sagebrush in the spring, but they are usually driven to the mountain ranges during the summer and fed in sheds during the winter. Pedigreed sheep from a ranch near Thousand Springs have won a number of national prizes. Each farmer in the region has a number of sheep and cattle which have often saved him during bad years. Many sheep and cattle are shipped from Hailey and smaller shipments are made from many of the towns in the district.

bottom. Even with this [illegible]

serious problem as seepage [illegible]

season to reclaim twenty thousand acres of land [illegible]

The Marie Reservoir [illegible]

ically no seepage loss [illegible]

beds lie to the west of the reservoir [illegible]

and are underlaid by a heavy [illegible]

base. Not only is there no loss in the reservoir [illegible]

there is really a gain [illegible]

bottom contribute [illegible]

water per day.

Stock Raising

Several large sheep companies have their headquar-

ters in [illegible]

range through the [illegible]

usually driven to the [illegible]

and fed in sheds [illegible]

from a range [illegible]

national crises. [illegible]

of sheep and cattle which have often [illegible]

bad years. [illegible]

Valley and [illegible]

towns in the district.

Mining

The Shoshone region, at the present time, derives no revenue from mining. A number of years ago a few gold placer deposits were worked in the Snake River canyon near Murtaugh. The gold was very fine and therefore difficult to recover. The yields were also small and the placers were soon abandoned.

The origin of this gold is a mystery. No streams enter the Snake River in the vicinity of the placer deposits, or for that matter for a hundred miles above it. Some suggest that the gold was derived from the basalt itself. Some suggest that the gold has been transported a long distance. This might be possible as the gold is so fine that it cannot be caught in the ordinary type of "riffle" used by the placer miners. The writer has heard the placer miners speak of making "riffles" out of carpet to use in recovering fine gold above Devil's Corral. Similar methods were used all along the Snake River but the mining was never a successful venture. The writer has visited the old placer workings above Devil's Corral but nothing is left there now but a few rusty pipes and the remains of an old flume.

[illegible]

[illegible]

no reason [illegible] gold placer [illegible] [illegible] fore [illegible] and [illegible]

[illegible] enter the [illegible] deposits, or for [illegible] it. [illegible] benefit [illegible] transported a [illegible] the gold [illegible] ordinary [illegible] The writer has [illegible] "riffles" [illegible] above [illegible] along the [illegible] ful venture. [illegible] workings above [illegible] now but [illegible] Times.

Scenic Attractions

With the exceptions of the Black Butte flow and the Shoshone Ice Cave, the Snake River plains do not offer great inducements to the tourist looking for scenery. The Snake River which cuts a deep canyon across the southern part of the region affords most of the scenery for the district. The Black Butte flow and the Ice Cave have been discussed previously. The scenic attractions of the Snake River canyon will be taken up under their special headings below.

Water-falls

Between Milner Dam and the town of Bliss, the Snake River cuts a deep canyon (see Figure 1, Plate 18) through layers of lava and beds of less resistant sedimentary material. The resistant ledges of lava have formed many rapids and a few large water-falls. The one exception to the above statement is offered by Shoshone Falls which owes its origin to a rhyolite ridge which is more resistant than the basalt flows which covered it. The Snake River canyon itself owes its origin mostly to the receding of the various falls in the region. Shoshone Falls is the highest and most

[illegible]

With the [illegible] the

Shoshone Ice Cave, the [illegible]
great indulgence [illegible]
The [illegible]
southern part of the [illegible] the
for the [illegible]. The [illegible]
have been discussed previously. The [illegible]
of the Snake River [illegible] with [illegible]
special headings below.

[illegible]

Between [illegible] the
Snake River cuts a deep gorge [illegible]
through layers of [illegible]
imentary material. The [illegible]
formed many [illegible] and [illegible]
one exception to [illegible]
Shoshone Falls which [illegible]
grade which is more resistant than [illegible]
which covered the [illegible]
its origin [illegible]
in the region.

Figure 1. Snake River canyon above Shoshone Falls.

Figure 2. Shoshone Falls.

pretentious falls in the district and will rank as one of the greatest in the world (see Plate 18, Fig. 2). Its height is 219 feet, which exceeds that of Niagara by more than fifty feet. In spring when as much as 30,000 second feet of water flows in the Snake River Shoshone Falls can certainly be called a wonderful sight. The water strikes the crest of the falls with a wild rush, and is nothing but a mass of foam until it strikes the green lake below.

The Twin Falls are not such a beautiful sight as Shoshone Falls. Their height is approximately 180 feet. The Twin Falls are formed by a resistant ledge of basalt overlying a weaker sedimentary bed (Figure 1, Plate 19). These falls are steadily receding by cutting trenches in the resistant lava ledge. (Figure 2, Plate 19)

The Lower Salmon and Upper Salmon Falls are located within a few miles of Hagerman. Each water-fall has a height of something like fifty feet. During spawning season, salmon come up the river as far as the Lower Falls. Sturgeon weighing more than 200 pounds are sometimes caught below Lower Salmon Falls.

Springs and Alcoves

Large springs are very common on the north wall of

Figure 1. The greater of the Twin Falls. The lesser of the falls is practically dry at such a low stage of the river.

Figure 2. Rapids above the Twin Falls. Notice how the grooves are being cut into the resistant lava ledge.

the Snake River canyon between Shoshone Falls and Bliss. The water issues from some gravel beds between lava flows and from slaggy, scoriaceous, torn beds of lava, formed where the molten flow ran into water. The most famous example of this nature is what is known as Thousand Springs. The name is really most descriptive, because there are really thousands of springs pouring out of the torn, slaggy bed of lava. The water-bearing bed is about two hundred feet above the level of Snake River. Originally the water poured down over the canyon wall as shown on Figure 2, Plate 20. Now a concrete retaining wall has been built in front of the water-bearing bed, conducting the water towards the center of the flow and dropping it through a power plant two hundred feet below. The writer visited this power plant in the summer of 1929 when a part of the retaining wall had been washed away. A clear exposure of the pervious bed could then be seen. The bed varies in thickness from a few inches to thirty feet or more. It is formed of lava boulders and a shredded type of lava evidently formed by the action of steam when a basalt flow ran into water. This bed of slaggy, glassy material can be followed for a number of miles. The pervious stratum passes beneath the river near the town of Bliss.

Figure 1. Blue Lakes Alcove .

Figure 2. Thousand Springs as seen before the retaining wall of the power plant was built.

This water-bearing stratum is not the only bed which carries water. Similar occurrences are found at Sand Springs two miles above Thousand Springs and at Blue Lakes and Clear Lakes still farther up the river. Blue Lakes really belongs to the separate classification of alcove springs, along with the similar flows of Big Box and Little Box Canyons and the Devil's Corral.

These alcoves are smaller "blind or box canyons" leading out from the main canyon of Snake River. The alcove at the Big Box Canyon is more than two miles in length and contains a large spring, or springs, flowing more than a thousand second feet of water. The alcoves at Little Box, Blue Lakes, and Devil's Corral are smaller in size and contain springs of lesser volume. The water issuing from these springs is a decided blue in color. The lakes in the alcoves all have bottoms of fine, white sand. None of the alcoves have streams entering them over the canyon rim. It is evident that these small canyons owe their existence to the large springs coming from them.

The blue color of the spring water is due to the amount of fine material carried in suspension. Evidently the stream passes through a thick stratum of fine sand before appearing at the surface. By the carrying away

of these fine particles, the stratum of sand is gradually eaten away. The overlying basalt flows are undermined and cave off into the void below where they are buried in the coarser sand which has not been transported away. The resulting bed would be a layer of large boulders set in fine sand. The automobile road passes over such a bed between the Blue Lakes and the bridge.

It will be noticed that no great amount of talus is found near the source of the spring. Also few rocks can be seen in the bottom of the lakes near where the springs rise. These two facts bear out the theory that the talus blocks are buried in the remaining sand of the thick, water-bearing bed. A small distance below the spring's source, talus is very plentiful and has dammed up the stream forming the lakes. Some of the fine matter in suspension has been dropped in the lakes covering the talus blocks with a deposit of fine, white sand.

The lower part of the Malad River is undoubtedly due partially to spring erosion like Blue Lakes and Box Canyon. Springs totalling about 3.000 second feet issue from similar beds. Erosion has been aided by a stream entering from the plain also, but the greater part of the erosion has been due to the springs.

Hot Springs

A number of hot springs are found on the Snake River plains and the adjoining mountains. When in the mountains, they are always near flows of Miocene rhyolite. Out on the plains they issue from the basalts but where they come from farther below is problematical. Russell*, from a study of wells of the Oregon Short Line Railroad, has determined that water increases one degree** in temperature with every forty-five feet of depth in the Snake River plains region. This increase is higher than that accepted for most other regions, which usually assume about one degree* for every sixty feet. Russell's findings might indicate that the region underlying the Snake River plains has not yet cooled completely. This is not such a startling thought when one considers that the flows of rhyolite in southern Idaho are no older than the same kind of flows in Yellowstone Park.

One hot spring is found out on the lava plains south of Murtaugh. Another is located in the Snake River valley two miles above, and on the opposite side

---

**All temperatures Fahrenheit.

* Russell, Israel C. Geology and Water Resources of the Snake River Plains. U. S. G. S. Bulletin 199. PP 153-154.

Figure 1. Interior Shoshone Ice Cave.

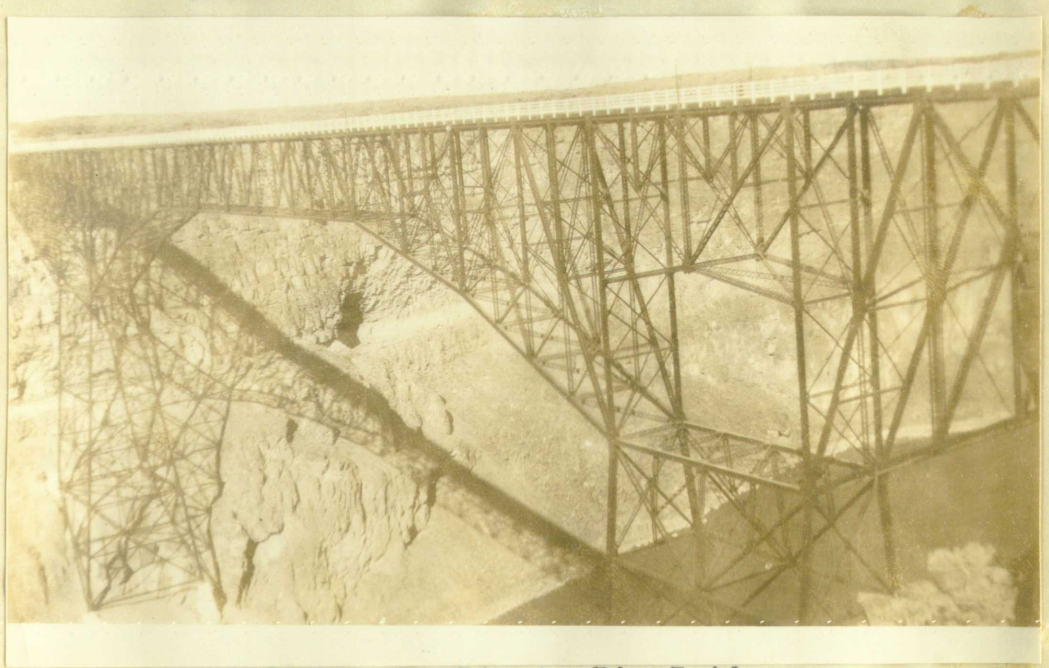


Figure 2. Rim to Rim Bridge.

The Snake River Canyon is 500 feet deep at this point. Notice the bed of volcanic dust in the lava wall to left.

of the river from Thousand Springs. The waters from these two springs have temperatures of about 180 degrees (F). Neither stream contains any large amount of sulphur. Springs of about an equal temperature rise west and north of Hailey. Rhyolite is found in the vicinity of the Hailey springs but the springs themselves flow from crevices in an older limestone. These springs contain enough sulphur to tarnish silver and give an offensive odor.

Several warm springs are found near King Hill and Mountain Home, to the west of Bliss. These springs are not extremely hot,- in fact they are cool enough to be used to irrigate crops with. Such warm springs, according to Russell*, are indications of water under pressure, and it would be a good idea to drill for artesian water near them. Very hot springs might also indicate water under pressure but it would be at such a depth that it would be impractical to drill for it. This theory seems to work out in this locality but it is doubtful if it could be taken for other regions where different conditions prevail.

---

* Russell, Israel C. A Preliminary Report on Artesian Basins in Southwestern Idaho and Southeastern Oregon. U. S. G. S. Water Supply and Irrigation Paper No. 78. Pages 14-16.

Water Power

The Idaho Power Company operates a number of hydro-electric plants along the Snake River. A plant at Thousand Springs generates 15,000 horse power. Smaller plants at Salmon Falls and Malad River each generate approximately 10,000 horse power. Several other large power plants are operated above Milner Dam at American Falls and Idaho Falls. Swendsen* states that in 1924 three permits for use of Snake River water between Buhl and Bliss were issued. These permits called for the use of 11,000 second feet of water which was to generate 87,000 horse power. These plants are feasible but, as yet, they have not been erected as there is not a great enough demand for power. The potential power possibilities between Milner Dam and Weiser are something in excess of half a million horse power. In years to come this will undoubtedly be utilized but at present the supply exceeds the demand, in spite of the fact that the modern house-wife in the region has every electrical convenience that is on the market.

Electricity, cheap enough for household heating,

*Swendsen, W. G. Third Biennial Report of the Department of Reclamation for the State of Idaho, 1923-24. State Department Publication.

is now available. Some schools and hotels in southern Idaho have even been heated by electricity. It is a very common thing to see a farmer have his barns, as well as his house, equipped with electric appliances. It is even conceivable that railroad electrification is not far distant. When that time comes, the steam train, burning Utah and Wyoming coal, will be a thing of the past.

is not [illegible] Idaho [illegible] very [illegible] well [illegible] It is [illegible] is not [illegible] fresh, [illegible] of the West.

BIBLIOGRAPHY

Anderson, Alfred L.
Geology and Ore Deposits of the Lava Creek District, Idaho. Idaho State Bureau of Mines and Geology. Pamphlet Number 32. August 1929. 70 pages.

Cleland, Herdman Fitzgerald.
Geology, Physical and Historical. American Book Company, 1916. 718 pages.

Kirkham, Virgil R. D.
A Geologic Reconnaissance of Clark and Jefferson and Parts of Butte, Custer, Fremont, Lemhi, and Madison Counties, Idaho. Idaho State Bureau of Mines and Geology. Pamphlet Number 19. January 1927. 47 pages.

Meinzer, Oscar E.
Ground Water in the Pahsimeroi Valley, Idaho. Idaho State Bureau of Mines and Geology. Pamphlet Number 9. February 1924. 35 pages.

Pirrson, Louis V.
Rocks and Rock Minerals. John Wiley and Sons, 1913. 414 pages.

Ross, Clyde P.
The Vienna District, Blaine County, Idaho. Idaho State Bureau of Mines and Geology Pamphlet Number 21. April 1927. 17 pages.

Ore Deposits in Tertiary Lava in the Salmon River Mountains, Idaho. Idaho State Bureau of Mines and Geology. Pamphlet Number 25. August 1927.21 pages.

Russell, Israel C.
Geology and Water Resources of the Snake River Plains of Idaho. U. S. G. S. Bulletin Number 199. 1902. 192 pages.

Preliminary Report on Artesian Basins in Southwestern Idaho and Southeastern Oregon. U. S. G. S. Water-Supply and Irrigation Paper Number 78 (1903) 57 th. Congress, Second Session, House of Representatives Document 441. 53 pages.

Shenon, P. J.
Geology and Ore Deposits of the Birch Creek District, Idaho. Idaho State Bureau of Mines and Geology, Pamphlet Number 27. April 1928. 25 pages.

Stearns, Harold T.
Craters of the Moon National Monument of Idaho. Idaho Bureau of Mines and Geology, Bulletin Number 13. July, 1928. 57 pages.

Umpleby, Joseph B.
Some Ore Deposits of Northwestern Custer County, Idaho. U. S. G. S. Bulletin Number 539. (1913) 104 pages.

Geology and Ore Deposits of the Mackay Region, Idaho. Professional Paper Number 97. (1917) 129 pages.

Varley, Thomas. (With others)
A Preliminary Report on the Mining Districts of Idaho. Department of the Interior, Bureau of Mines Bulletin Number 166. (1919) 113 pages.

Wood, George Mc Lane.
Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey, With Directions to Typewriter Operators. Government Printing Office, 1916. 120 pages.

Thesis accepted

Chairman of Committee on
Graduate Instruction

Stuart A. Northrop
Major Professor

S. P. Nanninga
Minor Professor

W. L. Shelton
Librarian