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**STATE OF OREGON**  
**DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES**

# The Ore Bin

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## GEOLOGY AND ORIGIN OF THE METOLIUS SPRINGS JEFFERSON COUNTY, OREGON

N. V. Peterson\* and E. A. Groh\*\*

### Introduction

"It flows from the north base of Black Butte, full bodied, and icy cold, and after winding northward through beautiful pine forests, swings around the north end of Green Ridge through a canyon of great depth and majestic grandeur, joining the Deschutes just north of the mouth of Crooked River." This description from Oregon Geographic Names by McArthur (1944) can only fit the Metolius River and its springs.

A visitor standing for the first time at the viewpoint overlooking the source of the Metolius cannot help but be astonished at this "instant river" and ask himself: "Where does all this water come from?" The purpose of this article is to explain the origin of the springs and their relation to the surrounding terrain.

### Location and Geographic Setting

The Metolius Springs are situated in timbered country in the southwest corner of Jefferson County about 30 miles northwest of Bend and Redmond (Figure 1). The locality is easily reached by several roads that leave U.S. Highway 20 between Santiam Pass and Sisters. The shortest route is a paved road from a well-marked junction about 10 miles east of Santiam Pass or 9 miles west of Sisters, which trends northeast for about 4 miles to the springs and continues northward to a loop road that parallels the Metolius River and provides access to the famous fishing resorts and popular recreation area.

A few years ago Mr. and Mrs. Sam Johnson, owners of the Metolius Springs, placed the property in the hands of the U.S. Forest Service for protection and maintenance. The Forest Service has built a parking lot, rustic trail, and viewpoint structure from which visitors can see the river begin.

In the vicinity of the springs the Metolius Valley is about 3 miles wide and nearly flat. Its elevation is approximately 3000 feet above sea

\* Geologist, State of Oregon Dept. of Geology and Mineral Industries

\*\* Private Geologist, Portland, Oregon

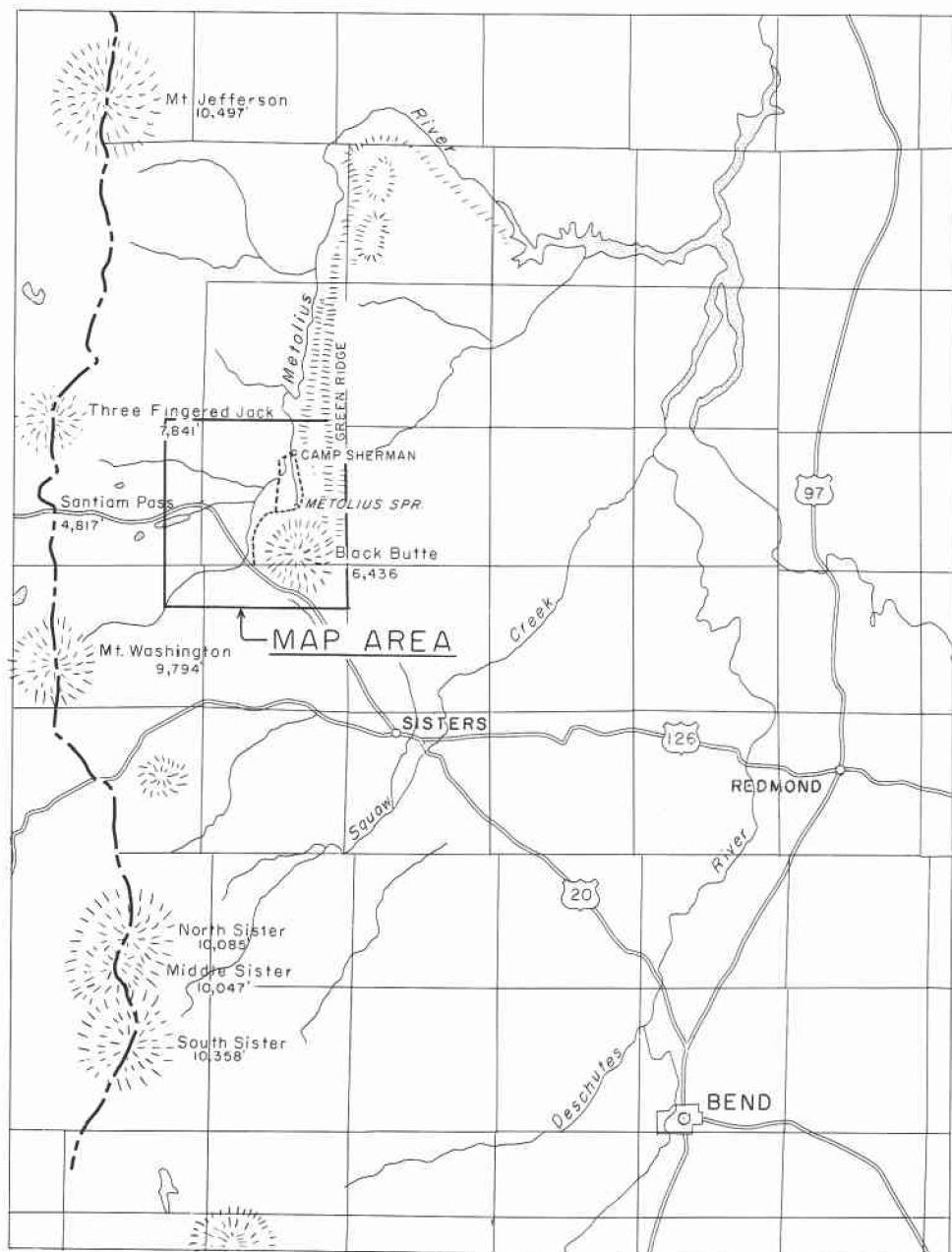


Figure 1. Index map showing location of Metolius Springs and area of geologic map shown on pages 48-50.



level. Immediately to the south is Black Butte, a symmetrical volcanic cone towering more than 3000 feet above the valley floor to a total elevation of 6346 feet. On the east is Green Ridge, a north-trending fault scarp which rises 2000 feet above the valley. On the west 10 miles distant are the snow covered volcanic peaks of Mt. Jefferson, Three Fingered Jack, and Mt. Washington.

The Metolius Springs rise from two groups of orifices about 200 yards apart at the northern base of Black Butte. The water bubbles out of bouldery valley fill at a chilly temperature of 48°F., and the two flows join within a short distance to make up the headwaters of the Metolius River (Figure 2). Total flow from the springs consistently measures from 45,000 to 50,000 gallons per minute the year around. In its 35-mile course northward and eastward to the Deschutes River, the Metolius gains an additional 600,000 gallons of water per minute from springs and tributary streams that drain the east flank of the Cascades.

### Geologic History

The Metolius Springs are in the transition zone between the High Cascades geomorphic province on the west and the High Lava Plains on the east.

The oldest rocks in the vicinity are exposed in the steep escarpment of Green Ridge. They consist of alternating layers of basaltic-andesite and breccia and agglomerate typical of shield volcano eruptive centers. These eruptive rocks overlie tuffaceous sandstones, ashy diatomite, and pumice that resemble rocks of the High Lava Plains to the east. The Green Ridge rocks are considered to be of Pliocene age. (See geologic map, p. 48-50.)

The younger rocks of the Metolius Springs area are part of the High Cascades province. They include a variety of volcanic and glacio-fluvial materials. Taylor (1968) reports evidence that the High Cascades platform of coalescing shield volcanoes of andesite and basalt and the majestic peaks that rise from it were formed during the last 1½ million years, (i.e., in Pleistocene and Holocene time rather than beginning far back in the Pliocene as had been commonly supposed). If Taylor's interpretation holds true for the Metolius area, then the numerous and varied geologic events post-dating the rocks of Green Ridge also occurred during this geologically short span of time.

The important geologic events associated with the Metolius Springs began with block faulting on a grand scale. Tensional forces in the earth's crust activated movement along north-trending normal faults gradually dropping a western block down to form the graben valley of the Metolius, causing Green Ridge, the eastern block, to stand as a horst. Once Green Ridge became an obstruction to drainage from west to east, surface water was diverted and an ancestral Metolius River began to flow northward.

The onset of volcanism in the High Cascades may have been coincident with this block faulting. The vast outpourings of basalt and andesite that



Figure 2. Head of Metolius River at Metolius Springs near northern base of Black Butte. Approximately 50,000 gallons of water per minute bubble out of ground (near willows, center of picture) and form an instant river.

built the chain of shield-shaped volcanoes in the High Cascades also obscured the western margin of the Metolius valley graben. After the lava from these shield volcanoes and their satellite vents had coalesced to form the broad, elevated platform of the High Cascades, some of the crowning peaks began to build by more violent volcanic eruptions.

In the High Cascades huge snow fields accumulated and glaciers advanced and retreated. Their powerful erosive forces spawned extensive debris for the streams to carry eastward and spread on the floor of the Metolius River valley.

By the time fault movement ceased and the Green Ridge escarpment reached its maximum height, volcanism was again triggered, this time in the Metolius Spring area along a fault within the graben. How long the eruptions continued we do not know but at their close Black Butte had attained its majestic stature (Figure 3). The rocks that make up Black Butte are typical of the High Cascades. They are light to dark gray, fine to medium grained, somewhat inflated, and of basaltic andesite composition. Outcrops of this blocky lava on the flanks are mixed with breccia zones and show that the cone was built from sluggish flows erupted from a central vent.



Figure 3. Black Butte volcano viewed from Indian Ford Creek area about 7 miles to the southeast. This symmetrical, craterless lava cone rises 3000 feet above the broad alluviated valley.

Taylor (personal communication) reports an age of 500,000 years for the Black Butte lava cone from K-Ar dating of its rocks. It hardly seems this old; no effects of glaciation can be seen and very little erosion; only shallow ravines scar its relatively smooth slopes.

Black Butte, by straddling the Metolius Valley and lapping onto the southern shoulder of Green Ridge, dammed the drainages and divided the valley into a northern part in which the Metolius River is now flowing and a southern park which contains Black Butte Swamp, Glaze Meadow, and the meandering Indian Ford Creek, which flows east, then south toward Sisters (see map). The Black Butte Swamp and Glaze Meadow area were probably once shallow lakes and they still act as sumps for the streams and subterranean drainages from the Cascade flanks southwest of Black Butte. U. S. Highway 20 affords a view of these beautiful upland meadow areas as it skirts the southwest flank of Black Butte.

After Black Butte was built, the High Cascade volcanoes continued to grow to their imposing heights. There were also sporadic eruptions from many small vents and cinder cones. Some of the more fluid lavas from these smaller eruptions reached the valley floor and one flow, now covered with

debris, laps on the western flank of Black Butte. Eruptions such as these have continued until very recent geologic time. One flow of stark black lava in the McKenzie Pass area not far to the west is only 1500 years old.

The last extensive glaciers of the High Cascades (late Wisconsin) were active until about 10,000 years ago. Long lateral moraines show the paths of the massive tongues of flowing ice which nosed toward the valley from the west. Hummocky piles of debris show where they stopped. On the map three of their glacial troughs are shown by the moraines they left. Suttle Lake occupies one of these. Glacial meltwaters continued to contribute large volumes of sands and gravels to the valley floor. This material, together with ash and cinders from the most recent explosive volcanic vents, provides the final cover which smooths the valley floor, laps onto the flanks of Black Butte, and covers all but the most recent lava flows in the McKenzie Pass area (Figure 4).

We come then to the present day--Black Butte astride a structural valley filled with tens of feet of glacial outwash, thin lobes of lava, and stream sediment.



Figure 4. Blanket of glacial outwash, cinders, and scoria between Black Butte and the High Cascades acts as sponge for snow and rain waters which percolate eastward into the Metolius River basin. Outcrop is about 3 miles west of Black Butte.

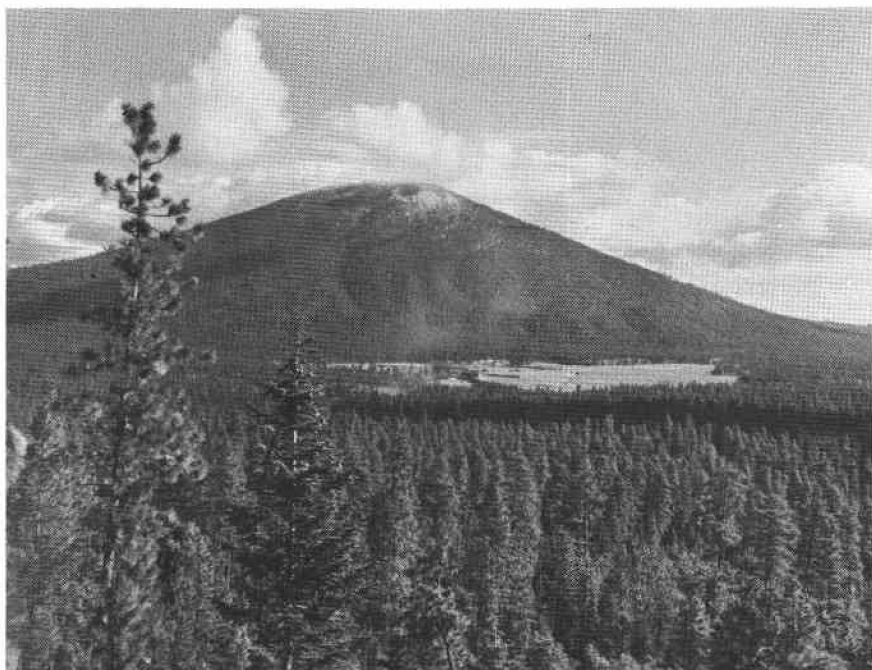


Figure 5. Black Butte viewed from the southwest at a distance of about 4 miles. The meadow area at the base, called Black Butte Swamp, is a sump for drainage northeastward from the High Cascades.

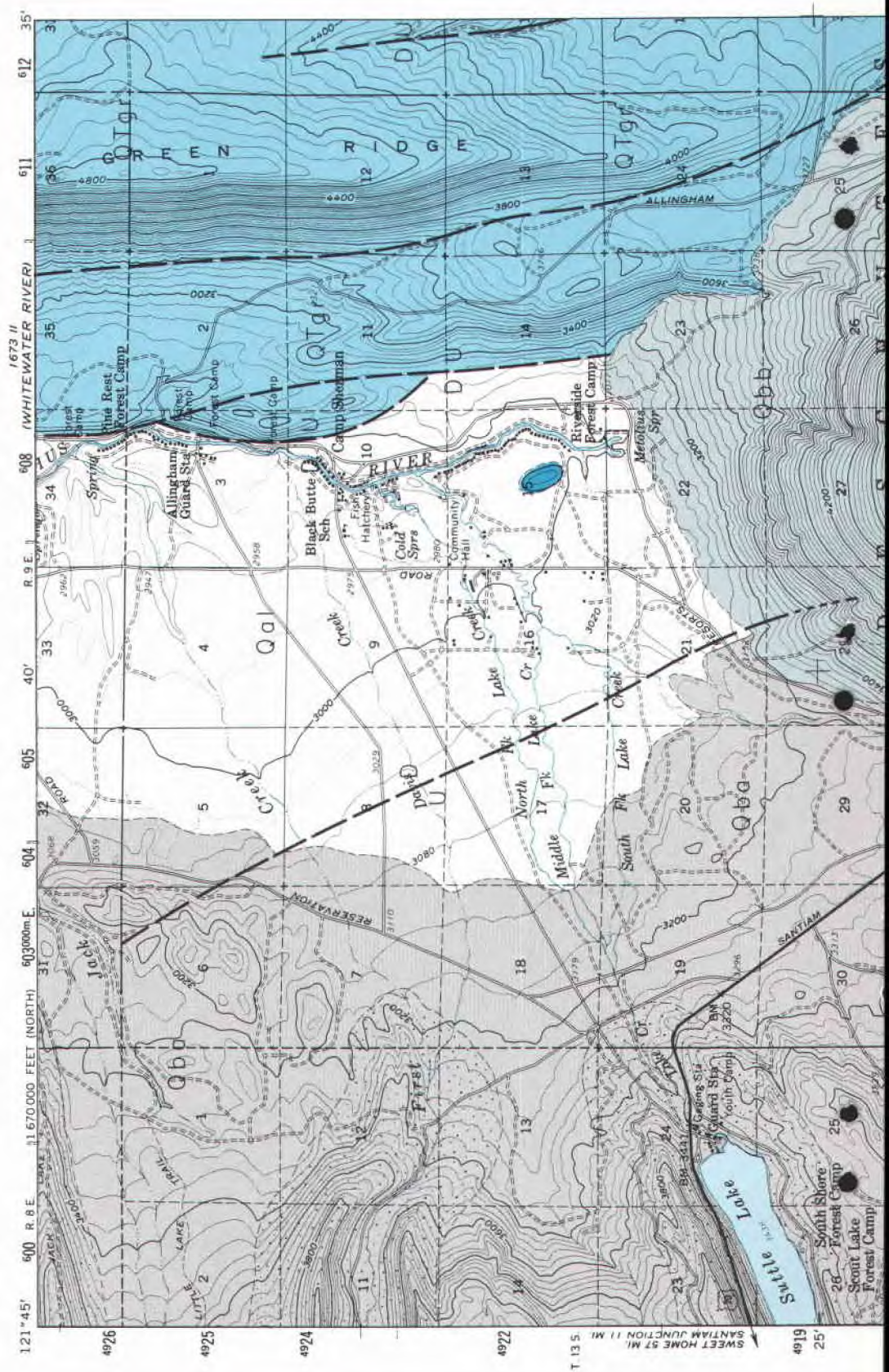
### Origin of Metolius Springs

The origin of Metolius Springs may best be understood by looking at the geologic map (p. 48-50) and pretending momentarily that Black Butte is not there. Visualize the remaining geologic and topographic features. This gives a fairly accurate picture of the way the area looked prior to the formation of Black Butte.

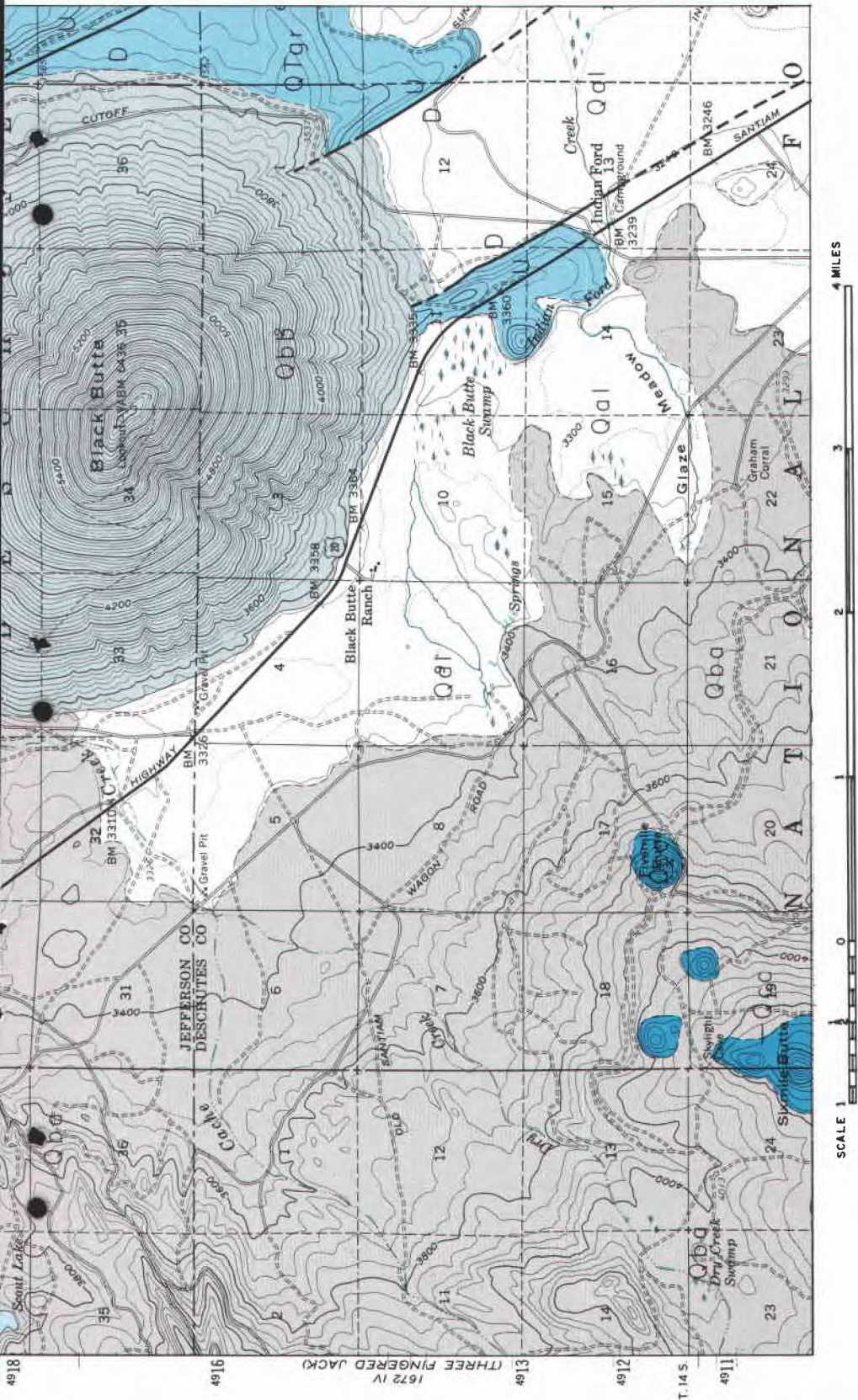
With Black Butte gone, the Metolius Springs do not exist. Instead the headwaters of the Metolius River extend to Black Butte Swamp or even farther south and west. Here, water from rain and melting snow in the High Cascades enters the valley in the form of small streams and as subterranean seepage through glacial outwash and porous zones of lava. Since drainage eastward is prevented by the southern extension of the Green Ridge escarpment, the upper Metolius River waters are channeled northward along the base of Green Ridge.

Now restore Black Butte to the present scene and it is apparent that Black Butte covers the ancestral course of the Metolius River. The water



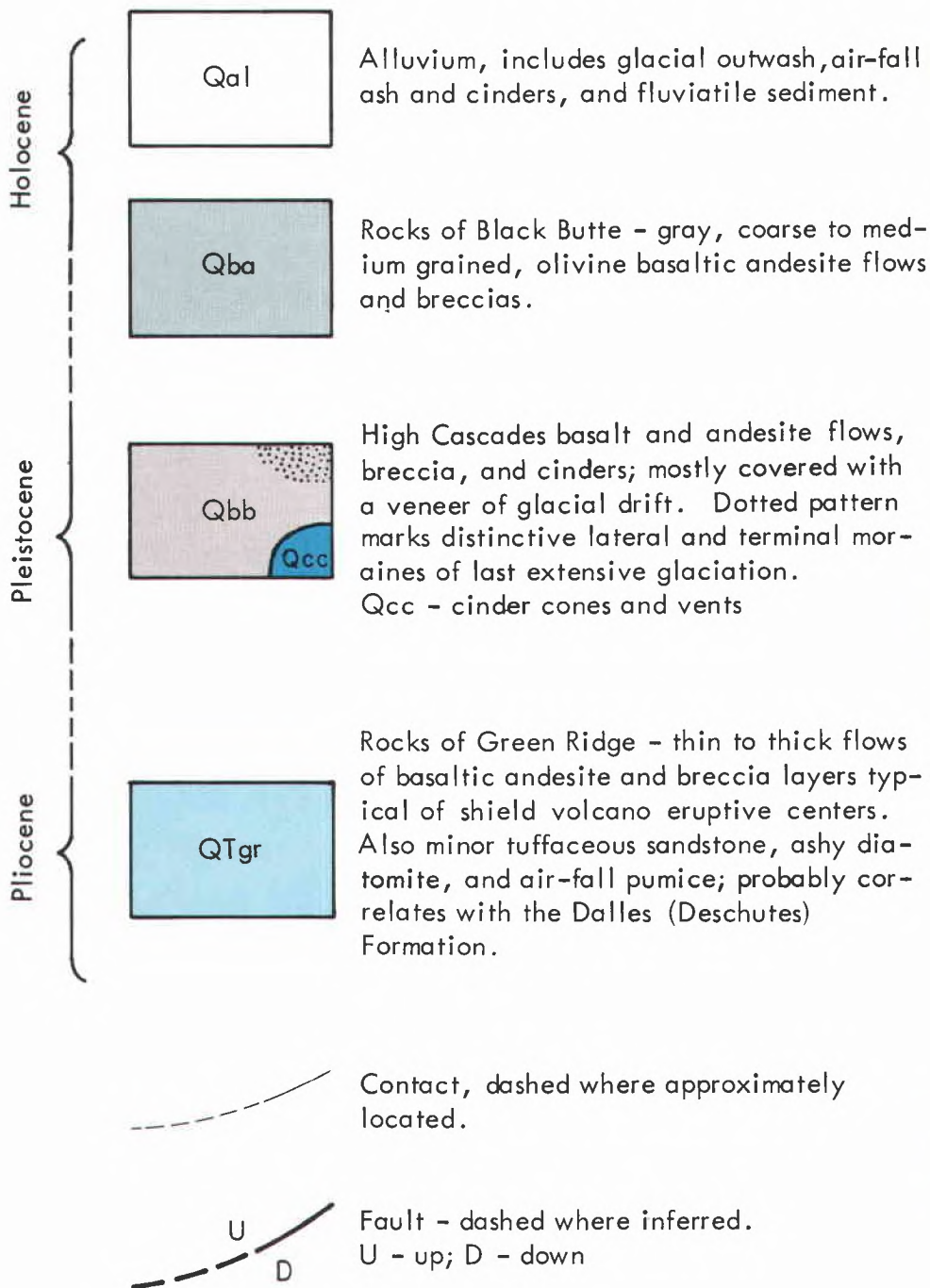






GEOLOGIC MAP OF METOLIUS SPRINGS AND VICINITY, OREGON

## MAP EXPLANATION





that once flowed on the surface as a river now percolates downward through the permeable sands and gravels of the ancient channel beneath the volcano and surfaces again at the lowest point just north of Black Butte, i.e., at Metolius Springs.

Black Butte Swamp plays an important role. The valley fill of which it is composed laps against the southern base of Black Butte and acts as a sump or container for the water migrating from the extensive drainage area to the southwest (Figure 5). An important feature is its elevation about 300 feet higher than the Metolius Springs. The collection basin that it forms acts as a standpipe and tends to keep a constant hydraulic head on the water from the springs, thus insuring their constant flow. More water enters Black Butte Swamp than surfaces at the springs. This excess is removed by Indian Ford Creek, which follows a circuitous route east then south past Sisters.

A geologist always welcomes an assignment when the landforms and the rocks give enough clues so he can be reasonably sure of the geologic history. In telling the story of the Metolius Springs we have not included all the geological details, many of which are found outside the map area. We are reasonably sure of the general sequence of events: the structural adjustments on the faults to form the valley and Green Ridge, the disruption and rerouting of the early drainages, the building of Black Butte, and the volcanism, glaciation, and natural erosion that have formed the present landscape.

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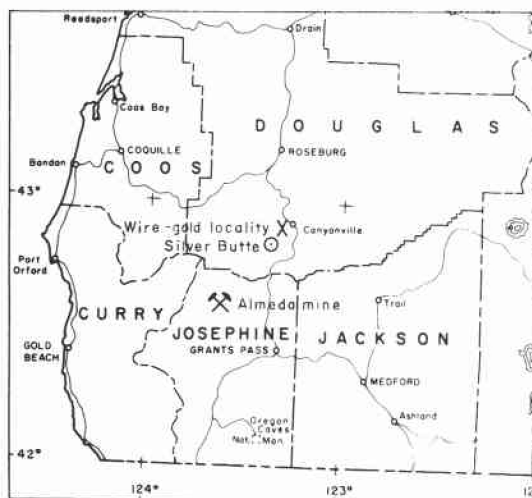
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## AN UNUSUAL GOLD OCCURRENCE FROM DOUGLAS COUNTY

Ronald C. Bartley  
Consulting Geologist, Ashland, Oregon

Sometime during the 1930's, a small amount of gold was recovered from an unusual geologic habitat near the town of Canyonville in Douglas County, Oregon.

This gold is in the form of wire-like nuggets which range from about 0.3 to 1.0 inch in length and average about 0.1 inch in thickness.\* It is slightly lighter in color than most gold, probably because of alloyed silver. Its shape and commonly striated surfaces suggest it formed in association with a fibrous mineral, probably amphibole asbestos.



Index map of Canyonville area showing location of gold occurrence

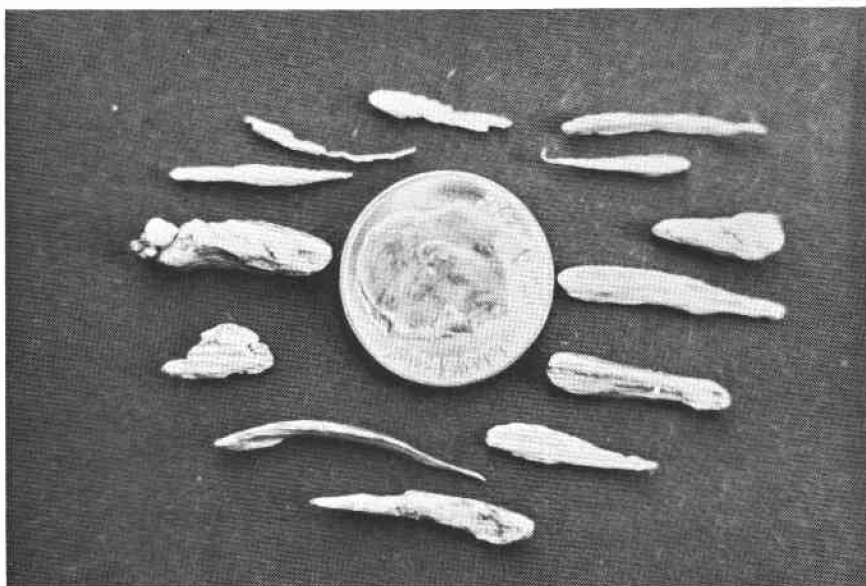
The gold was discovered in a near-surface "pocket" at the Gold Ridge mine, which is located in the SW $\frac{1}{4}$ Sec. 5, T31S, R5W. On a recent visit to the property the specific location could not be determined, since there are several small open pits and trenches.

The mine excavations are in a narrow belt of sheared serpentinite which apparently has intruded along a major fault zone separating the Jurassic Galice and Dothan Formations. Several narrow veinlets of amphibole asbestos were noted, and also some talc and minor amounts of chalcopyrite. Vein

quartz, which is so commonly associated with gold deposits was notably lacking.

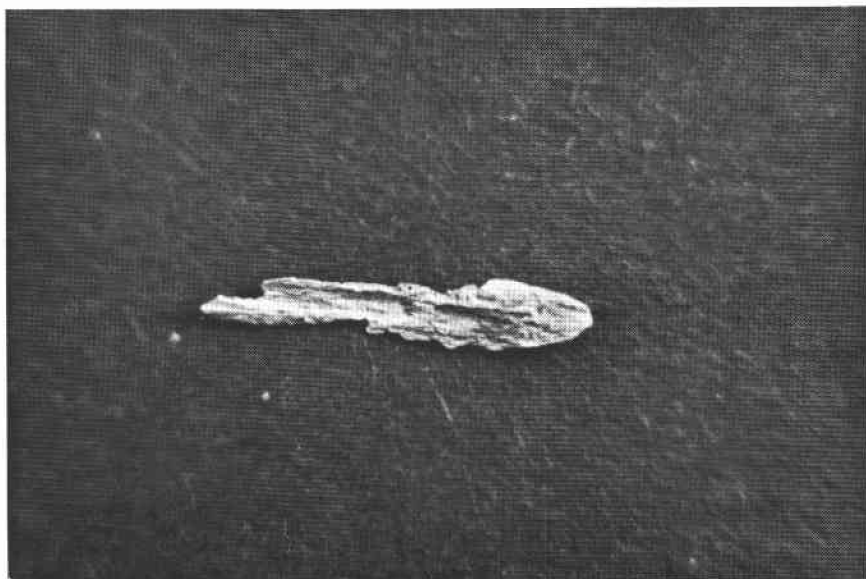
It is interesting to note that this old gold mine is one of at least 11 which are located along a very narrow structurally controlled zone extending southwest from Canyonville to Silver Butte. This zone is a northeast extension of the Alameda-Silver Peak trend, but exhibits a somewhat different type of mineralization. Although there are no other known occurrences of wire-like gold along the zone northeast of Silver Butte, a similar deposit has been reported a few miles southwest of Silver Butte and another on Tuller Creek west of Glendale.

\* Specimens examined were made available to the writer by Elton Bollenbaugh.



Above: Wire-like gold nuggets from the Gold Ridge mine.  
Enlarged; dime for comparison.

Below: Typical gold specimen. Note rough grooved surface.  
Enlarged 3X.



(Photographs by W. B. Purdom, Southern Oregon College)

## NATION TOO RELIANT ON METAL IMPORTS

An American Smelting and Refining Company official said in Caldwell, Idaho recently the United States is running the risk of losing its independence in foreign affairs by becoming increasingly reliant on imports of mineral raw materials.

S. Norman Kesten of Wallace, chief geologist for Asarco's Northwestern Mining Department, told the Caldwell Rotary Club that much legislation now being proposed would have the effect of further reducing domestic mining activity, thus forcing added dependence on foreign mineral sources.

Kesten said this nation exports only five major minerals--coal, phosphate, molybdenum, tungsten and magnesium--whereas it imports some or all of the dozens of its other essential mineral commodities. He noted, for example, that between 80 and 100 percent of America's chromium, nickel, asbestos, fluorite and aluminum are now imported.

"We are relying more and more on the good will and stability of other nations for many essential products," Kesten said. "However, other countries are not always stable, nor do they always feel good will toward us."

Kesten said it is plain that more ore deposits must be found and mined in the United States but there is a very strong tendency, among small but vocal groups, to try to prevent the discovery of new deposits. He said at least two major companies are prepared to invest large sums of money for mineral exploration and development in Idaho but are reluctant to do so because of possible harassment.

Kesten said 427 pieces of legislation which would adversely affect mining have been introduced at the Federal level. Some of the proposals are aimed at eliminating millions of acres from multiple use management and others at regulating mining to the point of destroying incentive for exploration and mineral development, he said.

(from The Wallace Miner, Wallace, Idaho)

\* \* \* \* \*

## GEOLOGY OF OREGON NOW ON POSTCARDS

Now you can buy a geologic map of Oregon on a 4x6" postcard. Twelve different geologic units based on age and type of rocks are shown in multi-color. Also indicated on the map are the major volcanoes, calderas, and faults.

The cards are for sale by the Oregon Department of Geology and Mineral Industries at its Portland, Baker, and Grants Pass offices. The price over the counter is \$.10 each or 3 for \$.25 (7 for \$.50; 12 for \$1.00). They may also be ordered by mail, but at a minimum of 12 for \$1.00. In large quantity the price is \$7.50 per 100 over the counter and \$8.00 per 100 by mail.

\* \* \* \* \*

## SAMUEL H. WILLISTON

Samuel Hathaway Williston, retired Sun Oil Company executive and president of the American Quicksilver Institute, is dead at the age of 72. Mr. Williston was well known in mining circles throughout the west for his activities in quicksilver. Williston was instrumental in expanding Sun Oil Company's interest in mining by establishing Cordero Mining Company, which eventually became the second largest mercury producer in the United States. The famed Horse Heaven mine in Jefferson County operated by Cordero produced a total of 17,000 flasks of quicksilver before the mine was shut down in 1958. Just south of the Oregon line in Nevada, the Cordero mine was the principal quicksilver producer in that state for many years.

Williston, as a geophysicist employed by Sun Oil, perfected a well-surveying device employing gyroscopic principles which is still the most-used well surveying instrument of its kind and was the basis for founding the Sperry-Sun Well Surveying Company. In later years Williston developed many other products, including an automatic elevation computing device which could be towed behind a car or truck and which gave instant readings. Another invention made it possible to detect remanent magnetism in drill cores. This discovery was a spin-off from an earlier device which had been developed to determine the orientation of drill cores by means of north-south magnetism induced in the rock at the time it was cored. A few years ago Williston perfected a mercury "sniffer" which contained an ultra-sensitive mercury detection device. The "sniffer," when transported across the countryside, could easily pick up slight changes in the mercury content of the surrounding air; these anomalies can be useful in the delineation of ore bodies with which mercury is often associated.

Sam Williston lived in Oregon during World War II. In addition to numerous other commitments, such as membership on national mineral advisory boards, he found time to serve on the Governing Board of the Department of Geology and Mineral Industries from 1943 to 1947.

Upon his retirement Williston devoted his efforts to research involving mercury in industrial applications and its impact upon the environment.

\* \* \* \* \*

## ASSAY AND SPECTROGRAPH PRICE SCHEDULE REVISED

The Department's assay and spectrograph prices, established as of July 1, 1971, have been changed to the benefit of those submitting samples. Up-to-date equipment recently installed in the Department's Portland laboratory makes it possible to process a number of the ores at a lower cost. The revised list of prices is available from the Department by writing to 1069 State Office Building, Portland, Oregon 97201. The list will also be published in a forthcoming issue of The ORE BIN.

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## DR. PAUL HOWELL

Dr. Paul W. Howell, 62, retired geologist for the U.S. Army, Corps of Engineers and adjunct professor at Portland State University, died February 28, 1972. Dr. Howell attended the University of Oregon and the University of Washington and obtained a doctoral degree at the University of Arizona. He was engineering and supervising geologist for the U.S. Army, Corps of Engineers for 20 years and worked on the sites for the Look-out Point, Dorena, Cougar, Fall Creek, and Green Peter Dams. After retiring from the Corps of Engineers in November 1969, he taught geology at Portland State University. He was a member of the Association of Engineering Geologists, the Oregon Academy of Science, and the Geological Society of the Oregon Country. At the request of the GSOC, the Earth Science Department at Portland State University has set up the Howell Memorial Fund, proceeds to go to students at Portland State doing research on the Troutdale and Molalla Formations. Contributions to this fund should be made to: "Portland State University Development Fund--Paul Howell."

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## GEOHERMAL RESOURCES COUNCIL PUBLICATIONS AVAILABLE

Copies of the papers presented at the Geothermal Resources Council First National Conference held in El Centro, California on February 16-18, 1972 are available for sale at the Portland office of the Department of Geology and Mineral Industries, and from the California Division of Oil and Gas, 1416 - 9th Street, Sacramento, California 95814.

The Proceedings of the Conference will be assembled into two publications. Presently available is the Overview of Geothermal Exploration and Development in the Western States, which is a compendium of all papers presented on the second day of the meeting, consisting of reports on each western state, except Alaska; 220 pages, price is \$6.00 postpaid. A compendium of the first day's papers is now being assembled and will sell for \$4.00 postpaid. A list of attendees is also available for \$2.00 postpaid.

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## NEW GEOHERMAL JOURNAL ANNOUNCED

A new publication devoted to geothermal resource research and development entitled GEOTHERMICS will be published quarterly by the International Institute for Geothermal Research, Pisa, Italy. Information on subscription rates is available from: Maxwell Scientific International, Inc., Fairview Park, Elmsford, New York 10523.

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