STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
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GEOLOGY AND MINERAL RESOURCES MAP OF THE SHEAVILLE QUADRANGLE, MALHEUR COUNTY, OREGON, AND OWYHEE COUNTY, IDAHO

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Geology and Mineral Resources Map of the Sheaville Quadrangle, Malheur County, Oregon, and Owyhee County, Idaho

By Norman S. MacLeod

Funded jointly by the Oregon Department of Geology and Mineral Industries, the Oregon State Lottery, and the U.S. Geological Survey COGEOMAP Program as part of a cooperative effort to map the west half of the 1° by 2° Boise sheet, eastern Oregon.

Plate 1

Base map by U.S. Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1968. Field checked 1969

Polyconic projection. 1927 North American datum 10,000-foot grids based on Oregon coordinate system, south zone, and Idaho coordinate system, west zone 1000-meter Universal Transverse Mercator grid ticks, zone 11

UTM GRID AND 1969 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

GN MN 0°03' 1 MIL 18½° 329 MILS

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

OREGON
QUADRANGLE LOCATION

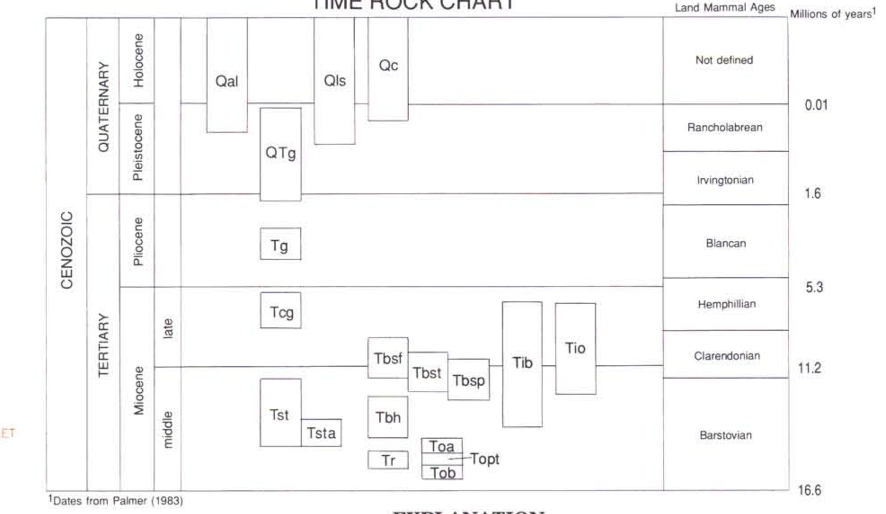
Geology by Norman S. MacLeod

Field work conducted in September, 1989

Map reviewed by David R. Sherrod, U.S. Geological Survey, and Mark L. Ferns, Oregon Department of Geology and Mineral Industries

Cartography by Paul E. Staub

TIME ROCK CHART



[1]Dates from Palmer (1983)

EXPLANATION

Qal — **Alluvium (Holocene and Pleistocene)**—Unconsolidated, poorly sorted to well-sorted, massive to well-bedded gravel, sand, and silt in and adjacent to stream channels and on flood plains

Qc — **Colluvium and alluvial fan deposits (Holocene and Pleistocene)**—Unconsolidated, poorly sorted, massive to poorly bedded debris forming alluvial fans and mass-waste deposits on slopes. Mapped only where thick enough to obscure underlying rocks

Qls — **Landslide deposits (Holocene and Pleistocene)**—Unconsolidated, poorly sorted deposits formed as a result of bedrock failure. Young landslide deposits, such as northeast of the junction of Succor Creek and Coal Mine Basin, east of U.S. Highway 95, have hummocky surfaces with numerous closed depressions and are formed of chaotic blocks of nearby bedrock. Old landslide deposits, such as on the north side of Spring Mountain and north of Succor Creek in secs. 11 and 14, T. 3 S., R. 6 W., have been greatly eroded and no longer show typical landslide morphology. Large queried landslide south of Succor Creek east of Emery Spring appears to consist of single coherent slide block. Small landslides and slumps are not mapped

QTg — **Gravel and sand terrace deposits (Pleistocene and Pliocene?)**—Unconsolidated, poorly sorted to well-sorted, massive to well-bedded gravel, sand, and silt on terraces and slopes above existing stream channels. Formed mostly of local rock types; locally contains abundant granitic and metamorphic clasts reworked from gravel and conglomerate deposits of units **Tg** and **Tcg**. Represents deposits of former stream systems that existed at various elevations during Pleistocene erosion of the area

Tg — **Gravel deposits (Pliocene)**—Poorly exposed unconsolidated fluvial gravel and sand deposits that form the upper surface of Thomas Creek Ridge. Shape of ridge suggests topographic inversion. Also crops out along east border of map, east of Coal Mine Basin. Unit is about 50 ft thick, but basal contact is not exposed

Tcg — **Conglomerate, gravel, and arkosic sandstone (upper Miocene?)**—Unconsolidated to very indurated conglomerate and arkose. Crops out in eastern part of map area where it unconformably overlies sedimentary rocks of unit **Tst**. Conglomerate is formed mostly of round plutonic, metamorphic, and volcanic clasts in an arkosic matrix; black chert clasts are abundant. Pebbles and cobbles range widely in size but are dominantly 2 to 25 cm and average about 10 cm across. Arkosic sandstone is locally very micaceous (mainly biotite, with minor muscovite), is characterized by traces of pink garnet grains, and contains scattered cobbles and pebbles. Cross bedding, foreset bedding, and cut-and-fill structures are common. Sandstone and conglomerate are locally very indurated where cemented by silica; elsewhere they are unconsolidated. Unit contains abundant petrified wood, especially in lower part. Interpreted to represent fluvial deposits of a major south-southwest-flowing drainage whose axis was near east border of map. Query indicates foreset-bedded pebbly arkosic sandstone in central eastern part of quadrangle south of Coal Mine Basin that may correlate with arkosic rocks of this unit or may be equivalent to arkosic rocks within unit **Tst**. Unit is cut by north-south basalt dike unit (**Tib**) of uncertain age and overlies sedimentary rocks of unit **Tst**, which contain middle Miocene (Barstovian) fossils. Thickness is as much as 200 ft

Basalt and basaltic andesite flows and pyroclastic rocks of Spring Mountain (upper or middle Miocene)—Flows, hyaloclastic tuffs, breccia, and pillow breccia that form Spring Mountain, the remnant of an old volcano. Exposures are sparse in many places owing to thick colluvium. Tuffaceous siltstone (uppermost part of unit **Tst**) is interbedded in this volcanic unit southeast of Spring Mountain and possibly in colluvium-covered areas. Analyses of flows and pyroclastic rocks are shown in Table 1, Plate 2, map letters B-H. Overlies sedimentary rocks of unit **Tst**, which contain middle Miocene (Barstovian) fossils. Unit is subdivided into the following units:

Tbsf — **Basalt and basaltic andesite flows (middle or upper Miocene)**—Subaerial flows and flow-breccia that form most of Spring Mountain. Basalt and basaltic andesite are dense to vesicular and porphyritic with phenocrysts of plagioclase and olivine. Flows are typically 15 to 40 ft thick. Locally overlies palagonitic hyaloclastic tuffs (unit **Tbst**), basaltic pillows and breccia (unit **Tbsp**), and tuffaceous siltstone (unit **Tst**). Some isolated, poorly exposed tabular basaltic masses interbedded with sedimentary rocks near base of main flow sequence may be invasive sills; small basalt masses associated with basaltic tuff (unit **Tbst**) may be shallow intrusions at former vents. Thickness is as much as 1,000 ft

Tbst — **Basaltic tuff and breccia (upper or middle Miocene)**—Massive to thinly bedded hyaloclastic tuff, lapilli tuff, tuff breccia, and breccia. Original glass of ash and lapilli is mostly hydrated and replaced by clay minerals (palagonitized). Locally contains steep antidune cross beds and bomb sags, which indicate a wet surge origin, but includes airfall deposits. Unit is a product of basaltic eruptions in a shallow lacustrine setting or a result of interactions of lava with shallow water table. Occurs generally beneath subaerial flow sequence (unit **Tbsf**). Thickness is as much as 200 ft

Tbsp — **Basaltic pillows and breccia (upper or middle Miocene)**—Isolated-pillow breccia, pillow-rim breccia, tuff breccia, and lapilli tuff of fine-grained to glassy olivine-phyric basalt. Represents subaqueous (lacustrine) extrusions of basalt that later formed the subaerial basalt of Spring Mountain (unit **Tbsf**). Thickness is as much as 300 ft

Tst — **Sedimentary rocks and tuff (middle Miocene)**—Interbedded arkosic and tuffaceous sedimentary rocks and tuff. Arkosic rocks occur mainly in eastern third of quadrangle and consist of sandstone, pebbly sandstone, and siltstone with minor carbonaceous mudstone, siltstone, and thin lignitic beds. Mostly poorly consolidated; locally strongly indurated owing to cementation by silica, especially in beds that originally had high porosity and permeability. Mostly of fluvial origin, but some is lacustrine. Beds show common cross bedding and foreset bedding whose orientation indicates deposition by south-flowing currents. Tuffaceous rocks consist of shard-rich siltstone, mudstone, and sandstone of fluvial and lacustrine origin. Some tuff beds as thick as 20 ft are formed of very pure, uniform-appearing glass shards; most, if not all, tuff beds are reworked. Thick tuff beds south of Succor Creek in southern part of quadrangle are altered to clinoptilolite. The tuffaceous rocks occur throughout quadrangle and are interbedded with arkosic rocks in eastern part. Unit contains Barstovian vertebrate fossils including fish as well as plant fossils (Taggart, 1971; Taggart and Cross, 1974; Cross and Taggart, 1983; Walden, 1986). Age of unit is 11 to 16 Ma in the Idaho part of the map according to Ekren and others (1981). Lithology of unit in Coal Mine Basin is described by Walden (1986). Mapped as upper part of the Sucker Creek Formation by Kittleman and others (1967). Exposed rocks in unit locally exceed 1,000 ft thick. Unit **Tst** also includes the following:

Tsta — **Altered tuffaceous rocks (middle Miocene)**—Massive to thin-bedded tuffaceous siltstone, sandstone and tuff that shows pervasive alteration including silicification, K-silicate alteration, and zeolitization. Occurs in two areas. Northern area straddles Succor Creek and is part of alteration area surrounding Mahogany hot-springs-type gold prospect 1 mi north of quadrangle boundary. Rocks and alteration in this area are described by Gilbert (1988). Alteration at Mahogany prospect has K-Ar age of 12.6±0.6 Ma (J.J. Rytuba and E.H. McKee, personal communication, 1990), an age presumed to be essentially the same as the age of the host rocks. Southern area of altered tuffaceous rocks straddles Succor Creek near east border of map surrounding a basaltic intrusion exposed near creek level. Low-grade thermal metamorphism has altered the tuffaceous rocks and fused some vitric tuff

Tbh — **Basaltic hyaloclastic tuffs (middle Miocene)**—Massive to thinly bedded, generally poorly to moderately sorted lapilli tuff, tuff, and local tuff-breccia of fine-grained to glassy olivine-phyric basalt. Deposits are mostly of surge origin, with common antidune and bomb sag structures, but locally include airfall lapilli tuff. Initial dips are as great as 80°. Former basaltic glass is mostly replaced by yellowish clay minerals (palagonitized); deposits are cut by abundant diagenetic calcite and zeolite veins as wide as 2 ft. Deposits were produced by water-affected basaltic eruptions probably from maars, tuff cones, and tuff rings. Occurs as deposits at several stratigraphic levels. Similar to deposits of several different ages in the Owyhee Reservoir area described by Cummings and Growney (1988). Interbedded in middle Miocene sedimentary rocks of unit **Tst**. Thickness variable, but locally as thick as 300 ft

Tr — **Rhyolite flows (middle Miocene)**—Massive to flow-banded rhyolite that shows ubiquitous vapor-phase alteration. Locally spherulitic and in places perlitic. Contains phenocrysts of sanidine and quartz. Mapped margins of unit are probably nearly the same as the original borders of the rhyolite flows, judging by distribution of perlite and flow banding. Probably younger than tuff of Leslie Gulch of Kittleman and others (1965) and Vander Meulen and others (1987a,b), which has a K-Ar age of about 15.5 Ma. Thickness about 200 ft; unit is much more extensive and thicker to west in Mahogany Gap quadrangle (MacLeod, 1990) and northwest in Bannock Ridge and Rooster Comb quadrangles (Vander Meulen and others, 1987a,b)

Toa — **Older andesite (middle Miocene)**—Andesite massive flow, flow breccia, and invasive sill along Succor Creek in northern part of map area. Near U.S. Highway 95, andesite appears to be invasive into tuffaceous rocks (unit **Tsta**). Age probably about the same as unit **Tr**. Thickness is about 150 ft or less

Topt — **Older hydrovolcanic deposits (middle Miocene)**—Hyaloclastic basaltic tuff, lapilli tuff, and tuff breccia along Succor Creek in northern part of map area. Similar lithologically to other hydrovolcanic deposits in area (units **Tbst** and **Tbh**). May be similar in age to unit **Tr** and probably only slightly younger than unit **Tob**. Thickness about 100 ft

Tob — **Older basalt flows (middle Miocene)**—Aphyric or olivine-phyric basalt along Succor Creek near north end of quadrangle. Tholeiitic, relatively high-Fe and low Na_2O, P_2O_5 composition (sample A, Table 1, Plate 2) contrasts with other analyzed basalt and basaltic andesite in area. Similar in composition to basalt (unit **Tob**) underlying rhyolite (unit **Tr**) in adjacent Mahogany Gap quadrangle (MacLeod, 1990). May correlate with Owyhee Basalt (unit Tbo of Ferns, 1989b) in the Owyhee Dam quadrangle and with some flows of unit Tb of Vander Meulen and others (1987a,b). Thickness not known as base is not exposed; probably is less than 200 ft

Tib — **Basaltic intrusions (Miocene)**—Dikes, sills, and irregular intrusions. Some sill-like intrusions associated with basalt of Spring Mountain (units **Tbsf**, **Tbst**, and **Tbsp**) may be invasive. Small basalt intrusion along Succor Creek in southeast corner of quadrangle has numerous dike-like apophyses (unmapped) and may be much larger at depth, based on wide zone of metamorphic effects. Ages range widely. Youngest intrusion may be north-south dike that cuts rocks as young as unit **Tcg** in northeast part of quadrangle

Tio — **Other intrusions (Miocene)**—Small intrusion on hill south of Emery Spring and a quarter of a mile east of U.S. Highway 95 is formed entirely of brecciated country rock with no juvenile material and probably is hydrobreccia pipe related to underlying basalt sill (unit **Tib**), which crops out on west side of hill. Small outcrops of andesite or dacite between Succor Creek and Cow Creek in southeast corner of quadrangle are possible intrusions

MINERAL RESOURCES

Metallic mineral resources

The Sheaville quadrangle lies within a broad belt of gold and silver mines and prospects (informally called the "Weiser Hot-Springs Belt"), which extends from the DeLamar and Silver City Mines in Idaho southeast of the quadrangle into the Owyhee region north of the quadrangle. Exploration has been intense in this area during the last decade, and several large-volume low-grade gold deposits have been identified and are now being explored.

One of the areas of interest is the Mahogany hot-springs gold prospect, 1 mi north of the Sheaville quadrangle between Succor Creek and U.S. Highway 95. The prospect was found by Manville Products Corporation in 1985 and acquired by Chevron Mineral Resources in 1986 as a joint venture. The geology and geochemistry of the prospect are described by Gilbert (1988). Gold occurs in hydrothermal breccias, in tuffaceous rocks that have undergone propylitic and K-silicate alteration, and in quartz veins. These rocks were produced as a result of hot-spring activity of about the same age as the middle Miocene tuffaceous rocks in which they occur. J.J. Rytuba and E.H. McKee (personal communication, 1990) report that the alteration has a K-Ar age of 12.6±0.6 Ma. Rocks show variable alteration in a broad area around the prospect and extending into the Sheaville quadrangle (see distribution of unit **Tsta** on geologic map). Three of eight samples analyzed from this area of alteration in the Sheaville quadrangle showed anomalous although low-level gold contents (18 to 32 ppb; see Table 2, Plate 2, map nos. 9, 19, and 23). Several areas of hydrothermal brecciation were noted, such as at map no. 8 (see Table 2, Plate 2). Quartz veins as wide as 30 in. occur in several places such as near the rim of Succor Creek at map nos. 19 and 20. The area underlain by altered rocks in the northern part of the quadrangle deserves detailed mapping and exploration.

Arkosic sandstone of units **Tst** and **Tcg** locally is cemented by silica, presumably as a consequence of migration of silica-bearing hot water. The silica cement seems to be most common in those sand beds that originally had greatest permeability and porosity; likely much of the flow was subhorizontal. The few samples collected from these silica-cemented arkoses did not show anomalous gold (Table 2, Plate 2, map nos. 2, 11, 12, 13) although further investigations of them are probably warranted. Other scattered areas of alteration were noted within the quadrangle, but none showed anomalous gold values.

Carbonaceous material at the bases of several thick vitric sandstone beds was analyzed for uranium (U) but showed only 3.1 ppm or less; one sample (Table 2, Plate 2, map no. 1) was anomalous in arsenic (As) (87.7 ppm), molybdenum (Mo) (63.1 ppm), and other elements. These samples were analyzed because the carbonaceous material may be expected to be the site of deposition from mineralizing fluids; the carbonaceous material itself occurs in only minor amounts.

Nonmetallic resources

A hydrocarbon exploratory hole, McKnight 1, was drilled near the axis of an anticline in the south end of the Sheaville quadrangle (SW¼NW¼ sec. 23, T. 3 S, R. 6 W.) (Newton and Corcoran, 1963). No petroleum or gas was encountered.

Coal Mine Basin possibly was named by early settlers who may have utilized lignitic material for heating. The lignite occurs in unit **Tst** but is too sparse to be a resource.

Large tonnages of clinoptilolite, an important industrial zeolite, occur south of Succor Creek in the southeastern part of the quadrangle (Sheppard and Gude, 1983, 1987). Several prospect pits expose the deposits that were discovered by R.H. Olson and F.A. Mumpton in 1958 during an exploration program for zeolites by Union Carbide Corporation (Sheppard and Gude, 1987).

The clinoptilolite occurs as a replacement of glass shards that form tuff beds as thick as 60 ft. Relatively fresh vitric tuff beds that probably correlate with the zeolitized tuff occur farther north in sec. 25 near U.S. Highway 95. Zeolitic alteration commonly occurs when ash is deposited in saline lakes. Sheppard and Gude (1987) suggest, however, that the interstitial water necessary for the diagenetic alteration of the Succor Creek deposits probably was flowing or percolating ground water that originated as meteoric water.

Several thousand tons of clinoptilolite have been mined from the Succor Creek deposits by Occidental Mineral Corporation, and the Norton Company has actively prospected and drilled the deposits. The zeolite is used chiefly in agricultural applications and as cat litter. Claims exist on most of the area where the deposits occur, and very large tonnages of material remain to be mined, should a market be available. It should be noted that much of the area in which the clinoptilolite deposits occur may be an old landslide block, and many small faults and fractures noted in this area may be a consequence of sliding rather than regional tectonism. Also, the anticline that passes through this area may have controlled ground-water flow and zeolitic alteration.

Agate, jasper, and petrified wood were noted at many localities in the quadrangle, especially in the Coal Mine Basin.

WATER RESOURCES

Succor Creek is the principal stream in the area and is perennial, although summer flow is controlled by a small dam farther upstream. Coal Mine Basin Creek, Thomas Creek, Cow Creek, and several small creeks that have their headwaters on Spring Mountain have intermittent flow but may occasionally flow year-round. Springs are abundant throughout the quadrangle. They are common on the flanks of Spring Mountain, especially at colluvium-covered contacts between basalt flows above and tuffaceous siltstone below. The only permanent dwellings in the Sheaville quadrangle are a ranch near U.S. Highway 95 astride secs. 13 and 14, T. 27. S., R. 46 E., and a ranch beside Cow Creek in sec. 13, T. 28 S., R. 46 E. Much of the quadrangle is grazed by cattle. The water resources are sufficient for current land use.

GEOCHEMISTRY

(see Tables 1 and 2, Plate 2)

Sample preparation

Samples for whole-rock analysis (WRA) (Table 1, Plate 2) were crushed to minus ¼-in. in a steel-jawed Braun chipmunk crusher and split in a Jones-type splitter in the Oregon Department of Geology and Mineral Industries (DOGAMI) laboratory. A split of about 100 g of each sample was ground to minus 200 mesh in agate grinding media by X-Ray Assay Laboratories (XRAL) of Don Mills, Ontario.

Samples for trace-element analysis (Table 2, Plate 2) were crushed to minus ¼-in. and split as indicated above. Each sample split was ground to about minus 200 mesh in chrome-steel grinding media in an Angstrom disk mill in the DOGAMI laboratory. Each minus-200-mesh split was split again to produce two subsamples, one for gold and one for other trace elements to be determined.

Chemical analysis

Whole-rock analysis: X-ray fluorescence (XRF) analyses were performed by XRAL. XRAL used a fused button for its analyses (1.3 g of sample roasted at 950 °C for one hour, fused with 5 g of lithium tetraborate, and melt cast into a button). Loss on ignition (LOI) was determined by the roasting.

Trace-element analysis:

1. Gold, uranium, tin. Bondar-Clegg, Ltd., of North Vancouver, British Columbia, performed the analyses for gold, uranium, and tin. The method employed for gold was fire assay preconcentration of the gold in a 20-g sample (gold was collected in added silver), acid dissolution of the resulting bead, and a directly coupled plasma (DCP) emission spectrometer finish. The detection limit was 1 part per billion (ppb). For uranium, a 0.1-g sample was digested with concentrated nitric acid, the solution diluted, an aliquot fused with NaF, and the uranium determined by fluorimetry. The detection limit was 0.2 ppm. Tin was determined (on an unpacked sample on a mylar film support) by X-ray fluorescence (XRF) on an energy dispersive XRF spectrometer. Corrections were made for inter-element interferences. The detection limit was 5 ppm.

2. Other trace elements. Geochemical Services, Inc., (GSI) of Torrance, California, performed the analyses for 15 other trace elements. The method employed a proprietary acid dissolution and organic extraction of a 5-g sample. The finish was by induction coupled plasma (ICP) emission spectrometry. GSI considers the digestion to provide total metal contents except for gallium and thallium. The detection limit for a given element varies slightly as a result of GSI's monitoring process; in all samples Te was below the detection limit of about 0.5 ppm.

MAP SYMBOLS

Contact—Approximately located. Short-dashed, queried contact indicates coherent block of unit **Tst** that has probably moved as a landslide

Fault—Dashed where approximately located; dotted where buried; queried where uncertain; ball and bar on downthrown side of faults with apparent vertical displacement; arrows show direction of horizontal offset

Anticline—Dotted where concealed; queried where uncertain

Syncline—Dotted where concealed; queried where uncertain

20 **Strike and dip of beds**

Horizontal beds

1 **Location of whole-rock sample analyzed in Table 1, Plate 2**

23 **Location of mineralized sample analyzed in Table 2, Plate 2**

Tables 1 and 2 are on a separate sheet (Plate 2)

GEOLOGY

The Sheaville quadrangle is formed of Miocene sedimentary and volcanic rocks mantled by Pliocene and Quaternary alluvial deposits. The oldest rocks are middle Miocene basalt flows, basaltic hyaloclastic tuff, and an andesitic flow and invasive sill along the northern part of Succor Creek. The basalt (unit **Tob**) has a composition similar to basalt in the adjacent Mahogany Gap quadrangle (Tob of MacLeod, 1990), where it underlies extensive rhyolite flows (unit **Tr**) covering Mahogany Mountain and extending into the northwest corner of the Sheaville quadrangle. The rhyolite flows are the product of eruptions from the magma system that produced the Mahogany Mountain caldera of Rytuba and others (1985) and Vander Meulen and others (1987a,b). The margin of the caldera is about 4 mi northwest of the Sheaville quadrangle according to Vander Meulen (1989). The 15.5-Ma tuff of Leslie Gulch, which formed during caldera collapse, is widespread within and adjacent to the caldera (Vander Meulen and others, 1987a,b) but is absent in the Sheaville quadrangle; presumably the tuff of Leslie Gulch is older than any of the rock units that crop out in the quadrangle including the rhyolite (unit **Tr**).

Tuffaceous siltstone and sandstone and arkosic sandstone and conglomerate with interbedded basaltic flows and hydrovolcanic deposits cover much of the quadrangle and are mostly younger than the rhyolite of Mahogany Mountain and the volcanic rocks along the northern part of Succor Creek. The intercalated sedimentary rocks are derived from two disparate sources.

The arkosic sandstone and conglomerate were deposited by streams that flowed southward through the area transporting clasts from a distant metamorphic and plutonic terrain. The arkosic rocks crop out principally in the eastern part of the quadrangle, especially in Coal Mine Basin and the drainage basin of the southern part of Succor Creek. Deposits of Coal Mine Basin are described by Walden (1986). The arkosic rocks occur at several stratigraphic levels within the otherwise tuffaceous sequence and appear to represent stacked stream deposits; that is, the streams traversed the eastern part of the area for an extended period, intermittently depositing arkosic sand while the tuffaceous rocks were being deposited in adjacent areas.

The tuffaceous sedimentary rocks are formed of light-colored, shard-rich siltstone, mudstone, bentonite, and sandstone derived by reworking of deposits from rhyolitic pyroclastic eruptions in the region and medium- or dark-colored siltstone and mudstone derived from a mixture of basaltic to rhyolitic sources. Some thick and widespread siltstone and sandstone beds are formed virtually entirely of vitric shards of uniform size, shape, and color. They are interpreted to represent slight reworking of ash that blanketed the area as a consequence of very large pyroclastic eruptions within the region, perhaps related to formation of calderas in eastern Oregon and southern Idaho. Minor basalt flows, intrusions, and hydrovolcanic deposits are interbedded with or intrude the tuffaceous and sedimentary rocks.

A thick sequence of basalt and basaltic andesite flows, hyaloclastic tuffs, and pillow basalts forms Spring Mountain, the most prominent feature in the area. The lava flows interfinger with and overlie the tuffaceous and arkosic sedimentary rocks. When the eruptions that produced this sequence began, part of the area was apparently a large lake, and pillow basalts and isolated pillow breccias were produced. Conceivably, the lake may have been a short-lived feature formed as a result of lava flows damming a major drainage. Hyaloclastic tuff and lapilli tuff buried large areas as a consequence of surge-dominated eruptions in the shallow lake or eruptions that interacted with the ground-water system. With lessening involvement of water, the eruptions produced subaerial flows that built a 1,000-ft-high volcano.

From Pliocene to Holocene time, the area was progressively eroded as a consequence of the development of north-flowing streams and progressive lowering of the base level. The change in flow direction from southward to northward and lowering of base level may have been a response to the Pliocene capture of the Snake River by the Columbia River and consequent development and downcutting of the Owyhee River system north and northwest of the area. Gravel and sand deposited by these streams cap Thomas Creek Ridge, and similar progressively younger deposits occur at successively lower elevations.

STRUCTURE

Faults with displacements of less than a few hundred feet offset the sedimentary and volcanic rocks of the quadrangle. The faults mostly strike north to northwest and presumably have normal displacement as a consequence of regional east-west-oriented Basin-and-Range extension. Most basalt dikes strike approximately north-south, indicating they were intruded in a regional stress field similar to that responsible for the faults. Three dikes on the lower flanks of Spring Mountain are oriented east-west, northwest, and northeast; probably their orientations were in response to a local stress field resulting from the presence of a large volcano at Spring Mountain (see Nakamura, 1977). Slickensides on one small north-striking fault in the central northern part of area indicate strike-slip motion, as was noted earlier by Walden (1986) and Gilbert (1988). Rocks in the Sheaville quadrangle are much less faulted than in areas farther north in the Owyhee region (see, for example, Ferns, 1988, 1989a,b).

Anticlines and synclines are prominently developed in the eastern part of the quadrangle. The symmetric limbs of the folds typically dip 10 to 15°, and the fold axes are broadly curved. A keystone graben is locally developed on the anticline exposed on the north side of Coal Mine Basin. Large-scale folding is clearly anomalous in the Owyhee region of Oregon and Idaho. It is interpreted that the folding is not of tectonic origin, but that it was in response to loading of the sedimentary rocks shortly after they were deposited and before they were indurated by the basalts and basaltic andesites that were erupted to form a volcano at Spring Mountain. This is consistent with the curved fold axes, which are rudely concentric to Spring Mountain.

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GEOLOGIC CROSS SECTION

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