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Geology and Mineral Resources Map of the Vines Hill Quadrangle, Malheur County, Oregon

1991

GMS-63

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By Howard C. Brooks

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

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

Base map by U.S. Geological Survey
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1966. Field checked 1967.
Polyconic projection. 1927 North American datum 10,000-foot grid based on Oregon coordinate system, south zone.

UTM GRID AND 1967 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

QUADRANGLE LOCATION

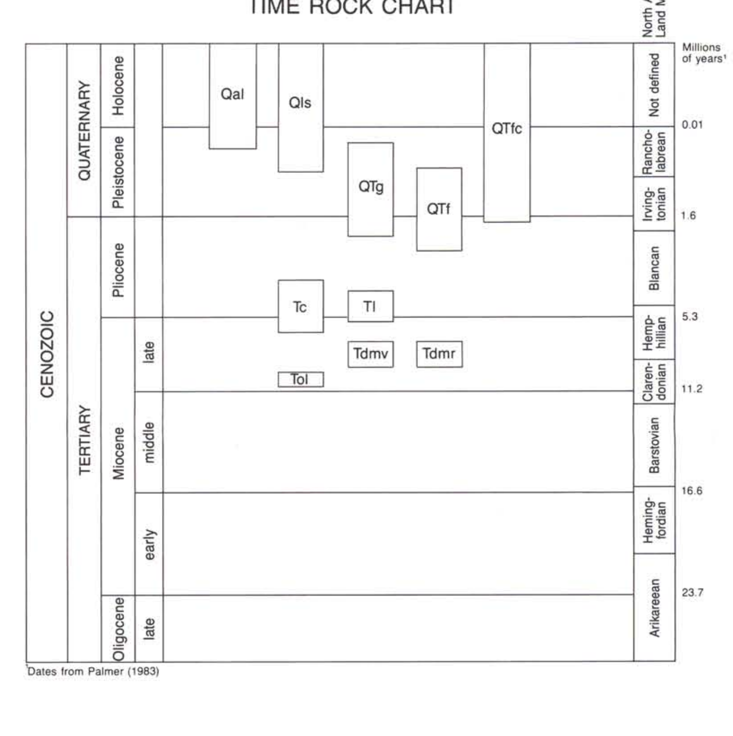
Geology by Howard C. Brooks, Oregon Department of Geology and Mineral Industries

Field work conducted in 1989

Map reviewed by M. L. Ferns, Oregon Department of Geology and Mineral Industries, and J. G. Evans, U.S. Geological Survey

Cartography by Allan Cartography

TIME ROCK CHART



Dates from Palmer (1983)

EXPLANATION

Qal — **Alluvium (Pleistocene and Holocene)**–Unconsolidated and unsorted to well-sorted deposits of gravel, sand, and silt. Mapped mainly in the flood plains of the Malheur River and Bully Creek. Small, poorly developed deposits occur in the bottoms of some streams draining the West Bench

Qls — **Landslide (Pleistocene and Holocene)**–Includes a slumped section of unit **Tdmv** over 2 mi long and up to 2,000 ft wide on the west side of the Malheur River. The hummocky area west of the river is underlain mainly by a fragmented sequence of light-colored sedimentary deposits and a few blocks of andesite or basalt; the southern part is composed chiefly of rotated blocks of unit **Tdmv**

QTfc — **Colluvium and alluvial fan deposits (Pliocene?, Pleistocene, and Holocene)**–Alluvial fans and slope wash consisting of unconsolidated gravel, sand, and silt. Also, extensive accumulations of windblown silt and sand on benches and ridge tops and in the broad valleys. On the West Bench and in Little Valley, unit **QTfc** mainly comprises a soil horizon up to 10 ft thick consisting partly of aeolian silt. Subjacent units are chiefly units **QTg, Tc,** or locally **Tdmv** or **Tdmr**

QTg — **Gravel deposits (Pliocene? and Pleistocene)**–Mostly unconsolidated and poorly sorted gravel, sand, and silt on terraces and slopes above existing stream channels. Gravel is composed mostly of clasts from unit **Tdmv** but includes clasts of silicic volcanic rocks, obsidian, and chalcedony. Chert is rare. Typically 5 to 20 ft thick but locally up to 40 ft thick. Caliche is common, occuring mostly in layered sequences a few inches to several feet thick and less commonly as a matrix cement

QTf — **Fluvial deposits (Pliocene and Pleistocene)**–Mostly unconsolidated to poorly consolidated, poorly to moderately sorted deposits of sand, silt, and gravel. Bedding in fine-grained deposits is visible locally. Gravel clasts are mostly andesite and basalt but include obsidian, rhyolite, limestone, and rare chalcedony. Clasts typically are less than 2 in. in diameter and range up to 4 ft thick. These deposits may be relics of terraces of an ancestral Malheur River

Tl — **Limestone (upper Miocene and Pliocene)**–Lacustrine deposits of limestone; sandy and silty limestone; tuffaceous limestone; calcareous sandstone, siltstone, and tuff; and limestone-matrix conglomerate and breccia. Typical colors are medium to light gray, brownish gray, yellowish to reddish gray, and pale yellow. Beds range from a few inches to about 20 ft thick with cumulative exposed thicknesses of 60 ft locally as in the NW¼ of sec. 16, T. 19 S., R. 43 E. Limestone rimrocks up to 20 ft thick mark the tops of slopes along the eastern margin of the main exposure belt. Small clam and gastropod shells are abundant locally. Stromatolitic and algal structures are visible in many outcrops. The limestone is depositional mainly on rocks of unit **Tdmv,** but in places it rests on unit **Tc.** Limestone matrix conglomerate and breccia are common near the base of the unit. Clasts are mostly andesite and basalt, and in several places breccia fragments as much as 4 ft across appear to have been derived from unit **Tdmv**

Tc — **Tuffaceous siltstone, sandstone, and limestone (Pliocene? and upper Miocene)**–Mainly lacustrine, locally fluviatile deposits of poorly consolidated light-gray to greenish, fine-grained, locally pebbly to conglomeratic tuffaceous sandstone, siltstone, and mudstone. Includes water-laid, poorly to moderately sorted, massive to faintly layered deposits varying from dirty-gray to near-white tuffaceous silt and sand to gray vitric ash and lapilli tuff that locally are sufficiently consolidated to sustain vertical cuts as much as 20 ft high along the Oregon Canal and the Bully Creek Lateral. The deposits locally contain fossil fish vertebrae and shell fragments. Siltstone and sandstone deposits directly under the limestone (unit **Tl**) in secs. 16, 21, and 34, T. 19 S., R. 43 E., locally contain andesite and basalt cobbles and small boulders. Well-indurated, locally shaly siltstones, some of which are partly altered to clinoptilolite and cristobalite (X-ray analyses by R.P. Geitgey, Oregon Department of Geology and Mineral Industries industrial minerals specialist), are exposed in a few places. Includes thin beds of diatomaceous siltstone and tuff and tuffaceous rocks that are partly altered to bentonite. Crossbedding and foreset bedding are visible in cuts along Highway 26. The unit is equivalent to the Chalk Butte Formation of Corcoran and others (1962) and units Tic and Tig of Ramp and Ferns (1989) and Urbanczyk and Ferns (unpublished data, 1989). Late Miocene age is based in part on a Hemphillian antilocaprid (prongbuck) jaw fragment found in unit Tic of Ramp and Ferns (1989) in the adjacent Double Mountain quadrangle to the southeast. Thickness of exposed beds in the southeastern part of the map exceeds 400 ft. A drill hole in SE¼ sec. 22, T. 19 S., R. 43 E., reportedly penetrated sedimentary deposits to a bottom-hole depth of 718 ft. Total thickness of the unit may be over 1,000 ft, as indicated by drilling in the adjacent Double Mountain quadrangle (Ramp and Ferns, 1989)

Tdmr — **Rhyolite (upper Miocene)**–Gray to white quartz-plagioclase phyric rhyolite exposed in the quadrangle only in a road cut in sec. 34, T. 18 S., R. 43 E. Exposure is about 100 ft long. Spherulitic and locally flow banded and locally brecciated. Thin section shows less than 5 percent partially resorbed quartz and plagioclase phenocrysts in aphyric groundmass of quartz and K-feldspar. May be correlative with rhyolites of late Miocene age mapped by Ramp and Ferns (1989) 8 mi to the southeast in the northwest corner of the Double Mountain quadrangle

Tdmv — **Andesite, basaltic andesite, and basalt (upper Miocene)**–Mainly holocrystalline, aphyric to locally porphyritic basaltic andesite and andesite flows. Includes plagioclase-phyric basalt flows exposed west of the Malheur River in secs. 7 and 18, T. 19 S., R. 43 E., and rare thin interbeds. The basaltic andesite and andesite typically are medium gray to dark gray and locally greenish gray on fresh surfaces and grayish to reddish brown in outcrop. Flows are commonly platy and dense to coarsely vesicular, with fine-grained pilotaxitic to trachytic textures. Phenocrysts are chiefly plagioclase but include hypersthene and hornblende. Iddingsite and opaque minerals are common minor constituents. Felsic xenoliths were observed in specimens from several places, including the SW¼ sec. 15, T. 19 S., R. 43 E. Parts of some flows contain chalcedony- or zeolite-filled vesicles. Unit in the SW¼ sec. 15, T. 19 S., R. 43 E., also includes scattered small exposures of red to black scoria, flow breccia, and palagonite. Capping basalt flows along the Oregon Canal in the SE¼ sec. 6, T. 19 S., R. 43 E., overlie a lens of interbedded lithic tuff and tuffaceous sandstone and siltstone at least 60 ft thick. The deposit pinches out to the south and appears to be involved in the large landslide to the north. The exposures of unit **Tdmv** along the Malheur River were correlated by Corcoran and others (1962) with the Owyhee Basalt. The unit is continuous with unit **Tdmv** of Urbanczyk and Ferns (1989) and Ramp and Ferns (1989) and is equivalent to unit Tui of Storm (1975). Flows range from a few feet to about 80 ft thick, and aggregate thickness of exposures is about 400 ft in the quadrangle. The small exposures of unit **Tdmv** in sec. 4, T. 19 S., R. 43 E., are enclosed in sedimentary beds of unit **Tc** and may be detached blocks that slid to their present position during deposition of unit **Tc**

Tol — **Older lacustrine sedimentary rocks (upper Miocene)**–Siltstone, tuffaceous siltstone, tuff, and sandstone, usually poorly exposed and poorly indurated. Exposures in the western part of sec. 22, T. 18 S., R. 43 E., include light-gray quartz-cemented arkosic sandstone beds from 4 ft to about 20 ft thick composed mainly of quartz and feldspar and minor biotite and other mafic minerals. Well-rounded chert pebbles are included locally. Parts of units **Tc** and **Tol** are lithologically similar and are distinguished mainly by stratigraphic position relative to flows of unit **Tdmv** and the local presence of arkosic sandstones in unit **Tol.** Base of the unit is not exposed. Exposed thickness is about 200 ft

MAP SYMBOLS

Contact–Approximately located

Fault–Dashed where approximately located; dotted where concealed; ball and bar on downthrown side

5 **Strike and dip of beds**

⊕ **Horizontal bed**

■E **Location of whole-rock sample analyzed in Table 1**

▲7 **Location of mineralized sample analyzed in Table 2**

GEOLOGY

The Vines Hill quadrangle is underlain by upper Miocene and lower Pliocene volcanic and sedimentary rocks mantled by Pliocene and younger alluvial deposits. The tuffaceous and arkosic sandstones and siltones (unit Tol) that underlie flows of unit Tdmv in the north-central part of the map area may be the oldest rocks exposed in the quadrangle. However, it is questionable whether unit Tol stratigraphically predates all of the much thicker section of Tdmv flows along the Malheur River to the south. Unit Tdmv, where it is best exposed in the west-central part of the quadrangle, is composed of a thick (at least 400 ft) sequence of upper Miocene calc-alkaline volcanic rocks, mainly andesite and basaltic andesite, some basalt, and a few thin sedimentary interbeds. The volcanic rocks are succeeded stratigraphically by a thick lacustrine sequence consisting mainly of tuffaceous sedimentary rocks (unit Tc) but including limestone (unit Tl). Unit Tc represents lacustrine deposition in a large basin marginal to an elevated block of unit Tdmv. Fluvial deposits are included locally. The limestone probably was deposited in organic-rich shallow water near the edge of the lake. Source of the carbon required to form the limestone may have been derived in part from hydrothermal fluids introduced along deep-seated faults along the basin margin. Conglomerate clasts, mostly andesitic rocks, in the lower part of the unit are limestone supported, indicating that the clastic debris was introduced during carbonate deposition. Units QTf and QTg represent fluvial activity during and after drainage of the lake. Unit QTfc is a product of mass wasting and aeolian processes. Wind deposits cover extensive areas believed to be underlain by deposits of unit Tc, particularly in the southeastern part of the map. Large landslide and slump deposits (unit Qls) occur along the Malheur River and probably are a result of bedrock failure due to oversteepening of the river banks by water action. The steep headwall of the slumped section of unit Tdmv on the east side of the river is up to 300 ft high locally.

GROUND-WATER RESOURCES

General

Very little ground-water information is available for the mapped area. Approximately 70 water-well reports (well logs) from the mapped area are on file with the State of Oregon. Most of the well logs are from the West Bench, the Malheur River valley south of the West Bench, and Little Valley.

Most wells in the mapped area produce water from unit Qal gravels, sediments of unit Tc, lava flows and interbeds within unit Tdmv, or unit QTg terrace gravels. The reported well yields vary from place to place within each unit. This variation reflects differences between intended uses of wells as much as actual hydrologic variability within the units. The State of Oregon has been monitoring water levels in three wells in secs. 2 and 3 of T. 19 S., R. 43 E., since 1962. These wells have shown no significant changes in water levels from 1962 to present.

Ground-water characteristics of map units

Unit Qal: There are records of 17 wells producing from unit Qal in the area, primarily in the eastern portion of the Malheur River valley and Bully Creek valley. Saturated gravels within this unit will yield moderate to large amounts of water to wells. Drillers report gravel or mixtures of sand and gravel ranging from 3 to 41 ft thick, generally being 10 to 20 ft thick. Wells producing from unit Qal are generally 30 to 50 ft deep. Most wells on record yield 15 to 30 gallons per minute (gpm), but a few wells yield 400 to 500 gpm. Static water levels in the alluvial valley are generally less than 10 ft below ground level.

Unit Qls: The ground-water characteristics of this unit are unknown.

Unit QTfc: The ground-water characteristics of this unit are unknown. This unit is probably not saturated in most places.

Unit QTg: The State of Oregon has records of 12 wells drilled on the West Bench. Driller logs indicated that sands and gravels of unit QTg range in thickness from 4 to 32 ft on the West Bench. This deposit is saturated, at least in part, in roughly half of the wells on file. In most of the wells, unit QTg is so shallow that it is cased off and is not used as a source of water. Only three of the wells on file appear to produce from unit QTg. Most of the wells on the bench produce from underlying sediments of unit Tc. Of the three wells apparently producing from unit QTg, two produce 20 and 30 gpm, respectively, and one well is reported to produce 200 gpm. Much of the recharge to this unit may be coming from irrigation canal seepage.

Unit QTf: The ground-water characteristics of this unit are unknown.

Unit Tl: The ground-water characteristics of this unit are unknown.

Unit Tc: In the mapped area, there are approximately 25 wells that produce water from sediments of unit Tc. About half of these are on the West Bench, with the remainder in the broad Malheur River flood plain or in the area of unit Tc south of the flood plain. Wells producing from unit Tc range from 51 to 690 ft deep. Most are in the 100- to 250-ft range, and six are greater than 400 ft deep. Yields of most wells in unit Tc range from approximately 10 to 30 gpm. Six wells are reported to produce greater than 100 gpm, three of which produce greater than 500 gpm. Static water levels in unit Tc vary with wellhead elevation and range from less than 10 ft to 166 ft below ground level.

Unit Tdmr: The ground-water characteristics of this unit are unknown.

Unit Tdmv: There are records of nine wells on file with the State from the Little Valley area in the southwest part of the map. All of these wells are in areas mapped as unit QTfc over units Tc and Tdmv. The wells range in depth from 230 to 430 ft, with all but two between 230 to 300 ft deep. Most of the wells appear to produce from lavas within the unit Tdmv sequence, although a few appear to produce from interbeds in that sequence. Depth to the lava reported for the various holes ranged from 33 ft to 265 ft. Production rates range from 2 to 25 gpm, with the exception of one that produces 400 gpm. Static water levels range from 8 to 160 ft below ground level. Differences in static levels are probably due to wellhead elevation differences and pressure differences in artesian zones.

Unit Tol: The ground-water characteristics of this unit are unknown.

GEOCHEMISTRY

Sample preparation

Samples for whole-rock analysis (Table 1) 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 60 g of each sample was ground to about minus 200 mesh in agate grinding media by X-Ray Assay Laboratories (XRAL) of Don Mills, Ontario.

Samples for trace-element analysis (Table 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 disc mill in the DOGAMI laboratory. Each minus-200 mesh sample was split again to produce two subsamples: one for gold and one for the other trace elements.

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, and 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 14 other trace elements. The method employed a proprietary acid dissolution/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.

MINERAL RESOURCES

Previously unreported low-grade limestone deposits cover an area of approximately 3 sq mi in the west-central part of the quadrangle. The limestone beds range from a few inches to about 20 ft in thickness and have cumulative thicknesses of about 60 ft in the central part of the exposure belt. Chemical analyses of three samples are given in Table 1.

The apparently anomalous arsenic and molybdenum values reported in some of the analyses in Table 2 may indicate that hydrothermal mineralization has affected parts of the area.

There is a slight possibility that natural gas resources occur within the quadrangle. Three exploration wells are located in the adjoining Double Mountain quadrangle (Ramp and Ferns, 1989). Two were drilled in 1909 and one in 1955. Traces of gas were reported in all three wells (Washburne, 1909; Newton and Corcoran, 1963).

REFERENCES

Corcoran, R.E., Doak, R.A., Porter, P.W., Pritchett, F.I., and Privrasky, N.C., 1962, Geology of the Mitchell Butte quadrangle, Oregon: Oregon Department of Geology and Mineral Industries Geological Map Series GMS-2, scale 1:125,000.

Ferns, M.L., and Ramp, L., 1989, Geology and mineral resources map of the Grassy Mountain quadrangle, Malheur County, Oregon: Oregon Department of Geology and Mineral Industries Geological Map Series GMS-57, scale 1:24,000.

Newton, V.C., and Corcoran, R.E., 1963, Petroleum geology of the western Snake River Basin, Oregon-Idaho: Oregon Department of Geology and Mineral Industries Oil and Gas Investigations 1, 67 p.

Palmer, A.R., 1983, The Decade of North American Geology 1983 geologic time scale: Geology, v. 11, no. 9, p. 503-504.

Ramp, L., and Ferns, M.L., 1989, Geology and mineral resources map of the Double Mountain quadrangle, Malheur County, Oregon: Oregon Department of Geology and Mineral Industries Geological Map Series GMS-58, scale 1:24,000.

Storm, A.B., 1975, Stratigraphy and petrology of the Grassy Mountain Formation, Malheur County, Oregon: Eugene, Oreg., University of Oregon master's thesis, 63 p.

Urbanczyk, K., and Ferns, M.L., 1989, Unpublished geologic map of the Kane Spring Gulch quadrangle, Malheur County, Oregon: scale 1:24,000.

Washburne, C.W., 1909, Gas and oil prospects near Vale, Oregon, and Payette, Idaho, *in* Campbell, M.R., geologist-in-charge, Contributions to economic geology, Part II, Mineral Fuels: U.S. Geological Survey Bulletin 431, p. 35-49.

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Table 1. Whole-rock analyses, Vines Hill quadrangle, Malheur County, Oregon[1]

Map letter	Laboratory no.	1/4	1/4	Sec.	T.(S.)	R.(E.)	UTM coordinates	Elev. (ft)	Lithology	Map unit	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	LOI	Total	Cr	Rb	Sr	Y	Zr	Nb	Ba
											Oxides (wt., percent)												Trace Elements (ppm)						
A	AXB-113	SE	SE	32	18	43	4867880N 462530E	2,700	Andesite	Tdmv	59.0	16.9	0.88	6.77	0.15	6.00	3.05	2.17	4.22	0.44	0.77	100.6	57	41	647	26	184	35	965
B	AXB-108	NE	SE	32	18	43	4867540N 462610E	2,500	Andesite	Tdmv	59.3	16.2	0.85	6.36	0.14	5.67	2.92	2.31	3.71	0.42	1.31	99.4	36	32	614	30	192	16	995
C	AXB-104	NE	NW	4	19	43	4866700N 463260E	2,460	Basaltic andesite	Tdmv	55.0	16.0	1.34	8.73	0.14	6.27	3.28	2.06	3.88	0.73	1.77	99.4	39	34	587	30	251	38	1070
D	AXB-105	NE	NW	4	19	43	4866700N 463260E	2,460	Basaltic andesite	Tdmv	52.7	15.8	1.52	9.11	0.16	6.71	3.61	1.82	3.61	0.68	2.85	98.8	40	36	560	31	266	35	1050
E	AXB-106	NE	SW	4	19	43	4865570N 463250E	2,700	Basaltic andesite	Tdmv	53.6	16.5	1.51	9.06	0.26	6.54	3.25	2.20	3.92	0.81	1.31	99.2	46	42	611	22	236	43	1160
F	AXB-107	SW	SW	4	19	43	4865290N 462970E	2,970	Basaltic andesite	Tdmv	53.3	16.2	1.49	9.11	0.20	6.57	3.67	1.94	3.92	0.79	1.70	99.1	48	18	600	32	251	39	1060
G	AXB-112	NE	NE	7	19	43	4864720N 460720E	2,600	Basalt	Tdmv	46.5	15.6	1.87	13.6	0.24	9.68	6.48	0.80	2.79	0.53	1.93	100.1	96	29	245	23	138	34	340
H	AXB-102	NE	NW	16	19	43	4863400N 463310E	3,160	Basaltic andesite	Tdmv	55.0	16.2	1.13	8.34	0.19	6.20	3.58	1.86	3.92	0.69	1.39	98.7	40	23	628	30	229	15	1160
I	AXB-103	NE	NE	20	19	43	4861880N 462320E	3,110	Basaltic andesite	Tdmv	54.9	16.4	1.45	8.29	0.17	6.39	3.31	1.98	3.97	0.70	1.54	99.4	35	26	603	41	260	31	1360
J	AXB-101	SE	NE	21	19	43	4861300N 464030E	2,940	Andesite	Tdmv	58.2	16.7	0.89	6.45	0.16	5.71	2.96	2.44	4.04	0.44	1.00	99.2	32	39	656	30	173	23	976
K	AXB-111	NW	SE	21	19	43	4860930N 463600E	3,040	Limestone	Tl	13.7	0.88	0.06	0.83	0.12	45.6	0.38	0.21	0.20	1.66	36.5	100.2	<10	14	293	<10	17	<10	171
L	AXB-109	SW	SW	22	19	43	4860370N 464300E	2,950	Limestone	Tl	25.6	0.75	0.05	0.47	0.11	39.3	0.48	0.21	0.20	0.52	32.7	100.5	<10	21	382	19	<10	<10	172
M	AXB-110	NE	NE	28	19	43	4859900N 463780E	2,850	Limestone	Tl	29.0	1.58	0.10	0.69	0.07	36.2	0.55	0.32	0.37	1.58	29.8	100.4	<10	20	607	14	<10	12	225

[1] XRF analyses by XRAL.

Table 2. Trace-element analyses, Vines Hill quadrangle, Malheur County, Oregon[1]

Map no.	Field no.	Laboratory no.	1/4	1/4	Sec.	T.(S.)	R.(E.)	UTM coordinates	Elev. (ft)	Lithology	Map unit	Ag (ppm)	As (ppm)	Au (ppb)	Cu (ppm)	Hg (ppm)	Mo (ppm)	Pb (ppm)	Sb (ppm)	Tl (ppm)	Zn (ppm)	Bi (ppm)	Cd (ppm)	Ga (ppm)	Se (ppm)	Te (ppm)	U (ppm)	Sn (ppm)
1	B-89-139	AXB-08	NW	NE	22	18	43	4871370N 465200E	3,000	Altered basalt	Tdmv	0.031	177.	<1	26.8	<1.0	15.7	3.53	0.497	<0.5	31.1	<0.25	0.120	2.84	<1.0	<0.5	0.6	<5
2	B-89-115	AXB-02	SE	NW	22	18	43	4870900N 464930E	2,900	Altered sandstone	Tol	0.035	20.1	<1	9.27	<1.0	11.9	2.52	0.344	<0.5	8.38	<0.25	<0.10	1.24	<1.0	<2.5	0.2	<5
3	B-89-116	AXB-05	NE	SW	22	18	43	4870350N 464700E	2,840	Altered sandstone	Tol	0.032	3.56	<1	4.58	<1.0	2.19	1.99	0.306	<0.5	7.72	<0.25	<0.096	1.07	<1.0	<0.5	1.1	<5
4	B-89-50	AXB-06	NE	SE	16	19	43	4862620N 464000E	3,000	Altered limestone	Tl	0.016	40.3	<1	3.30	<1.0	0.93	1.41	0.423	<0.5	8.11	<0.25	0.125	0.743	<1.0	<0.5	1.0	<5
5	B-89-148	AXB-04	SE	SE	16	19	43	4862160N 463880E	3,000	Chalcedony	Tl	0.025	11.1	<1	1.43	<1.0	0.59	3.60	0.300	<0.5	11.7	<0.25	<0.092	0.771	<1.0	<0.5	0.6	<5
6	B-89-148	AXB-09	SE	SE	16	19	43	4862160N 463880E	3,000	Altered sandstone	Tc	0.023	158.	3	16.5	<1.0	7.19	2.88	0.743	<0.5	26.7	<0.25	0.169	2.04	<1.0	<0.5	1.1	<5
7	B-89-146	AXB-07	NW	NW	22	19	43	4861950N 464390E	2,810	Altered limestone	Tl	<0.014	81.4	<1	6.19	<1.0	1.93	1.11	0.488	<0.5	7.52	<0.25	0.194	<0.466	<1.0	<0.5	0.6	8
8	B-89-27	AXB-01	SE	SW	15	19	43	4861820N 464860E	2,670	Altered limestone	Tl	0.022	71.9	<1	7.20	<1.0	1.03	1.53	0.690	<0.5	10.7	<0.25	0.143	1.16	<1.0	<0.5	0.3	<5
9	B-89-145	AXB-03	NW	NW	22	19	43	4861550N 464530E	2,810	Altered limestone	Tl	0.02	376.	1	7.95	<1.0	7.29	1.88	3.99	<0.5	13.2	<0.25	0.290	0.826	<1.0	<0.5	1.1	<5

[1] Gold, uranium, and tin analyses by Bondar-Clegg; other trace-element analyses by GSI.

GEOLOGIC CROSS SECTIONS