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

1988

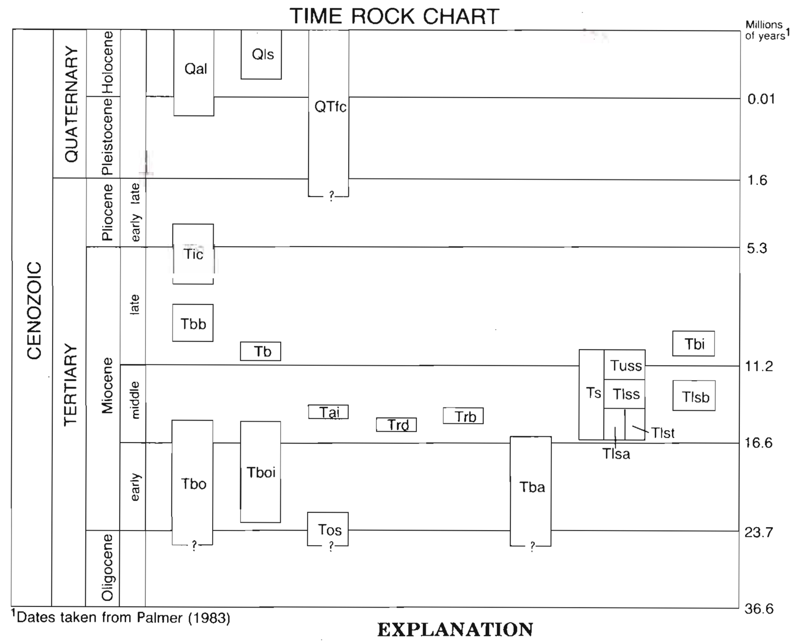
Base map by U.S. Geological Survey
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1966 and 1967. Field checked 1967
Polyconic projection. 1927 North American datum
10,000-foot grid based on Oregon coordinate system, south zone

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

Geology by Mark L. Ferns,
Oregon Department of Geology and Mineral Industries
Field work completed in 1987-88.

TIME ROCK CHART



[1]Dates taken from Palmer (1983)

EXPLANATION

Qal — **Alluvium (Holocene and Pleistocene)** — Unconsolidated and generally poorly sorted deposits of gravels, sands, and silts accumulated along modern stream flood plains

Qls — **Landslide deposits (Holocene)** — Landslide and slump deposits of unconsolidated and unstratified soil and angular rock fragments formed as the result of bedrock failure. Includes an active landslide in Long Gulch

QTfc — **Colluvial and alluvial fan deposits (Pliocene? to Holocene)** — Mainly alluvial fan and slope deposits consisting of unconsolidated coarse gravels and silts deposited by periodic flash floods debauching along the broad plain west of Succor Creek. Colluvial deposits include scree and talus along slopes of ridges and scattered accumulations of windblown silt and sand on the tops of benches and ridges and in the broad valleys. Previously mapped as part of the Chalk Hills Formation (Corcoran and others, 1962) where the depositional surface has been dissected by modern streams

Tic — **Tuffaceous sedimentary rocks (upper Miocene and Pliocene)** — Mainly light-gray to grayish-white, poorly consolidated tuffaceous silt and fine-grained sandstones. Includes interbedded tuff, diatomaceous siltstones, and arkosic sandstones. Also includes distinctive pebble conglomerates comprised in part of ¼-in.-diameter black chert pebbles that cap many of the resistant buttes in the region (e.g., Deer Butte and Blackjack Butte in the Owyhee Dam quadrangle and Browns Butte in the Adrian quadrangle). Siltstones and sandstones take on a yellowish hue and form resistant outcrops near hydrothermal systems where silica and/or carbonate cement have been introduced. Late Miocene and Pliocene ages based on fish fossils identified by Kimmel (1982) in the Adrian quadrangle to the north. Unit is correlative with the Chalk Butte Formation of Corcoran and others (1962) and the Glenns Ferry and Chalk Hills Formations of Malde and Powers (1962)

Tbb — **Basalt and basaltic andesite flows (upper? Miocene)** — Mainly gray to black, vesicular, generally aphyric holocrystalline basalt flows that fill paleocanyons eroded into underlying units **Ts** and **Tba**. Usually gray in color on fresh surfaces due to abundant framework feldspars in groundmass. Textures range from pilotaxitic to ophitic. Characterized by plagioclase phenocrysts less than 0.12 in. in length and microphenocrysts of clinopyroxene, orthopyroxene, and iddingsitized olivine. Unit **Tbb** is correlative with the Blackjack Basalt of Bryan (1929); uppermost flows of the Owyhee Basalt, as mapped by Corcoran and others (1962) and Kittleman and others (1965); and Deer Butte Basalt, as mapped on the west side of the Owyhee Reservoir by Kittleman and others (1967). Radiometric K-Ar dates summarized by Fiebelkorn and others (1982) range from 13.8 ± 0.3 to 16.1 ± 0.9 Ma. Distinguished from underlying flows of unit **Tba** by a generally fresher appearance due to thin weathering rinds, abundance of olivine (up to 5 percent) as a phenocryst phase, and the presence of narrow, discontinuous lenses of intervening tuffaceous sedimentary rocks. Major- and trace-element analyses (Table 1) indicate that the flows are calc-alkaline basalts similar in composition to the basal Owyhee Basalt (their unit Tob) flows analyzed by Brown and Petros (1985)

Ts — **Tuffaceous sedimentary rocks, undifferentiated (Miocene)** — Mainly light-orange-brown, fine-grained tuffaceous palagonite-rich volcaniclastic sandstones and pale-yellowish-white zeolitic tuffs. Includes white zeolitic tuffs and tuff breccias and yellowish-brown palagonitic sandstones. East of Devils Gate, unit **Ts** is divided into units **Tlsa**, **Tlst**, **Tlss**, and **Tuss**. Where capped by overlying flows of unit **Tbb** west of Devils Gate, unit **Ts** includes coarse white lithic tuffs composed of white inflated pumice and aphyric black basalt clasts that are interbedded with mafic lapilli tuffs. Also includes yellowish-brown palagonitic tuffs (maar-related deposits?) interbedded with thin basalt flows near the base of the section west of Devils Gate. Previously mapped as the Sucker Creek Formation (Kittleman and others, 1965). Has not been observed to contain arkosic conglomerates and sandstones west of Devils Gate

Tuss — **Tuffaceous siltstones (middle and upper Miocene)** — Mainly pale-yellowish-white and pale-greenish-brown, fine-grained tuffaceous siltstones. Includes poorly indurated granite-clast arkosic conglomerates overlain by and interbedded with white and yellowish-white tuff near the top of the section. Contains interbedded bentonite clay beds that locally attain composite thicknesses of 40 ft. Individual bentonite seams are gray to grayish-white and green in color and range from 2 to 8 in. in thickness where exposed in mine cuts. The bentonites weather to a characteristic popcorn-texture on unexcavated slopes. Unconformably overlies units **Tlss** and **Tlsb**. Unit **Tuss** is mantled by unit **QTfc** along Alkali Creek in sec. 8, T. 23 S., R. 46 E. (Glen Teague, personal communication, 1988)

Tlss — **Tuffaceous sandstones and siltstones (Miocene)** — Mainly light-orange-brown, fine-grained tuffaceous sandstones and pale-yellowish-white tuffaceous siltstones. Locally includes white, fine-grained zeolitic tuffs and pale-brown palagonitic tuffs and tuff breccias. Includes pale-yellow, fine-grained siliceous siltstones reportedly comprised of silicified diatoms (Glen Teague, personal communication, 1987). Also includes sandy pale-brown bentonitic clays

Tlsa — **Ash-flow tuff and tuffaceous sediments (Miocene)** — Mainly pale-greenish-white, nonwelded rhyolitic ash-flow tuffs and intercalated tuffaceous sedimentary rocks. Individual ash flows contain detached zones of vitrophyre and are crystal lithic tuffs with small amounts of sanidine, plagioclase, and quartz phenocrysts. The unit is over 200 ft thick on Board Corral Gulch, where it contains fragments of rhyolite over 1.5 ft in diameter. Unit **Tlsa** represents part of the intracaldera facies of the tuff of Spring Creek of Vander Meulen and others (1987) and marks the northern boundary of the Three Fingers Caldera of Vander Meulen and others (in preparation). According to Glen Teague of Teague Mineral Products (written communication, 1988), the unit contains as much as 50 percent clinoptilolite

Tlst — **Ash-flow tuff and tuffaceous sediments (Miocene)** — Mainly green to white quartz-sanidine lithic tuff with discontinuous, detached zones of black vitrophyre. Unit is believed to be the outflow facies of the tuff of Spring Creek. Includes overlying tuffaceous silt and sandstones. Ash flow is partly welded and contains flattened pink pumice clasts, mafic lithic fragments, and nearly completely resorbed quartz phenocrysts

Tlsb — **Olivine basalt flows (Miocene)** — Generally black to dark-gray, vesicular, aphyric olivine basalt flows found near the base of units **Ts** and **Tlss**. Includes interbedded orange palagonitic sandstones. Basal flows form bulbous outcrops projecting through the sandstones, suggesting that the flows have locally burrowed down into the underlying sediments. In thin section, the basalts are generally holocrystalline and lack phenocrysts. Textures range from pilotaxitic to ophitic. Groundmass olivine is abundant. Phenocrysts when present include both plagioclase and olivine. The uppermost flow in the Owyhee Ridge quadrangle is glomeroporphyritic and contains clinopyroxene, plagioclase, and olivine phenocrysts. Unit **Tlsb** depositionally overlies the tuff of Spring Creek and is in turn unconformably overlain by the Barstovian fossiliferous strata of unit **Tuss** west of Succor Creek. West of Devils Gate, the flows are interbedded with palagonite tuffs near the base of unit **Ts**

Trb — **Lithoidal rhyolite (Miocene)** — Mainly pale-brown to tan, porphyritic sanidine and quartz-bearing lithoidal rhyolite that contains subequal amounts of sanidine, quartz, and opaque phenocrysts. Total phenocrysts comprise less than 5 percent of the rock and include sanidine crystals up to 0.12 in. in length. Unit includes zones of black vitrophyre along contacts. Locally contains red siliceous aphyric clasts and broken, devitrified shards and may include welded tuff. Overlies and intrudes the tuff of Spring Creek (Vander Meulen and others, 1987) along the northern margin of the Three Fingers Caldera (Vander Meulen and others, in preparation) and may include post-collapse domes emplaced along the caldera ring-fracture system. Much of the rhyolite has been partially silicified by hydrothermal fluids (e.g., analysis 5, Table 1) and is cut by narrow veinlets of chalcedonic quartz and potassium feldspar

Trd — **Sanidine rhyolite (Miocene)** — Dark-purplish-gray to brownish-gray, locally flow-foliated rhyolite. Characteristically contains approximately 2 percent light-brown-weathering sanidine phenocrysts up to 0.24 in. in length. Marked by vertical flow-foliation zones and marginal zones of coarse vitrophyre breccias. Overlies and intrudes the tuff of Spring Creek (Vander Meulen and others, 1987) in Board Corral Gulch and is interpreted as a flow-dome complex erupted along the northern margin of the Three Fingers Caldera. Intrudes palagonitic sandstones in the lower part of unit **Ts** near Devils Gate. Previously mapped as part of the Jump Creek Rhyolite by Kittleman and others (1965)

Tba — **Mafic and intermediate lava flows and breccias (upper Oligocene? and Miocene)** — Mainly dark-gray to black, fine-grained platy plagioclase-phyric lava flows and autoclastic breccias that weather to various shades of red and brown. Includes generally thin, lenticular subaerial tuff and scoria deposits. Correlative with the basalt at Bishops Ranch (Kittleman and others, 1965) and the unnamed basalts and latites of Ekren and others (1981). May also be correlative with the lower part of the Owyhee Basalt of Bryan (1929) and mafic flows of the "unnamed igneous complex" of Kittleman and others (1965) that are exposed in the Malheur River gorge

Tbo — **Basalt, basaltic andesite, and andesite flows and breccias (upper Oligocene? and Miocene)** — Mainly dark-gray to black, fine-grained platy plagioclase-phyric lava flows and autoclastic breccias that weather to various shades of red and brown. Includes generally thin, lenticular subaerial tuff and red and black scoria deposits. Lower part of the unit along the Owyhee Reservoir is made up mainly of basalt flows that are pilotaxitic and occasionally contain both phenocryst and groundmass olivine. Unit **Tbo** may be correlative with unit **Tba**. The Owyhee Basalts may be a partially dissected calc-alkaline volcanic basement upon which the younger Miocene rhyolitic caldera systems were formed. Published radiometric K-Ar dates for the Owyhee Basalts range from 14.1 to 25.3 ± 1.8 Ma (Fiebelkorn and others, 1982; Brown and Petros, 1985)

Tos — **Mafic tuffs and tuff breccias (maar deposits?) (upper Oligocene? and Miocene)** — Mainly brown to light-orange-brown, thin-bedded, coarse- to medium-grained palagonitic breccias that contain plagioclase-phyric and aphanitic mafic volcanic clasts up to almost 2 ft in diameter. Underlies and may interfinger with the lower part of unit **Tbo** and partially overlies a plagioclase-phyric glassy rhyolite in the Owyhee Dam quadrangle to the north, where the uppermost beds include a 3-ft-thick white rhyolitic lithic tuff. Contacts between the rhyolite and the stratigraphically lower mafic tuffs and tuff breccias are not exposed. Age is based on a 22.8 ± 2.6-Ma K-Ar date obtained from the rhyolite (Brown and Petros, 1985). Both Corcoran and others (1962) and Kittleman and others (1965) indicate that distal parts of the rhyolite overlie sedimentary rocks to the south and west

Tboi — **Basalt and andesite dikes and sills (Miocene)** — Mainly narrow, columnar-jointed andesite and basaltic andesite dikes and sills similar in composition to overlying flows in unit **Tbo**

Tb — **Basalt (upper Miocene)** — Mainly coarse-grained black basalt in irregularly shaped dikes and sills. Unit may include intracanyon flows intercalated with sedimentary rocks near the top of unit **Ts**. Includes hyalo-ophitic basalts with zoned euhedral plagioclase phenocrysts up to 0.2 in. in length in a groundmass charged with opaques and altered glass

Tai — **Intermediate and mafic intrusions (Miocene)** — Mainly platy, plagioclase-phyric basalts and basaltic andesites emplaced as irregularly shaped dikes and sills

Tbi — **Mafic intrusions (upper Miocene)** — Mainly coarse-grained holocrystalline basaltic intrusions

MINERAL RESOURCES

Introduction

Several mineral commodities, including bentonite clay, zeolites, and various types of semiprecious gemstones, have been or are now being mined in the quadrangle. Several small areas of hydrothermal alteration, most of which are marked by small prospect pits and cuts, occur within the quadrangle.

Nonmetallic resources

Bentonite clay is the main mineral resource produced in the quadrangle. The clay, mined by Teague Mineral Products, is found in the lower part of unit **Tuss** near the eastern edge of the quadrangle. Teague reports that the main clay zone is over 40 ft thick. Where exposed in mine pits, the clay zone is comprised of an accumulation of 2- to 8-in.-thick gray, grayish-white, and green bentonite beds that together form a clay zone as much as 40 ft thick.

Zeolite in the form of clinoptilolite nearly completely replaces fine-grained airfall tuffs near the base of unit **Ts**. The tuffs are a brilliant white and form nearly monomineralic beds as much as 12 ft thick. The zeolite beds locally contain nodules and seams of green silicified tuff (picture rock).

Semiprecious gemstones

Semiprecious gemstones in the form of common opal and picture rock (multihued silicified tuff) occur in several areas. Picture rock is found in the zeolite pit in sec. 36, T. 23 S., R. 45 E., and as float boulders along the steep slope north of Board Corral Gulch in the northeast quarter of sec. 1, T. 24 S., R. 45 E. Opal and opalized wood in colors ranging from purplish-brown to green and white has been mined from a white lithic tuff in the extreme northeast quarter of sec. 11, T. 23 S., R. 45 E. The opal occurs as nodules and in vertical seams and locally replaces fragments of wood.

Metallic mineral resources

Although several areas have been prospected in the past for gold, precious metals have not been identified in the quadrangle. There are, however, several areas that may be favorable precious-metal exploration targets. A limited number of geochemical samples indicates anomalous amounts of arsenic and molybdenum (Table 2).

Large hydrothermal alteration zones are possibly associated with the rhyolite masses peripheral to the margins of the Three Fingers Caldera of Vander Meulen and others (in press). The rhyolite mass south of Board Corral Creek (unit **Trb**) in sec. 12, T. 24 S., R. 45 E., is altered and locally cut by narrow chalcedonic quartz and potassium feldspar veinlets. Wood (written communication, 1988) reports chalcedony with pyrite in a rhyolite breccia in the southwest corner of sec. 19, T. 23 S., R. 46 E.

Iron-stained and silicified arkosic sandstones are exposed in the floor of the small valley north and west of Danny Boy spring in sec. 31, T. 22 S., R. 46 E. The sandstones overlie a poorly exposed basalt that is cut by narrow calcite veins. Rare float of travertine with wood fragments suggests that a venting hot spring was once nearby. Several old prospect pits along a basalt dike on the east edge of the valley in a white tuff were reportedly dug in search of mercury.

MAP SYMBOLS

Contact — Approximately located

Fault — Dashed where inferred; dotted where concealed; queried where doubtful; ball and bar on downthrown side

Strike and dip of beds

Location of whole-rock sample analyzed in Table 1

Location of mineralized sample analyzed in Table 2

GMS-53

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

By M.L. Ferns

Funded in part by the U.S. Geological Survey (COGEOMAP)

GEOCHEMISTRY

Sample preparation

Samples for whole-rock analysis (WRA) (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 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) 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 split was split again to produce two subsamples: one for gold and one for the 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*—Bondar-Clegg, Ltd., of North Vancouver, British Columbia, performed the analyses for gold. The method employed was fire assay preconcentration of the gold in a 20-g sample (gold was collected inadded silver), acid dissolution of the resulting bead, and a directly coupled plasma (DCP) emission spectrometer finish. The detection limit was 1 ppb.

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/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.

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Table 1. Whole-rock analyses, Owyhee Ridge quadrangle, Oregon[1]

Map letter	Field and laboratory no.	¼	¼	Sec.	T.(S.)	R.(E.)	UTM coordinates	Elev. (ft)	Lithology	Map unit	SiO_2	Al_2O_3	TiO_2	Fe_2O_3T	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	87-B0-104	NE	SE	2	23	45	482680N 48562E	3,560	Basalt	Tbb	52.8	15.6	1.62	10.0	0.16	8.08	5.01	1.48	3.06	0.60	0.54	98.95	108	44	443	33	139	14	530
B	87-B0-121	NW	SW	5	24	45	481763N 48039E	4,580	Basalt	Tbb	53.0	16.7	1.36	10.2	0.17	8.70	5.14	1.18	3.08	0.49	0.47	100.49	139	40	513	14	128	20	553
C	87-B0-72	NE	NE	1	24	45	481820N 48774E	3,560	Sanidine rhyolite	Trd	73.8	12.0	0.30	2.67	0.03	0.08	0.11	5.07	3.87	0.05	0.62	98.60	12	160	<10	78	714	50	1400
D	87-B0-88A	NE	NE	11	24	45	481642N 48660E	3,600	Basalt	Tlsb	46.1	17.1	1.09	11.0	0.14	9.88	6.81	0.21	2.14	0.25	4.00	98.72	92	19	244	29	39	10	89
E	87-B0-86	NW	NW	12	24	45	481620N 48670E	3,240	Altered rhyolite	Trb	83.2	7.84	0.18	0.63	0.01	0.12	<0.01	4.26	1.51	0.03	1.08	98.86	15	105	<10	62	406	38	750

[1]XRF analyses by XRAL.

Table 2. Trace-element analyses, Owyhee Ridge quadrangle, Oregon[1]

Map no.	Laboratory no.	¼	¼	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)	Pd (ppm)	Se (ppm)	Te (ppm)
1	AVB-224	SE	NE	31	22	46	482896N 48892E	3,000	Calcite	Tuss	0.017	10.9	1	6.32	<0.094	2.47	1.53	0.290	<0.471	9.79	<0.235	<0.094	1.21	<0.471	<0.942	<0.471
2	AVB-221	NE	NE	11	23	45	482596N 48591E	3,560	Opal	Ts	0.029	21.9	2	5.01	<0.091	19.0	7.76	0.482	<0.456	6.65	0.348	<0.091	2.92	<0.456	<0.912	<0.456
3	AVB-220	NW	NW	13	23	45	482468N 48611E	3,640	Opaline breccia	Ts	0.039	3.82	2	14.0	<0.094	0.517	2.39	0.307	<0.471	17.7	<0.235	<0.094	0.906	<0.471	<0.942	<0.471
4	AVB-233	NE	SE	18	23	46	482370N 48908E	2,900	Silicified tuff	Tlss	0.024	4.96	2	10.4	<0.1	1.66	3.16	<0.25	<0.5	19.6	<0.25	<0.1	1.55	<0.5	<1.	<0.5
5	AVB-232	NE	SW	17	23	46	482356N 48980E	2,860	Calcite	Tuss	0.015	1.57	<1	2.20	<0.093	0.098	0.525	<0.234	<0.467	2.74	<0.234	<0.093	<0.467	<0.467	<0.935	<0.467
6	AVB-217	NE	SW	24	23	45	482228N 48662E	3,240	Calcite stringers	Ts	<0.015	4.09	2	21.3	<0.099	<0.099	1.03	<0.248	<0.496	16.6	<0.248	0.133	2.40	<0.496	<0.992	<0.496
7	AVB-222	SE	SE	23	23	45	482152N 48556E	3,880	Opal	Ts	0.02	3.44	<1	4.84	<0.1	1.24	2.43	0.437	<0.498	7.59	<0.249	<0.1	2.59	<0.498	<0.996	<0.498
8	AVB-223	NE	NE	26	23	45	482118N 48574E	3,520	Calcite	Ts	<0.014	2.44	2	27.6	<0.097	0.182	1.14	<0.241	<0.483	21.5	<0.241	<0.097	3.33	<0.483	<0.965	<0.483
9	AVB-216	SW	NE	2	24	45	481774N 48578E	3,520	Picture rock	Trd	0.043	52.1	2	10.6	0.162	3.20	15.7	2.75	<0.465	69.0	<0.232	0.268	4.76	<0.465	<0.929	<0.465

[1]Gold analyses by Bondar-Clegg; other trace-element analyses by GSI.

GEOLOGIC CROSS SECTIONS