STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
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GEOLOGY AND MINERAL RESOURCES MAP OF THE BOSWELL MOUNTAIN QUADRANGLE, JACKSON COUNTY, OREGON
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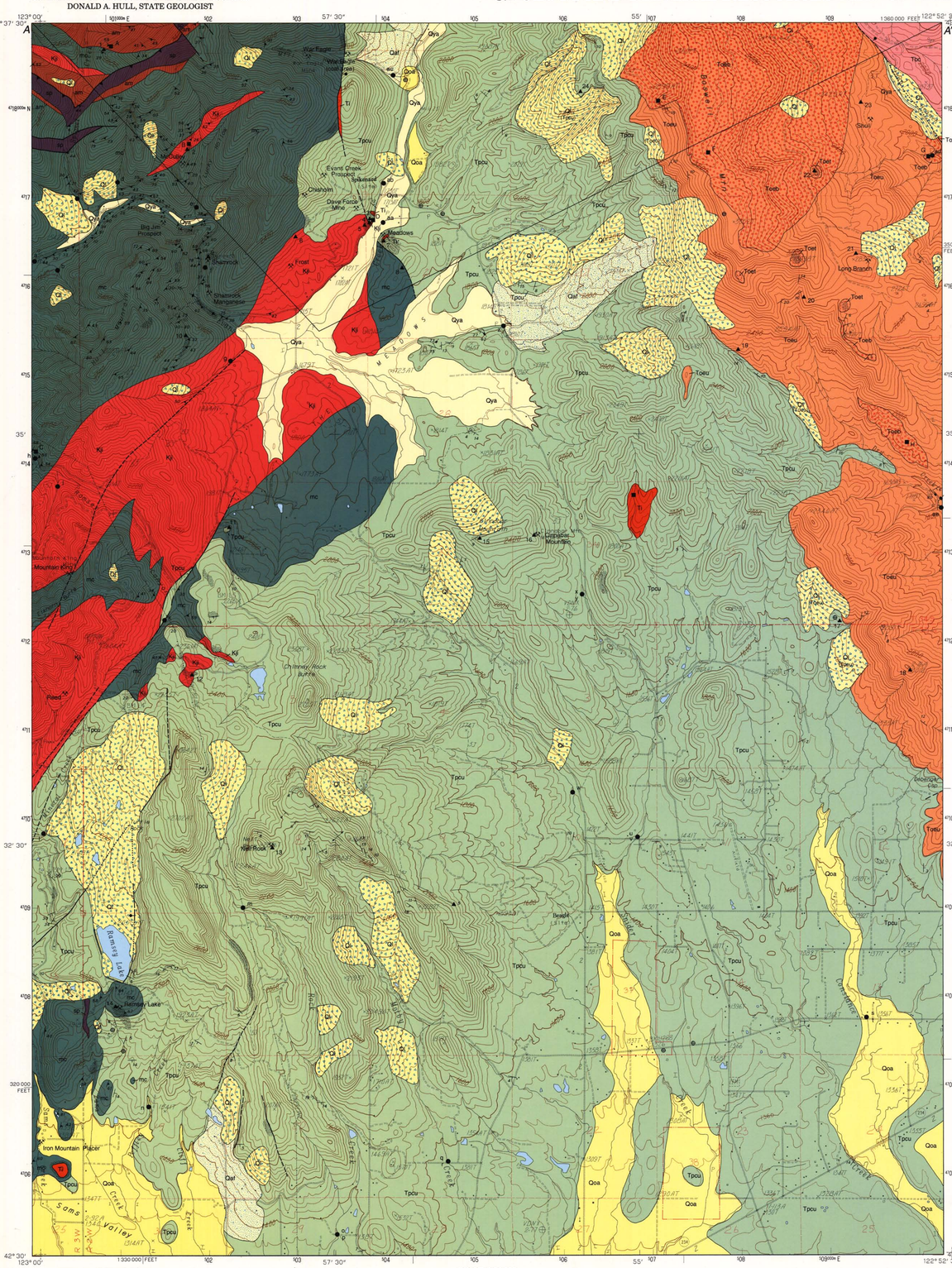
Geology and Mineral Resources Map of the Boswell Mountain Quadrangle, Jackson County, Oregon
By Thomas J. Wiley and Frank R. Hladky

Plate 1



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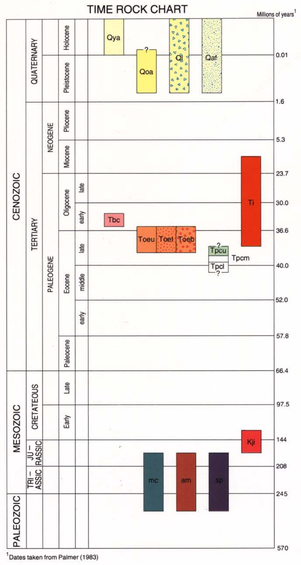
Field work conducted June-December 1990 and January-March 1991

Reviewed by Brian K. McKnight, University of Wisconsin at Oshkosh, and Mary M. Donato, U.S. Geological Survey

Cartography by Mark E. Neuhaus

TIME ROCK CHART



EXPLANATION

QUATERNARY DEPOSITS

Qya — **Young alluvium (Holocene)**—Gravel, sand, and silt deposited along modern stream channels

Qoa — **Old alluvium (Holocene? and Pleistocene)**—Gravel, sand, and silt; locally perched above modern stream channels; locally dissected; depositional surfaces preserved in places; thickness less than 8 m (25 ft)

Qaf — **Alluvial fan (Holocene and Pleistocene)**—Gravel, sand, and silt deposited in fans associated with abrupt decrease in stream gradient

Qt — **Landslide deposits (Holocene and Pleistocene)**—Fragments of bedrock mixed with gravel, sand, silt, or clay and displaced downslope by gravity sliding

ANGULAR UNCONFORMITY

TERTIARY (PALEOGENE) SEDIMENTARY AND VOLCANIC ROCKS

Tbc — **Tuff of Bond Creek of Smith and others (1982) (lower Oligocene, 34.9 Ma)**—Buff to tan, fine-ash, welded, rhyodacitic, biotite-quartz vitric ash-flow tuff. K-Ar age of 34.9 Ma on biotite reported by Smith and others (1980). Thickness exceeds 210 m (700 ft) in adjacent Cleveland Ridge Quadrangle

Toeu — **Volcanic and volcanogenic rocks undivided (lower Oligocene to upper Eocene?)**—Interbedded, gray-weathering, tan, olive, and brown volcanogenic conglomerate, mudstone, basalt, sandstone, and tuff not mapped separately. Conglomerate is typically chaotic, poorly sorted, and matrix supported and is interpreted as mudflows (lahar deposits); matrix mudstone increases and clast size decreases toward southeast; clasts to 2 m, angular to rounded, usually subrounded, typically mafic volcanic but also consisting of tuff, conglomerate, and carbonized wood. Mudstone is thickly laminated, lobate, crystal bearing; occurs frequently intercalated as lenses within or marginal to conglomerate; is increasingly abundant to southeast. Basalt is aphanitic and celadonitized, with small flows (sills?) intercalated with boulder conglomerate. Sandstone is coarse to pebbly and may be cross bedded. Ash and lapilli tuff is crystal lithic. Thickness of unit about 460 m (1,500 ft). The lithologies are similar to those reported from The Fisher Formation (Schenk, 1927; Hoover, 1963) near Cottage Grove in Lane County and from the northern part of the Colestin Formation (Wells, 1956) in the Medford 30-minute Quadrangle. Hoover (1963) described late Eocene fauna and flora from the lower Fisher Formation. Lux (1982) reported K-Ar ages of 37-40 Ma from basalt and basaltic andesite flows that overlie the Fisher Formation near Cottage Grove and are similar to the basalt here. Unit **Toeu** is intercalated with fluvial conglomerate and sandstone of Payne Cliffs Formation near the base, elsewhere lying as fill in subdued but eroded surface of Payne Cliffs Formation

Toeb — **Basalt**—Tan-weathering, gray to black, fine- to medium-grained basalt, intergranular to intersertal, locally glomeroporphyritic; on Boswell Mountain local microclastic. Consists of at least three flows (sills?). Phenocryst assemblages include 0-5 percent olivine, 0-3 percent enstatite, 2-15 percent augite/pigeonite, 0-15 percent plagioclase, 0-5 percent magnetite, also clay, orthoclase, iddingsite, and chlorophaeite. Plagioclase phenocrysts and microlites may be zoned, with composition ranging from An_{70} to An_{72} and averaging An_{65-66}. These rocks give whole-rock K-Ar minimum ages of 19.4 ± 0.2 (SW¼, sec. 11, T. 34 S., R. 2 W.) and 29.8 ± 0.5 Ma (SW¼, sec. 14, T. 34 S., R. 2 W.). Maximum thickness of flow (sill?) topping Boswell Mountain is 340 m (1,100 ft)

Toet — **Tuff breccia**—Reddish-purple, buff, and greenish-gray tuff breccia, significantly altered, poorly-sorted, lithic, vitric; contains large (7.5 cm) angular pumice clasts. Forms small knobs in secs. 13 and 24, T. 34 S., R. 2 W. Thickness approximately 13 m (40 ft)

Tpcu, Tpcm, Tpcl — **Payne Cliffs Formation of McKnight (1971), upper part, (upper Eocene)**—Unit consists of conglomerate, sandstone, siltstone, mudstone, and coal in nonmarine, fluvial deposits; provenance variation suggests local derivation in part. Pebble conglomerate is light olive to gray, weathers grayish brown, green, or yellowish orange, and is generally clast supported, locally imbricated or cross-bedded, with beds to 5 m thick (average 0.75 m); typical clasts are subrounded to well-rounded, oblate spheroids and average 2 cm in diameter, with maximum diameter <10 cm and occasional wood fragments to 50 cm; they are mainly porphyritic intermediate volcanic (to 70 percent) and quartzite, less frequently mafic volcanic, siltstone, mudstone, silicic volcanic, metamorphic, chert, vein quartz, and intrusive. Sandstone and pebbly sandstone are gray, green, tan, white, or red (altered) and weather grayish green to yellowish orange or brown; composed of lithic to arkosic wacke, micaceous, locally tuffaceous near base; cross-bedded, laminated, or massive; beds to 4 m thick. Mudstone is gray to grayish green, may contain concretions and leaves, and is more common near base of formation in The Meadows area. Coal, lignite, or coalified wood are found in rare occurrences; Schuette (1938) reports coal seams as thick as 1.2 m (4 ft) in the War Eagle Mine area (mine site 2). Middle (unit **Tpcm**) and lower (unit **Tpcl**) parts of the formation may be present at depth but do not crop out in the quadrangle. Age of unit reported by Brown (1956) as minimum late Eocene, based on fossil leaves from middle part (unit **Tpcm**) of the formation near Ashland. Intruded by basaltic dike with late Eocene K-Ar whole rock minimum age of 36.9 ± 0.8 Ma. Thickness approximately 670 m (2,200 ft)

ANGULAR UNCONFORMITY

JURASSIC OR OLDER METAMORPHIC ROCKS

mc — **May Creek Schist of Donato (1991b) (Jurassic or older)**—Moderate-yellowish-brown- to pinkish-gray-weathering, medium-gray biotite-quartz schist, garnet-biotite-quartz schist, quartzite, and minor amphibolite and gneiss. Schist typically of granoblastic quartz grains with foliation defined by aligned biotite. Foliation is generally northeast trending, dipping about 45° southeast. Donato (1990) reports a middle amphibolite-facies mineral assemblage. Unit is commonly intruded or replaced by igneous lithologies (see unit **Kji**) at scales from millimeters to kilometers. Minimum age based on 145-Ma date for metamorphism of associated amphibolite (Donato, 1991a). Age of protolith unknown. Formerly included in May Creek Formation of Diller and Kay (1924). Thickness about 1,900 m (6,200 ft)

am — **Amphibolite (Jurassic or older)**—Brown- to orange-weathering, gray amphibolite; generally comprises alternating layers of granoblastic plagioclase (An_{35-65}) and hornblende; is locally intruded or replaced by igneous lithologies (see unit **Kji**). Metamorphic $^{40}Ar/^{39}Ar$ ages of 145 Ma from hornblende in adjacent Cleveland Ridge and Skeleton Mountain Quadrangles reported by Donato (1991a). May include small bodies of premetamorphic intrusive rock. Age of protolith unknown

sp — **Serpentinite (Jurassic or older)**—Dusky-yellow- to brownish-gray- to moderate-reddish-brown-weathering, black to dusky yellow-green serpentinite. Locally contains metamorphic olivine, amphibole, pyroxene, and chlorite (Donato, written communication, 1991). Crops out along faults in northwest corner of quadrangle as lenses 10-100 m thick and tens of meters to kilometers long. Age is based on 145-Ma metamorphic age of associated unit **am**

INTRUSIVE ROCKS

Ti — **Dikes and small intrusive bodies (Tertiary)**—Gray to olive, intersertal, porphyritic basaltic intrusive in sec. 34, T. 34 S., R. 2 W., is comprised of approximately 15 percent augite up to 3 mm in length, 65 percent zoned plagioclase laths (An_{70-75}, average An_{72}) up to 0.5 mm in length, 15 percent interstitial chlorophaeite, and 5 percent magnetite. Basaltic dike along fault contact between units **Tpcu** and **mc** in northwest corner of quadrangle weathers pink to brown, is gray when fresh. Contains glomeroporphyritic augite/pigeonite and rare iddingsitized or calcitized olivine in groundmass of labradorite. Dike is 24 m (80 ft) wide in Dave Force Mine (Wells and Waters, 1934; mine site 6). One whole-rock K-Ar minimum age of 36.9 ± 0.8 Ma was obtained from NW¼ sec. 21, T. 34 S., R. 2 W. Several small, fine-grained sericitized basaltic dikes occur. Coarse-grained mafic intrusion in E½ sec. 24, T. 35 S., R. 3 W., does not abut unit **Tpcu** and may be older

Kji — **Intrusive rocks (Cretaceous and Jurassic)**—Hornblendite to hornblende-biotite gabbro to quartz diorite consisting of hornblende, biotite, quartz, and plagioclase in varying proportions. Hundhausen (1952) reports norite in the Shamrock Mine (mine site 10). Unit includes two-mica granite exposed in a borrow pit east of Elkhorn Butte and two-mica pegmatite that crops out near summit of Elkhorn Butte

MAP SYMBOLS

Contact—Approximately located; dotted where concealed; bar indicates dip

Fault—Dashed where approximately located; dotted where inferred; ball and bar on downthrown side. Arrows in cross section indicate direction of relative movement

Thrust fault—Sawteeth on upper plate

Plunging anticline—Dashed where approximately located

Strike and dip of beds — 65

Horizontal bed

Strike and dip of foliation — 67

Strike and dip of joints — 58

Contorted zone

Altered zone—Contains exotic limonite or silica or exhibits argillic alteration. Adjacent to intrusions and basaltic dikes, along brecciated or slickensided shear zones, and along pre-Tertiary unconformity

Mine site

Unaltered rock sample location and map letter (Tables 1 and 2, Plate 2) — A

Altered rock sample location and map number (Table 3, Plate 2) — 21

Stream-sediment sample location and map letter (Table 4, Plate 2) — W

GEOLOGIC HISTORY

Serpentinite, amphibolite, schist, and quartzite that crop out along the western edge of the quadrangle are the oldest rocks in the area. Donato (1990, 1991a,b) reports that (1) protoliths for this assemblage originated as a suite of continental-margin sediments (schist and quartzite of the May Creek Schist) thrust over (deposited on?) ultramafic (serpentinite) and mafic volcanic (amphibolite) basement of marginal basin origin; (2) metamorphic grade is at least middle amphibolite facies (550 °C); (3) bulk composition is generally unfavorable for formation of a diagnostic mineral assemblage; and (4) the age of metamorphism is indicated by two $^{40}Ar/^{39}Ar$ ages of 145 Ma on hornblende from the amphibolite. Pervasive intrusion and metamorphic segregation have locally produced migmatitelike textures in amphibolite and schist. Foliation dips about 45° southeast but is locally contorted.

An angular unconformity separates the rocks described above from nonmarine upper Eocene sedimentary rocks (unit Tpcu) of the upper part of the Payne Cliffs Formation (McKnight, 1971, 1984), requiring nondeposition or Paleogene erosion of the marine Hornbrook Formation (Upper Cretaceous) of Peck and others (1956) and the lower parts of the nonmarine Payne Cliffs Formation (units **Tpcm** and **Tpcl**; see cross section A-A') that occupy this stratigraphic level to the south. Well-indurated conglomerate and tuff occur locally along this contact, and although we believe they represent altered parts of the Payne Cliffs Formation, they may constitute a separate unit. The unconformity is offset by vertical and steeply east-dipping, northwest- to northeast-trending faults.

Near the basal unconformity in The Meadows area, unit Tpcu consists of a sequence of medium- to thick-bedded tuffaceous sandstone, pebbly sandstone, siltstone, mudstone, and coal, associated with a broad topographic low. These facies are overlain by resistant, thick-bedded to massive sandstone and clast-supported conglomerate that make up much of the base of Boswell Mountain and the hills north of Sams Valley. Higher on Boswell Mountain, tuffs and volcanogenic conglomerate at the base of unit Toeu are locally interbedded with Payne Cliffs Formation fluvial sandstone and conglomerate beds. Although structural data from the eastern part of Sams Valley are very limited, they suggest that unit Tpcu sandstone and conglomerate there occupy the same stratigraphic level as volcanogenic sedimentary rocks of unit Toeu on Boswell Mountain. However, mapping by Smith and others (1982) and Sherrod and Smith (1989) show this contact as an unconformity farther south. The eastward transition from broad, gentle folding to an east-dipping homocline that characterizes the Western Cascades occurs in the eastern part of the quadrangle. Tuffaceous rocks present near the base of unit Tpcu, volcanic provenance of conglomerate clast assemblages, and lithic sandstone that characterize the formation in this area indicate it is equivalent to the upper part of the Payne Cliffs Formation in its type area (McKnight, oral communication, 1990). Widely spaced, shallow dips measured in unit Tpcu south of The Meadows imply broad south-plunging folds. Relief in the hills north of Sams Valley is due mainly to differential erosion of resistant facies of massive sandstone and conglomerate.

Volcanic and related sedimentary rocks of units Toeu, Toet, and Toeb on Boswell Mountain show lateral variation of lithologic and textural characteristics of proximal volcanic facies including hot and cold debris flows with meter-sized angular clasts, autoclastic breccia, lateral variations in clast diameter, and lateral variations in provenance. Superposition implies that thick basalt flows capping Boswell Mountain (unit Toeb) generally overlie volcanogenic sedimentary rocks of unit Toeu, a relationship similar to that shown by Vokes and others (1951) for the Fisher Formation and related upper Eocene and lower Oligocene flows (Lux, 1982) in the Cottage Grove area in Lane County. The 34.9-Ma Tuff of Bond Creek (Smith and others, 1980, 1982) is thought to overlie units Toeb, Toeu, and Toet, although a fault separates them in the northeastern corner of the quadrangle. Whole-rock K-Ar ages for unit Toeb lavas are 19.4 ± 0.2 Ma and 29.8 ± 0.5 Ma. Because both sample localities are believed to lie underneath the well-dated Tuff of Bond Creek (34.9 Ma), and because alteration products are present in both samples, we interpret these to be minimum ages. Alternatively, these young ages suggest the possibility that some mapped flows are basaltic sills or that local erosion of unit Toeu has resulted in a younger volcanic sequence resting disconformably on the Payne Cliffs Formation.

Chemical and petrographic similarities between the basaltic dikes (unit Ti, whole-rock K-Ar minimum age 36.9 ± 0.8 Ma), E½ secs. 17 and 20 and NW¼ sec. 21, T. 34 S., R. 2 W.) and unit Toeb suggest they are related. If so, then the east-dipping fault the dike follows in the northwest part of the quadrangle would have been active during late Eocene time and may be representative of extensional structures that defined the Eocene basin and the extent of early Western Cascade volcanism. Prominent west-trending joint sets observed in Jurassic and older rocks and parallel faults reported from the War Eagle Mine (Wells and Waters, 1934; mine site 2) and Shamrock Mine (Hundhausen, 1952; mine site 10) were not observed to offset the Tertiary/pre-Tertiary contact.

MINERAL RESOURCES

The Boswell Mountain Quadrangle has produced metals as recently as 1954 (Brooks, 1971). The quadrangle contains the entire Meadows mining district (primarily mercury) and eastern parts of the Gold Hill mining district. Mineralization associated with metals is hosted in units of pre-Tertiary, Tertiary (Paleogene), and Quaternary age. Shear zones and portions of the pre-Tertiary unconformity act as conduits for migrating subsurface water and undoubtedly influenced the distribution of hydrothermal fluids. The locations of the following mines and prospects are shown on the map: 1, War Eagle (coal area); 2, War Eagle; 3, McCulley; 4, Evans Creek Prospect; 5, Chisholm; 6, Dave Force Mine; 7, Meadows; 8, Frost; 9, Big Jim Prospect; 10, Shamrock; 11, Shamrock Manganese; 12, Mountain King; 13, Reed; 14, Neil Rock; 15, Ramsey Lake; 16, Iron Mountain Placer; 17, Cinnabar Mountain; 18, Long Branch; 19, Shull.

The May Creek Schist (Jurassic or older) hosts nickel, copper, manganese, cobalt, platinum, carbon, mercury, arsenic, and minor gold mineralization in the Boswell Mountain Quadrangle. The War Eagle Mine has produced significant amounts of mercury (657 flasks; Brooks, 1963) from a fault zone within amphibolite and biotite schist. Ramp (1978) and Hundhausen (1952) report significant mineralization associated with the Shamrock Mine. The average ore is reported to grade 1.3 percent Ni, 1.1 percent Cu, 0.07 percent Co, and 0.03 oz/ton Pt (Ramp, 1978). The ore body is estimated to be a minimum of 61 m (200 ft) long, 61 m deep, and 1.5 m (5 ft) to 11.6 m (38 ft) wide. Mineralization at the Shamrock is associated with and concentrated within a norite intrusion in the May Creek Schist (Hundhausen, 1952). Our study found mineralization in biotite-quartz schist and quartzite country rock within postfoliation fault zones, supporting earlier conclusions that sulfide mineralization postdates metamorphism (Hundhausen, 1952).

Tertiary units have produced only mercury (Cinnabar Mountain Mine, Dave Force Mine), hosted in the Tertiary Payne Cliffs Formation. There are few indications of significant mineralization elsewhere in the Payne Cliffs Formation, except where mercury anomalies are associated with basaltic intrusions near the contact with the pre-Tertiary (Wells and Waters, 1934). The Payne Cliffs Formation hosts minor amounts of low-grade coal, usually less than 15 cm thick. J.M. McCauley, a driller for Amoco Petroleum, reported up to 12 m (40 ft) of "lignite" within 18 m (60 ft) of the surface in two wells he drilled on his ranch in the SW¼ sec. 35, T. 34 S., R. 2 W. However, his report has not been confirmed independently. Tertiary volcanic units on Boswell Mountain display anomalous mercury in altered vent-facies tuffs (map no. 22), but are otherwise metallogenically quiescent.

The U.S. Bureau of Mines reports Quaternary placer gold from Sams Creek (Iron Mountain Placer) in the NW¼SE¼ sec. 24, T. 35 S., R. 3 W. (Gray, 1991). This gold is inferred to have been eroded from upstream lode deposits hosted in pre-Tertiary rocks.

The problem of "nugget effect" (i.e., sample inhomogeneity) in the analysis for gold in stream-sediment samples was evident in the comparison of data from four sampling locations. All four sample sediments were derived from the Payne Cliffs Formation. Initial sampling at four locations and later resampling produced four sample pairs: o/p, q/r, s/t, and u/v (Table 4). Each pair was analyzed by three labs, providing six gold values for a single location. Locations o/p and u/v both yielded one high (>500 ppb) gold value and five low values (<5 ppb). Location q/r yielded two values (460 ppb, 783 ppb) that were high in comparison with the other four values (each ≤5 ppb). Location s/t yielded six closely grouped low gold values (all <5 ppb). The poor precision of gold data, as found in three of four locations, is common for this sample type and is attributed to the "nugget effect."

GROUND-WATER RESOURCES

Areas underlain by pre-Tertiary metamorphic rocks, pre-Tertiary igneous rocks, and the Eocene Payne Cliffs Formation are characterized by low matrix porosity and permeability. Ground-water flow is typically controlled by secondary permeability (fracture sets), resulting in compartmentalized ground-water storage. Ground-water levels are subject to significant seasonal fluctuations. Areas underlain by Eocene and Oligocene volcanic rocks and volcanogenic sedimentary rocks are characterized by low to high matrix porosity and permeability. Where permeability is low, ground-water flow may be restricted to volcanic interflow zones and zones of secondary permeability. Unconsolidated alluvium is less than 8 m (25 ft) thick and does not constitute a significant aquifer (Doug Woodcock, Oregon Water Resources Department, written communication, 1991).

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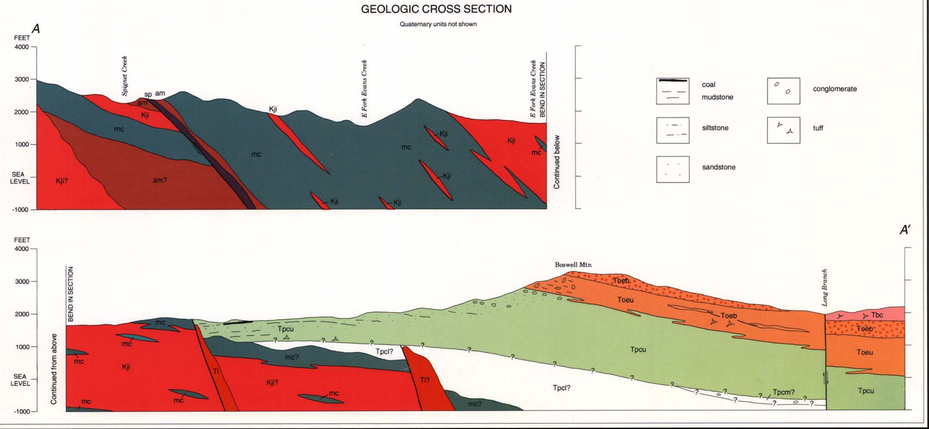
GEOLOGIC CROSS SECTION

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