Other Gold-bearing Deposits

Gold-bearing deposits can be placed in two broad classes: placer and lode. Gold-bearing lode deposits occur in three types of deposits discussed above; other types that occur or might occur in the Medford quadrangle are discussed below. Most lode gold deposits in the quadrangle are gold-quartz veins. Attempts at classifying the veins have led to uneven success (Hotz, 1971; Ramp and Peterson, 1979; Page and Johnson, 1982). Some of the veins are associated with feeder systems of massive sulfides in volcanic rocks but a large number are found in a variety of host rocks.

Because of the diversity of host rocks and locations in which lode gold deposits have been found, no attempt is made to delineate permissive tracts. There are some geologic units, however, in which lode gold deposits have not been found, or are rare. Deposits are not known in the volcanic rocks of the High Cascade Range, in marine and nonmarine sedimentary rocks of Tertiary age, or in sedimentary rocks of Jurassic age. The only major granitic plutons that host lode gold deposits are those near Ashland and Gold Hill. Some of the lode gold deposits may be related to the emplacement of the plutons (Page, Blakely and Cannon,1982). Lode gold deposits in the volcanic rocks of the Western Cascade Range appear to be only of the epithermal precious-metal type.

Incomplete production records from 135 lode gold deposits in the Medford quadrangle demonstrate that the deposits were small (figure 8) compared to other types such as epithermal precious metal veins (figure 7). Lesser amounts of silver were produced from some of the same lodes. Local high grade gold values led to extensive exploration up to and particularly during the 1930's. Because of this exploration, any undiscovered lode gold deposits are likely to exist at depth or in extensions of known deposits.

Few deposits are known in Cretaceous sediments, but Dunn (1894) reports a gold-bearing conglomerate deposit of Cretaceous age several miles northwest of Ashland. Early attempts at mining the conglomerate near Ashland were only marginally successful due to poor recovery (Dunn, 1894); except for some placer mining, this conglomerate seems to have been overlooked since then. Other Cretaceous conglomerates may also be auriferous (Ramp and Peterson, 1979).

At least 60 percent of the quadrangle's gold production has been from placer deposits. The gold-bearing placers in streams that drain areas containing ultramafic rocks also produced small amounts of platinum group metals (Page and others, 1975). The placers are localized in Tertiary, Pleistocene, and Holocene gravels with most of the production from Holocene deposits.

Nickel-bearing Laterite Deposits

These deposits are soils enriched in nickel, chromium, and cobalt; they formed in warm, humid climates by chemical breakdown of ultramafic rocks. Depending on the nature of chemical alteration, two different ore types--oxide and silicate--are formed. Oxide ores that contain up to about 1.5 percent nickel represent most ore mined in Cuba, the Dominican Republic, and the Philippines. Higher-grade silicate ores occur in New Caledonia and within the

quadrangle at Riddle, Oregon. Ores of both types frequently occur in varing proportions within the same deposit.

Because they are on the surface and are distinctively colored, few, if any, laterites remain to be found in the Medford quadrangle. Locations of the known nickel-bearing laterites, as mapped by Ramp (1978), are displayed on sheet 2. According to Ramp (1978), only a few deposits hidden under relatively steep, boulder-covered talus may not have been discovered.

The nickel-silicate laterite at Nickel Mountain near Riddle has been the most important producer of primary nickel in the U.S. since 1956. Through 1976 it produced 22,500 metric tons of nickel and is expected to continue producing until about the year 2000 (Ramp, 1978). Other nickel-bearing laterites in the Medford quadrangle are primarily the oxide type. Deposit data presented by Ramp (1978) allow calculation of preliminary tonnage and grade estimates of the Medford laterites which can be compared with estimates from other oxide-type laterites (figure 9). The other deposits are from elsewhere in Oregon, Cuba, the Dominican Republic, the Philippines, Australia, and Colombia. Deposits which have produced or for which capital expenditures have been made for production are indicated in figure 9; all producers have average grades greater than 1.2 percent nickel and are larger than three million tons in size. Other than the Nickel Mountain deposit, the laterite deposits of the quadrangle have been considered too small and too low in grade to be economic. Whether these deposits will be considered economic in the future largely depends on the development of an ore treatment process that uses much less energy than presently employed smelters and that also recovers much of the cobalt and chromium from laterites. Cobalt grades average 0.08 percent and chromium grades average 1.6 percent in the quadrangle's laterites. Several ore-treating processes, which may be more energy efficient and recover cobalt and chromium, are currently being considered for a proposed mining operation at Gasquet, California (AMM, 26 June 1981). If the venture at Gasquet is profitable, then the ore treating process will probably be applied to other laterites; whether the laterites in the Medford quadrangle would be considered depends on tradeoffs of higher grades and tonnages in foreign deposits versus a developed infrastructure in the Medford quadrangle.

Podiform Chromite Deposits

These deposits are found in ultramafic rocks typically associated with dunite; the dunite is commonly serpentinized. Chromium in the form of the mineral chromite is the only commodity of commercial interest in these deposits, although platinum group metals might be of interest locally (Page and others, 1975). Podiform chromite deposits are lenticular or roughly tabular pods that may exhibit disseminated, layered, massive, or nodular textures and structures (Thayer, 1960). The Cr:Fe ratio in unaltered chromite ranges from about 2:1 to 4:1. Podiform deposits are quite small compared to stratiform chromite deposits (Thayer, 1960).

All serpentinite and peridotite units on the geologic map (Smith and others, 1982), were used to delineate tracts permissive for the occurrence of podiform chromite (sheet 2). In addition, those areas of peridotite consisting predominately of tectonized harzburgite are indicated by hachures because

podiform chromite deposits occur less frequently in harzburgite than in dunite (Page and Johnson, 1977). A few deposits are known to exist outside of the delineated tracts in areas with permissive geology that are scattered and too small in extent to show on a 1:250,000 scale map.

Moreover, the aeromagnetic data suggest that sheets of ultramafic rocks with large lateral extent exist at relatively shallow depth. Model studies of the magnetic anomaly that extends south from Mount Bolivar, for example, show that the rocks at the topographic surface are not the source of the anomaly (Blakely, pers. com., 1982). The anomaly may be caused by a shallowly buried extension of the ultramafic sheet that crops out further to the south. Many other similar examples exist in the aeromagnetic data but, because these sources are buried, are not included as tracts on sheet 2.

Most primary chromite deposits in southwestern Oregon occur in the Medford quadrangle, including Oregon's largest, the Oregon Chromite Mine, which yielded about 32,000 tons of chromite. Almost half of the total production came from this single deposit (Page and Johnson, 1977). Information on tonnages and average grades of production from 148 podiform chromite deposits from southwestern Oregon, retrieved from the Computerized Resource Information Bank (Calkins and others, 1978), provides a means of showing grade and tonnage frequencies. Ninety percent of the deposits had average Cr_2O_3 grades greater than 40 percent and ten percent had production grades greater than 50 percent (figure 10). The rarity of large deposits is indicated by the fact that fifty percent of the deposits produced less than 40 tons and only ten percent produced more than 560 tons (figure 11).

Because podiform chromite deposits are small and most exploration for them consists of prospecting for surface outcrop or float, it is likely that undiscovered deposits remain below the surface in the Medford quadrangle. First, the contorted nature of the deposits and their host rocks suggests that extensions near known deposits could exist. Second, aeromagnetic data suggest that large sheets of ultramafic rocks exist at shallow depth. Third, there is no reason to believe that the density of deposits exposed on the surface is not representative of the density of deposits at depth and, in fact, there is some evidence the densities are about the same (Page and Johnson, 1977). Thus there is a good chance of numerous undiscovered podiform chromite deposits below the surface in the Medford quadrangle. Only small amounts of chromite could be expected to be produced from these deposits, however, because of a lack of a cheap and effective way to find the concealed deposits plus the deposits' typically small sizes.

Other Metal-bearing Deposits

A variety of deposits or occurrences containing metals such as molybdenum, manganese, antimony, tungsten, or nickel have been found in the Medford quadrangle; some of these deposits yielded small quantities of ore. Most are small and are not of economic interest. A few of the following deposits or occurrences might warrant further examination.

Several deposits in Secs. 14, 23, 24, 25, and 27, T.40 S., R.4 W. have produced small amounts of antimony. According to Wagner and Ramp (1969, p. 98), the area is incompletely explored and additional amounts of mineable antimony may be present. Schafer (1956, p. 101) reported two occurrences of uranium in rhyolite tuff that have not been thoroughly explored. A nickel sulfide deposit containing 1.3 percent nickel, 1.1 percent copper, 0.07 percent cobalt, and 1 gram/ton platinum has been explored in Sec. 19, T.34 S., R.40 W. (Ramp, 1978, p. 57).

Coal

Coal is the compressed and altered residue of plants that grew in swamps. Coal is found interbedded with sandstone and shale and commonly contains varying amounts of sand, silt, and mud that form the bulk of the ash when coal is burned. Ash content, along with sulfur and other deleterious constituents, are used to classify coal into grades. Fixed carbon and heat content are used to classify coal by rank--higher rank coals tend to have higher heat contents and are generally more desirable.

The Eden Ridge and less known Squaw Ridge coal fields are delineated as tract C1 on sheet 2. Six coal beds in Eocene shales and sandstones are known in the Eden Ridge field. One, the Carter bed, averages 6.1 feet thick and 6,900 Btu per pound. Another bed, the Anderson, averages 6.5 feet thick and 8,350 Btu per pound--both beds have low moisture, low sulfur, and high ash contents (Brownfield, 1981, p. 63). The other beds are thinner. According to Brownfield (1981, p. 63), a local utility determined that the two thickest coal beds in the Eden Ridge field contain resources of about 50 million tons. The adjacent Squaw Basin area has had considerable faulting and tilting. Coal beds of Squaw Basin area are not well explored, but may be extensive (Baldwin and others, 1973).

Minor amounts of Eocene subbituminous coal have been recovered for local use from the Rogue River field which is delineated as tract C2 on sheet 2. The coal occurs in sandstones and shales that have been covered by extensive lava flows. Although locally up to eight feet thick in the northern part of the field, average thickness is less than one foot. In addition, the thicker beds typically contain numerous clay and sandstone partings (Mason and Erwin, 1955). The coals are not well explored but appear to have low rank, high ash content, and to be too thin to mine except for local use.

Oil Shale

Oil shale is a fine-grained sedimentary rock containing organic matter that has the property of yielding substantial amounts of oil when treated with heat or chemicals. The most important deposits in the U.S. formed in Eocene lake beds in Colorado, Utah, and Wyoming. Quality is measured in gallons of oil yielded per ton of shale processed; low grade is considered to be less than 10 gallons per ton, marginal grade between 10 and 25 gallons per ton, and high grade over 25 gallons per ton.

Oregon's only explored oil shale deposit is located near Shale City in tract C3 of sheet 2. The shale is interbedded with Miocene to Oligocene

volcanic tuffs which were deposited in a lake bed. Newton (1969) reported that the Shale City deposit contained 150,000 tons of shale yielding 36 gallons per ton. Several attempts at mining the deposit for oil have been commercial failures. Recently some of the rocks at the oil shale deposit have been mined as a feed supplement for poultry.

Other shales that may also be rich in organic matter are known to occur in the volcanic rocks of the Western Cascade Range in the Medford quadrangle. These lake sediments are too small in areal extent to show on an 1:250,000 scale map, but some of the lake sediments are indicated on 1:62,500 scale geologic maps being prepared.

Petroleum and Natural Gas

In order for large accumulations of petroleum or gas to occur, the following geologic conditions must exist: (1) source beds rich in organic matter; (2)permeable ground permitting migration from source beds to reservoir beds; (3) suitable reservoir beds; (4) a seal or cap rock to prevent escape to the surface; and (5) suitable traps within reservoir beds so that accumulations can form. Large oil pools exist only in thick successions of marine strata. Some small oil pools and some large gas fields are found in or near nonmarine sediments that satisfy the above prerequisites.

In the Medford quadrangle, no thick successions of marine strata rich in organic matter are known. The only recognized possible source beds are those related to the coal and oil shale deposits discussed previously. Suitable reservoir rocks may exist in sandstones near the Eden Ridge coal beds and volcanic cap rocks may exist above some oil shales or coal beds in the Western Cascade Range. For much of the Medford quadrangle, evidence suggests that some of the prerequisites are not met; for other parts of the quadrangle, data are inadquate to determine whether prerequisites are met. Scant drilling to date has resulted in a small gas flow and an unconfirmed report of oil and gas shows (Wagner and Newton, 1969).

Geothermal Systems

The principal requirements for geothermal systems are a locally steep geothermal gradient (rate of earth's heat flow) caused by nearby magmatic activity or deep faults in tectonically active parts of the earth's crust and a system of reservoir rocks and seals that permit circulation of hot water and steam, yet prevent their escape at the surface. Many geothermal systems are associated with felsic volcanic centers in very young volcanic fields (Smith and Shaw,1975).

Mapping indicates that outside of Crater Lake National Park there are no young suitably silicic volcanic rocks expressed at the surface. Geologic mapping and aeromagnetic and gravity surveys likewise give no indication of buried silicic magma bodies of sufficient size to serve as sources of heat for geothermal systems. No young normal faults with major displacement are present.

Nonmetallic Commodities

Large quantities of limestone, sand, gravel, and rock suitable for various industrial and construction purposes exist in the quadrangle. A biotite granite near Ashland was quarried for momument and building stone; the quarry reportedly closed because of inadequate financing (Oregon Dept. Geology and Mineral Industries, 1943, p.22). High quality limestone has been mined at several localities in the quadrangle; large tonnages remain according to Ramp and Peterson (1979, p. 38). Sand, gravel, and rock are widespread in the quadrangle; their production is limited by local demand and other uses of the land.

References

American Metal Market, 1981, Mining new ground--planned laterite nickel mine would also yield cobalt and chromium: June 26, 1981, v. 89, no. 123, p. 10A.

_____, 1981 Baretta lifts ore reserves: September 18, 1981, v. 84, no. 181, p. 8.

Baldwin, E.M., Beaulieu, J.D., Ramp, L., Gray, J.J., Newton, V.C., Jr., and Mason, R.S., 1973, Geology and mineral resources of Coos County, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 80, 82 p.

Blakely, R.J., 1982, Compilation of aeromagnetic data in the Medford 2° quadrangle: U.S. Geological Survey Miscellaneous Field Studies Map MF-1383-B, sheet 1.

_____1982, Interpretation of aeromagnetic data from the Medford 2° quadrangle: U.S. Geological Miscellaneous Field Studies Map MF-1383-B, sheet 2.

Blakely, R.J., Page, N.J, Senior, Lisa, Ryan, H.F., and Gray, Floyd, 1982, Maps showing aeromagnetic data and interpretation for the Kalmiopsis Wilderness area, southwestern Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-1240-D, scale 1:62,500.

Blakely, R.J., and Senior, Lisa, 1982, Map showing aeromagnetic data and interpretation of the Wild Rogue Wilderness Area, Coos, Curry, and Douglas Counties, Oregon:U.S.Geological Survey Miscellaneous Field Studies Map MF-1381-E.

Boyle, R.W., 1974, Elemental associations in mineral deposits and indicator elements of interest in geochemical prospecting (revised): Canadian Geological Survey Paper 74-45, 40 p.

Brownfield, M.E., 1981, Oregon's coal and its economic future: Oregon Geology, v. 43, no. 5, p. 59-67.

Calkins, J.L., Keefer, E.K., Ofsharick, R.A., Mason, G.T., Tracy, Patricia, and Atkins, Mary, 1978, Description of CRIB, the GIPSY retrieval mechanism and the interface to the General Electric MARK III Service: U.S. Geological Survey Circular 755-Ak, 49 p.

Callaghan, Eugene, and Buddington, A.F., 1938, Metalliferous mineral deposits of the Cascade Range in Oregon: U.S. Geological Survey Bulletin 893, 141 p.

Dunn, R.L., 1894, Auriferous conglomerate in California: California Mining Bureau, 12th Report State Mineralogist, p. 459-471.

Hotz, P.E., 1971, Geology of lode gold districts in the Klamath Mountains, Californian and Oregon: U.S. Geological Survey Bulletin 1290, 91 p.

Koski, R.A., and Derkey, R.E., 1981, Massive sulfide deposits in oceancrust and island-arc terrains of southwestern Oregon: Oregon Geology, v. 43, no. 9, p. 119-125.

Mason, R.S., and Erwin, M.I., 1955, Coal resources of Oregon: U.S. Geological Survey Circular 362, 7 p.

Newton, V.C., Jr., 1969, Oil shale, in Mineral and water resources of Oregon: Oregon Department of Geology and Mineral Industries Bulletin 64, p. 278-280.

Oregon Department of Geology and Mineral Industries, 1943, Oregon metal mines handbook (Jackson County): Oregon Department of Geology and Mineral Industries Bulletin 14-C, v. 2, Sec. 2, 208 p.

Page, N.J, Blakely, R.J., and Cannon, J.K., 1982, Map showing geological, geophysical, and geochemical characteristics of granitic plutons in the Medford 1° x 2° quadrangle, southwestern Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-1383-E.

Page, N.J, and Johnson, M.G., 1977, Chromite resources of the podiform chromite deposits and exploration for concealed chromite deposits in the Medford-Coos Bay quadrangles, southwestern Oregon: U.S. Geological Survey open-file report 77-656, 14 p.

_____, 1982, Map showing characteristics of lode gold in Medford 1° x 2° quadrangle, southwestern Oregon: U.S Geological Survey Miscellaneous Field Studies Map MF-1383-D.

Page, N.J, Johnson, M.G., Haffty, Joseph, and Ramp, Len, 1975, Occurrence of platinum group metals in ultramafic rocks of the Medford-Coos Bay 2° quadrangle, southwestern Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-694.

Page, N.J, Miller, M.S., Grimes, D.J., Leinz, R.W., Blakely, R.J., Lipin, Bruce, Foose, M.P., and Gray, Floyd, 1982, Mineral resource assessment map of the Kalmiopsis Wilderness area: U.S. Geological Survey Miscellaneous Field Studies Map MF-1240-E,scale 1:62,500.

Ramp, Len, 1978, Investigations of nickel in Oregon: Oregon Department of Geology and Mineral Industries Miscellaneous Paper 20, 68 p.

Ramp, Len, and Peterson, N.V., 1979, Geology and mineral resources of Josephine County, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 100, 45 P.

Schafer, Max, 1956, Uranium prospecting in Oregon: Oregon Department of Geology and Mineral Industries, The Ore Bin, v. 18, no 12, p. 101-107.

Singer, D.A., 1975, Mineral resource models and the Alaskan Mineral Resource Assessment Program: in Vogely, W.A., ed., Mineral Material Modeling, Resources for the Future, Johns Hopkins Press, Baltimore, p. 370-382.

Smith, J.G., Page, N.J, Johnson, M.G., Moring, B.C., Gray, Floyd, 1982, Preliminary geologic map of the Medford 1° x 2° quadrangle, Oregon and California: U.S. Geological Survey Open-File Report 82-955.

Smith, R.L., and Shaw, H.R., 1975, Igneous-related geothermal systems: in White, D.E., and Williams, D.L., eds., Assessment of geothermal resources of the United States--1975: U.S. Geological Survey Circ. 726, p. 58-83.

Thayer, T.P., 1960, Some critical differences between alpine-type and stratiform peridotite-gabbro complexes: Internat. Geol. Congr. 21st., Copenhagen, pt. 13, p. 247-259.

Wagner, H.C., Newton, V.C., Jr., 1969, Petroleum and natural gas, in Mineral and water resources of Oregon: Oregon Department of Geology and Mineral Industries Bulletin 64, p. 280-298.

Wagner, N.S., and Ramp, Len, 1969, Antimony, in Mineral and water resources of Oregon: Oregon Department of Geology and Mineral Industries Bulletin 64, p. 93-98.