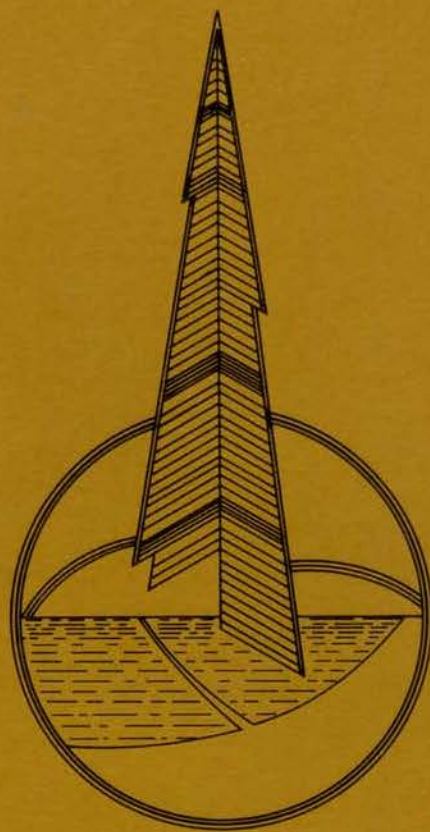


GEOLOGY & MINERAL RESOURCES
of
DOUGLAS COUNTY, OREGON



1972

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
R. E. CORCORAN, STATE GEOLOGIST

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
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of
DOUGLAS COUNTY, OREGON

Len Ramp
Oregon Department of Geology and Mineral Industries

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Douglas County



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FOREWORD

Douglas County has a history of mining operations extending back for more than 100 years. During this long time interval there is recorded production of gold, silver, copper, lead, zinc, mercury, and nickel, plus lesser amounts of other metalliferous ores. The only nickel mine in the United States, owned by The Hanna Mining Co., is located on Nickel Mountain, approximately 20 miles south of Roseburg. The mine and smelter have operated continuously since 1954 and provide year-round employment for more than 500 people. Sand and gravel production keeps pace with the local construction needs. It is estimated that the total value of all raw minerals produced in Douglas County during 1972 will exceed \$10,000,000.

This bulletin is the first in a series of reports to be published by the Department that will describe the general geology of each county in the State and provide basic information on mineral resources. It is particularly fitting that the first of the series should be Douglas County since it is one of the mineral leaders in the state and appears to have considerable potential for new discoveries during the coming years.

R. E. Corcoran
Oregon State Geologist

October 1972

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GEOLOGY AND MINERAL RESOURCES OF DOUGLAS COUNTY, OREGON

By

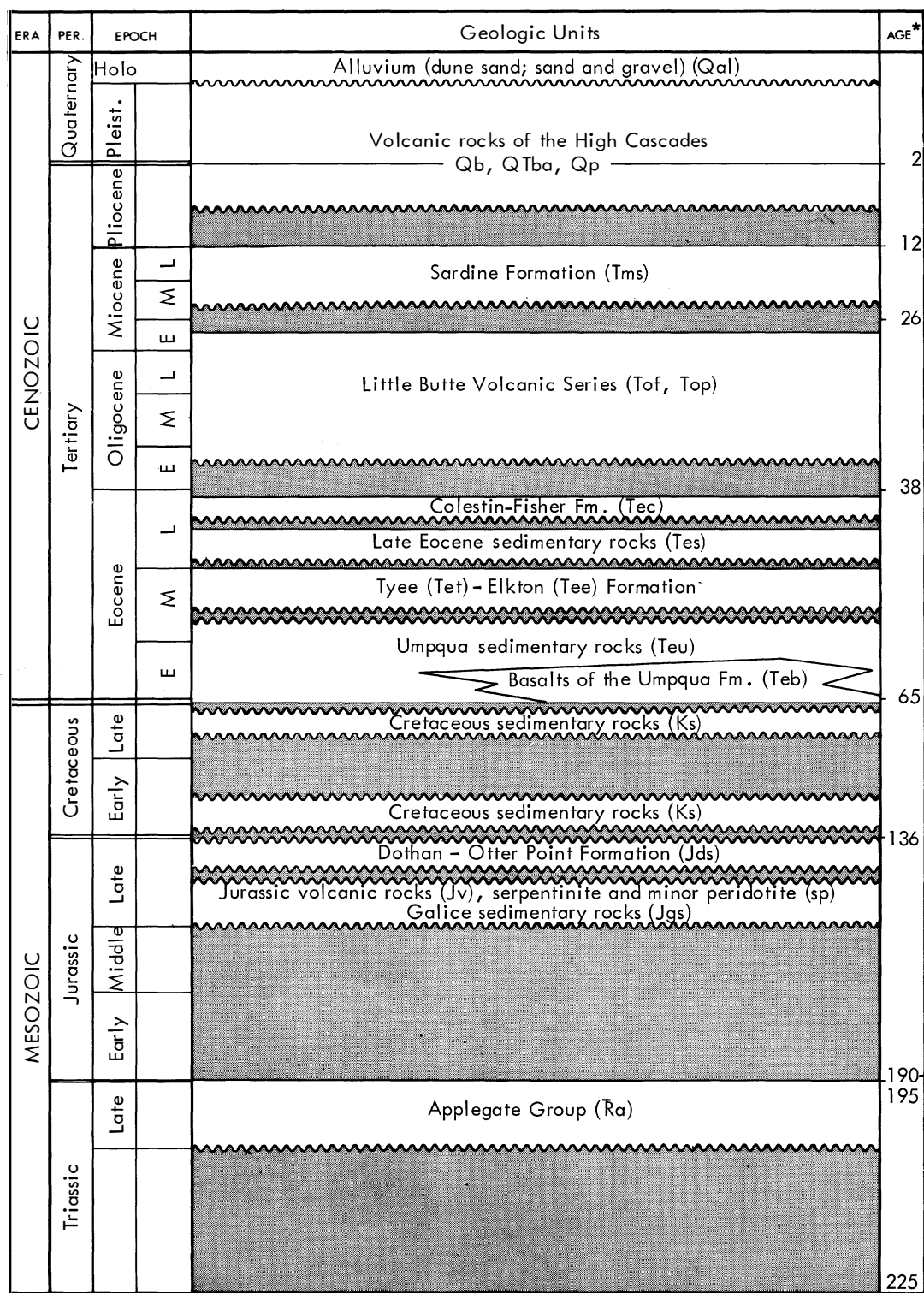
Len Ramp

INTRODUCTION

This report gathers under one cover all the pertinent information on the geology and mineral resources of Douglas County. Its purpose is to assist the county in evaluating its mineral resource potential and to furnish information that will aid in prospecting for and developing these resources.

Data on geology and mineral resources were gathered from all known available published and unpublished reports, which are listed alphabetically under references at the end of this report. Published reports include mainly those of the Department of Geology and Mineral Industries, the U.S. Bureau of Mines, and the U.S. Geological Survey. Unpublished reports include those from the Department's mine files, master's theses and doctoral dissertations, and a few county records and personal references. Department mine files contain additional information on ownership and a few mine maps; most of these are available in the Department's Grants Pass field office for the cost of copying.

Chapters on sand and gravel, crushed rock, and building stone were prepared by N. V. Peterson. The chapter on oil and gas potential was prepared by V. C. Newton and John D. Beaulieu. John Beaulieu compiled the geologic map and the stratigraphic column and collaborated in the chapter describing geology. Editing was done by Margaret L. Steere and Carol S. Brookhyser; camera copy was typed by Ruth Pavlat. Cartography was by S. R. Renoud and M. E. Lawson. Information on production and operations of the Hanna Nickel mine and smelter were furnished by E. J. Maney, General Manager, Hanna Mining Co., Riddle, Oregon.



* Millions of years

Figure 2. Stratigraphic and time chart for Douglas County.

GENERAL GEOLOGY

Geology of Geomorphic Provinces

Within Douglas County are located parts of four distinctive geomorphic provinces recognized in western Oregon (see inset on Geologic Map, Figure 1). They include the Klamath Mountains, the Coast Range, the Western Cascades, and the High Cascades. Each province is characterized by a more or less unique suite of rocks, which in turn is responsible for the particular topographic expression and mineral resources of the area.

The oldest rocks in the county are of Mesozoic age (Figure 2) and are restricted to the rugged Klamath Mountains Province in the southern part of the county. They consist primarily of marine sediments and volcanic rocks, and have a composite thickness of about 6 miles. Tertiary rocks underlying the more gently deformed Coast Range Province consist of a composite thickness of 15,000 to 20,000 feet of submarine basalt and rhythmically bedded sandstone and siltstone. Deltaic deposits are present locally. Dune fields of Holocene and late Pleistocene age overlie the older marine strata along the coast.

The Western Cascades Province is composed of late Eocene andesitic breccias and fluvial sedimentary rocks, middle Tertiary silicic ash-flow tuffs and subordinate flow rock of andesitic to basaltic composition, and late Miocene andesitic flow rock. Total composite thickness for the units probably does not exceed 20,000 feet. The geologically youthful High Cascades Province to the east consists of a series of Plio-Pleistocene flows of basalt and basaltic andesite spotted with several late Pleistocene volcanic peaks and cinder cones. The province is mantled locally in the south with Holocene ash and pumice deposits.

Klamath Mountains Province

The Klamath Mountains Province is an area of complex geology and rugged topography. Major streams include Cow Creek and other tributaries of the South Umpqua River. Cultivation is restricted to the lowlands bordering the rivers. Mining has yielded a variety of useful metals including gold, silver, copper, chromite, nickel, mercury, and zinc. Industrial minerals and potential non-metallic ores in the province include sand, gravel and crushed rock, building stone, barite, limestone, asbestos, talc, olivine, and semiprecious gem rock.

Applegate Group (Ra): The Applegate Group was defined by Wells and others (1949) for exposures south of the county line in the Applegate River Drainage. It is equivalent to the May Creek Schist of Diller and Kay (1924). The Applegate Group consists of several tens of thousands of feet of amphibolite, slate, slaty siltstone, chlorite schist, quartz-mica schist, and quartzite representing metamorphosed sandstone, shale, and volcanic rock. The gneissic amphibolites appear to have been derived mainly from volcanic rocks and possibly in part from gabbros related to the ultramafic rocks associated with the unit.

The Applegate Group underlies approximately 30 square miles of terrain in south central Douglas County and extends southward into Jackson County. It is intimately folded with serpentinites and peridotites and is intruded by quartz diorite of Mesozoic age. To the west the Applegate Group is thrust over a series of younger, generally less metamorphosed, strata here assigned to the Jurassic volcanics (Jv) and the Galice sedimentary rock unit (Jgs).

Based on fossils collected by Diller and Kay (1909) and re-examined by Wells and others (1949), the Applegate is believed to be Late Triassic in age. Diller (1898) erroneously interpreted a Paleozoic age.

Metaliferous mineral deposits occurring in the Applegate Group include gold, silver, copper, zinc, mercury, and manganese. Potential industrial mineral resources from the formation include talc,

mica, garnet, and building stone.

Jurassic volcanic rocks (Jv): All the mappable volcanic rocks of Jurassic age in Douglas County are included in this unit. As such it is composed of rocks assigned to the Rogue Formation by Wells and Walker (1953), the volcanic rocks of the Galice Formation by Wells and Peck (1961), and pillow basalts of the Dothan Formation by Wells and Peck (1961). Lumping of the Jurassic volcanic rocks into one unit is a convenient treatment based on the similarity of rock type and in no way implies precise age equivalence or uniformity of origin.

The Jurassic volcanic rocks form a discontinuous set of exposures in south central Douglas County which varies in thickness from 1 mile to 10 miles and trends northeasterly. A small additional exposure is situated in the extreme southwestern corner of the county. Many smaller bodies of volcanic rock of Jurassic age are too small to be mapped and are included in the other Jurassic units.

The Jurassic volcanic rock consists of thick, greenish-gray, altered andesite and basalt flows and flow breccias assigned to the Galice Formation, and light gray to greenish gray lenses of porphyritic andesite and dacite flow rock, tuff, and flow breccia assigned to the Rogue Formation by Wells and Walker (1953). Some of the massive greenstone exposed in cuts along the freeway in the southern part of the county appears to be altered pillow lavas. A few lenticular bodies of serpentinite and small dikes and stocks of quartz diorite intrude rocks assigned to the Jurassic volcanic unit.

Rocks assigned to the Galice and Rogue Formations by other authors are dated as Late Jurassic and rocks assigned to the Dothan Formation are believed to be Latest Jurassic in age on the basis of recent fossil discoveries (Ramp, 1969). Intrusive rocks of the Late Jurassic Nevadan Orogeny cut the Galice and Rogue Formations, but are absent in the Dothan Formation.

Mineralization is largely restricted to the volcanic rocks in the vicinity of Canyon Creek and Silver Peak, where gold, silver, copper, and zinc have been mined. Some of the more massive greenstones constitute excellent sources of road rock for subgrade and surfacing aggregate.

Galice sedimentary rocks (Jgs): The Galice Formation was defined by Diller (1907) to include thick interbeds of andesitic flows and agglomerates and thick sections of marine sedimentary rock. The volcanic rocks are assigned to the Jurassic volcanic rock unit and the sedimentary strata are termed Galice sedimentary rock in this report. Diller and Kay (1924) mapped the sediments separately from the volcanic rocks. Wells and others (1949) assigned the volcanic rocks to the Galice Formation, and Wells and Peck (1961) assigned some of the volcanic rocks to the Rogue Formation.

The sedimentary rocks of the Galice Formation are exposed in south-central Douglas County as a northeasterly trending band which extends into the county from the south and is terminated on the north by a prominent east-west fault immediately south of Days Creek. The rocks consist primarily of dark slaty siltstone with lesser amounts of interbedded graywacke sandstone and occasional lenses of conglomerate.

The Galice sedimentary rocks are Late Jurassic in age, but they predate the Dothan Formation. Koch (1966) reports the discovery of *Buchia concentrica*, a late Oxfordian to early Kimmeridgian pelecypod, within beds assigned to the unit. Intrusive bodies of the Late Jurassic Nevadan Orogeny cut the Galice sedimentary rocks in places, indicating that the unit predates at least the later phases of the orogeny.

Non-metallic industrial mineral potential of the Galice sedimentary rocks is confined to a few select zones of slaty rock suitable for use as patio stones, and clay suitable for use as brick and tile. The clay is derived from extensive weathering of some of the more argillaceous sedimentary interbeds.

Dothan-Otter Point Formation (Jds): Rocks of this unit include strata assigned to the Dothan Formation of Diller (1907) and equivalent to rocks assigned to the Otter Point Formation by Koch (1966). Although they differ somewhat in lithology, the Otter Point Formation and Dothan Formation are believed to be contemporaneous units. Together they form a discontinuous northeasterly trending set of exposures that extends from the southwestern corner of the county to the center of the county east of Roseburg.

Rocks of Dothan type are restricted to the area south of the major east-west fault which passes immediately south of Canyonville. They consist primarily of massive to thickly bedded graywacke sandstone and thin interbeds of dark mudstone. Lenticular bodies of thin-bedded chert and pillow basalt are

present in places. The larger bodies of volcanic rock are included in the Jurassic volcanic rock unit (Jv) of this report.

The Otter Point Formation is exposed north of the major east-west fault and exhibits a somewhat more diverse lithology than does the Dothan Formation. It consists of sheared graywacke, siltstone, greenstone, limestone lenses, blueschist pods, and chert. The unit is highly disordered and was extensively deformed during or shortly following deposition. A few small bodies of highly sheared serpentinite have apparently become involved in this tectonism.

Specimens of *Buchia piochii* recovered from both the Dothan Formation (Ramp 1969) and the Otter Point Formation are indicative of a Tithonian (Latest Jurassic) age. The rocks postdate the Nevadan Orogeny and none of the exposures are intruded by igneous bodies associated with that period of tectonism.

Copper mineralization occurs in the altered volcanic rocks near the head of Rice Creek and near Bolivar Mountain just outside of Douglas County. The bedded cherts have been considered as a source for roofing granules, and the massive sandstones and altered pillow basalts have been used on a limited basis for road aggregate. Pods of limestone of uncertain origin (Whitsett limestone lentils of Diller, 1898) associated with the Otter Point rocks have been mined to a limited extent.

Cretaceous sedimentary rocks (Ks): This unit includes all the conglomerate, sandstone, and siltstone in the county for which a Cretaceous age is interpreted. The unit includes strata assigned elsewhere to the Riddle Formation (Imlay and others, 1959), the Day Creek Formation (Imlay and others, 1959), and the Late Cretaceous sediments. Much of the strata correspond to the upper part of the Myrtle Formation as originally defined by Diller, (1898). Exposures include the large area surrounding Riddle, Days Creek and Myrtle Creek, a small exposure in the extreme southwestern part of the county, and small exposures south of Tenmile Creek between Roseburg and Camas Valley.

The stratigraphically lowest part of the unit (Riddle Formation) consists of massive chert pebble conglomerate overlain by medium-bedded dirty-gray lithic sandstone, siltstone, and conglomerate. A few small limestone lentils, possibly equivalent to some of the Whitsett limestone lentils of Diller (1898), are present within the Riddle Formation.

Overlying the Riddle beds with probable conformity are the beds assigned to the Days Creek Formation by Imlay and others (1959). They consist of a lower, relatively fine-grained, dark-gray, sandy siltstone and a subordinate light-gray, fine-grained sandstone overlain by thick- to medium-bedded, fine- to medium-grained gray sandstone. Overall these beds are thicker and contain more sand than those of the underlying Riddle Formation. Both the Riddle and Days Creek Formations are Early Cretaceous.

Small exposures of Late Cretaceous marine sedimentary rock of local extent consist of conglomerate and pebbly massive grayish-green to brown sandstone and dark siltstone. The beds are less deformed than the underlying strata and correlate in part with the lower Hornbrook Formation in Northern California.

Thin-bedded greenish-gray flagstone of the Riddle Formation exposed along Cow Creek west of Riddle has been quarried for building stone. A small outcrop of Late Cretaceous pebbly sandstone overlying the Days Creek Formation west of the community of Days Creek has been quarried for roadfill ballast. No valuable metallic minerals are known to occur in the Cretaceous sedimentary rocks.

Igneous rocks (ig): Several large bodies of granitic-textured igneous rocks intrude the pre-Nevadan units in the mapped area. The two largest intrusive masses are situated in the drainage areas of Myrtle Creek in the central part of the county and of Applegate and Coffee Creeks in the south-central part of the county. Smaller, unmapped bodies of similar rock are genetically related to the larger bodies although the map scale requires that they be treated as part of the units which they intrude.

The igneous rocks postdate the Galice, Rogue, and Applegate Formations and much of the Jurassic volcanic rock unit of this report. They are interpreted to have been formed during the Late Jurassic Nevadan Orogeny. Lithologically they range in composition from gabbro to granite, and texturally they range from fine-grained rocks to pegmatites. They constitute the heat source for fluids which mineralized the older rocks of the Klamath Mountains Province.

Serpentinite and minor peridotite (sp): Ultramafic* bodies in the county are limited to the pre-Tertiary terrain and form two discontinuous bands which extend northeasterly through the central and southern parts of Douglas County. The northern body extends from the Cow Creek area about 10 miles

* See glossary.

west of Riddle to the Peel area on Little River. The southern exposures extend from the headwaters of Quines Creek to the Tiller area.

Serpentinite is a dark greenish rock composed of minerals of the serpentine group which include antigorite, chrysotile, and lizardite. The minerals are hydrated derivatives of parent ultramafic rocks which include peridotite (harzburgite) and dunite. Relict crystals and small bodies of these rocks are preserved locally within the serpentinite masses.

The age and origin of these ultramafic rocks are difficult to define since they may have been emplaced over an extended period of time. Presumably the serpentinite in Douglas County represents part of the Mesozoic upper mantle which emerged along an ancestral sea floor rise and was rafted eastward to become incorporated into the continent. (Coleman, 1971) The actual time and mode of alteration of the parent ultramafic rocks to form serpentinite is uncertain. In addition, some of the serpentinite was tectonically remobilized along steep faults after its initial emplacement, further obscuring the critical features regarding its origin.

The serpentinite and associated ultramafic rocks are important host rocks for several mineral resources including chromite, nickel, gold, silver, copper, and platinum. Industrial minerals such as asbestos, talc, and olivine also may be recovered locally.

Coast Range Province

The Coast Range Province consists of Tertiary submarine lavas and marine sediments. The region is less deformed than the Klamath Mountains Province and exhibits lower relief. Nonetheless, the terrain is rugged in places owing to the resistance to erosion of many of the sandstone interbeds and small intrusive bodies. Major peaks include Bear Mountain (3,178), Old Blue (2,536), and Roman Nose Mountain (2,856). Mineral wealth of the area is limited to a few unworked deposits of impure coal, localized quarry rock, and sand and gravel.

Basalt of the Umpqua Formation (Teb): The Umpqua Formation was defined by Diller (1898) in mapping of the Roseburg quadrangle. The formation consists of a thick series of rhythmically bedded sandstones and siltstones underlain by a basement of submarine basalt. The basalt is here treated as an individual unit and is termed "basalt of the Umpqua Formation (Teb)."

Basalt low in the Umpqua section is exposed at Mt. Yoncalla and Dickinson Mountain, and is extensively exposed in the area surrounding and extending northeast from Roseburg. The elongate bodies occupy the axes of northeast trending anticlines and are faulted locally. The basalt is commonly pillowed and fine grained. Compositionally the basalts are calc-alkalic and range in composition from tholeiitic to olivine-rich. They are comparable to the basalts of the early Eocene Siletz River Volcanics to the north and to those which make up the floor of the present day Pacific Ocean.

The basalts are overlain conformably by the sedimentary rocks of the Umpqua Formation. To the west in Coos County, Paleocene foraminifera have been recovered from sedimentary rocks interbedded with the basalt. Locally Cretaceous strata are interpreted to conformably underlie the basalt in Coos County (Baldwin and Beaulieu, in preparation).

Umpqua sedimentary rocks (Teu): Sedimentary rocks within the Umpqua Formation consist of three rhythmically bedded sequences of sandstone and siltstone, each of which is underlain locally by basal conglomerate or pebbly sandstone (Baldwin, 1965). The rocks form a 10- to 20-mile-wide north-easterly trending band from the southwestern to north central parts of the county.

On the basis of extensive field mapping the sedimentary rocks were subdivided into three unconformity-bounded sequences by Baldwin (1965), which he termed the lower member, middle member, and upper member of the Umpqua Formation. Strata of the lower member are conformable over the basalts of the Umpqua Formation and are much more deformed than the strata of the two younger sequences. Although a composite thickness of 15,000 feet is estimated for the three sequences, the thickness of the rocks at any one particular locality is considerably less than this.

Based on fossils and stratigraphic position the three sequences taken as a whole range in age from early Eocene to middle Eocene.

The lithology of the three units is remarkably uniform and the distinction between them is based

primarily on detailed stratigraphic relationships. The three sequences are treated as one unit (Teu) in this report and on the geologic map.

In the Roseburg and Glide quadrangles basalt of the lower member of the Umpqua Formation is thrust over sedimentary strata of the lower member of the Umpqua Formation along the northeast-trending Bonanza fault. Significant quicksilver mineralization occurred along this fault, probably in late Eocene time or later (Baldwin, 1964). The Bonanza and Nonpareil mines and other quicksilver prospects are situated on this structure.

A few sandstone quarries are located within the lower part of the Umpqua Formation in the vicinities of Oakland and Sutherlin. Also, a few clay pits are situated near Roseburg. Sand and gravel is quarried locally from the lower part of the middle member of the Umpqua Formation. In the Olalla area small amounts of placer gold in present-day streams apparently originated from the lower conglomerate of the middle member. Small quantities of coal are reported in the Glide area by Diller (1898) and in the Melrose and Camas Valley area.

Tyee-Elkton Formation (Tet,Tee): The Tyee Formation was described and defined by Diller (1898) in the Roseburg quadrangle. Baldwin (1961) assigned the finer-grained siltstones which comprise the upper parts of the section to the Elkton siltstone member (Tee) of the Tyee Formation. Subsequently Thoms (1965) and Bird (1967) proposed elevating the unit to formational status in their respective theses. Lovell (1969) treats the unit as a formation. To date, however, no formal definition of the Elkton siltstone as a formation has been forthcoming.

The Tyee-Elkton unit blankets much of the northwestern part of Douglas County. The Tyee Formation (Tet) is composed of flat-lying to gently folded, rhythmically bedded, buff to greenish-gray sandstone and dark siltstone. The sandstone interbeds range in thickness from a few inches to 10 feet or more and characteristically form bold outcrops and cliffs. Tyee Ridge bordering Lookingglass Valley is composed of sandstone interbeds of the Tyee Formation. In general the sandstone is medium- to coarse-grained and micaceous. Total thickness for the Tyee-Elkton unit is approximately 7,000 feet.

Upsection the Tyee Formation grades into finer-grained siltstone in which sandstone interbeds are rare or lacking. Most exposures are restricted to the area southwest of the Umpqua River near the community of Elkton and are treated as the Elkton siltstone member of the Tyee Formation.

The Tyee Formation contains important coal beds in the Eden Ridge syncline in Coos County and some coal has also been found in the formation farther to the north in the Elkton area of Douglas County. Large blocks of massive Tyee sandstone have been quarried along the north bank of the Umpqua River east of Reedsport for experimental use as jetty rock.

Late Eocene sedimentary rocks (Tes): Assigned to this unit are exposures of the Spencer Formation in the north-central part of Douglas County, exposures of Coaledo Formation along the coast, and exposures which Baldwin (1961) termed the Coaledo(?) in west-central Douglas County overlying the Elkton siltstone member of the Tyee Formation. The Spencer Formation was defined by Turner (1938) and the Coaledo Formation was defined by Diller (1899).

The Spencer Formation consists of a massive, arkosic, micaceous, semi-friable sandstone with interbeds of light-colored, fissile siltstone and fine tuff. Locally the formation contains thin beds of impure coal and pebbly conglomerate. The Spencer Formation is only about 600 feet thick in the Comstock area, but thickens to 2,000 feet north of Douglas County in the Eugene area.

The Spencer Formation overlies the Tyee Formation unconformably and was probably derived in part from that unit. The lower contact marks the boundary between the Coast Range Province and the Western Cascades Province in northern Douglas County.

Exposures of Coaledo Formation along the coast are limited in extent and represent the northernmost tip of larger exposures of that unit to the south. In Coos County the Coaledo Formation consists of several thousand feet of marine arkosic sandstone separated by a prominent middle member of siltstone. In Coos County estimated reserves of recoverable coal exceed 50 million tons.

Beds assigned to the Coaledo(?) by Baldwin (1961) in west-central Douglas County and adjacent Coos County consist of micaceous, locally coal-bearing, deltaic sandstone with a total thickness of approximately 1,200 feet. The unit overlies the Elkton siltstone conformably in places and with slight angular unconformity in others. It contains megafossils characteristically found in the Tyee Formation.

Tertiary intrusives (Ti): Dikes and sills of gabbro and basalt of probable Oligocene age intrude the Tyee Formation in the northern part of the county at Roman Nose Mountain, Baldy Mountain, and Mount Grayback. Other exposures include those northeast of Sutherlin and at Ben More Mountain, where a sill approximately 400 feet thick is exposed within the Tyee Formation. Several miles northeast of Ben More Mountain a 100-foot-thick sill is exposed.

Two dikes too small to be indicated on the map cut the Umpqua Formation immediately west of Scotts Valley in northeastern Douglas County. They are olivine-bearing and are thought to be genetically related to the basaltic volcanism of the Umpqua Formation (Teb).

Dikes cutting the Tyee Formation are composed of porphyritic basalt which shows affinities to the volcanic rocks of the Fisher Formation. They are probably late Eocene in age. Some which resemble intrusives within the Fisher Formation may be as young as late Miocene.

Tertiary intrusive rock is of use as road ballast and in projects such as public highway and logging road construction where resistant crushed rock is needed.

Quaternary alluvium (Qal, Qd): Alluvial deposits cover the valley floors of parts of many of the major streams in the Coast Range Province. Major deposits of Quaternary alluvium include those along the Umpqua, North Umpqua, and South Umpqua Rivers in the Roseburg and Elkton areas. The flat bottom lands represent local flood-plain deposits which were formed as the stream established a series of local base levels while cutting through barriers in the more resistant parts of the Coast Range to the west. The alluvium is composed of silts and pebbly sands with lenses of gravel in places. At present most of the streams are dissecting the alluvial fill. Locally terraces are preserved along the sides of the valleys as at Reedsport. The flatland is valuable from a farming standpoint and in places may contain economic deposits of sand and gravel.

Dune fields are well developed along the coast particularly south of the Umpqua River where they extend inland as much as $2\frac{1}{2}$ miles. In that area Clear Lake and Eel Lake were formed when migrating sand blocked the ancestral mouth of Tenmile Creek.

Western Cascades Province

The Western Cascades Province is characterized by a rugged topography having irregular ridges and deep narrow valleys. The region is underlain by a variety of late Eocene through late Miocene volcanic and subordinate fluvial sedimentary rocks. The higher peaks range upward to 4,000 or 5,000 feet in elevation. Small intrusions are scattered throughout the area and localized mineral deposits include cinnabar, antimony, gold, silver, copper, and silica.

Colestín-Fisher Formation (Tec): This unit includes late Eocene volcanic rocks equivalent to the Colestín Formation of Wells (1956) in Jackson County and the Fisher Formation of Hoover (1963) in the Anlauf quadrangle. The Fisher Formation was originally defined in the area south of Eugene by Schenck (1927). Both formations are nonmarine in origin. Together they form a discontinuous band which trends north through the central part of the county and underlies the western part of the Western Cascades Province.

The rock types include massive greenish-gray pumiceous tuff, poorly bedded andesitic tuff breccia and conglomerate. Also included are interbeds of tuffaceous sandstone and siltstone and intercalated flows of andesite. The formation approaches one mile in thickness east of Elkhead. It is gently folded and faulted and regionally it dips to the east.

In the South Umpqua drainage the lower part of the section consists of bedded sandstone and siltstone and some conglomerate. Higher in the section there is a thick sequence of massive ash-flow tuffs and subordinate flow rocks of dacitic to basaltic composition that resembles the overlying Little Butte Volcanic Series. The Little Butte Formation is more silicic than the Colestín, but the two units are difficult to distinguish in this area.

The Colestín-Fisher unit is unconformable over the Tyee and Spencer Formations and is unconformable beneath the Little Butte Volcanic Series. An upper late Eocene age is inferred on the basis of stratigraphic position. In the Eugene area the lower Fisher Formation is assigned to the late Eocene on the basis of leaf fossils found near Comstock and other similar fossil collections reported by Hoover (1963).

The Colestin-Fisher strata are characterized by pronounced lateral variations and individual beds are of only local stratigraphic significance.

A few areas of hydrothermal alteration and later weathering, such as that surrounding Hobart Butte on the Douglas-Lane County line, contain deposits of high alumina clay (Hoover, 1963). Low-temperature mineralization, with minerals such as cinnabar and stibnite, is associated with some of these areas. The Zinc Creek mineralization in the South Umpqua area appears to be related to a small diorite intrusive in the Colestin Formation.

Little Butte Volcanic Series (Tof, Top): The term "Little Butte Volcanic Series" was originally used in reference to one of the post-Colestin volcanic rock units of Oligocene age in the Medford quadrangle (Wells, 1956). Subsequently the term has been applied by Peck and others (1964) to all the Oligocene and early Miocene volcanic rocks and related terrestrial deposits in the Western Cascades. In Douglas County the unit constitutes the bulk of the Western Cascades physiographic province and forms a 25-mile-wide band that trends north through the east-central part of the county.

Briefly the unit consists of massive beds of andesitic and dacitic tuff of ash-flow origin (Top) and lesser amounts of flow rock of andesitic and basaltic composition (Tof). Bedded tuffs and intrusives are minor. A distinctive lower or basal unit of rhyodacitic welded ash-flow tuff unconformably overlies the Colestin-Fisher unit in the southern part of Douglas County. Total thickness for the formation approaches 15,000 feet in parts of the Western Cascades, but in general it ranges from 5,000 to 10,000 feet. The unit is described as primarily a rhyodacitic ash-flow tuff in the South Umpqua drainage by Kays (1970).

Regionally the unit dips easterly. Locally random attitudes are a function of faulting, deformation, and initial dips.

The Little Butte Volcanic Series unconformably overlies the Colestin Formation and it is unconformable beneath the Sardine Formation. It ranges in age from early Oligocene through the early Miocene. In the Eugene area it interfingers with marine sedimentary rocks of early and middle Oligocene age.

Evidence of mineralization is present in areas of propylitically altered rocks surrounding intrusive bodies such as those in the Bohemia mining district of Lane County. Some of these altered areas probably represent the effects of hydrothermal activity similar to that observed around fumaroles and hot springs. Fairly extensive areas of altered rock are present along the North and South Umpqua Rivers and are discussed later in the report. The silica deposit at Quartz Mountain is a hydrothermal replacement of tuffs in the Little Butte Volcanic Series.

Sardine Formation (Tms): The Sardine Formation was defined by Peck and others (1964) to include the bulk of the Miocene volcanic rocks in the Western Cascades. In northern Oregon it forms most of the Western Cascades physiographic province and to the south in the central and southern parts of the province it forms smaller discontinuous exposures. Exposures assigned to the unit form a discontinuous north-trending band in eastern Douglas County between the Little Butte Volcanic Series and the rocks of the High Cascades Province. It also forms a few isolated exposures within the Little Butte Volcanics, as at Snow Bird Mountain adjacent to Quartz Mountain. Exposures at Collins Lookout Tower immediately south of the South Umpqua River are assigned to the Sardine Formation by Kays (1970).

The Sardine Formation consists of an upper series of layered hypersthene andesite flows and a lower series of basalt and dacite-andesite flows with intercalated pyroclastic deposits in the South Umpqua drainage (Kays, 1970). Where silicic flows are present, the lower unit is similar to parts of the underlying Little Butte Volcanics from which it is distinguished with difficulty primarily on the basis of interbedded andesite flows. In most areas the dacite flows are distinguishable from the ash-flow tuffs of the Little Butte Volcanic Series. In the Sardine Formation the abundance of andesite flows increases upsection and their presence is considered diagnostic of the unit. Platy jointing, so prevalent in many of the flows, is also considered characteristic.

The Sardine Formation rests unconformably on the Little Butte Volcanic Series and fills an irregular pre-Sardine topography. On the basis of numerous fossil leaf localities a middle and late Miocene age is interpreted for exposures of the unit about the periphery of the Western Cascades Province in northern Oregon. Age and identity of rocks assigned to the unit in the interior and to the south are less certain, although Peck and others (1964) interpreted a middle and late Miocene age for them also.

The Sardine Formation in Douglas County does not exhibit the widespread alteration so prevalent

in the Little Butte Volcanics. Mineralized areas are of limited extent and include those near Fish Mountain and Foster Creek. Also of interest is the occurrence of native sulfur at the Cove Sulfur deposit. Quartz Mountain, assigned to the Sardine Formation by Peck and others (1964), was interpreted to be a silicified ash-flow tuff by Kays (1970), who reassigned it to the Little Butte Volcanics.

Tertiary intrusives (Ti): Bodies of Tertiary intrusive rock in the Western Cascades are generally small and consist of plugs, dikes, sills, domes, and stocks of variable composition and texture. They range in age from late Eocene to late Miocene and are divided into medium-grained and fine-grained types by Peck and others (1964).

The medium-grained intrusives range in composition from augite diorite to quartz monzonite and are believed to be genetically related to metallic mineral deposits found in the province. The fine-grained intrusive bodies include small dikes, sills, pipes, plugs and domes and are related to the volcanic rocks of the Colestin Formation, the Little Butte Volcanics, and the Sardine Formation. They are composed of basalt, andesite, dacite, and rhyodacite. They commonly have porphyritic textures and generally are too small to be represented on the accompanying map. Intrusive bodies large enough to be shown on the geologic map include those at Hobart Butte, Scott Mountain, the North Fork of the Umpqua River, and the Black Rock Fork of the South Umpqua River.

High Cascades Province (QTba, Qb, Qp)

The High Cascades Province is characterized by high plateaus of Pliocene and Pleistocene volcanic rock capped by a variety of volcanic peaks which include Mt. Thielsen (9,182 feet), Mt. Bailey (8,363 feet), Trap Mountain, Cowhorn Mountain, and Elephant Mountain. The rocks are essentially flat-lying except for initial dips and are among the least deformed strata in the county.

Rocks of the High Cascades Province are younger than rocks of the Western Cascades Province. They range in age from Pliocene through Pleistocene and include a variety of flow rocks and air-fall pumice deposits. The bulk of the Plio-Pleistocene flows (Cascades Formation) consist of open-textured olivine basalt and olivine-bearing andesite and are designated (QTba) on the geologic map.

Less extensive extrusions of late Pleistocene light- to dark-gray dense- to open-textured olivine basalt and olivine-bearing andesites form intracanyon flows (Qb) north and south of Pig Iron Mountain. Westerly remnants of the flows are preserved as several small patches in the valley of the North Umpqua River in the Western Cascades Province.

In the headwaters of the Rogue River in the extreme southeastern part of the county deposits of white to buff dacitic ash fall and ash-flow tuff form rudely sorted valley bottom deposits (Qp) in the valley of the Rogue River drainage. Eruption of these ash deposits from Mt. Mazama occurred between 5,000 and 7,000 years ago.

Mineral resources of the High Cascades area include pumice, cinders and lava rock of various compositions, most of which makes excellent road aggregate. Emery is reported from near Pig Iron Mountain

Age of Mineralization

It is difficult to determine the age and chronological order of metalliferous mineralization in Douglas County, but in general the metallic minerals appear to be related to two main periods of igneous activity -- one during the Nevadan Orogeny in Late Jurassic time and the other during middle to late Tertiary time.

The majority of the metallic mineral deposits in the Klamath Mountains Province are related to the igneous intrusions which occurred during the Late Jurassic Nevadan Orogeny. Rocks of granitic texture and gabbroic to granitic composition (mainly diorites) are thought to have generated the heat source and at least part of the volatile ingredients for the mineralizing solutions that penetrated joints, fractures, and fault zones in the older rocks.

The later period of mineralization is related to dikes, sills, and plugs of Tertiary age. In the Coast Range and Western Cascades Provinces, the Tertiary intrusive rocks include basalt, diabase, diorite, and nepheline syenite; in the Klamath Mountains Province they are represented by a few dikes of dacitic

composition. It is probable that most of the Tertiary mineralization occurred during the Miocene Epoch, but some may have been associated with earlier or later periods of igneous intrusions. Mineralization that produced the quicksilver deposits in the Western Cascades occurred in middle to late Tertiary time (Brooks, 1963). The age of mineralization along the shear zone in the Silver Peak area is uncertain, but is possibly Tertiary.

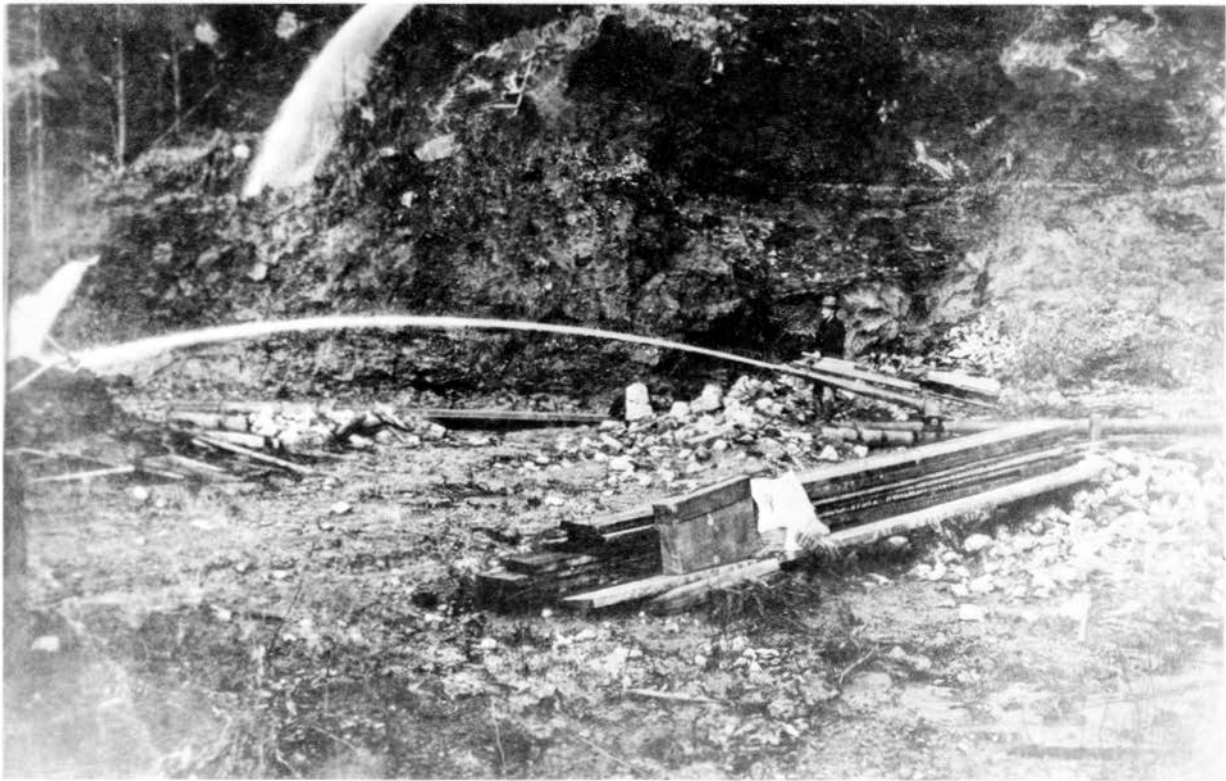


Figure 3. Hydraulic mining on North Myrtle Creek in the early 1900's. (Photograph courtesy of Douglas County Museum)

MINING ACTIVITY

Early History

During the 1850's, following the rush to Jacksonville, prospectors explored essentially all of the streams of Douglas County for placer gold. They found fair to good prospects on only a few of the streams. Noteworthy among these are Starvout, Hogum, Quines, Bull Run, Coffee, and North Myrtle Creeks. Others on which some placer mining was done include Steamboat, Windy, Cow (bench gravels), West Fork Cow, Beaver, Jordan, Willis, Drew, Coarse Gold, Byron, Thompson, and Bushnell Creeks.

The early-day placer mining was done mainly by hand methods, usually by shoveling into a rocker or long tom sluice box. In the richer streams, the miners were often able to stake out only small plots and worked them the best way they could. If an individual or company bought up a sizeable area and had adequate financing or cooperation, a ditch and pipe were installed so that the area could be mined by hydraulic methods (see Figure 3).

Spreen (1939), in his history of placer gold mining in Oregon, quotes a letter of M. J. Suark in The Oregonian, December 18, 1858 as follows:

"Coffee Creek is a small branch of the South Umpqua River. Three men had been working at the mouth of the creek for several months with sluices, but owing to the fineness of the gold and bad management, very little was made by them. In the latter part of July 1858, a company of men, including one of the above three, started up the creek to prospect. They worked until September when they 'struck a prospect' three miles from the mouth which paid them four dollars per day per man. Further prospecting located a strike which paid as high as two dollars and a half per pan. Each of the party, consisting of seven men, staked claims of two hundred yards each. All the prospectors on Texas Gulch (a tributary of Coffee Creek) got as high as two dollars and a half per pan on bed rock. One man took out a nugget weighing six ounces."

Another early-day discovery in Douglas County was the Bonanza quicksilver deposit east of Sutherlin, said to have been found some time during the 1860's. The Gold Bluff mine southwest of Canbyville was discovered in the 1890's and the Silver Peak mine in 1910. The deposit of nickel at Nickel Mountain west of Riddle (at that time called "Old Piney Mountain") was discovered by sheepherders in 1865. The green ore (garnierite) was thought to be both copper and tin before it was determined by assay to contain 6 percent nickel and no copper or tin.

Diller (1898) reported that placer mining on Lee Creek and Buckfork of upper North Myrtle Creek had been active during the rainy seasons for many years and that production prior to 1898 was estimated to have been about \$150,000. The Chieftain-Continental Vein on South Myrtle Creek was discovered in 1898, shortly after Diller mapped the area geologically.

The story of placer mining activity on upper Cow Creek is not well recorded. It has been handed down that in the early days two placer camps were working on creeks now called Starvout Creek and its tributary, Hogum Creek. Occupants at the camp on Starvout Creek ran out of food and visited the camp on Hogum Creek to see if they could purchase supplies with newly-mined gold, but they were refused. The result was some hard feelings and name calling and subsequent naming of the creeks. A tributary of Hogum Creek, called Fizzleout tells a story of its own. Quines Creek and its tributaries, Bull Run and Tennessee Gulch, had fairly good placers and were centers of considerable activity, probably during the late 1850's and 1860's. A Chinese settlement is said to have been established near the head of Tennessee Gulch.

Diller (1914, p. 103) reported on placers of the Umpqua and its tributaries as follows: "On portions of the South Fork of the Umpqua and its tributaries, especially Olalla Creek, Myrtle Creek, Cow Creek, and Coffee Creek, there are auriferous gravels of considerable importance.

"One of the branches of Olalla Creek traverses a mass of Jurassic slates that have been much intruded by greenstones and furnished considerable bodies of auriferous gravel. On Myrtle Creek, near Nugget, the granular greenstone by its disintegration has furnished residual material and stream gravel that has been mined more or less actively for a number of years. The same is true of gravel on the upper course of the South Fork of the Umpqua, about Coffee Creek, and in places along the course of Cow Creek, whose middle portion is in a rugged canyon.

"Starvout Creek, near Booth, is a tributary of upper Cow Creek that drains the northwest slope of Green Mountain, where the Green Mountain Copper Co. is prospecting. Several small placers on Starvout have been irregularly active for a long time. A large tract has been covered by these placers near the present stream level. Their reputed richness in the early days has stimulated search for the source of the gold.

"In Cow Creek canyon below Glendale, high gravel benches have been extensively mined. The Victory and Gold Flat, about 7 miles from Glendale, are on terraces about 150 feet above the stream, and the Cracker Jack and Cain mines, a dozen miles farther down the canyon, are on terraces more than 500 feet above Cow Creek.

"Among the hills on the valley border between Riddle and Canyonville there are a number of small mines which appear to derive at least part of their gold from the decomposition of the Cretaceous beds on which they rest."

Mineral Production

Separate production records for individual counties were not kept prior to 1880, but after the turn of the century, production statistics began to be recorded for Douglas County.

Oregon's reported peak year of gold production was 1940. In that year Douglas County produced 1,467 fine ounces of gold from 13 placer mines and one lode mine. The county ranked 6th in gold production for the state. Total state production recorded in 1940 was 113,402 fine ounces with a value of nearly \$4 million. Domestic production of gold since that time dropped sharply owing to the onset of World War II and governmental regulations established in 1942. In 1943 Oregon's total gold production had dropped to 1,097 fine ounces and no production was recorded for Douglas County. (See Table 1.)

Libbey (1963) reports higher gold production figures for southwestern Oregon (see Gold and Silver chapter).

Present Mining Activity

The operation that keeps Douglas County leading all other counties in the state in value of mineral production is the nickel mine and smelter near Riddle. During the 1960's and early 70's the Nickel Mountain mine operated by the Hanna Mining Company has yielded slightly more than 1 million tons of ore annually with an average nickel content of 1.41 to 1.50 percent, and the smelter has produced in excess of 20,000,000 pounds of nickel metal in the form of ferronickel alloy.

Sand and gravel production ranks second in monetary value in the county. The two principal producers in the Roseburg area during 1971 were Roseburg Sand and Gravel and Beaver State Sand and Gravel. Umpqua River Navigation Co., Reedsport, which dredges the lower Umpqua, is the largest producer in the County.

A few established quarries for crushed rock and building stone have been worked from time to time over a long period. Some volcanic tuff, an attractive mottled stone in various shades of green

Table 1. Douglas County mineral production (metals) 1903-1971 (from available records)

YEAR	GOLD (ounces)	SILVER (ounces)	COPPER (pounds)	CHROMITE (short tons)	NICKEL (short tons)	MERCURY (flasks)	YEAR	GOLD (ounces)	SILVER (ounces)	COPPER (pounds)	CHROMITE (short tons)	NICKEL (short tons)	MERCURY (flasks)
1903	2,048	1,245					1938	362	40				1,183
1904	426.56						1939	340	49				2,199
1905	897.54	1,404					1940	1,471	107				5,739
1907	216	62					1941	145	270	6,000			5,552
1908	919.85	409					1942	110	24				3,940
1909	86.78	27					1943						3,294
1910	442.49	98					1944	2					2,426
1911	212.12	78					1945						2,350
1912	684.07	2,832					1946						1,261
1913	128.97	23					1947						1,182
1914	228.67	41					1948						1,351
1915	116.54	26					1949	4.1	10				1,161
1916	1,188	133	1,939	956*			1950	8	3				
1917	1,080.65	63					1951	15**	3**				1,177
1918	201.19	66		1,721⊕			1952	19	2				846
1919	35.22	5					1953				192		593
1920	78.81	14					1954	35	2		263	159	383
1921	148.95	29					1955	42% ^o			127	3,253	604
1922	227.24	225	170				1956		1	400	20	5,691	977
1923	117.79	7					1957				89	9,061	1,439
1924	128.85	91	88				1958					10,617	795
1925	72.64	7					1959					10,397	722
1926	159.13	2,854	47,080				1960					11,115	183
1927	37.90	2					1961					10,325	1
1928	53.23	2,567	136,014				1962					10,569	
1929	165.03	5,976	188,197			4	1963					10,724	
1930	151.27	1,084	26,153			700	1964					11,236	19
1931	634.50	766	1,392				1965					12,666	32
1932						40	1966					12,266	12
1933	418	53				30	1967					13,035	56
1934	619	276	530			9	1968					13,126	76
1935	482	98	384			22	1969					13,086	23
1936	494	4,420	118,000				1970					12,674	261
1937	434	5,623	232,000			156	1971					12,967	

* Includes Grant County, Chromite

⊕ Includes Coos, Curry, & Douglas Counties together, Chromite

** Includes Warner Mine - Jackson Co., Au, Ag

%^o Includes Wheeler County on Au, Ag

Information mainly from U.S. Bureau of Mines Minerals Yearbooks and U.S. Geological Survey Mineral Resources

with yellow and red, has been used in recent years by architects. Small tonnages of this stone have been quarried in the western Cascades near Snowbird Mountain.

The Big Quartz silica mine on Quartz Mountain, about 35 miles east of Roseburg, has produced some metallurgical-grade silica for the nickel smelter near Riddle in recent years and since 1971 has become their principal source of silica for the production of ferrosilicon metal needed in the smelting process.

The Elkhead Quicksilver mine in northern Douglas County was operated by the Alcona Mining Company for the period of 1965 to 1971 with a small production each year. There has been some small intermittent production of gold from placer mining operations in the Quines Creek area.

The Mining-Minerals Manufacturing Co. at Riddle uses slag from the nickel smelter to produce a high-quality sandblasting grit, which it packages under the name of "Green Diamond Abrasives." Production has been increasing since the plant installation in 1961 (ORE BIN, 1971).

Future Mining Potential

The need for building materials will expand with population growth in the area. It is therefore logical that there will be a greater demand for, and increased production of, sand and gravel, stone, and crushed rock. The use of stone facings in modern architecture will undoubtedly see considerable increase.

The nickel mine at Nickel Mountain has limited reserves that will eventually be exhausted. Present ore reserves appear to be adequate to maintain the operation until about 1990. The Green Diamond abrasive plant, which utilizes the slag from the nickel smelter, will have adequate supplies to last about 100 years at the present rate of consumption. Large, growing piles of reject rock at the Nickel Mountain mine contain a high percentage of dunite rock, which is nearly pure olivine. These piles and significant reserves of rock in place represent a potential supply of olivine for use as a refractory, as a foundry sand, or even as a source of magnesium.

As exploration methods improve, metal prices increase, and metallurgical techniques become more sophisticated, it seems reasonable to expect a growth in the metal mining industry of southwestern Oregon. Areas of copper, gold, silver, and zinc mineralization, such as the Silver Peak, Rowley, and Fish Mountain areas, may well see production in the future.

It seems reasonable to expect that additional reserves of mercury may be found along the Bonanza thrust fault. A significant discovery of cinnabar in this area could revive Douglas County's mercury production. Although the price of mercury characteristically fluctuates, each period of price increase usually sees new highs, so that with increased population resulting in increased demand future prices should attract exploration on the part of mercury mining interests.

As methods of searching for geothermal energy in the form of steam fields improve, Douglas County will not be overlooked. Evidence of near-surface hot water, such as mercury mineralization, propylitic alteration, and hot springs, both active and extinct, will undoubtedly lead to exploration in the near future.

METALLIC MINERAL RESOURCES

Antimony

Although only one occurrence of antimony (the T & M prospect) is recorded for Douglas County, samples of antimony (stibnite) from a few other localities have been submitted to the Department of Geology and Mineral Industries for assay (see Table 2).

The principal ore mineral of antimony is stibnite (Sb_2S_3), a lead-gray, metallic, bladed or needle-shaped mineral with a lead-gray streak, hardness of 2, and specific gravity of 4.5. Stibnite occurs in a few mineralized zones in volcanic rocks of the Western Cascades associated with other sulfides such as orpiment, realgar, cinnabar, and pyrite, but it has not been reported in sufficient quantities to constitute a commercial source of antimony. Antimony is associated with a few gold-bearing veins in the Bohemia district of southern Lane County, where the El Capitain vein is reported to contain at least 25 percent stibnite.

The T & M antimony prospect is located in sec. 11, T. 32 S., R. 1 W., on a ridge crest forming the boundary of Douglas and Jackson Counties near Ragsdale Spring Camp. The occurrence consists of a narrow silicified zone in coarse tuffs and interbedded rhyolite flows. The core of the zone contains some scattered stibnite in quartz. It strikes north and has been trenched for 45 feet with only one small area of stibnite encountered (see sample RG-231, Table 2) (A.B. Griggs, written communication, May 10, 1951).

Table 2

Antimony Assay Data

Sample Number	Location			%	%	%	%	lb/ton	%	Date
	Sec.	Ts	R.W.	Sb	Au	Ag	As	Hg	Mo	Assayed
RG-190	13	29	1	0.50	---	---	0.50	0.30	---	6-57
RG-231*	11	32	1	5.90	0.01	3.00	---	---	---	6-57
RG-424	13	29	1	1.08	---	---	0.80	Tr	---	9-57
SG-60	NW $\frac{1}{4}$	13	29	1	1.90	---	---	1.1	---	3-58
P-29428	S E $\frac{1}{4}$	23	31	1	28.43	0.04	2.00	---	Tr	8-64
P-29429	S E $\frac{1}{4}$	23	31	1	11.93	0.02	1.00	---	Tr	8-64

* T & M Antimony

Arsenic

Arsenic minerals have no commercial value owing to the surplus of arsenic produced as a by-product of smelting ores of other metals, but arsenic minerals are of interest because of their association with mercury, gold, antimony, zinc, etc. The chief arsenic minerals are orpiment, realgar, and arsenopyrite.

A few veins containing arsenic sulfides are known to occur in the volcanic rocks of the Western Cascades. A typical example is the B & H or Lucky Logger occurrence on Boulder Creek, NE $\frac{1}{4}$ of NW $\frac{1}{4}$ sec. 13, T. 29 S., R. 1 W. It is exposed in a small cut in the road bank a short distance from the main Boulder Creek road. Realgar, orpiment, and some stibnite occur in a fractured zone which strikes about N. 45° W. and dips steeply to the east. Assays from the occurrence (sample numbers RG-190, RG-424, SG-60) are listed in Table 2.

Another occurrence, not visited by the Department, has been reported on the west flank of Scott Mountain about 5 miles north of Glide. Samples reported to be from this occurrence contain abundant orpiment and realgar but have not been sampled for assay.

Chromite

Chromite, a heavy black metallic mineral, is the only commercial source of chromium. It is a complex oxide of chromium, iron, magnesium, and aluminum. The percentage of oxides in chromite can vary widely, and their variation determines the use specifications of the ore. High-chromium ores containing 46 percent and greater Cr_2O_3 and having a Cr:Fe ratio of 2:1 or more are classed as metallurgical grade. High-iron ores containing 40 to 46 percent Cr_2O_3 and a Cr:Fe ratio of less than 2:1 are used for chemical purposes. High-alumina ores containing 20 percent or more Al_2O_3 , 60 percent or more Cr_2O_3 and Al_2O_3 combined, and not more than about 12 percent Fe, are used in refractories.

Chromite is found exclusively in the ultramafic rock peridotite and its alteration product, serpentinite. In Douglas County these rocks occur only in the Klamath Mountains Province. Chromite may occur either as discrete mineral grains scattered through the rock or as massive accumulations in layers or pods. It is usually an early mineral to crystallize in the cooling process of an ultramafic magma and the mechanisms of segregation are as varied as the history of the origin and emplacement of the rock. Banded or streaked-out disseminated chromite is believed to have formed during emplacement of the ultramafic rock when it reacted as a plastic mass. Stratiform or uniformly layered chromite is believed to have developed by crystal settling in the upper mantle where the crystallizing magma was undisturbed.

Chromite is highly resistant to weathering processes, and because of this property most of the known occurrences were discovered by tracing surface float ore uphill to its source.

Current theories of plate tectonics involving impingement of oceanic crust with a continental front resulting in either subduction or obduction (under-thrusting or over-riding) of the oceanic crust and the accompanying complex folding and faulting may help to explain why most ultramafic bodies appear to have been emplaced tectonically as "cold intrusives" from their place of origin, the upper mantle. The resultant tearing-apart and distortion of what may have been uniform layers of massive chromite to form scattered, strung-out, lense-shaped pods has complicated the search for buried chromite ore bodies.

A number of occurrences of chromite in Douglas County were described by Ramp, (1961, p. 119-126). All of these deposits are small, and total known production for the county is estimated to be about 1,500 long tons. The largest producer in the county is the Black Boy mine, No. 15, of the Starvout Group, located on Quartzmill Peak at the head of Starvout Creek. This mine reportedly produced about 900 tons (19 freight carloads) during World War 1 (1916).

Chromite production in Oregon has been restricted to periods of high incentive price brought on by war-time demands and the more recent government stockpiling program of 1951 to 1958.

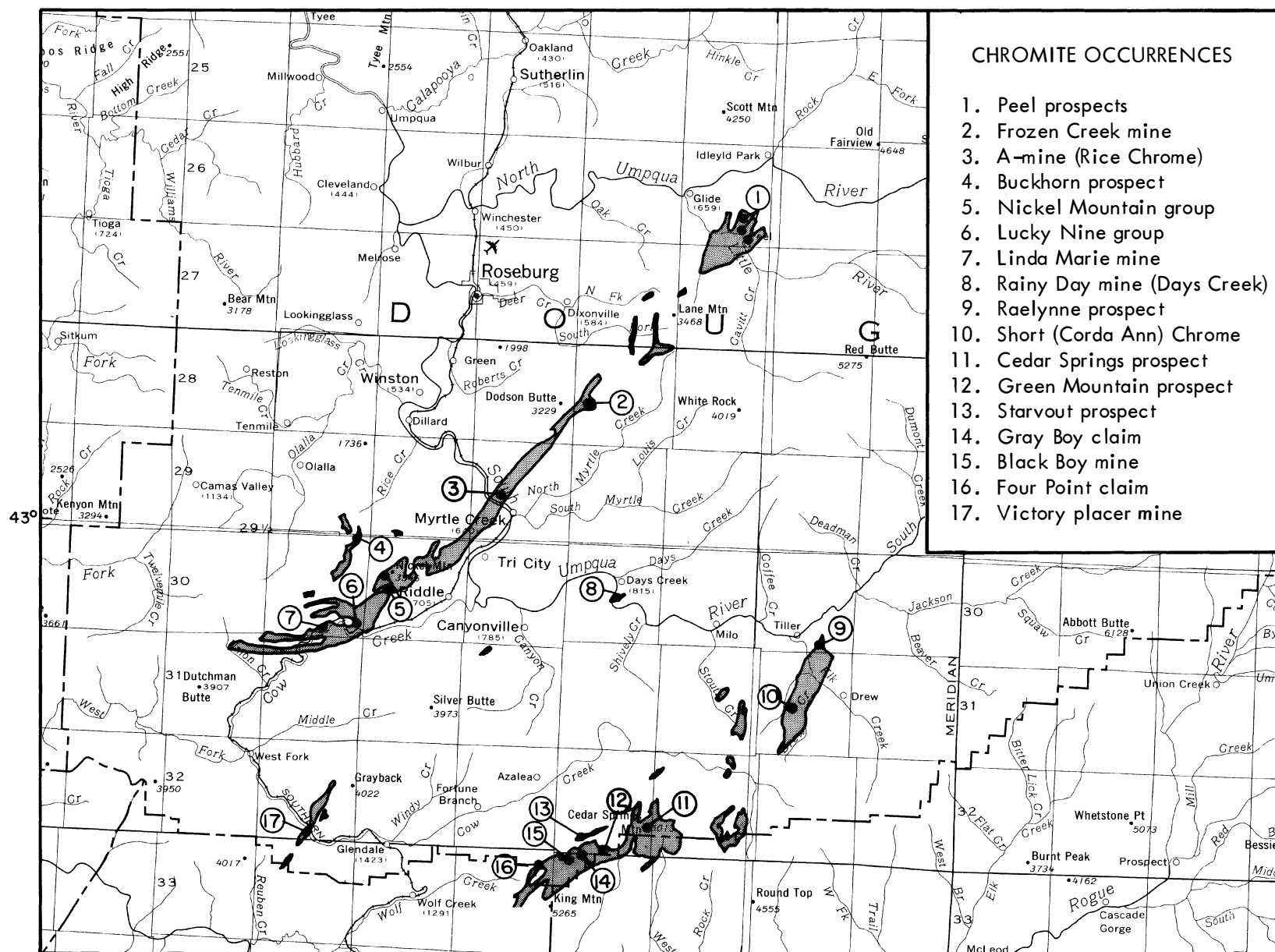
Chromite mines and prospects in Douglas County are listed below alphabetically and described briefly. Numbers refer to map locations on Figure 4.

A-MINE (RICE CHROME) (No. 3)

Location:	NE $\frac{1}{4}$ sec. 20 and NW $\frac{1}{4}$ sec. 21, T. 29 S., R. 5 W., at about 1,000 feet elevation on privately owned land.
Development:	Several hundred feet of shallow trenching and five open cuts up to 15 feet deep.
Geology:	Two main chromite pods and small scattered float were recovered from a light green talcy serpentinite. Trend of upper pod (7 or 8 feet wide, 6 feet thick, tapering to west) was N. 75° W. and dip 25° to 30° N. Ore zone lies 500 to 1,000 feet from SE margin of NE-trending serpentinite belt. The belt is intruded by several small dacite dikes. The country rock is serpentinitized harzburgite.
Production:	The first main production was about 20 tons in 1941. Smaller additional production in 1952. Total less than 50 tons.
References:	Ramp (1961) Treasher and Allen (Oregon Department of Geology and Mineral Industries mine file report 1942, unpub.)

CHROMITE OCCURRENCES

1. Peel prospects
2. Frozen Creek mine
3. A-mine (Rice Chrome)
4. Buckhorn prospect
5. Nickel Mountain group
6. Lucky Nine group
7. Linda Marie mine
8. Rainy Day mine (Days Creek)
9. Raelynne prospect
10. Short (Corda Ann) Chrome
11. Cedar Springs prospect
12. Green Mountain prospect
13. Starvout prospect
14. Gray Boy claim
15. Black Boy mine
16. Four Point claim
17. Victory placer mine



BLACK BOY MINE (STARVOUT GROUP) (No.15)

- Location: SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 5, T. 33 S., R. 4 W., at about 4,000 feet elevation on the south-east flank of Quartzmill Peak. Black Boy and June Bug mining claims.
- Development: Two large open cuts 50 feet apart are about 100 feet long, 20 feet wide and 30 or more feet deep at the back ends. Also several small cuts and a 50-foot tunnel driven south from the end of the upper open cut.
- Geology: Lenses of massive chromite having a maximum thickness of 6 feet occur in a zone perhaps 2,000 feet long which trends about N. 20° E. and dips steeply SE. The country rock is a highly sheared dark greenish-black serpentinite.
- Production: 19 freight carloads were reportedly shipped in 1916; some shipped in 1937; about 20 tons in 1955; and 20 tons in 1956. Total about 1,000 tons. Average grade was about 45 percent Cr₂O₃ and 12 percent Fe.
- References: Allen (1941) Ramp (1961)
Diller and others (1921) Thayer and Ramp (1969)

BUCKHORN PROSPECT (No. 4)

- Location: N $\frac{1}{2}$ sec. 1, T. 30 S., R. 7 W., about 2,000 feet elevation.
- Development: Two bulldozer cuts about 50 feet long, 10 feet wide, and 12 feet deep.
- Geology: A small amount of massive, high-grade chromite float and one small lens were found in a 200- to 300-foot wide sheared serpentinite band which trends about N. 20° E. and dips 57° SE.
- Production: About 2 tons of chromite, mostly float, was recovered (1955)
- Reference: Ramp (1961)

CEDAR SPRINGS PROSPECT (No.11)

- Location: SE $\frac{1}{4}$ sec. 25, T. 32 S., R. 4 W., about 4,500 feet elevation.
- Development: Unknown. Assay information only.
- Geology: Massive ore, probably float, submitted for assay. Prospect not examined. Ore assayed 48.23 percent Cr₂O₃.
- Production: None
- Reference: Ramp (1961)

FOUR POINT CLAIM (No.16)

- Location: SW $\frac{1}{4}$ sec. 1, T. 33 S., R. 5 W., at about 3,075 feet elevation.
- Development: Shallow bulldozer cuts.

Geology: A NE-striking, SE-dipping zone of disseminated to massive chromite up to 4 feet thick may be traced by intermittent exposures and float for over 200 yards. It lies within a NE-striking body of serpentinite about 1,500 feet wide. Concentrates assayed about 43 percent Cr_2O_3 with fairly high iron.

Production: 10 tons ore were concentrated to $4\frac{1}{2}$ tons in 1957.

Reference: Ramp (1961)

FROZEN CREEK MINE (No. 2)

Location: $\text{SE}\frac{1}{4}\text{SE}\frac{1}{4}$ sec. 19, T. 28 S., R. 4 W., at 1,600 feet elevation.

Development: Open cut 45 x 60 x 30 feet deep at the face and a short adit.

Geology: An offset segment of sheared disseminated to massive chromite was exposed in a N. 70° W.-striking, 18° SW-dipping shear in the cut and short adit. The country rock is a highly sheared, light, grayish-green serpentinitized harzburgite.

Production: About 70 tons of concentrates assaying 42 to 44 percent Cr_2O_3 and about 2.5 Cr:Fe ratio were produced from 238 tons of low-grade ore mined in 1954 and 1955.

Reference: Ramp (1961)

GRAY BOY CLAIM (STARVOUT GROUP) (No. 14)

Location: $\text{SW}\frac{1}{4}\text{NE}\frac{1}{4}$ sec. 5, T. 33 S., R. 4 W., at 3,550 feet elevation.

Development: An open cut 60 x 120 x 25 feet deep at the face.

Geology: Disseminated chromite in serpentinitized dunite is exposed over a 26-foot width and contains two barren zones of 3 and 4 feet wide. It has an apparent trend of N. 20° E. and dips steeply to the west. The body appears to be faulted into several segments but is poorly exposed. A 19-foot chip sample from the face assayed 20.2 percent Cr_2O_3 . Assays of panned concentrates indicate a possible refractory grade.

Production: Mill tests were reportedly made but no ore shipped.

References: Ramp (1961)
Thayer and Ramp (1969)

GREEN MOUNTAIN PROSPECT (No. 12)

Location: $\text{SW}\frac{1}{4}$ sec. 34, T. 32 S., R. 4 W.

Development: Unknown

Geology: Massive ore with mixed serpentinite, probably float, assayed about 35 percent Cr_2O_3 , 12 percent Fe and 11 percent SiO_2 . Assay forms P-22375 and P-22376

Production: None

Reference: Ramp (1961)

LINDA MARIE MINE (No. 7)

Location: NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, T. 30 S., R. 7 W., at about 850 feet elevation.

Development: Three bulldozer cuts, three small hand-dug trenches and a 65-foot tunnel.

Geology: Small lenses of massive chromite were found to occur in a NW-trending sheared zone of blue-green serpentinite.

Production: About 20 tons of 46 percent Cr₂O₃ ore were produced in 1955 (?). Diller and others (1921, p. 34) reported that "In 1917 considerable chromite was mined about 10 miles south of Nickel Mountain."

References: Diller and others (1921)
Ramp (1961)

LUCKY NINE GROUP (including Davis, Baxter, and Pansy) (No. 6)

Location: Secs. 25 and 36, T. 30 S., R. 7 W., between 1,000 and 1,800 feet elevation.

Development: Several shallow bulldozer cuts and one short caved tunnel.

Geology: The several occurrences appear to lie along a NNE-trending, SE-dipping zone in a highly sheared serpentinite about 1,000 feet east of its contact with a phyllitic metavolcanic rock.

Production: Records are incomplete, but reported to be about 50 tons of sorted high-grade ore assaying about 47 percent Cr₂O₃ with a 2.8 Cr:Fe ratio, and 400 tons of low-grade mill ore. The occurrences were worked in 1954 and 1955.

Reference: Ramp (1961)

NICKEL MOUNTAIN GROUP (No. 5)

Location: W $\frac{1}{2}$ NW $\frac{1}{4}$ sec. 20, T. 30 S., R. 6 W., at about 2,550 feet elevation.
Also near west edge of sec. 17, T. 30 S., R. 6 W., at 3,240 feet elevation.

Development: The lower occurrence was explored and mined by several small open cuts and bulldozer trenches. The upper occurrence was exposed in a quarry face in the nickel mine on the west side of Nickel Mountain.

Geology: The lower occurrence is in a highly sheared serpentinite. Both low grade disseminated ore and pods of massive, high-grade chromite were produced. Topography of the lower area suggests some slumpage or landsliding. The upper exposure was described as a lens of streaked, disseminated to massive chromite in dunite having a maximum thickness of 4 feet and exposed for about 12 feet with a strike of N. 20° E. and dip of 55° SE.

Production: This area had its largest production of chromite in 1916; but Douglas County production records for that year were given together with Grant County (see production, Table 1).

There was also some production from the lower occurrence in 1954.
The total production of high-grade ore and mill concentrates is estimated to be less than 100 tons.

References: Diller and others (1921)
Ramp (1961)
U.S. Geological Survey (1916)

PEEL PROSPECTS (No. 1)

Location: Secs. 27 and 34, T. 26 S., R. 3 W., (includes 3 occurrences described in detail in Ramp, 1961, p. 126)

Development: Several small cuts and trenches.

Geology: The country rock is a sheared serpentized harzburgite which encloses several small, hard, altered bodies of metavolcanic rock and is intruded by later dacite or rhyolite porphyry dikes. Small lenses of massive chromite assaying from 30 to 45 percent Cr_2O_3 with a fairly high iron content appear to lie in a nearly vertical zone trending NNE.

Production: There is no record of production.

Reference: Ramp (1961)

RAEYNNNE PROSPECT (No. 9)

Location: $\text{SE}\frac{1}{4}\text{SW}\frac{1}{4}$ sec. 34, T. 30 S., R. 2 W., at 1,600 feet elevation.

Development: Five small cuts.

Geology: The cuts expose a tapering schlieren-banded, disseminated to nearly massive chromite-bearing zone as much as 4 feet thick in serpentized harzburgite. The zone strikes about N. 18° E., dips 80° SE. and is exposed for a distance of about 90 feet. A sample of the more massive ore assayed 37.76 percent Cr_2O_3 and 14.11 percent Fe.

Production: None

Reference: Ramp (1961)

RAINY DAY (DAYS CREEK) MINE (No. 8)

Location: $\text{S}\frac{1}{2}$ sec. 15, T. 30 S., R. 4 W., at about 1,300 feet elevation.

Development: Shallow open cuts.

Geology: Small pods of massive chromite occur in a highly sheared small body of serpentinite exposed on the hillside $\frac{1}{4}$ miles south of Days Creek. This body includes numerous small blocks of massive greenstone and has probably been tectonically emplaced along the thrust fault contact between the Dothan Formation and the greenstone.

Production: Estimated to be about 20 tons.

References: Allen (1941)
Diller and Kay (1924)
Ramp (1961)

SHORT (CORDA ANN) PROSPECT (No. 10)

Location: SW $\frac{1}{4}$ sec. 21, T. 31 S., R. 2 W., about 2,800 feet elevation.

Development: Small open cuts.

Geology: Ore is massive and assayed 49 percent Cr₂O₃ and 14 percent Fe. The deposit was not visited.

Production: A few tons of ore were piled on the dump, but production information is lacking.

Reference: Ramp (1961)

STARVOUT PROSPECT (No. 13)

Location: SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 32 S., R. 4 W., at about 2,570 feet elevation.

Development: Shallow cuts only.

Geology: Disseminated chromite and a few small lenses of massive chromite were exposed in an irregular NE-striking, steep, SE-dipping zone about 3 feet thick. Samples of massive ore assayed about 38 percent Cr₂O₃ and 12 percent Fe.

Production: None.

Reference: Ramp (1961)

VICTORY PLACER MINE OCCURRENCE (No. 17)

Location: Sec. 33, T. 32 S., R. 7 W.

Development: Assay information only.

Geology: Samples of massive ore assayed 38.72 percent Cr₂O₃ and 23.98 percent Fe, and 41.27 percent Cr₂O₃ and 25.45 percent Fe. Bedrock under a portion of the placer mine is a narrow body of sheared serpentinite. State assays P-11635, (1951) and P-18214, (1955).

Production: None.

Reference: Ramp (1961)

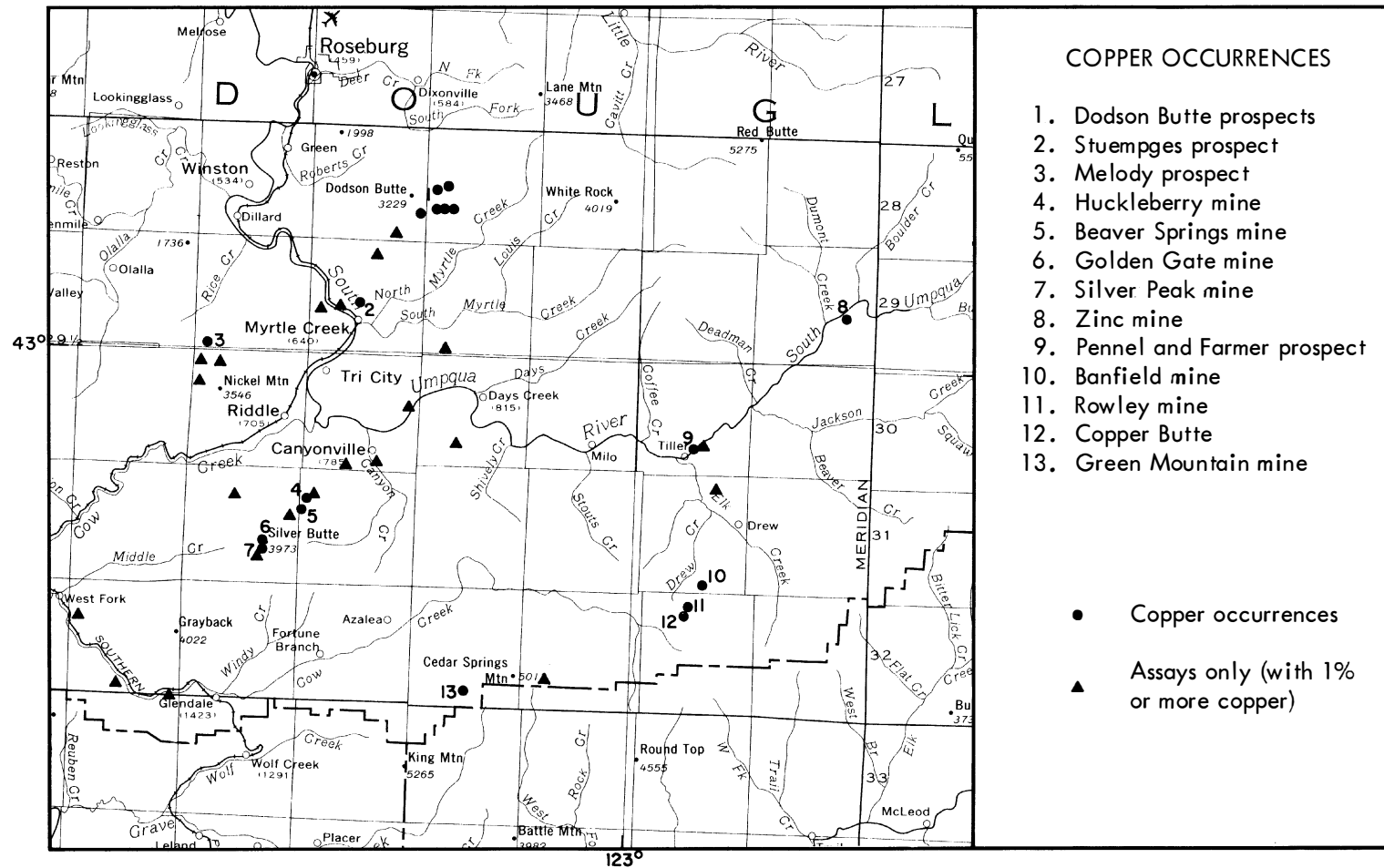


Figure 5. Map showing location of copper occurrences in Douglas County.

Copper, Lead, and Zinc

Occurrences of copper, lead, and zinc mineralization are scattered in the southern half of Douglas County (Figure 5). Production has come mainly from the Silver Peak mine during the periods 1926 to 1930 and 1934 to 1937. Total production from the Silver Peak mine has been about 6,620 tons of ore with an average assay of 5.67 percent copper and an equal or slightly greater percentage of zinc. The Banfield mine shipped 52 tons of ore in 1928 containing 10,059 pounds of copper and a small tonnage in 1956 which contained 400 pounds of copper and some silver. Minor copper production was obtained as a by-product from the Huckleberry and the Chieftain-Continental gold mines.

Copper-bearing minerals occurring in Douglas County include the usual primary chalcopyrite and secondary malachite which are present in all of the known deposits. A greater variety of copper minerals is present at the Silver Peak mine where tennantite, chalcocite, bornite and covellite have been identified. Zinc is present in a few of the copper mines mainly as sphalerite. At the Silver Peak mine, sphalerite appears to increase with depth as copper decreases. Sphalerite is also present in the western sulfide vein at the Rowley mine and at the Zinc Creek occurrence on the South Umpqua River. Lead occurs as galena at a few of the copper and gold-silver mines but is generally a rare mineral and an indicator of silver values. There is no record of lead production from ores mined in the county.

Two areas of special interest have been investigated from time to time which appear to have some potential for the development of fairly large tonnages of low-grade ore. These are the northeast-striking Silver Peak zone and the Rowley-Banfield area. A third area near Dodson Butte may also merit investigation.

Diller (1914) was the first to recognize the similarity in strike and mineral assemblage of the ore zone in the Silver Peak mine area with that of the Almeda mine on the Rogue River about 21 miles to the southwest. He referred to this apparently extensive zone as the Big Yank Lode. In later investigations, Dole and Baldwin (1947) and White and Wolfe (1950) reported on a number of occurrences along this general trend and discussed their similarity. The mineralization generally occurs in a sheared, altered, metavolcanic rock mapped as "greenstone" by Diller and Kay (1924) and described as a highly altered chlorite and sericite schist by Shenon (1933). Where mineralized, the shear zone with sericite schist usually contains considerable quartz, barite, and disseminated to nearly massive sulfides, mainly pyrite and chalcopyrite. The Big Yank zone is apparently not continuous, but is, rather, a set of independent northeast-striking, southeast-dipping shear zones lying en echelon. From south to north the zones are situated progressively westward across the section from the Galice-Rogue Formation contact at the Almeda mine in Josephine County to near the Rogue-Dothan contact at the Silver Peak mine.

The Rowley-Banfield area is situated about 7 miles south of Tiller in the headwaters of Drew Creek. The Rowley and Banfield mines occur in a body of schist and gneissic amphibolite which is unconformably overlain by Tertiary volcanics to the east and intruded by quartz diorite to the west. The amphibolite and schist are also intruded by small bodies of serpentinite near the mineralized areas. Mineralization is accompanied by a bleaching and hydrothermal alteration of the amphibolite and schist. Two ages of mineralization may be represented. The large body of quartz diorite to the west is of probable late Jurassic (Nevadan) age whereas some of the smaller intrusives in the area are of Tertiary age (Kays 1970). The presence of cinnabar in the Banfield mine is evidence of mineralization during the Tertiary Period.

The main (eastern) zone of mineralization at the Rowley mine is an altered, bleached zone in quartz chlorite schist with disseminated chalcopyrite ranging in width from about 50 to 150 feet, over an exposed length of about 1,200 feet. The average grade is about 0.5 percent copper. The zone strikes north and dips 45° E. Ore at the Banfield mine is more spotty, with higher-grade streaks and small segregations of sulfides, but the bleached, altered area surrounding the mineralized portion is very similar in appearance to the Rowley ore. More detailed prospecting of the area of these two occurrences seems warranted.

Diller (1898) described the Dodson Butte area as follows:

"Near Dodson Butte there has been much prospecting for copper within the last few years. It occurs in irregular and rather sparsely

distributed particles of various sizes, scattered through the serpentine and metagabbro at a number of localities, in the form of the carbonates and sulphide. That in the serpentine is almost wholly in the form of the green or blue carbonates, malachite and azurite, with traces of the sulphide, chalcopyrite, whereas in the metagabbro, lower down upon the slope of the ridge, where a larger amount of surface material has been removed, the ore is almost wholly in the form of chalcopyrite, associated frequently with pyrite. It occurs in the metagabbro of that region only a short distance from the contact with the serpentine, and impregnates the rock in belts. Several tunnels over a hundred feet in length have been run through this mass toward the serpentine, but when visited in October, 1897, the contact had not yet been reached. Analyses of samples of the ore, representing approximately an average of the material in the mineralized belts then in view, show 2.53 percent of copper for the 200-foot tunnel of the Black Republican mine and 5.78 percent of copper for the open cut of the Yankee Boy."

Copper mines and prospects in Douglas County are shown on Figure 5 and are listed alphabetically in the brief discussion which follows:

BANFIELD MINE (No. 10)

- Location:** Sec. 34, T. 31 S., R. 2 W., at about 2,200 feet elevation.
- Development:** Five adits total 3,500 feet. There are a few raises and minor stoping.
- Geology:** Mineralization occurs in a north-striking, steeply east-dipping schist belt several hundred feet wide, which is bounded on the west by diorite and on the east by Tertiary volcanics of the Western Cascades. Chalcopyrite and pyrite with associated magnetite are irregularly distributed through the bleached, altered schist in part as narrow stringers and thin lens-shaped masses. Minor cinnabar is also present.
- History and Production:** Located by H. Banfield in 1900. In 1928 production of 52 tons of ore containing 10,059 pounds of copper and 19 ounces of silver was reported. In 1956 a small tonnage of ore was shipped which contained 400 pounds of copper and some silver. The mine has been examined by several companies in recent years and was drilled in 1968 following a geophysical survey.
- References:** Department mine file report and maps, unpub.
Diller and Kay (1924)
Oregon Dept. Geol. and Mineral Indust. (1940)
Shenon (1933)

BEAVER SPRINGS MINE (No. 5)

- Location:** Secs. 7 and 18, T. 31 S., R. 5 W., and secs. 12 and 13, T. 31 S., R. 6 W., at about 2,800 feet elevation. In the 1920's a group of about a dozen claims were located 3 abreast in a northeasterly direction from the head of Russell Creek.
- Development:** Several cuts, short adits, one tunnel over 1,000 feet in length, a 370-foot adit and summit shaft. Probably all caved.

- Geology: Ore is reported to have contained pyrite, chalcopyrite, bornite, and sphalerite; it assayed as high as 12 percent copper, 1 ounce gold, and 12 ounces silver per ton. This occurrence was discovered by tracing the Silver Peak vein in a north-easterly direction.
- Production: There is no record of production.
- References: Department mine file report and maps (1938), unpub.
Shenon (1933)

COPPER BUTTE (No. 12)

- Location: Sec. 9, T. 32 S., R. 2 W., adjoins Rowley mine on the south.
- Development: No information.
- Geology: The Rowley vein reportedly extends into the Copper Butte Claim.
- Production: None.
- Reference: Oregon Dept. Geol. and Mineral Indust. (1940) p. 123

DODSON BUTTE PROSPECTS (GREEN GULCH GROUP) (No. 1)

- Location: The four main workings are in the SE $\frac{1}{4}$ sec. 18, N. center sec. 19, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 19, and N. edge NE $\frac{1}{4}$ sec. 30, T. 28 S., R. 4 W., 1,600 to 2,500 feet elevation.
- Development: Several cuts; Panama tunnel SE $\frac{1}{4}$ sec. 18 about 250 feet; Black Republican tunnel north edge sec. 19, about 200 feet; and possibly other adits.
- Geology: Sulfides and secondary carbonates of copper occur in irregular and sparsely distributed particles in serpentinite and metagabbro near the serpentinite contact. Representative samples for the 200-foot Black Republican tunnel assayed 2.53 percent copper and 5.78 percent for the Yankee Boy open cut.
- Production: There is no record of any production.
- Reference: Diller (1898)
Dr. G. N. Lenci (personal communication, 1967)

GOLDEN GATE MINE (No. 6)

- Location: Sec. 23, T. 31 S., R. 6 W., between 3,000 and 3,300 feet elevation.
- Development: About 600 feet of underground work and some surface cuts.
- Geology: The mine is on the northern extension of the Silver Peak mineralized zone and of similar appearance but with notably less quartz and barite. A layer of northeast-striking, steep southeast-dipping chlorite schist exposed near the Silver Peak road contains disseminated pyrite cubes and some stringers of chalcopyrite.
- Production: Shenon (1933) reported shipment of 3 cars of ore. Values were mainly gold with some copper.
- Reference: Shenon (1933)

GREEN MOUNTAIN MINE (No. 13)

- Location: Near the corner common to secs. 27, 28, 33 and 34, T. 32 S., R. 4 W., between 3,500 and 4,000 feet elevation.
- Development: In 1911, 3 short tunnels and an inclined shaft aggregated about 280 feet of workings.
- Geology: Lenses of chalcopyrite, pyrrhotite, and pyrite occur in sheared altered greenstone.
- Production: Records are lacking on production, but a 2-stamp mill was erected at the mine in 1911.
- Reference: Diller (1914)

HUCKLEBERRY MINE (No. 4) (see chapter on gold and silver)

MELODY PROSPECT (No. 3)

- Location: Sec. 31, T. 29 S., R. 6 W., at about 2,300 feet elevation.
- Development: Exposures were found in logging roads about 1949. Several small cuts have been dug since.
- Geology: Spotty mineralization consisting of disseminations and streaks of pyrite and chalcopyrite with secondary limonite and malachite and small quartz veinlets and epidote. Occurs in a northeast-striking body of altered basalt and diorite (?) within an area of approximately 300 feet by 1 mile. Preliminary samples assayed from trace to 2 percent copper.
- Production: None
- Reference: Department mine file report (1957), unpub.

PENNEL AND FARMER PROSPECT (No. 9)

- Location: Sec. 27, T. 30 S., R. 2 W., at about 1,020 feet elevation, on the South Umpqua River about 1 mile above Tiller.
- Development: An exploration shaft was being sunk in 1930. No follow-up reports are available.
- Geology: Grains and streaks of chalcopyrite are exposed in outcrops of hornblende-quartz-chlorite schist. Extent of the deposit is not known.
- Production: None
- Reference: Shenon (1933)

ROWLEY MINE (No. 11)

- Location: S $\frac{1}{2}$ sec. 4, T. 32 S., R. 2 W., between 2,920 and 3,500 feet elevation.
- Development: About 1,500 feet of trenching and more than 500 feet of underground work in 3 tunnels, two of which are caved.

Geology: There are two zones of mineralization in altered amphibolite and schist. The eastern zone of hydrothermally altered schist with streaks and disseminations of chalcopyrite is from 50 to 150 feet wide and at least 1,000 feet long. It strikes north, dips 45° to 60° E., and surface samples average about 0.5 percent copper. The western zone, which is about 12 feet wide and 150 feet or more in length, strikes about N. 20° W. and dips steeply NE. It contains abundant granular pyrite with quartz, minor sphalerite, and chalcopyrite. A sample across the pyrite vein in the lower north adit assayed 1.1 percent copper and 7.3 percent zinc.

Production: None

References: Department mine file reports and maps (1943), unpub.
Parks and Swartly (1916)
U.S. Bureau of Mines mine file report (1954) unpub.

SILVER PEAK MINE (No. 7)

Location: SW $\frac{1}{4}$ sec. 23 and NW $\frac{1}{4}$ sec. 26, T. 31 S., R. 6 W., at about 3,300 feet elevation. The mineralized zone extends southwest into sec. 27.

Development: There is about half a mile of underground workings in three adits. In addition there are several shallow surface cuts and a 30-foot shaft.

Geology: Lenses and bands of nearly massive granular to disseminated sulfides including pyrite, sphalerite, chalcopyrite and minor bornite, galena, tennantite, chalcocite, and covellite in a gangue of quartz and barite occur in a northeast-striking and steep southeast-dipping altered zone of sericite chlorite schist in metavolcanic rocks of the Rogue (?) Formation near the thrust contact with the Dothan Formation. In places the mineralized zone is more than 100 feet wide.

Production: The mine was discovered in 1910. Estimated total production for the years of operation - 1926, 1928, 1929, 1930, 1931, 1936, and 1937 includes 6,620 tons of ore containing 735,600 pounds of copper, 21,980 ounces of silver, and 490 ounces of gold. Zinc present in the ore was not paid for, but approximately equaled the copper content.

References: Oregon Dept. Geol. and Mineral Indust. (1940)
Shenon (1933)
U.S. Bureau of Mines Minerals Yearbooks

STUEMPGES PROSPECT (No. 2)

Location: Secs. 16 and 21, T. 29 S., R. 5 W., at about 1,600 feet elevation.

Development: Small surface cuts.

Geology: Magnetite segregations associated with disseminated chalcocite in serpentinite with malachite on sheared faces appears to occur near a small dacite dike. Grab samples assayed 2.54 percent and 2.90 percent Cu.

Production: None

References: Department mine file report on Rice Chrome (1942), unpub.
U.S. Bureau Mines mine file report (1955), unpub.

ZINC MINE (No. 8)

Location: Sec. 23, T. 29 S., R. 1 W., at about 1,450 feet elevation on both sides of the South Umpqua River.

Development: There are reported to be 17 short tunnels in the area, most of which are caved at the portal. Total underground workings may be about 2,300 feet.

Geology: Mineralization consists mainly of disseminated pyrite and associated clay alteration in tuff breccias that have been intruded by andesite and augite-diorite dikes. A few small sulfide lenses with sphalerite, galena, and chalcopyrite are found in the more intensely mineralized areas with associated calcite and quartz gangue.

Production: Discovered in 1910. Some ore was reportedly shipped in the 1920's but there is no record of production.

References: Callaghan and Buddington (1938)
Department mine file report (1940), unpub.
Oregon Dept. Geol. and Mineral Indust. (1940)

Gold and Silver

History and production

The first gold mining in Douglas County probably started in 1852 or 1853. Early mining was mainly from placers; lode mining began in the 1890's. Small but occasionally significant amounts of gold were produced annually through 1942, with 1903 being the reported peak production year for the county. Since 1942, gold mining activity has been limited mainly to a very few seasonal placer operations, and production records are scarce because operators have either hoarded their gold or have sold it to private buyers who have hoarded it. Existing records indicate that at least 60 percent of the gold production in Douglas County originated from placers and at least 85 percent of the silver production was derived from lode mines as a byproduct of gold and copper mining.

It is estimated from U.S. Bureau of Mines and U.S. Geological Survey records that the five southwestern Oregon counties produced about \$10,000,000 worth of gold prior to 1900. Douglas County production is not accurately known but on the basis of more recent production figures we can estimate it to be about one-tenth of the total southwestern Oregon production, or possibly \$1,000,000, which would represent about 50,000 ounces of gold. This added to the total estimated production since 1900 (see Table 1) gives an approximate total of 64,000 ounces of gold. Total silver production for Douglas County has been possibly 50,000 ounces.

Libbey (1963) reports more generous gold production figures for southwestern Oregon. He stresses that the bulk of production came from rich placers during the first 10 years of feverish mining activity before production statistics were recorded by federal agencies, and he shows a peak production of about \$5.2 million from southwestern Oregon for 1862. This is considerably higher than the 1940 peak production figure of \$4 million for the entire state. For the period 1852 to 1901, Libbey (1963) estimates a total production for southwestern Oregon of 2.5 million ounces of gold.

Distribution

The accompanying map (Figure 6) shows that most of the gold and silver mines and prospects are concentrated in two main areas in the southern portion of Douglas County, one southeast of Azalea and the other west of Glendale and extending northeast to a point near Canyonville. Other gold occurrences are scattered placer deposits, most of which have a few nearby related lode deposits.

The area southeast of Azalea, in the drainages of Quines and Starvout Creeks, has had the greatest production. It is a northern extension of the Greenback district in Josephine County and is described by Brooks and Ramp (1968, p. 218). The deposits in this area are clustered in and about serpentinite bodies, mainly in veins penetrating volcanics and sediments of the Galice Formation, but also in shear zones along serpentinite contacts, and in altered rocks included within serpentinite.

Ore minerals found in the veins and mineralized shear zones include native gold, pyrite, chalcopyrite, arsenopyrite and in some places galena and sphalerite with a gangue of quartz, calcite, chlorite, talc, and epidote. Arsenopyrite sometimes contains unusually rich amounts of gold.

The other main area of gold and silver mines is the narrow northeast-trending zone west of Glendale that includes the Silver Peak mine, Levans Ledge, Gold Bluff, Huckleberry, Sweetbrier and others to the southwest. Although this mineralized zone appears to align with the Ben Hur and Chieftan-Continental-Hall group northeast of Canyonville, it is believed to be unrelated.

As mentioned in the chapter on copper, the Silver Peak mineralized zone is similar to and possibly a northeastern extension of mineralization of the Big Yank lode that includes the Almeda mine on the Rogue River in Josephine County about 20 miles to the southwest. Dole and Baldwin (1947) determined that the mineralized belt is made up of an echelon shear zones only part of which are mineralized. The mineralization lies within the Rogue Formation of altered volcanic rock (greenstone). In the shears, this rock is altered to a dark green chlorite schist, and near the ore-bodies the schist is bleached to a light gray, almost white, and contains abundant sericite. Where mineralized the schist contains considerable quartz, barite and disseminated to nearly massive granular sulfides, mainly pyrite with some chalcopyrite, sphalerite and rare galena. The surrounding greenstones are in part saussuritized and contain

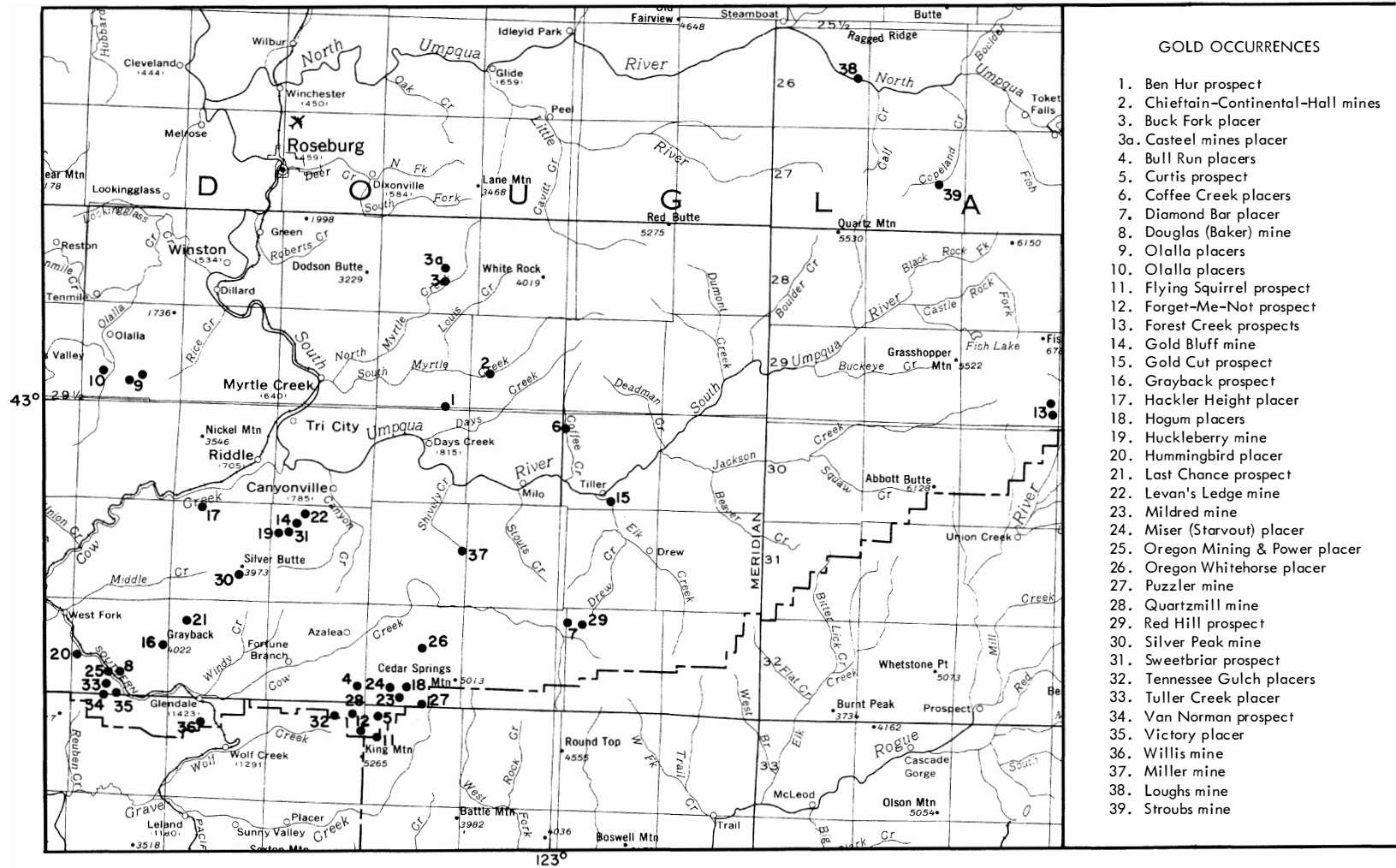


Figure 6. Map showing location of gold occurrences in Douglas County.

epidote, quartz, chlorite, and zoisite. Further prospecting and exploration at depth along these related mineralized zones may well be justified.

White and Wolfe (1950) pointed out interesting occurrences of sulfide mineralization in greenstones along Canyon Creek and its west fork, which in places show minor amounts of gold and copper that may well justify further prospecting.

Mines and prospects

BEN HUR MINE (No. 1)

- Location: Sec. 35, T. 29 S., R. 4 W., on Wood Creek 3.3 miles north of Days Creek at about 1200 feet elevation.
- Development: A 75-foot shaft on the vein near the bed of Wood Creek filled with water in 1939.
- Geology: Diller (1898) mapped the area as metagabbro. No other information is available. The occurrence may be similar to the Chieftain-Continental-Hall vein to the northeast.
- Production: None reported.
- References: Diller (1898)
Oregon Dept. Geol. and Mineral Indust. (1940) p. 118

BUCK FORK PLACERS (No. 3)

- Location: Secs. 12, 13, 14, 23, and 24, T. 28 S., R. 4 W., along North Myrtle Creek.
- Development: Diller (1898) reported that a ditch nearly 40 miles in length bringing water from the Cavitt Creek drainage was almost completed. Several placer pits were worked in the main valley and on higher gravels on the south slopes near the summit of the ridge between Lee and Buck Fork Creeks.
- Geology: The bedrock is a deeply weathered diorite. Most of the values reportedly came from the high bench gravels near the heads of small streams from the north.
- Production: Diller (1898) estimated total production from this area and the Casteel placers on Lee Creek (map location 3a) to be \$150,000. A small amount of seasonal mining was done in the area through 1940 as well as a minor amount more recently.
- Reference: Diller (1898)

BULL RUN PLACERS (No. 4)

- Location: Secs. 25 and 36, T. 32 S., R. 5 W., and sec. 31, T. 32 S., R. 4 W.
The principal mining was done in the bed of the creek in the S $\frac{1}{2}$ sec. 25.
- Development: A short ditch and various pits are still in evidence.
- Geology: The area is mapped by Diller and Kay (1924) as Galice Formation slates and volcanics (greenstone); some schistose rocks and quartzite are also present. No reports are available on the extent or thickness of the gravels.

Production: No records are available, but the extent of worked area is indicative of good values.

Reference: Diller and Kay (1924)

CASTEEL MINES PLACER (No. 3a)

Location: Secs. 14, 15, & 22, T. 28 S., R. 4 W., 160 acres on Lee Creek, a tributary of North Myrtle Creek.

Development: In 1916 there were several short ditches, flumes, flood dams, two large giants, and 1,200 feet of pipe. The operators had plans to put in a 15-mile ditch to enable 7 or 8 months of operation.

Geology: The bedrock is mainly a decomposed quartz diorite (Champ, 1969). Diller (1898) mapped the rocks in the area as metagabbro, and suggested that the source of gold was derived from small quartz veins in the deeply weathered rock.

Production: Diller (1898) estimated that the North Myrtle placers had produced a total of \$150,000. Records are not complete, but these placers were worked in a small way seasonally in the early 1900s and probably through 1940.

References: Diller (1898)
Oregon Dept. Geol. and Mineral Industries (1940) p. 131
Parks and Swartley (1916)

CHIEFTAIN, CONTINENTAL, AND HALL MINES (No. 2)

Location: NE $\frac{1}{4}$ sec. 19 and NW $\frac{1}{4}$ sec. 20, T. 29 S., R. 3 W., at 1,200 feet elevation.

Development: About 1,500 feet in Chieftain, over 2,000 feet in Continental workings and two caved shafts on the Hall property in sec. 19 to the west.

Geology: These properties develop the same quartz fissure vein, which is 1 to 4 feet thick, about 3,000 feet long, strikes westerly, and dips steeply north. Ore minerals include pyrite, chalcopyrite, sphalerite, sylvanite, and petzite. The country rock is metagabbro.

Production: Estimated value of production, mostly prior to 1930, was probably greater than \$100,000 for each of the Chieftain and Continental mines. The Hall mine had small production in 1935. There was some byproduct copper production but the records are not available.

References: Brooks and Ramp (1968)
Wells (1933)

COFFEE CREEK PLACERS (No. 6)

Location: Secs. 5, 6, 7, and 18, T. 30 S., R. 2 W.

Development: About 5 miles of stream, including Texas Gulch and Russell Gulch, were placered. Water was obtained from several small ditches. Some drifting of gravels was done in the early days. A small community, Coffeetown, including a general store and saloon, was built in 1858.

- Geology: Bedrock includes quartz diorite, pelitic schists, amphibolites, and quartzites. Source of the gold is uncertain but none was found above Texas Gulch.
- Production: The rich placers of Texas Gulch were discovered in 1858. Reinhart (1962) reported that the creek was full of men, 300 to 400 miners, in 1859 and undoubtedly the bulk of the production was in the first few months. No accurate records of total production are available, but it is possible that more than a million dollars worth of placer gold was produced. A small amount of seasonal mining is still being done.
- References: Kays (1970)
Reinhart (1962)
Spreen (1939)

CURTIS PROSPECT (No. 5)

- Location: W $\frac{1}{2}$ sec. 5, T. 33 S., R. 4 W., at about 4,000 feet elevation. Four claims were held by location in 1939.
- Development: A 100-foot crosscut tunnel; other short adits and surface cuts.
- Geology: Gold is found associated with talc seams in black serpentinite.
- Production: None reported.
- Reference: Department mine file report (1939), unpub.

DIAMOND BAR PLACER (No. 7)

- Location: Sec. 6, T. 32 S., R. 2 W., on Beaver Creek at about 2,500 feet elevation.
- Development: 7,000 feet of ditch, 550 feet of 10-inch pipe, and a No. 2 giant with a 90-foot head of water.
- Geology: The country rocks are schists of the Applegate Formation. The gold is mostly fine. Gravel containing many boulders is up to 10 feet deep.
- Production: Less than 1 acre had been mined by 1939. No record of the production is available.
- Reference: Department mine file report (1939), unpub.

DOUGLAS (BAKER) MINE (No. 8)

- Location: NW $\frac{1}{4}$ sec. 27, T. 32 S., R. 7 W., at about 1,800 feet elevation.
- Development: A 150-foot adit, with a winze; some drifting and stoping (1938). The mine was equipped with a small mill with concentrating table.
- Geology: Gold occurs in a small quartz vein on or near a serpentinite-greenstone or meta-gabbro (?) contact.
- Production: Small, but not reported.
- Reference: Oregon Dept. Geol. and Mineral Indust. (1940) p. 101-102.

FLYING SQUIRREL LODGE (No. 11)

- Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 7, T. 33 S., R. 4 W., at about 4,750 feet elevation.
- Development: A 150-foot tunnel, caved at the portal and four bulldozer cuts. A small ball mill was being used on the property in 1939.
- Geology: Geology of the area is complex, serpentinites and associated metagabbro intruded greenstones (altered volcanics). Mineralization occurs along the contacts of these rocks and in localized shear zones. Chalcopyrite with secondary malachite and azurite occur in an east-west shear in iron-stained talcy serpentinite. The better gold values in this type of deposit are associated with arsenopyrite.
- Production: There was only a small production during exploration and development work done in 1939.
- References: Department mine file report (1962), unpub.
Oregon Dept. Geol. and Mineral Indust. (1943) p.67

FORGET-ME-NOT LODGE (No. 12)

- Location: SW $\frac{1}{4}$ of NE $\frac{1}{4}$ sec. 12, T. 33 S., R. 5 W., at about 2,950 feet elevation.
- Development: Several short adits, one shallow shaft, and a number of bulldozer trenches.
- Geology: Mineralization consists of silicification and some talc alteration of metavolcanic rocks with pyrite, minor chalcopyrite, and gold. The altered metavolcanics are intruded by serpentinite and diorite. The mineralized zone is 200 to 300 feet wide and 3,000 feet long. Overall values are quite low with a few spots of high grade.
- Production: It has been reported that \$1,300 in gold was milled from 400 pounds of high-grade ore (no date). A few mining companies have done preliminary exploration on this deposit.
- References: Brooks and Ramp (1968) p. 223
Department mine file reports (1945 and 1967), unpub.

FOSTER CREEK PROSPECT (No. 13)

- Location: Secs. 24 and 25, T. 29 S., R. 3 E., in the drainage of Foster Creek.
- Development: Minor exploration work only; includes surface sampling, panning of soil and stream sediments, three shallow drill holes, and a few shallow discovery cuts.
- Geology: Fine particles of free gold can be panned from the soil horizon over hydrothermally altered zones in siliceous tuffs and andesitic rocks. The main mineralized zone strikes about N. 40° W. and contains a few gold bearing zones ranging from 20 to 200 feet wide and several hundred feet in length. Assays are commonly below 0.15 oz. per ton in gold and silver, but have contained as much as 0.57 oz. per ton. The mineralized area appears to have a mercury halo.
- Production: None.
- Reference: Department mine file report (1971), unpub.

GOLD BLUFF MINE (No. 14)

- Location: S $\frac{1}{2}$ sec. 5, T. 31 S., R. 5 W., at about 2,400 feet elevation. Includes 40 acres patented land which adjoins Levans Ledge property to the northeast.
- Development: Several short tunnels have been driven. One is 100 feet in length; others not reported.
- Geology: A 15-foot thick, iron-stained, bleached schist zone in foliated greenstone with disseminated sulfides (mainly pyrite) strikes northeast and dips steeply southeast. The workings are close to a small serpentinite mass.
- Production: Total reported production about \$70,000 in the 1890's.
- References: Department mine file report, undated and unpub.
White and Wolfe (1950) p. 73.

GOLD CUT MINE (No. 15)

- Location: Sec. 34(?) T. 30 S., R. 2 W., on ridge north of Elk Creek about 1 mile east of Tiller on 160 acres deeded land.
- Development: Two open cuts 60 x 20 feet and 60 x 15 feet.
- Geology: Country rocks are gneissic amphibolite with nearby serpentinite and quartz diorite. Mineralization occurs in small quartz vein and intersecting fractures. Ore minerals are pyrite and minor free gold.
- Production: Small. The first work was done in 1917 with some additional work done in 1932 and 1934. Ore was ground in a small prospecting mill.
- Reference: Oregon Dept. Geol. and Mineral Indust., (1940) p. 123.

GOLDEN GATE (see listing under copper mines)

GRAYBACK MOUNTAIN PROSPECT (No. 16)

- Location: Sec. 13 (?) T. 32 S., R. 7 W. Reported to be on the NW side of Grayback Mtn. at about 3,600 feet elevation.
- Development: Two short tunnels and one open cut.
- Geology: This prospect is on a southwestern extension of the Silver Peak mineralized zone.
- Production: None
- Reference: Department mine file report (1939), unpub.

HACKLER HEIGHT PLACER (No. 17)

- Location: SE $\frac{1}{4}$ SW $\frac{1}{4}$ and SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 32, T. 30 S., R. 6 W., and lots 2 and 3 of sec. 5, T. 31 S., R. 6 W., at about 1,370 feet elevation. There are 166.24 acres patented land.

- Development: 3½ miles of ditch from Council and Cold Creeks.
- Geology: Probably bench gravels overlying conglomerate of the Umpqua Formation. The gold is fine and closely associated with detrital quartz fragments. Gravels are reported to be as much as 60 feet deep.
- Production: Unknown. Property was mined in a small way for several years.
- Reference: Department mine file report (1939), unpub.

HOGUM PLACER (No. 18)

- Location: Secs. 20, 21, 28 and 33, T. 32 S., R. 4 W., on Hogum Creek.
- Development: There are 11 ditches with a total length of 6 miles which delivered water from Whitehorse, Fizzleout, Boulder, and Upper Hogum Creeks.
- Geology: The bedrock is Galice Formation slates and greenstone at the very upper end on the flanks of Green Mountain. The gravels vary from 7 to 12 feet in thickness and the average pay channel was about 100 feet wide. Greenstone boulders 2 or 3 feet in diameter are common.
- Production: Hogum Creek was worked from the time of discovery in 1853 to recent years. Only a few small patches of virgin ground and some isolated high bench gravels remain. This creek has undoubtedly furnished a significant amount of Douglas County's total gold production and shares this importance with Coffee, Starvout, and Quines Creeks.
- Reference: Oregon Dept. Geol. and Mineral Indust. (1940), p. 104-105.

HUCKLEBERRY MINE (No. 19)

- Location: Near center sec. 7, T. 31 S., R. 5 W., at about 1,850 feet elevation.
- Development: Two tunnels with several hundred feet of workings.
- Geology: Northeast extension of the Silver Peak mineralized zone which at this point contains disseminated pyrite in a chloritic schist and greenstone. The zone strikes N. 40° E. and dips 75° SE. This occurrence is similar to the Sweetbriar mine about 1 mile to the northeast on the same zone.
- Production: Produced \$2,000 from 1912 to 1915 and about \$16,000 between 1931 and 1936 using a two-stamp mill with amalgamation plates and a table.
- References: Oregon Dept. Geol. and Mineral Indust. (1940), p. 105
White and Wolfe (1950), p. 72-74

HUMMINGBIRD PLACER (No. 20)

- Location: W½ SE¼ NW¼ sec. 19, T. 32 S., R. 7 W., at about 1,400 feet elevation on the west side of Cow Creek.
- Development: A 2-mile ditch which gave a 100-foot head of water.

METALLIC MINERAL RESOURCES

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Geology: This is an old channel or bench gravel deposit. The bed rock is Dothan Formation sandstone. The mineable area was reportedly about 200 x 50 feet. Depth of gravel not reported. The gold is fine.

Production: Unreported.

Reference: Department mine file report (about 1939), unpub.

LAST CHANCE LODE (No. 21)

Location: SW $\frac{1}{4}$ sec. 5, T. 32 S., R. 6 W., at about 2,800 feet elevation at the head of Peavine Creek.

Development: One tunnel 158 feet in a northeasterly direction, the portal of which is reported to be 24 feet from the west line of sec. 5.

Geology: Reported to be in greenstone on a southwest extension of the Silver Peak mineralized zone. This is close to an occurrence in a small serpentinite body surrounded by greenstone, reported by White and Wolfe (1950 p. 76) as the Peavine-Panther Creeks prospect.

Production: None reported.

References: Department mine file report (1939), unpub.
White and Wolfe (1950) p. 76.

LEVANS LEDGE MINE (No. 22)

Location: NE $\frac{1}{4}$ sec. 5, T. 31 S., R. 5 W., at about 1,700 feet elevation.

Development: Seven tunnels having an aggregate length of about 2,400 feet as well as raises, shafts, and stoped areas on 169 acres patented land.

Geology: The country rocks are greenstone and serpentinite with one or more small diorite dikes. The vein consists of a series of overlapping quartz lenses in a 2- to 8-foot mineralized shear zone which strikes N. 70° to 80° E. and dips 60° to 70° SE. Ore minerals are pyrite, chalcopyrite, and gold.

Production: The property reportedly had production in the early days on the order of \$70 or \$80 thousand, using a stamp mill, amalgamation plates and a table.

References: Department mine file report (1945), unpub.
Oregon Dept. Geol. and Mineral Indust. (1940) p. 106

LOUGHS MINE (No. 38)

Location: Sec. 13, T. 26 S., R. 1 E., at about 2,800 feet elevation.

Development: A 40-foot shaft and numerous small tunnels and open cuts.

Geology: Not reported, but probably tuffs and lavas with some rhyolite intrusives.

Production: None reported.

Reference: U.S. Forest Service, Steamboat Ranger District, written communication, 1972.

MILDRED MINE (No. 23)

- Location: NW $\frac{1}{4}$ sec. 33, T. 32 S., R. 4 W., at about 2,500 feet elevation. The property consists of one 19-acre patented claim.
- Development: Five caved tunnels total about 200 feet.
- Geology: Values are in quartz stringers in andesite porphyry (greenstone).
- Production: Worked in a small way for about 20 years prior to 1936. A mill was built in 1936 and a \$630 pocket was mined in 1937.
- Reference: Oregon Dept. Geol. and Mineral Indust. (1940) p. 106-107

MILLER MINE (No. 37)

- Location: On East Fork Shively Creek, N $\frac{1}{2}$ sec. 13, T. 31 S., R. 4 W., at about 1,900 feet elevation.
- Development: No reports available.
- Geology: The area is mapped as Galice Formation slates and greenstone.
- Production: Some placer mining was reportedly done in this area by a Mr. Shively in the early days.
- Reference: Diller and Kay (1924)

MISER (STARVOUT) PLACER (No. 24)

- Location: Secs. 20, 29, and 32, T. 32 S., R. 4 W. on Starvout Creek. Area includes 320 acres in 16 claims, 12 of which were patented (1939).
- Development: About 2 miles of placer ditch remaining. There were probably about 5 miles of ditch in use at one time. Most of the lower 4 miles of Starvout Creek has been placered.
- Geology: The Miser channel is reported to be about 300 feet wide and extend for 2 miles along the creek. The gravel is 6 to 12 feet deep and has a few large boulders and some clay. The gold is coarse. One nugget of about 19 ounces was reportedly recovered. The bedrock is largely Galice Formation slates with minor greenstone and serpentinite.
- Production: Starvout Creek placers have been active producers through the years since about 1853 and, like the Hogum and Coffee Creek placers, were responsible for a significant part of Douglas County gold production.
- References: Oregon Dept. Geol and Mineral Indust. (1940) p. 107
U.S. Bureau of Mines Minerals Year Books

OLALLA PLACERS (Nos. 9 & 10)

- Location: The principal placer activities have been in secs. 19 and 20 on Coarse Gold Creek, and secs. 22, 26, 27 and 28 on Byron and Bushnell Creeks, T. 29 S., R. 7 W.

- Development: These were small, independant hydraulic placer operations. Water was obtained from the old Olalla ditch.
- Geology: Bedrock is Umpqua Formation, mainly shales and sandstones and minor conglomerate. Source of the gold is probably greenstones and serpentinites to the east, some may have been derived from Tertiary conglomerates in Coarse Gold Creek drainage.
- Production: Small, mainly during the 1930's. The ground along Olalla Creek was reportedly tested in 1907 as a possible dredge site.
- References: Oregon Dept. Geol. and Mineral Indust. (1940), p. 102, 109-110

OREGON MINING AND POWER CO. PLACER (No. 25)

- Location: Sec. 28, T. 32 S., R. 7 W. 320 acres of deeded land.
- Development: This was an early-day hydraulic operation with ditches that provided a 350-foot hydraulic head and a flume that dumped tailings into Cow Creek.
- Geology: The deposit is a high bench gravel on the east side of Cow Creek. The bedrock here is greenstone. Values were reported to be about 20 cents per yard at the \$20.67 price of gold per ounce (1916). The gold is reported to be fine in both size and purity.
- Production: The mine was operated for a "great many years" prior to 1915. No records of production were given.
- Reference: Parks and Swartley (1916), p. 173

OREGON WHITEHORSE PLACER (No. 26)

- Location: Secs. 10 and 15, T. 32 S., R. 4 W., about 2 miles up Whitehorse Creek.
- Development: One mile of ditch from Whitehorse Creek delivered water with a 100-foot head. Three acres had been mined by 1939.
- Geology: The gravels are 6 to 10 feet deep and about 200 feet wide and contain many large greenstone boulders. The bedrock is Galice Formation slates, greenstones, and some diorite.
- Production: 160 acres of ground were located in 1930. It is not known if the area was worked prior to that time. Values and production are not reported.
- Reference: Department mine file report (1939), unpub.

PUZZLER MINE (No. 27)

- Location: Sec. 34, T. 32 S., R. 4 W., elevation 4,000 feet at the head of Last Chance Creek.
- Development: There was a 12-foot shaft, a shallow open cut, and a 44-foot tunnel in 1938.

Geology: The country rocks are serpentinite, argillite (slate) and greenstone. Nearby mineralization is localized on sheared serpentinite contact zones.

Production: Ore was milled in an arrastra driven by a 16-foot, overshot water wheel; production figures are not reported.

Reference: Oregon Dept. Geol. and Mineral Indust. (1940) p. 110

QUARTZMILL MINE (No. 28)

Location: $W\frac{1}{2}$ NW $\frac{1}{4}$ sec. 1, T. 33 S., R. 5 W. on Quines Creek, at about 2,150 feet elevation.

Development: A 250-foot drift heads S. 55° W.

Geology: Country rocks are greenstone. Values occur in small quartz veinlets with pyrite and as free gold.

Production: The property was equipped with a water-powered two-stamp mill in 1939. It was first located in the 1860's. Production is not reported.

Reference: Oregon Dept. Geol. and Mineral Indust. (1940) p. 110

RED HILL PROSPECT (No. 29)

Location: Near the $\frac{1}{4}$ corner of secs 5 and 6, T. 32 S., R. 2 W., at about 3,450 feet elevation.

Development: A 50-foot diameter, 20-foot-deep open cut and a short adit entering in the gully below the cut.

Geology: The country rocks are quartzite, quartz mica schist, talc schist, and phyllitic argillite. Pyrite impregnation occurs in a highly sheared, talcy zone about 40 feet wide which strikes north and is nearly vertical. Reportedly, some gold may be panned from small gossan-like pockets in the pyrite-impregnated talcy shear zone. Channel samples, however, indicate very low values.

Production: This is a fairly new prospect and there has been no production. Some placering has been done below the prospect on Beaver Creek.

Reference: Department mine file report (1967), unpub.

SILVER PEAK MINE (No. 30) (see listing under copper mines)

STARVOUT PLACER (see Miser)

STROUBS MINE (No. 39)

Location: On the line of secs. 14 and 23, T. 27 S., R. 2 E., on the northwest side of Copeland Creek at about 2,800 feet elevation.

Development: A 15-foot shaft and small cuts.

- Geology: The country rock is reported to be rhyolite.
- Production: No record. The mine was active from 1929 to 1933. There has been no recent activity.
- Reference: U.S. Forest Service Glide Ranger Station written communication (1972)

SWEETBRIAR PROSPECT (No. 31)

- Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 8, T. 31 S., R. 5 W., at about 1,800 feet elevation on east fork of Mitchell Creek.
- Development: An open cut and 35-foot drift and other small cuts.
- Geology: Workings are on a pale green to white schist with disseminated pyrite and chalcopyrite and a small amount of malachite. This is a northeast extension of the Silver Peak mineralized zone.
- Production: None reported.
- References: Department mine file report (1939), unpub.
White and Wolfe (1950) p. 73

TENNESSEE GULCH PLACER (No. 32)

- Location: Sec. 2, T. 33 S., R. 5 W., and extending downstream into SW $\frac{1}{4}$ sec. 35, T. 32 S., R. 5 W.
- Development: Three miles of ditch out of Quines Creek. About 1 mile of the stream channel has been mined.
- Geology: The channel is from 250 to 500 feet wide and 8 to 12 feet deep. Bedrock is Galice Formation slates and greenstones.
- Production: The stream was pretty well worked out by the 1890's, and parts of the tailings and small patches of virgin ground on the sides were worked during the 1930's and in the upper reaches of the stream during more recent years. No estimates of total production are reported.
- Reference: Department mine file report (1939), unpub.

TULLER CREEK PLACER (No. 33)

- Location: W $\frac{1}{2}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 33, T. 32 S., R. 7 W.
- Development: Not described. This property adjoins the Victory placer on the west.
- Geology: The deposit is part of a high bench gravel deposit on the southwest side of Cow Creek. The gravel is reported to be about 60 feet deep. The bedrock is greenstone and some serpentinite.
- Production: The property had a first water right on Tuller Creek for 20 C.F.S., dated 1853. Production records are not available.

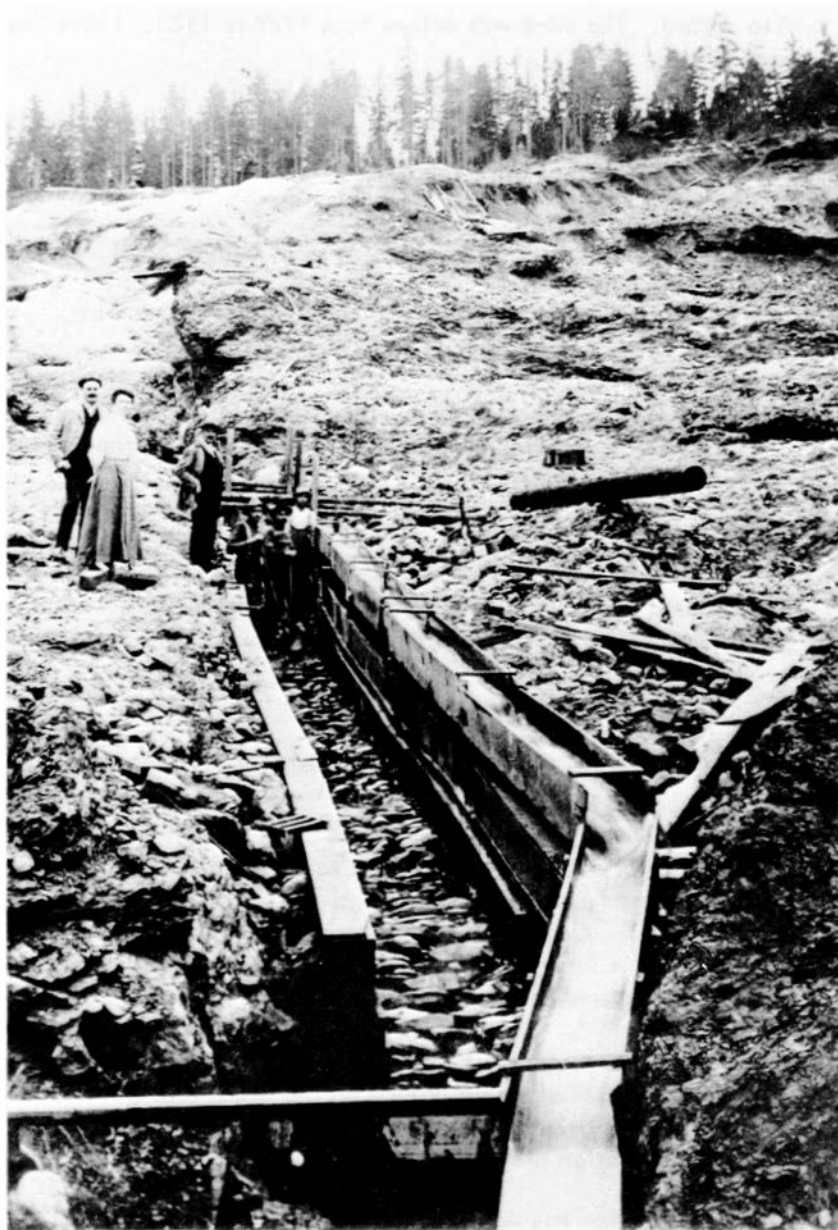


Figure 7. Victory placer mine about 1906. Note by-pass flume used during clean-up of sluice box. (Photograph courtesy of Douglas County Museum)

Reference: Department mine file report (about 1939), unpub.

VAN NORMAN (DUTCHMAN) PROSPECT (No. 34)

Location: Near the common line of secs. 32 and 33, T. 32 S., R. 7 W., at about 2,000 feet elevation on the west side of Tuller Creek.

Development: Small open cuts and ground-sluiced areas.

Geology: Gold occurs free in iron-stained talcy tremolite and iron-stained sheared talcy serpentinite surrounded by sheared greenstone. Some long narrow striated wire gold is recovered from the fibrous amphibole.

Production: The prospect was being worked in a small way during the 1960's. Some hillside placering (ground-sluicing) had been done earlier. The nearby bench gravel and gulches of Tuller Creek were placered in the early days.

References: Bartley, (1972)
Department mine file report (1965), unpub.

VICTORY PLACER (No. 35)

Location: Secs. 27, 28, 33 and 34, T. 32 S., R. 7 W., including 300 acres of patented land and 120 acres located claims.

Development: The principal area worked is in sec. 33. The property is served by three short ditches, two from Marion Creek and one from Tuller Creek.

Geology: The bedrock is serpentinite and greenstone belonging to the Rogue Formation. The deposit is a high bench gravel of about 300 acres in extent and up to 60 feet deep. It has been pretty well worked out.

Production: The first water right was taken in 1854. The mine was worked intermittently for more than 100 years by a number of different operators. Both fine and coarse nuggets have been recovered. (Figure 7) Average values per yard are modest to low. No records or estimates of total production are available.

Reference: Department mine file report and map (1940), unpub.

WILLIS MINE (No. 36)

Location: NW corner sec. 9, T. 33 S., R. 6 W., at about 1,600 feet elevation.

Development: A 200-foot adit trends N. 86° E.

Geology: The country rocks are metavolcanics, in part altered rhyolite with sparsely disseminated pyrite. Samples taken in the tunnel indicated very low gold values. Water from the tunnel is used by the town of Glendale.

Production: None reported.

Reference: Oregon Dept. Geol. and Mineral Indust. (1940) p. 117

Iron

No potentially commercial deposits of iron ore are known in Douglas County. One occurrence of magnetite is reported in the Tiller-Drew area. This occurrence, the Cooper and Young prospect, is located near the corner common to sections 3, 4, 9, and 10, T. 31 S., R. 2 W., at about 1,750 feet elevation on a bare hillside underlain by partly serpentinized peridotite. Lenses of disseminated to massive magnetite as much as 2 feet thick occur in a zone intermittently exposed for a distance of about 45 feet. The zone strikes about N. 20° E. and appears to dip nearly vertically. It was exposed in a shallow bulldozer cut when examined by the writer in 1960. A sample of the more massive magnetite (P-25470) assayed 67.17 percent Fe.

Manganese

Two small occurrences of manganese have been reported, but there has been no production of manganese ore other than small quantities of rhodonite which have been used for ornamental and lapidary material. The manganese resources of southwestern Oregon are summarized by Appling (1958).

BULL RUN MANGANESE

- Location: SW corner sec. 30, T. 32 S., R. 4 W., and extending into sec. 25, T. 32 S., R. 5 W., at about 2,200 feet elevation.
- Development: Several small open cuts 5 to 18 feet deep, the largest about 200 feet long.
- Geology: The area is underlain by highly altered sedimentary and volcanic rocks. Rhodonite occurs in an area 35 feet long and 20 feet wide in soft, weathered red mica schist. The rhodonite is coated by a 4- to 6-inch covering of black manganese oxides. Strike of the zone appears to be NE-SW.
- Production: Small amounts of the rhodonite have been taken out for ornamental building stone and lapidary material.
- References: Appling (1958) p. 18-21
Department mine file report (1969), unpub.

SITTING DUCK MANGANESE

- Location: Sec. 19, T. 30 S., R. 3 W.
- Development: Shallow open cut.
- Geology: A bed of manganese oxides about 6 feet thick and exposed for 30 feet strikes about N. 60° E. and dips 55° SE. The country rocks are massive argillites and siltstones mapped as Dothan Formation by Diller and Kay (1924). Some banded manganese-stained cherts are found nearby and some rhodonite is found at a depth of about 10 feet beneath the oxidized surface material. Surface ore assays about 47 percent Mn.

Production: None.

Reference: Department mine file report (1956), unpub.

OTHER OCCURRENCES

There are probably a few other unreported occurrences of minor surface concentration of manganese oxides associated with chert bodies in the Dothan Formation. One such example known to the writer is on the ridge west of Big Dutchman Butte in sec. 7, T. 31 S., R. 8 W., at about 3,100 feet elevation.

A search of these occurrences may result in finding minor amounts of rhodonite but they are not considered a good potential source of manganese ore.

Mercury (Quicksilver)

Douglas County is the largest producer of mercury (quicksilver) in Oregon. About 97 percent of the total output for the county has come from the Bonanza mine, which has been the most productive mercury mine in the state. Other mines in Douglas County that have contributed to the total production include the Elkhead, Nonpareil, and Red Cloud mines. The Maude S. and Buena Vista mines also produced a few flasks. A number of other occurrences may have had minor production that was not recorded.

There are four main areas of quicksilver occurrences, each with its own characteristic type of geology. The four areas, comprising the Elkhead, Bonanza-Nonpareil, Tiller-South Umpqua, and Upper Cow Creek (see Figure 8), are discussed below.

Quicksilver areas

Elkhead area: Brooks (1963, 1971) describes the Elkhead area as extending along Elk Creek south of Scotts Valley in T. 23 S., R. 4 W., about 4 miles west of the Black Butte quicksilver mine in Lane County. Deposits in the area include the Elkhead mine and the Thompson, Wilson, and Allen prospects. The Elkhead and Thompson lie within a zone of shearing along the steeply-dipping contact between amygdaloidal basalt and overlying sandstone of the Umpqua Formation. The Wilson prospect, about 3 miles to the northwest, and the Allen prospect, three quarters of a mile west, are along small faults in the basalt.

The Elkhead mine is the only producer in the area, with a recorded production of at least 551 flasks and a possible total production of several hundred flasks more.

Bonanza-Nonpareil area: The area lies a few miles east of the community of Sutherlin. It includes a group of five mines and prospects fairly well aligned in a northeast direction along or adjacent to a reverse fault zone which dips about 45° SE. Ore bodies appear to be localized by cross faults and to occur mainly in tuffaceous sandstone where overlain by a relatively impervious layer of shale. The distance between the northern-most occurrence, the Butte prospect, and the southern-most occurrence, the Sutherland mine is about 6 3/4 miles. In between are the Nonpareil mine, the Bonanza mine, and the Longbrake prospect. The Bonanza mine has been by far the largest producer of quicksilver in the state with a total of 39,540 flasks. The deposit is said to have been discovered in the 1860's. Ore was mined to a depth of 1,450 feet down dip. The mine was closed in 1961 and the lower levels are flooded.

Tiller-South Umpqua area: Nine small quicksilver occurrences are found in the drainage of the South Umpqua River above Tiller. Eight of them lie north of the South Umpqua between Quartz Creek and Deadman Creek, and a ninth is on Elk Creek near Drew. All of these deposits occur in Tertiary lavas and pyroclastics (tuffs) of the Western Cascades Volcanic Series, with the exception of the Buena Vista mine, where older Tertiary sedimentary rocks are in fault contact with the volcanics. Cinnabar is

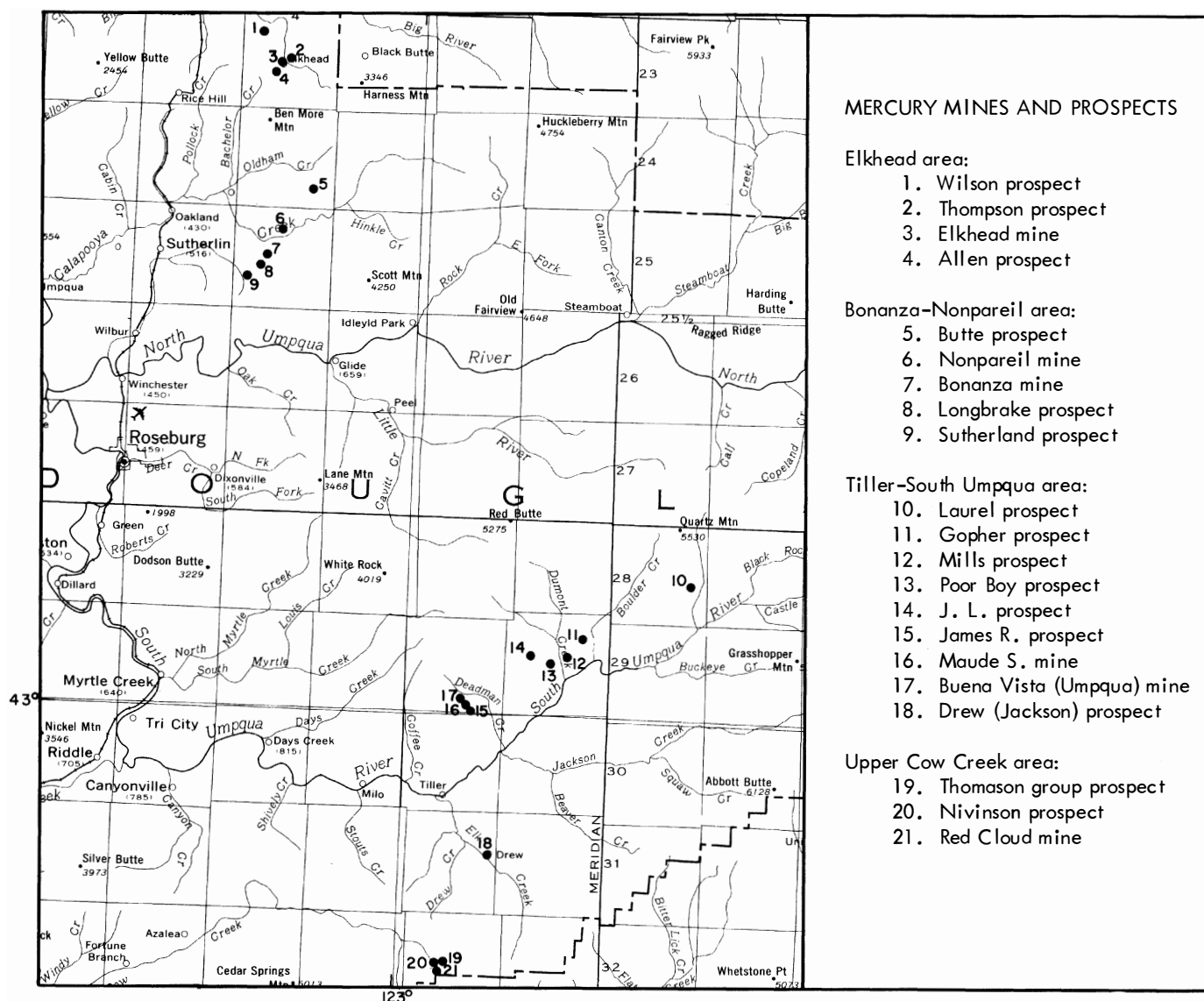


Figure 8. Map showing location of mercury mines and prospects in Douglas County.

associated with veinlets of calcite and chalcedony in zones of shearing and hydrothermal alteration. Only two of this group of occurrences have had any production. The Buena Vista mine recorded 9 flasks production; however, it is likely that it actually produced more and that the nearby Maude S. also produced a few flasks that were never recorded.

Upper Cow Creek area: The Upper Cow Creek area has a group of quicksilver mines and prospects in the headwaters of East Fork Cow Creek in sections 16 and 21, T. 32 S., R. 2 W. This group includes the Red Cloud mine and the Nivinson and Thomason prospects.

The country rocks are schistose amphibolites and quartz mica schists of the Triassic Applegate Formation, which is locally overlain by Tertiary volcanics. Several nearly vertical faults trending N.20° to 40° W. and an occasional northeast-trending shear zone have been exposed by the mine and prospect workings.

Brooks (1963, p. 60) states:

"Only at the Red Cloud mine is any appreciable amount of cinnabar known to have been found in place, although it occurs as float and pannings in the surface mantle of many parts of the area. The fact that the many other workings penetrated barren or only weakly mineralized rock suggests that the float was probably derived from numerous occurrences which alone are too small and widely scattered to permit profitable exploitation."

Mines and prospects

ALLEN PROSPECT (No. 4)

Location: N $\frac{1}{2}$ SW $\frac{1}{4}$ sec. 21, T. 23 S., R. 4 W., about 3/4 mile west of the Elkhead mine.

Development: Short adit and 2 or 3 small pits, all caved.

Geology: Some cinnabar reportedly occurs in a narrow fault zone in altered basalt.

Production: None.

Reference: Brooks (1963) p. 43

BONANZA MINE (No. 7)

Location: W $\frac{1}{2}$ sec. 16, T. 25 S., R. 4 W., about 7 miles east of Sutherlin. (Figure 9)

Development: There are approximately 17,500 feet in 12 levels in the main workings area. These are mainly drifts but include winzes and crosscuts. In addition, there are a number of large stoped areas and surface pits.

Geology: Ore bodies are irregular lenses scattered along a zone of shearing that roughly parallels the bedding in a tuffaceous sandstone horizon overlain by shales. These sediments belong to the Umpqua Formation. The zone appears to be a reverse fault that dips about 45° SE. The ore bodies are in sheared argillized sandstone that is veined and impregnated with calcite, siderite, chalcedony, quartz, and cinnabar. Some metacinnabarite and native quicksilver were found in the upper workings. Marcasite is locally abundant in the mineralized zone, but arsenic and antimony sulfides are extremely rare. The main ore body encountered on the 370-foot level was about 600 feet long, as much as 60 feet thick, and tapered both laterally and downward, pinching to 4 feet thick and 150 feet long on the 700-foot

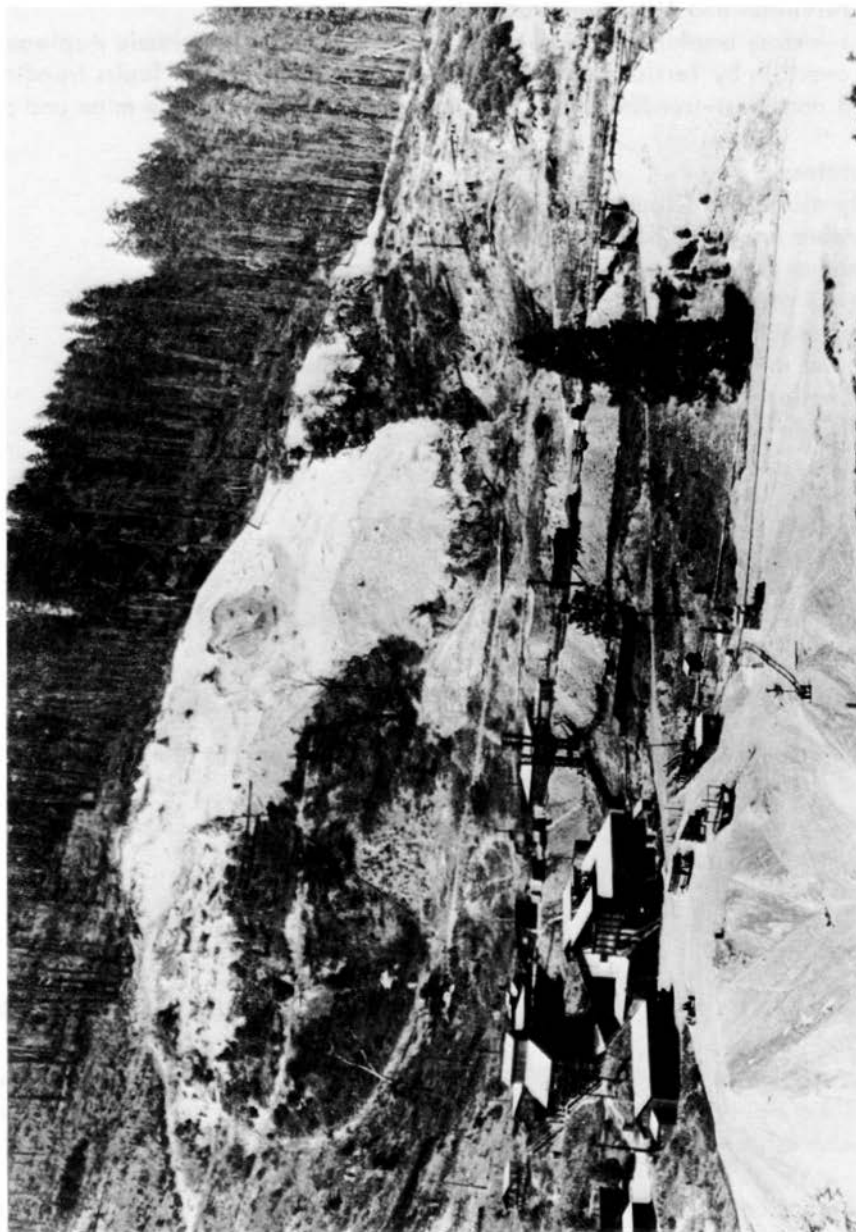


Figure 9. Surface workings and plant at the Bonanza quicksilver mine in 1960. (Photograph courtesy of Roseburg News Review)

level. Some of the ore assayed as high as 60 pounds to the ton, but the average tenor was probably about 6 pounds.

Production: Total production is estimated to be 39,540 flasks. The main period of production was from 1937 to 1960. The mine was discovered about 1865 and was owned for brief periods by several individuals and groups. The first recorded production was 15 flasks in 1887. No other production was recorded between that date and 1937.

References: Brooks (1963) p. 44-49;(1971)
Brown and Waters (1951)
Wells and Waters (1934)

BUENA VISTA (UMPQUA) MINE (No. 17)

Location: N $\frac{1}{2}$ sec. 34, T. 29 S., R. 2 W., at about 2,000 feet elevation.

Development: The main adit contains about 480 feet of crosscuts and 350 feet of drifts. It is connected by raises and stopes to intermediate and upper levels which contain 60 and 100 feet of drifts respectively. There is a 100-foot adit above the upper level and several caved open cuts.

Geology: Conglomerates, sandstones, and siltstones of the Umpqua (?) Formation are in fault contact with overlying andesites and tuffs. The fault zone strikes N. 65° to 70° E. and dips about 80° N. The workings explore carbonatized and kaolinized andesite and tuff breccia in the fault zone. Spotty cinnabar mineralization occurs in the main fault zone and locally along transverse fractures with veinlets of chalcite and chalcedony associated with pyrite and marcasite.

Production: Nine flasks recorded, probably a few more. Development began in 1918. Most of the work was done in the 1920's and early 1930's. Recorded production was in 1929 and 1943.

References: Brooks (1963) p. 52-55
Wells and Waters (1934) p. 42-45
Williams and Compton (1943)

BUTTE PROSPECTS (No. 5)

Location: SE $\frac{1}{4}$ sec. 26, T. 24 S., R. 4 W., about 2 $\frac{1}{2}$ miles northeast of the Nonpareil mine.

Development: The main tunnel was caved and a short tunnel is nearby. Other details are lacking.

Geology: The workings penetrate a brecciated tuffaceous sandstone cemented by iron ribs. The zone of altered rock in which the prospects are located is about 100 yards wide and 1 mile long. No cinnabar was seen.

Production: None.

References: Brooks (1963) p. 51
Brown and Waters (1951)
Wells and Waters (1934)

DREW (JACKSON) PROSPECT (No. 18)

- Location: NW $\frac{1}{4}$ sec. 13, T. 31 S., R. 2 W., at about 1,400 feet elevation beside State Highway 227.
- Development: A 25-foot tunnel in the highway cut and two shallow caved shafts a short distance up the hillside.
- Geology: The country rocks are interbedded basalts and tuffs. Minor amounts of cinnabar occur in calcite-chalcedony veinlets along fractures in hydrothermally altered basalt. The adit follows a zone of multiple fractures striking N. 10° to 30° E., and dipping 65° NW. There may be increased mineralization where the fracture zone cuts the overlying tuffs but this area was not exposed.
- Production: None.
- Reference: Department mine file report (1965), unpub.

ELKHEAD MINE (No. 3)

- Location: NE $\frac{1}{4}$, sec. 21, T. 23 S., R. 4 W.
- Development: At least 1,800 feet of workings in 6 adits with about 1,000 feet of drifts and crosscuts connected by raises to two glory holes at the surface. The 6th adit has been largely destroyed by trenching.
- Geology: Amygdaloidal basalts are overlain by a series of interbedded sandstones and shales of the Umpqua Formation. Fracturing and hydrothermal alteration has taken place along a faulted contact of the basalt with a tuffaceous sandstone. The contact fault trends northeast and dips 70° to 80° SE. Cinnabar has been deposited as disseminations and occasional veinlets in the altered tuffaceous sandstone within 25 or 30 feet of the basalt contact. Other faults occurring in the overlying sediments strike roughly parallel to the contact, but one fault dips in the opposite direction. These faults probably served as channelways for mineralizing solutions. The shale horizon has acted as a barrier to the rising solutions.
- Production: Records show 551 flasks. Some additional production was probably not recorded in the early history of the mine, which was first worked in about 1870. It was reopened in 1916 after many years of inactivity and had a history of intermittent activity to its recent closure in 1972 owing to low prices.
- References: Brooks (1963) p. 41-43; (1971)
Wells and Waters (1934)

GOPHER PROSPECT (No. 11)

- Location: N $\frac{1}{2}$ sec. 11, T. 29 S., R. 1 W., at about 2,000 feet elevation.
- Development: A short discovery tunnel and open cut about 600 feet northeast of the tunnel.
- Geology: Country rock is reported to be rhyolite. It is reported that you can pan cinnabar over a distance of 1,000 feet.

Production: None.

Reference: Oregon Dept. Geol. & Mineral Indust. (1940) p. 124

JAMES R. PROSPECT (No. 15)

Location: Sections 34 and 35, T. 29 S., R. 2 W., a short distance southeast of the Maude S. mine.

Development: A lower adit 140 feet long and an upper 80 feet long as well as several other short adits and open cuts. All are caved.

Geology: Workings explore veinlets of calcite and chalcedony in small faults cutting altered andesite lavas and tuffs. Very little cinnabar was found.

Production: None.

References: Brooks (1963) p. 57
Wells and Waters (1934)

J.L. PROSPECT (No. 14)

Location: NW $\frac{1}{4}$ sec. 17, T. 29 S., R. 1 W., at about 3,500 feet elevation.

Development: Several shallow bulldozer cuts.

Geology: Cinnabar occurs in a 10-foot wide shear zone containing silicified fault breccia in altered basalt. The fault zone strikes about east, and is nearly vertical. Similar mineralized shears also cut the interbedded tuffs and are exposed in nearby cuts. Assay values are generally low.

Production: None.

Reference: Department mine file report (1965), unpub.

LAUREL PROSPECT (No. 10)

Location: SW $\frac{1}{4}$ sec. 24, T. 28 S., R. 1 E., at about 3,360 feet elevation.

Development: A shallow discovery cut.

Geology: The prospect is on a 3-foot mineralized zone in a rhyolite dike or plug that penetrates tuffs and lavas of the Western Cascades volcanics. The zone contains narrow seams of barite crystals with some goethite crystals, pyrite, and minor cinnabar. Assays of 0.80 and 0.50 lb. per ton Hg were obtained.

Production: None.

Reference: Brooks (1963) p. 57

Longbrake Prospect (No. 8)

Location: NE $\frac{1}{4}$ sec. 20, T. 25 S., R. 4 W., on the east slope near the crest of the ridge about $\frac{3}{4}$ mile southwest of the Bonanza mine.

- Development: A 360-foot crosscut adit and small open cut.
- Geology: Only a trace of cinnabar was found. It occurs in slightly altered sandstone with thin interbeds of shale which strikes about N. 25° E. and dips 35 to 40° SE.
- Production: None.
- Reference: Brooks (1963) p. 51

MAUDE S. MINE (No. 16)

- Location: N $\frac{1}{2}$ sec. 34, T. 29 S., R. 2 W., at about 2,400 feet elevation. The mine is about 1,600 feet S. 25° E. and 400 feet above the Buena Vista (Umpqua) mine and is part of the same property.
- Development: About 900 feet in three adits with connecting raises and a glory hole. A 4th adit lying 600 feet northwest and down slope is 220 feet long. In addition there are several open cuts.
- Geology: Mineralization occurs along a system of gouge-filled faults, which trend N. 25° to 45° W. and dip 60° to 80° SW. These faults cut tuffs and andesites. The rocks are sheared and altered by carbonatization and are penetrated by calcite veinlets and silica-limonite ribs. A small amount of high-grade ore was found, but the over-all tenor of ore developed is low.
- Production: The development began in 1927 and a few flasks of mercury were reportedly produced between 1928 and 1936. Judging by the size of the calcine dump at the site of a small Scott furnace, about 100 tons of ore were treated. Some of the ore was treated in retorts at the Buena Vista mine.
- References: Brooks (1963) p. 55-57
Wells and Waters (1934)p. 45-46
Williams and Compton (1943)

MILLS PROSPECT (No. 12)

- Location: Sec. 15, T. 29 S., R. 1 W., about $1\frac{1}{2}$ miles by trail up Dumont Creek from South Umpqua road.
- Development: Several pits and short adits; the main adit is reported to be 42 feet long with a short winze at the end.
- Geology: Cinnabar occurs in veinlets of calcite and chalcedony within a north-trending fault zone cutting andesites and tuffs.
- Production: None. Exploration was done in the late 1930's and early 1940's by L.O. Mills.
- Reference: Brooks (1963) p. 58

NIVINSON PROSPECT (No. 20)

- Location: SW $\frac{1}{4}$ sec. 16, T. 32 S., R. 2 W., near the bridge crossing East Fork Cow Creek at about 3,500 feet elevation.

- Development: Several short adits and open cuts. One adit enters the south bank of the creek just above the old bridge. Another enters the north bank a short distance below the bridge. Both are caved.
- Geology: The bedrock is amphibole schist cut by calcite veinlets. Pieces of high-grade float cinnabar were reportedly panned from stream terrace gravels encountered near the portal of the lower adit.
- Production: None recorded. The work was done by the Nivinson brothers prior to 1929.
- Reference: Brooks (1963) p. 62
- NONPAREIL MINE (No. 6)
- Location: SW $\frac{1}{4}$ sec. 3 and NW $\frac{1}{4}$ sec. 10, T. 25 S., R. 5 W.
- Development: There are two principal areas of workings about 2,000 feet apart. The South Nonpareil has 4 adits and an open cut with a total of more than 3,000 feet of workings which explore an area of 520 feet long and 165 feet deep. Ore was mined from 5 stopes. The North Nonpareil has at least 12 short adits, two shallow shafts, and several open cuts. Three of the 12 adits are between 250 and 300 feet long and the rest are 10 to 30 feet. Ore was mined from an isolated pocket in adit 5 N.
- Geology: Ore bodies are formed along northwest-trending cross faults in tuffaceous sandstone some distance below the same shale horizon that aided in localizing ore bodies at the Bonanza mine. The cross faults are marked by zones of brecciation and intense hydrothermal alteration including silicification. Ore is localized along lens-shaped bedding-plane shears extending short distances from the cross faults. Exploration of the intersection of the cross faults with the sandstone-shale contact failed to disclose good ore bodies.
- Production: Brown and Waters (1951) estimated the total production at about 340 flasks. The records show 90 flasks. The mine was discovered between 1865 and 1870. About 34 flasks were reportedly produced before 1880 using a Scott furnace. The mine was worked by several different operators over the years and was idle at times. The latest exploration work was done in 1956 and 1957 by Bonanza Oil and Mines, Inc.
- References: Brooks, (1963) p. 49; (1971)
Brown and Waters (1951)
Wells and Waters (1934)
- POOR BOY PROSPECT (MONTE CARLO) (No. 13)
- Location: S $\frac{1}{2}$ sec. 16, T. 29 S., R. 1 W., on Budd Creek at about 2,100 feet elevation.
- Development: Two short adits on the north side of Budd Creek about 2,000 feet apart. The eastern adit in the road cut is 48 feet long. The western adit, near creek level, is about 70 feet long.
- Geology: The country rocks are altered tuffs and lavas. The workings follow northwest-trending shear zones made up of several sub-parallel faults. Evidence of mineralization includes iron-stained clayey gouge, chalcedony, and calcite veinlets. Areas of more intense brecciation and alteration are found accompanying a set of



Figure 10. Rotary furnace at the Red Cloud mine about 1940.

intersecting northeast-trending fractures. Pannings of the clay gouge and altered rocks show some cinnabar.

Production: None.

Reference: Brooks (1963) p. 58

RED CLOUD MINE (No. 21)

Location: Near center NW $\frac{1}{4}$ sec. 21, T. 32 S., R. 2 W., between 3,750 and 4,300 feet elevation.

Development: About 1,250 feet in three main levels, including a few crosscuts, stopes and raises, plus other short adits and open cuts. The workings are mostly caved.

Geology: The country rocks are Applegate Formation amphibolites alternating with quartz hornblende and quartz mica schists. Mineralization occurs along a nearly vertical fault zone trending N. 25° to 35° W. Cinnabar occurs as paint-thin coatings on fractures and disseminations in the fault gouge. It also occurs with pyrite in calcite veinlets.

Production: Records show 6 flasks; probably about 63 were produced. The mine was discovered in 1907. Production periods were 39 flasks during 1932 to 1934; 14 flasks during 1936 to 1938; and 10 or 12 flasks during 1940 and 1941 (see Figure 10). In 1957 a 20-ton rotary furnace that had been installed in 1940 was moved to a mine in Lake County.

References: Brooks (1963) p. 60-62
Department mine file report, 1946, unpub.
Williams and Compton (1943)

SUTHERLAND PROSPECT (No. 9)

Location: NE $\frac{1}{4}$ sec. 30, T. 25 S., R. 4 W., about 1 $\frac{1}{2}$ miles southwest of the Bonanza mine.

Development: A 30-foot tunnel.

Geology: Coarse tuffaceous grit and fine-grained sandstone have iron ribs. Little or no cinnabar was found.

Production: None.

References: Brooks (1963) p. 51
Wells and Waters (1934) p. 41

THOMASON GROUP PROSPECTS (No. 19)

Location: SE $\frac{1}{4}$ sec. 16, T. 32 S., R. 2 W., about 3,650 feet elevation.

Development: At least 4 bulldozer trenches each about 100 feet long, several shallow shafts and pits, and about 500 shallow auger holes were all dug by Lewis Thomason in the early 1940's (?).

Geology: The country rocks are decomposed schists. Most of the auger holes of 6 or 8 feet

depth reportedly had favorable pannings of cinnabar; however, none of the trenches contained an appreciable amount of cinnabar.

Production: None.

Reference: Brooks (1963) p. 62

THOMPSON PROSPECT (No. 2)

Location: SW $\frac{1}{4}$ sec. 15, T. 23 S., R. 4 W., adjoining the Elkhead property on the north-east and once part of it.

Development: A short adit, a shallow shaft, and four bulldozer trenches each 250 to 300 feet long.

Geology: Traces of cinnabar were found in fractured sandstone along a northeast-trending contact with basalt. This is the northeastern extension of the mineralized contact of the Elkhead mine.

Production: None. Exploration trenches were dug in 1958 by Moneta Porcupine Mines Ltd.

Reference: Brooks (1963) p. 43

WILSON PROSPECT (No. 1)

Location: N $\frac{1}{2}$ sec. 8, T. 23 S., R. 4 W., about 3 miles northwest of the Elkhead mine.

Development: Small discovery cut and 10-foot adit (caved).

Geology: Cinnabar occurs as disseminated specks and thin coatings on shear surfaces in a weakly argillized west-trending fault zone of 1- or 2-foot width in basalt of the Umpqua Formation. Samples contain less than 1 pound per ton of quicksilver. The fault has not been explored sufficiently to determine continuity or amount of mineralization along it.

Production: None.

Reference: Brooks, (1963) p. 43

Nickel

Nickel is by far the most important mineral resource in Douglas County when measured by economic impact. Since 1954, when the Hanna Nickel mine started production, the region has felt the strong beneficial effect on the economy of the area. The mine and smelter combined employ about 500 persons and the gross annual value of nickel metal produced has risen in recent years to about \$30 million. This single operation puts Douglas County ahead of all other counties in the state in mineral production.

The Hanna Nickel mine is the only productive nickel mine in the United States. In view of its singular importance, it is discussed in greater detail in this report than is any other mining enterprise in Douglas County. Figures 11 and 12 are aerial photographs of the mine and smelter.

Location of Hanna Nickel mine

The mine is on Nickel Mountain in secs. 7,8,9,16,17,18,20, and 21, T. 30 S., R. 6 W. The top of Nickel Mountain is at 3,546 feet elevation. The nickel deposits occur at the top, on all of the flanks of the mountain, and as low as 1,800 feet elevation on the southeast flank. The deposits are about 4 miles west of Riddle, which is 2 miles west of Interstate 5. The Southern Pacific Railroad passes through Riddle, and a spur leads to the Hanna smelter at the base of the mountain.

History

The town of Riddle was named after William H. Riddle, who, with his family, was the first settler in that part of Cow Creek Valley in 1851. In the early days Nickel Mountain was covered with pine trees and was known as "Old Piney".

The deposit of nickel was first discovered in 1865 by sheepherders who thought it to be tin, but in digging deeper they found green ore and thought it was copper. Samples sent to William Q. Brown, a mining expert, who was mining on Althouse Creek in Josephine County, were analysed and found to contain 6 percent nickel and no copper or tin. Brown and associates purchased the property in 1882, the same year that the railroad was extended south from Roseburg to Riddle. They explored the deposit by open cuts, tunnels, and shafts. More than 3,000 tons of ore was mined and stockpiled on the dumps. The ore averaged about 5 percent nickel and was valued at about \$150,000 at that time. In 1891, Brown and J.B. Riddle sold 200 acres of the property to the International Nickel Mining Company of Chicago. The company spent over \$100,000 in constructing a hotel, houses for workmen and a saw mill; a 150-ton smelter was purchased but never erected. Stockholders got into litigation and a Mr. Winslow of Chicago became owner. Winslow and W.Q. Brown, who still held some of the property, apparently sold to the Adams family of Oakland, California.

In the late 1930's and early 1940's at least two interested mining companies examined the deposit. A few churn drill holes were put down, some metallurgical testing was probably done, but no publicity resulted.

In 1941, Freeport Sulphur Company obtained a lease from Edison F. Adams and in 1942 did extensive exploration and testing work. In 1943, Freeport relinquished its lease due mainly to difficulties in economic treatment of the ore. (The market price of nickel was then 35 cents per pound.)

Following World War II, in 1947, the M.A. Hanna Company of Cleveland, Ohio negotiated and obtained a lease from the Adams estate. Hanna began extensive exploration and metallurgical testing and in January 1953 signed a contract with the government. Thus began the first U.S. production of nickel other than a small by-product recovery from the smelting of copper ores. The mine tramway and smelter were constructed during 1953 and 1954 and the first ferronickel pigs were poured in July, 1954. Production between 1954 and 1971 is given in Table 3.



Figure 11. Aerial view of the Hanna Nickel mining operation on the top of Nickel Mountain. (Photograph by Warren Studio, Myrtle Creek)



Figure 12. Aerial view of Nickel Mountain showing the Hanna smelter and the tramway that carries the ore from the mine at top of the mountain to the stockpile at the base. (Photograph by Western Ways, Inc., Corvallis)

For the first 17 years of plant operation, silica ore from the Bristol Silica mine in Jackson County was used to make ferrosilicon, and since 1970 silica rock from the Quartz Mountain deposit in eastern Douglas County has been utilized at the rate of from 20 to 25 thousand tons per year.

Table 3. Mine and Smelter Production summary *

<u>Year</u>	<u>Crude Tons Mined</u>	<u>Nickel Production (pounds)</u>
1954	129,000	319,000
1955	423,000	6,505,000
1956	614,000	11,383,000
1957	1,087,000	18,122,000
1958	1,243,000	21,234,000
1959	1,287,000	20,794,000
1960	1,426,000	22,229,000
1961	1,422,000	20,650,000
1962	1,395,000	21,139,000
1963	1,480,000	21,448,000
1964	1,813,000	22,473,000
1965	1,898,000	25,333,000
1966	1,691,000	24,533,000
1967	1,672,000	26,070,000
1968	1,898,000	26,252,000
1969	1,781,000	26,172,000
1970	2,137,000	25,349,000
1971	2,215,000	25,934,000
TOTAL	25,611,000	365,939,000

* Furnished by Hanna Mining Company

Geology of the nickel deposit

A number of reports contain information on the geology of the Nickel Mountain deposit. Some of the more easily obtained references are: Clark (1888); Kay (1907); Diller and Kay (1924); Pecora and Hobbs (1942); ORE BIN (1953); Hotz (1964); Chace and others (1969); and Hotz and Ramp (1969). The geology is briefly summarized below and shown on the small geologic map of the area (Figure 13).

The top 1000 feet of Nickel Mountain is composed of relatively unserpentinized peridotite believed to have been emplaced during the Nevadan Orogeny in Late Jurassic time. Masses of serpentinite (altered peridotite) extend to the southwest and northeast of the main peridotite body. The peridotite and associated serpentinite appear to override, by means of a high-angle reverse fault, Late Jurassic sedimentary and volcanic rocks of the Dothan-Otter Point Formation to the northwest. The ultramafics are overlain by Cretaceous and early Tertiary sediments to the southeast.

The nickel ore has formed by the process of laterization in which chemical weathering and leaching have decomposed the original peridotite and caused downward enrichment of the nickel. Percolating rain water through fault zones and numerous fractures have hastened the process. It is suggested by Cumberlandidge and Chace (1968) that the subtropical and warm-temperate climates of the early Tertiary Period helped to form the laterite. The serpentinites are more resistant to weathering and do not develop into laterite.

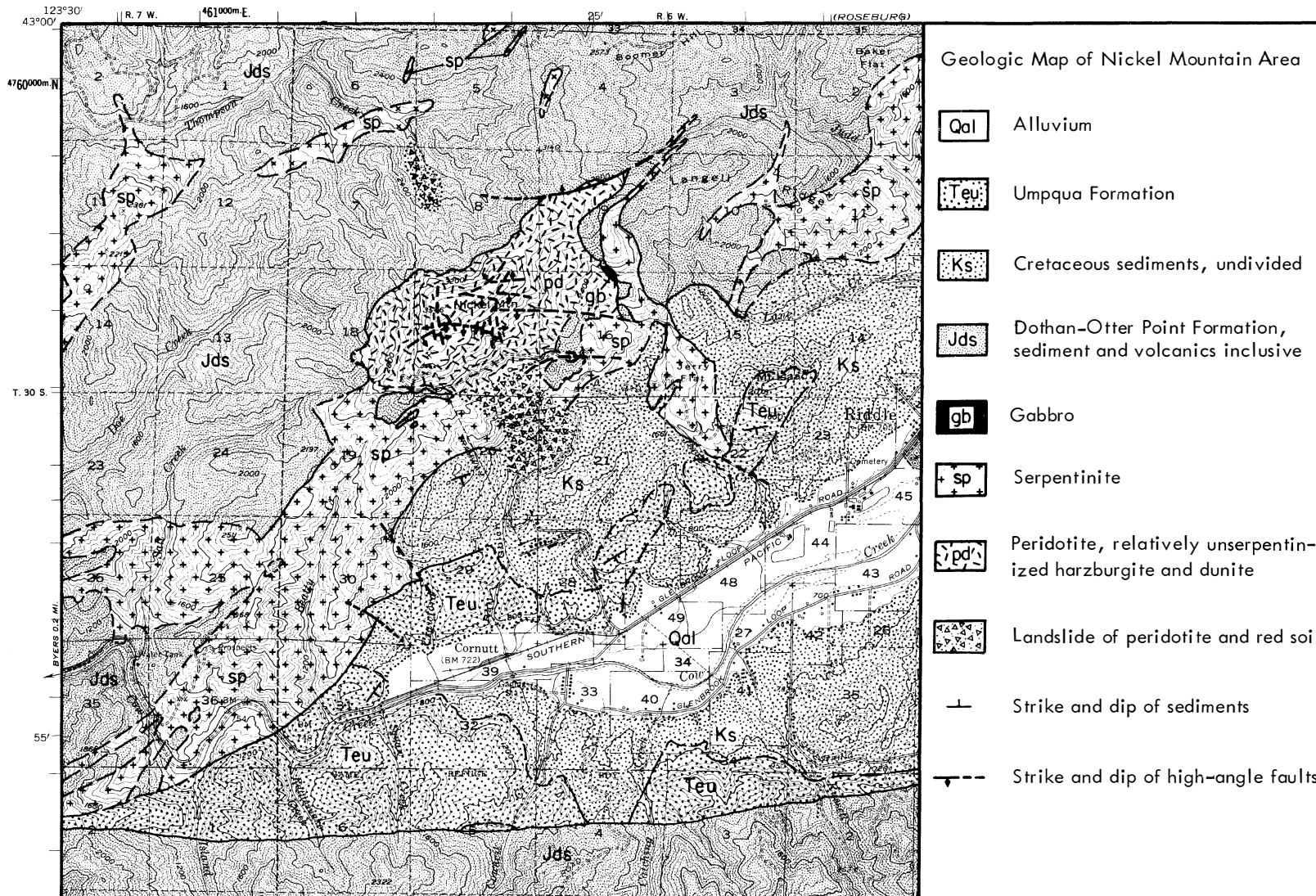


Figure 13. Geology modified from Diller and Kay (1924) and Cornell (1970); Nickel Mountain and vicinity by L. Ramp (1972).

Description of the ore

The main ore deposit at the top of the mountain is approximately 3,000 by 6,000 feet in area and averages 60 feet thick. A lower, somewhat smaller deposit lies on a bench on the southeast slope of the mountain. This and other smaller areas of nickel-bearing lateritic soil and peridotite are, at least in part, ancient landslides or slump deposits. One entirely detached landslide ore body lies in the upper drainage of Thompson Creek northwest of Nickel Mountain (Figure 13).

The main deposit is overlain by a blanket of reddish brown lateritic soil that averages 2 to 3 feet thick. Beneath the surficial layer is the main nickel-bearing zone, which Pecora and Hobbs (1942, p. 217) called the "quartz-garnierite boxwork layer." This layer, of highly variable thickness, but commonly ranging from 5 to 40 feet thick, is a soft, limonitic soil containing a network of veins and veinlets of microcrystalline quartz and garnierite. In its lower part the quartz-garnierite boxwork zone grades downward through progressively less weathered material into fresh peridotite. Nickel occurs throughout the weathered zone but is most abundant in the quartz-garnierite boxwork. The base of the weathered zone is highly irregular and is characterized by pinnacles and "horses" of unweathered peridotite surrounded by soft, weathered rock, containing quartz-garnierite boxwork, and rootlike extensions into fresh rock of weathered material containing quartz-garnierite veins. These downward extensions are localized in zones of faulting and fracturing.

Laterization has produced a crudely stratified ore (Table 4). From the surface downward a typical section through the ore body is as follows: 1. brick-red to reddish brown top soil, 2. yellow soil, 3. soft saprolite, 4. hard saprolite, 5. saprolitized peridotite, and 6. peridotite. The rich, supergene garnierite-bearing silica or quartz-boxwork ore may extend from just beneath the soil zone downward into peridotite and is therefore not part of the stratification.

Table 4. A comparison of peridotite and ore types at Nickel Mountain, showing their approximate chemical analyses (from Hotz, 1964, and Cumberlandidge and Chace, 1968)

<u>Ore type</u>	<u>Approx. Thickness</u>	<u>MgO%</u>	<u>Ni%</u>	<u>Fe%</u>	<u>SiO₂%</u>
Red soil	1 - 10 ft.	0 - 1	0.1 - 0.6	12	50
Yellow soil	5 - 10 ft.	0 - 5	0.2 - 0.8	12	50
Soft saprolite	5 - 10 ft.	0 - 24	0.8 - 1.5	10	54
Hard saprolite	20 - 40 ft.	24 - 34	1.0 - 1.4	8	48
Saprolitized pd.	5 - 50 ft.	34 - 40	0.7 - 1.1	7	44
Peridotite	Very thick	45	0.28	5.8	43
Boxwork (high grade)	Variable	22	1.4 - 2.0	7	60

As shown in Table 4, iron oxides, magnesia and silica make up the major constituents of the ore. The various types of ore are classified in the drill holes on the basis of their magnesia and iron content. At present (1972), the average grade of blended and upgraded ores going into the smelter is about 1.4 percent nickel. As the main ore body on the south and east slopes of the upper portion of the mountain becomes depleted, lower-grade ores in the fringe deposits may result in lower-grade smelter feed.

Mineralogy

The main nickel mineral, garnierite, is an apple-green, hydrous magnesium nickel silicate that contains

variable amounts of nickel and magnesium. The pure mineral may contain as much as 35 percent nickel. The color of garnierite varies from bright to pale green and nearly white. The lighter colored varieties contain less nickel.

Other nickel-bearing minerals of lesser importance reported to occur in the deposit include sepiolite and a pale blue-green micaceous chlorite. The greatest amount of ore reserves are in the soils and saprolites and the identity of some of the nickel minerals in these ores are not well known.

Cumberledge and Chase (1968, p. 1668) state that "a clay-sized fraction of ore picked clean of green nickel-bearing minerals still contained between 1.0 and 2.0 percent nickel." They further relate that "the form in which the nickel occurs is not known. It is likely that Ni^{2+} released from olivine would proxy for Mg^{2+} in montmorillonite, chlorite, serpentine, and talc. It is also likely that Ni^{2+} would be adsorbed on nearby limonite."

Prospecting in other areas

Although considerable prospecting for nickel ore has been done elsewhere in Douglas County, no other deposits have been found to date. Most of the ultramafic rock other than the Nickel Mountain peridotite body appear to be serpentinized to a greater degree and to lack sufficient soil cover. In spite of this apparent poor prospect, it seems reasonable to search carefully all ultramafic rocks in the county for significant areas of red soil cover and to do at least some preliminary auger sampling into the soil zone to establish possible presence of nickel enrichment. Several areas of nickel-bearing ferruginous laterite deposits are known in Josephine County about 60 miles south of Nickel Mountain. These are described by Hotz (1964) and Hotz and Ramp (1969).

Mining and smelting at the Hanna operation

The following information on the Hanna operation is extracted from a report provided by the Hanna Nickel Smelting Company at Riddle (dated June 1, 1970):

Grade control: Nickel content of ore delivered to the smelter stockpile is approximately 1.4 percent. This grade must be maintained as uniform as possible to produce optimum metallurgical results. This is somewhat difficult due to the wide, inconsistent variations in nickel content throughout the deposit. Twenty foot bench heights, narrow shovel cuts, bank samples, drillhole samples, geologic interpretations and visual classification, combined with widely spaced daily cuts, make up the grade control pattern.

Development: Open cut mining methods are utilized. The topography is ideal for the development of level mining benches at 20-foot vertical intervals. This interval was chosen for grade control purposes. Benches are a minimum 50-foot width and extend to the limits of the deposit. Main haulage roads, 60 feet wide, traverse the area at a 10 percent maximum grade and intersect the mining benches at intervals controlled by the maximum haul on level benches.

Mining and hauling: Much of the ore can be dug without blasting. When this is necessary, however, a 6½" down-hole drill is used. Ammonium nitrate-fuel oil is the blasting agent.

Loading is accomplished with 3½ cubic yard diesel shovels. Large residual boulders, called pit reject, are separated from the ore by the shovel operator and ultimately deposited on waste dumps. The ore is loaded into 60-ton diesel trucks and hauled to the screening plant.

Screening and crushing: The ore is deposited directly into the screening plant feed hopper. A separation is made on a wobbler feeder and scalping screens, with the minus 5½ inch product going directly to the tramway surge pile and the plus 5½ inch to the crusher. Crushed material is visually classified and directed to the ore product or to the reject stockpile. After screening and crushing, the ore product is deposited in a 12,000 ton tramway surge pile.

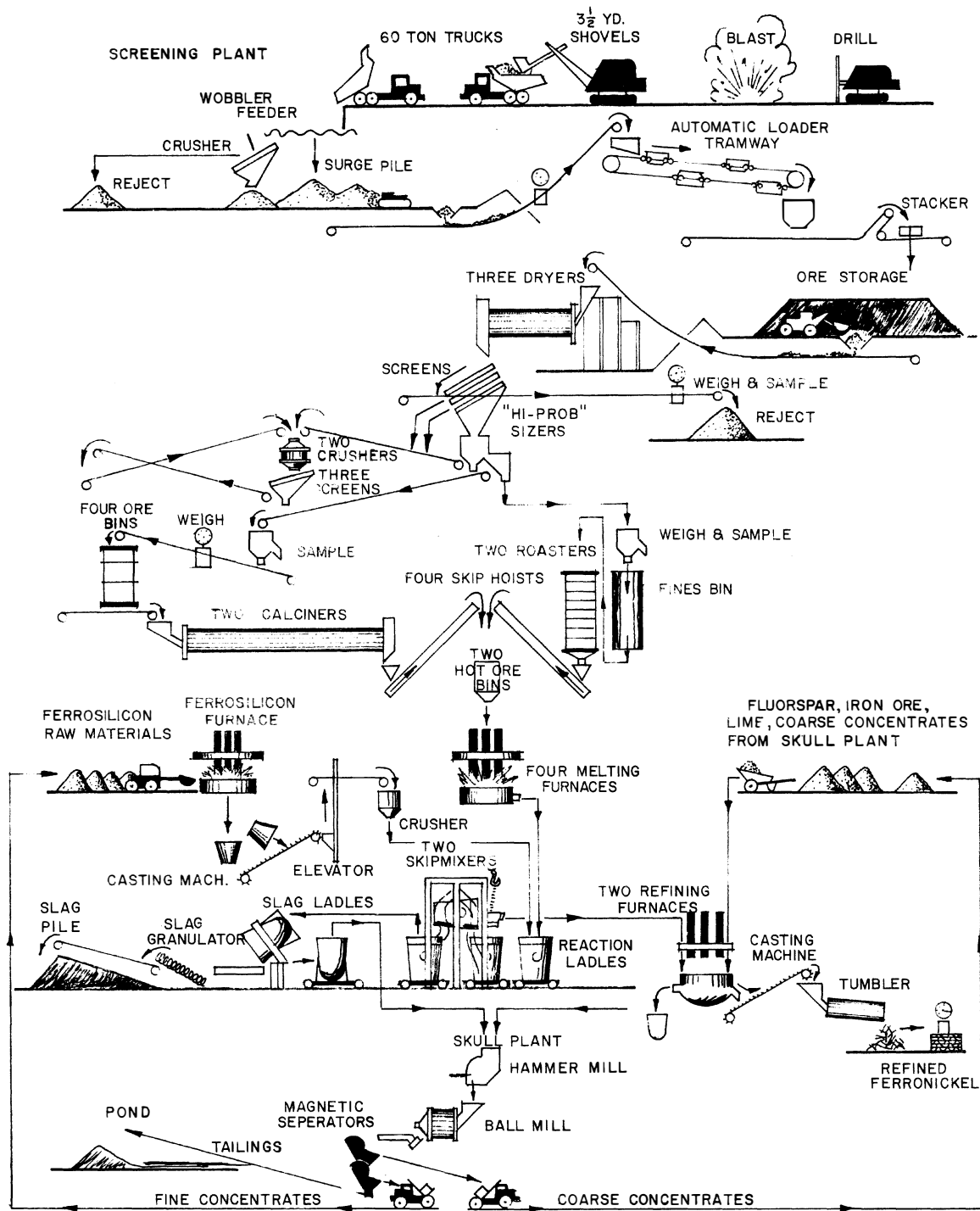


Figure 14. Flow diagram of the Hanna Nickel smelter.

Tramway: From the surge pile the ore is fed to the tramway loading terminal, where it is loaded automatically into 50-cubic-foot tram cars. It is conveyed downhill to the smelter storage stockpile at a maximum rate of 250 short tons per hour.

The tramway runs continuously carrying ore in the upright tram cars on the upper pair of suspended track cables and returning empty in an inverted position on the lower pair of track cables. Ore is loaded automatically and discharged by inverting the cars at the lower discharge terminal, where it is bedded in the smelter stockpile by an overhead belt conveyor and traveling wing tripper.

A speed of 500 feet per minute is maintained by two 300-horsepower induction generators driven by the loaded tram cars through a gripwheel and gear train in the loading terminal. The braking action of the generators produces approximately 500 horsepower, which is used in the operation of the mine facilities.

The tramway is 8,300 feet long and drops a vertical distance of 2,000 feet in its length.

Smelter summary: Ore from the stockpile is processed at the smelter to produce ferronickel containing approximately 50 percent nickel. Steps in the process include reclaiming of ore, drying, fines screening, rejection of lean rock by screening, crushing, sampling, calcining, melting, reducing to ferronickel, refining, casting, and skull metallics recovery (Figure 14).

Ore preparation: Ore is reclaimed from the stockpile by rubber-tired front end loaders and is conveyed to the dryers, where the moisture content is lowered from an average of 21 percent to about 4 percent in three concurrent fired rotary dryers. The dryers are heated by hogged fuel waste-wood product from local sawmills. Natural gas auxiliary burners are installed for use in case sufficient hogged fuel is not available.

After drying, the ore is conveyed to the screening, crushing and sampling plant, where the coarse, low-grade rock is rejected from the top deck of a double-deck screen. The ore remaining on the second deck of the screen, normally $+5/16'' - 3/4''$ is passed through cone crushers in closed circuits before it continues to storage. The $-5/16''$ ore passes through Hi-Prob screens where fines are removed and sent to a storage bin. The coarse fraction from the screens is sent to separate storage bins. Both fine and coarse ore is sampled and weighed before going to storage.

From the storage bins the coarse ore ($-5/16'' + 28$ mesh) is fed to two natural gas fired rotary calciners, while the fines are fed to two natural gas fired multiple hearth roasters. To the feed of both calciners and roasters, sawdust is added as a pre-reductant to convert approximately three-quarters of the trivalent iron contained in the ore to the divalent state.

After calcining to approximately 1300°F , the ore discharged from both the calciners and roasters is transported by automatic skips to hot ore bins above four electric melting furnaces in the smelter building. Skips, transfer chutes and bins are insulated to conserve the heat in the calcined ore.

Melting and reduction: The ore is charged to the melting furnaces by gravity and heated to a temperature of 2900° to 3000°F . Molten ore is poured from the melting furnaces into ladles for the reduction process.

Reduction of nickel and iron is accomplished by the Ugine Process, which consists of adding a reducing agent containing metallic silicon to an oxide ore in the presence of molten, ferrous metals and using vigorous mixing action for good contact of reductant and ore. In Hanna's smelter, crushed 48 percent ferrosilicon is used as the reductant, the ferrosilicon being produced in a separate electric furnace in the smelter. After the vigorous mixing cycle, the ferronickel is allowed to settle to the bottom of the ladle, after which the slag is skimmed off and granulated with high pressure water jets.

Refining: As the reducing reactions continue, ferronickel accumulates in the ladle. At regular intervals, a portion of this product is removed, or "thieved," and transported to one of two identical small electric steel furnaces. Here the impurities, predominantly phosphorous, are removed by suitable refining slags, after which the ferronickel is cast into pigs weighing approximately 28 pounds.

Samples from each cast are taken for complete chemical analysis and an accurate record of all casts is available for consumers. The ferronickel pigs are packaged on 4,000 pound pallets, with the exact weight and analysis stamped on each pallet.

INDUSTRIAL MINERALS AND ROCKS

Aggregate (Sand, Gravel, and Crushed Rock)

Sand and gravel, and crushed rock are the basic materials for the construction industry. An adequate supply of low-cost, good-quality aggregate is essential for the concrete used in the highways, bridges, streets, sidewalks, foundations, and buildings of an expanding urban area.

Sand and gravel

The scope of this report and time available did not permit a detailed study of the sand and gravel resources of the county; however, a careful inspection of aerial photographs, and topographic and geologic maps reveals sizeable but limited amounts of sand and gravel along and adjacent to the Umpqua River and its major tributaries. Large reserves are reported in the channel of the lower Umpqua River in the vicinity of Reedsport.

Like most other areas, the best quality sand and gravel in Douglas County occurs in the flat ground near the streams, highways and railroads. This is fortunate in one way because this is where it is needed the most. On the other hand this land is usually also the best agricultural land and quite often prime land for industrial or urban expansion. As urban expansion encroaches on land underlain by sand and gravel, the industry's problems of land use and environmental problems accelerate. Operators will then be called upon to minimize air, water, and noise pollution, land disturbance, and the general unsightliness that is inherent to the industry.

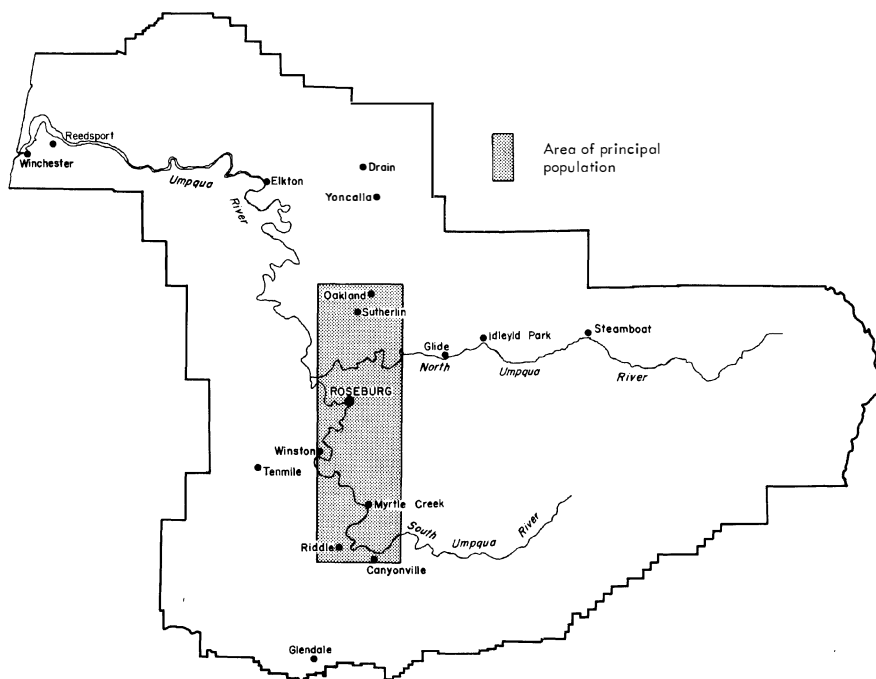


Figure 15. Map of Douglas County showing area of principal population.

Projected needs: Figure 15 shows the long, narrow area of the central part of the county where about 80 percent of the population is concentrated. This area, which includes the cities and communities of Roseburg, Winston, Dillard, Sutherlin, Oakland, Myrtle Creek, Riddle, and Canyonville, has shown the most rapid growth in the past and is predicted to grow at a faster rate than the rest of the county. By 1990 this area is expected to have about 82,000 people, or 85 percent of the 97,200 total population forecast for the county (Figure 16-a).

U.S. Bureau of Mines production statistics show that the Douglas County sand and gravel industry produced about 812,000 tons of sand and gravel aggregate in 1960. The 1970 totals show that production had increased to about 883,000 tons. Estimates from other studies in Oregon indicate that the annual per capita use of sand and gravel is about 6.5 tons; this figure appears to be realistic for Douglas County also.

An estimated population for the county of about 78,000 now requires 507,000 tons of sand and gravel per year. The balance of the production, about 350,000 tons, is mainly dredged from the lower Umpqua River and is exported out of the county. Projecting the same per capita usage rate to 1990 when the population is expected to reach 97,200, Douglas County will require about 630,000 tons of sand and gravel every year (Figure 16-b).

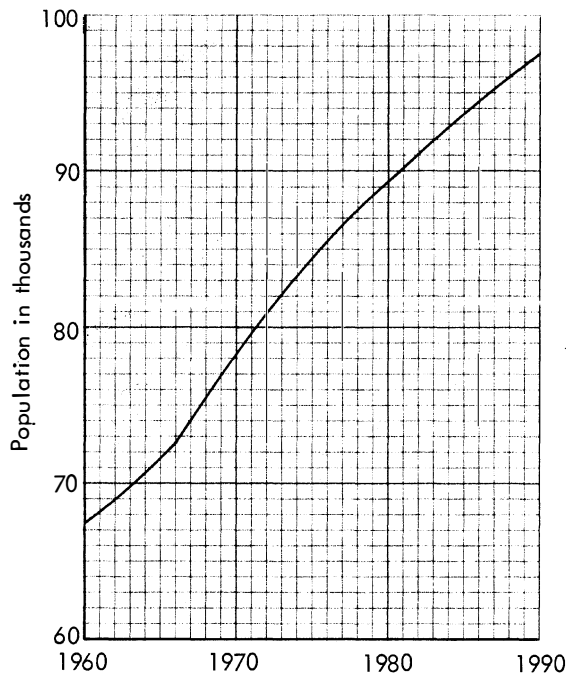


Figure 16a. Population growth projection for Douglas County

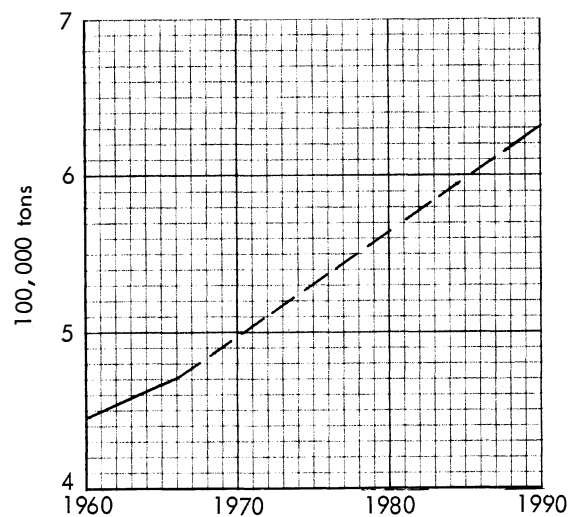


Figure 16b. Projected use of sand and gravel for Douglas County

Central Umpqua area: Sand and gravel reserves underlie at least 135 acres between Canyonville on the South Umpqua River and a point just below Cleveland on the main Umpqua River. All of the deposits are within economic transportation distance of the central Umpqua area where most of the aggregate is used. The sand and gravel occur in the channel and in bars and flood-plain terraces at slightly different levels mainly on the inside bank of large meanders of the streams. Thickness of the gravel ranges from a few feet in the shallow bars to as much as 20 feet in the higher flood-plain terraces (Figures 17 and 18).

Assuming an average minable thickness of 10 feet, we can estimate 35,000 tons of sand and gravel per acre, or nearly 5 million tons of saleable gravel in the 135-acre area. At the present rate of gravel consumption for the central Umpqua area, this reserve should last at least 15 years.



Figure 17. Typical of large sand and gravel operations in the Roseburg area is this one on the North Umpqua River near Winchester.



Figure 18. Sand and gravel being screened and crushed from a terrace at Rainbow Hollow on the South Umpqua River. Mineable deposit appears to be about 10 feet thick.

Table 5. Sand and gravel occurrences, central Umpqua area, Douglas County.

<u>Location</u>	<u>Description of deposits based on air photo interpretation only</u>
Sec. 23, 24, 25, 26, T. 26 S., R. 6 W., near Akin on north side of North Umpqua River.	Extensive high terrace deposit being mined by Beaver State Sand & Gravel Co. About 5 acres of mineable material left just downstream from Winchester Dam, which will limit replenishment.
D.L.C. 37, 53 (sec. 30, 31), T. 25 S., R. 6 W., north side of North Umpqua River at mouth of Calapooya Creek near Umpqua.	If suitable gravels occur here, could be used in the Sutherlin-Oakland area.
Sec. 13, 14, T. 24 S., R. 7 W., on inside of big bend of Umpqua River at Tyee.	Small deposit of channel and bar gravels; Sutherlin-Oakland area most convenient market.
Sec. 7, T. 26 S., R. 6 W., on east bank of Umpqua just east of Woodruff Mountain.	Flood plain and terrace gravels; possibly 5 acres of mineable material.
Sec. 4, 5, T. 27 S., R. 6 W., south side of South Umpqua River at north end of Shady Lane.	Large sand and gravel deposit being mined by Umpqua Sand & Gravel Co; estimate 15 acres of material left.
Center sec. 5, T. 27 S., R. 6 W., about 1 mile southwest of Umpqua Sand & Gravel Co. deposit near Melrose School.	Flood-plain and terrace gravels cover about 30 acres. Mineable gravel estimated to be 10 acres.
NE $\frac{1}{4}$ sec. 9, T. 27 S., R. 6 W., east bank of South Umpqua near the Conn Ford Bridge.	Flood-plain gravels cover about 20 acres. Appear to be thin but estimate 10 acres mineable.
N. edge sec. 22, T. 27 S., R. 6 W., north side of South Umpqua River near Calkins.	Small amount of flood-plain and tree-covered terrace gravels.
Sec. 34, T. 27 S., R. 6 W., on inside of large bend of South Umpqua River at Little Valley.	Low terrace and flood-plain gravels cover about 10 acres.
E. $\frac{1}{2}$ sec. 9, T. 28 S., R. 6 W., east bank of V bend of South Umpqua River 1 $\frac{1}{2}$ miles north of Winston.	Appears to be as much as 30 acres of terrace and flood-plain gravel.
SE $\frac{1}{4}$ sec. 20, SW $\frac{1}{4}$ sec. 21, T. 28 S., R. 6 W., south bank of South Umpqua across from mouth of Looking-glass Creek.	Thin flood-plain gravels cover up to ten acres; some gravel has been removed in the past.
Sec. 29, T. 28 S., R. 6 W., east bank of South Umpqua northwest of Dillard.	5 to 10 acres of bar and flood-plain gravels; some has been mined.
S $\frac{1}{2}$ sec. 35, T. 28 S., R. 6 W., south bank of South Umpqua River at Rainbow Hollow near Round Prairie.	At least 30 acres of flood-plain and terrace gravel; being mined by Roseburg Sand & Gravel Co.; about 1/3 has been removed.
SE $\frac{1}{4}$ sec. 2, D.L.C. 42, T. 29 S., R. 6 W., east bank of South Umpqua River at the mouth of Clark Branch Creek.	Channel, flood-plain and terrace deposits cover 5 to 10 acres; estimate at least 5 acres mineable.
SE $\frac{1}{4}$ sec. 18, T. 30 S., R. 5 W., south bank of South Umpqua, about a mile below mouth of Cow Creek.	Appears to be a sizeable quantity of gravel available only from Riddle side of the river.
SE $\frac{1}{4}$ sec. 19, T. 30 S., R. 5 W., north bank of South Umpqua just below I-5 crossing at Ford Bridge.	Fairly large deposit of terrace and flood-plain gravel.
Center sec. 21, T. 30 S., R. 5 W., in South Umpqua River across from Stanton County Park.	Large channel gravel bar covers about 10 acres.
SE $\frac{1}{4}$ sec. 22, SW $\frac{1}{4}$ sec. 23, T. 30 S., R. 5 W., north bank of South Umpqua.	Terrace and flood-plain gravels cover about 10 acres; about half removed.



Figure 19. Umpqua River Navigation Co. dredging operation on the Umpqua River near mouth of Indian Charlie Creek about 10 miles east of Reedsport. Equipment includes clam-shell dragline, barge-mounted screening plant, and conveyor belt for loading barges.



Figure 20. Barge-load of sand and gravel just above Reedsport waiting to be moved to unloading facility of Umpqua River Navigation Co. at Reedsport.

The above calculations can only be considered an approximate estimate of reserves; a completely realistic summary will require a field study to determine the land area actually available for mining, the thickness of the deposits, and quality of the materials. Table 5 gives the location of the sand and gravel deposits from which the estimates of reserves were made. The aerial photos from which the acreage was calculated were taken in 1966 so that some of the deposits on the list will already have had considerable aggregate removed. There are possibly other sizeable deposits that are obscured by vegetation.

It appears that all the favorably located sand and gravel resources in the central Umpqua area will be needed for future use. This will require some kind of zoning protection to insure their availability.

Southern Douglas County: In the southern part of the county the flood plain of Cow Creek from Azalea to Glendale appears to contain a sufficient supply of good-quality sand and gravel for local use.

Northern Douglas County: The northern part of the county from Oakland to Drain is underlain mainly by the shales and sandstones of the Umpqua Formation. There are no large streams, and sand and gravel is not available in sufficient quantities for any large highway, bridge, or building projects. Several quarries in pillow basalt have provided crushed rock aggregate for freeway and other highway construction. Crushed rock is substituted for sand and gravel in this and other areas where the distance is too far from the lower-cost sand and gravel deposits.

Eastern Douglas County: Population density is the lowest in this large area so the need for concrete aggregates is quite low. The topography of this area is generally rugged and elevations range from about 1,500 feet in the foothills of the Western Cascades to 7,000 feet along the Cascade divide at the eastern boundary of the county. Andesite, basalt, and other volcanic rocks of the Western and High Cascades are usually conveniently available for quarrying to supply rock for the logging roads and highways of the area.

Western Douglas County: The channel of the lower Umpqua River between Scottsburg and Reedsport contains large reserves of sand and gravel. The material is dredged from the river bottom and is either exported out of the county by barge or trucked to markets as far away as Coos Bay. Some of the gravel is reportedly shipped as far as San Francisco. Figures 19 and 20 show dredging and barging operations on the lower Umpqua River.

Crushed rock

Crushed quarry rock will continue to increase in importance to the construction industry of Douglas County as the more desirable good-quality sand and gravel deposits become depleted. To be used as a substitute for sand and gravel, the rock, after crushing and sizing, must meet the required specifications for the specific use. These include its resistance to abrasion, chemical stability, specific gravity, and its resistance to weathering.

The U.S. Bureau of Mines reported a production of 285,000 tons of crushed rock for Douglas County in 1960 and by 1970 the statistics showed an increase to 446,000 tons. Of the total aggregate produced, crushed rock has increased from 25 percent to 34 percent in the ten years since 1960, and it will probably continue to assume a larger part of the market for construction materials. As with sand and gravel, crushed rock cannot be hauled very far economically, so quarries must be conveniently located to urban areas and to the projects where large quantities will be used.

Similar land use and environmental problems are present in the quarrying and crushing of rock as for sand and gravel pits. Local and state regulations are becoming increasingly more stringent, and permit and reclamation plans are now required where 10,000 cubic yards or more are to be removed, or where 2 acres or more are disturbed annually.

Douglas County, with its varied and complex geology, has large reserves of good-quality crushing rock, but like all mineral deposits it is not always distributed at the most convenient locations in respect to the present markets or proposed projects. No attempt has been made to tabulate the quarries currently

Table 6. Properties of asbestos minerals (modified after Rice (1957))

	<u>Chrysotile</u>	<u>Tremolite</u> ¹	<u>Crocidolite</u>	<u>Amosite</u>	<u>Anthophyllite</u>
Color	Green, greenish-yellow, gray, or white	White, grayish-white, greenish-yellow, or bluish-gray	Lavender, blue, or greenish	Ash-gray, greenish or brown	Grayish-white, brownish-gray, or green.
Texture	Soft to harsh, silky	Generally harsh, some soft	Soft to harsh	Coarse, but somewhat pliable	Harsh
Mineral association	In serpentine, magnetite, antigorite, picrolite, etc.	In serpentine, magnesium limestones and various metamorphic rocks	Iron-rich, siliceous argillite in quartzose schists	In crystalline schists, etc.	In crystalline schists, gneisses, or metaserpentine
Veining and fiber length	Cross and slip fibers; short to long	Slip or mass fiber; rarely cross fiber; short to long	Cross fiber; short to long	Cross fiber; mostly long	Mass or slip fiber; rarely cross fiber; short
Tensile strength (p.s.i.)	80,000 to 100,000	8,000 or less	100,000 to 300,000	16,000 to 90,000	4,000 or less
Flexibility	Very flexible	Fairly flexible to brittle	Flexible	Flexible	Mostly brittle
Spinnability	Very good	Generally poor; rarely spinnable	Fair	Fair	Very poor
Fusibility	Fusible at 6	Fusible at 4	Fusible at 3	Fusible at 6	Infusible or difficultly fusible
Acid resistance	Poor	Good	Good	Good	Very good

¹ Tremolite grades into actinolite by replacement of magnesium with ferrous iron.

in operation or to locate on the geologic map (Figure 1) the many quarries that have been operated for specific projects in the past. The geologic map can, however, be useful in finding rock types that are suitable for concrete or asphalt aggregate or for road-surfacing material. Characteristics of the major rock types in relationship to their suitability for such purposes are discussed below.

The sedimentary rocks, such as sandstone and shale, generally disintegrate quite rapidly and are not satisfactory for concrete or asphalt aggregate. In the western part of the county, however, where hard rock is largely absent, considerable sedimentary rock is used for road building.

The metamorphic rocks, especially the altered volcanic rocks of the Galice, Rogue, and Dothan Formations make satisfactory aggregate for most uses because they are generally fine-grained and contain considerable quartz. These rocks crop out mainly in the southern part of the county and adequate supplies are available for projects in that area.

Pillow lavas of the Umpqua Formation crop out extensively in the Roseburg area and quarries have been developed at many locations. A typical quarry in the pillow lavas is shown in Figure 21. The basalt varies in quality but where it is massive it is generally acceptable for a variety of aggregates. In the eastern part of the county, lava flows of andesite and basalt are extensive. Such rocks are suitable for road building and if closer to urban centers would make good-quality aggregate. Granite is locally available in the Tiller and North Myrtle Creek areas and where not decomposed makes good road-building material. There are a few dikes and sills of basalt in the Coast Range that can be utilized locally in an area where other good-quality road-building materials are scarce.

Asbestos

The United States is the world's largest consumer of asbestos, but it does not have an adequate domestic supply of this important industrial mineral. The nation depends principally on fiber imported from Canada.

The term "asbestos" applies to a group of naturally fibrous minerals which differ somewhat in their chemical and physical properties (see Table 6).

The asbestos minerals may be divided into two main types - chrysotile and amphibole. Tremolite, crocidolite, amosite, and anthophyllite are all members of the amphibole group of minerals and are much less important commercially than chrysotile.

Chrysotile is a hydrous magnesium silicate, an important member of the serpentine group of minerals, and is found exclusively in serpentinites derived either from alteration of peridotite as found in southwestern Oregon (Figure 22), or from magnesium-rich limestones or dolomites such as occur in Arizona. Chrysotile asbestos usually occurs as cross-fiber veins in serpentinite. Veinlets of this mineral with silky luster vary from barely visible cobweb-size to more than 3/8 inch thick. The thicker veins usually have several partings so that the cross fiber is shorter than is sometimes apparent. Chrysotile fibers of good quality are highly flexible and have a tensile strength ten times that of nylon. Some fibers are less flexible and somewhat harsh or brittle and therefore of poorer quality.

In order to have commercial value a deposit of chrysotile asbestos in serpentinite must be quite large, several million tons, to justify the installation of an expensive mill. Fiber veinlets should be 1/8 inch or greater in thickness and constitute approximately 10 percent of the rock mass. Since prices vary with the length of fiber, a deposit containing longer fiber but lower percentage may be considered ore. Sometimes less than 5 percent fiber can be worked profitably. Mining is generally done by open-pit methods, although some asbestos is mined underground.

Douglas County has fairly extensive areas of serpentinite, and although there are no reported asbestos prospects, it appears that systematic prospecting of these areas would be justified.

One tremolite mine, The Liberty Asbestos, is located on the south flank of Cedar Springs Mountain in Jackson County near the Douglas County line, sec. 36, T. 32 S., R. 4 W., at about 4,500 feet elevation. At this mine a fairly good-quality white iron-free tremolite asbestos occurs in fractures of serpentinite with included greenstone. There was a small production during World War II. Development consists of 3 adits and several open pits.



Figure 21. Short and Angel quarry (NW $\frac{1}{4}$ sec. 15, T. 26 S., R. 5 W.) in pillow basalt of the Umpqua Formation is a typical crushed-rock quarry.

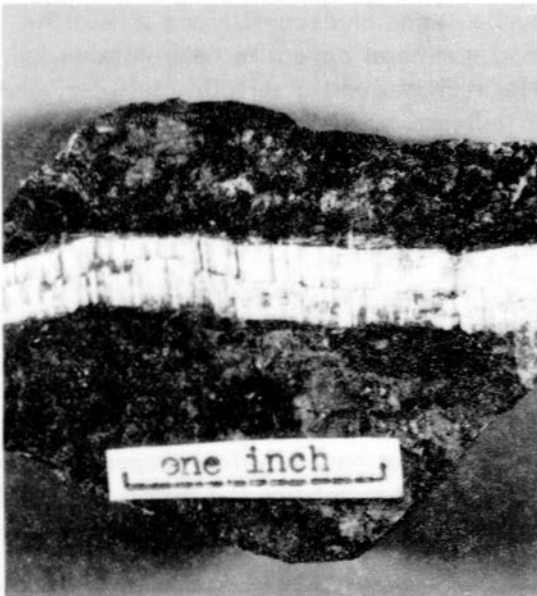


Figure 22. Typical cross fiber chrysotile veinlets in serpentinite; note partings.

Favorable areas in which to prospect for chrysotile include areas of blocky serpentinized peridotite where serpentinization has been complete but the rock still retains most of its igneous texture.

Prospecting for slip-fiber tremolite asbestos should probably be directed to zones of more intense shearing in serpentinite. Tremolite is often found in talc schists and highly sheared talcy serpentinite.

Stafford (1903) mentioned a few occurrences of asbestos in Douglas County as follows:

"Asbestos is reported as occurring in the following localities....

Canyonville, Perdue, Starvout, and upon Cow Creek, Douglas County."

These occurrences are not described elsewhere and it is not known if they refer to chrysotile or amphibole. Since minor occurrences of tremolite have been found at a number of places, it is likely that these were of that type.

Barite

Barite is a heavy mineral composed of barium sulfate (BaSO_4). Its chemical inertness, high density, ease of grinding, and low cost, make it desirable as a weighting agent that is mixed with clays and other additives to produce oil- and gas-well drilling muds. This use accounted for about three-fourths of the domestic barium consumption in 1968 (Lewis, 1970). Like asbestos, barite is consumed in greater quantity in the United States than it is produced. The price of crude barite depends on its purity and use. Drilling-mud grade, unground, is valued at \$18 to \$22 per short ton (E. & M. J. Markets, April 1972).

Most commercial sources of barite in the United States are replacement deposits in limestone, dolomite, sandstone and shales or as residual lumps in clay caused by differential weathering. In southwestern Oregon, Douglas and Josephine Counties in particular, barite occurs as a gangue mineral in veins and mineralized zones containing copper, zinc and silver as is found at the Silver Peak mine-Almeda mine (Big Yank) mineralized zone described in the section on copper. At various places along these mineralized zones, barite has partially replaced quartz-sericite or chlorite schists and contains abundant disseminated to nearly massive granular sulfides including pyrite, some chalcopyrite and sphalerite. None of the Douglas County deposits containing barite as a gangue mineral appear to have commercial potential as a source of barite owing to the presence of impurities such as quartz, sericite, sulfides, and other gangue minerals. Also none of the deposits described indicate ore bodies of sufficient size to be of commercial interest as a source of barite. Since larger bodies of more massive barite are known to occur in Josephine County in the vicinity of the Almeda mine, it is possible that similar deposits may be found elsewhere along the Silver Peak mineralized zone.

Building Stone

Although there are many rock types in Douglas County that have physical properties to make good building stone, the only type being used currently in significant quantities is a partly silicified rhyolite tuff from the Snowbird Mountain area of east-central Douglas County. Typical uses of the Snowbird rock are shown in Figures 23 and 24.

Several quarries in sec. 24, T. 27 S., R. 1 E. have yielded varicolored and banded tuffs that have been used as rubble stone in buildings and walls in the Roseburg area. Sandstones of the Umpqua Formation have historically been used for foundations from Sutherlin to Roseburg. Hard bluish-gray Cretaceous sandstone was mined near Riddle for use as flagstone. The gray-veined limestone of the Whitsett Limestone has been quarried and polished for local buildings in the past and may have some future potential. Abundant iron-stained silica boulders at the Quartz Mountain silica deposit, which is being mined for production of ferrosilicon at the Hanna Nickel Co. smelter, would make an excellent source of rubble stone for the building industry.

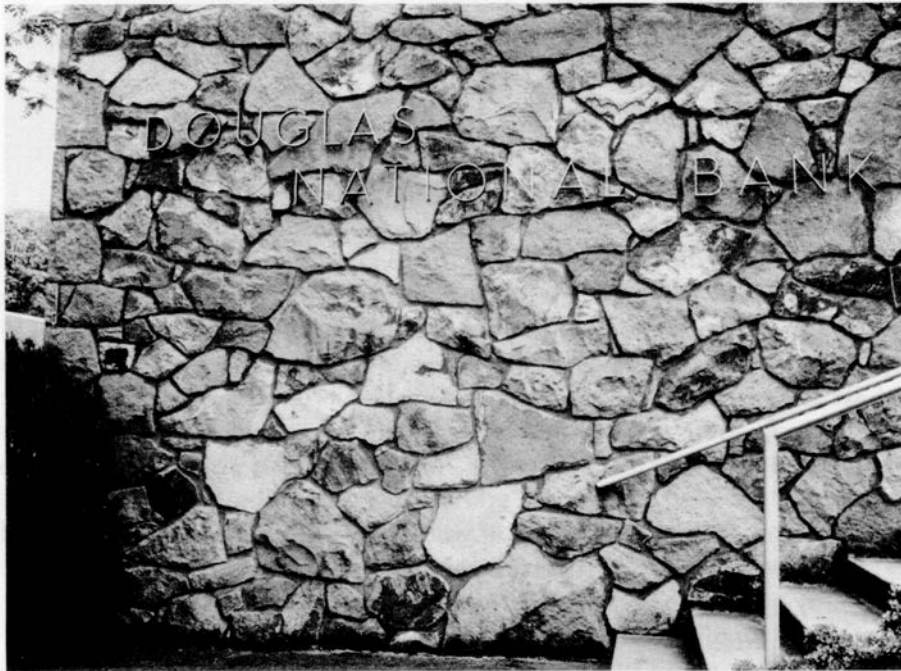


Figure 23. Front wall of the Douglas National Bank showing texture and varied color of the "Snowbird" rhyolite tuff building stone.

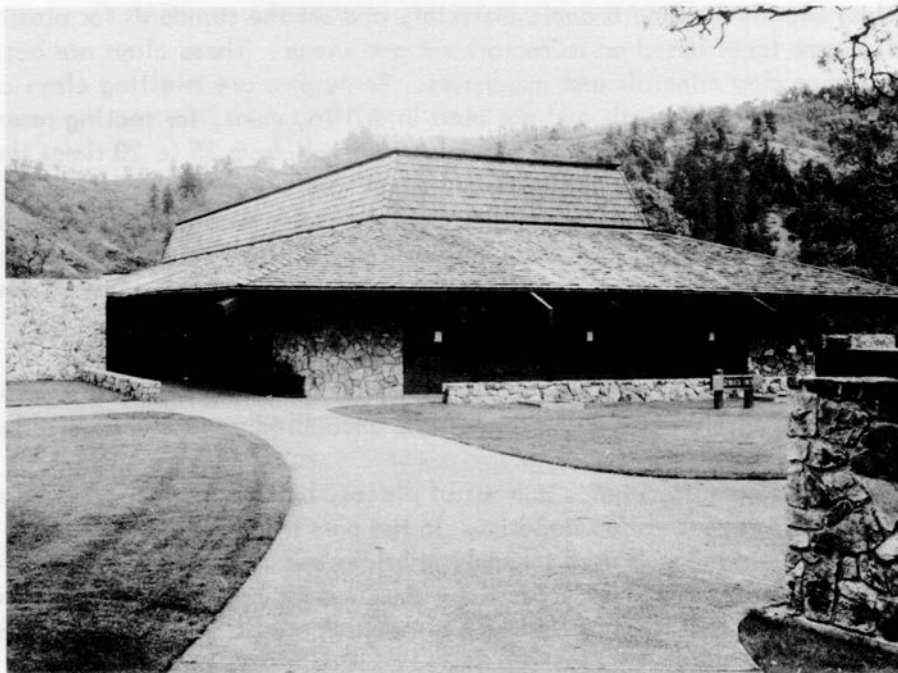


Figure 24. Typical building on the Umpqua Community College campus showing extensive use of rubble stone from the Snowbird Mountain area.

Clay

Clay has a long history of usage for brick, tile, pottery, and art objects. It is believed to be one of the first mineral materials used by ancient man. Clay is a natural, earthy, fine-grained material composed largely of a limited group of crystalline minerals known as "clay minerals" (Murray, 1960). The term has also been used in reference to the finest detrital size range with a maximum of 2 to 4 microns. Most, but not all, clays are plastic when wet. Clays are generally classified according to the use to which they are best suited and are tested for their various properties, such as plasticity, expansion in water, shrinkage on drying, color when fired, fusion temperature (pyrometric cone equivalency), and bloating. Special instruments, such as differential thermal analysis equipment, electron microscopes, and infrared spectroscopy, are used to identify and classify clay minerals.

Most clay minerals are formed as a result of weathering processes. Others, usually of a more restricted occurrence, have been formed by hydrothermal action, such as the alteration of rocks around hot springs. Deposits of clay may have formed in place or have been eroded, transported, and deposited elsewhere by the action of running water.

Ladoo and Myers (1951, p. 143) list a few of the more important clay minerals as kaolinite ($\text{Al}_2\text{O}_3 \cdot 2 \text{SiO}_2 \cdot 2 \text{H}_2\text{O}$), halloysite ($\text{Al}_2\text{O}_3 \cdot 2 \text{SiO}_2 \cdot 4 \text{H}_2\text{O}$), illite (a complex hydrous silicate of Al, Fe, Mg, and K) and montmorillonite (a complex hydrous silicate of Al, Mg, and Na).

In order to provide terms and specifications for marketing, U.S. Bureau of Mines has classified clays into six groups. These are kaolin, ball clay, fire clay, bentonite, fullers earth, and miscellaneous clay (Cooper, 1970, p. 924).

Kaolin, used mainly in making china, is predominantly kaolinite and the classification also includes halloysite. Ball clays also consist principally of kaolinite. They are usually finer-grained than kaolins, have more impurities, usually include organic material, and set the standards for plasticity. "Fire clay" and "stoneware clay" are terms based on refractoriness and usage. These clays are basically kaolinitic, but usually include other clay minerals and impurities. Bentonites are swelling clays composed mainly of the montmorillonite group of minerals and are used in drilling muds, for sealing reservoirs, and numerous other purposes. Good bentonites when submersed in water swell from 15 to 20 times their dry volume. Fullers earth, originally used for cleaning textiles and now marketed mainly for use in floor sweeping compounds, pet litter and as a carrier for pesticides, is essentially montmorillonite or attapulgite (a light green, magnesium-rich clay mineral). The term "miscellaneous clay" refers to clays and shales not specified under the other types. This category includes clays used in the manufacture of common brick and tile. "Miscellaneous clay" usually contains some kaolinite and montmorillonite, but illite is the dominant clay mineral, particularly in the shales.

In Oregon in the past, clays have been used mainly for the manufacture of common brick and tile. Douglas County has a few reported clay occurrences and undoubtedly more unreported ones. Diller, (1898) states:

"Clay has been found at a number of places, but its association is in all cases with recent valley deposits. In the pass a short distance south-west of Oakland it is used for making bricks and drain tiles. At several points near Roseburg, clay has been obtained for bricks, from which most of the larger buildings of the town are constructed. There is clay in abundance to supply all local demands."

Allen and Mason (1949) cite two localities in Douglas County where clay samples were obtained for testing. These and a half dozen other samples from various other localities in the county have been tested by the Oregon Department of Geology and Mineral Industries. Although a few of the samples show excessive shrinkage, the majority display good firing properties and appear to be suitable for the manufacture of common brick and tile. The samples were obtained from near Comstock, just east of Glide, west of Drain, near Myrtle Creek, in the Western Cascades on Clay Creek above Idlewild Park,

and near Little River in Clover Ridge area. No reports are available as to the size or quality of the deposits.

Weathered Umpqua Formation siltstones and sandstones were probably the source of clay for the bricks made in the early days near Roseburg. Clays are also common on weathered surfaces of other formations in the county, especially the tuffs, tuffaceous sediments, and fine-grained marine sediments, including the Umpqua, Tyee-Elkton, Spencer, and Fisher Formations.

Hoover (1963) reports that high-alumina clay is found at several localities in the Fisher Formation, but that only the deposit at Hobart Butte, which is about 9 miles east of Yoncalla but mainly in Lane County, is large enough to be of economic interest. The Hobart Butte deposit consists in part of hydrothermally altered tuffs, conglomerate, and microbreccia and is largely a sedimentary deposit of kaolinite derived from a weathered surface to the east. The sedimentary clay deposit has been subjected to post-depositional hydrothermal alteration and mineralization with varying amounts of mansfieldite, pyrite, quartz, realgar, scorodite, siderite, and stibnite.

The clay deposit on Hobart Butte was discovered in 1930. The Willamina Clay Products Co. mined and shipped about 14,000 tons of the clay between 1933 and 1942 for use in manufacturing refractory brick. The U.S. Bureau of Mines and U.S. Geological Survey mapped and drilled the deposit in 1943 and the results were reported by Allen and others (1951).

Clays derived from hydrothermal alteration in the vicinity of quicksilver mines, such as at the Elkhead and Bonanza, may possibly be able to furnish future local needs. Landslide areas where fairly deep weathering has occurred on rocks of Tyee, Umpqua, Fisher, and perhaps Galice Formations may also prove to be good sources for clay.

Emery

Emery is a variable mixture of aluminum oxide (corundum) and magnetite containing impurities such as titania, silica, and magnesia. It was used extensively as an abrasive prior to the development of electric furnace products, such as silicon carbide which sometimes goes by the trade name of "carborundum".

Float boulders described by White, Gray and Town (1968) as emery-like material were found at various points on the Santiam, Willamette, McKenzie and North Umpqua Rivers. These black, naturally polished cobbles and boulders are dense fine-grained mixtures of corundum-magnetite and mullite-hercynite. Some white cristobalite-mullite and tridymite-mullite-hercynite occur in associated emery-like rocks that were evidently formed by pyrometamorphism of alumina-bearing material in contact with lavas or intrusive rocks of the Cascade range.

The Oregon Emery Company of Albany, Oregon recently (1971) located two emery claims in eastern Douglas County in sections 19 and 28, T. 26 S., R. 5 E. The occurrence of emery in sec. 19 is reported to be formed at the lower contact of a basalt dike which measures about 10 feet wide and half a mile long. Emery and some porcelanite occur as a thin sheet near one end of the dike. The occurrence in sec. 28 appears to be a residual placer deposit of large angular boulders of emery. Information on these prospects was furnished by J.J. Gray (written communication, May 25, 1972). Additional details on these deposits will have to await further exploration and development. There has been no production to date.

Gem Stones

Douglas County is considered to be one of the more important producers of semiprecious gem stones in the form of agate, jasper, and fossil wood. There is also some potential for the production of rhodonite (see section on manganese).

Most of the gem-stone material is derived from volcanic rocks of the Western Cascades and is usually traced to its source by chunks found in gravels of streams draining the area. In addition, attractive jasper material is found in the varicolored, banded cherts of the Dothan Formation. Naturally tumbled specimens of agate, jasper, and petrified wood are sometimes found along the beaches, especially following a storm. Occasional specimens of attractive, polishable chalcedony and chrysoprase are reportedly derived from Nickel Mountain.

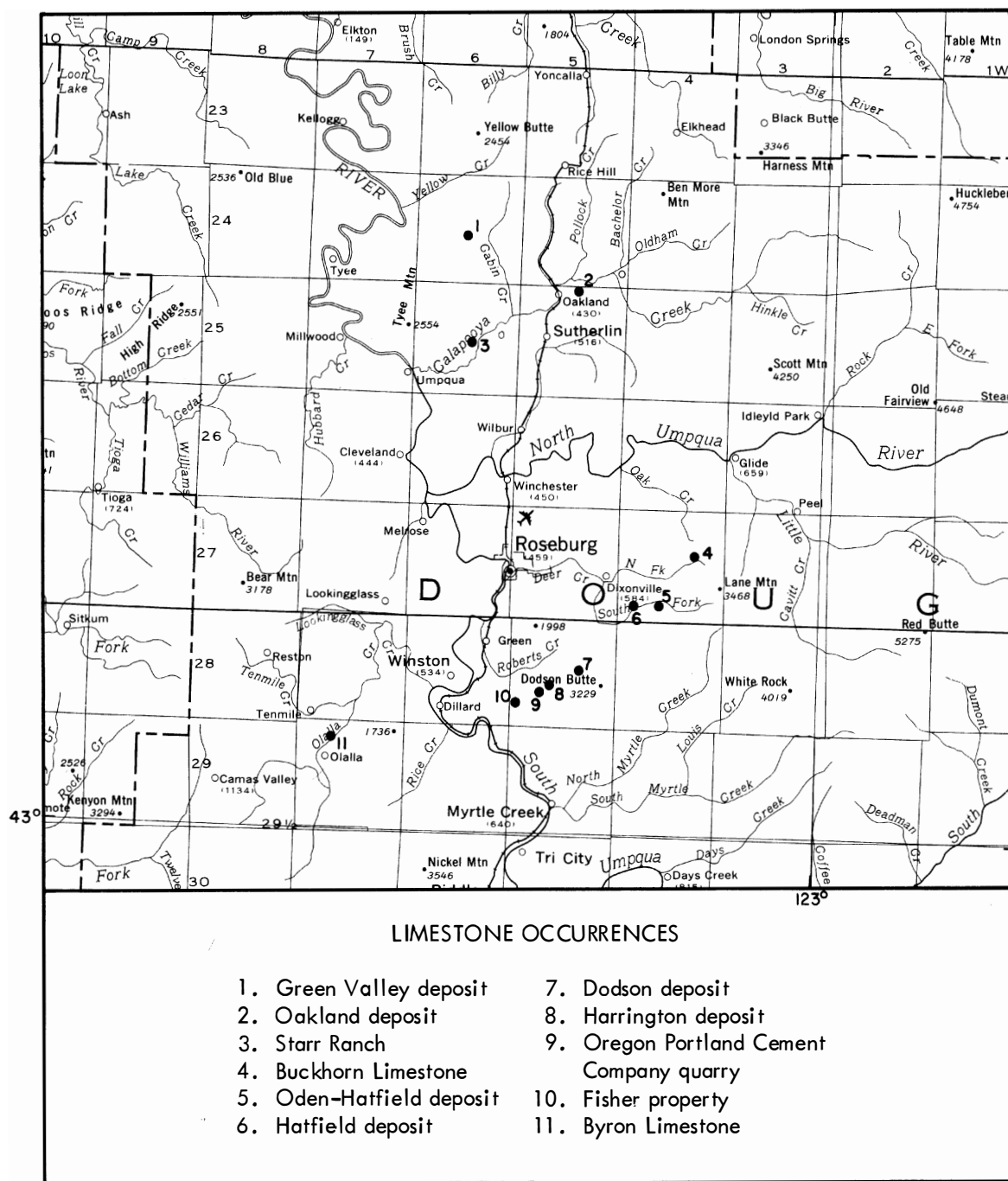


Figure 25. Map showing location of limestone occurrences in Douglas County.

A few deposits of agate have been located as mining claims, as in the Zinc Creek area of the upper South Umpqua drainage and in the Steamboat drainage; but for the most part the industry is carried on by individual hobbyists who have favorite hunting areas and do not attempt to establish mining claims on public lands yielding gem rock.

Local rock-hound clubs, such as the Umpqua Mineral Club of Roseburg and the South Douglas Gem and Mineral Society of Canyonville, have helped to popularize the hobby by displaying excellent cut and polished gem-rock material at the county fair.

Mason (1969, p. 211) points out the difficulty of measuring the value of semiprecious gem-stone production in the state and suggests that the annual value of \$750,000 reported by the U.S. Bureau of Mines is probably an overly conservative figure.

Limestone

There are a number of small limestone occurrences in Douglas County, a few of which were worked in earlier times; but none are being actively mined at present.

Of the 11 occurrences of limestone shown on the accompanying map, Figure 25, only the old Oregon Portland Cement quarry (No. 9 on the map) has been developed and mined to any extent. Lime from this quarry was mined for several years and shipped to the Oswego cement plant near Portland. A spur line from the Southern Pacific Railroad was extended from Carnes about 4 miles to a point below the quarry. At the peak of operations the company produced about 250 tons per day. Hodge (1938) described the operation as follows:

"Rock was quarried first by glory-hole and later by underground open stopes, delivering through cross-cut tunnels and surface trams to the tops of two gravity planes discharging into railroad cars. Each of the limestone bodies is bounded on the east by quartzite and chert, and on the west by intrusion of ultra-basic igneous rock. It was never clearly established whether the three limestone bodies were separate lenses or faulted segments of a single lens, although the limits of the individual bodies were accurately ascertained by drifting and diamond drilling.

In October, 1935, the company abandoned operations and caved the crosscut tunnels to make the underground working inaccessible. The last of the spur track was taken up by the end of that year."

The grade of the limestone produced was of good quality with about 93 percent CaCO_3 , less than 1 percent MgO , and about 6 percent silica plus alumina, iron, and other impurities. Most of the impurities resulted from accidental mixing of wall rock and interbedded cherts. Total tonnage mined from this deposit is not reported. Before abandonment, the deposit was drilled and carefully explored and found to contain no more bodies of limestone of sufficient size to be profitably mined by methods being used.

Limestone at the Oden-Hatfield deposit (No. 5 on the map), was sawed with a marble saw in 1889 and 1890 for use in the Douglas County Courthouse in Roseburg.

Because of their relatively small size, it appears unlikely that limestone deposits in Douglas County will be exploited, unless by a small operation to produce crushed agricultural lime for local use.

Limestone occurrences that have been reported in the county are described below in alphabetical order.

BUCKHORN LIMESTONE (No. 4)

Location: SE corner NW $\frac{1}{4}$ sec. 14, T. 27 S., R. 4 W., on the ridge west of Buckhorn Road on the divide between Oak and North Fork Deer Creeks.

quarry. Diller (1898) also reported a considerable quantity shipped to Oregon City for making cement several years before his report. The small tonnage and poor grade of the material apparently precluded further development.

References:	Diller (1898) Hodge (1938)	Peterson and Mason (1958) Williams (1914)
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HARRINGTON DEPOSIT (No. 8)

Location:	SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 21, T. 28 S., R. 5 W., about half a mile east of the Oregon Portland Cement Company quarry.	
Description:	Limestone crops out over an area of 500 by 300 feet. Only small surface excavation and no production. There may be as much as half a million tons of reserves present. Assays indicate a good quality limestone containing about 97 percent CaCO ₃ .	
References:	Department mine file report, (1943), unpub. Hodge (1938) Peterson and Mason (1958)	

HATFIELD DEPOSIT (No. 6)

Location:	SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 31, T. 27 S., R. 4 W., 1 mile west of the Oden-Hatfield deposit.	
Description:	A small pod of light-colored limestone trends N. 75° E., largely hidden by overburden; similar to the Oden-Hatfield deposit. Some of the marble from this deposit was slabbbed and used in the courthouse along with that from the Oden-Hatfield deposit.	
References:	Diller (1898) Hodge (1938)	Oregon Dept. of Geol. & Min. Ind. (1940) Peterson and Mason (1958)

OAKLAND DEPOSIT (No. 2)

Location:	NW $\frac{1}{4}$ sec. 3, T. 25 S., R. 5 W., about 1 mile northeast of Oakland.	
Description:	Small deposit of bluish, shaly, fossiliferous limestone. Diller (1898) mapped these occurrences as the Oakland limestone member of the Umpqua Formation. He further stated that "material is quite limited in quantity and not promising for the purpose of making cement."	
References:	Diller (1898) Peterson and Mason (1958)	Williams (1914)

ODEN-HATFIELD DEPOSIT (No. 5)

Location:	NW $\frac{1}{4}$ sec. 33, T. 27 S., R. 4 W.	
Description:	A 25-foot wide lens of limestone with vertical dip traceable for about 225 feet. The deposit was developed by a 30 by 30 foot cut on the west end where dimension stone was quarried and sawed in 1889.	

References:	Diller (1898)	Oregon Dept. Geol. Mineral Indust. (1940)
	Hodge (1938)	Peterson and Mason (1958)

OREGON PORTLAND CEMENT CO. QUARRY (No. 9)

Location:	SE $\frac{1}{4}$ sec. 20 and NE $\frac{1}{4}$ sec. 29, T. 28 S., R. 5 W., at 1,200 to 1,500 feet elevation, about 10 miles (by road) south of Roseburg.	
Description:	Mined for several years by glory hole and underground methods in a large lens of steeply dipping limestone. Faulting and interbedded chert resulted in high mining costs. The rock contains 97 to 98 percent CaCO ₃ . It was transported by rail via a 4-mile spur to the property. The operation was abandoned in 1935. Total production is not reported.	
References:	Diller (1898)	Oregon Dept. Geol. Mineral Indust. (1940)
	Hodge (1938)	Peterson and Mason (1958)
	Libbey (1957)	Williams (1914)

STARR RANCH (No. 3)

Location:	NW $\frac{1}{4}$ sec. 22, T. 25 S., R. 6 W., about 4 miles northeast of Umpqua.	
Description:	Small thin beds of brittle fossiliferous limey shale.	
References:	Diller (1898)	
	Hodge (1938)	
	Peterson and Mason (1958)	

Olivine

Olivine, also known as chrysolite and peridot, is an orthosilicate of magnesium and iron in which the magnesium to iron ratio can vary greatly. It is a pale yellow green to bottle green and the unfractured varieties (peridot) are used as gems. Olivine occurs in igneous rocks that are relatively rich in magnesium and iron such as peridotites, gabbros, and basalts. It may also occur in high-temperature metamorphic rocks.

Dunites are ultramafic igneous rocks composed almost wholly of olivine usually with minor accessory pyroxene, magnetite, and chromite. In addition to its use as a semiprecious gem, olivine is used to make refractory brick for furnace linings, refractory mortar to join refractory brick and patch furnace linings, as a foundry moulding sand, and for sandblasting. Potential uses of olivine include: production of magnesium metal (which is produced indirectly from sea water) and magnesium compounds such as magnesium oxide, sulfate, chloride, and the hydrous sulfate epsom salts.

High-magnesian dunites, containing 45 percent to 49 percent MgO, are being mined in North Carolina and Washington (Hunter, 1941; Vhay, 1966).

Douglas County has one potentially important deposit of high-magnesian dunite at Nickel Mountain. This rock occurs with and underlies the nickel deposit being mined by the Hanna Mining Company. It is located mostly in sec. 17, T. 30 S., R. 6 W., on the highest part of Nickel Mountain. Much but not all of the peridotite in this area can be classed as a dunite as there are probably equal or greater quantities of harzburgite, which is a peridotite composed of olivine and pyroxene.

Large quantities of dunite and olivine-rich harzburgite are being stockpiled in reject piles at the nickel mine. Analyses of dunites from Nickel Mountain show that they contain about 45 percent MgO (Clark 1888; Hotz 1964).

Present production and demand for olivine in the United States is quite small, and crude dunite in this area has little or no value. Should the demand for olivine increase significantly, the Nickel Mountain deposit could become an important new source.

Silica

Silica composed of silicon metal and oxygen (SiO_2), the two most abundant elements in the earth's crust, is also one of the most abundant minerals; but large deposits of high purity silica suitable for industrial use are not common. The main silica minerals are quartz and chalcedony, including chert.

Silica rock

Douglas County is fortunate to have a large deposit of fairly pure silica rock at Quartz Mountain situated in the Western Cascades about 35 miles east of Roseburg in sec. 2, T. 28 S., R. 1 E., at an elevation of about 5,500 feet. The deposit is a fine-grained microcrystalline silica, which occupies the upper portion of the mountain. It was formed by alteration and replacement of tuffs by silica, probably through the action of thermal waters related to Tertiary vulcanism. The geology of the area was mapped and described in detail by Ramp (1960) (see Figure 26). The tuffs are of Oligocene-Miocene age and are equivalent to the Little Butte Volcanic Series. The tuffs are overlain by basalt flows and intruded by basalt and rhyolite dikes. The volcanic rocks strike northwest and dip gently northeast. A number of high-angle normal faults in the area may have served as channelways for the mineralizing solutions. An east-trending, vertical fault appears to have displaced the north side of the deposit downward so that more silica rock may lie beneath the talus and slide debris. Silicification and clay alteration are fairly extensive in the vicinity of the deposit. Areas of almost complete alteration of tuffs and basalts to clay often contain abundant fine-grained disseminated pyrite.

The main deposit of silica at Quartz Mountain measures about 3,000 feet by 1,200 feet and crops out between 4,800 and 5,500 feet elevation. Layer-like zones of partly silicified tuff containing abundant clay and displaying cavernous weathering occur within the deposit. The more massive areas of complete silicification contain large tonnages of silica rock that will assay from 96 to 99 percent SiO_2 . The principal impurities are iron, alumina, titania, and water.

The deposit was located in 1957, the year that timber access roads were first built into the area. Following exploration and development work, a few shipments were made to the Hanna Nickel Smelting Co. in Riddle for metallurgical testing during 1962 and 1963. The silica rock is used to manufacture ferrosilicon metal necessary in the reduction of ferronickel (see Nickel chapter). Quartz Mountain became the principal source for this resource in 1970. Present annual production is between 20 and 25 thousand short tons, all of which is used at the nickel smelter. Total estimated production to January 1972, including rock used for road surfacing material in the area, is probably nearly 60,000 tons. Present quarrying operations (1972) are on the top of the mountain (Figures 27 and 28). The rock is so very hard and tough that abrasive action on equipment increases mining costs.

One other occurrence of apparently similar origin and containing a similar large deposit of fine-grained massive silica rock is located on the Jackson County line near Abbott Butte in secs. 27 and 34, T. 30 S., R. 2 E., on a point also known as Quartz Mountain. This occurrence has not been visited by the writer. Claims were staked on this deposit, but no development work or production has resulted to date.

Chert

A number of lens-shaped bodies of varicolored chert are known to occur in the Dothan-Otter Point Formation. These bodies are usually not greater than 100 feet thick and a few hundred feet in length. They are characterized by impurities such as manganese, iron, aluminum, and calcium.

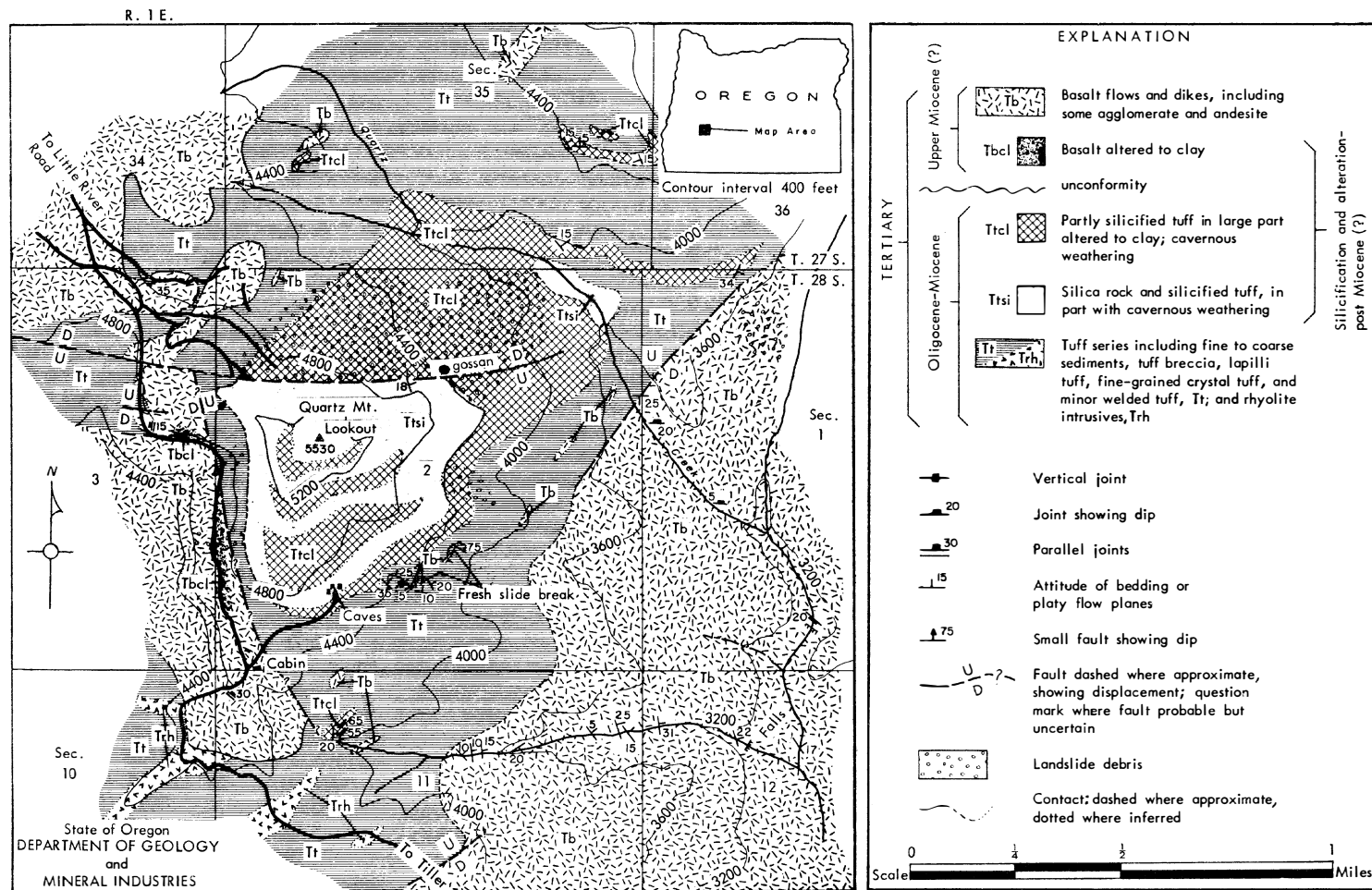


Figure 26. Geologic map of Quartz Mountain, Douglas County (from Ramp, 1960).



Figure 27. Quarry operations at the Quartz Mountain silica deposit. About 30,000 tons per year are mined, crushed, and screened for use at the Hanna Nickel smelter.



Figure 28. The massive silica deposit, which is a replaced rhyolite tuff, occurs at the top of Quartz Mountain.

A body of chert on private land near Brockway, in the NE $\frac{1}{4}$ sec. 24, T. 28 S., R. 7 W., was being considered as a source of roofing granules in 1945. Some exploration and testing work was done, but there was no production. This and other apparently large bodies of chert were mapped in the vicinity of Brockway and Winston by Diller (1898), and it is possible that further investigation of these deposits as potential sources of silica granules is justified.

Slag

A large growing stockpile of slag from the smelting of nickel ore at the Hanna Nickel Smelting Co. smelter west of Riddle presents an opportunity and challenge for possible utilization.

The slag is an amorphous compound (glass) composed of approximately 51 percent silica, 23 percent magnesium oxide, 23 percent iron oxide and about 1 percent each of chromic oxide and aluminum oxide, with other elements present in only trace amounts.

The Green Diamond abrasive plant at Riddle, operated by the Mining-Minerals Manufacturing Co. began utilizing this slag for manufacturing of sandblasting grit and other specialty granules in 1961 (Figure 29). In 1971 the plant employed 10 men and produced about 3,000 tons per month (ORE BIN, 1971).

The slag appears to be durable both chemically and mechanically with little evidence of alteration on exposure to weather. Its color is a pale gray-green to dark-green and varies somewhat with the various screen sizes. The slag is reported to have good refractory properties. It is hoped that research into potential new uses of this growing by-product resource will result in expanded markets and increased utilization.

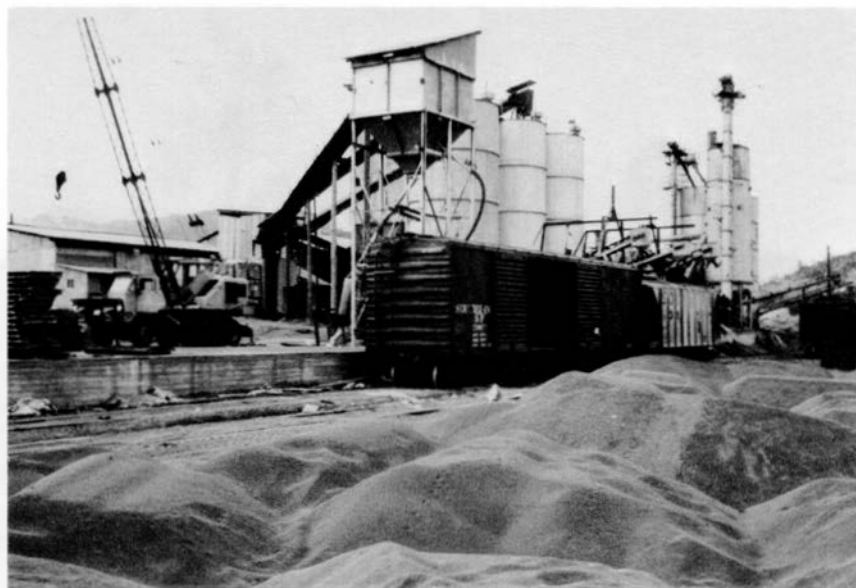


Figure 29. "Green Diamond" plant at Riddle. The large storage tanks with their conveyors are the bulk loading facility; rotary dryer and screening circuits are behind the storage tanks. The bagging facility is at the left. Piles of granulated slag in the foreground.

Sulfur

An interesting occurrence of native sulfur was located in eastern Douglas County in 1904. The occurrence is known as the Cove Sulfur prospect or Last Chance mine. It is located at the head of Castle Rock Fork of the Umpqua in the SE corner of sec. 3, NE corner sec. 10, NW corner sec. 11, T. 29 S., R. 3 E., at about 5,300 feet elevation.

Sulfur occurs as a thin vein and discreet lenses as much as 11 inches thick and 24 inches long within a hydrothermally altered clay gouge along a fault zone that strikes north-northwest and dips 45° W. The fault cuts Cascade volcanic rocks including andesite and/or basalt lavas, in part vesicular, and interbedded tuffs. In the vicinity of the fault, the rocks have been bleached and altered to clay and in places contain abundant disseminated pyrite. The fault zone is reported to have a maximum width of 12 feet and to be traceable for over half a mile. The sulfur probably originated from solfataric gasses, heavily charged with sulfur, which worked their way up through the fault zone. Development consists of several trenches and pits and at least 3 caved adits.

Production has been limited to samples and specimens that have been packed out over the years. Analyses indicate that the hand-selected native sulfur is quite pure. Several samples of the blue pyrite-bearing clay assayed from 2.1 to 7.25 percent sulfur. Available reports suggest that there is probably insufficient tonnage to be of importance as a commercial source of sulfur (Oregon Dept. Geol. and Min. Indust., 1940; Department mine file reports, unpublished).

Talc and Soapstone

Talc is a soft, hydrous magnesium silicate mineral ($3 \text{ MgO} \cdot 4 \text{ SiO}_2 \cdot \text{H}_2\text{O}$). Soapstone is a term for an impure massive talcose rock.

The uses of talc are many and varied but the principal consumption in the United States is for ceramics, paints, roofing, insecticides, rubber, paper, cosmetics, and pharmaceuticals. For most uses the talc is finely pulverized. Block talc or soapstone has several applications, such as electronic insulators, marking "chalk" or "pencils" for cloth or steel, and sculpture.

Impure talc and soapstone have been found at a few localities in Douglas County and one prospect has been explored to a limited extent.

The talc is usually found in shear zones associated with serpentinite and has formed by hydrothermal alteration. Some is found in mineralized shear zones associated with gold mines and prospects as in the Starvout and Quines Creeks area, Silver Peak mineralized zone, at the Red Hill prospect, and others. Talc schist is also reported with serpentinites in the Banfield-Rowley copper area and in the Red Mountain area, where serpentinites are in contact with diorite. None of these areas has been prospected for talc, however, and no details as to its potential commercial importance are available.

The Lilja and Moyer talc prospect located on private land in SE $\frac{1}{4}$ sec. 33, T. 30 S., R. 5 W., about 1 mile west of Canyonville was explored to a limited extent about 1936. Treasher (unpublished department mine file report, 1941), described the geology of the occurrence. Talc has developed along sheared contacts of both walls of a 300-foot wide northeast-striking serpentinite body cutting greenstone. The quality varies with intensity of alteration. Development work consists of numerous small cuts and trenches which have exposed a 3-foot lens of apparently good grade talc. The prospect is approximately in line with a major fault zone which trends about N. 80° E. and can be traced for several miles. It appears reasonable to expect other similar areas of talc alteration elsewhere along this important structural feature.

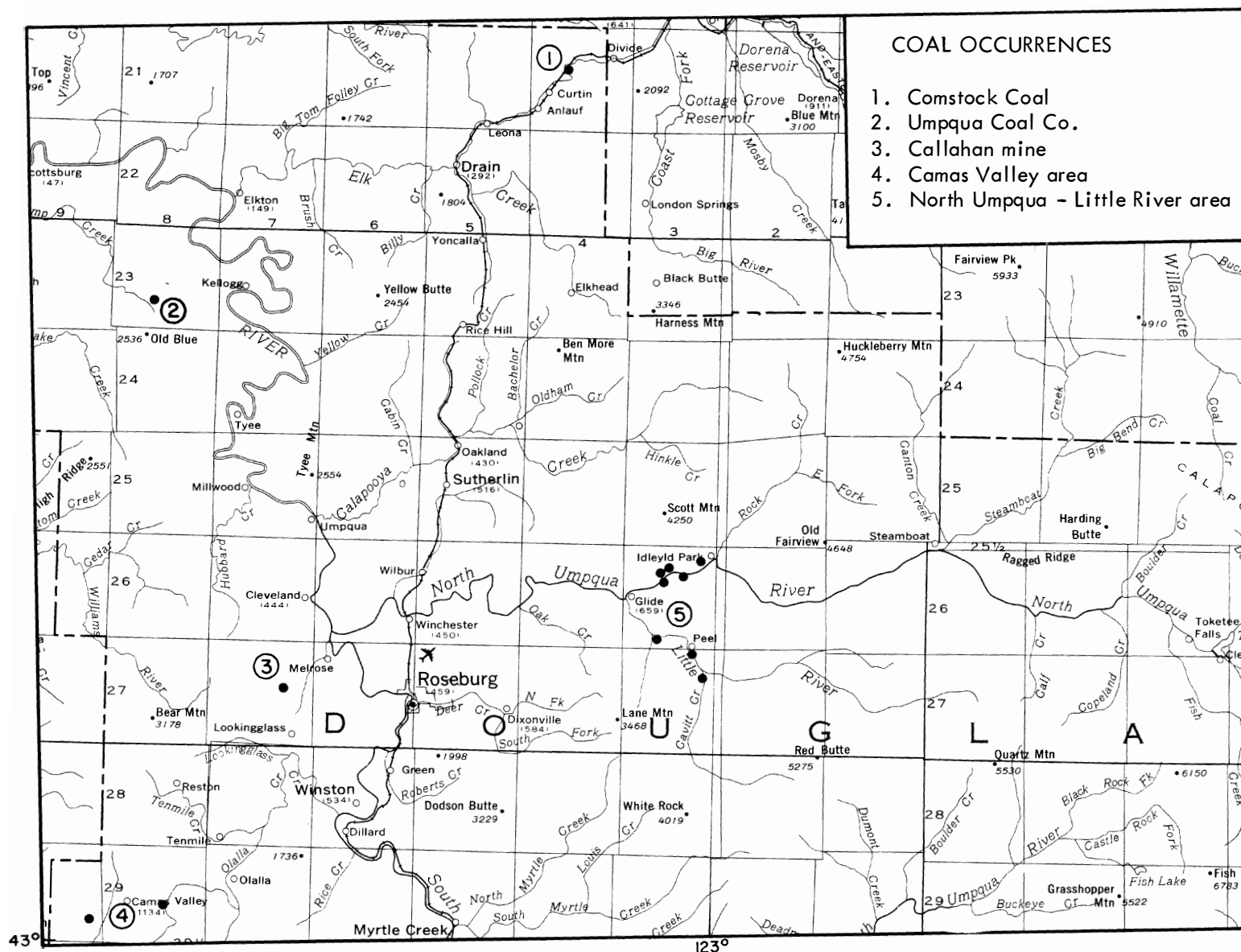


Figure 30. Map showing location of coal occurrences in Douglas County.

MINERAL FUELS

Coal

A few occurrences of coal are known in Douglas County, but apparent lack of available quantity, distance from markets, or poor quality have prevented their development. There was small production from a few of the occurrences in the early days, but no records were kept and most, if not all, of the exposures and workings are caved and covered so that they would be difficult to find.

The five occurrences shown on the map, Figure 30, are described alphabetically below.

CALLAHAN MINE (No. 3)

- Location:** Center sec. 14, T. 27 S., R. 7 W., on private land about 3 miles SW of Melrose.
- Development:** There are at least 4 caved adits reported at this location. The Perkins-Mundy adit about 450 feet in length trends S. 65° W. down dip; Carpenters adit about 200 feet long trends S. 10° W.; and the Callahan adit about 400 feet long trends S. 35° E., and goes up the dip at about 10°. It has an air shaft at 200 feet that is 35 feet deep. There is no information on the fourth adit. In about 1910, at least three fairly deep exploratory holes were drilled in sections 3, 15, and 32, T. 27 S., R. 7 W., and coal was reportedly struck in all three.
- Geology:** The coal occurs in pebbly sandstone and shale of the Umpqua Formation. The rocks dip about 10° N. 35° W. The thickness of the coal seam is reported to range from 20 to 48 inches, with about 20 inches of mineable, good-quality bituminous grade.
- History and Production:** The coal has been known since the 1860's and was mined intermittently since about 1909. It was estimated by the property owners in 1942 that a total of about 400 tons of coal had been marketed to that time.
- References:** Diller (1914)
Department mine file report (1942), unpub.

CAMAS VALLEY AREA COAL (No. 4)

- Location:** The Krogel Coal prospect is in E. half sec. 22, T. 29 S., R. 8 W., and another reported occurrence of uncertain location in sec. 26 (?), T. 29 S., R. 9 W., about a mile from the mouth of Holmes Creek.
- Development:** Not reported in either occurrence. An old shaft was said to be "somewhere north of Camas Valley Post Office along the creek;" and a small tunnel located "somewhere south of the Post Office" (Tom Taylors tunnel).
- Geology:** The coal at the Krogel occurrence in sec. 22 is reported to be about 3 feet thick, dirty, and to slack readily. The country rocks are Umpqua Formation pebbly massive sandstone with some interbedded shale. The Krogel vein dips about 15° west. The coal vein on Holmes Creek is reported to be about 6 inches thick. Neither occurrence was visited by the Department geologist reporting them.

Production: No records of production; however, it was reported that in the early days some coal from the Camas Valley area was shipped to Marshfield for blacksmithing purposes.

Reference: Department mine file report, 1942, unpub.

COMSTOCK COAL (No. 1)

Location: $N\frac{1}{2}$ NW $\frac{1}{4}$ sec. 16, T. 21 S., R. 4 W., on private land $\frac{3}{4}$ mile NE of Comstock (railroad siding). The site of the caved adits is at the mouth of a small gulch on the west side of Pass Creek.

Development: There were 4 or 5 short adits all caved.

Geology: The coal is a lignite grade in rocks of late Eocene Spencer Formation. The enclosing sediments are somewhat tuffaceous. The exposure is covered by a slide. Narrow (1- to 2-inch) seams of lignite are separated by less pure bone coal and shale that is iron stained and weathered. It slacks readily into small chunks. The beds strike NNW and dip about 15° E.

Production: No records available, but small quantities were reportedly mined for local use several years ago.

Reference: Department mine file report, 1943, unpub.

NORTH UMPQUA - LITTLE RIVER AREA (No. 5)

Location: Sections 9, 10, and 32, T. 26 S., R. 3 W., and sections 2 and 11, T. 27 S., R. 3 W.

Development: Minor, but details are not reported.

Geology: The coal beds mark a horizon in the upper Umpqua Formation which contains a thin, basal conglomerate or pebbly sandstone grading upward into siltstone, and appears to be of shallow-water origin (Baldwin, 1964). Dips are generally gentle (about 15°) east. Thickness is not reported, but beds are said to be small and of subbituminous grade.

History: Diller (1898) reports as follows:

"Small beds of coal have been found upon the north fork of the Umpqua; also upon Little River and Cavitt Creek, as well as Coal Creek, which flows into the Calapooya. All of these localities are near the eastern border of the Roseburg 30-minute quadrangle and indicate the accumulation of vegetation along the shores of the ancient Eocene sea. None of the beds are of considerable economic importance. It is said that a wagon load was taken out on the north fork and hauled to Roseburg for trial, but its quality did not prove to be especially good. Several tons have been removed from an opening near the mouth of Cavitt Creek, for blacksmithing, but the supply is limited. An analysis of the coal from this locality shows its composition to be as follows:



Figure 31. This coal seam in the Elkton area was discovered and explored about 1900. Coal bed no longer exposed and exact location unknown. (Photograph courtesy of Douglas County Museum)

Analysis of coal from near the
mouth of Cavitt Creek

	Percent
Moisture	4.64
Volatile matter	38.54
Fixed carbon	39.00
Ash	17.80
Sulphur	0.44
Total	100.42 "

References: Baldwin (1964)
Diller (1898)

UMPQUA COAL CO. (No. 2)

Location: Secs. 16 and 28, T. 23 S., R. 8 W., at the head of Mehl Creek, west of Kellogg about 7 miles SW of Elkton.

Development: There is mention of a 10-foot and a 60-foot adit on the coal seams. Other cuts and short adits were probably made at one time. There has been no on-site investigation by the Department.

Geology: The area is presumably underlain by Eocene sandstone and siltstone of the Tyee-Elkton Formation. The coal beds are described as follows: the upper seam is 14 feet thick but very dirty and underlies about 125 acres. The next lower seam is 24 inches thick with no partings and reported to be of good quality. The third seam is 50 feet lower in the section, 30 inches thick, and has a 6-inch bone parting in the middle. The fourth seam is reported as 48 inches thick with a 3-inch bone seam. It underlies the entire hill and is reported to dip 7° NW. The coal is reported to be subbituminous grade.

History: This coal field was discovered before the turn of the century (Figure 31). In 1906 the Union Pacific Railroad became interested in the deposits but their interest ceased when the proposed Drain-Reedsport Railroad was abandoned. Very little work has been done since that time.

References: Department mine file report, 1941, unpub.
Oregon Dept. Geol. and Mineral Indust., (1940) p. 133.

Oil and Gas Potential

Twelve oil and gas wells have been drilled in Douglas County since the early 1920's (see Table 7 and map, Figure 32). No commercial quantities of oil or gas have been discovered and no surface seeps of petroleum are known to exist in the county. Traces of hydrocarbons have been found in several of the wells, however. They occur principally in rocks of the early Eocene Umpqua Formation. Figure 33 shows the old wooden derrick used in the 1930's at the Kernin site near Roseburg.

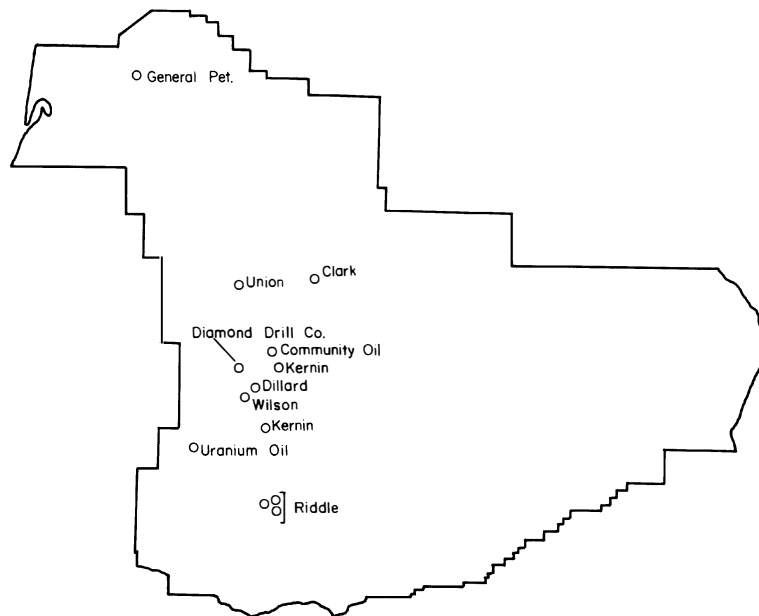


Figure 32. Map showing oil and gas exploration wells and prospects in Douglas County.

Hydrocarbon fluorescence and oil-stained cores were obtained in the Uranium Oil and Gas Company well in Camas Valley, and at a depth of 1,640 feet a small flow of petroleum gas was produced on a formation test. Hydrocarbon fluorescence was also obtained from samples in the General Petroleum Co. "Long Bell No. 1," Community Oil and Gas Co. "Scott No. 1," and Union Oil Co. "Liles No. 1" wells.

Gas sand was indicated on the electric log of the "Long Bell No. 1" well at 4,377-4,386 feet, but formation testing of the thin zone yielded no positive results. Mechanical problems associated with the testing may account for the ambiguity. It is difficult to make open-hole tests on zones as thin as this one, and the formation may have been damaged by drilling fluid. Figure 34 shows the equipment used in 1957 at the General Petroleum Long Bell site near Smith River northeast of Reedsport.

Oil and gas are usually generated at depth in thick sequences of marine sedimentary rock rich in organic debris. As the oil migrates away from the source rock through layers of permeable strata, it commonly becomes entrapped under impermeable obstructions along faults, at the crests of anticlines, or within the host strata. Accumulations of oil and gas behind these obstructions form the reservoirs sought in drilling.

In Douglas County sedimentary rocks making up part of the lower member of the Umpqua Formation (Baldwin, 1965) are the most favorable in terms of potential for oil production. The rocks are thick and contain adequate organic material locally. Many of the sandstone interbeds exhibit permeability adequate for oil migration, and potential structural and stratigraphic traps are numerous. The unit is locally faulted, steeply folded, and unconformably overlain by the Tyee Formation and other members of the Umpqua Formation. In addition lateral variations in lithology suggest the presence of stratigraphic traps within the unit.

Table 7. Oil and gas exploration wells and prospects in Douglas County (from Newton, 1965)

COMPANY	WELL NAME	LOCATION AND ELEVATION	DATE	DEPTH	REMARKS
Clark, Sheldon C.	"Oakland Well"	Oakland area. SE $\frac{1}{4}$ sec. 8, 25S., 5 W. Elev. 640'	1926	2235'	Reported considerable amount of gas with a trace of oil (Smith, 1924)
Community Oil & Gas Co. (Oil Developers, Inc.)	Scott No. 1	West of Roseburg SW $\frac{1}{4}$ sec. 5, 27S., 6W. 570' N. of S. line & 485' E. of W. line Elev. 400' Gr.	1954	3693'	Rotary. Oil shows in cores 1500-3520' (Dept. file)
Diamond Drill Contract Co.	Coal prospect hole	Lookingglass area Approx. sec. 21, 27S., 7 W. Elev. 800'	1910	1109'	Gas encountered at 605' (Dept. file)
Dillard, F.W.	?	Lookingglass area Sec. 36, 27S., 7 W. Elev. 580'	1910	700'	Cable tools. Some oil in shale reported (Washburne, 1914)
General Petrol. Corp.	Long Bell No. 1	North of Reedsport SW $\frac{1}{4}$ sec. 27, 20S., 10W. 1640' E. & 1244' N. from SW cor. Elev. 48' Gr.	1957	9004'	Rotary. Slight gas show 5345'. Faint amber cut in cores at 5590'. Faint yellow fluorescence in core 6040-6060' (Dept. file)
Kernin, W.F.	Well No. 1	West of Roseburg Sec. 16, 27S., 6W. Elev. 800'	1931-1948	3900'	Cable tools. Shows of gas and oil reported (McCusker, Dept. file)
Kernin, W.F.	D. Coon No. 1	Dillard area SE $\frac{1}{4}$ sec. 30, 28S., 6W. 900' S. of N. line & 900' W. of E. line. Elev. 940' Gr.	1954-1958	400'	Cable tools (Dept. file)
Melrose Seep	Oil seep	Melrose area Approx. sec. 21, 26 S., 6 W.	1958	--	Light oil reported seen rising on gas bubbles in South Umpqua River near bank. Near confluence of North and South Umpqua Rivers (Dept. file)
Riddle Gas & Oil Prod., Ltd.	Aikins No. 1	Riddle area SE $\frac{1}{4}$ sec. 27, 30S., 6W. 1647' N. of S. line & 555' W. of E. line. Elev. 800'	1958	480'	Cable tools. No shows reported (Dept. file)
Riddle Gas & Oil Prod., Ltd.	Dayton No. 1	Riddle area. SW $\frac{1}{4}$ sec. 34, 30S., 6W. 960' N. of S. line & 1040' E. of W. line Elev. 800'	1955-1958	1370'	Cable tools. A small flow of gas was found below 1000' (Dept. file)
Riddle Gas & Oil Prod., Ltd.	Wollenberg No. 1	Riddle area NE $\frac{1}{4}$ sec. 28, 30 S., 6W. 601' S. of N. line & 35' W. of E. line. Elev. 800'	1956	1170'	Cable tools. Salt water encountered at 755' (Dept. file)
Union Oil Co.	Liles No. 1	West of Sutherlin SE $\frac{1}{4}$ sec. 27, 25 S., 7W. 173' S. & 1144' W. from E $\frac{1}{4}$ cor. Elev. 725' Gr.	1951	7002'	Rotary. No shows reported except for one faint hydrocarbon cut (Dept. file)
Uranium Oil & Gas Co.	Ziedrich No. 1	Camas Valley NW $\frac{1}{4}$ sec. 16, 29 S., 8W. 1570' S. & 238' W. of N $\frac{1}{4}$ cor. Elev. 1305'	1955	4368'	Rotary. Bright yellow fluorescence in cores 4020-4050'. Some gas found at 1900' (Dept. file)
Wilson Farm	Water Well	Lookingglass area. Sec. 3, 28 S., 7W. Elev. 640'	1950	--	Small amount of paraffinic oil in well water (Dept. file, Dole, July 1, 1953)

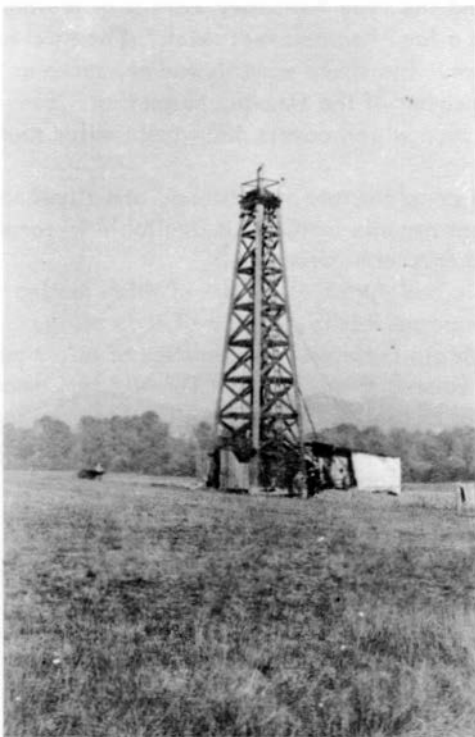


Figure 33. Wooden derrick used in the 1930's at the Kernin site near Roseburg.

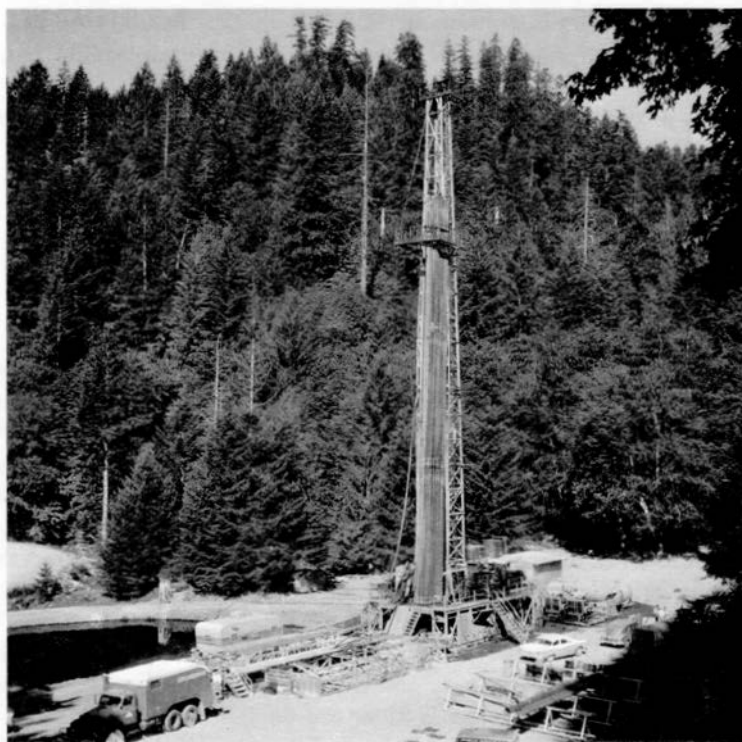


Figure 34. Equipment used at the General Petroleum Long Bell site near Smith River northeast of Reedsport in 1957.

The middle and upper members of the Umpqua Formation and the Tyee Formation consist of rhythmically bedded sandstone and siltstone and are generally less than a few thousand feet thick. The thicknesses present are probably not sufficient for the generation of petroleum. The strata may, however, serve as reservoir or trap rock for oil generated in the underlying lower member of the Umpqua Formation. Beds as young as late Eocene are preserved in a large synclinal depression which covers 430 square miles south of Elkton.

Cretaceous rocks in southwestern Oregon consist of marine conglomerate, sandstone, and siltstone and are more deformed than the younger Tertiary units. Sufficient organic material is available in some areas to warrant exploration in regions of adequate thickness and favorable structure.

Although most of the older units of Douglas County (Triassic and Jurassic) consist of thick marine sequences of strata, the specific environments of deposition, low permeability, degree of induration, and extent of deformation indicate that they are not likely to contain commercial quantities of oil or gas.

Prime areas for drilling are located along the trend of the Eocene shoreline from Tenmile to Camas Valley and southward. Targets include sands of the lower member of the Umpqua Formation and possibly parts of the Tyee Formation and the middle and upper members of the Umpqua Formation. Reservoirs may also be developed in Cretaceous strata along the contact with the overlapping Tertiary units.

The area where early Eocene volcanic rocks are exposed north of Roseburg should be avoided, as these highs may represent volcanic centers which extend to great depth. Prospects with some potential for the commercial discovery of petroleum include the area along the margin of the Western Cascades in the north central part of the county, where shoreline deposits may exist at depth.

Along the coast near Reedsport, oil and gas may have migrated updip from thick sections out to sea to become entrapped behind folds and stratigraphic traps near shore. Sands encountered in the General Petroleum well northwest of Reedsport were too impermeable to be considered as reservoir rocks, but similar rocks to the south may be more favorable. The Umpqua Formation in the General Petroleum well yielded numerous traces of hydrocarbons.

Probably the lowest ranking prospect of any promise is the Elkton-Tioga Basin. The sedimentary section in this area is believed to be more than 15,000 feet thick. Possibly folding and faulting on a local scale within this synclinal structure could have trapped commercial quantities of oil. Even the Tyee Formation may have some potential in this area.

New interpretations of geologic origin based on the plate tectonics theory may give rise to better ideas in prospecting for oil and gas in the future.

Geothermal Resources

The earth is a tremendous reservoir of heat which continues to be generated by the decay of radioactive elements in its interior. This natural heat of the earth sometimes occurs close enough to the surface to be utilized as energy from natural steam or hot water. These "hot spots" where there is a greater than normal heat flow at the surface usually are found near areas where volcanic activity has occurred in the relatively recent geologic past. The western United States including Oregon is considered to have a high potential for finding usable geothermal energy.

Douglas County has several indicators that may point to high heat flow and therefore potential sources for geothermal energy. Hot springs, mercury mineralization, and intensive rock alteration are signs of geothermal activity.

The Umpqua Hot Spring in the Toketee area (sec. 20, T. 26 S., R. 4 E.), the extensive quicksilver mineralization in the Nonpareil-Bonanza area, and extensive rock alteration and native sulfur near Hole-in-the-Ground at the head of the South Umpqua River are only a few of the surface indicators of present or past high temperature. These may serve as starting points in evaluating the geothermal potential of the county.

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GLOSSARY

Actinolite. A bright green to grayish-green, bladed to fibrous, iron-bearing variety of tremolite belonging to the amphibole group of minerals.

Alluvial. Pertaining to deposits made by flowing water, as a sand and gravel bar.

Amphibole. A group of rock-forming minerals that are generally prismatic, bladed, or fibrous. They contain variable amounts of magnesium, iron, calcium and sodium along with silica alumina and water. A few of the more common varieties are hornblende, tremolite-actinolite, anthophyllite, and glaucophane.

Amphibolite. A metamorphic rock consisting mainly of amphibole and some plagioclase feldspar.

Amygdoidal. Pertaining to volcanic rocks having numerous gas cavities (vesicles) that are filled with secondary minerals.

Andesite. A volcanic rock having a composition intermediate between basalt and rhyolite.

Antigorite. A mineral belonging to the serpentine group (hydrous magnesium silicates) generally formed by hydrothermal alteration of peridotite or dolomite.

Argillite. A rock derived either from siltstone, claystone, or shale that has undergone a somewhat higher degree of induration than is present in those rocks. Argillite holds an intermediate position between shale and slate.

Arkosic. Pertaining to a sandstone composed largely of quartz and feldspar grains.

Augite. A calcium, magnesium, and iron-bearing aluminum silicate mineral belonging to the pyroxene group.

Azurite. A deep-blue, secondary hydrous copper carbonate mineral.

Bituminous. A rock containing variable amounts of solid and semi-solid hydrocarbons as asphalt. Also a soft coal high in carbonaceous matter and with 15 to 50 percent volatiles.

Bornite. A reddish-brown ore mineral of copper (Cu_5FeS_4) often with iridescent purple tarnish.

Breccia. A rock made up of highly angular coarse fragments. May be sedimentary, volcanic or formed along a fault by its crushing action.

Buchia piochii. A small fossil pelecypod that lived during latest Jurassic time.

Calc-alkalic. An igneous rock series having a relatively high alkali-lime content.

Calcite. A common rock-forming mineral composed of calcium carbonate; the major constituent of limestone and often a gangue mineral in sulfide-bearing veins.

Chalcedony. A cryptocrystalline form of quartz. It occurs as chert, jasper, agate, etc.

Chalcocite. A lead-gray copper sulfide mineral containing 79.8 percent copper.

Chalcopyrite. A brass-yellow copper-iron-sulfide mineral containing 34.5 percent copper.

Chert. A cryptocrystalline silica rock (chalcedony) generally of marine origin.

Covellite. An indigo blue secondary copper sulfide ore mineral containing 66.4 percent copper.

Cristobalite. A high-temperature silica mineral found in volcanic rocks.

Dacite. The extrusive, (fine-grained) equivalent of a quartz diorite.

Deltaic. Pertaining to sedimentary deposits laid down in a river delta.

Diorite. A plutonic igneous rock composed essentially of sodic plagioclase feldspar with variable amounts of hornblende, biotite, or pyroxene and occasionally small amounts of quartz and orthoclase.

Epidote. A light green silicate mineral containing calcium, aluminum and iron.

Feldspar. An important group of rock-forming minerals including orthoclase, microcline, plagioclase, and anorthoclase that are aluminum silicates with variable amounts of potassium, sodium, and calcium.

Fluvial. Deposited by stream or river action.

Foraminifera. An important group of unicellular marine animals (protozoa) whose skeletons (usually microscopic in size) are good index fossils.

Gangue. Non-valuable minerals associated with ore minerals.

Garnierite. A green, hydrous, nickel-magnesium silicate ore mineral.

Goethite. A crystalline hydrated oxide of iron mineral similar to limonite.

Harzburgite. A variety of peridotite (ultramafic) rock containing olivine and orthorhombic pyroxene.

Hercynite. An iron spinel, FeAl_2O_4 . A massive, fine granular, black mineral.

Hogged fuel. Finely chopped waste wood material sometimes used as a reductant in smelting.

Horse. Waste rock inclusions within ore deposits.

Kaolinized. Formation of a kaolin clay by either weathering or hydrothermal alteration processes.

Laterite. A reddish residual soil developed in humid, tropical, or subtropical regions of good drainage.

Limonite. A yellow-brown hydrous iron oxide mineral.

Malachite. A green, copper carbonate which is a common secondary mineral and ore of copper.

Mansfieldite. A white to pale gray, hydrous, aluminum arsenate mineral that occurs at Hobart Butte. It is isomorphous with scorodite.

Mantle. The layer of the earth between the crust and core believed to consist of ultramafic rock in a semi-plastic condition.

Marcasite. The orthorhombic form of iron sulfide (FeS_2) deposited in a low temperature and acid environment. The more stable isometric pyrite would form in an alkaline environment.

Metacinnabarite or metacinnabar. A black polymorph of cinnabar (HgS) that crystallizes in the isometric system (tetrahedral) and is usually associated with marcasite.

Micaceous. Composed of or resembling mica – having thin plates or scales.

Montmorillonite. Clay minerals which are hydrous aluminum silicates with variable amounts of magnesium, calcium, and other impurities. Montmorillonite is the chief constituent of bentonite and fullers earth.

Monzonite. A granular plutonic rock that contains approximately equal amounts of orthoclase and plagioclase feldspars. Quartz is usually present, but if greater than 2 percent the rock is called a quartz monzonite.

Mullite. An aluminum silicate which is stable at high temperatures and used in ceramic whiteware and refractories.

Orogeny. The period of (or process of) regional mountain building, involving folding, faulting, and uplift.

Pelecypod. Clam, mussel, oyster, etc. Invertebrate, bivalves of the phylum Mollusca.

Pelitic. Pertaining to sedimentary rocks that are fine-grained, argillaceous and aluminous.

Peridotite. A nonfeldspathic plutonic rock consisting of olivine, with or without other mafic minerals such as pyroxenes, amphiboles, spinels, and sometimes micas.

Phyllitic. Having a metamorphic foliated texture intermediate between a slate and a schist, i.e., coarser than a slate and finer than a schist.

Picrolite. A columnar, semifibrous variety of serpentine.

Plutonic. Refers to an igneous rock which has crystallized from a molten magma at great depth.

Porphyritic. A textural term for those igneous rocks which have large crystals (phenocrysts) set in a finer groundmass.

Propylitic alteration. A rock alteration consisting of the abundant development of chlorite and pyrite, sometimes epidote, and in some instances carbonates and a little sericite.

Pyroxene. An important group of rock-forming minerals having a composition similar to the amphiboles, but lacking water. Some of the more common varieties include: enstatite, augite, hypersthene, diopside, and pigeonite.

Rhyolite. A fine-grained igneous rock having a chemical composition similar to granite, occurring as flows or minor intrusives.

Saprolite. Thoroughly decomposed (weathered) earthy untransported rock.

Schist. A crystalline metamorphic rock having strong parallel foliation due to preferred orientation of enclosed micaceous, prismatic or tabular minerals.

Scorodite. A pale green to brown, hydrous iron arsenate mineral which is isomorphous with mansfieldite.

Siderite. A gray to brown iron carbonate (FeCO_3) mineral.

Sphalerite. A yellow, brown, or black resinous zinc sulfide (ZnS) mineral.

Tennantite. A dark gray to black, metallic, sulfarsenide of copper and iron mineral which is isomorphous with tetrahedrite and may contain some antimony.

Tremolite. Usually gray to white, bladed or fibrous, amphibole mineral associated with metamorphic rocks.

Tridymite. A high-temperature form of silica (SiO_2). Occurs in siliceous volcanic rocks.

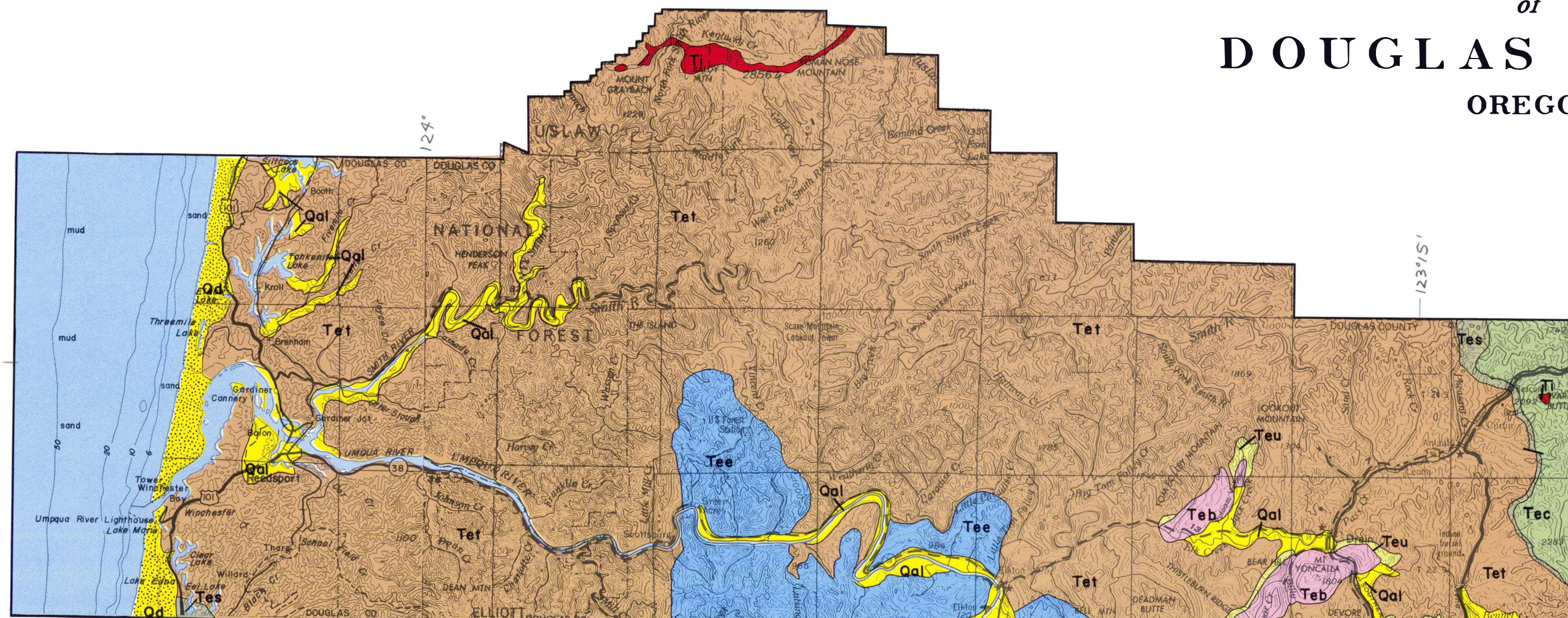
Tuff. A rock formed of compacted volcanic fragments, generally smaller than 4 millimeters in diameter. Varieties containing larger fragments are given modifiers such as lapilli tuff, tuff breccia, etc.

Ultramafic. An adjective used to describe a rock having a relatively high magnesium and iron content, less than 45 percent silica, and virtually no quartz or feldspar. Includes peridotite and serpentinite.

Unconformity. A surface of erosion or nondeposition, usually the former, that separates younger strata from older rocks. If, as is common, the sets of bedding are at an angle to each other, it is called an angular unconformity.

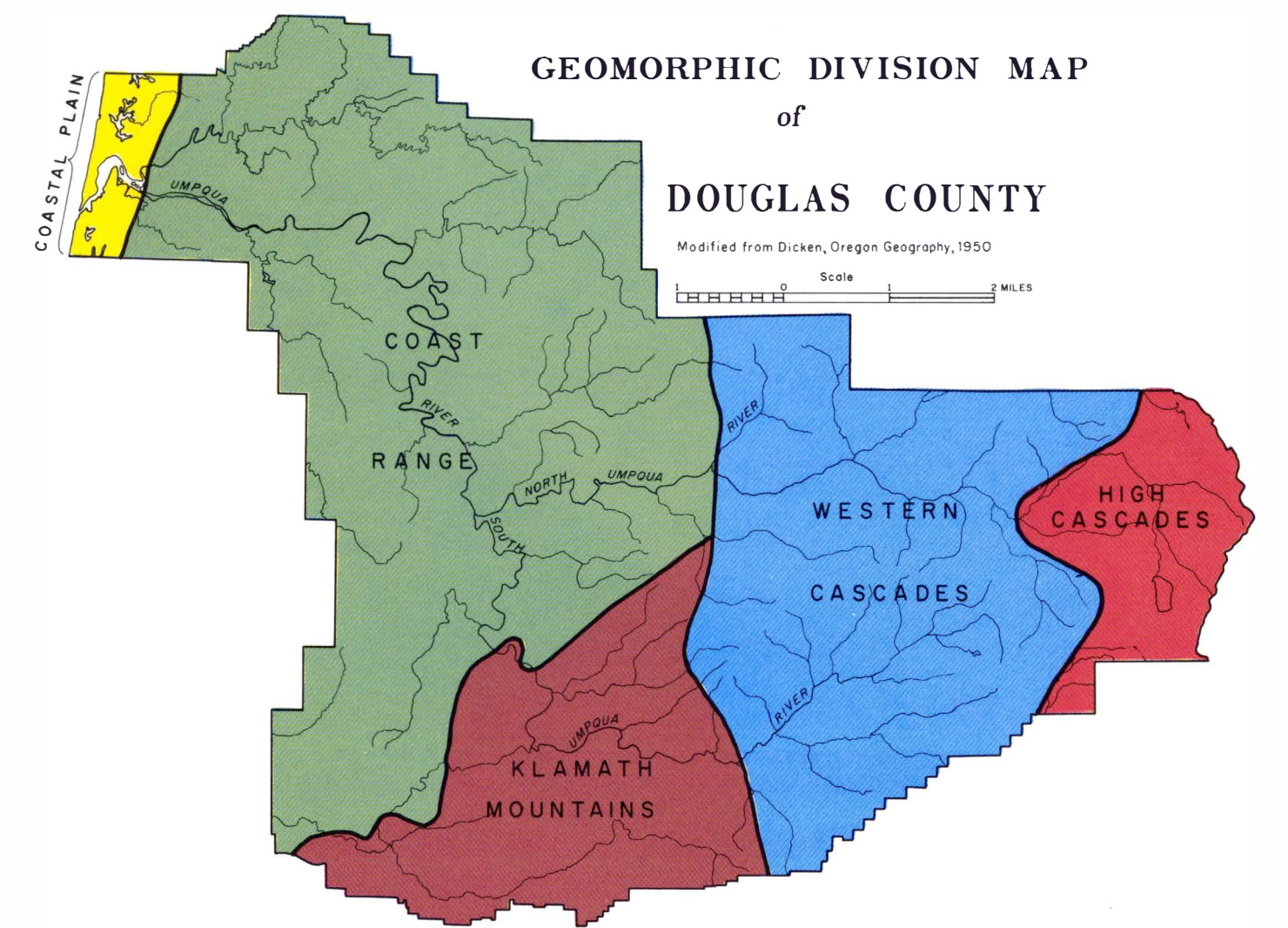
Zoisite. A usually grayish-white secondary mineral belonging to the epidote group.

GEOLOGIC COMPILATION MAP
of
DOUGLAS COUNTY
OREGON



STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
R. E. CORCORAN, STATE GEOLOGIST

Geology compiled by J. D. Beaulieu
and Len Ramp.



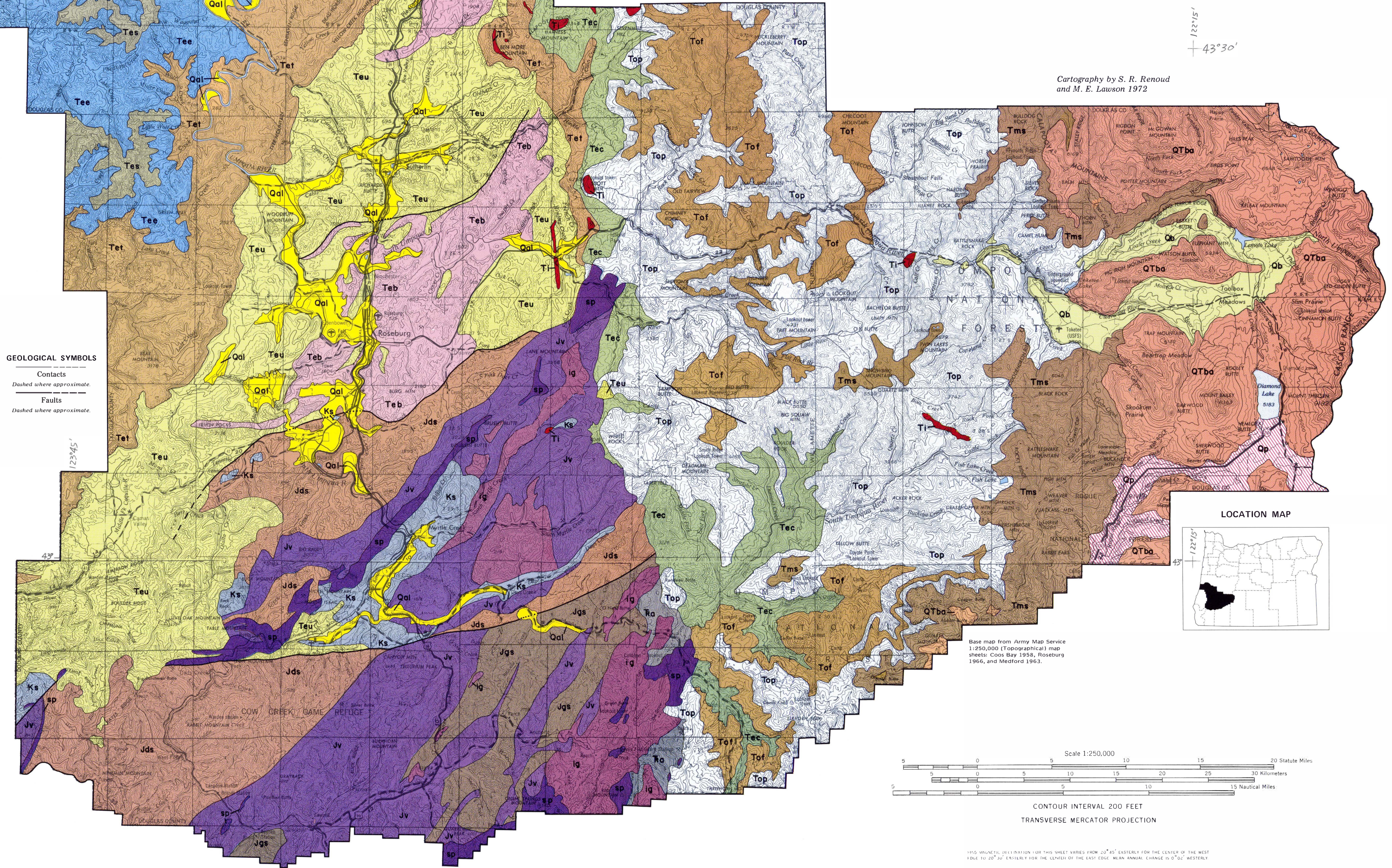
Cartography by S. R. Renoud
and M. E. Lawson 1972

- EXPLANATION**
- QUATERNARY**
- PLEISTOCENE**
- HOLOCENE**
- Qd, Qa**
Dune Sands and Alluvium
Deposits of silt, sand, and gravel in the larger river valleys (Qal) and local accumulations of dune sands along the coast (Qd).
- Qp, Qb**
Pumice and Intracanyon Flows
Surficial deposits of ash-fall dacitic tuff (Qp) and intracanyon flows of olivine basalt and olivine-bearing andesite (Qb).
- MIocene**
- PILOCENE**
- QTba**
Open-textured olivine basalt and olivine-bearing andesite.
- Tms**
Sardine Formation
Basalt and dacite-andesite flows overlain by a series of platy hypersthene andesite flows.
- OLIGOCENE**
- Top, Toi**
Little Butte Volcanic Series
Massive beds of dacite and andesitic ash-flow tuff (Top) and lesser amounts of flow rock of andesitic and basaltic composition (Toi). A distinctive basal rhyolitic ash-flow tuff is recognized in southern Douglas County.
- ECENE**
- Tec**
Colestin-Fisher Formation
Massive greenish-gray pumiceous tuff, andesitic tuff breccia, andesite flows, conglomerate, tuffaceous sandstone, and siltstone.
- Tes**
Late Eocene Sedimentary Rocks
Massive, friable, arkosic sandstone (Spencer Formation) in the Comstock area, and micaceous, arkosic, deltaic sandstone (Coaleto Formation) in western Douglas County.
- Tet, Tte**
Tyee-Elkton Formation
Rhythmically bedded, buff to greenish-gray, arkosic, micaceous sandstone and dark siltstone passing upward into a dominantly siltstone section.
- TEU**
Umpqua Sedimentary Rocks
Rhythmically bedded sandstone and siltstone.
- Teb**
Basalts of the Umpqua Formation
Tholeiitic olivine-bearing basalts similar in composition to the volcanic rocks on the floor of the Pacific Ocean at the present time.
- CRETACEOUS**
- Ks**
Cretaceous Sedimentary Rocks
Chert-pebble conglomerate and medium-bedded lithic sandstone and siltstone of the Riddle Formation; dark-gray sandy siltstone and fine- to medium-grained sandstone of the Days Creek Formation; and conglomerate, sandstone, and siltstone of Late Cretaceous age.
- Jds**
Dothan-Otter Point Formation
Massive to thickly bedded graywacke sandstone with thin interbeds of dark siltstone (Dothan Formation) and a diverse assemblage of sheared graywacke, siltstone, greenstone, and limestone (Otter Point Formation).
- Jgs**
Galice Sedimentary Rocks
Dark slaty siltstone and lesser amounts of interbedded graywacke sandstone and occasional lenses of conglomerate.
- Jv**
Jurassic Volcanic Rocks
Volcanic rocks of Jurassic age. Includes andesitic breccias and flow rocks of the Galice Formation, Rogue Formation, and Dothan Formation.
- TRiassic**
- TRa**
Applegate Group
Amphibolite, slate, slaty siltstone, chlorite schist, quartz-mica schist, and quartzite representing metamorphosed sandstone, shale, and volcanic rock.
- INTRUSIVE ROCK**
- Tertiary Intrusives**
Dikes and sills of gabbro and basalt of middle Tertiary age in the Coast Range and a variety of small intrusive bodies in the Western Cascades composed of medium- to fine-grained rock of basaltic to rhyolitic composition.
- Ig**
Igneous Rock
Granitic-textured igneous rock of Neovadan age ranging in composition from granite to diorite.
- Serpentine and Minor Peridotite**
Greenish rock composed of minerals of the serpentine group and containing scattered relict bodies of the parent ultramafic rock.
- GEOLOGICAL SYMBOLS**
- Contacts**
Dashed where approximate.
- Faults**
Dashed where approximate.

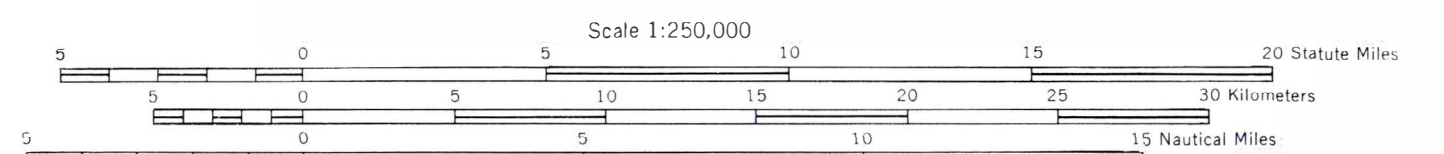
GEOLOGICAL SYMBOLS

Contacts
Dashed where approximate.

Faults
Dashed where approximate.



Base map from Army Map Service
1:250,000 (Topographical) map
sheets: Coos Bay 1958, Roseburg
1966, and Medford 1963.



CONTOUR INTERVAL 200 FEET
TRANSVERSE MERCATOR PROJECTION

1:250,000 (1:111,111) ORIGIN FOR THIS SHEET VARIES FROM 12° 45' EAST OF THE CENTER OF THE WEST
1:250,000 (1:111,111) ORIGIN FOR THE CENTER OF THE EAST EDGE. MEAN ANNUAL CHANGE 10" 0.02" WEST.