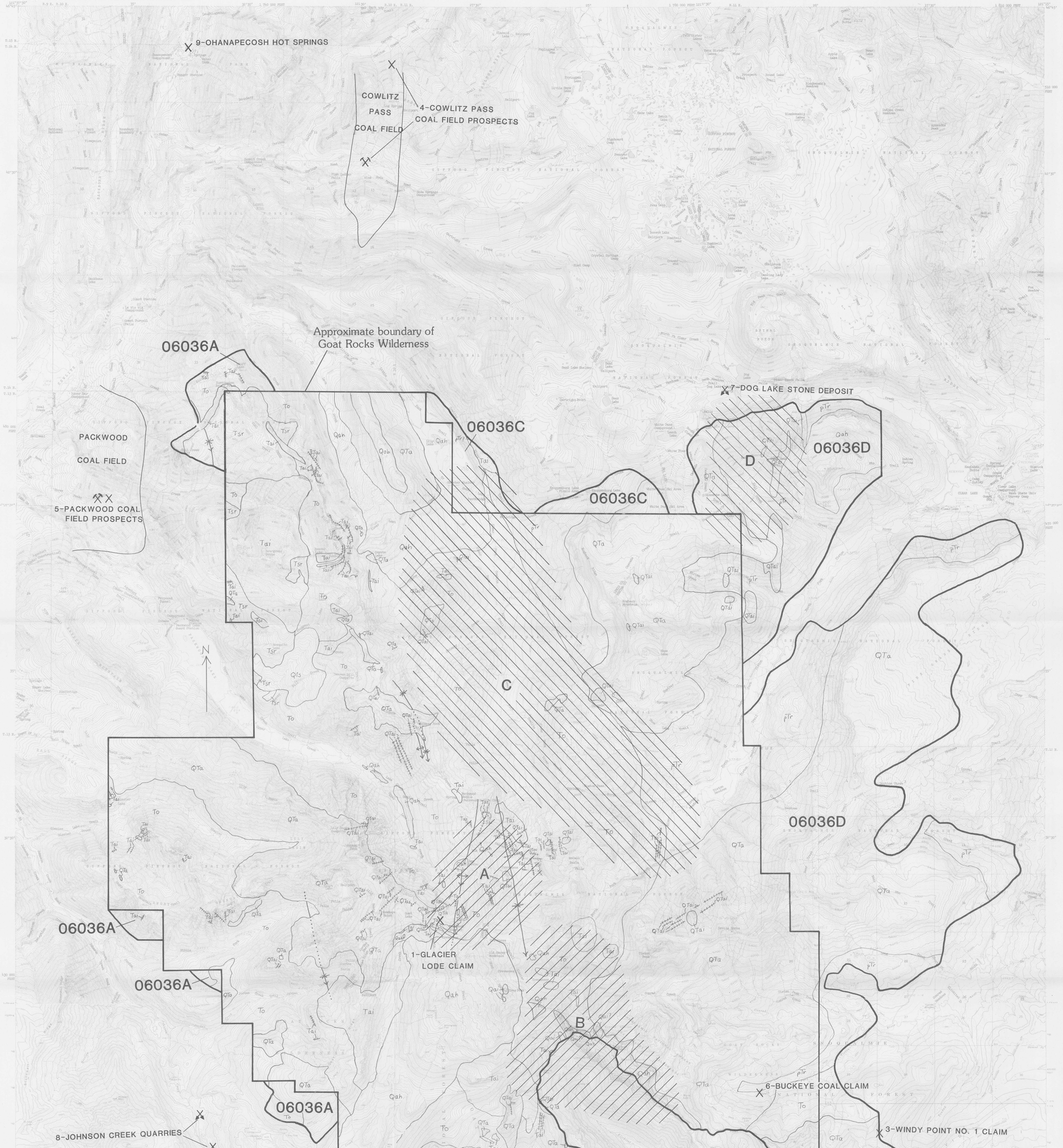
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1653-A
PAMPHLET ACCOMPANIES MAP



Base from U.S. Geological Survey, 1:24,000
Jennies Butte, Walupt Lake, Hamilton Butte, 1970; 1:62,500, Packwood, White Pass, 1962

SCALE 1:48 000
1 ½ 0 1 2 3 MILES
1 .5 0 1 2 3 KILOMETERS

Geology modified from Swanson and Clayton (1983)

MINERAL RESOURCE POTENTIAL MAP OF THE GOAT ROCKS WILDERNESS AND ADJACENT ROADLESS AREAS, LEWIS AND YAKIMA COUNTIES, WASHINGTON

By
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1983

EXPLANATION OF MINERAL RESOURCE POTENTIAL

- APPROXIMATE BOUNDARY OF WILDERNESS AND ADJACENT ROADLESS AREAS
- AREA OF MODERATE RESOURCE POTENTIAL FOR BASE-METAL RESOURCES
- AREA OF LOW RESOURCE POTENTIAL FOR BASE-METAL RESOURCES
- MINE
- PROSPECT
- GRAVEL PIT OR QUARRY

EXPLANATION OF GEOLOGIC BASE

(Base shown in gray on map)

CORRELATION OF MAP UNITS

Qls	Qob	Qah	Qai	Pleistocene	QUATERNARY
QTa	QTai			Pliocene	
Tsr				Eocene	TERTIARY
Tai					
To					
pTr					PRE-TERTIARY

DESCRIPTION OF MAP UNITS

Qls LANDSLIDE DEPOSIT (PLEISTOCENE)--Mapped only where contact relations of bedrock units are obscured

Qob OLIVINE BASALT (PLEISTOCENE)--Flows and tephra of gray, commonly diktytaxitic olivine and olivine-bearing basalt. Plagioclase phenocrysts present in most flows

Qah HORNBLENDE ANDESITE (PLEISTOCENE)--Light-gray, commonly oxidized flows and minor tephra of hornblende and hornblende-bearing andesite.

Qai ANDESITIC INTRUSIONS (PLEISTOCENE)--Plugs and dikes of hornblende and pyroxene andesite. Feeders for unit Qah

QTa PYROXENE ANDESITE (PLEISTOCENE AND PLIOCENE)--Flows and minor tephra of porphyritic andesite and basaltic andesite. Includes olivine basalt flows erupted from vents on Hogback Mountain and interbedded with pyroxene andesite flows. Also includes several hornblende dacite domes overlain by the olivine basalt flows. Plagioclase, hypersthene, and clinopyroxene generally present as phenocrysts. Hornblende occurs in some rocks

QTai ANDESITIC AND BASALTIC-ANDESITIC INTRUSIONS (PLEISTOCENE AND PLIOCENE)--Plugs and dikes of pyroxene andesite, basaltic andesite, and hornblende andesite at least in part related to pyroxene andesite of unit QTa. Dikes of pyroxene andesite and basaltic andesite in central part of area show radial pattern centered on Upper Lake Creek

Tsr STEVENS RIDGE FORMATION (EOCENE)--Light-colored, silicic ashflow tuff and associated bedded tuff and rhyolite flows. Quartz phenocrysts common. Secondary minerals, especially clay, calcite, quartz, and zeolites abundant

To OHANAPECOSH FORMATION (EOCENE)--Chiefly altered basaltic and andesitic lava flows and bedded volcaniclastic rocks. Also includes silicic flows and tuffs, as well as small intrusive bodies of mafic to silicic compositions. Unit consists predominantly of lithic tuffs, lapilli tuffs, and breccias in north half of area and of andesitic lava flows in south half of area. Zeolites, quartz, calcite, and clay minerals abundant; rocks commonly have a green or white cast. Basaltic flows and rhyolite near base of formation along Clear Fork Cowlitz River and in McCall Basin area may be separated from overlying Ohanapecosh beds by an angular unconformity

Tai INTRUSIVE ROCKS OF MAFIC AND INTERMEDIATE COMPOSITIONS (TERTIARY)--Dikes, sills, plugs, and shallow-seated plutons, predominatly of porphyritic pyroxene andesite but including diorite and quartz monzonite. Age range unknown; includes feeders for flows and tuffs in the Ohanepecosh Formation as well as upper Tertiary bodies. Generally altered; clays and calcite especially common

pTr RUSSELL RANCH FORMATION (PRE-TERTIARY)--Graywacke, argillite, and less abundant basaltic flows, most of which have pillow structures. Sheared in most places. Most flows are metamorphosed to greenstone

- CONTACT
- ANTICLINE--Showing direction of plunge; dotted where concealed
- SYNCLINE--Showing direction of plunge; dotted where concealed
- DIKES

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Goat Rocks Wilderness and adjacent wilderness additions in the Gifford Pinchot and Snoqualmie National Forests, Lewis and Yakima Counties, Wash. Goat Rocks Wilderness (NF032) was established by Public Law 88-577, September 3, 1964. The Goat Rocks Roadless Areas (06036A, C, D) were classified as wilderness additions during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

MINERAL RESOURCE POTENTIAL SUMMARY

The mineral potential of Goat Rocks Wilderness and adjacent roadless areas has been evaluated by a multidisciplinary team of geoscientists from the U.S. Geological Survey and the U.S. Bureau of Mines. The potential for mineralization in the Goat Rocks study area has been evaluated using geologic, geochemical, and geophysical data and records of past mining activity. Several areas within the Goat Rocks study area may have undiscovered mineral resources. Area A, located north of Old Snowy Mountain (Packwood Glacier-McCall Basin), has a moderate potential for the occurrence of base-metal resources in a porphyry-copper deposit. It is located near a cupola on top of the Goat Rocks pluton as defined by the gravity data. A pronounced magnetic low is coincident with a mapped geochemical anomaly, suggesting the presence of a hydrothermal system at depth. Area B, Glacier basin, is located in the headwaters of the Klickitat River on the Yakima Indian Reservation and in the headwaters of the South Fork of the Tieton River in the Goat Rocks Wilderness. We also classify area B as having a moderate potential for the occurrence of base-metal resources in a porphyry-copper deposit. Area C, along the Clear Fork of the Cowlitz River, is defined by a widespread geochemical anomaly. This area has a low potential for the occurrence of base-metal resources in hydrothermal veins. Area D, defined by small geochemical anomalies in a submarine basaltic terrane, has a low potential for the occurrence of base-metal resources in volcanogenic massive sulfide deposits.

There is a small, inferred resource of coal in the Cowlitz Pass coal field located north of the study area, and a potential for coal resources in the Packwood coal field located west of the study area. However, the coal-bearing rocks do not extend into the Goat Rocks study area; there is a low potential for the occurrence of coal resources in the study area.

A small quarry near Dog Lake, northeast of but adjacent to the study area, is in andesite suitable for building stone for local markets. The Goat Rocks study area has a high potential for building stone resources; however, the demand can be readily supplied from the existing quarry. Abundant sand and gravel deposits suitable for construction purposes exist in the study area, but alternate sources occur closer to local markets.

The potential for geothermal resources in the Goat Rocks study area is low because there are no active hot springs or evidence of Holocene silicic volcanism. The potential for oil and gas resources is largely undefined by available data; on the basis of available data, a low potential for the occurrence of oil and gas resources is indicated.

INTRODUCTION

The Goat Rocks Wilderness and adjacent Goat Rocks Roadless Areas (06036 A, C, D) straddle the crest of the Cascade Range in Lewis and Yakima Counties, south-central Washington (fig.1). The wilderness (82,680 acres) and roadless areas (eight separate units totalling 25,240 acres) lie in the Gifford Pinchot National Forest west of the Cascade crest and in Snoqualmie National Forest east of the crest. The Yakima Indian Reservation borders the southeastern and southern parts of the wilderness. Mount Rainier National Park is about 5 mi north of the area, and the Mount Adams Wilderness about 6 mi south of the area. Elevations range from 2,930 ft along Upper Lake Creek to 8,184 ft at Gilbert Peak. Access to the wilderness and roadless areas is provided by good unpaved roads leading south from U.S. Highway 12. Travel within the area is aided by the Pacific Crest National Scenic Trail and connecting trails.

This report summarizes studies designed to evaluate the mineral potential of the Goat Rocks study area. Studies conducted by the U.S. Geological Survey focused on geology (Swanson and Clayton, 1983), geochemistry (Church and others, 1983, and in press), and gravity and aeromagnetics (Williams and others, 1983). The U.S. Bureau of Mines searched courthouse records (Lewis and Yakima Counties) for mining claims, and examined the U.S. Bureau of Land Management and U.S. Bureau of Mines files and records for information on mineral prospects. Prospects were examined and the associated hydrothermally altered zones found in the field were sampled to determine if mineral resources were present. Analyses of these samples are on file at the U.S. Bureau of Mines, Western Field Operations Center, Spokane, Wash. Areas of mineralization potential were evaluated and represent the classification of the resources (U.S. Bureau of Mines and U.S. Geological Survey, 1980) of the Goat Rocks study area as of 1983.

GEOLOGY

The oldest rocks in the wilderness and adjacent roadless areas are marine sedimentary rocks (Russell Ranch Formation), which comprise the southernmost known exposures of pre-Tertiary rocks in the Cascade Range of Washington and Oregon. The Russell Ranch Formation is overlain by a thick sequence of Cenozoic volcanic rocks. The thickest and most extensive formation is the Eocene Ohanapecosh Formation, which consists of volcaniclastic rocks and lava flows predominantly of andesitic composition. The Ohanapecosh is overlain by silicic ashflow tuff of the Stevens Ridge Formation. A major erosional unconformity separates these rocks from upper Pliocene rhyolitic tuff and flows that occur in the eastern part of the study area. A thick sequence of pyroxene andesite lava flows was erupted during the late Pliocene and Pleistocene from a large volcano, the Goat Rocks volcano, centered in the core of the wilderness; satellite vents fed andesite and basalt flows. The youngest volcanism, of late Pleistocene age, produced hornblende andesite from vents in the central and northern part of the wilderness and olivine basalt in the southern part.

Intrusive bodies of mafic and intermediate compositions are common. They range from narrow dikes to shallow plutonic bodies several kilometers in diameter. Ages are poorly defined; it is likely that the dikes and plutons intruded country rock throughout much of the Cenozoic. Many of the plutonic rocks and adjacent country rocks underwent phyllic (quartz-sericite-pyrite) and propylitic (chlorite-epidote) alteration.

The Russell Ranch Formation is cut by major north-trending faults, but the Ohanapecosh and Stevens Ridge Formations are only broadly folded along north-northwest trends. Rocks of Pliocene to Quaternary age are not demonstrably deformed.

Several thin layers of tephra produced by Quaternary eruptions of Mount Rainier and Mount St. Helens occur in the area. The most recent tephra, from the May 18, 1980, eruption of Mount St. Helens, forms a layer that blankets the entire area and varies systematically in thickness from about 1/2 in. at the north boundary to about 1 1/2 in. near Walupt Lake (Waitt and Dzurisin, 1981). The bulk composition of the 1980 tephra is dacitic, but the easily leached glassy matrix is rhyolitic.

GEOCHEMISTRY

A reconnaissance geochemical survey of the Goat Rocks study area was conducted in July 1981 to contribute to the mineral resource assessment. Several geochemical sample media were investigated; stream-sediment samples, heavy-mineral concentrates panned from stream sediments, water samples from the drainages in the area, and rock samples from both altered and unaltered outcrops were collected. A total of 142 stream-sediment samples, 91 heavy-mineral concentrates, 135 water samples, and 140 rock samples were analyzed using semiquantitative emission spectrography, aqua regia leach/ICP (Inductively Coupled Plasma) analysis, and atomic absorption and specific ion chromatography analysis. Mineralogical identifications of sulfide minerals in the nonmagnetic, heavy-mineral concentrates were also made. The geochemical data and the interpretation of the results are given in Church and others (1983 and in press).

The presence of a blanket of volcanic tephra from the May 18, 1980, eruption of Mount St. Helens (Waitt and Dzurisin, 1981) complicated the stream-sediment sampling program. Many of the drainages sampled contained a substantial component of ash. Samples were taken at depth in a high-energy flow regime to minimize the dilution effect of the ash. The stream-sediment samples were analyzed by spectrographic techniques and anomaly patterns were obtained; however, the aqua-regia leach/ICP analytical technique was used on the minus-80-mesh stream-sediment samples and gave superior results (Church and others, in press). Furthermore, leach studies of an ash sample collected a few days after the May 18, 1980, eruption of Mount St. Helens indicated a negligible contribution of the volcanic ash to the geochemical anomalies defined (Church and others, 1983).

GEOPHYSICS

Geophysical investigations included gravity and aeromagnetic surveys (Williams and others, 1983). The interpretation of the gravity data indicates a large, central, positive gravity anomaly (fig. 2) and three smaller, superimposed, positive anomalies. The large anomaly is about 16 by 7 mi and has an amplitude of about 16 mgals. The anomaly appears to delineate a large pluton that lies directly beneath and apparently fed the Goat Rocks volcano. The source of this positive gravity anomaly is interpreted to be the dense plutonic rocks intruding less dense, older volcanic and sedimentary rocks of the Ohanapecosh and Russell Ranch Formations. On the basis of model calculations of density contrasts, Williams and others (1983) concluded that the top of the main body of the pluton lies at a depth of approximately 5,000 ft.

The three smaller positive anomalies are approximately equally spaced and each is roughly circular, with a diameter of 3 mi (fig. 2). The anomalies have approximately equal amplitudes and are an additional 6 mgals greater than the main gravity high. These smaller anomalies appear to delineate shallow intrusive cupolas, rising above the main pluton. These shallow bodies crop out irregularly and are mapped as andesitic and basaltic andesitic intrusions.

The aeromagnetic survey indicates anomalies that, in general, reflect the terrain of the area. Topographic highs produce magnetic highs in undeformed, normally magnetized rock; topographic lows produce magnetic lows. Significant deviations from this pattern can delineate subsurface geology. Magnetic lows are of particular interest in locating zones of mineralization. Alteration of magnetite in the hydrothermally altered area reduces the magnetic susceptibility of the rock producing a magnetic low. One magnetic low is defined by the aeromagnetic data (fig. 2, area D). This magnetic low is approximately 2/3 by 1 1/3 mi in size, and has an amplitude of about 300 gamma. The magnetic anomaly is located on Old Snowy Mountain and coincides with a large zone of hydrothermally altered rock.

MINES, PROSPECTS AND MINERALIZED AREAS

U.S. Bureau of Mines personnel examined courthouse records for the locations of mining claims. Three lode mining claims and one coal claim were found; none are currently held. There is no record of development or production for these claims (Peters and Linne, 1981; Close, 1982).

Field investigations were made of the claim areas, along with an examination of the coal claims in the Packwood coal field located west of the northwest corner of the Goat Rocks study area. Field examination of the hydrothermally altered areas between Elk Pass and Cispus Pass were also made. A total of 30 chip samples from the altered zones were collected. The rock samples were checked for radioactivity and fluorescent minerals and were analyzed using semiquantitative emission spectrography and atomic absorption methods. Fifty-four concentrates panned from stream sediments were collected to evaluate the area for placer potential.

Coal was discovered in the Spiketon Formation (Gard, 1968) in the Cowlitz Pass and Packwood coal fields in the early 1890's. According to Smith (1911, p. 156), interbedded coal and shale are best exposed in 600 ft of workings near the summit of the ridge between Coal and Lake Creeks. The beds strike N. 5° E. and dip 30° W., away from of the study area.

Stone is the only mineral commodity mined in the vicinity of the Goat Rocks study area; there is no record of mining activity within the wilderness or adjacent roadless areas. Near Dog Lake and along Johnson Creek, 1 mi north and 1 mi west of the wilderness, respectively, are building-stone and road-metal quarries of andesite and basalt which are exploited on a small scale, as needed.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

The geochemical, geophysical, and geologic data suggest that the Goat Rocks study area has two areas (A, B) with moderate potential for mineral resources. Area A has a moderate potential for the occurrence of base-metal resources in a disseminated porphyry-copper deposit. The geologic setting, structure, alteration pattern, color anomaly, geochemical signature, and magnetic low associated with area A closely resemble features diagnostic of porphyry-copper deposits in the Cascade Range (Grant, 1969; Brown, 1976; Hollister, 1979). Geophysical evidence suggests the presence of a hydrothermal system at depth. Area B also has a moderate potential for the occurrence of base-metal resources in a porphyry-copper deposit. The area contains visible alteration, has a distinct red-brown color anomaly, and contains geochemical anomalies of a number of base metals. Area B is also near an old volcanic center and is on the side of a cupola on the Goat Rocks pluton. However, there is no magnetic low associated with this altered area.

Two areas (C, D), defined largely by geochemical data, occur where the geology is favorable for mineralization. Area C has a low potential for the occurrence of base-metal resources in hydrothermal veins associated with an intrusive contact zone. The area is defined by geochemical anomalies in the stream sediments and heavy-mineral concentrates; exposures in this area are very poor, landslides are common, and the area is covered with brush. Gravity data suggest a subsurface contact between the Goat Rocks pluton and the sedimentary rocks to the east. The nature of this contact could not be discerned from geologic mapping. Area D, defined by a small geochemical anomaly in the stream sediments from the outcrop of the Russell Ranch Formation in roadless addition 06036D, may be indicative of a volcanogenic massive sulfide deposit, but the presence of a deposit is not supported by geochemical anomalies in the water samples from these drainages. Area D has a low potential for the occurrence of base-metal resources in volcanogenic massive sulfides in the Russell Ranch Formation.

Outside the study area, there is a small, inferred coal resource in the Cowlitz Pass coal field (Beikman and others, 1961, p. 103) and a potential for coal resources in the Packwood coal field. Neither of these fields, nor the sedimentary units containing the coal beds, appear to extend into the study area. A low potential for coal resources in the Goat Rocks study area is indicated.

Identified resources of building stone and gravel occur adjacent to the study area. The Goat Rocks study area has a high potential for stone resources, but more accessible stone resources occur outside the study area.

Because of the lack of Holocene silicic volcanic activity and the absence of hot springs in the vicinity, the Goat Rocks study area has a low potential for geothermal resources.

Recent modeling of regional magnetotelluric data (W. D. Stanley, unpub. data, 1983) and interpretation of the gravity data of Williams and others (1983) suggest the possibility of oil and gas in the sedimentary rocks on the east and west sides of the Goat Rocks pluton within the study area. Drilling indicates marine sedimentary rocks beneath the Columbia River Basalt Group just west of the study area (Lewis, 1982), and oil and gas are currently being produced from Eocene marine sedimentary rocks in the Mist field about 40 mi north of Portland, Oreg. W. D. Stanley (unpub. data, 1983) interprets his data to reflect a probable sedimentary section about 6 mi thick just east of the study area. If a marine sedimentary section underlies the Russell Ranch Formation, this melange may contain numerous structural and stratigraphic traps on either side of the Goat Rocks pluton. Further definition of the potential for oil and gas resources can only be addressed by subsurface exploration and possibly by drilling. On the basis of available data, a low potential for oil and gas resources in the Goat Rocks study area is assigned.

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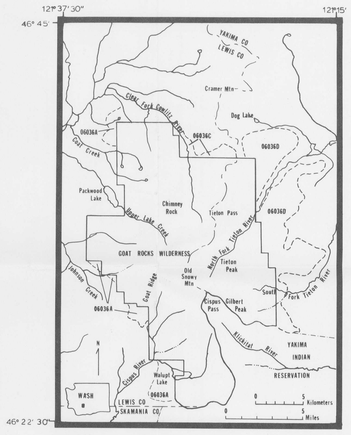
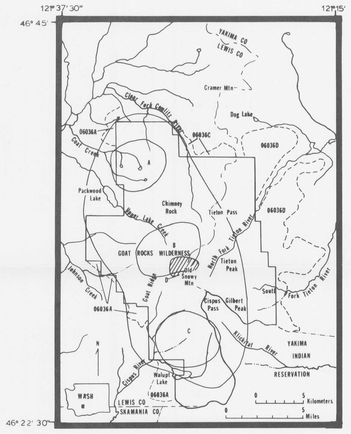


Figure 1.--Map showing location of the Goat Rocks study area, Lewis and Yakima Counties, Wash.



EXPLANATION

- Approximate boundary of Goat Rocks Wilderness
- Approximate boundary of adjacent roadless areas

Figure 2.--Map showing the outline of the buried Goat Rocks pluton based on the gravity survey (Williams and others, 1983); cupolas on the pluton are designated A, B, and C. Location of the magnetic low (D) inferred to be related to hydrothermal alteration is indicated by crosshatching.

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