0

Approximate boundary of

0

LOSTILAKE

000

0

UPPER TROPINGAN

000

101

0

0

PACKWOODGLACIER

QTa

WALUPT LAKE

Qob

Qah

000

Goat Rocks Wilderness

000

200

0

8-QTa

4000

06036A

10

0009

- 3500 - 3000

4000 3500

~ 3000

Base from U.S. Geological Survey, 1:24,000

Jennies Butte, Walupt Lake, Hamilton Butte, 1970; 1:62,500, Packwood, White Pass, 1962

100

N

5500

QTa

BASTAY

GIL BERT PEAK

Pob

3 MILES

00

3 KILOMETERS

DIST.

OTO 0

0,0

A QTai

0

0/

0

0

 \Diamond

00

LEACH LAKE

WHITE RASS SKI AREA

500

PINE GRASS

GRAVITY SURVEY

The Bouguer gravity anomaly map of the area encompassing Goat Rocks Wilderness contains 184 gravity stations (Z. F. Danes, unpub. data; Finn and

Williams, 1983). Elevation control is from either

observations. The terrain of the Goat Rocks study area

The methods utilized for analysis of data in volcanic terrain have been discussed in some detail in Williams and Finn (1982). Commonly, one of the most

important aspects is the choice of the value for the

Bouguer reduction density. In the Goat Rocks Study area, we experimented with a variety of Bouguer reduction densities ranging from 2.2 g/cm³ to 2.7

gravitational effect of the topography in this area is

g/cm³. The same general gravity anomaly patterns

persisted regardless of the value of the Bouguer

much less than the gravitational effect of masses

buried beneath the topography. It is nevertheless

important to choose an appropriate Bouguer reduction

density. The actual bulk density of the topographic

highs is probably quite variable. Some topographic highs are low-density volcanic cones, whereas others

are dense intrusive rocks. Some valleys are filled with low density alluvium or lava flows; others are

canyons cut into dense intrusive rocks, We chose a Bouguer reduction density of 2.43 g/cm³ as being the

Ohanapecosh and Russell Ranch Formations. Where rocks have a density of 2.43 g/cm³, topography should be nearly transparent in our Bouguer gravity map, whereas topographic features where rocks differ significantly

The Goat Rocks study area is near the Pacific

continental margin and shows some of the transition

from high oceanic Bouguer gravity values in the west

to lower continental values to the east. The central

portion of the map contains a large (approximately 16

by 7 mi) gravity high with three superimposed smaller (3 mi diameter) gravity highs. The amplitude of the main high is about 16 milligal (mgal) in the east-west

direction and about 10 mgal north to south. The three

amplitude and are about 6 mgals more positive than the

The main gravity high appears to delineate a

5,000 ft, directly beneath the eroded remnants of the

throughout the 1 to 2 million year eruptive history of

Goat Rocks volcano. The pluton presumably fed the

various eruptive centers of the Goat Rocks volcano

that volcano. The three smaller positive anomalies

above the main pluton. These three intrusive bodies

basaltic-andesitic intrusions. The most northerly

shallow intrusion is located near Lost Lake, the

Lake is probably the most recently active of the

three. Radial dikes centering on the gravity highs

center one is located near Goat Lake, and the most

crop out irregularly and are mapped as andesitic and

southerly of the three is near Sheep Lake. Geologic

mapping indicates that the shallow intrusion near Goat

have been mapped near Goat Lake and Sheep Lake. These shallow intrusive bodies apparently mark the location of major eruptive vents of the Goat Rocks volcano. Presumably, large volcanic cones stood several thousand feet above the present land surface when

The difference in density between the buried

intrusive rocks and the less dense country rock makes the intrusive bodies appear as gravity highs. These

composition (diorite?) and many have a density near 2.7 g/cm³. The country rock is presumably the older, somewhat altered volcanics of the Ohanapecosh

Formation and some sediments (Stanley, 1983). Its density probably increases significantly with depth

from a value of about 2.4 g/cm³ at the surface to a value closer to 2.6 g/cm³ at depth. A good median value would be 2.5 g/cm³. This analysis indicates a density contrast of about 0.2± 0.1 g/cm³.

Utilizing a simple, single density contrast,

three-dimensional technique, we inverted the gravity

data to produce a model of the intrusive bodies. The

REFERENCES

inn, C., and Williams, D. L., 1983, Principal facts

for one-hundred-six gravity stations near the

Goats Rocks Wilderness area, Washington: U.S.

studies in volcanic terranes [abs.]: Society of

Abstracts, Los Angeles, Calif., Fall 1982 meeting,

Exploration Geophysicists Technical Program

Geological Survey Open-File Report 83-176.

Williams, D. L., and Finn, Carol, 1982, Gravity

0.2 g/cm³ density contrast produced the best results

intrusive rocks are presumably of intermediate

appear to delineate shallow intrusive cusps rising

pluton whose top lies at a depth of approximately

smaller gravity highs have approximately equal

main gravity high.

these vents were active.

pluton mentioned earlier.

most appropriate for the shallow portions of the altered volcanics (Williams and Finn, 1982) and a good

compromise for the sedimentary rocks of the

from this density will produce anomalies.

reduction density. This implies that the

spot elevations taken from U.S. Geological Survey

topographic maps or from laser theodolite

data reveal a distinct anomaly pattern.

CORRELATION OF MAP UNITS QTa QTai Pliocene Tai Eocene pTr

DESCRIPTION OF MAP UNITS

contact relations of bedrock units are obscured gray, commonly diktytaxitic olivine and olivine-bearing basalt. Plagioclase phenocrysts present in most flows
HORNBLENDE ANDESITE (PLEISTOCENE)--Light-gray, commonly oxidized flows and minor tephra of hornblende and hornblende-bearing andesite.

of hornblende and pyroxene andesite. Feeders for unit Qah 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

some rocks 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

and rhyolite flows. Quartz phenocrysts common. Secondary minerals, especially clay, calcite, quartz, and zeolites abundant 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 tuffs, and breccias in north half of area and of andesitic lava flows in south half of area. Zeolites, quartz, calcite, and clay or violet cast. Basaltic flows and rhyolite

calcite especially common in most places. Most flows are metamorphosed to greenstone

unconformity

concealed

GRAVITY CONTOUR--Contour interval 2 mgal

♦ GRAVITY STATION

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 and yielded the 5000 ft depth to the top of the main the public and be submitted to the President and the Congress. This report presents the results of geophysical surveys of the Goat Rocks Wilderness (NFO32) and adjacent Goat Rocks Roadless Areas (RARE II 06036, Parts A, C, and D) in Gifford Pinchot and Snoqualmie National Forests, Lewis and Yakima Counties, Wash. Goat Rocks Wilderness was established by Public Law 88-577, September 3, 1964. The Goat Rocks Roadless Areas were classified as futher planning areas during the Second Roadless Area Review

INTRODUCTION

The wilderness and adjacent roadless areas are underlain by pre-Tertiary marine sedimentary rocks (the Russell Ranch Formation), which comprise the southernmost known exposures of pre-Tertiary rocks in the Cascade Range of Washington and Oregon. The Russell Ranch 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 ash-flow tuff of the Eocene 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 area. A thick sequence of pyroxene andesite lava flows was erupted in the late liocene and Pleistocene from a large volcano, the Goat Rocks volcano, centered in the core of the wilderness area; 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

Intrusive bodies of mafic and intermediate compositions are common. They range from narrow dikes to shallow plutonic bodies several miles in diameter. Ages are poorly constrained; it is likely that the dikes were intruded throughout much of the Cenozoic. Many of the bodies and adjacent country

wilderness area and olivine basalt in the southern

Stevens Ridge Formations are only broadly folded along north-northwest trends. Rocks of Neogene age are not demonstrably deformed.

is quite rugged, leading to a significant uncertainty in both station elevations and individual terrain corrections. Similarly, accessability is difficult and many areas can only be reached on foot. Even helicopter operations were severely restricted by the rugged terrain as well as by poor weather. As a LANDSLIDE DEPOSIT (PLEISTOCENE) -- Mapped only where result, the distribution of data is somewhat less than optimum. Individual values are only accurate to about ±2 mgal (one contour interval). Nevertheless, the

OLIVINE BASALT (PLEISTOCENE) -- Flows and tephra of ANDESITIC INTRUSIONS (PLEISTOCENE) -- Plugs and dikes

present as phenocrysts. Hornblende occurs in

central part of area show radial pattern centered on Upper Lake Creek STEVENS RIDGE FORMATION (EOCENE) -- Light-colored, silicic ashflow tuff and associated bedded tuff

bodies of mafic to silicic compositions. Unit consists predominantly of lithic tuffs, lapilli minerals abundant; rocks commonly have a green near base of formation along Clear Fork Cowlitz River and in McCall Basin area may be separated from overlying Ohanapecosh beds by an angular

INTRUSIVE ROCKS OF MAFIC AND INTERMEDIATE COMPOSITIONS (TERTIARY) -- Dikes, sills, plugs, and shallow-seated plutons, predominantly of porphyritic pyroxene andesite but including diorite and quartz monzonite. Aye range unknown; includes feeders for flows and tuffs in the Uhanepecosh Formation as well as upper Tertiary bodies. Generally altered; clays and RUSSELL RANCH FORMATION (PRE-TERTIARY) -- Graywacke, argillite, and less abundant basaltic flows, most of which have pillow structures. Sheared

 ANTICLINE--Showing direction of plunge; dotted where concealed

SYNCLINE--Showing direction of plunge; dotted where -+++++++ DIKE

STUDIES RELATED TO WILDERNESS The Wilderness Act (Public Law 88-577, September

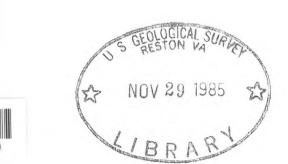
and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

The Goat Rocks Wilderness (NFO32) and adjacent Goat Rocks Roadless Areas (RARE II 06036, parts A, C, and D) hereafter referred to as the Goat Rocks study area, straddle the crest of the Cascade Range in Lewis and Yakima Counties, south-central Washington. The study area lies in the Gifford Pinchot National Forest west of the Cascade crest and in the 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 is about 6 mi south of the area. Elevations range from 2,930 ft along Upper Lake Creek to 8,184 ft at Gilbert Park. 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.

rocks underwent quartz-sericite-pyrite and propylitic

The Russell Ranch Formation is cut by major north-trending faults. Both the Ohanapecosh and

MAP A. BOUGUER GRAVITY MAP



INTERIOR-GEOLOGICAL SURVEY, RESTON, VIRGINIA-1984 For sale by Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225

M(200) MF-165

GRAVITY AND AEROMAGNETIC MAPS OF THE GOAT ROCKS WILDERNESS AND ADJACENT ROADLESS AREAS, LEWIS AND YAKIMA COUNTIES, WASHINGTON David L. Williams, Carol Finn, D. Randall Spydell, and Frank Daneŝ

3 1818 00148232 0

4000 4500 5000

Geology modified from Swanson and Clayton (1983);

gravity and aeromagnetic data mapped in 1983

MF-1653-C