MISCELLANEOUS FIELD STUDIES
MAP MF-1418-B
PAMPHLET

MINERAL RESOURCE POTENTIAL OF THE WONDER MOUNTAIN ROADLESS AREA, MASON COUNTY, WASHINGTON

By

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STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, the U.S. Geological Survey and U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the Wonder Mountain Roadless Area (U.S. Forest Service Number 06086), Olympic National Forest, Mason County, Wash. Wonder Mountain Roadless Area was classified as a further planning area during the Second Roadless Area Review and Evaluation (Rare II) by the U.S. Forest Service, January 1979.

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

The results of geological, geochemical, and mining activity and production surveys in the Wonder Mountain Roadless Area indicate low potential for manganese resources. Deposits are small, pod-shaped bodies (about 12,000 tons of identified resources), and the manganese occurs primarily as bementite (a manganese silicate), which is difficult to refine. Currently, there is one lode claim for manganese in the roadless area, along Copper Creek. There is no indication of any potential for other metallic, nonmetallic, or energy resources in the area.

INTRODUCTION

High mountain ridges with rugged outcrops of basalt characterize the Wonder Mountain Roadless Area in the southeastern Olympic Mountains (fig. 1). The area adjoins Olympic National Park to the north, Lake Cushman Reservoir to the east, and heavily logged areas within Olympic National Forest to the south and west. It covers 9,468 acres of the Olympic National Forest. Access to the roadless area is through Hoodsport on U.S. Highway 101. A paved road leads northwest to Staircase Rapids in Olympic National Park at the head of Lake Cushman. The south and west sides of the area are accessible by logging roads along the South Fork of the Skokomish River.

GEOLOGY

The Olympic Mountains comprise two geologic terranes: (1) a peripheral belt of Eocene to Miocene basaltic volcanic rocks and sedimentary rocks, which wraps partly around (2) a core of mostly sedimentary rocks of about the same age (Tabor, 1982). The fossiliferous peripheral rocks are faulted and folded, but generally the stratigraphy within structural blocks is preserved. Core rocks of the Olympic Mountains are highly deformed, mostly unfossiliferous, and, in the eastern part, are penetratively sheared and metamorphosed. Beds in the core rocks dip predominantly eastward, but units become younger to the west. The core rocks were stacked and thrust under the peripheral rocks during plate-margin convergence (Tabor and Cady, 1978a). The deformation in the eastern part of the Olympic Mountains culminated during the Oligocene about 29 million years ago, but local faulting and folding continued at least into the Miocene (Tabor, 1972).

Tabor (1982) has prepared a detailed geologic map of the roadless area, and a simplified version of his geologic map is used as a base in figure 2. Most of the Wonder Mountain Roadless Area is in the peripheral belt southwest of the Olympic Mountain core rocks. The rocks of the peripheral belt are divided into two units: the Crescent Formation and the rocks of Blue Mountain. The Crescent Formation is lower(?) and middle Eocene (Rau, 1964, p. G4; 1967, p. 11) oceanic basalt, pillow basalt, and breccia, as well as diabase, gabbro, minor interbedded sedimentary rocks, and red, manganiferous argillite

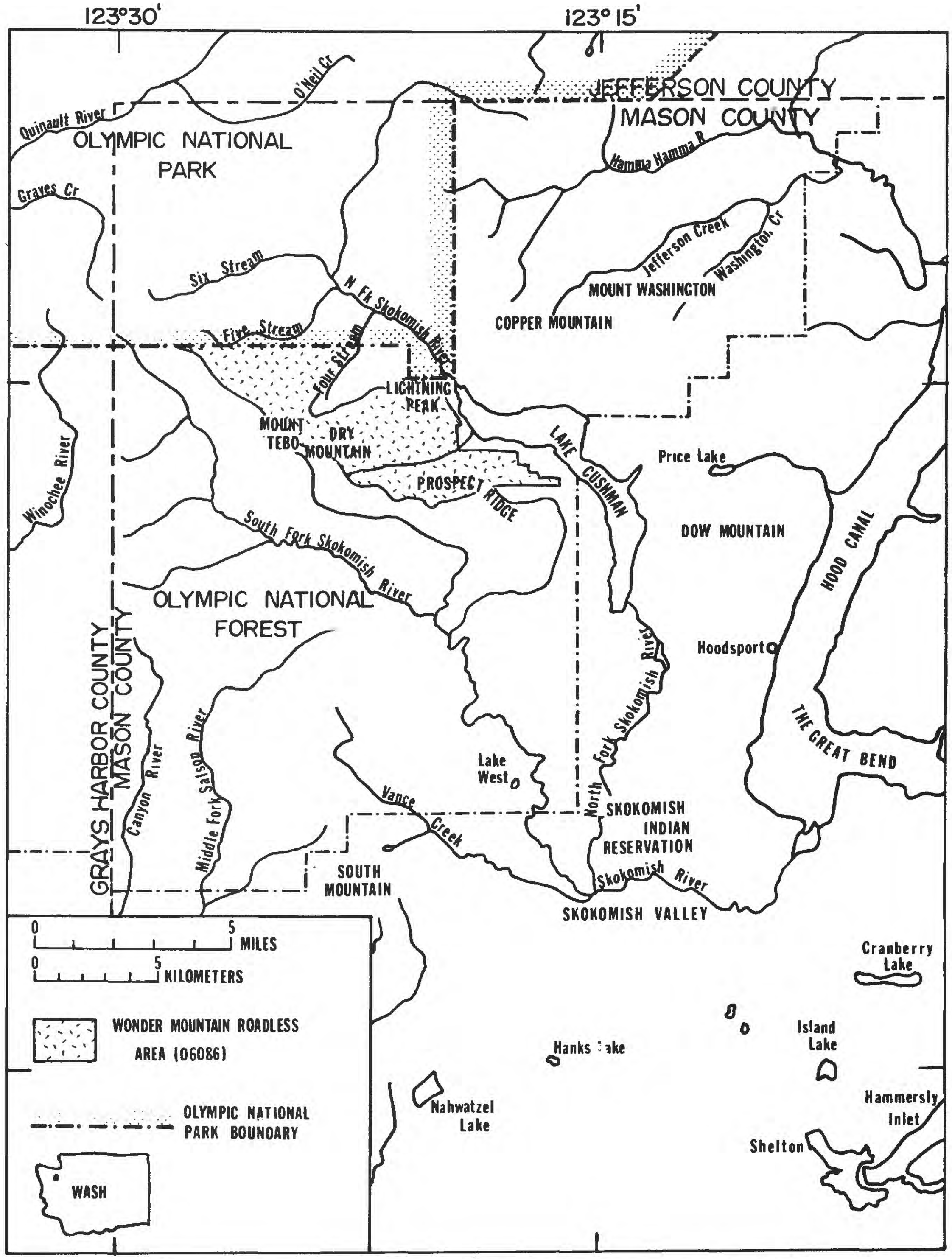


Figure 1.—Index map showing the location of the Wonder Mountain Roadless Area (06086) on the southeastern flank of the Olympic Mountains, Mason County, Wash.

and limestone. The lava erupted mostly from the ocean floor and formed seamounts fairly near the continent (Cady, 1975, p. 579–580). The upper part of the Crescent Formation bears shallow marine foraminifera and locally has columnar jointing, which suggests the seamounts reached sea level. The distinctive lithologic units of the Crescent Formation are subdivided on the simplified geologic base (fig. 2).

Underlying the Crescent Formation, and locally interfingering with it, are marine turbidites, rich in volcanic clasts, and dark argillite. These rocks are best exposed on Blue Mountain and are informally referred to as the sandstone and argillite of Blue Mountain. In the roadless area, these rocks are more strongly deformed than is most of the Blue Mountain unit north of the roadless area, but the deformation is less intense than that seen in the core rocks.

Within the roadless area, a zone of rocks rich in red, limy argillite and red limestone contains the manganese mineralization. This zone occurs at the base of the Crescent Formation and extends into a zone of interfingering basaltic rocks and sedimentary rocks of the Blue Mountain unit. All of the known manganese prospects of the roadless area are in this red zone; a few red argillite and limestone lenses crop out in the Crescent Formation south of the red zone.

Olympic core rocks crop out only in a small part of the Wonder Mountain Roadless Area. Along much of its length, the contact between the peripheral rocks and core rocks is marked by faulting, truncation of structure, and (or) a change in sandstone lithology (Cady and others, 1972a, b; Tabor and others, 1972; Tabor and Cady, 1978b, p. 5). In the vicinity of the roadless area, the contact is marked by the change from the mildly deformed rocks of the peripheral belt to the highly deformed core rocks, which are broken and show a strong penetrative cleavage. No fossils have been found in the core rocks of the roadless area; however, fossils of a late Eocene fauna have been found within the core rocks to the north (Cady and others, 1972b). Although, within the roadless area, the basaltic rocks of the Olympic core are mostly indistinguishable from the Crescent Formation, the basaltic rocks of the Olympic core do not contain red argillite, limestone, or concentrations of manganese minerals.

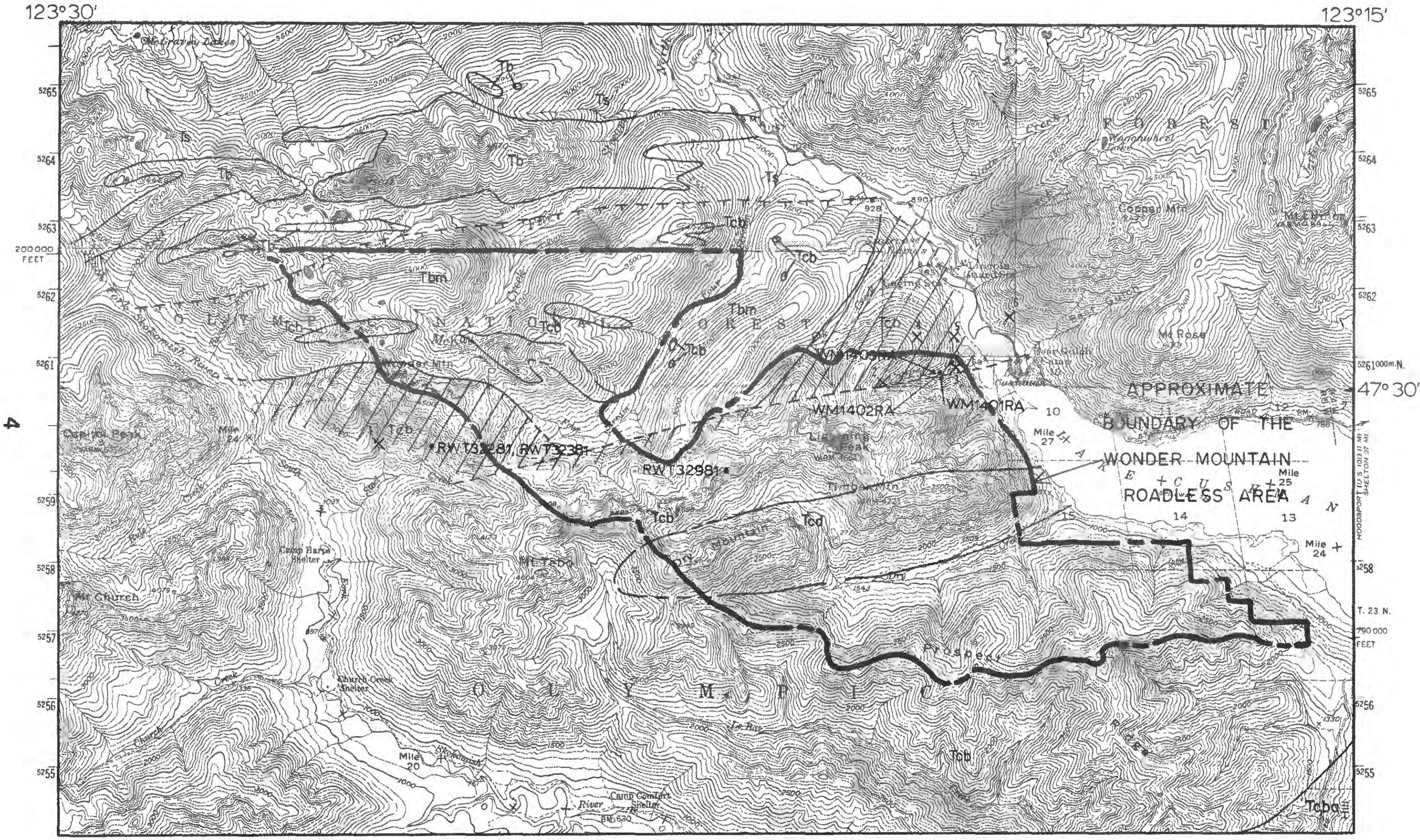
There are about 150 known deposits of manganiferous rocks in a 125-mi belt around the north, east, and south sides of the Olympic Mountains. These deposits have been described by several authors (Park, 1942, 1946; Magill, 1960). Roy (1981, p. 272–277) classified the deposits as volcanogenic-sedimentary type. Park (1946, p. 318) concluded that the deposits were the result of direct chemical precipitation of oxides from seawater. Work by Sorem and Gunn (1967, p. 45), as well as experimental data (summarized by Roy, 1981, p. 82–87), substantiates the mechanism of precipitation of manganese oxides from seawater as a function of Eh and pH. Basically, the manganese deposits of the Wonder Mountain Roadless Area are small, lenticular bodies that are associated with the deposition of red limestone, siltstone, and some jasper. These zones show irregular stratigraphic relationships with the underlying basalts of the Olympic core and with the overlying Crescent Formation of the peripheral belt (Tabor, 1982). Garrison (1973, p. 590–592) noted that the deposition of manganese-rich zones is strongly dependent on the local relief in the basin, as well as on the currents transporting the sediments. Volcaniclastic sediments accumulate near zones of active volcanism. Away from these areas, in quiet water, chemical precipitates, along with pelagic ooze, settle on cooled pillow basalt and are swept by currents and gravity into topographic lows and into open spaces in the underlying basalts. Garrison (1973, p. 580–592) also considered this ponding of sediments and the subsequent postdepositional volcanic activity (the Crescent basalts) that disrupted the manganese-ore-formation process to be the major reasons for the lenticular and disrupted nature of the deposits.

GEOCHEMISTRY

During the summer of 1981, a geochemical reconnaissance of the Wonder Mountain Roadless Area was conducted. Forty stream-sediment samples and 44 panned-concentrate samples from stream sediments were collected from first- and second-order streams draining the roadless area. Twenty-two rock samples were taken to characterize chemically the volcanic and sedimentary units cropping out in the roadless area and to determine the chemical constituents of the manganese-rich zones. The rock samples were crushed and pulverized, and the stream sediments were sieved to minus-80 mesh and pulverized. The panned-concentrate samples were sieved to minus-30 mesh, and a heavy-mineral fraction was separated with bromoform (specific gravity >2.8). A nonmagnetic, heavy-mineral concentrate was then produced using a Frantz Isodynamic Magnetic separator[1]. These concentrates were examined under the microscope for mineral identification and then pulverized. All three sample media were analyzed for 31 elements by a six-step, semiquantitative emission-spectrographic technique routinely used by the U.S. Geological Survey (Grimes and Marranzino, 1968). The analytical and statistical data have been published (Church and others, 1982), and a geochemical interpretation is given by Frisken and others (in press).

The geochemical investigations reveal a suite of elements from the nonmagnetic, heavy-mineral fraction of panned-concentrate samples from stream sediments (barium, manganese, copper, cobalt, nickel, vanadium, and lead) that reflects the sedimentary origin of the manganese deposits of the Olympic Peninsula (Frisken and others, in press). Geochemical data for drainage basins draining only basaltic terrane do not indicate a potential for manganese deposits. However, geochemical data from drainage basins having outcrops of the Blue Mountain unit show anomalous metal concentrations for several of the elements given above (Frisken and others, in press). Favorable areas for manganese deposits are those underlain by the sedimentary rocks (fig. 2). These areas are in the drainage basins of Elk Creek and Copper Creek on the east side of the roadless area, and of Steel Creek on the west side of the roadless area (see fig. 2). Fragments of red limestone are abundant in these drainages. Analytical data for manganese-rich zones are given in table 1. Samples

[1]Any use of brand names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.



Base from U.S. Geological Survey
Mt. Steel, 1947, and Mt. Tebo, 1953.

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1 1/2 0 1 2 3 4 MILES

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Figure 2.--Simplified geologic map showing localities of mineralized samples, mines, and prospects studied for the mineral potential assessment of the Wonder Mountain Roadless Area, Mason County, Wash.

EXPLANATION

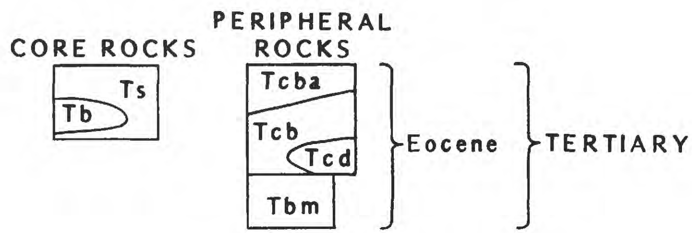
× PROSPECT—1. Steel Creek prospect; 2. Apex prospect; 4. Black Queen prospect; 5. Discovery prospect; 6. Hi Hopes Nos. 1 and 2 prospects

⚒ MINE—3. Brown Mule Mine

•WM1402RA SAMPLE LOCALITY

(Note: The following correlation, list of map units, and map symbols are for the screened geologic base map.)

CORRELATION OF MAP UNITS



LIST OF MAP UNITS

CORE ROCKS

Ts — SANDSTONE, FOLIATED SANDSTONE, SEMISCHIST SLATE AND PHYLLITE (EOCENE)

Tb — BASALTIC ROCKS (EOCENE)

PERIPHERAL ROCKS

CRESCENT FORMATION (MIDDLE AND LOWER (?) EOCENE)

Tcba — Basalt flows, mudflow breccia, tuffaceous argillite, and fine-grained sandstone

Tcd — Diabase and gabbro

Tcb — Basaltic rocks and sedimentary rocks

Tbm — SANDSTONE AND ARGILLITE OF BLUE MOUNTAIN (MIDDLE AND LOWER EOCENE)

——— CONTACT—Dashed where approximately located

– – – – INFERRED FAULT

┴ ┴ ┴ ┴ INFERRED FOLDED THRUST FAULT—Hachures toward overthrust plate

▨ ZONE OF ABUNDANT RED ARGILLITE, LIMESTONE, AND JASPER

Figure 2.—Continued

of the red limestone-argillite unit also contain high concentrations of manganese.

Table 1.—Analytical results[1] from ores sampled within the Wonder Mountain Roadless Area, Mason County, Wash.

[All results given in parts per million (μg/g); N, not detected at a given value; >, concentration greater than value given]

Element	Copper Creek drainage[2]	Elk Creek drainage[3]	Steel Creek drainage[4]
V———	100–150	1,500	150–200
Mn———	5,000	>5,000	>5,000
Co———	N5–20	1,000	30–50
Ni———	70–200	150	100–300
Cu———	30–200	3,000	10–100
Mo———	N5	20	N5–15
Pb———	N10–30	N10	N10
Sr———	100–5,000	N100	N100–300
Ba———	200–>5,000	150	100–200

[1]Data from Church and others, 1982, table 4.
[2]Samples WM1401RA, WM1402RA, and WM1403RA (see fig. 2).
[3]Sample RWT32981 (see fig. 2).
[4]Samples RWT32281 and RWT32381 (see fig. 2).

MINING DISTRICTS AND MINERALIZATION

The Wonder Mountain Roadless Area is within the indefinite boundaries of the Lake Cushman, Mount Tebo, and Wonder Mountain mining districts. Prospecting for manganese and copper ore in these districts began in the late 1800's. In 1890 James McReavy organized the Mason County Mining and Development Company to prospect for iron and copper ore in the Lake Cushman area (Overland, 1981, p. 16), and in 1895 the Discovery claims on Copper Creek were located. Manganese was discovered in the Lake Cushman area in 1903. In 1911 Frank Wonder discovered manganese and located several claims near Steel Creek, west of the roadless area. According to Pardee (1921, p. 237), in 1916 a shipment of lode ore was excavated from shallow pits and trenches at the Triple Trip (Brown Mule) Mine. During World War I, Robert Rowe shipped manganese ore from the Lake Cushman mines (probably from the Black and White Mine 4 mi north of the roadless area) to his smelter in Tacoma, Wash. The 5-ton shipment assayed 0.40 oz silver per ton, 7.85 percent copper, 3.2 percent iron and 65 percent insoluble residue (Magill, 1960, p. 64). When the war ended, demand for manganese decreased, and the claims and plans to build a smelter near Copper Creek were abandoned (Overland, 1981, p. 17).

The Crescent Mine, about 35 mi northwest of the roadless area, in Clallam County, produced about 46,000 tons of manganese ore, primarily hausmannite (Mn_3O_4), and accounted for 98 percent of the total manganese production from the Olympic Peninsula (Magill, 1960, p. 76). Six prospects located within or adjacent to the roadless area were also examined (see table 2). The Apex prospect and the Brown Mule Mine are in the Wonder Mountain Roadless Area, whereas the Steel Creek, Black Queen, Discovery, and Hi Hope prospects are just outside the roadless area boundary (see fig. 2). Salient geologic features of these prospects are given in table 2.

Sorem and Gunn (1967) conducted a detailed study of the mineralogy of ore samples from seven typical manganese deposits of the Olympic Peninsula. In samples from the Brown Mule deposit, they identified the following: alleghanyite, bementite, johannsenite, neotocite, rhodonite, and tephroite (all manganese silicates); hausmannite, jacobsite, and rancieite (all manganese oxides); and rhodochrosite, the manganese carbonate. Other minerals identified were quartz, calcite, barite, copper, cuprite, hematite, grossularite, and hydrogrossular. This suite is typical of the region, and typical ore samples are composed of a mixture of very fine grains of several of these minerals. Lithification and contact metamorphism from intruding and overriding basaltic lavas may have modified the original chemical compounds, perhaps creating some of the silicate minerals. There is, however, little evidence that the suite of minerals has changed much since deposition. Bementite is the most abundant manganese mineral. Supergene mineralization is not significant in most deposits. Sulfides and sulfates, including alabandite, barite, cinnabar, chalcopyrite, and pyrite, have been described from many of the deposits, but nowhere are these dominant ore-zone minerals.

Three placer claims and 117 lode claims have been recorded in the roadless area since 1892. At present, there is one lode claim for manganese in the roadless area near the boundary, on Copper Creek.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

About 12,000 tons of manganese resources occur in or near the Wonder Mountain Roadless Area. As far as known, the manganese deposits are small, pod-shaped lenses (Park, 1942, p. 435; Roy, 1981, p. 87); therefore, the potential for significant manganese resources is low. Geologic conditions favorable for the occurrence of manganese deposits are limited to the belts of sedimentary rocks (fig. 3). Furthermore, the manganese occurs primarily as bementite, a manganese silicate that is difficult to refine. In comparison with manganese deposits elsewhere in the world (Dorr and others, 1973, p. 393), the deposits in the Wonder Mountain Roadless Area are small.

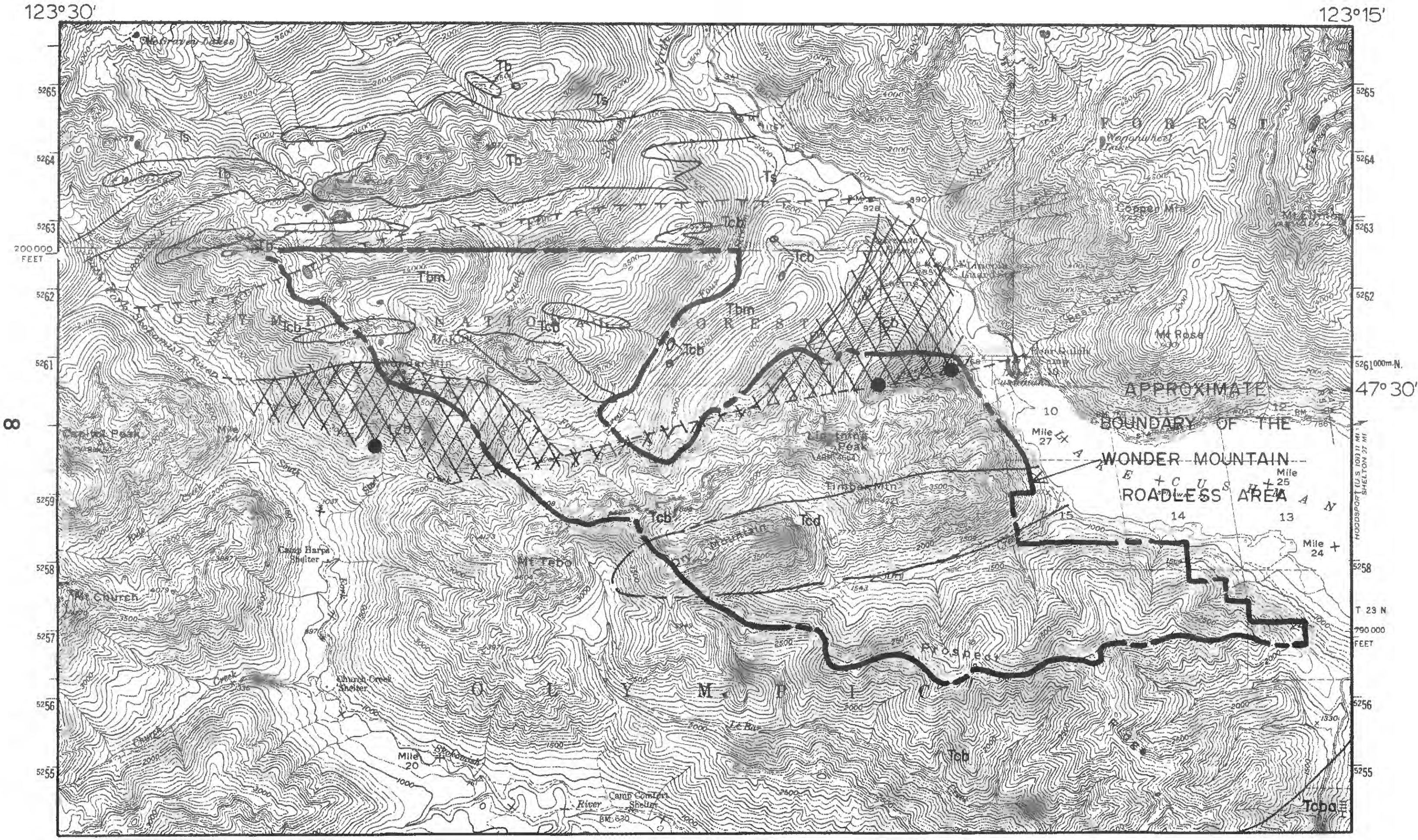
The only nonmetallic resource in the area is basalt, quarried locally for road base. An ample supply of basalt is available for this purpose outside the roadless area.

There has been no exploration for oil and gas in the immediate vicinity of the Wonder Mountain Roadless Area. No oil and gas have been produced from wells drilled elsewhere on the Olympic Peninsula in rocks of similar age, type, and structural setting.

There is no indication of potential for any geothermal resource.

Table 2.--Mines and prospects in and near the Wonder Mountain Roadless area, Mason County, Wash.

Map No.	Name	Summary	Production and workings	Sample data	Resource estimate
1	Steel Creek prospect.	Three deposits of hausmannite-stained bementite occurring with jasper along a contact between red limestone and basalt. Deposit A is exposed for 25 ft and has average thickness of 4 ft. About 200 ft to the east, deposit B is exposed for 85 ft and has average thickness of 7 ft. Deposit C consists of small lenses occurring in an area 100 ft by 200 ft about 1,000 ft northeast of deposit B. These deposits have general northeast strike and dip from 50° to 85° SE. (Magill, 1960, p. 64-66).	Several pits	Thirteen channel samples taken during U.S. Bureau of Mines' 1940 exploration program indicate that deposits A, B, and C averaged 13.2, 32.4, and 32.4 percent manganese, respectively (Magill, 1960, p. 65, figs. 44 and 45). In 1981, U.S. Bureau of Mines collected a chip sample from deposit B; it assayed 38.0 percent manganese.	Wiebelt (written commun., 1942) estimated 948 tons of resources averaging 27.0 percent manganese. There is potential for discovery of additional resources.
2	Apex prospect.	Bementite and other manganese silicates and oxides occur as a lens containing jasper, silicified limestone, and minor amounts of malachite at contact between basalt and limestone. Manganiferous lens is about 200 ft long, maximum thickness is 28 ft at the surface, and minimum depth is 100 ft; it strikes approximately N. 75° E. and has near-vertical dip. Faulting occurs at the west end of manganiferous zone, offsetting it a few feet (Magill, 1960, p. 60-62).	Several pits	During U.S. Bureau of Mines' 1940 exploration program, 62 channel samples were taken, and seven diamond-drill holes aggregating 773 ft were drilled. Channel-sample assays ranged from 1.0 to 40.6 percent manganese. Selected drill-hole intervals assayed from 1.05 to 46.8 percent manganese (Wiebelt, written commun., 1942). In 1981, U.S. Bureau of Mines took one chip sample from manganiferous zone; it assayed 15.0 percent manganese and 0.031 oz gold per ton.	Wiebelt (written commun., 1942) estimated 10,662 tons of resources averaging 27.1 percent manganese. There is potential for discovery of additional resources.
3	Brown Mule (Triple Trip) Mine.	Tabular body of hausmannite-stained bementite occurs with jasper along a contact between red limestone and basalt. Deposit is exposed for 70 ft in a trench, but underground exposure by two adits indicates a discontinuous body. Manganiferous zone averages 1.5 ft thick, 30 ft deep, strikes northeast, and dips from 60° to 70° SE.	According to Pardee (1921, p. 237), manganese ore (possibly a 30-ton carload) was shipped in 1916. Workings include one trench 120 ft long, two adits totaling 213 ft, and several pits.	One composite sample of three small pods from lower adit, assaying 31.0 percent manganese, and two samples across a manganiferous zone in the trench, assaying 29.5 and 20.8 percent manganese, were taken during U.S. Bureau of Mines' 1940 exploration program (Magill, 1960, p. 63, fig. 43). In 1981 U.S. Bureau of Mines resampled manganiferous pods in lower adit and sampled a manganiferous zone in upper adit. Manganese contents are 25.0 and 31.0 percent, respectively.	Wiebelt (written commun., 1942) estimated 294 tons of resources averaging 24.8 percent manganese. There is potential for discovery of additional resources.
4	Black Queen prospect.	Deposit of bementite, associated with jasper and bounded by basalt and red calcareous argillite was examined by Green (1945, p. 41). No samples were taken. The deposit strikes N. 50° E., dips 75° NW., and has a thickness of 2-3 ft and a strike length of approximately 20 ft.	Several open cuts and a shallow shaft (Green, 1945, p. 41).	None	Prospect not found in 1981 because of dense vegetation. Exposures not sufficient to determine mineral potential.
5	Discovery prospect.	Limonite- and manganese-stained shear zone bounded by red limestone and basalt strikes northeast, dips 70° NW., and has an average thickness of 4 ft.	Two adits, 20 ft and 38 ft long.	Four samples were taken from 38-foot adit; one sample from the shear zone assayed 0.07 percent copper and 5 percent manganese.	Exposures not sufficient to determine mineral potential.
6	Hi Hope Nos. 1 and 2 prospects.	Deposit of bementite along a basalt-argillite contact (Green, 1945, p. 41). Location is outside the roadless area.	One caved adit reported to be 50 ft long (Green, 1945, p. 41).	None	Exposures not sufficient to determine mineral potential.



Base from U.S. Geological Survey
Mt. Steel, 1947, and Mt. Tebo, 1953.

SCALE 1:62 500

1 1/2 0 1 2 3 4 MILES

1 .5 0 1 2 3 4 KILOMETERS

Figure 3.--Map showing indicated resources and area of low mineral resource potential for manganese in the Wonder Mountain Roadless Area, Mason County, Wash.

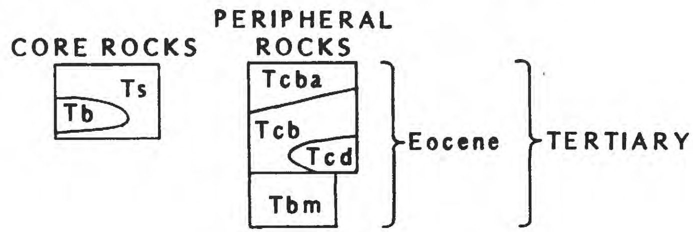
EXPLANATION

● AREA OF INDICATED MINERAL RESOURCES

▨ AREA OF POTENTIAL MINERAL RESOURCES

(Note: The following correlation, list of map units, and map symbols are for the screened geologic base map.)

CORRELATION OF MAP UNITS



LIST OF MAP UNITS

CORE ROCKS

Ts SANDSTONE, FOLIATED SANDSTONE, SEMISCHIST SLATE AND PHYLLITE (EOCENE)

Tb BASALTIC ROCKS (EOCENE)

PERIPHERAL ROCKS

CRESCENT FORMATION (MIDDLE AND LOWER (?) EOCENE)

Tcba Basalt flows, mudflow breccia, tuffaceous argillite, and fine-grained sandstone

Tcd Diabase and gabbro

Tcb Basaltic rocks and sedimentary rocks

Tbm SANDSTONE AND ARGILLITE OF BLUE MOUNTAIN (MIDDLE AND LOWER EOCENE)

——— CONTACT—Dashed where approximately located

- - - - - - INFERRED FAULT

⊥⊥⊥⊥⊥ INFERRED FOLDED THRUST FAULT—Hachures toward overthrust plate

▨ ZONE OF ABUNDANT RED ARGILLITE, LIMESTONE, AND JASPER

Figure 3.—Continued

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