# MINERAL RESOURCE POTENTIAL OF THE MOUNT EDDY AND CASTLE CRAGS ROADLESS AREAS, SHASTA, SISKIYOU, AND TRINITY COUNTIES, CALIFORNIA

## SUMMARY REPORT

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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 the 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 Mount Eddy (05229) and Castle Crags (B5219) Roadless Areas, Shasta-Trinity National Forest, Shasta, Siskiyou, and Trinity Counties, California. The Mount Eddy and Castle Crags Roadless Areas were classified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

## SUMMARY

Although ultramafic terranes such as that underlying the Mount Eddy and Castle Crags Roadless Areas may contain chromite, nickel, platinum-group metals, cobalt, and asbestos, there are no significant identified concentrations of these resources within the roadless areas. Platinum-group metals were sought but not detected in stream-sediment concentrates, although this does not rule out their possible occurrence. Nickel and cobalt did not occur in anomalous amounts although slightly higher nickel values in the northern part of the Mount Eddy Roadless Area may indicate low-grade mineralization within small dunite bodies, if the nickel occurs in sulfide phases rather than in olivine. The region has been examined on the surface for chromite and asbestos. Although both minerals are ubiquitous there is probably only a low potential for asbestos on the basis of the small size of veins at the surface. Only a few small areas of chromite were noted in the Mount Eddy Roadless Area; without subsurface data, however, any dunite body must be considered to have potential for chromite. The geochemical data for boron, barium, and mercury plus abundant quartz veining in gabbro and hornblende diorite suggest pervasive hydrothermal alteration, which could have formed mercury or vein gold deposits. Sand and gravel deposits occur in the Castle Crags Roadless Area but they cannot compete with superior deposits closer to markets. At a borrow pit northwest of the Mount Eddy Roadless Area, sheared serpentinite is quarried for road metal; similar rock occurs in the roadless area; however, better material is more readily available elsewhere.

## INTRODUCTION

The Mount Eddy and Castle Crags Roadless Areas occupy 9,600 acres and 3,300 acres, respectively, in Shasta, Siskiyou, and Trinity Counties, Calif. approximately 8 mi west of the towns of Mount Shasta City and Dunsmuir (fig. 1). The Castle Crags Roadless area is divided into two sections: the northern section 6 mi west of Dunsmuir and the southern section 4 mi west of Castella. Access is provided by trails and secondary roads from Interstate 5. The areas are located in a rugged terrain of glacially scoured, north-trending ridges and peaks in the easternmost part of the Klamath Mountains where altitudes range from about 2,500 ft along the north fork of Castle Creek to 9,025 ft on Mount Eddy. At lower elevations manzanita and other brush are prevalent whereas higher elevations are devoid of vegetation except for ground plants and occasional gnarled conifers.

Four weeks were spent in the field by U.S. Geological Survey personnel during the summer of 1982. During this time geologic maps from theses covering the areas were checked (Quick, 1981a; Throckmorton, 1978; Vennum, 1971), reconnaissance geology between the two areas was mapped, and rock samples were collected for geochemical analysis. One week during the summer of 1981 was spent in collecting stream-sediment samples. The U.S. Bureau of Mines conducted a mineral resource assessment of the Castle Crags Roadless Area during 1981 and of the Mount Eddy Roadless Area during 1982; county claim records, U.S. Bureau of Land Management records, and U.S. Forest Service files and records, and published literature were searched, and localities with possible mineral resources were examined. An attempt was made to find and sample all claims and prospects in or adjacent to the study areas. A scintillometer was carried during field investigations to measure gamma radiation. For the Castle Crags Roadless Area nine samples were taken of outcrops and float; one sample of lateritic soil was collected, and one sample was taken from stream terrace sand and gravel near the area. Fifteen lode samples were taken in the Mount Eddy Roadless Area. Lode and laterite samples were fire assayed for gold and silver; chromium, nickel, and cobalt were determined by colorimetric methods. Lode samples were analyzed further by semi-quantitative spectrographic methods for 42 elements[1] to detect the presence of unsuspected elements. Heavy minerals in the placer sample were initially concentrated by hand panning, and then further concentrated on a laboratory-sized Wilfley table. All samples were checked for radioactivity and fluorescence.

## GEOLOGY, GEOCHEMISTRY, AND GEOPHYSICS PERTAINING TO MINERAL RESOURCE ASSESSMENTS

### Geology

The terrane underlying the Mount Eddy and Castle Crags Roadless Areas is part of the Trinity ultramafic sheet, one of the largest such bodies in the United States, covering 400 $mi^2$ (Lipman, 1964). The ultramafic rocks have been intruded by large gabbro bodies, hornblende diorite, and younger granitic plutons, all of which are Paleozoic in age (Throckmorton, 1978; Vennum, 1980; Quick, 1981b).

The Trinity ultramafic sheet dips to the east and is several miles thick. It consists of harzburgite, dunite, and plagioclase lherzolite with minor amounts of other ultramafic rocks, frequently emplaced as dikes (Quick, 1981b). The degree of serpentinization of the ultramafic rock varies considerably and in general increases southward. In the Mount Eddy area the different ultramafic rock types are usually easily distinguished in the field, whereas to the south serpentinization has obscured the original petrography. Dunite, which is the host rock for chromite deposits, forms small bodies inches to feet in size and large thick (up to 300 ft) tabular bodies more than 0.6 mi long. Where the rock type is distinguishable, dunite may comprise 15 to 20 percent of the peridotite. The peridotite is considered to be part of the upper mantle emplaced onto the continent and the dunite bodies are thought to be genetically related to this mantle section (Quick, 1981c).

A large gabbro body emplaced into the Trinity peridotite underlies most of the northern Castle Crags Roadless Area (Throckmorton, 1978). The body is composed of gabbro that grades upward into massive coarse-grained non-cumulus gabbro and downward into cumulus peridotite. Dikes from this gabbro and other similar gabbro bodies near Mount Eddy intrude joint and shear zones within the Trinity peridotite.

Hornblende diorite, consisting of plagioclase and hornblende and sometimes a significant amount of quartz, occurs as small plugs in the northern part of the Mount Eddy area. Inclusions of peridotite and gabbro in the diorite demonstrate that the diorite is younger (Quick, 1981b).

Granitic rocks of the Castle Crags pluton crop out east of the Castle Crags areas. The concentrically zoned pluton consists chiefly of sodic granodiorite that grades outward into a fine-grained granodiorite rim adjacent to the peridotite and inward to an alkalic trondhjemite core (Vennum, 1980). The pluton and adjacent areas, including the northern Castle Crags Roadless Area are intruded by a variety of dikes and small plugs related to the pluton. A 3- to 5-ft-wide metamorphic aureole surrounds the pluton. In it the peridotite becomes more serpentinized and in places tremolite has developed. Gabbro adjacent to the pluton has been converted to albite-epidote hornfels facies assemblage.

Both the gabbro and hornblende diorite are intruded by quartz veins that range in size from 0.5 in. to greater than 1 ft wide; the average width is about 1 in. The veins are usually traceable for only a few feet. These quartz veins may have been formed by hydrothermal fluids or by residual fluids associated with the Castle Crags pluton.

Much of the area is covered by Quaternary deposits, including talus, alluvium and glacial debris which obscures the bedrock geology.

### Geochemistry

Analyses of rock, stream-sediment, and stream-sediment-concentrate samples from within and near the roadless areas (Peterson and others, 1983) indicate a pervasive hydrothermal imprint on the ultramafic and mafic rocks: boron, barium, and mercury in all stream-sediment samples are present in higher concentrations than expected for ultramafic and mafic terranes. Rock samples show a similar but less pronounced pattern for boron and barium. Of particular note are the high barium values (150-2,000 parts per million (ppm)) in rock samples of hornblende diorite, which may be related to extensive quartz veining in the unit. The areas underlain by gabbro, hornblende diorite, and granitic rocks yielded no geochemical anomalies that might be indicative of mineralization. Quartz veins within the gabbro and hornblende diorite, however, may contain small amounts of copper and gold. One quartz sample from the Half Century No. 1 prospect (fig. 2) contains 700 ppm copper. Small amounts of gold were detected by analysis of the quartz veins, and a small amount (0.2 and 0.01 ppm) was measured in two of the stream-sediment concentrates in the northern part of the Mount Eddy Roadless Area, and it is believed that the source of this gold is the quartz veins. The presence of gold in the stream-sediment concentrates indicates that small amounts of placer gold may be present in stream deposits. Within the ultramafic rocks, dunite samples in the northern part of Mount Eddy Roadless Area yield higher nickel values than other rocks. This may indicate low-grade mineralization although no visible suflides were seen and the values are within normal abundances reported for ultramafic rocks. A small dunite pod in the southern part of the Mount Eddy Roadless Area contains anomalous amounts of chromium, verified by abundant visible disseminated chromite crystals in outcrop. This locality is only 2 mi southwest of the inactive Johnson mine, (fig. 2) (see mining discussion below). U.S. Bureau of Mines assays of samples from the Castle Crags Roadless Area indicate trace amounts of nickel, chromium, cobalt, and gold. One sample of lateritic soil near the Castle Crags Roadless Area contained 0.3 percent nickel, 0.09 percent chromium, 0.02 percent cobalt, and no gold or silver. One gravel sample had trace amounts of gold. Assays from the Mount Eddy Roadless Area indicate small amounts of gold (less than 0.005 to 0.271 oz/ton) from samples collected in the northern part of the area. Chromium and iron values show 0.38-39.9 percent $Cr_2O_3$ and 6.1-11.2 percent iron.

### Geophysics

An unpublished aeromagnetic map at a scale of 1:250,000 produced by the University of Oregon covers the Mount Eddy and Castle Crags Roadless Areas. The character of the magnetic anomalies reflects the rock types exposed at the surface. Areas underlain by hornblende diorite and granodiorite show magnetic lows relative to areas underlain by peridotite and gabbro. The magnetic low associated with the Castle Crags pluton is somewhat less than might be expected because of its high topographic relief. Variations within the magnetically high areas reflect topography, with ridge tops corresponding to magnetic highs. The small scale of the map precludes any aeromagnetic interpretation of ore potential.

## MINING DISTRICTS AND MINERALIZATION

The U.S. Bureau of Mines examined county, U.S. Bureau of Land Management, and U.S. Bureau of Mines reports and published literature to determine claim

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[1] Aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, columbium, copper, gallium, gold, hafnium, indium, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, platinum, rhenium, scandium, silicon, silver, sodium, strontium, tantalum, tellurium, thallium, tin, titanium, vanadium, yttrium, zinc, and zirconium.

locations. The claims were then sampled for chemical analysis.

No mining claims are located in the Castle Crags Roadless Area. Four chromite claim groups located east and south of the area were active from 1906 to 1917, and briefly in the 1940's. There is no evidence of current mining activity on these claims, or in the roadless area.

Chromite has been the principal metallic mineral mined in the region. The Little Castle Creek mine, 3 mi east of the study area yielded 16,625 tons of chromite ore between 1906 and 1953. It was abandoned after World War I, briefly operated during World War II, and closed in 1954 (Lydon and O'Brien, 1974; Wells and Hawkes, 1965). Just west of this mine is the Hearst mine which yielded 60 tons of chromite ore prior to 1918 (Wells and Hawkes, 1965). A total of 3,938 tons of chromite ore was reported produced at the Coggins mine, between 1916 and 1943 (Wells and Hawkes, 1965). Closer to the study area the Lucky Strike mine produced 31 tons of hand-sorted chromite ore in 1943 (Wells and Hawkes, 1965).

The Montrose mill about 2 mi east of the Castle Crags Roadless Area was built in 1942 to custom mill low-grade chromium ore which was then sold to the government stockpile. Mines as far as 150 mi away supplied ore while the mill operated intermittently between 1942 and 1955. About 1958, the millsite was included in the Castle Crags State Park; subsequently, the mill equipment was removed and the site cleared and planted (Lydon and O'Brien, 1974).

Interest in chromite and asbestos occurrences on Mount Eddy began in 1916, continued through World Wars I and II, and subsided in 1956. Since 1916, 36 mining claims have been located in the Mount Eddy Roadless Area. Three lode claims were active in 1982. The Mount Eddy Roadless Area encompasses six mineral properties, but only one mine and two prospects have mineral resource potential. A borrow pit northwest of the area is quarried for road metal. The Johnson mine southeast of the Mount Eddy summit produced an unrecorded amount of chromium ore during World War II (Wells and Cater, 1950). Production came from a 35-ft decline in podiform chromite in dunite located in a shear zone of serpentinized peridotite which trends N. 15° W. and dips 60° SE. A grab sample from the remaining stockpile assayed 39.8 percent $Cr_2O_3$. On the Ratero prosepct, northeast of Mount Eddy, a pod of chromite 16 in. wide is exposed for 40 ft. It strikes east-west and dips at 45° N. in serpentinized peridotite. A sample at the prospect assayed 38.1 percent $Cr_2O_3$. On the Half Century No. 1 prospect discontinuous irregular vuggy iron-stained quartz lenses average 5 in. wide. They occur in hornblende diorite and strike N. 70° E. and dip 50° NW. The quartz contained small amounts of chalcopyrite, bornite, and malachite. A grab sample from quartz found down slope from the pits assayed 0.271 oz/ton gold.

## ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Although ultramafic rocks may contain deposits of asbestos, platinum-group metals, cobalt, chromite, and nickel, there is little evidence for significant deposits of these commodities within the Mount Eddy and Castle Crags Roadless Areas as of the writing of this report. The region has been prospected on the surface for asbestos and chromium. Although both minerals are ubiquitous, they do not occur in large concentrations anywhere within the area. The Ratero prospect is estimated to have 260 tons of inferred chromite resources. Potential also exists for discovering more chromite at the Johnson mine. The chromite-bearing dunite pod in the southern corner of the Mount Eddy Roadless Area has a surface area of only about 300 $ft^2$, which is not sufficiently large to form a viable ore deposit unless it expands greatly and becomes more massive at depth. Without subsurface information the extent of chromite mineralization cannot be determined. Because dunite bodies are permissive hosts for chromite deposits, they must be considered to have potential for chromite. A 3-in.-wide asbestos vein of slip-fiber chrysotile was found in a stream drainage about 0.3 mi west of the southern Castle Crags area, but it could be traced along strike for only about 10 ft. The asbestos fibers were about 0.25 in. long and quite brittle. This was the largest concentration of asbestos found during field work. Low-grade nickel mineralization may occur in the northern part of the Mount Eddy area, but further work is needed to determine whether sulfide phases are present. Little lateritic soil has developed in either of the roadless areas. The Mount Eddy area has little or no soil on ridge crests, and hillsides and valleys are covered with talus and alluvial material. The parts of the Castle Crags areas underlain by ultramafic rocks typically have a thick cover of manzanita or abundant trees, not usually found in lateritic soil. Any mineralization within the quartz veins appears to be restricted to small quantities of copper and possibly gold. The Half Century No. 1 prospect (where the gold and high copper values occurred) contains traces of chalcopyrite, bornite, and malachite and the quartz is heavily stained by limonite.

Although sand and gravel deposits occur in the Castle Crags Roadless Area, they are too far from major markets. At a borrow pit northwest of the Mount Eddy Roadless Area, sheared serpentinite is quarried for road metal; similar rock occurs in the roadless area; however, better material is readily available elsewhere.

To conclude, small amounts of asbestos, chromite, and nickel are present at the surface within the Mount Eddy and Castle Crags Roadless Areas, but they have low resource potential at this time. Evidence of hydrothermal activity may indicate the presence of mercury, copper, and gold mineralization although specific locations for such mineralization were not found except for the Half Century No. 1 prospect in the Mount Eddy Roadless Area.

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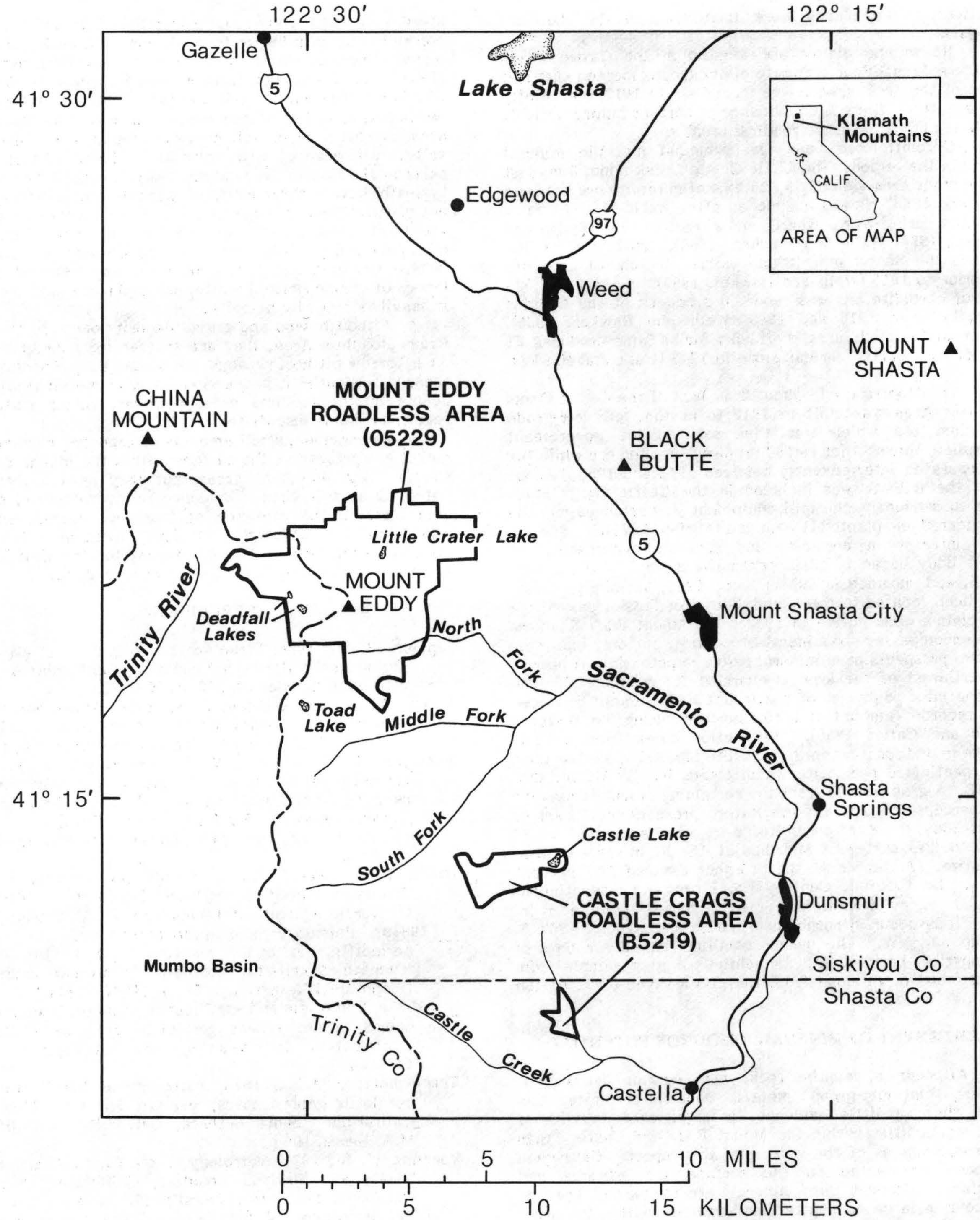


Figure 1. Index map showing location of Mount Eddy (05229) and Castle Crags (B5219) Roadless Areas, California.