MINERAL RESOURCE POTENTIAL OF THE CARSON-ICEBERG ROADLESS AREAS, CENTRAL SIERRA NEVADA, CALIFORNIA

SUMMARY REPORT

By

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STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and the Joint Conference Report on Senate Bill 4, 88th Congress, 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 Carson-Iceberg Roadless Areas, Stanislaus and Toiyabe National Forests, Alpine and Tuolumne Counties, California. The Carson-Iceberg was established as a wilderness study area under the Joint Conference Report on Senate Bill 4, 88th Congress. It was later classified as recommended wilderness (C4-986 and C5-986) and further planning (B5-986) during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

SUMMARY

The Carson-Iceberg Roadless Areas have potential for the occurrence of base and precious metals, molybdenum-tungsten, and uranium. Three areas are favorable (A and B, medium to high potential; C, low to medium potential) for the occurrence of undiscovered epithermal gold-silver vein deposits and one (B) has medium potential for the occurrence of a porphyry molybdenum-tungsten deposit. Potential areas A and C in roadless areas C4-986 and C5-986 are characterized by geochemical anomalies, alteration, host rocks, and mines and prospects in the immediate vicinity, all of which indicate favorability for undiscovered deposits. The mineral potential of area B in roadless area C4-986 is also supported by geochemically anomalous concentrations of elements, favorable host rocks, and the presence of mines and prospects in and near the area. A fourth area (D) in roadless area B5-986 North has low potential for a minor pegmatite- or quartz vein-type molybdenum-tungsten deposit.

Areas underlain by the Relief Peak Formation of Slemmons (1966) which is or was initially overlain by the Eureka Valley Tuff of the Stanislaus Group are considered to be sites of low potential for uranium mineralization.

Low-temperature thermal water flows from springs at the base of Soda Cone in the east-central part of area C4-986, but regional studies appear to indicate low, if any, geothermal potential for the area.

INTRODUCTION

The U.S. Geological Survey and the U.S. Bureau of Mines conducted a study of the Carson-Iceberg Roadless Areas in 1979-1981. The purpose of the study was to evaluate the mineral potential of the areas. The geology of these areas as shown on the geologic map (Keith and others, 1982) is a compilation of existing geologic mapping, modified and supplemented by additional mapping by U.S. Geological Survey personnel. Geophysical and geochemical studies of the area were conducted by the U.S. Geological Survey; the U.S. Bureau of Mines investigated mines, prospects, and mineralized areas.

Location and geographic setting

The Carson-Iceberg Roadless Areas (C4-986, C5-986, B5-986 North, and B5-986 South) form a roughly circular area (fig. 1) of 219,630 acres (89,000 ha) in Alpine and Tuolumne Counties, California. The study area is approximately bisected by the northwest-trending boundary of the Stanislaus and Toiyabe National Forests which coincides with the crest of the Sierra Nevada. This is also the boundary between C4-986 and C5-986. The Carson-Iceberg Roadless Areas are bounded approximately on the east by the Mono-Alpine County boundary; on the south by California State Highway 108; on the west by the west boundary of the Dardanelles Cone 15-minute quadrangle; and on the north by California State Highway 4 and the East Fork of the Carson River.

Geologic setting

The Carson-Iceberg Roadless Areas lie astride the crest of the Sierra Nevada and consist mainly of a series of

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volcanic rocks and mudflows of Tertiary age which overlie a plutonic complex of Mesozoic age. An erosional hiatus between the plutonic rocks and the base of the volcanic section has produced an irregular contact surface between these units. The study area is located in a tectonically active zone, as evidenced by continuing uplift and westward tilting.

GEOLOGY, GEOCHEMISTRY, AND GEOPHYSICS PERTAINING TO MINERAL RESOURCE ASSESSMENT

Geology

The oldest rocks in the study area are granitic gneisses of the Mokelumne Peak roof pendant of McKee and Howe (1981) and undivided metamorphic rocks (Keith and others, 1982), which are largely metasedimentary. These are either surrounded by or included in plutonic rocks of Mesozoic age. The plutonic rocks are mostly granodiorite, although small bodies of alaskite, tonalite, and adamellite occur locally.

Tertiary and Quaternary volcanic and sedimentary rocks overlie the plutonic rocks and have been divided into six units. These units are, from oldest to youngest: Valley Springs Formation, Relief Peak Formation of Slemmons (1966), Stanislaus Group, Disaster Peak Formation of Slemmons (1966), rhyolitic rocks, and mafic rocks.

The Valley Springs Formation consists of a thin sequence of interbedded tuffaceous sedimentary rocks, siliceous welded tuffs, and local flow rocks.

The Relief Peak Formation is a sequence of interbedded mafic lava flows and mudflows usually overlying poorly to well-sorted water-laid sedimentary rocks. Similar stratigraphic sequences appear throughout the formation.

The Stanislaus Group unconformably overlies the Relief Peak Formation. The Stanislaus Group is composed of three formations (Noble and others, 1974), from oldest to youngest: Table Mountain Latite, Eureka Valley Tuff, and Dardanelles Formation. Rapp and Short (1980) suggest that the Eureka Valley Tuff is the probable source of the uranium in the Relief Peak Formation. Their study (Rapp and Short, 1980, p. 63/64) shows that glass from the Eureka Valley Tuff has 10 to 14 ppm (parts per million) uranium and 35 to 43 ppm thorium. The Eureka Valley Tuff is composed of a series of ash-flow tuffs which generally are highly permeable, thus allowing the tuffs to be easily leached and the uranium to be remobilized. The Table Mountain Latite also contains high values of uranium and thorium but lacks the permeability of the Eureka Valley Tuff.

The Disaster Peak Formation unconformably overlies the Stanislaus Group and is lithologically similar to the Relief Peak Formation. The Disaster Peak Formation is almost impossible to distinguish from the Relief Peak Formation when the Stanislaus Group is absent. No uranium anomalies have been detected in the Disaster Peak Formation.

The younger silicic volcanic rocks lie stratigraphically above and also intrude the older units. These rocks range from rhyolite to dacite and consist of lava flows; dikes, sills, and plugs; and tuffs. They are both aphanitic and porphyritic and are relatively young (6.3-4.7 m.y. B. P., Dalrymple, 1964; E. H. McKee, oral commun., 1980). The silicic volcanic rocks lie in a northeast-trending belt of altered rocks in the north-central part of the map area (area A, fig. 2). These rocks have been prospected in the past, and some areas have produced minor amounts of precious metals (Clark, 1977). Rocks of similar composition and of similar ages have acted as precious metal hosts in the region to the east (Clark, 1977).

The younger mafic rocks occur sporadically throughout the Carson-Iceberg area but appear to have had little if any effect on the resource potential of the area.

Area C4-986 consists of Mesozoic plutonic rocks locally containing older metamorphic rocks that are overlain by or intruded by Tertiary and Quaternary sedimentary and volcanic rocks. The northern part of this area is laced with small dikes, shear zones, and faults. In many cases, these have acted as conduits for mineralizing fluids. A northwest-trending fault in Nobel Canyon appears to have hosted fluids responsible for local silicification, pyritization, and leaching. This fault is within a northeast-trending zone of hydrothermal alteration in the northwest corner of C4-986 that extends southward into C5-986.

The geology in C5-986 is similar to that of C4-986 except for the presence in the northwestern part of C5-986 of more abundant granitic rocks and the granitic gneisses of the Mokelumne Peak roof pendant of McKee and Howe (1981). The Nobel Canyon fault possibly extends southwest of Tryon ridge into C5-986 and could be responsible for some of the alteration and mineralization occurring there. The silicic volcanic rocks also extend into this area from Nobel Canyon. Shear zones occur in this area, but mineralized areas appear to be fewer in number than in C4-986.

The east end of B5-986 North contains silicic volcanic rocks of the type and age found in C4-986 and C5-986. The major plutonic unit in this area is an adamellite (Keith and others, 1982) rather than the granodiorite which predominates in C4-986 and C5-986. Area B5-986 South is similar geologically to C4-986 and C5-986 except that no young (6.3-4.7 m.y. B. P.) silicic volcanic rocks are present.

Geochemistry

A total of 131 rock samples, 220 stream-sediment samples screened at minus-0.25 mm, and 221 nonmagnetic heavy-mineral-concentrate samples were analyzed for the investigations of the Carson-Iceberg Roadless Areas. All of the samples were analyzed for 31 elements (silver, arsenic, gold, boron, barium, beryllium, bismuth, cadmium, cobalt, chromium, copper, iron, lanthanum, magnesium, manganese, molybdenum, niobium, nickel, lead, antimony, scandium, tin, strontium, thallium, titanium, vanadium, tungsten, yttrium, zinc, and zirconium) by a six-step semiquantitative emission spectrographic method. The rock and stream-sediment samples were also analyzed for bismuth, cadmium, antimony, and zinc by atomic-absorption spectrometry and arsenic by a colorimetric method. The rock samples were collected primarily to provide information on the normal, or background, chemical abundances of the rock units in the study area; consequently, only the stream-sediment and concentrate analyses are discussed here. For the stream-sediment samples 9 elements (silver, arsenic, bismuth, cadmium, copper, molybdenum, lead, antimony, and zinc) were selected as possibly being related to mineralization; for the concentrate samples, 4 elements (barium, cobalt, iron, and strontium) were selected as possibly being related to hydrothermal alteration but not necessarily mineralization, and 13 elements (silver, arsenic, gold, boron, beryllium, bismuth, copper, molybdenum, lead, antimony, tin, tungsten, and zinc) were selected as possibly being related to mineralization. The mineralization-related concentrate elements were further divided into two groups—a base- and precious-metal deposit suite (silver, arsenic, gold, copper, lead, antimony, and zinc) and a molybdenum-tungsten deposit suite (boron, beryllium, bismuth, molybdenum, tin, and tungsten).

Concentrations for the individual selected elements in each sample were weighted using a technique called Scoresum (Chaffee, 1982), and the anomalies resulting from this technique were then plotted on a geologic base map of the Carson-Iceberg Roadless Areas to aid in evaluation of mineral resource potential.

Geophysics

Two geophysical mapping methods were used to aid geologic mapping and mineral appraisal in the study area. A regional gravity survey resulted in a gravity anomaly map that is dominated by closely spaced north-south-trending contours that reflect eastward thickening of the crust beneath the Sierra Nevada. The gravity map has little use in mineral appraisal, because the large regional gravity gradient obscures anomalies that might be related to distributions of near-surface rocks.

An aeromagnetic survey flown at about 1,000 ft (300 m) above the ground along lines spaced at intervals of 1 mi (1.6 km) was the second geophysical mapping method used. Anomalies on the resulting magnetic intensity map closely correlate with the underlying mapped geologic units.

The most significant correlations with geologic units are as follows. A member of the Eureka Valley Tuff of the Stanislaus Group and some of the younger silicic volcanic rocks are characterized by reversed magnetization that results in prominent magnetic lows. The Table Mountain Latite of the Stanislaus Group and later basalts, however, are characterized by magnetic highs. The younger mafic rocks also tend to produce magnetic highs. Plutonic rocks generally have low magnetization, and the plutonic terrains are reflected on the magnetic map by subdued magnetic anomalies. Prominent magnetic lows, however, seem to be correlated with the granodiorite of Topaz Lake, possibly indicating an associated magnetic reversal.

MINING DISTRICTS AND MINERALIZATION

Except for prospecting, claim staking, and annual assessment work, there has been no recent mining activity within the boundaries of the study area. The area contains no mineral, oil and gas, or geothermal leases.

Mining districts were established in the middle 1800's that included parts of the Carson-Iceberg area. The Alpine, Mogul, Monitor, Highland, Silver Valley, Raymond, Mokelumne, Silver Mountain, Silver King, and Webster mining districts (Reed, 1864a, 1864b, and 1866) are within or near the study area.

As many as 600 claims, mostly lode, have been located in the Carson-Iceberg area over the years. Of these, more than 400 lode and 40 placer claims were located in or near C4-986; at least 100 lode claims were located in or near C5-986; more than 30 placer claims were located along the Middle Fork of the Stanislaus River and the Clark Fork, mainly adjacent to C5-986 and B5-986 South; and at least 20 lode and placer claims were located in B5-986 North and adjacent land. In 1981, 18 claims were current. Three patented claims are in or near area C4-986. Two of these are in the Mountain claim group, east of the old Silver Mountain townsite; the third is the Lost Sleigh mine, adjacent to area C4-986, near Ebbetts Pass.

Prospecting in the Carson-Iceberg area began in the 1850's (Long and others, 1964, p. 43; Clark, 1977). No mineral production has been recorded within the study area; the nearest mine is the Lost Sleigh, adjacent to the northwest border of area C4-986. Production from this property in 1926 and 1934 totaled 33 tons (30 t) of ore, from which was recovered 35 oz (1.1 kg) of gold and 58 oz (1.8 kg) of silver.

Uranium was produced at the Juniper mine, about 3 mi (4.8 km) south of C4-986; most of the ore was carbonaceous sedimentary rocks interlayered with volcanic rocks. Ore containing at least 45,000 lb (20,412 kg) of uranium oxide was mined from 1963 to 1966 (Rapp, 1981).

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Area C4-986

Area C4-986 includes three areas, A, B, and C, (fig. 2) which contain significant mineral potential. Only two of these, area A, which also extends into C5-986, and area B, have much potential for hosting undiscovered epithermal base- or precious-metal deposits. However, much of the Relief Peak Formation in the area has minor potential for the discovery of uranium in the sedimentary rocks in the lower part of the unit. Regional studies appear to indicate little, if any, potential for geothermal energy (Brook and others, 1979; Sammel, 1979; Barnes and others, 1981). However, low-temperature thermal waters (Muffler and Guffanti, 1979) flow at the base of Soda Cone, and nearby rocks have been hydrothermally altered.

North of C4-986, the Lost Sleigh mine has potential for small, high-grade gold deposits. Gold content in 33 tons (30 t) of ore produced in 1926 and 1934 averaged about 1.0 oz per ton (34 g/t). Although the structure of the Lost Sleigh mine extends into the roadless area, surface sample data did not indicate resources within the roadless area.

Area A

Area A includes the Nobel Canyon drainage basin that contains geochemically significant concentrations of silver, arsenic, copper, and lead. In addition to favorable host rocks, there is a fault system in Nobel Canyon that could conceivably extend into the Highland Lakes vicinity. This area also contains a zone of intense hydrothermal alteration, as indicated by the presence of the iron-barium-strontium-cobalt alteration suite, silicification, argillization, and strong bleaching and pyritization.

The Silver Mountain mining district includes the northern part of area A and probably had a total output value of less than $300,000 (Clark, 1977, p. 28), all from outside the study area. One of the better known mines in the district is the I.X.L., north of the Silver Mountain townsite, which produced approximately $50,000 to $60,000 worth of gold and silver shortly after it opened in 1861 and had small amounts of production in the 1930's.

Area B

Area B includes two drainages that have geochemical anomalies: Silver King Valley, which contains anomalous amounts of lead and arsenic, and Corral Valley, which is anomalous in silver, lead, antimony, bismuth, tin, and beryllium. Geologically, area B includes favorable host metamorphic rocks, granitic rocks, plutonic contacts and hydrothermally altered rocks. Small vein systems are also present. This area also includes part of the Silver King mining district. Prospects and claims which contain gold, silver, and tungsten mineralization exist in and near the area.

The Hilltop mine, on the east edge of area B, has about 720,000 tons (650,000 t) of indicated submarginal resources containing an estimated 0.17 oz gold per ton (5.8 g/t). Under 1982 conditions the Hilltop deposit probably could not be mined except in conjunction with another nearby deposit such as the Log Cabin (Dixon) mine, which has 900,000 tons (800,000 t) of indicated marginal reserves containing 0.1 to 0.4 oz gold per ton (3.4 to 13.7 g/t).

At Mineral Mountain, near the mouth of Snodgrass Creek, potential for deposits containing silver, lead, zinc, and copper justifies further prospecting. As much as 8.6 oz of silver per ton (295 g/t), 3.8 percent lead, 0.6 percent zinc, and 0.41 percent copper were found in schist. The mineralized schist layer may be about 10 ft (3 m) thick, but the length of the zone is obscured.

The area also contains moderate to strong anomalies for boron, beryllium, bismuth, molybdenum, and tin which may be associated with a porphyry molybdenum system.

Area C

Area C contains strongly anomalous amounts of copper, lead, silver, antimony, and arsenic. It does not include the Log Cabin (Dixon) mine, which is north of area C, but could be related to the same structural system that supported mineralization in the Log Cabin area. Country rock is andesite of the Relief Peak Formation that may host mineralized vein systems. This data plus the presence of strong alteration-suite chemical anomalies indicate this area has low to medium potential to host a precious-metal mineral deposit.

Area C5-986

Area C5-986 includes only one area, A, that appears to be significant in terms of base- or precious-metal mineral potential. Much of the Relief Peak Formation in the area has low potential for the occurrence of uranium in the basal sedimentary rocks. Near Highland Lakes, a few pounds of radioactive carbonaceous fragments, containing 0.92 percent uranium oxide (U_3O_8), have been found at the base of volcanic rocks.

Samples from the Highland Lakes drainage in area A contain anomalous concentrations of silver, copper, lead, zinc, iron, and barium. The rocks for about a mile (1.6 km) around Highland Lakes have been argillized and silicified, both along shears and in stockworks. The rocks have been explored by three short adits and at least 32 shallow pits and trenches. Of 23 samples, 1 contained 3.1 oz silver per ton (106 g/t) and 2 contained 0.1 and 0.3 percent copper.

Samples near Iceberg Peak , south of Highland Lakes, contain anomalous concentrations of silver, copper, cadmium, molybdenum, barium, and strontium. At least 20 pits, trenches, and possible caved adits are in an area about one-half mi (0.8 km) square. Of 21 samples, 16 contained traces of gold, and 1 contained 0.02 oz gold per ton (0.7 g/t); 6 samples contained a trace to 1.0 oz silver per ton (34 g/t). Six selected samples contained 0.13 to 1.3 percent copper. Creeks in Hiram and Champion Canyons, which flow west of Iceberg Peak, contained small amounts of placer gold.

The Nobel Canyon fault in area C4-986 could continue into this area and would thus act as a supporting structure for the formation of base- and (or) precious-metal deposits. A northeast-trending belt of alteration extends across C4-986 and C5-986. The belt also contains silicic volcanic rocks that are highly favorable hosts for precious-metal deposits in other parts of the surrounding Walker Lake 1° by 2° quadrangle. Subeconomic gold has been detected in placers along Highland Creek and its tributaries and along the Middle Fork of the Stanislaus River. These factors indicate a strong possibility for the occurrence of mineral deposits similar to those in the Silver Mountain mining district to the north and would place area A in the medium- to high-potential category.

At the northwest side of C5-986, away from designated geochemical anomalies, Bull Run No. 1 deposit contains subeconomic resources of tungsten in tactite. The deposit is estimated to contain 9,000 T (8,000 t) containing 0.46 percent tungsten trioxide (WO_3).

Area B5-986 North

Area B5-986 North includes one area, D, that has a single drainage basin containing geochemical anomalies of molybdenum, tin, and tungsten. Area D forms a structural basin at the contact between two plutons and, as such, could be conducive to favorable mineralization such as remobilization of the molybdenum and tungsten in one pluton by the other or concentration of late-stage fluids from the younger pluton. Altered mineralized rocks containing anomalous copper and silver near Highland Lakes extend from C5-986 to B5-986 North.

All of these conditions could lead to pegmatite or quartz-vein metallic mineral deposits. They could also be an indication that the Stanislaus Meadow Adamellite of Parker (1961) is more enriched in the molybdenum-tungsten suite of elements than are other Cretaceous intrusive units. The data appear strong enough, however, to indicate the area has low potential for mineral deposits.

Much of the Relief Peak Formation in this area has low potential for the occurrence of uranium in the sedimentary rocks of the lower part of the unit.

Area B5-986 South

The only potential in B5-986 South is low and is for uranium at the base of the Relief Peak Formation (fig. 2). Subeconomic traces of placer gold were found along Highland Creek.

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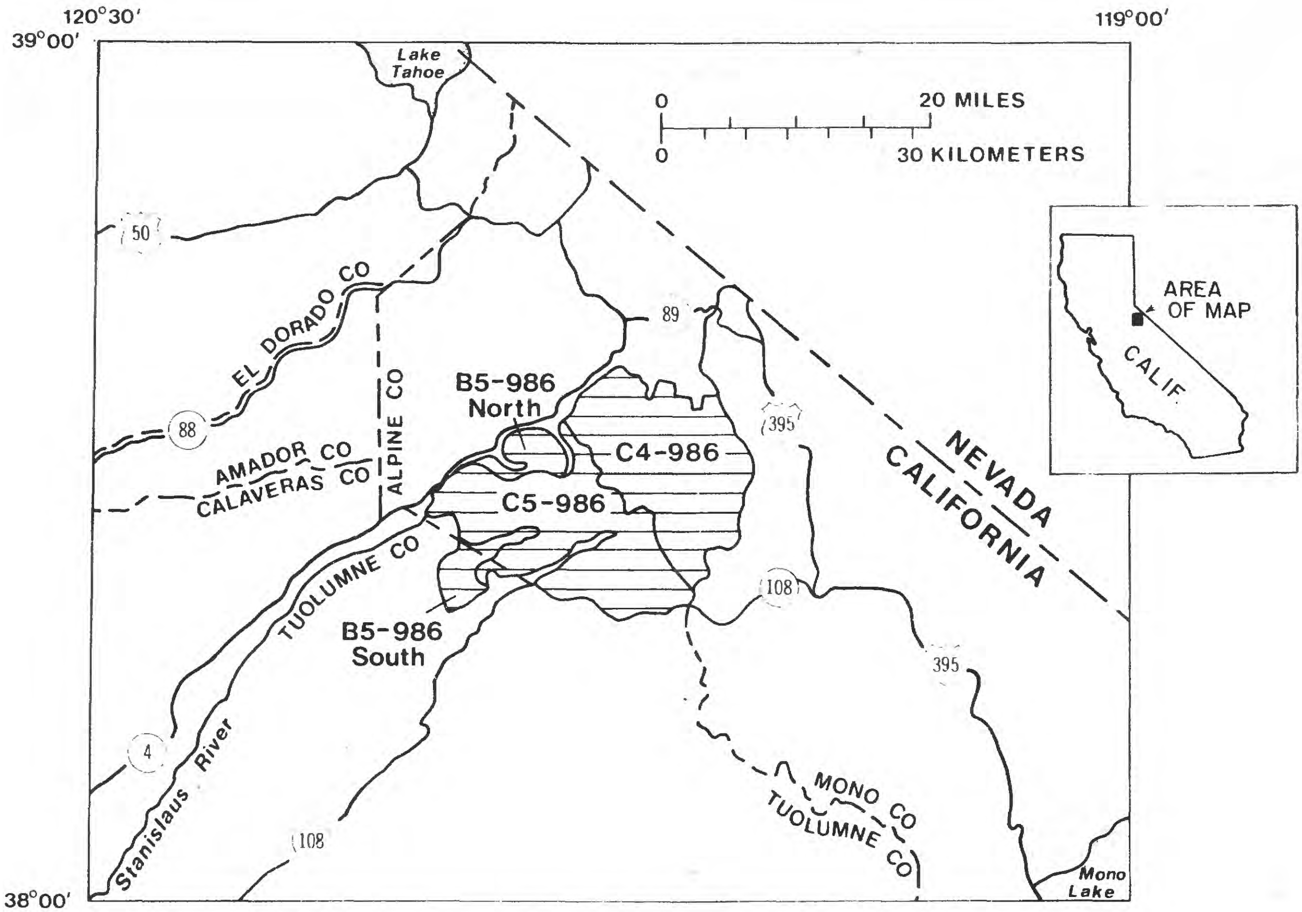

Number	Area
C4-986	Toiyabe National Forest
C5-986	Stanislaus National Forest
B5-986 North and South	Stanislaus National Forest

Figure 1.--Index map showing location of the Carson-Iceberg Roadless Areas (lined areas).

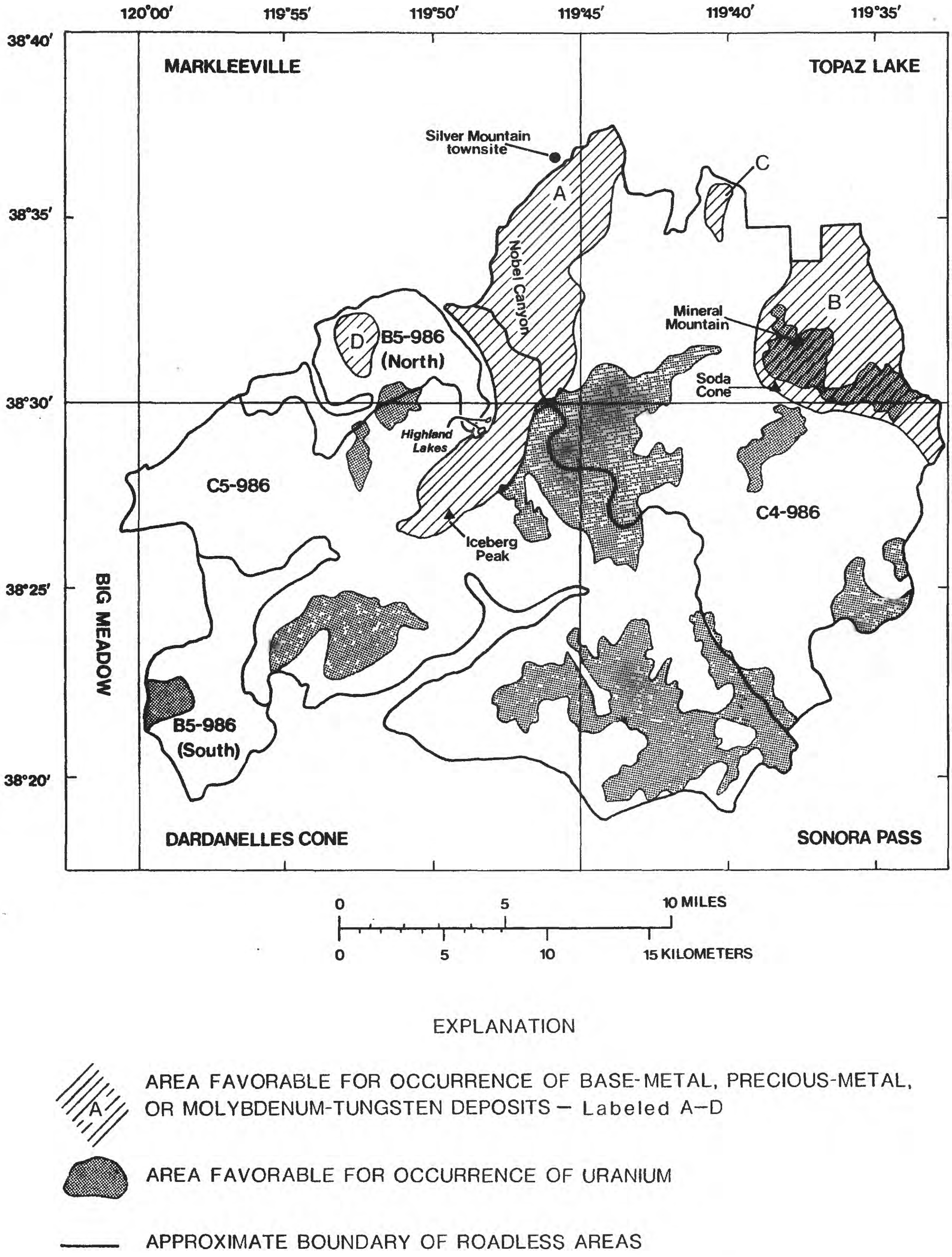

Figure 2.--Locations of areas having mineral resource potential in the Carson-Iceberg Roadless Areas (C4-986, C5-986, B5-986 North and South), and locations of U.S. Geological Survey 15-minute quadrangles.