UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

# Mineral resource potential of the Caribou Wilderness and Trail Lake Roadless Area, Lassen and Plumas Counties, California

by

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

1. U.S. Geological Survey

2. U.S. Bureau of Mines

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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 desgination 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 Caribou Wilderness and Trail Lake Roadless Area (B5095), Lassen National Forest, Lassen and Plumas Counties, California. The Caribou Wilderness was established by Public Law 88-577, September 3. 1964. The Trail Lake 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.

## SUMMARY

Geologic mapping, geochemical sampling, and an aeromagnetic survey by the U.S. Geological Survey and field assessment by the U.S. Bureau of Mines show no indications of mineral potential. Geothermal potential within the Caribou Wilderness and Trail Lake Roadless Area exists. The wilderness is a high plateau of Pleistocene basaltic andesite flows and basalt buttes. A thin veneer of glacial and lacustrine deposits occupies a central valley of the plateau. A Holocene basaltic cinder cone and flows that emanated from it sit on the north end of the plateau. The Trail Lake Roadless Area is on the east flank of the Caribou Wilderness. Rocks exposed there are the Pleistocene basaltic andesite which forms the high plateau of the wilderness. Northwest of Silver Lake the wilderness and roadless area are physically separated by a vertical fault scarp up to 150 feet high. No mining claims are known to be in the study area. Cinder deposits, useful for road building, are located on some of the peaks in the wilderness; these are small in volume and inaccessible. No evidence of metallic mineralization were found during field examination of the rocks or in chemical analyses done on 37 rock samples. There are no hot springs, deposits of minerals that might be sublimates of hot gas, or other surface evidence that potential exists for a geothermal energy resource within the Caribou Wilderness and Trail Lakes Roadless Area. Because of the proximity of the wilderness and roadless area to known geothermal resources of Lassen Volcanic National Park, 10 miles to the west, complete assessment of the geothermal resources of Caribou Wilderness and Trail Lake Roadless Area would require drilling.

## INTRODUCTION

The Caribou Wilderness and Trail Lake Roadless Area are in Lassen and Plumas Counties of northeastern California; both are within Lassen National Forest. They are adjacent to the east boundary of Lassen Volcanic National Park and together are roughly 8.5 mi from north to south and 6 mi east to west. Susanville, California, the nearest population center is 25 mi to the east. Redding, California is 65 mi to the west (see fig. 1).

The areas of the wilderness is 19,080 acres. The wilderness, a glaciated plateau dotted with lakes, lies between elevations of 6,600 and 8,374 ft. A cinder cone, Black Butte (fig. 2), dominates the north boundary of the area. Red Cinder and Black Cinder Rock are prominent peaks on the east boundary. A broad central valley is heavily forested relative to the peaks and is punctuated by a series of buttes up to 300 ft high that are spaced along the north-south trend of the valley. A local veneer of glacial drift and lake deposits are limited to the central valley of the wilderness. There are no perennial streams. Trail Lake Roadless Area covers roughly 2,000 acres, sparesely forested, on the east flank of the lava plateau of the wilderness. The northernmost boundary between the roadless area and the wilderness is a 150-ft scarp.

Access to the wilderness and roadless area can be gained at Forest Service trailheads at Cone Lake on the north, Silver Lake on the east, and Hay Meadow on the south. Access from the west is by foot trail from Lassen Volcanic National Park.

The U.S. Geological Survey and the U.S. Bureau of Mines collected the data used for evaluation of mineral resource potential. U.S. Geological Survey field work consisted of geologic mapping and geochemical sampling. Thirty-seven bedrock samples were collected from the wilderness and roadless area for semiquantitative spectrographic analysis of 35 elements. Samples were taken from each of the mapped geologic units. The sampling density of one sample per square mile was inadequate to allow statistical analysis of the date in such a small study area. The chemical analyses (table 1) were compared to backround data for similar rocks outside of the study area in order to identify anomalous values. The U.S. Bureau of Mines conducted field work to assess any mineralization and associated mining activity. None was found.

Geologic mapping by Williams (1932) of Lassen Volcanic National Park covered the area on the western boundary of the wilderness. Macdonald's (1965) geologic map of the Harvey Mountain quadrangle included the area of the wilderness north of latitude 40 30'. These studies with other work by Macdonald (1964), provide a basis for understanding the regional geologic setting and relative ages of the major rock units.

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

### Geology

Caribou Wilderness and Trail Lake Roadless Area lie within the southernmost part of the Cascade Range. The wilderness and roadless area are near the juncture of three major geologic provinces: the Cascade Volcanic province, the Modoc Plateau Volcanic province, and the Sierra Nevada province of metamorphic and plutonic rocks. The volcanic rocks within the wilderness have been assigned to the High Cascade Volcanic Series by Macdonald (1966). These are the post-Miocene rocks that form the crest of the Cascade Range. The oldest rocks of this series are deeply eroded block-faulted lavas east and west of the map area that are assigned a latest Pliocene age by Macdonald (1963, 1964). The lavas of the Caribou Wilderness and Trail Lake Roadless

Area (fig. 3) are less deeply eroded and less pervasively block faulted and are probably Pleistocene to Holocene in age.

The oldest unit in the map area is a light-medium-gray porphyritic basaltic andesite--a major unit in the wilderness and the only unit in the roadless area. It is a composite unit which includes flows from numerous vents erupted over a fairly long period of time. A major-element chemical analysis of samples from the unit is presented in table 2. The unit is mostly flows, with subordinate cinders. The most prominent vents within the wilderness, Black Cinder Rock, North Caribou, and South Caribou, are characterized by the presence of oxidized gray and red cinders. Many flows show crescentic flow ridges. The unit is clearly Pleistocene in age (Macdonald, 1963, 1964) and has been glaciated; rocks topping ridges on the east and west boundaries of the wilderness and commonly striated. Small moraines in the broad central valley of the wilderness contain cobbles of flow rocks of the unit. In the northern part of the wilderness, flows of this unit underlie the fresh, blocky, unstriated Holocene basalt of Black Butte. Roughly north-trending vertical faults cut the basaltic andesite unit. In outcrop, the basaltic andesite is light medium gray, locally rose gray or brownish gray. Phenocryst phases may include olivine, plagioclase, clinopyroxene, and rarely hypersthene. Olivine grains (1-3 perecent) as much as 0.1-in. in length are the only phenocryst phases in some flows; most commonly the medium-gray rock is spotted with 5 percent small phenocrysts of olivine. Plagioclase phenocrysts (1-15 percent) as much as 0.4 in. in length are found in many flows. Locally the flows have glomeroporphyritic clots as much as a half inch in diameter. The texture of the rock in thin sections is seriate. Phenocrysts and laths of plagioclase define flow foliation. Plagioclase in the olivine+plagioclase phyric rocks is bytownite and calcic labradorite; plagioclase in the olivine +plagioclase+clinopyroxene phyric rocks is labradorite. Subhedral to anhedral clinopyroxene phenocrysts, as much as 0.4 in. long, are 1-5 percent of the rock. The groundmass of flows varies from intergranular to slightly intersertal. Light-brown glass does not exceed 10 percent; mafic grains are commonly too fine to identify. Equant fine grains of magnetite are present in all samples. Knobs at the head of a few flows, possibly plugs, have the phenocryst assemblage plagioclase (labradorite)+olivine+hypersthene. Olivine in these rocks has coronas of magnetite and pyroxene. These rocks offer a sharp contrast to the olivine+plagioclase+clinopyroxene rocks of the unit which are found at the toes of the same flows.

Lavas erupted from Red Cinder overlie the basaltic andesite. The basalt of Red Cinder is medium dark gray and sparsely porphyritic and glomeroporphyritic. Phenocrysts are plagioclase, orthopyroxene, and rare clinopyroxene. Flows are commonly platey and vesicular. Flows are distinguished from flows of basaltic andesite by the generally darker color, greater number of glomeroporphyritic clots, and more platey jointing of the flows of the basalt of Red Cinder. In thin section, the basalt of Red Cinder is distinctly different from the basaltic andesite. The texture is porphyritic, rather than seriate. Phenocrysts may comprise up to 15 percent of the rock and include plagioclase (5-10 percent), hypersthene (2-7 percent), and rare clinopyroxene. They do not generally exceed 0.2 in. in long dimension. Euhedral plagioclase grains are labradorite and have faint normal zoning. Hypersthene phenocrysts are generally finer in size than plagioclase, euhedral, and commonly occur in clots. Grains of hypersthene may occur as inclusions in the coarest plagioclase phenocrysts. Rare phenocrysts of clinopyroxene (less than

1 percent) are euhedral, may be as much as 0.4 in. long, and may occur in clots or may rim hypersthene. The groundmass is intersertal. Glass is light brown and crowded with microlites of plagioclase and magnetite. Glacial striations are common on bedrock surfaces, and the unit is cut by vertical north-trending faults.

Rocks mapped as the basaltic andesite and basalt of Red Cinder on the west edge of the wilderness were mapped as Eastern basalt by Williams (1932). As described, however, the Eastern basalts are pale-gray massive or dark-gray-black vesicular basalts with abundant augite phenocrysts. As neither the basaltic andesite nor the basalt of Red Cinder have abundant augite phenocrysts, neither fit the description of Eastern basalts. Macdonald includes the basalts of Red Cinder and rocks between Red Cinder and Black Butte in his basalt unit and includes rocks in the eastern part of the wilderness and in the roadless area in the Eastern basalts unit. As described both of Macdonald's units are olivine-phyric. The basalt of Red Cinder, lacking olivine, can not be assigned to either of those units. The description given for both the basalt and Eastern basalt units of Macdonald could be applied to the basaltic andesite unit of this study. Contacts mapped by Macdonald between basalt and Eastern basalt were not distinguishable in the course of field work for this study. The basaltic andesite of this study is probably about the same age as the basalt and Eastern basalt units of Macdonald: early Pleistocene. No stratigraphic relations between the basaltic andesite of this study and older rocks were recognized in the wilderness and roadless area; it is difficult to suggest a more specific stratigraphic position for the basaltic andesite unit.

A series of steep talus-sided flat-topped buttes from 1/3 to 1/2 mi in diameter and up to 300 ft high are found in the central valley of the wilderness. They were erupted along a roughly north-trending line that is parallel to the vertical faults which cut the basaltic andesite unit. These buttes are composed of glassy olivine basalt and apparently overlie the basaltic andesite and basalts of Red Cinder. Jointing perpendicular to the margin of the buttes is found in outcrop at the top of the talus slopes. The basalt is dark gray and sparsely porphyritic, with occasional phenocrysts of plagioclase and equant honey-colored to light-green olivine. Phenocrysts are 0.4 in. long and comprise as much as 5 percent of the rock. The rock is finely vesicular and has a dull glassy luster in hand specimen. Two of the southern buttes are capped by a medium-gray to purple aphanitic flow rock which is similar in mineralogy and texture to the underlying buttes but is more fully crystallized. In thin section, euhedral phenocrysts of plagioclase (30-40 percent), olivine (2-12 perecent), and augite (1-5 percent) are in a hyalopilitic-intersertal groundmass of brown glass with microlites of labradorite and magnetite. Plagioclase phenocrysts have labradorite cores and andesine rims. Some portions of the unit display very good flow foliation.

Similar flat-topped, steep-sided basaltic volcanoes (tuyas) have been described in Iceland and British Columbia (Mathews, 1947). Mathews found the lack of lateral extent of the basalt flows capping the tuyas (in the absence of evidence of much erosion) and the presence of fragmental material at their base characteristics suggestive of subglacial eruption. Fragmental material is not exposed at the base of the flat-topped buttes of the Caribou Wilderness; such deposits may be obscured by talus, if they exist. However, the general shape, limited lateral extent, glassy texture, and jointing perpen-

dicular to the margins of the buttes are strongly suggestive of subglacial origin.

The glacial deposits in the central valley of the Wilderness consist of a thin veneer of ground moraine that is locally overlain by lacustrine deposits. The ground moraine is forested and has a hummocky surface relief; lacustrine deposits are flat grasslands that show varying degrees of encroachment by forest vegetation. Kane (1982) has identified the ground moraine of the wilderness as middle Tioga (late Wisconsin) in age and infers that the central plateau was covered with a thin ice sheet that radiated from a divide located between Red Cinder and a peak 1 mi west of Black Cinder Rock. Much of the Caribou Wilderness and Trail Lake Roadless Area is exposed glaciated bedrock. Glacial striations are common on outcrops of the basaltic andesite and basalts of Red Cinder. The orientation of these striations indicates that Red Cinder, as well as the divide Kane (1982) inferred just to the south and west, was a local high from which ice radiated.

Several flows--the basalt of Black Butte--emanate from Black Butte, a prominent cinder cone on the northern boundary of the wilderness. Blocky, 6 to 30 ft thick, and poorly vegetated, they rest on glacially striated flows of the basaltic andesite and are the youngest flows in the wilderness. The Black Butte flows are commonly coarsely vesicular and are reddish-gray at flow surfaces, where cinders may be abundant. The basalts are dark gray to grayish black, vesicular, and porphyritic. Phenocrysts of euhedral olivine (2 percent) generally 0.1 in. in diameter, sit in an intersertal to intergranular grounmass of euhedral laths of plagioclase (labradorite, 4 percent) and dark-brown glass (57 percent), which is clouded with very fine grains of magnetite, and grains of birefringent minerals too small to identify (1 percent).

## Geochemistry

Examination of chemical analyses of the 37 rock specimens collected revealed no significant geochemical anomalies. No zones of alteration possibly associated with mineralization were observed in the field. A summary of the average values, range of values and most common value determined for 35 elements by semiquantitative spectrographic analysis is presented for each unit in table 1. Values within units were generally consistent. Values from unit to unit are consistent for all but a few elements: nickel and chromium are lower in the basalt of the buttes and barium slightly higher in the basalt of Red Cinder than all other averages.

One zone of alteration was found in the basaltic andesite unit. Blobs and lenses of dark-green-brown basaltic andesite were found in a matrix of orange-red basaltic andesite 3/4 mi north-northwest of Black Cinder Rock. The blobs and lenses make up as much as 30-50 percent of the rock flow in two areas approximately 7 ft high and 10 ft wide at the base of a bedrock knob. The lenses are aligned with long axes parallel in a roughly vertical plane. In thin section, the altered blobs and lenses show the same original texture as the surrounding flow rock. The altered patched may be the result of gas streaming along joints during the crystallization of the flow. Alternatively, they may be cognate inclusions. Whole-rock major element analyses of the altered and unaltered basaltic andesite are given in table 2; there seems to have been little or no chemical alteration.

## Geophysics

An aeromagnetic survey was made of the wilderness. The anomaly patterns reflect the distribution of the volcanic units and topographic relief. Aeromagnetic highs are coincident with major peaks in the area: Red Cinder, Black Cinder Rock, North Caribou, South Caribou, and Black Butte. None of the anomalies or anomaly patterns are suggestive of the existence of subsurface deposits of massive metallic minerals.

## MINING DISTRICTS AND MINERALIZATION

No mining claims have been located, and no mines or prospects are known within the study area. Metallic minerals nearest the study area include gold found in the Diamond Mountain district, 25 mi to the southeast in Mesozoic granitic rocks. Gold, in Miocene rhyolitic tuffs, was mined at Hayden Hill, 36 mi to the northeast. Mines in the Plumas copper belt, 27 mi southeast of the study area, produced more than 160 million pounds of copper before 1930 (Smith, 1970, p. 8). Host rocks for these deposits are older than rocks of the Caribou Wilderness. In Lassen Volcanic National Park, the Supan Sulphur Works, 15 mi west of the wilderness, produced a small amount of sulfur before 1900 (Lydon, 1957, p. 616). Sulfur was deposited from hot gasses or water released at the earth's surface.

The Caribou Wilderness is considered to have potential for geothermal resources (U.S. Geological Survey, 1978). The wilderness is 1 mi northeast of the Morgan Springs Known Geothernmal Resource Area (KGRA) that adjoins the south side of Lassen Volcanic National Park. More than 100 hot springs are 7 to 15 mi west of the area (Waring, 1968, p. 20-21).

Volcanic cinders have been mined from at least 14 sites within 10 mi of the wilderness. Most were used as road-building material, railroad ballast, or as lightweight aggregate in concrete. Several million cubic yards of good quality cinders are available within the wilderness at Black Butte, Red Cinder, and other smaller cones. These potential sources of cinders will not be required to satisfy local demand in the forseeable future.

Large volumes of basalt and andesite within the study area are potential sources of stone for construction uses. Quarries throughout the region have yielded undetermined quantities of stone, mostly used for road building. Stone sources outside the wilderness are sufficient to meet future needs.

## ASSESSMENT OF MINERAL AND GEOTHERMAL RESOURCE POTENTIAL

Geologic mapping, geochemical sampling, and aeromagnetic surveys by the U.S. Geological Survey and field assessment by the U.S. Bureau of Mines have found no evidence of a potential for metallic mineral resources in the Caribou Wilderness and Trail Lake Roadless Area. Metallic mineral resources were not found exposed on the surface or indicated by geochemical and geophysical surveys. Cinders, suitable, for road metal, are locally abundant but inaccessible relative to more plentiful deposits outside of the wilderness. Hot springs, mineral sublimates from fumaroles, or other surface features indicating geothermal resource potential were not found. Close proximity to the known geothermal resources in the vicinity of Lassen Volcanic National Park

makes drilling necessary for complete assessment of the geothermal resource potential of Caribou Wilderness and Trail Lake Roadless Area.

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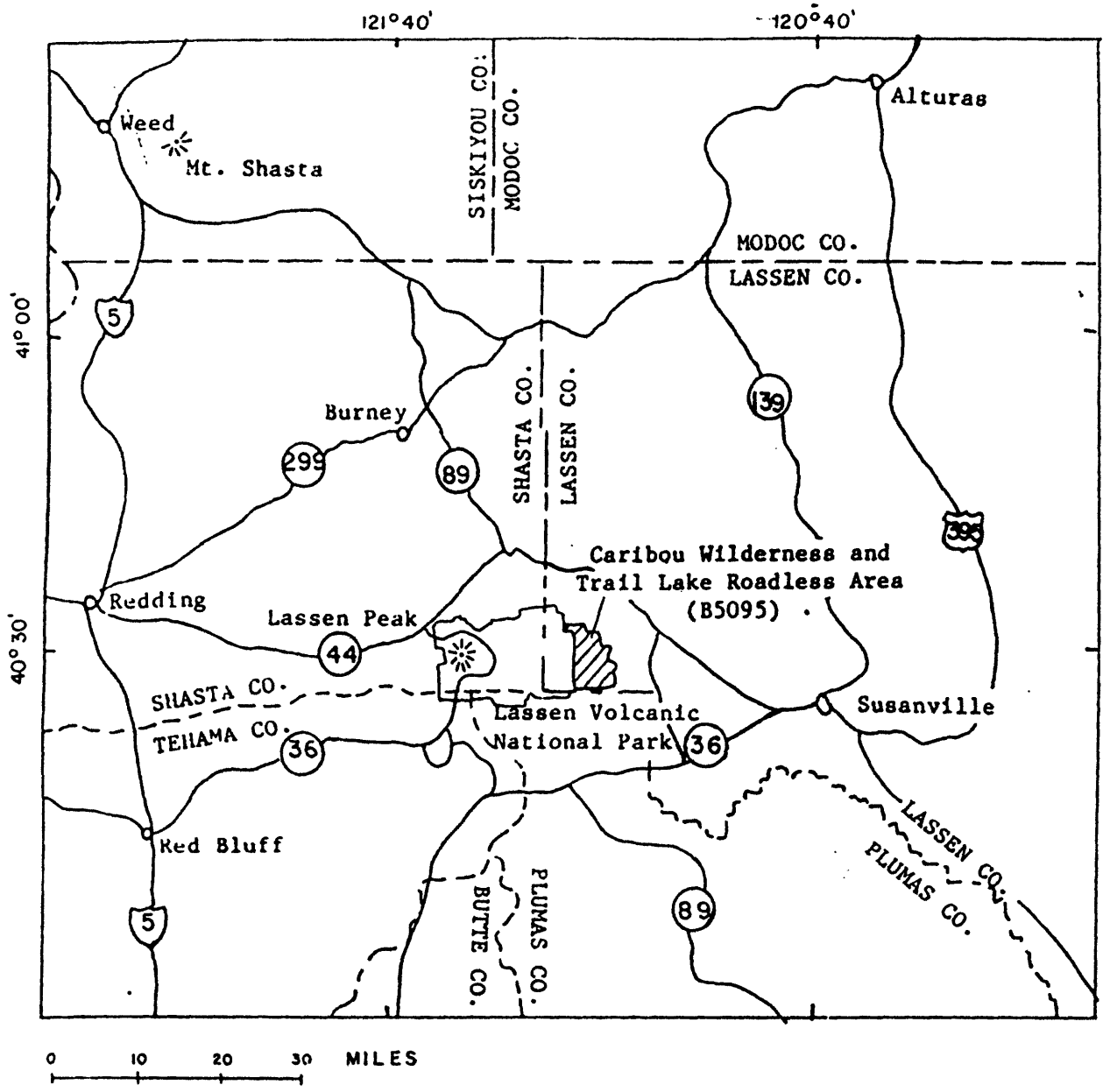




Figure 1 Location of Caribou Wilderness and Trail Lake Roadless Area, Calif.

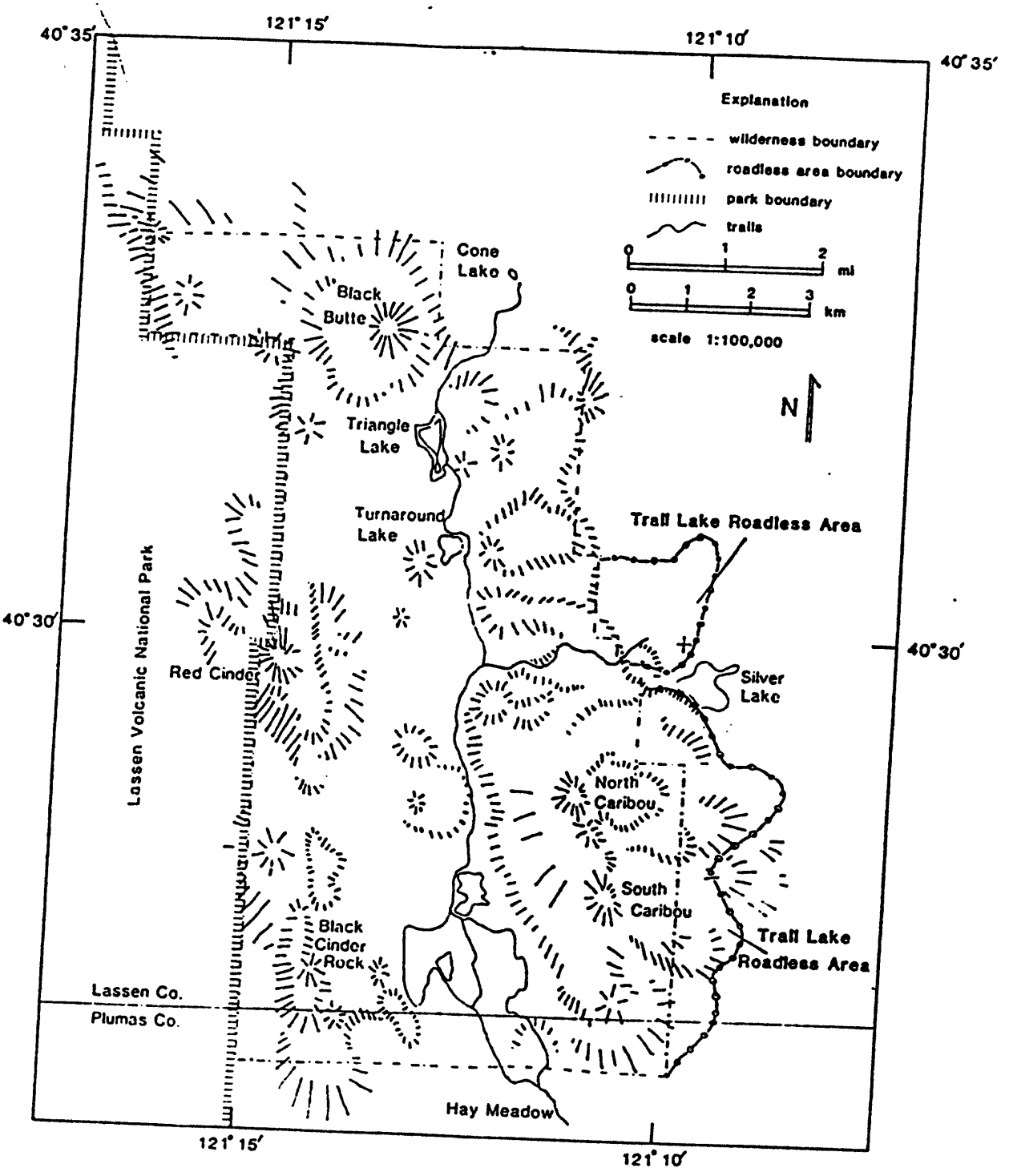
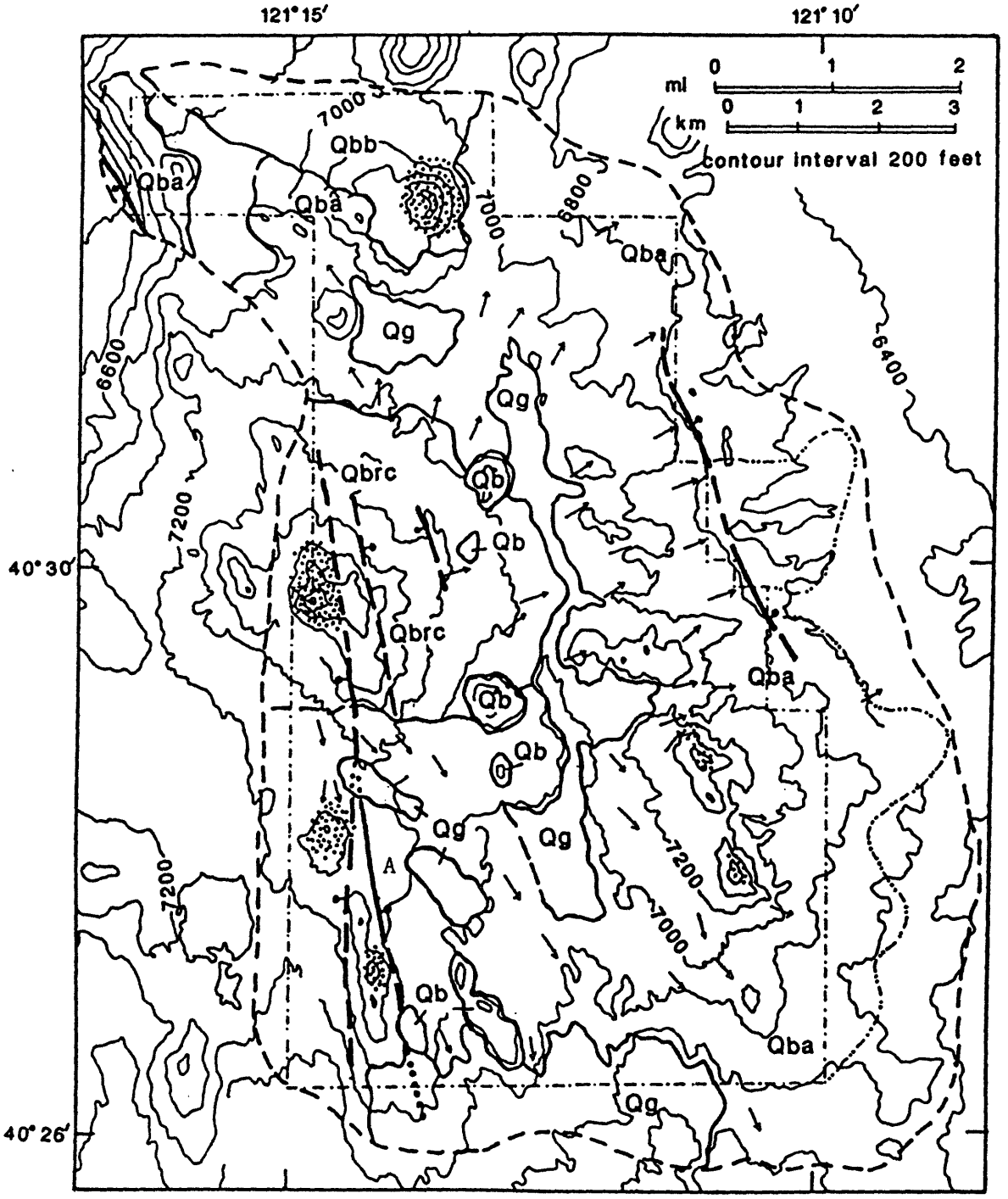



Figure 2 Geographic features of Caribou Wilderness and Trail Lake Roadless Area, Lassen National Forest, California




Base from U.S.Geological Survey Prospect Peak, 1957; Chester, Harvey Mountain, Mount Harkness, 1956; 1:62,500

Geology from Macdonald (1964, 1965); mapping by A.B. Till, K.D. Schafer, 1979

Figure 3 Geologic map of Caribou Wilderness and Trail Lake Roadless Area. Letter A indicates sample locality for Table 2.

## DESCRIPTION OF MAP UNITS

| | |
|---|---|
| Qbb | BASALT OF BLACK BUTTE (HOLOCENE) |
| Qg | GLACIAL DEPOSITS (PLEISTOCENE) |
| Qb | BASALT OF THE BUTTES (PLEISTOCENE) |
| Qbrc | BASALT OF RED CINDER (PLEISTOCENE) |
| Qba | BASALTIC ANDESITE (PLEISTOCENE) |
|  | CONTACT--Dashed where approximately located |
|  | FAULT--Dashed where inferred; dotted where buried; ball and bar on downthrown side |
|  | CINDERS |
|  | GLACIAL STRIATIONS--Arrow indicates probable direction of ice movement |
|  | BOUNDARY OF WILDERNESS |
|  | BOUNDARY OF ROADLESS AREA |
|  | BOUNDARY OF GEOLOGIC MAPPING |

## CORRELATION OF MAP UNITS

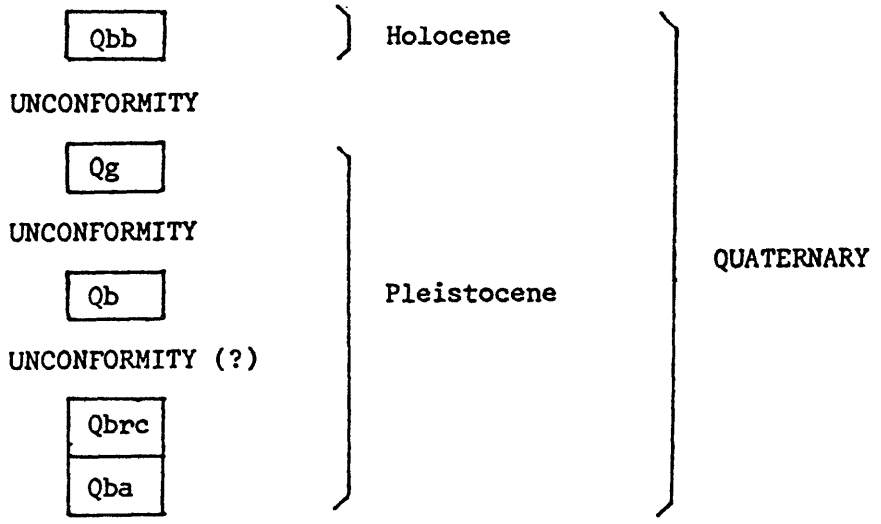



Figure 3, continued

Table 1.--Semiquantitative spectrographic analysis on rock samples, Caribou Wilderness and Trail Lake Roadless Area

[Range, average, and most common value given for each mapped geologic unit; L, element detected, but below detection limit; NA, averages not made since some values are 0 or L. Number of samples per unit given in parentheses after unit name. Analyses by E. A. Mosier, U.S. Geological Survey, and Specomp Services, Inc., Hayden, Colo.]

| | Qba(28) | | | Qbrc(3) | | | Qb(5) | | | Qbb(1) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Average | Most common value(s) | Range | Average | Most common value(s) | Range | Average | Most common value(s) | (Single analysis) | Detection limit |
| | | | | | | weight percent | | | | | |
| Al | 3-7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 3 | 0.5 |
| Ti | 0.2-0.7 | 0.4 | 0.3 | 0.2-0.5 | 0.3 | - | 0.3-0.7 | 0.4 | 0.3 | 0.3 | .002 |
| Ca | 1.5-10 | 4 | 3 | 3-7 | 5 | - | 3-7 | 4.2 | 3 | 3 | .05 |
| Na | 2-5 | 3 | 3 | 2-3 | 2.7 | 3 | 4 | 4 | 4 | 3 | .15 |
| Mg | 1.5-5 | 3 | 3 | 2 | 2 | 2 | 2-3 | 2.8 | 3 | 3 | .02 |
| Fe | 1.5-10 | 7.5 | 7 | 7-10 | 8 | 7 | 7-10 | 7.6 | 7 | 7 | .05 |
| | | | | | | parts per million | | | | | |
| Mn | 500-1,000 | 700 | 700 | 700 | 700 | 700 | 500-700 | 660 | 700 | 700 | 10 |
| Au | - | - | - | - | - | - | - | - | - | - | 10 |
| Ag | 0-7 | NA | 0 | - | - | - | 0-0.5 | NA | 0 | - | .5 |
| Cu | 30-70 | 50 | 50 | 30-50 | 37 | 30 | 20-50 | 32 | 20 | 50 | 5 |
| Pb | L-50 | 15 | 10 | 30-50 | 37 | 30 | 10-20 | 14 | 10 | 20 | 10 |
| Zn | 0-200 | NA | L | - | - | - | 0-L | NA | 0 | L | 200 |
| Mo | - | - | - | - | - | - | - | - | - | - | 5 |
| W | - | - | - | - | - | - | - | - | - | - | 50 |
| Ni | 15-200 | 65 | 30,70 | 70 | 70 | 70 | 7-10 | 7.6 | 7 | 70 | 5 |
| Co | 15-30 | 30 | 30 | 15-30 | 22 | - | 15-30 | 26 | 20,30 | 20 | 5 |
| Cr | 70-500 | 190 | 100 | 200 | 200 | 200 | 10-50 | 26 | 20 | 200 | 10 |
| Cd | - | - | - | - | - | - | - | - | - | - | 20 |
| As | - | - | - | - | - | - | - | - | - | - | 200 |
| Sb | - | - | - | - | - | - | - | - | - | - | 100 |
| V | 30-200 | 150 | 150 | 150 | 150 | 150 | 150 | 134 | 150 | 150 | 10 |
| Bi | - | - | - | - | - | - | - | - | - | - | 10 |
| Sn | - | - | - | - | - | - | - | - | - | - | 10 |
| Zr | 20-200 | 80 | 70 | 100-200 | 130 | 100 | 70-100 | 88 | 100 | 100 | 10 |
| B | L-30 | NA | 10 | 15-20 | 16.7 | 15 | L-10 | NA | 10 | 10 | 10 |
| Ba | 100-700 | 390 | 500 | 700-1,000 | 900 | 1,000 | 500-700 | 540 | 500 | 700 | 10 |
| Be | 0-2 | NA | 1 | 1-2 | 1.7 | 2 | 1-2 | 1 | 1 | 1 | 1 |
| La | 0-50 | NA | 0,20 | 20 | 20 | 20 | 0-20 | NA | 0 | 20 | 20 |
| Nb | - | - | - | - | - | - | - | - | - | - | 20 |
| Sc | 10-30 | 24 | 30 | 15-20 | 18.3 | 20 | 30 | 30 | 30 | 20 | 5 |
| Sr | 300-1,000 | 700 | 700 | 500-700 | 630 | 700 | 700-1,000 | 760 | 700 | 700 | 100 |
| Y | 10-50 | 30 | 30 | 30 | 30 | 30 | 30-50 | 34 | 30 | 30 | 10 |
| Li | - | - | - | - | - | - | - | - | - | - | 100 |
| Th | - | - | - | - | - | - | - | - | - | - | - |
| U | <1-2 | NA | <1 | <1-1 | NA | <1 | - | - | - | - | 100 |

Table 2 -- Rapid-rock analyses of the basaltic andesite unit 0.75 mi north-northeast of Black Cinder Rock. Location of samples shown on figure 3. Number of samples given in parentheses after unit name. Analyst - M. Kremer.

| | Qba (2) | Qba (altered) (2) |
|---|---|---|
| $SiO_2$ | 53.66 | 53.62 |
| $Al_2O_3$ | 17.34 | 16.93 |
| $Fe_2O_3$ | 1.88 | 2.35 |
| FeO | 5.76 | 5.10 |
| MgO | 5.26 | 5.30 |
| CaO | 7.60 | 7.50 |
| $Na_2O$ | 3.91 | 3.78 |
| $K_2O$ | 1.42 | 1.47 |
| $H_2O$ | .33 | .58 |
| $H_2O-$ | .51 | 1.03 |
| $TiO_2$ | 1.09 | 1.10 |
| $P_2O_5$ | .39 | .39 |
| MnO | .13 | .11 |
| $CO_2$ | .06 | .07 |
| Total | 98.34 | 99.33 |