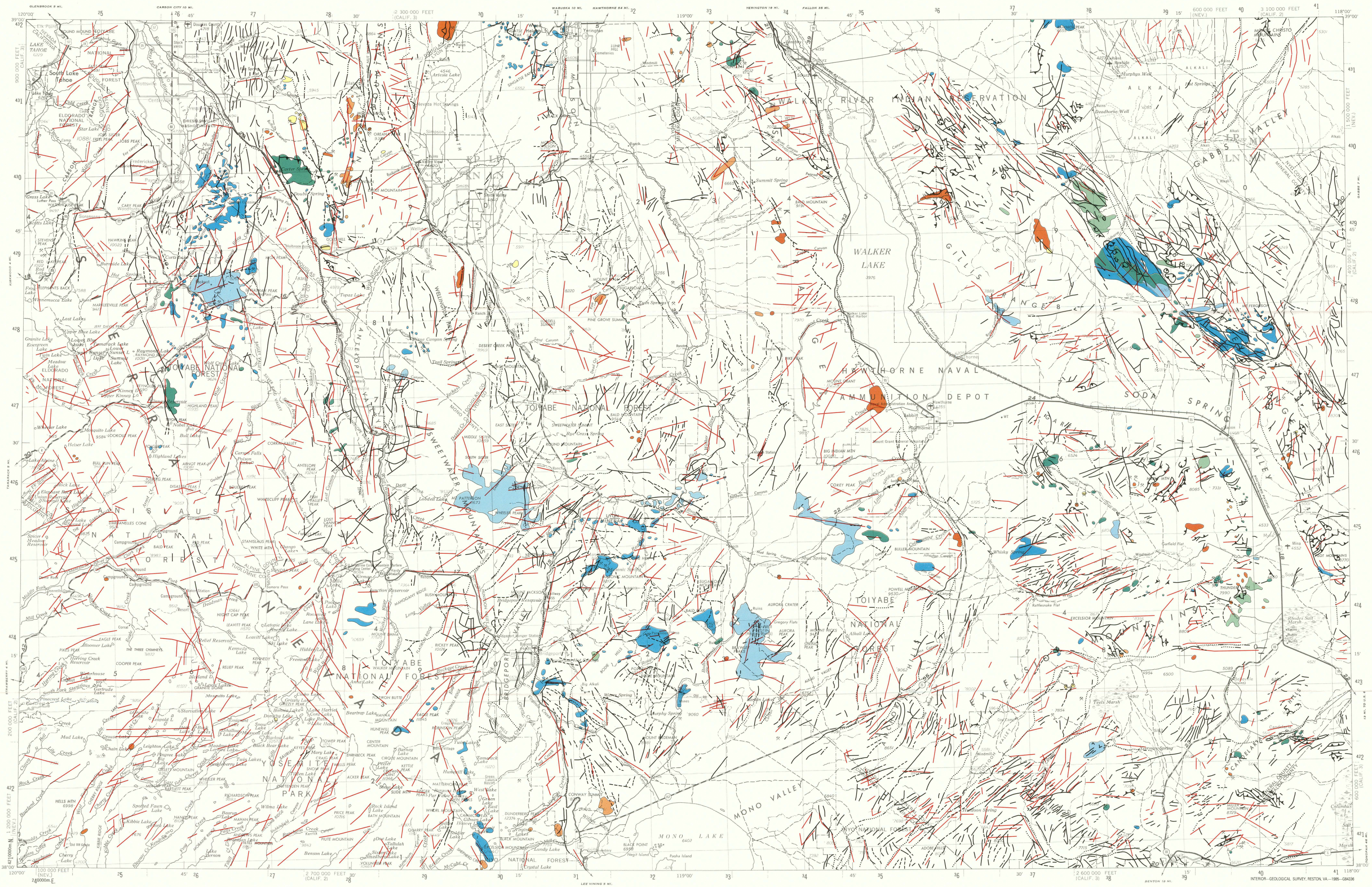

Base from U.S. Geological Survey, 1969
100,000-foot grids based on Nevada coordinate system, west zone, and California coordinate system, zones 3 and 2
10,000-meter Universal Transverse Mercator grid, zone 11

SCALE 1:250 000

DESCRIPTION OF MAP UNITS

- Silicified rock
- Argillized rock
- Silicified and argillized rock, silicified rock dominant
- Argillized and silicified rock, argillized rock dominant
- Skarn deposit
- Altered, miscellaneous
- Altered rocks undifferentiated

EXPLANATION OF MAP SYMBOLS

- Linear features
- Fault
  - Normal
  - Inferred
  - Concealed
  - Thrust—Sawteeth on upper plate

INTRODUCTION

This map shows the distribution of faults, linear features, and hydrothermally altered rocks in the Walker Lake 1° x 2° quadrangle, California and Nevada. Faults were taken directly from the geologic map of the quadrangle (Stewart and others, 1982). Linear features were mapped from digitally enhanced Landsat Multispectral Scanner (MSS) images (Rowan and Purdy, 1984a). The distribution of hydrothermally altered rocks was produced through field evaluation of Landsat MSS images that were digitally processed to enhance the diagnostic spectral reflectance of limonite (Rowan and Purdy, 1984b).

The purpose of this map is to present these data on a single map sheet in order to facilitate evaluation of their relationships. The methods used to map the linear features and hydrothermally altered rocks are described briefly, and the main conclusions of this study are summarized. The reader is referred to the reports of Rowan and Purdy (1984a and b) for a more detailed discussion.

LINEAR FEATURES AND FAULTS

Linear features mapped on Landsat images represent linear or slightly curvilinear topographic features, such as stream valleys, ridges, and escarpments or are tonal anomalies related to linear boundaries in bedrock or between vegetation types. Most of these features probably represent faults or fracture zones that control topography and the distribution of vegetation.

The mapping of regional fracture zones is facilitated by MSS images, because the synoptic coverage that they provide allows spatially related linear features to be traced for large distances. Linear features in the eastern three-fourths of the quadrangle were mapped on black-and-white MSS band 5 and band 7 images that were digitally processed to enhance image contrast. In the western part of the quadrangle, a digitally enhanced color-infrared composite image, using MSS bands 4, 5, and 7, was used because of the importance of the distribution of vegetation for detecting linear features in this area. Linear cultural features were excluded by using information on topographic maps, Skylab photographs, and aerial photographs.

In many parts of the map, faults and linear features correspond closely, particularly in the south-central part of the map about 20 to 30 km east and northeast of Mono Lake where numerous young faults have been mapped (Stewart and others, 1982). However, differences in their distributions are also evident elsewhere. The most conspicuous difference is the much higher density of linear features as compared to the density of faults in areas consisting mainly of crystalline rocks, such as the Sierra Nevada, Wassuk Range, Eagle Mountain, and an area near Pine Grove Summit (fig. 1). In these areas, linear features are dominantly expressions of fracture zones and microfaults that generally are not shown on small-scale geologic maps. In the Sierra Nevada area, the linear features generally trend northeast and northwest, which is consistent with the orientations of microfaults that were mapped on aerial photographs and in the field by Lockwood and Moore (1979).

Faults are more numerous than linear features in several areas, including the Mason Valley, Wellington Hills, southeast of Belleville, Nevada, and east of Gardnerville, Nevada, because the faults have subtle topographic and tonal expressions that were not evident in the MSS images. In the central part of the Gabbs Valley Range, northwest-trending faults of the major Walker Lane right-lateral strike-slip zone are more numerous than linear features with this orientation, because the topographic expression of the faults is suppressed in the images by the nearly parallel orientation of the southeast solar-illumination direction. Thrust faults are not well expressed by linear features owing to their generally non-linear traces, and in some areas range-front normal faults also lack linear traces.

The objective of analyzing the linear features was to identify large fracture zones that may have had some influence on mineralization in the quadrangle. Because of the complexity of the linear features map, the data were analyzed statistically (Rowan and Purdy, 1984a). Eleven major lineaments were identified (fig. 2). A lineament is a "simple or composite linear feature of a surface, whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differ distinctly from the pattern of adjacent features and presumably reflect a subsurface phenomenon" (O'Leary and others, 1976, p. 1467). The Walker Lane, Eagle Creek, Pine Nut Creek, and Aurora-Bodie Hills lineaments are coincident with concentrations of mapped faults whose orientations are generally similar to the orientations of the linear features that make up the lineaments (fig. 2). Although faults are locally present along the other lineaments, these lineaments probably reflect linear zones of fractures that lack conspicuous displacement and hence were not mapped in the field.

HYDROTHERMALLY ALTERED ROCKS

The distribution of hydrothermally altered rocks was determined by an integration of data from Landsat MSS images and from fieldwork. The first step was processing of the MSS data to delineate anomalous exposures of limonite (Rowan and others, 1974; Rowan and Purdy, 1984b), a combination of ferric-iron oxides and hydrous ferric-iron oxides (Blanchard, 1968). Limonite can be used as an indicator of hydrothermal alteration, because it commonly results from oxidation of pyrite associated with many hydrothermally altered rocks. Limonite is detectable in MSS images, because it has diagnostic spectral reflectance in the four MSS spectral channels (0.5–1.1 μm) (Rowan and others, 1974, 1977). Although properly processed color-infrared MSS composite images show highly limonitic areas, color composites of ratio images are more effective for displaying the more subtle spectral reflectance characteristics of weakly to moderately limonitic rocks. Color-ratio composite images minimize brightness variations due to topographic slope and albedo and therefore enhance spectral reflectance variations (Rowan and others, 1974, 1977).

A map of the quadrangle showing the distribution of limonitic bedrock and associated soil was prepared from MSS color-ratio-composite images (Rowan and others, 1980) by mapping all limonitic materials and then deleting alluvial limonitic areas. Extensive field evaluation was needed to distinguish between exposures of limonitic altered rocks and unaltered limonite-rich rocks. Fieldwork also revealed areas of altered rocks that are not limonitic and thus were not detected in the MSS color-ratio composite images. Another limitation of this method is that MSS data cannot be used for mapping limonite in areas where vegetation cover exceeds approximately 35 percent.

In the field, altered rocks were divided into seven broad categories: (1) Silicified rocks—These rocks have undergone extensive cation leaching, commonly resulting in porous fine-grained masses of silica and minor argillic material. Alunite is common, and kaolinite and pyrophyllite may be locally abundant. (2) Argillized rocks—These rocks contain kaolinite and montmorillonite as the dominant minerals, however alunite, sericite, pyrophyllite and quartz may be present. Sericitized rocks are included in this category owing to their limited distribution within the quadrangle. (3) Mixed silicified and argillic alteration with silicified alteration dominant. (4) Mixed argillic and silicified alteration with argillic alteration dominant. (5) Calc-silicate zones and altered rock around skarn deposits. (6) Miscellaneous altered rocks—This category includes hematitically altered rocks and assemblages of chlorite-epidote-quartz (propylitized rocks) and andalusite-cordierite-quartz. (7) Undifferentiated altered areas—This category includes areas where the type of alteration is uncertain, because the areas were only briefly examined in the field.

INTERPRETATION

As figure 3 illustrates, the geographic distribution of altered rocks, particularly when combined with the locations of mines and prospects, indicates the presence of six alteration belts (Rowan and Purdy, 1984b). Most of the alteration belts are marked by lineaments (figs. 2 and 3). The orientations of the alteration belts and of the linear features that constitute the coincident lineaments are generally similar, but in some areas lineaments comprised of features with other trends are present. For example, four lineaments are spatially associated with the Markleeville alteration belt. The Markleeville and Wolf Creek lineaments are made up of generally northeast-oriented linear features, whereas the Pine Nut Creek lineament consists of north-northwest and northwest-trending features (figs. 2 and 3). Also, the Sweetwater Mountains-Garfield Flats lineament, which is present in the southern part of the Markleeville alteration belt, is defined by west-northwest-trending linear features (Rowan and Purdy, 1984a). Only in the Pine Nut Creek lineament are numerous faults of the same general orientation present. Eastward along the major Sweetwater Mountains-Garfield Flats alteration belt, northeast-oriented linear features, as well as faults, are conspicuous, especially where the Eagle Creek and Aurora-Bodie Hills lineaments are present (figs. 2 and 3).

The spatial relationship of the alteration belts with mapped faults and lineaments indicates that the flow of hydrothermal fluids was controlled mainly by fractures. The fracture patterns are complex with more than one trend being present in many areas. Also, in some areas, such as the Walker Lane and Pine Nut Creek lineaments, the linear features are expressions mainly of mapped faults, whereas in others they appear to reflect fractures with little or no displacement. In the latter areas, the use of Landsat images for mapping the linear features is an important complement to conventional field mapping.

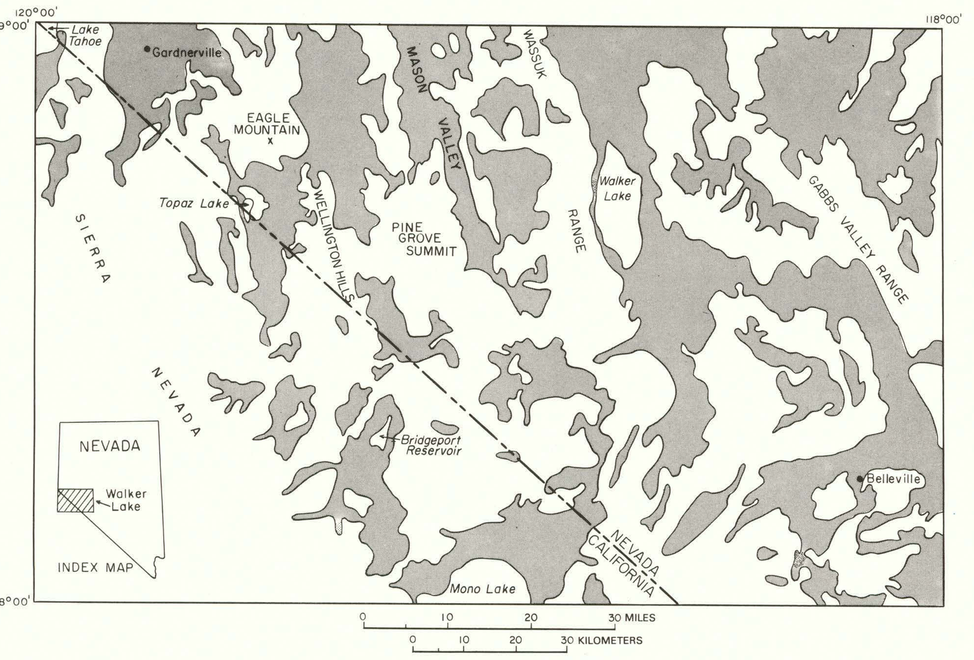

FIGURE 1.—Index map showing the locations of features discussed in the text. The generalized distribution of alluvial deposits is indicated by the stipple pattern.

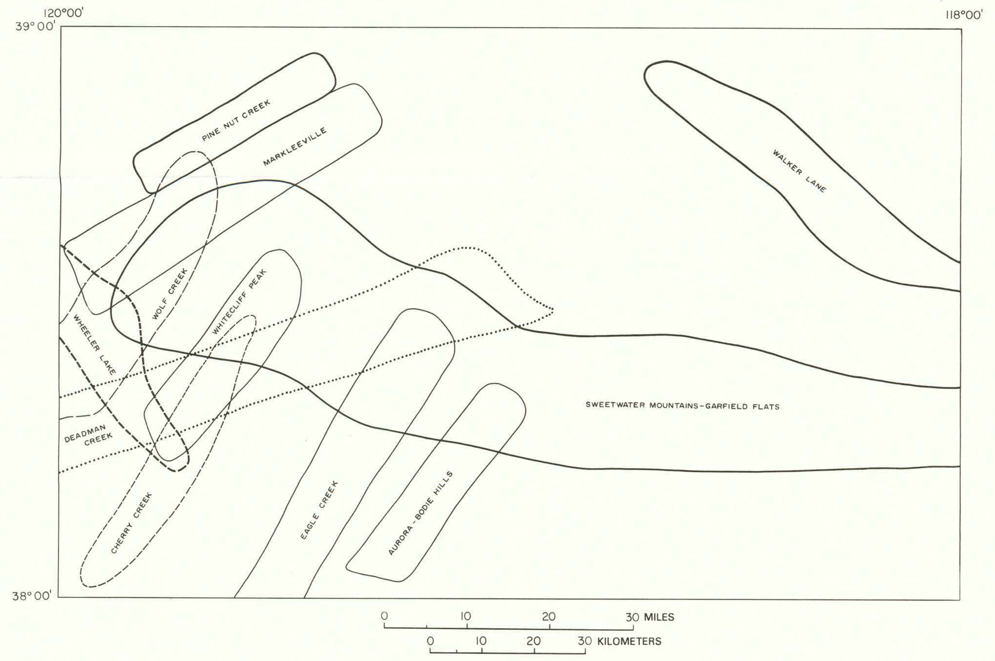

FIGURE 2.—Map showing the location of lineaments in the Walker Lake, Nevada and California 1° x 2° quadrangle.

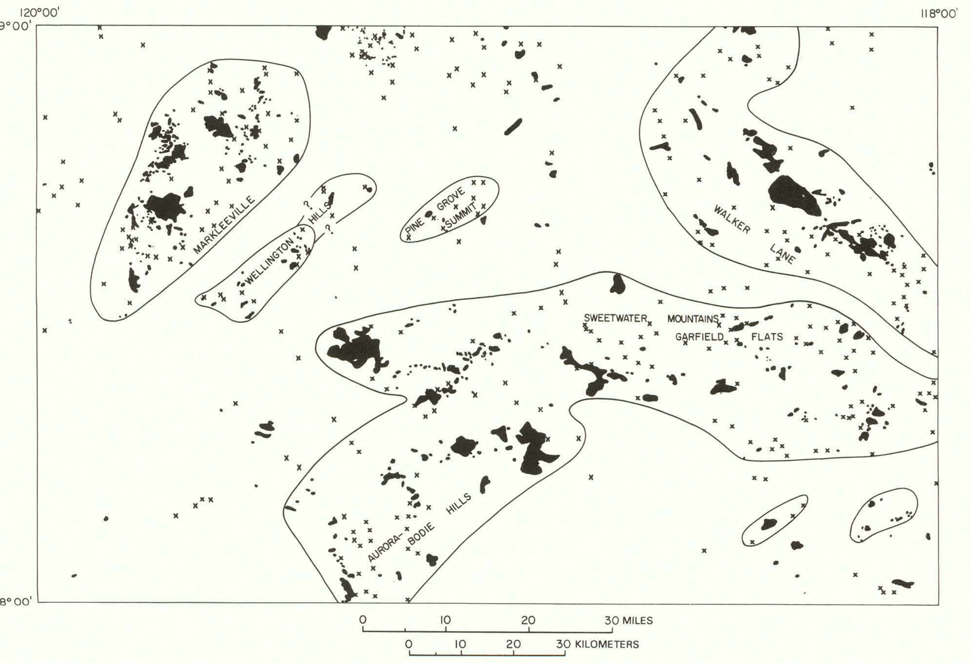

FIGURE 3.—Map showing the distribution of both hydrothermally altered rocks and mines and prospects where altered rocks were not mapped. Belts of hydrothermally altered rocks are delineated by heavy lines. Locations of mines and prospects are indicated by X's.

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MAP SHOWING DISTRIBUTION OF ALTERED ROCKS, FAULTS, AND LINEAR FEATURES IN THE WALKER LAKE 1° X 2° QUADRANGLE, NEVADA AND CALIFORNIA

By
Terri L. Purdy and Lawrence C. Rowan

1985

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