GEOLOGICAL SURVEY CIRCULAR 589

Distribution of Gold, Silver and Other Metals Near Gold Acres and Tenabo Lander County, Nevada

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DISTRIBUTION OF GOLD, SILVER, AND OTHER METALS NEAR GOLD ACRES AND TENABO, LANDER COUNTY, NEVADA

By CHESTER T. WRUCKE, THEODORE J. ARMBRUSTMACHER, and THOMAS D. HESSIN

ABSTRACT

Geochemical investigations in a 70-square-mile area on the east flank of the Shoshone Range has resulted in the delineation of two well-defined northwest-trending belts that contain anomalous concentrations of antimony, arsenic, bismuth, cadmium, copper, gold, lead, mercury, molybdenum, silver, tin, tungsten, and zinc. A third poorly defined belt is enriched in a few of these elements. Each belt is 1 to 2 miles wide and 5 to 6 miles long and contains a slightly different suite of metals associated with gold. Strong concentrations of silver occur in the western parts of the two main belts, whereas gold is greatly enriched in the eastern parts, especially around the granodiorite stock at Tenabo and on the flank of a magnetic anomaly thought to represent a buried stock at Gold Acres.

INTRODUCTION

A program of geochemical investigations in a 70-square-mile area on the east flank of the Shoshone Range (fig. 1) was undertaken in 1966 and 1967 to determine the distribution of many metallic elements in the vicinity of the gold-mining camps of Tenabo and Gold Acres. This work was conducted for the Heavy Metals program of the U.S. Geological Survey as part of an investigation of the geochemical, structural, and stratigraphic setting of some of the major gold deposits of north-central Nevada. The area studied is of particular interest because it contains the Gold Acres open-pit mine, which had the greatest production of any gold mine in Nevada during the 1950's.

This report and the accompanying maps in figure 2 summarize information obtained on the concentration and distribution of antimony, arsenic, bismuth, cadmium, copper, gold, lead, mercury, molybdenum, silver, tin, tungsten, and zinc. The maps show that the Tenabo and Gold Acres areas occupy parts of well-defined northwest-trending belts in which many of the elements are concentrated. One result of this study is the observation that an area of anomalous metal concentrations west of Gold Acres was found to contain few prospects although it occurs on the flank of a magnetic anomaly and bleached bedrock is exposed.

Steven P. Gariepy, William R. Jones, Jr., and Michael J. Maxson assisted in the field studies, and Leeland Cress helped prepare the illustrations.

GEOLOGIC SETTING

Exposed bedrock in the area consists principally of two depositional sequences of lower and middle Paleozoic rocks (fig. 1). One of the sequences contains carbonate strata of Silurian(?), Devonian, and Mississippian age, whereas the other sequence consists of siliceous and volcanic rocks of Ordovician, Silurian, and Devonian age. These sequences of contrasting lithologies but of similar ages occur in juxtaposition along the Roberts Mountains thrust—the carbonate sequence forms the lower plate, the siliceous sequence the upper plate. Also present in the area are small intrusive bodies, minor patches of sedimentary rocks, and a few remnants of tuffs and flows, all of Tertiary age. The general geology of much of the area was studied by Gilluly and Gates (1965), who included in their report a brief summary of the economic geology by Ketner. Gilluly and Masursky (1965) have reported on the geology south of lat 40°15′ N.

Intrusive rocks occur in the northern part of the area, in the vicinity of Tenabo and near Gold Acres. Small granodiorite stocks of Ter-

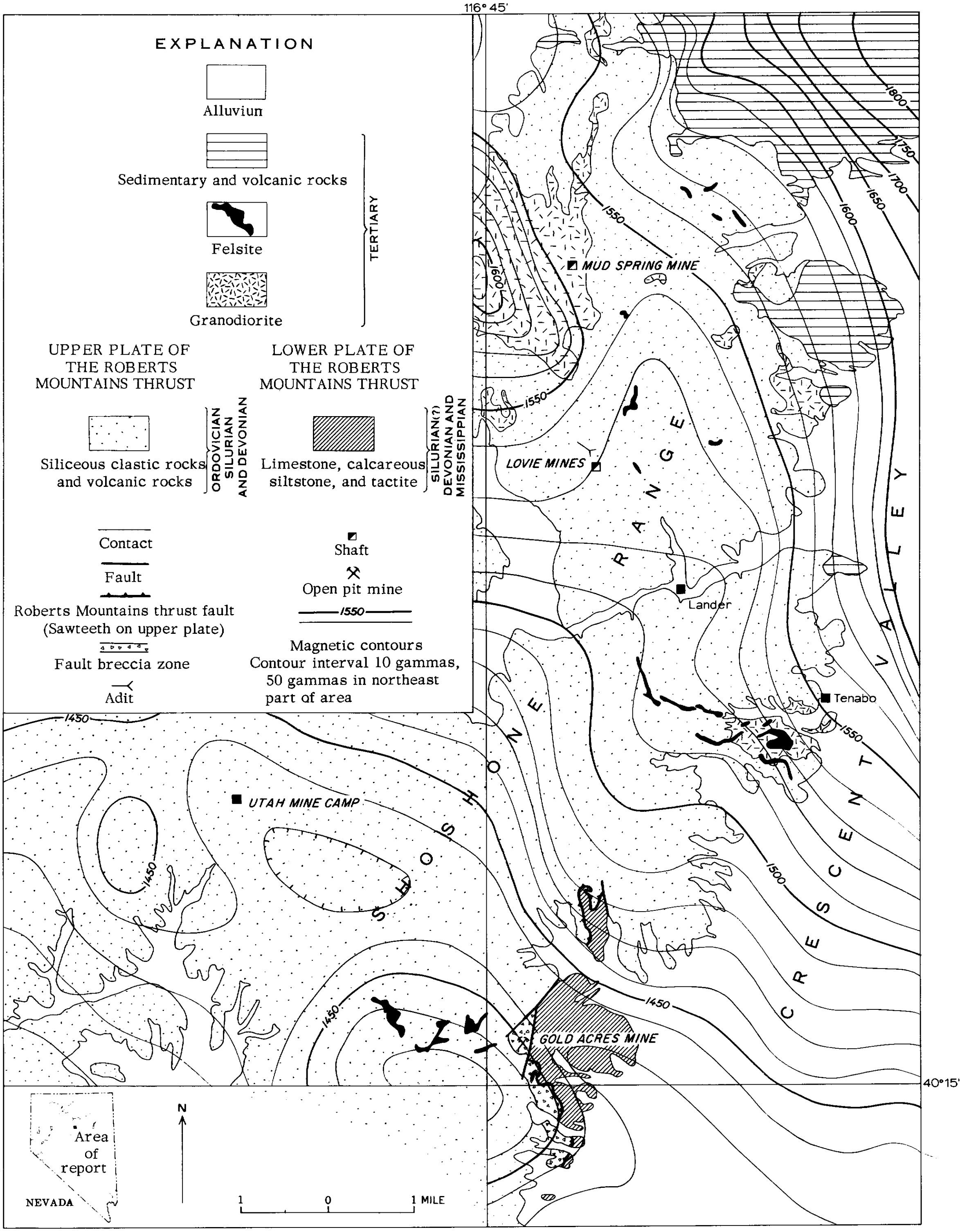

FIGURE 1.—Generalized geologic map and aeromagnetic map of part of the northern Shoshone Range. Geology modified from Gilluly and Gates (1965) and Gilluly and Masursky (1965). Aeromagnetic data from Philbin Meuschke, and McCaslin (1963).

tiary age crop out in the northern part of the area and at Tenabo, and younger felsite dikes crop out in all three places. A magnetic anomaly in the vicinity of Gold Acres and another anomaly centered 1½ miles west-southwest of the Utah mine camp (fig. 1) suggest that concealed stocks may occur in the southern part of the area. Bedrock adjacent to some of the intrusive rocks has been bleached or converted to hornfels, especially in the 1-square-mile area around the felsite dikes west of Gold Acres and around the stock at Tenabo.

The Roberts Mountains thrust and numerous thrusts in the upper plate constitute the dominant structural features of the area. The Roberts Mountains thrust has been recognized in a large part of central and northern Nevada (Roberts and others, 1958; Gilluly and Gates, 1965; and Roberts, 1966). In general, the thrust plates dip westward, but in the vicinity of Tenabo they dip northeast along the flank of a northwest-plunging anticline. Numerous high-angle faults also occur throughout the area shown in figure 1.

Because the position of the Roberts Mountains thrust at depth is difficult to determine from the surface exposures, and because some mineral deposits in north-central Nevada seem to be spatially related either to the structure itself or to bulges on it (Roberts, 1966), the Geological Survey is conducting a drilling program to determine the depth to the thrust along the axis of the anticline in the Tenabo area and to ascertain the stratigraphic and geochemical details of the sections penetrated. The Roberts Mountains thrust was cut at a depth of 3,032 feet in the first drill hole (NE¼ sec. 6, T. 28 N., R. 47 E.), located on Indian Creek near the abandoned townsite of Lander. Tremolitic limestone in the lower plate at this hole has been identified tentatively as the Roberts Mountains Formation of Silurian age; upper-plate rocks belong to the Slaven Chert of Devonian age. A second drill hole (SE¼ sec. 16, T. 28 N., R. 47 E.), situated on the pediment gravels southeast of Tenabo, was abandoned at a depth of 2,046 feet in upper plate rock. Metal values in core from both holes generally are low.

MINERAL DEPOSITS

The principal mineral deposits of the area occur in northwest-trending belts. The southernmost belt includes the Gold Acres open-pit mine and extends from there northwestward to near the Utah mine camp. The middle belt extends from Tenabo northwestward through Lander to the Lovie mines and contains the gold mines at Tenabo and the silver deposits between Lander and Lovie mines. Each of these belts includes gold mines near the mountain front and lead-silver deposits several miles to the northwest; the Tenabo-Lovie belt has an abandoned copper mine near the gold deposits. A vaguely defined northern belt passes through the Mud Spring mine and includes a few scattered gold mines and prospects. Turquoise deposits occur throughout the area. The three mineral belts together constitute part of the Battle Mountain-Eureka mineral belt described by Roberts (1966).

Many of the mineral deposits show a spatial relation to the intrusive rocks or to the magnetic anomalies that may represent buried stocks. This relation is especially striking at Tenabo where the mines occur around the periphery of the granodiorite stocks. Furthermore, most of the large mines at Tenabo lie along the southern border of the stock where Tertiary dike rocks are numerous. In the Gold Acres area, the largest mines also are present along the belt of felsite dikes. The Gold Acres open-pit gold mine (fig. 1) is in the breccia zone of the Roberts Mountains thrust near the east end of the belt of dikes.

CHARACTER OF THE BEDROCK

Chert in greenish-gray to black nodular beds commonly 1 to 4 inches thick, in the upper plate of the Roberts Mountains thrust, is the host rock for the majority of samples collected. Black carbonaceous argillite is interbedded with chert in the Devonian (Slaven Chert) part of the upper-plate section. Other upper-plate host rocks include quartzite, greenstone, and limestone of the Valmy Formation and siltstone of the Elder Sandstone. Most of the upper-plate rocks are contorted and intensely fractured. Lower-plate host rocks consist principally of limestone of the Wenban Limestone but also include limestone and tactite from the

Roberts Mountains(?) Formation and calcareous siltstone of the Pilot Shale.

Most of the granodiorite is fresh, but some of it contains sericitic feldspars and chloritic mafic grains. Conversely, most of the felsite dikes are intensely altered, notably those near Gold Acres. However, a few dikes of relatively unaltered felsite occur in the Tenabo area.

MATERIAL COLLECTED

Most of the 1,875 samples collected for this study consist of oxidized material from veins, fractures, and breccia zones in rock thought to be favorable host material for introduced metals. Typically, this material is rich in brown, yellow, and red iron oxides. Many samples also contain veinlets of quartz and calcite, and a few contain base-metal carbonate minerals and turquoise. The few samples of unoxidized material collected consist mostly of pyrite, chalcopyrite, arsenopyrite, galena, or sphalerite. Some unaltered bedrock was collected to provide data on the background concentrations of elements.

The majority of samples from localities between the mining camps were obtained from outcrops or from float close to outcrops. Within the mining camps, prospect pits and mine dumps provided most of the samples. A few samples were collected underground. Composite samples were collected at most localities.

The density of sample localities varies throughout the area partly because of the uneven distribution of outcrops of suitable material outside the mine areas and partly because of the abundance of man-made exposures at the mine camps. As a result, the density of sample localities is greatest in intensely prospected places, and the maps therefore emphasize the concentration of elements in those places.

ANALYTICAL METHODS

Gold and mercury were determined by atomic-absorption techniques. The other elements were determined by a semiquantitative spectrographic method. Detection limits for the elements were: gold, 0.1 ppm (part per million) for some samples and 0.02 ppm for others; mercury, 0.1 ppm for some samples and 0.01 ppm for others. The upper detection limit for mercury varied from 2.6 to 5.0 ppm. Detection limits for the other elements are the lowest and highest values indicated in the explanations of the geochemical maps (fig. 2).

The analysts for gold were W. L. Campbell, T. G. Ging, Jr., R. F. Hanson, E. E. Martinez, R. L. Miller, M. S. Rickard, T. A. Roemer, T. M. Stein, A. J. Toevs, and G. H. VanSickle; for mercury, R. F. Hanson, S. I. Hoffman, V. D. James, H. D. King, R. L. Marshall, E. E. Martinez, and K. R. Murphy; for the other elements, W. B. Crandell, K. J. Curry, Arnold Farley, Jr., E. L. Mosier, J. M. Motooka, K. C. Watts, and H. W. Worthing.

DISTRIBUTION OF THE ELEMENTS

The geochemical maps in figure 2 show that anomalous concentrations of many elements occur in the three northwest-trending mineral belts, each 1 to 2 miles wide and 5 to 6 miles long (Wrucke and Armbrustmacher, 1967). The general location of these belts appears when mines and prospects are plotted on a map, but the distribution and concentration of the individual elements within the belts would not be evident. In addition to delineating areas of metal enrichment, the maps show that significant geochemical differences exist between the three belts and that different suites of metals are closely associated with gold.

The southern belt, which extends with a clearly marked northwest trend from the mountain front near Gold Acres to the vicinity of the Utah mine camp, is well defined by the distribution of mercury and most of the other elements except gold, molybdenum, and tungsten. A pronounced characteristic of this belt is that gold—and to a lesser extent arsenic, bismuth, and tungsten—occurs mainly at the southeast end, whereas antimony, copper, lead, silver, and tin are more abundant toward the northwest. Arsenic, cadmium, mercury, molybdenum, and zinc occur in various concentrations throughout the belt.

At the southeast end of the belt, gold values diminish abruptly from several parts per million in the Gold Acres open-pit mine to less than 1 ppm immediately to the west. This sharp decrease occurs across a steep fault of north-northeast strike that bounds the west side of the Gold Acres window and drops the Roberts

Mountains thrust down an unknown amount to the west. Only one sample collected from lower-plate rock of the Gold Acres window contained more than 0.5 ppm gold.

Samples from part of the central segment of the southern belt indicate considerable enrichment in bismuth, copper, mercury, and zinc and lesser concentrations of arsenic, lead, silver, and tin; yet, this part contains few prospects. This part of the belt occupies an area of about 1 square mile and is centered 1 mile west of the Gold Acres open-pit mine. The area contains abundant bleached chert and numerous dikes of altered felsite and is on the north flank of the magnetic high (fig. 1) that underlies the Gold Acres area. The Roberts Mountains thrust lies at an unknown depth beneath the enriched area and, in view of the strong concentration of metals along the thrust zone at the east end of the belt, may constitute an exploration target of some interest.

The middle belt extends from Tenabo to the Lovie mines, and perhaps beyond, and is well defined by most of the elements, especially gold, mercury, and silver. These metals and the other elements, except tungsten, are greatly enriched around the granodiorite stock at Tenabo, but strong enrichment of most of the metals extends only a short distance from the stock. Anomalous concentrations of lead, silver, and a few of the other metals also occur in the northwest part of the belt, chiefly between Lander and the Lovie mines. Bismuth is restricted to the immediate vicinity of the stock; cadmium, gold, and molybdenum are generally confined to the same area.

The northern belt of metal enrichment passes through the Mud Spring mine and is poorly defined. Concentrations of gold, lead, and silver suggest the existence of the belt, but significant concentrations of other elements occur only at scattered localities.

Gold, the principal metal produced in the area of this study, forms strong geochemical anomalies in the vicinity of Gold Acres and Tenabo. Comparison of these areas shows that at Gold Acres elements strongly concentrated throughout the area of greatest gold enrichment include arsenic, cadmium, mercury, tungsten, and zinc, whereas at Tenabo gold is associated with all the metals studied except tungsten.

The geochemical association of gold with antimony, arsenic, mercury, and tungsten has been recognized at several localities in north-central Nevada, including Bootstrap, Carlin, Cortez, Getchell, and Gold Acres (Erickson and others, 1966). The present study reveals that this association exists at both Tenabo and Gold Acres, though at Gold Acres antimony is only weakly concentrated and at Tenabo tungsten occurs only at a few localities. A. S. Radtke (written commun., 1968) suggests that tungsten is not appreciably concentrated in gold ore at Carlin.

The area of this study probably does not completely include any of the enriched belts. The southern and middle belts may extend at least a short distance southeast of the mountain front under the gravels, because each belt contains high metal concentrations adjacent to the valley fill. Almost certainly the western end of the southern belt lies within the area, but the middle and northern belts probably merge a few miles west of the area and extend westward across the range along a single narrow zone of mineral deposits.

INTERPRETATIONS

Each enriched belt follows the string of intrusive bodies associated with the mineral deposits of the area, and it seems likely that concealed igneous rocks underlie much of all three belts. Only the middle belt coincides with a zone of steep faults and the axis of an anticline. Detailed mapping might reveal that the northern and southern belts also contain faults that strike northwest, but well-defined zones of steep faults along these belts probably do not exist. The enriched zones seem to be spatially related to the intrusive bodies, which may have provided structural control for upward migration of the enriching solutions.

The enriched zones may represent leakage upward from mineral deposits along or beneath the Roberts Mountains thrust. Erickson, Masursky, Marranzino, and Oda (1961) advanced a similar speculation as a possible explanation for the concentration of metals in upper-plate rock near Cortez, Nev. Certainly, strong concentrations of elements occur along the breccia zone of the Roberts Mountains thrust at the Gold Acres open-pit mine—by far the most productive mine in the area of this study. Reasonable places to test the leakage concept may be the areas of high metal concentration around the stock at Tenabo and the strongly enriched areas in the southern belt, for the thrust zone or the Roberts Mountains Formation below the thrust in these areas could be favorable environments for metallization. Moreover, the restriction of strong concentrations of gold to the periphery of the stock at Tenabo and to the flank of the magnetic anomaly at Gold Acres suggests that any concealed gold deposits would probably be close to intrusive bodies.

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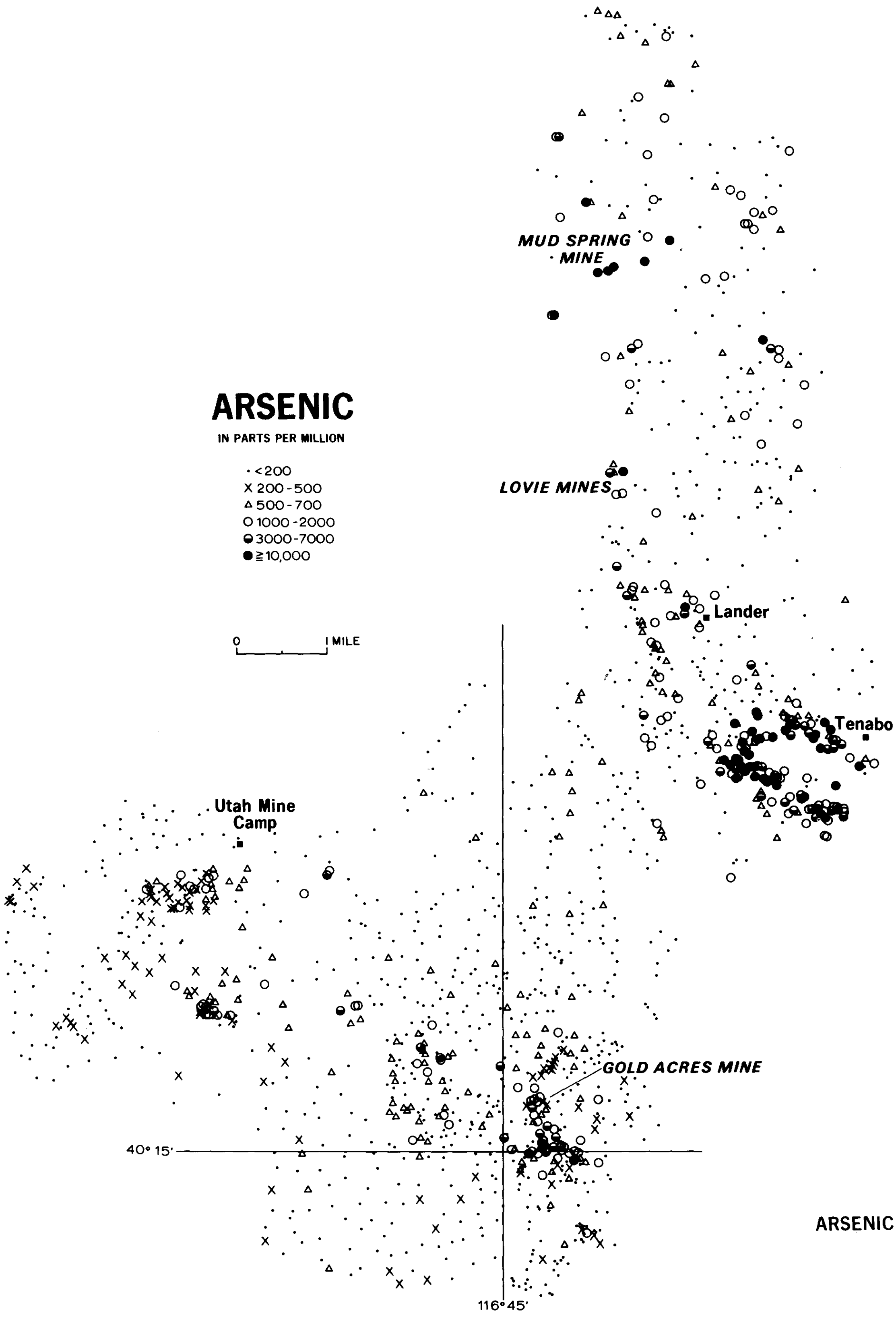
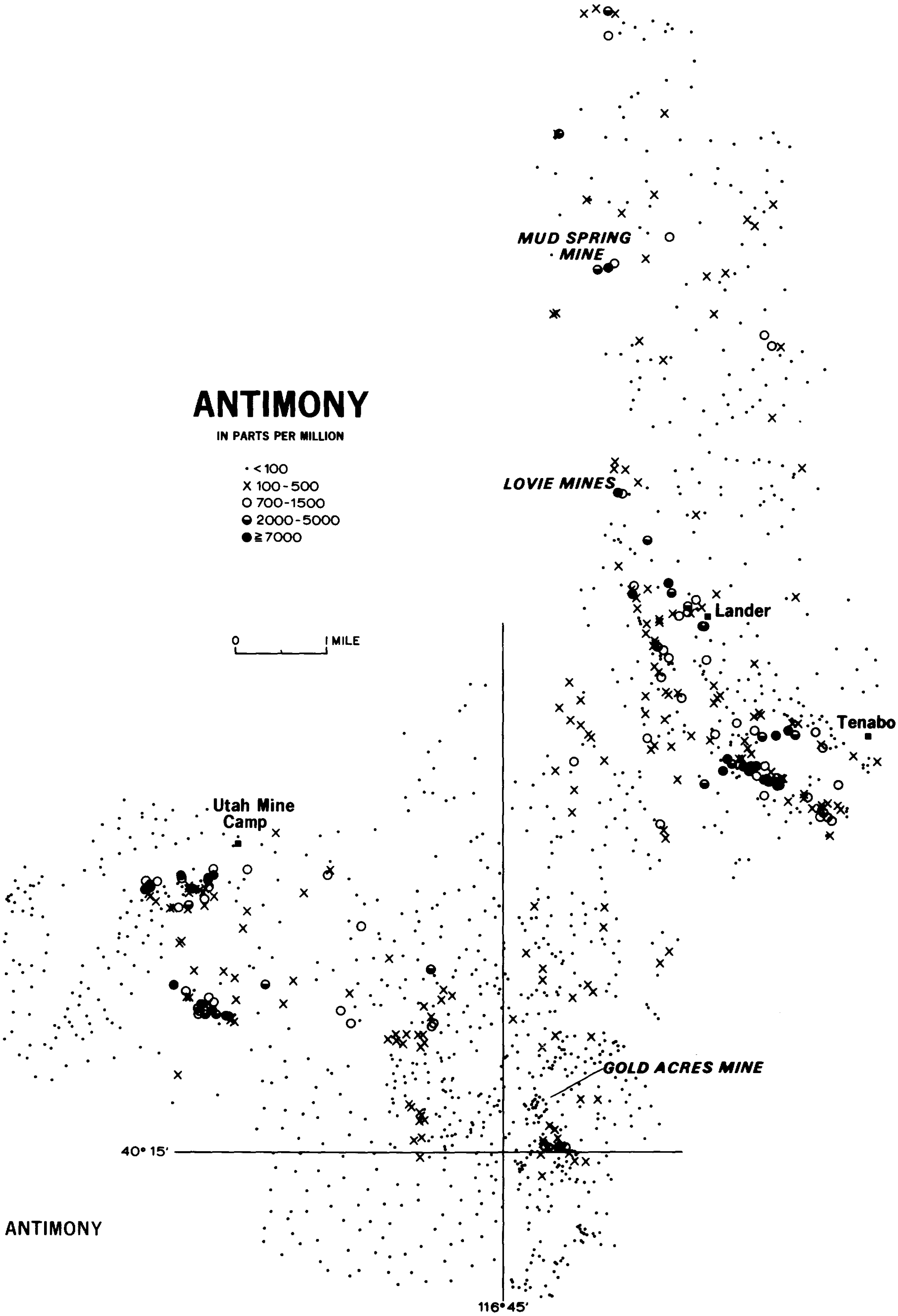


FIGURE 2.—Distribution of elements in part of the Shoshone Range. Samples collected from veins and fractures.



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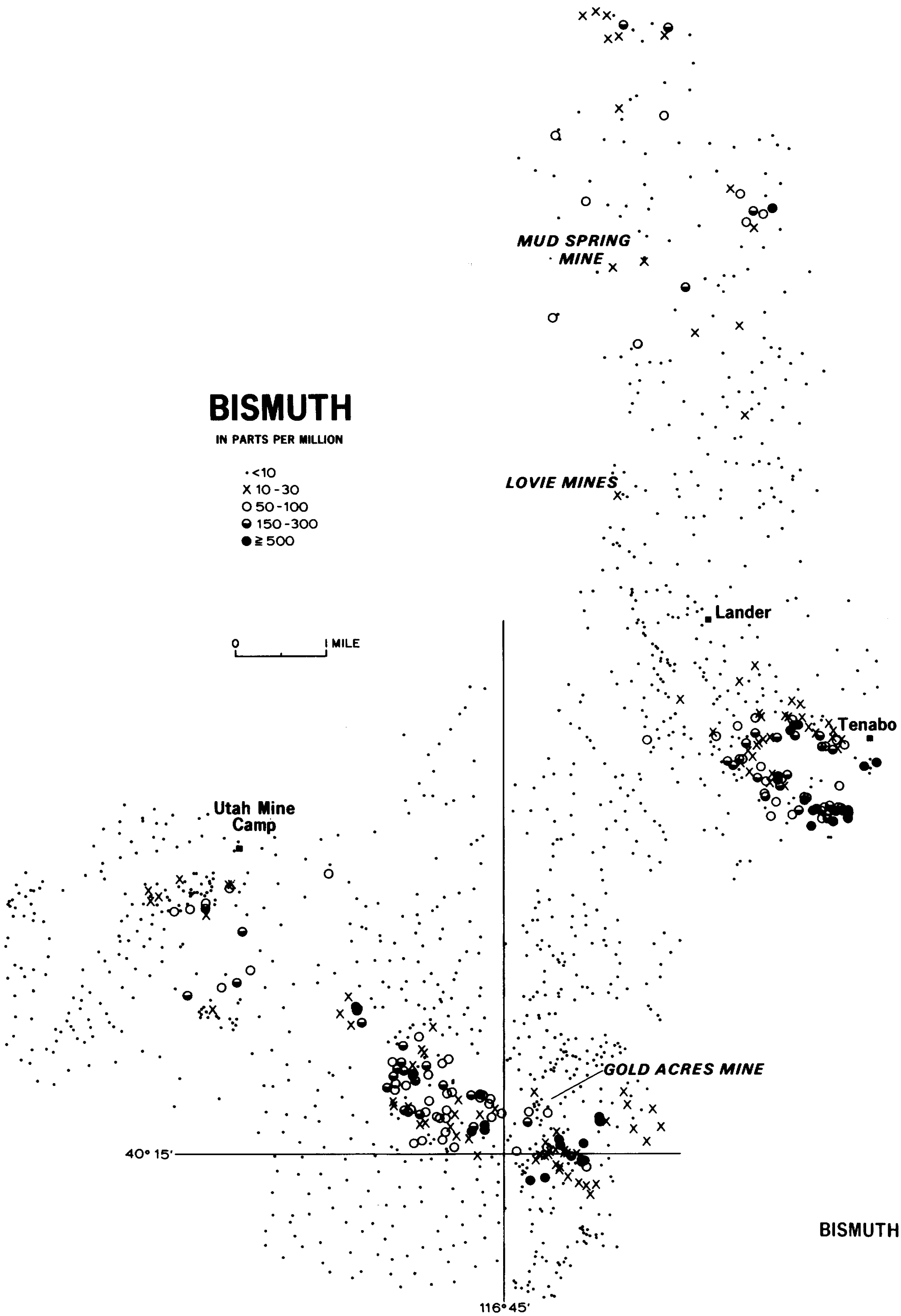

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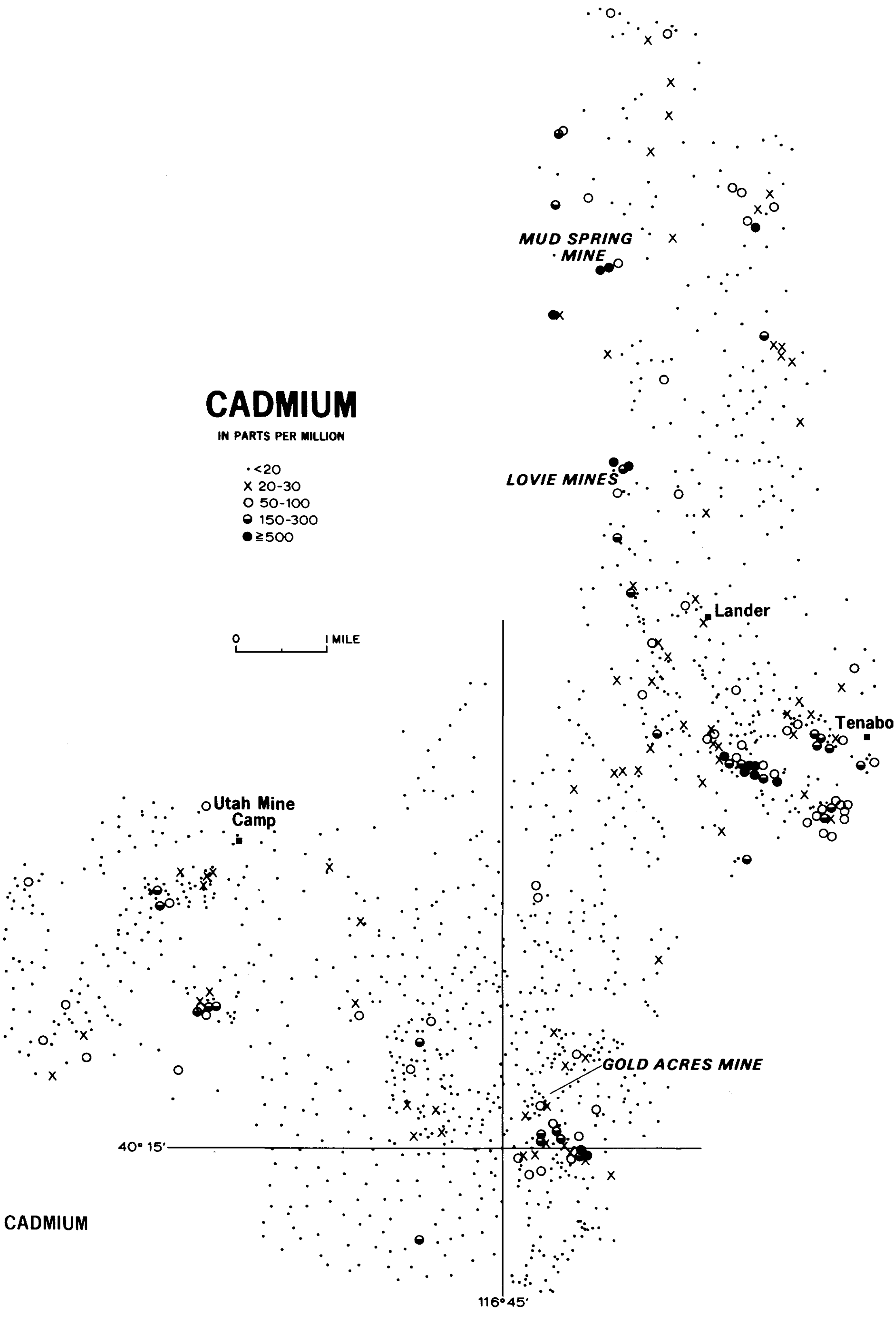

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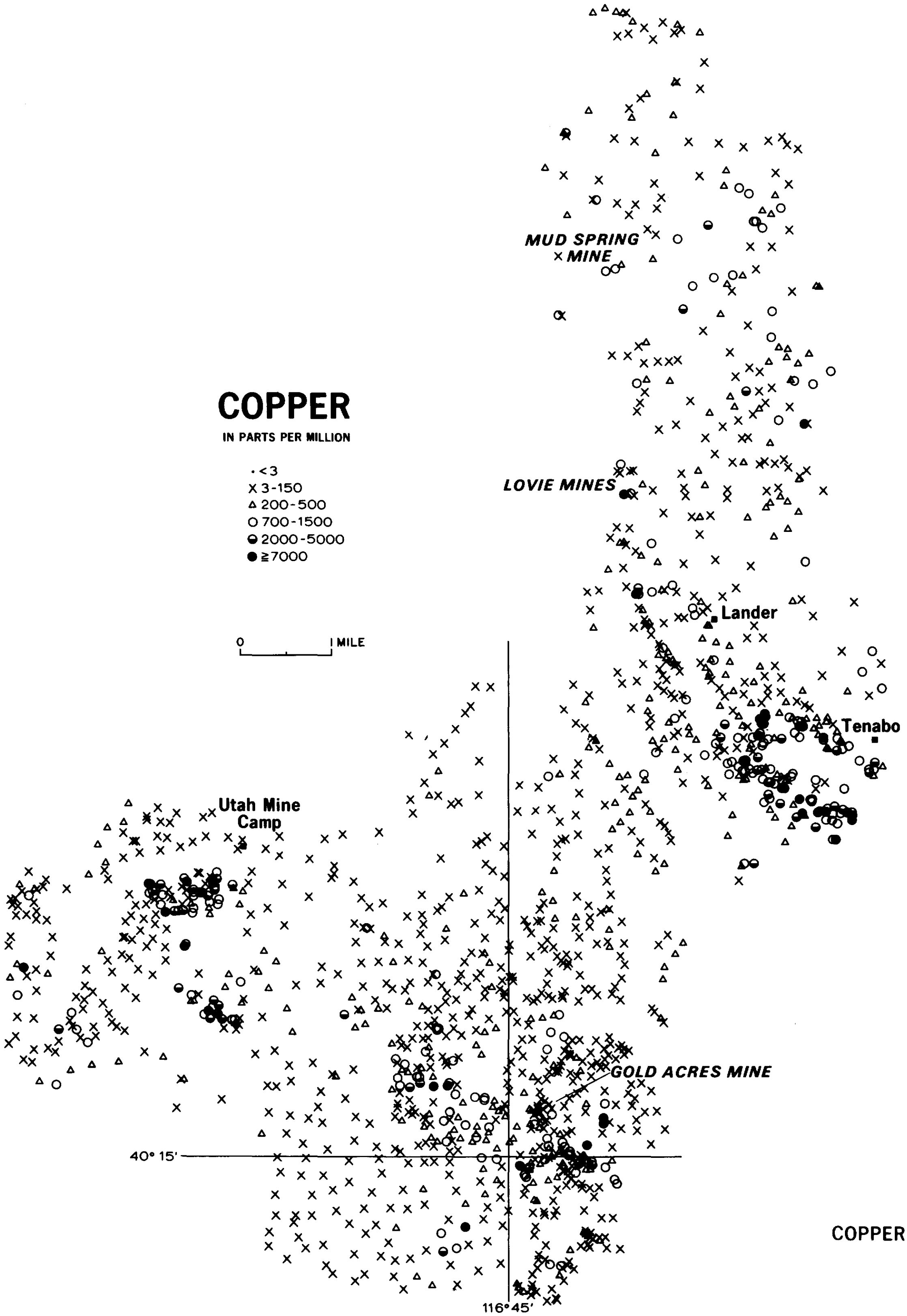

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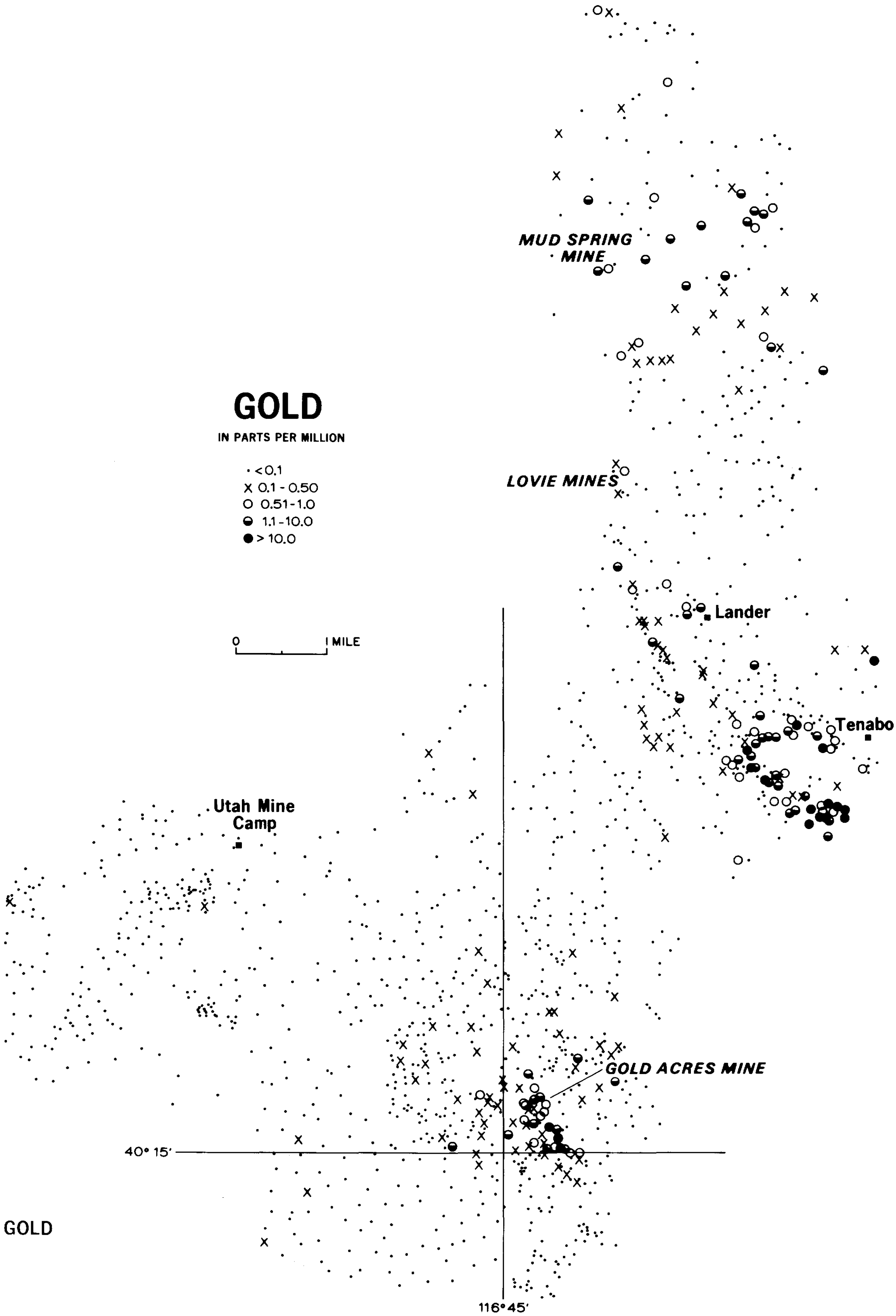

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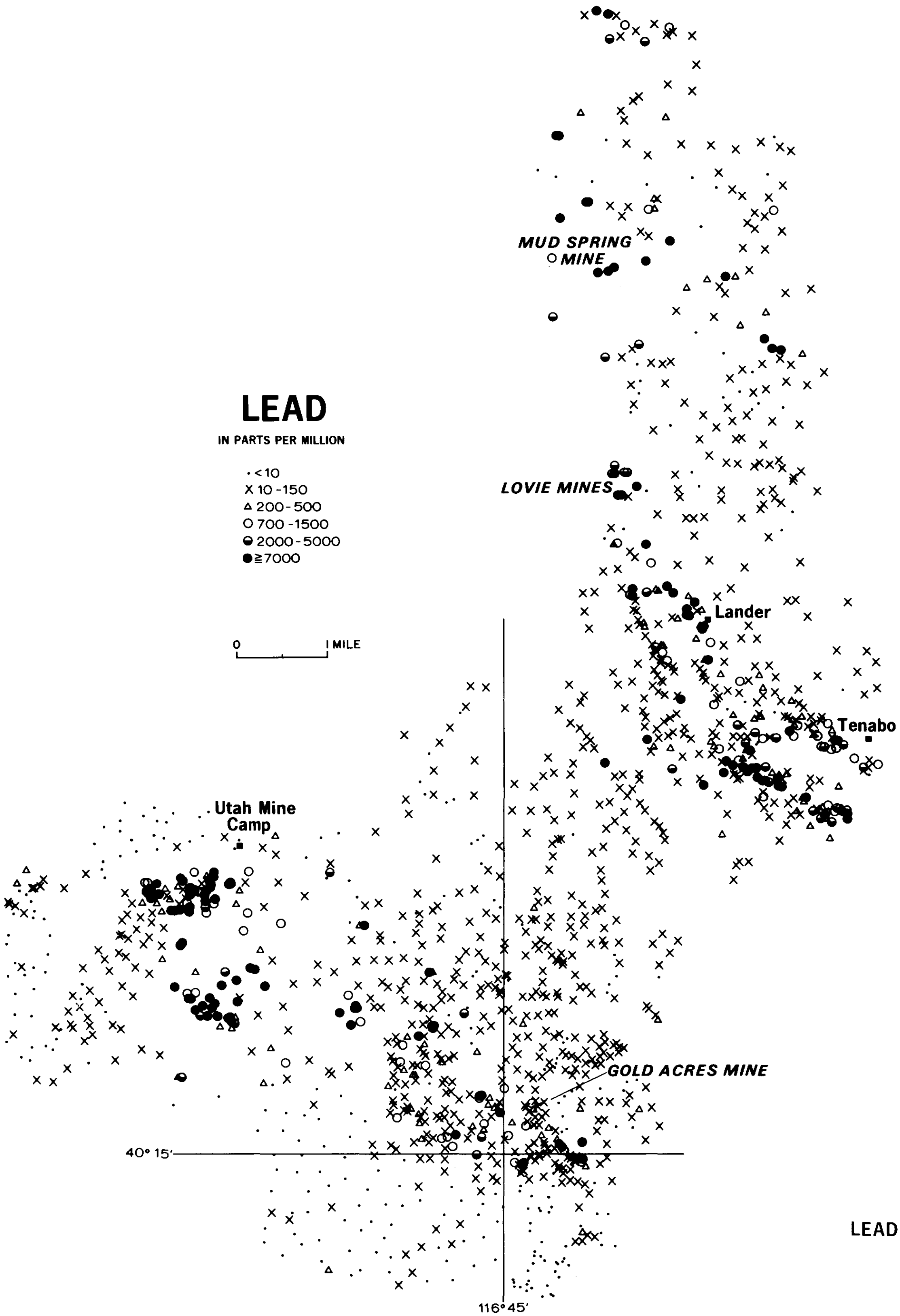

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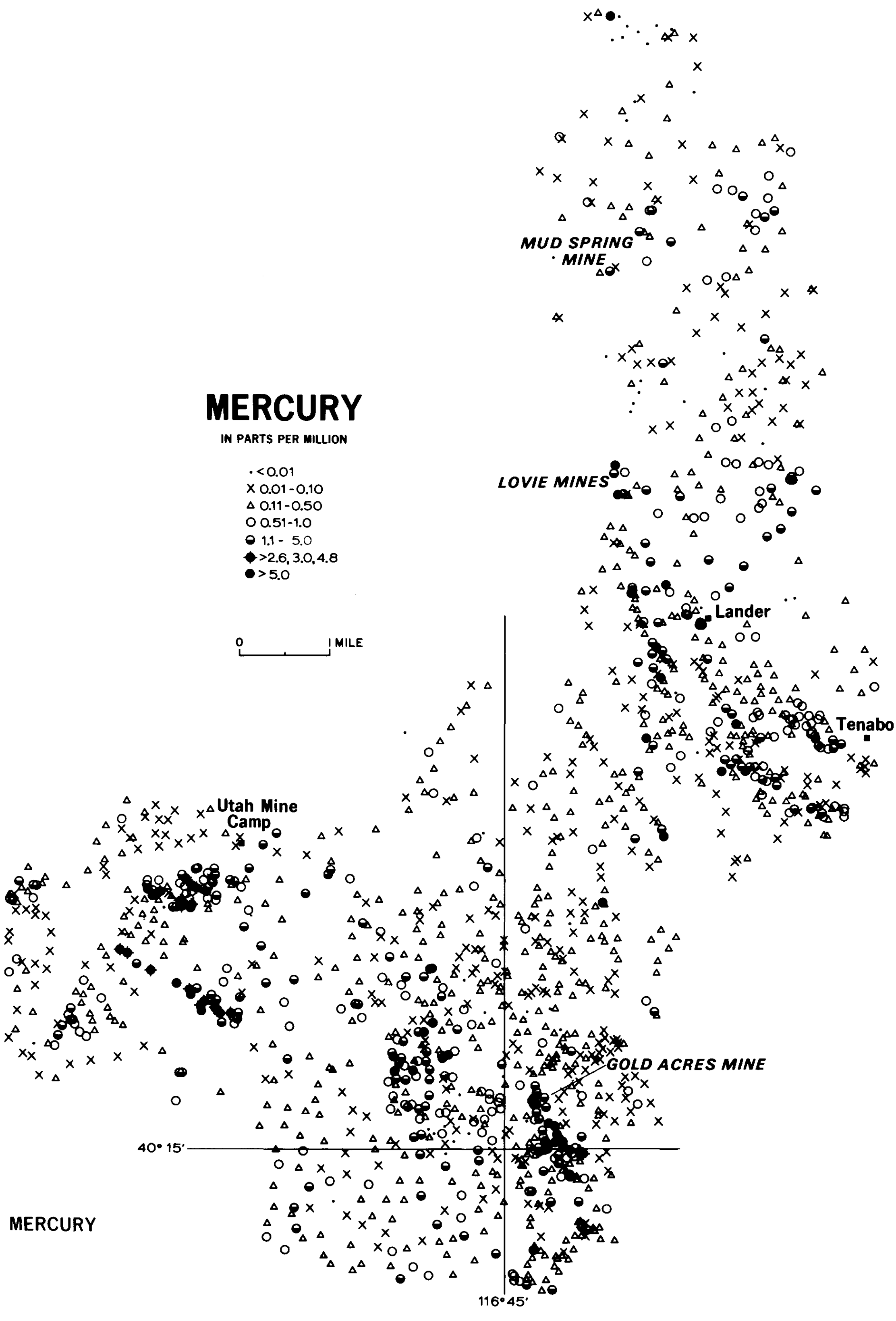

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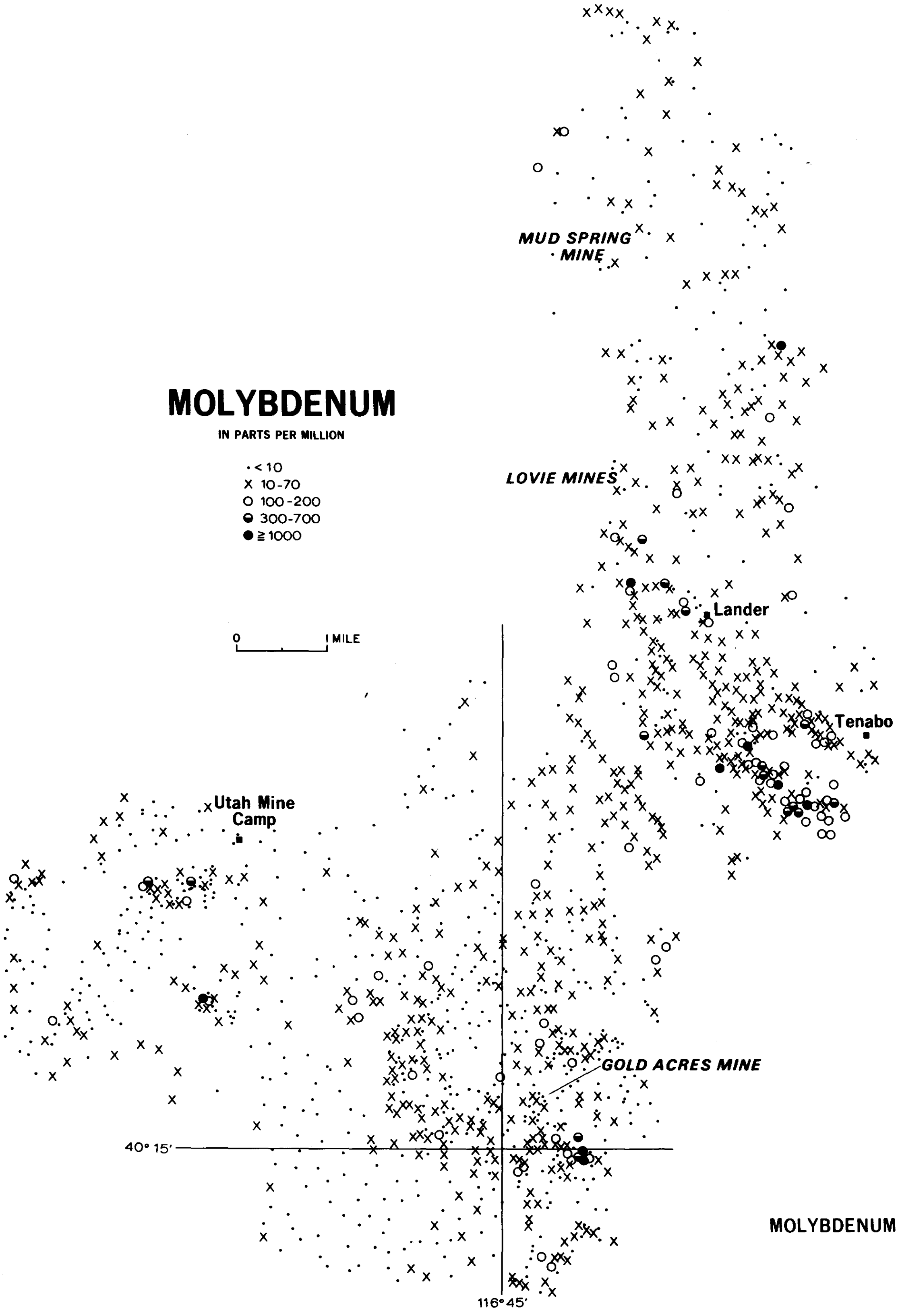

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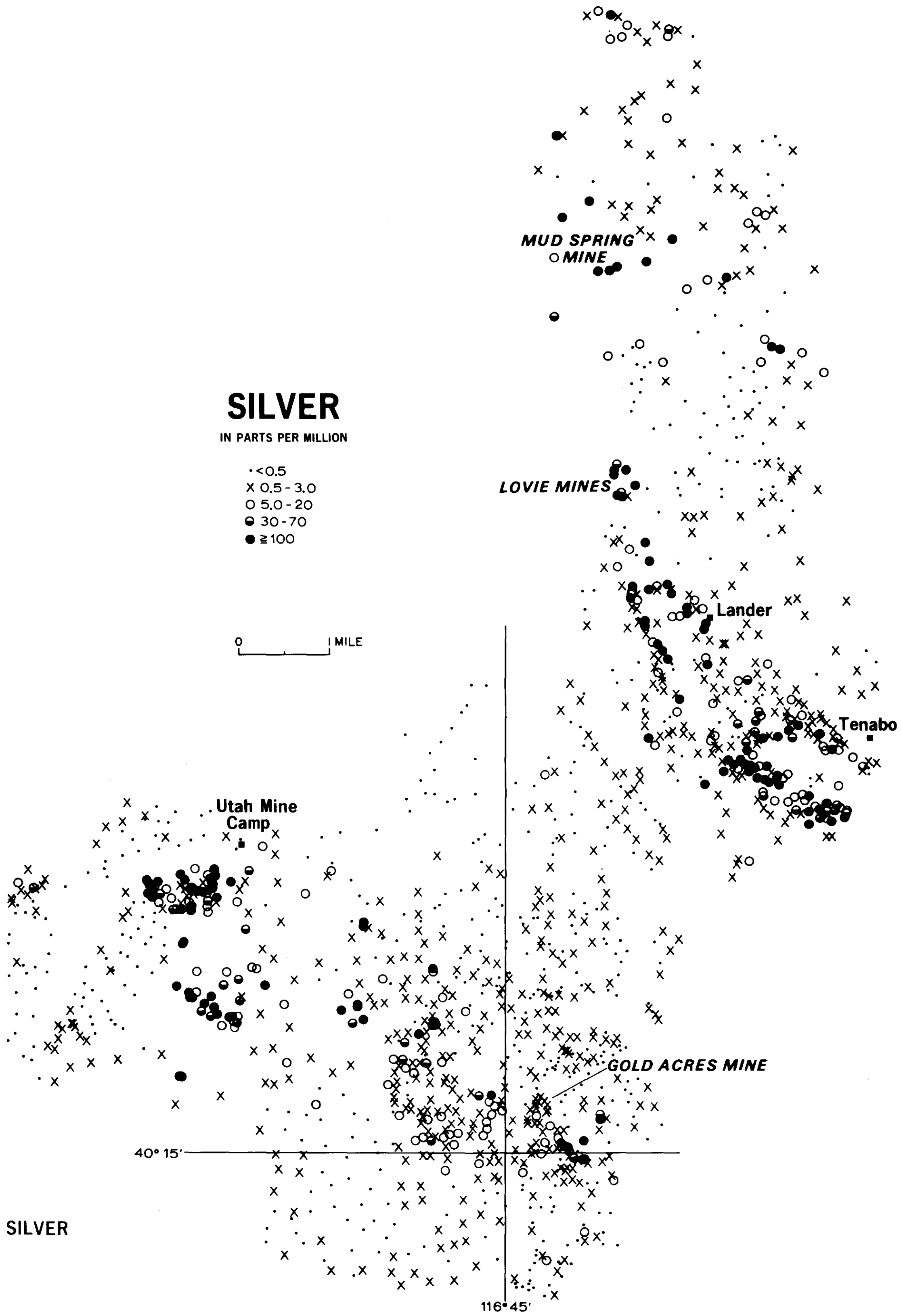

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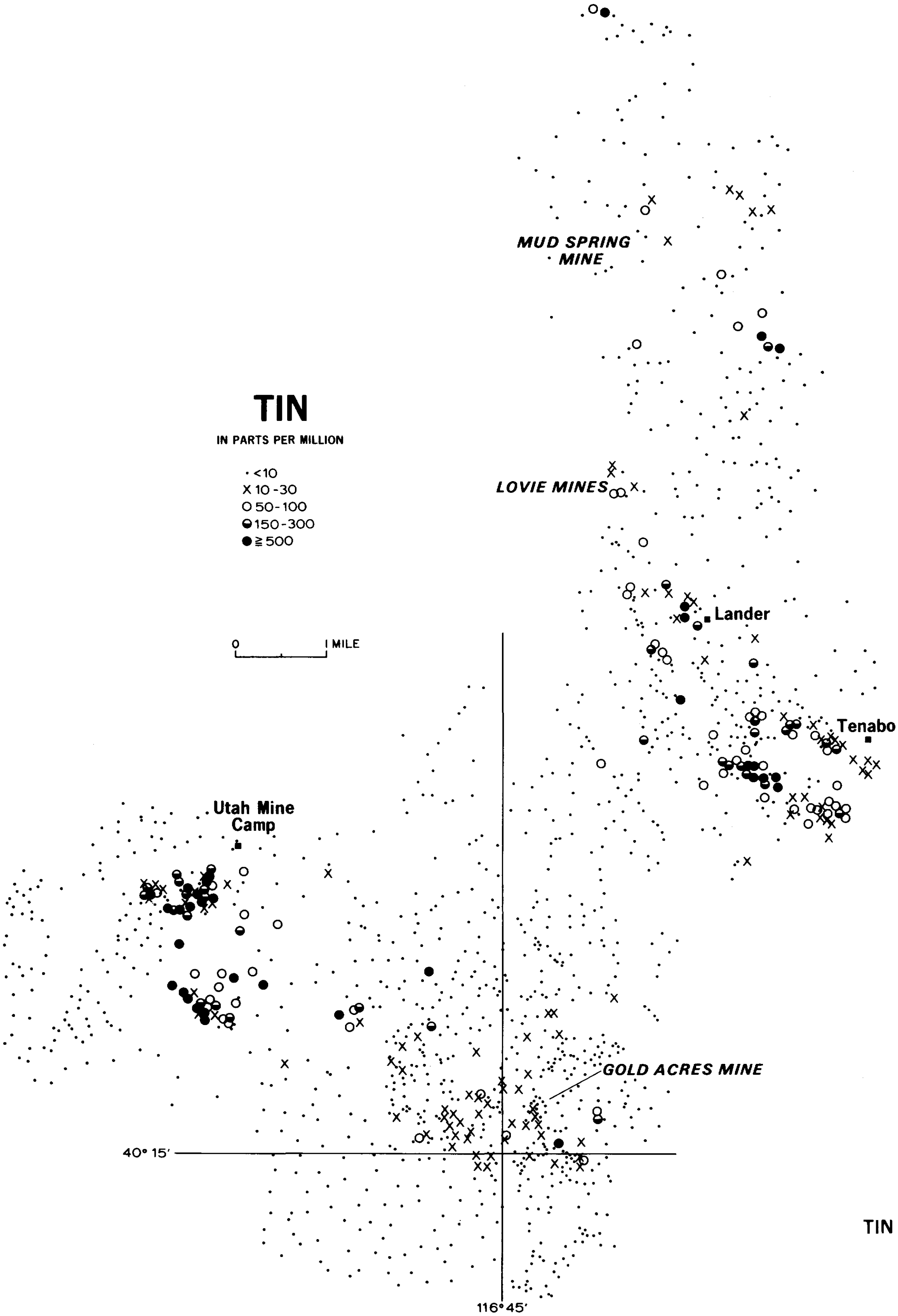

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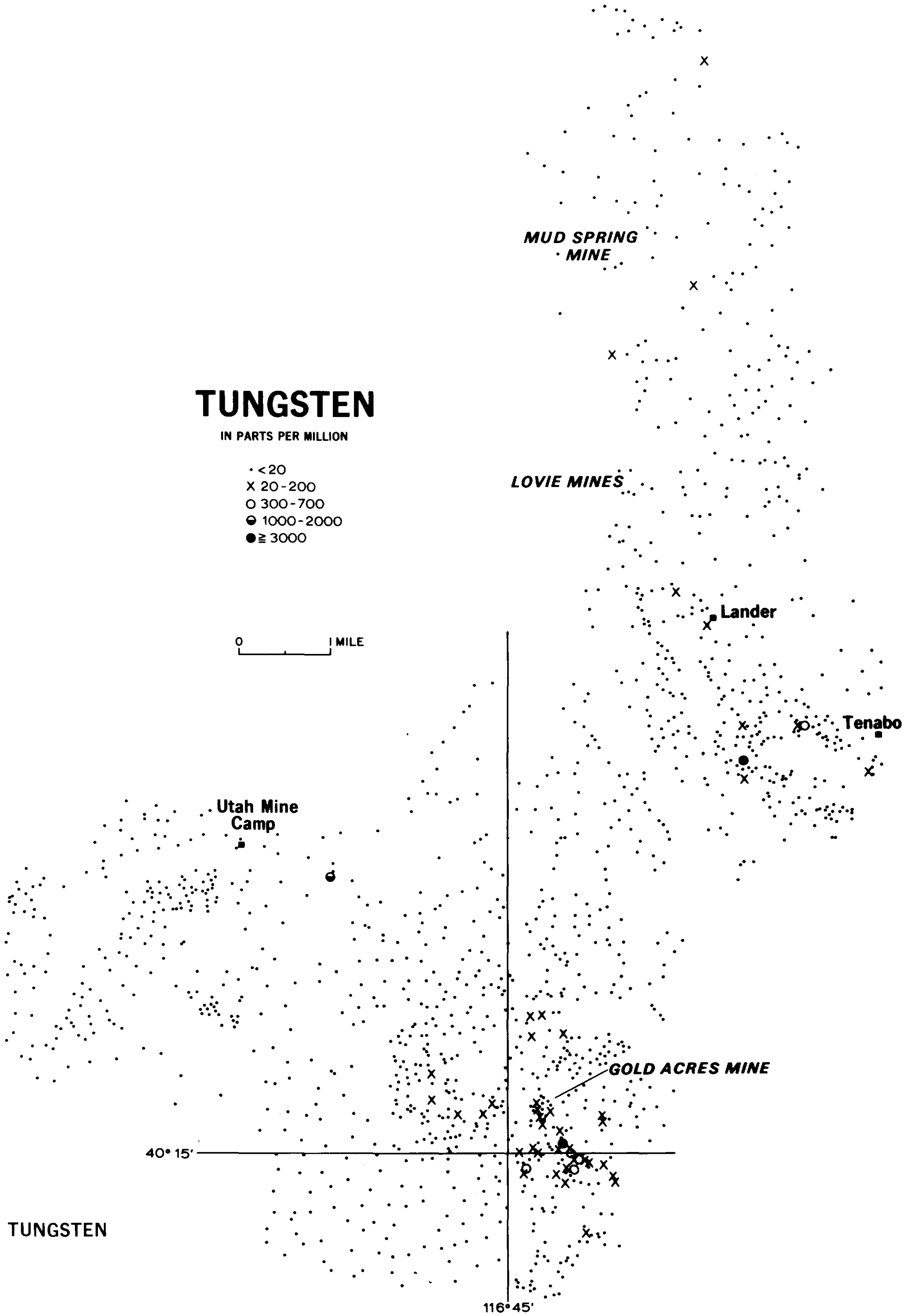

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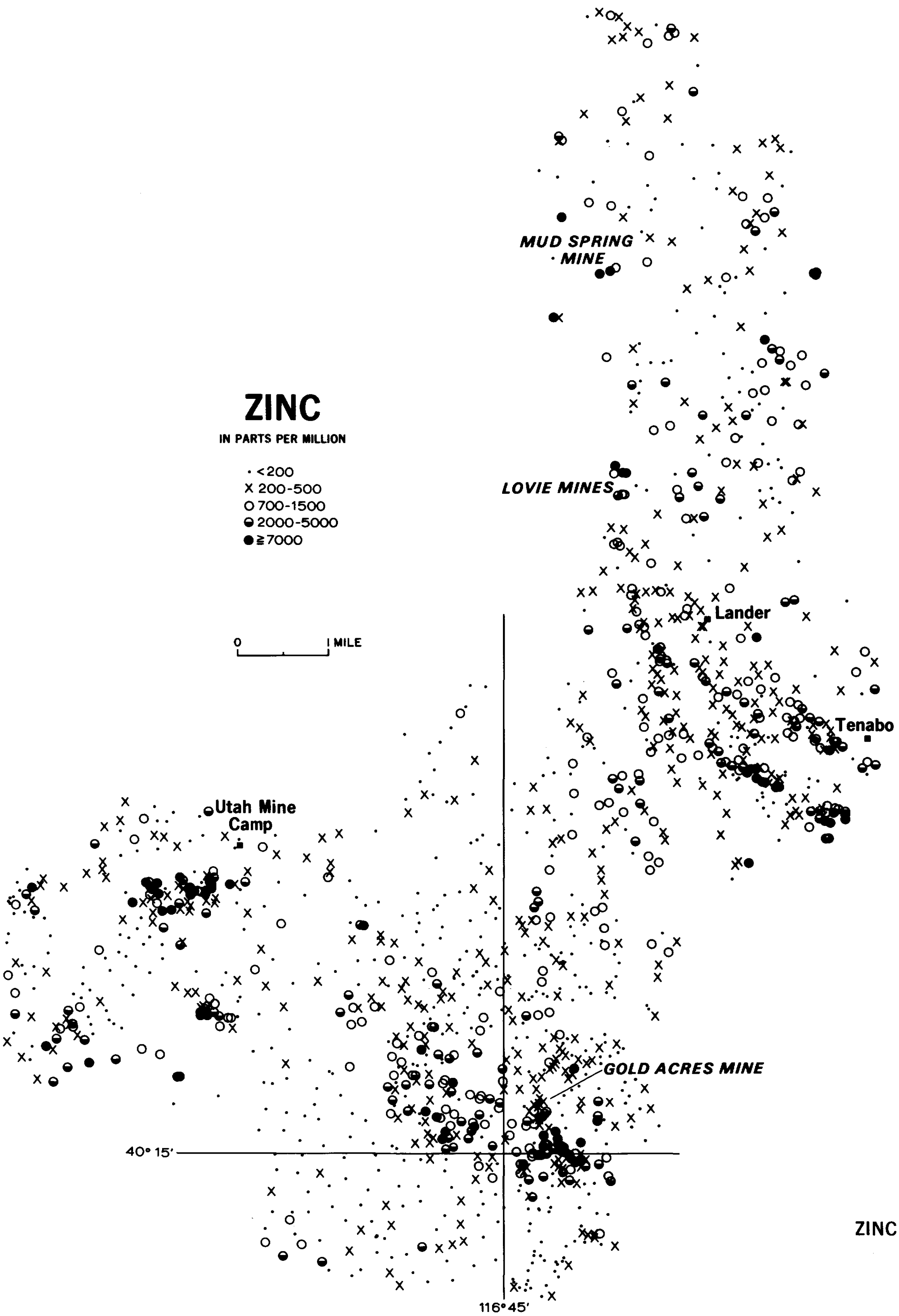

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