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William T. Pecora, *Director*

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Base and noble metals are concentrated around quartz latite porphyry plugs and were probably spread along a thrust fault intruded by the plugs

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STRUCTURAL CONTROL OF GEOCHEMICAL ANOMALIES IN THE GREATERVILLE MINING DISTRICT, SOUTHEAST OF TUCSON, ARIZONA

By Harald Drewes

ABSTRACT

Geochemical reconnaissance of the Greaterville mining district in the northern part of the Santa Rita Mountains shows anomalously high concentrations of metals, especially of silver, arsenic, copper, lead, and zinc, as well as high values of gold, barite, mercury, molybdenum, antimony, and tellurium. These anomalies are centered around a group of quartz latite porphyry intrusives of late Laramide (Paleocene) age. The ore-forming fluids probably spread from the intrusives along a gently southeastward-dipping thrust fault that underlies a disharmonically folded plate of arkosic rocks. Maximum concentrations of metals may be expected, not only near the stocks, but also along and superjacent to the thrust fault.

INTRODUCTION

Recent investigations in the Santa Rita Mountains, Pima County, Ariz., have shown the existence of several groups of geochemical anomalies. One group of anomalies is associated with altered plutonic rocks in a north-northwest-trending belt near the crest of the southern part of the mountains (Drewes, 1966, 1967). Another is associated with a series of hypabyssal quartz latite porphyry intrusives in the northern part of the mountains. This report briefly describes the distribution of base metals (copper, lead, zinc, bismuth, tellurium, arsenic, and tungsten) and noble metals (gold, silver, and mercury) near the southernmost of these intrusives, in the Greaterville mining district.

The Greaterville district surrounds the community of Greaterville (fig. 1), 35 miles southeast of Tucson and 8 miles northwest of Sonoita. That part of the district where bedrock is well exposed comprises about 3 square miles in the southeast corner of the Sahuarita 15-minute quadrangle and 1 square mile in the northeast corner of the Mount Wrightson quadrangle. Most of the placer deposits were in an area extensively covered by piedmont gravel immediately to the east.

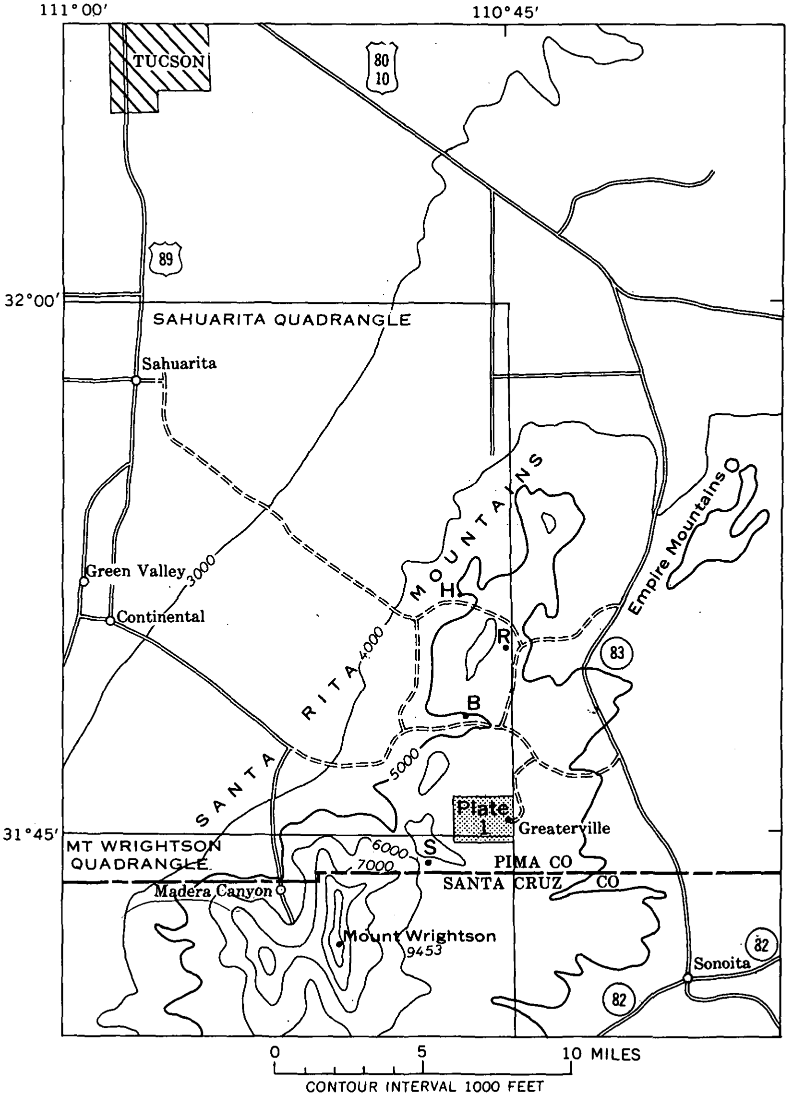

Figure 1.—Index map showing location of Greaterville Ariz., area. H, Helvetia mining district; R, Rosemont mining district; B, Box Canyon; and S, Sawmill Canyon.

Greaterville is best known as a gold-placer camp, which reached its heyday about 1878. Since then numerous efforts have been made to extend the placer operations and to find workable lode deposits of gold and base metals. The geology was described by Schrader (1915, p. 152–166) and by Root (1915). With the current increase in exploration activity throughout the region, this district has been reexamined and undoubtedly will continue to generate interest.

The present report is, thus, not intended to imply a new discovery, but to show how the mineralization is related to igneous bodies and structures that are inferred to have served as ore controls. It is hoped that if these ideas are found to have some validity here, they may be useful in the exploration and development of similar districts elsewhere. The work is based on a 5-year geologic study of the Sahuarita and Mount Wrightson quadrangles, and is supported by similar studies to the northeast by T. L. Finnell, to the southeast by R. B. Raup, and in the surrounding mountains by P. T. Hayes, J. R. Cooper, F. S. Simons, and S. C. Creasey.

This study was greatly facilitated by G. C. Cone and W. M. Swartz, who helped with the mapping and sampling, by E. L. Mosier and J. M. Motooka, spectographers, and by the following chemists, whose contribution is given parenthetically: E. P. Welsch and J. B. McHugh (As), W. W. Janes (Hg), John Watterson (Au), R. L. Turner (Te), and Thelma Harms and J. H. Turner (Sb). This study has also been greatly improved through frequent consultation with J. H. McCarthy, both in the field and during the preparation of the report. W. R. Griffitts, F. C. Canney, and R. L. Erickson, who reviewed the report, provided many useful ideas in evaluating the geochemical data.

GEOLOGY

STRATIGRAPHY AND PETROGRAPHY

Rocks of the Bisbee Group, of Early Cretaceous age, underlie most of the western part of the Greaterville district. Other units present include granitic and gneissic rocks of Precambrian age, quartz latite porphyry of Paleocene age, rhyolite porphyry of Oligocene age, and gravels of Pliocene to Pleistocene ages (pl. 1). Although Paleozoic rocks, consisting largely of carbonates and quartzite, are not exposed within the area, they are abundant nearby and may possibly be present at depth (pl. 1).

PRECAMBRIAN ROCKS

Precambrian granitic and metamorphic rocks crop out along the west edge of the district between Fish and Enzenberg Canyons (pl. 1). Granite gneiss, hornblende gneiss, migmatite, biotite-chlorite schist, and phyllite form a large mass of poorly exposed rock along the Ophir Gulch jeep trail. These rocks grade northward into the Precambrian Continental Granodiorite (Drewes, 1968a, b) and are faulted against the granodiorite to the south. The metamorphic rocks are provisionally correlated with the Pinal Schist, which here and elsewhere in the Santa Rita Mountains forms roof pendants, inclusions, and possible remnants of wallrock in and around the Precambrian granodiorite batholith.

Continental Granodiorite forms the main mass of Precambrian rock in the mountains. It ranges in modal composition from typical granodiorite to quartz monzonite and includes many small masses of aplite and fine-grained quartz monzonite. The coarse-grained granitic rocks disaggregate readily through weathering and thereby form a gently rolling terrain in which outcrops are few and a veneer of grus is fairly extensive. The main mass of granodiorite has a coarsely crystalline hypidiomorphic granular groundmass that contains 1–5 percent of microcline as phenocrysts or porphyroblasts as much as 2 inches long. Samples from about a mile southwest (table 1, sample 100) and west (sample 104) of the area of plate 1 show the wide range of composition that is typical. The plagioclase is an albite that is largely altered to sericite and clay minerals; microcline also is much kaolinized. Biotite is mostly chloritized but, where unaltered, consists of large crystals instead of the felty aggregates that are typical of the metagranodiorite of the Box Canyon area (fig. 1, B) and Helvetia mining district (fig. 1, H).

TABLE 1.—*Modes of Continental Granodiorite near the Greaterville district*

Sample No.	100	104
Quartz	32.2	16.7
Plagioclase	39.4	26.7
Microcline	13.7	38.6
Biotite	10.7	11.7
Magnetite	3.0	2.9
Apatite	.8	1.0
Zircon	.1	.2
Sphene	.0	2.3
Total	99.9	100.1

PALEOZOIC ROCKS

Paleozoic rocks are nowhere exposed within the Greaterville district, but they are widely exposed nearby, and the possibility of their presence at depth is worthy of attention because of their potential as a host for ore. The Paleozoic rocks of southeastern Arizona normally form a sequence about 5,000 feet thick that extends, with several discontinuities, from the Cambrian Bolsa Quartzite to the Permian Rainvalley Formation. The nearest exposures of these rocks lie immediately outside the area of plate 1, just south of the lower end of Fish Canyon and also about midway between the east end of Box Canyon and the northeast corner of the area of plate 1. In both places the units present are mainly the lowest and oldest parts of the section, the Bolsa Quartzite and Abrigo Limestone of Cambrian age and the Martin Formation of Devonian age. These relations are consistent with the southward wedging out of Paleozoic rocks from Rosemont (fig. 1, R) to and beyond Box Canyon and, together with an abundance of granodiorite clasts in the base of the Bisbee Group, imply marked local uplift and erosion in the Greaterville area before the deposition of the Bisbee. This situation alone could account for the absence of the Paleozoic rocks between the Cretaceous and Precambrian rocks. The thrust fault, which has now sheared off the entire section of the Cretaceous rocks from the basement, complicates the matter sufficiently so that the paleogeography of the Paleozoic rocks remains uncertain.

In the cross sections on plate 1 undifferentiated Paleozoic rocks are projected into the southern part of the Greaterville district at depth. This interpretation is suggested by the block of Bolsa Quartzite near the southwest end of section *B–B′*; however, the distance this sheet of rock extends northeastward is conjectural, as is its thickness. If Paleozoic rocks are present at all, the Cambrian and Devonian formations are the most likely ones to be represented. In essence, I have chosen to illustrate the reasonable possibility of the presence of these units near the intersection of structure sections *A–A′* and *B–B′* because of the importance they have as hosts to mineralization in the Helvetia and Rosemont mining districts.

CRETACEOUS ROCKS

Rocks of the Cretaceous Bisbee Group, which underlie most of the Greaterville district, are a thick sequence of typically drab-colored conglomeratic and arkosic rock whose clast size, in general, diminishes gradually upsection. Of the five formations of the group that are mapped by T. L. Finnell in the Empire Mountains (fig. 1), the lower three are recognized in the Greaterville district; these are the Glance Conglomerate, only sparsely present, and the Willow Canyon and Apache Canyon Formations. The lowest unit of the Bisbee is the Glance Conglomerate. In its type locality, the Glance is a basal conglomerate which is thick and continuous and which consists predominantly of a wide assortment of Paleozoic rocks. In the Santa Rita Mountains, however, it is highly lenticular, it intertongues with the overlying finer sedimentary rocks, and it consists of Paleozoic clasts or of granodioritic detritus and locally of gneissic clasts, all of which may be of local origin.

The only body of rock tentatively identified as Glance in the area of plate 1 is a 15-foot-thick wedge of conglomerate on the northeast side of Fish Canyon. It is inferred to be in fault contact with Precambrian granite gneiss on the southwest and to grade into arkosic sandstone of the Willow Canyon Formation on the northeast. The pebbles of this conglomerate are also granite gneiss, and the matrix is red mudstone. Although this rock is designated Glance Conglomerate on plate 1, it is undoubtedly faulted along its west edge and may prove to be faulted on its east edge also, and thus may prove to have little relationship to the adjoining body of Willow Canyon arkose.

The Willow Canyon Formation of the Bisbee Group lies conformably on the Glance and is in fault contact with the Continental Granodiorite in Enzenberg and Fish Canyons. The formation is about 2,800 feet thick and consists largely of arkose but also contains pebbly arkose, conglomerate, and siltstone. In the Enzenberg Canyon area the lowest beds are commonly a red siltstone or less commonly brownish-gray arkose. Scattered beds of unsorted chip-bearing siltstone, probably of colluvial or sheet-wash origin, are intercalated in the siltstone units low in the Willow Canyon Formation. Upsection, southeast of Enzenberg Canyon, where exposures are best, coarse brown arkose, conglomeratic arkose, and subordinate amounts of conglomerate alternate with relatively few and thin units of gray to yellowish-brown siltstone. Along strike, toward the northeast and near the northern edge of the area of plate 1, many of the coarse-grained beds wedge out or grade into fine-grained rocks. A few thin beds of dark-gray limy siltstone occur in the upper half of the Willow Canyon Formation. South of Ophir Gulch, arkose is strongly dominant over conglomerate and siltstone, but outcrops are too few to make further stratigraphic refinement practical at this scale.

The uppermost of the three local units of the Bisbee Group is the Apache Canyon Formation, which is at least 1,500 feet thick and which consists largely of siltstone and of finer grained arkosic sandstone beds than those in the Willow Canyon Formation. Its basal contact is broadly gradational but locally, north of Ophir Gulch, it is placed at the top of the highest prominent thin conglomerate bed. Sandstone beds are fewer and thinner upsection, and siltstone and black to greenish-gray silty shale beds are thicker and more numerous. Laminated limestone beds also are common in the upper half of the formation but, although they are relatively resistant to weathering, they are too lenticular to provide extensive marker beds. One such laminated limestone bed near the highest part of the local section south of Greaterville contains scraps of pelecypods and gastropods. Outside the Greaterville district similar but better preserved fossils from the upper part of this member are of long-ranging marine types.

CENOZOIC ROCKS

A light-colored quartz latite porphyry, commonly referred to here and in adjoining districts as the "ore porphyry," crops out extensively in a northwest-trending belt through the head of Ophir Gulch. Pluglike bodies as much as 1,500 feet in diameter, many smaller irregular bodies, and dikes and sills crop out in an elliptical area about 1 mile wide and 2 miles long. It is noteworthy that both the long axis of this ellipse and the longest single dike are alined paralled to the axis of the Boston syncline.

The rocks of these intrusives vary in texture, and more detailed study may show that they vary in composition also. Samples from the stocks generally contain as much as 30 percent small phenocrysts of feldspars, quartz, and commonly biotite in a much altered fine-grained groundmass. In the sparsely porphyritic rocks feldspar alone is recognized. Most dikes are much less porphyritic than are the stocks, and their groundmass is very finely granular to cryptocrystalline; a few dikes are nonporphyritic. Some of the rocks mapped as aphanitic sills were tentatively identified in the field as hornfelsed beds and, despite some thin-section work, this uncertainty persists. Modes of two samples of the coarser grained rocks and one of a porphyritic fine-grained dike (sample 897) are given in table 2.

TABLE 2.—*Modes of igneous rocks of the Greaterville district*

Sample No.	897	893	921
Rock	Granodiorite	Quartz latite porphyry	
Quartz	25. 1	22. 9	24. 4
Plagioclase	42. 8	45. 2	56. 1
Orthoclase		26. 3	13. 6
Microcline	11. 1		
Biotite	16. 2	3. 9	4. 2
Magnetite	2. 4	1. 1	1. 4
Apatite	1. 0	. 3	. 2
Zircon	. 05	. 05	Tr
Sphene	1. 4	. 2	. 1
Allanite		. 05	
Total	100. 1	100. 0	100. 0

Plagioclase crystals generally show cores of sodic andesine and rims of calcic oligoclase, but some are albitized (for example, sample 897, obtained from the long dike on the southwest side of the intruded area). They are also generally much altered to sericite and clay minerals, which gives them a chalky appearance. Most of the biotite is intensely chloritized, although in a few places from which samples 893 and 1472 were obtained, about half the biotite is unaltered. Quartz phenocrysts are notably stubby. Sulfide minerals are sparsely disseminated in some of the porphyry and are suspected to be at least partly of primary origin. Secondary minerals of iron, copper, and manganese are more widespread than the sulfides.

The bodies of quartz latite porphyry probably are mostly synchronous intrusives despite their variations in habit, texture, and mineralogy. Local geologic relations indicate only that these rocks are post-Bisbee. A biotite concentrate from sample 1472 has given a potassium-argon age of 55.7±1.9 m.y. (million years) (R. F. Marvin, H. H. Mehnert, and Violet Merritt, written commun., 1968). The rock is also correlated with "ore porphyry" of the Rosemont and Helvetia districts, where biotite from two bodies has yielded potassium-argon ages of 56±1.7 m.y. (Drewes and Finnell, 1968, p. 323) and 55.8±1.7 m.y. (R. F. Marvin, H. H. Mehnert, and Violet Merritt, written commun., 1967); these ages are indicative of the late Paleocene.

Two rhyolite porphyry dikes trend northeastward along Enzenberg Canyon. These are part of a swarm of similar dikes which extends across the mountains to the west and north. Locally, the dikes cut both the Continental Granodiorite and formations of the Bisbee Group and the fault separating them. Most of these dikes are long, regularly tabular bodies that have a strong flow lamination and a light-brownish-gray color. They lack the chalky appearance of the dikes of "ore porphyry," and in places their groundmass is glassy. Phenocrysts are usually moderately abundant and are of sanidine, quartz, and rarely also of biotite. Sanidine from one vitrophyric dike one-half mile west of the Greaterville area is dated by the potassium-argon method as 26.1±0.8 m.y. (Drewes and Finnell, 1968, p. 521), an age placing it in the late Oligocene.

Gravel covers the extensive piedmont area east of Greaterville and barely extends into the area of plate 1. North of the Greaterville district similar gravels are faulted against the older rocks of the mountains, but to the east and south of the area they lap unconformably across the Bisbee Group along a belt one-fourth to one-half mile wide; this belt suggests the presence of at least a narrow pediment southeast of the axis of the mineralized area. This gravel is of Pliocene and Pleistocene age.

Younger gravels, apparently remnants of once more extensive stream terraces, are mapped in a few places along Enzenberg Canyon and Ophir Gulch. Similar bodies of terrace gravel too small to be mapped are present along other stream courses throughout the area of plate 1. Many of these gravels are auriferous, particularly those along streams draining the mineralized area. The age of these terrace gravels is uncertain, but Blake (1898) reported the recovery of bovine fossils of Quaternary age from one of the placer pits. A terrace gravel at Elgin, 9 miles east of Sonoita, that is believed to be roughly correlative with the terrace remnants at Greaterville has yielded remains of *Mammuthus columbi*, possibly of middle Pleistocene or more likely of late Pleistocene age (Everett Lindsay, written commun., 1968).

STRUCTURE

The major geologic structure of the Greaterville district is a gently dipping thrust fault which separates a disharmonically folded upper plate consisting largely of Cretaceous rocks from a massive unfolded lower plate consisting of Precambrian rocks. In addition, a large northwest-trending high-angle fault separates a northeastern block containing both of these plates from a southwestern block containing only rocks of the lower plate. Some field evidence is projected into this area from the immediately adjacent areas to provide a broader base for interpreting the structures. Likewise, the inferred geologic history of the Greaterville area relies considerably on that history developed in the Sawmill Canyon area (fig. 1, 5) to the southwest and in the Rosemont and Helvetia districts to the north.

Most of the Greaterville district is underlain by the folded but sparsely faulted rocks of the Bisbee Group in the upper plate of the thrust. Such faults as have been found within this plate are small or are obscured because they are parallel to the strike of the beds or because they cut a poorly exposed uniform sequence of rocks. The axes of all folds but one plunge gently southeast; axial planes of the larger folds are commonly inclined to the southwest. Of these larger folds, the most conspicuous one is an asymmetrical syncline, the Boston syncline, which strikes through the mineralized area. Except for some minor disharmonic folds and some local irregularities around the plugs, rocks of the syncline's northeast flank dip gently southward and those of its southwest flank dip steeply northeastward. In addition, other large steep-limbed folds deform the rocks of the southwest flank of the Boston syncline, largely south of the mapped area. The long dike of quartz latite porphyry is injected in part along the axis of one such subsidiary syncline. These folds, and other better exposed ones like them lying south of the area of plate 1, resemble chevron folds and appear to be a paired syncline and anticline that end together either through a merging of their axial planes or through a gradual loss of structural identity of their common limb as its strike merges with that of the outside limbs. Several small folds warp the alternating shale and sandstone units of the Apache Canyon Formation north of Ophir Gulch. These folds are local disharmonic structures, as shown by the fact that they are not transmitted to the underlying sandy rocks also of the Willow Canyon; thus, they are instructive in the relations of the larger folds to the surface beneath them. The Boston syncline axis ends against the thrust surface beneath the Bisbee, and it reappears in the klippe northwest of Enzenberg Canyon; the basal surface of the Bisbee is not itself folded (pl. 1).

A single syncline lying north of Enzenberg Canyon trends northeastward. Only a short segment of this fold falls within the area of plate 1, but the fold extends to the end of the klippe more than a mile beyond the north edge of the mapped area (Drewes, 1968a). This fold, too, is disharmonic and does not affect the thrust fault beneath the Willow Canyon Formation. The two orientations of fold axes illustrated in this area probably formed during separate episodes in the structural history of the region.

The thrust fault that separates Cretaceous rocks from Precambrian rocks crosses Enzenberg Canyon but is too poorly exposed for one to be certain of its character; however, along the northern extension of this thrust surface, south of Box Canyon (Drewes, 1968a), an extensive sheet of Bisbee dips at a moderate angle into the fault. North of Box Canyon a similar fault truncates rocks in both plates. These relations confirm that the structure is indeed a thrust fault, although it may have followed bedding or an unconformity in many places.

The west end of the trace of the thrust fault south of Enzenberg Canyon swings southward and southeastward and dips steeply to resemble the transition of a thrust fault into a tear fault bounding the southwest edge of the upper plate. West of hill 5988 this inferred tear fault merges with another high-angle fault, and together they continue southeastward across the area of plate 1, and are offset only by two minor west-northwest-trending faults. The klippe of Willow Canyon Formation northwest of Enzenberg Canyon is also truncated by the northwest-trending major fault, and another sliver of that formation lies along the fault at the crest of the Santa Rita Mountains beyond the edge of the mapped area. Several other high-angle faults, both normal faults with graben blocks of Bisbee and tear faults merging with thrust faults, trend northwestward across the northern Santa Rita Mountains (Drewes, 1966 and 1968a; Drewes and Finnell, 1968).

Plugs and many small dikes of quartz latite porphyry are roughly alined along the axis of the Boston syncline. These bodies of quartz latite porphyry are correlated with the "ore porphyry" bodies of Paleocene age in the Helvetia and Rosemont districts, where they typically intrude faults. On the basis of this regional habit, it seems likely that the porphyry stocks of Greaterville also may have spread along the thrust fault beneath the Bisbee, and very likely some of them merge at depth (pl. 1, section A–A′). This interpretation is supported by the abundance of small dikes between several of the stocks. The coincidence of the abundant dikes with the axis of the Boston syncline suggests that there may be a greater tendency for fractures to form along the attenuated trough of a syncline than along the limbs of the fold.

The folds and faults of the Greaterville district were formed during the Laramide orogeny, which in southeastern Arizona is dated as Late Cretaceous (about 90 m.y.) to Paleocene (about 52 m.y.) by Drewes (1969). Two phases of this orogeny are identified in the Santa Rita Mountains, an earlier or Piman phase associated with regional northeast-directed compression and a later or Helvetian phase associated with less widespread northwest-oriented compression. Some disharmonic folds, thrust faults, and tear faults were formed during each phase, and most stocks were emplaced toward the end of one or the other phase. Inasmuch as the two phases are superimposed, many Piman phase faults were reactivated during the Helvetian phase, and the direction of movement shifted. Locally, this has produced some conflicting evidence pertinent to interpreting direction and time of movement.

The thrust fault near Greaterville was probably active during both phases, as shown by the two diverse trends of folds (pl. 1). The regional evidence suggests that during the Piman phase of the orogeny the upper plate moved northeastward a relatively large distance, with the result that many large northwest-trending disharmonic folds formed in the allochthonous plate. During the Helvetian phase, local deformation was concentrated along the fault zone at Sawmill Canyon, probably as a combination of vertical movement and left-lateral movement. However, the major structural block north of this fault zone, in which the Greaterville district lies, was also broken, largely by northwest-trending high-angle faults. The left-lateral strain, however, was imperfectly transmitted across the block, as indicated by strike-slip displacements on some of the minor northwest-trending faults. At this time too, local thrust faults commonly also formed at the base of the Cretaceous and of the Paleozoic rocks. The quartz latite porphyry was probably intruded near the end of the Helvetian phase deformation, and therefore, little or no faulting of the intrusives occurs, and their roots are believed to be essentially in place. The truncation of the thrust fault by a dike of quartz latite porphyry along Enzenberg Canyon supports this interpretation of the timing of the structural events. In all likelihood the quartz latite porphyry narrows downward, perhaps forming only dikes a short distance into the massive granodiorite of the lower plate. It is inferred that the intrusives swelled locally along the thrust plane, then branched out upward where they encountered the weaker, much fractured rocks of the upper plate.

ALTERATION AND MINERALIZATION

The rocks within about half a mile of the area of plugs and dikes are mildly metamorphosed and mineralized; near some of the intrusives this alteration increases slightly. The arkosic sandstone beds are relatively refractory to the mild metamorphism and usually are only slightly epidotized and kaolinized. The finer grained beds are epidotized, the feldspathic material is altered to clay minerals, and in places the beds are hornfelsed. Calc-silicate minerals replace some of the limestone beds of the northern and eastern parts of the area. Along with increased alteration, commonly bedding details are sufficiently obliterated near the intrusive center that control of structure is tenuous at best.

Small quartz veinlets, commonly less than a few inches thick and rarely as much as 2 feet thick, are exposed in many of the numerous small prospects and also on some outcrops, and the local abundance of quartz float suggests that the veins are equally abundant beneath the colluvium. Most thicker veins (pl. 1) lie within the plugs, but few of these are as much as 500 feet long. No favored orientation of strike or dip was noted, although a systematic compilation of the veinlet orientation was not made. Some veinlets contain only quartz but others also contain feldspar, calcite, dolomite, barite, sulfides, and secondary minerals derived from the sulfides. Copper, lead, and zinc minerals are fairly abundant; spectrographic analyses show the presence of a wide variety of elements which suggests that other minerals are also present. The veinlets are less numerous away from the intrusive center than near it and are especially persistent and mineralized along the main axis of altered and intruded ground. Very likely some mineralized veins occur still farther southeast of the area sampled.

GEOCHEMICAL SAMPLING AND RESULTS

The purpose of the geochemical study was to show: (1) what metals had been introduced, (2) the distribution of these metals with respect to the geology and to each other, and (3) an approximation of the quantitative distribution of the metals. Composite samples were collected of assorted mineralized rock chips taken on outcrops, from prospect walls and dumps, and, where neither of these sources was available, from the rubble on slopes near ridge crests and hilltops on which the probable source area of the rubble was no larger than about 200 by 300 feet. Altogether, almost 200 samples were taken from about 175 sites; in some of these sites, bedrock and colluvium were tested separately. Typically, at each site four to eight chips were collected to include quartz vein, gossan, and altered rock along fractures; barren-looking rock was excluded. No attempt was made to weight the variety of chips according to their apparent local abundance because the rocks that are strongly sheared and altered inevitably are less frequently exposed than those that are less sheared and altered. The samples are probably also biased because most are from small prospects that seem to occur mainly on mineralized veinlets rather than on mineralized fractured rock. Because of this sampling procedure, the variety of metals and the content of the metals relative to each other are more meaningful than the tenor of the samples.

In addition to the sampling of rock chips, colluvium was sampled in about six sites where there were no outcrops and where the potential source area of the sample was large. These samples were taken in pairs, one at a grass-roots depth about 18 inches beneath the surface, and the other at a depth as near to bedrock as practical, commonly at a depth of 3–6 feet, where the abundance of coarse angular blocks seriously hampered digging. In each case the fine fraction of colluvium was collected. Some further study was made, as described below, to evaluate the significance of these colluvial samples with respect to the chip samples and to adjust the colluvial values so that they are as nearly comparable to the chip samples as practical.

Each sample was pulverized enough to pass an 80-mesh screen. One split was analyzed by semiquantitative spectrographic methods for 25 elements. A second split was analyzed by atomic-absorption methods for gold, mercury, and tellurium, and other splits were analyzed by wet methods for antimony and arsenic. The results are shown in table 3.

The values of the elements were plotted on a geologic map, and contours were drawn (figs. 2–19) to show their distribution and relation to the geology. For most elements the range of values was so large that the results were contoured using class intervals of successive orders of magnitude. For others, the range of values was low, and therefore arbitrarily determined class intervals were used. These contours, it should be emphasized again, cannot be used to make quantitative calculations, such as of ore grade or reserves, if indeed the geochemical highs reported indicate any ore present.

A cursory check was made of the change in concentration of the analyzed elements from local bedrock to the base of colluvium to the grass-roots level of colluvium in order to provide some basis for sampling larger covered areas. Very roughly, it appears that the concentrations of most sulfophile elements decrease upward to values ranging from about one-third to one-twentieth of the values in nearby rock; the concentrations of chromium, vanadium, and scandium increase upward about fivefold, and the changes in concentration of other elements are erratic. Some of the values obtained from the colluvial samples were thus adjusted, but inasmuch as colluvial samples are relatively few and because they rarely changed the data by as much as a contour interval, the adjustments, shown in figures 2–19 as those dashed contour lines not lying near the edges of the sampled area, scarcely affect the patterns of element distribution.

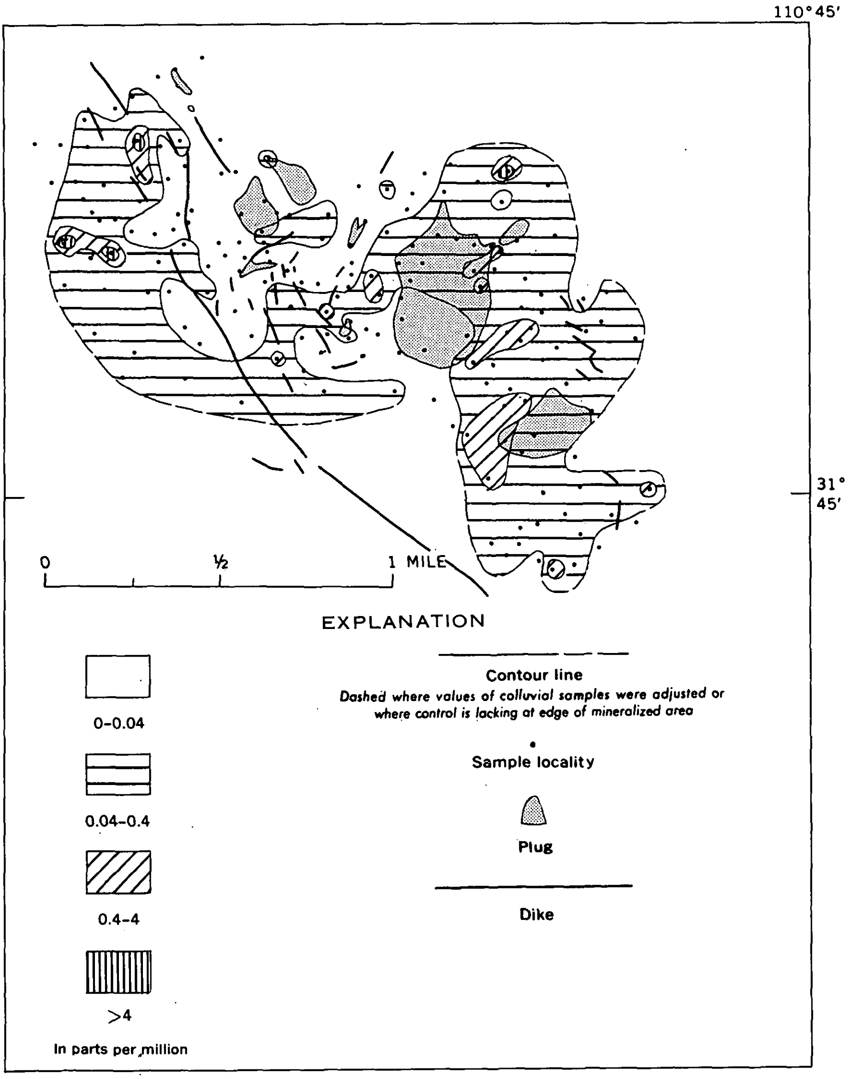

FIGURE 2.—Distribution of gold in the Greaterville area, Arizona.

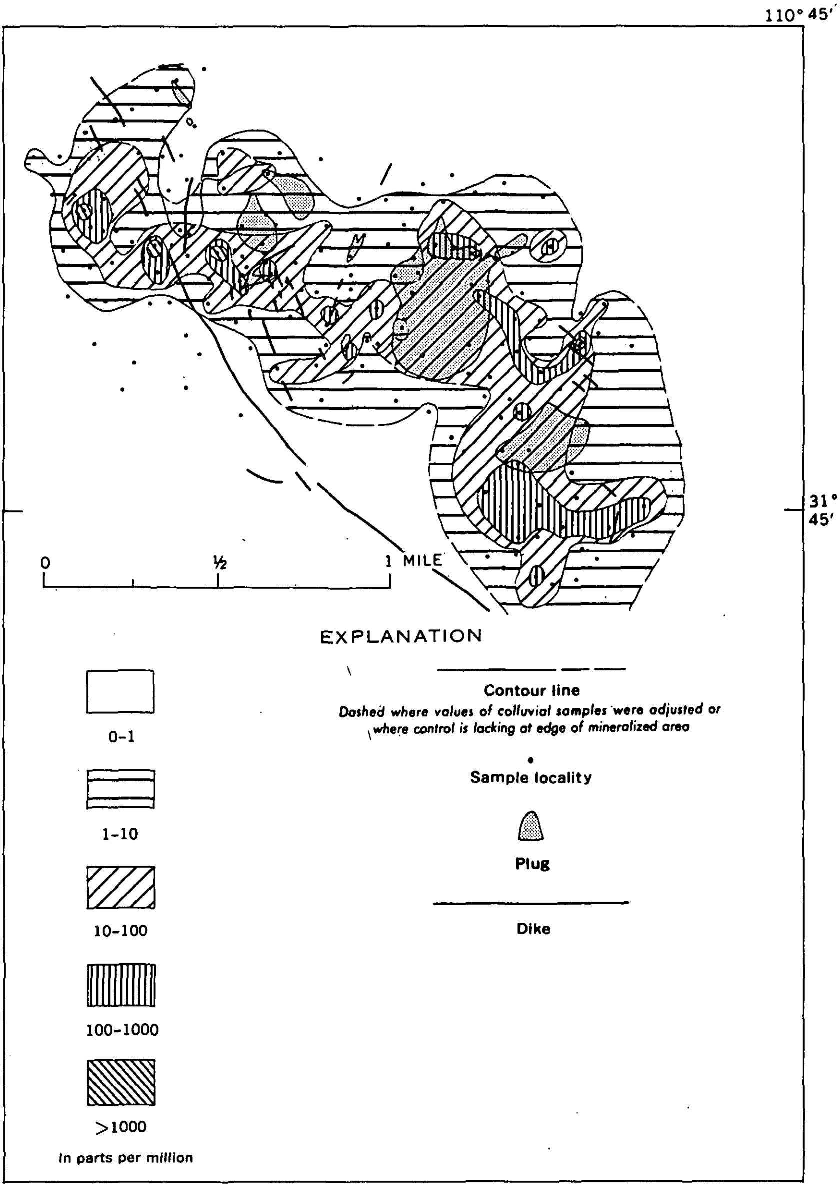

FIGURE 3.—Distribution of silver in the Greaterville area, Arizona.

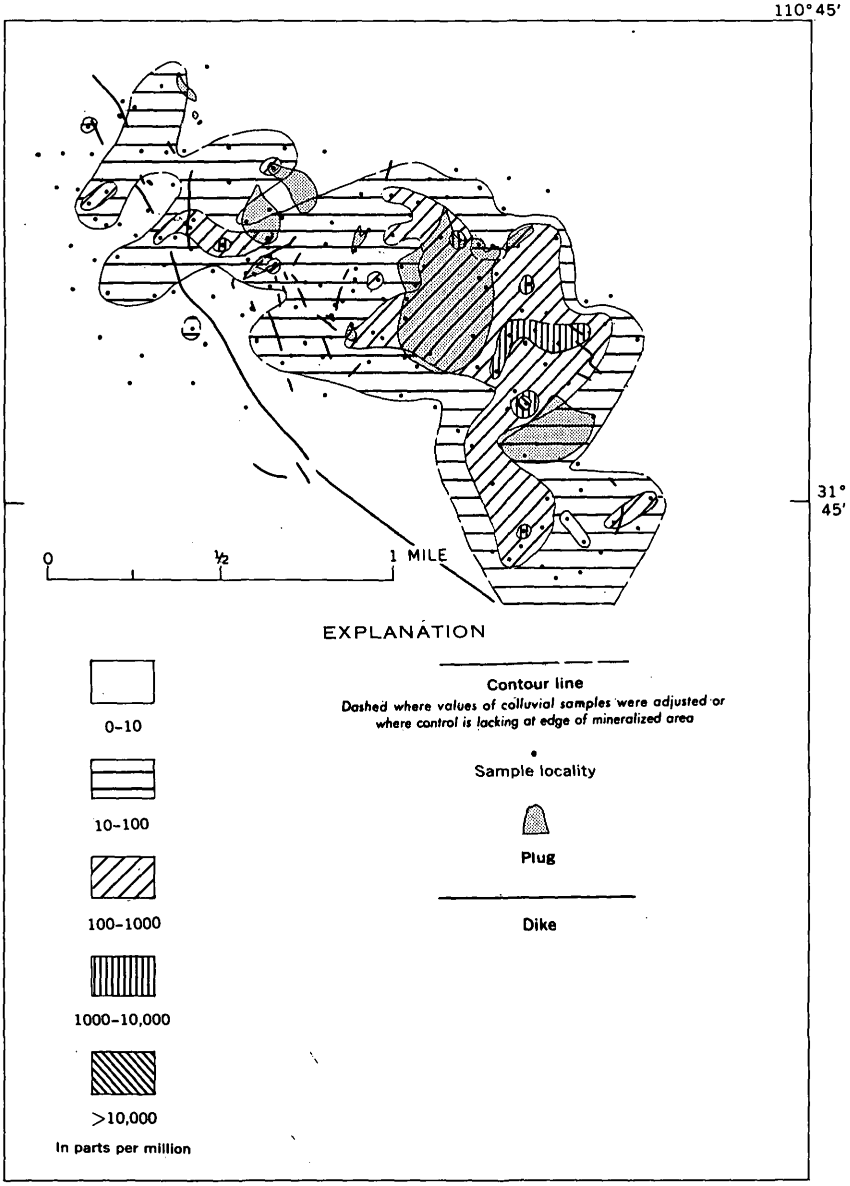

FIGURE 4.—Distribution of arsenic in the Greaterville area, Arizona.

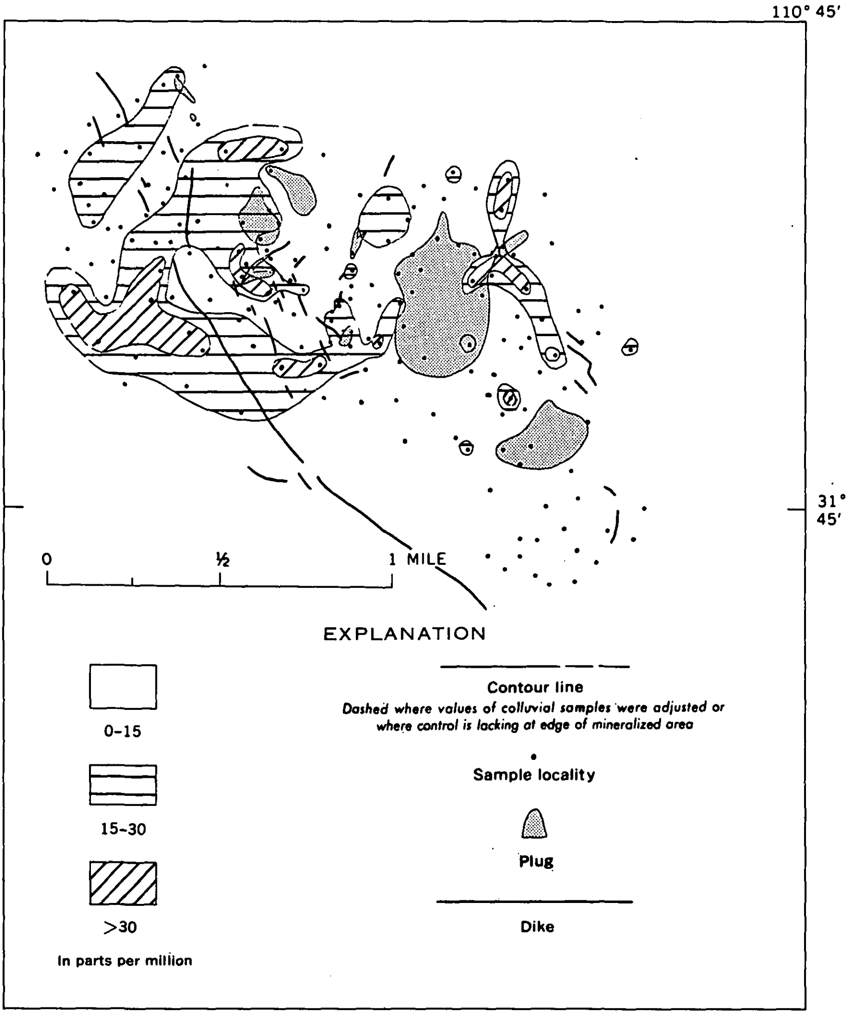

FIGURE 5.—Distribution of boron in the Greaterville area, Arizona.

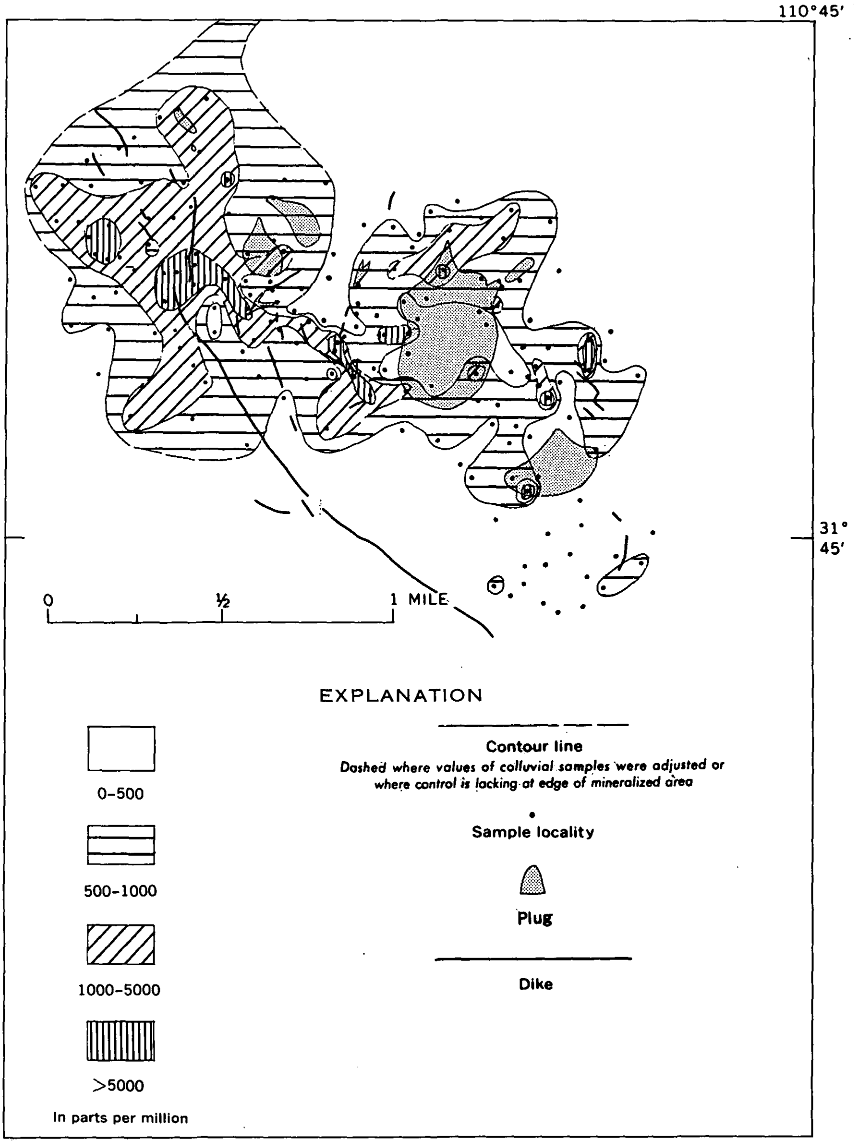

FIGURE 6.—Distribution of barium in the Greaterville area, Arizona.

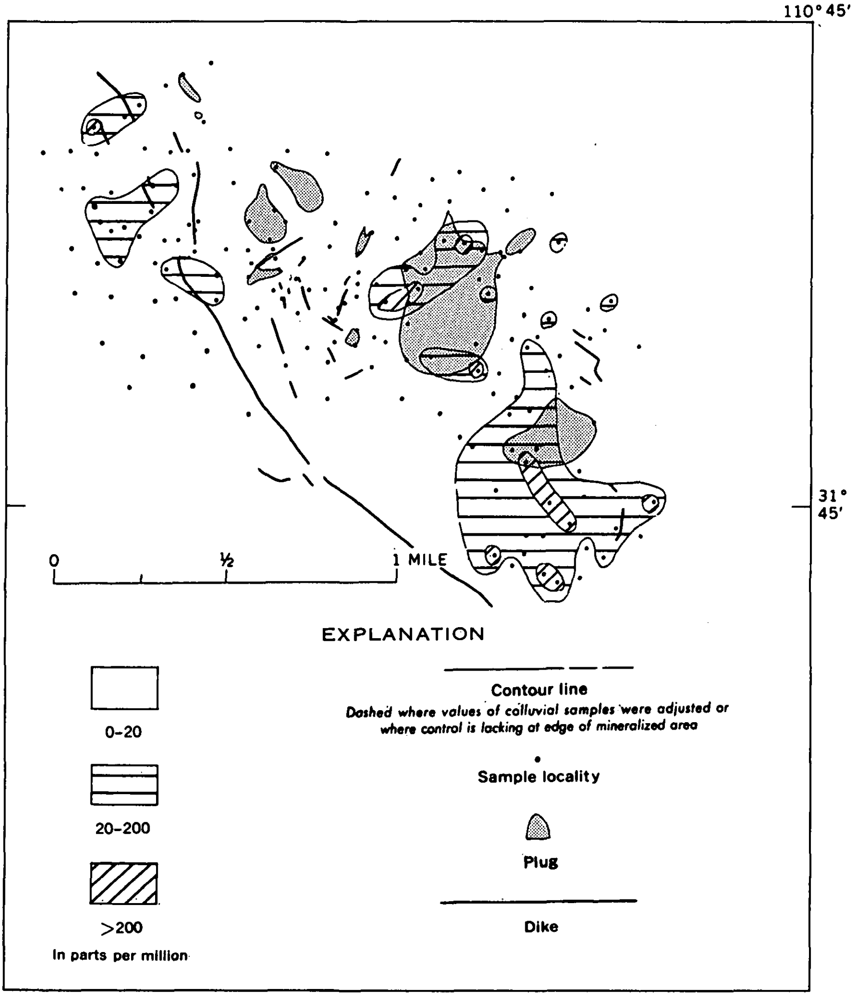

FIGURE 7.—Distribution of bismuth in the Greaterville area, Arizona.

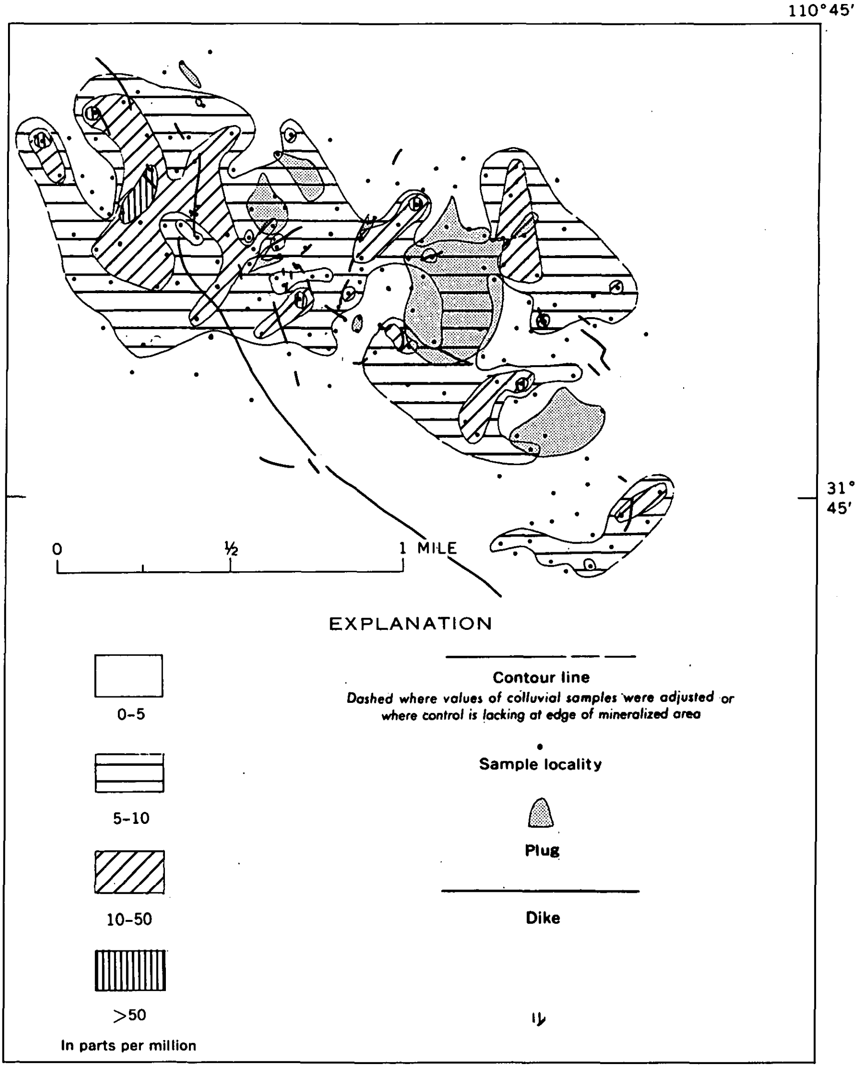

FIGURE 8.—Distribution of cobalt in the Greaterville area, Arizona.

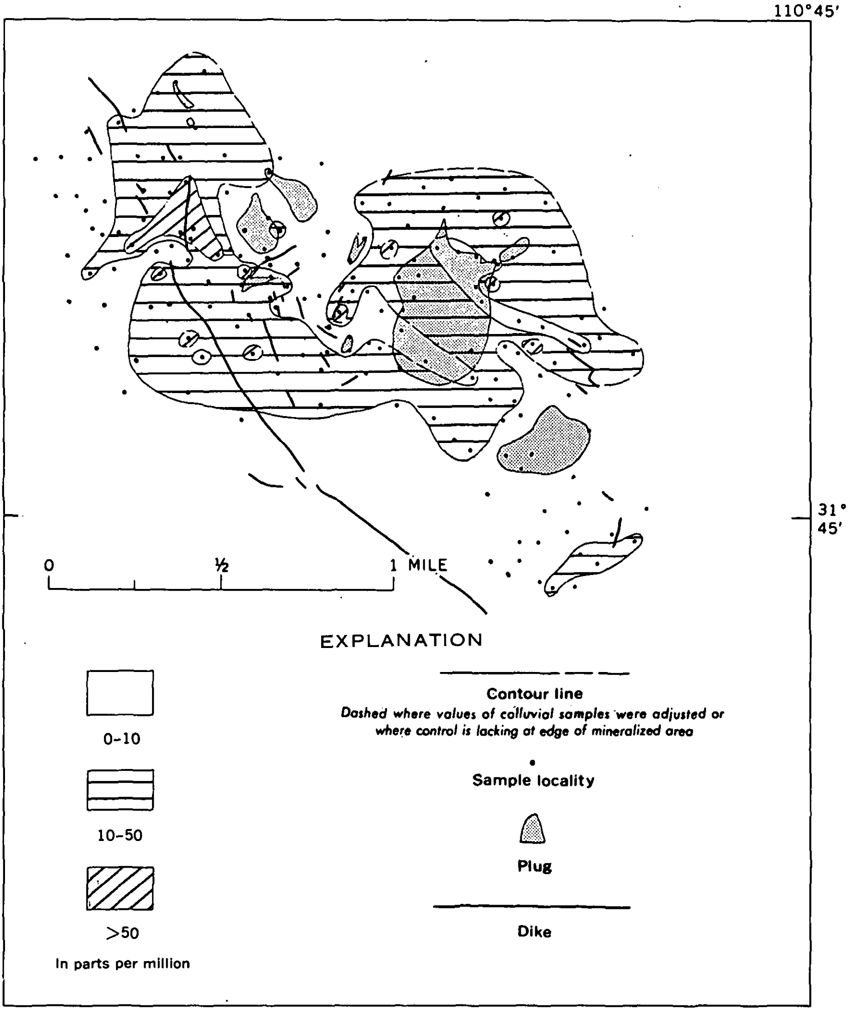

FIGURE 9.—Distribution of chromium in the Greaterville area, Arizona.

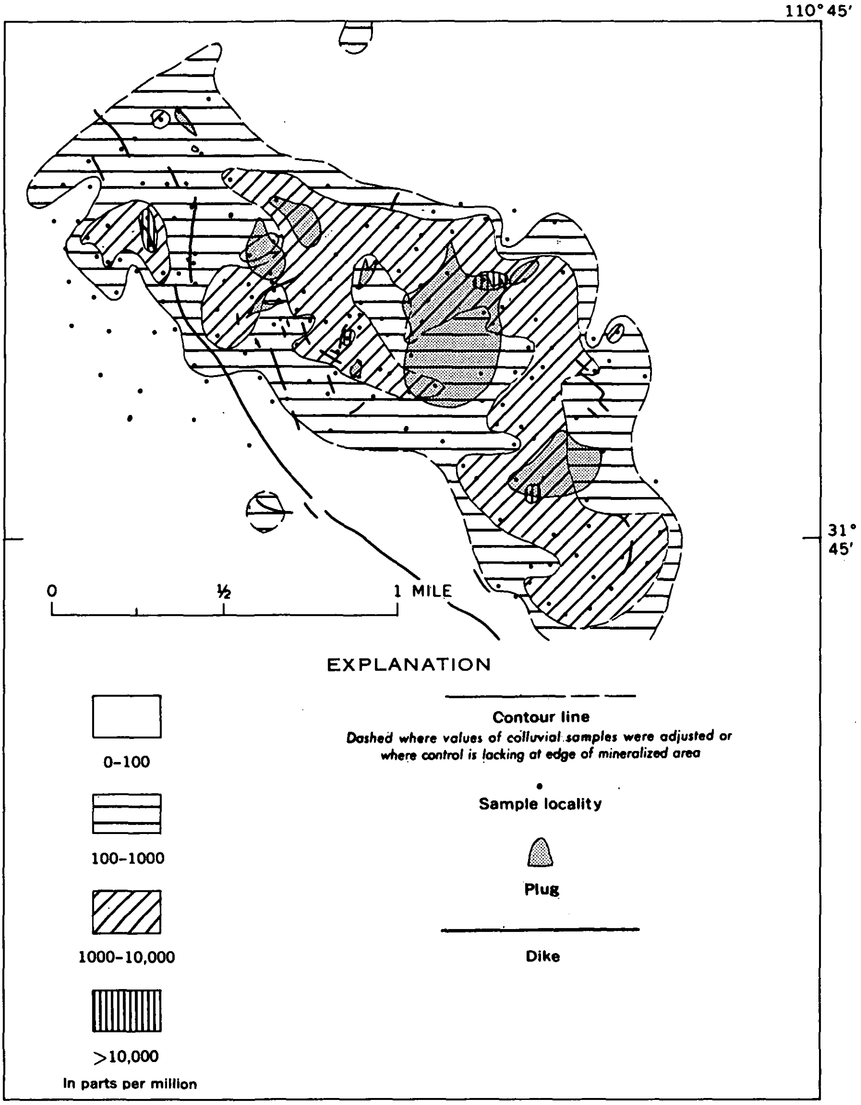

FIGURE 10.—Distribution of copper in the Greaterville area, Arizona.

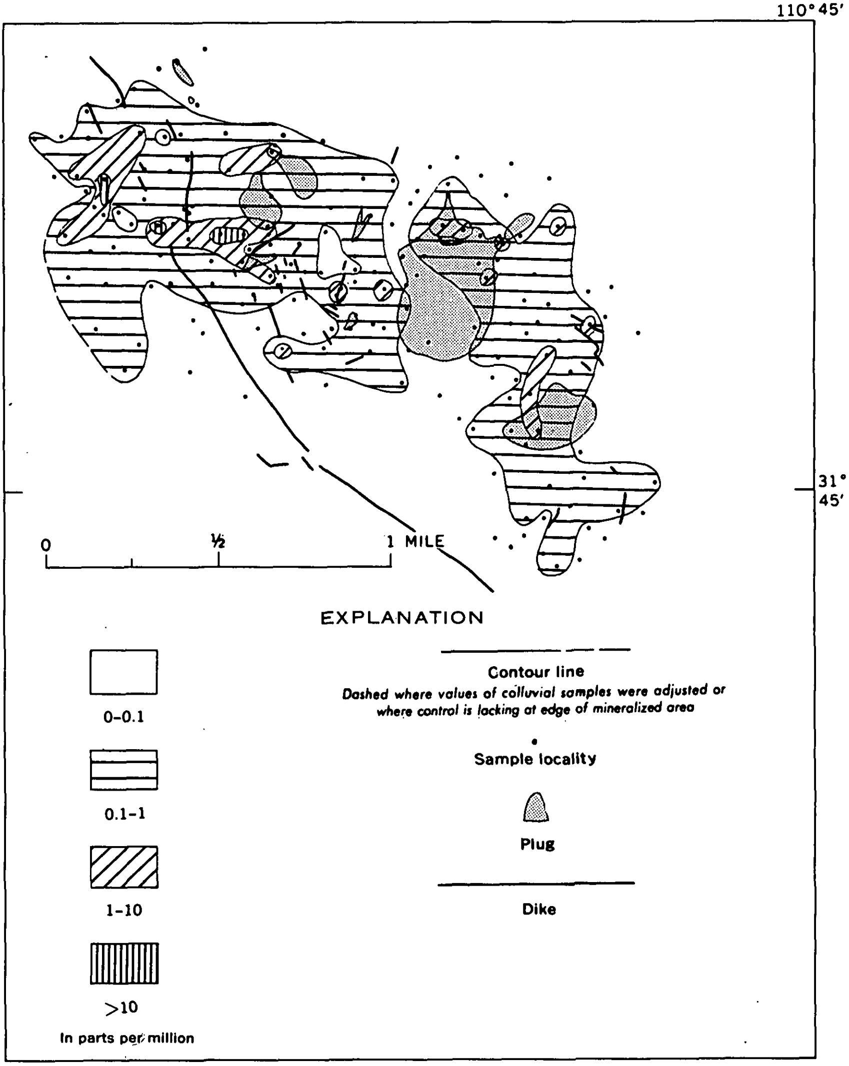

FIGURE 11.—Distribution of mercury in the Greaterville area, Arizona.

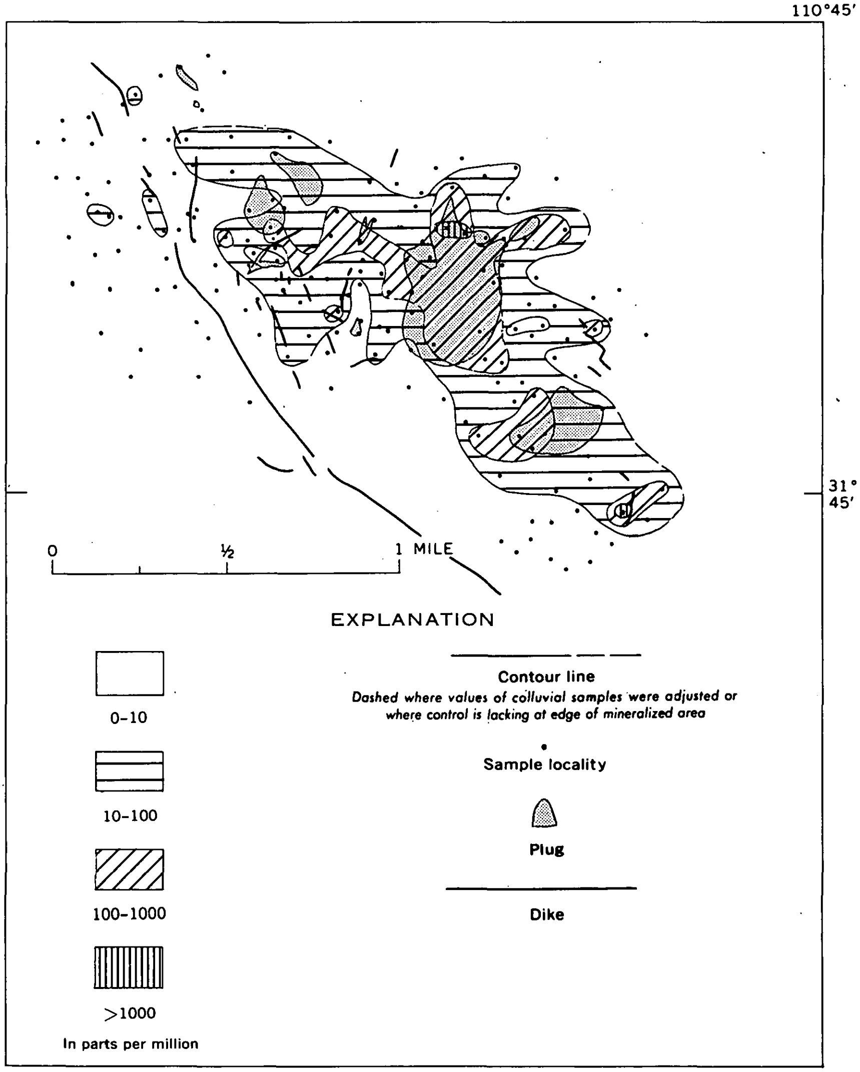

FIGURE 12.—Distribution of molybdenum in the Greaterville area, Arizona.

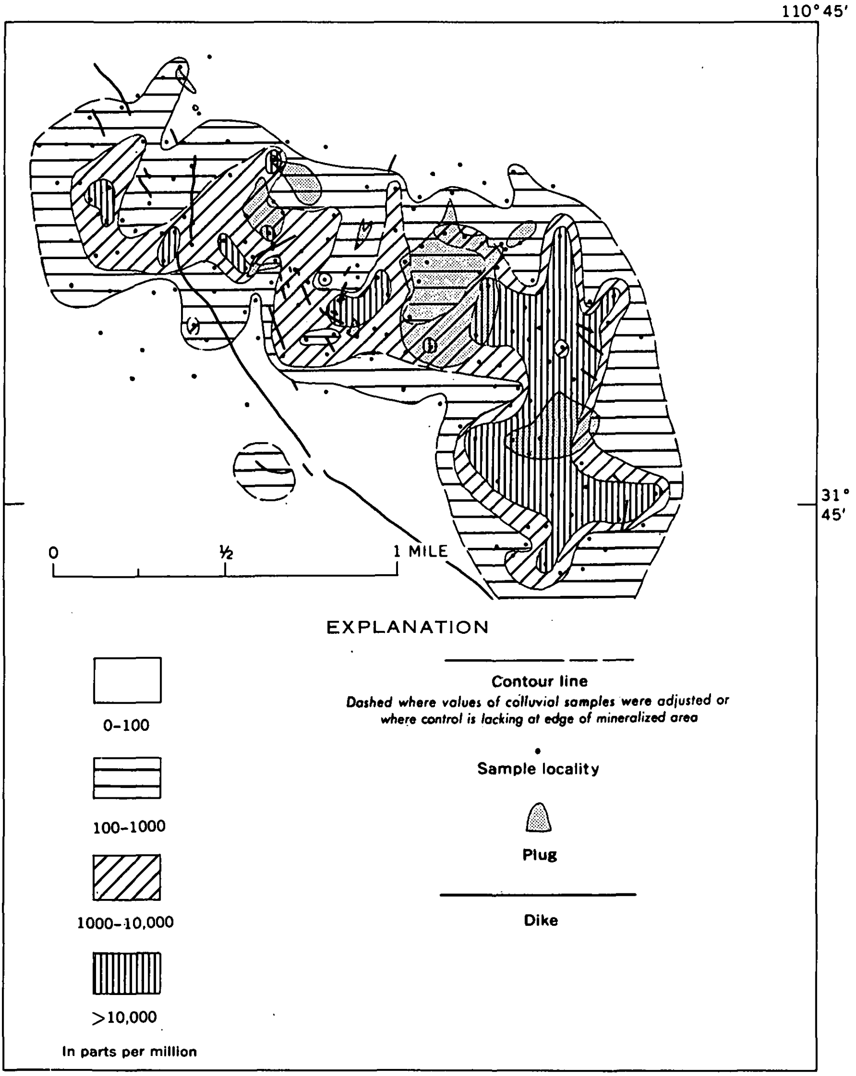

FIGURE 13.—Distribution of lead in the Greaterville area, Arizona.

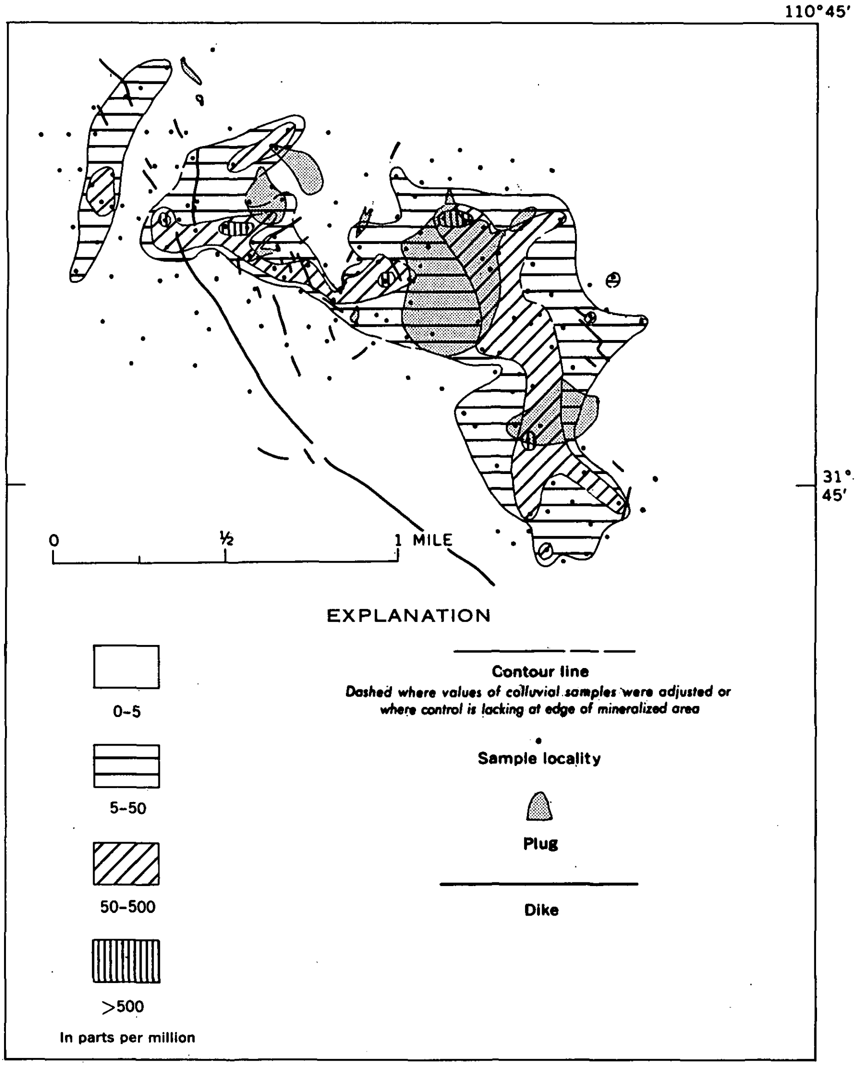

FIGURE 14.—Distribution of antimony in the Greaterville area, Arizona.

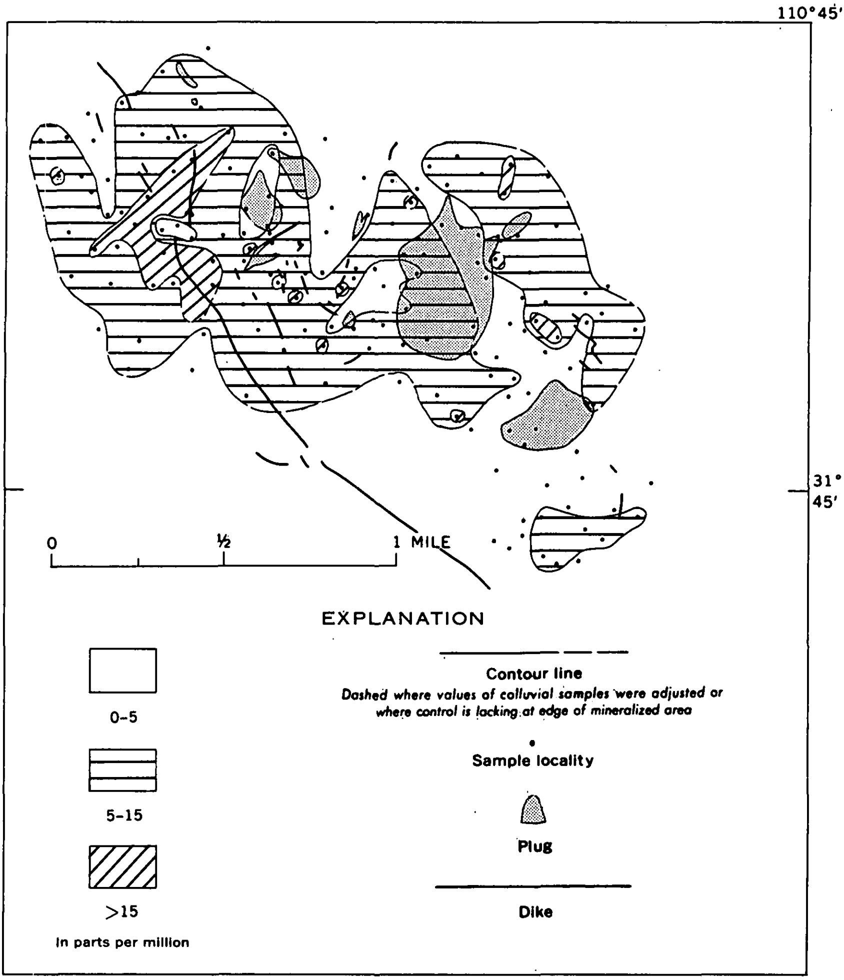

FIGURE 15.—Distribution of scandium in the Greaterville area, Arizona.

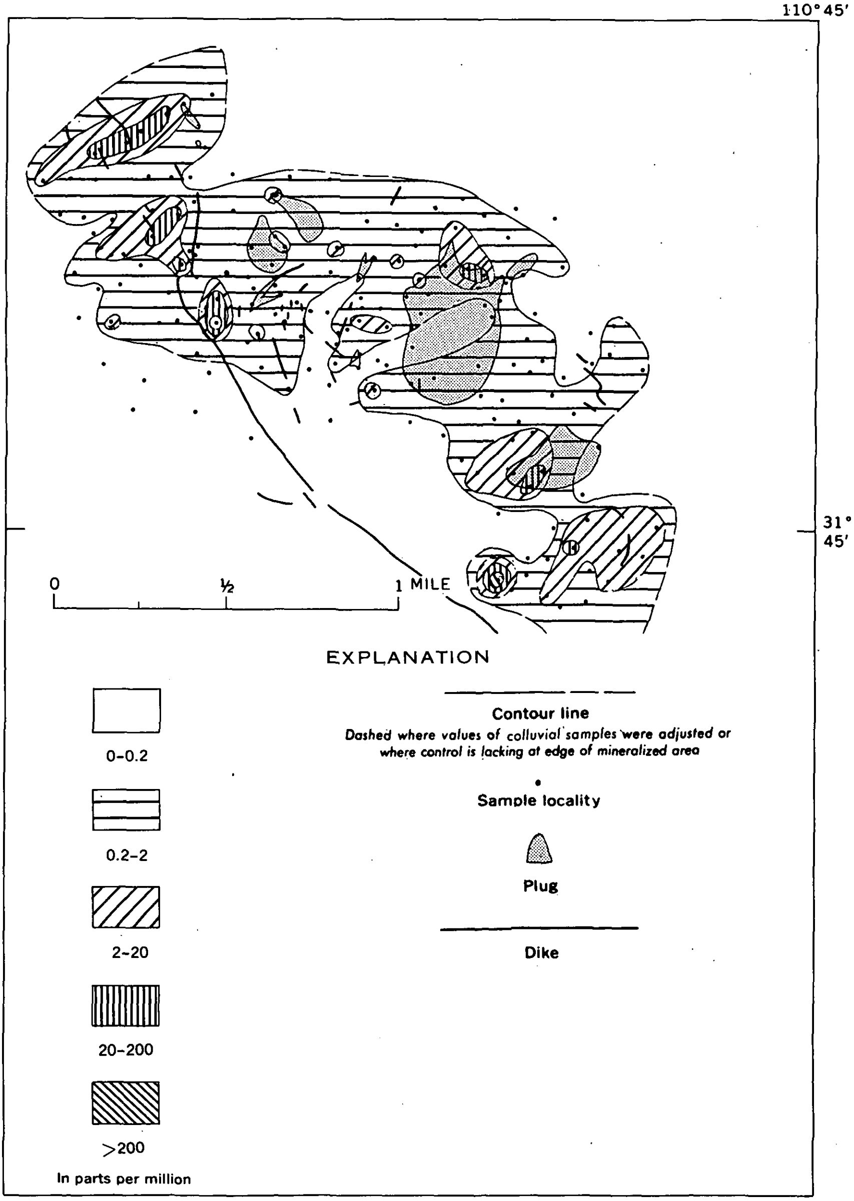

FIGURE 16.—Distribution of tellurium in the Greaterville area, Arizona.

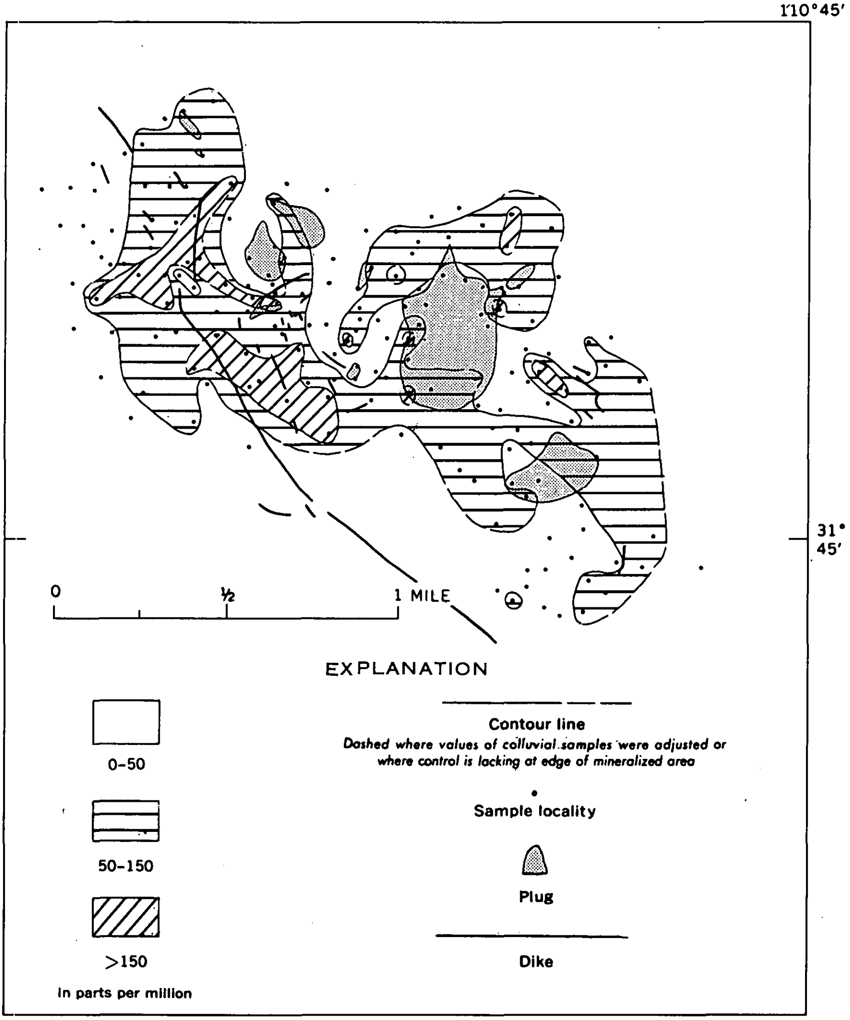

FIGURE 17.—Distribution of vanadium in the Greaterville area, Arizona.

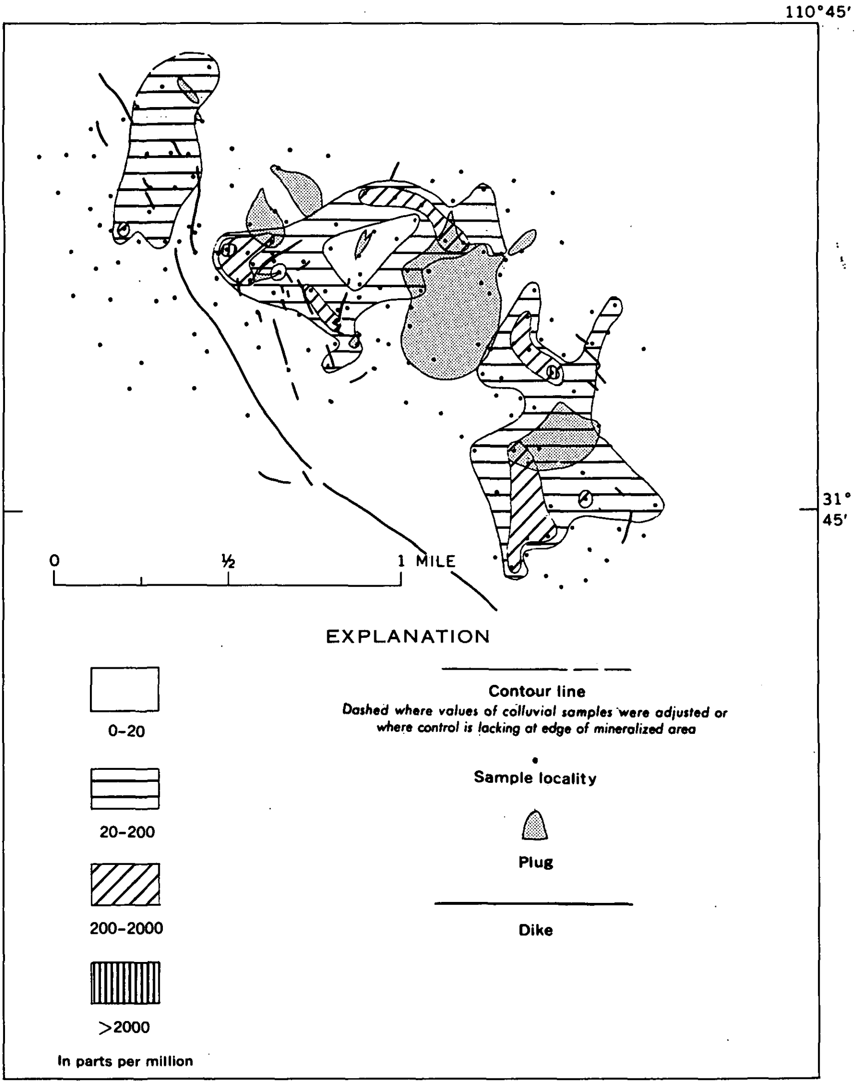

FIGURE 18.—Distribution of tungsten in the Greaterville area, Arizona.

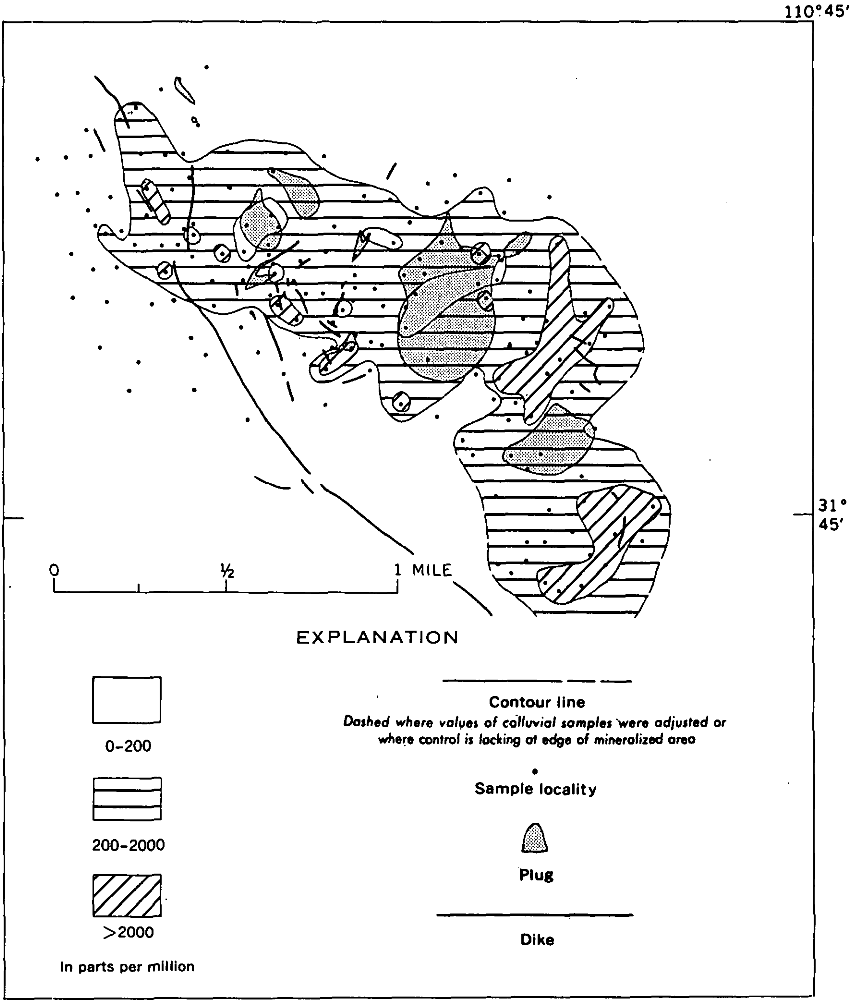

FIGURE 19.—Distribution of zinc in the Greaterville area, Arizona.

EVALUATION OF DATA

Two approaches are used to evaluate the geochemical data; one emphasizes the empirically determined spatial relations of the geochemical data to the local geology, and the other emphasizes a crude statistical evaluation of group data. More weight is placed on the first effort, because the local geology is fairly well understood and because the speculations along these lines lead more directly to ideas about where the projected mineralization has the greatest economic potential.

The distribution of 18 of the elements tested is compiled on a series of maps, figures 2–19, that also show the outcrops of the Paleocene intrusive rocks. In addition, the distribution of the mineralization, considering not only location of peak concentrations of individual elements but also the frequency of occurrence of elements in anomalous abundance, is plotted in figure 20. In general all these maps, and in particular figure 20, show the close spatial relation of a mineralized area with the roughly elliptical area occupied by the quartz latite porphyry. This relation points to a genetic association of the mineralization with the intrusives. Examined in somewhat greater detail, the elliptical areas of mineralized ground in figures 3–12 are indented along their southwest edges. This indentation may be spurious and may reflect a lack of data rather than a real absence of mineralization. Prospects are virtually absent from the area south of elevation 5,600 feet (fig. 2), and if veinlets are present west of the Greaterville-Fish Canyon road, they are difficult to find because of the relatively thick cover of colluvium. Likewise, with additional effort, the mapped area of mineralization probably can be extended farther southeast and farther north.

In addition to the broad spatial association of the mineralization to the intrusive bodies, there are several other obvious associations with structures. Mineralization seems to be largely restricted to rocks of the upper plate. As shown on plate 1, the mineralization spreads along the trace of the thrust fault, and it occurs in the rocks of the lower plate to the northwest in line with the intrusives. Both the quartz latite porphyry intrusives and the major axis of the elliptical core of mineralized ground lie along the Boston syncline, which does not extend down into the lower thrust plate. Apparently the magma and ore-forming fluids alike found access easier along the fractured trough of the fold than to the southwest, where the tighter folds indicate that the rocks there are more compressed, or to the northeast, where the bedding is subparallel to the thrust plate and thus is probably less fractured.

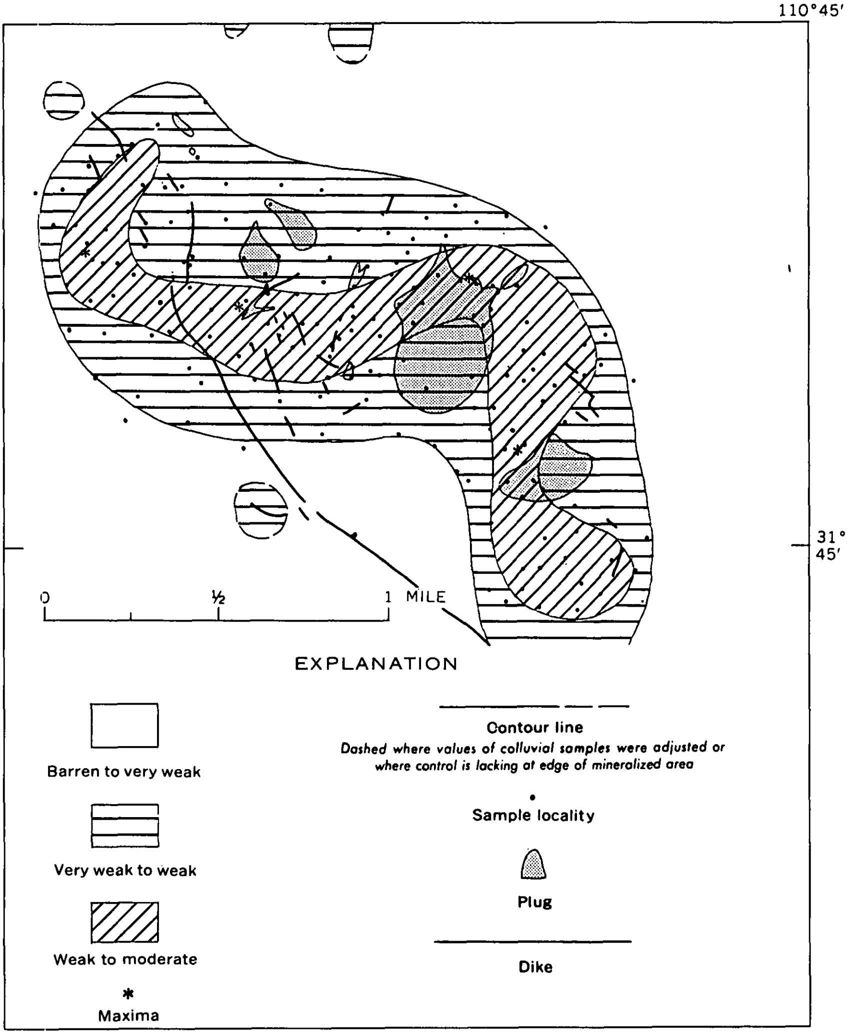

FIGURE 20.—Summary of mineralization in the Greaterville district, Arizona. Sample localities, dikes, and plugs are shown for reference.

The zone of strongest total mineralization, shown in figure 12, has a sinuous trend that swings southwest of the exposed plugs at the head of Ophir Gulch, northeast of the main plug lower in Ophir Gulch, and southwest of the plug at the head of Boston Gulch. The sinuous zone thus crosses and recrosses the axis of the Boston syncline, as well as the belt of plugs. This sinuosity of the moderately strongly mineralized rock cannot be explained from known geologic features at the surface; however, it may be caused by the subsurface configuration of sill-like wedges of porphyry intruded along the thrust fault beneath the Bishbee Group, much as the porphyry is known to intrude faults elsewhere.

The distribution of four areas of maximum mineralization within the sinuous zone are also shown in figure 20. The westernmost of these localities is probably related to the tear fault bounding the thrust plate, a fault along which movement of mineralizing fluids might readily be concentrated. The other three localities lie near the edges of intrusive bodies, where the rocks presumably were most favorably fractured for the concentration of mineralizing fluids. Viewed this closely, the lack of regularity of total mineralization peripherally to the stocks suggests that a more detailed stratigraphic and structural study would be useful; however, the distribution of some individual elements or groups of elements does show modified annular patterns.

In the following paragraphs the distribution of individual elements or groups of elements is discussed. Molybdenum (fig. 12) appears to be closely associated with the central plug, the high values extending outward in a few arms, especially toward smaller intrusives along the syncline axis. The concentrations of lead, copper, antimony, and tungsten (figs. 10, 13, 14, 18) are greatest peripherally to the central plug and to the core of the molybdenum anomaly, again being spread chiefly along the northwest-trending structural axis. The highest values of silver, arsenic, tungsten, zinc, and possibly also of gold (figs. 2, 3, 4, 18, 19) are distributed somewhat more erratically but farther from the central plug than the lead group of elements. The overlap in distribution of the area of highest concentration of the lead group is greater with that of the silver group than it is with molybdenum. The other elements tested, largely of the lithophile type, show no obvious symmetry with respect to the central intrusion. This zonation of many metals reinforces the belief that plugs and mineralization are genetically associated, and the particular zonation around the central intrusion supports the idea that the plug and the mineralizing solutions followed the same conduit (pl. 1, section *A–A′*). The northwest elongation of the zone pattern around the stock is believed to reflect the basic structural controls on plugs and mineralization; the mineralizing fluids presumably leaked away from the central plug partly along the thrust fault and especially along the fractured trough zone of the syncline and perhaps locally also along minor cupolas and sills of intrusive rock that were injected along the fault.

There is another less conspicuous asymmetry of distribution of anomalously high metal values with respect to the central stock; some metals are more heavily concentrated to the southeast, downdip of the thrust plane, and others are more heavily concentrated to the northwest, updip on the thrust plane. Highest concentrations of lead, arsenic, zinc, and bismuth lie a relatively short distance southeast of the central stock. On the other hand, most of the highest concentrations of mercury, tellurium, vanadium, and gold lie a relatively long distance to the northwest of the stock. Apparently the mineralizing fluid leaked preferentially updip along the thrust plane and fold axis and carried with it a relatively large amount of the more volatile elements. In addition, the less strongly enriched elements, chiefly the lithophiles, including boron, barium, cobalt, chromium, and scandium (figs. 5, 6, 8, 9, 15), are most abundant northwest of the central plug. However, an explanation of the preferred concentration of the metals southeast of the central plug is more speculative; perhaps a second conduit was used by the magma and mineralizing fluid (pl. 1, section *A–A′*) to the level of the thrust plane, or perhaps the fluids replaced a fault slice of Paleozoic host rock, from which the excess mineralizing fluid leaked upward.

A crude statistical evaluation of the group data of the analyses is based on the list of associated elements on table 3, which shows association of elements in their highest 10 percentiles. A strong positive association between silver and arsenic, for example, indicates that when silver is abundantly present arsenic is usually also abundantly present; and a strong negative association between silver and chromium, for example, indicates that when silver is abundantly present chromium is usually absent. Examining the associations of the elements in their lowest 10 percentile range, which would give a truer basis of negative association, is impractical because at their low values of abundance many elements are at or below their detection limits. The table shows a positive association between two groups of elements, associations that are a composite effect of initial emplacement, secondary movement, if any, and weathering, if any. One group, chiefly of the sulfophile elements, includes silver, arsenic, cadmium, lead, antimony, and less strongly also barium, bismuth, copper, mercury, molybdenum, strontium, tellurium, tungsten, and zinc. The other group, chiefly of the lithophile elements includes chromium, nickel, scandium, vanadium, yttrium, and less strongly also boron, beryllium, cobalt, lanthanum, niobium, and zirconium. The other analyzed elements are less restricted in their associations. The sulfophile elements appear, at first glance, to be more gregarious than the others—that is, where any one is present, most others are also present, but this probably is the result of the predilection for analyzing these elements in order to show common types of mineralization.

TABLE 3.—*Analytic results, in parts per million, condensed to show range of values and associated elements*

[Analyses by semiquantitative spectrographic method, except as noted. N, not detected; C.C., concentration coefficient]

	Detection limit	Range of values						Associated elements (with respect to highest 10 percentile)			
		Absolute		Middle 80 percentile		Middle 60 percentile		Positive		Negative	
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Strong (C.C.>0.5)	Weak (C.C. 0.25-0.5)	Weak (C.C. 0.05)	Strong (C.C. 0)
Ag	0.5	2,000	N	150	0.5	30	1.5	Ba, Cd, Pb, Sb	As, Bi, Cu, Hg, Mo, Sr, Te, W, Zn	B, Be, Nb, V	Cr, La, Ni, Sc, Sr, Zr
As	200	>10,000	N	1,000	<200	200	<200	Ag	Cd, Mo, Mu, Pb, Sb, W, Zn	Cr, Hg, Ni	La, Zr
As [1]	10	14,000	<10	400	<10	160	<10		Ag, Co, Mo, Sb, W, Zn, V, Y	Hg	La, Nb, Zr
Au [2]	.02	19	<.02	.44	<.02	.14	.02		V, Y	Cr, La, Nb, Sr, Sn	Cu
B	10	70	N	30	<10	15	<10		Be, Cr, La, Ni, Sc, V, Y	Ag, Ba, Cd, Sb, Sn, Zn	Bi, Cu, Pb, Te
Ba	20?	>5,000	20	5,000	100	1,000	300	Ag, Sb	Cd, Hg, Mn, Pb, Sb, Sr, W, Zn	B, Co, Cr, La, Sc, Sn, Zr	Ni
Be	1	7	<1	3	1	1.5	1		B, Co, Cr, Ni, Sc, V, Y	Ag, Bi, Cd, Nb, Pb, Sn, Sr	Te
Bi	10	700	N	100	N	20	N		Ag, Cu, Mo, Te, Zn	Be, Bi, Nb, Sn, Sr	B, Hg, Zr
Cd	20	300	N	20	N	N	N	Ag, Pb, Sb, Zn	As, Ba, Hg, Sr	B, Be, Te, V	Cr, La, Ni, Sc, Zr
Co	5	100	N	15	N	7	N		As, Be, Cr, Cu, Mn, Mo, Nb, Ni, Sc, Y	Ba, Hg, Sn, Sr	
Cr	5	50	N	20	5	20	5	Nb, Ni, Sc, V	Be, B, Co, La, Y, Zr	As, Au, Ba, Hg, Sb	Ag, Cd, Pb
Cu	5	>20,000	5	3,000	70	1,500	200		Ag, Bi, Co, Mo, Sb, Te, W, Zn	Bi, La, Sn	Au, B, Zr
Hg [2]	.02	60	<.02	2.6	.035	.8	.05		Ag, Ba, Cd, Sb, Sr, Y	As, Co, Cr, La, Sc, Te	Bi, Nb, Ni
La	20	100	N	50	N	20	N		B, Cr, Ni, Sc, V, Y	Au, Ba, Cu, Hg, Mo, Sn, Te	Ag, As, Cd, Mn, Pb, Sb

Mn	50	>5,000	50	3,000	200	2,000	500		As, Ba, Co, Ni, Zn	Sn	La
Mo	5	>2,000	N	200	N	30	N		Ag, As, Bi, Co, Cu Pb, Sb, Sn, W, Zn	La, Sc	Nb, Ni, Zr
Nb	10	30	N	20	<10	10	<10	Cr	Co, Ni, Sc, V, W, Zr	Ag, Au, Be, Bi	As, Hg, Mo, Sr
Ni	5	50	N	15	N	7	<5	Cr, Sc	B, Be, Co, La, Nb, V, Y, Zn	As, W	Ag, Ba, Cd, Hg, Mo, Pb, Sb
Pb	10	>20,000	15	>20,000	50	15,000	150	Ag, Cd, Sb	As, Ba, Mo, Sb, Sr, W, Zn	Be, V	B, Cr, La, Ni, Sc, Zr
Sb	100	10,000	N	500	N	150	N	Ag, Ba, Cd	As, Cu, Hg, Mo, Pb, Sr, W	Cr, Sn	La, Ni, Sc, Zr
Sb[1]	.5	3,500	<.5	200	.5	70	1	Ag, Cd, Pb	As, Ba, Cu, Hg Mo, Sr, W, Zn	B, V	La, Zr
Sc	5	15	N	10	N	7	<5	Cr, Ni, Y	B, Be, Co, La, Nb, V, Zr	Ba, Mo, Hg	Ag, Cd, Pb, Sb
Sn	10	50	N	10	N	N	N		Mo	Au, B, Ba, Bi, Be, Co, Cu, La, Mn, Sb, Sn, Y, Zr	Sr
Sr	100	5,000	N	500	N	200	N		Ag, Ba, Cd, Hg, Pb, Sb, Y	Au, Be, Co, Zr	Nb, Sn
Te[2]	.1	264	<.1	19	<.1	3.1	.1		Ag, Bi, Cu, Zn	Cd, Hg, La	B, Be
V	10	200	N	100	15	70	20	Cr, Y, Zr	Au, B, Be, La, Nb, Ni, Sc	Cd, Pb, Sb, Sn, W	
W	20	7,000	N	200	N	50	N		Ag, As, Ba, Cu, Mo, Nb, Pb, Sb	Ni, V	Zr
Y	10	100	N	30	<10	30	10	Sc, V	Au, B, Be, Co, Cr, Hg, La, Ni, Sr, Zr	Sn	
Zn	200	>10,000	N	2,000	N	1,000	<200	Cd	Ag, As, Ba, Bi, Cu, Mo, Mn, Pb, Ni, Sb, Te	Zr	
Zr	10	>1,000	N	300	20	200	50	Y	Cr, Nb, Sc, Y	Ba, Sn, Sr, Zn	Ag, As, Bi, Cd, Cu, Mo, Pb, Sb, W

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[1] Field method wet test.
[2] Atomic absorption.

The elements of potentially the greatest economic significance in the Greaterville district are gold, silver, copper, lead, zinc and molybdenum. By statistical association gold seems to favor slightly the group of elements composed largely of lithophiles, especially vanadium and yttrium, and seems to favor least the habitat of copper. This would indicate that it does not seem desirable to explore for gold by use of indicator elements, such as mercury, unless one considers that the more mobile mercury may be concentrated near gold rather than with it. Its strong negative association with copper is believed to reflect the contrast in the secondary mobility of the two elements; gold, to judge from the nearby placer deposits, is in the relatively stable native form (native gold was seen in the field), and copper was commonly in a mobile form to become deposited as oxides.

Some of the elements of greatest economic potential in the district are also those most strongly concentrated with respect to their normal crustal abundance. For instance, silver, gold, antimony, and tellurium are enriched more than 10,000 times their clarke. The elements arsenic, bismuth, cadmium, mercury, molybdenum, and tungsten are enriched at least 1,000 times; copper, lead, and zinc, at least 100 times; and tin, about 25 times. Most of the remainder of the elements tested are only slightly enriched or are essentially at their clarke.

SUMMARY

Geochemical reconnaissance of the Greaterville district, combined with regional mapping, confirms that an area of at least 2 square miles was slightly mineralized with base and noble metals. It reveals that values are highest along the Boston syncline near the bodies of quartz latite porphyry and lends support to a long-suspected genetic relationship. The regional habit of this porphyry and the local irregularities of the mineralization suggest that the porphyry forms an irregular body at depth, most likely extending some distance along the low-dipping base of the sedimentary rocks, a contact inferred to be thrust faulted. The thrust fault is suspected to lie at a depth of about 2,000 feet in the central part of the district and to dip gently southeastward.

Stronger mineralization is anticipated in the Bisbee Group at depth near the thrust fault, especially along the trough of the fold and near the porphyry plugs. The chance of finding thrust slivers of Paleozoic rock beneath the Bisbee in the southeastern and even in the central part of the district, though speculative, may be worth testing. If present, such rocks would greatly enhance the possibility for a strong concentration of metals. Values are expected to be chiefly in silver and base metals, as in the Rosemont and Helvetia districts to the north, and at the 1,500- to 2,000-foot depth at which greatest mineralization is anticipated, these metals should occur as sulfides rather than as the mixed oxides and sulfides that appear at the surface. Significant gold mineralization may be present also and based on surface indications, values should be greatest in abundantly fractured rock, such as might be expected along the syncline trough and intrusive margins. This zone is closest to the surface in the northwest end of the district. Gold may be expected to become an important byproduct to a base-metals and silver operation.

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Root, W. A., 1915, Dredge mining operations in the Santa Rita Mountains, Arizona: Mining and Eng. World, v. 42, p. 377.

Schrader, F. C., 1915, Mineral deposits of the Santa Rita and Patagonia Mountains, Arizona: U.S. Geol. Survey Bull. 582, 373 p.

TABLE 4

TABLE 4.—*Geochemical analyses of*

[Semiquantitative spectrographic analyses: E. L. Mosier and J. M. Motooka. Chemical analyses: Au, John Te, R. L. Turner. N,

Semiquantative spectrographic analyses [1] (ppm)														
Sample No. [2]	Ag	B [3]	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Mn	Nb	Ni
Base of colluvium														
249	<0.5	<10	500	2	N	N	5	15	100	50	<5	1,000	<10	5
251	<.5	<10	1,000	2	N	N	7	20	150	30	<5	1,500	10	10
254	N	10	1,000	1	N	N	5	20	30	30	<5	1,000	10	7
255	70	20	1,500	5	N	N	10	30	700	50	30	>5,000	<10	15
260	1	10	1,000	2	N	N	5	30	100	50	N	500	<10	15
268	N	10	1,000	1	N	N	5	20	30	30	N	500	<10	10
273	<.5	15	700	1	N	N	5	<10	200	30	15	300	<10	5
275	2	10	1,000	1	N	N	<5	30	700	50	7	500	<10	5
279	1.5	20	700	1	N	N	5	20	500	30	<5	500	<10	7
282	1	10	500	3	N	N	7	20	700	30	N	1,000	<10	10
301	1.5	10	500	2	N	N	10	20	700	50	10	1,000	<10	10
305	.5	20	1,000	1.5	N	N	<5	10	150	30	15	300	<10	5
309	1	20	1,000	1.5	N	N	10	30	150	50	N	500	<10	10
323	N	<10	500	2	N	N	7	10	50	50	N	300	<10	7
326	<.5	15	500	3	N	N	5	30	30	50	N	300	<10	10
329	N	10	1,000	1	N	N	7	20	15	30	N	500	<10	5
359	1	10	700	2	N	N	7	30	700	30	5	300	<10	7
361	1	<10	700	2	N	N	10	50	700	50	5	500	<10	15
363	2	30	500	3	N	N	10	30	1,000	50	30	300	<10	10
Top of colluvium														
250a	0.5	20	1,000	2	N	N	5	50	100	50	N	700	10	10
250b	<.5	20	1,500	3	N	N	10	50	70	70	N	1,500	15	15
252a	.5	15	1,000	2	N	N	10	50	70	50	N	1,000	10	15
252b	.5	15	1,000	2	N	N	10	30	50	50	N	700	10	15
253a	.5	15	1,000	2	N	N	10	50	70	70	N	1,000	<10	15
253b	<.5	20	1,000	2	N	N	10	50	70	70	N	1,500	10	15
256a	1.5	10	700	3	N	N	10	70	150	50	N	500	<10	10
256b	.7	20	700	2	N	N	10	50	150	50	N	1,500	<10	10
259	1	20	700	2	N	N	10	50	300	50	N	1,000	10	15
267	<.5	15	700	2	N	N	10	50	50	70	N	1,000	10	15
272	.7	20	500	3	N	N	5	15	300	30	N	1,000	<10	7
274	7	20	700	2	N	N	15	50	1,000	70	10	1,500	15	15
278	1	20	500	2	N	N	10	20	300	30	7	770	10	10
281	1.5	20	500	3	N	N	15	50	500	50	<5	1,500	10	15
300	3	20	500	5	N	N	15	50	700	50	5	1,500	10	15
304	1	20	500	2	N	N	5	20	300	30	5	700	<10	5
308	1.5	20	500	3	N	N	10	50	300	70	N	1,000	10	10
322	<.5	20	500	3	N	N	10	70	300	70	N	1,000	15	20
325	N	50	700	5	N	N	10	50	150	70	N	2,000	10	10
328	N	30	1,000	3	N	N	10	50	70	70	N	2,000	10	10
360	2	20	1,000	3	N	N	10	50	700	70	7	1,000	10	15
362	5	30	1,000	2	N	N	10	50	300	50	7	1,000	15	15
Rock chips														
257	1,500	20	>5,000	3	N	300	15	5	5,000	<20	500	3,000	N	7
258	700	30	500	1.5	N	200	<5	5	150	N	50	1,500	N	7
261	300	30	5,000	3	N	N	7	20	5,000	50	15	2,000	10	10
266	5	15	500	1	N	N	7	20	150	30	N	1,500	20	5
269	10	30	300	5	N	N	<5	10	200	20	20	3,000	10	7
270	.7	15	500	1	N	N	5	15	100	30	N	1,000	20	<5
271	20	<10	1,500	2	N	N	20	5	1,000	<20	200	>5,000	N	<5
276	7	<10	200	2	100	N	5	10	500	50	700	500	N	<5
277	20	<10	150	<1	200	N	N	15	1,500	<20	500	50	N	<5
280	1.5	10	300	1.5	N	N	<5	5	150	20	30	150	<10	<5
283	30	10	200	3	50	N	<5	7	2,000	<20	300	200	N	5
299	30	70	1,000	3	N	N	5	<5	1,500	20	300	150	<10	<5
302	15	30	700	1.5	N	N	7	<5	300	<20	500	700	<10	<5
303	100	<10	100	1	50	N	<5	7	1,500	N	200	1,000	N	7
306	5	30	200	7	N	N	15	20	1,000	N	<5	2,000	<10	10

See footnotes at end of table.

colluvium and rocks at Greaterville, Ariz.

Watterson; As, E. P. Welsch and J. B. McHugh; Hg, W. W. Janes; Sb, Thelma Harms and J. H. Turner; not detected]

Semiquantitative spectrographic analyses [1] (ppm)—Continued									Chemical analyses (ppm)				
Pb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Au	As	Hg	Sb	Te
Base of colluvium—Continued													
15	10	<10	200	50	<50	30	200	300	<0.02	10	<0.01	1	0.3
30	10	<10	100	70	<50	30	1,000	150	<.02	20	<.01	2	.2
<10	5	<10	100	50	N	30	N	500	<.02	<10	<.01	<0.5	.1
500	10	<10	<100	300	150	30	3,000	100	<.02	60	.80	600	.1
<10	10	N	100	70	<50	30	300	200	<.02	<10	.06	4	<.1
<10	5	N	100	50	N	15	<200	300	<.02	<10	<.01	<.5	.4
<10	<5	N	300	30	N	10	N	150	<.02	<10	<.01	2	<.1
<10	5	N	150	50	N	30	N	200	<.02	<10	<.01	1	.3
10	5	N	200	50	N	30	<200	200	<.02	20	<.01	8	<.1
<10	10	<10	200	70	N	30	200	150	<.02	<10	.04	2	.3
<10	10	<10	150	70	N	30	200	150	.02	30	.04	10	.3
70	5	N	200	50	N	10	500	150	.06	10	.04	2	<.1
10	15	N	100	100	N	30	300	300	1.4	40	<.01	4	.1
<10	15	N	200	50	N	30	N	100	<.02	<10	<.01	3	.2
<10	10	N	<100	100	N	30	N	200	<.02	<10	<.01	.5	.1
<10	10	N	150	70	N	20	N	300	<.02	<10	<.01	<.5	<.1
<10	15	<10	100	70	<50	30	300	150	<.02	<10	.06	6	<.1
10	15	<10	200	150	<50	30	200	200	<.02	<10	<.01	1	<.1
50	10	<10	<100	100	<50	50	200	150	<.02	30	.28	100	.2
Top of colluvium—Continued													
150	10	N	150	150	N	30	N	500	<0.02	10	0.03	0.5	0.1
100	10	N	150	150	N	30	200	700	<.02	<10	.04	1	.2
50	15	N	150	150	N	30	200	300	<.02	<10	.04	.5	.4
30	7	N	150	100	N	30	300	700	<.02	<10	.03	.5	.4
70	10	N	150	150	N	30	N	300	<.02	<10	.05	.5	.4
70	10	N	150	150	N	30	N	700	<.02	10	.05	.5	.2
100	10	N	<100	150	N	30	N	300	<.02	10	.05	1	.5
100	10	N	100	150	N	30	N	200	<.02	10	.07	2	.3
100	10	N	100	150	N	30	300	200	<.02	<10	.06	2	<.1
30	10	N	100	150	N	50	<200	500	<.02	<10	.03	.5	.4
70	5	N	300	100	N	15	N	300	<.02	<10	.04	1	<.1
200	10	N	200	150	<50	50	500	500	.04	10	.08	4	1.3
150	7	N	300	150	N	20	N	500	<.02	10	.09	8	.1
200	10	N	150	150	N	30	200	200	<.02	<10	.08	1	.1
150	15	N	200	150	N	50	<200	150	.04	30	.07	10	.3
500	7	N	300	100	N	20	500	300	<.02	10	.06	3	.2
150	10	N	150	150	N	30	200	300	1	30	.11	8	.2
100	15	N	150	200	N	30	<200	500	<.02	10	.10	.5	.2
100	15	N	150	200	N	50	N	500	<.02	<10	.10	1	.2
70	15	N	150	150	N	30	N	500	.02	<10	.20	.5	.1
30	15	N	150	200	50	100	<200	700	<.02	<10	.10	3	.2
200	10	N	150	150	<50	70	<200	500	<.02	<10	.20	15	<.1
Rock chips—Continued													
>20,000	<5	N	700	50	7,000	50	1,000	70	<0.02	1,200	12.00	3,500	0.1
5,000	N	N	N	30	<50	10	N	200	<.02	150	13.00	600	<.1
>20,000	10	10	300	100	1,500	50	300	200	<.02	40	5.20	100	.4
200	5	<10	200	200	N	30	N	>1,000	<.02	<10	.11	8	.4
1,000	5	N	N	150	<50	30	1,000	300	1.1	60	14.00	25	.2
50	7	<10	200	200	N	10	N	>1,000	.02	<10	.14	4	.2
10,000	<5	N	300	15	500	<10	500	20	.04	600	2.00	100	.8
5,000	<5	N	300	30	100	<10	300	50	.06	30	.02	35	.8
150	<5	50	100	100	50	<10	N	70	.20	<10	<.02	6	.6
200	<5	N	100	30	N	<10	N	150	.02	30	.10	4	.1
>20,000	5	N	N	70	N	10	300	150	.10	200	.04	35	.4
200	5	N	N	70	N	10	<200	200	.02	80	1.00	100	.4
300	<5	N	100	20	<50	10	N	150	.02	100	.50	100	.1
>20,000	<5	15	N	15	N	<10	>10,000	20	3.4	100	2.70	80	.1
300	7	N	N	50	100	30	700	300	.06	1,200	.12	45	<.1

TABLE 4.—*Geochemical analyses of*

Semiquantative spectrographic analyses [1] (ppm)

Sample No. [2]	Ag	B [3]	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Mn	Nb	Ni
Rock chips—Continued														
307	150	<10	100	1	70	100	7	10	1,500	N	300	2,000	N	5
310	7	50	200	5	N	N	N	30	500	N	70	3,000	N	15
321	30	70	2,000	7	N	N	7	30	200	30	<5	>5,000	10	20
324	<.5	50	1,000	2	N	N	<5	<5	20	30	N	500	15	5
327	N	<10	1,500	1.5	N	N	7	20	30	30	N	500	15	10
330	300	<10	>5,000	1.5	50	50	5	<5	700	20	7	500	N	7
344	1	70	500	7	N	N	30	20	30	50	N	2,000	20	30
345	7	10	300	1.5	70	N	5	5	200	70	N	200	N	5
346	.7	20	1,000	3	N	N	7	10	30	30	5	500	10	7
347	N	<10	1,500	1.5	N	N	<5	5	20	<20	N	>5,000	N	<5
348	<.5	30	150	1.5	N	N	<5	5	5	N	N	300	N	<5
349	.7	30	500	2	N	N	7	7	20	30	N	2,000	N	5
350	7	<10	150	1.5	<10	N	5	5	10	20	<5	1,000	N	5
351	500	15	>5,000	1	<10	50	<5	<5	2,000	20	N	1,000	N	<5
352	20	20	700	2	N	N	5	5	20	20	N	2,000	N	5
353	15	20	300	3	N	N	10	15	500	30	N	3,000	15	10
354	.7	<10	500	1	N	N	5	7	200	<20	30	200	10	5
355	50	<10	1,500	5	100	N	70	10	20,000	<20	N	700	N	50
356	7	30	1,500	3	N	N	<5	15	1,000	50	<5	2,000	N	<5
357	.7	<10	500	2	N	N	<5	<5	150	20	N	700	N	<5
358	N	15	100	1	N	N	<5	10	70	30	N	1,000	<10	<5
364	2	10	70	<1	N	20	5	7	200	20	N	1,500	10	5
365	.7	10	1,500	<1	N	N	<5	30	200	30	N	500	30	<5
366a	N	15	500	2	N	N	<5	10	30	20	N	500	N	5
366b	<.5	<10	500	1	N	N	5	10	100	20	N	1,000	15	10
367	N	15	700	1.5	N	N	<5	7	30	20	N	300	10	5
368a	1	10	150	1.5	N	N	<5	15	1,000	<20	10	200	N	10
369a	300	N	300	2	50	50	<5	7	2,000	<20	200	500	N	<5
370a	5	10	1,500	2	N	N	<5	5	150	20	10	70	<10	5
371a	1.5	20	700	2	N	N	5	15	100	30	<5	500	10	5
372a	2	10	200	2	N	N	7	10	100	20	N	5,000	10	5
373a	30	<10	100	<1	20	<20	10	5	1,000	<20	5	5,000	N	<5
374a	<.5	<10	>5,000	1	N	N	5	10	30	20	N	500	10	5
375a	<.5	50	1,000	3	N	N	10	50	50	50	N	500	15	20
376a	2	<10	300	1.5	N	N	5	7	2,000	<20	150	>5,000	N	<5
459	.5	15	1,500	2	10	N	20	50	70	30	N	1,500	20	20
460	.5	<10	1,500	2	30	N	50	30	300	20	N	1,500	20	15
461	500	<10	>5,000	1	20	20	N	<5	1,500	N	10	100	<10	N
462	100	20	>5,000	1.5	20	N	<5	5	200	N	10	700	10	<5
463	2,000	20	>5,000	1.5	20	N	N	<5	2,000	30	N	5,000	<10	5
464	10	20	2,000	2	<10	N	N	<5	50	50	N	700	10	5
465	.7	10	1,000	1.5	<10	N	10	15	30	30	5	1,000	20	20
466	1.5	10	1,500	1.5	10	N	50	7	100	20	5	700	30	10
467	.7	10	2,000	2	<10	N	<5	5	100	70	N	1,000	20	5
468	7	<10	700	1.5	200	N	50	7	300	N	N	3,000	10	15
469	2	10	700	2	20	N	10	10	300	20	5	1,000	10	7
470	7	10	700	1	50	N	5	5	700	N	15	500	10	5
471	2	20	1,000	1.5	15	N	N	30	1,000	30	5	200	10	5
473	5	15	1,000	1	N	N	N	20	500	N	5	150	20	5
474	<.5	10	1,000	1	N	N	N	15	300	N	N	300	30	<5
475	.7	10	1,000	2	<10	N	5	20	500	N	5	500	20	10
476	.5	10	2,000	2	<10	N	5	30	300	20	N	2,000	20	10
477	.5	<10	1,500	1	70	N	5	30	200	20	7	3,000	20	20
478	7	<10	500	1	150	N	100	30	20,000	20	10	3,000	20	20
479	20	10	700	1	70	N	20	5	300	N	5	2,000	15	5
480	1,000	10	>5,000	2	10	150	5	5	1,000	N	10	>5,000	10	5
481	50	20	>5,000	1.5	<10	N	N	5	500	N	N	3,000	10	5
482	70	10	300	1	<10	N	N	N	100	N	N	1,000	<10	<5
483	1.5	<10	300	1	50	N	5	10	300	30	N	1,000	10	10
484	15	N	300	1	100	N	20	30	15,000	70	N	2,000	15	30

See footnotes at end of table.

colluvium and rocks at Greaterville, Ariz.—Continued

Semiquantitative spectrographic analyses [1] (ppm)—Continued									Chemical analyses (ppm)				
Pb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Au	As	Hg	Sb	Te
						Rock chips—Continued							
>20,000	5	15	<100	30	N	15	>10,000	70	.30	120	4.20	200	1.1
3,000	15	N	<100	150	N	15	2,000	100	.20	3,000	.17	35	.1
5,000	15	N	N	150	50	30	2,000	150	.02	60	.21	35	<.1
150	<5	N	150	20	N	20	N	200	.02	<10	.05	<.5	<.1
70	10	N	200	100	N	30	N	1,000	<.02	<10	.10	.5	1.1
>20,000	5	N	300	20	N	30	2,000	200	.10	20	.11	50	1.1
100	30	N	N	200	<50	100	<200	700	.04	<10	.12	6	<.1
100	5	N	N	30	N	15	N	100	.08	20	.10	4	2.5
150	10	N	N	100	<50	30	N	200	.04	<10	.10	8	<.1
30	5	N	N	10	N	30	200	70	.06	<10	.24	.5	<.1
20	<5	N	N	15	N	10	N	100	.06	<10	.10	1	<.1
150	7	N	N	20	N	20	200	200	.06	<10	.10	6	<.1
300	5	N	N	30	N	30	200	50	19	<10	1.00	2	.2
>20,000	<5	N	700	10	N	15	N	150	.10	120	60.00	300	<.1
700	<5	N	N	20	N	10	N	150	.06	10	.35	15	.2
1,000	7	N	N	100	50	30	1,500	300	16	30	3.40	50	.5
100	5	N	<100	50	50	<10	N	100	.04	<10	.14	1	.1
150	5	N	<100	50	100	20	2,000	150	1.2	10	.44	1	4.0
1,500	10	N	N	70	300	70	500	150	.10	160	.28	45	.9
50	<5	N	300	20	N	10	N	150	.02	<10	.07	.5	.2
20	5	N	500	30	N	30	N	150	.04	<10	.05	<.5	.4
300	<5	N	300	30	N	20	3,000	150	.10	30	.15	2	<.1
20	7	N	200	150	N	10	N	700	.04	<10	.02	1	<.1
30	<5	N	N	100	N	20	N	300	.04	10	.06	1	<.1
20	5	N	300	100	N	30	<200	200	.02	<10	.03	<.5	<.1
20	5	N	<100	30	N	15	<200	200	.04	<10	.07	<.5	<.1
30	7	N	150	50	N	15	N	300	.08	40	.03	3	.5
>20,000	<5	N	150	50	100	<10	10,000	N	.80	14,000	2.40	400	2.5
500	5	N	500	100	N	<10	N	200	.04	20	.08	2	<.1
300	7	N	N	100	N	50	300	500	.04	80	.08	6	.4
500	5	N	N	50	N	15	500	300	.04	150	.03	2	.7
20,000	<5	N	N	20	70	10	5,000	20	.20	<10	.04	25	1.8
70	5	N	300	100	N	20	N	300	.02	<10	.06	<.5	<.1
30	15	N	1,500	150	N	50	N	500	.02	<10	.04	.5	.3
2,000	<5	N	N	10	N	15	700	20	.06	60	.03	4	.4
150	15	N	N	150	N	30	500	300	<.02	10	.02	3	.9
50	10	N	N	70	300	30	200	300	.04	10	.05	3	17
20,000	N	N	5,000	N	N	N	700	20	.24	60	9.50	80	2.5
5,000	5	N	700	15	N	10	<200	150	.08	30	2.00	80	1.3
>20,000	5	N	700	10	N	50	200	70	.12	120	.08	250	<.1
2,000	5	N	N	20	N	50	<200	200	.04	<10	8.00	4	1.3
200	15	N	N	70	N	30	N	150	.02	<10	.14	2	.3
100	10	N	N	70	N	30	N	300	.02	10	.30	2	3.7
100	10	N	100	30	<20	30	N	200	.02	10	.08	1	.4
500	<5	N	N	20	N	20	200	150	.04	15	.14	4	120
300	5	N	N	50	N	20	500	300	.02	10	.09	10	31
50	<5	N	N	30	100	10	200	500	.08	80	.30	15	99
200	10	N	<100	100	20	<10	N	100	.02	30	.07	8	20
200	7	10	100	70	150	<10	N	200	<.02	15	.07	2	.3
15	<5	10	100	70	100	<10	N	1,000	<.02	10	.03	.5	.4
30	10	N	<100	70	<20	15	N	100	.02	10	.03	.5	1.7
50	10	10	N	70	70	20	500	100	<.02	15	.09	1	.3
100	15	20	200	70	50	20	1,000	150	.02	<10	.26	3	21
150	15	N	N	70	150	30	5,000	70	.10	10	.60	1	110
3,000	7	N	N	50	N	30	500	70	7.8	15	.45	3	1.8
15,000	N	N	2,000	150	50	50	1,000	10	.04	240	10.00	600	.2
1,500	N	N	500	30	N	15	300	70	.02	30	3.00	45	1.4
5,000	N	N	N	20	N	<10	200	20	.04	30	1.50	60	.4
200	5	N	150	50	N	30	300	200	.02	<10	.10	1	75
500	15	N	300	150	N	50	500	200	.08	10	.10	.5	260

TABLE 4.—*Geochemical analyses of*

Semiquantative spectrographic analyses [1] (ppm)

Sample No. [2]	Ag	B [3]	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Mn	Nb	Ni
Rock chips—Continued														
485	<.5	30	700	1.5	N	N	10	30	50	30	N	1,000	15	15
486	7	20	700	1	10	N	5	N	50	N	N	700	10	5
487	3	15	700	1.5	<10	N	5	N	50	N	N	700	10	5
488	50	<10	700	1	10	N	N	<5	1,000	20	70	100	<10	N
489	15	15	500	1.5	<10	N	N	5	200	20	10	70	10	N
490	1	20	500	1.5	N	N	10	10	700	30	20	1,000	10	5
491	.5	10	500	1.5	N	N	5	20	1,000	30	10	700	15	10
492	2	<10	300	1.5	<10	N	5	20	1,500	50	7	1,000	10	10
493	2	10	700	1.5	N	N	10	5	500	N	200	500	10	5
494	1.5	15	700	1	N	N	N	5	300	N	20	500	10	N
495	.5	<10	150	1.5	N	N	N	10	1,000	N	10	500	10	N
496	15	<10	300	1	10	N	5	5	1,000	N	700	2,000	10	<5
497	10	<10	700	1.5	<10	N	7	10	5,000	30	20	700	15	10
498	20	10	150	1.5	<10	N	N	5	500	N	150	200	10	<5
499	7	10	200	1	<10	N	N	5	200	50	50	150	10	<5
500	1	10	200	1.5	N	N	5	7	1,000	20	100	1,500	10	5
501	20	30	1,000	2	N	N	N	5	300	N	10	2,000	20	5
502	2	10	300	1	10	N	N	5	1,000	N	20	300	10	<5
503	150	10	>5,000	1	<10	20	5	7	1,500	20	10	1,500	10	7
504	50	15	>5,000	1.5	N	<20	5	5	1,000	20	150	5,000	20	5
505	1	<10	500	2	10	N	70	30	1,500	50	15	1,000	10	15
506	15	10	700	1.5	N	N	N	<5	300	N	15	>5,000	10	5
507	30	70	2,000	5	N	N	N	20	100	20	15	1,500	20	10
508	<.5	<10	1,500	1.5	<10	N	5	15	100	N	7	1,000	10	<5
509	<.5	10	500	1.5	N	N	5	10	100	N	20	700	10	5
510	1	<10	200	<1	N	N	N	10	500	N	5	200	10	<5
511	1	<10	5,000	<1	15	N	5	10	100	20	N	500	15	7
512	20	50	300	2	N	N	10	15	1,500	20	15	5,000	10	10
513	20	20	700	1.5	N	N	N	5	100	N	5	2,000	10	7
514	100	20	>5,000	1.5	N	20	N	7	1,000	N	7	>5,000	10	5
515	5	<10	500	1.5	N	N	N	15	1,000	N	30	3,000	10	5
516	200	10	5,000	1	300	70	N	5	700	N	500	1,000	10	<5
517	5	10	500	1	10	N	50	10	2,000	N	30	500	10	<5
518	3	10	500	1	10	N	N	10	2,000	N	50	300	10	<5
519	50	10	500	1	50	N	N	5	500	N	50	700	10	<5
520	7	20	500	1.5	N	N	50	15	2,000	20	30	2,000	10	15
521	2	<10	100	<1	N	N	N	10	1,000	N	5	1,000	15	<5
522	.5	10	500	1	N	N	N	10	500	N	5	700	10	10
523	500	<10	>5,000	<1	500	N	5	5	>20,000	N	500	2,000	10	<5
524	20	10	700	1	20	N	N	5	1,500	N	150	200	10	<5
525	30	<10	150	1	70	N	N	5	3,000	N	200	100	10	<5
526	7	<10	100	1	10	N	N	5	300	N	20	500	<10	5
527	50	<10	100	1.5	20	200	N	5	3,000	N	50	>5,000	20	<5
528	100	<10	70	1	500	N	N	5	1,500	N	5	150	<10	N
529	200	<10	70	<1	700	N	N	5	1,000	N	5	70	10	N
530	100	<10	70	<1	100	N	N	7	1,000	N	50	200	<10	<5
531	15	15	500	2	50	N	20	20	1,000	30	300	>5,000	10	10
532	2	10	150	1.5	N	N	30	10	3,000	N	30	500	10	10
533	70	10	500	<1	70	N	N	5	500	N	20	200	10	N
534	10	30	700	3	N	N	50	15	2,000	N	10	5,000	10	20
535	50	10	1,000	1	10	20	N	10	1,000	N	100	1,500	<10	N
536	70	10	500	<1	500	N	N	5	500	N	300	200	<10	N
537	30	10	300	<1	<10	N	N	5	500	N	5	500	10	N
538	200	<10	20	<1	50	N	N	5	2,000	N	50	300	10	N
539	700	10	5,000	<1	70	70	N	5	2,000	N	5	1,500	20	N
540	70	<10	200	<1	N	N	5	5	700	N	7	1,500	10	N
541	1,000	10	>5,000	<1	N	100	N	N	3,000	N	100	300	10	N
542	50	15	2,000	<1	50	30	5	7	1,000	N	20	>5,000	<10	5
543	150	<10	2,000	<1	<10	N	N	7	500	N	30	1,500	10	N
551	2	<10	500	1	N	N	30	20	2,000	N	500	1,000	10	7

See footnotes at end of table.

colluvium and rocks at Greaterville, Ariz.—Continued

Semiquantitative spectrographic analyses [1] (ppm)—Continued									Chemical analyses (ppm)				
Pb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Au	As	Hg	Sb	Te
						Rock chips—Continued							
50	15	N	N	100	N	30	N	150	.04	30	.04	2	.5
1,000	N	N	150	20	N	<10	<200	100	.02	10	.10	3	.5
200	N	N	150	30	N	<10	N	100	.02	10	.07	15	.1
15,000	N	N	N	10	N	20	300	10	.08	160	8.50	250	5.6
700	5	N	N	20	<20	10	200	70	.02	20	5.40	80	1.6
200	7	N	<100	70	<20	20	500	100	.02	30	.22	8	2 .4
200	10	N	300	70	N	30	500	100	.02	30	.08	1	.9
150	10	N	300	50	50	30	1,000	70	.04	30	.17	6	2.1
300	<5	N	100	30	<20	10	700	100	.02	60	.14	25	.
200	<5	N	100	50	<20	15	N	500	.02	20	.10	1	.5
150	<5	N	N	30	200	15	500	150	.02	30	.10	1	.4
5,000	<5	10	N	30	70	10	500	20	.06	30	.14	10	4.9
100	10	N	100	100	50	30	200	150	.08	30	.14	4	1.7
5,000	5	N	N	30	20	10	700	100	.04	30	2.60	60	.7
2,000	N	N	N	20	100	<10	N	70	.02	40	.50	35	.5
3,000	5	15	N	50	50	15	500	200	.02	30	1.00	45	.3
1,500	5	N	N	30	500	15	500	200	.02	15	.70	60	.1
50	<5	N	N	30	50	10	N	200	.02	15	.09	4	.1
>20,000	5	N	500	30	30	15	2,000	50	.04	30	1.00	300	1.1
15,000	5	N	300	30	500	15	1,000	50	.44	120	.55	250	.1
100	15	N	200	150	N	30	3,000	100	.04	40	.08	4	.
3,000	<5	N	150	70	20	20	2,000	15	.24	10	.50	60	.8
700	7	N	N	70	20	15	700	200	<.02	15	1.10	60	.4
30	5	N	200	50	N	15	N	300	<.02	<10	.10	.5	.2
20	5	N	N	50	N	15	N	150	<.02	40	.09	<.5	.1 1
30	<5	15	N	50	<20	N	N	100	.02	10	.05	.5	.8
200	7	N	300	70	N	10	N	200	<.02	30	.10	3	3.3
1,500	10	N	N	50	<20	20	1,000	100	.10	320	.40	45	<.1
20,000	<5	N	N	20	<20	15	1,000	100	<.02	10	.28	25	.2
5,000	5	N	1,000	30	20	15	5,000	200	.04	320	.28	35	<.1
3,000	5	N	200	30	N	15	300	70	<.02	120	.15	45	<.1
20,000	<5	N	200	20	<20	15	700	100	.54	15	1.30	1,000	11
500	5	N	200	30	<20	15	1,000	70	.04	150	.10	10	1.2
500	5	N	N	70	50	<10	700	100	.06	60	.12	8	.1
20,000	<5	N	500	30	150	15	700	100	.32	<10	.40	80	<.1
500	15	N	N	70	<20	20	700	100	<.02	10	.07	8	.9
70	<5	N	100	50	200	10	N	70	.02	160	.05	.5	.4
70	5	N	N	30	N	<10	N	100	.02	40	.05	1	1.2
>20,000	N	N	500	50	300	N	1,000	N	.32	40	.18	600	180
10,000	N	N	N	10	200	N	1,000	100	.72	60	.50	25	16
15,000	N	N	N	N	150	10	200	20	.06	40	2.60	60	24
2,000	<5	N	N	15	20	N	700	10	.02	10	.09	.5	<.1
>20,000	N	N	N	10	1,500	N	7,000	N	.14	30	.75	100	4.0
15,000	N	N	N	10	N	10	1,500	20	.04	10	.12	10	27
10,000	N	N	N	10	N	N	500	100	.14	320	.13	8	<.1
20,000	N	N	N	50	100	<10	1,000	10	.86	120	.05	25	.1
10,000	15	N	300	100	50	30	1,000	150	1.3	400	.12	6	2.9
100	5	N	100	50	N	30	200	50	.02	40	.04	15	1.4
1,000	N	N	N	10	N	N	1,000	20	1.3	320	.26	25	12
500	10	N	150	70	N	20	1,500	70	.08	600	.04	45	.2
3,000	<5	N	N	20	20	30	2,000	15	.30	1,200	.35	100	1.0
3,000	<5	N	N	20	20	N	N	50	.42	400	.80	100	14
15,000	<5	N	<100	10	300	N	200	20	.40	3,200	.45	100	.3
>20,000	N	N	<100	10	500	10	700	10	.44	600	.14	250	1.7
>20,000	N	N	150	N	2,000	N	7,000	N	.12	200	1.20	450	17
>20,000	N	N	N	10	70	50	1,000	50	.08	160	.15	35	.6
20,000	N	N	5,000	20	300	N	2,000	<10	.08	1,200	2.10	350	.1
10,000	5	N	300	20	<20	15	7,000	30	.24	400	.35	10	.7
>20,000	N	N	100	10	1,000	N	700	<10	.08	800	.35	25	.6
150	7	N	100	70	N	15	1,000	50	.08	320	.05	60	.1

TABLE 4.—*Geochemical analyses of*

Sample No.[2]	Semiquantative spectrographic analyses[1] (ppm)													
	Ag	B[3]	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Mn	Nb	Ni
Rock chips—Continued														
552	7	10	700	1.5	<10	N	10	15	5,000	30	300	700	10	7
553	500	<10	700	<1	100	150	N	5	15,000	N	20	100	10	5
554	300	10	700	1.5	700	N	N	5	3,000	N	>2,000	100	10	<5
555	150	10	5,000	1.5	50	N	N	5	3,000	N	1,000	150	10	<5
556	10	10	1,000	1	15	N	N	10	1,500	N	100	300	15	5
557	2	N	500	1	N	N	7	20	3,000	N	20	1,500	10	5
558	1	50	1,500	1.5	N	N	10	30	70	50	10	1,000	10	15
579	1	10	500	1.5	N	N	<5	20	100	30	7	700	10	5
560	3	<10	700	1.5	500	N	5	5	500	N	5	300	<10	5
561	5	10	70	<1	<10	N	<5	5	70	100	N	300	<10	5
562	5	<10	100	1	20	N	5	5	1,000	N	5	1,500	<10	<5
563	300	10	150	1	500	20	7	5	2,000	N	N	1,000	<10	5
564	30	N	50	1	20	N	N	5	700	N	N	200	<10	<5
565	20	<10	100	1.5	70	N	N	5	300	N	5	300	10	<5
566	30	10	100	1	500	N	N	10	1,000	N	N	150	10	<5
567	5	<10	300	2	N	N	15	7	3,000	N	5	200	<10	10
568	1	10	1,500	1	50	N	5	20	1,000	N	7	1,000	10	5
569	3	10	500	1	10	N	5	20	1,000	N	30	700	10	<5
570	200	10	70	<1	500	N	10	5	2,000	N	500	3,000	<10	N
571	1.5	<10	70	<1	10	N	N	20	1,500	N	5	300	10	<5
572	200	10	100	<1	50	20	20	5	1,000	N	1,500	2,000	<10	<5

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[1] Semiquantitative spectrographic analyses were also made of Au, As, and Sb but are not tabulated, although a few values were used in this report.

[2] Sample Nos. 249–433 have a prefix of 67D or 67S, depending on collector of sample, and Nos. 434–644 have a prefix of 68D or 68M, depending on collector.

[3] The lower limit of detectability of samples 459–644 is reported at 20 ppm, that of other samples, at 50 ppm.

colluvium and rocks at Greaterville, Ariz—Continued

Semiquantitative spectrographic analyses [1] (ppm)—Continued									Chemical analyses (ppm)				
Pb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Au	As	Hg	Sb	Te
						Rock chips—Continued							
3,000	7	N	200	70	50	15	2,000	100	.12	80	.45	35	.5
>20,000	<5	N	300	10	<20	10	>10,000	150	.28	80	.80	200	35
20,000	<5	30	<100	10	500	10	700	N	.20	1,600	1.80	1,000	50
10,000	<5	<10	150	15	500	10	500	50	.08	200	2.30	600	2.0
300	5	10	N	70	<20	<10	<200	150	.08	30	.12	3	12
50	10	N	500	70	20	20	300	70	.04	40	.05	1	.5
100	15	N	2,000	150	N	30	N	100	9.6	<10	.06	1	<.1
70	7	N	300	50	N	30	N	500	.04	<10	.04	.5	<.1
300	<5	N	150	20	N	10	N	50	.06	20	.04	2	200
2,000	<5	N	N	70	300	15	1,000	20	.04	250	.04	4	.8
500	<5	N	N	20	N	15	700	15	.04	160	.03	4	1.0
>20,000	5	N	100	20	N	15	3,000	20	.02	80	.35	90	12
5,000	N	N	N	20	200	N	5,000	N	.10	1,200	.22	80	.1
1,000	5	N	N	30	300	20	1,500	20	.06	160	.06	8	1.3
5,000	5	N	N	30	<20	15	2,000	70	.10	20	.11	4	12
150	<5	N	100	50	N	20	5,000	100	.04	40	.09	6	.4
200	5	N	200	100	N	20	2,000	500	.02	40	.03	3	21
150	5	N	100	50	N	15	500	300	.02	20	.03	2	.3
>20,000	N	N	100	100	20	20	5,000	N	.88	400	.20	45	19
700	5	N	150	70	N	10	N	70	.04	10	.03	6	.2
>20,000	N	15	300	15	20	15	3,000	<10	.04	600	.18	200	3.1

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