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WHITE ELEPHANT PROPERTY

Mohave County, Arizona

Gordon J. Hughes, Jr.
ECM, Inc.
November 1989

Reno 11-25-89

ECM, Inc.

Mining Properties

November 20, 1989

Mr. Randy Moore
Senior Geologist
Cambior USA, Inc.
230 South Rock Blvd
Reno, NV 89502-2345

Dear Mr. Moore:

As you requested, I am sending the report dated November, 1989, covering our White Elephant property located in Mohave County, Arizona.

Cambior has our permission to go on these claims and to conduct such exploration work as it deems advisable. In return for the permission granted in this letter, Cambior will furnish ECM: the data, if any, generated by such exploration work; and, if requested by ECM, an accounting of the time Cambior's employees spent on such exploration work as well as their expenses and third-party charges incurred. Cambior understands that ECM may apply Cambior's exploration work to ECM's assessment obligation on these claims.

The Land Status map shows ECM's staked claims, which cover most of the targets we have identified. However, we are conducting negotiations with mining claim owners and mineral interests owners in Sections 16, 21 and 29, T29W, R18W. Also, we have contacted the State of Arizona about Section 36, T29N, R19W and Section 2, T28N, R19W and learned that they are not available because of exchange negotiations with the BLM. We will continue to pursue this ground.

Given the addition to ECM's property position which may be necessary, we will require, as a part of any transactions with Cambior, that there be an area of influence covering the sections noted in the paragraph above.

As we discussed, ECM has also assembled two other exploration targets in the general area. We hope to have reports covering these, complete and to you within the next two weeks.

Sincerely,

Thomas E. Ballard

Thomas E. Ballard

11605 Fowler Drive Northglenn, Colorado 80233 (303) 450-7276

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Location - The White Elephant property is located in the White Hills of northwestern Mohave County, Arizona. It lies approximately 80 miles southeast of Las Vegas, Nevada and 65 miles north of Kingman, Arizona. The property is wholly within Sections 20 and 30; T29N, R18W. Access to the area from U.S. highway 93 is by way of the Pierce Ferry road for about 22 miles and then the Hualapai Wash road for another seven miles. Numerous four wheel-drive vehicle roads and trails in washes provide access on the property itself.

The White Elephant property is located on the Garnet Mountain and Senator Mountain 15-minute topographic sheets.

Land Status - The property consists of 72 lode claims (PAT 1-72) that were located in April, 1989. PAT 1 through PAT 36 are located in Section 30, and PAT 37 through PAT 72 are in Section 20. The property is situated within a checkerboard of Santa Fe Pacific Land Co. holdings that normally includes the odd-numbered Sections. Numerous lode and placer claims are located in all directions around the White Elephant property for at least several miles.

Historic Activities - The White Elephant property is within the Gold Basin mining district. Gold was first discovered there in the early 1870's. Production records from the 1870's to 1900 are non-existent, but from the amount of ore extracted from at least six different mines, an estimated 25,000 to 50,000 ounces of gold were produced. Recorded metal production for the period from 1901 to 1942 is nearly 15,000 ounces of gold. Since that time there was probably another couple of thousand ounces recovered, mainly from the richer portions of extensive low-grade placer deposits.

The Gold Hill mine, located about a mile northeast of the White Elephant property, was a producer of gold ores from 1930 to 1942. Ore from the mine was probably treated at the Malco mill, a cyanide-flotation plant designed to extract gold from sulfide ores. Some of the ore at the Gold Hill mine was mined from a strand of the northeast trending White Elephant shear zone, a geologic feature that will be discussed later in this report.

Small-scale placer mining occurred on and immediately adjacent to the White Elephant property. Source(s) for this gold is not readily apparent though mineralized veins and altered zones along the large White Elephant shear zone are strong suspects. Small prospect pits and trenches are widely scattered along this extensively covered structural zone indicating the past search for lode deposits.

General Geology - The Gold Basin mining district is in the southern Basin and Range province, approximately 15 miles west of the southwestern edge of the Colorado Plateau. It is in an uplifted region of structurally complex Early Proterozoic basement rocks located near the leading edge of the North American Precambrian crustal plate. It also coincides with the Paleozoic miogeoclinal hinge zone and the Mesozoic Sevier orogenic belt. The northwest trending grain of the Walker Lane tectonic feature as well as the Las Vegas shear zone project into the Gold Basin area.

A thick and complexly deformed sequence of Early Proterozoic (1.7-1.8 b.y.) gneisses and schists dominate the geologic picture in the Gold Basin district (see accompanying regional geologic map). Biotite bearing quartzofeldspathic gneiss is the most common rock type. It indicates a probable protolith largely consisting of graywackes with subordinate amounts of arkosic clastic sediments. Kyanite-biotite-quartz gneiss and sillimanite bearing gneiss and schist interlayered with the biotite quartzofeldspathic gneiss probably represent more alumina-rich pelitic sequences that were originally interbedded with the coarser grained graywackes. Pelitic schist and gneiss also includes a garnet-biotite-quartz-feldspar assemblage.

Biotite-muscovite-quartz schist and biotite-amphibole schist are sporadically present in the gneissic terrane. Many of these rocks contain a high carbonate content that appears to be an Fe-rich variety. Retrograde metamorphic affects and hydrothermal alteration have converted many of these rocks into chlorite-magnetite rich schists. These mafic schists are believed to represent original volcanic tuffaceous materials deposited in an Early Proterozoic volcanotectonic basin along the edge of the North American craton.

Lesser quantities of quartz-sericite schist, tourmaline-rich schist, metachert, and banded iron formation are also included in the gneissic terrane. These units probably represent original chemical sediment components mixed with variable amounts of felsic volcanic tuffaceous material and hydrothermal muddy sediments.

Intermixed with the more dominant gneisses and schists in the Gold Basin district are numerous amphibolite bodies that are mainly conformable with the layering in the surrounding lithologies. The amphibolites are extremely variable in size and shape, and they have a highly erratic distribution within the gneissic terrane. Relict textures and overall shapes indicate most amphibolite was derived from igneous protoliths, probably gabbroic and pyroxenitic sills and dikes. Most show some degree of preserved chilled margins against the enclosing rocks. Some amphibolites (especially more schistose varieties) are undoubtedly representative of a sedimentary protolith.

Another important suite of intrusive igneous rocks in the Gold Basin district are gneissic granodiorite and gneissic diorite plutons. These well-foliated rocks were intruded into the paragneiss and orthogneiss or their protoliths sometime before major dynamothermal metamorphic events were completed. These rocks display an interesting spatial relationship with a significant number of gold bearing vein deposits, suggesting the possibility of some genetic link.

A large mass of porphyritic monzogranite was intruded into the gneissic terrane at about 1.6 b.y. ago. The exposed levels of this pluton were not deformed syntectonically during the main metamorphic event of the region. Thus peak, upper amphibolite-facies were developed prior to 1.6 b.y. ago. A biotite-rich border facies appears to define the contact zone for large portions of this intrusive complex. The porphyritic monzogranite hosts gold bearing quartz veins located along northeast as well as northwest striking fissures and fractures.

Another type of pluton of certain Proterozoic age consists of foliated leucogranite that normally occurs as conformable bodies interlayered with the gneissic rocks. Textures in these rocks grade from medium grained equigranular to pegmatitic. Some leucogranites have an intense mylonitic fabric, and those near some of the gold prospects contain pale pink garnets.

A Cretaceous age (72 m.y.) peraluminous two-mica granite has been intruded into the Proterozoic rocks in the southern portion of the Gold Basin district. This pluton normally has sharp contacts with the surrounding metamorphic rocks. Several minor facies variations that occur within this pluton are depicted by overall grain size contrast and changes in its porphyritic nature. Some syenitic zones are also present and usually show enrichments in muscovite, K-feldspar, and fluorite. Quartz-pyrite-muscovite veins with related carbonate and fluorite enrichment have formed in some of the syenitic rocks.

Overall, the geologic structure in the Gold Basin district is poorly mapped and therefore even more poorly understood. The White Hills, themselves, are separated from the Lost Basin Range to the east by a major basin-and-range fault called the Hualapai Valley fault. It trends mainly north-south on the east side of the White Hills, but swings toward the southeast on the east side of the southern White Hills. The east side of the Hualapai Valley fault is probably down-dropped relative to the west side.

Within the White Hills the dominant fault and shear zone trends appear to be northeastward. These structures are probably of ancient (Proterozoic?) vintage with numerous reactivations occurring into Tertiary times. Dominant motions were probably strike-slip though significant amounts of dip-slip and oblique-slip movements were also produced along their extents. The White Elephant shear zone, named herein, is probably the major northeast trending structure in the Gold Basin district. This structural zone lies along the north edge of the anomalously straight White Elephant Wash, a topographic feature that is presently cut into older pediment gravels.

Northwest trending and nearly east-west striking faults and shears also occur in the district. Relative displacements across these structures are unknown though locally they may be considerable (+1000's of feet).

One of the major structural features mapped in this region is a low-angle detachment fault extending in a very winding course from the northern end of the White Hills to the extreme south end. This fault crops out mainly along the western margin of the White Hills where it defines the eastern leading edge for low-angle detachment terranes in this part of Arizona and adjacent Nevada. This detachment zone hosts a number of the old producing gold mines as well as significant prospects in the Gold Basin district.

The gneissic rocks exposed in the Gold Basin district contain highly deformed and lithologically complex sequences that can change abruptly over short distances. Highly contorted and isoclinally folded units are present everywhere, indicating the pervasive nature of the deformational stage(s) that occurred sometime during the Early to Middle Proterozoic. Many of the isoclinal folds in the district have northeast trending axes, some, of which, plunge in that direction as well. These were later refolded across northwesterly trending axes into more open-style folds, perhaps during the Laramide or even earlier.

Locally pervasive cataclasite and mylonite can be observed in areas of very strong shearing, such as along the White Elephant shear zone. Such features indicate both brittle-type deformation as well as ductile flow. Many of the gneissic layers, and especially some of the amphibolitic layers, display a pulling apart or boudinage of the original rock fabric. Obviously, these structures were formed at deep crustal levels in the presence of metamorphogenic fluids.

Cover rocks and unconsolidated material overlying the Proterozoic and Cretaceous lithologies consist of a) Tertiary volcanics and intermixed fanglomerate deposits, b) Miocene limestones, claystones, and siltstones, c) younger Tertiary fanglomerate deposits, and d) Recent pediment gravels, talus, colluvium, and sand and gravels in active stream washes.

<u>Local Geology</u> - Rocks exposed at the White Elephant property mainly consist of medium to dark gray, equigranular paragneisses that developed from a protolith dominated by graywacke and arkosic sedimentary rocks. The overall sequence is reminiscent of other Proterozoic-age turbidite-dominated metaclastic basinal assemblages located in the western Cordillera. Minor amounts of cleaner quartzitic rocks interbedded with the gneiss suggest a possible coarsening

and thickening upward sequence, barring a completely overturned section.

The paragneiss unit also changes upward into a sequence of orthogneisses consisting of a lower assemblage of mafic schists that grade upward into much more felsic units. These rocks are considered to be metamorphosed aquagene tuffs. Associated with some of these felsic schists in the SW/4 of Section 30 and NW/4 of Section 29 are ferruginous, cherty-looking rocks that could be recrystallized chemical sediments (i.e. exhalites). The overall thickness of these unique rocks could not be determined, though several individual beds(?) were only about 2 to 6 feet thick. Similar-looking rocks occur at the Gold Hill mine in the NE/4 of Section 16.

The biotite-rich quartzofeldspathic gneiss contains numerous interlayered masses of amphibolite, of which, only the larger masses are shown on the geologic map in N/2 of Section 30. These appear to be several thousand feet lower in the section from the mafic and felsic schists. They are probably metamorphosed gabbroic sills that were emplaced in the graywacke sequence during basin evolution. Retrograde metamorphic effects have caused some chloritization and hematitic alteration of these rocks; whereas, amphibolites caught in the White Elephant shear zone show nearly complete transformation to chlorite schist with variable amounts of associated silicification and Fe-carbonate enrichment.

The general foliation trends in these gneissic and schistose rocks is about N45E with dominant dips to the southeast. Some north-northwesterly dips in Section 19 and the N/2 of Section 20 suggest a possible anticlinal fold in this area, though conclusive evidence for such a feature was not found. On the otherhand, if the amphibolites represent some of the lowermost units in the sequence of gneisses, they may approximate the position of an eroded anticlinal fold hinge.

Intruded into the gneissic rocks in the W/2 of Section 30 is a porphyritic monzogranite. This pluton contains a considerable amount of alteration mainly represented by partially to completely argillized feldspars phenocrysts, chloritized mafic minerals, and a fine network of quartz-Fe-carbonate-hematite- limonite veinlets. This type of alteration is most intense where these rocks have been highly sheared and foliated due to their proximity to major structures.

A number of other intrusive rocks, too small to portray on the geologic map, were observed at the White Elephant property. Many are thin, sill-like bodies of gneissic granodiorite that occur in the E/2 of Section 20. Similar small, tabular to lense-like bodies of leucogranite are interlayered with the paragneisses. These may be spatially related to pegmatite pods of quartz-K-feldspar-muscovite mixtures that are mainly located in the N/2 of Section 20. Both the leucogranites and pegmatites contain limonites that suggest an initial sulfide content of at least 3 volume percent, and, locally, some jarositic outcrops indicate nearly 10 volume percent sulfide associated with some of the intensely sheared leucogranites.

A broad zone, as much as a mile wide in places, contains major northeast trending shears that cut through all the Proterozoic lithologies at White Elephant. This zone appears to be part of a much larger regional tectonic feature that I am calling the White Elephant shear zone because of its location adjacent to and paralleling the White Elephant Wash. The shear zone is mainly characterized by intensely foliated and locally mylonitized gneissic rocks. The main elements of the zone (i.e. master shears) appear to cut diagonally through the central portion of Section 30, and the south-central portion of Section 20. Parallel shears were observed several thousand feet to the northwest, and there are local indications that others are located to the southeast under extensive cover.

Alteration is very impressive along the trend of the White Elephant shear zone. Mylonitized rocks are largely changed into punky mixtures of clays-hematite-carbonate and variable amounts of quartz mixed with sericite and limonite crusts that indicate the former presence of sulfides. Widths for these tectonically-softened rocks are highly variable and difficult to assess because of the recessive way in which they weather. However, several exposures in the central portion of Section 20 show extremely sheared and mylonitized rocks over a cross-strike distance of nearly 200 feet, with the southern edge of the zone still hidden beneath cover.

Alteration and mineralization occurring along the White Elephant shear zone has been examined by prospectors in the past. Several pits in Section 20 expose very intensely silicified and limonite-stained rocks that contain small flecks of visible gold associated with quartz veins and micro-veinlets. The host rocks are mainly chlorite-sericite-Fe-carbonate schists that show abundant small-scale kink-bands, and irregular crenulations. Some thin mafic (amphibolitic?) igneous rocks in the vicinity of the prospects are extremely silicified as well.

In the W/2 of Section 30 the White Elephant shear zone is complicated by northwest trending sets of cross-fractures and a significant amount of low-angle shears and crush zones. These are also altered (quartz-sericite-Fe-carbonate) and have been prospected in the past. Small placer operations were located around these anomalously altered and sheared areas.

Most of the placer mining in the White Elephant Wash area took place in Sections 28 and 29. However, a significant amount of work was also conducted in the SE/4 of Section 20 and SW/4 of Section 21. The gold in these placers could have been derived from the main White Elephant shear zone, though some may have also came from gold-enriched lithologies associated with the mafic and felsic schists and orthogneisses in the same vicinity. Both the White Elephant shear zone and the metavolcanic rocks appear to merge with one another near the eastern edge of Section 20.

Geochemistry - Rock chip sampling conducted at the White Elephant property was focused along the main White Elephant shear zone. A limited number of samples were also collected from rocks within the belt of metavolcanic schists. Due to the reconnaissance nature of the initial examination, and the limited exposures of mineralized rocks, the sampling was mainly random but concentrated in areas where some visually anomalous characteristics (e.g. silicification, limonite-staining, etc.) could be found.

Results from sampling along the White Elephant shear zone indicate a gold-enriched area extending from the NE/4 of Section 30 northeastward across Section 20. Anomalous values range from 100 ppb to over 10,000 ppb Au. The apparent high-grade (+1000 ppb) samples represent rocks containing visual quartz-limonite veins associated with the highly sheared and locally mylonitized gneissic lithologies. Several of these high-grade samples were collected from obviously mineralized rocks found at old prospects.

Gold values along the White Elephant shear zone in the W/2 of Section 30 are surprisingly low since the rocks appear very similar to those containing anomalous gold farther to the northeast. On the otherhand, arsenic values are very anomalous (100-2000 ppm) in the western portion of Section 30, and in a small area near the NE-corner of the same Section. These may suggest some primary zonation of metals along the shear zone, or perhaps even a plunge for the mineral system. Another possibility would be some relationship between arsenic and the porphyritic monzogranite located in the same general vicinity.

The high arsenic areas also coincide with very anomalous amounts of base metals (Cu,Pb,Zn,Sb) and silver. Similarly, the high gold values detected in Section 20 coincide with anomalous molybdenum values (50-600 ppm). These relationships seemingly support the notion that the mineral system located along the White Elephant shear zone is distinctly zoned in a lateral sense, and perhaps is even zoned vertically as well.

The anomalous gold values found in samples from the metavolcanic stratigraphy do not show the same strongly anomalous values for associated arsenic and base metals, except possibly for copper.

The likelihood of geochemical domains related to the various lithologies found along the White Elephant shear zone was not addressed in the preliminary assessment of the property. A much more detailed sampling program would be necessary in order to assess any such relationships. However, it can be safely stated, at this point, that gold enriched rocks show at least some degree of hydrothermal alteration accompanied by a suspected anomalous amount of sulfide minerals as indicated by the abundance and type of limonites that are present. Gold contents of rocks in the shear zone may also be related to several different types of veins.

Quartz-muscovite-Fe-carbonate veins nearly always have anomalously high gold contents. Quartz-limonite (after sulfide) veins may only have high base metal contents, with gold being absent. Quartz-chlorite-Fe-carbonate veins may or may not have high gold contents. In general, there is nearly always some detectable gold in samples that contain at least 5-10 volume percent Fe-rich carbonates.

Finally, there also appears to be a strong relationship between high gold values and rocks containing some amount of leucogranite, especially if it is pegmatitic. This relationship needs further study.

Target Type - At least two target areas are recognized at the White Elephant property. Probably the most obvious is that associated with the White Elephant shear zone. This target area is at least 5000 feet long, and perhaps as much as 15,000 feet in length. The width of the target area probably varies between 1000 and 2000 feet.

Individual targets within the White Elephant shear zone need further refinement. In order to do so, some ideas regarding the type(s) of targets that might be expected should be proposed.

Metamorphogenic gold deposits located along major shear zones are one of the most common types of gold deposits known, especially in Precambrian terranes. These types of deposits normally form in some portion of a major shear zone that facilitated the focusing of large volumes of gold-enriched fluids during the mineralizing process. Typically, such focused flow occurs in dilational zones created by a) bends along the strike of the shear zone, b) separation wedges formed near the junctions with strong cross-structures, or c) where dense networks of extension fractures develop between anastomosing branches of complex shear zones. Focused fluid-flow can also be achieved where a "heat pump" drives the fluid into some brittley-fractured portion of the tectonic zone. All of these conditions can be enhanced when the process of mineralization takes place near the transition between brittle and ductile styles of deformation.

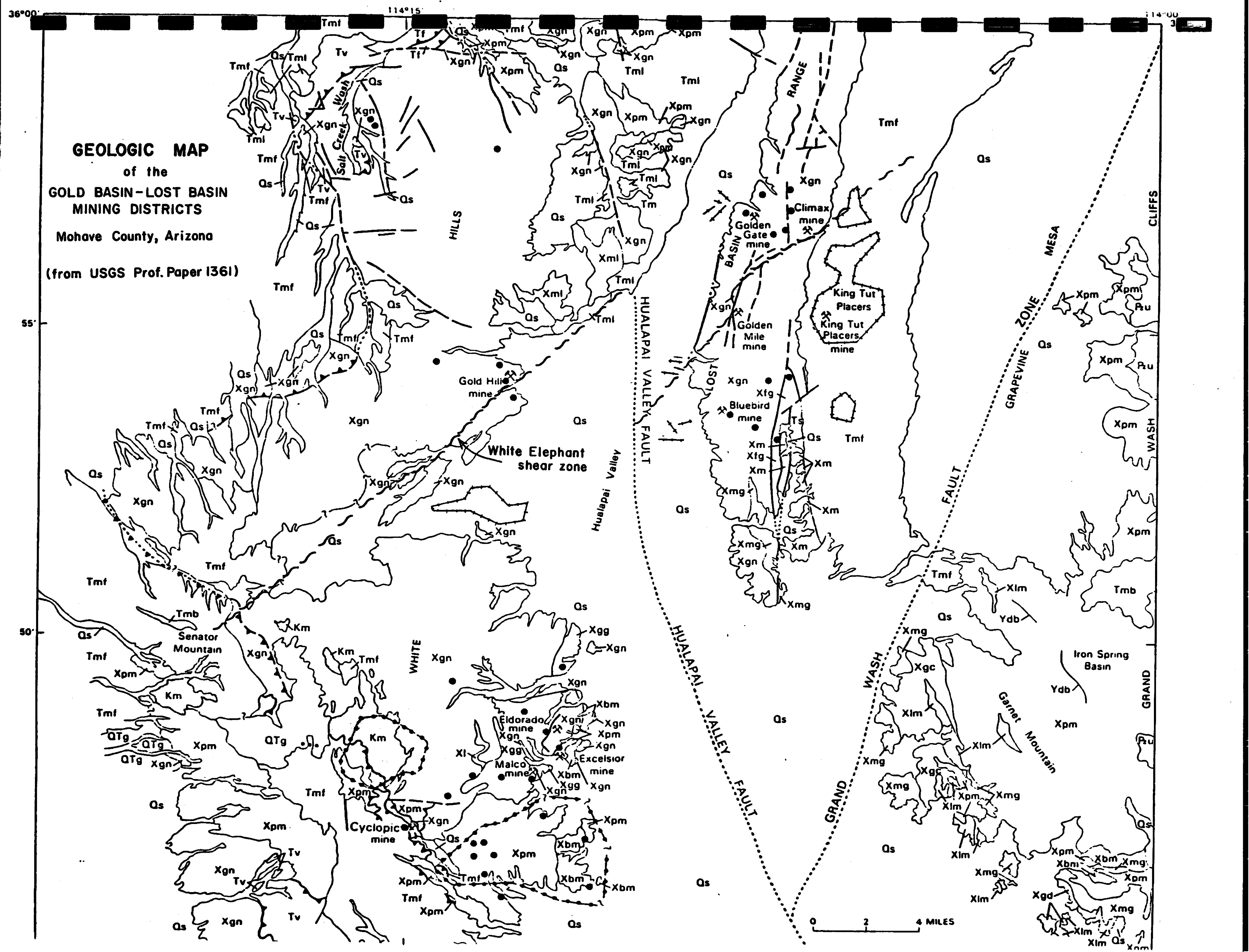
The gold anomalous area situated along the White Elephant shear zone in Section 20 may coincide with both a bend in the zone and a locus of cross-structures. Wrenching along the zone in this area could have created pull-apart extensional areas where fluids from metamorphic dehydration reactions could have been concentrated. Such fluids may have been derived from lithologies containing preconcentrated amounts of gold, such as volcanogenic-hydrothermal sediments or simply other rocks within the shear zone that were mineralized during earlier events. Gold precipitated from metamorphogenic fluids moving through the shear zone was probably accompanied by the formation of sulfides, carbonates, and K-rich silicates. These could serve as diagnostic mineral associations for defining specific targets along the White Elephant shear zone.

The second important target area coincides with the distribution of volcanogenic components in the gneissic terrane. A belt of these rocks has been identified in the SE/4 of Section 30 extending northeastward along the regional strike direction to the SE/4 of Section 20. The same belt of rocks is unmapped farther to the northeast but probably extends to the Gold Hill mine where similar lithologies have been recognized.

Before specific targets can be identified in the belt containing volcanogenic rocks, a detailed lithofacies map will be required. Differentiation between mafic and felsic components as well as probable chemical sediment bearing units should produce favorable target stratigraphy. A further step to target identification would then be to determine the lithogeochemical signatures of the key rock units. Any primary syngenetic, stratiform deposit is likely to have been enriched in other diagnostic elements. Some may have been relatively more mobile than gold in the original ore-forming system, thus leading to halo signatures.

A third, and also quite obvious target area, is where the White Elephant shear zone and the belt of volcanogenic rocks merge together, i.e. the E/2 of Section 20. Interestingly, this area contains a significant amount of leucogranite as narrow, conformable bands within the the intensely sheared gneissic rocks. Felsic pegmatites are also present in the same vicinity. Both the leucogranite and pegmatitic rocks contain anomalous gold contents in this area. Could they represent a gold-enriched metamorphic component derived from a protolith containing preconcentrated amounts of gold?

Finally, the area of anomalous arsenic and base metal values in the W/2 of Section 30 should be more thoroughly evaluated. Specifically, the wallrocks around the porphyritc monzogranite should be mapped in detail and extensively sampled. A possible target type in this setting could be the combined effect of a stockwork of mineralized quartz-muscovite-carbonate veinlets within the intrusive (near its margins), and a gold-enriched fracture system in the contact halo with the surrounding gneisses, schists, and amphibolites.


GEOLOGIC MAP
of the
GOLD BASIN-LOST BASIN
MINING DISTRICTS
Mohave County, Arizona
(from USGS Prof. Paper 1361)
36°00'
114°15'
114°00'
55'
50'
0 2 4 MILES
Salt Creek Wash
HILLS
WHITE
HUALAPAI VALLEY FAULT
Hualapai Valley
White Elephant shear zone
Gold Hill mine
LOST BASIN RANGE
Golden Gate mine
Climax mine
Golden Mile mine
Bluebird mine
King Tut Placers
King Tut Placers mine
GRAPEVINE MESA
ZONE
FAULT
CLIFFS
WASH
GRAND WASH
GRAND
Iron Spring Basin
Garnet Mountain
Senator Mountain
Eldorado mine
Excelsior mine
Malco mine
Cyclopic mine

DESCRIPTION OF MAP UNITS

Qs Sedimentary deposits (Quaternary)—Includes sand and gravel along active stream washes, talus, colluvium, poorly consolidated fanglomerate currently being dissected, and landslide deposits; also may include extensive high-level fanglomeratic deposits, west of Grand Wash Cliffs in general area of Grapevine Mesa, that may be Tertiary and (or) Quaternary in age

QTg Fanglomerate (Quaternary and (or) Tertiary)—Locally derived fanglomerate deposits that include mostly clasts of metamorphic rock south-southeast of Senator Mountain and that do not contain clasts of rapakivi granite or any interbedded tuffs

Muddy Creek Formation (Tertiary)

Tml Hualapai Limestone Member—Includes limestone interbedded with thin beds of limy claystone, mudstone, and siltstone. Weathered limestone beds have a predominantly reddish color and form steep cliffs where they are dissected by Hualapai Wash

Tmb Basalt—As shown, flows at Senator Mountain, near west edge of map area, and at Iron Spring Basin, near east edge. Basalt in these two areas correlates probably with basalt flows (not shown) that conformably underlie the Hualapai Limestone Member and also are interbedded with fanglomerate of the Muddy Creek Formation near northwest corner of map area. Whole-rock K-Ar age determination of basalt from this area yields age of 10.9 Ma (see section by E.H. McKee, this report)

Tmf Fanglomerate—Alluvial fanglomeratic deposits that include conglomerate, sandstone, siltstone, mudstone, and locally abundant gypsum lenses. Locally includes lenses and beds of rhyolitic tuff and, as shown near southwest corner of map area, fanglomerate mapped previously by Blacet (1975) as unit Tf. Unit is also intruded by minor basalt dikes, especially in general area of Senator Mountain. Near northwest corner of map area, unit includes well-exposed flows of basalt

Tv Volcanic rocks (Tertiary)—Includes mostly andesite. Map unit near northwest corner of map area internally is highly broken by numerous faults, and near here, unit also includes air-fall tuff and reddish-brown sandstone interbedded with chaotic sedimentary breccia composed of fragments of Early Proterozoic gneiss. In places, unit also includes massive porphyritic hornblende andesite and basalt flows and breccia and overall minor amounts of tightly cemented volcaniclastic rocks. Flow layering and bedding generally dip at angles of 35° in contrast with shallow dips of about 5° in unconformably overlying basal fanglomerate of the Muddy Creek Formation. Age ranges of 11.8 to 14.6 Ma are reported near type section of the Mount Davis Volcanics (Anderson and others, 1972), whereas K-Ar age determination on sanidine from air-fall tuff near Salt Creek Wash in northwestern part of area yields age of 15.4 Ma. The volcanic rocks may be equivalent of the Mount Davis Volcanics or the Patsy Mine Volcanics (see section by E.H. McKee, this report).

Ts Rhyolitic tuffaceous sedimentary rocks and fanglomerate (Tertiary)—Includes well-bedded mudflows and rhyolitic tuffaceous sedimentary rocks and minor amounts of fanglomerate. Crops out as steeply dipping sequence of rocks, bounded by north-striking faults, near south end of Lost Basin Range. Possibly equivalent to the Mount Davis Volcanics

Tf Fanglomerate (Tertiary)—Coarse fanglomeratic deposits that locally include landslide or mudflow breccia. Overlain unconformably by fanglomeratic deposits of the Muddy Creek Formation, and apparently intercalated with andesite possibly equivalent to the Mount Davis Volcanics

Km Two-mica monzogranite (Cretaceous)—Includes mostly highly leucocratic muscovite-biotite monzogranite and some minor amounts of felsic muscovite granodiorite and episyenitic-altered muscovite-biotite monzogranite. Some facies are fluorite bearing. Porphyritic variants contain as much as 5 percent quartz phenocrysts. In places, contains very weakly defined primary layering of dimensionally oriented potassium feldspar and biotite

Pu Sedimentary rocks, undivided (Paleozoic)—Includes Cambrian Tapeats Sandstone, Bright Angel Shale, and Muav Limestone

Ydb Diabase (Middle Proterozoic)—Includes normally zoned laths of plagioclase set in very fine grained matrix of granules of opaque mineral(s) and clinopyroxene. Close to chilled margins of some fresh outcrops of undeformed diabase, olivine is found in concentrations of as much as 10 volume percent. Small masses of fine-grained diabase crop out sporadically in Early Proterozoic igneous and metamorphic rocks. Most extensive exposures are about 2 km east of Garnet Mountain. Subophitic textures are dominant. Lower chilled margins of some sills contain sparse hornblende and biotite microveinlets. Presumed to be correlative with the diabase of Sierra Ancha, Ariz., having an emplacement age of 1,150 Ma (Silver, 1963)

Xpm Porphyritic monzogranite of Garnet Mountain (Early Proterozoic)—Includes conspicuous, large potassium feldspar phenocrysts, set in a light-pinkish-gray, coarse-grained hypidiomorphic groundmass. Many exposures show tabular phenocrysts as much as 10 cm long. Some phases are predominantly subporphyritic seriate and show an almost continual gradation in size of their euhedral potassium feldspar phenocrysts. Most widely exposed mass crops out in the general area of Garnet Mountain, in the southeastern part of the area, and extends discontinuously from there to north along the low hills leading to Grand Wash Cliffs. Dated by Wasserburg and Lanphere (1965) to be about 1,660 Ma

Xgd Granodiorite border facies of porphyritic monzogranite (Early Proterozoic)—Gray granodiorite that includes variable proportions of biotite, hornblende, quartz, plagioclase, and potassium feldspar. Includes less abundant porphyritic granodiorite and porphyritic monzogranite phases. Locally coarse grained and sparsely porphyritic. Porphyritic phases show potassium feldspar phenocrysts set in coarse-grained hornblende-biotite hypidiomorphic granular matrix that is very magnetite rich. Crops out along west and southwest flanks of Garnet Mountain as mafic border facies of porphyritic monzogranite of Garnet Mountain. Found as homogeneous discrete bodies and also in the mixed granodiorite complex (Xgc)

Xbm Biotite monzogranite (Early Proterozoic)—Includes a homogeneous light-gray, fine-grained monzogranite and some porphyritic facies containing potassium-feldspar and quartz phenocrysts. Crops out south-southeast of Garnet Mountain and in the southern part of the Gold Basin mining district. In southern Gold Basin district, forms host rock for numerous fluorite-bearing, quartz-carbonate veins, presumably Late Cretaceous in age, some of which contain visible gold

Xlm Leucocratic monzogranite (Early Proterozoic)—Typically light-yellowish-gray rock and generally nonporphyritic. Partly chloritized biotite makes up less than 5 percent of most outcrops. Crops out as discontinuous, lensoid masses along western front of Garnet Mountain. Where well exposed, contacts with porphyritic monzogranite of Garnet Mountain (Xpm) show irregular dike offshoots of porphyritic monzogranite of Garnet Mountain cutting leucocratic monzogranite

Xgc Mixed granodiorite complex (Early Proterozoic)—Composite unit that includes mainly granodiorite (Xgd), some of which is porphyritic, and porphyritic monzogranite of Garnet Mountain (Xpm). Also includes some leucocratic monzogranite (Xlm)

Xgg Gneissic granodiorite (Early Proterozoic)—Generally, well-foliated, medium-gray-green rock containing highly variable alkali feldspar to plagioclase ratios. Biotite makes up about 20 volume percent of unit. Crops out in elongate body in southern White Hills

Xl Leucogranite (Early Proterozoic)—Includes coarse-grained leucogranite to pegmatitic leucogranite that contains potassium feldspar phenocrysts as much as 8 cm wide. Largest mass is 1-km-long sill cropping out 3 km northeast of Cyclopic mine. Stringers several centimeters wide parallel layering throughout much of the gneiss (Xgn). Fabrics grade from relatively undeformed to intensely mylonitic. Northeast of Gold Hill mine, large sills of pegmatitic leucogranite increase in abundance and eventually grade into complexes of migmatitic leucogranite (Xml). Most facies show modal compositions that plot in the field of granite; some outcrops of gneissic leucogranite contain garnet

Xfg Feldspar gneiss (Early Proterozoic)—Generally, light gray to light pinkish gray; compositionally homogeneous and typified by a strongly lineated fabric. Includes minor amounts of amphibolite, mafic gneiss, highly crenulated quartz tourmaline schist, and tourmalinite. Crops out in a 5-km-long and 0.8-km-wide sliver, bounded by faults in southern Lost Basin Range. Cut by quartz-feldspar veins, some of which contain gold

Xml Migmatitic leucogranite complex (Early Proterozoic)—Composite unit that includes swarms of leucogranite (Xl), aplite, and pegmatite dikes, together with pegmatoid quartz veins all cutting gneiss (Xgn). Complex and highly deformed by a ductile (mylonitic and gneissic) style of deformation

Xgn Gneiss (Early Proterozoic)—Includes variably metamorphosed gneiss and some metaquartzite in northern parts of the Lost Basin Range, and in northern White Hills. Exposed sequence of gneiss in southern parts of the Lost Basin Range includes abundant metabasite and amphibolite consisting partly of metagabbro, metaclinopyroxenite, metawehrlite, metadiabase, and metabasalt. Intruded to varying degrees by porphyritic monzogranite of Garnet Mountain (Xpm), biotite monzogranite (Xbm), leucocratic monzogranite (Xlm), leucogranite (Xl), and diabase (Ydb)

Xmg Migmatitic gneiss (Early Proterozoic)—Composite unit that includes mostly gneiss (Xgn) intruded to varying degrees by porphyritic monzogranite of Garnet Mountain (Xpm), biotite monzogranite (Xbm), and granodiorite (Xgd)

Xm Migmatite (Early Proterozoic)—Composite unit that includes mostly medium-grained, sparsely porphyritic monzogranite of Garnet Mountain (Xpm) complexly intruded into gneiss (Xgn)

?Contact—Queried where location uncertain

Fault—Dashed where approximately located; dotted where concealed

? Detachment fault—Dashed where approximately located; dotted where concealed; queried where uncertain. Sawteeth on upper plate

● Lode-gold locality—Collected for this report or observed (see Blacet, 1975; and section by J.C. Antweiler and W.L. Campbell, this report)

? Fluorite occurrence—Outer limit observed either in veins or disseminated in the Late Cretaceous two-mica monzogranite; dashed where approximately located; queried where uncertain

Area of placer deposit and (or) mine

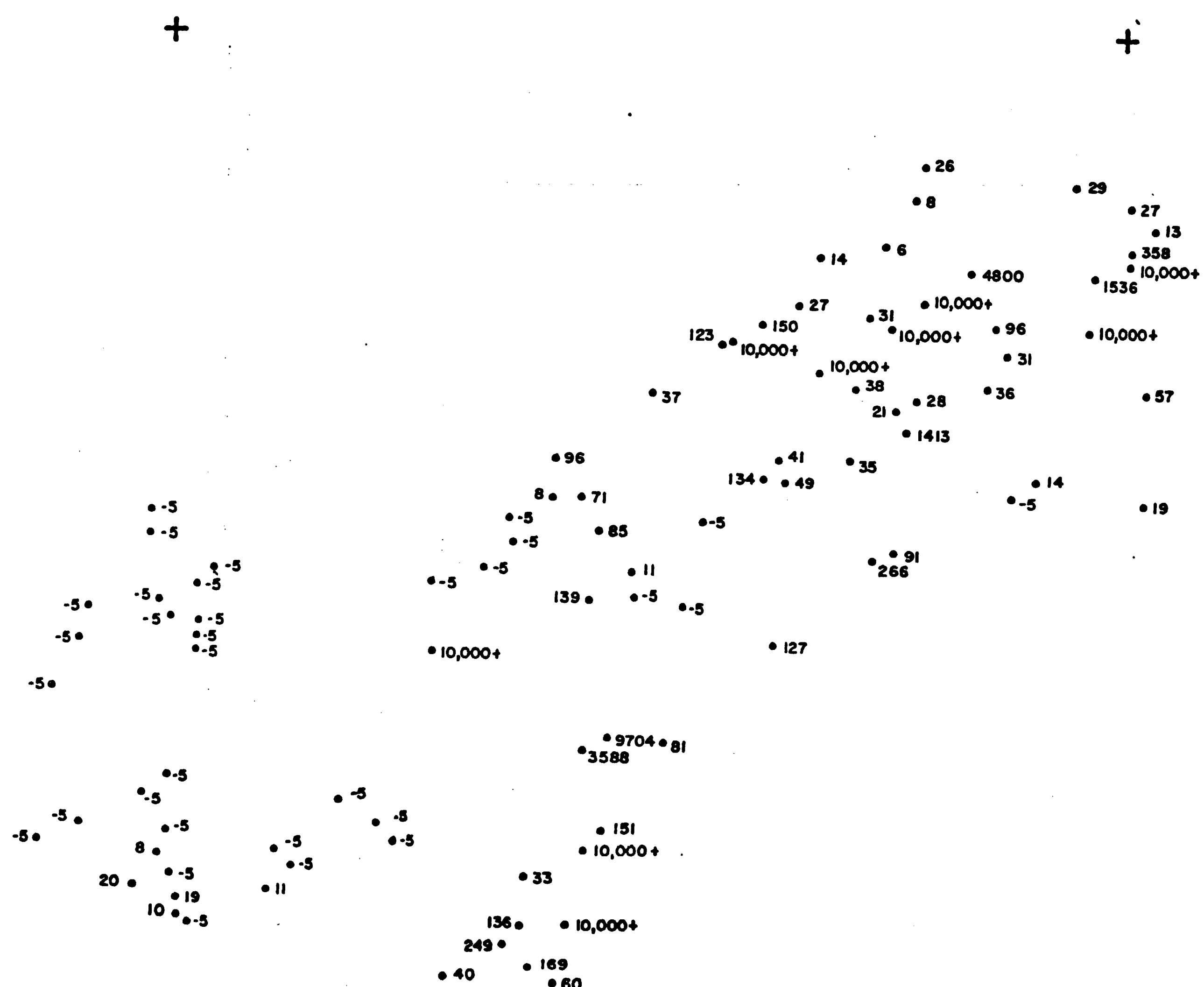
Au GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: White Elephant
LOCATION: Mohave Co., Arizona
DATA BY: GJH, USGS
DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103

• 1536 Gold in ppb



As GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: White Elephant

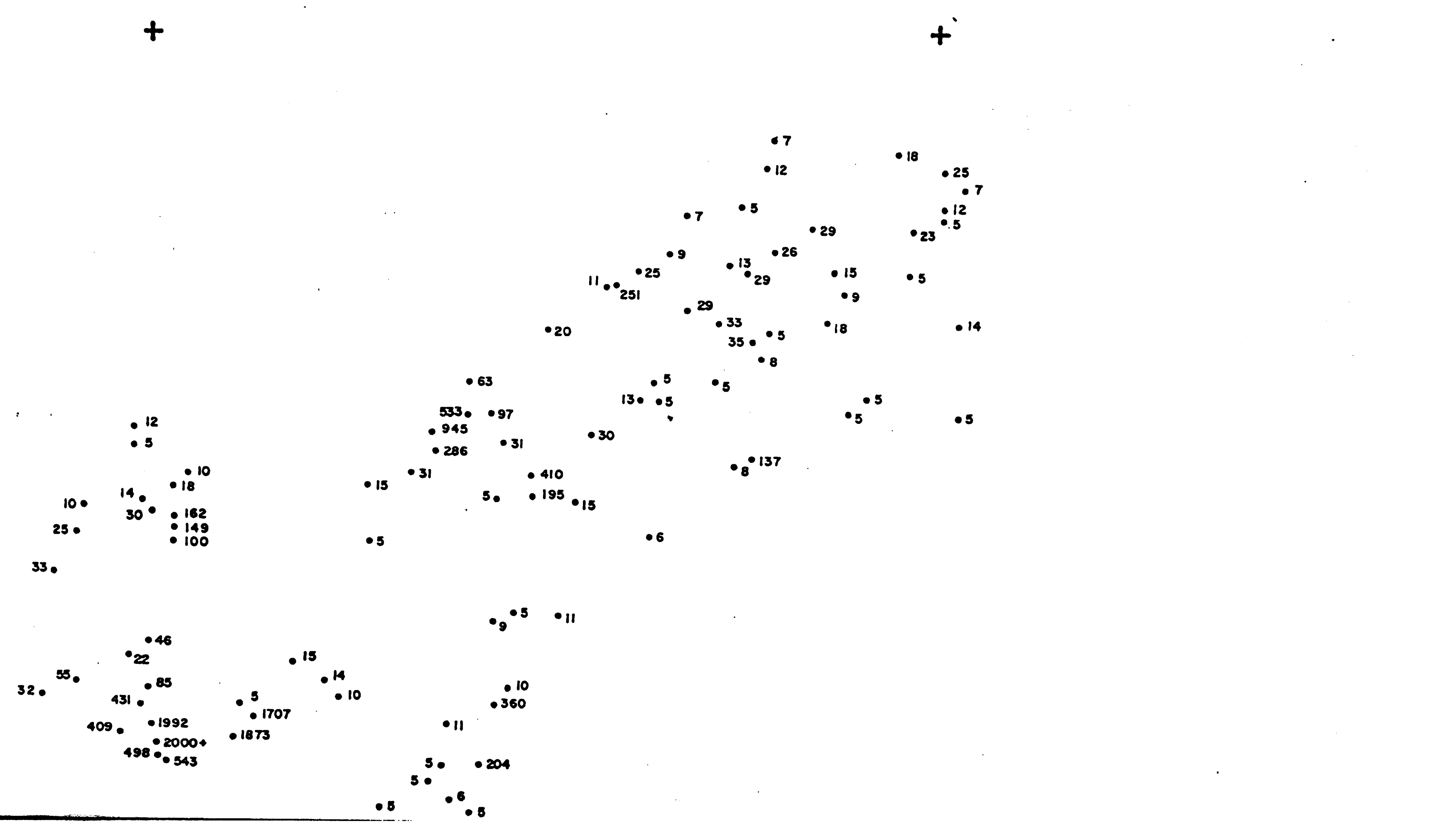
LOCATION: Mohave Co., Arizona

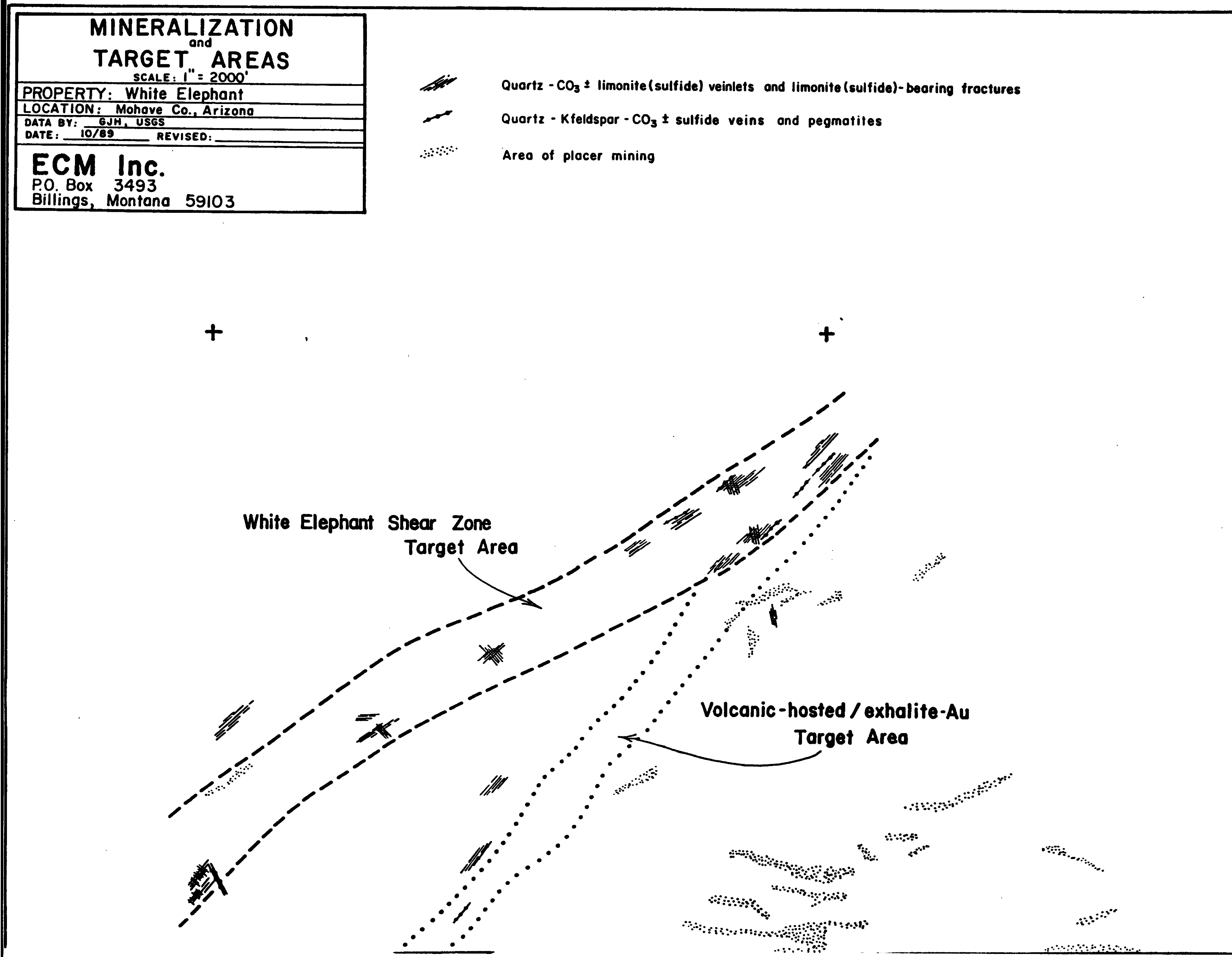
DATA BY: GJH, USGS

DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103

• 251 Arsenic in ppm



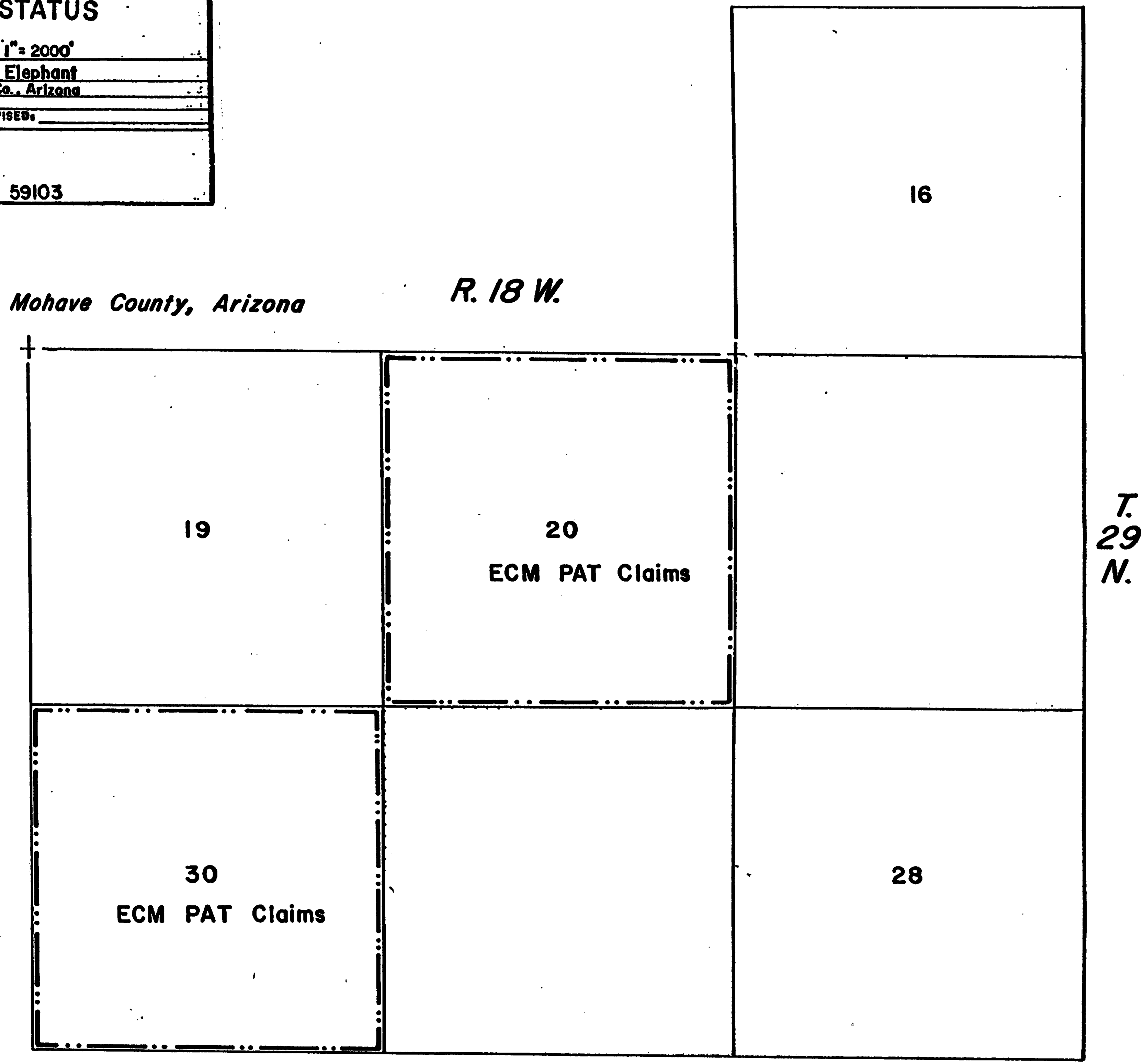

MINERALIZATION
and
TARGET AREAS
SCALE: 1" = 2000'
PROPERTY: White Elephant
LOCATION: Mohave Co., Arizona
DATA BY: GJH, USGS
DATE: 10/89 REVISED:
ECM Inc.
P.O. Box 3493
Billings, Montana 59103
Quartz - CO_3 ± limonite(sulfide) veinlets and limonite(sulfide)-bearing fractures
Quartz - Kfeldspar - CO_3 ± sulfide veins and pegmatites
Area of placer mining
White Elephant Shear Zone
Target Area
Volcanic-hosted / exhalite-Au
Target Area

LAND STATUS

SCALE: 1" = 2000'

PROPERTY: White Elephant
LOCATION: Mohave Co., Arizona
DATA BY: GJH, USGS
DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103

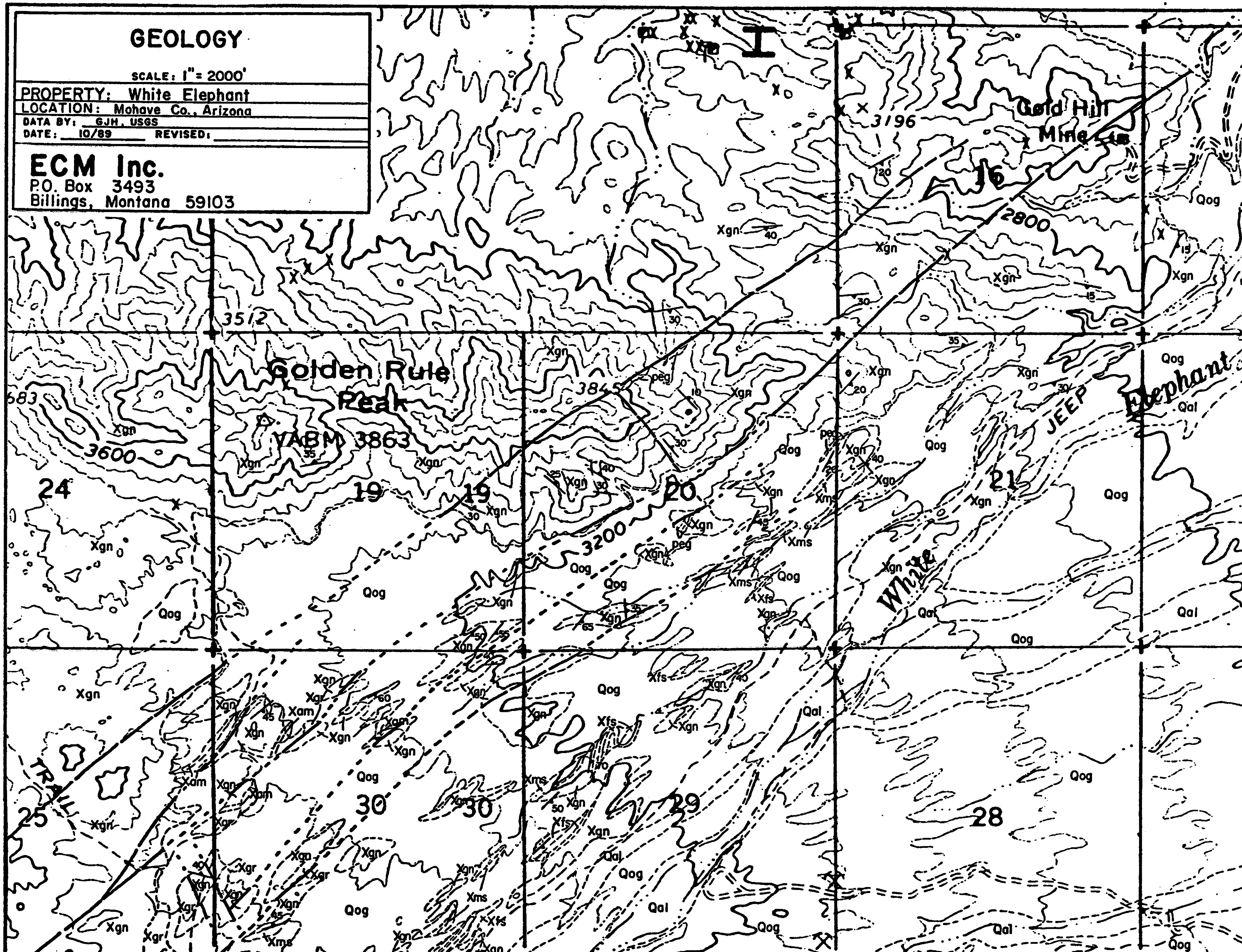


GEOLOGY

SCALE: 1" = 2000'

PROPERTY: White Elephant
LOCATION: Mohave Co., Arizona
DATA BY: GJH, USGS
DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103



SAMPLE LOCATIONS

SCALE: 1" = 2000'

PROPERTY: White Elephant

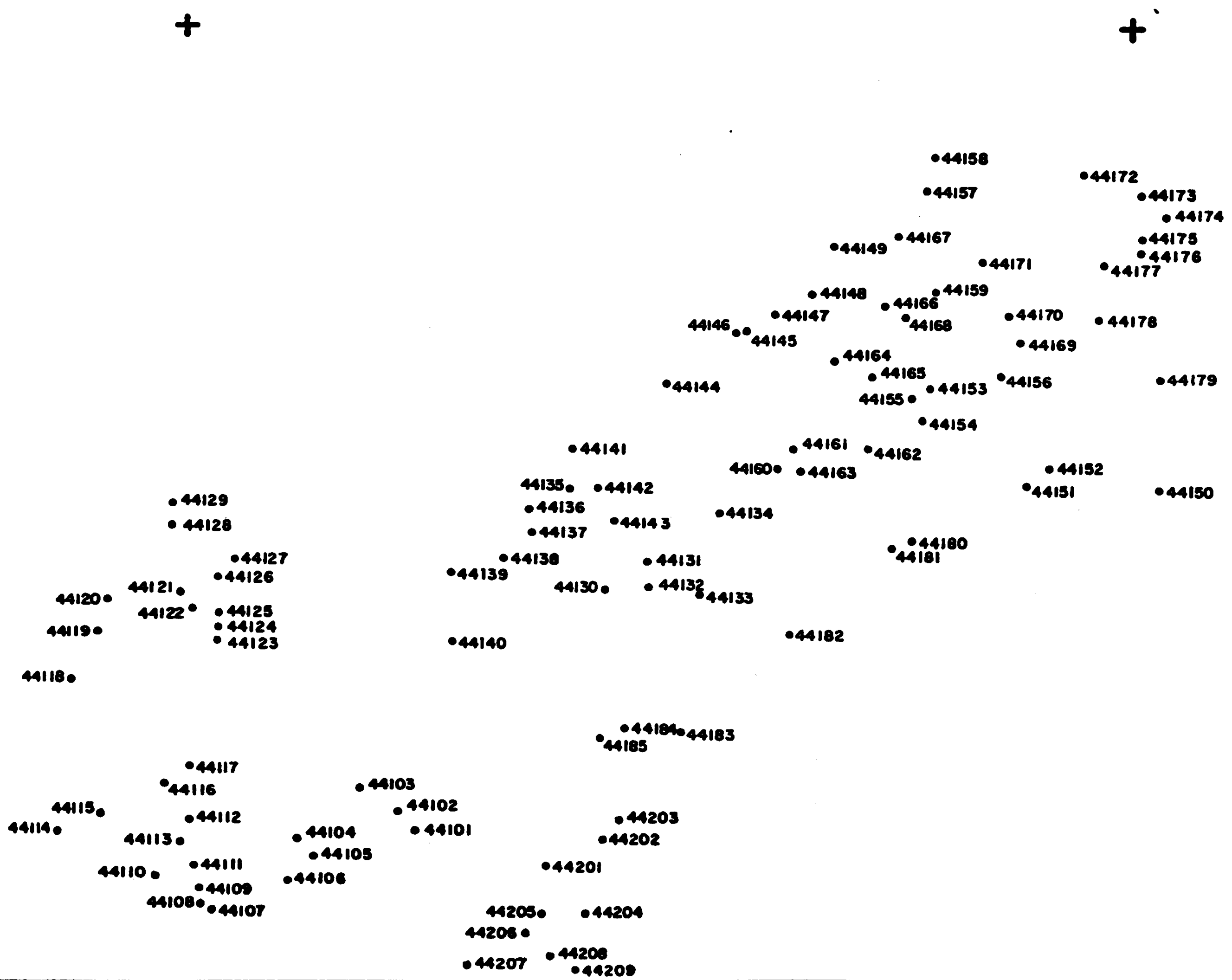
LOCATION: Mohave Co., Arizona

DATA BY: GJH, USGS

DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103

• 44165 Rock chip sample location and number

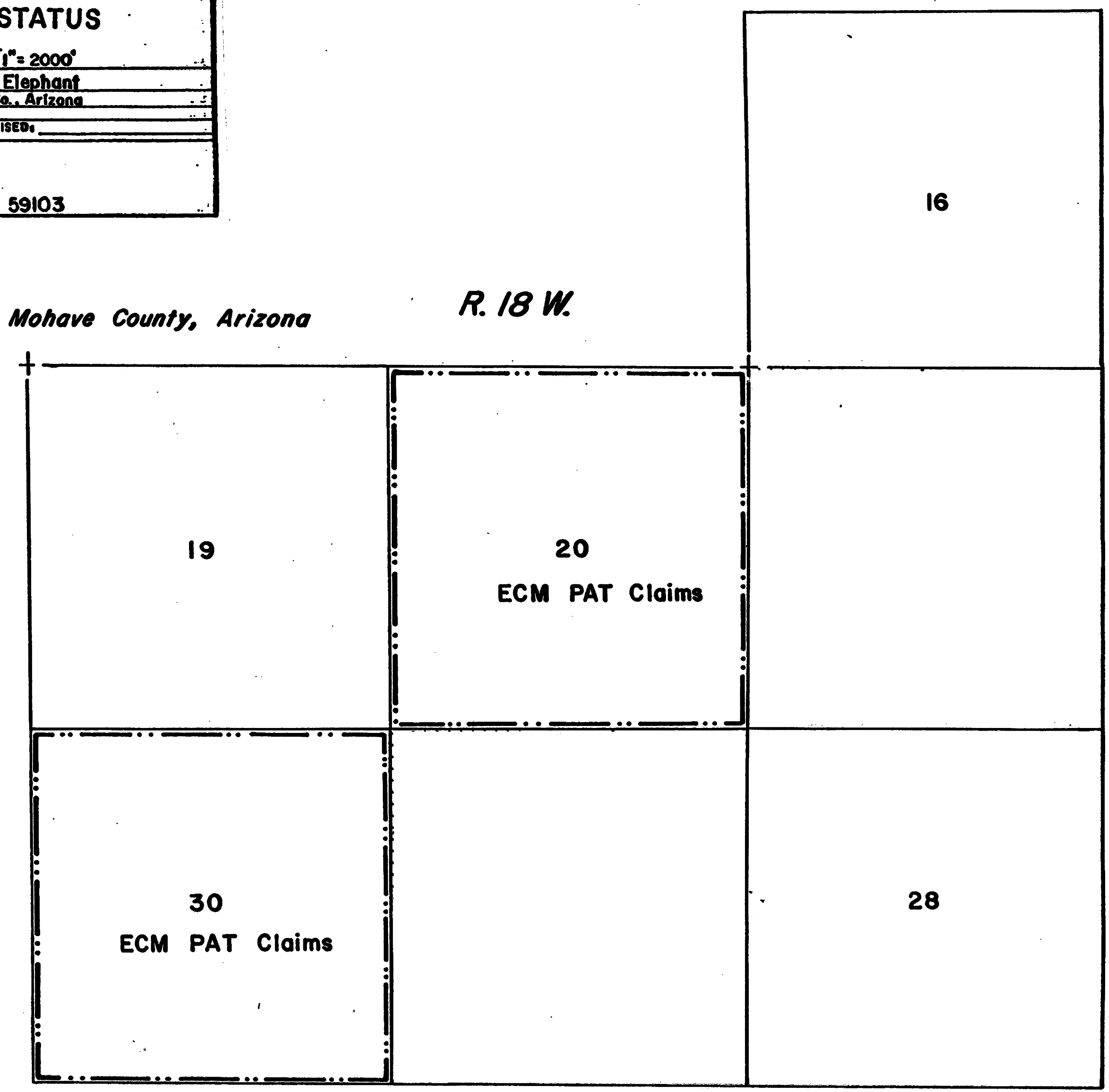


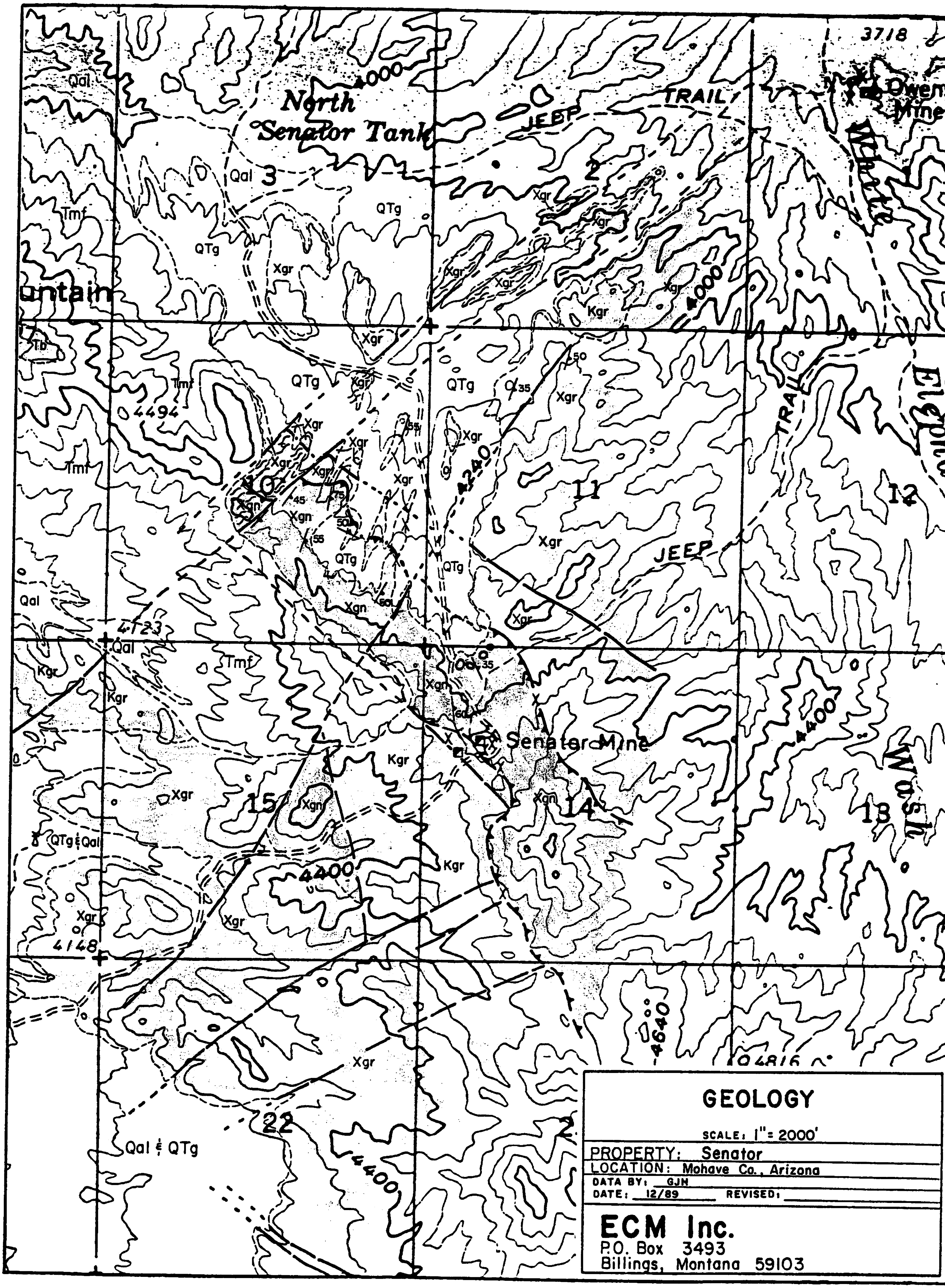
LAND STATUS

SCALE: 1" = 2000'

PROPERTY: White Elephant
LOCATION: Mohave Co., Arizona
DATA BY: GJH, USGS
DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103





GEOLOGY

SCALE: 1" = 2000'

PROPERTY: Senator
LOCATION: Mohave Co., Arizona
DATA BY: GJN
DATE: 12/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103

ROADRUNNER PROPERTY

Mohave County, Arizona

NOVEMBER 1989

ROADRUNNER PROPERTY

Mohave County, Arizona

Location - The Roadrunner property is located near the southeastern corner of the White Hills in northwestern Mohave County, approximately 65 miles north of Kingman, Arizona. Access from Kingman is 30 miles north on U.S. highway 93 to the Pierce Ferry road, then northeast for a distance of about 20 miles to the Malco mine road which is traveled for about another four miles to the southern edge of the property. There are several old mine roads on the property as well as a number of more primitive trails passable by four-wheel drive vehicles.

The Roadrunner property is located on the Garnet Mountain 15-minute topographic sheet.

Land Status - ECM has staked 48 claims and is in the process of staking approximately 28 additional claims within the area outlined on the Land Status map. These cover some or all of the targets identified. ECM is now negotiating with three other parties in an attempt to acquire mining leases covering approximately 1200 acres within the area.

Historic Activities - The Roadrunner property is within the Gold Basin mining district of northwestern Arizona. District production of gold since the 1870's is estimated to be in the range of 40,000 - 60,000 ounces. Silver, copper, and lead were also recovered from several of the mining operations in the district.

Some of the past producing mines are located on lands that border the ECM claims. The most important of these were the Eldorado (SW/4 Sec.21), Malco (SE/4 Sec.21), Excelsior (NW/4 Sec. 22), and the O.K. (NW/4 Sec.28). The ores extracted from these mines were largely confined to northeast trending fissure veins hosted by gneissic granodiorite and biotite-rich quartzofeldspathic gneisses. At the Excelsior mine the veins occurred along a fault separating coarse grained, porphyritic monzogranite from biotite-rich paragneisses. The run-of-the-mill grade for most of these mines was 0.3 - 0.75 opt Au.

Many of the small arroyos and washes in this part of the district were prospected for placer gold. However, no large areas with economic concentrations were apparently found.

General Geology - The Gold Basin district is in the southeastern corner of the Basin and Range province and only 15 miles west of the Colorado Plateau. It straddles a small north trending, block-faulted range called the White Hills. These are separated from the Virgin Mountains to the north by the Colorado River canyon at Lake Mead.

The White Hills are cored by Early Proterozoic metamorphic rocks that date back to at least 1.7 b.y. ago (see accompanying regional geologic map). This central metamorphic complex is mainly comprised of paragneiss with locally significant subordinate amounts of orthogneiss.

The peak dynamothermal metamorphic event overprinted on the gneissic and schistose rocks occurred sometime before the emplacement of large masses of porphyritic monzogranite at about 1.65 b.y. ago. The regional northeast trending gneissic and schistose foliations in these metamorphic rocks were locally contorted into complex fold patterns near the intrusives, as well as near some of the larger, regional faults and shear zones.

The gneissic terrane consists of a dominant assemblage of biotite-rich quartzofeldspathic gneiss with fairly abundant quantities of interlayered amphibolite, biotite-muscovite schist, and quartz-muscovite schist. The protolith for these rocks is believed to have been a thick sequence of deep-water clastics, probably dominated by turbidites. Mixed within this sedimentary sequence are metamorphosed volcanic and plutonic rocks representing either parts of an ancient arc terrane or a back arc tectonic basinal setting.

Gneissic diorite and granodiorite are common in the southeastern portion of the White Hills, and especially in the vicinity of the Roadrunner property. These well foliated plutons were, themselves, intruded by a coarse grained, rapakivi-type, porphyritic monzogranite at about 1.65 b.y. ago. This intrusive is generally not foliated or only weakly foliated near some shear zones and intrusive contacts. However, many of the large, tabular microcline phenocrysts show a well developed preferred orientation that parallels the foliation in the surrounding gneisses.

Leucocratic granites are quite plentiful in the southern White Hills. Many are in sill-like bodies that were apparently intruded into the gneissic rocks. These conformable intrusives probably belong to an older age of igneous activity since they are well foliated and even intensely mylonitized at some exposures. Many of the leucogranites show a strong spatial relationship to gold prospects throughout the Gold Basin district.

The Proterozoic rocks in the southern portions of the White Hills were also intruded by an undeformed leucocratic two-mica peraluminus granite. This pluton is Late Cretaceous in age and comprises many smaller bodies of aplite, episyenite, and pegmatite. Further, it reresents one of many such plutons that form a regionally extensive inner-cordilleran belt of two-mica granites extending from northeastern Washington to southeastern Arizona. Two major gold districts in the southwestern U.S., Mesquite and Cargo Muchacho, are associated with igneous rocks of this type.

The major structural grain in the White Hills region consists of north-south trending fault blocks that formed during Mid-Tertiary extensional tectonism. These are in turn made up of rocks exhibiting older northwest and northeast tectonic fabrics. The northeast appear to be more abundant or better displayed in the areas around the Roadrunner property. Several N40-65E fault and shear zones that cut across the property account for rapid lithologic changes, mylonitized rock textures, alteration, and, most importantly, localized gold occurrences.

A large low-angle fault is intermittently exposed throughout portions of the southern White Hills. This detachment structure is considered to be Miocene in age since it involves volcanic rocks and fanglomerate deposits of that age. This same fault probably extends northward along the west flank of the White Hills. Several of the larger gold mines in the district were located within the brecciated and mylonitized rocks associated with this large regional structure.

Middle to Late Tertiary volcanics were erupted in the region during an episode of block-faulting and local tilting. These young igneous rocks are mainly found along the western side of the White Hills or the eastern side of the Lost Basin Range to the east. The Tertiary volcanic sequences and their intercalated deposits of coarse fanglomerates are moderately to steeply dipping along some of the north trending normal faults.

Late Tertiary gravels are present throughout the region as dissected alluvial fan remnants. Many of these gravel deposits are auriferous and have yielded small, economic placers where they were reworked by younger stream systems.

Local Geology - The Roadrunner property is situated in a portion of the Gold Basin district where the geology is considerably more complex than in the surrounding areas. Attributing to the complexity of the area are a) at least three major plutonic masses, b) intersecting zones of large, regional structures, and c) multiple events that contributed hydrothermal alteration products to rocks already exhibiting both pro- and retrograde metamorphic assemblages. Notably, the property also lies within an area where the known gold deposits are at their greatest density.

The central feature in the Roadrunner area is an Early Proterozoic gneissic granodiorite. This northeasterly elongated pluton was probably intruded as a stock into a clastic-dominated sedimentary sequence sometime between 1.7 and 1.8 b.y. ago. Foliations in this pluton are very well developed and conspicuously displayed in outcroppings due to a relatively high biotite content (15 - 20 percent). Much of the gneissic granodiorite has been altered to a chlorite-rich rock that also contains variable amounts of sericite and carbonate. This alteration is frequently found in association with gold-bearing fissure veins that formed at dilational sites along several of the major northeast trending fault and shear zones.

The gneissic granodiorite and rocks in immediate contact with it are some of the most important host rocks for gold mineralization in the southern White Hills. These include several of the largest vein deposits in the district which are located along the eastern fault-bounded contact of the pluton. This contact displays rocks that have been repeatedly disturbed by major fault movements along northeast trending zones of weakness. The intensity of deformation along these faults and their extension over large distances suggest that this zone is part of a major crustal-scale shear system that probably controlled the emplacement of the granodiorite pluton to begin with.

The northern portion of the gneissic granodiorite hosts an impressive number of coarsely crystalline and locally mylonitized leucogranite occurrences. These relatively small igneous bodies typically contain central cores of pegamtitic minerals, notably quartz, K-feldspar, muscovite, biotite, Fe-carbonate, and some moderately coarse sulfides, probably pyrite. Most leucogranite and pegmatite occurrences are conformable with the foliation in the granodiorite, but can also have highly complex shapes that cut across the structural fabric of the host rocks. Interestingly, these pegmatitic rocks are frequently located near gold prospects, especially in the S/2 of Section 16. Here, they seem to have a higher sulfide content than normal as indicated by the amount of limonite that has developed on the weathered surfaces. Some of these more Fe-stained rocks also contain appreciable amounts of jarosite indicating that the local sulfide contents may have exceeded 10 volume percent.

A much larger mass of leucocratic granite is present in the E/2 of Section 20. This sill-like intrusive(?) mass dips shallowly to the west beneath several gold prospects as well as the Never-Get-Left gold mine located in the SE/4 of Section 20. Some portions of this igneous rock appear to be pervasively silicified by a vitreous, bluish-gray quartz that locally grades into irregular networks of thin vein-like streaks. A finely developed fibrous amphibole may also be associated with these silicified zones.

The pegmatites and leucogranites in the southern White Hills could have formed as felsic differentiates from the granodiorite magma. It is also possible that they are genetically related to the porphyritic monzogranite that lies mainly south of the Roadrunner property.

The large mass of coarse grained and relatively unfoliated monzogranite appears to host gold occurrences only where it has been extensively deformed by large faults and zones of intense ductile shearing. For instance, the gold ores extracted from the Excelsior mine came from veins located along the large northeast trending fault zone that separates the monzogranite from paragneisses. Farther south along this same structural zone the monzogranite is quite pervasively altered to variable mixtures of chlorite, clays, and even sericite in some places. These altered areas host gold-bearing vein occurrences that are quite different from most others in that they also carry appreciable amounts of fluorite.

The same northeast trending fault zone that contained the ores at the Excelsior mine broadens to the southwest into at least three major segments that span a distance of 1000 - 1500 feet in the N/2 of Section 28. Complicating this wide zone of steep faults and shears are a significant number of low-angle, westerly dipping faults. These structures cannot be traced very far in outcrops, usually because they either merge into the high-angle faults, or they are terminated against them. Nonetheless, these low-angle structures are important because they are mineralized at a number of places in the NE/4 of Section 28. From here they project beneath cover into the adjacent Sections 22 and 27.

Another important northeast trending fault zone occurs within Section 16 and adjacent areas. A broad portion of this zone (central portion of Section 16) is defined by sheeted and mylonitized gneissic granodiorite. Injection pegmatites also occur in this area and they appear to be associated with a subtle but pervasive argillic alteration overprinted on the granodiorite. Coincident with this alteration is a strong build-up of carbonate in both the granodiorite and pegmatites.

In the SW/4 of Section 16 the northeast trending fault zone hosts gold-bearing, high-sulfide fissure veins. These veins also carry a strong Fe-carbonate content in addition to a pinkish-colored carbonate that may be Mn-rich. A weak silicification envelopes these vein occurrences within the fault zone, extending approximately 20 to 30 feet outward from them. Locally, there are small stockwork-like developments of quartz-carbonate veinlets.

On the south side of the fault zone in the same location (SW/4 of Section 16), there is a fairly narrow band (200-250 ft. wide) of paragneiss that shows a considerable amount of alteration. Most of the rock has been affected to varying degrees by hydrothermal fluids that probably pervaded outward from the fault zone. The alteration assemblage generally consists of variable mixtures of chlorite-sericite-carbonate±sulfides. A weak but distinct color anomaly is also associated with these altered rocks indicating an elevated background of probable disseminated sulfides as well as Fe-carbonate. A weak silicification occurs in patchy distribution throughout the same area.

Reno 12-4-89

ECM, Inc.
Mining Properties

December 1, 1989

Mr. Randy Moore
Cambior USA
Suite 23
230 S. Rock Blvd.
Reno, NV 89502-2345

Dear Mr. Moore:

Enclosed is our recent report on the Roadrunner Property dated November 1989 that you requested.

Cambior has our permission to go on these claims and to conduct such exploration work as it deems advisable. In return for the permission granted by this letter, Cambior will furnish ECM: the data, if any, generated by such exploration work; and, if requested by ECM, an accounting of the amount of time Cambior's employees spent on such exploration work as well as their expenses and third-party charges incurred. Cambior understands that ECM may apply Cambior's exploration work to ECM's assessment obligation on these claims.

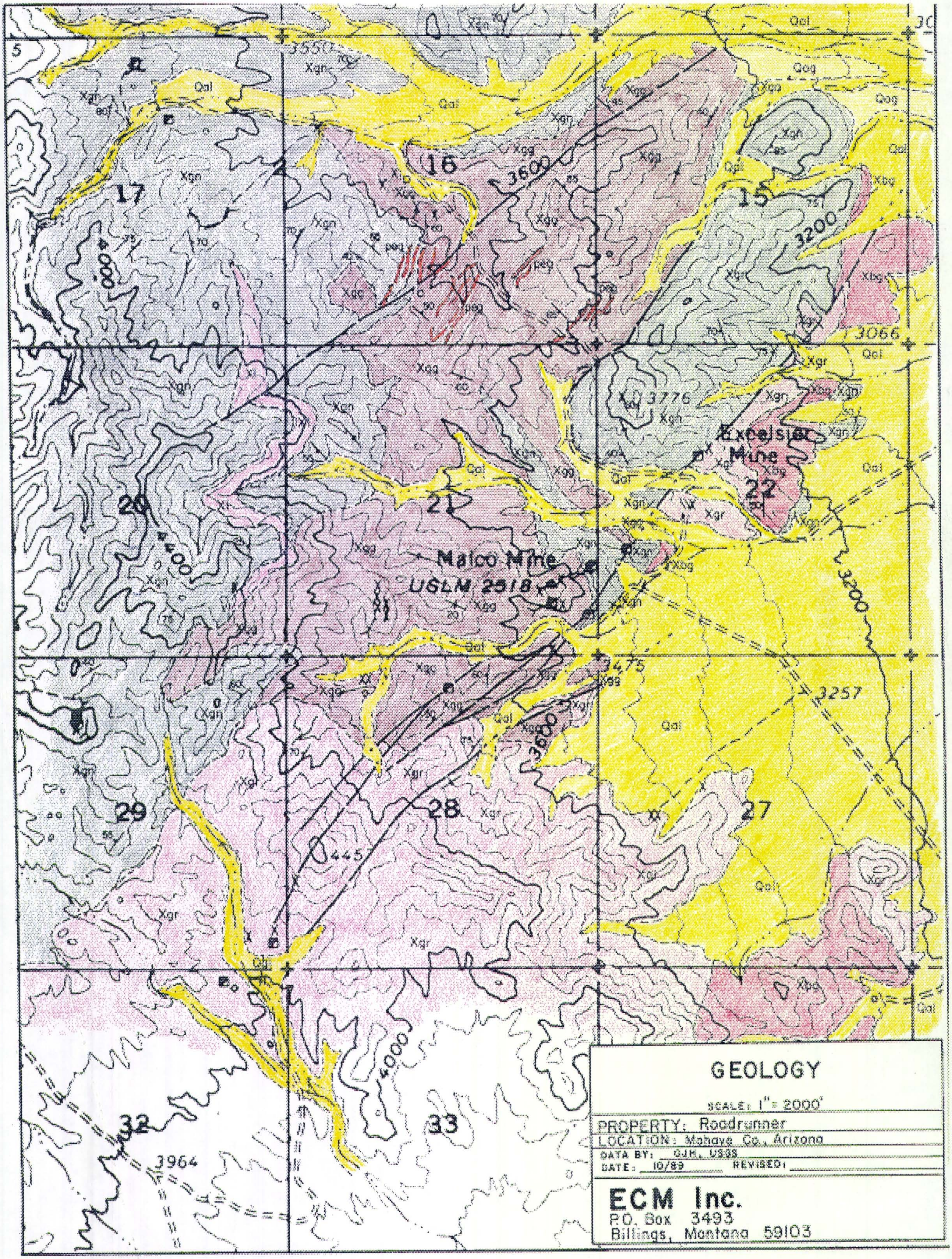
Sincerely,

Thomas Ballard

Thomas E. Ballard

TEB:dkh
enclosure

11605 Fowler Drive Northglenn, Colorado 80233 (303) 450-7276


GEOLOGY
SCALE: 1" = 2000'
PROPERTY: Roadrunner
LOCATION: Mohave Co., Arizona
DATA BY: GJR, USGS
DATE: 10/89
REVISED:
ECM Inc.
P.O. Box 3493
Billings, Montana 59103
Excelsior Mine
Malco Mine
USLM 2518
Xgn
Xgg
Xgr
Xbg
Qal
Qog
peg
3600
3200
4000
4400
3550
3776
3066
3475
3257
3964
16
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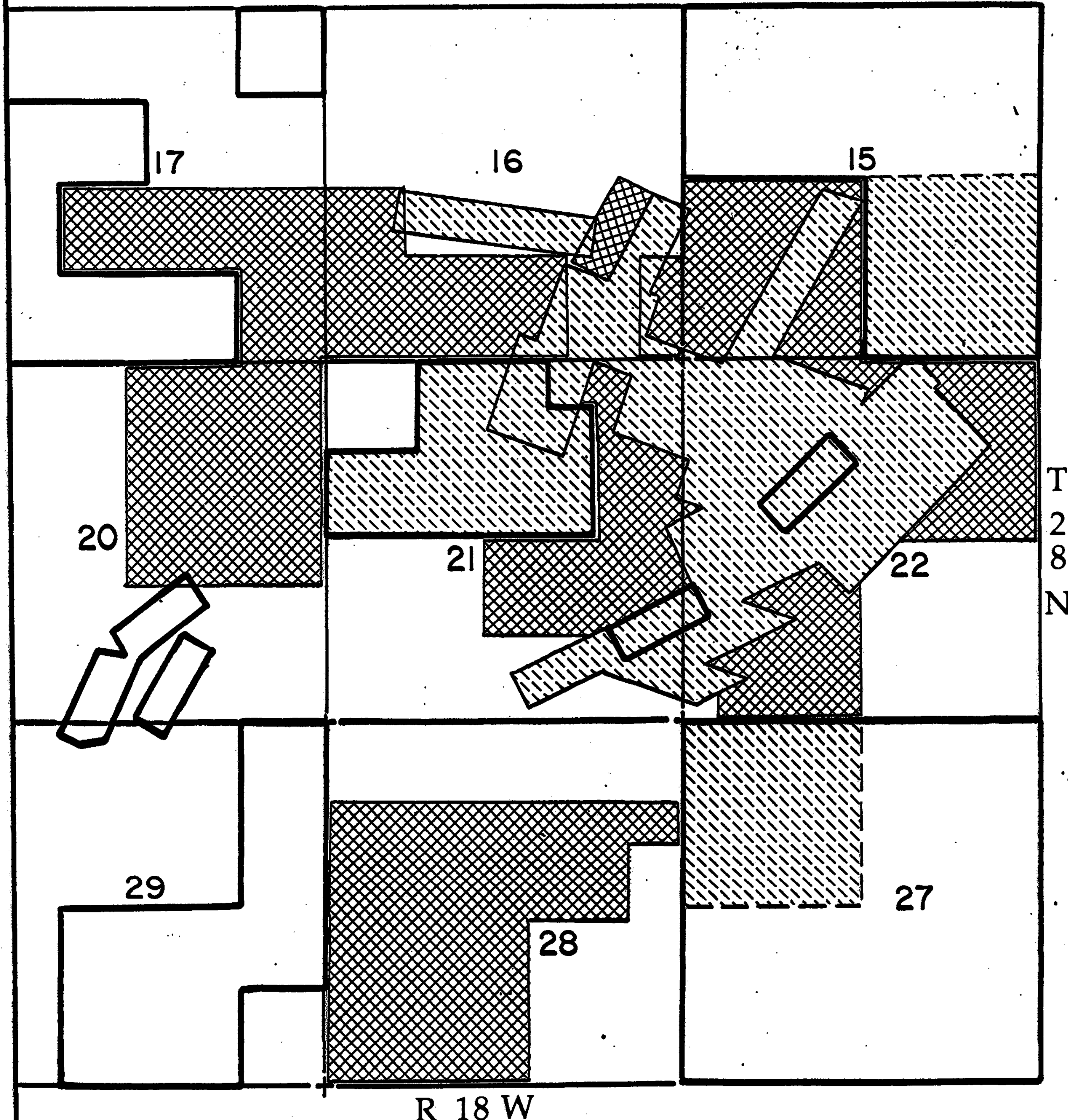


ECM Claims

Lands under negotiations

LAND STATUS

SCALE: 1" = 2000'

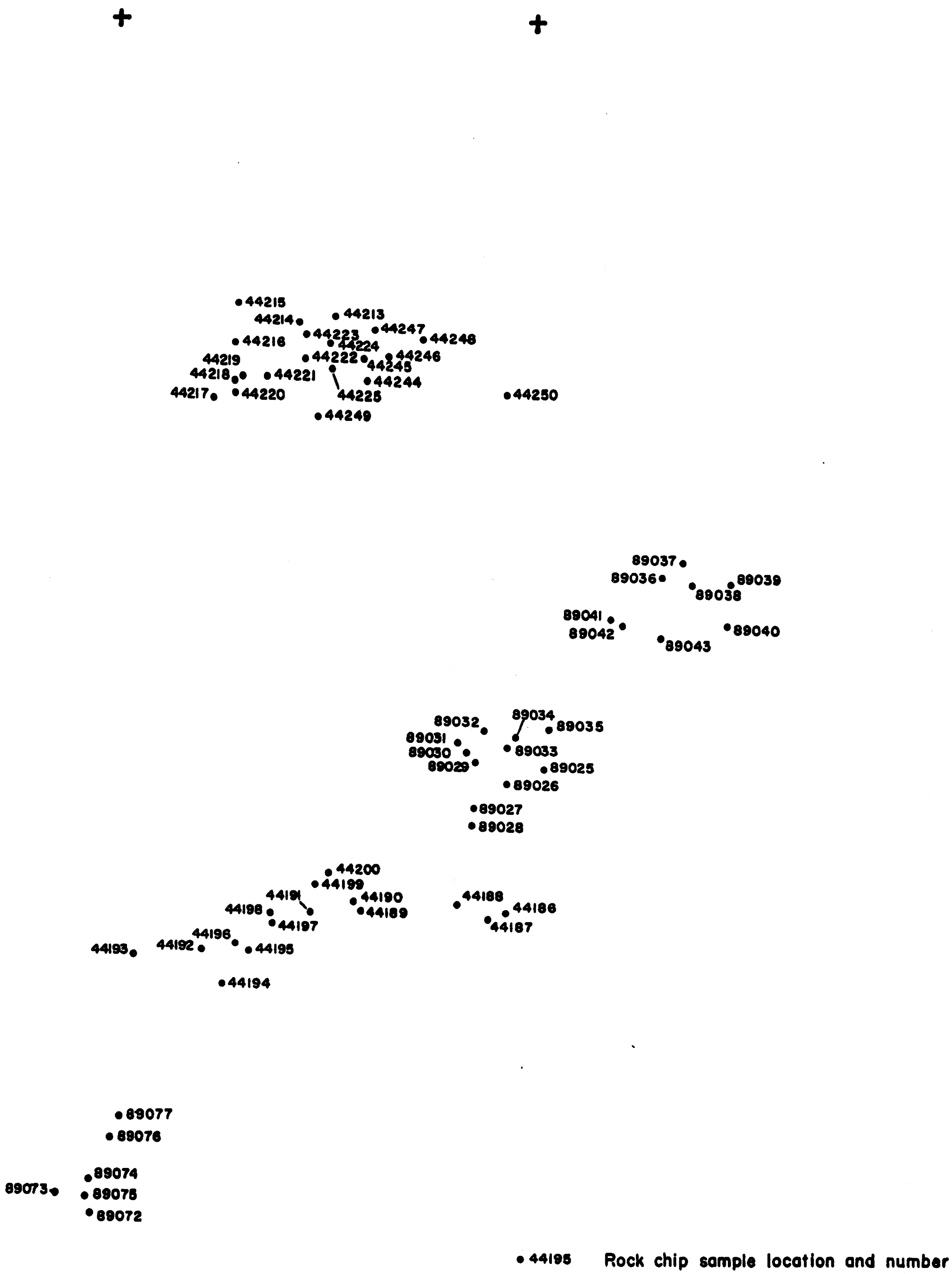
PROPERTY: Roadrunner

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103

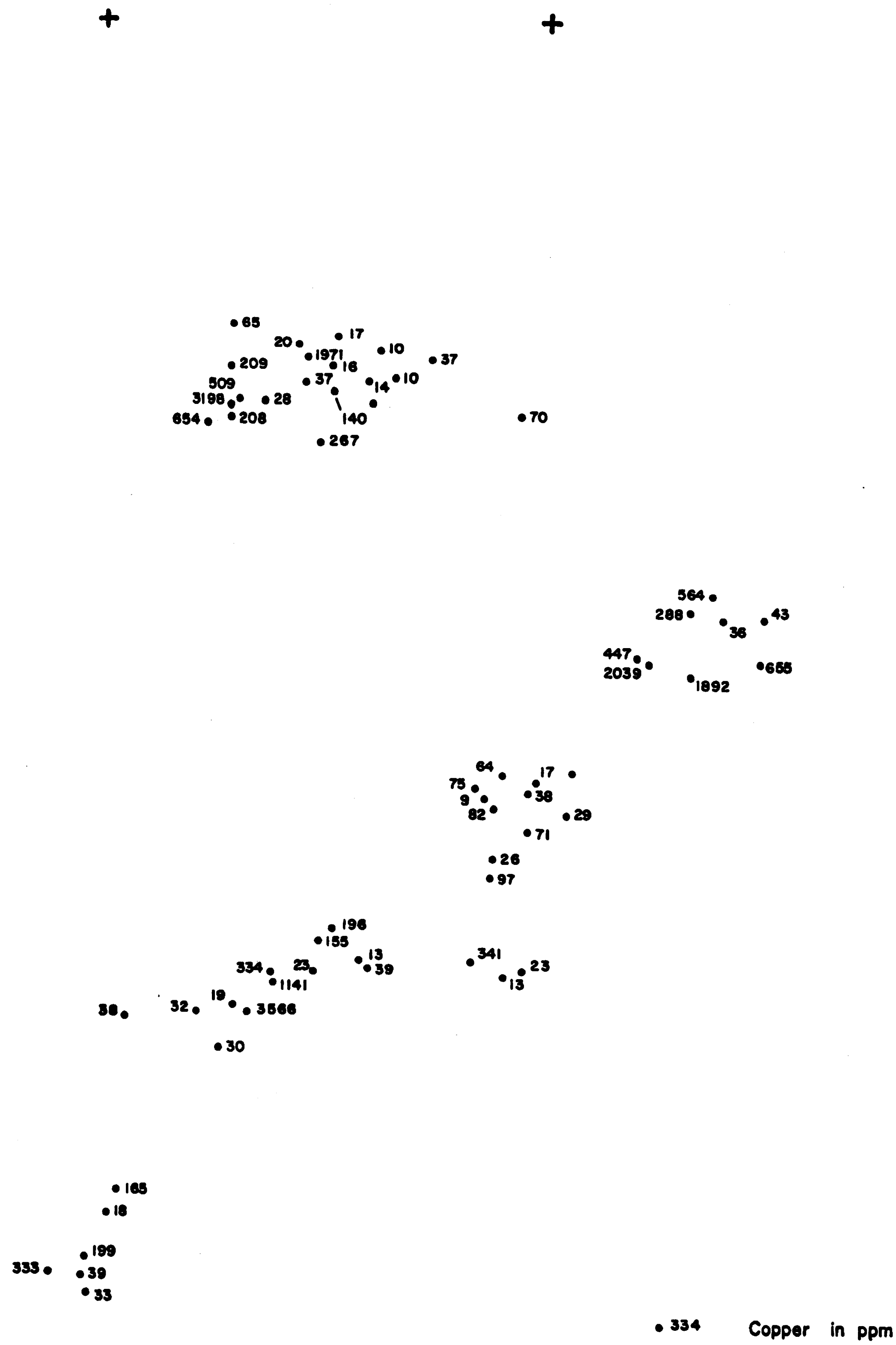


SAMPLE LOCATIONS

SCALE: 1" = 2000'

PROPERTY: Roadrunner
LOCATION: Mohave Co., Arizona
DATA BY: GJH
DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103



Cu GEOCHEMISTRY

SCALE: 1" = 2000'

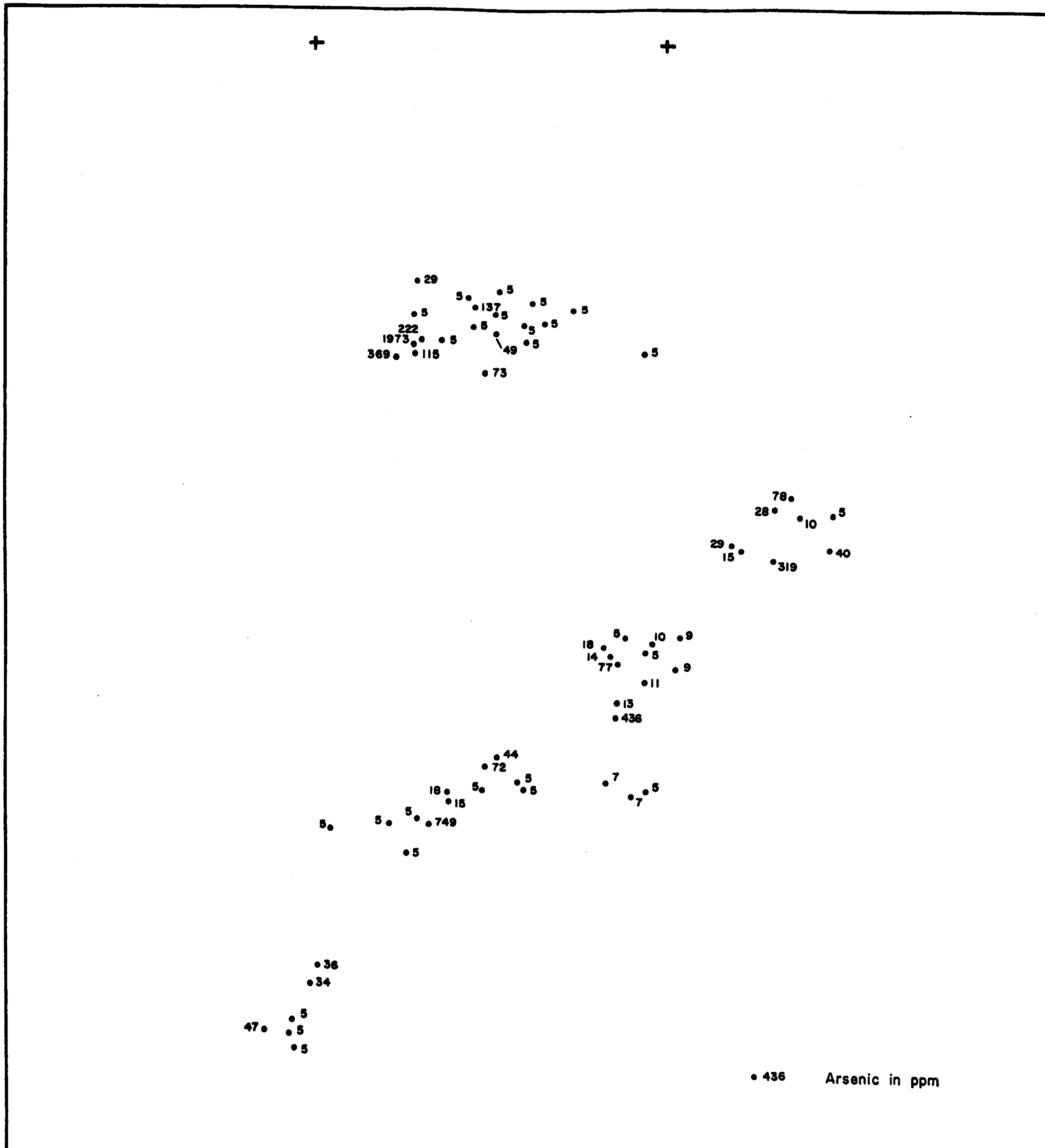
PROPERTY: Roadrunner

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103



As GEOCHEMISTRY

SCALE: 1" = 2000'

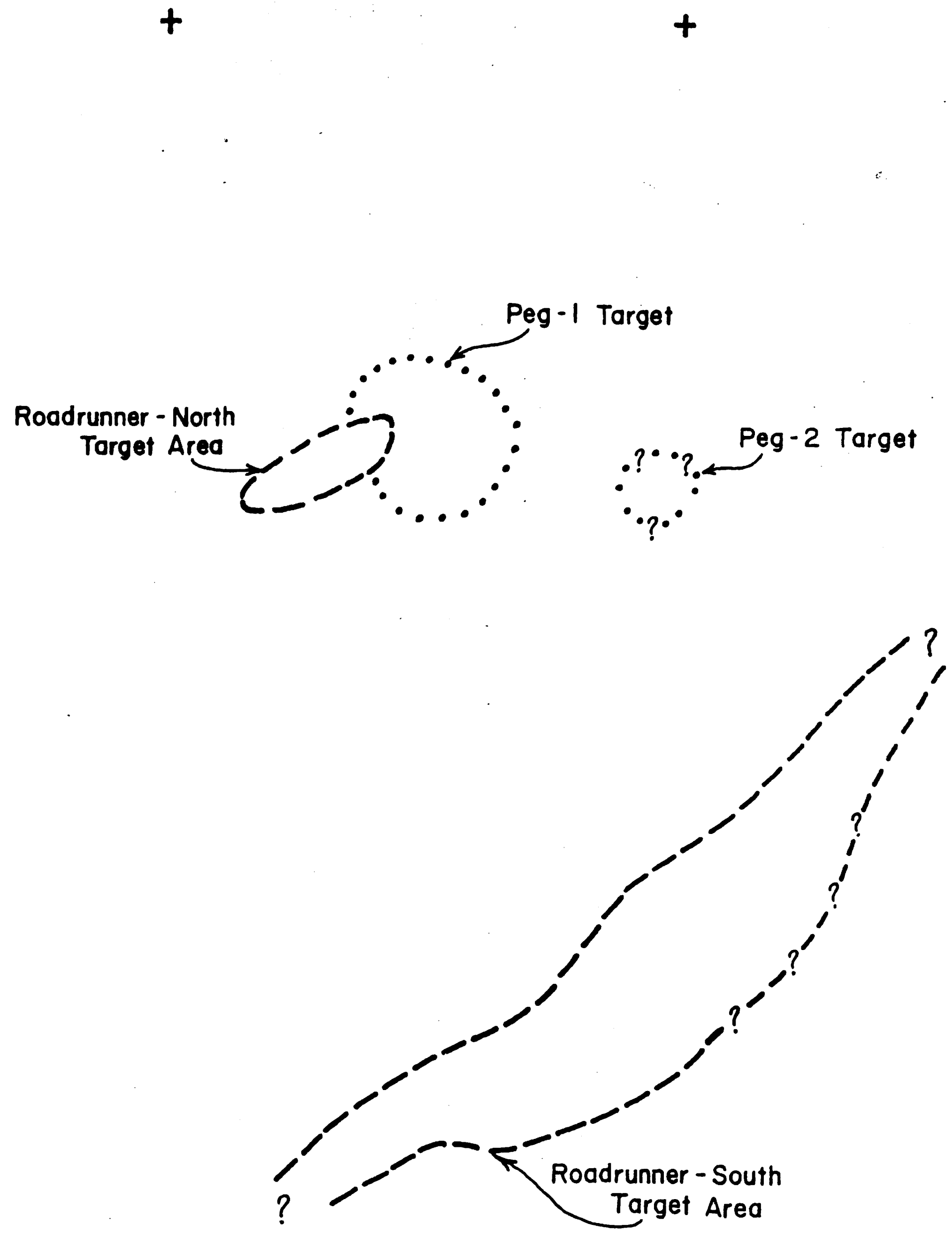
PROPERTY: Roadrunner

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103



TARGET AREAS

SCALE: 1" = 2000'

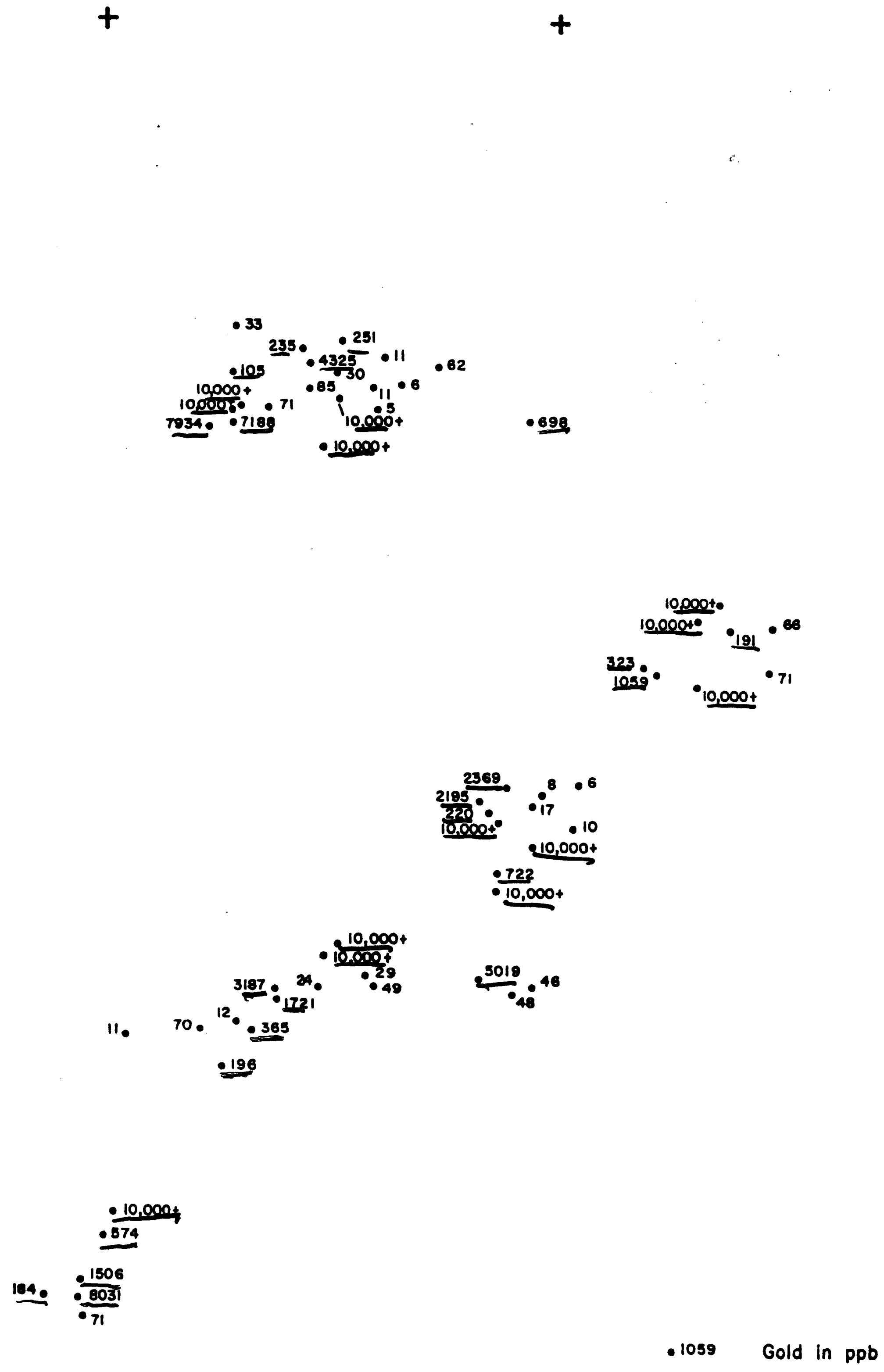
PROPERTY: Roadrunner

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103



Au GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Roadrunner

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 10/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103

Geochemistry - Preliminary reconnaissance sampling at the Roadrunner property was mainly focused along the northeast trending fault and shear zones, and in areas containing an appreciable amount of altered leucogranite and pegmatite. Detailed sampling traverses across the main structures would be needed to better define the extent of gold-enrichment associated with the many smaller, parallel shears and fracture zones. Mylonitized rocks adjacent to the larger vein structures, especially those along the Malco mine - Excelsior mine trend, should also be sampled in greater detail.

Basically, there are at least two broad zones of metal enrichment associated with the gneissic granodiorite stock at Roadrunner. Altered rocks located along the structurally complex contact zone at the southeast corner of this pluton contain very high gold values, especially where quartz-carbonate-sulfide veins formed within the granodiorite. Base metals (Cu,Pb) are also anomalous in this same area; whereas, anomalously high arsenic values appear to be more sporadically distributed along the same zone.

Random rock-chip sampling across silicified, mylonitic rocks adjacent to the larger quartz-carbonate veins at the Malco mine showed that high gold values (200 - 2300 ppb) are maintained in the altered rocks for distances of more than 20 feet from the vein structures. However, both base metals and arsenic values in these same samples were surprisingly low suggesting that they may not be useful indicator elements for some types of gold mineralization in the region.

A sample (#44188) collected across a 20-foot wide low-angle shear zone in the NE/4 of Section 28 yielded about 5 ppm Au. No other samples were taken from this structure because the amount and intensity of alteration associated with it was not very impressive. On the otherhand, a finely developed network of quartz-carbonate veinlets was noted, and probably corresponds to the gold enriched portions of this low-angle structure. Once again, however, the arsenic (7 ppm) and base metal values for the same sample interval were very low.

The northeast trending fault zone in Section 16 is another gold-enriched structural setting. A couple of samples from the altered paragneiss located on the south side of this structure (SW/4 of Section 16) yielded high gold values (7 ppm) probably associated with the more pervasive quartz-carbonate alteration there. Also worth noting for these samples are the highly anomalous values for both arsenic and base metals, indicating that the paragneiss probably hosts a different metal signature than the intrusive rocks from the same area. Quite obviously, these rocks need to be mapped and sampled in greater detail in order to delineate the location and extent of possible exploration targets.

Finally, the pegmatite and leucogranite occurrences in the same area of Section 16 have also produced some anomalous gold values. Samples of these rocks contain moderately anomalous values of base metals, but are surprisingly low in arsenic content. Samples of pegmatite containing the highest gold values (235 - 10,000+ ppb) were collected where these rocks are altered (argillic) and overprinted by a considerable amount of iron(?) carbonate (+15 volume percent). Samples from apparently fresher pegmatite yielded much lower values (6 - 30 ppb).

<u>Target Type</u> - Studies of field and geochemical relationships at Roadrunner indicate that gold was most readily deposited along the major fault and shear zones in the area, especially where dilation zones allowed formation of fissure veins. Both metamorphogenic and hydrothermal fluids probably contributed metal to these structural sites. The major northeast trending fault and shear zones formed in response to large-scale, regional tectonic events that began at least back in the Early Proterozoic. Periodic reactivations along these tectonic lineaments allowed channelized fluid-flow to occur at different times, probably through the mid-Tertiary.

Emplacement of the main mass of gneissic granodiorite probably was followed closely by hydrothermal fluid convection around its intrusive contact. Another intrusive event involving the porphyritic monzogranite followed quite closely in time, and probably contributed yet another hydrothermal component to the major structural sites.

Hydrothermal fluids appear to have leached iron, alkali metals, and alkaline earth metals while depositing silica, carbonate, and various sulfide minerals. Gold was probably precipitated along with finely disseminated sulfides (mainly pyrite) where the hydrothermal fluids could move most freely. The largest volumes of fluids may have been accommodated where the high-angle, northeast trending faults and shears intersect with low-angle fault zones.

Probably the most obvious and largest target area at Roadrunner is the gold-enriched portion of the northeast trending tectonic zone extending from the southwest corner of Section 28 to the Excelsior mine area in Section 22. Previous work along this belt was focused on the high-grade fissure veins that had only a limited size potential. Results from the current study, however, indicate a very good probability for more pervasively mineralized zones. Perhaps the optimum target is where this structural zone is intersected by an as yet unknown number of low-angle faults. This appears to occur in an area close to the common corner for Sections 21,22, 27, and 28, and probably extends into Section 22 beneath a thin cover of pediment gravels. I refer to this area as the Roadrunner-South target (see accompanying overlay).

The Roadrunner-South target area is a complex geologic setting where probably at least two or three mineralizing events have taken place. It differs from the target areas in the northern portion of the property in the intensity and types of alteration associated with these multiple events. The widespread presence of this alteration and associated gold-anomalous rocks is strong evidence that a large, bulk-tonnage, low-grade gold deposit was likely to have formed in this vicinity.

The target areas on the northern portion of the property represent smaller areas of anomalous alteration and geochemical signatures. However, they are probably not as well defined, at this point, as the Roadrunner-South target area.

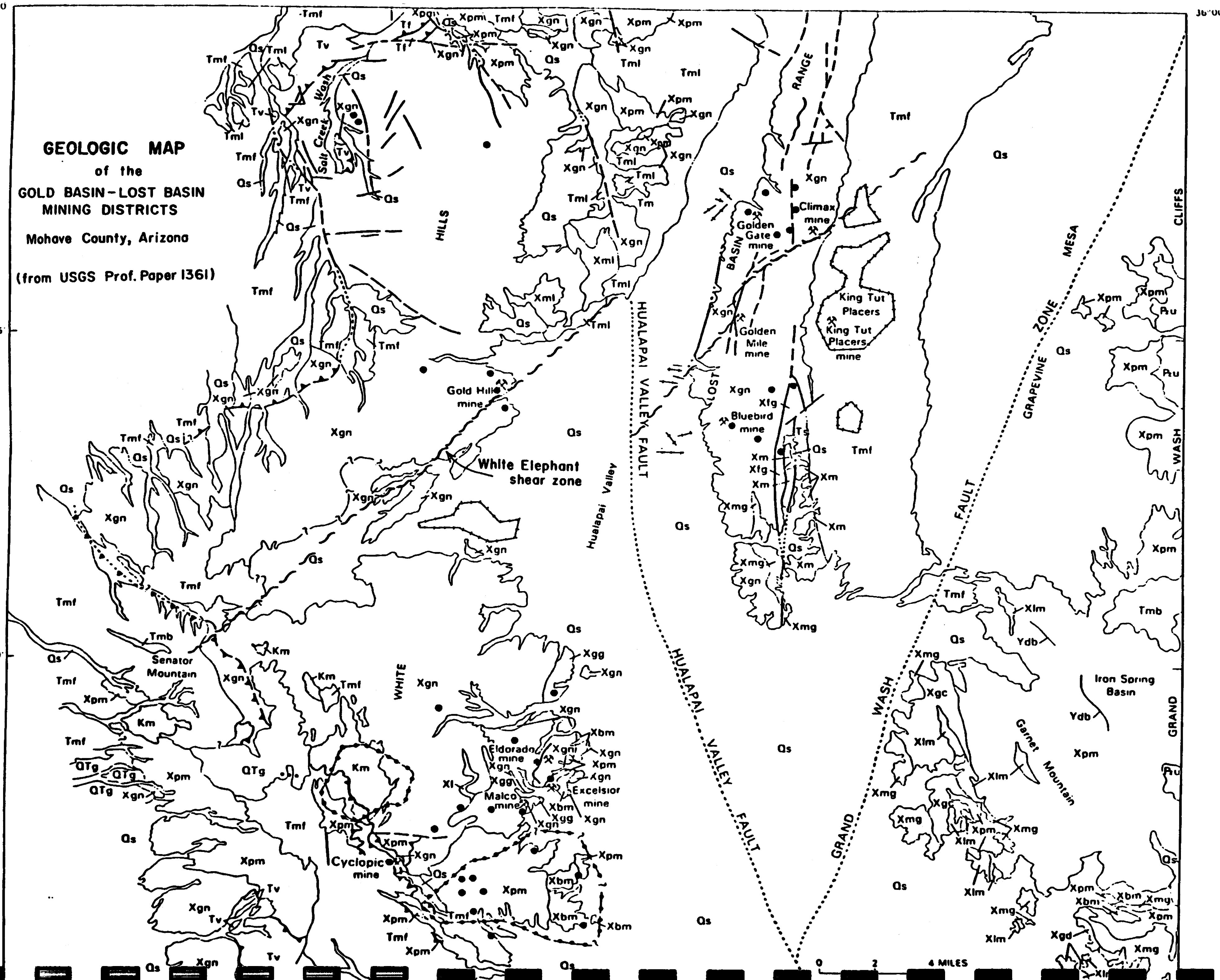
The most readily defined target area in the north is also located along a major northeast trending fault zone. It is similarly associated with high-grade fissure veins that formed at the structural contact between gneissic granodiorite and rocks of the paragneiss sequence. The potential size of the target in this area is enhanced by the possibility of a much broader mineralized (disseminated sulfide) zone occurring along the south side of this structure. This is where a band of altered paragneiss appears as a pendant in the granodiorite intrusive. However, a more thorough sampling of this target area is necessary before any specific parameters can be developed.

Immediately adjacent to the Roadrunner-North target area is an ill-defined zone within the gneissic granodiorite that contains a swarm of pegmatites and leucogranite.

Some of these unusual rocks contain very high gold contents, and, even though their individual sizes are small, there may be a sufficient density of them to warrant their consideration as a target.

These mineralized pegmatites and their intensely sheared and mylonitized wallrocks resemble similar lithologies associated with the Picacho gold mine in southeastern California. At Picacho, though, there is a readily observed zone of intense brecciation believed to represent faulted portions of a large, regional-scale detachment surface. No such features could be seen at the pegmatite bearing areas on the northern Roadrunner property, though the possibility of such a feature in this vicinity is very strong.

A detailed map showing the distribution of pegmatites and altered leucogranite would determine the size of the permissive area for targets. Further, a thorough sampling of these rocks and their associated wallrocks is necessary before specific targets can be delineated.


GEOLOGIC MAP
of the
GOLD BASIN-LOST BASIN
MINING DISTRICTS
Mohave County, Arizona
(from USGS Prof. Paper 1361)
HILLS
WHITE
Salt Creek Wash
White Elephant shear zone
Gold Hill mine
Senator Mountain
Cyclopic mine
Eldorado mine
Malco mine
Excelsior mine
Hualapai Valley
HUALAPAI VALLEY FAULT
LOST BASIN RANGE
Golden Gate mine
Climax mine
Golden Mile mine
Bluebird mine
King Tut Placers
King Tut Placers mine
GRAND WASH FAULT
GRAPEVINE MESA
ZONE
Iron Spring Basin
Garnet Mountain
GRAND WASH CLIFFS
0 2 4 MILES
36°00
55'
50'

DESCRIPTION OF MAP UNITS

Qs Sedimentary deposits (Quaternary)—Includes sand and gravel along active stream washes, talus, colluvium, poorly consolidated fanglomerate currently being dissected, and landslide deposits; also may include extensive high-level fanglomeratic deposits, west of Grand Wash Cliffs in general area of Grapevine Mesa, that may be Tertiary and (or) Quaternary in age

QTg Fanglomerate (Quaternary and (or) Tertiary)—Locally derived fanglomerate deposits that include mostly clasts of metamorphic rock south-southeast of Senator Mountain and that do not contain clasts of rapakivi granite or any interbedded tuffs

Muddy Creek Formation (Tertiary)

Tml Hualapai Limestone Member—Includes limestone interbedded with thin beds of limy claystone, mudstone, and siltstone. Weathered limestone beds have a predominantly reddish color and form steep cliffs where they are dissected by Hualapai Wash

Tmb Basalt—As shown, flows at Senator Mountain, near west edge of map area, and at Iron Spring Basin, near east edge. Basalt in these two areas correlates probably with basalt flows (not shown) that conformably underlie the Hualapai Limestone Member and also are interbedded with fanglomerate of the Muddy Creek Formation near northwest corner of map area. Whole-rock K-Ar age determination of basalt from this area yields age of 10.9 Ma (see section by E.H. McKee, this report)

Tmf Fanglomerate—Alluvial fanglomeratic deposits that include conglomerate, sandstone, siltstone, mudstone, and locally abundant gypsum lenses. Locally includes lenses and beds of rhyolitic tuff and, as shown near southwest corner of map area, fanglomerate mapped previously by Blacet (1975) as unit Tf. Unit is also intruded by minor basalt dikes, especially in general area of Senator Mountain. Near northwest corner of map area, unit includes well-exposed flows of basalt

Tv Volcanic rocks (Tertiary)—Includes mostly andesite. Map unit near northwest corner of map area internally is highly broken by numerous faults, and near here, unit also includes air-fall tuff and reddish-brown sandstone interbedded with chaotic sedimentary breccia composed of fragments of Early Proterozoic gneiss. In places, unit also includes massive porphyritic hornblende andesite and basalt flows and breccia and overall minor amounts of tightly cemented volcaniclastic rocks. Flow layering and bedding generally dip at angles of 35° in contrast with shallow dips of about 5° in unconformably overlying basal fanglomerate of the Muddy Creek Formation. Age ranges of 11.8 to 14.6 Ma are reported near type section of the Mount Davis Volcanics (Anderson and others, 1972), whereas K-Ar age determination on sanidine from air-fall tuff near Salt Creek Wash in northwestern part of area yields age of 15.4 Ma. The volcanic rocks may be equivalent of the Mount Davis Volcanics or the Patsy Mine Volcanics (see section by E.H. McKee, this report).

Ts Rhyolitic tuffaceous sedimentary rocks and fanglomerate (Tertiary)—Includes well-bedded mudflows and rhyolitic tuffaceous sedimentary rocks and minor amounts of fanglomerate. Crops out as steeply dipping sequence of rocks, bounded by north-striking faults, near south end of Lost Basin Range. Possibly equivalent to the Mount Davis Volcanics

Tf Fanglomerate (Tertiary)—Coarse fanglomeratic deposits that locally include landslide or mudflow breccia. Overlain unconformably by fanglomeratic deposits of the Muddy Creek Formation, and apparently intercalated with andesite possibly equivalent to the Mount Davis Volcanics

K.. Two-mica monzogranite (Cretaceous)—Includes mostly highly leucocratic muscovite-biotite monzogranite and some minor amounts of felsic muscovite granodiorite and episyenitic-altered muscovite-biotite monzogranite. Some facies are fluorite bearing. Porphyritic variants contain as much as 5 percent quartz phenocrysts. In places, contains very weakly defined primary layering of dimensionally oriented potassium feldspar and biotite

Ru Sedimentary rocks, undivided (Paleozoic)—Includes Cambrian Tapeats Sandstone, Bright Angel Shale, and Muav Limestone

Ydb Diabase (Middle Proterozoic)—Includes normally zoned laths of plagioclase set in very fine grained matrix of granules of opaque mineral(s) and clinopyroxene. Close to chilled margins of some fresh outcrops of undeformed diabase, olivine is found in concentrations of as much as 10 volume percent. Small masses of fine-grained diabase crop out sporadically in Early Proterozoic igneous and metamorphic rocks. Most extensive exposures are about 2 km east of Garnet Mountain. Subophitic textures are dominant. Lower chilled margins of some sills contain sparse hornblende and biotite microveinlets. Presumed to be correlative with the diabase of Sierra Ancha, Ariz., having an emplacement age of 1,150 Ma (Silver, 1963)

Xpm Porphyritic monzogranite of Garnet Mountain (Early Proterozoic)—Includes conspicuous, large potassium feldspar phenocrysts, set in a light-pinkish-gray, coarse-grained hypidiomorphic groundmass. Many exposures show tabular phenocrysts as much as 10 cm long. Some phases are predominantly subporphyritic seriate and show an almost continual gradation in size of their euhedral potassium feldspar phenocrysts. Most widely exposed mass crops out in the general area of Garnet Mountain, in the southeastern part of the area, and extends discontinuously from there to north along the low hills leading to Grand Wash Cliffs. Dated by Wasserburg and Lanphere (1965) to be about 1,660 Ma

Xgd Granodiorite border facies of porphyritic monzogranite (Early Proterozoic)—Gray granodiorite that includes variable proportions of biotite, hornblende, quartz, plagioclase, and potassium feldspar. Includes less abundant porphyritic granodiorite and porphyritic monzogranite phases. Locally coarse grained and sparsely porphyritic. Porphyritic phases show potassium feldspar phenocrysts set in coarse-grained hornblende-biotite hypidiomorphic granular matrix that is very magnetite rich. Crops out along west and southwest flanks of Garnet Mountain as mafic border facies of porphyritic monzogranite of Garnet Mountain. Found as homogeneous discrete bodies and also in the mixed granodiorite complex (Xgc)

Xbm Biotite monzogranite (Early Proterozoic)—Includes a homogeneous light-gray, fine-grained monzogranite and some porphyritic facies containing potassium-feldspar and quartz phenocrysts. Crops out south-southeast of Garnet Mountain and in the southern part of the Gold Basin mining district. In southern Gold Basin district, forms host rock for numerous fluorite-bearing, quartz-carbonate veins, presumably Late Cretaceous in age, some of which contain visible gold

Xlm Leucocratic monzogranite (Early Proterozoic)—Typically light-yellowish-gray rock and generally nonporphyritic. Partly chloritized biotite makes up less than 5 percent of most outcrops. Crops out as discontinuous, lensoid masses along western front of Garnet Mountain. Where well exposed, contacts with porphyritic monzogranite of Garnet Mountain (Xpm) show irregular dike offshoots of porphyritic monzogranite of Garnet Mountain cutting leucocratic monzogranite

Xgc Mixed granodiorite complex (Early Proterozoic)—Composite unit that includes mainly granodiorite (Xgd), some of which is porphyritic, and porphyritic monzogranite of Garnet Mountain (Xpm). Also includes some leucocratic monzogranite (Xlm)

Xgg Gneissic granodiorite (Early Proterozoic)—Generally, well-foliated, medium-gray-green rock containing highly variable alkali feldspar to plagioclase ratios. Biotite makes up about 20 volume percent of unit. Crops out in elongate body in southern White Hills

Xl Leucogranite (Early Proterozoic)—Includes coarse-grained leucogranite to pegmatitic leucogranite that contains potassium feldspar phenocrysts as much as 8 cm wide. Largest mass is 1-km-long sill cropping out 3 km northeast of Cyclopic mine. Stringers several centimeters wide parallel layering throughout much of the gneiss (Xgn). Fabrics grade from relatively undeformed to intensely mylonitic. Northeast of Gold Hill mine, large sills of pegmatitic leucogranite increase in abundance and eventually grade into complexes of migmatitic leucogranite (Xml). Most facies show modal compositions that plot in the field of granite; some outcrops of gneissic leucogranite contain garnet

Xfg Feldspar gneiss (Early Proterozoic)—Generally, light gray to light pinkish gray; compositionally homogeneous and typified by a strongly lineated fabric. Includes minor amounts of amphibolite, mafic gneiss, highly crenulated quartz tourmaline schist, and tourmalinite. Crops out in a 5-km-long and 0.8-km-wide sliver, bounded by faults in southern Lost Basin Range. Cut by quartz-feldspar veins, some of which contain gold

Xml Migmatitic leucogranite complex (Early Proterozoic)—Composite unit that includes swarms of leucogranite (Xl), aplite, and pegmatite dikes, together with pegmatoid quartz veins all cutting gneiss (Xgn). Complex and highly deformed by a ductile (mylonitic and gneissic) style of deformation

Xgn Gneiss (Early Proterozoic)—Includes variably metamorphosed gneiss and some metaquartzite in northern parts of the Lost Basin Range, and in northern White Hills. Exposed sequence of gneiss in southern parts of the Lost Basin Range includes abundant metabasite and amphibolite consisting partly of metagabbro, metaclinopyroxenite, metawehrlite, metadiabase, and metabasalt. Intruded to varying degrees by porphyritic monzogranite of Garnet Mountain (Xpm), biotite monzogranite (Xbm), leucocratic monzogranite (Xlm), leucogranite (Xl), and diabase (Ydb)

Xmg Migmatitic gneiss (Early Proterozoic)—Composite unit that includes mostly gneiss (Xgn) intruded to varying degrees by porphyritic monzogranite of Garnet Mountain (Xpm), biotite monzogranite (Xbm), and granodiorite (Xgd)

Xm Migmatite (Early Proterozoic)—Composite unit that includes mostly medium-grained, sparsely porphyritic monzogranite of Garnet Mountain (Xpm) complexly intruded into gneiss (Xgn)

?Contact—Queried where location uncertain

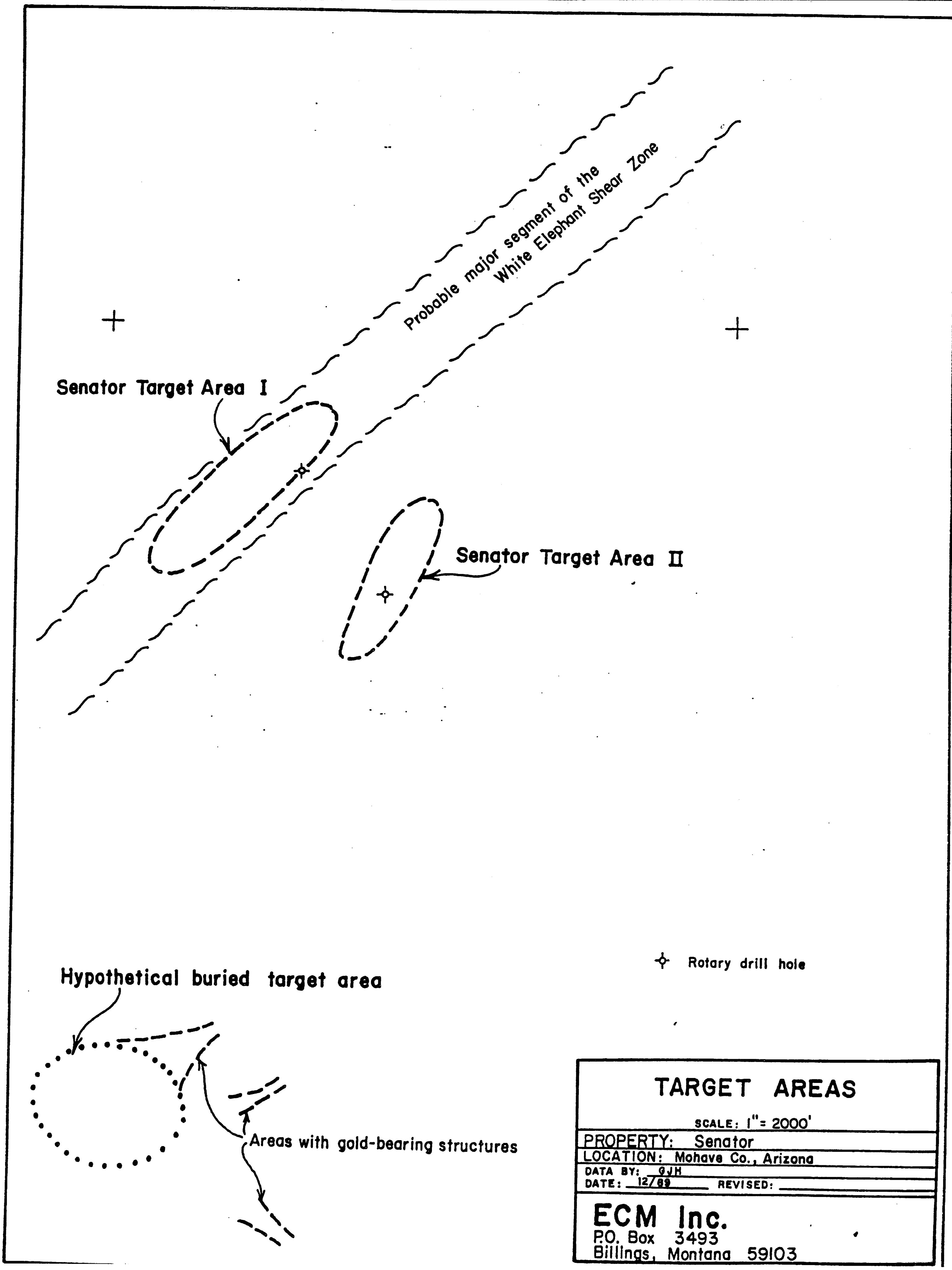
Fault—Dashed where approximately located; dotted where concealed

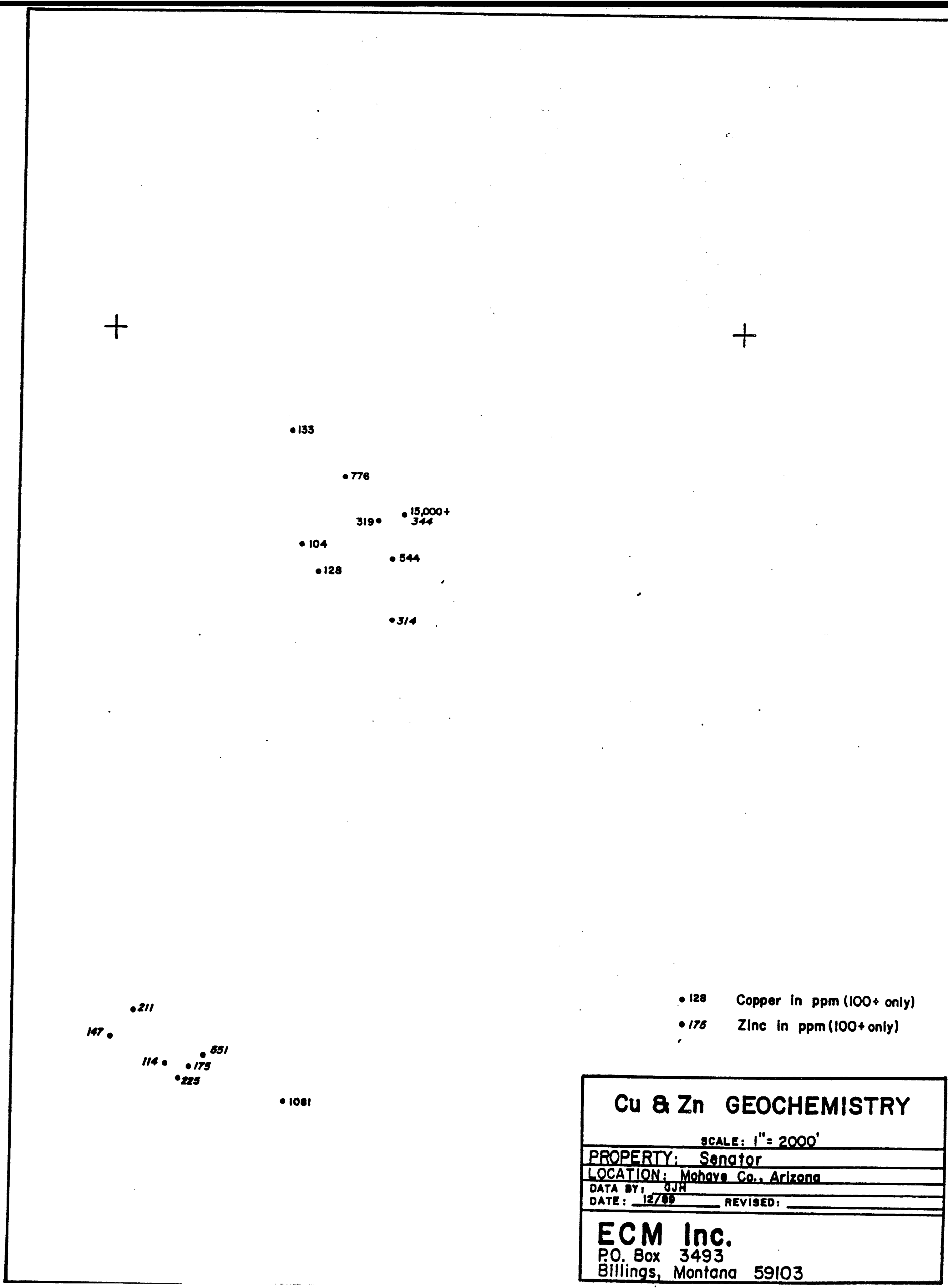
? Detachment fault—Dashed where approximately located; dotted where concealed; queried where uncertain. Sawteeth on upper plate

● Lode-gold locality—Collected for this report or observed (see Blacet, 1975, and section by J.C. Antweiler and W.L. Campbell, this report)

? Fluorite occurrence—Outer limit observed either in veins or disseminated in the Late Cretaceous two-mica monzogranite; dashed where approximately located; queried where uncertain

Area of placer deposit and (or) mine


Probable major segment of the White Elephant Shear Zone
Senator Target Area I
Senator Target Area II
Rotary drill hole
Hypothetical buried target area
Areas with gold-bearing structures
TARGET AREAS
SCALE: 1" = 2000'
PROPERTY: Senator
LOCATION: Mohave Co., Arizona
DATA BY: GJH
DATE: 12/89
REVISED:
ECM Inc.
P.O. Box 3493
Billings, Montana 59103



133
776
319
15,000+
344
104
544
128
314
211
147
114
851
175
225
1081
128 Copper in ppm (100+ only)
175 Zinc in ppm (100+ only)
Cu & Zn GEOCHEMISTRY
SCALE: 1" = 2000'
PROPERTY: Senator
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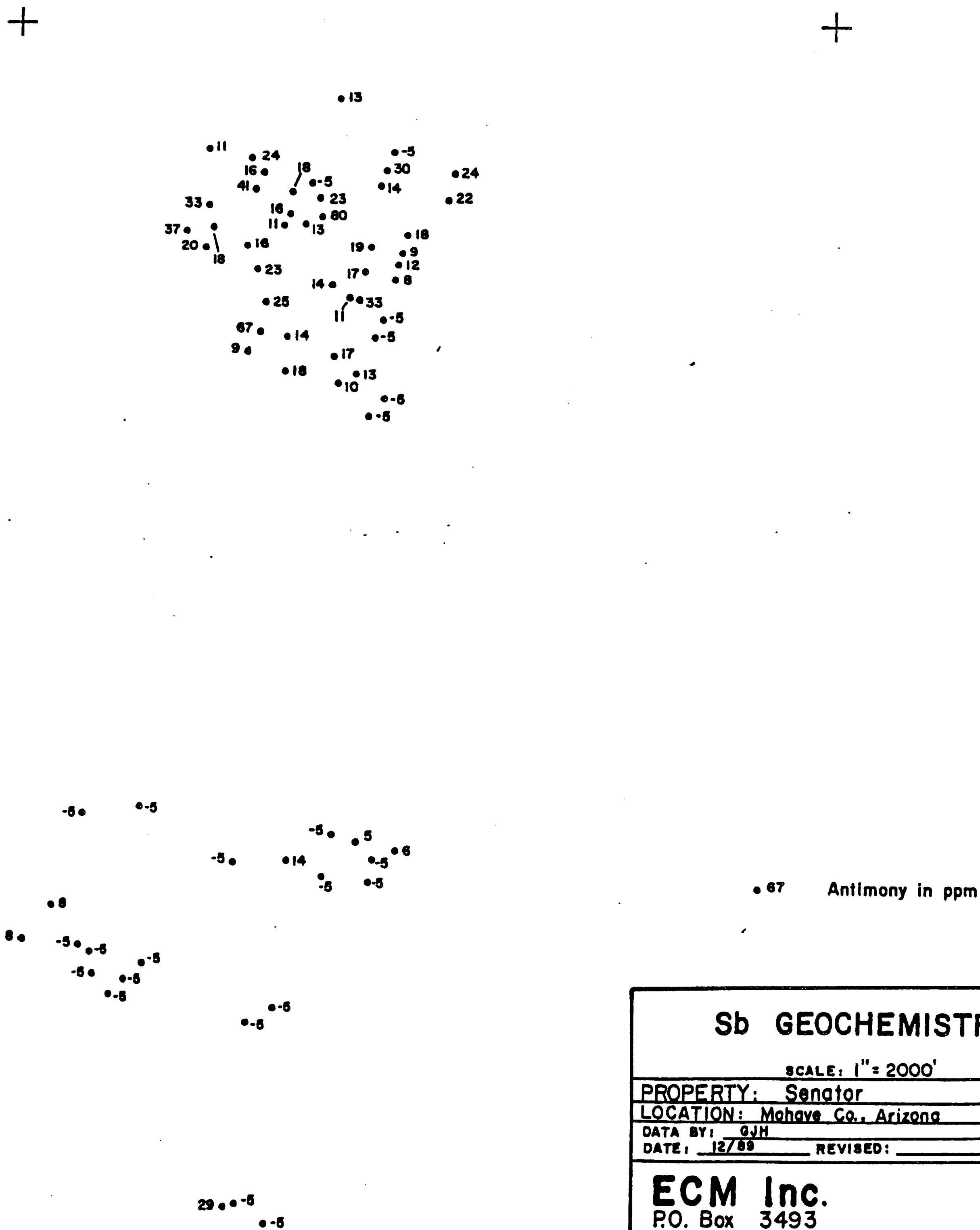

Sb GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 12/89 REVISED:

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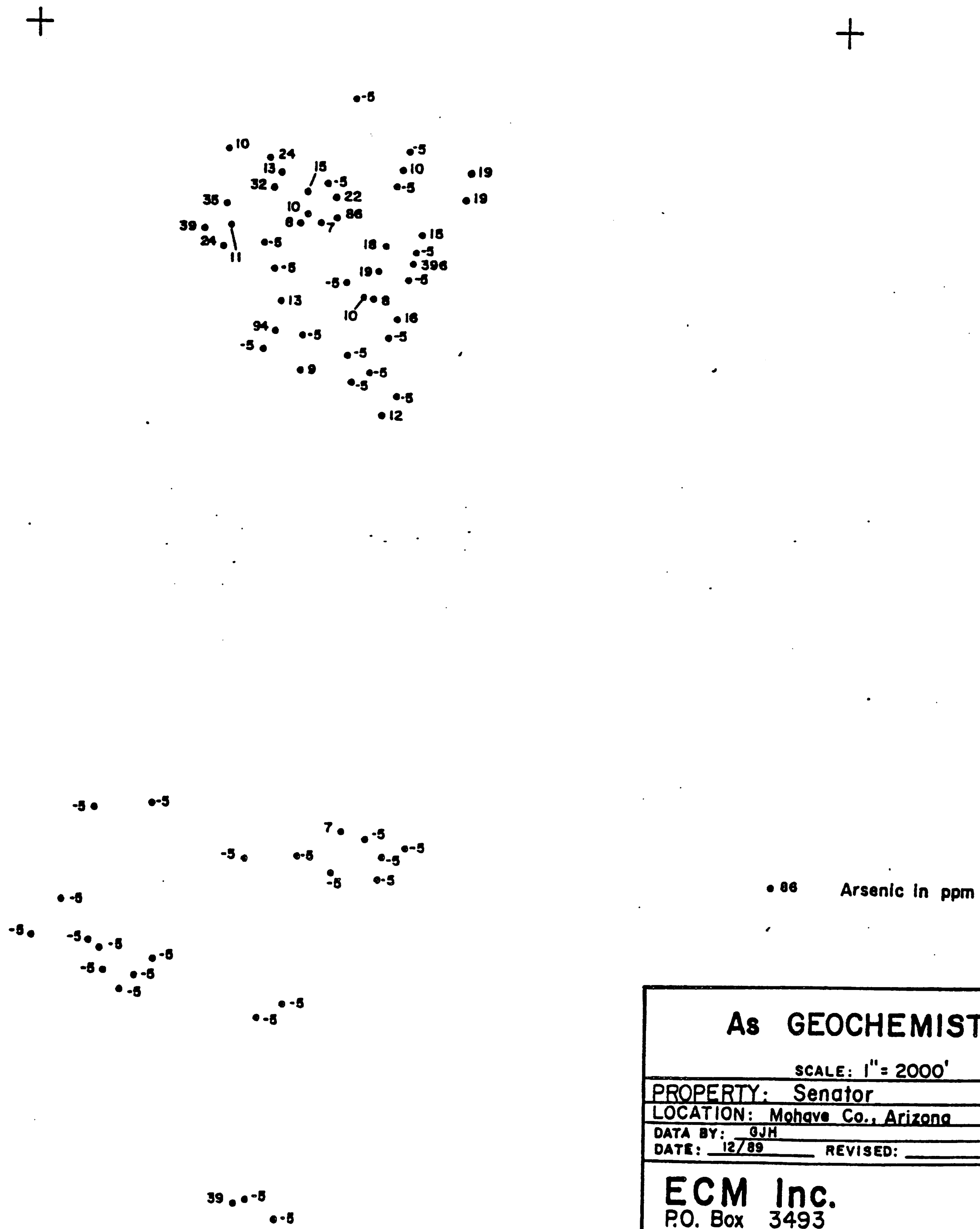

As GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

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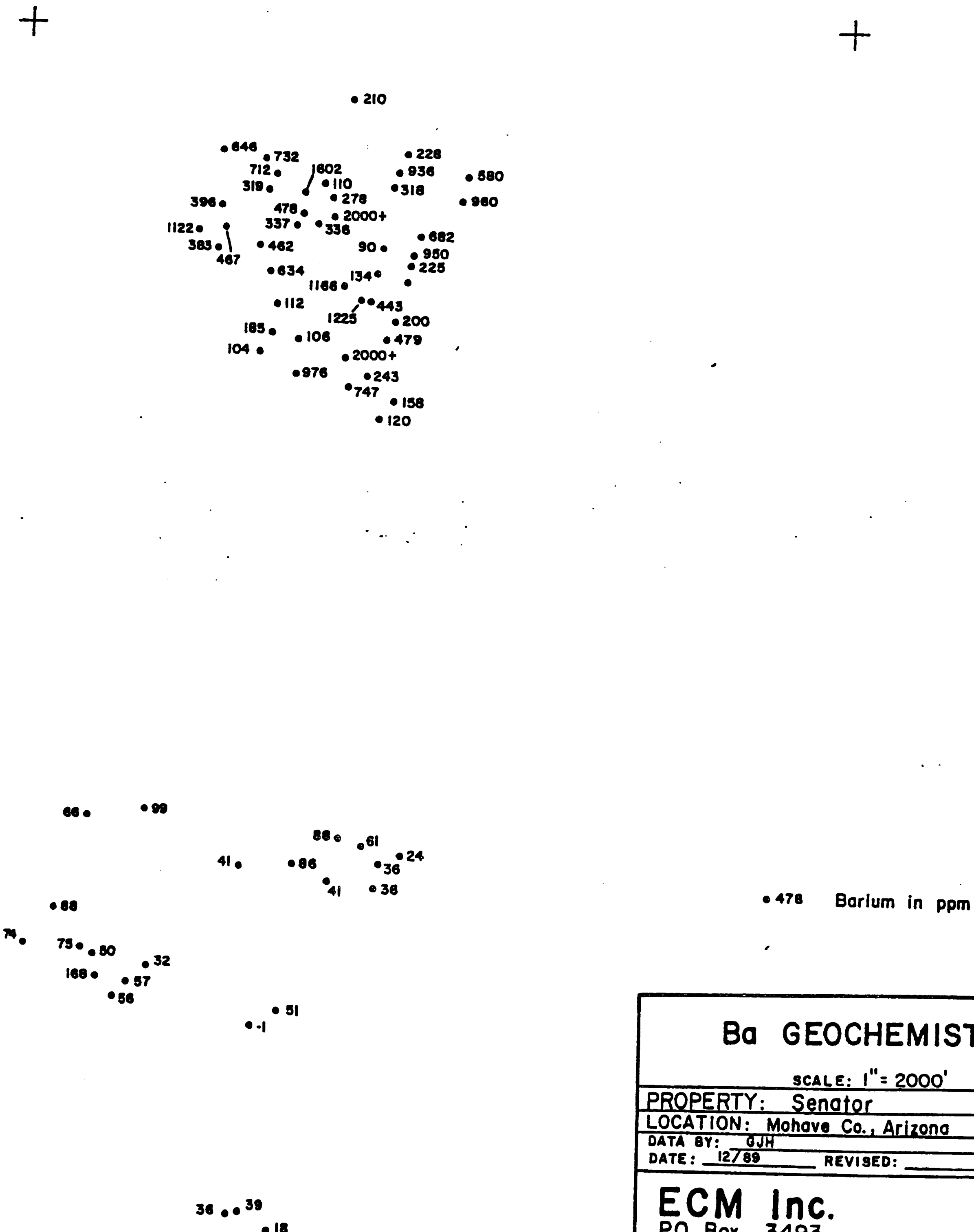

Ba GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

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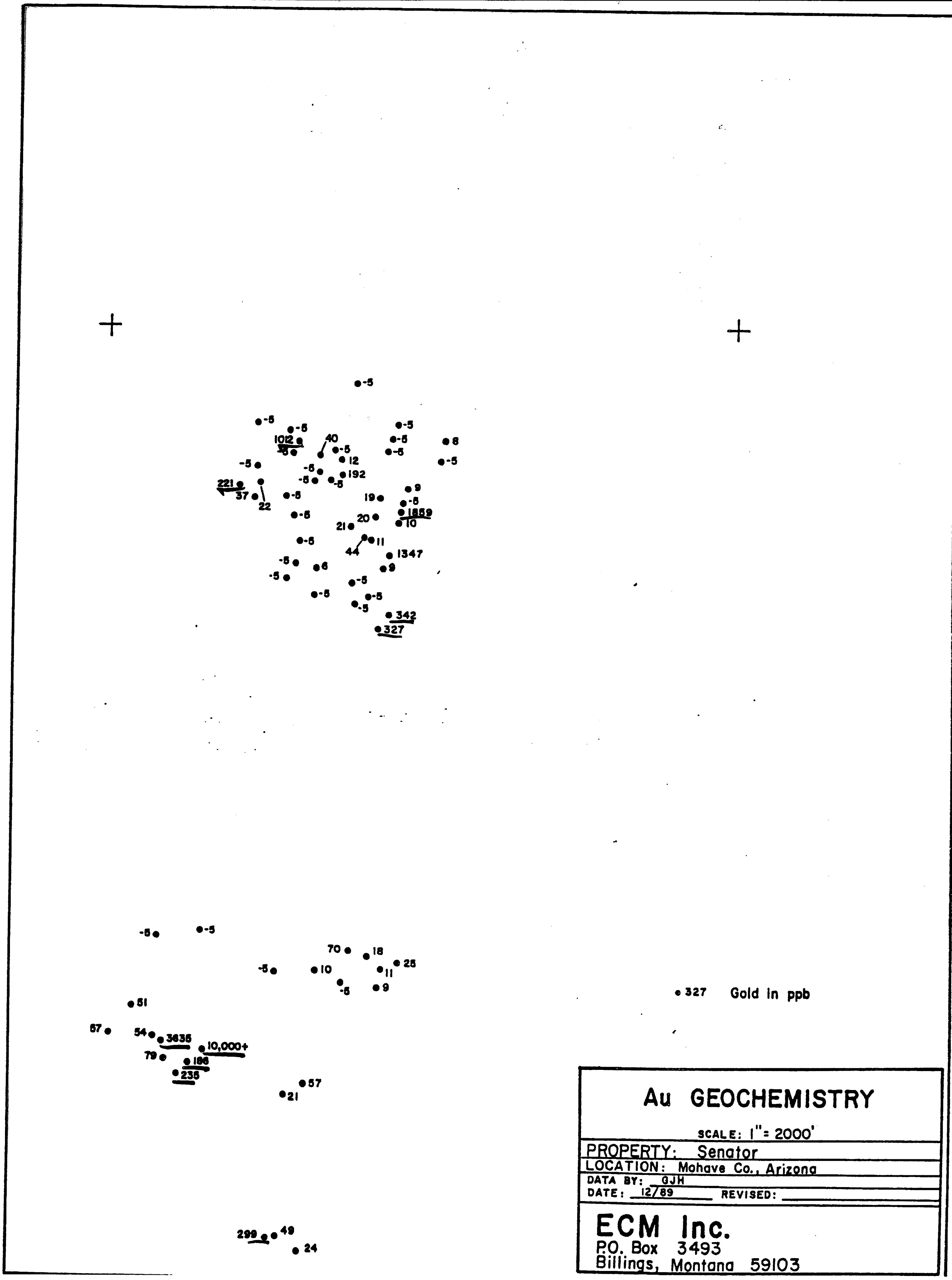


Au GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 12/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103

GORDON J. HUGHES, JR.

Consulting Geologist

P.O. Box 3387
Missoula, MT 59806
(406) 728-4857

January 19, 1990

Randy Moore
Cambior USA Inc.
230 South Rock Blvd.
Suite 23
Reno, Nevada 89502-2345

Dear Randy:

Enclosed is the data package for ECM's Senator property in Mohave County, Arizona. I hope the report makes some sense as I was writing it while trying to do about a dozen other things at the same time.

If you have any questions regarding the Arizona properties after you've had a chance to look them over on the ground, don't hesitate to call me.

Good luck with your ventures.

Sincerely,

Gordon

Gordon J. Hughes, Jr.

SENATOR PROPERTY

Mohave County, Arizona

Location - The Senator property is located in the west-central portion of the White Hills in northwestern Mohave County, Arizona. The distance from Kingman, Arizona is approximately 75 miles. Access from U.S. Highway 93 is via the White Hills road for about three miles to a junction with a desert (unimproved) road that leads to the Senator mine area (about 12 miles). These roads are shown on the White Hills and Senator Mountain 15-minute topographic sheets.

Land Status - ECM has staked 72 claims in Sections 10 and 22; T28N, R19W. These cover all of Section 10, and all but a narrow parcel of land in the far east-central portion of Section 22. The surrounding odd-numbered Sections are owned by the Santa Fe Pacific Land Co.

Historic Activities - The area of the Senator property is generally considered within the Gold Basin mining district and is just northeast of the White Hills mining district. The Owens mine (Section 1) and Senator mine (Section 14) are nearest past-producing properties. Production figures for either of these mines are unknown, though the Owens mine was probably the largest operation.

Schrader (USGS Bulletin 397) reported that the Senator mine operated for a short time in the 1890's. The ore was shipped to a 10-stamp mill located near the Colorado River at least 15 miles to the north. The mine was shut down in the early 1900's because its low-grade ores couldn't pay for the haulage to the mill. Schrader also reported that the deposits are "nearly flat-lying and similar to those of the Cyclopic mine, but they form a larger body". The deposits at the Cyclopic mine are considered by the USGS to be related to a large, regional detachment fault. The Senator ores were said to average about $3.00 (at $20/oz) in gold per ton.

The Owens mine produced gold ores from "veins" that were conformable with foliations in paragneiss and amphibolite. An apparent abundance of copper occurred with the gold ores based on the noticeable presence of copper oxides found on the dumps. In 1985-86 the Owens mine area was being explored by a joint-venture between Nerco and American Copper and Nickel Corp. Nerco also staked Section 10 at this time. Two drill sites found in Section 10 were presumably related to the activities of the JV program in this area.

Several small prospects are located on the Senator property in Section 10, and a couple of small pits were found in Section 22. Small drywasher placer prospects can be found in many of the washes around the Senator property. Most are located where the stream beds drain from the paragneiss terrane, and especially where these rocks are intensely deformed along shear zones.

General Geology - The rocks of the White Hills, and, more importantly, the Gold Basin district, can be subdivided into five main groups. Early Proterozoic gneisses and schists crop out throughout more than half of the area. Both foliated and weak to non-foliated Proterozoic plutonic rocks occupy large areas at the north and south ends of the White Hills. Cretaceous granitic rocks found mainly in the southern White Hills were emplaced into the Precambrian rocks at about 72 m.y. ago. Tertiary volcanic rocks mainly comprised of andesite flows and some remnant patches of felsic tuffaceous rocks are largely found scattered around the margins of the White Hills. Thick alluvial fanglomerate deposits and lacustrine siltstones, mudstones, and thin limestones make up much of the younger Tertiary eastward tilted sequences.

The gneiss and schist terrane comprises rocks of Early Proterozoic age (1.7 b.y.) that represent protoliths dominated by clastic sedimentary material mixed locally with volcanic tuffaceous components as well as chemical sediments. The dominant biotite and quartzofeldspathic gneisses represent metamorphosed greywackes that probably accumulated as deep-water turbidites.

Biotite-rich schists and irregular masses of amphibolite probably represent mafic volcanic and plutonic rocks. Quartz-muscovite schist that frequently occurs in association with metachert and banded iron formation is considered to be felsic volcanic tuffaceous material. These rocks suggest the presence of a dominantly bimodal igneous suite that represents the earliest magmatic events in the Early Proterozoic tectonicallyactive basin.

Plutons of gneissic granodiorite and leucogranite intruded the Early Proterozoic basinal assemblage prior to peak dynamothermal metamorphism. Located mainly in the southern White Hills, these intrusive rocks are important hosts for major gold-bearing veins that formed along several large shear and fracture zones. The plutons themselves appear to have been emplaced along structures that were precursors to those that now contain the mineralized zones.

At about 1.65 b.y. ago the rocks of the southern White Hills were again intruded by stocks of porphyritic monzogranite. These weakly foliated rocks contain large, conspicuous, pink K-feldspar phenocrysts set in a coarse grained groundmass with a light pinkish-gray color. The euhedral to ovoid K-feldspar phenocrysts are frequently mantled by plagioclase producing a classical rapikivi texture. The emplacement of the Proterozoic porphyritic monzogranites was after the main regional dynamothermal metamorphic event, but prior to the retrograde, greenschist-facies overprint.

Lying along an apparent northwest trending zone in the southern White Hills are several Cretaceous age two-mica granites. These are fine to medium grained rocks that generally display an equigranular fabric, though some outcroppings show them to also have local porphyritic textures. The two-mica granites in the Gold Basin district are peraluminous thus resembling a large number of similar plutons found in gold districts throughout the western United States.

Rocks of syenitic composition occur within portions of the two-mica granites. These probably reflect local areas of desilicated and hydrothermally metsomatized granite, and therefore are more correctly termed episyenites. A high carbonate content as well as local quartz-muscovite-fluorite-pyrite veins have been found associated with these unique rocks. One of the episyenite bodies in the White Hills has been reported to contain disseminated visible gold (Blacet, 1969).

The White Hills occupy a structurally complex area representing the junction between the Paleozoic miogeoclinal flexure, the Mesozoic Sevier orogenic belt, the Walker Lane shear zone, and the southern edge of the Basin and Range block-faulted terrane. Three major structural features predominate: first, is a northeast trending structural grain expressed by high-angle shear zones and fracture systems, belts of mylonitization, and veins; second, a north-south trending system of moderate- to high-angle normal block faults; and third, a regionally extensive low-angle detachment fault.

The northeast trending fault and shear zones in the White Hills are part of a regional tectonic fabric. The major zones are believed to represent deep-tapping crustal zones of weakness. Though best developed in the Precambrian terranes of the southwestern U.S., major structures with northeast trends also occur in rock assemblages as young as mid-Tertiary. In many of the porphyry copper districts these northeast trending fault zones intersect with younger (Laramide) northwest oriented zones of shearing and displacements. Interestingly, most of the metal-bearing, hydrothermally-altered systems in the White Hills coincide with some of the major northeast trending structures in the region.

North-south trending normal faults probably are the most easily identified structures in the White Hills and surrounding regions. They represent some of the southernmost elements of the Basin and Range extensional terrane. The major faults of this tectonic system are typically near the range fronts , or buried in the valleys. Shorter faults (usually with much smaller displacements) can be found within the "uplifted" ranges where they appear more as linking structures between faults with different trends, e.g. the northeast trending ones. Some of the younger Tertiary volcanic centers and weak epithermal systems are controlled by north-south trending faults in the Gold Basin district.

One of the most extensive structures in the White Hills is a low-angle detachment-type fault that effectively wraps around the north, west, and south sides of the range. The Miocene age fault surface, itself, is probably quite undulatory though in most places it appears to dip westward. The origin of this unusual structure is unresolved but likely to be related in some way to the Tertiary age extensional tectonic environment. Actually, the fault appears to be regional unconformity along which some deformation has taken place.

The most recent USGS study (Professional Paper 1361) of gold occurrences in the Gold Basin district has identified three main types of lode deposits. The majority are veins and irregular zones of silicification and hydrothermal alteration localized along structures in the Early Proterozoic rocks. The generation of these vein-type occurrences is considered to have occurred both in Precambrian and Late Cretaceous times. Another type is identified as disseminated gold associated with fluorite-enriched episyenitic rocks that formed by hydrothermal metasomatization. These types of occurrences formed as a consequence to the emplacement of Cretaceous two-mica granites. The third type of lode gold deposit involves gold-quartz breccia veins that originally may have been formed as cap-rock silica-shells above the desilicated episyenitic rocks. Some of them were then disjointed and brecciated where they became involved in deformation along the extensive Miocene detachment fault.

Late Tertiary gravels mainly observed as dissected alluvial fans form much of the post-mineral cover in the White Hills and surrounding region. These fanglomerate deposits contain low-grade placer gold occurrences. Where they have been reworked by more recent stream activity, the resulting placers are noticeably smaller but significantly upgraded to more ecomonic concentrations.

Local Geology - The Senator property lies in an area where several major structural zones intersect one another. These structures and the fracture systems that developed near their intersections contain anomalous amounts of gold, some that were mined in the past. The largest number of gold-anomalous structures are northeast trending fractures and shears. However, a significant amount of gold-quartz vein mineralization at the Senator mine appears to have been related to north-northwest trending structures that are part of the low-angle, regional detachment(?) zone. Finally, there are also northwest trending faults along which the rocks have been hydrothermally altered. These occur both on and adjacent to the Senator property.

The predominant lithologies in the area of the Senator property are the Early Proterozoic gneisses and monzogranite. The biotite quartzofeldspathic gneisses are part of the regional sequence of paragneisses and schists that represent the oldest rocks in the region. Local, small bodies of amphibolite are common in the gneissic sequence, especially about a mile northeast of Section 10 in the vicinity of the Owens mine. The metamorphic sequence at the Owens mine also includes thin beds of banded iron formation mixed with siliceous units that are probably metacherts. Some of these thinly laminated cherty-looking units have also been observed in the limited outcroppings in Secion 10.

Both the Owens mine and the Section 10 area of the Senator property lie along the trend of the White Elephant shear zone (see attached regional map). This northeast trending tectonic zone consists of many parallel shears and associated fracture systems that probably were initiated during the Precambrian and then reactivated at several times since – especially during Laramide deformation. Gold-enriched zones of silicification and associated hydrothermally-altered rocks coincide with some of the larger structures along the White Elephant shear zone.

The principle northeast trending structures in Section 10 are located in the central part of the section, and in the southeast-quarter. The larger and apparently more intensely deformed zone is the one through the central portion of the section. It is only exposed in a small area near the center of the section where several outcroppings display intensely sheared and variably altered monzogranite and gneissic rocks. In this same location, it intersects with both the low-angle detachment fault and a northwest trending fault that cuts through the monzogranite.

The northeast trending shear zone in the southeast-quarter of Section 10 also appears to intersect the detachment fault and the northwest trending fault. However, the zones of intersection are effectively covered by Quaternary-Tertiary gravels. The gneissic rocks in the hanging wall of the detachment fault are intensely sheared and altered (argillic) where this northeast trending fault passes through them. Strong hematitization and chloritization accompanies the sheared rocks, and, at several places, baritic quartz veins were noted along the same structure.

The main rock type in the Section 22 portion of the Senator property is Proterozoic porphyritic monzogranite. This coarse grained igneous rock is generally quite fresh-looking except where it is cut by a couple of northeast trending shear zones, and in the southern part of the section where a northwest trending fault zone was observed. The rocks along these structures show evidence of argillic alteration (mainly clay-altered feldspars), and chloritization of mafic minerals. Iron oxides are also quite abundant along the same zones.

Between Sections 10 and 22, and west of the Senator mine, is a body of Cretaceous two-mica granite. This interesting rock shows a patchy distribution of hydrothermally altered zones consisting of a quartz-sericite-limonite assemblage. This two-mica granite occurs only in the footwall of the regional detachment zone. At the Senator mine where the detachment fault is in immediate contact with this pluton, a broad zone of silicification with quartz vein-breccias has been formed. This zone was the apparent target of the gold mining activities, though several pits and a shaft were excavated on a high-angle, northeast trending zone of fault-veins as well.

Cretaceous two-mica granites also crop out in the southern portion of Section 2, and near the common corner of Sections 9, 10, 15, and 16. A particularly large mass of two-mica granite is located a couple of miles southeast of Senator (see attached regional map). And, farther southeast, the Proterozoic monzogranite has been changed to episyenite in irregular zones that may be positioned above apical portions of a buried Cretaceous granite. All of these occurrences seem to define a northwest trending corridor in which they were intruded.

The alteration in Section 10, found associated with rocks along the northeast trending structures as well as the detachment zone, could have resulted from hydrothermal fluids circulating above a Cretaceous granite. Emplacement of such a thermal "engine", into Precambrian rocks suspected of containing preconcentrated amounts of gold, forms an interesting hypothesis for explaining the gold-bearing structures.

The gold occurrences related to the Miocene detachment zone at the Senator mine and in Section 10 consist of irregular masses of quartz vein-breccia. These highly resistant blocks are typically encased in iron oxide stained gouge. Some very fine grained sulfides have been observed in this "tectonic paste", and small, broken veinlets of quartz-barite-iron oxide have also been found in the gouge material. Copper oxides (mainly chrysocolla) are commonly associated with the vein-breccias, and several wulfenite crystals were observed in a sample from the central portion of Section 10.

All in all, the mineralized vein-breccia material caught up in the detachment zone appears to have formed at some time prior to the development of the low-angle faults themselves. In fact some of the vein material closely resembles recrystallized epithermal sinter, i.e. some delicate banding and crustiform textures are faintly visible. If so, the detachments could actually be old erosional (unconformities) surfaces along which more recent tectonic adjustments had taken place.

<u>Geochemistry</u> - Reconnaissance sampling at the Senator property was necessarily restricted to the relatively small area of bedrock exposures in Section 10. Additional samples were also collected from the altered rocks associated with the several structural zones identified in Section 22. No systematic approach was utilized, though a conscientious effort was made to sample rocks that appeared to be visibly altered, or contained limonites that indicated a likelihood of having been sulfide-bearing rocks prior to oxidation. At no places were samples "high-graded" with only obviously mineralized vein materials. However, vein material was represented in samples from zones that carried a sufficient density so as to to warrant its influence as part of a mineralized area.

The gold values in Section 10 do not indicate a large gold-ore zone at grassroots. The basic results from the sampling to date confirm the presence of gold (and other associated metals) in altered zones located along the major structures. In Section 10 these are the two main northeast trending faults and shears, the detachment zone, and a northwest trending fault. Samples collected away from these structural zones are effectively barren with respect to gold, at least in those areas that have been sampled to this point.

A couple of the highest gold values in Section 10 have come from the northwest trending fault zone. At each of the sample sites the rocks contained irregular zones of silicification in otherwise weakly to moderately argillically altered and chloritized Proterozoic monzogranite. Near the eastern boundary of Section 10, where the sample containing 1859 ppb Au was collected, the monzogranite was flooded with very small quartz-limonite-copper oxide veinlets. The distribution of this material could not be accurately defined because of the extensive gravel cover surrounding the mineralized exposure. It should also be noted that there were also a significant number of limonite stained fractures at this location that had a N30E strike direction.

The analytical results from the Section 10 samples also indicate something about the possible nature of the mineralizing system that caused the localized gold enrichment and associated alteration. Relatively anomalous values for barium, arsenic, and antimony have been detected throughout this area. Typically, elevated amounts of the elements in association with gold would suggest a high-level, possibly epithermal-type system. Unfortunately, mercury was not analyzed in these samples or it too might have confirmed this suspicion.

The anomalous barium values in Section 10 appear to be widely distributed with no apparent bias for either structure or lithology. This is in accord with the fact that quartz-barite veinlets were found throughout the entire area of bedrock exposure, and especially in the float material located in the eastern half of the section.

Weak to moderately anomalous arsenic and antimony values show a slight preference for the altered rocks located along the northernmost of the northeast trending fault and shear zones in Section 10. It also appears that the monzogranite contains higher arsenic values as compared to those in the paragneiss. On the otherhand, antimony seems to be evenly distributed between the two different lithologies.

Base metals (Cu,Pb,Zn) in samples from Section 10 do not indicate any widespread distribution of anomalous values. Rather, it appears that some high copper contents are present along the detachment zone as well as the northwest trending fault. Zinc values suggest a similar relationship though only two of the samples Can be considered anomalous (+100 ppm Zn). Basically, these results imply that if there is base metal enrichment in this system, it would have to be at some deeper level.

The Section 22 area also revealed some interesting geochemical results from the relatively few samples taken there. A couple of the most anomalous gold values from the Senator property were found in rocks collected from along northeast trending fault and fracture zones in the northwest-quarter of the section. Similarly, a northwest trending fault zone in the southern portion of the area also contained somewhat anomalous gold values. All of these samples were collected from the Proterozoic monzogranite that appeared to show the effects of alteration only near these structures.

Barium, arsenic, and antimony were not found in anomalous quantities in the samples from Section 22. However, a number of samples from the northeast trending faults in the northwest-quarter of the section did contain anomalous zinc (114-551 ppm). Also, one sample from a parallel fault farther south yielded a 1081 ppm copper value. These results, together with an apparent lack of more pervasive alteration, indicate that hydrothermal fluids were effectively channeled through the broken rocks of the fault zones. The location of these anomalies near the edge of bedrock raises the intriguing question of what lies beneath the post-mineral cover to the west.

<u>Target Type</u> - Structure-controlled alteration and geochemical anomalies in Section 10 clearly indicate the importance of rock fracturing with respect to potential ore-forming environments. The gold ore zones (+0.1 opt) at the nearby Senator mine were probably controlled by the distribution of gold-quartz vein-breccias caught up in the detachment zone; yet the question still remains to be answered – where did these mineralized veins form originally? An hypothesis recently proposed by the USGS (Professional Paper 1361) shows the siliceous zone at the Senator mine and adjacent areas to be the result of reprecipitated silica (and metals) from episyenite-producing hydrothermal metasomatism (see attached figure).

Basically, a Cretaceous two-mica granite is emplaced at relatively shallow depth within the Proterozoic crust. Fluids evolving from the magma will mix with those released from the altering wallrocks near the contacts to produce a hybrid fluid with high water content, high K^+, and low silica. Further reaction of the fluid with wallrocks should make it quite alkaline and capable of dissolving and transporting gold. The gold may have been supplied from preconcentrated facies in the Early

Proterozoic paragneiss sequence. The gold-enriched exhalite-bearing stratigraphy at the Owens mine appears to substantiate such a model.

During their upward migration the alkaline and fluorine-bearing fluids will dissolve silica. At some point the changing alkalinity (to acidic) of the fluids causes excess-silica and any gold to precipitate. This would account for the so-called caprock silica-breccias at the Senator mine. Veins containing quartz-barite-carbonate±gold would form from the same general fluids that made it to relatively higher levels, i.e. less than one kilometer below the surface.

Since the quartz-barite±gold veins in Section 10 are largely controlled by the locations of major fracture and shear zones, the obvious targets for exploration would be somewhere along these structures. The most persistent(regionally) and intensely deformed structural zones are those with northeast trends. These appear to be segments of a major shear zone that cuts through the entire White Hills, and probably beyond. Some of the most intense alteration is localized along this zone of deformation.

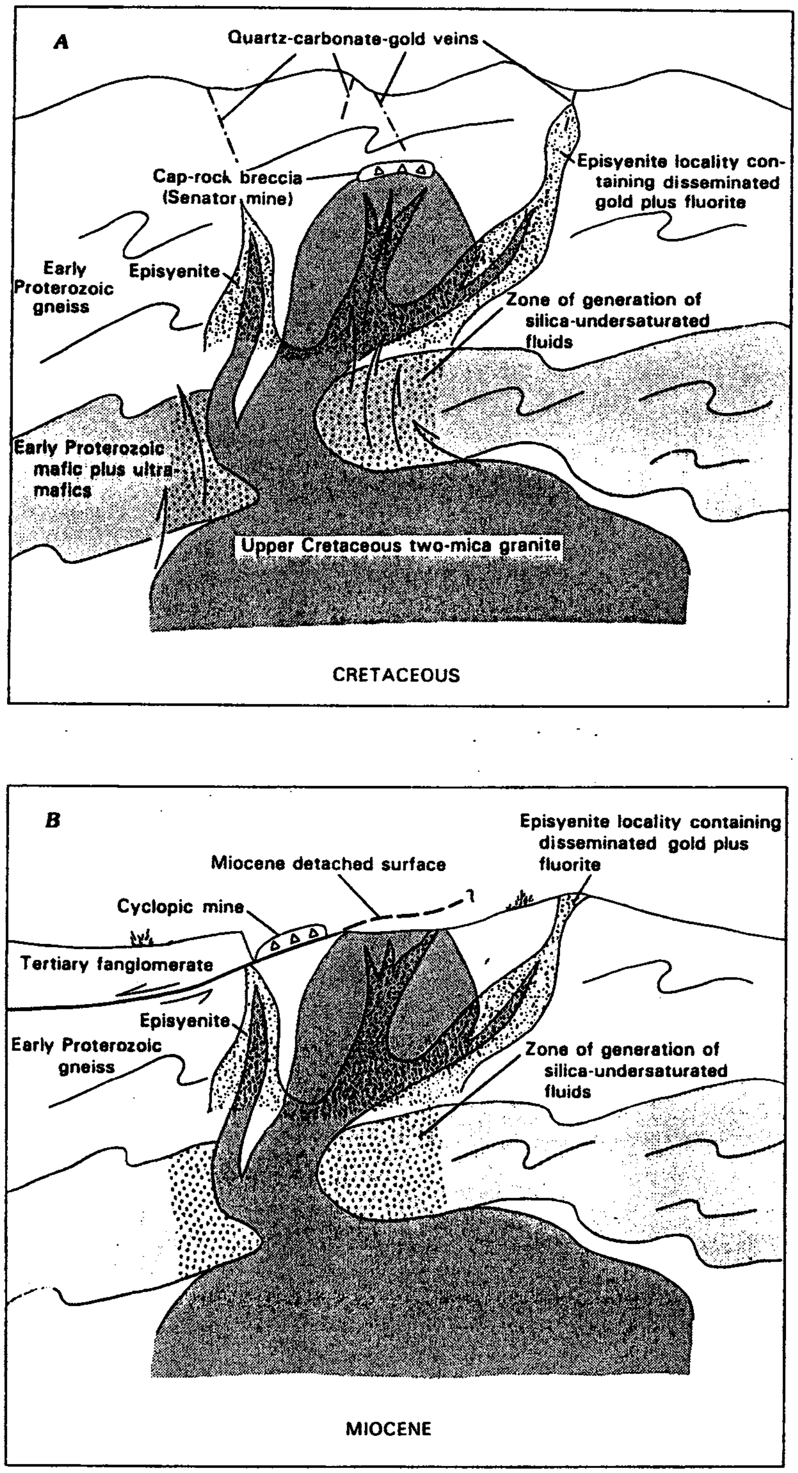
The two target areas proposed for Section 10 show a clear bias for the northeast trending structures located there. As first approximations they are believed to represent the areas in which detailed follow-up work should be conducted. Post-mineral cover in these and adjacent areas will hamper the amount of surface work that effectively can be accomplished during their evaluation. Likewise, the apparent low total sulfide content of the systems (except for a possible increase at depth) will not make them very good geophysical targets. At some point, the only way to really test their merits as ore targets will be to drill shallow, recon-type holes.

Hypothetical ore zones would probably occur in areas where the major structures intersect. Intersections between the northeast and northwest trending fracture and shear zones are particularly interesting sites. The detachment zone itself is probably not a good structural host because it should post-date the Cretaceous two-mica granite-related alteration and mineralization processes. However, it may serve to indicate locations where the Cretaceous age systems have been caught up in the deformation along the low-angle fault zones.

An hypothetical buried target area is proposed for the western portions of Section 22. The exact type of target is not clearly understood though it would occur in a zone of projected intersecting structures. The geochemical nature of the rocks along these structures at the edge of exposed bedrock, suggests the possibility of buried porphyry-type system with a peripheral en-enrichment of copper, zinc, and gold. Local areas of quartz-sericite alteration along the fracture zones supports the model for intrusive-related hydrothermal fluids.

An anomalous amount of iron oxide (mainly hematite) in the gravels surrounding this target area leads to the interesting speculation that a sulfide system may have been partially oxidized prior to its complete burial beneath the overburden. In fact, close examination of some of the components of the gravels revealed the presence of cobbles of altered two-mica granite with abundant disseminated and fracture-coated limonites.

A Cretaceous age, intrusive-related target within the Proterozoic monzogranite should show up in magnetic data that could be generated at relatively low cost. Likewise, any build-up of sulfides related to a buried fossil hydrothermal system should be detectable with an IP-resistivity survey.



Schematic relations among Late Cretaceous two-mica monzogranite, cap-rock breccia, episyenite, and Miocene detachment fault. *A*, Silica-undersaturated fluids (arrows) associated genetically with episyenite probably were generated by chemical interaction with Proterozoic mafic and ultramafic rocks during the Late Cretaceous as fluids evolved from two-mica monzogranite (see text). Flat-lying cap-rock breccias, such as that at Senator mine, probably represent areas of silica deposition above deep episyenite. *B*, Subsequent faulting along low-angle Miocene detachment surfaces further brecciated veins, such as those at Cyclopic mine, during tectonic transport from site(s) of original deposition. Fault, solid line; dashed where projected, queried where uncertain, arrows indicate direction of relative movement.

Model for gold occurrences related to Cretaceous two-mica granites in the Gold Basin district, Mohave County, AZ. (from USGS PP 1361)

DESCRIPTION OF MAP UNITS

Qs Sedimentary deposits (Quaternary)—Includes sand and gravel along active stream washes, talus, colluvium, poorly consolidated fanglomerate currently being dissected, and landslide deposits; also may include extensive high-level fanglomeratic deposits, west of Grand Wash Cliffs in general area of Grapevine Mesa, that may be Tertiary and (or) Quaternary in age

QTg Fanglomerate (Quaternary and (or) Tertiary)—Locally derived fanglomerate deposits that include mostly clasts of metamorphic rock south-southeast of Senator Mountain and that do not contain clasts of rapakivi granite or any interbedded tuffs

Muddy Creek Formation (Tertiary)

Tml Hualapai Limestone Member—Includes limestone interbedded with thin beds of limy claystone, mudstone, and siltstone. Weathered limestone beds have a predominantly reddish color and form steep cliffs where they are dissected by Hualapai Wash

Tmb Basalt—As shown, flows at Senator Mountain, near west edge of map area, and at Iron Spring Basin, near east edge. Basalt in these two areas correlates probably with basalt flows (not shown) that conformably underlie the Hualapai Limestone Member and also are interbedded with fanglomerate of the Muddy Creek Formation near northwest corner of map area. Whole-rock K-Ar age determination of basalt from this area yields age of 10.9 Ma (see section by E.H. McKee, this report)

Tml Fanglomerate—Alluvial fanglomeratic deposits that include conglomerate, sandstone, siltstone, mudstone, and locally abundant gypsum lenses. Locally includes lenses and beds of rhyolitic tuff and, as shown near southwest corner of map area, fanglomerate mapped previously by Blacet (1975) as unit Tf. Unit is also intruded by minor basalt dikes, especially in general area of Senator Mountain. Near northwest corner of map area, unit includes well-exposed flows of basalt

Tv Volcanic rocks (Tertiary)—Includes mostly andesite. Map unit near northwest corner of map area internally is highly broken by numerous faults, and near here, unit also includes air-fall tuff and reddish-brown sandstone interbedded with chaotic sedimentary breccia composed of fragments of Early Proterozoic gneiss. In places, unit also includes massive porphyritic hornblende andesite and basalt flows and breccia and overall minor amounts of tightly cemented volcaniclastic rocks. Flow layering and bedding generally dip at angles of 35° in contrast with shallow dips of about 5° in unconformably overlying basal fanglomerate of the Muddy Creek Formation. Age ranges of 11.8 to 14.6 Ma are reported near type section of the Mount Davis Volcanics (Anderson and others, 1972), whereas K-Ar age determination on sanidine from air-fall tuff near Salt Creek Wash in northwestern part of area yields age of 15.4 Ma. The volcanic rocks may be equivalent of the Mount Davis Volcanics or the Patsy Mine Volcanics (see section by E.H. McKee, this report).

Ts Rhyolitic tuffaceous sedimentary rocks and fanglomerate (Tertiary)—Includes well-bedded mudflows and rhyolitic tuffaceous sedimentary rocks and minor amounts of fanglomerate. Crops out as steeply dipping sequence of rocks, bounded by north-striking faults, near south end of Lost Basin Range. Possibly equivalent to the Mount Davis Volcanics

Tf Fanglomerate (Tertiary)—Coarse fanglomeratic deposits that locally include landslide or mudflow breccia. Overlain unconformably by fanglomeratic deposits of the Muddy Creek Formation, and apparently intercalated with andesite possibly equivalent to the Mount Davis Volcanics

Kmt Two-mica monzogranite (Cretaceous)—Includes mostly highly leucocratic muscovite-biotite monzogranite and some minor amounts of felsic muscovite granodiorite and episyenitic-altered muscovite-biotite monzogranite. Some facies are fluorite bearing. Porphyritic variants contain as much as 5 percent quartz phenocrysts. In places, contains very weakly defined primary layering of dimensionally oriented potassium feldspar and biotite

Ru Sedimentary rocks, undivided (Paleozoic)—Includes Cambrian Tapeats Sandstone, Bright Angel Shale, and Muav Limestone

Ydb Diabase (Middle Proterozoic)—Includes normally zoned laths of plagioclase set in very fine grained matrix of granules of opaque mineral(s) and clinopyroxene. Close to chilled margins of some fresh outcrops of undeformed diabase, olivine is found in concentrations of as much as 10 volume percent. Small masses of fine-grained diabase crop out sporadically in Early Proterozoic igneous and metamorphic rocks. Most extensive exposures are about 2 km east of Garnet Mountain. Subophitic textures are dominant. Lower chilled margins of some sills contain sparse hornblende and biotite microveinlets. Presumed to be correlative with the diabase of Sierra Ancha, Ariz., having an emplacement age of 1,150 Ma (Silver, 1963)

Xpm Porphyritic monzogranite of Garnet Mountain (Early Proterozoic)—Includes conspicuous, large potassium feldspar phenocrysts, set in a light-pinkish-gray, coarse-grained hypidiomorphic groundmass. Many exposures show tabular phenocrysts as much as 10 cm long. Some phases are predominantly subporphyritic seriate and show an almost continual gradation in size of their euhedral potassium feldspar phenocrysts. Most widely exposed mass crops out in the general area of Garnet Mountain, in the southeastern part of the area, and extends discontinuously from there to north along the low hills leading to Grand Wash Cliffs. Dated by Wasser-

Xgd Granodiorite border facies of porphyritic monzogranite (Early Proterozoic)—Gray granodiorite that includes variable proportions of biotite, hornblende, quartz, plagioclase, and potassium feldspar. Includes less abundant porphyritic granodiorite and porphyritic monzogranite phases. Locally coarse grained and sparsely porphyritic. Porphyritic phases show potassium feldspar phenocrysts set in coarse-grained hornblende-biotite hypidiomorphic granular matrix that is very magnetite rich. Crops out along west and southwest flanks of Garnet Mountain as mafic border facies of porphyritic monzogranite of Garnet Mountain. Found as homogeneous discrete bodies and also in the mixed granodiorite complex (Xgc)

Xbm Biotite monzogranite (Early Proterozoic)—Includes a homogeneous light-gray, fine-grained monzogranite and some porphyritic facies containing potassium-feldspar and quartz phenocrysts. Crops out south-southeast of Garnet Mountain and in the southern part of the Gold Basin mining district. In southern Gold Basin district, forms host rock for numerous fluorite-bearing, quartz-carbonate veins, presumably Late Cretaceous in age, some of which contain visible gold

Xlm Leucocratic monzogranite (Early Proterozoic)—Typically light-yellowish-gray rock and generally nonporphyritic. Partly chloritized biotite makes up less than 5 percent of most outcrops. Crops out as discontinuous, lensoid masses along western front of Garnet Mountain. Where well exposed, contacts with porphyritic monzogranite of Garnet Mountain (Xpm) show irregular dike offshoots of porphyritic monzogranite of Garnet Mountain cutting leucocratic monzogranite

Xgc Mixed granodiorite complex (Early Proterozoic)—Composite unit that includes mainly granodiorite (Xgd), some of which is porphyritic, and porphyritic monzogranite of Garnet Mountain (Xpm). Also includes some leucocratic monzogranite (Xlm)

Xgg Gneissic granodiorite (Early Proterozoic)—Generally, well-foliated, medium-gray-green rock containing highly variable alkali feldspar to plagioclase ratios. Biotite makes up about 20 volume percent of unit. Crops out in elongate body in southern White Hills

Xl Leucogranite (Early Proterozoic)—Includes coarse-grained leucogranite to pegmatitic leucogranite that contains potassium feldspar phenocrysts as much as 8 cm wide. Largest mass is 1-km-long sill cropping out 3 km northeast of Cyclopic mine. Stringers several centimeters wide parallel layering throughout much of the gneiss (Xgn). Fabrics grade from relatively undeformed to intensely mylonitic. Northeast of Gold Hill mine, large sills of pegmatitic leucogranite increase in abundance and eventually grade into complexes of migmatitic leucogranite (Xml). Most facies show modal compositions that plot in the field of granite; some outcrops of gneissic leucogranite contain garnet

Xfg Feldspar gneiss (Early Proterozoic)—Generally, light gray to light pinkish gray; compositionally homogeneous and typified by a strongly lineated fabric. Includes minor amounts of amphibolite, mafic gneiss, highly crenulated quartz tourmaline schist, and tourmalinite. Crops out in a 5-km-long and 0.8-km-wide sliver, bounded by faults in southern Lost Basin Range. Cut by quartz-feldspar veins, some of which contain gold

Xml Migmatitic leucogranite complex (Early Proterozoic)—Composite unit that includes swarms of leucogranite (Xl), aplite, and pegmatite dikes, together with pegmatoid quartz veins all cutting gneiss (Xgn). Complex and highly deformed by a ductile (mylonitic and gneissic) style of deformation

Xgn Gneiss (Early Proterozoic)—Includes variably metamorphosed gneiss and some metaquartzite in northern parts of the Lost Basin Range, and in northern White Hills. Exposed sequence of gneiss in southern parts of the Lost Basin Range includes abundant metabasite and amphibolite consisting partly of metagabbro, metaclinopyroxenite, metawehrlite, metadiabase, and metabasalt. Intruded to varying degrees by porphyritic monzogranite of Garnet Mountain (Xpm), biotite monzogranite (Xbm), leucocratic monzogranite (Xlm), leucogranite (Xl), and diabase (Ydb)

Xmg Migmatitic gneiss (Early Proterozoic)—Composite unit that includes mostly gneiss (Xgn) intruded to varying degrees by porphyritic monzogranite of Garnet Mountain (Xpm), biotite monzogranite (Xbm), and granodiorite (Xgd)

Xm Migmatite (Early Proterozoic)—Composite unit that includes mostly medium-grained, sparsely porphyritic monzogranite of Garnet Mountain (Xpm) complexly intruded into gneiss (Xgn)

———? Contact—Queried where location uncertain

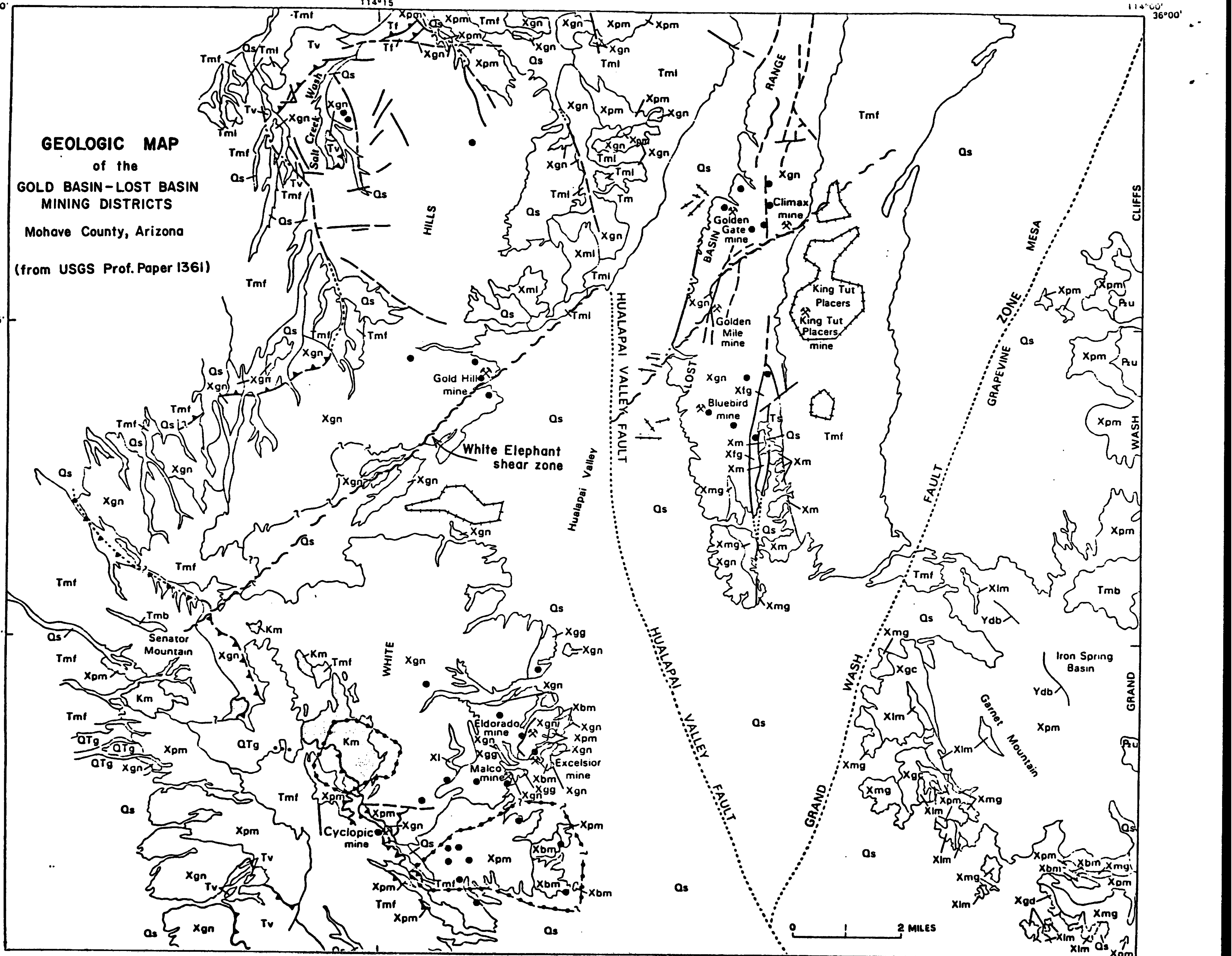
——— Fault—Dashed where approximately located; dotted where concealed

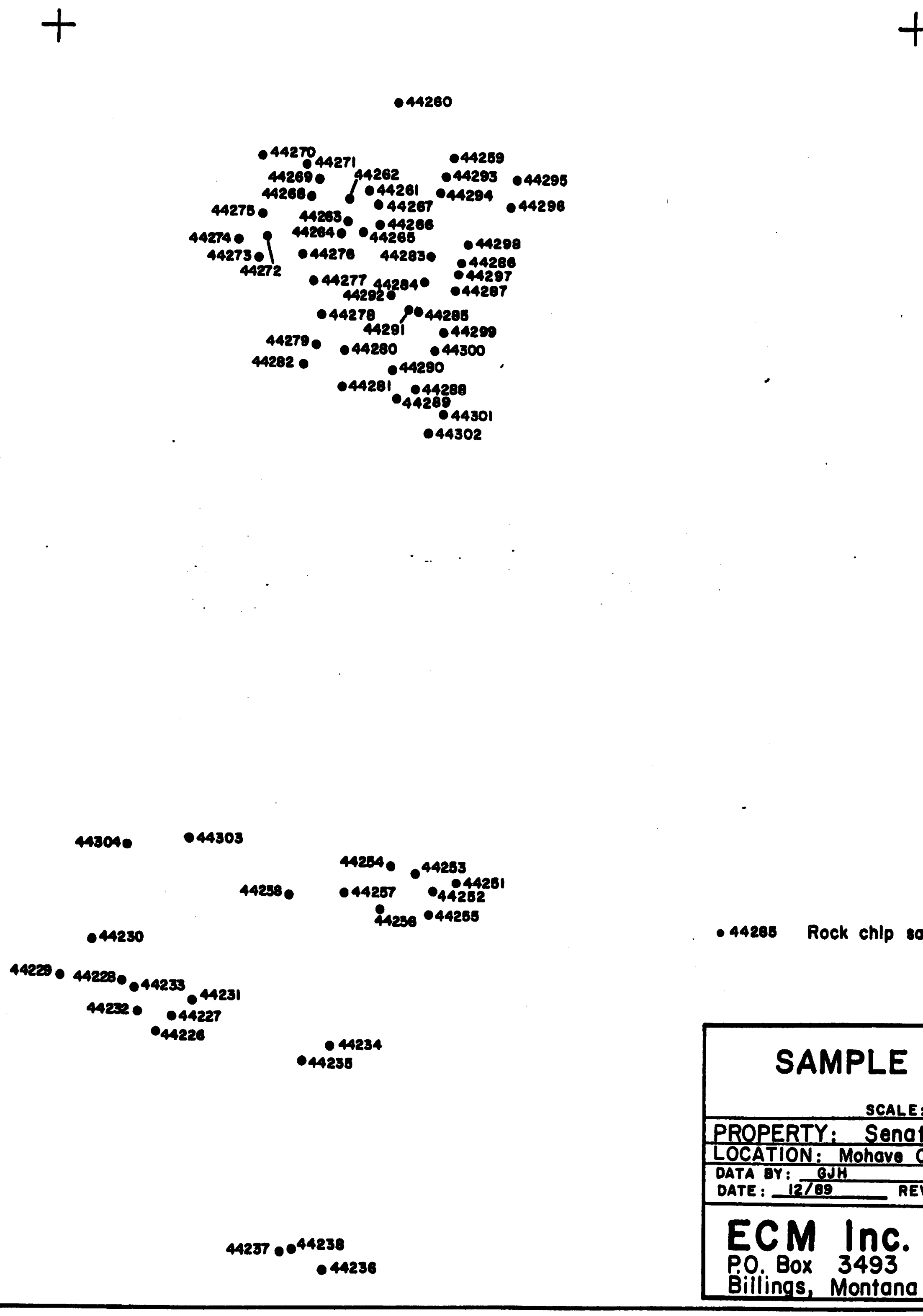
—▲—▲—? Detachment fault—Dashed where approximately located; dotted where concealed; queried where uncertain. Sawteeth on upper plate

● Lode-gold locality—Collected for this report or observed (see Blacet, 1975; and section by J.C. Antweiler and W.L. Campbell, this report)

-•-•-•-? Fluorite occurrence—Outer limit observed either in veins or disseminated in the Late Cretaceous two-mica monzogranite; dashed where approximately located; queried where uncertain

Area of placer deposit and (or) mine


GEOLOGIC MAP
of the
GOLD BASIN-LOST BASIN
MINING DISTRICTS
Mohave County, Arizona
(from USGS Prof. Paper 1361)
36°00'
114°15
114°00'
55'
50'
Salt Creek Wash
HILLS
LOST BASIN RANGE
Golden Gate mine
Climax mine
Golden Mile mine
King Tut Placers
King Tut Placers mine
Bluebird mine
Gold Hill mine
White Elephant shear zone
Hualapai Valley
HUALAPAI VALLEY FAULT
GRAND WASH
GRAPEVINE MESA
FAULT ZONE
WASH
CLIFFS
GRAND
Iron Spring Basin
Garnet Mountain
WHITE
Senator Mountain
Eldorado mine
Excelsior mine
Malco mine
Cyclopic mine
0
2 MILES



• 44285 Rock chip sample location and number

SAMPLE LOCATIONS

SCALE: 1" = 2000'

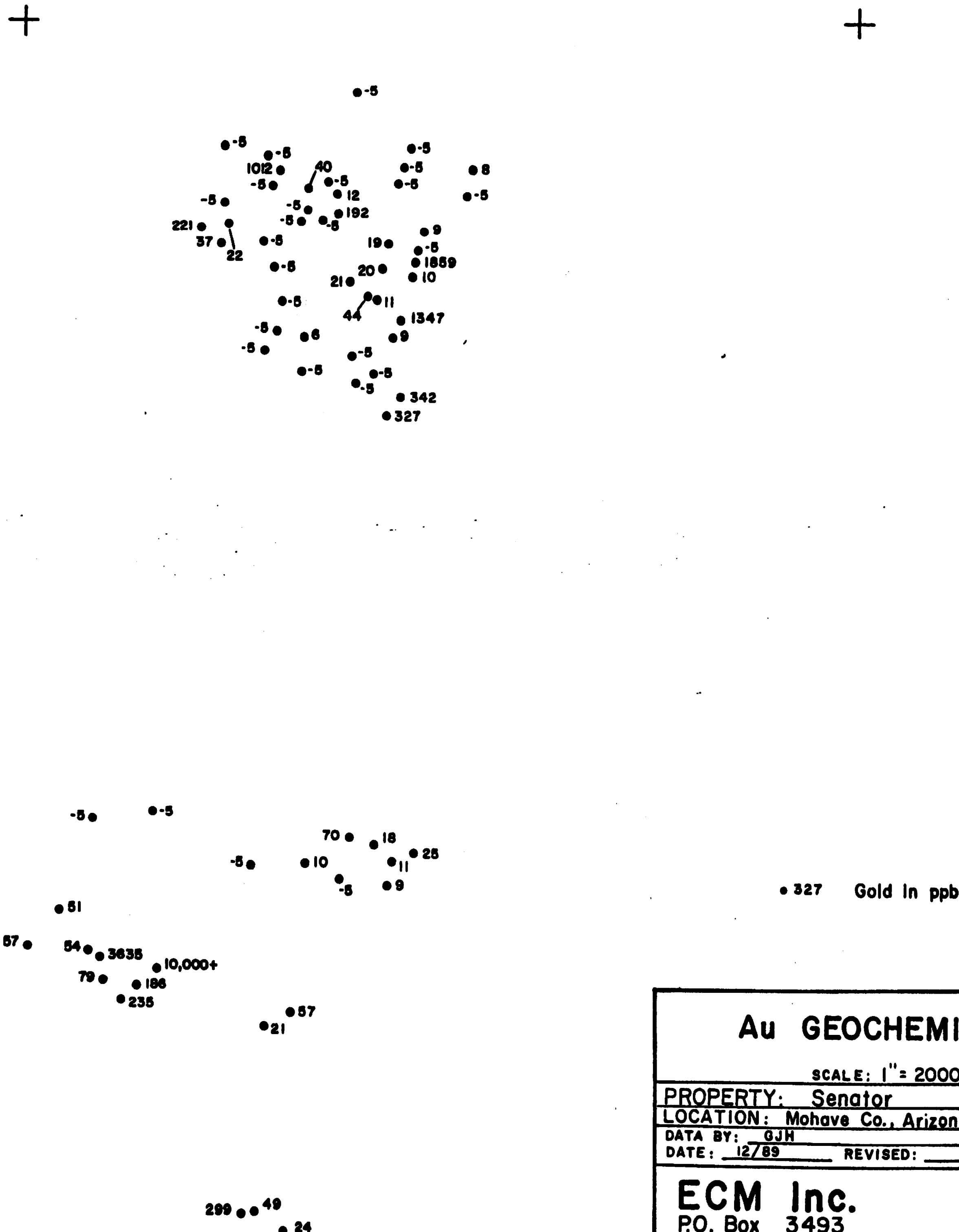
PROPERTY: Senator

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 12/89 REVISED:

ECM Inc.
P.O. Box 3493
Billings, Montana 59103



Au GEOCHEMISTRY

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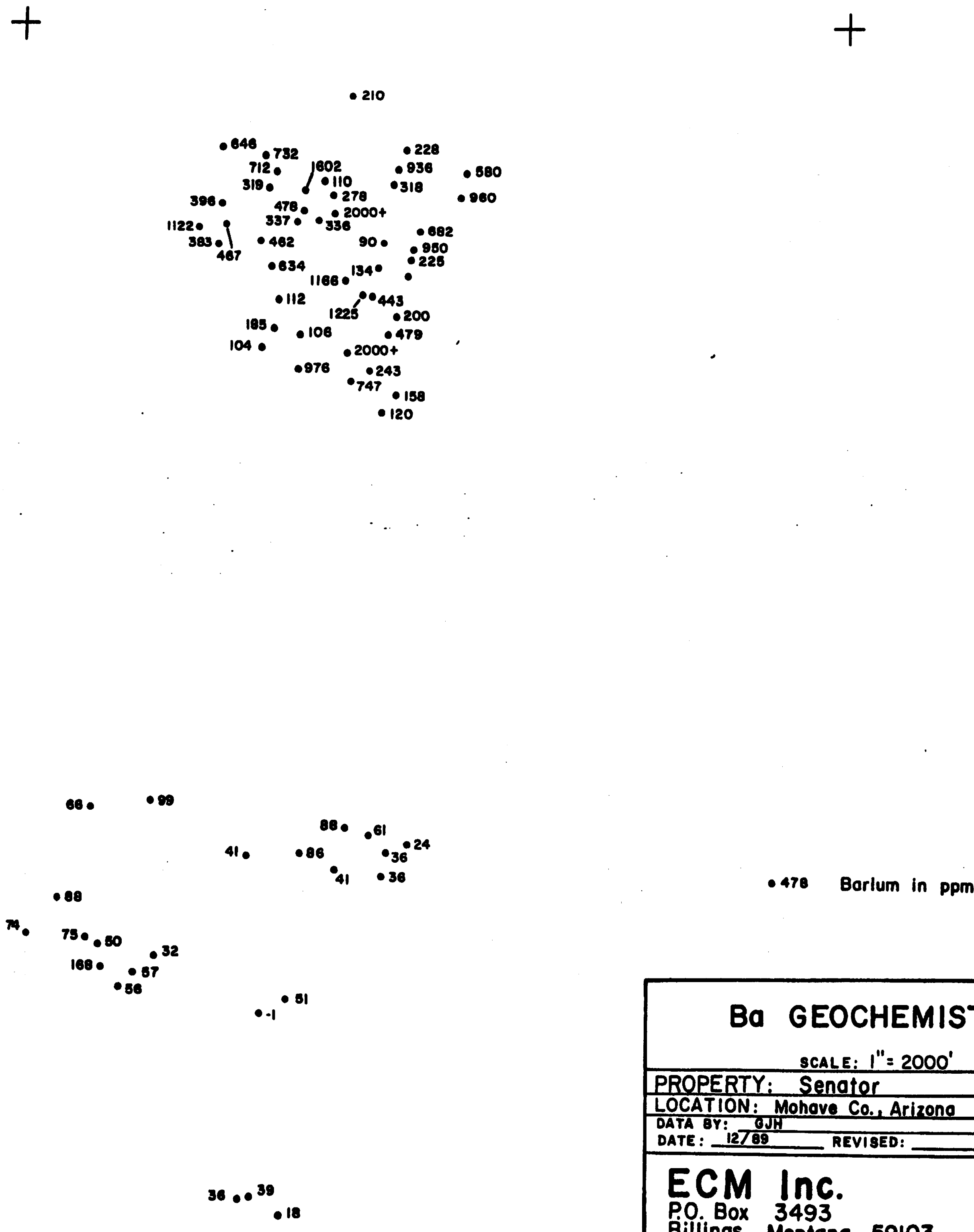

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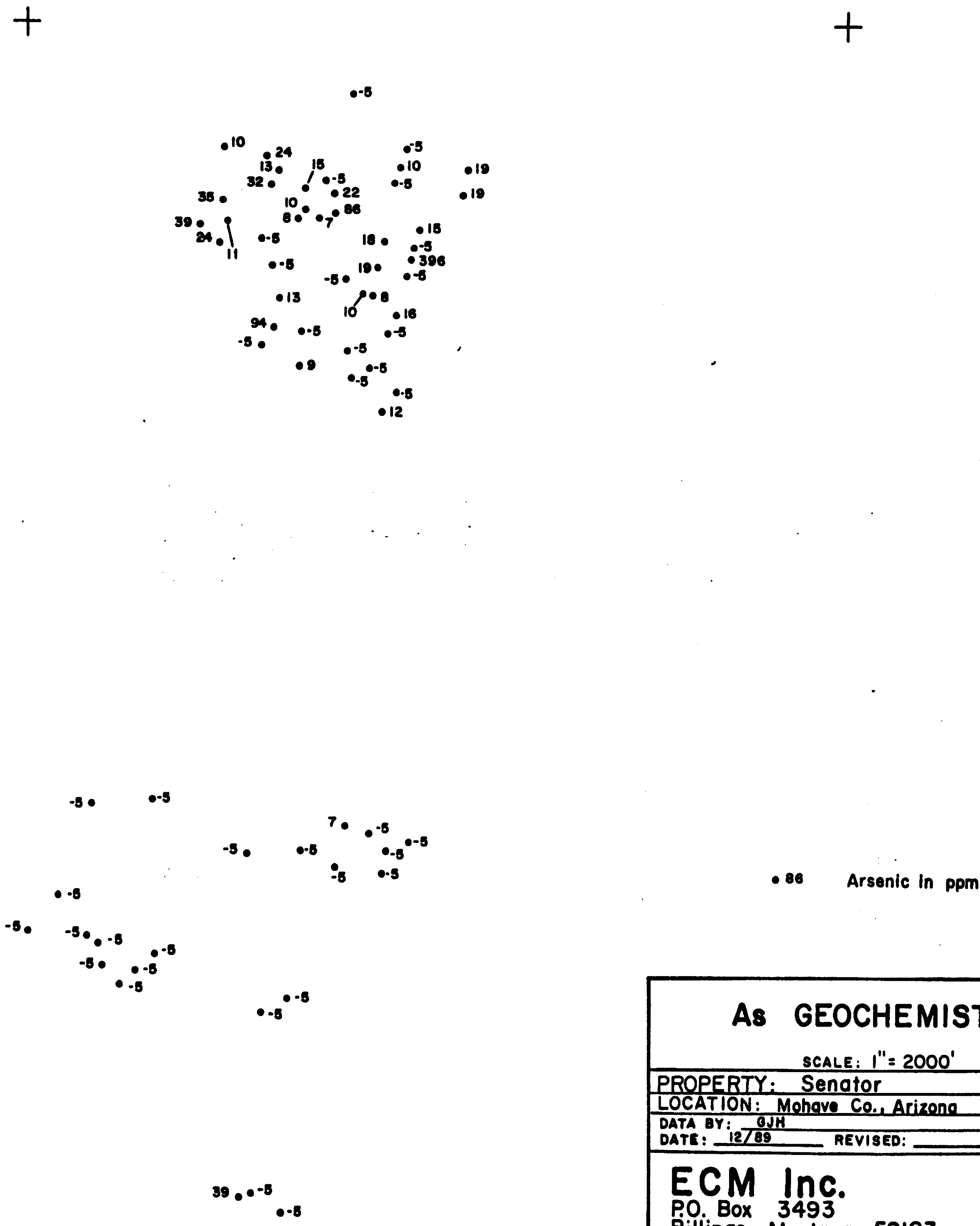

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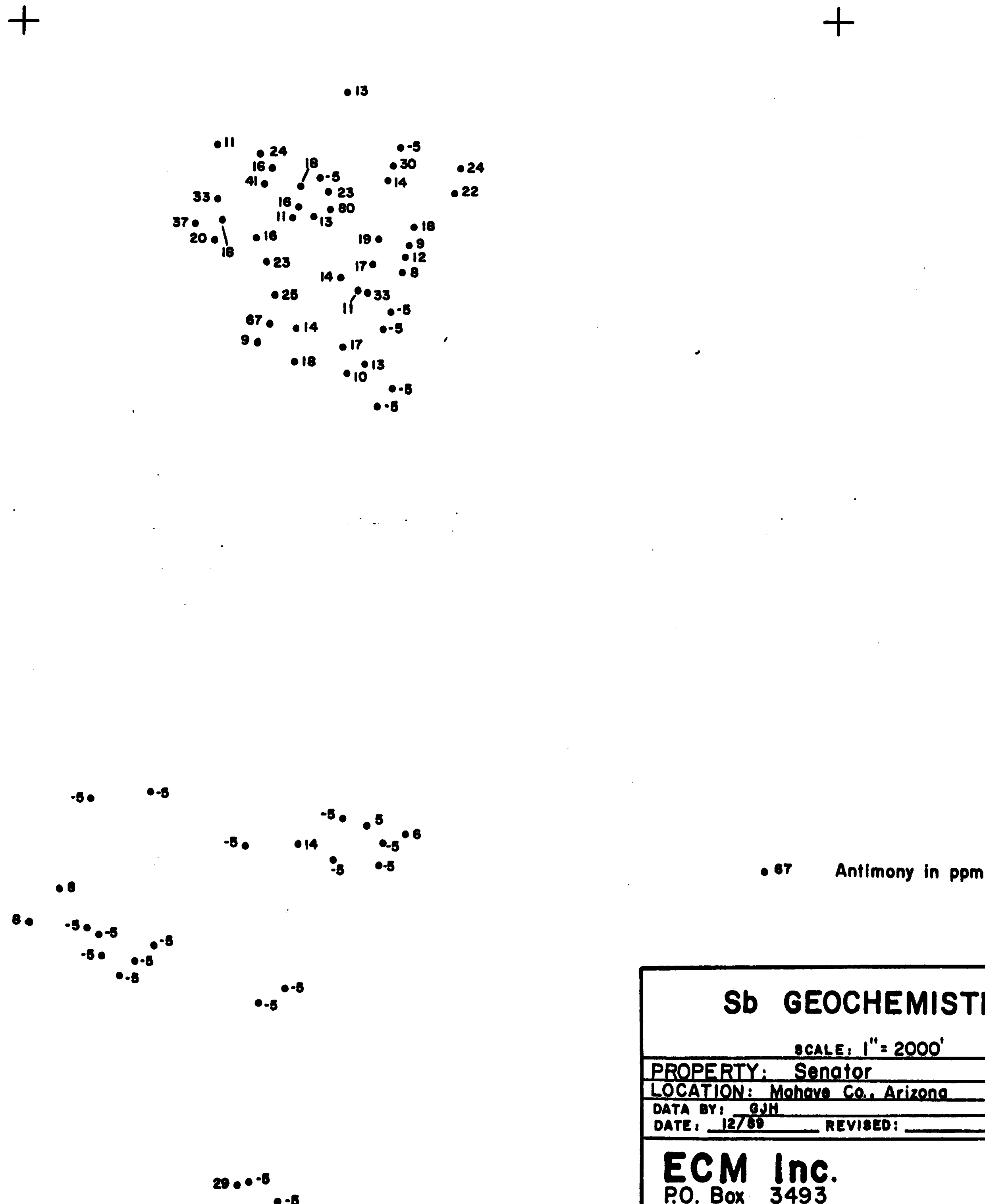

Sb GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 12/89 REVISED:

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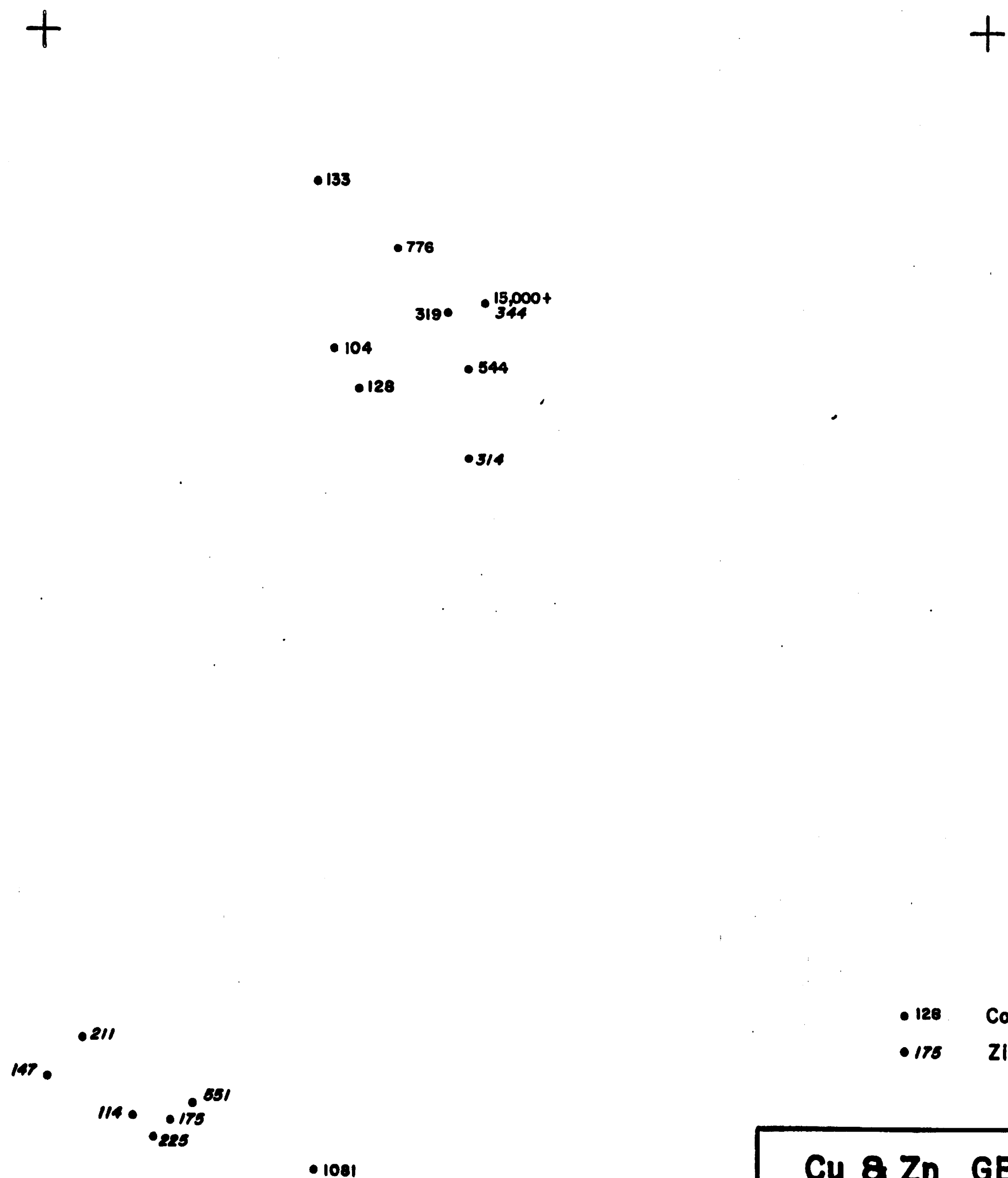
P.O. Box 3493
Billings, Montana 59103



• 128 Copper in ppm (100+ only)

• *175* Zinc in ppm (100+ only)

Cu & Zn GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 12/89 REVISED:

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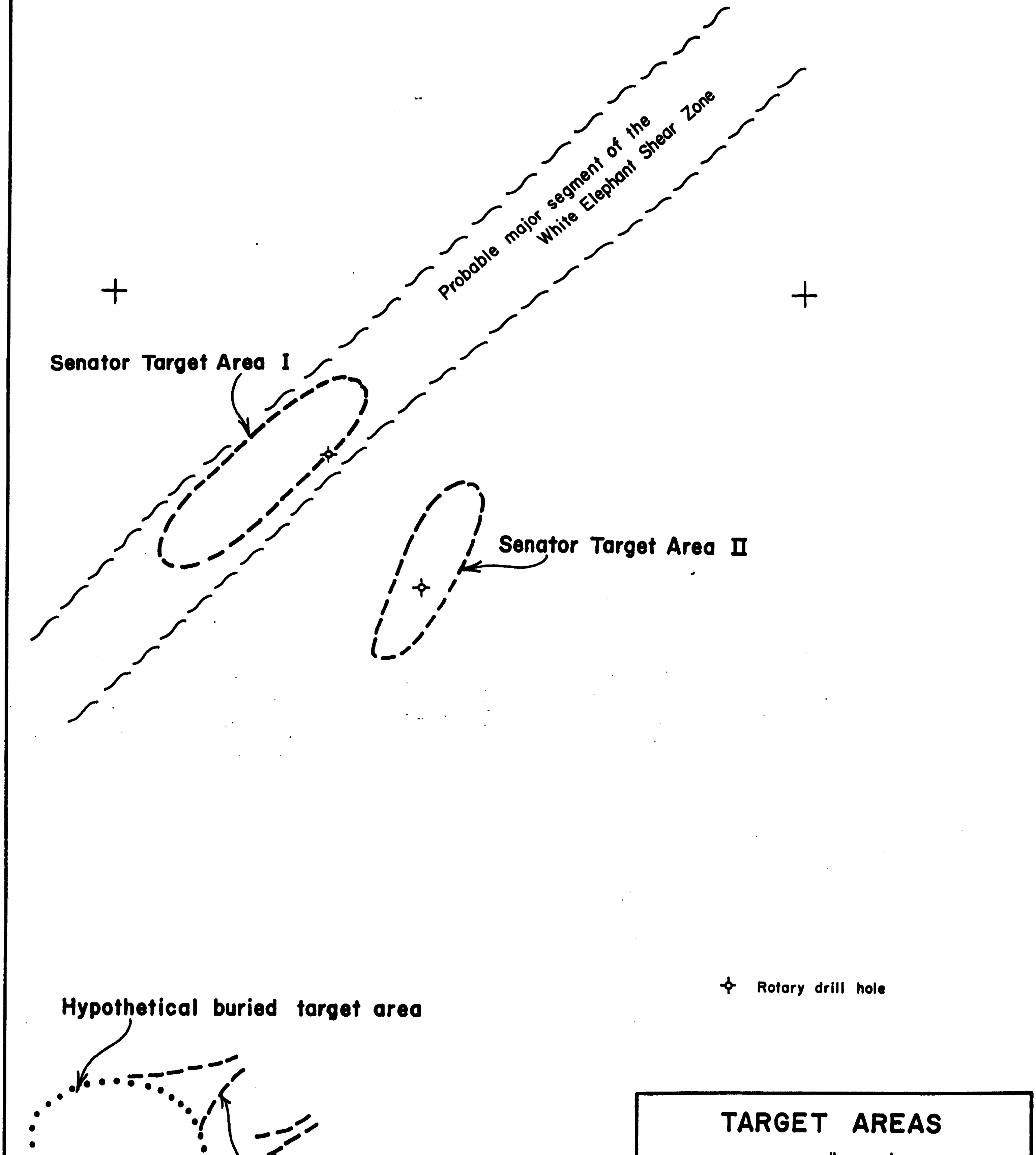

TARGET AREAS

SCALE: 1" = 2000'

PROPERTY: Senator
LOCATION: Mohave Co., Arizona
DATA BY: GJH
DATE: 12/89 REVISED:

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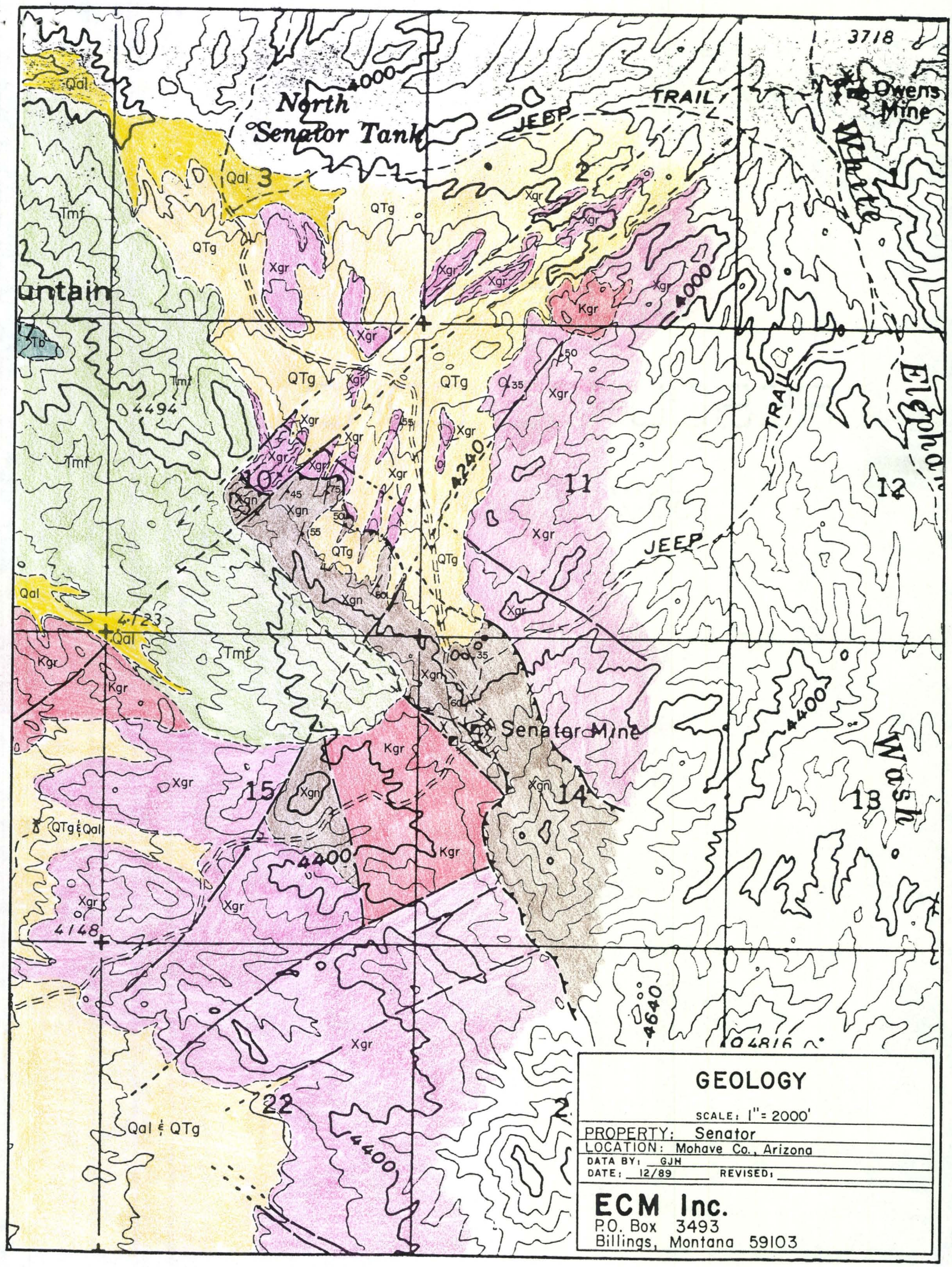
Qal	Recent alluvium, colluvium, and local talus.
QTg	Older terrace gravels and locally thick fanglomerates.
Tb	Basalt flows; locally at the top of Senator Mountain.
Tmf	Alluvial fanglomerate deposits with intercalated silt-stones and mudstones. Locally includes rhyolite tuffs.
Kgr	Two-mica granite. Generally equigranular but locally some porphyritic phases. Some facies of episyenite with fluorite-carbonate-sericite alteration.
Xgr	Porphyritic monzogranite. Locally leucocratic phases with quartz veining. Large K-feldspar phenocrysts.
Xgn	Paragneiss with locally minor orthgneiss. Includes small, conformable bodies of amphibolite.
	Faults and shear zones.
50	Strike and dip of foliation
	Intensely sheared rocks
	Approximate geologic contact.

Explanation for the geologic map of the Senator property, Mohave County, Arizona.



North Senator Tank
JEEP TRAIL
Owens Mine
White
Elephant
Wash
Senator Mine
3718
4000
4494
4240
4400
4123
4148
4640
4816
Qal
QTg
Tmf
Tb
Xgr
Xgn
Kgr
Qal & QTg
QTg & Qal
untain
2
3
10
11
12
13
14
15
22
GEOLOGY
SCALE: 1" = 2000'
PROPERTY: Senator
LOCATION: Mohave Co., Arizona
DATA BY: GJH
DATE: 12/89
REVISED:
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