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ore is said to have been found below it. The altered granite for a width of 100 feet or more bordering the deposit is also said to contain \$2 to \$4 a ton in gold.

The ore is of low grade, and is said to mill on the average from \$7 to \$8 a ton in gold, and to cyanide well. It contains also a little silver and a trace of copper, the latter occurring chiefly as malachite and not in sufficient amount to interfere with the cyanidation. The company is reported to have recently computed about 1,000,000 tons of ore in sight.

GOLD BELT MINE.

The Gold Belt mine is located on the southeast side of Banker Wash, at about 5,000 feet elevation. It is owned by Henry Paully. The country rock is an amphibolite schist, dipping about 30° W. At the western of the two principal openings the deposits are contained in a blanket vein of quartz 15 feet thick, inclining gently eastward, but thinning out in a distance of about 30 feet. The eastern opening shows two quartz blanket veins, each 2 to 6 feet in thickness, dipping gently westward and separated by a 4-foot dike of some volcanic rock that seems to be basalt, but is altered beyond identification.

The ore is said to be of two grades, the lower grade yielding from \$4 to \$7 in gold to the ton and the better grade from \$16 to \$20 to the ton and some as high as several hundred dollars a ton, that occurring in the porous or honeycombed quartz being the best. The deposit is reported to have produced a few hundred dollars' worth of ore.

SENATOR MINE.

The Senator mine is located some distance beyond the border of the Gold Basin district, about 7 miles northwest of the Eldorado and Golden Rule mines and about 7 miles south of Colorado River, on a low round hill at the southeast base of a prominent landmark known as "Senator Mountain." The mine was discovered late in the eighties by John Burnett, who in 1892 sold it for \$14,000 to Senator Page, of Los Angeles, who in turn sold it to a Colorado company. The company at once installed a 10-stamp mill on Colorado River, 2 miles below Salt Springs, operated the mine and mill for about six months, and then suspended. Later the property was acquired by or leased to the Salt Springs Mining Company, which operated it about a month in 1903 and shut down, the ore being of too low grade to pay for its haulage to the mill, 7 miles distant, and for bringing supplies from Hackberry and Kingman, 50 and 60 miles distant, respectively. The mine is reported to have been abandoned since then.

The [illegible] developed principally by open work, cuts, and adit [illegible] deposits are said to be nearly flat lying and similar in [illegible] those of the Cyclopic mine (p. 125), but they form a

larger body. The ore is said to be similarly low in grade, averaging about \$3 in gold to the ton. According to Comstock,[a] the deposits exhibit structural features resembling those of "brecciated fusion" and "cooling lamination" and in origin seem to be associated with igneous intrusion.

DEPOSITS AT SALT SPRINGS.

The Salt Springs mine is about 7 miles northeast of the Senator mine and several miles south of Colorado River, in the first canyon west of Hualpai Wash. It is owned by the Salt Springs Mining Company, which is said to include members of the Arizona-Minnesota Gold Mining Company. The country rock is granite. The gold ore is said to occur sporadically in quartz bodies, and its downward limit is usually indicated by copper-stained quartz.

Other properties in this district are the Smuggler-Union group, the Eureka mine, and the Lutley group.

WHITE HILLS DISTRICT.

GENERAL DESCRIPTION.

LOCATION AND HISTORY.

The White Hills district is located about 28 miles north of Chloride, in the western border of the White Hills, at about 3,000 feet elevation. It comprises an area about 2 miles in diameter and is a part of the Indian Secret mining district, so named because the knowledge of the presence of its mineral was for a long time withheld from the whites by the Indians.

The first discovery of mineral in the district by white men was made by Henry Shaffer in May, 1892, through the aid of an Indian known as Hualpai Jeff, who exhibited a piece of rich silver ore at Gold Basin and showed Shaffer its source, where the Indians procured the supply of red iron oxide with which they adorned their faces. The locality is at the site of the Hidden Treasure mine.

After making several locations, Shaffer reported the discovery at Gold Basin and was soon joined by John Burnett and John Sullivan, who also located what later proved to be some of the best mines. The trio began work and were soon shipping very rich ore, some averaging \$1,000 a ton. The camp soon became the largest in the region and reached its zenith in 1894, with a population of 1,200. Within a short time the camp was owned by one company, the White Hills Mining Company, of which the chief men were R. T. Root and D. H. Moffatt, of Denver. A 10-stamp mill was built early in 1904; in

[a] Comstock, Theodore B., Geology and vein phenomena of Arizona: Trans. Am. Inst. Min. Eng., vol. 30, 1900, pp. 1048-1049.

... richer in the sulphide zone in the lower part of the mine than in the oxide zone near the surface. Its run of mine, roughly computed from a record of the output from October 10, 1885, to March 6, 1901, is about as follows: Silver 160 ounces and gold 2 ounces to the ton; lead, 12 to 20 per cent.

Production.—The production is reported to be $1,300,000, that of silver alone amounting to about $1,000,000; and several thousand dollars' worth of medium-grade ore are said to now lie on the dump. The output was mostly made between the autumns of 1885 and 1892. During this period 3,687 tons of ore are reported, according to smelter return sheets, to have contained about 402,000 ounces of silver, 1,180 ounces of gold, and 515,760 pounds of lead. Later, about 1900 to 1902, about 17,550 ounces of silver, 180 ounces of gold, and 114,360 pounds of lead are said to have been obtained from 330 tons of concentrates.

MINES OF CANYON STATION WASH.

In Canyon Station Wash, about a mile north of C. O. D. Wash, there are reported to be several small mines, of which the most important seem to be the Baden-Baden, King, and Queen mines, said to be owned by Lewis Davidson, of Kingman.

MINES IN "TOP OF STOCKTON HILL" AREA.

The "top of Stockton Hill" is situated in the northwestern part of the district, at the crest of the range, between the northern part of the Cerbat district on the west and the heads of I. X. L. and C. O. D. washes on the east. The mines include the Cincinnati, Miner's Hope, Blue Bell, Fountain Head, Brown, and others, the most important of which seems to be the Cincinnati. It is situated near the crest of the range about midway between Lane Springs and I. X. L. basins. It has not been worked for many years, but is regarded as a good property.

GOLD BASIN DISTRICT.

GENERAL FEATURES.

The Gold Basin mining district, of which Basin is the post-office, is situated in the eastern part of the White Hills (fig. 18). It extends over a hilly area about 6 miles in diameter, sloping to Hualpai Wash on the east, and ranges from 2,900 to 5,000 feet in elevation. The northeastern portion, where most of the mines are situated, is rugged, being marked by longitudinal fault scarps and scored by several deep transverse washes, of which the principal ones are Banker, O. K., and Cyclopic, situated about 2 miles apart. The nearest railway station is Hackberry, 40 miles to the south, with which connection is made by stage line. Colorado River lies 16 miles to the north. Mineral was first discovered here early in the seventies, but remoteness from the base of supplies, together with scarcity of fuel and water, renders operations expensive and has materially retarded developments. Nevertheless, considerable progress has been made and much ore has been produced and worked in arrastres and mills.

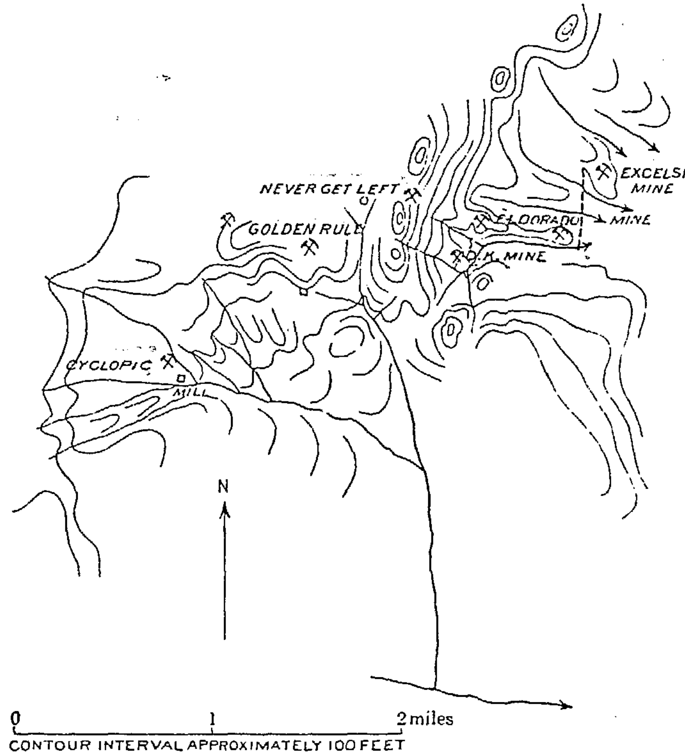


FIGURE 18.—Sketch map of Gold Basin district.

The deposits occur mainly in fissure veins in the pre-Cambrian crystalline rocks. The veins dip southeastward or northwestward, mainly at angles of 40° or 70°. The gangue is quartz, in places with siderite, and the metal is gold, mostly free milling, but it is associated with lead or copper ores, copper stain being a good indication of the gold values. Pyrite, chalcopyrite, galena, molybdenite, and wolframite are found, but the ore is largely oxidized, the water level not having been reached. Among the oxidized products are limonite, malachite, cerusite, and vanadinite.

The mine is said to contain no copper above the 200-foot level, but in an opening a half a mile west of the mine and about 500 feet above it, on what is thought to be same C. O. D. vein, the ore, which here occurs in a milk-white quartz gangue, consists chiefly bornite and chalcopyrite, with some zinc blende, and about $20 in gold to ton.

USGS Bull 397 F. C. Schrader 1909

The district contains about half a dozen small mines and about an equal number of good-looking prospects. The relative location of the most important is shown in the small sketch map (fig. 18). The principal mines are the Eldorado, Excelsior, Golden Rule, Jim Blaine, Never-get-left, O. K., and Cyclopic. The production of the district is given as more than $100,000, most of which came from the Eldorado mine.

ELDORADO MINE.

Location and history.—The Eldorado mine is located in the high foothills in the eastern part of the district, at about 4,000 feet elevation and 1,000 feet above Hualpai Wash, which is about 2 miles distant. The mine is reached by wagon road, over which most of the ore was hauled to the Basin or O. K. mill, 4 miles distant in Hualpai Valley. This mill, which was burnt while in operation in August, 1906, contained 10 stamps and a cyanide plant.

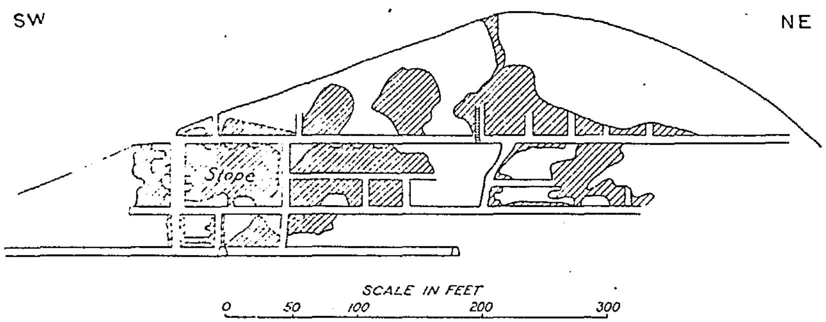


FIGURE 19.—Longitudinal section of Eldorado mine, showing stopes.

The mine was discovered late in the seventies and produced the first bullion taken from the district, much of its ore being at first worked in arrastres. It is owned by the Arizona-Minnesota Gold Mining Company, of Minneapolis. The production is reported to be $65,000, of which $5,000 was produced prior to 1902.

Developments.—The mine is developed principally by about 2,000 feet of tunnels and drifts and 40,000 cubic feet of stopes on three levels, aggregating probably about 90,000 cubic feet of underground work and distributed approximately as shown in the accompanying diagram (fig. 19). The lower tunnel trends about N. 33° E. and strikes the vein at about 200 feet in from the mouth. From this point the drift extends about 200 feet to the northeast.

Geology.—The country rock is a reddish schistose medium-grained granite. On the northeast, however, as shown at the surface and in the bottom of the mine, this rock gives way to a dark friable biotite granite. The contact between the two rocks dips about 30° W. It is usually sharp and is probably a fault plane, which seems to cut off the vein on the northeast.

Veins and ores.—The deposit is a fissure vein, which strikes about N. 50° E. and dips 65° SE. It is continuous from the apex at the crest of the ridge to the contact in the lower tunnel of the mine and is stoped out through most of this extent. The walls are fair, but not regular. The vein averages several feet and the ore shoot about 20 inches in width. It contains iron-stained, free-milling gold-quartz ore, and is reported to average from $12 to $15 a ton in gold. The other associated minerals are malachite, lead carbonate, and vanadinite, the last occurring locally as incrustations of crystals one-fourth inch in maximum length. The principal mill treatment given to the ore was crushing, plate amalgamation, and cyanidation.

Just northwest of the apex of the vein above described and about 80 feet above it is the blanket vein, which is exposed for a length of 600 feet and a width of about 100 feet and which has contributed largely to the output of the mine. It dips about 25° E.

O. K. AND EXCELSIOR MINES.

The O. K. and Excelsior mines were discovered and located by three prospectors, Patterson, Rowe, and Fox, early in the eighties. They worked the ores in arrastres and hauled some to the 4-stamp mill at Grass Springs. In 1886 the O. K. was sold to a Kansas City company, which at once put up the O. K. mill in Hualpai Valley and ran it intermittently from 1887 to 1890. The mill burned down in 1893, but was rebuilt in 1896 and operated by lessees for a time, and then again shut down. It started once more early in 1902 and ran intermittently until 1906, when it burned down while in operation. The water used at the mills was piped from the springs or water tunnels in the upper part of Grand Wash Cliffs, 7 miles to the northeast. The mines are now owned by the Arizona-Minnesota Gold Mining Company.

O. K. mine.—The O. K. mine is about half a mile south of the Eldorado mine and about 100 feet below it, on the opposite side of O. K. Wash. The mine is developed mainly by adit drifts, winzes, and stopes on four levels. There is about 1,600 feet of underground work, distributed approximately as shown in the section (fig. 20). The production is reported to be about $25,000.

The country rock is a dark biotite granite, about the same as that which occurs in the bottom of the Eldorado mine. The strike is N. 30° E., with dip vertical. Slickensides pitch northeast-east toward the mouth of the drifts at angles of about 35°.

The vein trends N. 65° E., but curves to the north in its course and dips about 75° NW. It averages about 18 inches in width and is

12/26/85

Lost Basin - Baron Files

Senator Mine - section thru knoll which measures 400' NS 300' EW
five samples long lower tunnel (10' cuts at 25' intervals trace or nil
Dec. 1966

Golconda near Salt Springs
4' thick 2500 long visible gold

May 1990

Property Name: Senator

Location: Sections 10 and 22, T28N, R19W
Mohave County, Arizona

Acreage: Approximately 1440 acres

Land Status: 72 unpatented lode claims located by ECM.

Underlying Royalty: None

Work to Date: The Senator property is immediately adjacent to the Senator mine, a former gold producer from breccia veins associated with a low-angle fault zone. The area is also adjacent to the Owens mine where a drilling program by the Nerco/ACNC joint venture was conducted during 1985-1986. Two holes from this phase of exploration appear to be located on ECM lands. Sampling and mapping by ECM have defined gold anomalous zones related to well fractured and sheared gneissic rocks.

Target: A gold-enriched area in Section 10 coincides with two intersecting regional-scale fault zones. A fracture-controlled gold system is indicated where the projection of the northeast trending While Elephant shear zone intersects with altered Precambrian gneisses in the hanging wall and a two-mica granite in the footwall of a low-angle fault. A Mesquite-type deposit is hypothesized.

Positive Data: High-grade gold mineralization at the Senator mine appears to have formed from hydrothermal fluids flowing along a low-angle fault zone that extends onto ECM property. An area at least half a square mile in size, and largely surrounded by post-mineral cover, contains anomalous levels of gold. Strong silicification with associated sericitization and variable amounts of argillization are indicative of a pervasive hydrothermal system that migrated upwards through a Cretaceous granite and spread laterally through Precambrian Metamorphic rocks.

[redacted]

Senator Property
Sec. 10, 11, 14, 15, 22
T28N R19W
White Hills Area
Gold Basin Dist.
Mohave Co, AZ

SENATOR PROPERTY

Mohave County, Arizona

Gordon Hughes

January 1990

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.

Geochemistry - 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.

Target Type - 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.

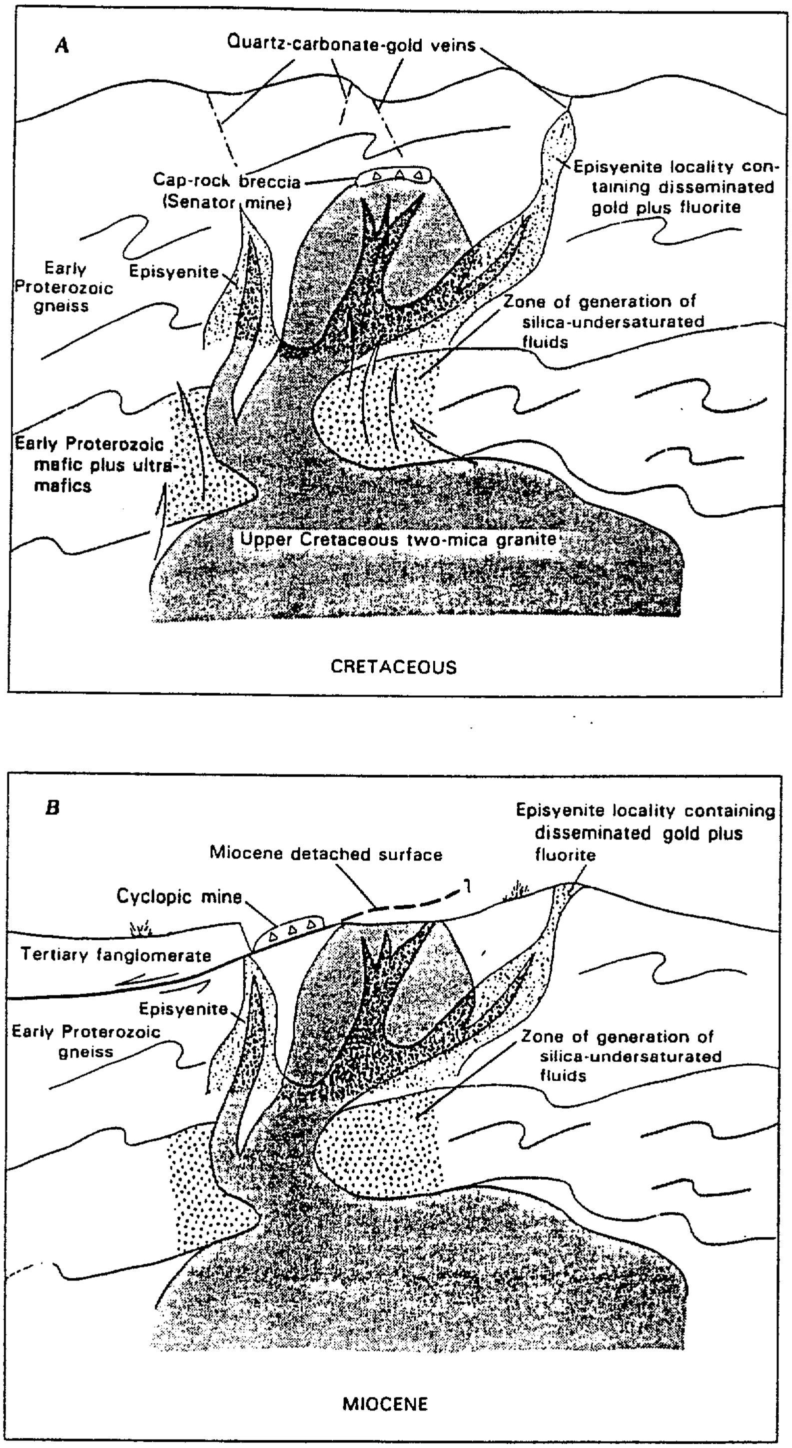
The two target areas proposed for Section 10 show a clear bias for the northeast trending structures located there. As first approximations they are believed to represent the areas in which detailed follow-up work should be conducted. Post-mineral cover in these and adjacent areas will hamper the amount 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)

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 epigenitic-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

Pzu 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

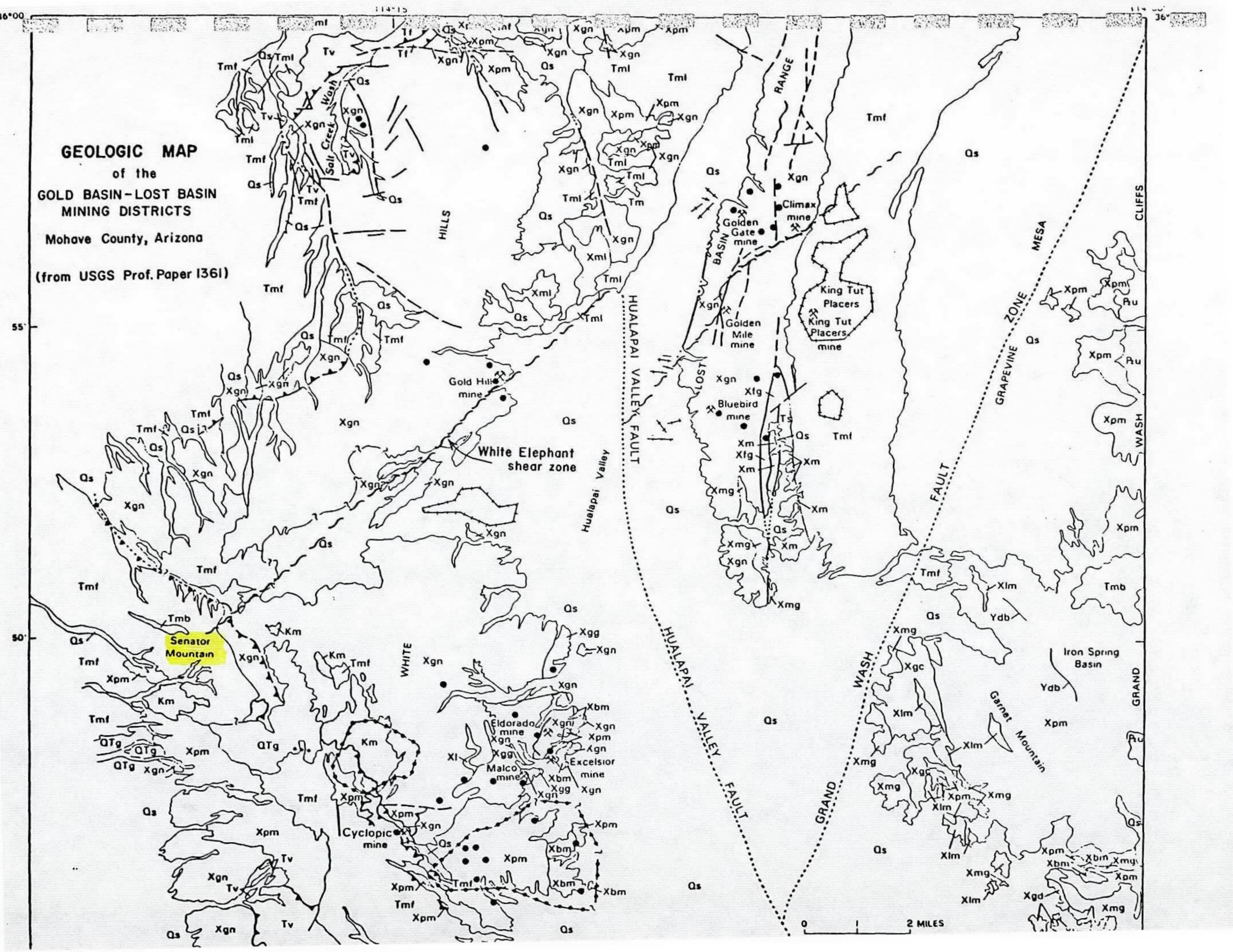
Fault—Dashed where approximately located; dotted where concealed

?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

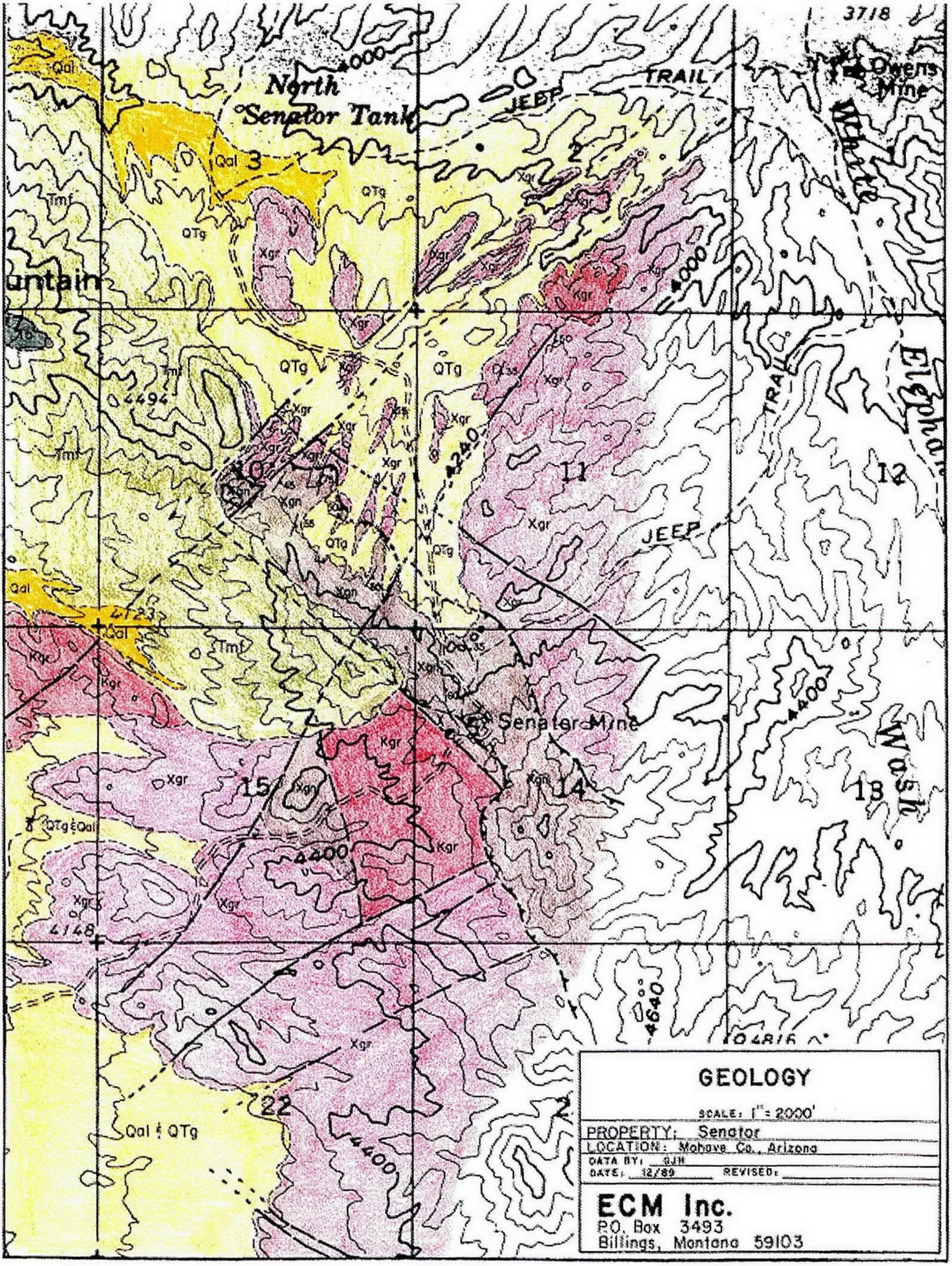
Area of placer deposit and (or) mine


GEOLOGIC MAP
of the
GOLD BASIN - LOST BASIN
MINING DISTRICTS
Mohave County, Arizona
(from USGS Prof. Paper 1361)
36°00'
55'
50'
HILLS
Salt Creek Wash
RANGE
BASIN
LOST
Climax mine
Golden Gate mine
Golden Mile mine
King Tut Placers
King Tut Placers mine
Gold Hill mine
Bluebird mine
White Elephant shear zone
Hualapai Valley
HUALAPAI VALLEY FAULT
GRAND WASH FAULT
GRAPEVINE MESA ZONE
CLIFFS
WASH
GRAND
Senator Mountain
WHITE
Eldorado mine
Excelsior mine
Malco mine
Cyclopic mine
Iron Spring Basin
Garnet Mountain
0 1 2 MILES

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.



GEOLOGY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

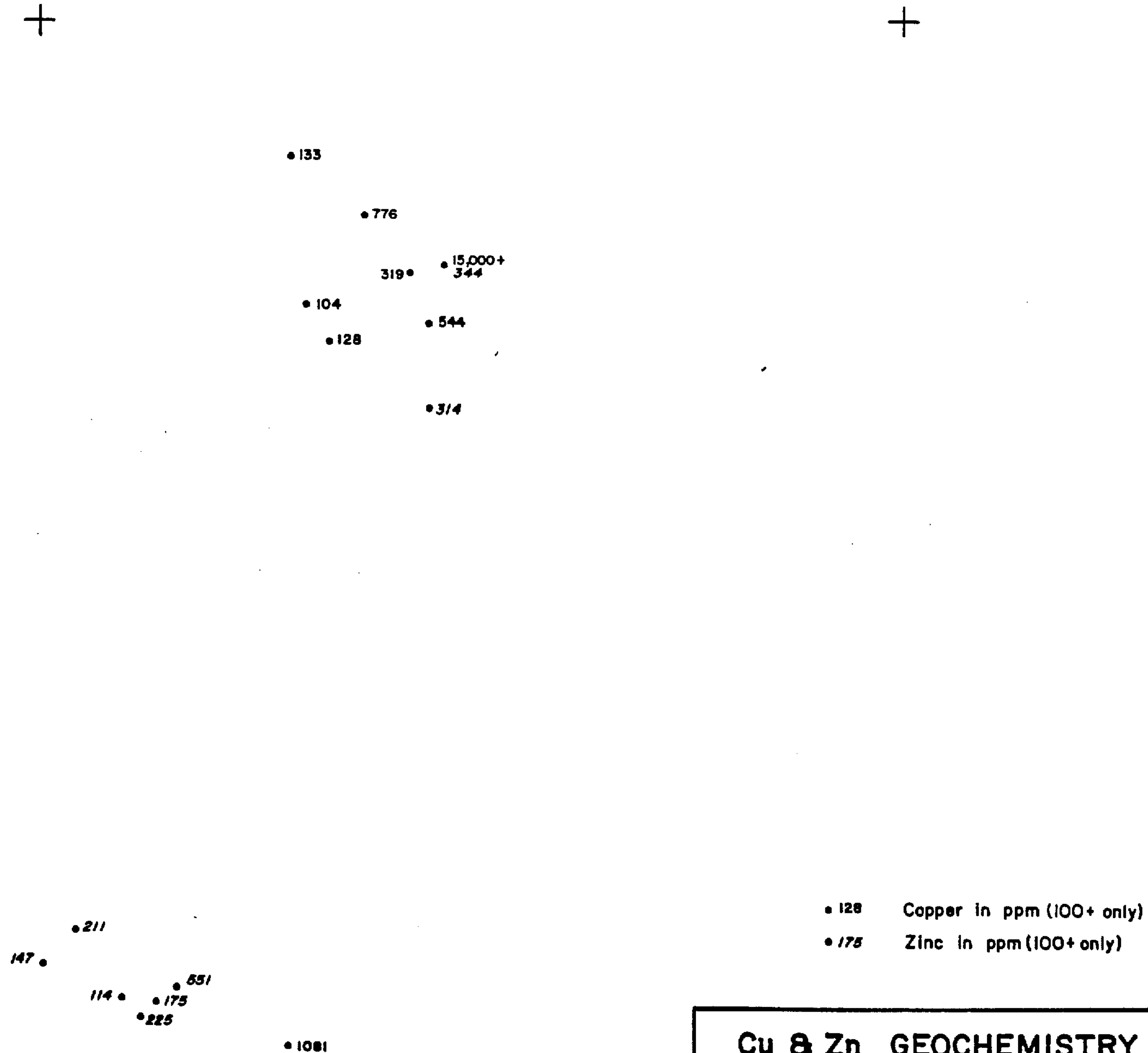
DATA BY: GJH

DATE: 12/89 REVISED:

ECM Inc.

P.O. Box 3493

Billings, Montana 59103



Cu & Zn GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 12/89 REVISED:

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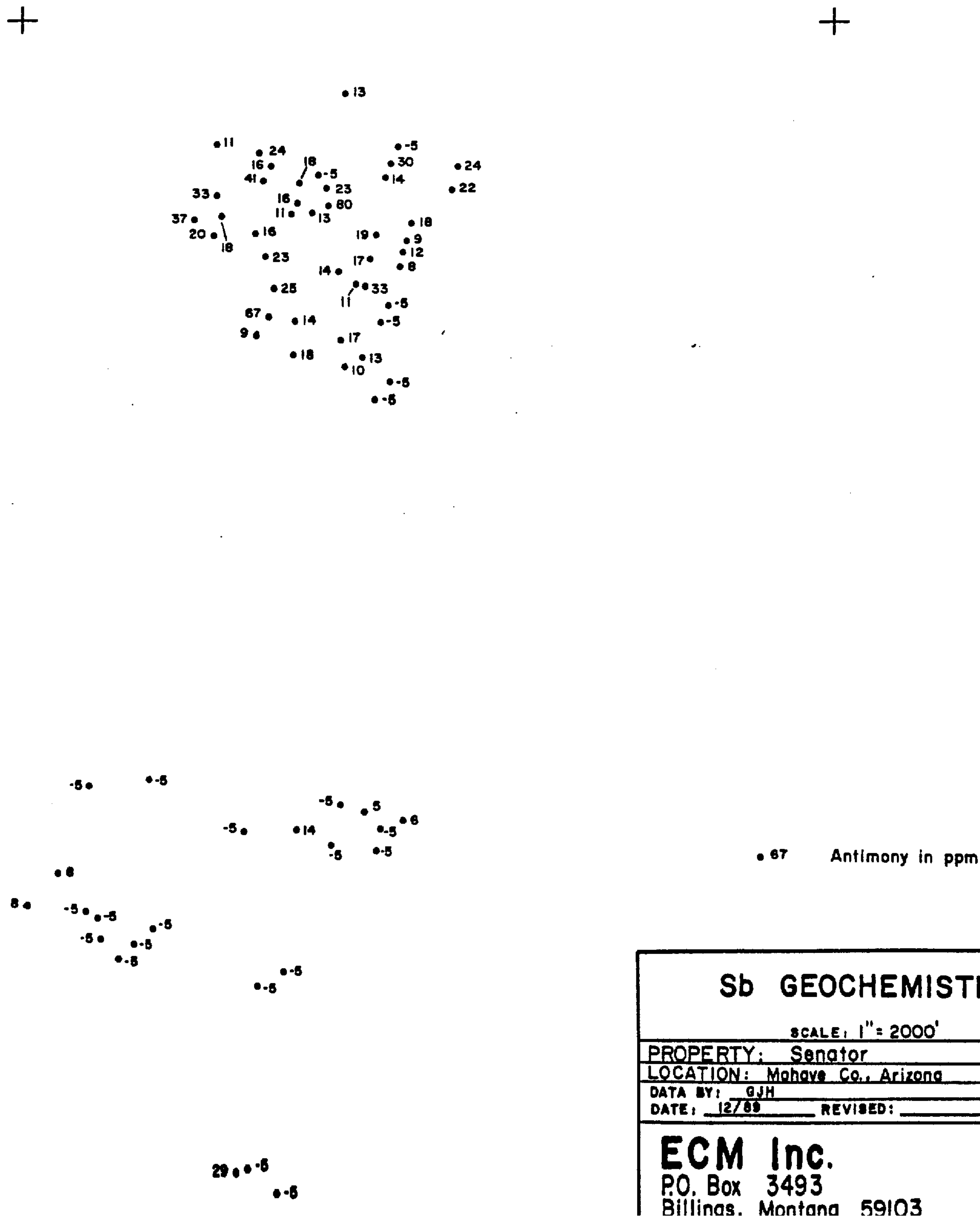

Sb GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 12/89 REVISED:

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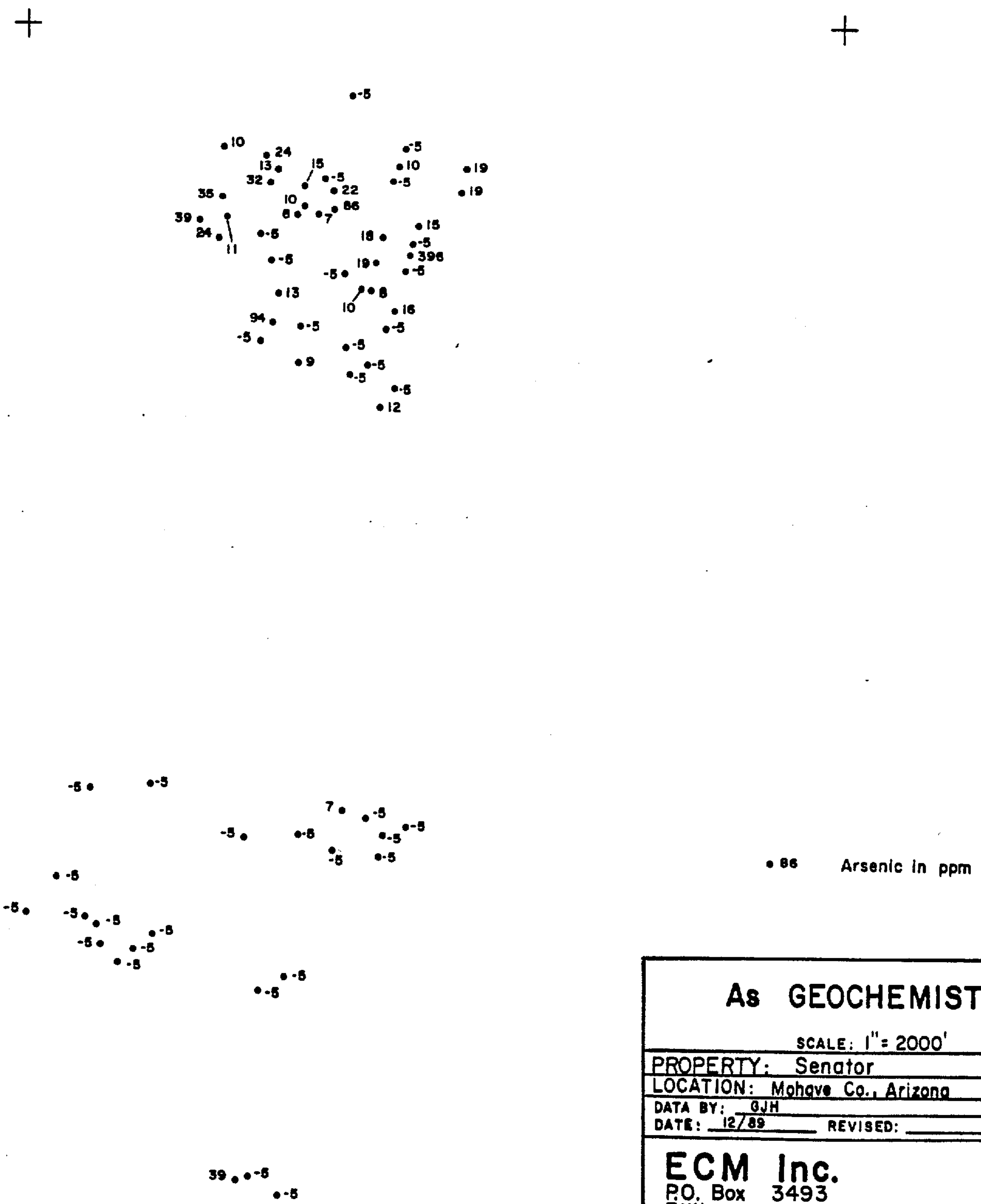

As GEOCHEMISTRY

SCALE: 1" = 2000'

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LOCATION: Mohave Co., Arizona

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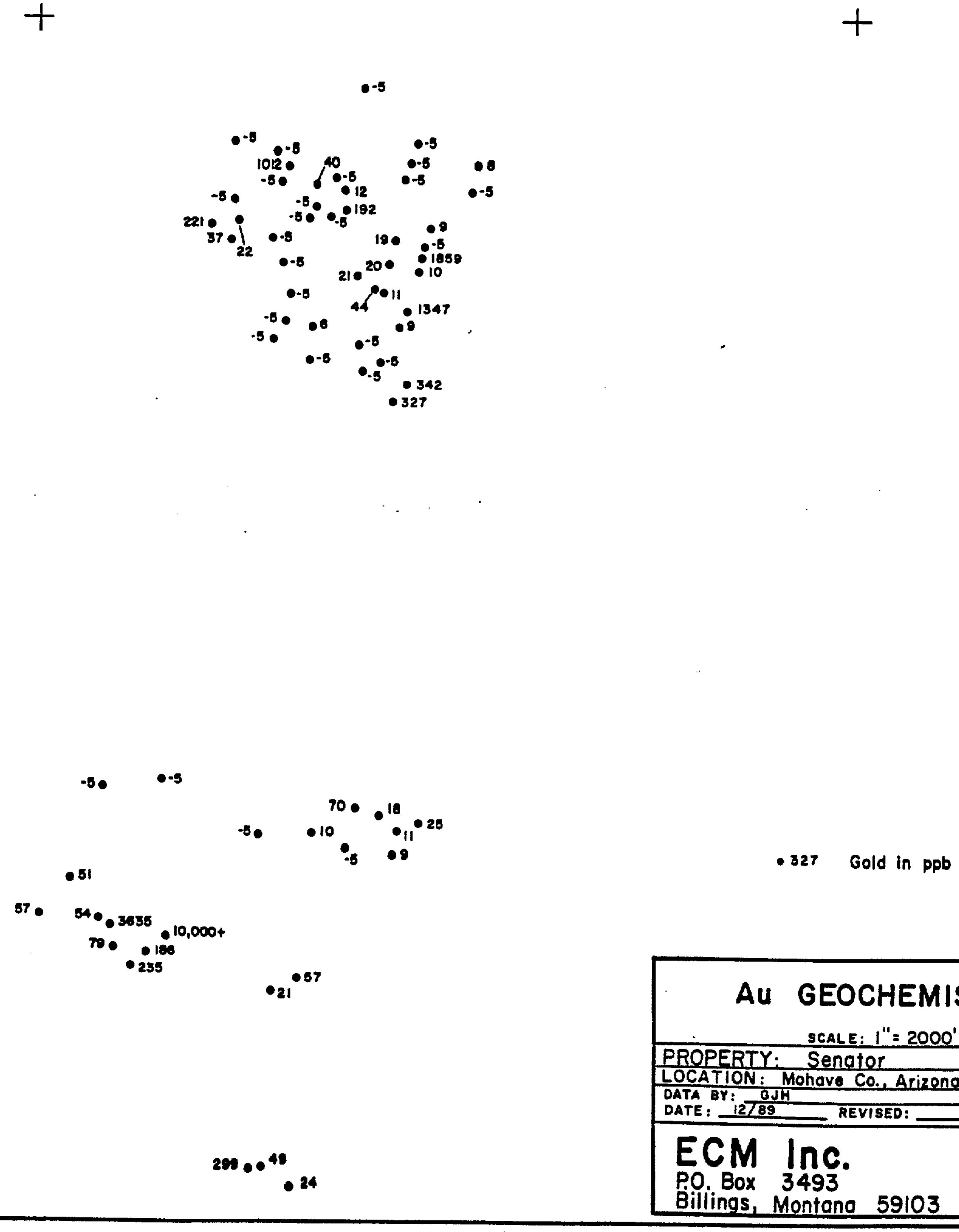

Au GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator
LOCATION: Mohave Co., Arizona
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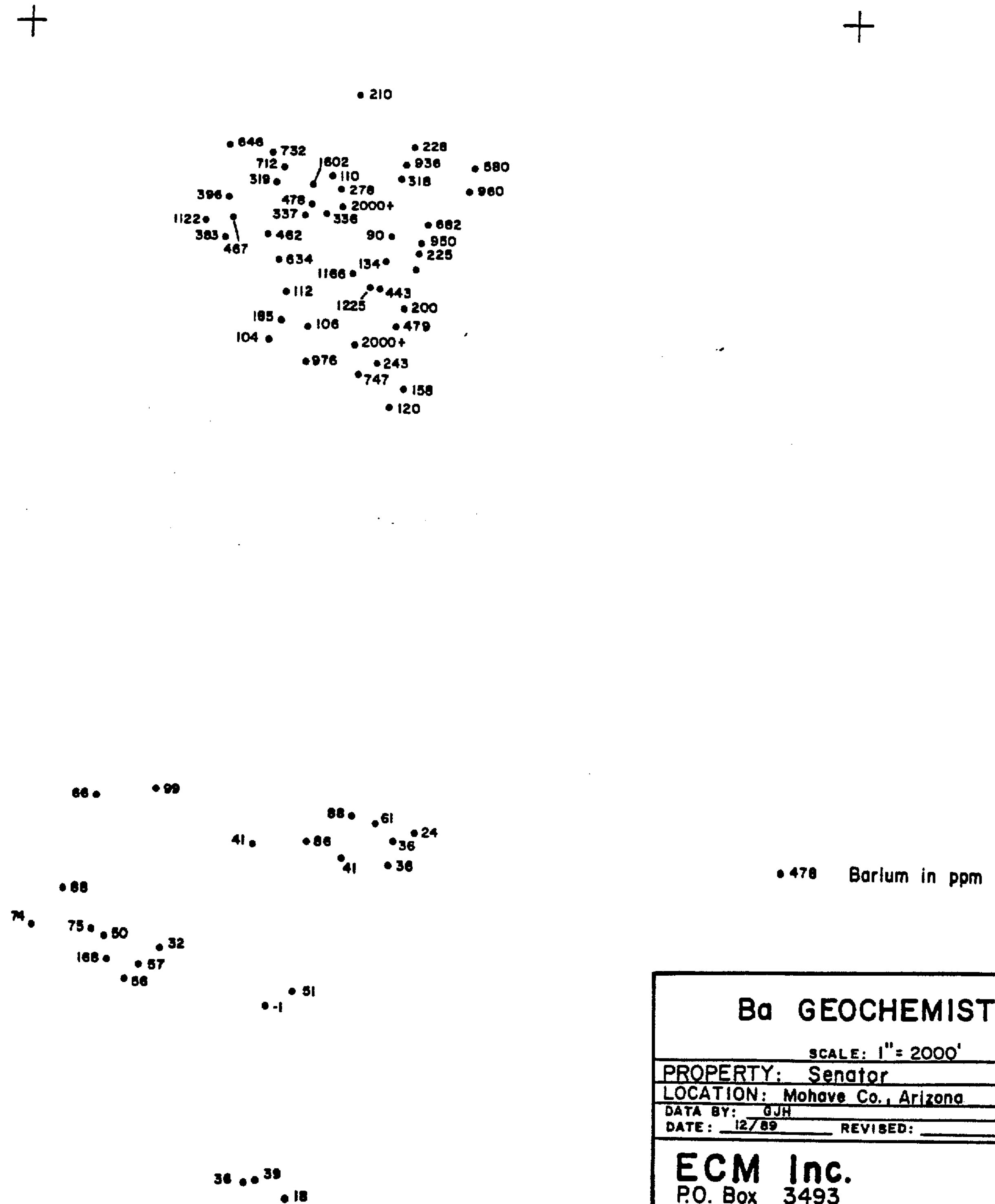

Ba GEOCHEMISTRY

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 12/89 REVISED:

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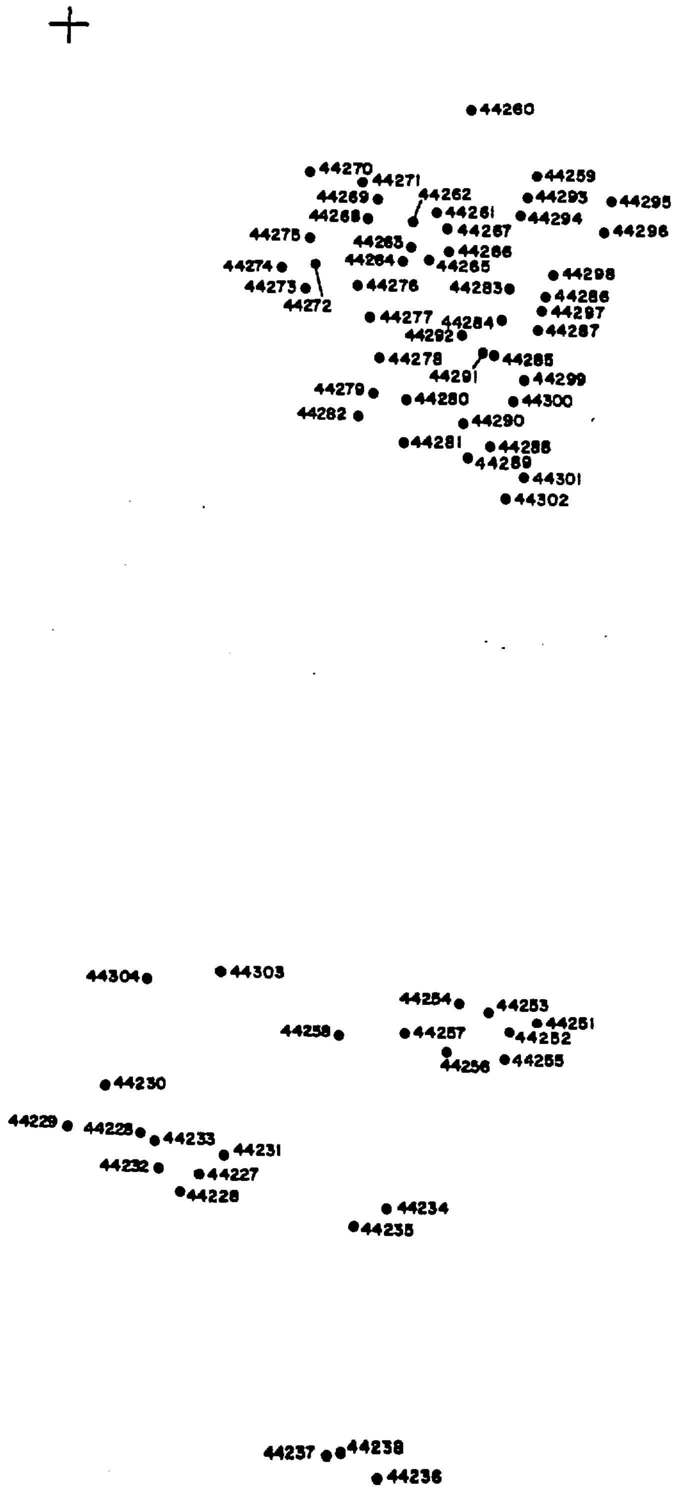

• 44285 Rock chip sample location and number

SAMPLE LOCATIONS

SCALE: 1" = 2000'

PROPERTY: Senator

LOCATION: Mohave Co., Arizona

DATA BY: GJH

DATE: 12/89 REVISED:

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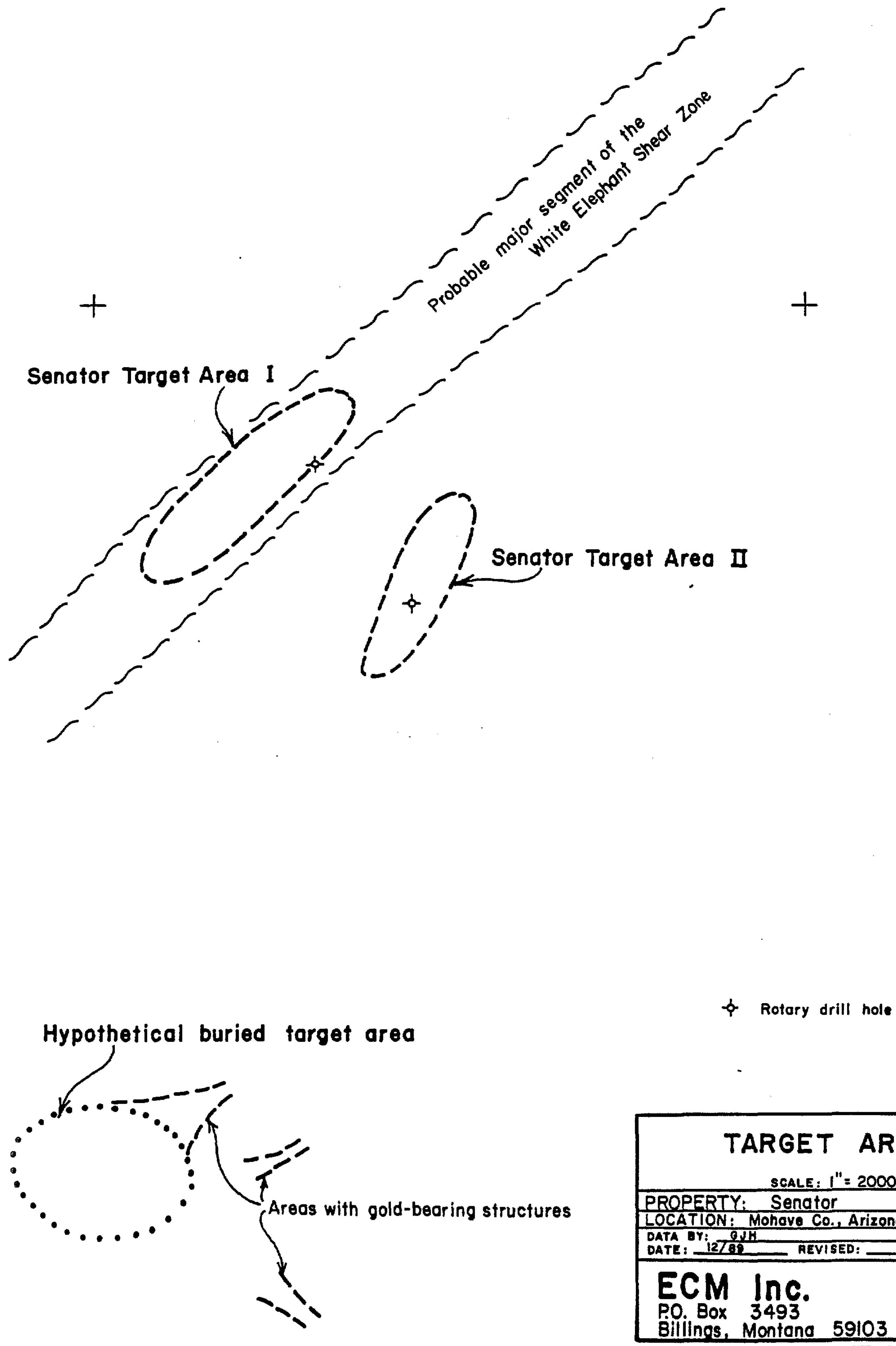
Billings, Montana 59103



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