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INTERUM GEOLOGIC REPORT ON THE TOMBSTONE MINING DISTRICT
COCHISE COUNTY

with particular emphasis on
THE STATE OF MAINE MINE AREA

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October 16, 1973

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2. General Geology of Central Cochise County, Arizona, U.S.G.S. Professional Paper 281 by James Gilluly, U. S. Government Printing Office, 1956.

3. Journal of the Alberta Society of Petroleum Geologists, Vol. 10 No. 3, Special Issue on Folding, March 1962.

4. Field Geology, F. H. Lahee, McGraw Hill, New York 1961.

5. Structural Geology, Second Edition, M. P. Billings, Prentice-Hall, Englewood Cliffs, N.J., 1958.

6. Elements of Structural Geology, E. Sherbon Hills, John Wiley & Sons, New York, 1963.

INTERUM GEOLOGIC REPORT ON THE TOMBSTONE MINING DISTRICT, COCHISE COUNTY

with particular emphasis on THE STATE OF MAINE MINE AREA

INTRODUCTION

In April of this year, the writer was engaged by Mr. Dick Hewlett, President, Sierra Mineral Management Company, to examine and geologically map the State of Maine area in order to determine the potential for the discovery of additional mineralization and to assess its mining potential. Sierra had at that time consummated lease-option agreements with Messrs. Ernest Escapule Sr., Jr., Charles, and Lewis Escapule which covered patented and unpatented mining claims in the general State of Maine area. It was anticipated that Sierra would work toward obtaining the ground within the Tombstone basin on lease-option basis and adjacent ground to the north owned by Joe Escapule (Att. 12). In short, the objective was to consolidate the entire district in order to facilitate exploration and production of base and precious metals.

It was anticipated that bonanza-type ore bodies within the State of Maine would be relatively small and high grade requiring detailed geologic mapping. Therefore the first order of business was to obtain a detailed, accurate topographic map. A first order ground triangulation survey tied to the State survey was put in. All pertinent claim corners and other important geographic features were targeted, and aerial photography flown. A topographic map was prepared photogrammetrically by Cooper Aerial Survey of Tucson, at a scale of 1"=200', with a

5-foot contour interval. All claim corners and other monuments were surveyed photogrammetrically to the nearest ½ foot. Detailed geologic outcrop mapping and alteration mapping was then performed using the topographic base and air photos enlarged to the same scale. Detailed channel type rock chip samples across veins were collected by Mr. J.T. Stockdale. Geologic and assay results are plotted on the 1"=200' base map (Atts. 1 & 2).

SOUTHWESTERN PORPHYRY COPPER PROVINCE has the greatest concentration of copper mines in world. The mines shown on this map produce about 1,250,000 tons of copper per year and production is increasing as new mines constantly are being developed.

Figure 1 LOCATION MAP, TOMBSTONE MINING DISTRICT

SUMMARY AND CONCLUSIONS

The Tombstone Mining District was discovered in 1877 by Ed Schieffelin and was active from that time up until approximately 1937. It is generally thought that production in the district was halted because of large quantities of water which were encountered in the mines. A more important reason for cessation of production however, was depressed metal prices. Prices for silver, lead, zinc, and copper were so low at the time the mines were closed that economic operation could probably not have sustained even had there been no water problem.

Value of the total Tombstone mineral production has been substantial. Using approximate figures for current metal prices of: silver at $3 per ounce, gold at $100 per ounce, copper at $0.80 per pound, lead at $0.20 per pound and zinc at $0.25 per pound, the value of metals produced between 1877 and 1936 would be approximately 145,400,000 dollars.

The geologic history of the Tombstone Mining District has been exceedingly complex. Paleozoic and Mesozoic sediments have been folded and thrust-faulted by two periods of tectonic compression. Igneous rocks of various types have intruded the area during five distinguishable episodes. Hydrothermal fluids have saturated an area of approximately 42 square miles and implaced lead, zinc, and silver mineralization at Tombstone and Charleston.

Discovery of porphyry copper type breccia pipes and associated porphyry copper type alteration has been one of the most important accomplishments of this current study. Presence of this type of alteration in the Tombstone district makes it possible to apply modern concepts of porphyry copper zoning which appear to explain salient aspects of the district. It is now apparent that the Robbers Roost breccia pipe area is the central part of a very large alteration zone. Tombstone and Charleston, which are approximately equidistant from the breccia pipe area represent opposing lead-zinc-silver zones peripheral to the porphyry copper alteration center. Exploration for economic ore bodies of copper associated with the area of breccia pipes is complicated by sub-horizontal geologic features in the area, including: the thin Uncle Sam quartz latite porphyry sill, and alluvial cover over layers of Bisbee Group pelitic sediments which in turn overlie favorable ore horizons in Paleozoic limestones.

The great majority of the production in the Tombstone district has come from ore bodies associated with anticlinal structures in the so-called Tombstone Basin, a large syncline in the Bisbee Group sediments located on the south edge of the town of Tombstone. Detailed geologic mapping in the State of Maine area has revealed that similar fold structures occur in the same rock types, which lie beneath a thin sill of Uncle Sam quartz latite porphyry. Recognition of several windows of sediments exposed in the main body of the sill is probably the second most important discovery resulting from this study. Careful plotting of these features on accurate cross sections indicates the Uncle Sam is at most a few tens to a few hundreds of feet thick in the State of Maine area.

Detailed mapping has shown that vein zones in the area have a greater continuity than had been previously realized.

Favorable structural and chemical horizons formed by folded beds below the Uncle Sam porphyry make attractive ore targets where they are intersected by projections of strongly altered surface vein zones. These vein zones appear wider and stronger than similar veins in the old part of the district. This might be expected since they are closer to the apparent source of mineralization -- the porphyry copper breccia pipe zone toward Charleston. The width of the veins suggests potential for disseminated near-surface ore, though to date surface samples, albeit strongly leached, have not been particularly encouraging.

Thus, this study suggests potential for two types of mineralization occurring in economic grades and tonnages. The first would be near surface values in vein zones within the Uncle Sam porphyry which might be minable by surface methods. Higher grade shoots of this type of mineralization might also be found along more narrow zones comprising ore of the type mined in the State of Maine mine. Extensions of this type of ore might be localized along newly discovered parts of the Maine vein in the Brother Jonathan area. Vein intersections on the Clipper and San Pedro veins might also be productive. The second type of ore would be replacement orebodies in favorable structural traps in sedimentary horizons in the Bisbee Group and Paleozoic sediments beneath the Uncle Sam porphyry.

Two types of exploratory drill programs are proposed to test these two possibilities. To test ore potential in the Uncle Sam porphyry, within 100 feet of the surface along mapped vein zones, holes should be drilled with an air track percussion drill. If encouraging results are obtained, up to two hundred such holes should be drilled. The cost per foot should be in the range of $2.00 and the cost of the program, including assays, should be in the range of $65,000 for 20,000 feet of drilling.

Exploration for replacement ore in sediments beneath the Uncle Sam should be done with a rotary drill rig in the initial stages. Twenty-five holes have been proposed, each testing various specific targets while yielding information on thickness of the Uncle Sam sill and structure of underlying sediments. Considering an average depth of 500 feet, this program would entail 13,000 feet of drilling. Approximate cost including sampling and assaying would total $62,000. If the deeper penetration suggested on several holes were made, about $10,000 would be added to the cost. Total cost of both programs would be about $127,000 and require two to four months for completion.

Exploration of the porphyry copper target in the Robbers Roost area will require additional geologic and alteration mapping to define meaningful drill targets. Geochemical surveys in the area may also prove to be a valuable exploration tool. Induced polarization surveys will be of little value since they only indicate the presence of sulfides without respect to base or precious metal content -- and there is already abundant indication of sulfides in surface exposures. Magnetic surveys may be helpful in indicating magnetite associated with possible replacement type copper ore in limestone horizons.

A thorough knowledge of the geology of the district in three dimensions will probably be the most productive exploration method in the Tombstone district, -- for both precious and base metals. Careful geologic mapping and drill hole logging should therefor be of the first priority in future work in the district.

HISTORY

In 1877, Ed Schieffelin, Army scout at Camp Huachuca, took leave from his duties to go prospecting in the nearby hills. At that time, Apaches were running rampant over the area and his companions tried to dissuade him from going alone into the mountains, telling him that the only thing he would find would be his tombstone. Undaunted, Schieffelin set out and when he made a discovery of rich silver outcrops in the hills to the east of Camp Huachuca, he determined to call the new district "Tombstone" in honor of his companions' warnings.

News of Schieffelin's discovery spread quickly and Tombstone soon became a boom camp with thousands of fortune seekers moving into the area. Between the discovery date of 1877 and 1880, the price of silver was averaging $1.20 per ounce (a price not again to be attained until almost 100 years later). Production amounted to approximately 2½ million dollars at the then current metal prices. The greatest production of the camp was between 1881 and 1886 during which time silver ranged from $0.99 to $1.14 per ounce, and the mines produced almost 17 million dollars in metal. This rate of production was never again attained, decreases being due to lower metal prices and depletion of rich surface ores. The district has mainly been affected by economic events, experiencing buoyant periods during high metal prices and depressed conditions during low metal prices. One of the most buoyant periods was 1918-1922, when production was stimulated by the Pittman Act which supported the price of silver at $1.12 per ounce.

Water was encountered in the mines in 1882 and the 1,000-foot deep Pump shaft was sunk to dewater the district in the 1897 era. In 1909 a defect in the pumping system caused the lower levels of the Pump Shaft to be flooded and the pumps were lost in the lowest levels. This flooding of the pumps was generally thought to be the reason for the closing of the district. However, if silver prices had held at previously high levels, pumping would have been resumed and production continued. An examination of mineral prices during the life of the district suggests that low metal prices coupled with increasing mining costs precluded economic operation of the mines (Fig. 2), causing the death of the camp.

Period	Price of silver	Production	Remarks
1877-80	$1.15 -$1.20	$ 2,318,567	Discovery and early development. Mills built on San Pedro River.
1881-86	0.99 - 1.14	16,877,175	Active development and large production. Water encountered in mines in 1882, and mills built at Tombstone.
1887-96	0.63 - 1.05	4,564,650	Decreased production due to depletion of many of the large ore bodies above water level.
1897-1911	0.52 - 0.68	5,575,900	Consolidation of principal properties and attempted unwatering of district by a 1,000-foot pump shaft.
1912-14	0.553- 0.615	379,917	Lessee operations.
1915-17	0.507- 0.824	1,117,687	War period. Considerable production of manganiferous silver ore and concentrates.
1918-32	0.282- 1.12	5,150,789	Mainly lessee operations. Production of silver during 1918-22 stimulated by Pittman Act.
1933-36	0.35 - 0.77	1,118,325	Production stimulated by increased price of gold and silver.

FIGURE 2

GENERAL GEOLOGY OF THE DISTRICT

The Tombstone Mining District lies within the southwestern porphyry copper province. Nearby large porphyry copper deposits are located at Bisbee some 25 miles to the southeast, and the newly discovered deposits at Dragoon are some 25 miles to the northeast. Exploration drilling on porphyry copper at Gleeson, about 15 miles northeast, is presently underway.

The Tombstone area itself has had a complex geologic history which includes sedimentation, folding, thrust-faulting, several stages of intrusion by igneous rocks, and mineralization from hydrothermal solutions. Basement rocks are Pre-cambrian granodiorite, and Pinal schist. Over this are deposited approximately 5,000 feet of Paleozoic sediments consisting, for the most part of limestone. Mesozoic sedimentation includes the Bisbee Formation consisting of approximately 4,000 feet of sandstones, minor limestones, mudstones, and shales. Tertiary surface volcanic rocks include the Bronco volcanics, which are comprised of a lower andesite breccia overlain by a quartz latite welded tuff. The Bronco volcanics are interesting in that they are co-relative, at least in time and composition, to the Silver Bell andesite complex and the Cat Mountain rhyolite. Work by Richard and Courtright show that these units occur rather pervasively throughout the porphyry copper province in south-eastern Arizona and are closely associated with porphyry copper mineralization. Recent sediments within the Tombstone area include cemented conglomerates of the Gila type and normal alluvial material occurring in the stream drainages and the valley of the San Pedro River.

The tectonic history has been complex. At least two episodes of folding and thrust faulting have taken place (Gilluly, p. 122 through 130). It is apparent (Gilluly, p. 128) that an earlier period of deformation created eastward-trending features and later deformation formed northward-trending and oblique features. During the first stage, north-south compression formed east-trending folds and minor thrusts with a north strike and northerly low-angle dips. After this structural episode, the Bronco volcanics were deposited on erosion surfaces formed on Bisbee Group sediments. The disconformity is in general low angle, the volcanic units being subparallel to the pre-existing Bisbee. Following extrusion of the Bronco volcanics, the area underwent southwest-northeast compression, which produced thrust faults of northwesterly trend and was probably responsible for the large features visible in the district today, including the Tombstone Syncline, the Ajax Hill fault, the Prompter fault, and the Horquilla fault. After this structural episode, the Uncle Sam quartz latite porphyry was injected into the area. Feeder dikes of Uncle Sam porphyry are seen to the west of Ajax Hill. The large expanse of porphyry in the western Tombstone Hills and the State of Maine area is apparently a very large sill, which was intruded along a pre-existing thrust plane. Over most of its expanse, the Uncle Sam porphyry is replete with xenoliths and near its basal contact with underlying Bisbee sediments, the amount of xenoliths increase until they comprise 10 percent or more of the total rock volume. Since there are for practical purposes, only occasional windows through the Uncle Sam sill, we can only surmise at the rock type lying beneath. Because of its thrust-fault relationship, prediction as to the type of underlying rock is further complicated. All exposures in the State of Maine area seen to date have been of Bisbee Group sediments.

After the implacement of the Uncle Sam porphyry northeast-trending shearing developed within the district. This zone of shearing is expressed topographically and can be easily noted on topographic maps and aerial photos of the area. After development of northeast-trending shears, the area was invaded by andesite porphyry dikes. After solidification of the andesite dikes the area was intruded by rhyolite porphyry dikes, following parallel and sometimes the same fissures as the andesite dikes. This relation is seen near the Gold Bug workings in the State of Maine area, where a composite dike of rhyolite and andesite is exposed. The andesite comprises the central part of the dike with rhyolite intruding on either side of the andesite. The relative age is indicated by numerous sphereoidal xenoliths of andesite in the rhyolite. Extrusive equivalents of these rocks may have been deposited on the surface. However, there are no surface exposures which can be related to the dikes, and it is assumed their extrusive equivalents have been eroded away.

Emplacement of the Schieffelin granodiorite was the next intrusive event. The granodiorite forms a stock of northwesterly trend on the northern edge of the district, north of the Ajax fault, and it is quite possible that the granodiorite was intruded along this structural feature.

Subsequent to the granodiorite intrusion and possibly associated with it, hydrothermal solutions invaded the district and formed the known ore bodies at Tombstone and Charleston and were responsible for porphyry copper type mineralization, alteration and formation of breccia pipes in the Robbers Roost area. Examination of new color air photographs of the Tombstone District show red areas of probable hydrothermal alteration extending from the northern edge of the Tombstone district south to Lewis Springs--a distance of some 11 miles. The width of this alteration zone is approximately 4 miles, giving a total of some 42 square miles of hydrothermal alteration. If it is assumed that the Robbers Roost breccia pipe area, which is approximately 3,000 feet in diameter is the central part of this alteration zone, then the Tombstone Mining District is approximately the same distance from the breccia pipe center as is the Charleston area. Typical mineral zoning, characteristic of large porphyry copper deposits, would thus be the source of the Tombstone and Charleston lead-zinc-silver mineralization with porphyry copper occurrences to be expected in the Robbers Roost area. These relations are shown diagrammatically on Attachment 14 which is a transparent overlay for James Gilluly's map of the area (Att. 13). Possible mineral zones are shown as circular features with the center point being in the Robbers Roost breccia pipe area. The radii of the hypothetical zones are; the outward edge of the Tombstone district and the inner edge of the Tombstone basin, the outer edge of the State of Maine area, and the inner edge of the State of Maine area, and the Charleston mine. It is interesting to note that by using these radii, the Charleston circle falls on the point where copper staining was noticed west of the T.M.R. mill

(Section A-A', Att. 3), suggesting the possible peripheral zone of copper mineralization. Further, the State of Maine zone coincides almost exactly with the Charleston zone, while the Tombstone zone falls into the Lewis Springs area, outside of known mineralization. As was noted previously, there is a strong northeast-trending shear direction prevalent in the district as indicated by northeast-trending faults, veins, and topographic alignments. This northeast trend is one of the most typical features of porphyry copper alteration zones in the southeast Arizona area. In response to this fracture pattern it can be expected that proposed alteration zones may take an elliptical rather than circular pattern, being elongated in the northeast and southwest direction. As noted, alteration visible on the color air photos is elongate, in a northeast-southwest direction (Att. 14) corresponding to the above observation. It has also been noted in the Arizona porphyry copper province that in a predominant number of the productive districts, there is more than one center of mineralization, and are in some cases, numerous centers which contain economic mineralization. Examples of this would include the Silver Bell district, the Safford district, the Pima district, and the Globe-Miami district. It is conceivable then, that there may be other centers of porphyry copper type mineralization located along the alteration trend in addition to the exposures at Robbers Roost. The circular Tombstone basin area in fact could possibly represent a porphyry copper center with the copper zone being at great depth below the present horizon of erosion. Certainly circular features are also typical of porphyry copper deposits as exemplified by

Copper Creek and Copper basin near Prescott, Red Mountain at Patagonia, and the Safford district (verbal communication, Grover Heinrichs).

Geologic interpretation as related to mineral deposits within the Tombstone district is greatly complicated by the presence of almost horizontal geologic units. These would include: (1) Quaternary soil and alluvial cover; (2) the pre-mineral Uncle Sam porphyry sill forming a thin veneer (Section A-A', Att. 3) over Mesozoic and Paleozoic sediments; (3) Bronco volcanic units, which are sub-horizontal; (4) apparently almost horizontal thrust plane(s), which involve Paleozoic, Bisbee Group, and Bronco volcanic sedimentary units; and (5) Bisbee formation and Paleozoic limestone units of unknown orientation. Because of the greatly differing chemical composition and reactivity of these various units to ascending hydrothermal solutions, and uncertainties as to the presence or absence of these features in any one given spot, interpretation of surface exposures of alteration and mineralization--or lack of it--are made extremely difficult. For example, strongly altered vein systems in Uncle Sam porphyry could be indicative of great potential for substantial bodies of replacement type mineralization, if the Uncle Sam is underlain by reactive limestone units. On the other hand, should such reactive units be absent, the presence of hydrothermal veining may have no significance directly relating to economic mineralization lying below. The corollary of this might be; if areas of poorly altered Uncle Sam porphyry, which would seem to have essentially no potential for mineralization, were underlain by a thick sequence of reactive lime, presence of the lime--which tends to react vigorously with hydrothermal solutions--might be indicated by the very absence of hydrothermal effects in the Uncle Sam porphyry. It is obvious then that a very thorough understanding of the detailed geologic aspects of the district will be necessary before a meaningful porphyry copper drilling program can be laid out. The extensive amount of pyritic mineralization as indicated by the coloration on the color air photos suggests that induced polarization surveys, which merely show the presence or absence of pyritic mineralization, will be of little use in determining areas which have greater content of base and precious metals. However, because of the presence of Paleozoic and Mesozoic limy sediments throughout the district, there appears to be great potential for the occurrence of significant replacement ore bodies within these limy units. Since magnetite generally accompanies this type of mineralization, magnetic surveying might be a useful guide. It should be remembered, however, that magnetic response falls off as the inverse square of the distance from the magnetic source and thus, small bodies with ~~low~~ high magnetic susceptability if even moderately buried, show little or no magnetic response, even though they may carry significant ore grade mineralization. The most reliable guide to ore within the district will be an intimate knowledge of the geologic and alteration features of the district, both on the surface and related to the subsurface.

SURFACE GEOLOGY IN THE STATE OF MAINE AREA

GENERAL STATEMENT

The major part of the writer's time has been spent in detailed mapping within the State of Maine area in order to delineate geologic targets that would relate to production anticipated from the old State of Maine workings and processing of gob from the old stopes. Since potential was for relatively small, but rich bonanza type ore bodies, it was felt that a very detailed map would be required. The first order of business, then was to obtain an accurate topographic map at a scale of 1"=200' with 5-foot contour intervals. The base triangulation survey for this map was surveyed by Florian and Collins, Civil Engineers of Tucson, Arizona. Control was tied to the State survey, using the benchmark at the public library in Tombstone. Primary control points were surveyed using theodolites and a Hewlett-Packard distance measuring device. The survey is first order in nature and adheres to minimum Government specifications. In addition to the primary control points, all identifiable claim monuments and posts were targeted with white, 24-inch wide butcher paper, in the form of a "Y" with the monument in the center and legs extending outward 10 feet in length. In addition to claim monuments, fence corners, other property boundaries of interest, and some power poles were thus targeted. Although no accurate count was kept, probably at least 200 points were so identified. The area was then flown by Cooper Aerial Survey and photographed with black and white film using a Wild RC-10 mapping camera. The map was compiled using Kelsh plotters.

Each of the targeted claim monuments and other points of interest were surveyed on the Kelsh with their location and elevation being noted to the nearest 1/2 foot. Thus, in addition to the topographic lines, there are numerous permanent points of reference scattered throughout the map area. Patent corners of the patented claims were thus accurately located and claim lines were plotted on the map. Topographic features were scribed on mylar scribcoat and a screened mylar, right-reading base map sheet was then photographically reproduced from the scribcoat master. The scribcoat master remains on file at Cooper Aerial, and additional mylar copies can be made at any time.

Geologic features were plotted on this topographic base and black and white photos at the same scale were used as an assist to mapping. The technique of geologic outcrop mapping was employed. That is; only features that were actually seen in outcrop were plotted on the map. Little or no interpretive material has been added. Further, actual rock outcrops are shown in darker color (Att. 1) while talus-covered slopes on which bedrock was indicated by presence of only one type of rock detritus are indicated by lighter colors. For the most part, it was impossible to trace small vein or dike features through areas of detrital soil cover. To aid in exploration, numerous bulldozer roads and cuts were put in, an effort being made to anticipate future drill sites. More of the dozer cut work was laid out than has been completed as of this writing because of unanticipated breakdowns in the bulldozer equipment. As more dozer cuts and roads are made, it is probable that more vein exposures and hence a better knowledge of the area will be gained.

In addition to the surface geologic mapping, the black and white air photos were examined stereoscopically and linear features identified. These linear features are shown on Attachmant 1 as heavy dashed blue lines. They probably represent fault or shear zones of substantial magnitude, although their effect can rarely be seen on the ground.

SEDIMENTARY ROCKS

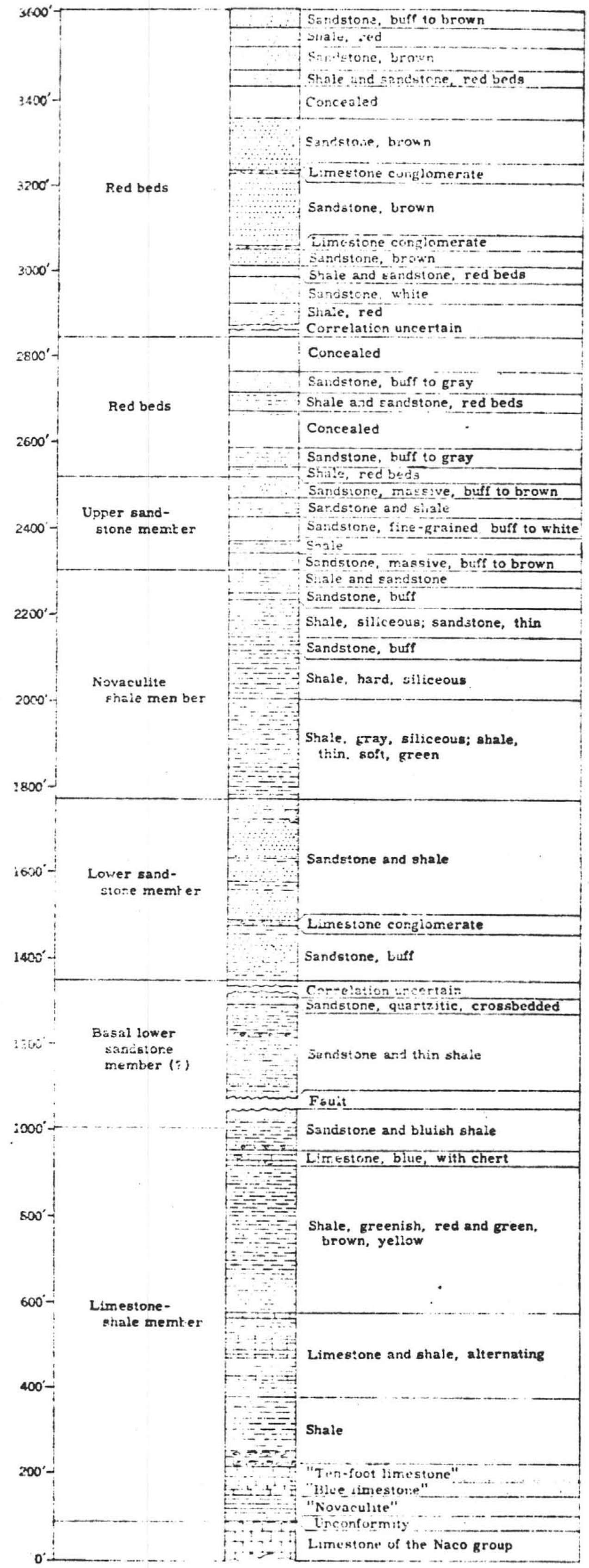
Quaternary Alluvium

Quaternary alluvium consisting, for the most part of stream wash, is located in valley bottoms. The thickest accumulations of Quaternary alluvium occurs in the north-trending drainage directly east of the Free Coinage claim where it is probably ten to a few tens of feet thick. In this area, it obscures the contact between Bisbee Group sediments and Uncle Sam porphyry. It is locally up to 15 or more feet thick in the Fox Ranch area as indicated by scraper cuts. However, in the remaining wash areas it is probably 5 feet or less in thickness. The contact of the alluvium with bedrock is generally arbitrary and marked with a dashed line. There was insufficient time to map in detail all of the small outcrops within the stream drainage areas marked Quaternary alluvium on the map. In the Fox Wash area in particular, there are numerous windows of bedrock sticking through alluvium, which are not shown on Attachment 1. As time is available, the Project Geologist should endeavor to detail the outcrops in this area as it may shed light on alteration and mineralization patterns. Since the stream drainages are obviously structurally controlled, they are probably also the loci of veins which may carry significant mineralization and for this reason they should not escape continued effort at detailed mapping. This is particularly true of the northeast-trending drainage directly below the State of Maine dump. In this area several caved shafts have penetrated alluvium and strongly altered Uncle Sam porphyry can be seen on their dumps. To test this drainage, I have suggested the drilling of several air-track holes (See Att. 1).

Bisbee Group Sediments

The great preponderance of sedimentary outcrops within the bounds of the State of Maine 200-scale map are nondescript Bisbee Group sediments--probably equivalent of the Morita and Cintura formations as described in the Bisbee area. The sediments can generally be characterized as red bed units consisting of sandstones, quartzites, and arkosic sandstones, shaley mudstones, and shales (Figs. 3&5). Over most of their exposures within the map area, these sediments are soil covered; rock type indicated only by detrital fragments. Because of this rapid weathering to soil, few exposures show sufficient bedding to determine strike and dip. Where seen, divergent attitude of bedding precludes meaningful comment regarding the detail structure of Bisbee Group sediments in this area (Att. 16). It is suggested by regional aspects, however, that the beds are generally tilted to the east so that by progressing in a westerly direction, the base of the unit is approached. This idea is reinforced by the presence of limestones cropping out north-northwest of the Free Coinage claim (about 1,600 feet north of the Uncle Sam shaft)

FIGURE 3



...URE 5.—Composite section of the Bisbee formation in the Tombstone mining ...trict. After Lyden, O'Donnell, Hernon, and Higdon (unpublished mine rept., ...).

The lowest and thickest is as much as 40 feet thick in places. These six beds of blue-gray and silty limestone contain abundant marine fossils. The formation contains at least two other beds of limestone 2 miles to the southwest; these contain fresh-water faunules. About 2 miles east of Dragoon Camp (Black Diamond), several thin beds of blue-gray shaly limestone occur in the Bisbee formation at a horizon that is many hundreds of feet stratigraphically higher (with respect to the local base of the formation) than these southern beds. The limestones near Dragoon Camp also contain a marine fauna, but so poorly preserved as to be of little service in correlation. The fauna is principally of interest because it shows the persistence, at least at times, of marine conditions during the deposition of the Bisbee formation as far north as Dragoon Camp.

Everywhere in the area the top of the Bisbee formation is an erosion surface, either ancient or recent. Accordingly, even if exposures were much better and structural complexities much less, it would be impossible to determine the original thickness of the formation. Under these conditions it is possible only to estimate the minimum thickness of the rocks. A careful study of the much-faulted and metamorphosed strata exposed in the mining district at Tombstone has been made by Messrs. J. P. Lyden, R. M. Hernon, Neil O'Donnell, and C. E. Higdon, who kindly supplied the following composite generalized section, synthesized from many partial sections measured in the Tombstone district.

Generalized composite section, Bisbee formation, Tombstone Hills.

	Feet
Erosion surface.	
1. Sandstone and shale, alternating; a few 10-foot limestone conglomerate beds; shale members chiefly red or maroon; sandstone beds buff to brown, a few gray or white; sandstone members range from 20 to 170 feet in thickness, predominate over the shale	1, 040±
2. Sandstone, buff, gray, and white, some interbedded gray-green hard shale; thick bedded	220
3. Shale, gray to green, hard and siliceous, a few thin buff sandstone beds	540
4. Sandstone, buff, white, and brown, a few green shale beds, at least one thin bed of limestone	422±
5. Shale, green and bluish, some conglomerate	58
6. Limestone, massive, blue, cherty	25
7. Shale, green, mottled red and green, brown, and yellow	345
8. Limestone	10
9. Shale, some sandy beds	29
10. Shale and limestone, alternating in thin beds	15
11. Shale, greenish, some limy beds	30
12. Limestone	5
13. Shale, poorly exposed	53
14. Limestone	4
15. Shale, gray, green, and black	43
16. Sandstone, yellow	9
17. Shale, red and brown	65
18. Shale, black	14
19. Shale, green and gray, siliceous	42
20. Limestone, "Ten-foot bed" of miners	10
21. Shale, with arkose at base	24
22. Limestone, "Blue limestone" of miners	34
23. "Novaculite," silicified shale, local intercalations of limestone conglomerate	60
Total	3, 097±

The above section cannot be considered accurate because it represents the synthesis of at least four partial sections, the correlations between which are all dubious. Nevertheless, as it was based on very detailed and careful work, there can be little doubt that it is as fair a representation of the stratigraphy of the formation at Tombstone as it is possible to give with the present exposures. It is shown graphically in figure 5. The formation elsewhere in the area is lithologically much the same.

No effort was made to measure a section of the Bisbee formation in the Dragoon Mountains; but from the dips and width of outcrop, it can be seen that there is about 15,000 feet of Bisbee rocks in the section northeast of Walnut Springs, where neither base nor top is exposed. This thickness, though large, is not surprising, as the aggregate thickness of the Bisbee group in the Mule Mountains was measured by Ransome (1904, p. 56) as 4,750 feet, with the top eroded. In the Little Hatchet Mountains, N. Mex., 80 miles to the east, Lasky (1938, p. 524–540) has found a section of Comanche rocks over 17,000 feet thick, of which fully 15,000 feet are of late Trinity (Glen Rose) age. The thinning of the Mural limestone northward from the Bisbee area does not, of course, imply the northward thinning of the clastic rocks above and beneath it. At any rate, whatever the a priori probabilities, the consistent attitudes and gradual changes in strike and dip of the section exposed northeast of Walnut Springs strongly oppose the idea that this section has been greatly repeated by faulting, despite the structural complexities of the mountains to the west.

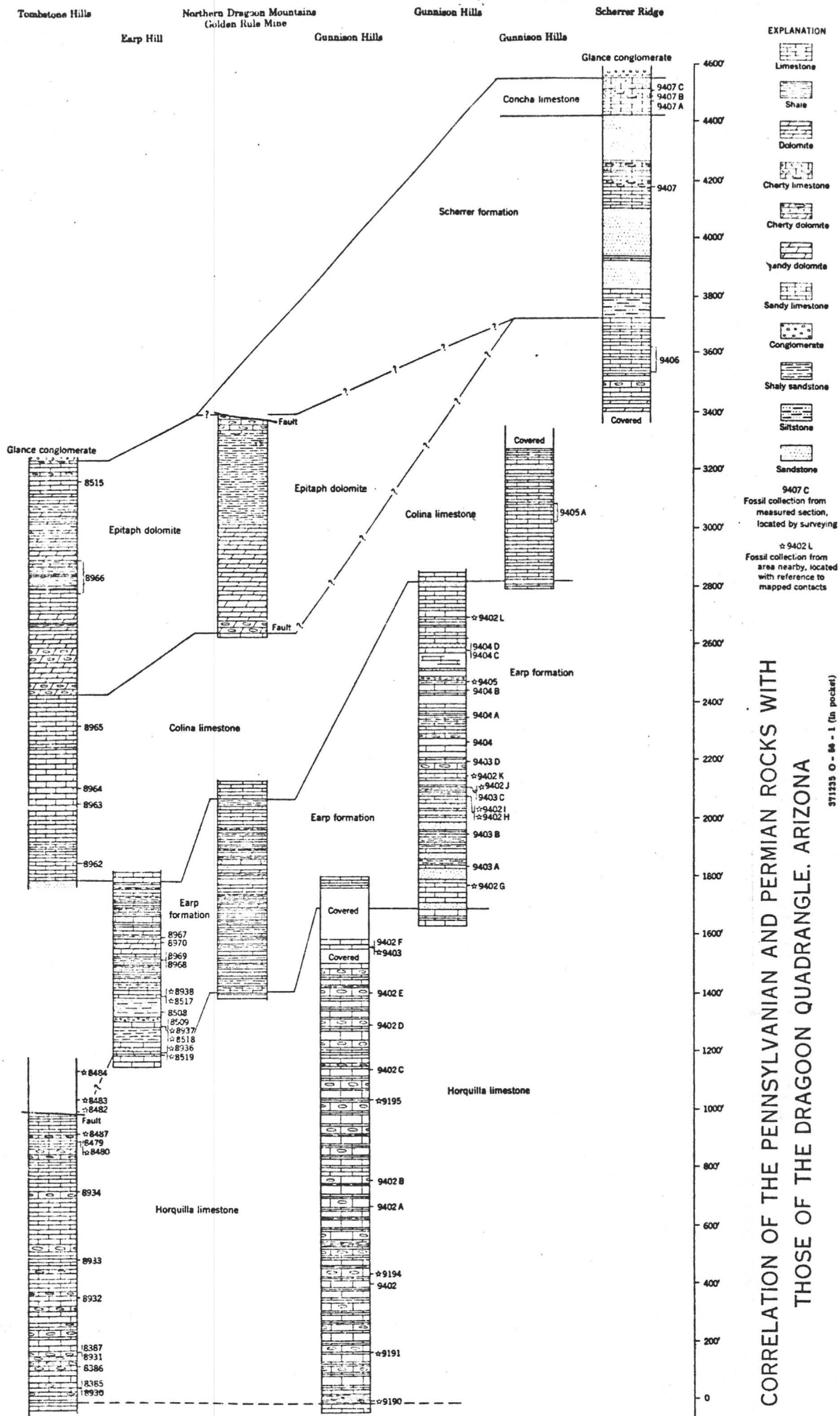
CONDITIONS OF DEPOSITION

The Bisbee formation contains a few beds of definitely marine origin, at least as far north as the foothills east of Black Diamond Peak. On the other hand, fresh-water fossils have been found in the formation between Charleston and the Tombstone Hills. The fossils are confined to a few thin beds, and the great bulk of the rocks are unfossiliferous.

The sandstone beds are commonly current-bedded, with scour on their bases, ripple marks, and considerable grit or even fine conglomerate, and thus give evidence of shallow water at the time of their deposition. The mudstones are generally red, brown, maroon, or and also exposed in the window in the Fox Ranch area (Att. 1). These limestone units are probably corelative of either the Ten Foot or the Blue limestone (Fig. 5). Further evidence of this is suggested by the presence of a quartzite pebble conglomerate, exposed in the Fox Ranch window. This conglomerate is probably the Glance conglomerate. In most of the Tombstone area the Glance is not present; however, as shown in Figure 4 and Figure 5, Gilluly and other workers in the district do show the Glance to be present, at least locally. In a small outcrop 2,000 feet north-northwest of the Uncle Sam shaft (at the site of P-17) there is exposed bleached quartzite breccia, which may be the equivalent of the Novaculite. Similar limestones appear to be absent in the Solstice Hill area and thus, although not conclusive because of small outcrops and structural complexities, it is presumed that the limestones exposed north of the Uncle Sam shaft and in the Fox Creek window are basal Bisbee formation --a critical point since this implies that Paleozoic Naco limestone should be present within a short distance, either horizontally or vertically (see Sections A through I, Atts. 3-11).

Paleozoic Sediments

No Paleozoic sediments have been mapped within the State of Maine area 200 scale map, Attachment 1. Geologic relations indicating that lower Bisbee sediments are exposed in the central part of the mapped area (as discussed above) suggest that Paleozoic sediments should be located shallowly beneath the lower Bisbee in the Fox Ranch area. Further, it is possible that Paleozoic limes may surface beneath the Uncle Sam sill as shown in Sections B through I (Atts. 4-11).



Based on section measurements by J. R. Cooper and J. Gilluly; paleontologic work by J. S. Williams

CORRELATION OF THE PENNSYLVANIAN AND PERMIAN ROCKS WITH THOSE OF THE DRAGOON QUADRANGLE, ARIZONA

371235 O - 56 - 1 (In pocket)

IGNEOUS ROCKS

Schieffelin Granodiorite

The Schieffelin granodiorite is a holocrystalline rock. In hand specimen it is light greenish-gray or pinkish-gray and mildly porphyritic (Gilluly, p. 103), weathering to a buff color. Petrographically, it is intermediate between quartz monzonite and granodiorite and could easily be called a quartz monzonite (Gilluly, p. 102). No outcrops of this rock were mapped within the State of Maine area, although outcrops could occur in the poorly covered area to the north and northwest of the Free Coinage claim. A complete petrographic description is given in Gilluly, p. 103.

Rhyolite Dikes

Several discontinuous rhyolite porphyry dikes crop out in the central part of the mapped area and can be traced from the area of the Gold Bug prospect to the north end of the Clipper claim. The dikes generally have a steep northwesterly dip, although in the Brother Jonathan area one dip of 42° is recorded. Flow structure generally parallels the walls of the dikes. However, a large dike on the Clipper claim shows turbulent flow structure. The dike outcrops are generally limonite-stained from disseminated pyrite content and are occasionally cut by vein structures. The spatial relationship of the rhyolite porphyry dike swarm to the productive part of the State of Maine vein suggests some subtle relationship to mineralization. What this is, however, is not clear and numerous assays of dike material show only background amounts of base and precious metals.

Andesite Porphyry Dikes

Andesite porphyry dikes were mapped on the State of Maine map in only one area which is slightly south and west of the Gold Bug prospect. Dikes of the same type, however, were observed south of the southwest endline of the Chance claim. Lack of time, however, precluded detailed mapping in this area. Similar dikes are very prevalent in the Robbers Roost breccia pipe area. The dike rock consists of a dark-green chloritic looking matrix, in which are set white feldspar phenocrysts. The dikes are pre-mineral in age and also predate the rhyolite porphyry. In the one andesite dike mapped southwest of the Gold Bug area, rhyolite porphyry invades both the hanging wall and foot wall of the dike and is younger in age as indicated by spherical xenoliths of andesite porphyry in the rhyolite.

Uncle Sam Quartz Latite Porphyry

Uncle Sam quartz latite porphyry comprises the largest area of outcrop within the State of Maine area. The high peaks of Three Brothers Hill, the Dome, Maine Hill, and Uncle Sam Hill are all composed of the Uncle Sam porphyry.

The porphyry has an aphanetic ground mass with phenocrysts of quartz and plagioclase feldspar. Xenoliths of Bisbee Group sediments are prevalent throughout its exposures and where it is in contact with the underlying Cretaceous Bisbee Group, the xenolith content increases and the rock appears to almost grade into the sediments. The tops of the higher hills appear to be composed of a more resistant unit of the Uncle Sam. It is unclear whether this is a primary rock feature or a secondary

1985- Because its an ash fall tuff ignimbrite JAB alteration feature. Preliminary examination of color air photos covering the area shows light coloration, possibly due to a horizontal alteration front, occurring at an approximate equi-elevation line in the Uncle Sam. The suggestion is that the hard capping facies of the Uncle Sam atop the prominent ridges is then due to alteration rather than a primary rock feature.

4/17/85 more welding & less friable xenoliths & less alt. AB

The Uncle Sam shows sill-like relations in most of the State of Maine area (Atts. 4-11). However, its contacts with the Bisbee Group, approximately 600 feet northeast of the northeast sideline of the Merrimac claim, appears to be vertical as indicated by its lack of deviation across steep contours in the area. At the northern exposure of the State of Maine vein, 1,100 feet north of the Uncle Sam shaft, the exposure appears to be flat and sill-like, again indicated by topography while a couple of hundred feet north, it again appears to dip steeply. It is concluded that while in gross aspect, most of the Uncle Sam exposure in the State of Maine area shows sill-like relations; in all probability there are areas which are feeder dikes and as such, have continuity in depth.

STRUCTURAL FEATURES OF THE STATE OF MAINE AREA

General Statement

Structural features within the State of Maine area can be broken down into two broad categories--steeply dipping features and horizontal and sub-horizontal features. Steeply dipping features which can be easily traced and mapped on the surface would include veins, vein zones, dikes, post mineral faults and photo-linears. Horizontal and sub-horizontal features would include thrust fault planes, bedding and fault planes with an angle of dip of less than 20 degrees and the basal contact of the Uncle Sam porphyry. These features are either poorly exposed or not exposed at the surface, and can only be inferred from detailed surface geologic mapping. Only the steeply dipping features will be discussed in this section, while the low angle features will be discussed under the heading Sub-Surface Geology, State of Maine Area.

Vein Zones

The strongest direction of structural shearing within the Tombstone Mining District is north approximately 55 degrees east. This is the typical northeast fracturing direction which is invariably seen in the Arizona porphyry copper deposits. The shearing is represented by topographic alignments of ridges and stream drainages, by rhyolite dikes, and andesite dikes, and by the vein system which is responsible for most of the mineralization within the district. In the Tombstone Basin, northeast of the north-trending Ajax fault, these northeast trending fractures dip to the southeast, while in the State of Maine area, west of the Ajax fault, most of the veins dip to the northwest. The exception to this observation is the Fox vein which dips southeasterly at about 50 degrees. Right lateral movement along the northeast trending veins is suggested by antithetic faults occurring along the shallowly dipping State of Maine structure and the Clipper vein zone (Att. 1). The strongest antithetic structure is the Triple X vein which appears to be continuous between the State of Maine vein and the Clipper vein zone. Apparent antithetic structures along the San Pedro vein also suggest right lateral movement.

One fracture zone within the State of Maine area trends almost north-south with a vertical dip. This is the San Pedro vein just north of the Fox Ranch. The vein appears to bend to the northeast where it intersects the Fox vein and continues in a northeasterly-trending arc through the San Pedro workings, and is lost in the alluvium to the East.

Dikes

Two types of dike rock crop out within the State of Maine area. The most predominant type being rhyolite with only a few exposures of subordinate andesite being seen. The dikes are probably related closely in time and are both pre-mineral. The andesite predates the rhyolite as is indicated southwest of the Gold Bug area where a composite rhyolite-andesite dike shows spherical xenoliths of andesite in rhyolite. Discontinuous and irregular outcrop patterns of the rhyolite suggest intrusion into tension fractures.

Post-Mineral Faults and Photolinears and Topographic Alignments

Surface evidence of significant post-mineral faulting has only been seen in a few areas. A possible fault was noted in the southwest corner of the May claim, apparently being responsible for a bold ridge of Uncle Sam porphyry a few hundred feet long. One small probable left lateral fault was noted a few feet southwest of the Triple X shaft. This fault apparently offsets a rhyolite dike. A few small strike-slip faults were noted in the window in the Fox Ranch area, offsetting limestone beds in the Bisbee sediments. The most significant fault could not be identified in the field, yet is indicated by its left lateral offset of the composite andesite-rhyolite dike southwest of the Gold Bug prospect. This liner appears to correspond with a poorly defined structure visible on aerial photographs. The structure can be traced on the color air photos approximately 4000' to the south, but apparently terminates against another photolinear northwest of the Gold Bug area (Att. 1).

Topographic alignments, which have not been specifically delineated on Attachment 1 except in the case of the Fox Wash zone, probably also represent structural features. The washes probably represent vein zones along which there may have been post mineral movement; at any rate they are the least resistant areas of rock exposure, and alteration generally appears stronger along their trend. Preliminary examination of the color air photos shows red coloration localized along the drainages while absence of this coloration on the ridge tops suggests fresh resistant rock.

Examination of the 1"=200" enlargements of the black and white photographs reveals linears which are shown on Attachment 1 as heavy dashed blue lines. The linears are for the most part topographic, vegetation or small drainage alignments, and cannot generally be seen from the ground. They appear to be post mineral and one of the most prominent, a north-trending feature traceable for in excess of a mile north of Fox Wash, appears to make a right lateral offset in the Fox Wash vein zone. The photo-linear which trends east-west and cuts through the top of the State of Maine hill (Att. 1) projects through the State of Maine shaft and essentially parallels the State of Maine wash which is alluvial covered. Dump rock on old caved prospect shafts along this wash show fragments of strongly altered Uncle Sam porphyry. The intersection of the structure with the State of Maine shaft suggests that it may be pre-mineral and may have had some influence on mineralization. For the most part, however, it still appears most of these features are post-mineral and may be quite recent. Except in the case of the fracture which offsets the Gold Bug area dike, there is no way at present to measure their dynamic effect on the rocks in the area. It may be, however, that these features bound structural blocks which have been displaced in a vertical sense, either up or down in relation to each other. For this reason, they may have an important bearing on the spatial positions of ore bodies within the area and thus their correct interpretation may be of economic significance. Knowledge of their location may be critical in correct interpretation of drill-hole data.

MINERALIZATION

Hydrothermal solutions associated with vein mineralization in the area appear to be mesothermal in nature. Alteration along the veins in the Uncle Sam porphyry consists of emplacement of pyrite, minor galena, possibly some sphalerite and primary manganese minerals. Wall rock has been silicified to varying degrees and alteration to clay and sericite has taken place in the reactive feldspars. Where alteration and vein intensity is greatest, sericite is dominant, while in poorly altered vein areas, argillization is the primary effect. Pyrite is represented at the surface by jarosite and red and yellow limonites. In the most strongly altered veins, maroon, red "relief" or "live limonite" is present on fractures. In the most poorly altered areas, occasional suggestions of pseudomorphs of pyrite are seen. All of the dumps in the area, with the exception of the San Pedro dump show only oxidized material. Examination of the sulfide bearing fragments on the San Pedro dump show them to be intensely bleached and altered Uncle Sam porphyry with finely disseminated white pyrite along siliceous fractures and disseminated through the rock. Accessory gangue minerals in the veins consist of silica and some manganese. Barite is seen only in the Gold Bug area. Manganese appears to be more prevalent in the San Pedro area with lower amounts being seen in the Gold Bug, Lowell, and State of Maine areas. No primary manganese minerals have been identified in the State of Maine area to the knowledge of the writer.

The only silver mineral which has been identified within the area is bromyrite ($AgBr$). It is a pistachio green, waxy mineral which occurs in the oxide zone on fracture planes and is termed horn silver by the local miners. It is essentially the equivalent of cerargyrite ($AgCl$) and can only be differentiated by chemical analysis. The probable source of the silver is argentiferous galena. Numerous assays show a strong geochemical presence of lead ranging up to multiple thousands of parts per million. The lead is probably present as cerussite, or anglesite, but no specimens of these minerals have been identified as yet. Silver is probably also tied up as argentojarosite or plumbojarosite and in the manganese oxide minerals.

In spite of very careful observation of the rock in several hundred assay samples, there appears to be no way of judging silver content by eyeballing the rock, unless horn silver is present, in which case high assays can be anticipated. Traces of copper oxide were seen in the San Pedro area and also the dump of the Brother Jonathon shaft, but no copper sulfides have been noted.

Mineralization in the sediments consists of silicification and disseminated limonite after pyrite. There also appears to be a greater manganese content than in the Uncle Sam porphyry. Alteration is less noticeable, possibly because argillic and sericitic alteration of the Uncle Sam porphyry yields white bleached zones which have been subsequently stained red and orange by limonite while in the sediments alteration has been confined to silicification and a rather minor amount of limonite staining.

The veins in the State of Maine area can best be described as vein zones rather than discreet sharp-sided vein features consisting of emplaced hydrothermal minerals. Put another way, they are actually narrow alteration zones with numerous discreet fractures, all sub-parallel, along which mesothermal solutions have traversed, altering the rock present, and depositing base and precious metal sulphides, silica, and in some areas manganese and barite. Subsequent weathering has resulted in oxidation of the sulphides and deposition of various limonites and oxide minerals.

The most significant feature of the veins in the State of Maine area is their width. The State of Maine vein itself appears to be only about 15 feet wide, however, the Gold Bug vein zone is silicified and strongly altered over width of about one hundred feet and shows moderate to strong alteration over a width of approximately 300'. The Fox Wash vein zone is approximately 100' wide and sub-parallel fracture zones associated with the Fox Wash vein zone appear to be up to 300' in maximum dimension. The north-trending San Pedro vein in the area of the Fox Ranch windmill is intensely altered over a width of 30' and shows moderate to strong alteration over a width of approximately 20 to 30 feet. A parallel structure which is intensely silicified but has not been mined, shows a width of 10 to 25 feet. A zone southeast from the San Pedro shaft (in the area of Hole P-12) shows disseminated sub-parallel fracture zones over a width of approximately 400 feet. This zone apparently continues across alluvial cover to intersect the north-trending San Pedro vein in the area of hole P-9.

In the Three Brothers shaft area (the vicinity of hole P-10) altered rock containing sub-parallel fractures is approximately 300' wide. Throughout the general area of the True Blue claim, Three Brothers shaft, San Pedro and Fox veins, the Uncle Sam porphyry shows sub-parallel and intersecting veining, the rock being pervasively altered over an area approximately 400 to 700 feet in width and about 1500' in length. In the area of the Lowell claim, a vein zone which may be the extension of the State of Maine vein, alters rock over a width of up to 200', and a length of three or more hundred feet. The Clipper Free Coinage claims are located on what the writer has termed the Clipper Zone. This zone consists of sub-parallel fractures showing weak- to strong-hydrothermal alteration over a width of from 20 feet to about two hundred feet and a length of at least 3500 feet.

The width and intensity of mineralization of these veins suggest greater volume and intensity of mineralization than that present in the Tombstone Basin area. Further, when it is considered that these vein structures are underlain by reactive limestone units, which would have the effect of diluting any ascending hydrothermal solutions, their apparent potential is further emphasized. Since they appear to be closer to the source (the Robbers Roost porphyry copper center) it would be reasonable to assume a greater intensity of mineralization than that present in the Tombstone Basin. The best targets for ore bodies, of course, would occur where the hydrothermal vein zones intersect the chemically and structurally reactive host rocks -- the tightly folded lower Bisbee and upper Paleozoic sediments.

SUBSURFACE GEOLOGY STATE OF MAINE AREA

GENERAL STATEMENT

As mentioned previously under general geology of the district, low angle structures caused by two episodes of thrust faulting are responsible for some of the complexities of the sub-surface geology within the Tombstone mining district. The Uncle Sam porphyry which comprises the major portion of the outcrops in the western part of Tombstone Mining District is actually a very thin remnent of a sill which has probably been intruded along the plane of a pre-existing thrust fault. This fact is verified by several windows of sediments peeking from beneath the sill and also the intersection of Bisbee Group sediments in the bottom of the State of Maine shaft. The low angle of this structure is also attested to by its semi-circular outcrop on its eastern edge caused by topographic effects. Recent color aerial photography reveals a probable fault of normal displacement paralleling the San Pedro River which is not shown in any pre-existing geologic map. This fault or faults are most probably downthrown on the west side, tending to give the impression of greater thickness of the Uncle Sam porphyry than is the probable case. One outcrop of Permian Colina limestone on the northwest edge of May's Hill (on the up-side of the fault) indicates the relative thinness of the Uncle Sam. Were it not for the normal faults occurring to the west of this outcrop, Bisbee Group sediments and Paleozoic limes might also be exposed along the western margin of the Uncle Sam porphyry to the west of Uncle Sam Hill. Examination of cross section A-A' which is drawn at 1"=1000' (Att. 3) shows the true thickness of the Uncle Sam as related to its surface contacts and elevations of windows which the writer has located and mapped. To further complicate the vertical picture, the pre-Uncle Sam, pre-thrust Bronco volcanic series also forms a thin veneer over Bisbee Group sediments which in turn overly, at apparent low angles, Paleozoic sediments. All of the planar formations which predate the Uncle Sam porphyry (including the Bronco volcanics, the Bisbee Group and Paleozoic sediments) have been involved in thrust faulting. How many layers of thrust sheets are present is not known. Thus, good ore horizons which would include basal Paleozoics and basal Bisbee Group sediments, could lie either near the surface or at great depth depending on their involvement with thrust and other faults. The only method of determining what the true layer cake nature of the district is would be additional detailed geologic mapping at a scale of 2000 or possibly 1000 feet per inch followed up by exploratory drilling.

THICKNESS OF THE UNCLE SAM QUARTZ LATITE PORPHYRY

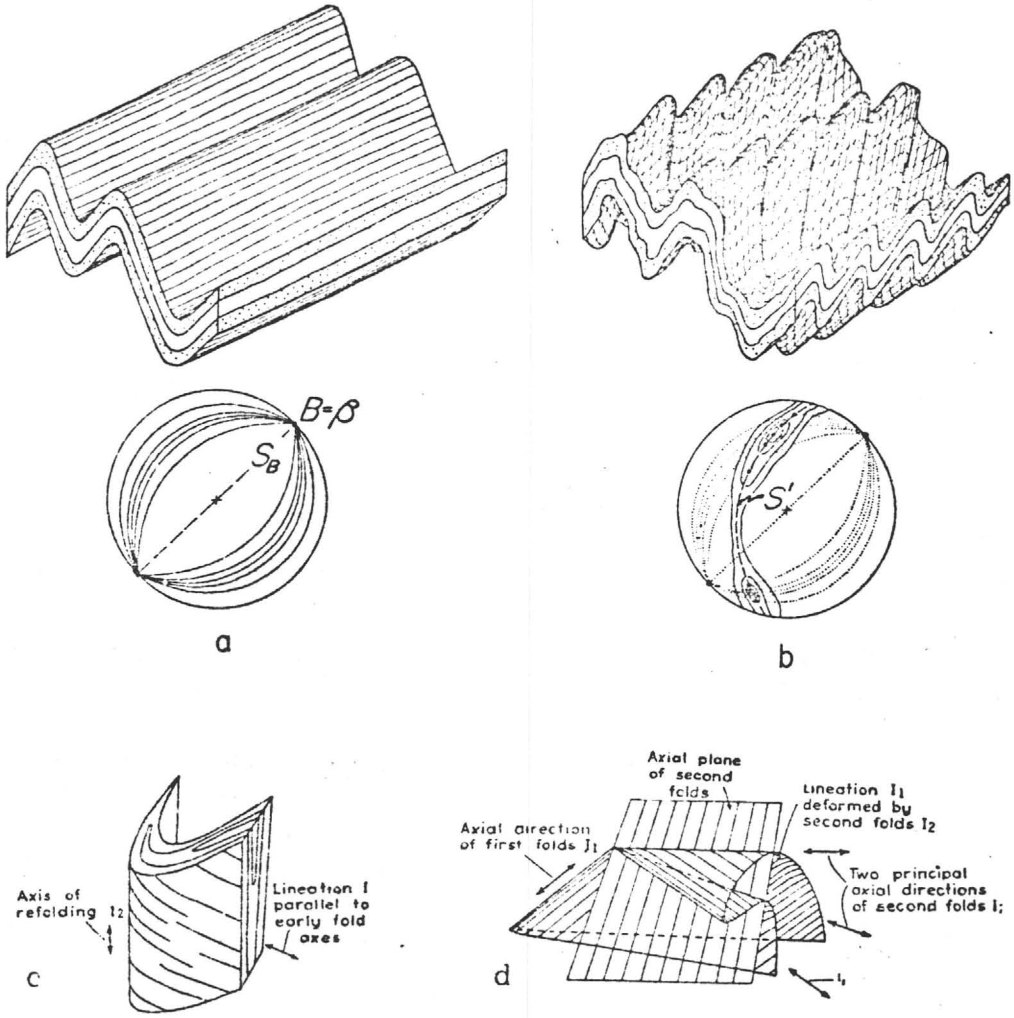
In order to determine what the sub-surface beneath the Uncle Sam porphyry in the State of Maine area was like, eight structural cross sections--Sections B through I (Atts. 4-11) were constructed from the surface geologic map (Att. 1). On these sections, the vertical scale is equal to the horizontal scale so that no graphic distortion is involved. All surface contacts and strike and dip information were used on these maps. On each cross section, apparent angles of dip were plotted from tables dependent on their angle of intersection with the plane of the section. Thus, features such as surface contacts, angles of strike and dip, locations of proposed drill holes, geographic features and projections of planar features such as dikes and veins can be considered real and accurate. Curving features such as bedding, folds, etc. were drawn in using general background knowledge of the district. They must be considered only typical of what could be found in the sub-surface but it should be understood that sub-surface data are at this point too scanty to allow the accurate projection of such complex features as folded sediments and true contacts of curving features. The approximate thickness of the Uncle Sam porphyry in various places is plotted from its surface contacts and the intersection of the State of Maine shaft with the Bisbee Group sediments. Additional data used in plotting the possible location of the bottom contact of the Uncle Sam include: verbal report of intersection of sediments in the bottom of the Escapule drillhole southeast of the Fox Ranch windmill (reported to have cut sediments at approximately 90 feet), exposures of sediments in windows in the Uncle Sam sill to the west of Sections D, C, and B, and to the south of F, G, and H.

Using these data, it is apparent that the thickness of the Uncle Sam ranges from several hundred feet from the tops of the highest hills to a few tens of feet in the bottoms of the washes. The thin areas would be exemplified by the San Pedro Mine area where the porphyry appears to be 300 feet or less in thickness (Section F-F'). It should be remembered, however, that since the Uncle Sam is an intrusive rock, it could very easily have an undulating contact with the underlying sediments. Thus, the geologic projections from surface outcrops can only generalize its true angle of contact and it may thicken and thin in a complex fashion. Another factor may be important in determining the true thickness of the Uncle Sam from spot to spot are the photo linears indicated by heavy blue dashed lines on Attachment 1. As mentioned previously, they may define fault blocks which have been randomly jumbled up and down so that one block may have been downdropped considerably, giving an apparent increase in thickness to the Uncle Sam, while an adjacent block may have been relatively upthrown, thus giving a thin aspect to the sill. There are, however, enough exposures of sediments in the various windows to suggest that the thicknesses of the sill displayed on Sections B through I are probably fairly accurate.

STRUCTURE OF SEDIMENTARY ROCKS BENEATH THE UNCLE SAM SILL

The Bisbee Group sediments are rather massive nondescript sandstones, siltstones, and mudstones over most of their exposure with the State of Maine area. However, north and east of the Free Coinage claim, and in the Fox Ranch area, marker horizons which show structure are exposed. These marker horizons are limestone beds which may be the equivalent of either the Blue limestone occurring near the base of the Bisbee, or the so-called Ten-Foot limestone occurring slightly above the Blue limestone. Mapping of the sediments exposed in the window on the north end of the State of Maine vein show they are warped into a tight anticline plunging to the East. The type of fold and direction of plunge appears to be the equivalent of folds within the Tombstone Basin. It is preliminarily concluded that they were due to the same tectonic forces. In the Fox Ranch window there are exposed two limestone beds and one bed of conglomerate. It is assumed the conglomerate is the Glance conglomerate, and thus the limestones appear to be overturned. Section G-G' shows this bedding sequence to represent a recumbent fold. Several other fold structures might be proposed to explain the geometry of the exposed features. However, until more data are acquired by drilling, the recumbent fold seems to fit the general geologic environment as well as any. Remembering that at least two events of folding and thrust faulting occurred in this area, it is quite probable that folds developed during the first episode were again folded during the second episode, thus creating extremely complex fold surfaces (Figs. 6 through 9).

It was assumed in drafting the cross sections that the folds were generally trending northwest-southeast as they are in the Tombstone Basin and would be similar to that known within the Tombstone Basin. Considerable artistic license was used in diagrammatically showing what the subsurface sediments might be like and no attempt was made for each cross section to adhere exactly to what had been portrayed in the other cross sections as far as the folded sediments are concerned. Instead, an attempt was made to illustrate various possibilities. It should, however, be noted that on Sections B, C, and D rather open structures were portrayed which would be the case if the sections were indeed drawn obliquely through northwest-southeast-trending folds. Thus, the projections of the veins, dikes, and Uncle Sam contact is probably accurate as it exists. However, the locus of intersection of veins with potentially reactive sediments is only generalized, and is not presented as



Figs. 16a and 16b.—Superposed cylindroidal folding with oblique axes, as drawn by Weiss, showing stereographic projections of the bedding and fold axes (from Weiss, 1959, Fig. 5). 16c and 16d.—Superposed deformation of early lineated folds (from Ramsay, 1960, Figs. 1 and 2). Axes and directrices are oblique.

B, C, the sections parallel to the respective fold systems are shown in his Plate IVA and traces on oblique surfaces are shown in his Plate V. Oblique intersection of superposed folds is shown in his Plate IC, IIB, C and IIIA,C and Text-figs. 1, 4, 5 and 6, which show that the resulting domes and basins have sigmoid fold axes which have right or left echelon according to the relative angles of shear of the two interfering fold limbs. It is commonly assumed that such echelon sigmoid anticlines indicate wrenching transcurrent movements. However O'Driscoll emphasizes that nothing but vertical transport is involved in producing these sigmoid echelon patterns. Offset occurs whenever the interfering fold axes are parallel or have a common component of movement (i.e. they are not orthogonal). These offsets cause the sigmoid patterns (offset in opposite senses on either side of the composite crest) and may cause migration of crests or culminations below an unconformity (see O'Driscoll, Text-fig. 9).

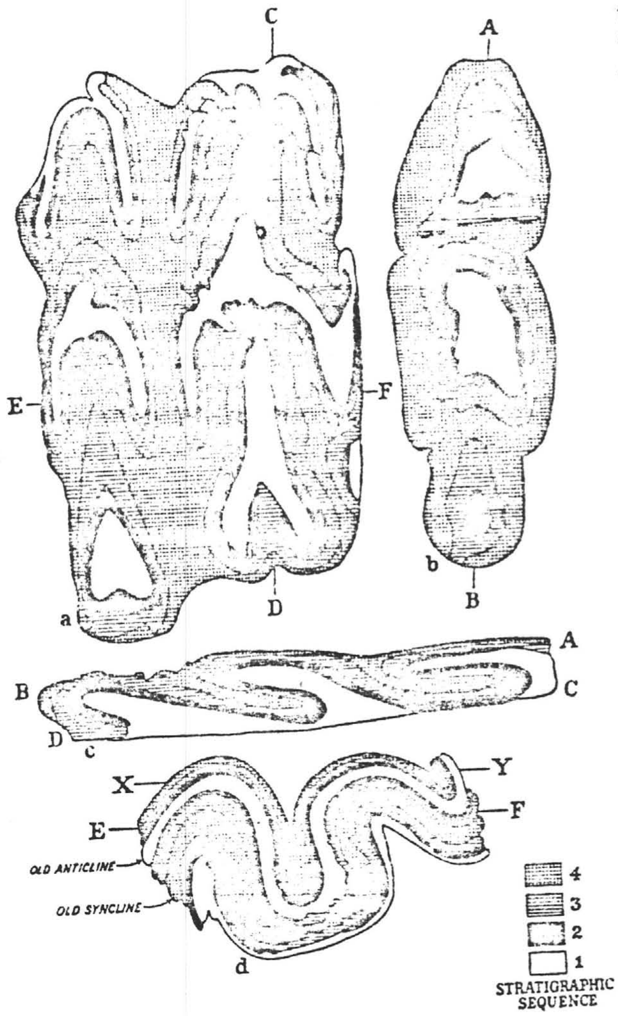


Fig. 17.—Superposition of similar folds with orthogonal strikes and divergent directrices (from Reynolds and Holmes, 1954, Text-fig. 13). EF is the axial direction of the first folding and CD (or AB) that of the second. (a) Surface outcrops after slicing. (b) Surface outcrops on the right-hand side only, as seen at a higher level than that of (a). (c) Section of the model, before slicing off its top, cut along CD of (a) and AB of (b). AB and CD represent the levels at which (b) and (a) were respectively sliced. (d) Section of the model, before slicing off its top, cut along EF of (a). XY and EF represent the levels at which (b) and (a) were respectively sliced.

Weiss (1959) has studied the same kind of cases as O'Driscoll by statistical analysis of S-planes (see Fig. 16).

Reynolds and Holmes (1954) have investigated by field mapping and petrofabric analysis, confirmed with plasticene models, a case of overprinted folding where the strikes are orthogonal but the directrices are oblique. They have shown that under these conditions the traces on a horizontal surface (corresponding to Figs. 19 and 20 of O'Driscoll) develop trident-, heart-, stirrup- and anchor-shaped outcrops (Fig. 17).

When the orthogonal axes of Reynolds and Holmes are made oblique, with the fold directrices also divergent, the same patterns are produced in a skewed form, as shown in Fig. 18. The obliquity also results in sigmoidal axial traces for the same reasons as in O'Driscoll's common directrix case.

In the left hand column of Fig. 18 the fold axes are at right angles to each other. In the right hand column they intersect at 30°. In Fig. 18a both folds are symmetrical but one has twice the wave length of the other. In Fig. 18b the first is overturned. In 18c the first folds are overturned but crestlines are at different heights, although the axial lines for all folds are horizontal and wave lengths are equal. Fig. 18d shows conditions identical to

FIGURE 8

direction of domal migration from f to f′ depends on the attitude of the inclined surface DEF with respect to the horizontal surface ABC. Where the strike of surface DEF is parallel to BC, EF becomes horizontal and the dome f′ moves in the direction of BA; where the strike of DEF is parallel to BA, DE becomes horizontal and f′ moves in the direction of BC.

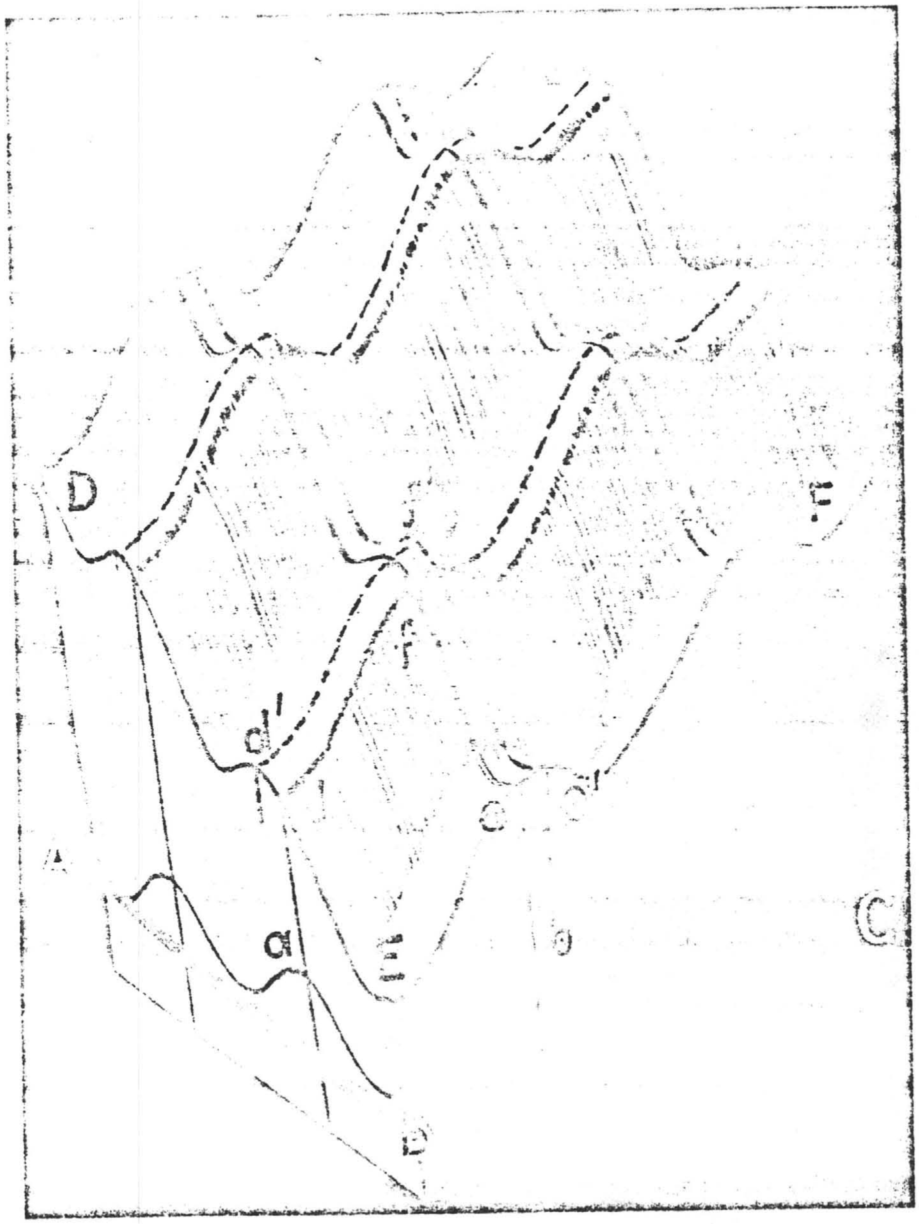


Fig. 9.—The shape of a horizontal fold interference surface (AaBbC), transmitted vertically to an inclined surface, (DdEeF), results in the lateral migration of corresponding domal crests.

Fig. 8 shows a specimen of the type of card used in the models to be described. As used, the cards are unmarked except for the succession of similar fold profiles printed upon them. For the purpose of this description, notations have been added ot the specimen card in Fig. 8. The similar fold profiles represent the "first" fold system, with vertical axial planes parallel to A-A and S-S, which mark the anticlines and synclines of the accentuated stratum on the card. The lines P-P mark the loci of maximum shear on the limbs of the folds. In the figure they have equidistant spacing. The line M-M represents the slopes of a larger structure on which the smaller fold profiles have been imposed. It may be regarded as a "regional" gradient or differential. For reasons already described the axes A-A and S-S are therefore not equidistantly spaced. Although terminology in these matters is not confirmed, the writer has rather loosely employed the prefixes "micro-" and "mega-" to denote scales relative to the basic elements. In this way the line M-M has been regarded as the slope of a "mega-structure" on which the basic profile is imposed. The profiles in Fig. 8 have been described as anticlines on a "meganticline" (or domes on a "mega-dome") and the line M-M has accordingly been described as defining the "mega-slope."

Plate IV (A) shows a printed card model in which the continuous interference surface of domes and basins is seen intact in the upper foreground. On the vertical plane X of the cards may be seen the printed profile of the first fold system. On the vertical plane Y is the profile representing the second fold system. Where the cut edge of a card intersects a printed fold trace, a dark spot shows on the edge, and when a stack of cards is guillotined or

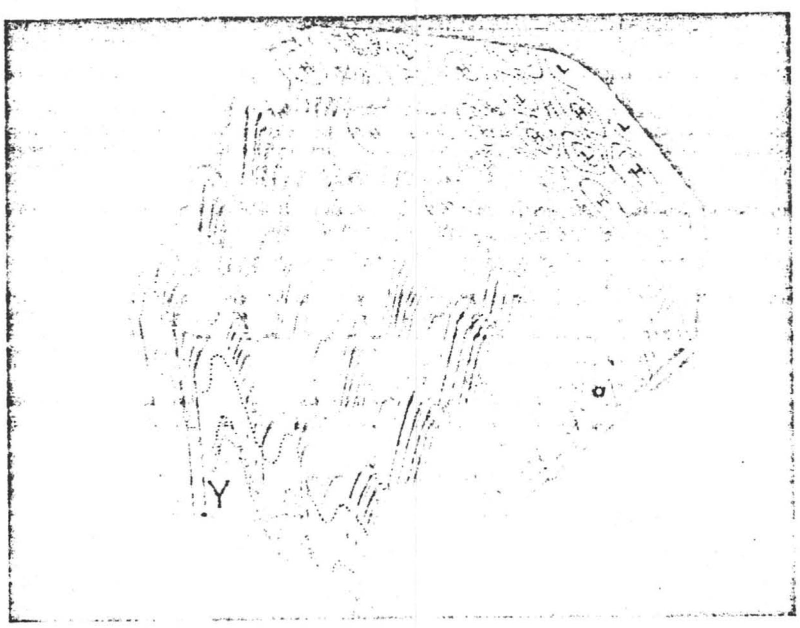


Plate IV (A).—Printed card model showing interference surface intact in foreground, and truncated in background to expose traces of successive surfaces.

an estimation of their true locus in space. The true position and shape of these folded sediments will only be known after numerous holes have been drilled and detailed plots made of the subsurface information.

MINERAL POTENTIAL

Within the Quartz Latite Porphyry

Mineral potential within the Uncle Sam quartz latite porphyry might be generalized in two categories. Category 1 would consist of very near surface low-grade open pittable material. The economics would be based on the cheapness of handling and would be dependent on (a) its degree of dissemination and thus ease of bulk mining within some of the pervasively altered rock areas such as the Gold Bug prospect, the San Pedro area, or the Fox Wash area, (b) the development of a cheap method of bulk treatment such as drum leaching (as suggested by Mr. John White) or some type of cheap agitation leaching (as suggested by Mr. Nicholas Caruso), or dump leaching. Category 2 would be relatively high-grade supergene oxide type ore shoots such as were mined in the State of Maine workings. These would consist of bromyrite (horn silver) in fissures ranging from a few feet to possibly as wide as 15 feet. It is apparent from numerous samples that the surface material is strongly leached, and that silver mineralization begins some several feet below the present erosion surface. It is possible that richer supergene ore bodies might be found at the water table interface along vein structures such as the State of Maine, Gold Bug, San Pedro, Fox Wash, etc. Exploration for these narrow zones would be by underground methods or surface drilling using air track equipment.

Replacement Ore Bodies in Lower Bisbee Formation and Paleozoic Sediments

The writer feels the greatest potential in the State of Maine area is for intermediate size bonanza type ore bodies located below the Uncle Sam sill at intersections of veins with chemically reactive beds and favorable structural traps. In this respect, the State of Maine area is very much like the East Tintic district of Utah wherein a previously productive precious metal district was extended by correct interpretation of alteration zoning in pre-mineral cover rock. If we adhere to the hypothesis that the Robbers Roost area is a central part of a porphyry copper zone, and Tombstone and Charleston lead-zinc-silver mineralization is peripheral to this zone; then, since the State of Maine area is closer to the source, it may be reasonable to expect stronger mineralization.

As indicated on Butler, Wilson, and Rasor's Bulletin 143, cross sections Attachments 27 through 36, the best horizons in the Tombstone Basin area were the Blue limestone, the Novaculite, and the Naco formation, although ore was also encountered within the Bisbee Group redbeds. Ore was not, however, found preferentially in any one of these formations, first being in one formation to the exclusion of the others and then another. It is not clear what caused a particular horizon in one spot to be preferable. However, it may have been some combination of favorable structure and/or chemistry. It is apparent, as indicated on Attachment 36, that fractures along the crests of anticlines or "rolls" were the best locales for ore deposition. Since these structures are present within the State of Maine area and beneath the Uncle Sam porphyry, as indicated by the outcrops north of the Uncle Sam shaft and in the Fox Ranch area, exploration drilling should be designed to delineate and test these structures.

Because of the complex sub-Uncle Sam structure in the sediments, it might not be impossible that lower Paleozoics could lie near the surface, only covered by Uncle Sam porphyry. Thus, stratigraphic units like the Devonian martin limestone which form rich horizons in other districts may also have potential for production within the State of Maine area.

In addition to favorable stratigraphic and strato-structural targets, the intersection of strong veins may also have potential for forming important ore bodies. Examples of this would include the intersection of the Fox and San Pedro veins which on the surface, are heavily pitted by prospects (Section C-C', Att. 5). Less obvious, but possibly even more significant, would be the intersection of the Free Coinage vein and the unnamed vein (Section D-D', Att. 6, and H-H', Att. 10). Further, it can be seen by inspection that if the surface structures have continuity in depth, there is potential for 3-way intersections as exemplified by the intersection of the Triple X vein with the intersection of the Free Coinage and unnamed vein-cylinder of intersection (Section H-H', Att. 10). Further complicating the three-dimensional aspects, this three-way intersection might (or might not) fall on the crest of an anticline (or at the bottom of a syncline) within favorable (or unfavorable rocks) which would tend to enhance (or decrease) the ore making potential of the structure. It appears then, that the best exploration tool within the State of Maine area will be detailed surface mapping, projection of strong structures to the sub-surface, determination of their loci by descriptive geometry and testing by exploration drilling. Careful logging of exploration drill holes will yield additional data regarding the geometry of faulted Mesozoic and Paleozoic sediments, changes in trend of vein and dike structures, and the gradual refinement of geologic targets. As this process of data gathering continues, a more accurate understanding of the geometry of the sub-surface features will be gained, and thus a sharpened aim of exploration drilling.

PROPOSED DRILLING PROGRAM IN THE STATE OF MAINE AREA

GENERAL STATEMENT

Two objectives are paramount within the State of Maine area. The first is to delineate near surface ore bodies within the Uncle Sam porphyry, preferably those which could be mined by open pit methods to form immediate mill feed or feed for a heap leach operation. The most rapid and efficient means of doing this will be rotary percussion drilling using an air track drill.

The other objective is to test veins below the Uncle Sam porphyry sill for potential replacement bodies within the lower Bisbee group and upper Paleozoic section. Because of the problem at hand, three primary objectives in order of their importance become obvious. These are:

1. Determination of the thickness of the Uncle Sam porphyry by drillhole intersection.
2. Determination of the thickness, approximate geometry and location of Bisbee units and their relation to underlying Paleozoic units.
3. Determination of grade of mineralization in veins within the Bisbee or upper Paleozoic sections.

Since pinpointing the exact location of potential ore bodies will be exceedingly difficult until the information points 1 and 2 are known, i.e. thickness of the Uncle Sam and location of receptive beds within the sedimentary units, it is more important to determine those two points at the expense of detailed sampling than it is to have careful sample assays of each foot of exploratory drillhole. Therefore, because of the rapidity of drilling and the low cost, the writer suggests that air rotary drilling above the water table and water circulation or mud circulation rotary drilling below the water table, be used for the initial holes. Good samples can be obtained from the air rotary drilling, while with water circulation, these samples will be much less accurate, but will reflect rock type, and certainly strong mineralization, so that no significant ore bodies will be missed. If interesting structures are intersected, spot cores can always be taken with the drill rig. Cost of this drilling using Sierra equipment should be no more than $3 to $3.50 per foot, to a depth of 500 to 800 feet. This compares with a commercial cost of $5 to $6 per foot for comparable rotary drilling or a cost of approximately $10 a foot for diamond drilling.

AIR TRACK DRILLING

Purpose and Objectives

The purpose of the air track drilling is to test the various vein structures present in the State of Maine area to a depth of approximately 100 feet. Surface sampling suggests that all of the values have been completely leached from the surface, and therefore the only feasible way of making rapid tests is by drilling. The air track has the capability of drilling either vertical or inclined holes to a depth of approximately 100 to 120 feet. The holes are approximately 3½ inches in diameter and are drilled by percussion with air cleaning and circulation in the hole. Progress is quite rapid and should amount to 200 to 300 feet per shift. Cost should be in the $1 to $2 per foot range. Drill cuttings can be sampled every 5 feet and compiled on core boards for geologic logging.

Since ore may occur in shoots within the vein structures relatively close sampling of the veins will probably be necessary to delineate all the ore present. On Attachment 1, suggested hole locations have been indicated by black dots. These locations are spaced at approximate 100-foot intervals along the various vein structures. Determination of whether the hole should be drilled vertically or at some inclined angle--so to intersect the vein in a perpendicular fashion--can best be made in the field, and thus no attempt was made to give specific orientations. Further, exact hole placement should also be done in the field rather than adhering exactly to the locations plotted on Attachment 1. It may be that in some areas the Uncle Sam is thin enough so that the air track drilling will give some information regarding the underlying sediments. It will, therefore, be important carefully to log all of the drill cuttings within these holes in addition to the normal assay logs.

ROTARY DRILLING

Purpose and Objectives

The purpose and objectives of the 25 proposed holes plotted on Attachment 1 is to explore mapped vein structures within and below the Uncle Sam porphyry and to determine the type and structure of sediments lying below the Uncle Sam.

Sample Handling and Logging

The total sample from each hole should be collected and split down to approximately 2 quarts in volume, using a Jones type splitter. From this 2-quart sample, 1 quart should be split again and retained in permanent storage. From the other quart, a pint of assay material should be split out and approximately the same volume should be taken for construction of core boards. Atomic absorption determinations for silver, gold, lead, zinc, and copper should be made routinely on each 5-foot sample. Core boards should be made for each hole, including a panned fraction for each sample. These should be logged immediately and the results posted on cross sections so that the sub-surface work can be continually updated.

FIGURE 10

TOTAL COST OF PROPOSED DRILLING PROGRAM

SIERRA ROTARY DRILL PROGRAM

Cost per foot to 500 feet = $3.50/foot
" " " 500-1000 " = 4.50/foot

25 holes 500' deep = 12,500' @ $3.50 =	$43,750
12,500 ÷ 5' sample intervals = 2,500 Assay samples	
Geochem Assays for Au, Ag, Pb, Zn, Cu	
Hawley & Hawley Discount Price	
Cu, Pb, Zn - $2.10; Au, Ag - $3.32 = $5.42	
Assay & Sample Preparation ($1.00) = $6.42 x 2,500=	16,050
	$60,675

AIR TRACK - PERCUSSION DRILL PROGRAM

200 holes x 100' deep each = 20,000 feet at $2.00/foot =	$40,000
Sampling at 5' intervals = 4,000 samples	
Assay cost (with Hawley & Hawley Discount)	
$5.42 for Au, Ag, Pb, Zn, Cu + $1.00 Sample Preparation = $6.42 x 4,000	25,680
	$65,680

Total cost $126,355

Objectives of Each Hole

The positions of proposed rotary drill holes are shown on the geologic map of the State of Maine area (Att. 1), and cross sections at a scale of 1"=200' (Atts. 4-11).

Hole P - 1 10

P-1 is located on the ridge above and to the northwest of the Brother Jonathon inclined shaft. Assuming the State of Maine vein is approximately 15 feet in thickness and dipping at approximately 40°, P-1 should cut the State of Maine vein at a depth of 195 feet to 230 feet. The hole should be drilled a minimum of 250 feet deep, and close track should be kept of cuttings near the bottom. If it continues in altered rock the hole should be deepened until fresh rock is encountered. As indicated on Section H-H' (Att. 10) the base of the Uncle Sam porphyry sill should be encountered at approximately 450 to 500 feet. It is the writer's opinion that this hole should be drilled to at least 500 feet, or until the sediments below the Uncle Sam porphyry are intersected. If these sediments show alteration, then drilling should continue at least some distance into the sediments in order to determine their character. Ideally, a core sample should be cut at the bottom of the hole.

Hole P - 2

Hole P-2 is located with respect to the intensely silicified zone at the Gold Bug prospect north of the Lowell claim. Its purpose is to test the alteration at the Gold Bug prospect and penetrate through the Uncle Sam porphyry to determine if replacement type ore bodies are located within the underlying sediments. It should be drilled to a minimum depth of 500 feet. It would be preferable to drill to a depth of 1000 feet in order to get a clear idea of the sedimentary sequence lying beneath the Uncle Sam in this area, and to test possible extension of other veins which might project toward the hole (Section F-F'). The base of the Uncle Sam porphyry should be intersected at approximately 150 feet (See Section F-F'). Between 320 feet and 400 feet it might well encounter the composite rhyolite andesite dike which crops out to the southwest of the hole location.

If the decision is made to bottom the hole at 500 feet, then it should be filled with mud so that it could possibly be re-entered at a later date. In any event, should it encounter mineralization it should be deepened until the mineralization is penetrated.

Hole P - 3

Hole P-3 is located on the Fox Wash structure. Its purpose is to test grade of mineralization within this structure in the Uncle Sam porphyry and for possible replacement mineralization in sediments beneath the Uncle Sam. The hole will probably cut the bottom of the Uncle Sam at about 240 to 300 feet, and should be drilled to a minimum depth of 500 feet to gain information about the underlying sediments.

Hole P - 4

Hole P-4 is located to the East of the shop area on the Clipper claim, and along the Clipper structure (Att. 1, and Section I-I', Att. 11). Its purpose is to cut the zone of intersection between the Triple X vein structure and the Clipper vein structure at the interface between the sediments and the Uncle Sam porphyry. This should occur at approximately 120 feet, and drilling should be continued to a minimum depth of 500 feet in order to determine the nature of the underlying sediments (Cross Section I-I', Att. 11 and Section B-B', Att. 4).

Hole P - 5

Hole No. 5 is located 1600 feet north of the Uncle Sam shaft on the crest of an anticline in lower Bisbee Group sediments (Section H-H', Att. 10). Its purpose is to test for mineralization in favorable horizons along the crest of the anticline and also along the projection of the State of Maine vein. It should be drilled to a minimum depth of 500 feet or to a depth where the Bisbee Novaculite has been penetrated, and the Naco limestone unquestionably cut. Preferably it could be drilled to a depth of 1500 feet in order to cut the zone of intersection of the Free Coinage vein and the Unnamed vein (See Section H-H'). However, this deep drilling could be postponed until the Unnamed vein and the Uncle Sam vein have been tested by Holes P-25, and P-18 in order to determine their continuity. Further, a better location might be chosen so that a deep hole could penetrate the 3-way intersection of the Free Coinage, the Unnamed vein, and the Triple X vein structure as shown on Section H-H'. At any rate, Hole P-5, if drilled to a shallow depth, should be mud filled and capped for later re-entry.

Hole P - 6

Hole P-6 is located in the Fox Ranch area on the extension of what appears to be the San Pedro vein and collars in altered Uncle Sam porphyry. Its purpose is to test the thickness of the Uncle Sam, the tenor of the altered rock in the Uncle Sam, and to test for replacement deposits within the lower Bisbee sediments below the Uncle Sam porphyry. It should be drilled to a minimum depth of 500 feet.

Hole P - 7

Hole P-7 is located in the northeast corner of the Lowell claim, and collars in altered Uncle Sam porphyry. The vein responsible for the alteration at the hole collar dips approximately 42° to the north and may be the continuation of the State of Maine vein. P-7 is designed to test the tenor of the altered Uncle Sam porphyry, the depth to the Uncle Sam sediment interface, and to determine whether there is mineralization in the sediments beneath the Uncle Sam. It should penetrate the Uncle Sam at approximately 200 feet (Section G-G', Att. 9). And should be drilled to a minimum depth of 500 feet.

Hole P - 8

P-8 is located approximately 300 feet west of the Escapule Mill at the Fox Ranch. It is designed to test the alteration zone which appears to parallel the Fox Wash and to penetrate the Uncle Sam sill and test the sediments lying below. It should be drilled to a minimum depth of 500 feet (Section B-B', Att. 4).

Hole P - 9

Hole P-9 is located approximately 350 feet north of the Fox Ranch windmill on the San Pedro claim on the San Pedro vein at its intersection with a north~~west~~ east?-trending vein zone. It is designed to test the tenor of mineralization along the San Pedro vein both in the Uncle Sam porphyry and in sediments lying beneath the Uncle Sam porphyry. It should be drilled to a depth of 500 feet and should penetrate the base of the Uncle Sam at approximately 100 feet (See Section C-C', Att. 5).

Hole P - 10

Hole P-10 is located approximately 250 feet southeast of the Three Brothers shaft on the Fox vein system. P-10 is designed to test the tenor of the Fox vein alteration zone in the Uncle Sam porphyry and in the sediments beneath the Uncle Sam porphyry. The hole should penetrate the Uncle Sam at approximately 120 feet, and should be drilled a minimum depth of 500 feet. Altered rock will probably be cut for the total length of the hole.

Hole P - 11

Hole P-11 is located approximately 440 feet north of the Fox Ranch windmill, and approximately 100 feet northwest of hole P-9. It is located so as to intersect the plane of intersection of Fox vein and San Pedro vein within Bisbee Group sediments (Section C-C', Att. 5). P-11 should penetrate the Uncle Sam at approximately 100 to 120 feet and cut the point of intersection of the two vein systems at 200 to 250 feet. It should be drilled to a minimum depth of 500 feet.

Hole P - 12

P-12 is located approximately 350 feet south of the San Pedro shaft on a strong northeast-trending vein system which is in total almost 400 feet wide. P-12 is collared in what appears to be the strongest part of the vein system, and is designed to test its tenor in the Uncle Sam porphyry and in sediments which lie beneath. It should cut the Uncle Sam porphyry in the vicinity of 200 feet and should be drilled to a minimum depth of 500 feet. It should intersect altered rock throughout its total length.

Hole P - 13

Hole P-13 is located approximately 250 feet northeast of the San Pedro shaft on the San Pedro vein zone. It is designed to test the tenor of this vein zone in both the Uncle Sam porphyry and the sediments lying beneath. It should penetrate the Uncle Sam porphyry at 250 to 300 feet and should be drilled a minimum depth of 500 feet. It should be in mineralized rock throughout its length. However, it may cut the most strongly altered part of the vein system between 10 and 40 feet. When the exact location of this hole is spotted in the field it may be better to move it 50 to 100 feet to the south in order that a greater section of the intensely altered vein material be cut.

Hole P - 14

P-14 is located 170 feet southwest of the San Pedro shaft along the San Pedro vein and between surface stopes on that vein. Copper oxide mineralization crops out to the north of the proposed hole location. P-14 is designed to test this intensely altered vein area both in the Uncle Sam porphyry and the sediments below as seen on Section F-F' (Att. 8). It should cut the Uncle Sam porphyry at about 200 feet, and should be drilled to a minimum depth of 500 feet.

Hole P - 15

Hole P-15 is located approximately 550 feet to the northeast of the San Pedro shaft and is collared in Quaternary alluvium. It is on the projection of the very wide San Pedro vein zone, while the north-south trending area of alluvium may represent an intersecting zone of alteration. It is designed as a further test of San Pedro vein zone, both in the Uncle Sam porphyry and in underlying sediments. It should cut the Uncle Sam porphyry at about 300 feet and should be drilled to a minimum depth of 500 feet.

Hole P - 16

P-16 is located approximately 750 feet east of the San Pedro shaft on the projection of the alteration zone tested by P-12. P-16 is designed as another test of this alteration zone for tenor of rock both in the Uncle Sam porphyry and in the sediments beneath. It should be drilled to a minimum depth of 500 feet and should penetrate the Uncle Sam at a depth of approximately 100 feet (Section D-D', Att. 6).

Hole P - 17

P-17 is located 400 feet north of P-5 and approximately 2000 feet north of the Uncle Sam shaft. It is collared on a brecciated and strongly manganese oxide mineralized quartzite breccia, and is designed to test this zone in depth. It should be drilled to a minimum depth of 300 feet, or until it penetrates the breccia zone and goes into unaltered, unmineralized rock.

Hole P - 18

Hole P-18 is located approximately 200 feet west of the Free Coinage vein system (Section D-D'). It is designed to test the grade of the Free Coinage vein system below existing workings and hopefully within the Bisbee Group sediments. It should intersect the Free Coinage vein between 120 and 170 feet. The hole should be drilled a minimum depth of 500 feet in order thoroughly to test the Bisbee Group sediments in this area.

Hole P - 19

Hole P-19 is located approximately 150 feet northwest of the quarter corner marker for sections 9 and 16, and is located on the Merrimac claim. It is designed to test the Free Coinage vein system and sediments lying beneath that area. It should be drilled to a minimum depth of 500 feet and will probably remain in altered rock over that depth.

Hole P - 20

Hole P-20 is located approximately 1000 feet north of the Uncle Sam shaft, and collars in Uncle Sam porphyry along the projection of the State of Maine vein. It is designed to test the grade of mineralization of the State of Maine vein in both the Uncle Sam and the Bisbee Group sediments which shallowly underly this location. It should be drilled to a minimum depth of 300 feet.

Hole P - 21

Hole P-21 is located approximately 380 feet south-southwest of the quarter corner marker of section 9 and 16 and lies on the Merrimac claim. It is designed as another test of the strong Clipper vein system both in the Uncle Sam porphyry and underlying sediments. It should be drilled to a minimum depth of 500 feet and it is expected to remain in altered rock over this entire depth.

Hole P - 22

This hole is located approximately 250 feet from the State of Maine mine office in the State of Maine canyon. It is collared in alluvium, but is designed to test for the presence of a strongly altered structure projecting along State of Maine canyon. It should be drilled to a minimum depth of 500 feet and should penetrate the Uncle Sam porphyry at approximately 100 feet. If drilled to a depth of 1000 feet it would also penetrate the strong Clipper alteration zone within Bisbee Group sediments or possibly the Naco limestone (See Section I-I', Att. 11).

Hole P - 23

P-23 is located approximately 150 feet northwest of the Bonanza shaft and lies on the Red Top claim. It is designed to test the grade of mineralization along the Bonanza-Solstice-Chance vein and should be drilled to a minimum depth of 500 feet. It should remain in altered rock over this entire distance, and will probably penetrate an andesite porphyry dike with associated mineralization at about 300 feet (See Section C-C', Att. 5).

Hole P - 24

P-24 is located approximately 700 feet northeast of the mine gate in Maine Wash and is on the projection of the Clipper vein zone. It is designed as another test of the Clipper vein zone and as another penetration of the Uncle Sam porphyry. It collars in alluvium, but should penetrate the base of the Uncle Sam at approximately 50 feet and enter Bisbee Group sediments (Section C-C', Att. 5).

Hole P - 25

P-25 is located approximately 350 feet southwest of the Uncle Sam shaft, and is designed to penetrate the State of Maine vein in this area below known workings. It should cut the State of Maine vein at approximately 280 feet which is also the base of the Uncle Sam porphyry. It should be drilled to a minimum depth of 500 feet (Section I-I', Att. 11).

Supervision and Revision of Objectives

Because present knowledge of the sub-surface is so scanty, new data obtained by drilling might radically change the nature and objectives of the ensuing program. Recognition, therefore, that objectives might change with continued drilling should be made and the drilling work should be very closely supervised from a geologic standpoint so advantage can be taken of new information. It is suggested that the geologist in charge have enough assistants so that his time will not be occupied with routine sample preparation and handling duties. Rather, he should occupy himself in continued surface mapping or of plotting drill results and updating sub-surface maps. Continued and timely updating of sub-surface information to get an accurate and complete three dimensional picture of the area will be critical to ore finding.

PORPHYRY COPPER EXPLORATION

GENERAL STATEMENT

As mentioned previously, the discovery of porphyry copper breccia pipes in the Robbers Roost area is probably the single most important discovery resulting from this study. Recently obtained color air photos which cover approximately 234 square miles of the Tombstone District and its environs, show that Tombstone, Charleston, and the Robbers Roost area are part of one continuous alteration zone which is about 11 miles long, 4 miles wide and covers approximately 42 square miles. Thus the Tombstone Mining District, rather than being an epithermal precious metal district is part of a large porphyry copper type alteration zone. Identification of the district as a porphyry copper zone allows the application of knowledge of porphyry copper zoning criteria to salient geologic features of the district. The features mapped in the Tombstone district fit very well in the general porphyry copper picture and are easily explained in that context. These features would include:

1. Laramide stocks of quartz monzonitic to granodioritic composition represented by the Schieffelin granodiorite.
2. Silver Bell-type volcanic rocks represented by the Bronco volcanic units.
3. Strong northeast grain to fault and mineralized structures.
4. A zone of intense quartz-sericite alteration accompanied by breccia pipes and porphyritic dike rocks.
5. A large, continuous zone of disseminated sulfides (approximately 42 square miles at Tombstone).
6. Metal zoning. In the Tombstone district this is indicated by the occurrence of copper near the breccia pipe center and lead, zinc, silver mineralization near the town of Tombstone and at Charleston.

Although the Tombstone district has all necessary ear marks which identify it as a porphyry copper type alteration zone, as yet there is no known economic copper mineralization. Such mineralization may be obscured and hidden by both pre- and post-mineral cover rocks, partially as a result of numerous horizontal features existing in the district including; horizontal to sub-horizontal sedimentary beds, thrust faults, and the flat sill of Uncle Sam Quartz latite porphyry. Exploration methods must take into account these features if they are to be fruitful.

GEOLOGY BETWEEN THE STATE OF MAINE MINE AND CHARLESTON

Surface Geology

The major rock type cropping out between the State of Maine and Charleston is Uncle Sam quartz latite porphyry. Over much of the area thin soil covers the porphyry while in places, it is totally obscured by alluvium (Att. 13). Drainage and topography follow the northeast trending fracture and vein zones. Cutting the Uncle Sam in a northeasterly trend are greenish andesite dikes of the same type exposed near the Gold Bug prospect and elsewhere in the district. The dikes are particularly abundant in the Robbers Roost area. Alteration shows that they are probably late pre-mineral in age and fragments of the dike rocks are occasionally seen in the breccia pipes.

Intense quartz-sericite is seen in the Robbers Roost breccia pipe area, while pervasive argillic alteration is seen in the surrounding area. Northeast trending vein zones, in places up to 100 or more feet wide, also show sericite alteration.

Bronco volcanics are exposed in Charleston Hill. They are composed of a lower laharic andesitic breccia unit equivalent of the Silver Bell andesite complex. The upper unit where seen by the writer consists of a light-colored quartz latite welded tuff which displays eutaxitic texture and is similar in appearance to the Cat Mountain rhyolite. The top of Charleston Hill is a plug of Uncle Sam quartz latite porphyry as indicated by Gilully's map (Att. 18).

To the east and southeast of the Charleston-Tombstone road Bisbee Group sediments are exposed. The writer has only briefly visited a few of these outcrops and it is not known whether the upper- or lower-Bisbee is represented in the outcrops. Gilully's map shows a nearly conformable contact between the Bisbee and Bronco volcanics which are both dipping at shallow angles to the west in this area.

Subsurface Geology

Plotting of the basal contact of the Uncle Sam quartz latite sill on carefully constructed cross sections shows the sill to be very thin over its total exposure (Section A-A', Att. 3). The rock lying beneath the Uncle Sam in all exposures seen to date is Bisbee Group sediments. Contorted bedding and the possible presence of hidden thrust faults will probably necessitate drilling to obtain data regarding depth to Paleozoic sediments, although some idea of their depth might be gained by geologic mapping.

The base of the Uncle Sam sill appears to be tilted toward the San Pedro River. Normal faulting which can be identified on recent color air photos appears to drop the Uncle Sam down along the river, exaggerating its apparent thickness in that direction.

PROPOSED EXPLORATION PROGRAM

Photogeologic and Ground Geologic Mapping

Excellent quality color air photos over an area of 234 square miles comprising all of the Tombstone district and its environs were flown for Sierra by Cooper Aerial Photo. These photos which are at a scale of 1"=2000' feet show excellent color contrast and zones of alteration can easily be mapped using a stereoscope to observe the photos in 3 dimension. It is therefore suggested that photogeologic interpretation using the color photos be performed over the entire district and compared with existing maps. At the same time a photo alteration map should be prepared to show the geometry of alteration patterns within the area. During this mapping enough field trips should be made into the area so the photo interpreter can identify the various rock and alteration units visible on the photography. In this manner critical areas will be identified for ground follow-up. Ground reconnaissance mapping at a scale 1"=1000" should be done to plot the location of alteration zones, breccia pipes, windows in the Uncle Sam porphyry and other features which may not be visible on the color air photos. Another objective of the ground reconnaissance mapping would be to identify marker horizons in the exposed Bisbee Group sediments so that as the tectonic picture is reconstructed, some idea as to depth to receptive Paleozoic horizons may be gained.

When the broad scale characteristics of the district have been adequately mapped to define centers of mineralization, detailed mapping of the target areas should be done. Base mapping scale for the detail map(s) should be in the range of 1"=400 feet. The technique of outcrop mapping should be used and alteration features as well as structure and geology should be plotted.

Geochemistry

During the field mapping, geochemical profile lines should be run across significant features. If these initial lines show the presence of geochemical contrasts or anomalies, a gridded survey should probably be run.

Geophysics

Preliminary examination of the color air photography shows the presence of red coloration probably due to disseminated pyrite over an area of approximately 42 square miles. The induced polarization method only gives an indication of the intensity of pyritic mineralization, so therefore, IP surveys will probably be of little use in defining drilling targets.

Since it would be expected that mineralization may occur within the Paleozoic limestones or lower Bisbee Group sediments, possibly accompanied by magnetite, low level aeromagnetic surveys may be useful as might detailed ground surveys.

Drilling

The geologic mapping should have the objective of trying to determine at what depth receptive Paleozoic horizons such as the Martin limestone might be expected. Initial drilling should probably be by rotary methods to take advantage of low cost and rapid progress. Cuttings from the drill holes should be sampled at 5-foot intervals, and the samples compiled on core boards for logging. The holes should then be logged and the data plotted on structural sections so that an accurate understanding of the sub-surface geology is obtained.

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