SOME AERIAL MAGNETIC APPLICATIONS IN MINING EXPLORATION

and

INTERPRETATION OF SELECTED U.S.G.S. OPEN FILE AEROMAGNETIC RESULTS IN ARIZONA

for

THE SUPERIOR OIL COMPANY
Tucson, Arizona

September 1963

by
HEINRICHS GEOEXPLORATION COMPANY
P. O. Box 5671 Tucson, Arizona

TABLE OF CONTENTS

INTRODUCTION

Several informal discussions were held with Mr. Ralph Wilpolt and Mr. Jim Sell regarding the general application of aerial magnetics in mining exploration, particularly as might apply in Southern Arizona. Finally, a trial review of already existing and available U.S.G.S. data was suggested as the best means of providing a most rapid and valuable appraisal and demonstration of potential use of magnetics in your program. On July 3, 1963, Mr. Wilpolt called and authorized such work based on our estimate as proposed in our letter dated July 15, 1963, following receipt of your data of the Johnson-Dragoon area on July 13, 1963.

On July 18 and 19 further discussions on this and other similar or related mining exploration subjects were held in your Denver office with Mr. Howard Keck and others in attendance.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

1. That magnetic data is definitely valuable and provides some information available in no other way is the concensus of most successful exploration groups. This report gives some additional confirmation to that opinion.

2. Pros and cons between aerial and ground magnetics in mining exploration are often over drawn. Both approaches are useful though not always mandatory, and each method provides some information not practically obtainable by the other method. However, in most cases, eventual ground work is necessary to provide essential detail and resolution not available any other way. Other differential factors to consider are logistics, costs, objectives and timing.

3. Concerning the need and use of detail and resolution, once in a while special problems occur which warrant extreme accuracy and theoretical treatment. Beyond this point some so called "artistic" factors may rarely apply. However, such factors are strictly artistic and apply similarly to both mining and petroleum though in a vastly different manner. In any event, they are usually related to experience. On this same subject, notwithstanding Mr. Steenland's opinion to the contrary, U.S.G.S. aerial magnetic data is quite adequate and valuable and any greater accuracy and detail, at least in mining work, is mostly wasted. This is regardless of who interprets the results.

4. Almost always magnetics will at least reveal something about broad rock types and broad rock type differences, structural lineation, and order of magnitude depths. Occasionally these factors may be determined with considerable accuracy and at times there will be direct correlation with ore deposition, such as "contact" metamorphic, magnetite or altered igneous deposits, etc.

5. Whether <u>any</u> of the disseminated phorpyry copper deposits have a <u>direct</u> magnetic association is speculative and controversial. Suffice to say the evidence is circumstantial, indefinite and unproven in every case to date. On the other hand, this problem does warrant additional work.

6. The relatively more simple pure deep basement studies are important in mining exploration, but contrary to the petroleum basin problem, the shallow surface, near-surface and polarized effects are also essential and these are often infinitely more numerous and complex. It is usually necessary to note all highs and lows, slopes and slope intercepts, trends and correlations more or less simultaneously. One single feature alone, without other supporting evidence, is seldom conclusive and most often is quite insignificant in itself, especially from an economic mineral standpoint.

7. Except in specific cases, no single categorical mode of magnetic application is recommended. <u>All</u> approaches should be considered, including some broad blanket gridding and "wild-

catting". However, even wildcat areas, still should be selected on some pre-agreed objective basis. Quarter mile spacing is considered maximum practical detail for fixed wing flying, 1/8th mile for helicopter. One mile aerial griding is useful for broad reconnaissance purposes. However, even the most detailed aerial approach can and has missed essential discovery features recognizable and available only in a more resolving and detailed ground survey.

8. In other words, unless specifically looking for magnetite, aerial magnetometer results in metallic mineral exploration should mainly be used to help trace geologic outlines and structural patterns. Except for iron ore, instances where economic mineral deposits are associated with appreciable magnetite are in the minority and usually in such a porportion of concentration that <u>from the air</u> their resultant anomalies are for most practical purposes indistinguishable from other anomalies of no economic significance whatsoever.

9. For the most part, we strongly recommend reconnaissance flying of geologically selected areas where aerial data is <u>not</u> available. Further flying in areas where aerial data is available is essentially useless. Following the collection and interpretation of aerial magnetic data in abstract form, obviously checking on the ground is necessary. To confirm and accurately locate an aerial anomaly, usually one or two ground profiles are advised. Note attached example which compares fixed wing

continuous total intensity aerial data with continuous total intensity ground data and vertical intensity station data over one anomaly.

10. For favorable prospecting odds, select mineral districts or areas with the requisite geology or history of discoveries and production and get some aerial magnetic coverage. Districts that produced lead are particularly favorable. When the necessary magnetic lineaments are located, then do the follow up. Of first importance of course is correlation with photo geology and topography. Therefore it is preferable that these be available although not always mandatory. Next would be considerations of reconnaissance geochem and possibly gravity or other applicable geophysical methods, including induced polarization surveys. Eventually, if encouragement continues, land options are advised for appropriate protection consistent with investment and results, and finally drilling. If this approach is followed the percentage of valuable discoveries could be high.

GENERAL INTERPRETATION

It is clear that aerial magnetic results may contain the necessary clues pointing to the eventual discovery of certain kinds of ore bodies. An important factor is to locate intersections of magnetic trends. For example, when a strong E-W trend (or slightly north of east) intersects the regional NW-SE trend with an associated high-low, note it. If there is a third

intersection of approximately N-S lineation it may become very important to check whether there are, or have been, producing mines in the vicinity. Added favorable factors are the presence of tertiary intrusives and good Paleozoic sediments or older schist. If most or all of these factors are present, there could be a major deposition in the vicinity. This approach is used in analyzing the significance of the several areas of U.S.G.S. results which were studied. A separate text and accompanying map covers each of these in considerable detail.

Respectfully submitted,

HEINRICHS GEOEXPLORATION CO.

Walter E. Heinrichs, Jr.
President & General Manager

SUMMARY OF SELECTED AEROMAGNETIC RESULTS

In all, a total of thirty areas of interest are designated as follows:

Cochise and Dragoon Quadrangles (8 Areas)

A. Johnson Camp

B. North Dragoon Mountains

C. Dragoon Pass

D. South Johnson Camp

E. Keith Ranch

F. Red Bird Hills

G. Sheep Basin

H. Kelsy

Mammoth Quadrangle, Pinal and Pima Counties (4 Areas)

A. Tiger - San Manuel Production Zone

B. Mammoth

C. Mogul Fault

D. San Pedro River

Jerome - Prescott Area, Yavapai County (3 Areas)

A. Jerome

B. Humboldt

C. Lynx Creek

Bagdad Area, Yavapai County (4 Areas)

A. Bagdad Proper

B. Kyeke Mine

C. Old Dick

D. Northeastern

Globe Quadrangle, Gila and Pinal Counties (11 Areas)

A. Miami - Inspiration Zone

B. Miami and Copper Cities

C. Castle Dome

D. Area North of Globe

E. Cactus Marginal

F. Schultz and Stoval

G. North Castle Dome

H. East Miami - Inspiration

J. Central Southwest

K. Southeast.

Of these, San Manuel is the largest single current producer, Inspiration - Miami second; Bagdad, third and Humboldt - Iron King fourth. Jerome was once a major producer and is still a prime prospective area.

Additional prime possibilities are considered at Humboldt in the Jerome - Prescott area; Mammoth and Mogul - San Pedro in the Mammoth quadrangle area; one or more of the tentative areas of the Globe quadrangle. Priority of these should be

contingent upon fresh geological examination or inspection (not necessarily study or mapping) on the ground at each of the premises.

Next are considered the Bagdad and Cochise-Dragoon areas because of lesser past production and general over all impression of surface-evident mineralization intensity. Perhaps at Bagdad the Kyeke area is to be preferred and at Johnson-Dragoon, the areas closest to Johnson Camp with lesser desirability further away. One exception to this is the Keith Ranch area which certainly should be ground checked in the same manner suggested above for establishing priority among any of the areas.

This detailed study of the magnetics and general geology of the five areas contained in this report points toward future usefulness of a more regional study at a scale of 1:250,000. Comparing the geology and the magnetics at this scale would permit a more broad projection of important regional trends and lineaments that may not readily reveal themselves on a more localized study such as that made in this report.

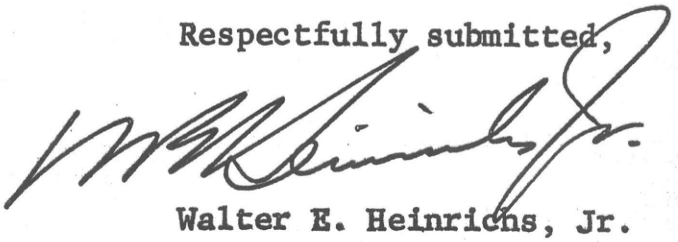
It is also recommended that better utilization of existing data could be realized by more elaborate reproduction techniques and drafting. Three types of data must be used more or less simultaneously to fully realize the most from this kind of interpretation:

1. Magnetic Data
2. Geology
3. Topography

Mylar or acetate basis, because they are transparent, are more efficient (though more expensive) for they make possible a combination overlay of topography, geology and magnetics. The major reason for using a topographic map in addition to showing surface relief, expression of faults and lineaments is to determine the topographic effect on the resolution of aerial magnetic data. This is especially important in mining applications.

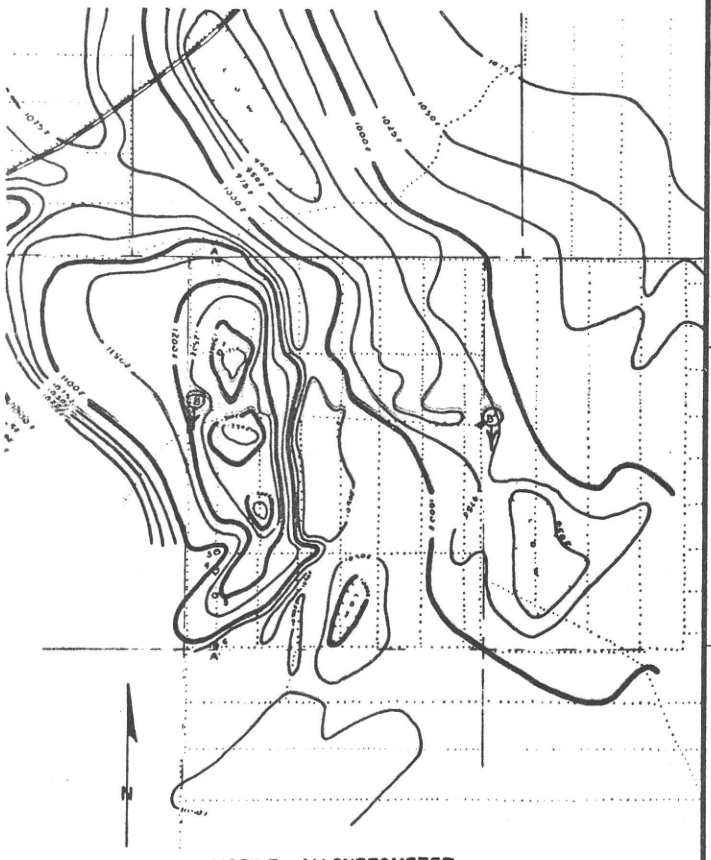
Consideration should also be given to flight directions in regard to planning or making lineation analysis. Naturally, N-S lines may accentuate N-S lineation, and attenuate or offset and complicate E-W lineation, and vice versa.

Respectfully submitted,



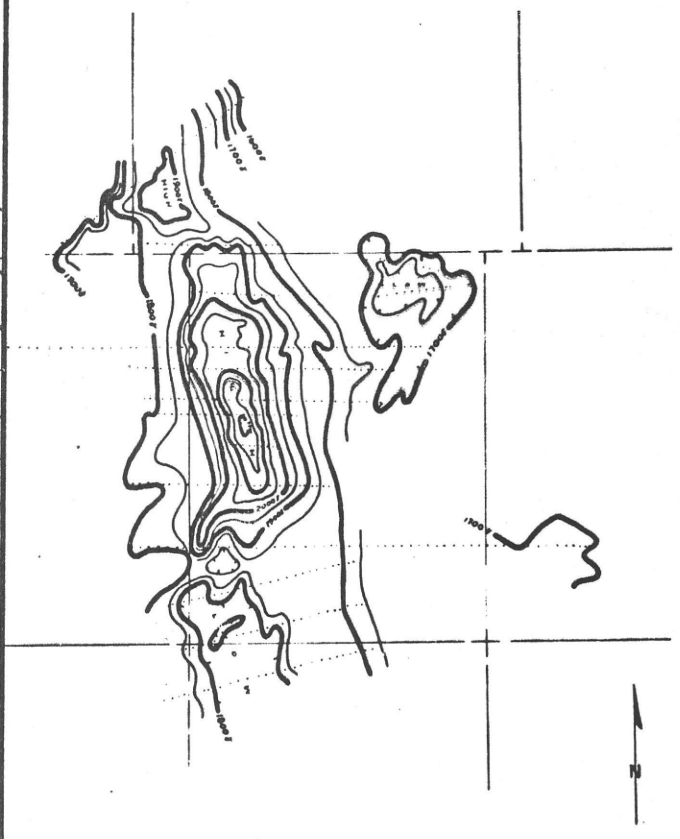
Walter E. Heinrichs, Jr.

October 2, 1963
P. O. Box 5671
Tucson, Arizona



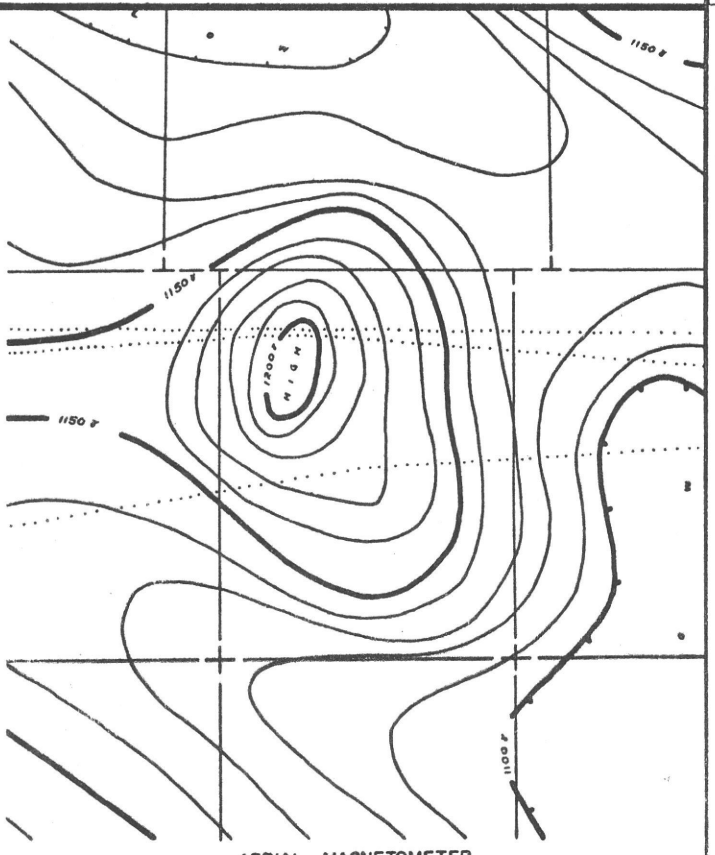
MOBILE MAGNETOMETER

RELATIVE TOTAL INTENSITY MAGNETIC SURVEY
CONTOUR INTERVAL 10, 25, 50 ℽ SCALE 2" = 1 MILE
INSTRUMENT SENSITIVITY 25 ℽ
..... INDICATES TRAVERSE ROUTE DATE 6|22|56
—+— SURVEYED LAND LINES



HAND MAGNETOMETER

RELATIVE VERTICAL INTENSITY MAGNETIC SURVEY
CONTOUR INTERVAL 50 ℽ SCALE 2" = 1 MILE
INSTRUMENT SENSITIVITY ± 2 ℽ
..... INDICATES TRAVERSE ROUTE DATE 6-22-56
—+— SURVEYED LAND LINES



AERIAL MAGNETOMETER

RELATIVE TOTAL INTENSITY MAGNETIC SURVEY
CONTOUR INTERVAL 10 ℽ SCALE 2" = 1 MILE
INSTRUMENT SENSITIVITY 10 ℽ DATE 6-22-56
..... INDICATED FLIGHT PATH
FLIGHT HEIGHT = 500' ABOVE GROUND LEVEL
—+— SURVEYED LAND LINES

COMPARATIVE ACCURACY

RESOLUTION AND DETAIL

This page illustrates in contour plan form, the comparison between three different magnetic methods over the same area.

The fine dotted lines show the coverage, or traverses, routes and flight paths.

HEINRICHS GEOEXPLORATION COMPANY

METHOD OF DEPTH ANALYSIS

Depths over the areas of known and tentative interest in the various aeromagnetic maps have been calculated using the general rule of thumb formula that depth to the top of the anomalous mass is equal to half the horizontal displacement of the anomaly at a position equal to half the maximum anomaly value.

Due to the surface or relatively shallow effects related to the topographic and geologic conditions controlling the results and collection of the aeromagnetic data, as considered in this report, such calculations are entirely adequate and about all that is generally justified.

These controlling conditions are: First, the flight pattern and elevation above the existing topography does not allow a qualitative resolution of the magnetic data. Second, in areas of such relatively high magnetic variation relief and gradient, the representative reliability of any susceptibility information also prohibits a ~~qualitative~~ quanti approach. Third, the available geologic control is of a regional nature and in many instances does not conform in detail to the actual conditions present.

When warranted, and with good magnetic data obtained on the ground, these depth calculations can be accurate to +/- 25% or better depending on how well actual geological and

geophysical conditions fit the assumptions made. Otherwise, with the general circumstances and aerial data related to this report, the calculations are really only estimates and as such could be off 50% to 100% either way.

EXPLANATION OF MAP COLOR CODE AND PROCEDURES USED

1. All important single closed highs were marked with a RED (+) and lows with a RED (-).
2. All important high and low trends connect the above, to the extent they may be single related features, using a GREEN for lows and ORANGE for highs; solid lines for definite, dashed lines for indefinite trends.
3. Definite faults are shown solid BLUE and indefinite faults dashed BLUE, then all trends and structural and rock type relationships were studied and are identified as indicated.
4. Anomalous zones or anomalies were then considered to explain possible depth, cause and potential if any.
5. Areas of known interest are shown in solid YELLOW and areas of potential interest in dashed YELLOW, both identified with a RED number or letter for reference to the text.

Concerning the BLUE lines, although we call them "faults", they are in fact, only magnetic interfaces. Thus they may actually be geologic contacts and/or sharp topographic breaks, or even merely gradational magnetic boundaries between differential susceptibilities and/or polarization effects.

INTERPRETATION OF SELECTED U.S.G.S.

OPEN FILE AEROMAGNETIC RESULTS

IN

A R I Z O N A

COCHISE AND DRAGOON QUADS

The most persistent and continuous magnetic lineament diagonally bisects the area from SE to NW and relates to a major NW-SE high and associated parallel fault zone which may be due in part to intrusion and related collapse effects and normal or thrust faulting. Perhaps the NE block is down because younger (?) rocks seem exposed on it. Across this zone is a prominent and apparently regional NE-SW trend which suggests some right lateral tear component and maybe the NW block down. Some important NNW structure seems due to combination factors of step, glide or thrust faulting and intrusion, along with several smaller NE-SW trending features of a similar nature.

The high between A, C, D and G (see map) reflects the Texas Canyon stock, post intrusive movement and the topo high on its NW part. The arcuate high between E and H is partly topographically influenced but also indicates intrusion with sediments draped on the east side. The high south and east of E may or may not be related to either of the two previously mentioned highs, but is likely intrusive related. The lows surrounding these highs are mainly due to relatively thick sections of sediments around the intrusives, negative polarization effects and lower topography.

The little high at D is known to be at least contact metamorphic magnetite stringers with some associated oxidized copper

mineralization. Results of work done here by Minerals Exploration Company of California, including drill cores, are now owned by us and, as you may know, may be arranged for your use. The example used for illustration under 'General Conclusions and Recommendations' accompanying this report is this anomaly.

The high at B is likely intrusive.

Relatively little is interpreted of the extreme NE and SE parts of the map, owing to lack of exposures and rather deeper indications for the most part. Known and likely very young extrusive rocks (basalt, etc.) are at least partly involved here and also in the Steele Hills and Winchester Mountains in the middle north part of the area. Such extrusives especially when at or near surface usually give rise to erratic and random highs, lows and steep and variable gradients such as noted here.

However, there are also some sediments. Therefore the vicinity requires some field checking before ignoring completely.

More obvious areas of potential interest are around A, B, C and D. This is because of known exploration or production results in all four places; also because of apparent lineament intersections and related highs and lows. Other possibilities are indicated around E, F, G and H and more ground information, geology and/or geophysics at these places would be helpful.

F is of interest mainly because of the major intersections. H may be similar, but lacks data to the north and west to be certain. The SE contact of G is known to be altered and

mineralized. B looks fairly deep, had gold production nearby and Newmont did some geophysics in the early 1950's but did not drill.

DEPTH CALCULATIONS

Submitted are a few depth calculations over various areas of known and tentative interest in the Dragoon and Cochise quadrangles. All depth estimates occur at the elevation of the maximum magnetic anomaly and the area locations are referred to on the original composite map.

Area B. Two depth determinations were made in Area B; the first on the southern anomalous peak or high and the second on the northern high. The southern high has an estimated depth of 900 ft. to the top of the anomalous mass and the northern high has an estimated depth of 2,500 ft. to the top of the anomalous condition. The magnetic pattern indicates that the two highs are reflective of the same feature but with this depth difference there is a question as to whether or not these two magnetic highs are the same feature; there is the possibility that they may be separated by a structural feature trending east-west.

Area D. One depth determination calculated is equal to 700 ft. to the top of the anomalous mass; but, from previous drill hole information a depth to the top of the first magnetite zone is approximately 400 ft. This mis-correlation may be

reflective of the poor resolution from the aero-magnetic data or it may reflect that the 400 ft. of depth to the first magnetic zone is not the zone producing the majority of the magnetic anomaly.

Area E. Two depth determinations have been calculated over the magnetic high in the area. The first was over the western magnetic high and a depth of 1200 ft. to the top of the anomalous mass was computed; the second, over the eastern magnetic high, was determined to be about 1,400 ft.

Area G. One depth calculation over the magnetic high in the southern portion of the area was estimated to be about 700 ft. to the top of the anomalous mass, but due to the nature of the high and the presence of proposed structural trends, this depth figure is more in doubt than the previous ones.

Of all parts of the district unknown to us but still of prime potential interest, as indicated by the magnetic data, is Area E, especially the high near Tres Alamos Wash about three miles south of Keith Ranch. This suggests contact metamorphic effects along the north side of a westerly projection of the Texas Canyon stock. The general situation is quite similar to that around Area D and somewhat like G except that amplitude strength and lineal persistence is greater.

If any of the magnetic lows on this coverage were to be directly related to major disseminated copper mineralization,

they would be the ones NE of E, N and S of A and NW of G. However, in our opinion none of these are very apt to be so related although indirect high and low relationships are definitely possible and warrant consideration for ground checking.

Doubtless other zones may be of interest to your personnel and other advisors. Any such ideas should be thoroughly compared with those presented here and all pros and cons carefully considered--not only within this particular district, but also in comparison with similar data from other districts as well.

MAMMOTH QUADRANGLE, PIMA AND PINAL COUNTIES

Aerial magnetic results here are, in some areas, very simple and in others, very complicated. The latter probably conforms to fairly complex geology, with most, if not all of the Arizona formations from very old to recent being present.

Most of the middle half of the quadrangle is exposed post-mineral Gila conglomerate and younger continental sediments with known thicknesses of at least 2,000 ft. Much of the extreme eastern and northeastern parts of the quadrangle have added interbedded and overlying tertiary and/or quaternary andesite and basalt extrusive rocks.

The most outstanding features are several parallel regional high and low trends which strike NW-SE. These, all or in part, relate to one or more major regional trending faults such as the one which passes diagonally from beyond the SE corner of the quadrangle past the San Manuel Mine to just east of Tiger and on northwesterly. This, and other parallel features to the northeast of the San Pedro River Valley, all tend to confirm semi-graben structure for this part of the Valley with minimum likely displacement of 2,000 ft. to 3,000 ft. along this main NW fault passing near Tiger. This indicates a somewhat greater depth toward the NE, and also probably toward the SW from this fault.

It is difficult to completely explain and identify

exactly what all the highs and lows represent. The Mogul Fault high does not appear volcanic and may be intrusive, contact metamorphic or pre-Cambrian rocks or any combination of these. The same may or may not apply to the two highs SW of Tiger. The long narrow NW-SE high from near Tiger to Catalina Wash suggests a granite ridge or formational dike or sill related to steeply dipping and/or tightly folded vertical structure on either side. The nearly parallel lows are likely zones of thick, deep or weakly magnetic sediments.

The next most prominent magnetic trends strike EW or WNW. At least four of these are noted with the most southerly one being the Mogul Fault. NE trends are fewer and less distinct, but one of these represents the low near San Manuel and another seems to pass on the NW side of the small, coincident magnetic low and outcrop of Cambrian-Devonian limestone in the SE part of the quadrangle. Partly because of the depth of the magnetic features, it is difficult to specifically identify anything but mainly vertical component displacement in the structure, except in these NE trends which barely suggest some questionable lateral offsetting. Also there is some peculiar N-S structure either in or beneath the Oracle granite in the SW part of the quadrangle. However, this could be due to the mechanical execution and compilation of the data.

The major San Manuel deposit near Tiger, similar to Bagdad,

is near a major magnetic low, encircled by highly magnetic volcanics (andesite and basalt?) and three major magnetic highs. Two of these to the SW certainly could be thick volcanic edge effects. In any event, the three highs and related polarization effects could definitely account for the magnetic low rather than direct reduction of primary magnetite in the intrusive stock owing to mineralization effects. Furthermore, it is known that a rapidly thickening wedge of Gila conglomerate overlies the deposit and dips or plunges to a depth and thickness of at least 2,000 ft. toward SE. Such a block, especially if surrounded by more magnetic material, could conceivably account entirely for such a low.

The NE part of the quadrangle provides another sidelight on the possible relationship of magnetic lows and mineralization. In the early 1950's after these data were released, Bear Creek Mining Company (Kennecott) did considerable deep drilling on the large symmetrical low cut by Copper Creek near the NE corner of the quadrangle. Reportedly, this effort was based solely on the fact that the nearest major feature is a large low, geographically correlating with San Manuel. We are told the drilling (to 3,000 ft?) never penetrated post mineral volcanics! The magnetic low in the NE corner of the quadrangel which was drilled by Bear Creek gives a depth of 1,250 ft.

The magnetics in this part of the quadrangle are indicative

of thick volcanics, probably mostly tertiary andesite and possibly quaternary basalt and maybe some diabase, all of which conforms well with the known geology.

Thumb rule order of magnitude depth calculations on the major anomaly of the three designated areas of potential interest give: B - 300 ft.

C - 1,500 ft.

D - 800 ft.

As pointed out elsewhere in this report, these depths are theoretical maximums to the top of the anomaly cause and assume no polarization effects. If much polarization effects exist, these depths could be off 50% to 100% either way.

JEROME - PRESCOTT AREA

Regional Trends

Considering the irregular patterns in the aeromagnetics, this district will be discussed in seven segments.

Northeast Corner of the District: This area contains several magnetic highs and lows exhibiting an erratic pattern mostly associated with the surface geological rock type of basalt.

The eastern slope is expressive of a general topographic and magnetic low--all doubtlessly related to the down dropped block on the northeast side of the regional Verde fault. The sharp gradient to the west is also due to down faulting of the Chino Valley block relative to the Mingus Mountain basalt-capped mesa.

The western zone of the basalt feature is generally a magnetically high area and in part is due to the slight apparent dip of the volcanic zone and the presence of a large magnetically low structural zone to the west. This zone, trending N-S is observed across the entire map.

Central Eastern Portion: This area contains exposed schist and granitic rocks and is expressive of only one major magnetic zone. This zone trends NNW and is a magnetic high which is terminated to the west by the previously mentioned major N-S structural zone and gradually disappears into the

regional gradient to the east. The magnetics of the northern flank of this high may be expressive of a shallow structural feature. Depth estimate normal to the eastern portion of this high gives zero depth, indicating that the anomalous zone is due to the magnetic properties of the rock units involved. But, from a geologic and/or magnetic viewpoint, the area may warrant investigation on the ground.

Southeast Corner of the District: Generally, there are several magnetic highs and lows of minor magnitude which are likely associated with the volcanic surface cover and rock type changes.

Two major magnetic highs are within this portion of the district but one may not be entirely associated with the exposed rocks. The minor of these two highs, 350 gammas, is located to the extreme east and a depth estimate gives a value of zero feet to the anomalous mass, indicating the magnetic high to be associated with the granite. The southwest part of the anomaly is also affected by the NW contact between the basalt and granite. The second major magnetic high, located about three miles northeast of Humboldt, has a magnitude of 400 plus gammas and an estimated depth of 1,300 ft. This magnetic high is terminated on the west by the large N-S structural zone and at the intersection of at least two other lineations.

Central Northern Area: The northern central zone consists of two areas of interest; both appearing as magnetic high ridges striking N-S, and both terminated to the south by NNW structure.

The easterly and most magnetically pronounced ridge has exposed granite and schist units. The southern tip of this ridge, which is a fairly pronounced symmetrical oval magnetic high has an indicated depth of 100 ft.

The west ridge is broader and less pronounced magnetically. Depth estimate is 500 ft on the north end.

Northwest Corner of the District: The mainly alluvial covered NW district is separated from the central northern area by a distinct structural zone trending N-S. The area is traversed by several NW and NE trends. The indications are mostly of slight down dropping or more erosion related to the region to the south and that the sub-alluvial formations are mainly apt to be granite and basalt. A depth of 600 ft. is estimated over the maximum anomaly.

South Central District: This district represents a magnetically high area bounded to the NE and E by major structural entities. The eastern border is terminated by the regional N-S structural zone and the northeastern border is bounded by the major NNW structural zone. One other major magnetic feature within this district is an E-W zone reflective of

magnetic highs to the south and lows to the north. Minor mineral production has occurred along this structure.

Within this district there are several minor magnetic trends which economically may also warrant further interest considering their trend intersections and geologic associations.

Depth estimates have been determined over two of the prominent magnetic highs on the eastern periphyry of the district. The first gives a calculated depth of 500 ft. to the top of the anomaly. This magnetic high is located in the extreme SE of the district. The second, located in the NE gives a calculated depth of 600 ft. to the anomalous mass. However, some strong polarization is known to exist in the region.

Southwest and West-Central District: Here there are several NNE elongated magnetic highs with associated NW and SE offsetting magnetic lows. The structural features within the district are minor and generally strike N-S, NW and NE. Some minor production appears to be associated with the NE trends in the southern part of this area and the extreme western part of the adjoining south central district. Depth calculations have been computed over three magnetic highs in the district. All of these values occur over highs located in the extreme southwest section of the area. A figure of 600 ft. to the top of the anomalous mass has been determined for the southernmost elongated magnetic ridge and 300 ft. for the next northerly

elongated magnetic high ridge. On the western periphyry and mid-center of the area there occurs a magnetic high which is normal to the general trends and a depth calculation of zero feet was obtained; thus the anomaly is probably due to the contact of the three rock types present in this area. Again, strong polarization effects are also to be expected in parts of the area.

AREAS OF INTEREST

Three areas, A, B and C are designated. A, of course, includes Jerome which has been one of the world's major copper producers. B includes Shattuck-Denn's underground Iron King lead-zinc, silver-copper mine. C is a tentative area of interest east of Prescott.

Lineations in almost every direction found in the area are at or near Jerome. All of these relate to structure, rock type, terrain, polarization and various combinations of these. Relation to mineralization is another matter. Obviously the Jerome problem is compounded by very complex geology and rugged terrain. Nevertheless, a careful magnetic-geological-ground correlation and study is definitely justified.

Similar comments apply to area B except that topographic relief is more moderate than at Jerome and to date the copper yield has been small.

Area C will require finding further evidence that subsurface geology may be more favorable than that which is exposed.

BAGDAD AREA, YAVAPAI COUNTY

U.S.G.S. Aerial Magnetic Data from this area was interpreted in some detail in G. S. A. Memoir 47 by Vacquier, et al., 1951. In general, we agree with the more obvious basic premises presented in this memoir. However, we also have some important additions, alternatives and exceptions.

First, there is insufficient regional coverage and thus, nothing else to compare with to allow for a more reliable relative interpretation of the larger, more apparent features. Therefore, it is necessary to make a much less certain absolute appraisal of single units. For example, an explanation equally plausable to that mentioned by Vacquier, et. al., for the large low west of Bagdad, is basalt edge effects and/or a SW plunging structure (anticline ?) of more basic rocks, related to the Mulholland Basin and the Copper King areas, and with these units draped over the presumably intrusive quartz monzonite stock of the Bagdad deposit. Certainly this low is well confined within a zone of the highest magnitude magnetic highs on the map and polarization effects are a distinct probability, as are some effects from topography. Similarities and differences with the other exposed mass of quartz monzonite to the north-east gives rise to further speculation, including that of more extensive monzonite.

Other than the large granite-related flat area, the most

significant and important magnetic effects are especially the N-S and possibly two NE-SW regional (?) trends, with respective intersections approximately near Bagdad, Hillside or Kyeke, and Grayback Mountain. The N-S trend continues south on beyond the Old Dick Mine.

Geology indicates an arcuate or circular pattern of the Sanders basalt around the Lawler granite. Magnetics show a similar circular pattern, but much wider. Therefore, the formations mapped geologically in this part of the area, especially those striking NE, may be relatively shallow.

Other than as mentioned above, the basic magnetic relief mainly reflects the broad rock types indicated by the known surface geology.

Major Regional Magnetic Trends

The first major trend occurs in the center of the area and represents a magnetic high oriented NE-SW. The second, also a magnetic high zone, again in the center of the area, oriented approximately N-S. The third major feature is a magnetic low, located in the lower center of the area to the NE corner. The low has a general trend of N-S.

Minor Regional Magnetic Trends

The four minor regional trends in this area occur as two magnetic high zones trending N 30° E, one in the western section of the map and the other in the southeastern section. The two

magnetic lows are trending NE-SW, one in the SE-central region and the other in the NE to central section.

AREAS OF INTEREST OTHER THAN BAGDAD PROPER (AREA "A" ON MAP)

"B" Area - Kyeke Mine. A little south of west from Kyeke is the second most outstanding magnetic low on the sheet. Although less favorable geologic formations are exposed here, there are the following criteria to be considered: 1) Extensive basalt cover could mask more favorable rocks. 2) Sulfides are known at Kyeke. 3) Although this is near the western limits of magnetic coverage there appears to be a triple magnetic trend intersection north of this low, a N 35° E, an E-W and a more nebulous N 35° W. 4) Anderson's geology (Prof. Paper 278) matches this magnetic thinking nicely and the magnetic trends agree, indicating anothosite dikes to the southwest trending about N 45° E but turning sharply north in the vicinity under discussion. Quartz monzonite dikes and plugs, trending about N 25° W and apparently terminated exactly in the area of interest, and the E-W trend of (a) Boulder Creek, (b) Sanders basalt of Centipede Mesa, suggest that this area be given a close ground check.

Also, possible extension of the mineralized zone to the north from the present Bagdad proper area is indicated by the continuation of the magnetically central low area and in the vicinity of the contact between granitic and schistose rocks

toward the Hillside Mine, and similarly area "C" south toward Copper King and Old Dick Mines and beyond.

In the northeastern portion of the map, situated on the N-E trending magnetically high zone, a possible area of interest, Area "D" occurs which is associated with a similar magnetic and geologic environment as the Bagdad proper area. This includes the magnetic low near White Springs Fault which, though apparently not showing much on the surface, may still justify checking for mineralized monzonite at depth. The main NE granite mass may have a halo at depth of various acidic rock types such as monzonite or quartz-monzonite which are occasionally exposed in the main mass.

Generally, none of these are considered exceptionally excellent prospects but they do bear comparison with the other possibilities in other regions.

GLOBE QUADRANGLE

Regional Effects: The quadrangle can be divided into six major magnetic zones. The three northern zones: ENE, WNE and NW consist of numerous variations due to both anomalous magnetic and rock conditions; the fourth, an east-west central stable region; the fifth, a southwestern zone consisting of several magnetic highs and lows, of which a considerable amount may be associated with the rock characteristics; and the sixth, a SE portion which expresses mainly regional magnetic gradients and trends.

North-Western Zone: This zone contains most of the major area-production and is bounded to the east by a known fault (trending approx. N-S) and on the south by probable E-W faulting. Through the sector there are at least two other N-S and two NE-SW trending faults as well as numerous other faults trending NW.

The magnetics appears to be trending (both highs and lows) N 45° E and N 45° W. In general, with one exception, the highs and lows appear not to be associated with the rock magnetism. The exception being one area in the volcanic region which appears to be an expression of dipole effects within the rock units.

Areas of interest are: A--Miami-Inspiration main production zone; B--Miami's Copper Cities pit area; C--Castle Dome pit area;

E--Cactus marginal disseminated-open-pit ore body; F--Schultz & Stoval - Bluebird leach area; G, H, I, J & K--lesser known potential areas of interest.

East-Northeast Zone: The area in general seems not to be expressive of the rock magnetism and the magnetics appear to be associated with rock type interfaces and structural features.

Several major known (from geology) faults are present in the area. These together with the related rock types and magnetic characteristics should be studied in further detail on the ground. The known area of interest "D" contains hundreds of small workings and prospects and several significant underground vein-type producers such as Miami's Old Dominion and a few others. Although nothing else specific can be referred to, the general aspects are favorable for this zone.

West-Northeastern Zone: The area has no extensive and significant exposed outcrops and magnetically, with the exception of one high and low area, appears to be of minor interest. This zone is bounded on the west and east by N-S trending faults.

The low and high appear to be under less than 1,000 ft. of post mineral cover. Owing to this and the proximity to Miami's Copper Cities production nearby it might warrant reconnaissance ground geophysics, in particular, induced polarization surveys. This zone is included under tentative area of interest "I".

Central Stable Region: This area extends in an EW direction with a total relief of about 200 gammas with some minor highs and lows. The area is terminated to the north by a structure and as the magnetic evidence shows, a steep slope increase to the north. The southern boundary is more irregular but again indicates topographic rise and older rocks exposed.

Several important magnetic trends are normal to this region, running N-S across the possible major E-W break and going down the middle.

The whole zone suggests thick continental sediments and is known to have at least 3,000 ft. of post mineral Gila conglomerate which is the exposed formation.

Southwestern Zone: The magnetic features may be divided into three parts, all essentially included within tentative area of interest "J".

1. (Eastern Area) The pattern of the highs and lows and their range of magnitude is mainly reflective of the dipole features of the rock units involved.

2. (Western Area) Again the pattern and order of magnitude is reflective of the rock characteristics which is expressive of several dipole type features not associated with an anomalous condition.

3. (Central Area) This zone has both minor highs and lows which exhibit no definite pattern and are believed not to be features of the rocks involved. There are likely several

main structural features trending through the area in a N-S, NE-SW and NW-SE direction. The order of magnitude of magnetic relief in the area is 200 gammas.

Much of area "J" is fairly rugged and inaccessible. However, there is some known mineralization. Bear Creek Mining Company has recently been conducting exploration operations in the area. The topography of the area is such that the magnetic highs may be situated over topographic highs and the offset lows in the topographic depressions.

Southeastern Zone and Tentative Area of Interest "K": The main interest here is the intersection of two major NW and NE trends, with fairly steep associated magnetic gradient effects, all in the vicinity of schist-granite exposures.

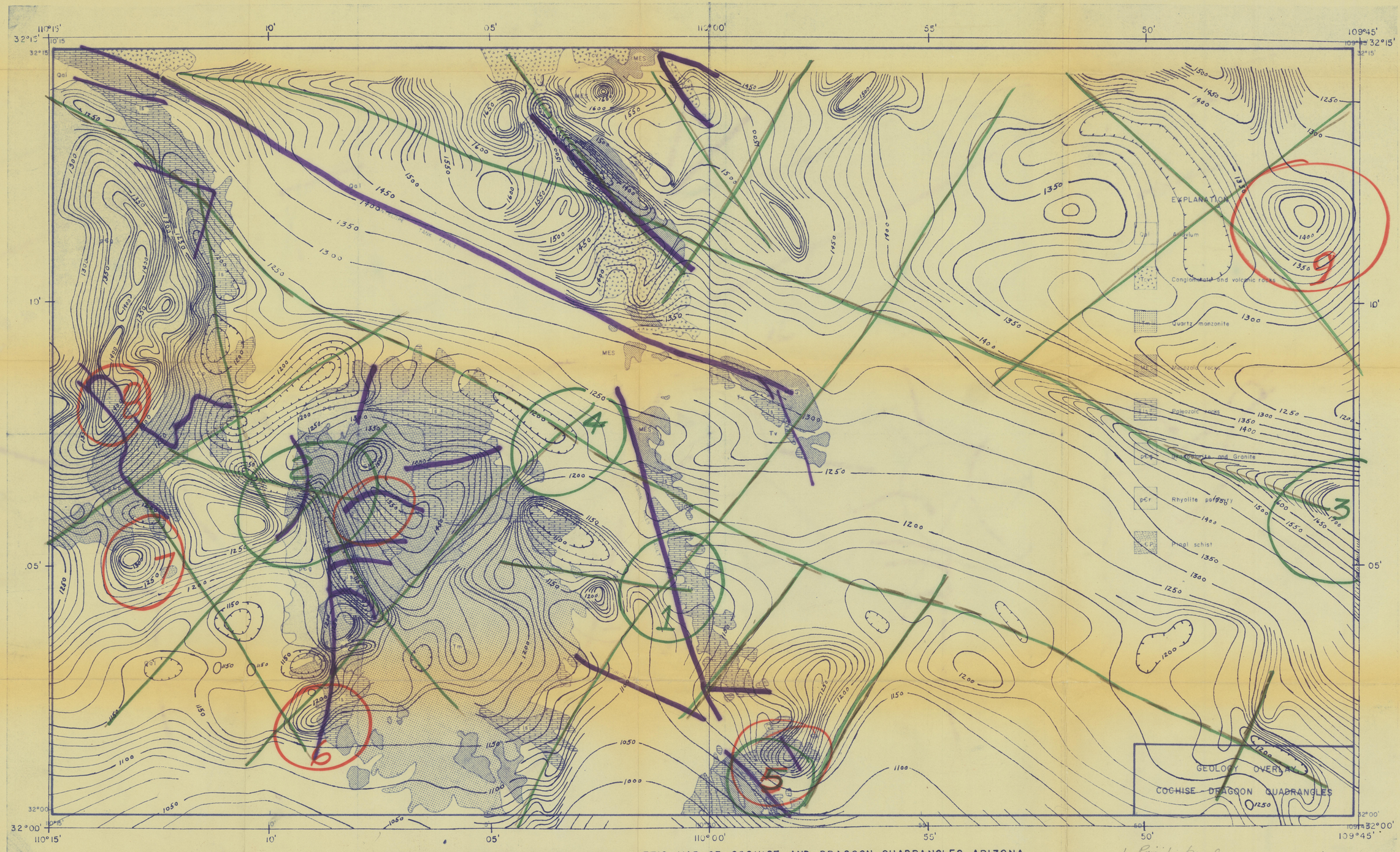
GENERAL COMMENT

By far the major value of production from the district has come from on or near a somewhat indefinite easterly-westerly lineament zone running easterly from Miami's Cactus deposit, area "E" on the west, then somewhat south of Miami's Castle Dome open pit, area "C", to just south of the main Miami- Inspiration area "A", and on to Miami's Old Dominion Mine just north of Globe in the southwest part of area "D". However, the main magnetic lineations are NE, NW and N-S, and at least one or two or more of these are associated with each producing area.

Many of these are apparently not surface evident and therefore do not show on U.S.G.S., PP #342 by Peterson.

Without more geologic familiarity with the district, we hesitate at this time to assign an exact correlation between any specific lineation pattern or intersection and ore genesis. Definitely more and doubtless very important ideas along this line will be revealed by added comprehensive and detailed study, but of course, nothing totally infallible is likely to develop.

For now, all that should be added to the above inferences is that in the main known area "A", some obtuse (or acute) intersections and/or bending or flexures are perhaps uniquely involved, but probably the total relationships are rather complex.



FROM U.S.G.S. OPEN FILE

PRELIMINARY TOTAL INTENSITY AEROMAGNETIC MAP OF COCHISE AND DRAGOON QUADRANGLES, ARIZONA

RELATIVE TO ARBITRARY DATUM

0 1 2 3 4 5 MILES

Contour interval 10 Gammas

Flown approximately 500 feet above the surface

1952

J.W.M.

Information

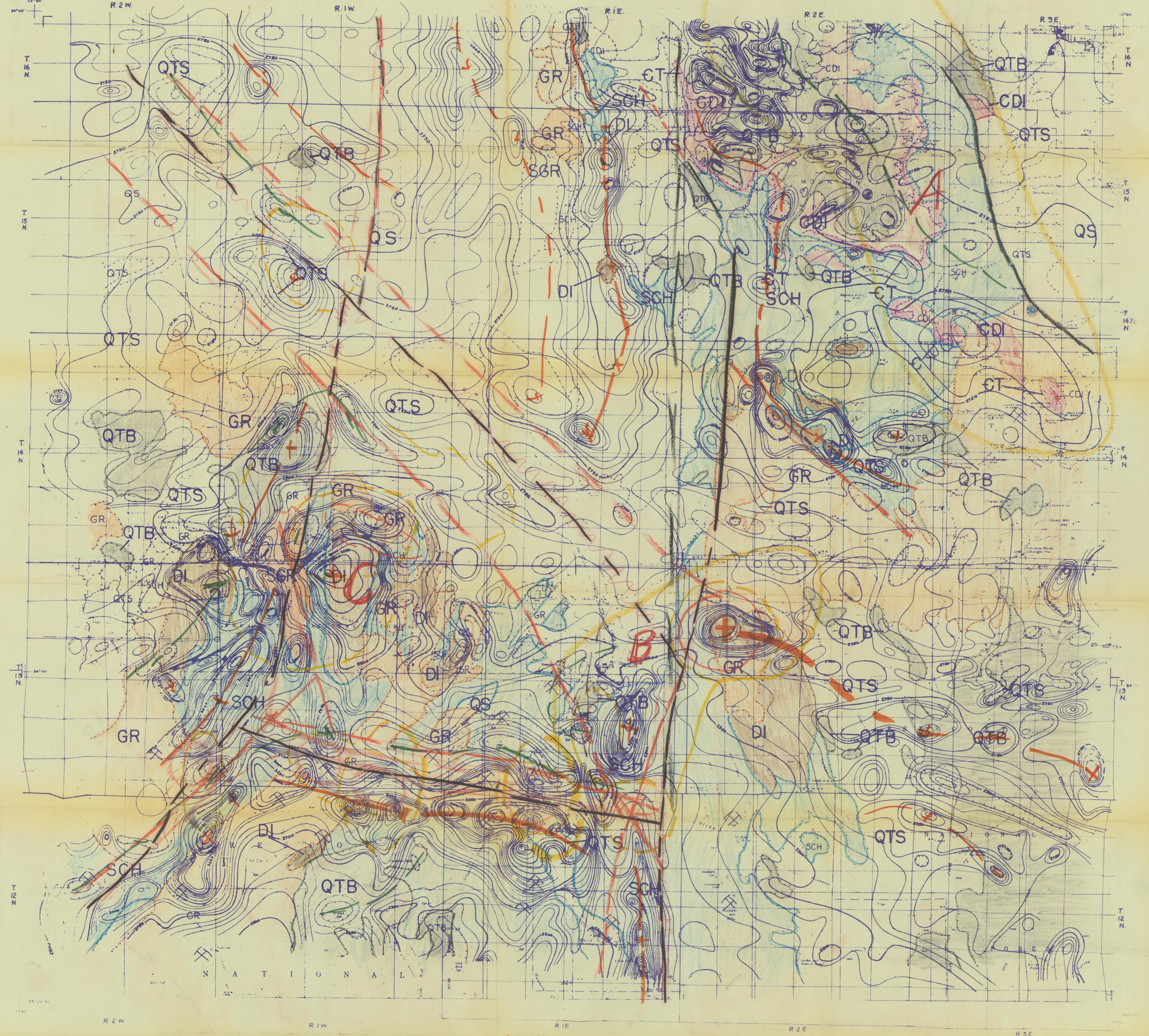
published faults

magnetic lineaments

× prospect pits

□ shaft

1. Priority based on geologic envir. & strength of lineaments
2. Recommendations



EXPLANATION

GR	GRANITE	SCH	SCHIST	DI	DIORITE PORPHYRY
QTB	BASALT	QS	GRAVEL, SAND & SILT	SGR	GRANITE & SCHIST UNDIFFERENTIATED
ЄT	TONTO GROUP	QTS	SILT, SAND & GRAVEL	CDI	REDWALL & MARTIN LIMESTONES

— = faults

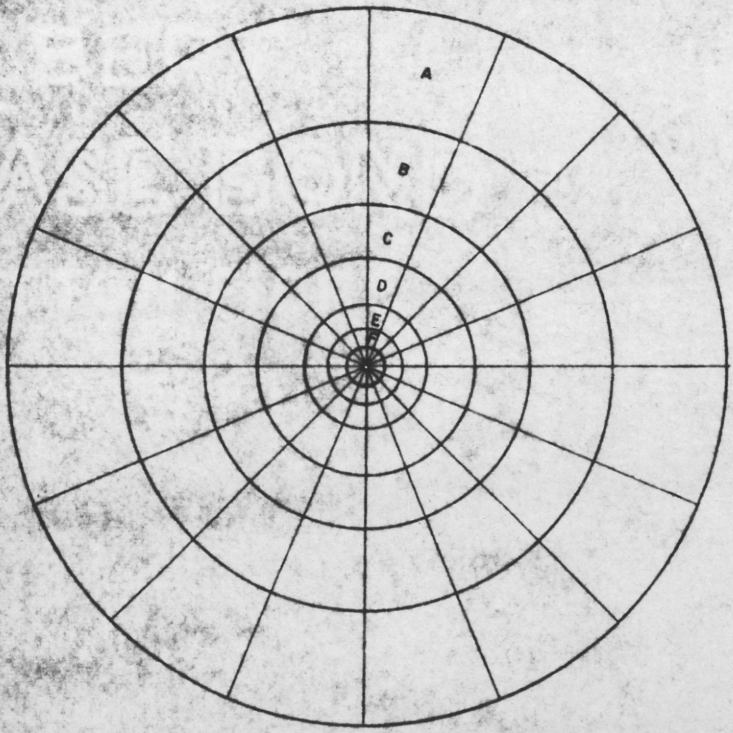
N

HEINRICHS GEOEXPLORATION COMPANY
P.O. Box 5671 Tucson, Arizona

COMPOSITE AERIAL MAGNETICS
AND GEOLOGY
FOR
SUPERIOR OIL CO.
MINERAL DIVISION
JEROME - PRESCOTT AREA
YAVAPAI CO., ARIZONA

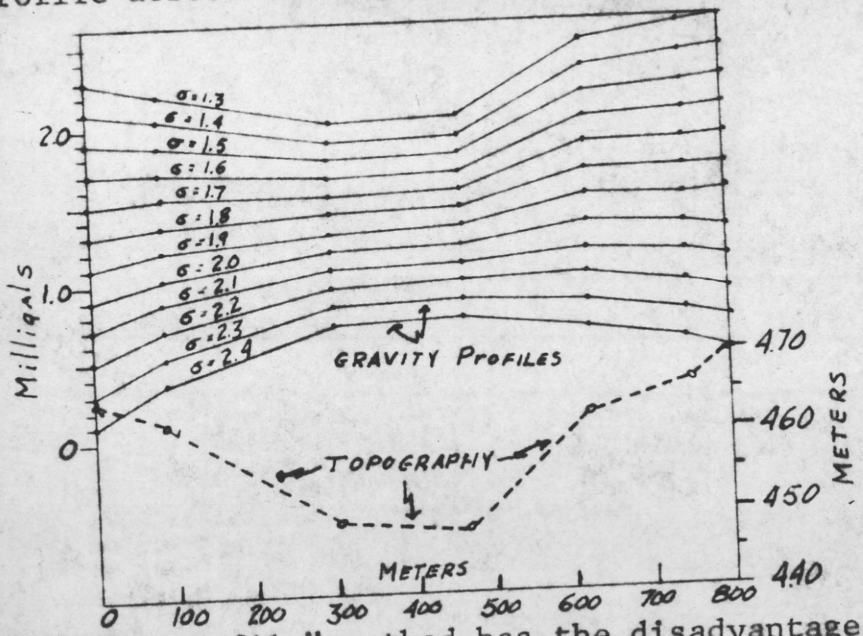
SCALE: 1" = 1 MILE APPROX.	CONTOUR INTERVAL: 50 γ	REVISIONS
	DATA BY	
DATE: SEPT. 1963	SHEET OF	
DRAWN BY: E. G. H.	DRAWING NO.	FILE:

rt is then centered at the gravity station which
ated on a topo map, and the average elevation of
partment is estimated from the map. The station
then subtracted from compartment elevation to giv
ference between the compartment and the station,
value h. Then for each zone the attraction in u
mg. is read from the "T" column of the bable as
responding to the Range within which the "h" valu



since the bou
y of the surface mat
ion differences a measureme
e.

his measurement, or profile consists of taking a seri
sely spaced stations over a local topographic irregul
rably a hill or valley or both). The gravity values
educed for different densities. The criterian for th
density is that which gives the smoothest reduced
y profile across the topographic irregularity.



e"density profile" method has the disadvantage
e gravity differences are needed, especially if
lief is small.

profile of the stations with the observed gravit
ious corrections and gravity values is shown by
ng illustration.