INTEROFFICE CORRESPONDENCE

LOS ANGELES

TO S.W. Exploration

ATTENTION B.N. Watson

FROM B.E. French

SUBJECT Geological Mapping and Geophysical Surveying Bromide Project Rio Arriba County, New Mexico

DATE: February 3, 1977

L. A. FILE via R.C. Munro & R.B. Kistler

YOUR FILE via B.N. Watson

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SUMMARY

The Bromide massive sulfide target is conceptual and is based on the presence of volcanogenic copper shows which are restricted to one horizon in a schistose pile of meta-andesites. Mapping revealed that these rocks occur in a thick series of interlayered Precambrian clastics, volcanoclastics, and flows which are characterisitic of a volcanogenic-type environment.

While rhyolitic ash flows with abundant quartz eyes are interlayered throughout this sequence, they are usually hard, siliceous and unaltered. The only well-altered ash flow occurs above the zone of copper-bearing andesites. Although not in actual contact with the mineralized zone, the altered ash flow could be the result of a volcanogenic system centered in the target area of the Whale and Pay Role mines.

Mapping showed that the NW trending metavolcanic belt in the district has been offset repeatedly and greatly complicated by NE trending cross faults. Fortunately the area of interest appears to be intact in one fault block.

Initial prospecting in the district was for younger Ag-Cu quartz veins which have cut the older volcanogenic mineralization. Thus workings like the Cosart and the Whale (see Map 2) were probably located on quartz veins and then with depth encountered the mas-

sive sulfide ore which is now in evidence on the dumps.

I.P.-Resistivity surveys were negative as expected, but indicate that if any massive sulfides are present, they must be greater than 200 feet below the surface. Although magnetite appeared to be interlayered ubiquitously in the meta-andesites, results of a ground magnetic survey show a large, elongate high which sub-parallels the zone of copper-bearing schist. The high widens and intersects the copper horizon in the vicinity of the Pay Role mine.

Core drilling is planned as soon as the snow melts this spring to test the potential at depth in the vicinity of the Pay Role and Whale mines. Prior to drilling, fill-in magnetic surveying is planned and detailed cross sections will be constructed to help calculate the necessary angle and placement of the drill holes.

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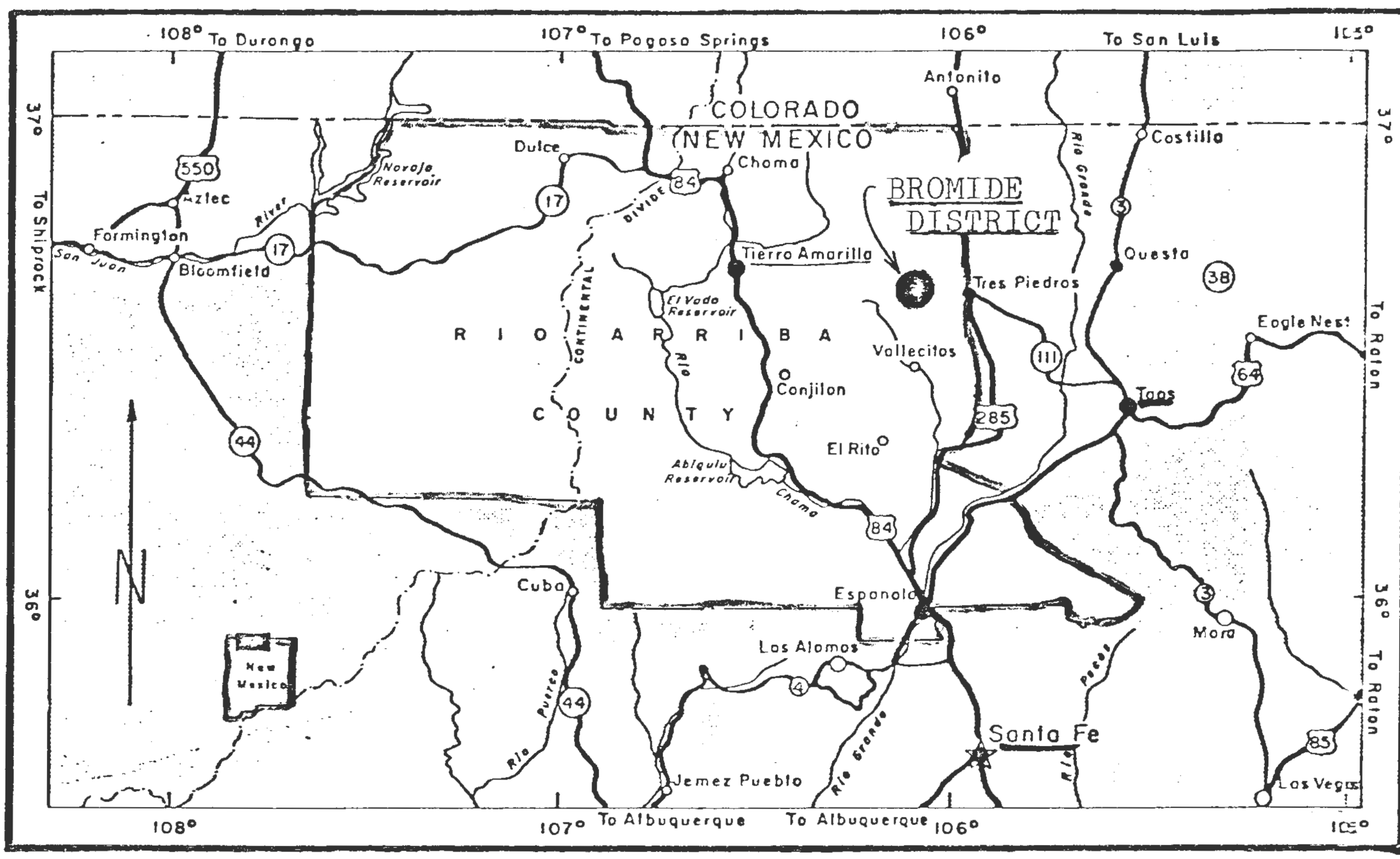
MAPS



Map 1. Index of the Bromide District, Rio Arriba County, New Mexico

INTRODUCTION

The Bromide project located in the Tusas Mountains of Northern New Mexico (see Index Map) resulted from our massive sulfide reconnaissance program during the summer of 1975. As described in an earlier USB report, dated December 8, 1975, the target is conceptual and is based on the presence of copper in the vicinity of a favorable andesitic-rhyolitic contact. Although the land available for acquisition was small, it consisted of the heart of the district and was felt to have the best potential. The property was finally acquired and drilling was recommended.

Because of the complexity of the geology and the smallness of the target, detailed geologic mapping and selected geophysical work was necessary prior to spotting any drill holes. The writer spent about 4 weeks during August and September mapping in the project area. This was followed in September by about 2 weeks of detailed I.P.-Resistivity and ground magnetic surveying by Mining Geophysical Surveys, Inc., over what was felt to be the critical area. Mapping was done using a 1-inch to 500-foot scale map, and the attached map is a 1-inch to 1000-foot reduction of the field map.

Drilling, originally planned to follow this work, was postponed due to budget overruns on other projects. Drilling at Bromide has now been slated for this spring as soon as the snow melts.

LAND STATUS

After extended negotiations, mineral rights to four patented claims belonging to H.S. Kuykendall were finally obtained. Because of our drilling postponement, our lease has been renewed for a second year.

Ownership of the Pay Role patented claim is still in limbo.

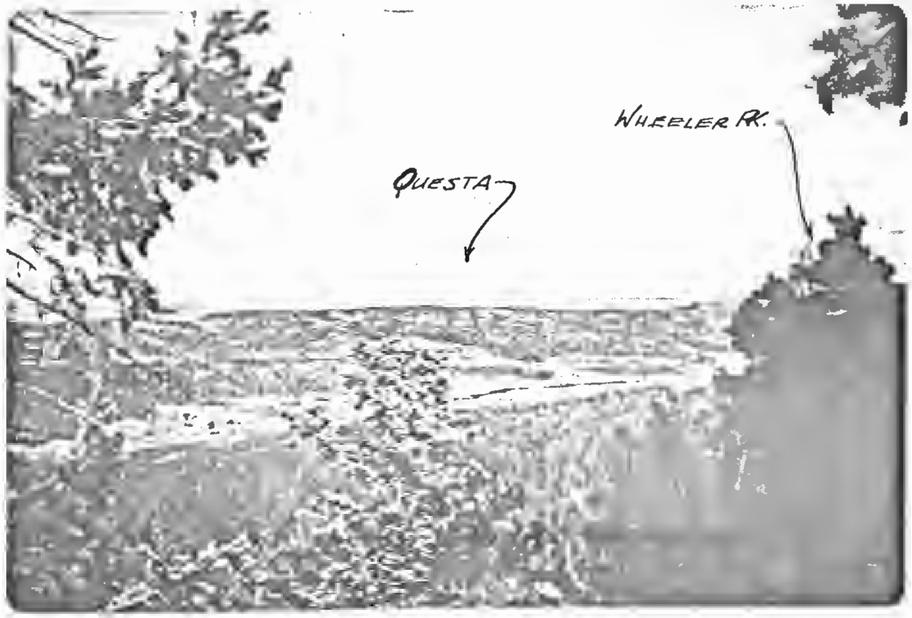


Plate 1A. View from Tusas Mountain looking east towards Rio Tusas Valley (foreground) and the Sangre de Cristo Mountains in background. Note: Questa mine dump in center background.

Plate 1B. From same location (1A) looking southeasterly towards Taos, N. M.

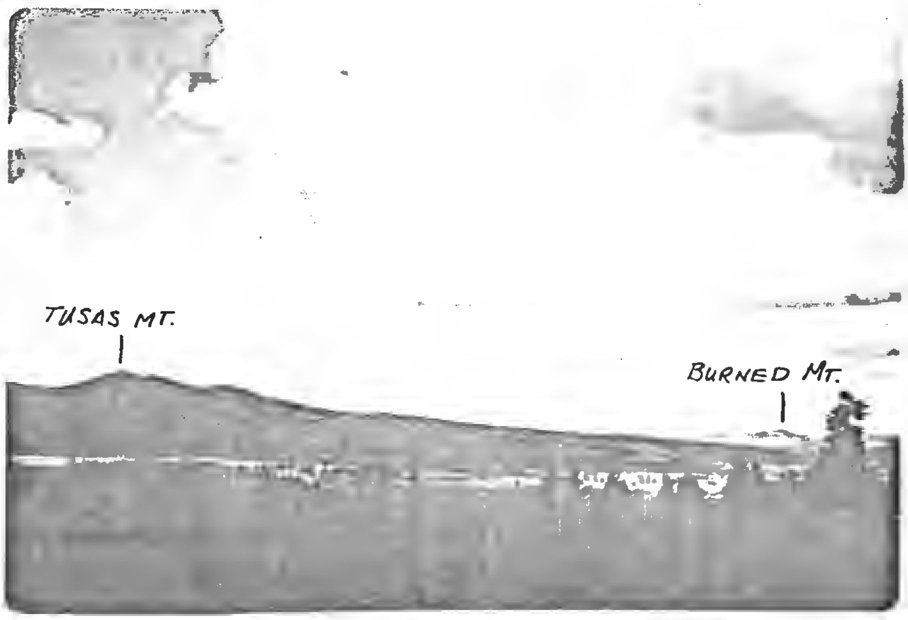


Plate 2A. From Rio Tusas Valley looking west and showing the fairly low relief of the Tusas Mountains. Map area extends from Tusas to Burned Mountain, approximately 5 miles in length.

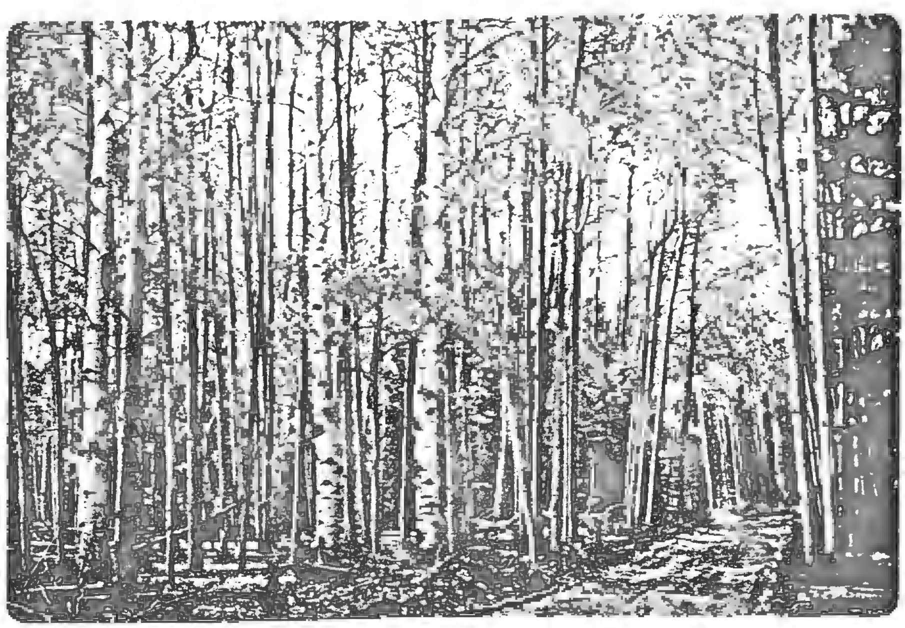


Plate 2B. Fall colors in the Bromide district, shows typical vegetation in the area.

Because of the excessive expense that would be involved in an attempt to track down the present heirs, and because no one else can legitimately acquire this claim, it was decided to continue the search only if our scheduled drilling proves encouraging.

The status of the unpatented claims which surrounded us improved in 1976. Earth Sciences relinquished all of their remaining Burn claims. It was hoped that Nord Resources would do likewise, however, inspite of the lack of physical evidence, they did file for their annual assessment on September 20, 1976. Nord's claim descriptions are very inaccurate, and the resulting plot does not agree with actual field locations. A survey of the actual claim corners would be needed for an accurate location.

Eleven unpatented claims, Tusas No. 1-11, were located on September 28, 1976, to acquire that part of Earth Science's former ground essential to our project. These claims were then validated with 10 feet drill holes on November 16, 1976. A map of the current land status is on file with the L.A. Land Department and with the Tucson office.

REGIONAL SETTING

The rocks in the Bromide district display high green schist to low amphibolite metamorphism. Original textures and primary features are still readily discernible. Recent work in Colorado revealed a much higher grade, amphibotite-granulite facies. Likewise, work in the summer before last showed a higher grade metamorphism from the Petaca district, immediately south of Bromide, to the Pecos district near Santa Fe. For some reason, the Bromide district has been the area least affected by metamorphism in the Colorado-New Mexico Precambrian belt. This may be related to pegmatite activity, since pegmatites are quite common in the rest of the belt, but absent in the Bromide area.

On a smaller scale, within the Hopewell-Bromide area, it is interesting (and possibly significant) that the target area is situated just about midway between two occurrences of iron-bearing greenschist, Jawbone Mountain about 5 miles to the northwest and Cleveland Gulch about 4 miles to the southeast. These iron-rich zones may represent the distal ends of a volcanogenic system which had its center in the copper-rich Bromide target area. Our examination of the workings from the Jawbone to the Cleveland Gulch area showed that the occurrence of copper in schist was much more abundant in the Bromide area.

GEOLOGY

The geology of the Bromide district has been mapped on a regional scale twice in recent times. The most helpful of these studies, economically, was that by Bingler, 1968. However, he took most of his geology from the earlier map by Barker, 1958. Unfortunately, while Barker may be well qualified as a petrographer and his overall conclusions reasonable good, his geology in the Bromide area was highly inaccurate to say the least. This can be seen by comparing Figure 2 in my report of December 8, 1975, with Map 2 in this report.

To begin with, Barker's map implied a more or less continuous belt of metavolcanics and metarhyolite throughout the district. This is not the case. Not only has the district been uplifted along major NW-trending border faults, but it has been transected by numerous northeasterly trending cross faults. This has resulted in a fairly complex structural picture in which the metavolcanic belt has been offset repeatedly. Adding to the distortion, Barker mapped large areas in Sections 16, 21, and 22 as his upper quartzite member of the Kiawa formation when, in fact, what he was mapping was thick alluvial cover consisting largely of quartzite cobbles. Also the metasediments

Plate 3A. Typical vegetation and rock exposure from map area. Shows small prospect pit in meta-andesite near confluence of left and right forks at Rock Creek.

Plate 3B. Typical hazard of the area.

("ms") present were not recognized.

Because of the complexity, a reconstruction of the structural offsetting would require much more study. Several interpretations could be possible from the geology as presented on Map 2. Fortunately, the area of primary interest (Section 15, and parts of Sections 14 and 16) seems to be contained in one structural block and more work along these lines is not necessary, especially since our past reconnaissance has ruled-out any apparent potential elsewhere along strike. Thus, without giving a detailed account of the structure, the present mapping indicates the following structural history for the map area: (1) The main ridge of the Tusas Mountains at one time must have been completely, or almost completely, covered with alluvial gravels; probably from a high belt of quartzites (kgu) which still crop out along the southwest flank of the area. (2) Rapid uplift along the major NW faults (see fault in Sections 17 and 21) caused stripping of the alluvial cover and rapid erosion of the metavolcanics to the NE and SW, so that much of the map area was still covered in its own debris. (3) When the NE cross faults first formed is uncertain, but their most recent movement offsets the older gravels as well as the metavolcanics and probably the older NW border faults. The area is still positive and erosion of the higher bedrock along with dissection of the older gravels is still in progress.

Geologically or stratigraphically, the area is well-suited to our volcanogenic model. Except for small intrusives in the Tampa mine area, all the rocks are Precambrian in age. The oldest, and most of the rocks exposed in the map area, consist of a complex series of clastics and volcanoclastics interlayered with andesitic flows and rhyolitic ash flows. I have called this sequence the Moppin group, after Barker's metavolcanic unit. The individual formations are described on Map 2 and will not be described further in this memo. The Burned Mountain metarhyolite of Barker, 1958, is included in the Moppin group, as it definitely resembles a welded ash flow rather than the intrusive sills of Barker. Inspite of origin, this rock (mr-1 and mr-2) is definitely rhyolitic and marks a break in a predominantly andesitic sequence, which is important for our concept. The interfingering andesites, agglomerates and sediments which make the majority of the Moppin, also show that at the time of their origin, the map area must have been a submarine basin which was rapidly accumulating clastic debris and intermediate volcanics -- the perfect volcanogenic massive sulfide environment. A typical section of Moppin group going up-section along a NNE tributary of Rock Creek (Sec. 15) is as follows:

<u>Meta-andesite (ma)</u>:

(1) Cu-bearing stretched pebble andesitic agglomerate

(2) andesite and porphyritic andesite

(3) stretched pebble agglomerate

(4) andesitic lava flow

(5) porphyritic andesite

<u>Metasediments (ms)</u>:

sandy siltstones (phyllite): coarse sand at base grading upwards to fine silt with conglomeratic interbeds

<u>Meta-andesite (ma)</u>:

andesitic flows and porphyritic andesites

<u>Metarhyolite (mr-2)</u>:

rhyolitic ash flow with abundant quartz-eyes in a sericitic and chloritic matrix

The Moppin group is intruded by a granodioritic gneiss and by a quartz feldspar porphyry. The best intrusive relationships of the gneiss are seen in the NW¼ of Section 9 and the SW¼ of Section 4 (north of 9). It is an equigranular, quartz-rich rock which in the map area appears to be sill-like in nature. The quartz feldspar porphyry is more of a stock-like mass which

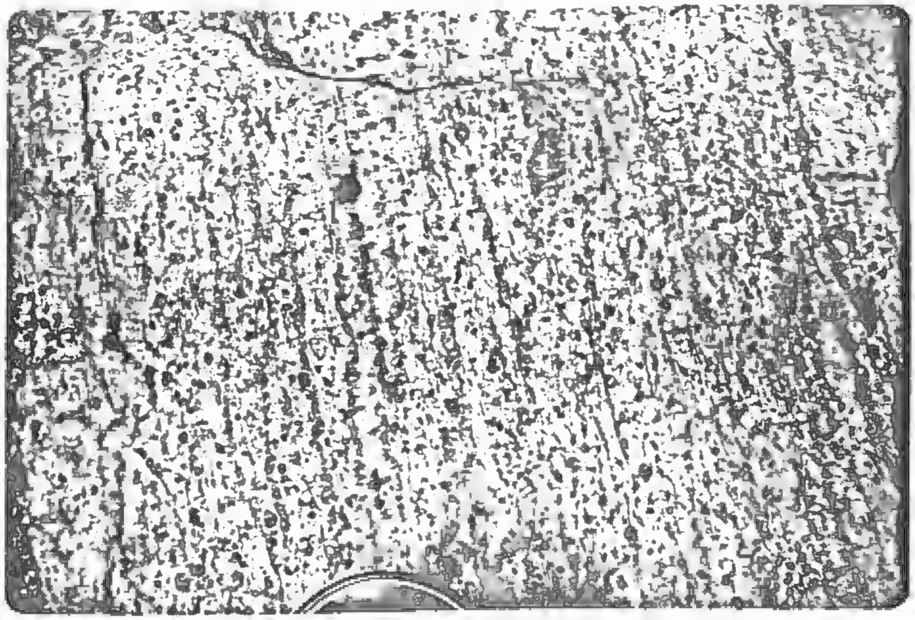


Plate 4A. Close-up of Burned Mountain metarhyolite (mr-1), showing welded or eutaxitic nature of what originally was an ashflow tuff. Notice abundant quartz and K-spar eyes, inclusion with flow structure around it, and pink stringers of remobilized silica (lens cover on left for scale).

Plate 4B. Close-up of conglomeratic horizon in the Moppin metasediments (ms). Notice large pink cobble (in center) of metarhyolite (mr-1).

Plate 5A. Close-up of quartzitic member of Moppin metasediments (ms) showing obvious cross bedding. Such cross bedding was useful in determining whether beds were overturned.

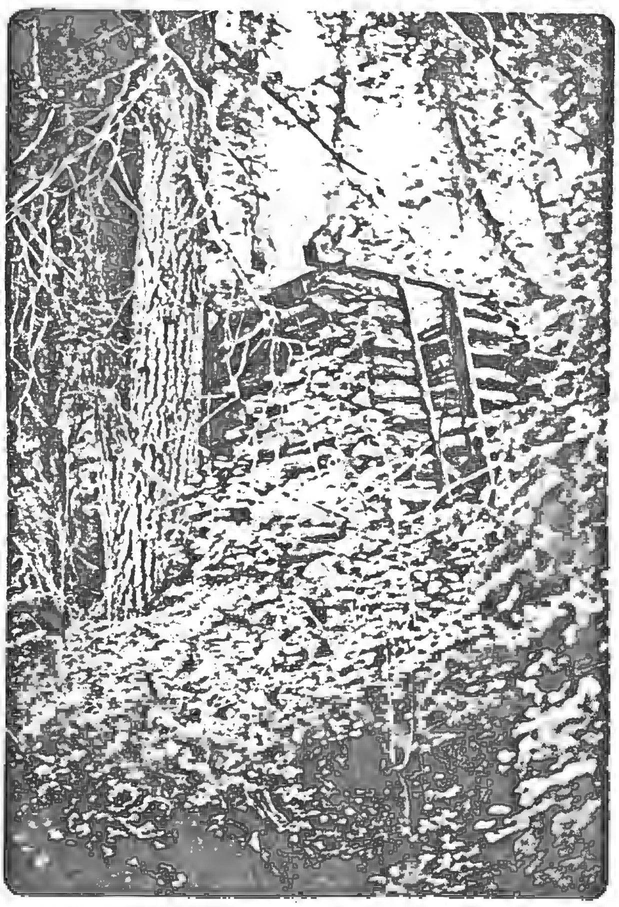


Plate 5B. Possibly the oldest two holer still standing in the SW!

forms Tusas Mountain. It intrudes the Moppin meta-andesite (best seen in the NE¼ of Section 23), but its relationship to the granodiorite is not clear. Barker, 1958, shows it as younger than the granodiorite. Locally (see pit on NE side of Tusas Mt.), the porphyry is well-sheared and closely resembles the metarhyolitic ash flows of the Moppin group. However, stratigraphically, it seems unlikely that it could have been the source of the metarhyolite, mr-1, to which it is most similar.

The only other Precambrian rocks exposed in the map area are the hard vitreous quartzite (kqu) which bounds the district on the southwest and an unnamed metamorphic in the Cleveland Gulch area. A small Tertiary intrusive at Tampa mine and some nearby dikes are the only rocks younger than Precambrian.

ALTERATION-MINERALIZATION

All the rocks in the Bromide district have been altered. However, the only alteration which might pertain to our target occurs in the metarhyolite mapped as mr-2 (N½, Section 15). Assuming that this rock was originally of a hard, welded, siliceous composition like that of mr-1, it is now completely altered to a soft sericitic and chloritic matrix.

Elsewhere in the Moppin group, alteration (aside from the normal widespread chloritic-sericitic greenschists of the andesitic units) occurs locally along sheared fault zones and adjacent to intrusives. The metasediments alter to a completely sericitic phyllite (resembling mr-1) in sheared zones along faults, and the meta-andesites generally become silicated and epidotized near the contact with the granodiorite gneiss. The chloritic-sericitic metamorphism occurs throughout the meta-andesite unit (ma) and not enough variation is present to map the changes. In general, the grade of metamorphism (or alteration) increases toward the Cunningham Gulch area.

The granodiorite often contains abundant quartz veining and secondary biotite and K-spar can be found on fractures. The Tusas Mountain porphyry as well as the granodiorite is intensely sericitized in the vicinity of the Tampa mine. This is most likely due to the Tertiary intrusive and mineralization.

Copper occurs in two modes in the Bromide district: in quartz veins and in the meta-andesite or greenschist. The copper in the metavolcanics is disseminated and occurs in stringers parallel to the schistosity and is almost certainly volcanogenic in origin. At the Cosart prospect amorphous silica nodules also occur in the andesites parallel to the schistosity.

The volcanogenic occurrences are restricted to a linear zone extending from the Pay Role shaft northwest for about 1-$\frac{1}{2}$ to 2 miles to the Cosart prospect. This zone is bounded on both ends by NE trending crossc faults. The Bromide mine may be on an offset extension of this zone, but most of the mineralization there seems to be related to a quartz vein. Elsewhere in the district copper is definitely related to quartz veins. While the copper-bearing schist horizon is not immediately adjacent to the metarhyolite on the surface, it may well encounter an interfingering unit of metarhyolite at depth.

The quartz veins occur throughout the district. Most are barren (devoid of copper) and most occur along faults or seem to be related to faults. The veins appear to be Precambrian in age, but their association with Tertiary faults could easily make some of them at least much younger. Whatever the age of the faults and associated veins, they offset and thus appear to be younger than the volcanogenic mineralization. Thus, the origin of the copper in the district seems to be volcanogenic and the copper in the quartz veins could well have been remobilized as the veins cut the older deposits.

The fact that there are not any major prospects (other than the Pay Role) which expose solely volcanogenic sulfides can probably be attributed to the early prospectors who were prospecting almost entirely on quartz veins. Thus, much of the good-looking massive sulfide mineralization exposed by these workings occurs in close proximity to quartz veins and faults. It is possible that massive sulfides could occur (as at the Pay Role) without the superposed quartz veins and thus have been missed by the oldtimers.

Because of time and the fact that the copper distribution was easily delineated visually, sampling was not undertaken. However, in a telephone conversation with Dave Giles of Earth Sciences, it was learned that they did grid sample the entire district using soil with rock chip where possible. They obtained a linear, "low-level" copper-zinc anomaly exactly where it would be expected: from the Whale area southeasterly to about ½-mile past the Pay Role. Fill-in samples in this area showed no better definition.

GEOPHYSICS

Separate reports by Mining Geophysical Surveys are included with this report. Their work is summerized on Maps 3 and 4 which are overlays for Map 2. Six lines of I.P.-Resistivity were run over the zone of volcanogenic copper occurrences. Results were uniformly disappointing. The low conductivity zone found northeast of the Pay Role is undoubtedly a fault zone and the more anomalous response at the southwest end of lines 1 and 2 is probably due just to the change in rock type.

From the start it was realized that I.P. would probably not be of much use, since our target is probably too deep and too narrow to be seen. A short dipole spacing can detect narrow bodies, but has no depth penetration. A wider spacing gives more depth penetration, but can miss narrow sulfide zones. Both spacings were tried without success. The only conclusion that can be drawn is that if an orebody is present, it must occur at a depth greater than 200 feet.

Results of a ground magnetic survey were more helpful. As the contoured values indicate (Map 4), there is an elongate magnetic high in the meta-andesite which is subparallel to the zone of volcanogenic copper. This high may represent the alteration pipe of a volcanogenic system which has been deformed and stretched out by metamorphism. It appears to culminate and widen in the vicinity of the Pay Role mine. This is also the only place where the high intersects the copper-bearing horizon. These results correspond quite well with the geochemical anomaly obtained by Earth Sciences.

CONCLUSIONS AND RECOMMENDATIONS

The composition of the rocks in the Moppin group is characteristic for volcanogenic-type environment. Inspite of structural offsetting, there is a central block with an intact 1-½ to 2-mile belt of meta-andesitic rocks. The upper part of this belt contains a stratabound horizon of massive sulfide-type copper shows. Copper-bearing quartz veins appear to be later than the volcanogenic mineralization; and the copper in them remobilized from the older deposits.

A magnetic high along with sampling results by Earth Sciences indicates that our original target area, the Pay Role-Whale portion of the copper-bearing schist horizon, is the site of greatest massive sulfide potential. I.P.-Resistivity work, while inconclusive, indicates that the target, if present, must occur at least more than 200 feet beneath the surface.

Prior to drilling, it is recommended and planned to: (1) construct detailed cross sections through the critical area in order to calculate the necessary angle and placement of drill holes, and (2) do additional ground magnetic surveying in order to better define the limits of the detected magnetic anomaly. The present evidence suggests that the first drill hole should test the meta-andesites at depth under the area of the Pay Role mine. Depending on the cost and results of this hole, one or two additional holes will test the remainder of the target area.

A drilling bid from Connors Drilling, Inc., for a minimum of 2000 feet has been accepted and a drilling agreement is presently being drafted. Drilling will start when the snow melts, hopefully sometime in April or May.

B E French

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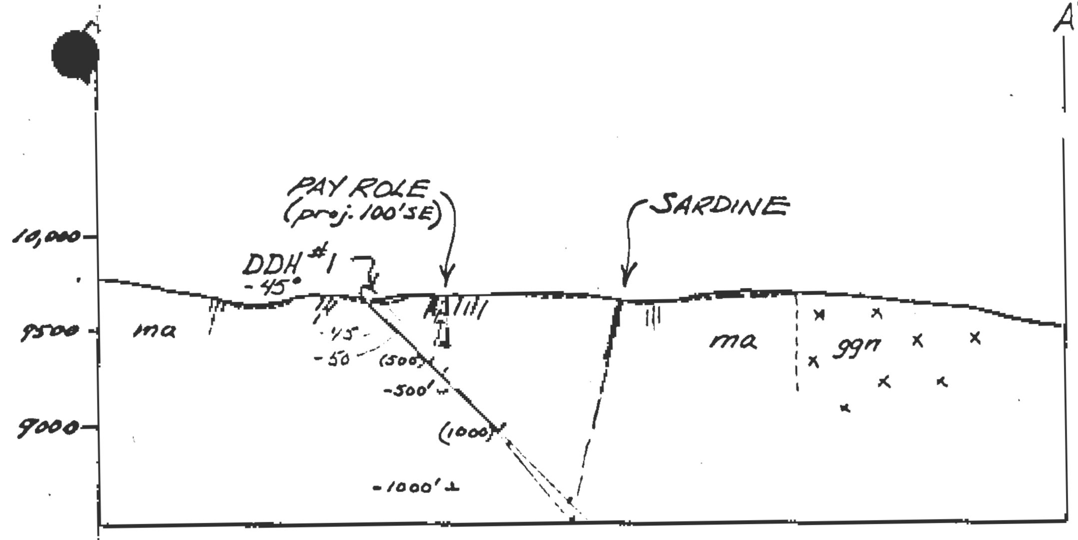
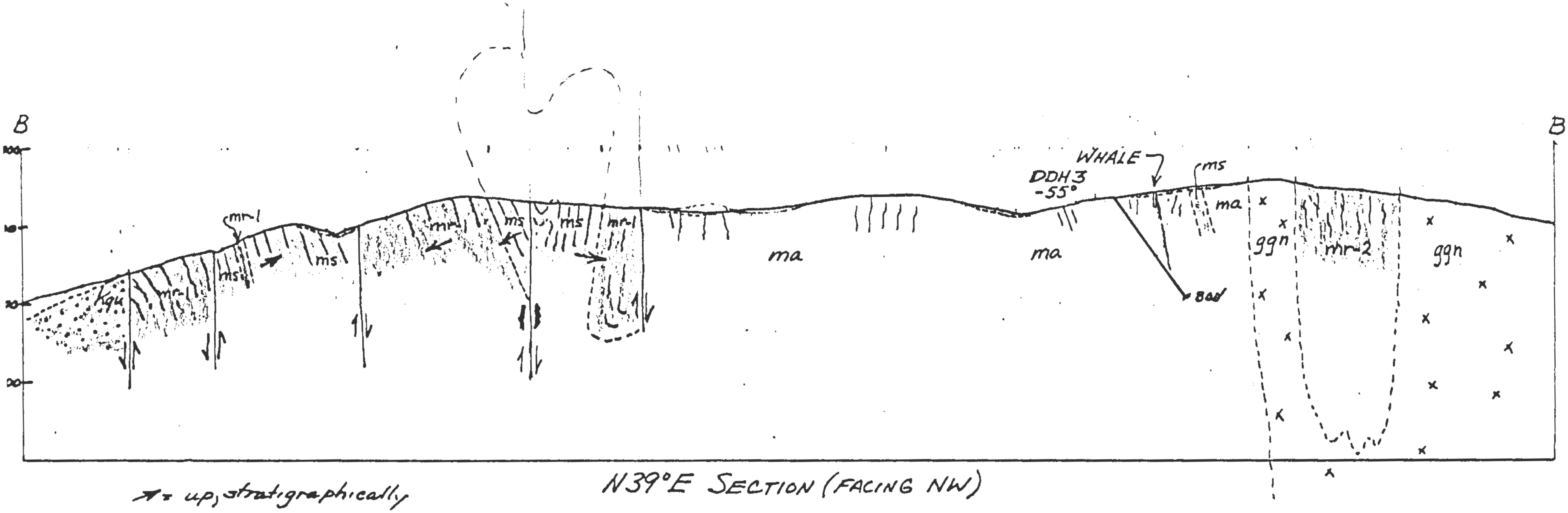
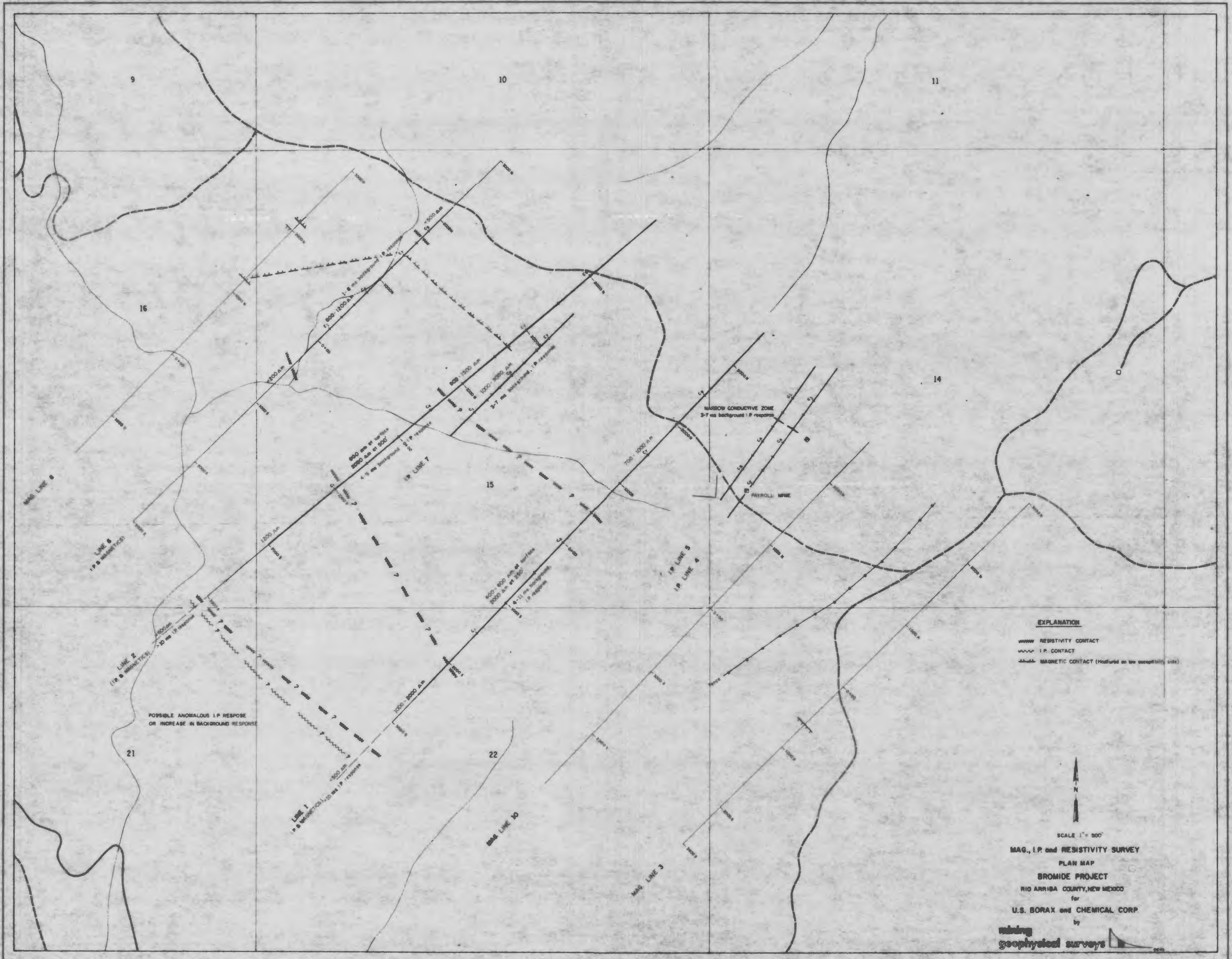


North 45°E Section (Facing NW)

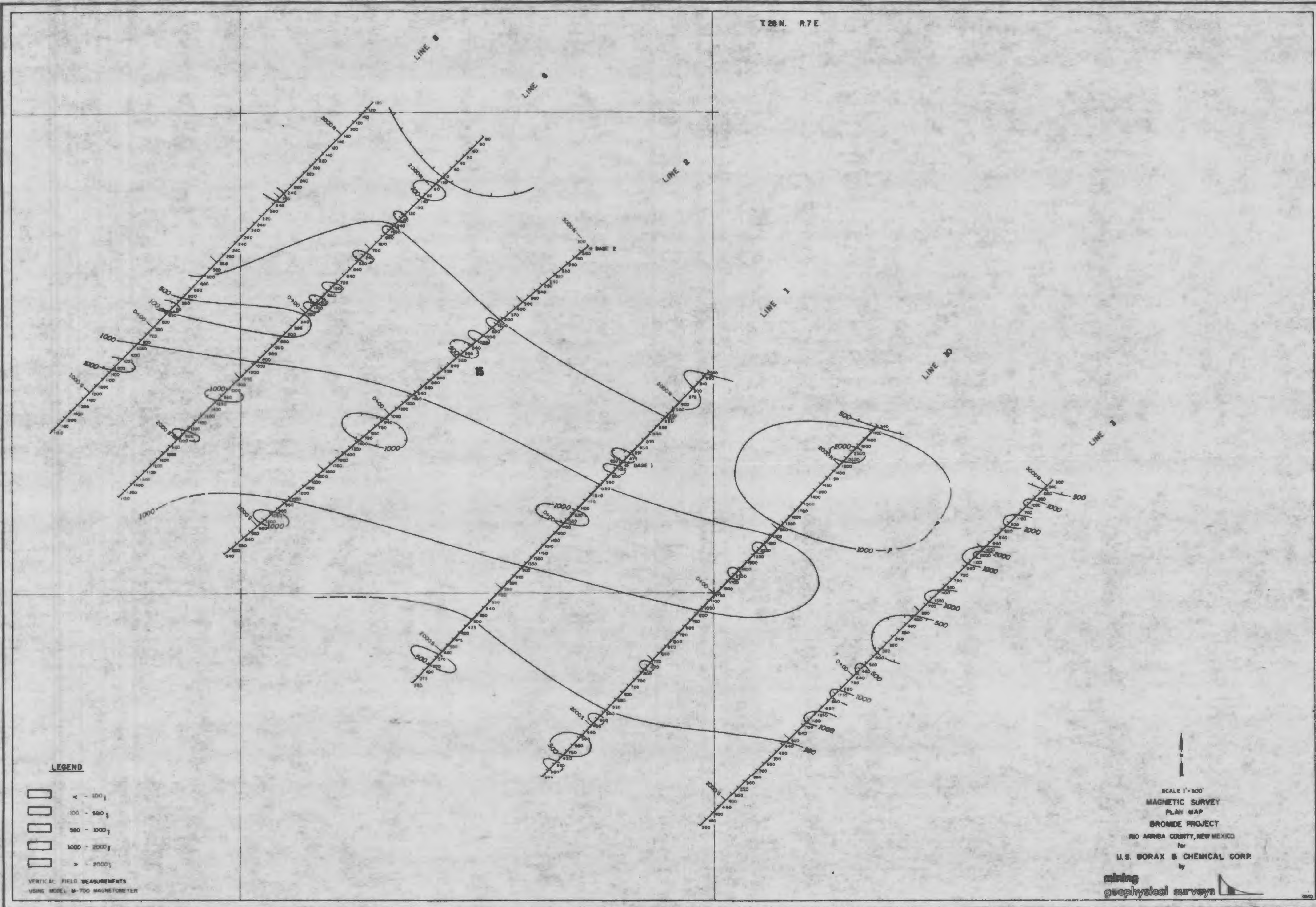


N39°E Section (Facing NW)

➚ = up, stratigraphically


9
10
11
16
14
15
21
22
NARROW CONDUCTIVE ZONE
3-7 ms background I.P. response
PAYROLL MINE
I.P. LINE 7
I.P. LINE 5
I.P. LINE 4
LINE 6
I.P. & MAGNETICS
LINE 2
(I.P. & MAGNETICS)
LINE 1
I.P. & MAGNETICS
MAG LINE 8
MAG LINE 10
MAG. LINE 3
POSSIBLE ANOMALOUS I.P. RESPOSE
OR INCREASE IN BACKGROUND RESPONSE
EXPLANATION
RESISTIVITY CONTACT
I.P. CONTACT
MAGNETIC CONTACT (Hachured on low susceptibility side)
N
SCALE 1" = 500'
MAG., I.P. and RESISTIVITY SURVEY
PLAN MAP
BROMIDE PROJECT
RIO ARRIBA COUNTY, NEW MEXICO
for
U.S. BORAX and CHEMICAL CORP.
by
mining
geophysical surveys

MAP 3


T.29 N. R.7 E.
LINE 5
LINE 6
LINE 2
LINE 1
LINE 10
LINE 3
BASE 2
BASE 1
15
LEGEND
< - 100γ
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1000 - 2000γ
> - 2000γ
VERTICAL FIELD MEASUREMENTS
USING MODEL M-700 MAGNETOMETER
SCALE 1" = 500'
MAGNETIC SURVEY
PLAN MAP
BROMIDE PROJECT
RIO ARRIBA COUNTY, NEW MEXICO
for
U.S. BORAX & CHEMICAL CORP.
by
mining
geophysical surveys

MAP 4