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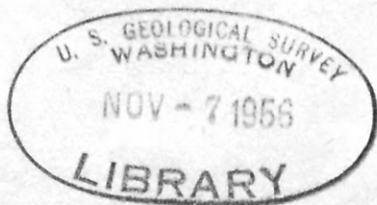
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[Reports - Open file, series no. 397]

MEMORANDA REPORTS ON GEOLOGIC SPOT EXAMINATIONS
OF MINES AND PROSPECTS IN IRAN, FEBRUARY 1954
THROUGH JUNE 1955

by

Russell Gibson, Geologist
U. S. Geological Survey



These studies were undertaken as a part of the cooperative program of the Iranian Ministry of National Economy and the Engineering and Construction Division, United States Operations Mission/Iran, International Cooperation Administration.

U. S. GEOLOGICAL SURVEY
OPEN FILE REPORT

This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature.



20 MAR 1957

Memoranda reports on geologic spot examinations
of mines and prospects in Iran, February 1954
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Memoranda reports on geologic spot examinations of
mines and prospects in Iran, February 1954 through
June 1955. By Russell Gibson

INTRODUCTION

A series of twenty-nine geological spot examinations of mines and prospects in Iran were carried out by Dr. Russell Gibson, Geologist, U. S. Geological Survey between February 1954 and June 1955. These studies were under the joint auspices of the U. S. Operations Mission of the International Cooperation Administration and the Iranian Ministry of National Economy. Dr. Gibson acted as Advisor in economic geology to both the Mission and the Government of Iran during this period. All mine or prospect visits including those to properties owned by private operators were made at the request of agencies of the Government of Iran.

Director of U. S. Operations Mission to Iran.

Russell Gibson, Geologist
(through Acting Chief, Engineering and Const. Division)

Trip to Kashan to make a geological examination of prospects near village of Jahack.

Travel to Kashan and Jahack was authorized by Travel Order No. CD4-1025, dated January 23, 1954. I was accompanied by David Y. David as assistant and interpreter.

The purpose of the trip was to examine mica and copper prospects along the Darz-now, and tributary valleys near the village of Jahack, which is in the mountains 40 kilometers south of Kashan. All the prospects seen are within a radius of six kilometers of Jahack. We were guided on the trip by Mohamed Ali Khoyloular and Seyd-Reza Seyd-Mirzai, who are prospecting these deposits.

The topography of the area is mountainous, the valleys V-shaped, and the slopes steep. The relief is about 1800 meters. The road into Jahack is little better than a trail and beyond this village there are no roads. In the valley bottoms are good donkey trails and the prospects are easily accessible by these.

The area is underlain by strongly folded sedimentary rocks the most conspicuous of which is a white to gray limestone. Of lesser importance quantitatively is a white friable sandstone. These sediments are cut by several intrusives similar in composition to diorite or granodiorite, not deeply weathered.

Near the borders of the intrusives, contact metamorphism has occurred along bedding and joint planes of the limestone. This has resulted in a replacement of the calcite of the limestone by epidote, brown garnet, pyroxene, green mica, phlogopite, and magnetite. Excepting magnetite (an iron oxide) all of these are silicates - rock minerals. In places where the limestone is completely replaced in pockety fashion by this aggregate of minerals, pale green mica is abundantly developed in little books up to two centimeters in thickness. The sheets are commonly only a few centimeters in diameter but a few were seen up to six centimeters in greatest dimension. At one locality malachite and azurite (copper carbonates) were deposited in a thin film along the bedding plane of a steeply dipping sandstone though most of the rock nearby is limestone. These copper carbonates are the oxidation products of chalcopyrite (copper iron sulfide), a very small

amount of which is still present in the cropping. More chalcopryite is probably present at slight depth, for weathering is not deep in these deposits. Small amounts of copper carbonate float along the mountain side above this occurrence testify to the presence of other small amounts of copper in the rocks nearby.

CONCLUSIONS: None of these prospects in its present state is of much interest. So little work has been done on them that no conclusions can be drawn concerning the size or continuity of the deposits. The prospectors propose to continue to work the deposits, however, and they will be re-examined later if they are reported to be more interesting.

Other prospectors and miners are attempting to develop deposits in this general region south of Kashan that will yield other minerals and metals and these, also, will be examined in the near future.

Director of U. S. Operations Mission to Iran.

Russell Gibson, Geologist
(through Acting Chief, Engineering and Const. Division.)

Trip to Kamsar to make a geological examination of prospects.

Travel to Kamsar was authorized by Travel Order No. CD4-1078 dated February 3, 1954. The area examined is about ten kilometers north of the small village of Kamsar which is thirty three kilometers south of Kashaan. Travel to Kamsar was by jeep station wagon; from Kamsar to the mining camp by donkey over poor trails. I was accompanied and aided in every way possible on the trip by Mr. Tunian of the Jupiter Trading Company, the firm doing the prospecting and their consulting engineer, Engineer Zanjani.

The topography of the area is mountainous, the slopes steep, the valleys narrow, and the relief at the camp about 1200 meters. The altitude at the prospects is about 1800 meters. The region is arid. There is no timber. A well driven 20 meters deep in the dry creek bed yielded no water. Water for the camp is carried on mule back from a spring higher in the mountains.

The region is underlain by strongly folded, light colored, medium bedded limestone. In many places the rocks are slickensided as a result of numerous small faults. Detailed examination of the stratigraphy would probably reveal strong, through-going faults also. The folded limestone is cut by dark colored dikes that range in thickness from one to three meters; and by larger intrusives of undetermined shape and size, some of which appear to be stock-like. The precise composition of these intrusives is not known. Some of the dikes are felsite, in part porphyritic, with feldspar phenocrysts. Engineer Zanjani classifies some dikes as andesite. Float in the valleys indicates that at higher elevations there are exposures of a coarse grained, deep seated intrusive similar to a diorite.

Contact metamorphic action close to the borders of the dikes has converted the limestone in places to garnet and epidote (silicates), hematite and magnetite (iron-oxides) and chalcopyrite (copper iron sulfide). Probably other pyrometamorphic minerals, also, are present. Certainly very small quantities of an unknown cobalt mineral are present closely associated with the iron oxides but none was seen. Hematite and magnetite are the abundant conspicuous minerals; chalcopyrite occurs only in negligible amounts. These are all typical pyrometamorphic minerals. They are formed under the influence of hot rising solutions from depth which had their source in the magma that produced the dikes. The replacement bodies are not veins but are lodes or

tabular bodies that conform to the shape of the limestone beds selectively replaced. They pinch out along the strike. Therefore in outcrop they are, in general, long and narrow, and appear as black bands on the surface. They range in thickness (or width) from a few centimeters to about four meters. The third dimension parallel with the contact but perpendicular to the surface of the ground is not known for any of the bodies because none has been explored to any appreciable depth.

Weathering of these deposits has converted the unknown cobalt mineral to erythrite, a pink, hydrous cobalt arsenate that appears in very thin seams and coatings, and in vugs in the masses of iron oxide. This colors the outcrop in places and makes it conspicuous. The chalcopryite likewise weathers to the hydrous copper carbonates malachite (green) and azurite (blue) but these are much less abundant than the erythrite.

Two adits are being driven in a northerly direction, one now about 20 meters long and the other about 30 meters to intersect at depth supposed projections downward of lodes opened up on the surface. One of these adits may intersect a lode from which a little ore was mined many years ago from an old inclined working that followed a lode downward for a few meters in a southerly direction. Both of these new adits will be watched and any lodes intersected by them will be examined and an effort will be made to correlate such lodes with surface outcrops to determine how persistent these deposits are likely to be with depth.

The tenor of the cobalt ore is not known because thus far only a few specimens have been analysed and these results give no basis for predicting the amount of cobalt metal that may be expected in a ton of what might be called run-of-mine ore.

Two shifts are working at the adits. The drilling is done by hand and the headings advance about one meter in 24 hours. About 35 men are employed at the mining camp.

The management is intelligent, aggressive, and apparently financially competent. They have risk capital and they are risking it but they know what they are doing. They employ both European and Iranian mining engineers. Thus far all they have requested from Point-Four is geological advice.

CONCLUSIONS: These prospectors are opening up outcrops of a valuable and high priced metal, cobalt. Up to the present they have only scratched the surface and little can be learned about the size and nature of the deposits from the present workings. The erythrite will disappear with depth, i.e., below the zone of oxidation, but some primary (hypogene) cobalt mineral, the weathering of which yields the erythrite, will take its place.

The prospects will be revisited later when the adits have advanced farther and opened up more of the deposits at depth.

Mr. William E. Warne, Director, Operations Mission to Iran.

Russell Gibson, Geologist
(through W. F. Benning, Chief Engineer, Engr. & Const. Division).

Copper Prospects Near Shirvaneh

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. CD4-1365 dated March 27, 1954, this trip was undertaken for the purpose of examining copper prospects near the village of Shirvaneh. I was accompanied on the entire trip by Engineer Rahim Mohamedi and from Kermanshah to the prospects and back to Kermanshah by Attar Zadeh, a citizen of that town, who is one of the owners of the prospects.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: None of these prospects, in its present state of development, is of great value or interest. Hope springs eternal in the breast of a prospector, however, for he is an incorrigible optimist, and the owners propose to deepen some of the pits. If this is done, and the results are reported to be much more promising, the area will be revisited.

LOCATION AND ACCESSIBILITY: The prospects are in an area about four miles northwest of Shirvaneh, a village on the main highway to Sanandaj, 49 miles northwest of Kermanshah in the Ostan of Kordestan. From Kermanshah to Shirvaneh and beyond there is a primary road. There are no roads or trails to the prospects, some of which are three or four kilometers from the main primary road. (See accompanying sketch showing location.)

TOPOGRAPHY: The topography of the area is mountainous but the slopes are not steep and the hills are rounded. Altitude in the area prospected is approximately 1550 meters and the maximum relief about 150 meters. The soil cover is thin and vegetation covers most of the hills (April, 1954), but there is very little timber available that is suitable for mining operations. The streams are reported to be intermittent but within 15 kilometers is a perennial stream, the north fork of the Qareh-Su River.

GEOLOGY: The area is underlain by folded limestone and a mafic intrusive (containing abundant iron magnesium minerals) of unknown size which are cut by thin, fine-grained, black dikes probably similar in composition to a basalt. Most of the host rock of the prospects to the east of the main road is limestone, whereas most of that to the west and southwest is the mafic intrusive.

Twenty small prospect pits were examined in an area about seven kilometers long and four kilometers wide the largest of which is three meters deep and about five meters long. These shallow pits reveal that in places, both the limestone and the mafic intrusive have been mineralized by a little copper and iron. Very small amounts of chalcopyrite (copper iron sulphide), pyrite, and pyrrhotite (iron sulphides) with accompanying quartz and calcite have filled small fractures and impregnated the walls near fractures and small faults. The mineralized zones are commonly only a few centimeters wide, irregular, and seemingly not persistent. No well-defined through-going veins or replacement masses were observed. Oxidation has converted the sulphides largely to malachite, azurite (hydrous copper carbonates), and limonite (hydrous iron oxide), and these brightly-colored minerals are spread through the wall rock a little beyond the small areas of hypogene (sulphide) mineralization causing the metallized zones to appear wide and promising, whereas the total amount of copper impregnating the rocks and distributed through tiny veinlets is exceedingly small. A little green malachite and blue azurite will paint up much country rock and fool inexperienced prospectors. These prospects are not very promising.

Mr. William E. Warne, Director, Operations Mission, Iran.

Russell Gibson, Chief, Geological and Mining Investigations Branch.
(through Mr. Thomas E. Kilcrease, Chief, Engr. & Const. Div.)

Copper Prospects near Kamsar.

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. CD4-1365 dated March 27, 1954, this trip was undertaken for the purpose of examining copper prospects near the village of Kamsar. I was accompanied on the trip by Engineer Vano Khanzadian and Yervand Tounian, one of the owners of the prospects.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: All of the prospects are in the initial state of development and no prediction can be made now concerning their premise or ultimate value. As the prospects are in a mineralized area, however, the operators were advised to deepen certain of the pits in order to determine the persistence of the lodes and veins.

LOCATION AND ACCESSIBILITY: All of the prospects are in the environs of Kamsar which is 26 kilometers directly south of Kashan in the Ostan of Tehran.

One group of copper prospects is scattered over an area that is between one and three kilometers south of Kamsar; the second group is about seven kilometers northwest of Kamsar. (See accompanying map.) There are no roads or trails to the prospects, but those northwest of Kamsar are a few hundred meters from a poor mule trail that is not an all-weather route.

TOPOGRAPHY: The topography of the area is mountainous. At the prospects south of Kamsar the hills are rounded and not steep, the valleys are broad, the relief about 100 meters, and the altitude roughly 1800 meters.

The topography of the prospects northwest of Kamsar is more rugged. The valleys are steep-sided and narrow, the relief about 375 meters, and the altitude 1800 meters.

Both areas are arid and the streams are intermittent. There is no timber available suitable for mining.

GEOLOGY: The region is underlain by strongly-folded, dark-colored shale and limestone with interbedded agglomerates. In places the agglomerates are

hydrothermally altered to epidote and calcite. These rocks are cut by numerous dikes ranging in width from two or three to 20 or 30 meters. The most abundant are dark-colored, very fine-grained, mafic intrusives (high in iron magnesium minerals); less abundant are light-colored, fine-grained to porphyritic, felsite dikes (low in iron-magnesium minerals and high in feldspar).

The prospects south of Kansar have opened up narrow mineralized zones trending eastward in the agglomerate that show disseminated through the rock a few grains of chalcopryite (copper iron sulfide) almost completely altered to malachite, azurite (copper carbonates), and limonite, accompanied by white quartz and calcite. Some veins are entirely calcite. The hypogene (primary) copper mineralization was poor, but oxidation of the chalcopryite has spread the oxidation products, malachite and azurite, through the rocks and widened the zone showing copper colors thus making the outcrops appear richer than they really are. Several pits at different altitudes along the trend of the zone were examined, showing that copper mineralization exists, though not necessarily continuously, through a vertical distance of at least 20 meters and for at least 300 meters along the strike.

The copper prospects northwest of Kansar are similar in mineralogical composition to those south of that village, but the form of the deposits and the host rocks are different. Eight or ten prospect pits, none of which is very deep or very long, have shown a series of thin veins usually less than ten centimeters wide. None of the veins seen thus far is very persistent along the strike, but they occur on echelon and where one pinches out another takes its place a few meters farther on. The veins cut the dark-colored shale and the mafic dikes. There is a tendency for the veins in the dark shale that are near the felsite porphyry dikes to hug the contact of the dikes but not penetrate them.

These prospects have scarcely scratched the surface, and therefore, the examination was made in reconnaissance fashion and no sweeping conclusions may be drawn concerning the deposits.

Mr. William E. Warne, Director, Operations Mission to Iran.

Russell Gibson, Geologist
(through Mr. T. E. Kilcrease, Chief, Engineering and Const. Division).

Lead, zinc, and copper prospects in the vicinity of Isfahan

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. CD4-1365 dated March 27, 1954, this trip was undertaken, starting June 15, for the purpose of examining the following prospects in the vicinity of Isfahan. I was accompanied on the trip by David Y. David and to the several prospects by the owners.

1. Faraz Company (Taghi Nazemi) lead and zinc prospects near Bagherabad, northeast of Isfahan.
2. Sherkate Sahami Maaden Lakane (Yervand Kessian) lead prospects near Zifreh, northeast of Isfahan.
3. Sherkate Omidwar (Reza Samar) copper prospects near Bogh Badron, southwest of Isfahan.
4. A. A. Bakhtiar copper and lead prospects near Asgarabad, west of Isfahan.
5. Seyed Abdorasol Mirbod lead and zinc prospects near Shah Reza, south of Isfahan.

Conferences were held with Engineer Abadi of the Ministry of National Economy in Isfahan and in the field; with the Governor at Golpaigan concerning the status of mining at Khomein; with Engineer Fayibi of the Mines Bonga at Isfahan; and with two groups of mine operators at Anarak, namely Messrs. Bagail and Tabatabai who operate the Sherkate Sahami Feliz (lead mines) and Engineer Gafari of the Mines Bonga who operates Maaden Moss Anarak (copper mine). These large properties will be visited at a later date. Conferences were held, also, at Isfahan with the following operators who requested advice: Aboulfazi Dadkha, prospects between Ardestan and Kupsayeh; Ahmad Malekpour, prospects near Bouran Village; Kassar Yazdani, prospects near Nayson Village; Mostafa Soltani and Reza Vakilzadeh, prospects near Pinavand village; Jahangir Massoud, prospect near Khan Sormeh; and Zabihoullah Khosravani.

PROJECT ACTIVITY SUMMARY: This field work was carried on under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: The Faraz Company has a very small producing mine but it is doubtful that the operation is profitable. This conclusion is based on curious contradictory statements made by the owners about their costs.

All the other properties are in the prospect stage and none shows sufficient development to warrant any confident prediction about its future. If most of these were abandoned the future metal production of Iran would doubtless suffer very little.

DESCRIPTION OF EACH GROUP OF PROSPECTS:

1. Faraz Company, lead and zinc prospects near Bagherabad, northeast of Isfahan.

The lead prospects are 56 kilometers by dirt road northeast of Isfahan; the zinc a few kilometers farther to the northwest. The prospects are on the lower slopes of low mountains; the altitude at the various pits ranges from 1900 to 2000 meters.

The lead and zinc deposits exposed in the present workings are in folded, gray to buff limestone that has been faulted and made more accessible to descending waters, especially by solution channels along some of the faults. The deposits are replacement bodies of great irregularity and attitude along the limestone beds, and are closely related to faults. They commonly range in thickness from 20 to 50 centimeters and rarely reach a meter, but all pinch and swell rapidly along the bedding. One of the owners reported that the ore was spotty and commonly pinches out in a short distance. No large continuous ore bodies were seen.

The chief mineral of the lead deposits is cerussite (lead carbonate) but small remnants of the original galena which the cerussite largely replaced are still visible.

The zinc deposits are similar in form to the lead deposits but the chief minerals are zinc carbonate and zinc silicate.

Total workings of both groups of prospects, including adits, shafts and shallow pits, amount to about 110 meters. The owners report that they have shipped 1000 tons of lead carbonate ore that assayed at least 43% lead.

2. Sherkate Sahami Maaden Lakane, lead prospects near Zifreh, northeast of Isfahan.

These prospects are 52 kilometers northeast of Isfahan in low hills at altitudes of 2150 to 2200 meters. More than half the

distance to the property is over good roads.

The deposits are irregular, pockety replacement masses composed chiefly of galena and lead carbonate near fault zones in gray to buff folded, fractured limestone. The gangue minerals are chiefly barite, calcite, and vuggy quartz. A very little malachite and azurite (copper carbonates) is present. The deposits are flat to vertical in attitude and range from small insignificant pockets to masses one meter in greatest dimension but these latter pinch down rapidly when followed along the trend of the ore. No large, continuous bodies of ore were observed. None were reported.

Adits, inclined shafts and pits total about 77 meters of workings in four places within a radius of about 500 meters.

3. Sherkate Omidwar, copper prospects near Bogh Badron, southwest of Isfahan.

The small Omidwar copper prospects are about 55 kilometers mostly over dirt road southwest of Isfahan in low hills near Bogh Badron. Eight or ten shallow pits with a total of about eight meters of workings have exposed a few insignificant veins, many of them paper-thin, in brown friable shale and in greenstone. The veins are composed chiefly of barite (barium sulfate), epidote (complex silicate), and iron oxide with a negligible amount of chalcopyrite (copper, iron sulfide), and copper carbonate.

4. A. A. Bakhtiar copper and lead prospects near Asgarabad, west of Isfahan.

Bakhtiar's small prospects are 25 kilometers west of Isfahan on the slopes of the low mountains north of Nejafabad and Karsang. Excepting the last eight kilometers or so, the road is good.

At two places, five kilometers apart, insignificant showings of lead and copper minerals along small faults have been opened up by pits and inclines totaling 20 meters of workings in gray, folded limestone.

5. Seyed Abdorasol Mirbod, zinc and lead prospects near Shah Reza, south of Isfahan.

These small prospects are 32 kilometers over dirt road southwest of Shah Reza on the northeast slope of a mountain belt that rises 1200 meters above the high plains. Altitude at the prospects is about 2150 meters.

Deposits of zinc carbonate and zinc silicate with lesser amounts of galena (lead sulfide) have been opened up along or near faults in the folded gray limestone that underlies these mountains. The deposits were formed chiefly by replacement of the limestone and are clearly related to the faults. They are irregular in size, in distribution, in outline (they fade into the wall rock), and in mineral composition. Most of the original sphalerite (zinc sulfide) has been converted to silicate and carbonate and none is visible in the ore, but laboratory tests indicate that microscopic grains of sulfide still remain. Galena, coated with lead carbonate and lead sulphate, is still abundant, but owners report that their ore commonly carries more zinc than lead. In summary, the ore is a mixture of sulfide, carbonate, and sulphate of lead; and sulphide, carbonate and silicate of zinc. The work of descending oxidizing waters has been facilitated by faults, joints, and solution channels in the very reactive limestone.

Exploration for ore has been unsystematic. Probably 40 or 50 meters of trenches, pits, adits, and inclined shafts have remnants of ore exposed in them. None of these is deep; none has reached below the zone of oxidation.

All the mining is done with hand steel. A few tons of mined ore, concentrated by hand cobbing, are piled at the prospects but as no sampling of this has been done, its tenor is not known.

Mr. William E. Warne, Director, Operations Mission, Iran

Russell Gibson, Chief, Geological and Mining Investigations Br.
(through Mr. T. E. Kilcrease, Chief, Engr. & Const. Division).

Antimony, copper, and lead prospects near Hamadan.

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. CD4-1365 dated March 27, 1954, this trip was undertaken for the purpose of examining antimony, copper, and lead prospects in the vicinity of Hamadan. I was accompanied on the trip by Seth Petrossian, Tehran Mining man, interested in these properties.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: All of the prospects are in the initial state of development and no confident prediction can be made now about their future. However, most of the showings are not very promising and those parts of the region seen on this trip do not show intense or widespread mineralization. The operators were informed, therefore, that unless future work showed very much better ore mineralization soon, the prospects should be abandoned. If, on the other hand, any one of them should, upon further exploration, improve greatly in promise, I have agreed to re-examine it.

LOCATION AND ACCESSIBILITY: The antimony prospects are three kilometers southwest of Hamadan at an altitude of about 2000 meters and easily accessible.

The copper prospects are 60 kilometers by road northwest of Hamadan, north of Miyaneh Bala at an altitude of about 2150 meters. Excepting the last five kilometers the road is fairly good.

The lead prospects are about two kilometers northeast of Tohanabad, which is 42 kilometers by road nearly east of Hamadan, at an altitude of about 1850 meters. For the first 19 kilometers out of Hamadan, the road is a good surfaced road; for the remaining 22 kilometers it is poor and not surfaced.

TOPOGRAPHY: All of the prospects are in low, rounded treeless hills where the relief is not great. All nearby streams are intermittent. Weathering is not deep and the soil is thin.

GEOLOGY: Both the antimony and copper prospects are in areas underlain by strongly folded, thin-bedded, dark gray shale. The shale wall rock at the copper prospects is ferruginous near the surface, and the joints are veneered with limonite. The wall rock at the lead prospects is gently folded, gray to buff, thin-bedded limestone.

The antimony deposits shown in these prospects are thin veins or clumps of veins ranging from 10 to 45 centimeters in thickness, composed chiefly of barite (barium sulfate) and quartz with a little stibnite (antimony sulfide). Some of the veins are in ill-defined fault zones. Over a distance of about 300 meters on the surface the deposits have been opened up by shallow trenches and narrow shafts, up to about 15 meters in depth. These show that some of the veins are not very persistent.

The copper prospects have opened up a few lean non-persistent veins composed chiefly of quartz with a little pyrite (iron sulfide), and chalcopyrite (copper iron sulfide). Oxidation has converted the sulfides in part to limonite (hydrous iron oxide) and malachite (hydrous copper carbonate). Over a distance of 120 meters the operator has trenched and dug pits and has sunk one shaft to a depth of 10 meters without exposing any promising veins.

The lead deposits are irregular, discontinuous, replacement zones in folded, fractured limestone. The best places in one of these zones are about 25 centimeters wide but the course or size of the lode is difficult to determine because the shafts are narrow and shallow. Hence the ore is not well exposed. The chief mineral is galena. Oxidation has converted some of it to cerussite (lead carbonate) and probably to anglesite (lead sulfate) with which is mixed more or less limonite derived in part from the ferruginous wall rock. The deposits have been explored by means of four pits and three shafts two of which are 13 meters deep and most of which show little or no ore.

Mr. William E. Warne, Director, Operations Mission, Iran

Russell Gibson, Chief, Geological and Mining Investigations Branch
(through Mr. T. E. Kilcrease, Chief, Engineering and Const. Division).

Antimony mines and prospects northwest of Hamadan

PURPOSE OF TRIP: In accordance with Travel Authorization No. MJF 5-18 dated July 1, 1954, this trip was undertaken beginning July 9 for the purpose of examining antimony mines and prospects near Baharlu, northwest of Hamadan. I was accompanied on the trip by Engineer Rahim Mohammedi of the Mines Bonga, and to the mines by Engineers Morteza Rastigar and F. Sorabi, also.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: Most of the old mine openings from which ore has been produced in the past were inaccessible at the time of this examination either because they could be reached only through deep vertical shafts without ladders or timbers, or because they were under water. Consequently the examination was not thorough. None of the engineers who accompanied me on the examination had ever seen the stopes in these shafts which yielded the ore. The ore exposed in the pits, adits, and trenches which are accessible was not very rich and did not look promising.

If the shafts are unwatered and put in condition to be entered, a reexamination will be made if it is requested.

LOCATION AND ACCESSIBILITY: All the properties are southwest of Baharlu and eighty-one kilometers northwest of Hamadan in hilly country of moderate slopes where the altitude is about 2000 meters. There is no perennial stream near and no timber. The road is good for the first 37 kilometers, third class for the next 30, and nonexistent for the last 14 kilometers. (See map.)

GEOLOGY: The area is underlain by a light-colored felsite porphyry with phenocrysts of feldspar and, to a minor extent quartz, that range in size up to ten mm. but are most commonly about half that length. The rock resembles a latite or quartz latite porphyry. In a few places this country rock is sheared in zones about 75 to 90 centimeters wide and near these zones the porphyry is strongly hydrothermally altered.

A line of pits and shafts that trends N. 30°-35° E. marks a prominent shear zone or series of zones along which stibnite has been deposited. It occurs as thin veinlets along the shear planes which are commonly tight; as narrow stringers 2 to 5 centimeters thick near these planes; and as small groups of radiating blades that replace the porphyry near the shear planes. These clumps of stibnite blades are only a few centimeters across.

Roughly parallel to, and about 50-60 meters northwest of, this zone is another line of pits and shafts near the valley bottom that have opened up a second nearly vertical shear zone that trends northeastwardly in the porphyry. It is not certain that all of the pits are along the same shear zone. A typical exposure of this zone shows very thin irregular veinlets of stibnite 2 or 3 centimeters thick and about 45 centimeters apart that pinch down rapidly, and small pockets of stibnite formed by replacement of the porphyry between the thin veinlets. The only gangue mineral is a little quartz. The porphyry is hydrothermally altered. It shows no brecciation near the veins.

Northwest of this zone of mineralization on the slopes above the valley a few similar small showings of stibnite have been opened up in a few trenches and short adits.

PRODUCTION: The owners report that in 1950 and 1951 when the price of antimony was much higher, 1500 tons of ore were shipped.

Mr. William E. Warne, Director, Operations Mission, Iran

Russell Gibson, Chief, Geological and Mining Investigations Branch.
(through Mr. T. E. Kilcrease, Chief, Engr. & Const. Div.)

The Ai Qaleh Seh Zinc Mine Northwest of Bijar.

PURPOSE OF TRIP: In accordance with Travel Authorization No. MJF 5-18, dated July 1, 1954, this trip was undertaken beginning July 18 for the purpose of making a reconnaissance examination of a zinc mine near Ai Qaleh Seh northwest of Bijar. I was accompanied on the trip by Yervand Tounian and Engineer Vano Khanzadian.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: The fault that is the locus of ore deposition is a strong structure and is likely to be persistent along the strike and to good depth, but not enough ore is exposed in a sufficient number of places under ground to afford a three-dimensional picture of the size and continuity of the deposit. This is because the operators live from hand to mouth and develop no ore reserves in advance of mining. It is reported that the winters are severe in the region and that for four or five months a year the mine is completely inaccessible. The region is remote and roads are bad or simply nonexistent, consequently transportation will be a large factor in costs. This is probably a marginal deposit.

LOCATION AND ACCESSIBILITY: The mine is about one kilometer northwest of the village of Ai Qaleh Seh which is 51 kilometers by airline northwest of Bijar and 37 kilometers by road southeast of Takob. For the first 40 kilometers the road from Hamadan to Bijar is good; for the remaining 111 kilometers it is not an all-weather road and the grades are steep. From Bijar to Divandareh to Takob, 166 kilometers, the road is fair to bad. Ruts are deep, grades steep, maintenance absent. To travel the 37 kilometers from Takob to the mine over the wide donkey trails that serve as roads takes two and one-half hours. If supplies are moved in and ore moved out over this route from Hamadan to the mine, transportation will be expensive.

The workings are in low mountains at an altitude of about 2200 meters. Streams nearby are reported to be perennial. Timber sufficient for mining purposes is not abundant. No power is available.

GEOLOGY: At the mine the rocks are dominantly light-colored sandstone with at least one interbedded felsite porphyry intrusive which is probably a sill. The rocks lie relatively flat at the portal of the adit. Higher on the hill they are gently folded. The rocks are cut by a strong fault that trends N. 25°-30° E. and dips steeply northwest but in places is vertical. The breccia and gouge zone shown in the principal working is one and one-half meters wide in some places.

A crosscut adit has been driven northwestwardly to intersect the fault zone which is opened up by a drift driven southwestwardly along the fault for about 40 meters. Along this drift are small remnants of ore on both walls and in the back; ore is shown best at the faces at both ends of the drift. Examination of all these exposures indicates that the deposit is a coarse-grained mixture of sphalerite (zinc sulfide), galena (lead sulfide), and pyrite (iron sulfide) which is least abundant. Some streaks of ore are dominantly zinc; others are dominantly lead. The sulfides are commonly concentrated along the sides of a central zone of breccia, i.e. between the breccia and the wall rock, but not in continuous layers.

Much water is entering along the fault zone and the mine is wet. Caving along the drift is common and, as the workings are not properly timbered, caving will continue. These are careless miners. The height of the back ranges up to seven or eight meters. It is not known whether these high places are old stopes from which ore has been extracted or merely caved places.

In a small open cut on the surface not far from the adit is an exposure of a vein about 30 centimeters wide of almost solid siderite (iron carbonate) containing a few grains of galena cutting flat-lying sandstone.

On the hill above the adit are a few parallel outcrops of thin replacement veins in the sandstone that exhibit abundant iron oxide and may contain a little lead and zinc. These are parallel with the above-mentioned fault vein.

Several open cuts and old shafts on the hill above the adit were not examined. All the active operations are now carried on through the adit.

The mine is reported to have produced 30 tons of lead ore recently.

cc: Provincial Director, Kermanshah

Mr. W. E. Warne, Director, Operations Mission, Iran. (through Mr. T. E. Kilcrease, Chief, Engr. & Const. Div.)
Russell Gibson, Chief, Geological and Mining Investigations Br.

Abe Garm lead prospect northwest of Semnan

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF 5-18 dated July 1, 1954, this trip was undertaken, starting July 29, for the purpose of examining a lead prospect at Abe Garm. I was accompanied by Seth Petrossian and Jahi Mohamad Hosein Sadriyeh, owner.

PROJECT ACTIVITY SUMMARY: This field work was carried on under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: These prospects have thus far exposed no strong, persistent, metal-rich veins but the workings are not very extensive. In the deepest shaft it is reported that the vein is barren at the bottom. The deposits, in their present state of development, are not very promising.

LOCATION AND ACCESSIBILITY: The prospects are in a mountainous area of steep slopes 24 kilometers by road northwest of Semnan at a spring called Abe Garm. Most of the road is not surfaced, and, as much of it is in valley bottoms, it would be impassable in wet weather. There is no village near the prospects. There is no timber or power available.

GEOLOGY: The country rock at the prospects is a gray limestone that dips westerly about 30° . Cutting these rocks are narrow shear zones from 15 to 60 cm. wide along which veins of barite and galena with a little calcite have been formed largely by replacement. The veins all strike about $N. 30^{\circ} W.$ and are nearly vertical. They pinch and swell rapidly. The galena is distributed irregularly in spotty fashion through the barite. To a minor extent it occurs in thin streaks parallel with the vein walls. Where the galena is present in large cleavable masses several centimeters across, it can be separated by hand cobbing from the barite matrix. In other places the mixture of ore and gangue is intimate.

The deposits have been explored by several open pits, short adits, and shafts, the deepest of which is 26 meters. Total workings are less than 100 meters. The miners follow the veins downward or along the strike until the amount of galena present becomes very small or disappears; then they open up another vein. One adit merely cuts a few insignificant, barren barite veins.

An exposure that may be regarded as typical is shown in a drift about 8 meters long at the bottom of a shaft 18 meters deep. At the southeast end of the drift the vein is 40 centimeters wide, of which 10 to 17 centimeters

is galena; but a short distance away no galena is shown in the back of the drift; the vein is solid barite. Eight meters northwest at the opposite end of the drift the same vein pinches down to 20 centimeters and is nearly barren of galena. This irregularity seems to be the habit of the veins.

The miners have accumulated a stock pile of a few tons of hand picked ore. None has been sold.

At the base of the hill where the prospects are is a warm spring containing hydrogen sulfide that formerly emerged at a little higher elevation. About 10 meters above the present water surface are remnants of spring deposits sloping gently down stream.

cc-Provincial Director, Tehran

8-11-1954

Mr. W. E. Warne, Director, Operations Mission, Iran

Russell Gibson, Chief, Geological and Mining Investigations Br.

Khane Sormeh Lead Mine

PURPOSE OF TRIP: In accordance with Travel Authorization No. MJF5-18, dated July 1, 1954, this trip was undertaken, beginning August 2, for the purpose of making a reconnaissance examination of the Khane Sormeh lead mine northwest of Najafabad. I was accompanied to the mine by Engineer Mehdi Gouli Fathi of the Mines Bongah and Mr. Jahangir Masoud of Isfahan.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: A rapid reconnaissance of the mine was made at the request of Engineer Fathi. From this it became clear that a more careful examination later is warranted. This is a going mine.

LOCATION AND ACCESSIBILITY: The mine is 51 kilometers by road nearly west of Isfahan and 10 kilometers northwest of Najafabad. All but about six kilometers is by good road. The workings are in the lower slopes of the mountain range north of Najafabad that trends roughly northwest-southeast. Altitude at the mine is about 2050 meters.

GEOLOGY: The host rock of the lead deposits is dark gray limestone that strikes northwesterly and dips 50° - 60° northeast. The limestone is cut by numerous steeply-dipping faults that seemingly have no common strike. Some are rather tight, some show a few centimeters of gouge, and one fault is a zone a meter wide. In and near these faults are irregular deposits of galena formed largely by replacement of the hospitable limestone wall rock. The ore fades out away from the faults.

The deposits are opened up by numerous short irregular adits that follow the irregularities of the ore. These gopher holes are scattered along the mountain front through a vertical range of at least 60 meters but none has been driven very far into the mountain. Only a few of these were entered and a more thorough examination will be made later. From the upper workings the ore is sent through two ore passes to the lowest adit level whence it is trammed by hand to the lump and sorted and sacked.

By hand cobbing three grades of concentrates are being made, according to Engineer Fathi, namely, 70-75%, 40-45%, and 15-20% lead. The production of the mine is not regular. No ore reserves have been developed.

cc-Provincial Director, Isfahan

Director, U. S. Operations Mission to Iran

Russell Gibson, Chief, Geological and Mining Investigations Branch
(Through T. E. Kilcrease, Chief, Engineering & Construction Div.)
Mines near Khomein

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF 5-18 dated July 1, 1954, this trip was made beginning August 11 for the purpose of determining what operations were being carried on by the Mines Bongah of the Plan Organization in the environs of Khomein. The trip was made at the request of Engineer Gharagozlu, Managing Director of the Mines Bongah.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: From information about these mining properties near Khomein furnished by Engineers Garagozlu and Yaghmai, it is clear that they merit detailed geological examination. This will be carried out in the near future.

LOCATION: The Mines Bongah has four properties in this area which, according to Engineer Abolfazl Yaghmai, who is in charge, are as follows:

- Lakan, a lead mine, 42 kilometers northwest of Khomein.
- Darre Noghre, a lead mine, 42 kilometers southwest of Khomein.
- Baba Sheikh, a lead mine 40 kilometers southwest of Khomein.
- Shamsabad, an iron mine, 48 kilometers northwest of Khomein.

PRESENT OPERATIONS: Lakan mine is producing about 1000 tons of ore per month. The other three properties are not producing. At both Darre Noghre and Baba Sheikh, however, a crew of miners is exploring for more ore. Shamsabad is idle.

cc: Mr. E. Shiffman, Provincial Director, Isfahan

Mr. William E. Warne, Director, USOM/Iran

Russell Gibson, Chief, Geological and Mining Investigations Br.
(through Mr. T. E. Kilcrease, Chief, Engr. & Const. Div.)

Lead and copper prospects near Atesh Kuh, South of Dilijan

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF 5-436 dated 28 September, 1954, this trip was undertaken beginning October 2 for the purpose of examining lead and copper prospects near the village of Atesh Kuh belonging to Engineer Mohamad Zarrabi. I was accompanied on the trip by Seth Petrossian, advisor to Engineer Zarrabi.

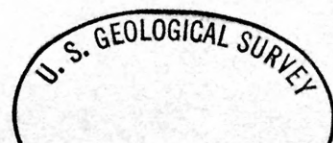
PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: These lead and copper prospects are very small. Not enough work has been done on any of them to reveal a significant deposit even if it were there. There are no stock piles of any size and no ore has been shipped.

LOCATION AND ACCESSIBILITY: The lead prospects are in an area about 17 kilometers south of Dilijan; the copper prospects about 10 kilometers south of Dilijan. All are within a radius of about 8 kilometers of Atesh Kuh. From Dilijan to Atesh Kuh the first 9 kilometers of the road is good; the last 6 kilometers is dirt road. There are no roads or trails to the prospects.

TOPOGRAPHY: The prospects are in low rounded mountains close to the mountain front and are scattered through a vertical range of 120 meters or more. The maximum altitude is 2000 meters. The soil is thin, outcrops are numerous, and slopes rather steep. Much of the float contains small disseminated grains of galena, in part oxidized.

GEOLOGY: The lead prospects, which are southwest of Atesh Kuh, have opened up small irregular replacement deposits rarely more than a few centimeters across in gray limestone that, in places, weathers light brown. The limestone is folded and dips range from a few to 50 degrees. Two of the deposits are related to small faults that strike northeast. Disseminated galena is present in the wall rock up to two and one-half meters from one of the faults. The chief minerals are calcite, barite, fluorite, and galena. A very little malachite and quartz is present in a few deposits. In places the galena is altered to cerussite (lead carbonate). Mineralization is nowhere strong, but float along the slopes shows a little galena here and there disseminated in the limestone. Any deposit now being explored may be larger than the present mine opening indicates.



The deposits have been explored by small pits, trenches or inclined shafts none of which thus far has revealed any deposit of significant size. The largest of six such openings examined is an incline two meters across and 15 meters deep along a fault that dips 50 degrees southeast.

The copper deposits are about 4 kilometers northeast of Atesh Kuh along the mountain front that here trends easterly. Three short adits three to 20 meters long which are little more than trenches have been driven in a northerly direction into the hill a few meters above the valley bottom. Two of these have intersected a fault, not much of which is exposed, that seems to trend easterly and dip northerly roughly parallel with the bedding. The country rock is thin- to thick-bedded gray limestone which strikes East to No. 60° E. and dips 20° - 40° northerly into the hill. The fault breccia, one to one and one-half meters thick, is irregularly mineralized in patches and streaks with specular hematite and a little calcite and pyrite. Very small amounts of malachite and azurite (copper carbonates) have painted the country especially along joints of the limestone and to a less extent in the breccia. Parallel with the beds are a few bed veins commonly only a centimeter or less in thickness containing small amounts of these same minerals. The small bed veins are more abundant in the thin-bedded limestone than in the thicker beds.

The large fault roughly parallel with the beds is a strong structure but it is very weakly and irregularly mineralized with copper. The little hematite (iron oxide) present may be regarded as a gangue mineral and even this is erratic and disappears in places along the strike a few meters from a small streak or patch of it several centimeters in thickness.

The lead prospects are not very promising; the copper prospects less so.

cc-Provincial Director, Tehran

Mr. W. E. Warne, Director, USOM/Iran
(through T. E. Kilcrease, Chief, Engr. & Const. Div.)
Russell Gibson, Chief, Geological and Mining Investigations Branch

Copper mine and prospects at Beitche Bagh West of Zanjan

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF5-436 dated September 28, 1954, this trip was undertaken, beginning October 7, for the purpose of examining a copper mine and two copper prospects at Beitche Bagh belonging to the Mines Bongah of the Plan Organization. I was accompanied on the trip by Engineer Rahim Mohamedi of the Engineering Bongah.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: The producing copper mine at Beitche Bagh is large and merits a detailed examination which will be done later. The two prospects, Ghoshnoodi and Taidian, have produced no ore and are not very promising.

LOCATION AND ACCESSIBILITY: All of the properties are in a small area called Beitche Bagh 47 kilometers by road southwest of Moshampa. From Zanjan to Nikpei (38 kilometers) the road is surfaced and is good. From Nikpei westward via Mehrabad to Moshampa (59 kilometers) the road is not surfaced and in places would be impassable in wet weather. At the time of this visit to the mine, the Qizil Uzun river at Moshampa could not be forded with a jeep. Part of the road between Moshampa and Beitche Bagh (47 kilometers) is in dry stream beds or along the flood plain of a perennial stream.

TOPOGRAPHY: The country rock at these properties is volcanic agglomerate which weathers to steep slopes. The valley of the Galeh Tchah, a perennial stream, is canyon-like in places and the sides are nearly vertical. The relief, however, is not great. Upper levels of the principal mine and the Taidian prospect are reached by steep trails. At a broad place in the valley of the Galeh Tchah the operators have cultivated a grove of trees to be cut for mine timbers.

WORKINGS: There are three different workings in the area all within a radius of about two kilometers:

1. The Beitche Bagh group, now operating, that has been a producer of copper ore, is the principal camp.

2. The Goshnoodi vein southeast of the Beitche Bagh, a copper prospect with no record of production.

3. The Taidian vein west of Beitche Bagh and about 150 meters higher than the Galeh Tchai river. This is a lean, unpromising copper prospect.

GEOLOGY: All the workings seen were in a light-colored volcanic agglomerate that, at the mine and prospects, was massive but showed crude bedding elsewhere in the area.

The Beitche Bagh group includes at least four veins in a zone roughly 130 meters wide that have been explored or mined on several levels. Three of the veins strike northeast and one northwest. All have steep dips. The two most productive veins are along faults and it is suspected that the less productive are also, but they were not carefully examined. The veins change rapidly along the strike and, in places, die out but the fault persists, occasionally as wide as the drift.

In some places the ore is made up of several seams of sulfide a centimeter or two wide with barren rock between. Elsewhere it is 25 centimeters wide but this is uncommon in those parts of the veins seen in this examination. The chief ore mineral is chalcopyrite; a little arsenopyrite and galena are present. The gangue is dominantly quartz and calcite.

The Goshnoodi vein, about a kilometer southeast of the Beitche Bagh group, is opened up by two adits driven northeasterly along the course of the vein which follows a fault in the agglomerate. The chief ore mineral is chalcopyrite. Pyrite, quartz, and calcite also are present. The upper working is 45 meters above the lower and is connected by two upraises, reportedly driven in the vein. As shown in the lower level, which is about 150 meters long, the Goshnoodi vein dips 65-70° N. 20 W. It is thin, commonly less than 14 centimeters wide, but ranges up to 60 cm. Where it is wide it is mostly barren rock. Like the Beitche Bagh, this vein pinches down rapidly or splits into divergent stringers which makes the grade erratic. Toward the northeast near the present face, a strong split from the main vein makes off and follows a course No. 15 W. but it pinches down to a knife edge within a few meters. The upper level reported to show a poorer part of the vein was not examined. No ore has been stockpiled or shipped.

The Taidian vein has been explored by an adit, drifts, and crosscuts amounting to about 250 meters. The vein is along a fault that strikes No. 30-40° E., in the agglomerate. The chief ore mineral is chalcopyrite with a little pyrite. The workings and the dump both show only a little copper. There are no stopes from which ore has been mined and gophing on both sides of the fault seems to have been fruitless. In many places the vein is only a centimeter or two wide. It is reported that no work has been done here for at least 13 years.

PRODUCTION: The operators report that they are shipping about 100 tons of hand-picked ore a month that runs about 15% copper. It is trucked to Zanjan, thence goes by rail to Tehran and is trucked to the smelter at Ghaniabad. Lower grade ore is stockpiled.

A small smelter at the mine which has been idle for 13 years formerly yielded a matte that is reported to have contained, in addition to copper, small quantities of zinc, lead, and gold. This was shipped to Ghaniabad for refining.

No systematic underground mapping or sampling is done. The operators depend upon reports from the smelter at Ghaniabad to learn the grade of shipped.

cc-Provincial Director, Tehran

Mr. W. E. Warne, Director, USOM/Iran
(through Mr. T. E. Kilcrease, Chief, Engr. & Constr. Division)
Russell Gibson, Chief, Geological and Mining Investigations Branch

Khane Sormeh Lead Mine West of Isfahan

PURPOSE OF TRIP: In accordance with Travel Authorization No. MJF5-436 dated September 28, 1954, this trip was undertaken beginning October 16, 1954, for the purpose of making a more thorough reconnaissance examination of the Khane-Sormeh Mine north of Najafabad. This mine was seen briefly on August 5, 1954. I was accompanied during the examination by Rahimi Pour, mine foreman. The property is operated by the Mines Bongah of the Flan Organization.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: Geological features that are guides to ore were pointed out to the foreman. As the concentrates can be sold readily, there is pressure to mine ore and no effort is made to develop reserves. The operators live from hand to mouth. Seemingly no systematic mapping and sampling of the mine is regarded as necessary. Until ore reserves of known grade and tonnage are developed, it is hard to justify any capital expenditures for equipment. There are no operating mines near this one and prospects in the region are all very small.

LOCATION AND ACCESSIBILITY: The mine is about 51 kilometers by road nearly west of Isfahan and 6 kilometers north of Hajabad. The workings are in the lower slopes of the mountain range north of Najafabad and Hajabad that trends northwestwardly. Altitude at the mine is about 2050 meters.

GEOLOGY: The country rock is gray limestone strongly folded and faulted. Commonly the beds strike northwesterly and dip 30-55° southwest near the mine, but locally the attitude changes rapidly due in part to the numerous strong faults.

At the steep mountain front where the mine workings have exposed the structure, the limestone is cut by several faults or fault zones that, in general, trend northeasterly though some strike nearly east. The dips are usually greater than 45° to the south and some are nearly vertical, but as the fault planes are curved, both dip and strike are seen to change as mining opens up more of the fault. One of the northeast faults, when followed to the southwest, shows a branch that strikes nearly west. Not all of the faults are mineralized. The adits follow the faults that are.

Three of the faults or fault zones have closely associated with them replacement masses of galena of significant size and extent. Insignificant quantities of pyrite and a little malachite are present, and the dominant gangue mineral is calcite. The limestone near the faults is laced with numerous criss-cross calcite veins. Galena replaces the wall rock irregularly adjacent to the faults and for some distance away from them. It occurs also in short lenticular veins a few centimeters wide near the faults. Rahimi Pour, the foreman at the mine, stated that he finds ore as much as 15 meters away from a fault. As mining progresses, the evidences of faulting are destroyed and an empty stope does not reveal how much waste was mined along with the ore. From what could be seen in the present workings, however, Pour's observation is probably correct.

Ore is being mined through a vertical distance of at least 60 meters. The foreman reported that a shaft sunk 28 meters below the lowest working, which is now the haulage level (altitude about 2015 meters), yielded very little ore but that some ore has been found above the highest working (altitude about 2075 meters.)

Mining Methods: The mountain face trends northwestwardly and is steep. The fault zones to which the ore is related trend northeasterly. Adits are driven northeasterly along those faults with which ore is associated and are widened at places to test the lateral extent of the ore. In places crosscuts also are driven where good ore is shown in the walls of the adit to test the width of the ore zone. These operations will indicate very roughly a swath of ore of known width and length (the length of the adit) on one level. The face of the mountain is then blasted down above this level little by little on both sides of the adit as wide as the ore zone, and the ore is then followed northeasterly. (Sketch) In unexplored ground above the adit the ore may deviate from the course of the adit; moreover, it may become narrower or wider than it was shown to be on the adit level. This is low-cost mining but it may result in much dilution of the ore with waste rock. Some exploration has been carried on above the main workings and ore has been extracted. In places these openings are connected with the lower workings by raises or ore chutes.

Ore mined in the upper workings is sent through three or four ore chutes to the haulage level below, whence it is trammed in steel cars or carried in wheel barrows to a place at about the same elevation near the portal where it is broken by hand and sorted.

Equipment: At present a Diesel-driven compressor supplies air for one jackhammer which does all the drilling. No hand drilling is done. Other equipment at the property, not in operation owing to needed repairs, includes a generator that serves an electric drill, a Diesel-driven crusher, and a Broomwade concentrating table.

Production: The equipment has a rated capacity of 150 tons of concentrates per month but only 60 tons of 70% lead are being produced at present (October, 1954) according to the foreman. This amount is recovered by hand clobbering the crude ore. Another lower grade stock pile of 35% lead is being saved. The balance of the ore is stockpiled and later will be crushed, screened, milled, and concentrated to 70% lead.

Two hundred men are employed in two shifts.

cc-Provincial Director, Isfahan

Mr. William E. Warne, Director, USOM/Iran
(through Mr. T. E. Kilcrease, Chief, Engr. & Const. Div.)
Russell Gibson, Chief, Geological and Mining Investigations Branch

Razavi Zadeh's lead prospect northwest of Mubarak and Northwest of Isfahan

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJP5-436, dated September 28, 1954, this trip was undertaken on October 20 for the purpose of examining a lead prospect belonging to Razavi Zadeh. I was accompanied to the prospect by Mr. Zadeh.

PROJECT ACTIVITY SUMMARY: This field work was carried on under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: This lead prospect is little better than a promising outcrop but, as there are other lead deposits of the east in this same range, the operator was advised to follow the ore and drive the adit farther into the mountain to explore the continuity of the deposit.

LOCATION AND ACCESSIBILITY: The prospect is nine kilometers northwest of Mubarak which is 78 kilometers northwest of Isfahan. Most of this distance is over a good highway but the last seven kilometers is over dirt roads or no road. The prospect is on the steep slope of the range that trends north westerly north of the highway between Isfahan and Hajlabad. There are other lead and copper prospects on the south slope of this same range and east of the deposit under discussion.

GEOLOGY: The lead deposit is in strongly folded, gray and brown limestone. At the prospect and to the west, the limestone strikes northwest and dips vertically or steeply southwest. East of the prospect the rocks strike North 40° - 50° West and dip about 40° Northeast.

An adit about three meters long has opened up a small replacement deposit chiefly galena in brownish limestone laced with veins of calcite and quartz. Galena is present in the small veins but more extensively as irregular replacement masses a few centimeters across in the limestone near the veins. A very little chalcocite and malachite are present. The mineralized zone is about three meters wide but its extent or trend is not known because little is shown in the short adit. The operator reports that there is another lead showing two kilometers to the northwest.

cc: Provincial Director, Isfahan.

Mr. William E. Warne, Director, USOM/Iran
(through Mr. T. E. Kilcrease, Chief, Engr. & Const. Div.)
Russell Gibson, Chief, Geological and Mining Investigations Branch

Sherkate Tofiq Copper Prospect northeast of Tarkh and North of Isfahan

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF5-436 dated September 28, 1954, this trip was undertaken on October 18, 1954, for the purpose of examining a copper prospect northeast of Tarkh belonging to Zabrihoullah Khosravani and Mohamad Bager Broomand. I was accompanied to the property by Mr. Broomand.

PROJECT ACTIVITY SUMMARY: This field work was carried on under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: Very little work has been done on these deposits. They are small, lean in copper, and not promising.

LOCATION AND ACCESSIBILITY: The copper prospects are about 5 kilometers northeast of Tarkh, a village 58 kilometers northeast of Morcha Khurt. Pits have been opened up at altitudes between about 2170 and 2230 meters along the steep slope of a rugged mountain that is part of a group that ranges up to 3900 meters in altitude. The road from Morcha Khurt to Tarkh is partly surfaced. There are no roads or trails to the prospects.

GEOLOGY: The oldest rocks of the area near the prospects are red sandstones that have been invaded by a porphyritic intrusive, probably an andesite, of unknown size and shape. The andesite is the host rock of the deposits. It has been cut by other intrusives less porphyritic or finer in grain than the andesite.

Along some of the stronger more persistent joints of the andesite minor faulting has occurred. All the faults seen strike northeasterly and, excepting one or two that are vertical, dip southeast. Some of the faults are not a single break but a group of closely-spaced parallel breaks. Some single narrow faults fan out into two or three.

MINERAL DEPOSITS: Five shallow open pits at successively higher elevations along the mountain slope, the deepest about three or four meters, have opened up small showings of copper through a vertical distance of 60 meters. A little chalcopryite (copper iron sulfide) has been deposited along with quartz or calcite in thin seams or veinlets commonly not more than a centimeter wide in or near the small faults. A little sulfide is disseminated, also, in the wall rock near the faults. The chalcopryite has been weathered incompletely to malachite (copper carbonate) and limonite. The green copper carbonate paints a thin film over the wall rock and seemingly widens the zone of mineralization, whereas very little copper is present.

Mr. William E. Warne, Director, USOM/Iran
(through Mr. T. E. Kilcrease, Chief, Engr. & Const. Div.)
Russell Gibson, Chief, Geological and Mining Investigations Branch

Copper prospects in Fatme Ali Shah region near village of Kahiaz southeast of Ardestan, and in the Sangheh Mess region south of Kahiaz

PURPOSE OF THE TRIP: In accordance with Travel authorization No. MFJ5-436 dated September 28, 1954, this trip was undertaken November 3, 1954, for the purpose of examining copper prospects near the village of Kahiaz which is southeast of Ardestan. I was accompanied on the trip by Engineer Rahim Mohamedi of the Mines Bongah and R. Rastigar, one of the owners of the prospects.

PROJECT ACTIVITY SUMMARY: This field work was carried on under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: All of these copper prospects are small; none has explored below the oxidized zone, consequently, the character of the ore will change with depth. The prospects range through a vertical distance of 80 meters and over a horizontal distance of several kilometers. They are remote from transportation. The copper mineralization is thin.

LOCATION AND ACCESSIBILITY: The Fatme Ali Shah prospects are a few kilometers northwest of Kahiaz; the Sangheh Mess prospects about six kilometers south of the same village. The properties are reached by following the highway between Ardestan and Nain to a point 22 kilometers southeast of Jaugand and thence dirt tracks northward into the range of mountains northeast of, and parallel to the highway. The altitude at the prospects ranges between 2120 and 2200 meters. To most of them there are neither roads or trails.

GEOLOGY: The region is underlain chiefly by fine-grained porphyritic and non-porphyritic igneous rocks and by minor red sandstone. The size and shape of the igneous bodies is not known. The wall rock at one prospect is a red sandstone, but 15 meters from the pit is a contact with a large body of porphyry. At the other prospects the host rocks are gray or mottled dark reddish rocks similar to andesite. To some extent these are hydrothermally altered, in part to epidote and calcite. The feldspar phenocrysts are dull looking and probably replaced by sericite.

The copper deposits are small. They are related to faults or fault zones that commonly strike N. 55-70° West. But at one pit a younger fault strikes North 40° East. The dips are not constant. Movement along some faults is horizontal. There is no breccia along the faults and gouge is thin. The deposits have been opened up by shallow pits and trenches commonly not deeper than three meters, consequently only the oxidized zone has thus far been exposed.

An inaccessible shaft at the Sangeh Mess prospect was said to be 18 meters deep. The mineralization everywhere consists of thin films or tiny veins of malachite and azurite accompanied by calcite gangue along the faults and joints and disseminated in the walls near them in zones commonly a meter or two wide. The total amount of copper present is small. At the Sangeh Mess the copper carbonate occurs in this same manner but related to a quartz vein up to 40 centimeters wide near a fault zone that strikes nearly east. This mineralized zone has been opened up by a trench along its strike for about 30 meters. The copper carbonate is scattered and not abundant.

cc- Provincial Director, Isfahan

Mr. William E. Warne, Director, USOM/Iran
(through Mr. T. S. Kilcrease, Chief, Engr. & Const. Div.)
Russell Gibson, Chief, Geological and Mining Investigations Branch

Bonnein Manganese Mine south of Ardestan

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF5-436 dated September 28, 1954, this trip was undertaken on November 4, for the purpose of examining the Bonnein Manganese mine operated by the Mines Bongah. I was accompanied on the trip by Engineer Rahim Mohamedi and Amir Ahmad Shahidi, both of the Mines Bongah. Mr. Shahidi is engineer-in-charge at the property.

PROJECT ACTIVITY SUMMARY: This field work was carried on under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: No ore has yet been shipped from this manganese mine, which has been in operation seven months. No sampling or mapping is done and no ore reserves have been developed. The grade of run-of-mine ore is not known. In fact the property is still in the prospect stage, but the present mine openings show promising exposures of ore. The cost of producing it, however, is not known.

LOCATION AND ACCESSIBILITY: The manganese mine is 20 kilometers by air line or 25 kilometers by dirt road south of Ardestan, and about 6 kilometers northeast of the village of Bagham. Most of the road to the mine is level, but the last kilometer or so the grades are very steep. Altitude at the mine is approximately 2060 meters.

GEOLOGY: All the rocks near the mine are igneous. The wall rock of the ore is gray quartz latite porphyry with phenocrysts of quartz and feldspar. The feldspars are soft and dull looking owing, probably, to hydrothermal alteration. A fine-grained greenish felsite dike at least three meters wide cuts the porphyry. This is exposed in an adit and in a shaft both described below.

The porphyry is much jointed, and, along some of the strong joints, faulting has taken place. The most prominent of the faults strikes North 30° East and dips 85° Southeast. Much shearing parallel to the fault and west of it has widened the break to a zone of indefinite width.

MINERAL DEPOSITS: The manganese mineralization is concentrated for the most part in this zone of faulting, as shown in a small open pit of irregular dimensions where mining is now being done. The chief ore mineral is manganite (hydrous manganese oxide) accompanied by lesser amounts of soft pulverulent pyrolusite (manganese oxide) and very small quantities of rhodochrosite (manganese carbonate). Rhodonite (manganese silicate) is probably present also. These minerals occur as veinlets, especially along joints and fault

planes in the fault zone, and as disseminated grains and masses replacing the solid porphyry between joints. The result is a kind of stockwork of veins and replacement ore. The ore fades out away from the fault zone so that the boundaries of minable ore are not sharp. Engineer Shahidi reported that the average width of the ore zone is five meters but that it narrows down to one meter. At the time of the examination the pit was about eight meters wide at the widest place.

Open joints of the porphyry as much as 10 meters distant from the ore are plated with manganese oxide and the rock near these joints is replaced by manganese oxide. As the fault zone is approached, the veinlets along joints become more numerous and the replacement more intense. In the fault zone the replacement is so thorough and the rock so intricately laced with veinlets that the structure is obliterated in places by almost solid ore. Most of this latter is hard manganite but the ore is somewhat vuggy and the vugs contain betrycidal manganese oxide and soft pyrolusite as well as calcite crystals and rhodochrosite.

Careful examination of ore specimens shows that some if not all the manganese oxide was derived from pink rhodochrosite and possible rhodonite. These hypogene (primary) minerals are found veined and partly replaced by manganese oxides.

MINE WORKINGS AND PRODUCTION: The principal working is an open pit mentioned in the foregoing paragraphs, excavated northeastwardly for about 30 meters in the mountain side and growing larger toward the northeast. At its widest it is about eight meters. This pit yields all the ore.

Lower on the mountain and to the southwest an adit has been started in a direction South 90° East, to intersect this ore zone at a lower level. This adit is 20 meters long (November 1954) and has not yet cut the ore.

A shaft has been sunk southwest of the open pit on what is presumed to be a continuation of the same fault exposed in the pit. The shaft is eleven meters deep and is in ore but not so rich as that in the pit.

From the bottom of the shaft to the highest point showing ore at the open pit, Shahidi estimates that ore is exposed through a vertical distance of 34 meters.

Approximately 30 meters west of the shaft two more zones of manganese oxide that trend respectively North 70° East and North 50° East have been opened up by short shallow open cuts. One of these is related to an ill-defined fault. Neither has been traced very far.

There are 70 men working one shift at the mine. All drilling is by hand. The ore is hand cobbled near the pit to make a concentrate, chiefly manganite, which is expected to run 50% manganese. The mine has been in operation for seven months.

No systematic sampling and mapping are done, consequently no ore reserves have been developed. Cost of producing the contemplated 50% concentrate is not yet known. To date no ore has been shipped.

In summary, this is a promising prospect in course of development but not yet a mine.

cc-Provincial Director, Isfahan

Mr. William E. Warne, Director, Operations Mission, Iran

Russell Gibson, Chief, Geological and Mining Investigations Branch.
(through Mr. T. E. Kilcrease, Chief, Engr. & Const. Div.)

Khalil Yeshurun's copper prospects near Mazra'eh northeast of Razan.

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MIF 5-436 dated September 28, 1954, this trip was undertaken on November 15-16, for the purpose of examining Khalil Yeshurun's copper prospects near Mazra'eh. I was accompanied on the trip by Engineer Yeshurun.

PROJECT ACTIVITY SUMMARY: The field work was carried on under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: These very small copper prospects are not very promising but the present openings have scarcely scratched the surface. It was recommended that some trenching be done to explore for a possible continuation of a fault showing the strongest copper mineralization; and that one of the present trenches in the andesite porphyry be extended along the strike.

LOCATION AND ACCESSIBILITY: Yeshurun's copper prospects are near the village of Mazra'eh 26 kilometers northeast of Razan which is 80 kilometers by air line northeast of Hamadan. Razan is on the highway between Gasvin and Hamadan. Travel from Razan to Mazra'eh is over dirt road or dirt tracks across the valley. The prospects are in the mountains close to the mountain front at altitudes of approximately 2130 to 2180 meters. Water is available but there are no trees suitable for mine timbers. Yeshurun stated that for about four months in the winter work at the prospects is shut down owing to deep snow and extreme cold.

GEOLOGY: All the rocks in the environs of Mazra'eh are igneous and all are hydrothermally altered to such an extent that it is difficult to determine their original mineral composition. The host rocks of the ore are (1) greenstone, a greenish gray rock that was originally probably a diorite, (2) dark gray andesite porphyry, and (3) a volcanic agglomerate that is older than the greenstone. These rocks have been altered to sericite, argillaceous minerals, silica, epidote, and calcite. The feldspars of the andesite porphyry are replaced by sericite and clay minerals. Silicification was noted especially in the wall rock adjacent to faults where metallic minerals have been introduced in small quantity. No rock seems more favorable for ore than any other. The control is probably faulting.

These rocks are cut by steeply-dipping faults of small displacement that commonly strike northwesterly. Gouge along the faults, where present, is exceedingly thin. No breccia is present. The faults are not very persistent along the strike, but where one ends another branches off from it with a slightly different strike. Ore mineralization is related to the faults, but it is not continuous along the faults.

MINERAL DEPOSITS: Very small quantities of copper, lead, and zinc minerals have been deposited in grains and small patches by replacement of the wall rock close to the faults. Chalcopyrite (copper iron sulphide) and its oxidation products, malachite and azurite (copper carbonates), are the most abundant and widespread minerals; but the quantities of these are everywhere small and the mineralized zone near the faults is not wide. Galena (lead sulphide) in tiny grains, in part altered to cerussite (lead carbonate), is even less abundant and sphalerite (zinc sulphide) is rare. These minerals are accompanied by pyrite (iron sulphide) altered to iron oxide, barite (barium sulphate), and quartz. None of the pits has reached below the zone of oxidation, but the water table in the neighborhood of the prospects is high and oxidation is probably not deep.

MINING OPERATIONS: Within a radius of about one kilometer there are six or eight openings, including pits, trenches and shallow shafts. About 140 meters of trenching has been done chiefly along the mineralized faults. One shaft is 18 meters deep; the others are three meters or less.

Mr. W. E. Warne, Director, USOM/Iran
(through T. E. Kilcrease, Chief, Engr. & Const. Division)
Russell Gibson, Chief, Geological and Mining Investigations Branch

Nezami copper and lead prospects at Kuh-i-Gulistan west of Ghom

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF5-781 dated December 28, 1954, this trip was undertaken on January 11, 1955, for the purpose of examining four copper prospects and a lead prospect at Kuh-i-Gulistan a mountain 34 kilometers by air line west of Ghom. I was accompanied on the trip by Mahmoud Nezami, owner of the prospects, and Engineer Badik Ordoukhanian.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: These are small shallow prospects not deep enough to warrant any opinion about their value. Work will be continued, however, because a selected sample from two of the copper prospects is reported to have shown, upon assay, a small amount of silver.

LOCATION AND ACCESSIBILITY: The five prospects are on the east side of Gulistan mountain about 34 kilometers by air line west of Ghom and 40 kilometers by dirt road or no road from the Ghom-Tehran highway (for 20 kilometers there is no road). The prospects are three and one-half kilometers southwest of the village of Husainabad. Altitude at the prospects is approximately 1465 meters.

GEOLOGY: Kuh-i-Gulistan mountain along its eastern face is underlain by a series of gray, reddish and bluish flows and other volcanic rocks similar in composition to an andesite. Some are porphyritic, some vesicular, and some amygdaloidal. These rocks are folded and the dip is easterly or north-easterly 35° to 50° in the neighborhood of the prospects.

At several places in the flows are small scattered veinlets and lenticular or irregular replacement masses a few centimeters across of supergene (secondary) copper minerals accompanied by calcite. Malachite and azurite are common but a little chalcocite (copper sulphide) also is present. These showings have been opened up on four different ridges, within a distance of about 200 meters, by eight or ten small pits or shafts, the deepest of which is 13 meters. None of these has exposed a significant deposit of copper ore, but all of the workings are very shallow and have scarcely scratched the surface. A selected sample of copper ore from two of the prospects is reported to have yielded a little silver.

The lead prospect is similar to the copper prospects and is in the same kind of host rock. Galena (lead sulphide) is present in small replacement masses a few centimeters across accompanied by calcite near a fault. Near the surface some of the galena has altered to cerussite (lead carbonate). A small pit not over two meters deep has not yet exposed a mineral deposit of significant size.

cc-Provincial Director, Tehran

Mr. W. E. Wame, Director, USOM/Iran
(through Mr. T. E. Kilcrease, Chief, Engr. & Const. Div.)
Russell Gibson, Chief, Geological & Mining Investigations Br.

Shemshak Coal Mine

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF5-436 dated September 28, 1954, this trip was undertaken on December 11 for the purpose of examining and Shemshak coal mine operated by the Plan Organization. I was accompanied on the trip by Engineers Ghassam Maghami and Sabat Ghadem of the Plan Organization.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: This is one of six coal mines run by the Plan Organization that are operating at a loss. The problems are not geological but operational, economic, and political. They are beyond the scope of this report.

LOCATION AND ACCESSIBILITY: The Shemshak mine is 35 kilometers by air line or 64 kilometers by road nearly north of Tehran. A truck road is maintained to the mine.

GEOLOGY: The mine is large and only a part of it was visited. This report is based on a reconnaissance of one adit where two seams being worked were examined.

The coal occurs in strongly-folded rocks, the dip in this adit being 50° northeasterly. Faulting was observed along the hanging wall of the coal at one place and is probably common. The beds enclosing the coal are black carbonaceous shale. The coal beds pinch and swell rapidly and, as observed on this level, range from 45 to 120 centimeters in thickness. At one place the coal pinched from 120 to 80 centimeters in a distance of three meters, but the greater thickness included at least 50% shale in layers in the coal. The coal contains sulfur in the form of veins of marcasite (iron sulfide).

OPERATIONS: The mine produces about 100 tons of coal per day (one shift). Total number of workmen on the payroll for the mine and the coke plant is 402, but this includes 49 pensioners who do no work. Some drilling is done by hand and some with compressed air. Underground haulage is by diesel locomotive that pulls 16 cars of 800 kilograms capacity each per trip. Run-of-mine coal is chiefly fine material. Probably 80% is less than three centimeters in diameter. The mine is gassy and no naked lights are used. Owing to the intense folding and faulting, caving is common and much timber is required to keep the haulage ways open. This timber comes from Mazandaran.

The annual production of about 30,000 tons is distributed as follows:

- 20,000 tons to cement plant at Ray (by truck)
- 6,000 tons to coke ovens, which yield 3,000 tons coke
- 3,600 tons is used locally around the camp and to run the electric power plant.

Engineer Maghami estimates that the coal is 25% ash and 2% sulfur.

COKING: There are 18 beehive-type ovens operating that turn out about 3,000 tons of coke a year from 6,000 tons of coal. Coal from the mine is screened and the fines that go to the ovens are smaller than one or two centimeters in diameter. Coking time is about 36 hours. The coke is used chiefly in the sugar refineries. It is not metallurgical coke.

cc-Provincial Director, Tehran.

Mr. W. E. Warne, Director of USOM/Iran
(through Mr. T. E. Kilcrease, Chief, Eng. & Const. Div.)
Russell Gibson, Chief, Geological and Mining Investigations Branch

Geological Field Trip to Meshed

PURPOSE OF THE TRIP: In accordance with travel authorization No. MPJ 5-436 dated September 28, 1954, and at the invitation of the Provincial Director at Meshed, the trip was undertaken to confer with the engineers at Meshed about ground water problems; and with the Ministry of National Economy and mine operators about the mining industry.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: The water problems cannot be solved without more information about ground water in the region. An effort is being made to obtain data that may throw light on these problems.

The limestone quarry visited seemingly is furnishing enough stone for the Minak Cement plant nearby.

The lead and "magnesite" (feldspar) prospects inspected are small and not impressive.

The coal mine is working thin, poor seams of low-rank coal difficult to extract.

More geological field work is indicated in this province and will be done when the weather moderates and the mineral deposits in the mountains are accessible.

GROUND WATER PROBLEM: Conferences were held in the office or in the field with Dr. Kady, Engineer Shahidi, Dr. C. Raglan, and Mr. H. L. Galt about ground water problems. The acute problem at the moment is the necessity for finding more water at the Torugh Farm.

Two wells on this farm south of Meshed are about 500-1000 meters apart. One yields about 200 gallons of water per minute more than the other. There were no obvious geological or other reasons for this difference. No well logs were available for these two or for the third well on the farm. An effort is now being made to obtain from the Yaganagi Institute in Tehran, the company that drilled the three wells, copies of their well logs in the hope that these may cast some light on the problem.

MINERAL INDUSTRY: Conferences were held with the following persons:

- A. Schail, operator of lead and coal prospects and mines.
- H. Rasavi, Ministry of National Economy
- Engineer Afghan, of USOM/Mashed about the information available in the Mashed office concerning the mineral industry
- Akbar Ouskoulian, operator of Turquoise mines near Nishabour
- Ebrahim Shayestih, of Sherkate Mosoleh, operator of coal and lead mines
- Mahmud Milani, operator of lead, zinc, and copper prospects.

Field trips were made to the following mines and quarries:

1. Lead and "magnesite" deposits near Khalaj
2. Limestone quarry of Minak Cement Company
3. Coal mine near Nokondar

These are discussed in detail below.

1. Lead and "magnesite" deposits near Khalaj southwest of Mashed.

LOCATION AND ACCESSIBILITY: These deposits are 10 kilometers southwest of Mashed at altitudes of 1120 to 1150 meters. Part of the way to the deposit is by poor dirt road or trail; part of the way there is no trail.

GEOLOGY: The country rock at the mountain front is chiefly schist, some of which is garnetiferous, with minor beds of white, crystalline, magnesian limestone one or two meters thick that are a little more resistant to weathering than the schist and stand out as discontinuous ribs. Some of the schist is graphitic.

The schist series has been invaded by a granite intrusive of unknown size, the contact with which is a little higher in the mountains. The upper slopes appear to be all granite. A few streaks and lenses of pegmatite up to 30 cm. across are present in the granite.

Irregular, narrow veins or irregular masses of very fine-grained feldspar mixed with a little quartz up to 15 cm. across have been developed in some of the magnesian limestone beds near the contact with the granite. The miners have mistakenly called this material magnesite. One of these is being mined in a small open cut.

A fault zone at least a meter wide in the granite a few tens of meters west of the contact with the schist has been worked in the past for galena veins in it. Nearby in one of the more persistent joints in the granite is a small showing of galena that has just been opened up. Thus far it is not promising.

OPERATIONS: The feldspar deposits are being operated in a small way by hand. It is reported that the feldspar is used in making bricks.

The lead prospects are idle.

2. Limestone quarry of Minak Cement Company

LOCATION AND ACCESSIBILITY: The quarry is 24 kilometers by air line or 35 kilometers by road northeast of Meshed. It is about 5 kilometers from the cement plant over a road in the flood plain of a mountain stream that would be washed out in wet weather. Altitude at the quarry is about 1140 meters.

GEOLOGY: The rock being quarried is a dark gray, massive-bedded limestone that weathers buff. Many of the beds are a meter or more in thickness. At the quarry the beds strike No. 40° W. and dip 35° SW. Along some of the joints, especially where a little faulting has occurred, there are very thin platings of brilliant red iron oxide and along others thin veins of coarsely crystalline calcite. Stronger faulting has occurred across the structure in at least two periods. Attitude of the more persistent faults ranges from N. 25° W. to N. 55° E. with dips high NE or NW. Some of these exhibit as much as five centimeters of gouge and breccia as well as iron oxide or calcite.

OPERATIONS: The quarry is opened up through a vertical distance of about 30 meters on the side of a hill with a slope of 40°, covered with very little overburden. At the time it was visited, the pit was idle because the cement plant was shut down temporarily.

3. Coal mine near Nokondar.

LOCATION AND ACCESSIBILITY: A small coal mine operated by A. Schail and associates is located 33 kilometers northwest of Meshed and about one kilometer northeast of Nokondar. Much of the road to the mine is not surfaced and part of the road is in valley bottoms where traffic might be interrupted in wet weather. Altitude at the mine is approximately 1330 meters.

GEOLOGY: The coal occurs in thin, strongly folded and faulted seams whose average thickness is difficult to determine because the coal pinches and swells so rapidly due in part to buckling during folding. In places it increases from 30 centimeters to 90 centimeters in a meter or two, but the greater thickness does not hold. In several places the seam is about 25 centimeters thick. In one place where a coal bed measured 40 centimeters it contained 15 to 17 centimeters of shale.

The coal appears to be subbituminous in rank and is extremely friable. Consequently most of the run-of-mine production is in fines that will go through a screen with holes two centimeters in diameter.

The coal is enclosed in carbonaceous shale which is greatly fractured and slickensided as a result of the faulting and folding. The beds are invaded by a granite intrusive of unknown dimensions.

OPERATIONS: The coal is worked in three short adits all driven southeasterly in a vertical range of about 15 meters. There are 10 men employed at the mine. The production is a few tons a day and is irregular. The coal is screened before it is loaded into trucks for transportation to Meshed. The largest pieces of material that come from the mine are commonly shale but some shale is included with the fines. Owing to the intense folding and faulting of the beds, the ground does not stand well and much timbering is required.

Mr. E. C. Bryant, (Acting) Director of U. S. Operations Mission to Iran
Russell Gibson, Chief, Geological and Mining Investigations Branch
(through Mr. T. E. Kilcrease, Chief, Engineering and Construction Division)

Geological Field Trip to Northeastern Iran

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF5-781 dated December 28, 1954, this trip was undertaken for the purpose of visiting mines and prospects near Torbat - Jan, Farinam, Derakht-i-tut, Meshed, and Himmatabad; and of conferring with persons in Meshed and environs interested in the mineral industry.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: The chromite deposits being operated south of Farinam are, at present, unprofitable. The grade is low and present prices are too low to meet the high costs.

The coal produced at Sherkate-Zoghal coal mine is low rank, low grade fuel, but evidently finds a very small market in Meshed.

The lead prospects north of Torbat-Jan are small and not significant. The Rezaei chromite mines south of Himmatabad are a going enterprise and small shipments are being made. It is reported that enough ore is in sight to enable the operators to expand production if demand, at present not very great, should rise.

1. MORADIAN CHROMITE PROSPECT

LOCATION AND ACCESSIBILITY: The approximate location of this prospect is latitude 35°30' North and Longitude 59°45' East. It is two kilometers north of Zi-o, a small village 32 kilometers south of Farinam, all but three or four kilometers of which is over gravelled road. The prospect is in low treeless hills.

/Geology

GEOLOGY: The host rock of the chromite deposits is a serpentized dark, mafic intrusive (high in ferromagnesian minerals) that has been much faulted and slickensided. Most of the fault planes are curved and the rock is broken up into large, irregular, pillow-like masses bounded by curved planes. The serpentine is grayish, light green and dark green.

The chromite occurs in lenses that trend northwesterly. They range in width up to about three meters but a single lens will pinch down from this dimension to about one meter in a distance of seven meters. The largest pit is only about ten meters long and half as deep, however, and more extensive mining may uncover larger bodies of chromite. Contact of chromite with serpentine is sharp but the contact becomes ragged where offset by small faults.

OPERATIONS: The workings consist of two open pits, one about six meters and the other about ten meters long. No shipments have been made but a few tons of chromite are stockpiled at the pits. The owners report that the grade is 44 percent Cr_2O_3 , too low to ship at present prices. They state that ore as high as 48 percent Cr_2O_3 which would bring a price of \$30.00 per ton F. O. B. Khoramshahr is not profitable with an exchange rate of 76-82 Rials per dollar.

2. SHERKATE ZOGHAL (COAL) MINE

LOCATION AND ACCESSIBILITY: The approximate location is Latitude $36^{\circ}5'$ North and Longitude $59^{\circ}36'$ East. The mine is situated in low hills near the village of Derakht - i tut, 28 kilometers south of Meshed, at an altitude of about 1350 meters. Four kilometers of this distance is over a dirt road. There is no timber suitable for mining nearby.

GEOLOGY: The coal is subbituminous and occurs in a strongly - folded series of conglomerate and shale that strikes North 40° - 60° East and dips 35° - 40° NW. Shale overlies and underlies the coal. The conglomerate contains pebbles up to two inches in diameter. The coal being an incompetent rock yielded during the folding, consequently is very irregular in thickness and much faulted. In places it was observed to pinch from 1.3 meters to less than half this thickness within a few meters. An average thickness has no significance. As the coal is much slickensided and fractured, the mine yields a high percentage of fines, though lumps up to 15 centimeters across were seen on the stock pile. The coal is not sized.

OPERATIONS: The mine is opened up by a narrow incline driven north-easterly at an angle of about 40° . Timbering is required along the entry as well as at the working places. Production is reported to be about 300 tons per month that sells for 270 Rials per ton of run-of-mine coal at the mine. The coal breaks readily underground and no blasting is necessary. The miners report that the coal is high in ash. This is certainly correct.

3. BOTECHAT LEAD PROSPECT

LOCATION AND ACCESSIBILITY: The prospect is about 32 kilometers north of Terbat-Jan. Of this distance five kilometers is over an unsurfaced road and two and one half kilometers over trails. Latitude is approximately $35^{\circ} 24'$ North and Longitude $60^{\circ} 48'$ East. The property is in low barren mountains at an altitude of about 1550 meters.

GEOLOGY: Most of the deposits seen were insignificant showings of galena accompanied by coarse calcite in small replacement masses a few centimeters across near faults in volcanic breccia or agglomerate. The faults commonly strike north or northeasterly and dip easterly 50° - 90° . A few similar small veins were observed in granitic rocks nearby but the contact between the two igneous rocks was not seen.

OPERATIONS: These small lead deposits have been opened up by an edit about 25 meters long and five or six shallow open pits. At the time of the examination the property was idle.

4. REZAI CHROMITE MINE

LOCATION AND ACCESSIBILITY: The mine is about seven kilometers south of Shurab, a village nineteen kilometers south of Himmatabad. All of these distances are over dirt roads. The approximate location is Latitude $36^{\circ} 08'$ North and Longitude $56^{\circ} 22'$ East. The deposits are in low barren rounded hills with very thin soil cover. There are no perennial streams near.

GEOLOGY: The host of the chromite deposits is a serpentized mafic rock of unknown original composition. In color it ranges from light to dark green to brown. The rock is greatly faulted in irregular

masses and many of the fault planes are curved. Some fault planes are veneered with thin coatings of talc. The original structure is obliterated and the resulting rock is made up of huge pillow-like masses of serpentine bounded by fault planes.

The chromite occurs in three ways: most importantly as lenses from 30 centimeters to several meters thick at the thickest place and up to 12 meters long; as irregular replacement masses that make out from the lenses into the serpentine, gradually getting smaller away from the lens; and as thin lines of chromite grains, six to ten lines in a thickness of 20 centimeters of rock. Most of the production is from the lenses though they are irregular in size and shape. Many are bounded by faults and some are cut across by faults that result in offsetting of a part of the lens.

OPERATIONS: The deposits are worked by open pits of different sizes depending upon the dimensions of the deposit worked. About 100 meters of the pits were seen. Mining is done by hand. The ore is cobbled to raise its grade to about 48% chromite oxide and trucked to Minmatabad where it is weighed and transferred to larger trucks for transportation to the railroad at Sharud.

CONFERENCES

Conferences were held in Meshed or in the field with the following persons:

Engineer Hassan Ghazazadeh of the Minak Cement Co. and Engineer Afghan of USOM/I concerning raw materials for the cement plant near Meshed.

Ali Rezai concerning chromite mines in the neighborhood of Shahrud, Minmatabad, Sabzavar Abbasabad, and other Place.

Hossein Tahbas, concerning copper prospects to be visited later.

cc. Provincial Director, Meshed

Mr. E. C. Bryant, Acting Director, U. S.
Operations Mission to Iran
Russell Gibson, Chief, Geological and Mining Investigations
Branch (through T. E. Kilcrease, Chief, Engineering and Construction Division

Geological Field Trip to Shiraz

PURPOSE OF TRIP: In accordance with Travel Authorization No. MJF-1135 dated March 16, 1955, this trip was undertaken, beginning April 2, 1955, at the request of D. W. Gilfillan, Provincial Director, for the purpose of inquiring into the mineral industry in the vicinity of Shiraz.

CONCLUSIONS AND RECOMMENDATIONS: The mining industry in the Shiraz region is seemingly not important. Not much prospecting is being carried on and some of the discoveries have not even reached the prospect stage.

NOTES ON THE MINERAL INDUSTRY: Several prospectors who had requested advice were called in to Mr. Gilfillan's office or were visited at their offices.

Said Mohamed Taghi who has been prospecting for oil and gold was informed that exploitation of these is restricted to the Government of Iran. He has, also, sulfur prospects near Kazeroon not much developed which may require examination later. He will bring specimens from some of his other prospects to Gilfillan's office for appraisal.

Mohamed Nahey Barkati, a merchant in Shiraz, who has been prospecting and who had sent to the Point IV office numerous specimens of lead, zinc and iron ores, limestone and furnace slag, some of which were either identified by him incorrectly or not identified, was advised about certain of his properties which at present are merely outcrops with no mine openings. If he opens up any of these that seem promising, he will notify Point IV.

Asghar Pairavi, a young merchant in Shiraz, has permits to prospect in certain areas. At present he has no mine openings but has sent for analysis selected specimens of ores of chrome, lead, manganese, and iron taken from outcrops. He said he distrusts the assay certificates from the Tehran assayer. Moreover, it is doubtful that his specimens represent true samples of his mineral deposits. He has, also, clay prospects and has made in his own laboratory crude fusibility tests on the clay which he believes is rather refractory. Mr. Pairavi will report to Point IV if he does.

/any

any extensive prospecting at any of his properties which might warrant an examination of them.

A visit was made to the local office of the Ministry of National Economy accompanied by Point IV Engineer Habib Khamsi. The Ministry has requested no help and they operate no mines. The office was not excessively well informed about the mineral industry in the Shiraz region, possibly because it is not of outstanding importance.

Mr. Clark S. Gregory, Director, USOM/Iran

Russell Gibson, Chief, Geological and Mining Investigations
Branch (through T. E. Kilcrease, Chief, Engineering and Construction Division)

Farviz Soroushian's Lead and Copper Prospects, Southwest of Kerman

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF5-1135 dated March 16, 1955, this trip was undertaken on April 19 and 28, 1955, for the purpose of examining lead and copper prospects belonging to Farviz Soroushian and associates, southwest of Kerman. I was accompanied on the trip by Mr Soroushian.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: The lead veins are lean and of doubtful worth even if they were favorably situated with respect to transportation.

The veins of copper, a higher priced metal, merit more prospecting and some adequate sampling at depth to determine persistence and grade. Directions were given for this work.

LOCATION AND ACCESSIBILITY: Soroushian's lead and copper prospects are about 75 kilometers by roads (unsurfaced) southwest of Kerman and southwest of the village of Bahramjird. The approximate location of the lead prospects is Lat. $29^{\circ}42'$ N. and Long. $56^{\circ}46'$ E; and the copper prospects Lat $29^{\circ}40'$ N and Long. $56^{\circ}52'$ E. The prospects are in the lower mountains near the front of the range that trends northwesterly in this region.

1. LEAD PROSPECT

GEOLOGY: The lead prospects are veins in reddish to gray andesite porphyry, in greenstone, and in black trap which may be a finer grained equivalent of the andesite. The rocks are present as a series of flows or shallow-seated intrusives which have been strongly folded. At the prospects the rocks trend easterly and dip steeply north or south.

The veins are from a few centimeters to two meters wide but the latter included slices of silicified country rock. Commonly the width is 30 - 60 centimeters and is made up of dominantly of barite with small quantities of quartz, very little galena, and insignificant malachite (copper carbonate). A little iron oxide is present and probably derived from chalcopyrite (copper-iron sulfide). The veins are very lean in lead. They strike N. 60-80 E and thus cut the flows at a low angle; they are vertical or dip steeply to north.

OPERATIONS: The veins have been opened up by at least 14 trenches none of which is more than two or three meters deep for about 1000 meters along the trend. No one vein has been proved for any significant length; but if it pinches out another slightly offset takes its place.

There are 25 men working at the prospects at the time they were visited. All work is by hand.

2. COPPER PROSPECTS

GEOLOGY: The copper veins trend northerly or northeasterly and have been opened up over a length of at least one kilometer in rough topography and through a vertical range of about 40 meters. The veins range in width from a knife edge to one meter, and some closely-spaced veins form a group three meters wide but this includes country rock. Some veins are a few meters long and others a few tens of meters. They pinch and swell rapidly.

The country rock is chiefly a fine-grained, even-grained rock, probably an andesite with porphyritic phases or with porphyry intrusives cutting it. Most of the veins are in the non-porphyritic rock, however.

The veins are dominantly quartz with small amounts chalcopyrite and insignificant amounts of bornite (copper iron sulfide) scattered through in grains or very small clumps of grains. Azurite and limonite are present in all croppings but oxidation is not very thorough and little copper has been leached from the veins. They are very lean in copper.

OPERATIONS: Numerous shallow pits, the deepest about 4 meters, have been sunk chiefly in the country rock beside the veins to test the continuity at depth. Little crosscutting of the veins has been done and nothing is known about the copper content except by visual inspection. No sampling has been done.

Mr. Clark S. Gregory, Director of U. S. Operations Mission to Iran
Russell Gibson, Chief, Geological and Mining Investigations Branch
(through Mr. T. E. Kilcrease, Chief Engineering and Construction Division)

Geological Trip to Rasht and Tabriz

PURPOSE OF TRIP: In accordance with Travel Authorization No. MJF5-1135 dated March 16, 1955, and with the prior approval of Messrs. Woods and Asher, this trip was made starting May 16, for the purpose of investigating mineral resources in northwestern Iran.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 19 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: It is recommended that, after more information concerning the mineral industry in Azerbaijan is collected by Mr. Asher, this region be revisited.

DISCUSSION: Conferences were held at Rasht with George B Woods, Ernest Diggs, and Dr. Fatola Samii of POA concerning the mineral industry of the Rasht region. Only one prospector came into the office for advice, and his specimens were worthless. Little information is available about any prospecting or mining in the region, probably because little is carried on.

Conferences were held at Tabriz with Joh Asher, Robert Reid, and Fariddeen Bazargan of POA, with Yousef Najmabadi, Director of the Ministry of National Economy in Azerbaijan about the mineral industry in Azerbaijan. Prospecting and mining are not major industries in this region, but the following information was elicited which, in Mr. Asher's and my opinion, is certainly incomplete.

1. Two coal mines are being operated by private enterprise near Maragheh south of Tabriz.

2. Two arsenic mines are known, both run by private operators. One is operating near the village, Valilu, which is between Tabriz and Ahar. The other, shut down at present, is near Dastijerd.

3. Salt is being produced by evaporation of the waters of Lake Rezaieh. Rock salt from mines is being or has been produced at or near the following places: Khaja, village between Tabriz and Ahar; Shurdaragh, village north of Tabriz; Evli, village; Khoy.

4. A copper mine near Songon on the road to Ahar is reported to have operated prior to 1941.

Mr. Najmabadi reported that the mines in the region were formerly under the direction of the Ministry of Finance and that he was not yet as familiar with the industry as he would like to be.

I agreed to return to Azerbaijan and visit some of the above mentioned properties and others that Mr. Asher said he hoped to learn about.

Mr. Clark S. Gregory, Director of U. S. Operations Mission to Iran
Russell Gibson, Chief, Geological & Mining Investigation Branch
(through T. E. Kilcrease, Chief, Engineering & Construction Division)

Mines Near Ray that Supply Clay for Making Refracting Bricks

PURPOSE OF THE TRIP: At the request of the Tehran Regional Office, this trip was undertaken on May 24 with Messrs. Elagg of USOM/Iran and Newcomer of George Fry and Associates for the purpose of examining and sampling some clay mines which furnish raw materials for the brick plant at Aminabad. The plant is near Ray and makes fire brick to line the kilns at the Ray Cement Plant. Two of the four or five mines that supply clay were visited briefly and faces where clay is now being extracted were inspected.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: The bricks presently being used to line the cement kiln at Ray are unsatisfactory. This may be because the clay shale used to make them is unsuitable or because the bricks are improperly made or for some other reason. A brief examination of the shale deposits being mined indicates that the grade of the deposits is irregular. Sorting of the clay on the dump by miners is done by visual inspection and the chief criterion seems to be iron content as indicated by color. Some sampling is done underground in advance of mining but its value as a control is somewhat doubtful.

Either the sorting is not well done or, if it is, the best clay may be unsuitable. Bulk sampling of sorted material just before it is made into bricks should be done.

It might be well to ascertain whether the bricks are being properly made but this is beyond the scope of this report.

GEOLOGY: The raw material being mined is a gray, irregularly ferruginous shale bed included in a series of steeply dipping limestones and shales. The beds are strongly folded and the shale is somewhat contorted and faulted and changes rapidly in color along the strike. The miners seemingly depend entirely upon color to determine grade though it is reported that samples are cut and analysed in advance of mining. The beds mined range in thickness up to a meter or so. In places the entire bed is good grade but it changes along the strike and a few meters away is below grade and left unmined. Elsewhere only a part of a bed is acceptable grade but the whole stratum may be taken down in mining. The waste is left

underground or trammed to the portal with good clay and sorted on the dump.

GRADING THE CLAY: At the two mines visited it is seemingly the custom to grade the clay trammed to the surface by visual inspection before it is sent to the plant to be made into bricks. This is done by laborers. As noted above, the foreman underground determines by eye what material is to be selectively mined. It is doubtful that the prior sampling and analysis exerts much control.

SAMPLING AND ANALYSIS: At the mine that is reported to furnish the best clay, the foreman selected underground at my request hand samples of first, second, and third grade material and these have been sent for analysis to Pittsburgh Testing Laboratories, Pittsburgh, Pennsylvania, partly to test his judgement and partly to determine the character of what is regarded as the best clay. It should be emphasized, however that these are grab hand samples and therefore not very significant; and that the final sorting of clay that goes into the bricks is done not by the foreman but by laborers.

If the grade of clay required to make satisfactory brick is present in the deposit and can be determined by analysis, it might be well to consider taking bulk samples of the sorted material for analysis either on the dump or at the brick plant. It will then be pertinent to try to determine whether selective mining can be done.

cc. Mr. George Fry and associates

Mr. Clark S. Gregory, Director of U. S. Operations Mission to Iran

Russell Gibson, Chief, Geological and Mining Investigation Branch
(Through T. E. Kilcrease, Chief, Engr. & Cons. Div.)
Chromite Mines near Daulatabad and Esfandagheh

PURPOSE OF TRIP: In accordance with travel authorization No. MJF5-1135 dated March 16, 1955, this trip was undertaken April 25 and 26 for the purpose of examining chromite mines in the environs of Daulatabad and Esfandagheh. I was accompanied on the trip by Engineers Taghi Mousavi and Ardashes Sarkissian of the Iran Chromite Co. The Abdasht, Marzeni, Solu, and Baghborj mines belonging to the Mines Bongsh and the Sheikh-Ali mine belonging to the Iran Chromite Co. were visited. There are other mines in the region which were not examined.

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: The chromite deposits seen on this trip are scattered and are irregular in size, shape, and attitude. Most of them do not persist to great depth. For the most part they are mined in open pits because, before much depth is attained, any one deposit is exhausted. Thus far it appears to be more economical to search for the outcrop of another deposit than to explore at depth. Moreover, deep mining is more expensive, especially so since at some of the pits the water table is close to the surface.

The ore bodies are restricted to the serpentized parts of mafic igneous rocks, similar in composition to peridotite, pyroxenite, or gabbro.

The ore is hand picked and cleaned at each pit.

Little sampling is done and ore reserves are not developed and measured, consequently the diversity of opinion concerning the present reserves is extraordinary. Most, if not all, the concentrates are trucked to Bandar-Abbas and exported.

LOCATION AND ACCESSIBILITY: Approximate location of the mines is as follows:

Sheikh-Ali	28°09 N. Latitude;	56°48 E. Longitude
Abdasht	28°20 N. Latitude;	56°48 E. Longitude
Baghborj	28°34 N. Latitude;	57°05 E. Longitude
Solu	28°31 N. Latitude;	57°10 E. Longitude
Marzeni	28°29 N. Latitude;	57°04 E. Longitude

The present Sheikh-Ali workings are all within a radius of about five kilometers and are roughly 23 kilometers southeast of Daulatabad.

Abdasht about 15 kilometers east of Daulatabad
Baghborj about 20 kilometers southeast of Esfandagheh
Solu about 20 kilometers nearly south of Esfandagheh
Marzeni about 27 kilometers southeast of Esfandagheh

All of the above figures are airline distances.

Most of the workings are reached by roads, commonly not surfaced to much extent. In fact some roads are little better than camel trails.

All the deposits being worked are in low mountains or in the lower slopes of higher rugged mountains. The road grades in places are steep.

GEOLOGY: The host rocks of the chromite deposits examined on this trip are serpentinitized intrusives which, in their original condition, were rich in ferromagnesian minerals. The original rocks were probably peridotite, pyroxenite, or gabbro but are now hydrothermally altered to serpentine. Away from the serpentine and chromite, dark-colored grained rocks similar in appearance to these are present; but microscopic examination of thin sections of the rocks to determine their precise composition was not made. The serpentine, in marked contrast to the unaltered rocks, is gray, pale green, or almost white. The grained ferromagnesian rocks are serpentinitized only in part; and chromite bodies make up only a small part of the serpentine.

The chromite occurs in lenses, short vein-like bodies, replacement masses, and irregular bodies with no special shape, and seemingly is distributed at random in the serpentine. The bodies may have any attitude and show great range in size. At the Baghborj mine one ore body has a dip 15° northerly; at the Solu a large ore body is nearly vertical. Detailed mapping might reveal structural or other controls, but these were not obvious in the reconnaissance examination.

The lenses pinch and swell rapidly. For example, a single lens swells from 15 to 60 cm. in a meter of length. Many are less than a meter in maximum thickness. Some vein-like bodies thin out to a knife edge. In places there are groups of three or four veins in a zone a meter wide with slices of barren rock between. Small veins, too small to mine, make off into the country rock from some of the minable lenses. In some of the chromite bodies, there are small inclusions of barren country rock and these may be veined by chromite. At the Solu mine a nearly vertical chromite body in places up to six meters thick bounded on one wall by a strong fault, is being mined; but no other ore body so large as this was seen in any of the other mines. It is reported that this is one of the richest ore bodies in the general area.

The chromite ore is fine grained and dense to coarse grained. The commonest gangue minerals are the serpentine itself and lesser amounts of magnesite and a little talc. In places near the chromite masses the serpentine is honey-combed with carbonate, probably chiefly magnesite.

The serpentine and chromite bodies are both cut by numerous faults many of which are curved. Some chromite masses are bounded by one or more faults and this yields a free wall that enables the chromite body to break easily from its serpentine matrix. Some chromite lenses are cut and offset by faults.

At a few of the pits in valleys the water table is close to the surface and gives trouble at a few meters of depth.

OPERATIONS: Almost all of the chromite is mined in open pits. Some underground work has been done at the Marzeni, Solu, and Baghborj mines but operations are not extensive. At the Baghborj, one winding adit about 100 meters long has exposed a few ore bodies not yet mined, the thickest of which is about one meter. Various pits have yielded from a few hundred to a very few thousand tons of crude ore. When an ore body is mined out, the pit is abandoned and another deposit is opened up.

At all the mines the ore is sorted and hand cleaned before it is shipped or stock piled. This yields a concentrate reported to contain from 46 to 51 percent Cr_2O_3 . The requirement for metallurgical chrome is ordinarily 48 percent Cr_2O_3 , and the practice at some properties (or of some brokers) is to sweeten the lower grade with the higher grade concentrate.

The concentrates are trucked to Bandar-Abbas, whence they are lightered to ships at this port.

At the time of this examination, the market for chrome was not strong and a total of about 14,000 tons of concentrates was reported to be stockpiled at the mines and at Bandar-Abbas.

Some operators mine, concentrate, transport, and ship their ore; others sell concentrates to brokers or others at the mine.

Mr. Clark S. Gregory, Director of U. S. Operations Mission to Iran
Russell Gibson, Chief, Geological and Mining Investigations Branch
(through Mr. T. E. Kilcrease, Chief, Engineering and Construction Division)

Salt and Iron Oxide Mines on Hormoz Island

PURPOSE OF THE TRIP: In accordance with Travel Authorization No. MJF5-1135 dated March 16, 1955, this trip was made April 22 for the purpose of examining the salt mine and the iron oxide mine on Hormoz Island. I was accompanied on the trip by Engineer -in-Charge, Yamini *Watin*

PROJECT ACTIVITY SUMMARY: This work was done under Project Funds Agreement No. 10 for the establishment of a reconnaissance geological survey of mineral deposits.

CONCLUSIONS AND RECOMMENDATIONS: Salt (sodium Chloride) is mined from a large dome on Hormoz Island where, seemingly, the reserves are abundant. Production, about 30,000 tons per year, could be increased if there were a larger market. One of the most troublesome problems of the operation at present is the elimination from the salt of calcium sulfate in the form of gypsum or anhydrite. This is done to some extent by grinding. The fine material contains a higher percent of calcium sulfate than the coarse.

Red iron oxide (hematite) is mined from a replacement deposit in a volcanic agglomerate whose composition is probably that of dacite or andesite. As shown in the present workings the deposit is bed-like and nearly horizontal. It grades upward into a bed of ferruginous agglomerate which is wasted. The ore reserves are not known.

Both deposits are worked by open-pit method.

LOCATION AND ACCESSIBILITY: The salt mine is in the northwestern part of Hormoz Island and the iron oxide mine is in the southern part. Hormoz is in the Persian Gulf, 23 kilometers southwest of Bandar Abbas at 27°03 North latitude and 56°30 East Longitude. The topography is mountainous and the climate arid. There is no potable water on the island and it must be brought from the mainland. The mines and piers are connected by passable truck roads.

/ Geology

GEOLOGY OF THE SALT DEPOSIT: The salt deposit is part of a dome the size and extent of which was not determined. At the mine face, which is an open cut, the salt is bedded and dips steeply, in places nearly vertical. Alternating with the purer salt beds are thin layers of red or brown iron oxide or salt heavily impregnated with iron oxide. This emphasizes the bedding. The iron oxide and other impurities are also, to some extent, mixed with the purer salt beds. It is reported that a little anhydrite or gypsum is also present in the salt. Above the salt are beds of agglomerate similar to dacite or andesite containing fragments up to 15 cm. across. The surface of the agglomerate is exceedingly rough owing in part to the solution and removal of salt beneath it in an irregular fashion, causing the agglomerate to slump. Where the agglomerate is removed by weathering and erosion, the salt exposed is weathered and eroded rapidly. Deep crevasses are developed which become partly filled with agglomerate debris and soil from above and beyond the crevasses. As the face is advanced in mining and one of these little valleys is encountered, the amount of waste that has to be handled is increased.

OPERATIONS AT THE SALT MINE: The salt is mined in a cut opened up against the steep face of the salt dome which is here the mountain front. The floor of the "quarry" is roughly the elevation of the land a little above the beach. The face is being advanced into the dome.

The agglomerate and soil overburden above the salt where it is now being mined is not thick and this is removed or partly removed before the salt below is mined.

The salt that is blasted down at the face is hand cobbled and sorted before being loaded into cars. The waste (below-grade salt) (barren rock and soil) is sent to a dump. The good grade material is trammed a short distance to a crusher operated by a diesel engine whence it is sent to a stock pile in the open. From the stock pile the salt is trammed about one kilometer or so to ships which anchor in about 5 fathoms of water. Present production is 200-300 metric tons per day. About 30,00 tons of salt per year is sold to Japan.

The mine is shut down for three months during the summer.

GEOLOGY OF THE IRON OXIDE DEPOSIT: The ore is a flat-lying replacement body of red iron oxide (hematite) ranging in thickness from a layer too thin to mine up to at least 8 meters. It lies beneath an overburden with a very irregular rough surface 30-40 meters thick which is probably an agglomerate more or less replaced by hematite and hard to distinguish from ore. All of the rocks are deep red. The ore appears to be more completely replaced agglomerate. Immediately overlying the ore is a transitional layer like the ore but containing selenite (gypsum) and not mined. In the midst of good ore are "horses" (inclusions of gray to yellowish hydrothermally altered igneous rock not replaced by hematite. Some of these are 30 cm. or more in diameter

Most of the ore is deep red, soft, pulverulent, structureless material but here and there are whisps and irregular patches or lumps of specularite (hard cyrstalline iron oxide)

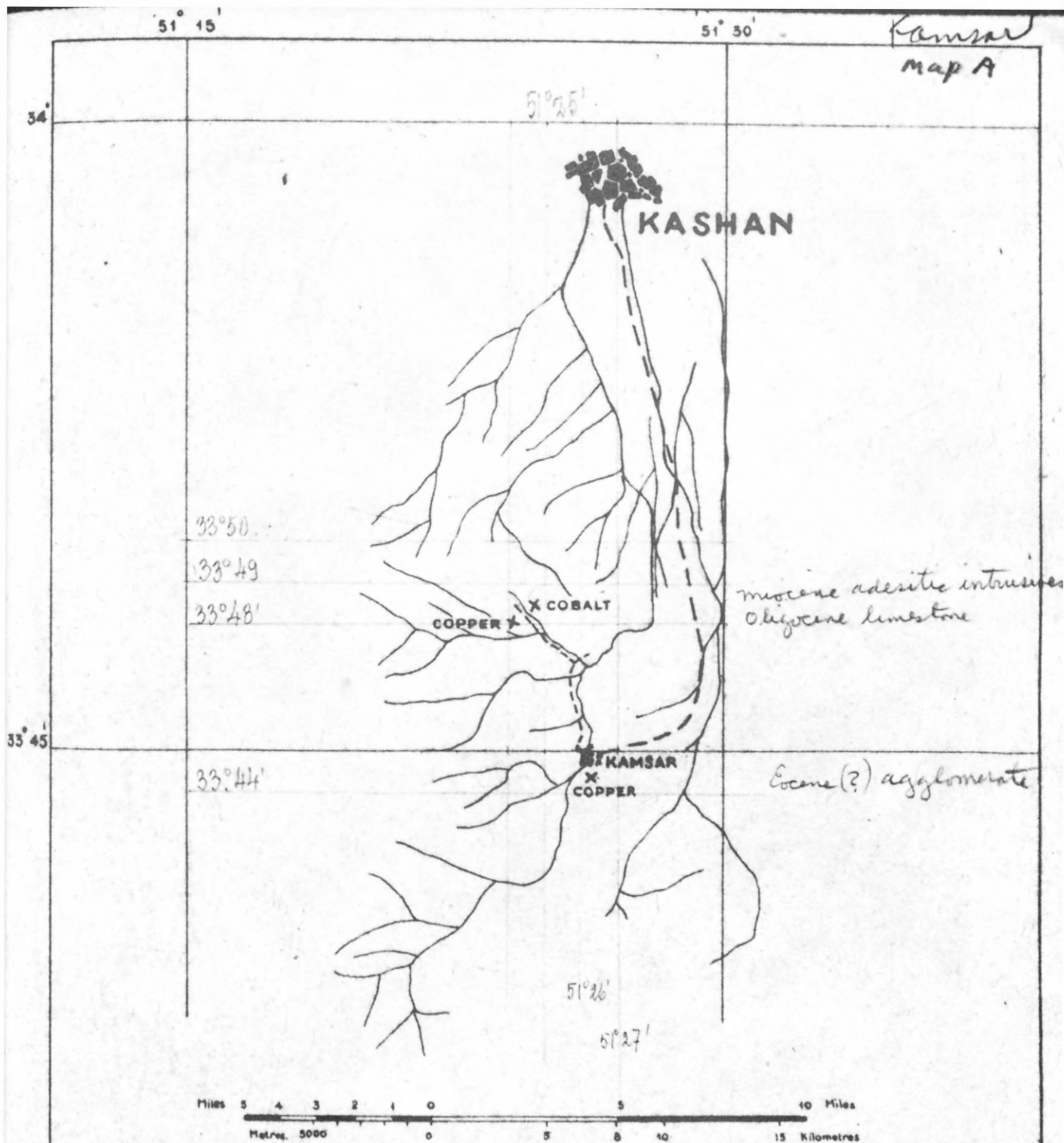
OPERATIONS AT THE IRON OXIDE MINE: The red oxide ore is mined from an open pit about 45 meters deep, hand picked to some extent to eliminate waste, and carried in baskets up an incline to the surface where it is loaded into cars and trammed a short distance to a stock pile. From the stock pile it is trucked to the oxide loading pier and lightered to ships anchored at a depth of about 5 fathoms.

Pneumatic drills are used, but little blasting is necessary. It is confined chiefly to breaking up "horses" of barren rock and lumps of hard compact specularite.

Mining is progressing in a direction that will encounter increasing overburden, but underground mining has not been adopted.

About 6000 tons of red oxide per year have been sold in the past chiefly to England, the United States, and India. More oxide could be produced if there was a market. It is used as a pigment.

The mine is shut down for three months during the excessively hot summer.



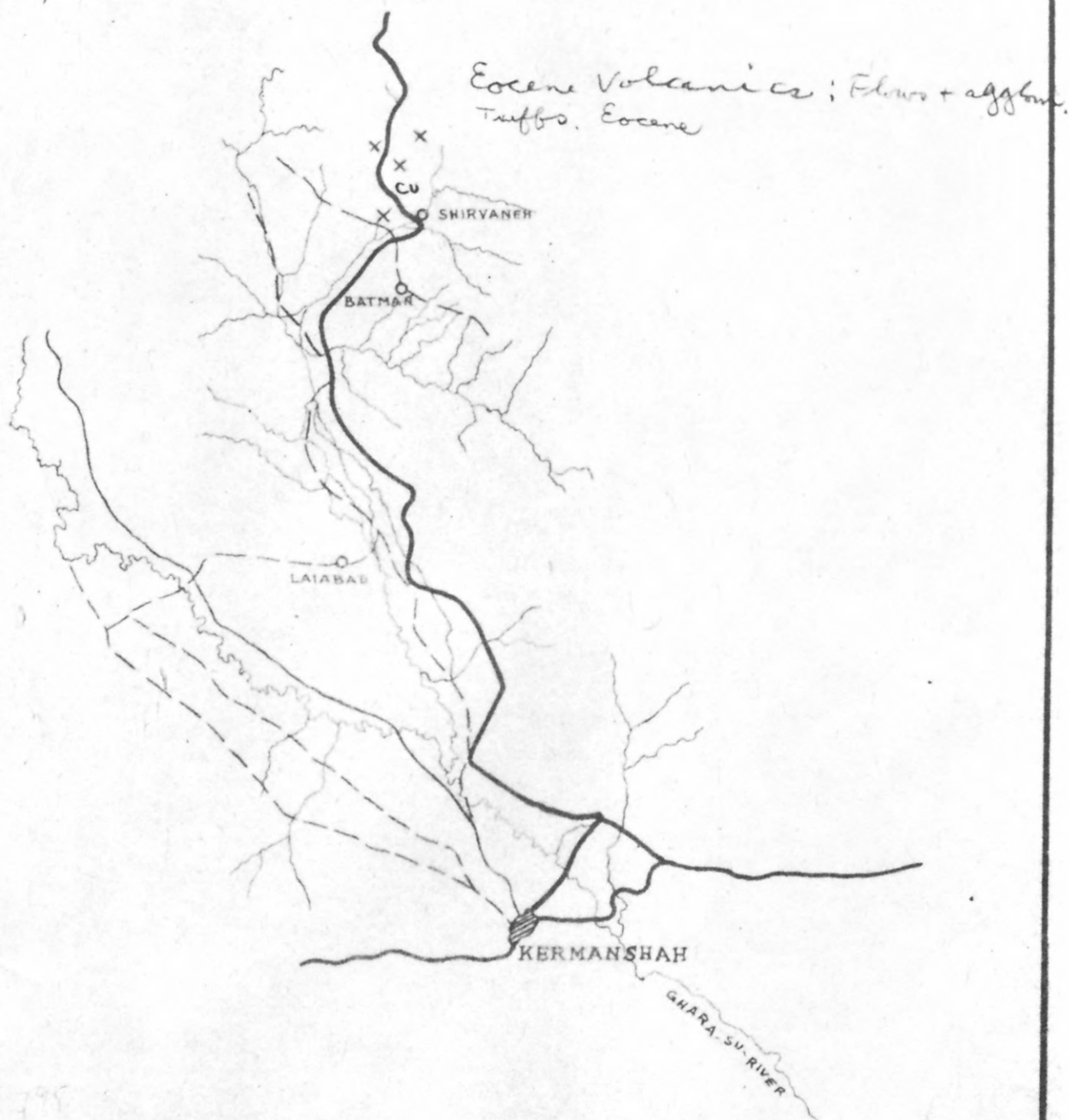
SCALE = 1:253,440

MAP SHOWING APPROXIMATE LOCATION OF PROSPECTS NEAR KAMSAR.

OMI. DRWG. N° GEN-465T-1403.
PROJECT N° 10
TEHRAN, 12, 4, 54.

34° 48' to 34° 52' N.
46° 57' to 46° 59' E.

Atlar Yadeh Copper prospect
near Shirvaneh,



0 1 2 3 4 5 10 15 20 30 40 50 K.m.

SCALE = 1:500000

MAP SHOWING APPROXIMATE LOCATION OF PROSPECTS NEAR SHIRVANEH.

OMI DRWG. N° GEN-455 T-1402
PROJECT N° 10.
TEHRAN, 5,4,54.

51° 15'

51° 30'

Map C

Jupiter copper prospects

KASHAN

COPPER *

miocene andesitic intrus
Oligocene l.s.KAMSAR
COPPER

Eocene(?) aggloms.

Miles 5 4 3 2 1 0 5 10 Miles
Metres 5000 0 5 10 15 Kilometres

SCALE = 1:253,440

MAP SHOWING APPROXIMATE LOCATION OF PROSPECTS NEAR KAMSAR.

OMI. DRWG. N° GEN-465T-1403.
PROJECT N° 10
TEHRAN, 12, 4, 54.

Copper prospects near Kamsar

mid. Creta. /s

48° 30'

48° 45'

Cu
X

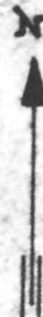
near are upp. Creta. shales

Miyomleh Bela

Miles 5 4 3 2 1 0 5 10 15 Miles
Metres: 5000 0 5 10 15 Kilometres

SCALE = 1:253,440

MAP SHOWING APPROXIMATE LOCATIONS
OF ANTIMONY, LEAD AND COPPER PROSPECTS
IN THE HAMADAN REGION.



35°

35°

Selihebad

*lower jur. shale or
mid. Creta. /s*

X Pb

Tohanshad

X Sb

HAMADAN

OMI. DRWG. N° GEN-490 T-1404.
PROJECT N° 10
TEHRAN, 14, 6, 54.

MAP E

S.B.

See report "E"

48° 15'

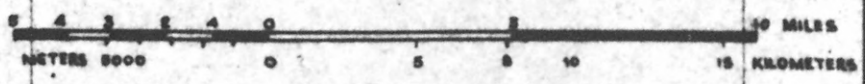
48° 30' Map F

Rastegar and Solabi

35° 15'

35° 15'

xsb
Baharlu
upper Cretaceous
Sediments
(intrusives are andesite)



**MAP SHOWING LOCATION OF
ANTIMONY MINES AND PROSPECTS
NEAR BAHARLU**

35° 0'

35° 0'



Salihabad

*Antimony mines and prospects
northwest of Hamadan*

HAMADAN

34° 45'

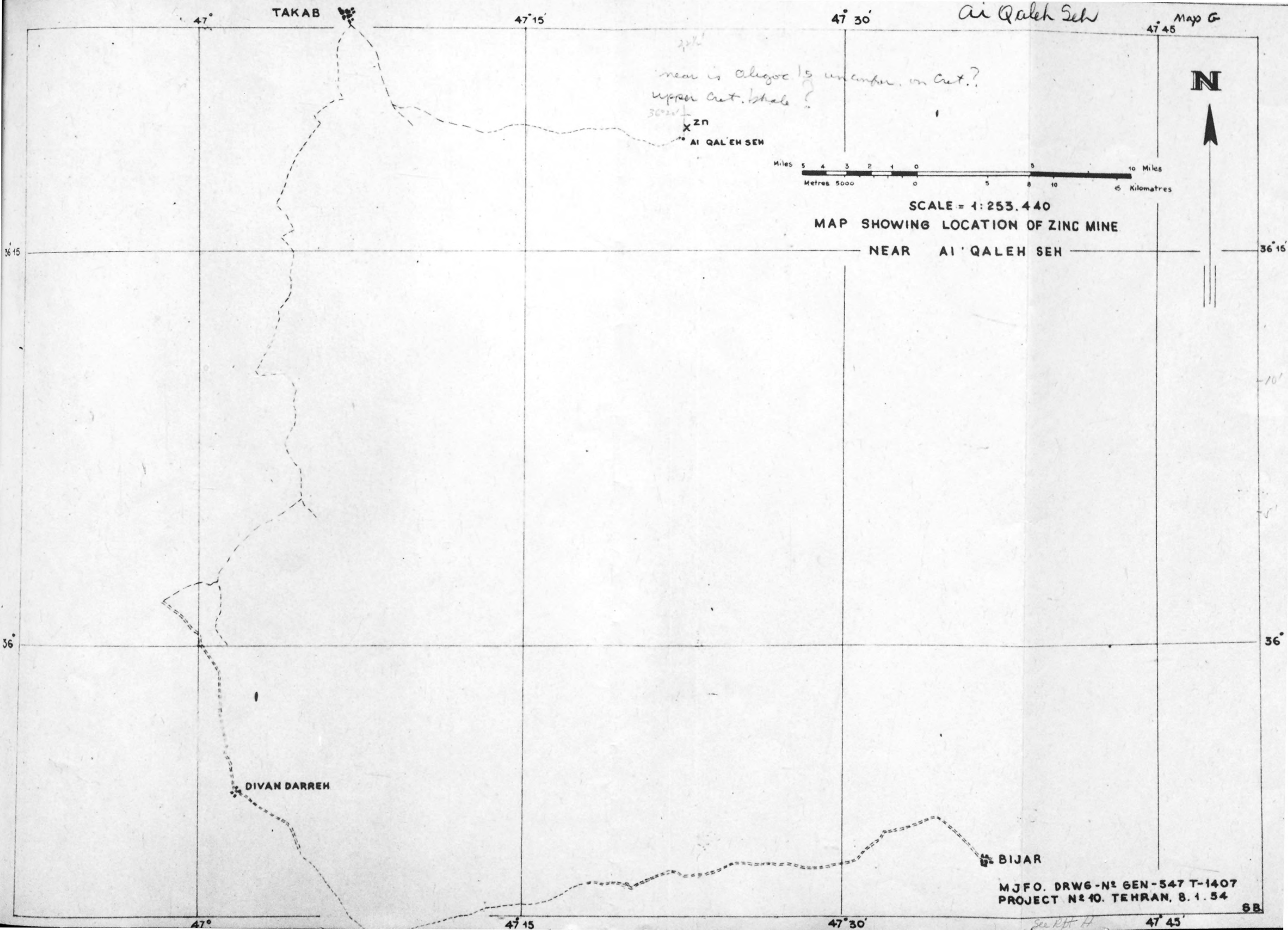
34° 45'

**MJFO. DRWG. N2 GEN. 531, T. 1406
PROJECT N2 10
TEHRAN, 7-19-54**

G.A.G.

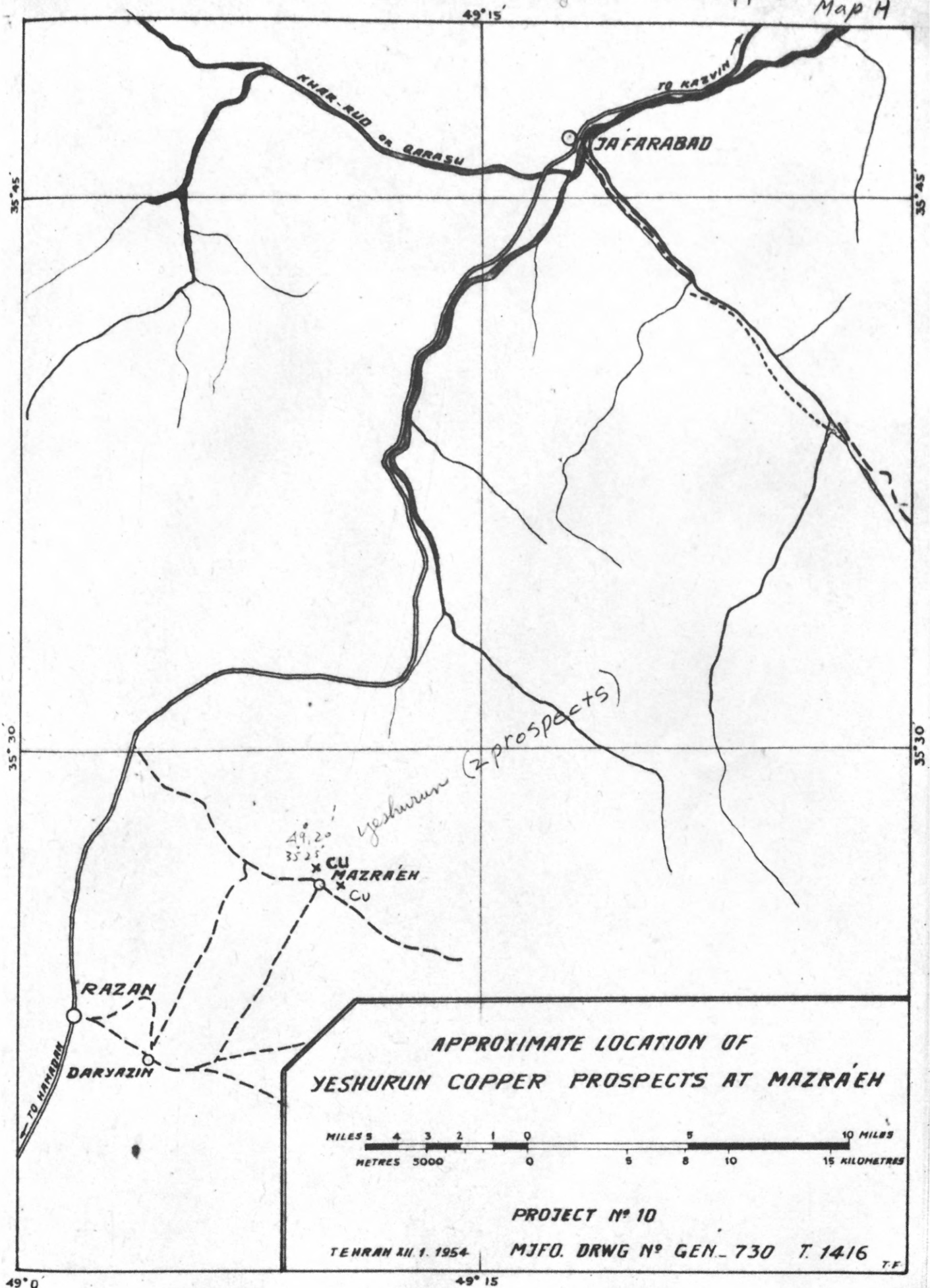
48° 15'

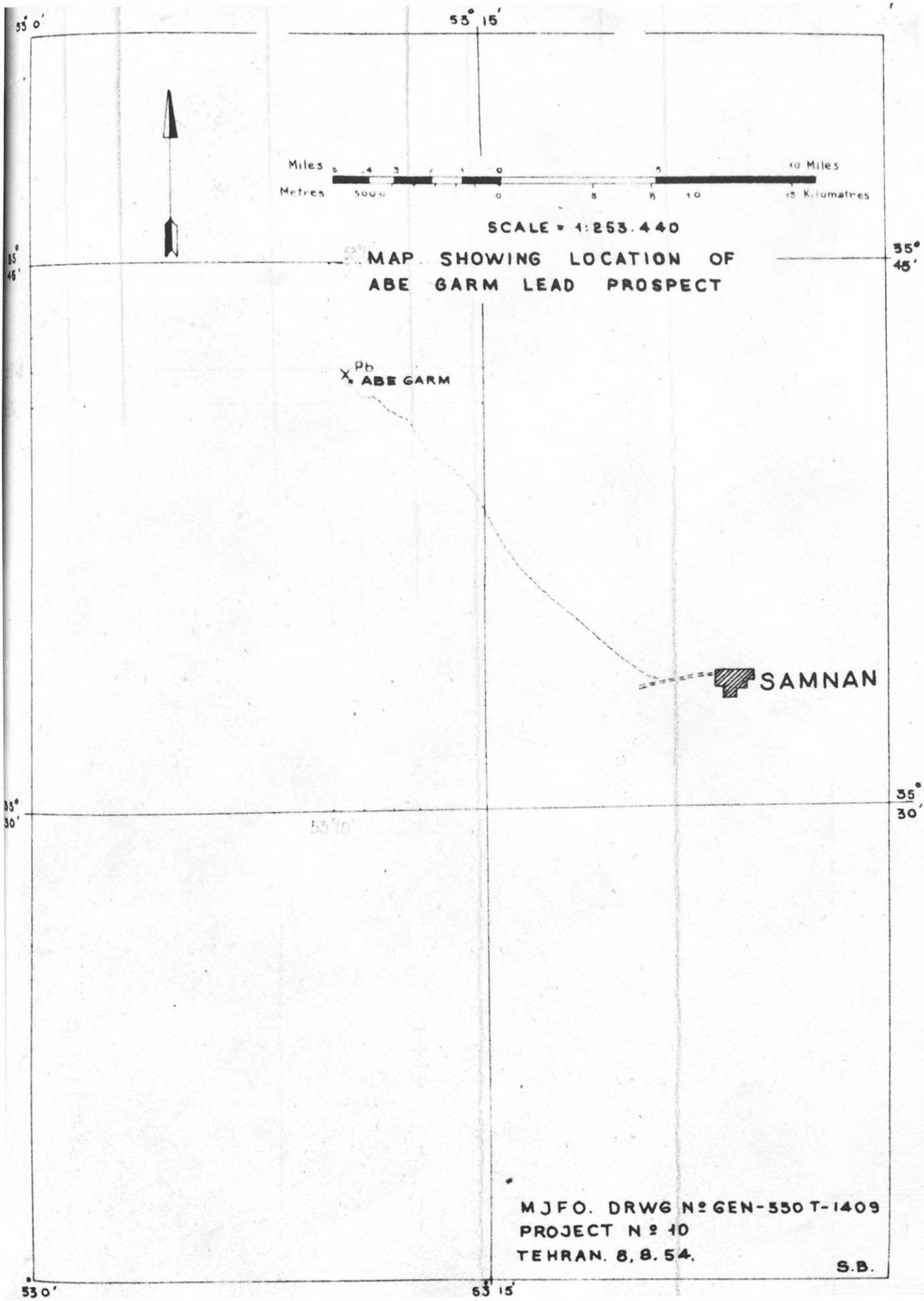
48° 30'



Yeshurun Copper

Map H





Miles 0 1 2 3 4 5 10 Miles
Metres 500 0 5 10 15 Kilometres

SCALE = 1:253.440

MAP SHOWING LOCATION OF
ABE GARM LEAD PROSPECT

X. ^{pb} ABE GARM

 SAMNAN

MJFO. DRWG N° GEN-550 T-1409
PROJECT N° 10
TEHRAN. 8, 8. 54.

S.B.

50° 30'

50° 45'

2



Dilijan

34°

X cu

• ATISH KUH

X
Pb33°
45'

LEAD AND COPPER PROSPECTS
NEAR ATISH KUH SOUTH OF
DILIJAN

Miles 5 4 3 2 1 0
Metres 5000 0
5 8 10 15 Kilometres

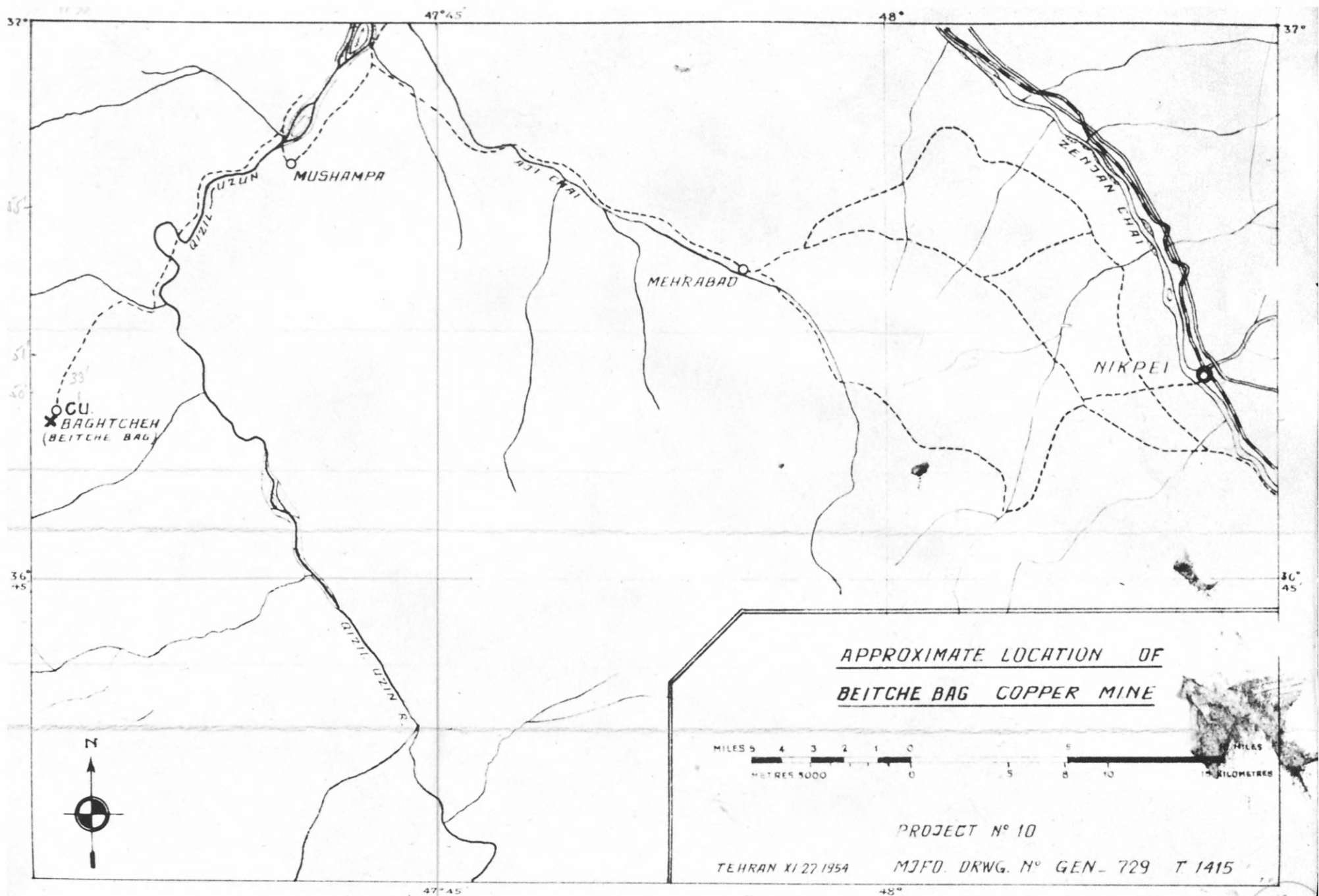
SCALE = 1:253,440

MJFO. DRWG N° GEN-631T 1410
PROJECT N° 10
TEHRAN. 10.14.54.

A.K.

50° 30'

50° 45'



51° 15'

51° 30'

4

N



Miles 5 4 3 2 1 0 5 10 Miles
Metres 5000 0 5 10 Kilometres

SCALE = 1:253,440

MAP SHOWING APPROXIMATE LOCATION
OF KHANE SORMEH LEAD MINE

32°
45'

32°
45'

x^{Pb}

HAJIABAD

NEJAFABAD

ISFAHAN

32°
30'

32°
30'

ZAYANDEH RUD

MJFO DRWG. N^o GEN-549 T-1408

PROJECT N^o 10

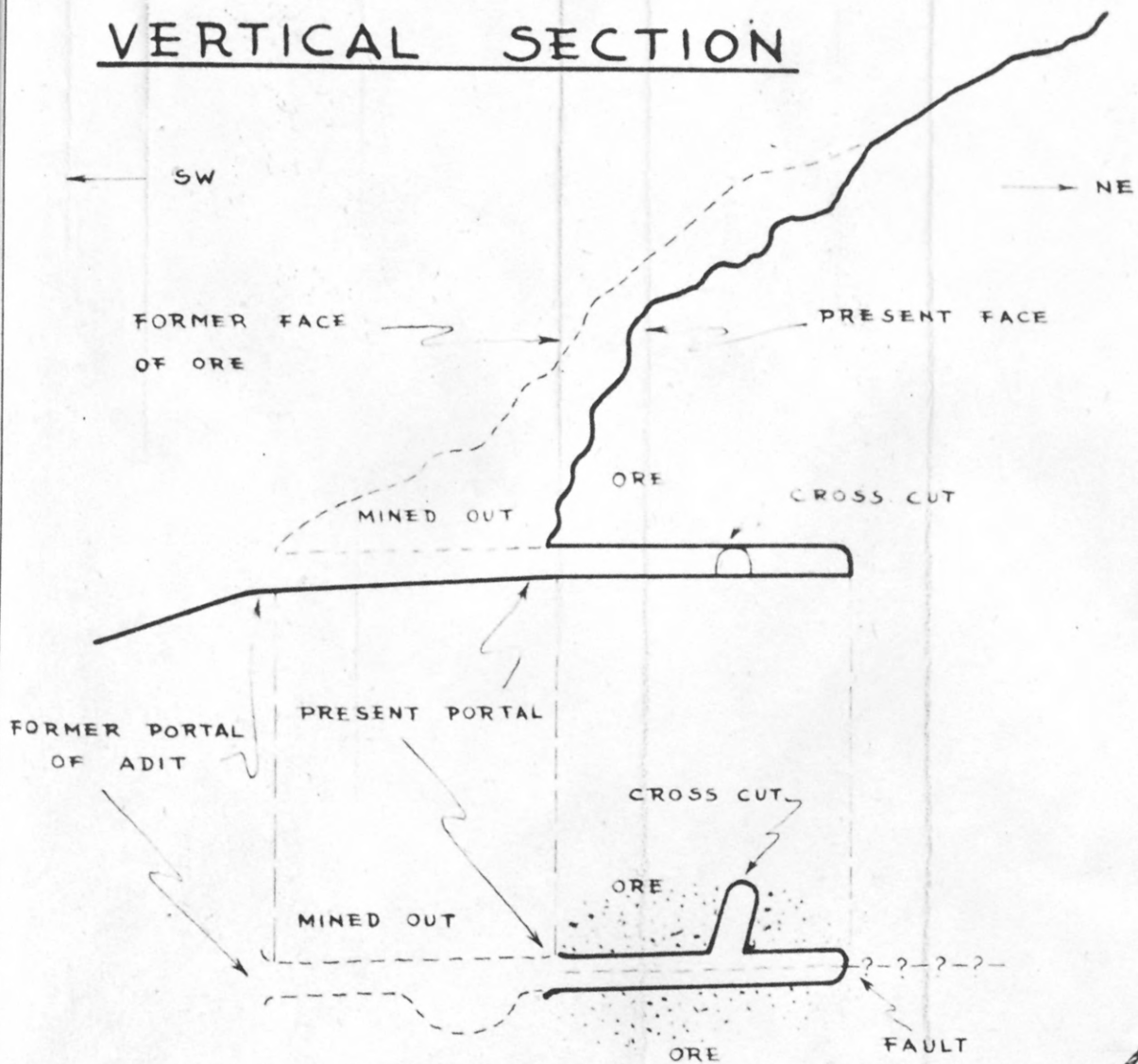
TEHRAN. 8. 8. 54.

S.B.

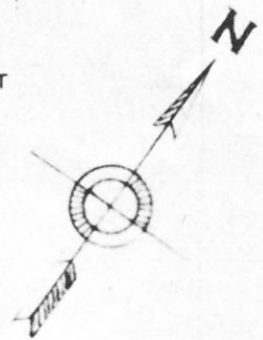
51° 15'

51° 30'

VERTICAL SECTION



PLAN



DIAGRAMMATIC SKETCH SHOWING MINING METHODS
AT KHANE SORMEH LEAD MINE

51° 0'

51° 15'

APPROXIMATE LOCATION OF
RAZAVI ZADEN LEAD PROSPECT
NORTH WEST OF MUBARAK.

Miles 5 4 3 2 1 0 5 10 Miles
Metres 5000 0 5 10 15 Kilometre



32° 45'

50° 56' 50° 57'

32° 45'

51° 0'

51° 15'

Nejafabad

MJFD. DRWG N° GEN 719-1412
PROJECT N° 10
TEHRAN. 11.9.1954.

7/54

51

APPROXIMATE LOCATION OF SHERKATE
TOFIG (BROOMAND) COPPER PROSPECT
NORTHEAST OF TARKH.

Miles 5 4 3 2 1 0 5 10 Miles
Metres 5000 0 5 10 15 Kilometres

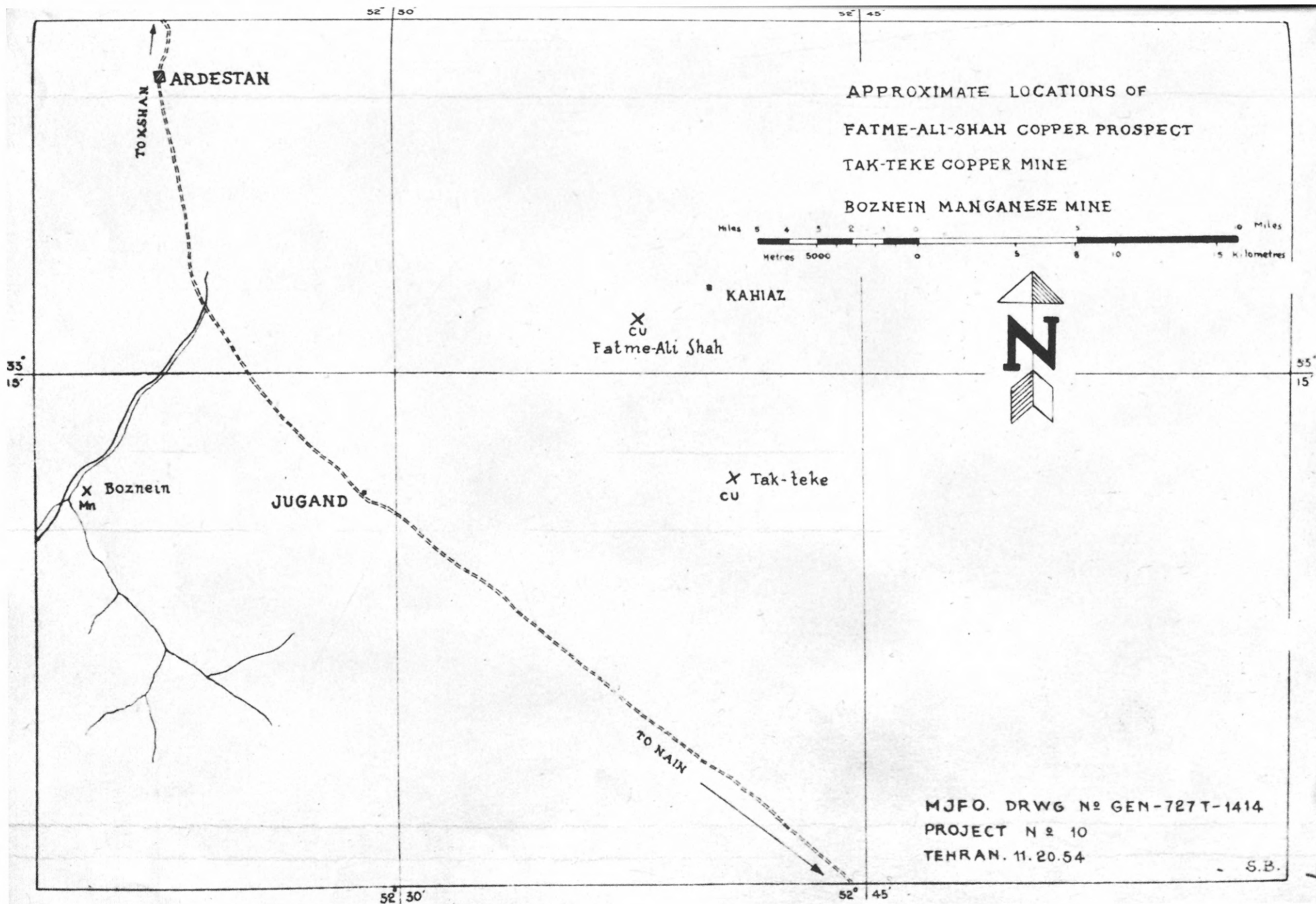


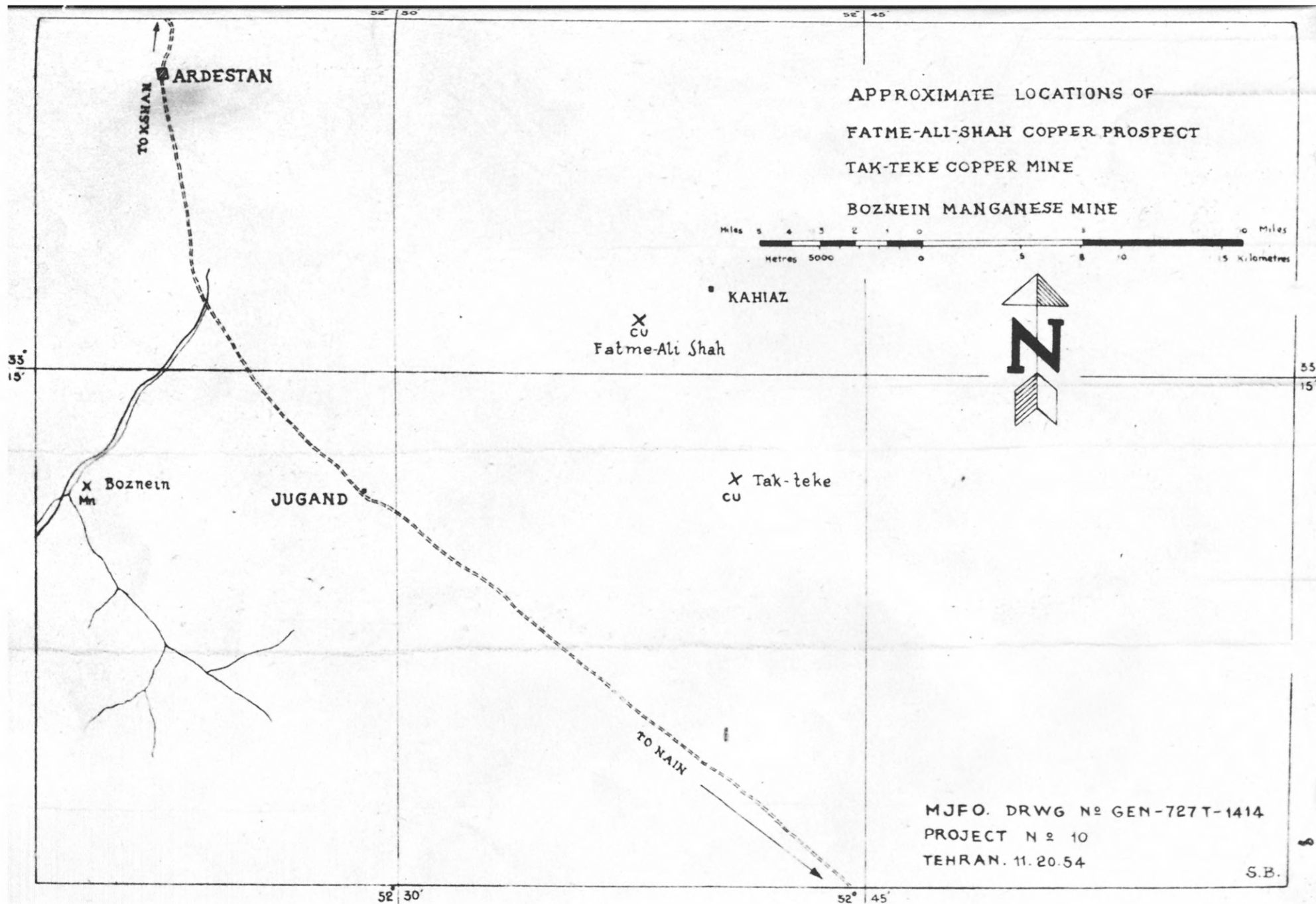
Morcha - Khurf
TO ISFAHAN

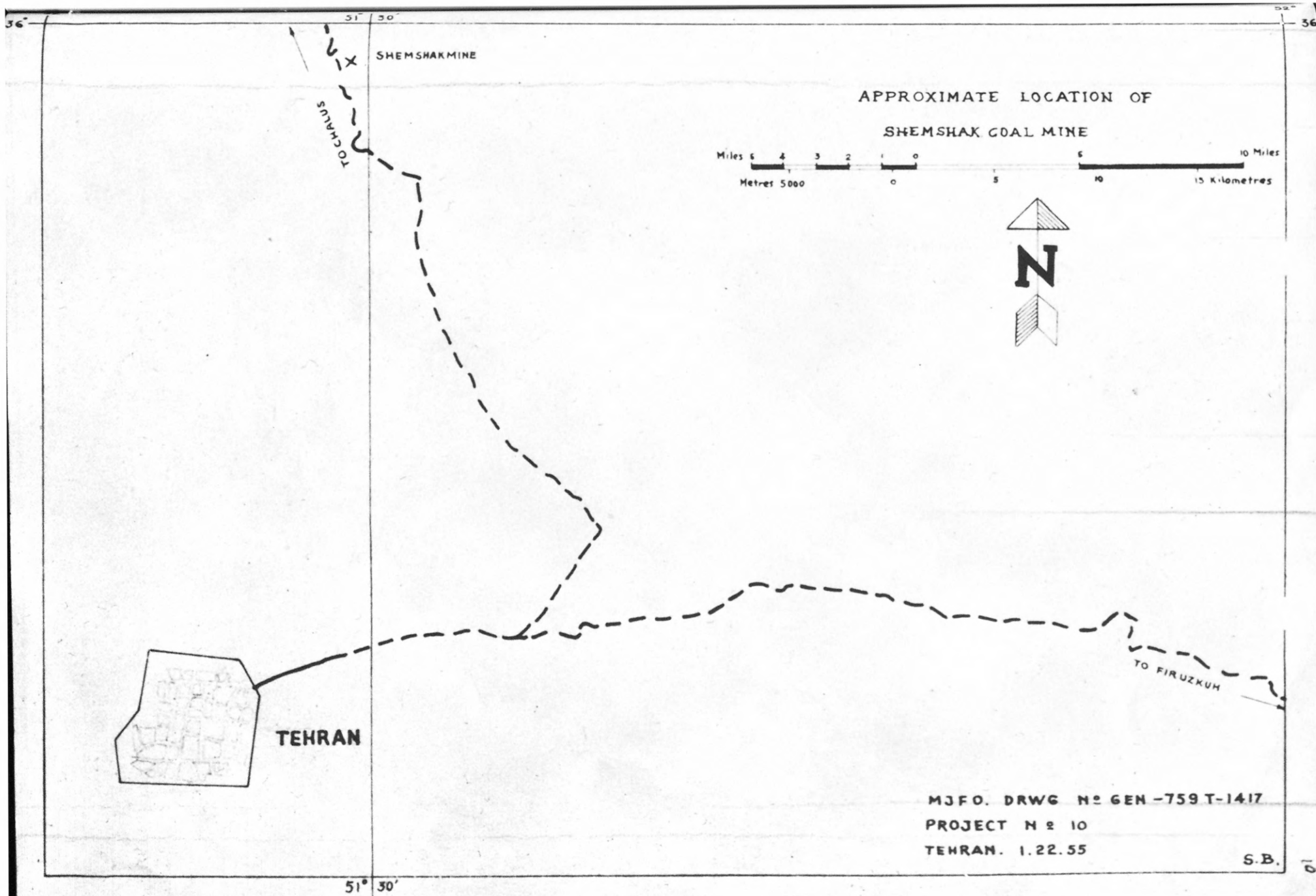
CU
Tarkh
Niyeh

MJFO. DRWG N^o GEN-718.T-1411
PROJECT N^o 10
TEHRAN. 11. 9. 54

88.







59° 30'

59° 45'

APPROXIMATE LOCATION OF LEAD AND COAL MINES NEAR MESHED.

36° 30'

36° 30'

Miles 0 1 2 3 4 5 6 7 8 9 10
Metres 5000 0 5 10 15 Kilometres



X
quarry

coal
X
Nokandar

MESHED

Pb.
X

X^o darakht-i-tut
Coal

36° 15'

MJFO. DRWG N^o GEN.-786 T-1418

PROJECT N^o 10.

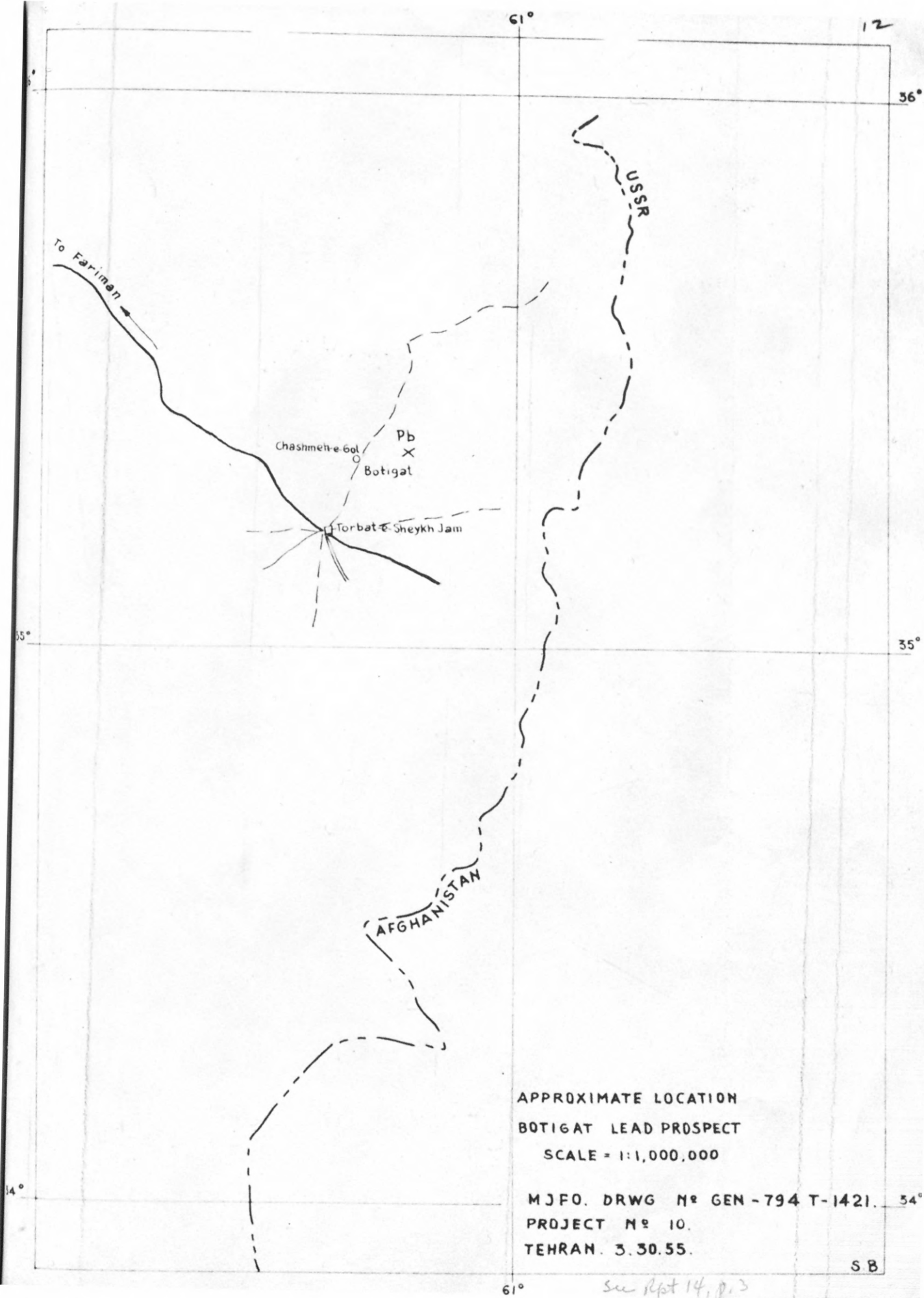
TEHRAN. 3.3.55.

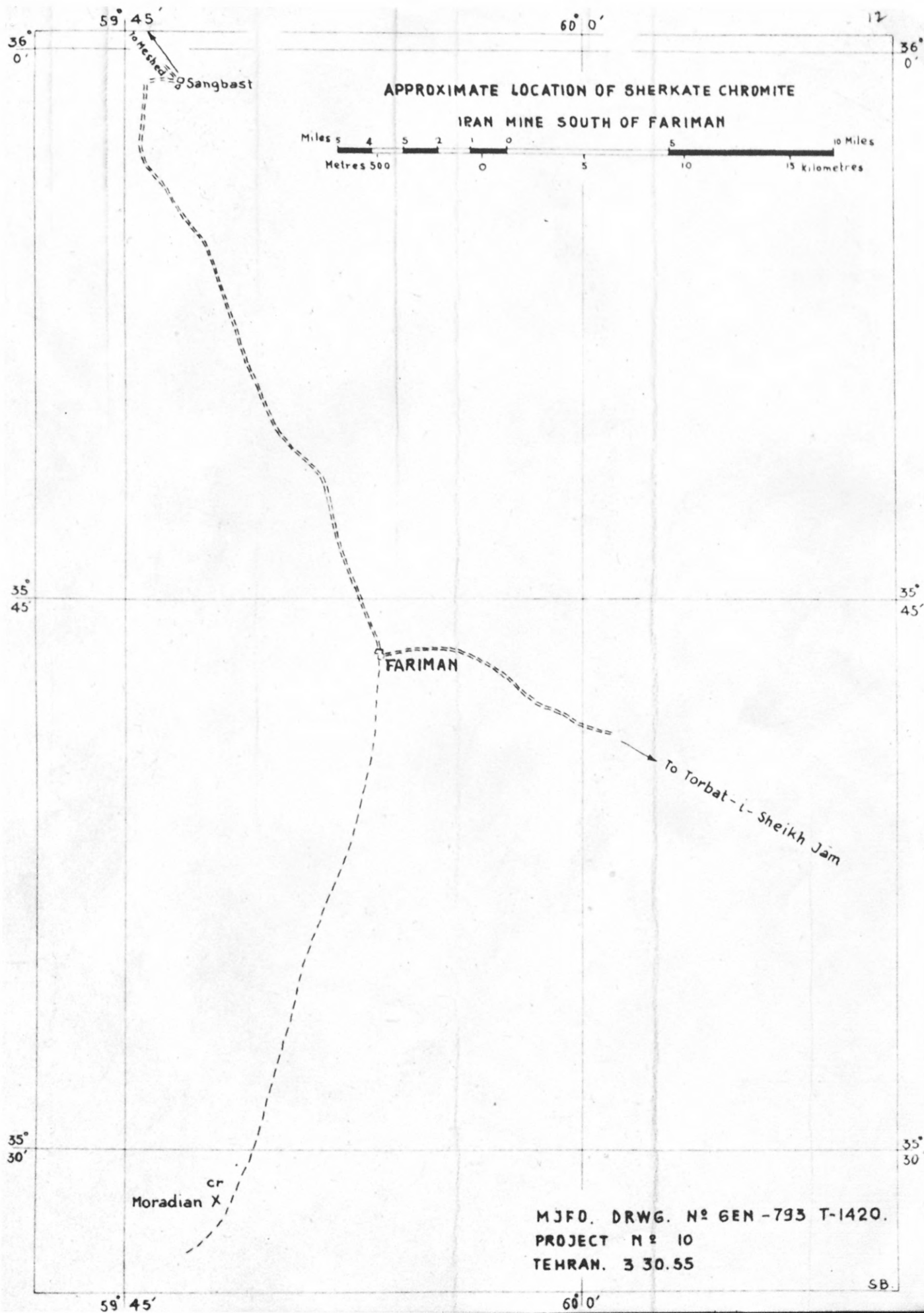
36° 0'

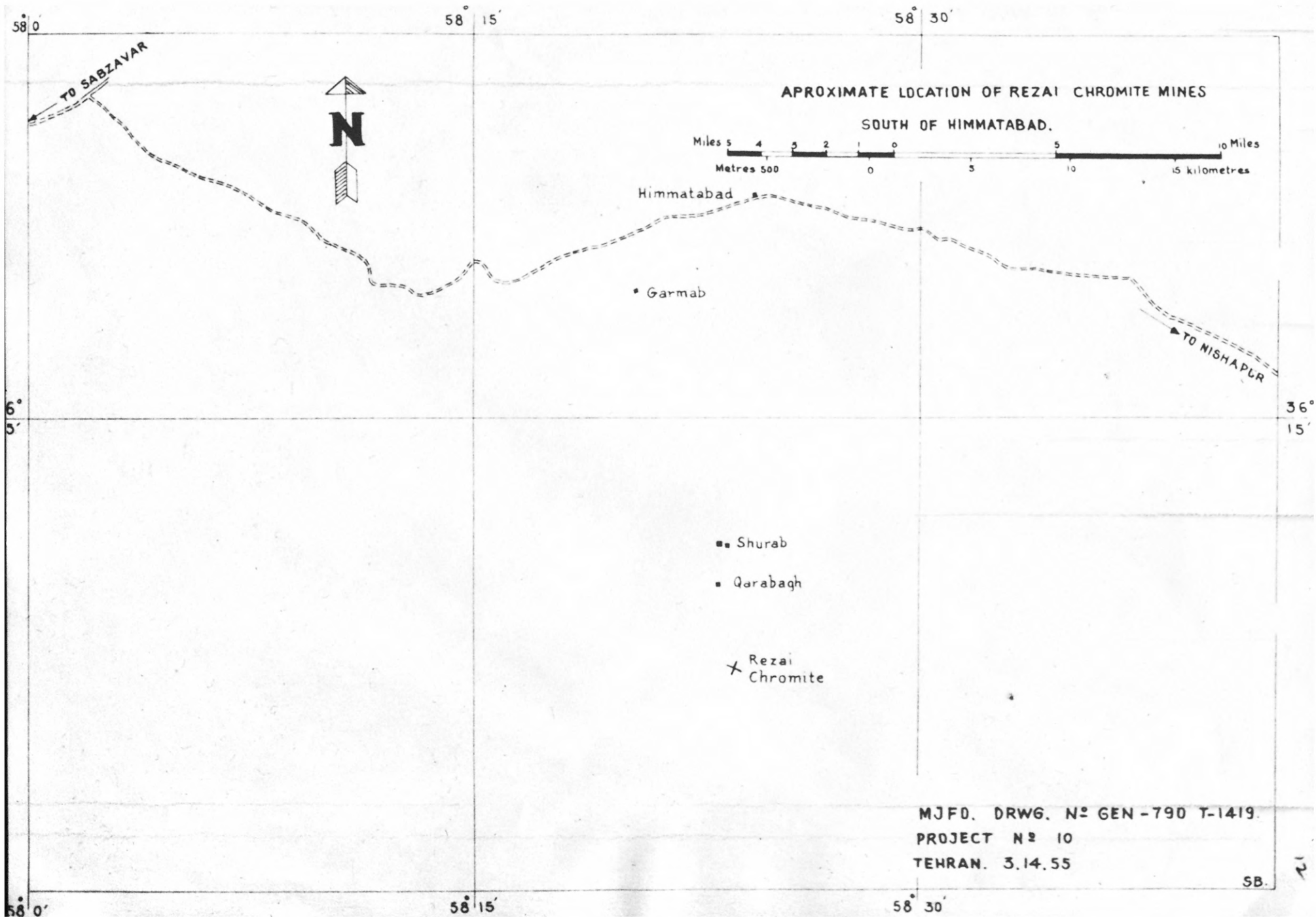
SB.

59° 30'

59° 45'







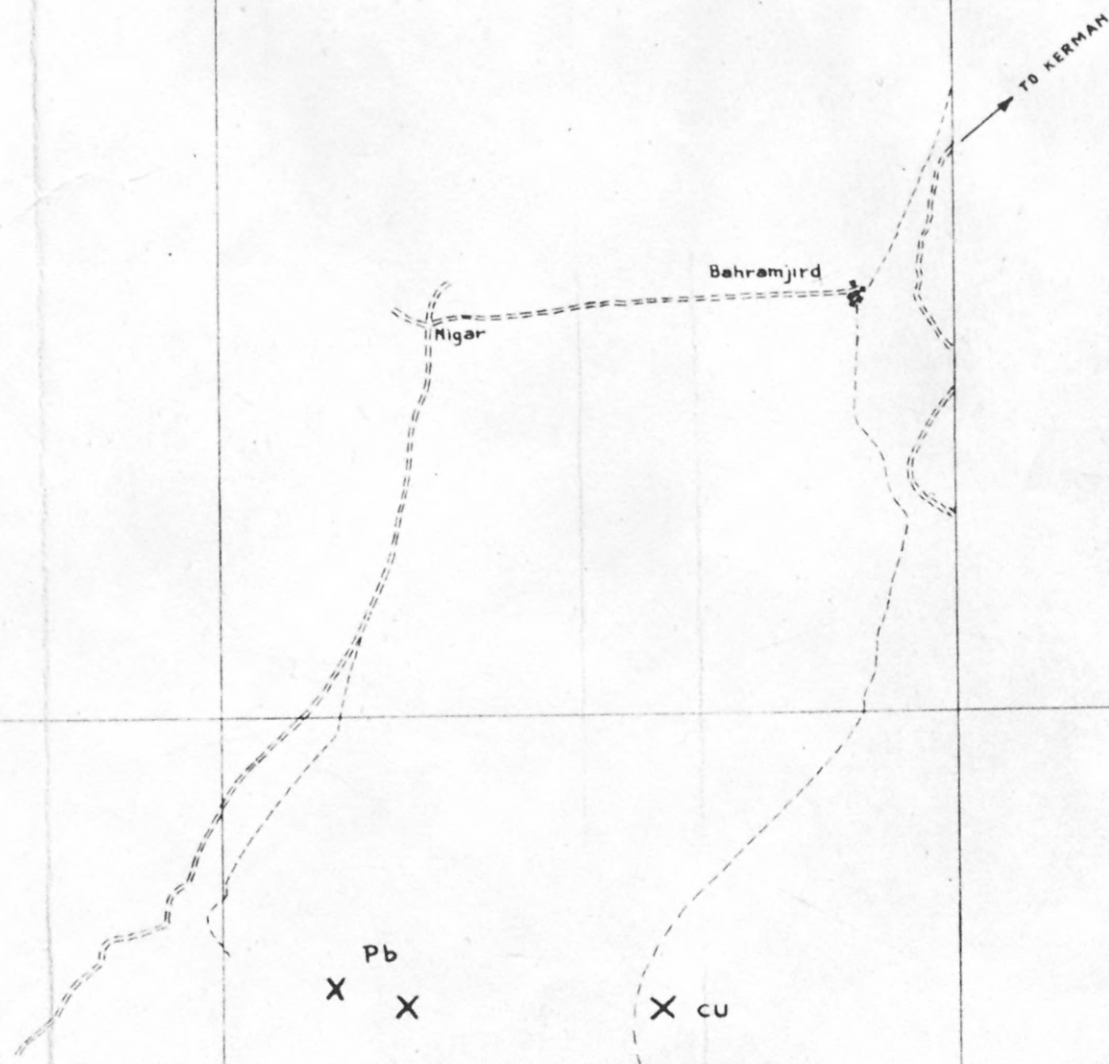
56° 45'

57° 0'

13

APPROXIMATE LOCATION SOROUSHIAN COPPER
AND LEAD PROSPECTS SOUTHWEST OF BAHRAMJIRD

Miles 5 4 3 2 1 0 5 10 Miles
Metres 5000 0 5 10 15 Kilometres

30°
0'30°
0'29°
45'29°
45'

MJFD. DRWG. N° GEN-814 T-1422
PROJECT N° 10
TEHRAN 5.10.55

S.B.

56° 45'

57° 0'

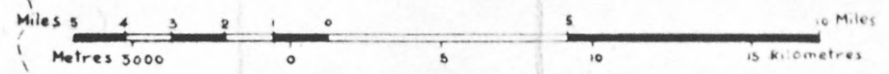
56° 45'

14

57° 0'



MAP SHOWING APPROXIMATE LOCATION OF
CHROMITE MINES NEAR DAULATABAD



28° 30'

28° 30'

28° 15'

28° 15'

Cr
ABDASHT X

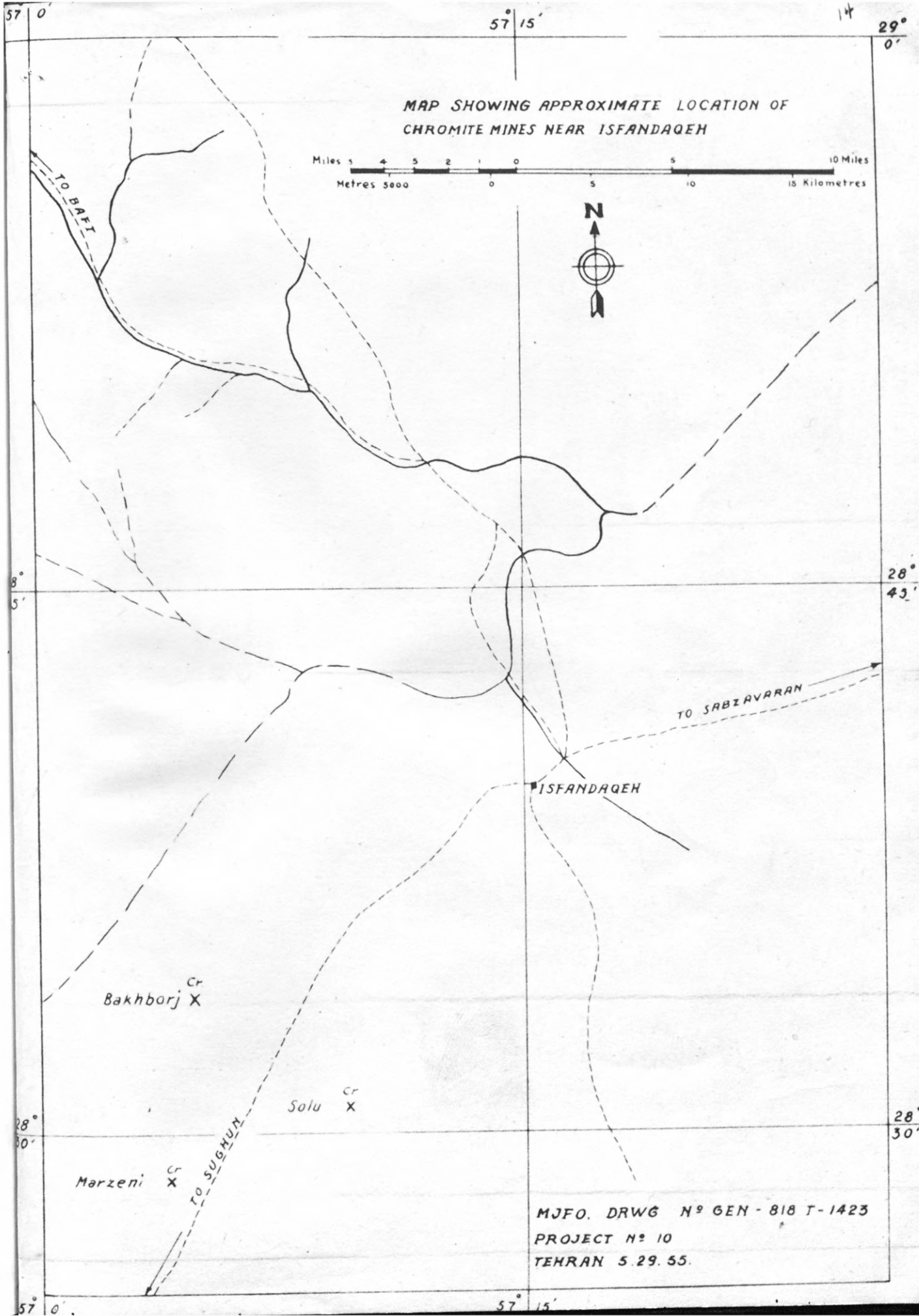
DAULATABAD

Cr
X
SHAIKH ALI

MJFO DRWG N° GEN-819 T-1424
PROJECT N° 10
TEHRAN 5.29.55

56° 45'

57° 0' 28°



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