Report on the
Field Evaluation of Mineral Deposit Model Targets at GSI Geomatics Ahar-Arasbaran Project, East Azarbaijan Province, Islamic Republic of Iran

by

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01 December 2005

Executive Summary

The Ahar-Arasbaran Zone is located in the province of East Azarbaijan. It is one of the twenty areas chosen by Geological Survey of Iran (GSI) Geomatics Division for grassroots exploration evaluation using geomatic modeling based on the following GSI data - 1:100,000 scale regional geology and silt geochemistry results, and Landsat TM data. Ahar-Arasbaran Zone is the first of several zones where the geomatic modeling was based on the geological environment criteria of the mineral deposit models of the United States Geological Survey (Cox and Singer, 1986) as well as the appropriate geochemical criteria for each model espoused by Dr. Hasani Pak.

The field evaluation program, the subject of this report, is the final phase of the Geomatics exploration program for the above mentioned zone which would test the predictive capability of the modelling and evaluate the mineral potential of the targets visited. For this purpose, Geomatics Division contracted C. A. (Jun) Angeles of Pars Kaaneh Kish (PKK) to conduct initial field evaluation of twenty-five (25) out of >100 targets identified by the GSI team within the Ahar, Kaleybar, Varzaghan and Siahrud sheets as well as conduct on-the-job training of the GSI geologists on the evaluation methods. The predominant deposit types identified are porphyry copper, skarns, and epithermal gold. The field evaluation was conducted from 30 September to 11 October 2005.

Pending the receipt of the analytical results of the rock samples collected, a full evaluation of the targets visited can be undertaken. In the meantime, all that can be said is that the high-level epithermal Au targets at Sarghein, Ghalandar, Zaylik and Babajan are the best targets found. This is besides the current mines and those already recognized and being worked on by GSI Gold Project. These are (1) porphyry Cu at Sungun Copper mine, (2) Cu skarn at Mazraeh Copper mine and Sungun skarn, (3) epithermal Au at Sharaf Abad, and (4) mesothermal Au at Nibijan. The possible skarn at South Kordlar, and epithermal/porphyry Cu at Keighal are interesting but depends a lot on encouraging analytical results.

Geomatic modeling using mineral deposit types is a powerful tool in mineral exploration. However, inherent problems in the various data layers inhibit the maximum potential of the modeling. The most problematic layers are the regional geology and geochemical data. One important data layer that was not utilized in the modeling was the mineral occurrence (or indices) map. The incorporation of the mineral occurrence map is a good empirical way to balance the imperfections of the geochemical layer.

Prudence should also be exercised on which mineral deposit types are relevant in an area based on the known geological / metallogenic setting and probability of these occurring in the area. The appropriate models to be used in the Ahar-Arasbaran Zone are porphyry Cu, Cu and Pb-Zn skarns, batholith-hosted mesothermal Au, intermediate sulphidation epithermal (Creede-type), high-sulphidation epithermal (quartz-alunite & volcanic-hosted Cu-As-Sb) and an undefined “arc-related” low-sulphidation epithermal type. It is also possible that the alkalic-type low-sulphidation epithermal (Au-Ag-Te vein type), polymetallic Ag-Pb-Zn replacement, polymetallic Ag-Pb-Zn veins and Hg-Sb models exist although have not yet been documented in the said Zone.

This field evaluation phase is best considered to be the start of further refining the potential maps for Ahar-Arasbaran Zone in order to increase the maps’ ability to predict correctly the appropriate deposit types and find more and better prospective areas.

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INTRODUCTION

The Ahar-Arasbaran Zone is one of the twenty areas chosen by GSI Geomatics Division for grassroots exploration evaluation using geomatic modeling based on the following GSI data - 1:100,000 scale regional geology and silt geochemistry and Landsat TM data. The Ahar-Arasbaran Zone is the first of several zones where geomatic modeling was based on the geological environment criteria of the mineral deposit models of the United States Geological Survey (Cox and Singer, 1986) as well as the appropriate geochemical criteria for each model espoused by Dr. Hasani Pak.

GSI Geomatics, through Mr. A. Mohammadi Joabadi and Mr. Vahid Futuwati, has contracted Mr. C. A. (Jun) Angeles of Pars Kaaneh Kish (PKK) to conduct field evaluation of twenty-five (25) targets located at the Ahar, Kaleybar, Varzaghan and Siahrud sheets (Fig. 1) as well as provide on-the-job training to GSI geologists on the methods of field evaluation. The field evaluation of above mentioned targets was conducted from 30 September to 11 October 2005. The field schedule is shown below –

29 September	Tehran – Tabriz flight / Travel to Ahar
30 September	Kordlar, South Kordlar & Babajan visits
01 October	Mazraeh & North Ghalandar visits
02 October	North Ghalandar, Ghalandar & Zaylik visits
03 October	Sungun mine, Sungun skarn & Khoynarud visits
04 October	Nabijan & Barazin visits
05 October	Keighal & Sharaf Abad visits
06 October	Ojagh visit
07 October	Anjerd visit
08 October	Pahnavar, North Ahmad Darazi, Ahmad Abad & Ahmad Darazi visits
09 October	Shirbit, West Shirbit & Ghaleh Jugh visits
10 October	Anikh visit
11 October	Sarghein visit / Tabriz – Tehran flight

The staff involved in the field evaluation of the target areas are as follow –

PKK Consultant	C. A. (Jun) Angeles
GSI GIS Staff	Ali Moosavi (project coordinator), Mehran Heidari, Amir Delavar, Mehdi Muradi
GSI Remote Sensing Staff	Davood Refahi
GSI Exploration Management	Ali Mokhtari

At Mazraeh copper mine, Engr. Iraj Ashti of National Iran Copper Co. (NICICO) toured us through the underground at Adit 1 and Stope 1 and the open pit at Adit 3, while Engr. Ali Absavaran toured us through the mill.

At Sungun copper mine, Mr. Farzin Talebi of NICICO briefed us on the geology, Mr. Mehdi Shahverdi toured us in the open pit and skarn area and Mr. Mehrdad Iranpour showed us the Khoynarud prospect.

SCOPE OF WORK & METHODOLOGY

As part of the programs that GSI has initiated to develop mineral exploration in Iran, GSI Geomatics Division has contracted Pars Kaaneh Kish (PKK) to provide a geological expert, C. A. (Jun) Angeles, to manage and supervise the Field Evaluation Program of the Ahar-Arasbaran Zone as well as conduct on-the-job training of the GSI geologists on field evaluation methods. Mr. Angeles has 28 years of experience in gold and base metals exploration programs.

The Ahar-Arasbaran Zone consists of nine 1:100,000 scale sheets, namely – Jolfa, Marand, Siahrud, Tabriz, Varzaghan, Kaleybar, Ahar, Lahraad and Meshkin Shahr sheets. Khajeh sheet, south of Varzaghan sheet, has not been included as there is no available 1:100,000 scale regional geology. The initial and major undertaking of this project consisted of the development of mineral potential (or prospectivity) models based on the United States Geological Survey (USGS) mineral deposit model classification (Cox & Singer, 1986). Four (4) data layers were utilized. These layers are (1) suitable geological environment layer extracted from the 1:100,000 scale geological map, ie. host rocks, age range and tectonic setting, (2) alteration layer extracted from Landsat TM clay and 1:100,000 scale geological map, (3) scores obtained from regional silt geochemical data as espoused by Dr. Hasani Pak, and (4) fault density data layer derived from structures in the 1:100,000 scale geology maps and Landsat TM remote sensing data. Essentially, the suitable geological environment layer creates large target areas. The other three layers are used to filter and cut down the size of the target areas delineated in the geological environment layer. It is unfortunate that the mineral occurrence (or indices) map could not be incorporated in the model as it was observed that most of the mineral occurrences were not pinpointed by the potential maps. The incorporation of the mineral occurrence map is a good way to balance the imperfections of the geochemical layer (see discussion under Potential Maps section below).

The Field Evaluation Program is the final phase of the Geomatics exploration program for the above mentioned zone which would test the predictive capability of the modeling and evaluate the mineral potential of the targets visited. Out of >100 targets generated, twenty-five targets were identified by the GSI team in the 1:100,000 scale Ahar, Kaleybar, Varzaghan and Siahrud sheets for initial characterization and evaluation (Figs 1 to 5). More targets required field evaluation but there were time and logistical constraints. The predominant deposit types identified were porphyry copper, skarns, and epithermal gold.

This report summarizes the results of the field evaluation of the target areas visited.

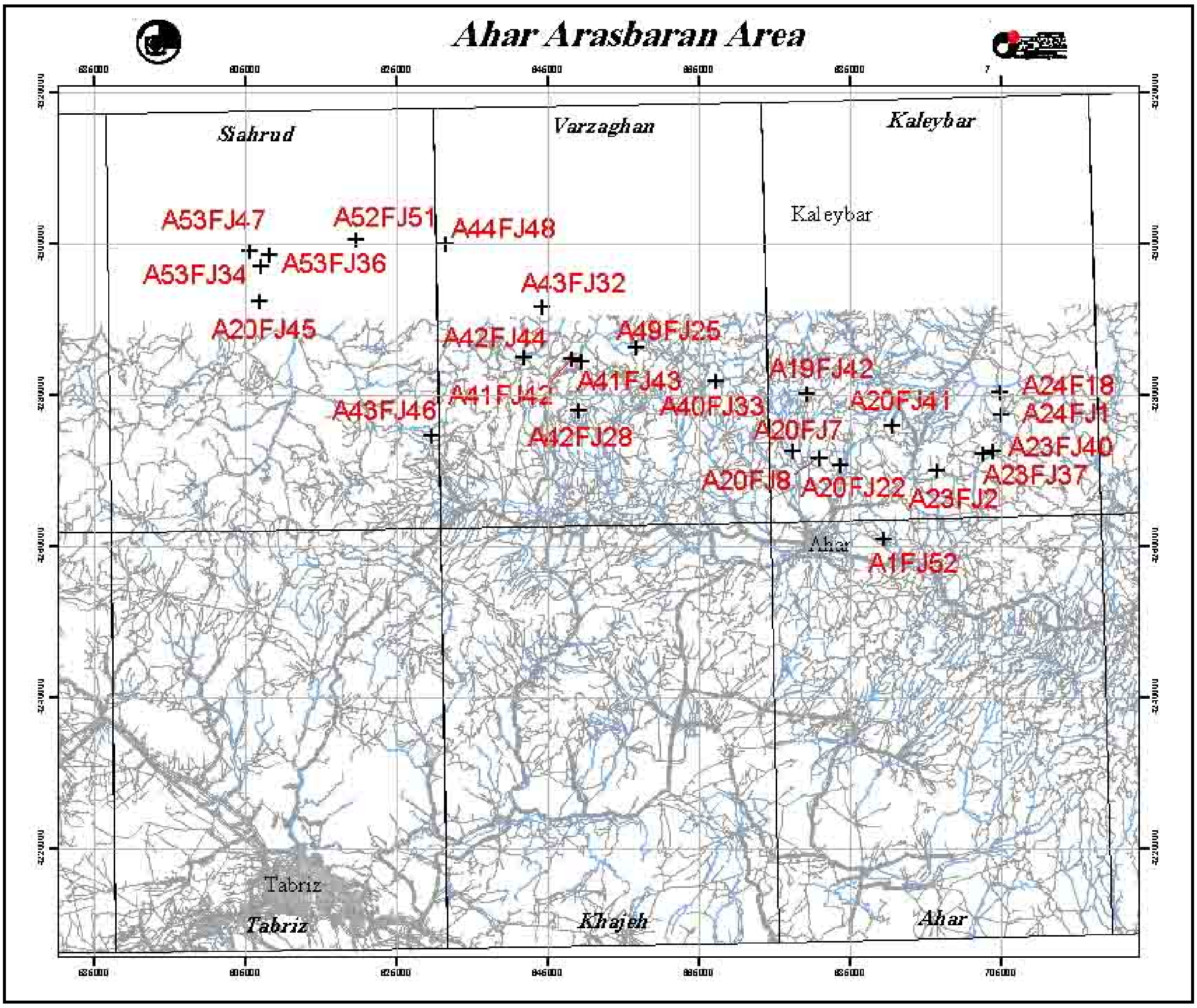


Fig. 1 Location and access of targets visited.

POTENTIAL MAPS

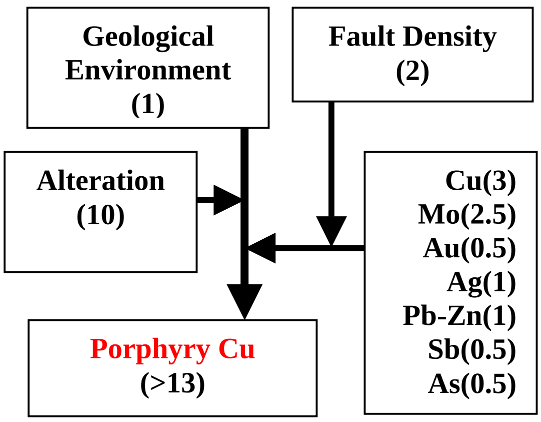
GSI Geomatic Division generated potential maps for 25 mineral deposit models for the Ahar-Arasbaran area. These are –

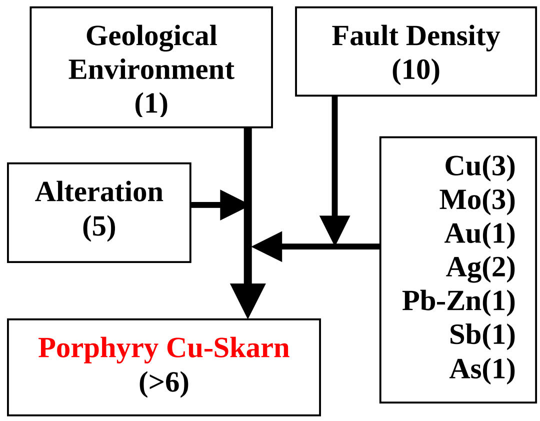
Metals	Mineral Deposit Model Type
Cu-Mo	Porphyry Cu
	Porphyry Cu-Skarn
	Porphyry Cu-Au
	Porphyry Cu-Mo
	Basaltic Cu
	Volcanic-hosted Cu-As-Sb
	Cyprus-Beshhi Massive Sulphides
	Kuroko Massive Sulphides
	Polymetallic Replacement Ag-Pb-Zn
	Kipushi Cu-Pb-Zn
	Sediment-hosted Cu
	Climax Mo
Au	Epithermal Au (derived from hot spring Au-Ag, Creede, Comstock, Sado, and

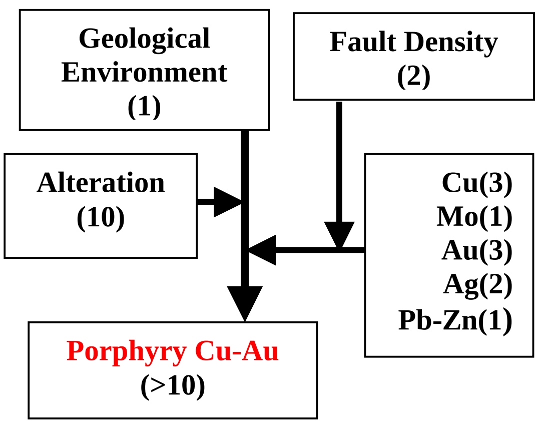
	quartz-alunite Au)
	Lateritic Au
	Au-Ag-Te Vein-type
	Distal Au-Ag
Pb-Zn	Pb-Zn Skarn
	Sandstone-hosted Pb-Zn
	Mississippi-Valley-Type (MVT) & Kipushi
	Sedimentary Exhalative Pb-Zn
Sb-Hg	Hotspring Hg
	Simple Vein Sb
Mn	Epithermal Mn
	Replacement Mn
	Volcanogenic Mn

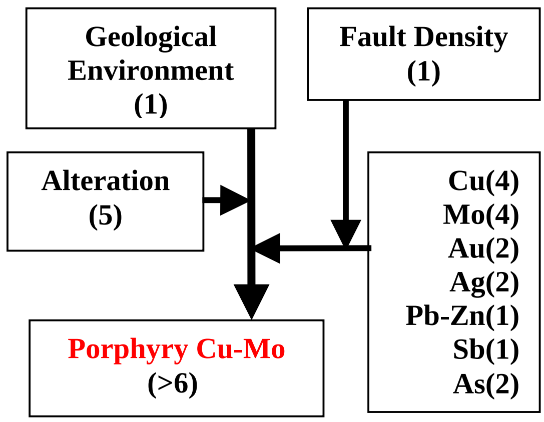
Flow sheets have been provided by A. Moosavi which illustrate the construction of each potential map. They are shown below -

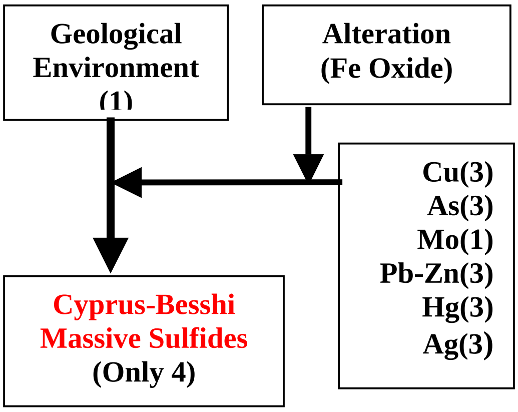
Cu-Mo Potential Maps

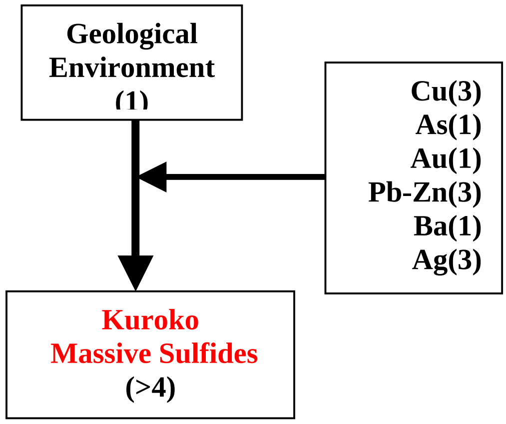


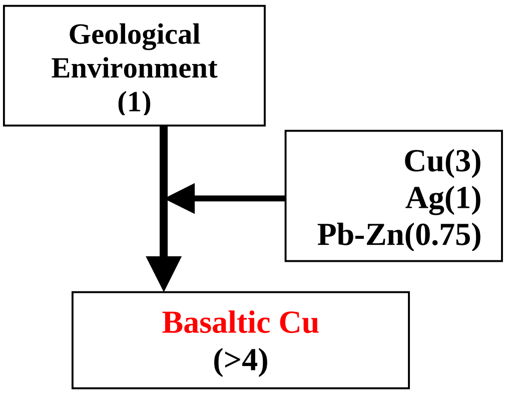


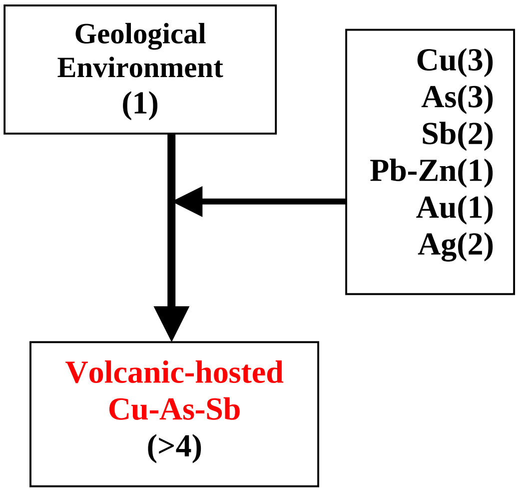


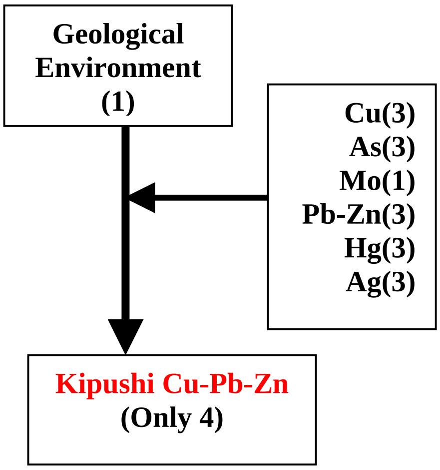


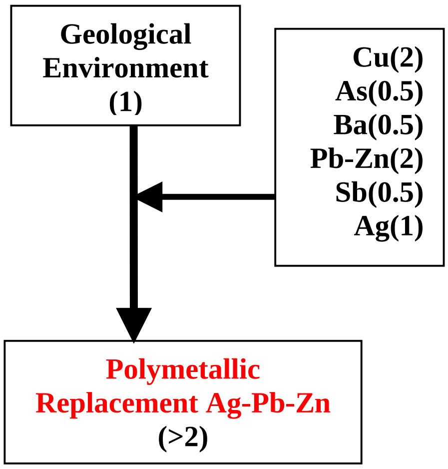

Geological Environment (1)
Alteration (Fe Oxide)
Cu(3)
As(3)
Mo(1)
Pb-Zn(3)
Hg(3)
Ag(3)
Cyprus-Besshi Massive Sulfides
(Only 4)

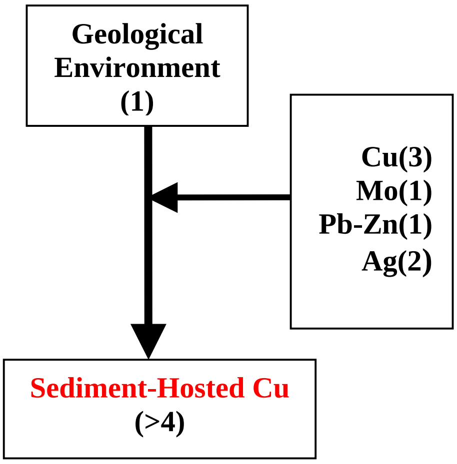

Geological Environment (1)
Cu(3)
As(1)
Au(1)
Pb-Zn(3)
Ba(1)
Ag(3)
Kuroko Massive Sulfides
(>4)

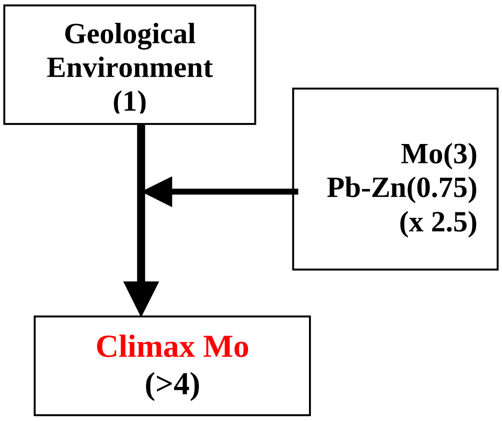

Geological Environment (1)
Cu(3)
Ag(1)
Pb-Zn(0.75)
Basaltic Cu
(>4)


Geological Environment (1)
Cu(3)
As(3)
Sb(2)
Pb-Zn(1)
Au(1)
Ag(2)
Volcanic-hosted Cu-As-Sb
(>4)

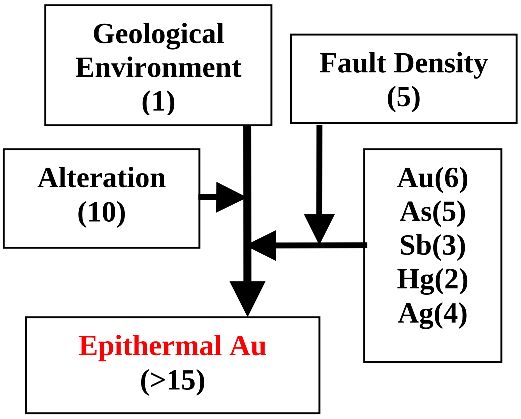

Geological Environment (1)
Cu(3)
As(3)
Mo(1)
Pb-Zn(3)
Hg(3)
Ag(3)
Kipushi Cu-Pb-Zn
(Only 4)

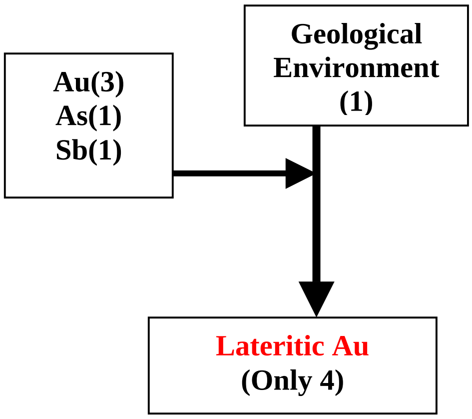

Geological Environment (1)
Cu(2)
As(0.5)
Ba(0.5)
Pb-Zn(2)
Sb(0.5)
Ag(1)
Polymetallic Replacement Ag-Pb-Zn
(>2)

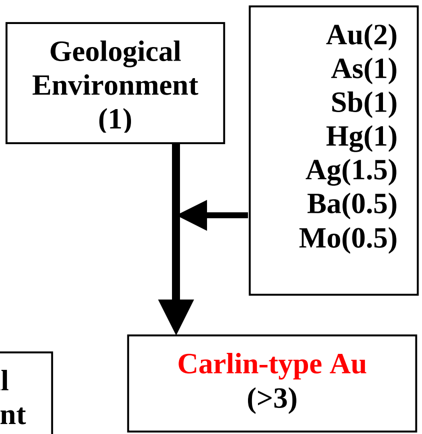


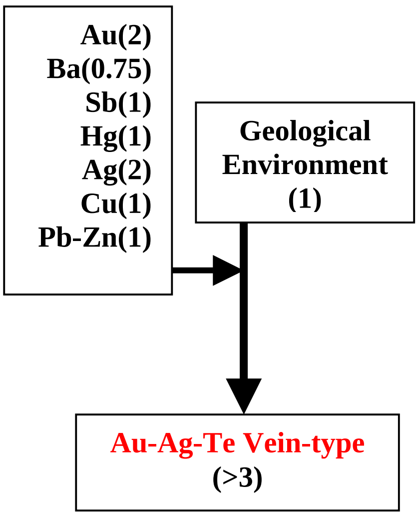


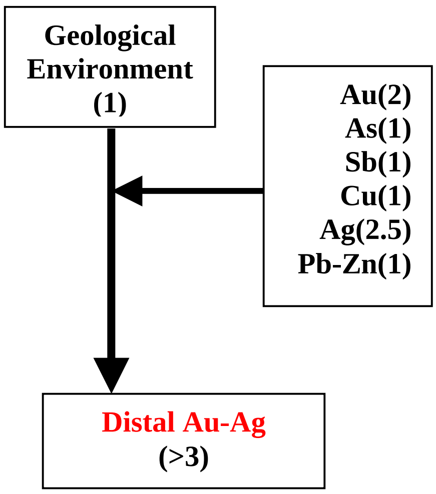
Au Potential Maps



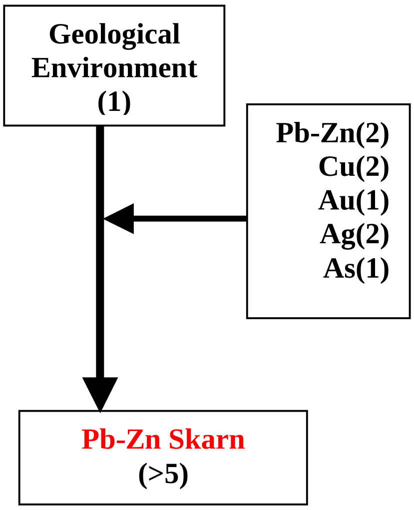


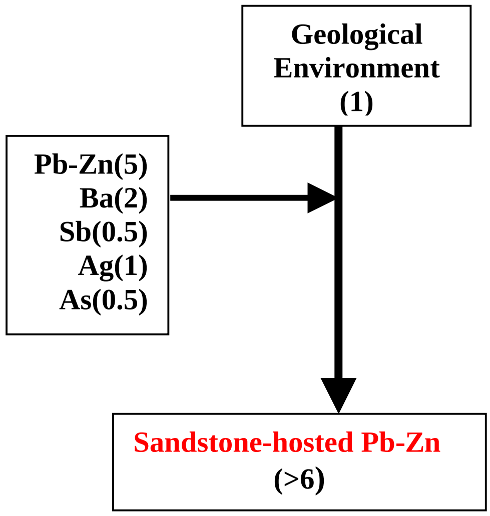


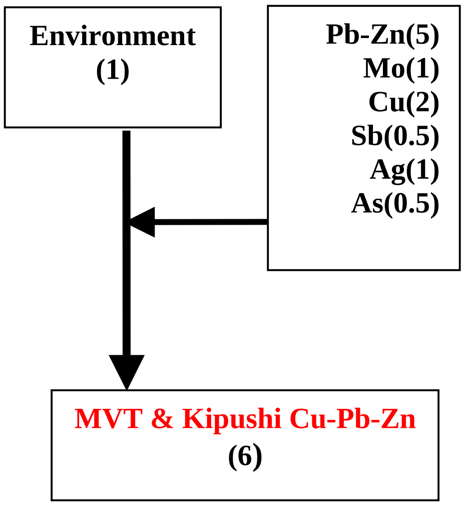


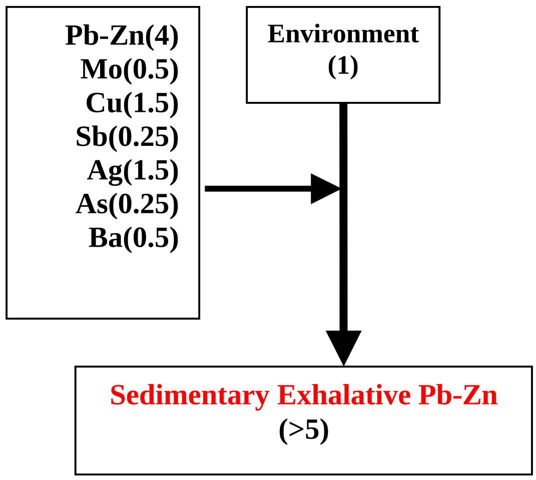


Pb-Zn Potential Maps

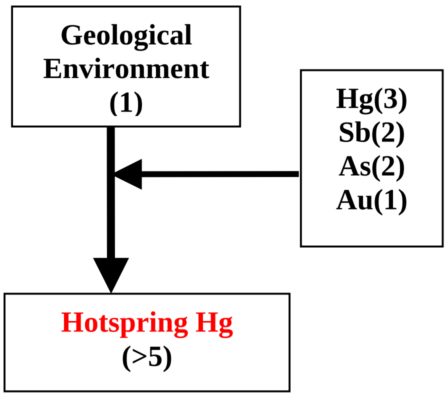


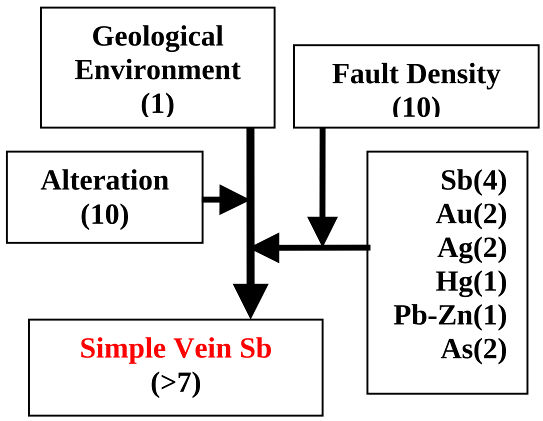




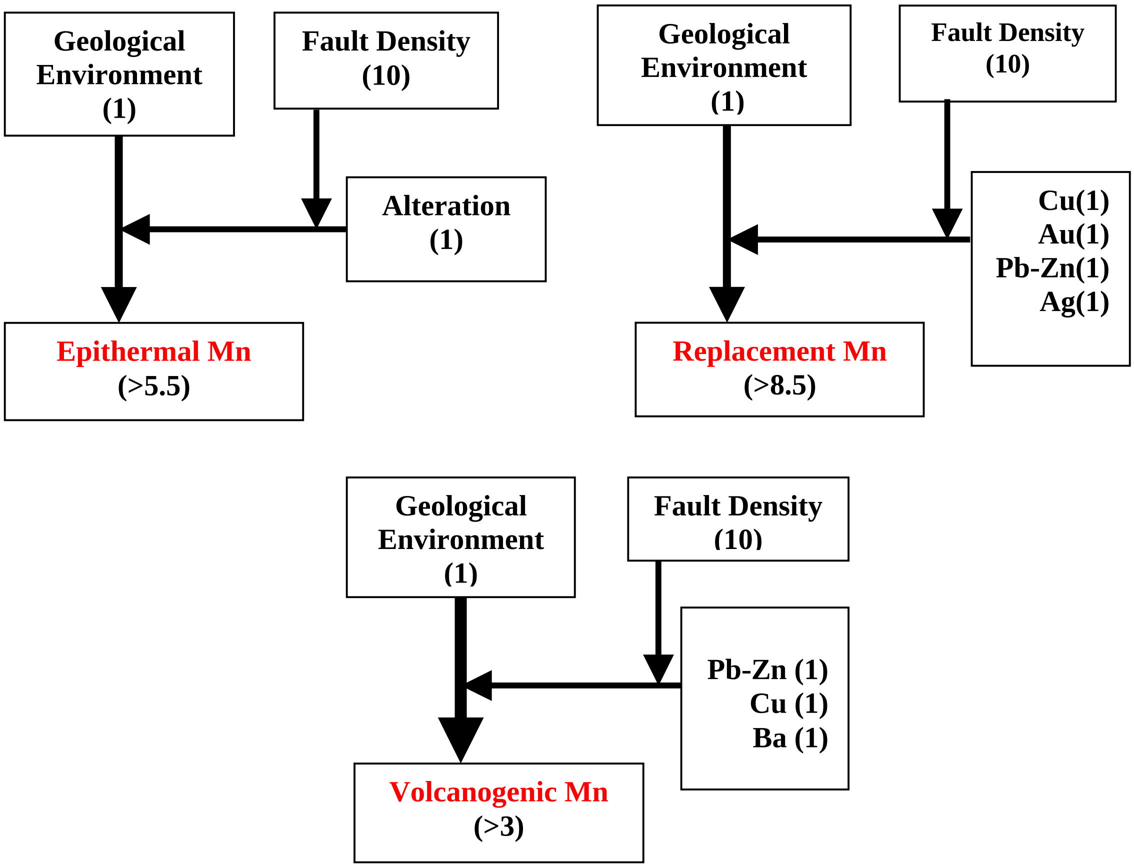


Sb-Hg Potential Maps





Mn Potential Maps



Discussion

I have not dealt with the various parameters GSI used in defining the geological environments nor the geochemical logic of the above mentioned models. This is a separate issue which requires time on my part in order to fully understand the parameters used and to confirm their validity. For example, in porphyry Cu environments, all intrusives were considered including non-porphyry-related granites and gabbros. This is understandable since the team believed that the 1:100,000 scale geologic maps may not be accurate about the intrusive types. However, after this field evaluation, it was very clear that the any rock unit which mentioned "granite" or "gabbroic" per se are quite reliably non-porphyry Cu-related.

It was also observed that the various data layers used in the modeling have inherent problems. The biggest problems were with the geology and geochemical data (Fig. 6) layers. For the geology layer, it was observed that the coordinates of Varzaghan, Kaleybar and Siahrud (at least) were shifted 1->3 km with respect to the correct GPS locations. Most of the problem probably had to do with the reliance on aerial photos in the old days with no other methods of geo-referencing. The Ahar sheet coordinates seem to be correct. As already mentioned, the Khajeh sheet, south of Varzaghan sheet, was excluded from the Ahar-Arasbaran Zone simply because there was no regional geology map.

For the geochemical data layer, the geochemical analytical data consists of various field and laboratory procedures (mostly undocumented) wherein reliability measures (precision and accuracy) were not quantified (ie. no duplicates and standards inserted in the batches of samples); and the sheets were not "leveled" with respect to each other. The latter meant that what may be anomalous in one sheet may not be anomalous in the adjacent sheet and vice-versa. Also, in the Varzaghan sheet which contains Sungun porphyry Cu mine, the data is considered not reliable as the data is quite old, pre-1978, and the anomalous geochemical shape files used were derived from scanned old interpretation geochemical maps and not from geostatical analysis of the raw data. Also, Au, As and Sb data were not available for Varzaghan sheet which are required in the Cu and Au models. In the Siahrud and Marand sheets, there is also no Au data.

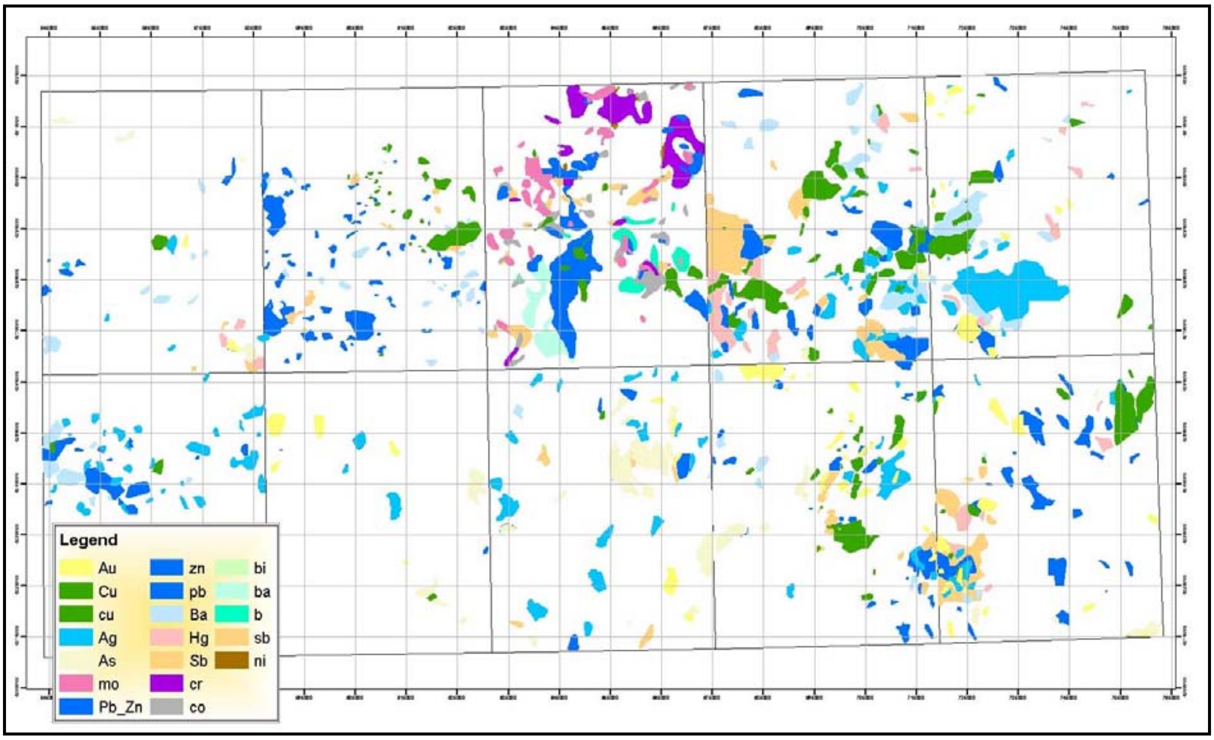


Fig. 6. Geochemical data layer of Ahar-Arasbaran Zone.

One data layer that was not utilized was the mineral occurrence (or indices) map. It was noted that a lot of the mineral occurrences were not pinpointed by the potential maps. This fact immediately raises an alarm bell. It confirms that the geochemical data is not that reliable. The incorporation of the mineral occurrence map is a good empirical way to balance the imperfections of the geochemical layer. It is suggested that a 3km buffer be applied to the mineral occurrences and a score be assigned. Only mineral occurrences containing the metals targeted by the models should be incorporated in each mineral deposit model. For example, only Cu, Au and Mo occurrences are added as scores to the porphyry Cu model.

With respect to choosing which deposit models to use in an area, prudence should be exercised. Although computer software have made it easy to create potential maps based on mineral deposit models, the use of models should be based on the known geological / metallogenic setting and probability of these occurring in the area.

Since Ahar-Arasbaran Zone is a continental-type magmatic arc area, the following models are not recommended to be used – all volcanogenic deposits (Cyprus-type, Besshi-type, Kuroko-type and volcanogenic Mn), basaltic Cu, Kipushi Cu-Pb-Zn, sediment-hosted Cu, Carlin-type Au, distal Au-Ag, sandstone-hosted Pb-Zn, Mississippi Valley-type (MVT) and sedimentary exhalative Pb-Zn. Neither is Ahar-Arasbaran a tropical region and therefore lateritic Au is not applicable. Also the following deposit models have not been noted in magmatic belts in Iran and therefore are recommended to be excluded also - Climax Mo, epithermal Mn and replacement Mn.

The following can be included in subsequent modeling – low-sulphide gold-quartz veins (or mesothermal Au) since this type can occur in batholiths / older terranes.

With respect to the current epithermal Au model, the following models were combined into one, namely (1) low-sulphidation adularia-sericite (hotspring Au-Ag, Comstock-type, Sado-type), (2) intermediate sulphidation (Creede-type) and (3) high-sulphidation (quartz-alunite Au). This may cause some ambiguity as the low-sulphidation adularia-sericite type occurs in non-arc rift environments and has not been documented yet in Iran. The more common epithermal type for Iran is the intermediate sulphidation type (Sillitoe & Hedenquist, 2003) and the arc-type low-sulphidation epithermal Au of Corbett (2002). Also, the volcanic-hosted Cu-As-Sb model should be incorporated with the quartz-alunite model since it is also a high-sulphidation epithermal Au±Cu.

In the porphyry Cu model, it is not advisable to include (1) batholiths (about 112 km^2 in area) unless there is a younger smaller intrusion intruding them and (2) granite/gabbros as favorable source rocks. Source rocks favorable for porphyry Cu range from diorite to quartz monzonite to syenite suite. For Cu skarns, however, non-granite batholiths are favorable source rocks in contact with calcareous rocks, eg. Mazraeh and Anjerd. These are called batholith-related skarns.

It can be concluded then that the appropriate models to be used in Ahar-Arasbaran Zone are porphyry Cu, Cu and Pb-Zn skarns, mesothermal Au (low-sulphide gold-quartz veins in batholiths), intermediate sulphidation epithermal (Creede-type), high-sulphidation epithermal (quartz-alunite & volcanic-hosted Cu-As-Sb) and an undefined “arc-related” low-sulphidation epithermal (Corbett, 2002). It is within the realms of possibility that alkalic-type low-sulphidation epithermal (Au-Ag-Te vein type), polymetallic Ag-Pb-Zn replacement, polymetallic Ag-Pb-Zn veins and Hg-Sb models exist although these have not yet been documented in the Ahar-Arasbaran Zone. After examining the regional geology maps and discussions with A. Moosavi and M. Heydari, it was concluded that there are only three applicable deposit model types present in the four sheets visited. These are - (1) porphyry Cu (general), (2) Cu skarn and (3) epithermal Au.

TARGET AREAS

The twenty-five (25) targets visited are as follows –

Target Name	Sheet Name	Target No.	UTM E*	UTM N*
Sarghein	Ahar	A1FJ52	689505	4260971
Kordlar	Kaleybar	A24F18	704697	4280314
South Kordlar	- do -	A24FJ1	704899	4277473
Babajan	- do -	A23FJ2	696542	4269932
Mazraeh	- do -	A19FJ42	679281	4280151
North Ghalandar	- do -	A20FJ7	677387	4272585
Ghalandar	- do -	A20FJ8	680972	4271710
Zaylik	- do -	A20FJ22	683646	4270776
Shirbit	- do -	A23FJ37	702595	4272187

West Shirbit	- do -	A23FJ40	703907	4272636
Ghaleh Jugh	- do -	A20FJ41	690459	4275997
Sungun	Varzaghan	A41FJ42	648235	4284726
Sungun Skarn	- do -	A41FJ43	649461	4284446
Khoynarud	- do -	A42FJ44	641850	4285044
Nabijan	- do -	A20FJ45	606953	4292400
Barazin	- do -	A49FJ25	656744	4286197
Keighal	- do -	A42FJ28	649066	4277871
Ojagh	- do -	A43FJ32	644252	4291714
Anjerd	- do -	A40FJ33	667124	4281742
Ahmad Abad	- do -	A44FJ48	631407	4299947
Sharaf Abad	Siahrud	A43FJ46	629605	4274552
Pahnavar	- do -	A53FJ34	606990	4297057
North Ahmad Darasi	- do -	A53FJ47	605577	4299118
Ahmad Darasi	- do -	A53FJ36	608268	4298570
Anikh	- do -	A52FJ51	619562	4300508

**38S UTM Zone*

All of the 25 targets visited are shown in Fig. 1. The Landsat TM image bands 3,5,1 for the four 1:100,000 scale Ahar, Kaleybar, Varzaghan and Siahrud sheets with their respective targets are shown in Figs. 2 to 5. The descriptions and recommendations for each target are listed below.

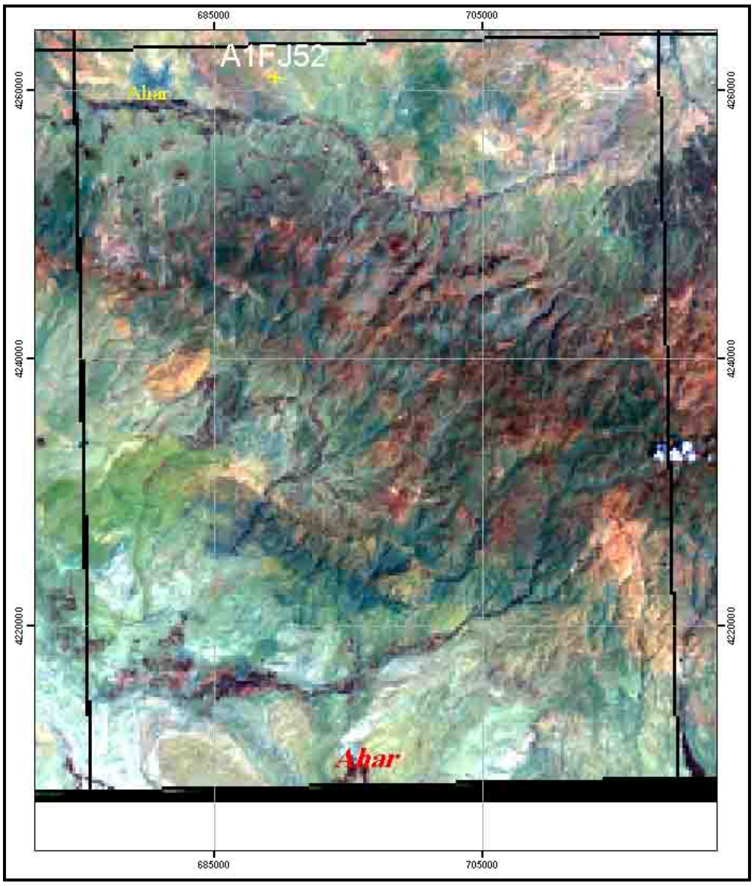


Fig. 2. Ahar Sheet Landsat TM 351 image showing targets visited.

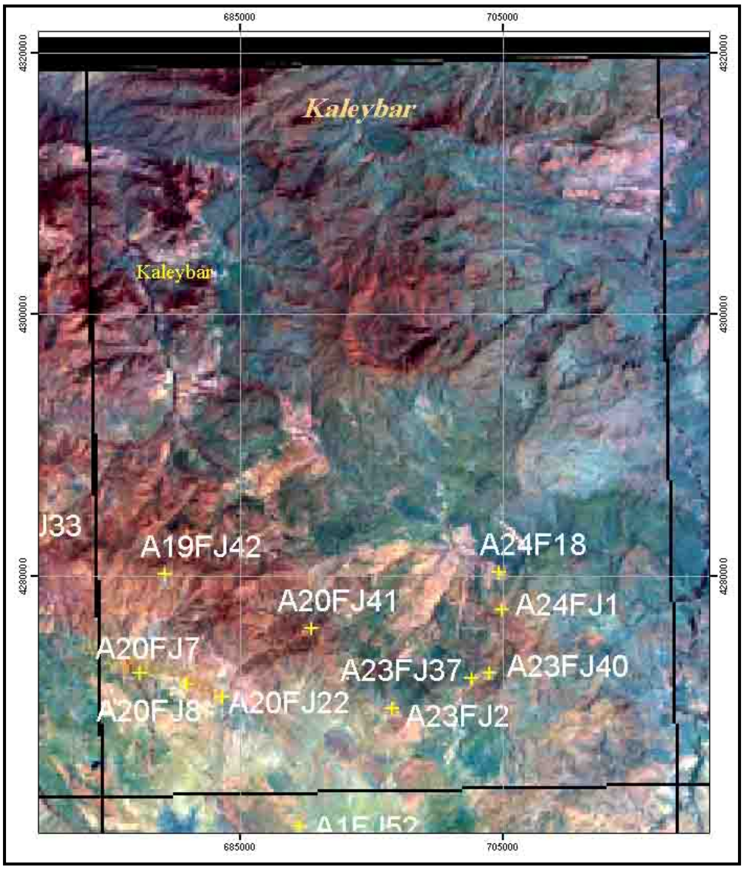


Fig. 3. Kaleybar Sheet Landsat TM 351 image showing targets visited.

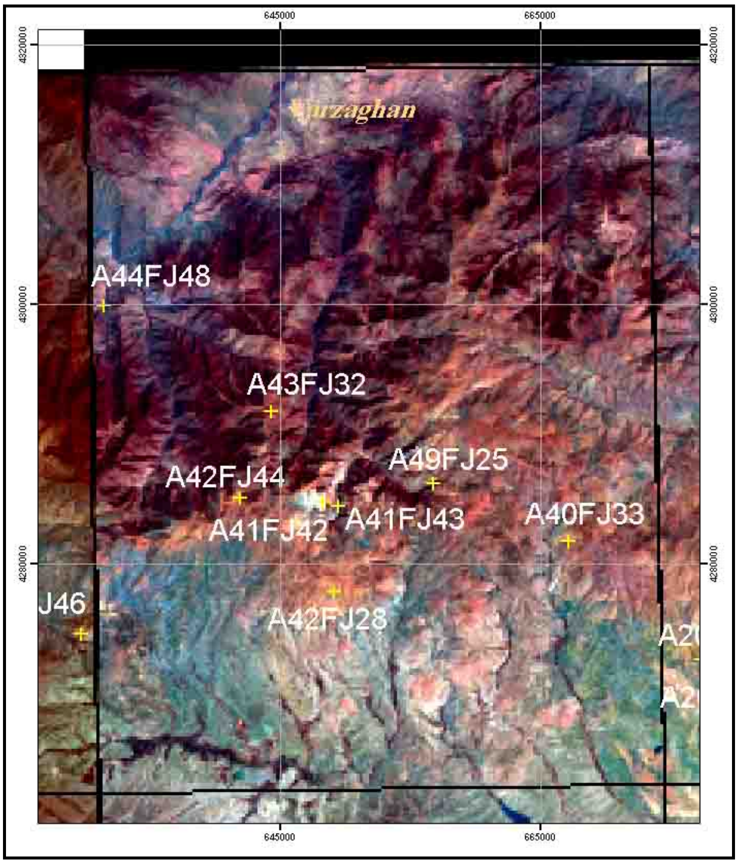


Fig. 4. Varzaghan Sheet Landsat TM 351 image showing targets visited.

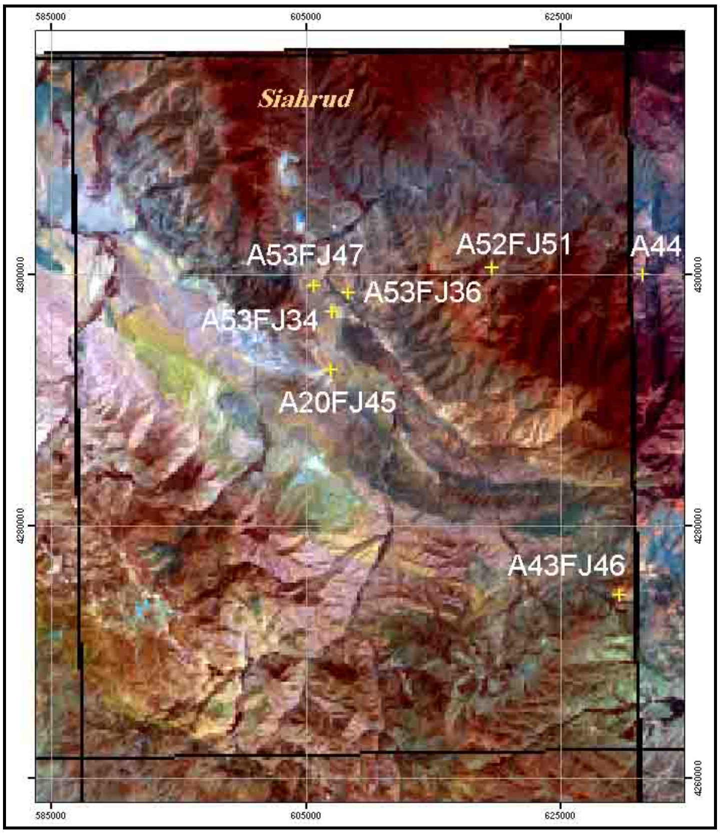


Fig. 5. Siahrud Sheet Landsat TM 351 image showing targets visited.

Sarghein (A1FJ52)

Location & Access

The target area is located between the villages of Sarghein in the south and Shirindarreh in the north, about 10kms east of Ahar town. It is within the 1:100,000 scale Ahar sheet (Figs. 1 & 2).

From Ahar town, the area is accessible through 7 kms of the Ahar-Meshkinshar highway and then through 4-12 kms of unpaved roads to the villages of Sarghein and Shirindarreh. Travel time is approximately 1/2 hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is an epithermal Au and Au-Ag-Te vein target.

Geology

The area is underlain by Eocene andesite lava flows and possibly dacite. In the regional geology map, Oligocene Anzan alkali granite to hornblende biotite granodiorite is indicated but was not found.

Structure

There are WNW- and NNE-trending Landsat TM lineaments. No structures are shown in the regional geology map. In the field, the silicification with attendant hydrothermal breccias and minor post-mineral faulting trend NW, NNE and E-W.

Landsat TM Imagery

The northern part of the area has Landsat-indicated clay alteration.

Alteration-Mineralization

A 5km long NW-trending corridor of discontinuous limonite-bearing chalcedonic silica zones in andesites occurs in the area (Photo 1). Individual silica bodies have widths ranging from 20 to >500m and lengths of up to 1km. There are three silica trends. The predominant one is 310-330^{o} while 80-100^{o} and 10-20^{o} are subordinate in occurrence. In some areas, two trends merge.

Photo 1. South view of the 5km long NW trending corridor of silicified zones.

Chalcedonic silica hydrothermal breccia dykes have been observed in the most intensely silicified and limonitic portions of the silica bodies (Photo 2). These breccias are perceived to be the feeder zones of the surrounding silicification/mineralization. The hydrothermal breccias consists of angular to subrounded silicified clasts set in a matrix of silica and iron oxides (after pyrite) (Photo 3). They exhibit mosaic to rotational breccia textures. Breccia width ranges from <1 to 20m and lengths from a few meters to hundreds of meters. Fe oxides are very common, ranging from <1 to 20%. They are mainly limonite, goethite and hematite. Seven rock chip samples on breccias were collected for analysis. They are Rock Sample Nos. 84.SAM.92 to 95, 84.SAM.97 to 99.

In one locality (Rock Sample No. 84.SAM.96), irregular 1 to 10mm milky vuggy crystalline quartz veinlet stockwork was observed. This is a good indication that epithermal quartz veins may be present very close to the surface.

Post-mineral faulting characterized by intense kaolinitization and gouge has been observed at the edges of the silicification/breccias which indicates continuity of long-lived structures during and after silicification.

Beneath and lateral to the silica zones, clay including kaolinite is observed for tens of meters. Further away, propylitic (chlorite-epidote) alteration was observed in one locality (near Sarghein village).

Photo 2. North view of 10m wide chalcedonic silica hydrothermal breccia containing 20% hematite-limonite (Rock Sample No. 84.SAM.94).

Photo 3. Close up of chalcedonic silica hydrothermal breccia with 10-20% hematite-limonite matrix. Shows mosaic to rotational breccia textures. (Rock Sample No. 84.SAM.92).

Discussion

Sarghein contains the largest area of silicification/hydrothermal breccciation among all the epithermal Au areas evaluated. The extensive chalcedonic silicification of the volcanics and related hydrothermal breccias are signs of the upper part of a low-sulphidation epithermal gold system. Presence of crystalline quartz veinlets in one area is a good sign that at that locality epithermal quartz veins may be near the surface, say within 100m. Although it remains to be seen if the system is productive, ie. with economic Au grades.

With the aerial extent of the silicification/breccias, the eight rock chip samples collected are not enough to evaluate the area. This would require at least 200 rock samples. It is hoped that some of the 8 samples collected return anomalous As (100s ppm) and Sb (tens of ppm) and possibly Au (say 0.1 ppm). If they do not, it does not mean that the area is not interesting. It may means that not enough rock sampling at the right sample density has been done.

Next Steps

Irregardless of the results of the rock chip sampling, the area should be investigated in more detail. Geological mapping at 1:5,000 scale coupled with rock chip sampling (at least 200 samples) should be undertaken with special emphasis on hydrothermal breccias and quartz veining.

Kordlar (A24F18)

Location & Access

The target area is located 24km NE of Ahar town within the 1:100,000 scale Kaleybar sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through 35 kms along the Vargahan road and then a 3km unpaved road to Kordlar village. Travel time takes 1 hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a replacement Cu target.

Geology

The area is underlain by Cretaceous calcareous sandy to silty shales cut by Oligocene pyroxene andesite dykes and sill-like bodies. The dykes in the visit are porphyritic orthoclase-bearing pyroxene diorite (possibly of alkaline affinity).

Structure

There are NNE and NNW trending faults near the granodiorite contact.

Landsat TM Image

There is no alteration detected by Landsat imagery.

Photo 4. Silicified fault zone, 2m wide, containing 1% pyrite, trace chalcopyrite and malachite stains. Fault gouge (white) indicate post-mineral movement.

Alteration-Mineralization

A silicified fault containing 1% pyrite and <1% chalcopyrite disseminations is in contact with an alkaline mafic diorite on the hanging wall side and bedded calcareous shales and mudstones on the footwall side (Photo 4). The mineralized fault trends 290^o with a 70^o S dip and measures about 2m wide x 50-100m long. Limonite and malachite stains were noted along the fault. The diorite is altered to weak to moderate chlorite-carbonate while the calcareous rocks are neither baked nor altered showing that the dykes are very dry, ie. non-hydrothermal fluid-bearing. The mineralized fault is probably mesothermal as it contained chalcopyrite. It is most probably discontinuous and will not be an attractive exploration target.

Discussion

The area is not a favorable setting for porphyry Cu mineralization as mafic diorite dykes are not known as causative intrusions as evidenced by their uninteresting chlorite-carbonate alteration which is deuteric in nature. The area is neither good for epithermal Au as it is mainly underlain by sedimentary rocks which do not normally host epithermal Au. Also, the presence of chalcopyrite in the fault indicate mesothermal conditions and therefore anything that might be epithermal in the immediate vicinity has been eroded away.

Next Steps

No further work is recommended.

South Kodrlar (A24F17)

Location & Access

The target area is located 22km NE of Ahar town within the 1:100,000 scale Kaleybar sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through 35 kms along the Vargahan road before reaching Kordlar village. Travel time takes 1 hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu target.

Geology

The area is underlain by Eocene latitic lava flows and dacitic ignimbrites intruded by an NE-trending Oligocene biotite granodiorite of almost batholithic dimension (1-5km x 14km).

Structure

There are NNE and NNW trending faults near the granodiorite contact.

Landsat TM Image

There is no alteration detected by Landsat imagery.

Alteration-Mineralization

The biotite granodiorite is altered by propylitic alteration (chlorite-epidote-carbonate) with no sulphides. Although only volcanic rocks are in contact with the granodiorite in the regional geology map, calcareous bedded clastics were found in the field where skarn-type alteration is present. Directly in contact with the granodiorite at its western portion, there is a N-S trending zone measuring about 15m x 500m of intense silicification with variable secondary biotite carry 3-5% pyrite disseminations and trace arsenopyrite and pyrrhotite (Photo 5). Two rock chip samples, Rock Sample No. 84.SAM.50 taken in this trip and another one during a previous GSI trip by A. Moosavi, were collected for analysis. Laterally away, there is silica-epidote skarnoid carrying rare hairline-wide magnetite stringers with no sulphides.

Discussion

The silica+biotite-sulphide mineralization could be gold-bearing retrograde skarn . The quartz-epidote-magnetite skarnoid is also retrograde but is essentially barren of mineralization.

Next Steps

If the 2 rock samples taken are anomalous in gold, further exploration work is recommended to delimit the sulphide skarn and find more possible skarn bodies in contact with the granodiorite in other areas.

Photo 5. Propylitic altered biotite granodiorite of Oligocene age (background) in contact with Cretaceous calcareous rocks (low lying area beside the road) which is probably a retrograde silica-3% pyrite-trace arsenopyrite skarn (Rock Sample No. 84.SAM.50).

Babajan (A23FJ2)

Location & Access

The target area is located at the vicinity of Babajan village, about 15 kms ENE of Ahar town within the 1:100,000 scale Kaleybar sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through 15 to 20 kms along the Vargahan asphalt road. Travel time to the site is approximately about 20 minutes by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is an epithermal Au and porphyry Cu target.

Geology

The area is underlain by Eocene trachyte-trachyandesite-latite lava flows.

Structure

The trend of the silcification is 60^{o} while the trend of the hydrothermal breccias are 290^{o} and 320^{o}.

Landsat TM Image

There is strong Landsat-indicated clay alteration in the area.

Alteration-Mineralization

The area is underlain by several zones of limonite-bearing chalcedonic silicification of the volcanics along a 2km long NE trending zone (Photo 6). There are zones of hydraulically emplaced discontinuous chalcedonic silica hydrothermal breccias (Photo 7) which are probably the feeder zones of the widespread silicification. The breccias exhibit mosaic to rotation breccia textures and consist of angular to subrounded granule to cobble-sized chalcedonic silicified volcanic clasts set in chalcedony-limonite±hematite matrix. It is most probable that the limonite±hematite is after pyrite. One silicified zone at FJ3 (696542E / 4269932N) is about 300m x <1km in size. Several hydrothermal breccia zones have been found of which the largest trends 320^{o} and measures about 20m wide x >200m long. The breccia zone contained 10 to 30cm wide discontinuous hydrothermal breccias spaced at several meters apart. Two rock chip samples were taken (Rock Sample No. 84.SAM.51 & 52). Another silicified zone was inspected about 1km south (695994E / 4269145N). It is about 50m x 100-300m zone which had 290^{o} trending chalcedonic silica hydrothermal breccia zone measuring 8m x 30m. One rock chip sample was taken (Rock Sample No. 84.SAM.53). Further east, a large 1km long silicified zone which is 300m higher in elevation can be seen. There was no time to investigate it.

At lower elevations and west of FJ3 area, the volcanics along the asphalt road are unaltered cut by narrow <1m wide kaolinite-limonite alteration.

Photo 6. East view of 60^{o} trending chalcedonic silicified hill (about 300m x >500m) with narrow irregular hydrothermal breccia zones trending NW.

Discussion

The chalcedonic silicification and related chalcedonic silica hydrothermal breccias are expressions of the higher level of a low-sulphidation epithermal system. The hydrothermal breccias are probably the feeder zones of the widespread silicification. The silicified rocks are not expected to have any appreciable gold as they are too high up in the system. Taking samples of the hydrothermal breccias especially those that contain appreciable amounts of limonite and/or sulphides have the better chance of containing anomalous elements such as Hg, Sb and As and possible up to 0.1-0.2ppm Au. About 2 full days are required to fully assessed the area. The 3 rock chip samples taken are not sufficient to adequately assess the area as they only represent a small part of the whole altered area.

Photo 7. Close up of chalcedonic silica-limonite (after pyrite) altered hydrothermal breccia consisting of angular to subrounded chalcedony clasts. Exhibits rotational breccia texture. (Rock Sample No. 84.SAM.51)

Next Steps

If the rock chip samples taken from hydrothermal breccias yield anomalous Au, As, Sb and/or Hg, further exploration work is fully justified. But even if the samples did not yield any anomalous metals, it is still recommended to spend about 2 field days to fully assess the whole area which includes about 50-100 more rock chip samples on hydrothermal breccia and/or silica veins.

Mazraeh Copper Mine (A19FJ42)

Location & Access

The Mazraeh copper mine is operated by National Iranian Copper Co. (NICICO) and located about 20 kms north of Ahar town. It is within the 1:100,000 scale Kaleybar sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through an 8 km stretch of the asphalt road to Ghalandar village and then 17 kms of unsealed road to the Mazraeh mine. Travel time takes about one hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the Mazraeh mine area is a porphyry Cu target.

Geology

The area is underlain by Cretaceous andesite lava flows and tuff breccias and thinly bedded limestone with bedding trend of E-W and dips of 70-80^{o}S. The said rocks are intruded by an E-W to SE-trending Oligocene hornblende granodiorite batholith. Flat-lying Quaternary trachyandesite lavas overlie unconformably the granodiorite.

Structure

The dominant faults are N-S trending.

Landsat TM Image

There is no Landsat-indicated clay alteration in the area.

Photo 8. View to the west of the propylitic Oligocene biotite granodiorite (right side) in contact with marbleized Cretaceous limestone (left side) as seen at the Open Pit at Adit 3 level. The 10m wide copper skarn is at the contact.

Alteration-Mineralization

The granodiorite is fresh to weakly chloritic to propylitic. The skarn is formed at the southern contact of the granodiorite with the limestone (Photos 8 & 9). There are about nine skarn orebodies at 1% Cu cut-off for 2kms along the E-W trending contact. The orebodies are about 10-12m wide x 50-100m long x 200m deep. The skarn consists of remnant prograde skarn of garnet-pyroxene-magnetite replaced by several stages of retrograde skarn (Photo 10). The main retrograde skarn stage is actinolite±epidote±calcite-chalcopyrite which intimately replaced the pro-grade skarn as blebs, patches and stringers. This followed by barren <1 to

1cm wide calcite veinlets and <1 to 2cm wide calcite±quartz-pyrite-chalcopyrite veinlets. Away from the skarn, the limestone is silicified and marbleized.

Photo 9. West view of 10m wide E-W trending malachite-stained mixed prograde/retrograde skarn (left side) in contact with propylitic altered biotite granodiorite (right side) containing rare magnetite-chalcopyrite stringers.

Photo 10. Prograde garnet-pyroxene skarn with magnetite veinlets cut by retrograde actinolite-epidote-chalcopyrite skarn at Stope 1, Adit 1 level.

Galena, sphalerite and molybdenite have not been observed and are reportedly rare in the mine. Tabular to rosette specular hematite was noted in one specimen with dogtooth quartz crystals in the open pit.

Reserves, Mining and Milling

The Mazraeh mine currently has 92 employees of which 3 are mining engineers. Since the start of the mine in 1956, about 180,000 tonnes of ore had been extracted and the current reserve is 730,000 tonnes at about 1.7% average Cu. There are nine orebodies, mined initially by open pit and then by underground shrinkage stoping. The underground mine has 6 mine levels, (Adit 0 to 5) spaced 35-40m vertically. The annual production is about 13,000 tonnes of ore. Currently an additional 5,000 tonnes of ore comes from developmental ore taken at Sungun porphyry Cu mine at about 0.7% Cu. The plant uses the flotation method to extract Cu concentrates. Cu recovery is reportedly about 95%. The ore:concentrate ratio is about 30:1. The concentrate grade is about 30% Cu, 18ppm Au and 24ppm Ag.

Discussion

Although the granodiorite is barren of mineralization, the skarn mine at Mazraeh proves that the batholith is capable of producing mineralized skarns similar to the Battle Mountain district in Nevada, USA. The mineralization type at Mazraeh is batholith-related proximal copper skarn which consist of two stages – a prograde skarn of garnet-pyroxene-magnetite and a retrograde skarn of actinolite-epidote-calcite-chalcopyrite-pyrite. No porphyry Cu mineralization is expected within the batholith unless younger hydrothermally altered porphyritic intrusives are located.

Next Steps

Calcareous rocks in contact with this granodiorite batholith should be investigated for possible skarn mineralization.

North Ghalandar (A20FJ7)

Location & Access

The target area is located north of Ghalandar village, about 15 kms north of Ahar town. It is within the 1:100,000 scale Kaleybar sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through 8 kms of the Ahar-Mazraeh mine asphalt road and thence through 6 kms unpaved road to the area. Travel time to the site is approximately 45 minutes by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu, volcanic-hosted Cu-As-Sb and an epithermal Au target.

Geology

The area is underlain by Cretaceous biotite trachyandesites.

Structure

There is a 70° trending argillic to silicified zone at the eastern portion of the area.

Landsat TM Image

There is weak Landsat-indicated clay alteration in the area.

Alteration-Mineralization

There is an extensive (~1 km^2) area containing cobble to boulder-sized float of quartz-?sericite altered fine-grained rock (possibly a dioritic subvolcanic intrusive) carrying <1 to 3% disseminations of fine grained tourmaline. 5 to 10cm wide silisic vein and hydrothermal breccia float material were also observed (Photo 11). Malachite is sometimes found in fractures of the tourmaline altered rocks as well as the silisic vein material. 3 rock chip samples were taken – Rock Sample Nos. 84.SAM.54 & 55 plus one more taken by a GSI team (A. Moosavi) previously. In the eastern area, there is 20-30m wide 70° trending argillic (kaolinite-clay)-limonite alteration with some narrow silicified zones in the trachyandesite (Photo 12).

Photo 11. Float of hydrothermal vein breccia with limonite (after sulphide) matrix – possible source of malachite stains.

Discussion

The tourmaline alteration is formed at very high temperatures wherein very little metals are deposited. The malachite stains associated with the tourmaline alteration is a supergene product of a possibly later lower temperature hypogene sulphide phase. Since the malachite stains are sporadic, it is not expected that there is an extensive sulphide phase. It is a mystery where the tourmaline-malachite float were coming from as no outcrop was located. Also, tourmaline is usually associated with an intrusive and yet the host rock appears to be subvolcanic in nature. The argillic-limonitic alteration zone in the eastern area is most probably related to a low-sulphidation epithermal system. It most likely does not carry appreciable gold as no quartz veins were found.

Photo 12. 70^{o} trending argillic-limonitic zone in Cretaceous biotite trachyandesites.

Next Steps

If there is appreciable gold in the 3 rock chip samples taken which is most unlikely, follow up work is recommended to find the source of the malachite-stained rocks. Otherwise, no further work is recommended.

Ghalandar (A20FJ8)

Location & Access

The target area is located east of Ghalandar village, about 13 kms north of Ahar town. It is within the 1:100,000 scale Kaleybar sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through 8 kms of the Ahar-Mazraeh mine asphalt road and thence through 2 kms unpaved road through Ghalandar village. Travel time to the site is approximately 45 minutes by 4WD vehicle.

Deposit Model Type

According to the USGS mineral modeling, the area is an epithermal Au target.

Geology

The area is underlain by Eocene trachyandesite and dacite.

Structure

NW-trending faults are the predominant structures. Subsidiary NE and N-S trending faults are also present.

Alteration-Mineralization

High-level milky chalcedonic silicification related to low-sulphidation epithermal hosted by the trachyandesites is widespread in the area (Fig. 7).

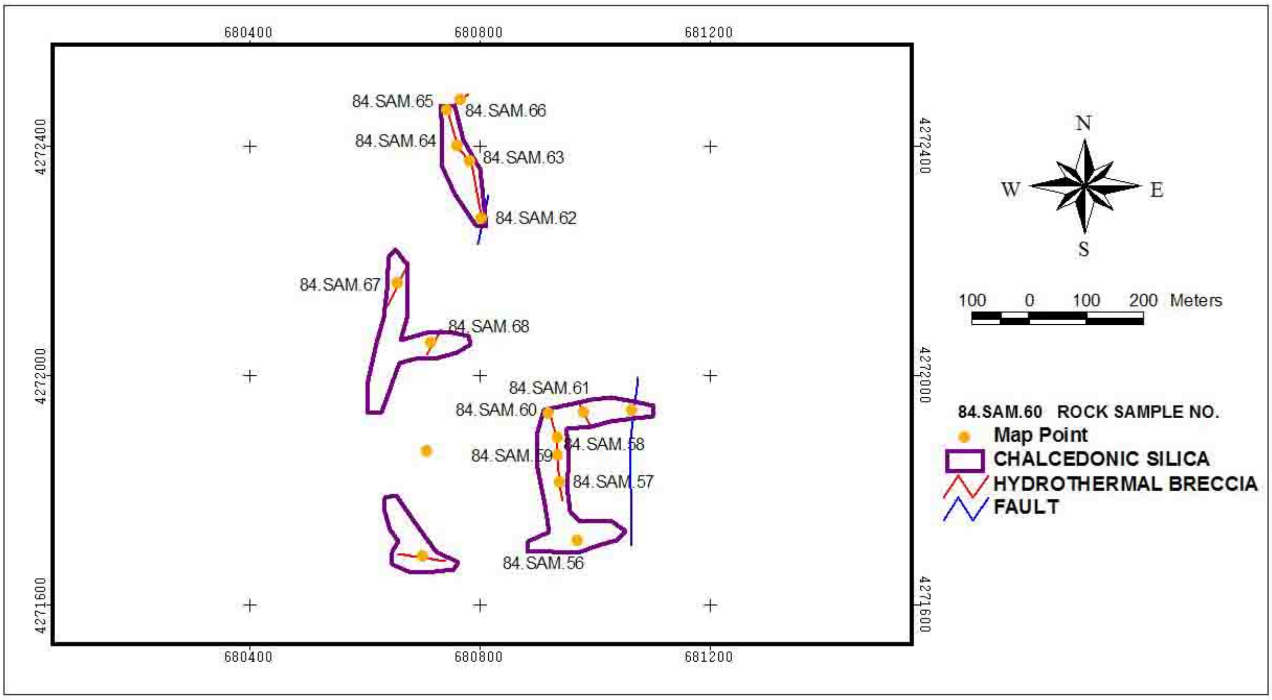


Fig. 7. Chalcedonic silica bodies with hydrothermal breccias at Ghalandar area.

There are at least 4 zones with dimensions up to 60m wide and 250m long. The trend of the silicified bodies is principally 320-340^{o} with a conjugate set at 80-110^{o}. The western silicified body trends 10^{o}. Chalcedonic silica hydrothermal breccias ranging from a few cms to 20m are found in the medial zones of the chalcedonic silicification and sometimes cuts the chalcedonic silicification at an oblique angle which means that they were later than the silicification. They are probably the main feeder zones as they contain limonite-goethite, 3 to 20% with traces of very fine grained pyrite (originally 3-10%). The northernmost silicified body contains the largest hydrothermal breccia, about 10 to 50m wide x 220m long (Photo 13). It is characterized by hematite-goethite matrix (Photo 14). 13 rock chip samples were collected mainly from hydrothermal breccias.

The hill slopes and valleys are generally altered to kaolinite-clay alteration which presumably envelops the silica bodies. There is a clay mine located 1-2 kms east of the area which shows the extensive zone of alteration present in the area.

Discussion

The chalcedonic silica nature of the mineralization implies that the higher levels of a low-sulphidation epithermal system are exposed. The paleo-surface is probably only 100 to 200m above. The rock chip samples were taken mainly from the hydrothermal breccias to increase the chance of detecting gold and other anomalous elements. At the level of exposure, the altered/mineralized rocks would hopefully show anomalous As, Sb and/or Hg and possibly traces of Au up to 100ppb. Conceptually, the Au zone will be located at 100 to 200m below the surface located at the upflow zone of the system. The milky chalcedonic silica will be barren of mineralization as they are devoid of limonite or sulphides.

Photo 13. North view of the 320^{o} trending hematite breccia zone measuring about 20-50m wide x >200m long (Rock Sample Nos. 84.SAM.62 to 65).

Photo 14. Close up of the chalcedonic silica hydrothermal breccia containing angular chalcedony clasts in hematitic matrix (Rock Sample No. 84.SAM.58).

Next Steps

If the rock chip samples return anomalous values, ie. >100ppm As, >10ppm Sb and >100ppb Au, exploration follow up is needed to locate and sample the other silicified zones in the area to the east and north.

Zaylik (A20FJ22)

Location & Access

The target area is located near Zaylik village, about 14 kms north-northeast of Ahar town. It is within the 1:100,000 scale Kaleybar sheet (Figs. 1 & 3).

From Ahar town, the area is accessible through 8 kms of the Ahar-Mazraeh mine asphalt road and thence through 6 kms unpaved road through Ghalandar village to the area. Travel time to the site is approximately one hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a volcanic-hosted Cu-As-Sb and an epithermal Au target.

Geology

The area is underlain by Eocene trachyandesites. There is an abandoned clay mine reportedly supplied to a cement factory.

Structure

In the field, there are NW-trending hydrothermal breccias and a post-mineral gougy N-S to NE-trending fault.

Alteration-Mineralization

The abandoned open pit mine is characterized by a >100m wide kaolinite-rich fault zone trending N-S to NE. At the western wall, there are argillic-silicified zones in the trachyandesite containing irregular <1 to 2m wide hydrothermal breccias (Photo 15). The breccias consist of angular to subangular argillic altered volcanic clasts set in hematite-rich matrix and comminuted rock flour (Rock Sample No. 84.SAM.69). In the eastern area outside of the open pit, a larger zone of silicified-argillic zone with hydrothermal breccias is exposed, about 20m x 220m (Photo 16). The trend of the silicification/breccia is 330^{o}. The breccias follow the same trend or are sub-parallel. The breccias in the eastern area are more extensive. The southern portion is 20m wide and range from mosaic-rotational breccias to fluidized milled breccias containing well-rounded wallrock clasts. Matrix is made up of 3 to 20% iron oxides with variable amounts of hematite, goethite and limonite. At the lower elevations, the breccias are more argillized than silicified, similar to the western area (Rock Sample No. 84.SAM.70 to 71). At the higher elevations (i.e. 30-40m higher) and to the north, the breccias are more chalcedonic silicified than argillic (Rock Sample No. 84.SAM.72 & 73). There are still isolated resistant E-W trending silicified zones observed to the south and a northern extension of the NW-trending eastern breccia. These were not visited due to lack of time.

Photo 15. Southwest view of the abandoned Fe-clay mine showing argillic-hematitic alteration of the andesites at the western flank (right upper side) and kaolinite-rich fault zone at the creek.

Photo 16. 320^{o} trending hydrothermal breccia, 20m wide, comprising of argillic altered volcanic clasts set in hematite-goethite matrix (Rock sample No. 84.SAM.70).

Discussion

The hydrothermal breccias and attendant silicification and argillization are expressions of the higher parts of a low-sulphidation epithermal system. Since there is less chalcedonic silicification and more of argillic alteration, the system is relatively deeper than that of Ghalandar (A20FJ8). The iron oxides are definitely derived from sulphides, most likely pyrite. Analysis of the rock chip samples collected will shed light on the genesis of the hydrothermal breccias and associated silicification and argillization.

Next Steps

If the rock chip samples return anomalous values, ie. >100ppm As, >10ppm Sb and >100ppb Au, exploration follow up is needed to locate and sample the other silicified zones in the area located north and south of the area and map in detail the dimensions of the breccias and attendant alteration.

Shirbit (A23FJ37)

Location & Access

The target area is located at the vicinity of Shirbit village, about 25.5 kms east-northeast of Ahar town and 1.5 km west-southwest from West Shirbit (A23FJ40). It is within the 1:100,00 scale Kaleybar sheet (Figs. 1 & 3).

From Ahar town, the area is accessible through 17 kms along the Ahar-Kaleybar asphalt road and then through 12 kms of the Kordlar asphalt road. Travel time is approximately 1/2 hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu and an epithermal Au target.

Geology

The area is underlain by Eocene pyroxene andesite and andesitc basalt. Silicified and hydrothermally altered rocks are present.

Structure

Both the regional geology map and the Landsat image show WNW and NE-trending faults/lineaments.

Landsat TM Imagery

There is Landsat-indicated clay alteration in the area.

Alteration-Mineralization

The alteration represents the higher levels of a low-sulphidation epithermal system which may not necessarily be mineralized at the surface nor at depth. There is a large boulder float area of chalcedonic silicified rocks measuring about 200m x 200m. However, the in-situ silicification is restricted at the hill top measuring 10m x 40m with a trend of 50^{o} (Photo 17). No hydrothermal breccias were noted.

Photo 17. NE view of 50^{o} trending chalcedonic silica zone with outcrop measuring about 10m x 40m.

Discussion

The silicification of the andesites is not widespread compared to Babajan (A23FJ2), Ghalandar (A20FJ8), Zaylik (A20FJ22) and Sarghein (A1FJ52). There are also no feeder zone indications as shown by the lack of hydrothermal breccias.

Next Steps

No further work is recommended.

West Shirbit (A23FJ40)

Location & Access

The target area is located at the vicinity of Shirbit village, about 26.5 kms east-northeast from Ahar town and 1.5 km east-northeast from Shirbit (A23FJ37). It is within the 1:100,000 scale Kaleybar sheet (Figs. 1 & 3).

From Ahar town, the area is accessible through 17 kms along the Ahar-Kaleybar asphalt road and thence through 14 kms of the Kordlar asphalt road. Travel time is approximately 1/2 hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu and an epithermal Au target.

Geology

The area is underlain by Eocene pyroxene andesite and andesitc basalt intruded by Oligocene hornblende biotite diorite. Silicified and hydrothermally altered rocks are present.

Structure

Both the regional geology map and the Landsat image show WNW and NE-trending faults/lineaments.

Landsat TM Imagery

There is Landsat-indicated clay alteration in the area.

Alteration-Mineralization

There is a tourmaline-quartz breccia pipe at the center of the hill (Photo 18). The outcrop is about 50m in diameter but the float area is 100-200 meters across. The clast- to matrix-supported breccia pipe consists of angular to subrounded silicified biotite diorite (or monzonite?) clasts set in tourmaline-quartz matrix (Photo 19). The breccia texture range from mosaic to rotational breccia. Occasionally, pyrite fracture fills are noted as a later structural overprint (Rock Sample No. 84.SAM.89). Late-mineral faults trending N-S contain pyrite along fractures. The breccia pipe intrudes a hornblende biotite diorite (or monzonite?) while is variably altered to intense sericite alteration at the center and weakly chloritic at the fringe. Along the asphalt road, about 300m from the breccia pipe, 340^{o} trending sheeted tourmaline-quartz veins (Rock Sample No. 84.SAM.87) and quartz-coarse pyrite (changed to limonite) veins (Rock Sample No. 84.SAM.88) with vertical dips cut the sericitized diorite (Photo 20).

Photo 18. Tourmaline-quartz breccia pipe.

Discussion

The presence of tourmaline indicates very high temperature of formation (magmato-hydrothermal, >600^{o}C) which negates the precipitation of base and precious metals. It simply indicates high volatile content of the hydrothermal fluids. The medium-grained sericite associated with the tourmaline also indicates that the alteration is deep-seated (>>2km from paleosurface). It is later hydrothermal fluids (at lower temperatures at or below 350^{o}C) which may contain base and precious metals. However, the absence of appreciable sulphides and supergene Cu carbonate (malachite/azurite) staining indicates that not much metals have been deposited after the tourmaline phase. Only pyrite was noted.

Photo 19. Close up of the tourmaline-quartz breccia comprising of angular quartz-sericite altered diorite clasts in tourmaline-quartz matrix. The breccia is clast- to matrix-supported shows rotational breccia texture.

Although Shirbit (A23FJ37) is only 1.5kms away, the high level epithermal-related silicification at Shirbit is no where related to the deep-seated tourmaline breccia pipe. The silicification has to be much later than the breccia pipe as the silicification is very near to paleo-surface while the breccia pipe is several kms from the paleo-surface.

Photo 20. Close up of quartz-limonite (after pyrite) vein (left side – Rock Sample No. 84.SAM.86) and tourmaline vein (right side – Rock Sample No. 84.SAM.87) in sericitized hornblende biotite diorite of Oligocene age.

Next Steps

If the 3 rock chip samples do not return appreciable Cu (>500 ppm) and Au (>0.1 ppm) values, no further work is warranted.

Ghaleh Jugh (A20FJ41)

Location & Access

The area is located at the vicinity of Ghaleh Jugh village, about 21 kms northeast of Ahar town. It is within the 1:100,000 scale Kaleybar sheet (Figs. 1 & 3).

From Ahar town, the area is accessible through 27 kms along the Ahar-Kaleybar asphalt road and then through 1-2 kms of the farm roads. Travel time is approximately 3/4 hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu target.

Geology

The area is underlain by Cretaceous andesitic lavas, tuff breccia and tuffs including ignimbrite intruded by Oligocene feldspar porphyry dome. In the regional geology map, Oligocene granite is indicated but was not found in the area.

Structure

There are WNW, NE and NNE-trending lineaments in the Landsat image. In the field, WNW, NW and E-W trending altered faults were observed.

Landsat TM Imagery

There is weak Landsat-indicated clay alteration in the area.

Alteration-Mineralization

The rocks are generally chloritic to propylitic (chlorite-epidote-carbonate) with narrow (<1 to 20m wide) structurally controlled silica-clay±sericite-limonite (after pyrite) alteration associated with faults. The faults are characterized by fault gouge and occasionally fault breccia. The largest altered zone is a 20^o trending quartz-sericite-clay-limonite (after pyrite) alteration structure hosted in andesite measuring about 20m x 50m (Photo 21). Post-mineral faults trending 20^o and 300^o are present. A rock chip sample was taken previously mistaking greenish blue opal coatings for malachite stains. Another rock chip sample was taken mainly on rock containing >1% pyrite disseminations and fracture fills (Rock Sample No. 84.SAM.89).

Photo 21. Quartz-minor sericite-limonite alteration structure with gougy kaolinitic post-mineral faults trending 20^{o} and 300^{o} (Rock Sample No. 84.SAM.89).

Discussion

There is no significant alteration-mineralization in the area. There are only regional chloritic to propylitic alteration and narrow structurally controlled argillic-phyllic alteration. Rocks surrounding granite is not a suitable geological environment for porphyry Cu. Intrusive rocks favorable for porphyry Cu ranges only from quartz diorite to quartz monzonite and rarely up to alkaline syenite.

Next Steps

No further work is recommended.

Sungun Copper Mine (A41FJ42)

Location & Access

Sungun Copper mine, operated by NICICO, is located about 20 kms north of Varzaghan town. It is within the 1:100,000 scale Varzaghan sheet (Figs. 1 & 4).

From Ahar town, the mine is accessible through 44 kms of the Ahar-Varzaghan asphalt road and then 29kms through the mine asphalt road. Travel time to the site is approximately 1.5 hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu, porphyry Cu-skarn and replacement Cu target.

Geology

The area is underlain by Cretaceous limestone, marls and volcaniclastics intruded by an intrusive complex of probable Oligocene age. Post-mineral Pliocene trachyandesite and basalt covers the southern portion of the area.

The main intrusive is a quartz monzonite (called SP for "Sungun Porphyry") intruded by late- to post-mineral dykes/sills of DK1A (biotite feldspar±quartz porphyry), DK1B (hornblende biotite diorite porphyry) and DK3 (hornblende diorite porphyry). All intrusives are found on the surface except for DK3 which was intersected at depth in the Mine Area and found in the skarn area to the east of the Mine Area (see below).

Structures

The whole area is highly faulted along N-S to NNW direction with a regional NW-trending structure at the southern area. The late- to post-mineral dykes follow more or less the former direction.

Landsat Image

Unexpectedly, only weak Landsat-indicated clay alteration is indicated in the modeling. This aspect should be re-investigated as in the field, the argillic-phyllic alterations seems to occupy several square kilometers. Also, the Landsat TM false color image shown to me by Mr. Talebi in my previous visit last June 2005 indicated 5km x 8km of clay alteration.

Alteration-Mineralization

The area is characterized by widespread phyllic-argillic zones. Cu mineralization is contained in 3 zones, namely (1) Mine Area and 2 smaller zones within 2 kms at the (2) Entrance Gate area and (3) Thickeners area. The zone to be mined is the Mine Area which is about 1km x 1km in dimension between Pachir river in the north and Sungun river in the east and south.

At the Mine Area, the ore is within the SP which is generally phyllic-argillic (quartz-sericite-clay-pyrite) and less as remnant potassic (not seen on the surface) and some advanced argillic at the highest mine level. Exposures at the Leached Zone at 2300m bench is reportedly advanced argillic altered SP with 3% pyrite as disseminations and fracture fills cut by chlorite-magnetite altered DK1B (hornblende biotite diorite porphyry). About 30% of the exposures were oxidized. Only rare 1cm wide milky quartz veinlets were noted in the SP. No chalcocite was observed. At 2260m bench, 50m wide 30^o trending DK1A (hornblende biotite quartz porphyry) cuts the SP (Photo 22).

The DK1A is altered to clay±chlorite carrying <1% pyrite disseminations and fracture fills. At 2200m bench, a representative exposure of the chalcocite ore in SP (biotite feldspar porphyry) was exposed. Chalcocite and pyrite occur together as disseminations, microfracture fills and <1 to 1cm wide stringers. Rare <1 to 1cm wide grey quartz-pyrite-chalcocite veinlets were noted (Photo 23). A 2m wide chlorite altered DK1B (hornblende feldspar porphyry) cuts the SP. At a ramp between 2200 and 2187.5m benches, typical oxidized SP with 2-5% malachite-azurite stains (Photo 24) in fractures was shown. The DK1A is altered to clay±chlorite carrying <1% pyrite disseminations and fracture fills. At 2200m bench, a representative exposure of the chalcocite ore in SP (biotite feldspar porphyry) was exposed. Chalcocite and pyrite occur together as disseminations, microfracture fills and <1 to 1cm wide stringers. Rare <1 to 1cm wide grey quartz-pyrite-chalcocite veinlets were noted (Photo 23). A 2m wide chlorite altered DK1B (hornblende feldspar porphyry) cuts the SP. At a ramp between 2200 and 2187.5m benches, typical oxidized SP with 2-5% malachite-azurite stains (Photo 24) in fractures was shown.

Photo 22. Unoxidized (grey in color) argillic-1% pyrite altered biotite feldspar±quartz porphyry (DK1A) dyke cutting oxidized (red brown in color) mineralized quartz monzonite (SP) at 2200-2187.5m ramp.

Drilling, Reserves and Mine Development

Two phases of drilling was conducted - 153 holes totaling 65kms in the 1990s and 88 holes totaling 20kms in 2002-2004. Final drill spacing is about 70-100m. It was mentioned that the ore reserve block is not as regular as in Sarcheshmeh and Meiduk. This is because of the complications of the barren dykes intruding the mineralized rocks. The Sungun mine reportedly contains a resource of about 1 billion tonnes @ 0.673%. Ore reserve is composed mainly of supergene chalcocite from 2300 to 1900m benches. At 0.25% Cu cut-off, it is reportedly 370 million tonnes @ about 1% Cu which will be mined in 30 years.

Open pit development started in 2000. Haulage trucks used are several 32-tonne Euclid and 2 84-tonne Komatsu trucks. Development ore is trucked and processed by flotation method at the nearby Mazraeh mine. The mill on site is under construction and will be operational by next year. In the next 5 years starting next year, the target annual production is 7 million tonnes of ore (about 20,000 tonnes/day) and by the 6th year, it will increase to 14 million tonnes of ore (about 40,000 tonnes/day). Total mine staff at full production is estimated at 2,000. Currently, there are 7 geologists and 20-30 mine engineers.

Photo 23. Supergene Cu sulphide ore - phyllic altered quartz monzonite (SP) with 2cm wide chalcocite veinlet and pyrite fracture fills cutting 3-10mm wide milky quartz veinlets at 2200m mine bench.

Photo 24. Supergene Cu oxide ore - azurite and malachite along fractures of oxidized phyllic altered quartz monzonite (SP) at 2200-2187.5m ramp.

Discussion

The Sungun mine illustrates that once an orebody is found, several more can be found in the vicinity as shown by the discovery of other porphyry Cu centers near the mine gate and thickener area.

The higher grade Cu mineralization (1% Cu) in Sungun is contained almost exclusively in the supergene chalcocite zones within the large phyllic-argillic zone of the porphyry Cu system.

Quartz-sulphide veining in the Sungun mine is minor. Most of the mineralization is chalcocite replacing pyrite disseminations, microfractures and veinings. Trace chalcopyrite was observed together with pyrite in my previous visit in June 2005. Supergene Cu oxide ore is reportedly minimal and is removed as mine developments proceeds and stockpiled for later leaching operation. Just like Sarcheshmeh and Meiduk mines, the hypogene Cu grades per se are too low to support mining.

Next Steps

Further exploration should be done to locate the size and tenor of the other porphyry Cu centers.

Sungun Skarn (A41FJ43)

Location & Access

The Sungun skarn area is located 1km east of the Sungun Copper Mine (A41FJ42), about 20 kms north of Varzaghan town. The skarn area is within the 1:100,000 scale Varzaghan sheet (Figs. 1 & 4).

From the Sungun Copper mine, the skarn area is accessible through a mine road across the Sungun river, about one km from the open pit. Travel time from the open pit to the site is approximately 15 minutes by 4WD vehicle.

Deposit Model Type

According to the pospectivity modeling, the area is a porphyry Cu, porphyry Cu-skarn, replacement Cu and epithermal Au (albeit without Au geochemical data) target.

Geology

The area is underlain by Cretaceous reefal limestone and Oligocene rhyolitic volcanics intruded by Oligocene intrusives. There are at least three intrusive phases recognized in the area. There is an SP-looking intrusive, a monzonite, which is heavily altered to argillic-phyllic-limonite (Photo 25). Then there are two post-mineral intrusives, an earlier propylitic altered hornblende diorite porphyry (DK1B) and a later unaltered aphanitic porphyritic hornblende andesite (DK3?). The skarn is probably related to the monzonite and the post-mineral intrusives cut the monzonite and the skarn.

Structure

No structure is indicated in the regional geology map.

Landsat TM Image

There is no Landsat-indicated clay alteration indicated in the area.

Photo 25. Oxidized phyllic altered monzonite (suspected SP) intruded by post-mineral propylitic hornblende diorite porphyry (DK1B) dykes (light color at right side).

Alteration-Mineralization

The skarn area is exposed for about 300m along a road across the Sungun river at about 1875m level. There are ancient adits in the area, one at the southern end and several at the northern end.

The skarn consist of two phases, namely (1) prograde skarn consisting of garnet-amphibole± magnetite intimately replaced by (2) retrograde skarn consisting of variable amounts of epidote, actinolite, chlorite, pyrite, galena, chalcopyrite, and pyrrhotite. The chalcopyrite-bearing skarns (Photo 26) are probably more proximal while the galena-rich skarn is more distal (Photo 27). The host rock of the skarn is reportedly the Cretaceous limestone. However, it seems to be calcareous metasediments.

Discussion

The skarn is formed at the eastern fringe of the SP-hosted porphyry Cu mineralization. The absence of a clear contact with SP might indicate that there is a continuation of porphyry Cu mineralization from the Sungun mine or a separate porphyry center at depth. Exploration at the Sungun Skarn has been minimal as the main focus is given obviously to the development of the main Sungun mine. However, this area must be explored more in detail by mapping, geophysics and drilling to find the true extent of the skarn and the contact relationship with the intrusive related to the skarn existence.

Photo 26. Middle part of the 300m wide Cu skarn zone in calcareous metasedimentary rocks showing ancient adits at the left side with malachite stains.

Photo 27. 4m wide distal garnet-magnetite-galena skarn near an ancient adit.

Next Steps

NICICO should not forget to undertake mineral exploration at the Sungun Skarn area to find either the extension of porphyry Cu ore from the main open pit or a separate porphyry Cu center in the area.

Khoynarud (A42FJ44)

Location & Access

The target area is located at the vicinity of Khoynarud village, about 21.5 kms north from Varzaghan town or 35 kms northwest of Ahar town. It is within the 1:100,000 scale Varzaghan sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through the 45 kms asphalt road to Varzaghan town, then through 23 kms of the Sungun asphalt road, and finally 3.5 kms of unpaved road to Khoynarud village. Travel time is approximately one hour by 4WD vehicle.

Deposit Model Type

According to the pospectivity modeling, the area is a porphyry Cu and epithermal Au (albeit without Au geochemical data). This area was not selected but was evaluated since the Sungun geological staff is working in that area.

Geology

The area is underlain by Paleocene andesite and andesitic basalt overlain by Oligocene rhyolitic volcanics and intruded by Oligocene monzonite and biotite hornblende diorite porphyry. There were two areas shown to us by Mr. Mehrdad Iranpour of NICICO. There is an epithermal quartz vein zone hosted in the diorite porphyry west of the main prospect. The main prospect is underlain by a monzonite cut by the diorite porphyry.

Structure

There are NNW and NE-trending faults in the area as indicated in both regional geology map and Landsat image.

Landsat TM Imagery

There is no Landsat-indicated clay alteration in the area.

Alteration-Mineralization

The prospect east of the main Khoynarud prospect is a low-sulphidation epithermal Au vein type. The E-W trending vein zone is hosted in the propylitic (chlorite-epidote-carbonate) altered biotite hornblende diorite porphyry. The vein zone consists of sub-parallel anastomosing quartz-minor carbonate veins in an area measuring about 10-30m wide x 200m long (Photo 28). The vein quartz is milky, vuggy, and coarse crystalline. Dogtooth quartz crystals are common, up to 1cm long. Crustiform and cockade textures are exhibited. There are several vein stages as exhibited by veins cut by vein breccias as well as later veins. Individual veins are 1 to 30cm wide and spaced about <1 to several meters apart. The grade is reportedly 1-3 ppm Au. There is also no perceptible alteration around the quartz veins.

The main Khoynarud prospect is located on a N-S trending hill about 1km x 2km in area, probably delimited by a N-S trending fault along the drainage (Photo 29). Sungun mine staff reckons that this is a porphyry Cu prospect. A monzonite, probably similar to Sungun

Porphyry, is exposed with variable alteration from phyllic-argillic to sericite-chloritic. It is cut by dykes of propylitc altered hornblende diorite porphyry (Photo 30). No indications of porphyry Cu mineralization was noted. There are no porphyry-type quartz veinlets, widespread potassic or phyllic alteration nor supergene Cu oxides/sulphides such as malachite and chalcocite. More time should have been spent here to completely be certain whether porphyry Cu mineralization exists. However, there was not enough time left.

Photo 28. E-W trending milky vuggy crystalline quartz vein zone in propylitic hornblende biotite diorite porphyry (possibly DK1B).

Photo 29. View of N-S trending main Khoynarud altered zone. Khoynarud village is seen at the right side.

Discussion

The quartz vein zone east of the main Khoynarud prospect is definitely a low-sulphidation epithermal Au vein type of mineralization. However the veins as currently shown are too small and low grade to constitute a viable mining operation. More exploration work is required to find substantially more of this kind of mineralization before serious exploration is undertaken.

The existence of porphyry Cu mineralization at the main Khoynarud prospect has not been confirmed.

Photo 30. Possible Sungun Porphyry (SP) equivalent, phyllic-argillic altered monzonite (red brown), intruded by propylitic hornblende diorite porphyry dykes (dark grey).

Next Steps

If there are no more epithermal quartz vein areas besides the one shown, no more work is warranted. If there is, trenching and channel sampling should be undertaken to fully define the dimension of the vein zones at a cut off of at least 1 ppm Au.

I can not comment on the main Khoynarud prospect unless more evaluation is done.

Nabijan (A20FJ45)

Location & Access

The target area is located at the vicinity of Nabijan village, about 39 kms northwest from Ahar town. It is within the 1:100,000 scale Varzaghan sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through 44 kms along the Ahar-Kaleybar asphalt road to Peyram village, then through 27 kms of unpaved roads to the area through Marz Rud village. Travel time is approximately one hour by 4WD vehicle.

Deposit Model Type

According to the pospectivity modeling, the area is a porphyry Cu-skarn target.

Geology

The area is underlain by Cretaceous andesitic flows with marl, sandstone and limestone intruded by Oligocene monzonite. The monzonite is fine to medium grained equigranular and ranges in composition from quartz biotite monzonite to biotite monzonite. At the contact with the limestone, it reportedly changed to diorite-gabbro. Outcrop exposure is very limited due to thick soil and colluvium. All of these rocks are unconformably overlain by Quaternary basalt and andesite.

Structure

There are NE and NNW-trending faults. The sedimentary rocks are folded with NNE-trending fold axes.

Landsat TM Imagery

There is no Landsat-indicated clay alteration in the area.

Alteration-Mineralization

The area is actively being explored by the GSI Gold Project team. There are two mineralization types in the area, namely (1) mesothermal Au-basemetal veining hosted in the monzonite and (2) iron skarn at the northern contact of the monzonite with the limestone (Angeles, 2005).

At the Au vein area, there are 4 trenches, T1 to T4, and 15 test pits dug by GSI Gold Project as well as ancient diggings and a tunnel (TL). It is obvious that the friable weathered monzonite (elluvium) allowed the ancient people to mine the area easily.

The quartz veinings in the trenches are generally about <1-1ppm Au with a maximum of 3.5ppm Au. Tunnel TL, located east of the trenches, returned <1ppm Au, ie. 0.1-0.49ppm. Only 5 out of 15 test pits returned >1ppm Au with a maximum of 95.5ppm Au. The high value of the latter sample is probably due to Au nugget effect, ie. Au occurs as discrete grains in the supergene zone. Associated metals are Cu and Zn. In the trenches, Cu ranges from 497 to 3500ppm while Zn ranges from 221 to 2853ppm. Pb is probably present also but no analysis was done. Supergene gold enrichment is most likely as an estimated 3 to 20% Mn oxides can be seen in the trenches (Photo 31). The veins are generally multidirectional and irregular, ranging in widths from <1 to 10cm and coalesce to lenses up to 50cm wide. The vein quartz is coarse to very coarse crystalline and vuggy in nature. Dogtooth quartz prisms are up to 2cm long. Sulphides were noted mainly in float and in one case in outcrop. They are predominantly pyrite with subordinate chalcopyrite, being characteristically coarse grained (Photo 32). There is no perceptible alteration around the quartz veining. Weak chloritization is prevalent throughout the monzonite. Skarnoid alteration (calcite-garnet-epidote-chlorite) was noted in one outcrop which is probably a limestone xenolith within the monzonite.

Photo 31. Trench 2 showing manganese-rich milky coarse crystalline quartz veinlets in oxidized biotite monzonite.

Photo 32. Float of manganese- and limonite-rich coarse crystalline quartz vein stockwork with partially oxidized coarse chalcopyrite-pyrite.

The quartz-sulphide vein mineralization in the area is most probably mesothermal. This is evidenced by the coarse crystalline nature of the vein quartz, lack of vein-related alteration around the veins and presence of coarse grained base metal sulphides. It is most likely that the hydrothermal fluids are volatile-rich which would explain the coarse nature of the quartz and sulphides.

Gradient array IP-resistivity survey coupled with 2 dipole-dipole profiles were done at the area. The results indicate a 50-100m x 650m high chargeability and generally low resistivity anomaly trending NE with a more intense anomaly at the SW portion, about 40 to 90m below the surface. The dipole-dipole profile over the trench area showed an anomaly at depth but did not continue to the surface. This anomaly hopefully would mean sulphides associated with the quartz veinings.

During this visit, the iron skarn could not be located as we had nobody who knew the precise location. All we saw 1-2kms northeast of the Au vein zones, was fresh to weakly chloritic hornblende biotite granodiorite intruding calcareous sediments and andesitic volcanics. Only skarnoid (quartz-epidote-chlorite+garnet) with some carrying <1% pyrite blebs and disseminations and hornfels were found.

Discussion

At the Au vein zone, the mineralization is mesothermal gold quartz vein stockwork type. The surface Au grades are about <1 to 3.5ppm. The presence of abundant Mn oxides would indicate supergene Au enrichment at the surface. This would mean that the hypogene Au grades at depth will be lower due to absence or reduced amounts of Mn oxides. Since there is a sizeable IP anomaly at depth, it would be prudent to test this with 1 or 2 scout holes.

The iron skarn was not found due to limited time and neither maps nor guide were available to direct us.

Next Steps

These were the recommendations given in my report to the GSI Gold Project (Angeles, 2005) for the mesothermal Au vein zone –

- Drill 2 scout holes at about 120-150m depth. One hole at the NE portion (100L) of the IP anomaly near the trenches at position 50m at -30^{o} inclination and SE directed, and another one at the SW portion (525L) where the IP anomaly is more intense and larger (250m x100m wide) at position 160m at -20^{o} inclination and NW directed.

- If the scout holes are encouraging, drill infill holes at 100m apart.

- If the scout holes are discouraging, then the only viable target is the supergene zone from the surface down to say 20m. However, this would mean a substantial reduction in possible volume of mineralization.

Barazin (A49FJ25)

Location & Access

The target area is located at the vicinity of Barazin village, about 27 kms north-northeast from Ahar town. It is within the 1:100,000 scale Varzaghan sheet (Figs. 1 & 4).

From Nabijan target (A20FJ45), the area is accessible through 17.5 kms of unpaved roads to Barazin village through Arpaligh village. Travel time from Barazin to Ahar town is approximately 1.5 hours by 4WD vehicle.

Deposit Model Type

According to the prospectivity model, the area is a porphyry Cu, porphyry Cu-skarn and epithermal Au target.

Geology

The area is underlain by Cretaceous volcano-sedimentary rocks, Paleocene andesitic and latitic lava flows intruded by Oligocene granodiorite dyke and overlain by Quaternary basaltic andesite.

Structure

There is a NNE-trending fault in the area.

Landsat TM Imagery

There is weak Landsat-indicated clay alteration in the area.

Alteration-Mineralization

Along a river valley, there is widespread argillic alteration carrying about 1% pyrite along a 40^o trending sub-parallel faults in andesites (Photo 33). The sub-parallel faults are post-mineral with gouge, fault breccias. Gypsum is conspicuously present. The alteration zone is probably 300-500m x 1km. Remnant blocks of chlorite-pyrite alteration are also observed. Neither hydrothermal breccias nor quartz veins have been found in the area.

Photo 33. Widespread argillic alteration trending 40^o in andesitic rocks along a fault zone along the river.

Discussion

Although the argillic alteration is widespread, there is no associated mineralization such as hydrothermal breccias or quartz veins. The argillic alteration is definitely related to the faults.

Next Steps

No further work is recommended.

Keighal (A42FJ28)

Location & Access

The area is located at the vicinity of Keighal village, about 36 kms northwest from Ahar town. It is within the 1:100,000 scale Varzaghan sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through 48 kms asphalt roads to Keighal village via Sumadel village and thence 2 to 5 kms of unpaved roads. This route was the original road to Sungun mine prior to 2000. Travel time is approximately 1/2 hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu, porphyry Cu-skarn, volcanic-hosted Cu-As-Sb and epithermal Au (albeit without Au geochemical data) target.

Geology

The area is underlain by Eocene dacite, trachyte and ignimbrite overlain by Oligocene trachyandesite and intruded by Oligocene biotite monzodiorite, biotite granodiorite and hornblende±biotite diorite porphyry.

Structure

There are NW-trending faults in the regional geology map. In the Landsat image, there are WNW, NW and ENE-trending lineaments.

Landsat TM Imagery

There is Landsat-indicated clay alteration in the area.

Alteration-Mineralization

The area has several zones of widespread argillic (and possibly some are phyllic) alteration ranging from a few 0.01 to >1 km^2 areas. At the southern area, a 4m wide N-S trending silicified-argillic zone dipping 80^o E carries 1% pyrite in an argillic altered area of about 0.1 km^2. 1-10cm wide vuggy quartz-limonite vein was found in the most intensely silicified portion of the zone (Rock Sample No. 84.SAM.75). Post-mineral fault with gouge is found at the hanging wall.

At the central area, a biotite±hornblende granodiorite to monzodiorite intrusive with patchy limonite-bearing argillic alteration was observed. It contained a 320° trending 1m wide silicified-pyritic fault (Rock Sample No. 84.SAM.76), some local hydrothermal breccias (Rock Sample No. 84.SAM.77) (Photo 34) and patchy 1 cm wide milky quartz veinlets (Rock Sample No. 84.SAM.78). There were also 1 to 3 m wide milky vuggy quartz vein breccias in the southern and central areas (Rock Sample No. 84.SAM.79).

Photo 34. Argillic altered hydrothermal breccia in granodiorite (Rock Sample No. 84.SAM.77).

Photo 35. 320° trending epithermal quartz vein zone (white in color), 1m wide, in sericite-limonite altered hornblende biotite diorite. Hydraulically brecciated patches are noted.

At the north area, about 5kms south of Sungun mine, widespread phyllic-argillic alteration has been observed in a hornblende biotite diorite (or monzonite). Suspect trace chalcocite stains were also observed (Rock Sample No. 84SAM.80). A hydraulically emplaced 1 m wide milky crystalline quartz vein trending 320° of low-sulphidation epithermal Au affiliation was also noted (Photo 35).

Discussion

Although there are definitely low-sulphidation epithermal quartz veins present, albeit narrow and discontinuous, the most interesting aspect of Keighal area is the widespread argillic to phyllic alteration among all the targets visited besides the Sungun mine. However, no clear signs of porphyry Cu mineralization such as malachite / chalcocite stains and porphyry-related quartz-sulphide veinings have been observed. If Rock Sample No. 84.SAM.80 contains >500ppm Cu, the northernmost area is the most prospective area for possible porphyry Cu mineralization.

Next Steps

1-2 days is required to fully evaluate the area for possible porphyry Cu mineralization.

Ojagh (A43FJ32)

Location & Access

The target area is located at the vicinity of Ojagh village, about 28 kms north from Varzaghan town or 46 kms northwest of Ahar town. It is within the 1:100,000 scale Varzaghan sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through the 45 kms asphalt road to Varzaghan town, then through 23 kms of the Sungun asphalt road, then 18kms of unpaved roads through Khoynarud village to the area. Travel time is approximately 2 hours by 4WD vehicle.

Deposit Model Type

According to the pospectivity modeling, the area is a porphyry Cu and porphyry Cu-skarn target.

Geology

The area is underlain by Cretaceous limestone and rhyodacite intruded by post-Cretaceous gabbroic diorite.

Structure

There is a major NNE-trending fault and minor NW and NNW-trending faults. In the Landsat image, there are NW and NNE-trending lineaments.

Landsat TM Imagery

There is no Landsat-indicated clay alteration in the area.

Alteration-Mineralization

The area is generally regionally altered by propylitization (chlorite±epidote-carbonate) and narrow (30m wide) patchy structurally controlled quartz-clay±sericite-pyrite alteration (Rock

Sample No. 84.SAM.81) (Photo 36). There is no skarn found in contact with the gabbroic diorite.

Photo 36. 30m wide phyllic-argillic-limonitic altered zone in andesite (Rock Sample No. 84.SAM.81).

Discussion

Gabbroic diorite is not a good causative intrusion for skarn and therefore should be removed as a criterion for skarn mineralization.

Next Steps

No further work is recommended.

Anjerd (A40FJ33)

Location & Access

The target area is located at the vicinity of Anjerd village, about 29 kms northeast from Varzaghan town or 25 kms north-northwest from Ahar town. It is within the 1:100,000 scale Varzaghan sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through 30 kms along the Ahar-Varzaghan asphalt road and then through 3 kms of unpaved roads. Travel time is approximately 1 hour by 4WD vehicle.

Deposit Model Type

According to the pospectivity modeling, the area is a porphyry Cu and porphyry Cu-skarn target.

Geology

The area is underlain by intercalated mudstones and andesite of Cretaceous age intruded by an Oligocene granodiorite. In the regional geology map, the sedimentary rock is reefal limestone but this was not found in the area.

Structure

There are N-S to NNW-trending faults south of the area.

Landsat TM Imagery

There is no Landsat-indicated clay alteration in the area.

Alteration-Mineralization

The abandoned mine consists of several <20m long subparallel adits driven 120^o into skarn. Skarn mineralization occurs in a 30m x 30m block within a 50m x 100m 290^o elongated roof pendant or "large xenolith" of calcareous mudstone within the hornblende biotite granodiorite stock (Photo 37). 290^o trending post-mineral faults with hematitic slickensides showing diagonal slip movement bounds the northern edge of the Cu skarn. The roof pendant is about 200m inside the granodiorite from its contact with the sedimentary-volcanic rocks. The granodiorite around the roof pendant is altered to epidote-chlorite-carbonate-pyrite endoskarn. Boulder float of garnet-magnetite-chalcopyrite endoskarn in the nearby creek and at the ore dump near the adits indicate that Cu mineralization extended into the granodiorite. The exoskarn in the mudstone consists of prograde skarn of garnet±pyroxene-magnetite intimately replaced by retrograde epidote-actinolite-chalcopyrite-pyrite skarn (Rock Sample No. 84.SAM.82) (Photo 38). At the northern fringe of the skarn, garnet-calcite-specularite skarn have also been noted (Photo 39).

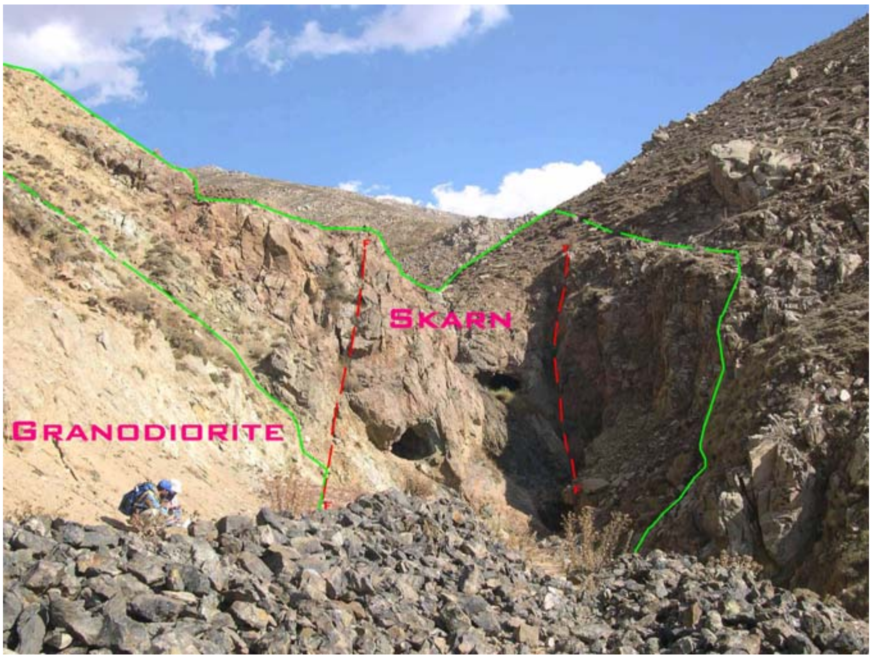


Photo 37. Skarn ore zone in calcareous mudstone (green outline) delimited by faults (red dashed lines) within the granodiorite. Ore dump see at foreground.

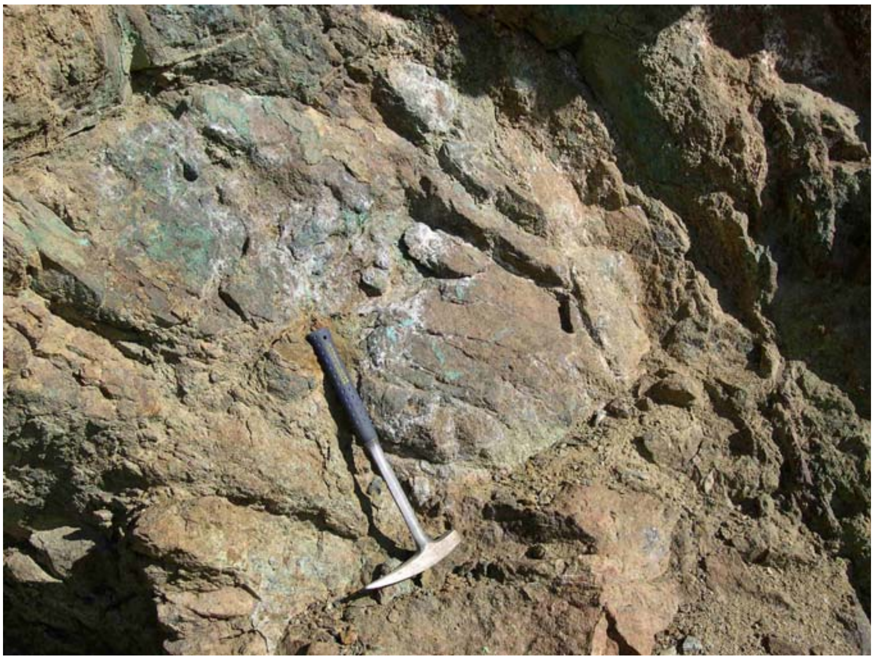


Photo 38. Prograde garnet-magnetite skarn replaced by actinolite-epidote-calcite-chalcopyrite-pyrite skarn ore in between the adits.

Outside of the roof pendant, the intercalated sedimentary rocks and andesite are altered to chlorite±epidote±magnetite-carbonate-pyrite (limonite) for more than 1 km from the contact of the hornblende biotite granodiorite stock. The granodiorite is only weakly chloritized except near the roof pendant mentioned above.

Photo 39. Garnet-calcite-specularite skarn.

<u>Discussion</u>

The alteration of the sedimentary rocks around the granodiorite stock is extensive (>1km) compared to that at Mazraeh Copper Mine. However, the lack of limestone and calcareous rocks in the sedimentary package most probably restricted the formation of productive skarns. The unique occurrence of skarn in the small roof pendant may be due to concentration of hydrothermal fluids that were available from within the intrusive, the calcareous nature of the roof pendant or both.

Next Steps

Any limestone or calcareous rocks in contact with or as large roof penedants in the granodiorite should be evaluated for possible skarns.

Ahmad Abad (A44FJ48)

Location & Access

The target area is located at the vicinity of Ahmad Abad village, about 38 kms north-northwest from Varzaghan town or 65 kms northwest from Ahar town. It is within the 1:100,000 scale Vargzaghan sheet (Figs. 1 & 4).

From Ahar town, the area is accessible through 193 kms of asphalt roads to Varzaghan town, then Kharvana town and then to the junction of the Jolfa-Pars Abad road; thence through 3 kms of unpaved road. Travel time is approximately 4 hours by 4WD vehicle.

Deposit Model Type

According to the pospectivity modeling, the area is a porphyry Cu and porphyry Cu-skarn target.

Geology

The area is underlain by Cretaceous reefal limestone and andesite intruded by Oligocene diorite to quartz diorite.

Structure

The regional geology map shows ENE and NE and NNW-trending faults. In the Landsat image, there are NNE, N-S and NW-trending lineaments.

Landsat TM Imagery

There is no Landsat-indicated clay alteration in the area.

Alteration-Mineralization

The rocks are generally altered by regional chloritic to propylitic (chlorite-epidote-carbonate) alteration overprinted by narrow (<1 to 10m wide) patchy structurally controlled silica-clay-limonite (after pyrite) alteration (Photo 40). There is no skarn development.

Photo 40. N-S trending 3-4m wide quartz-clay-limonite (after <1% pyrite) alteration structure in chloritic altered Cretaceous metavolcanics.

Discussion

There is no significant alteration-mineralization in the area.

Next Steps

No further work is recommended.

Sharaf Abad (A43FJ46)

Location & Access

The target area is located at the vicinity of Sharaf Abad and Hijehjan villages, about 18 kms northwest from Varzaghan town. It is within the 1:100,000 scale Siahrud sheet (Figs. 1 & 5).

From Ahar town, the area is accessible through 45 kms asphalt road to Varzaghan town and then through 35 kms of partly paved road to Sharaf Abad village. Travel time is approximately one hour by 4WD vehicle.

Deposit Model Type

According to the potential maps, there is a porphyry Cu and epithermal Au (albeit without Au geochemical data) target.

Geology

The area is underlain by Eocene trachyandesitic volcanic rocks intruded by Pliocene trachyandesite dome and overlain by its related pyroclastics.

Structure

There is no structure indicated in the regional map. In the Landsat image, there is a WNW-trending lineament.

Landsat TM Imagery

Only weak and scattered clay alteration is indicated in the Landsat image.

Alteration-Mineralization

The area is actively being explored by the GSI Gold Project team. There are at least 7 major vein zones in the project area, namely: V8, SZ5, SZ7, SZ1, V1, SZ2-V7 and SZ3-SZ4 (Angeles, 2005). So far, only V8 had been drill tested to depths of 45 to 90m – a total of 14 holes @ 995.70m. The vein zones are generally silica-clay-limonite structures in trachyandesites. Some contain mineralized hydrothermal breccias and quartz vein/ vein breccias such as V1, SZ7, SZ2-V7 and V8.

V8 is generally NW trending with dips of 52-66^{o}E. It is sigmoidal in shape which may reflect a tension gash generated within a NE-trending strike slip controlling fault. The NE-trending Hizehzan fault which may include the SZ7 zone (Photo 41) maybe the southern bounding fault. The dimension of the vein zone is 500m long, 1.2 to 12.45m wide (ave. 4m) and drilled down to 100m along the vein dip. The Au grades range from 1.7 to 12.36ppm Au with an average of 5 ppm Au. V8 is characterized by 2 main vein stages and several sub-stages. The main vein stages are (1) an earlier polymictic hydrothermal breccia (dark in colour) and cut by (2) a milky quartz vein breccia (Photo 42). Consistently, the former is almost always at the hangingwall side while the latter is at the footwall side. The hydrothermal breccia is generally higher in grade (1.80-15.77ppm Au) and richer in basemetal sulphides (up to 8.57% Pb & 1.33% Zn) than the milky quartz vein breccia (1.07-11.70ppm Au, up to 1.25% Pb & 0.64% Zn). There are at least 6 sub-stages in the dark hydrothermal breccia (Photo 43) and 2 sub-stages in the milky quartz vein breccia. The hydrothermal breccia is basemetal sulphide-rich. Besides pyrite, honey yellow to brown sphalerite (Fe-poor), galena and trace chalcopyrite are ubiquitous. In the milky quartz vein breccia, the predominant sulphide is pyrite and minor sphalerite. Supergene oxidation has transformed most of the sulphides to Fe oxides up to the depths drilled.

It is most likely that the sulphide-rich hydrothermal breccia is a deeper higher temperature carbonate-basemetal-gold (or intermediate sulphidation) event while the milky quartz vein breccia is truly a low-sulphidation epithermal.

Although the best mineralized zone so far, V8 zone does not have enough resources to support mining. Additional resources have to be found. In terms of ranking, the >1km long SZ5 and <1km long SZ7 zones have the potential for additional ore. At trench T2 at SZ5 zone, limonitic hydrothermal breccia with milky quartz vein carrying sphalerite was noted. Au grades at T1 to T4 range from 0.25 to 1.5ppm Au. On the other hand, SZ7 zone is characterized by massive chalcedony vein cut by chalcedonic silica-altered hydrothermal breccia, an expression of the highest levels of an epithermal system. The fact that the trenches returned anomalous Au, ie. 70-250ppb, is a good indication that higher Au grades may be present at depth.

Photo 41. Northern end of SZ7 zone (chalcedonic silica fault vein with hydrothermal breccia) which probably a continuation of the Hizehjan fault found at the left side of the widespread argillic alteration seen the background. Hizehjan village is shown at the middle ground.

Photo 42. Silicified polymictic hydrothermal breccia (dark) cut by milky quartz vein breccia (white).

Photo 43. BH10-1 / 79.8-80.1m. Portion of hydrothermal breccia (dark variety) at 77.4-81.3m. Six sub-stages are observed - (1) grey quartz-chalcopyrite in argillic altered andesite clast (white) (2) milky quartz-pyrite veinlet cuts the quartz-chalcopyrite veinlet (3) hydrothermal breccia (dark) which includes the veined andesite (4) 2 parallel grey chalcedonic veinlets cuts the hydrothermal breccia (dark) (5) milky quartz-sulphide veinlet cuts again the hydrothermal breccia (dark) and lastly (6) limonitic fractures (after pyrite) cut both stages 4 & 5. The breccia contains angular clasts composed of argillic altered andesite and silicified clastics.

Another possibility is the presence of other mineralized zones near to V8 underneath the post-mineral Pliocene trachyandesite dome-flow complex. The presence of widespread silicified pre-mineral rocks at the western and northern fringe of the post-mineral cover is a good sign that alteration and possibly mineralization lies beneath the cover rocks.

The northern area (SZ1, SZ2-V7 and SZ3-SZ4-V6) is about 300m lower than those at V8, SZ5 and SZ7. Since there seems to be no fault along the Hizehjan river, it is possible that the former area exposes the lower zones of the hydrothermal system.

Discussion

The mineralization in the area is multi-staged and encompasses both intermediate- and low-sulphidation epithermal Au systems. So far, only V8 has been drill tested.

Next Steps

Further exploration by GSI Gold Project should continue. Besides the extension to the south of V8, the other vein/silicified zones should also be drill tested such as SZ5 and SZ7.

Pahnavar (A53FJ34)

Location & Access

The target area is located northwest of Ahmad Darasi village, about 48 kms northwest from Varzaghan town. It is within the 1:100,000 scale Siahrud sheet (Figs. 1 & 5).

From Ahar town, the area is accessible through 110 kms of asphalt roads to Kharvana town via Varzaghan town, and then 52 kms of the Kharvana-Pars Abad road. Travel time is approximately 2.5 hours by 4WD vehicle.

Deposit Model Type

According to the potential maps the area is a porphyry Cu target.

Geology

The area is underlain by andesitic volcanics. In the regional geology map, the area is underlain by altered Oligocene limestone which was not found.

Structure

There is no structure indicated in the regional geology map and Landsat image. In the field, there are NNW-trending faults related to the widespread silica-clay alteration.

Landsat TM Imagery

There is Landsat-indicated clay alteration in the area.

Alteration-Mineralization

There is widespread >1 km^2 NW-trending alteration along the asphalt road between Pahnavar and Ahmad Darasi villages (Photo 44) which occurs along the trend of the Karachuan porphyry Cu located at the other side of the Iran-Armenian border. The andesites are altered to variable silica-clay-limonite (after pyrite) alteration. One intra-mineral fault with appreciable kaolinite trending 340^o and dipping 70^o NE was noted. Near to Pahnavar village, there are rare 3 to 10 cm wide grey chalcedonic veinlets (Rock Sample No. 84.SAM.83) (Photo 45) and a silica-limonite altered fault trending 110^o (Rock Sample No. 84.SAM.84).

Photo 44. Large >1km^2 hematite-limonite bearing chalcedonic silica cap with minor argillization in andesites. Whitish zone on the left side is an kaolinite-bearing intra-mineral fault striking 340^o with 70^o NE dip.

Photo 45. Qxidized chalcedony veinlets, 3 to 8 cm wide, with <1% pyrite hosted in kaolinite-silica altered andesitic crystal tuff (Rock sample No. 84.SAM.83). Vein density of 2 veins/meter.

Discussion

Although some local chalcedony veinlets were observed in the widespread silica-clay-limonite alteration, no large feeder-type zones such as hydrothermal breccia or large areas of quartz/silica veining were found. Neither phyllic alteration was found which may imply porphyry Cu environment. It is believed that the alteration is purely structure-controlled with no attendant mineralization.

Next Steps

If no Au is returned by the two rock chip samples collected, no further work is recommended.

North Ahmad Darasi (A53FJ47)

Location & Access

The target area is located northwest of Ahmad Darasi village, about 51 kms northwest from Varzaghan town. It is within the 1:100,000 scale Siahrud sheet (Figs. 1 & 5).

From Ahar town, the area is accessible through 110 kms of asphalt roads to Kharvana town via Varzaghan town, and then 55 kms of the Kharvana-Pars Abad road. Travel time is approximately 2.5 hours by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu target.

Geology

The area is underlain by altered Oligocene? andesitic volcanics and intruded by Oligocene granite. In the regional geology map, altered Oligocene limestone is reported but was not found.

Structure

NE-trending Landsat lineament is indicated.

Landsat TM Imagery

There is Landsat-indicated clay alteration in the area.

Alteration-Mineralization

This is another widespread area of silica-clay-limonite (after pyrite) alteration along the asphalt road NW of Pahnavar (A53FJ34) which lies along the trend of the Karachuan porphyry Cu located at the other side of the Iran-Armenian border. The outcrop inspected along the asphalt road is argillic altered andesite carrying <1% disseminated pyrite and very rare 1mm wide milky quartz veinlet (Photo 46). No grey quartz veinlets of possible porphyry Cu affiliation were noted. Although there is still large area of alteration which was not looked at, I was informed that GSI (Ali Mohtari) had looked at this area in more detail and did not find any interesting mineralization.

Discussion

The alteration is widespread argillic alteration with neither significant quartz veinlet development nor hydrothermal breccias. Phyllic alteration is also absent. Similar to Pahnavar, the alteration is purely structure-controlled with no attendant mineralization.

Photo 46. Quartz-clay-<1% pyrite altered andesite with rare 1mm wide quartz veinlet.

Next Steps

No further work is recommended.

Ahmad Darazi (A53FJ36)

Location & Access

The target area is located at the vicinity of Ahmad Darasi village, about 45 kms northwest from Varzaghan town. It is within the 1:100,000 scale Siahrud sheet (Figs. 1 & 5).

From Ahar town, the area is accessible through 110 kms of asphalt roads to Kharvana town via Varzaghan town, then 50 kms of the Kharvana-Pars Abad road, and thence 1km dirt road to Ahmad Darasi village. Travel time is approximately 2.5 hours by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu and porphyry Cu-skarn target.

Geology

The area is underlain by Oligocene andesitic tuffs, siltstones and mudstones with minor 5-10m wide lenses of limestone intruded by Oligocene quartz monzonite.

Structure

In the regional geologic map, there are arcuate NW-trending faults. In the Landsat, there are NNE and NW-trending lineaments.

Landsat TM Imagery

There is no Landsat-indicated clay alteration. NW and SE of the area, there are huge Landsat clay zones present.

Alteration-Mineralization

The tuffs and clastics within 2 kilometers from their contact with the monzonite are altered to weak argillic-limonite (after pyrite) and propylitic (chlorite-epidote-carbonate) while the limestone lenses are altered to marble, epidote-calcite±pyrite skarn and garnet-calcite±specularite skarn (Photo 47). No Cu skarns were formed.

Discussion

The hydrothermal system generated by the intrusive is probably too dry, i.e. lacks hydrothermal solution rich with metals, to create Cu skarns. Only pyrite and/or specularite are present in the skarns. Also there are no large limestone bodies in the area which may better host rocks for extensive skarns.

Photo 47. Bedded calcareous rocks of Oligocene age altered to epidote and garnet skarns. Mountain at background is the Oligocene quartz monzonite batholith.

Next Steps

No further work is recommended.

Anikh (A52FJ51)

Location & Access

The target area is located at the vicinity of Anikh and Arachilar villages, about 45 kms northwest of Kaleybar town. It is within the 1:100,000 scale Siahrud sheet (Figs. 1 & 5).

From Ahar town, the area is accessible through 80 kms along the Ahar-Kaleybar-Kharvana asphalt road and then 50 kms of the unpaved roads to Anikh village via Avant village. Travel time is approximately 2 hours by 4WD vehicle.

Deposit Model Type

According to the potential maps, the area is a porphyry Cu target.

Geology

The area is underlain by Oligocene granite/hornblende biotite granodiorite batholith intruded by hornblende quartz diorite dykes and stocks.

Structure

There is a large NNE to N-S fault zone to the east of the area. NW, N-S and NE trending Landsat lineaments are indicated. In the field, the mineralized veins trend E-W and N-S.

Landsat TM Imagery

Although the area is near to large Landsat-indicated clay alteration within the batholith complex to the SE and NW, there is no alteration detected in the area visited.

Alteration-Mineralization

The mineralization in the area is mesothermal Cu±Mo vein type hosted in both granodiorite and quartz diorite. There are two sub-types. The first one is dark grey chalcedonic silica veins carrying disseminated and stringers of pyrite and malachite/neotocite stains (after chalcopyrite) were found to the south (Photo 48).

Photo 48. 2m wide malachite and neotocite-stained grey silica vein containing 3% pyrite disseminations (most changed to limonite). Vein trend is 280^o with 40^o N dip. The granodiorite wallrock is altered to quartz-clay±sericite-limonite for up to 2m from the vein. (Rock Sample No. 84.SAM.90).

The second sub-type is milky crystalline quartz vein carrying pyrite, chalcopyrite (and malachite) and minor molybdenite (Photo 49). The observed vein widths are 0.4 to 2m with strike lengths of several meters to tens of meters. The first sub-type trend E-W with steep to moderate dips while the second sub-type trends N-S.

Alteration around the veins is non-existent to narrow. Alteration is either argillic-limonite or chlorite±epidote alteration. The intrusives are relatively fresh to very weakly chloritic.

Discussion

The quartz-sulphide veins in the area are mesothermal base metal veins. Since they are widely spaced and narrow, mining them is not economic. There has been allusion that since they carry chalcopyrite and molybdenite, that a porphyry Cu-Mo system is nearby. This is doubtful as the intrusives are very fresh with almost no alteration related to porphyry Cu such as potassic, phyllic and propylitic alteration. The intrusives are also equigranular, that is non-porphyritic, which indicate stable deep crystallization.

Photo 49. 40cm wide milky quartz vein carrying chalcopyrite and pyrite (almost completely changed to limonite) and minor molybdenite in biotite quartz diorite ((Rock Sample No. 84.SAM.91). Vein trend is N-S with 85^{o} W dip.

Next Steps

No further work is recommended.

CONCLUSIONS

1. Geomatic modeling using mineral deposit types is a powerful tool in mineral exploration. However, inherent problems in the various data layers inhibit the maximum potential of the modeling. The most problematic layers are the regional geology and geochemical data. One important data layer that was not utilized in the modeling was the mineral occurrence (or indices) map. The incorporation of the mineral occurrence map is a good empirical way to balance the imperfections of the geochemical layer.

2. Prudence should be exercised on which mineral deposit types are relevant in an area based on the known geological / metallogenic setting and probability of these occurring in the area. The appropriate models to be used at the Ahar-Arasbaran Zone are porphyry Cu, Cu and Pb-Zn skarns, mesothermal Au (low-sulphide gold-quartz veins in batholiths), intermediate sulphidation epithermal (Creede-type), high-sulphidation epithermal (quartz-alunite & volcanic-hosted Cu-As-Sb) and an undefined “arc-related” low-sulphidation epithermal (Corbett, 2002). It is within the realms of possibility that alkalic-type low-sulphidation epithermal (Au-Ag-Te vein type), polymetallic Ag-Pb-Zn replacement, polymetallic Ag-Pb-Zn veins and Hg-Sb models may exist. After examining the regional geology maps and discussions with A. Moosavi and M. Heydari, it was concluded that there are only three applicable deposit model types present in the

four sheets visited. These are - (1) porphyry Cu (general), (2) Cu skarn and (3) epithermal Au.

3. This field evaluation phase is best considered to be the start of further refining the potential maps for Ahar-Arasbaran Zone in order to increase the maps' ability to predict correctly the appropriate deposit types and find more and better prospective areas.

4. The potential maps have created >100 targets of which only twenty-five (25) were evaluated in the field on the basis of having as many model deposit types assessed, deemed higher prospectivity than others, and time/logistical constraints. It is clear that more targets should be evaluated after this first round of evaluation.

5. Pending the receipt of the analytical results of the rock samples collected, a full evaluation of the targets visited can be undertaken. In the meantime, all that can be said is that the high-level epithermal Au targets at Sarghein, Ghalandar, Zaylik and Babajan are the best targets found. This is besides the current mines and those already recognized and being worked on by GSI Gold Project. These are (1) porphyry Cu at Sungun Copper mine, (2) Cu skarn at Mazraeh Copper mine and Sungun skarn, (3) epithermal Au at Sharaf Abad, and (4) mesothermal Au at Nibijan. The possible skarn at South Kordlar, and epithermal/porphyry Cu at Keighal are interesting but depends a lot on encouraging analytical results.

RECOMMENDATION

It is recommended that with the results of this field evaluation, the prospectivity models can be re-run again by GSI Geomatics Division to generate better targets.

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