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IP/RS Survey Workshop in Muteh Gold Mine

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Location

Muteh gold complex is located 295 km southwest of Tehran and 7 km northwest of Mute village, Isfahan province. This mine product about 300 kg pure gold bullion annually.

Geology

Muteh gold mine is located in the central part of the Sanandaj-Sirjan Metamorphic Zone. Geological units in this area include: Precambrian (green schist facies), hornfels, mineralized veins and granite intrusions. Mineralization is corresponding to faults in this region. Gold mineralization has a high correlation with pyrite.

Applied Geoelectric Training Course

Geoelectrical Training course organized in collaboration with Iranian Mines & Mining Industries Development & Renovation (IMIDRO), PTB Company (Iran) and GDD Company (Canada) in Muteh Gold Mine in October 2018. This course consisted two sections: Theory and field Operational sections.

Theory section: In this section, principle of geoelectric methods, arrays and key points related to geoelectrical investigation with GDD instruments were discussed. Finally, IP-POST PROCESS software was introduced and using some case study was shown how this software help to user to upgrade data quality. **Field Operational section:** In Muteh mine pit, one profile design to determine mineralized vines. This profile performed whit pole-dipole array and it have about 50m length and 5m electrode spacing. Data was collected using TXII transmitter and GRx10 receiver.

Figure 1. Theory and Field Operational Training course in Muteh Gold Mine

Figure 2. Theory Training course in Muteh Gold Mine

After data acquisition, data processed using Res2Dinv software. For one station decay curve ploted in figure 3 that show good data quality. According to the results, a fault zone was identified at 25 meters distance from the beginning of the profile. High chargeability in this zone can also confirm the existence of a sulfide vine (pyrite). Also chargeability background along this profile is medium-high which is due to the presence of pyrite in the metamorphic unit (green schist) (figure3). High chargeable zone had a good correlation whit gold grade base on geological maps and chemical analysis of borehole samples.

In order to identifying good geophysical methods to perform detail geophysical investigation in Muteh mine, 2 samples picked from the pit. Sample 1# and sample 2# picked up from non-mineralized and mineralized zones respectively. Samples sent to Canada for physical property investigation studies.

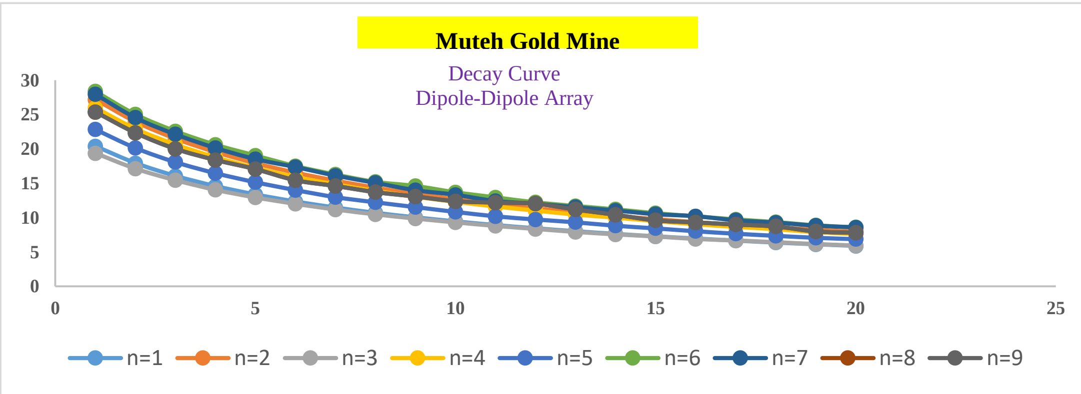


Figure 3. Decay curve diagram that show data quality

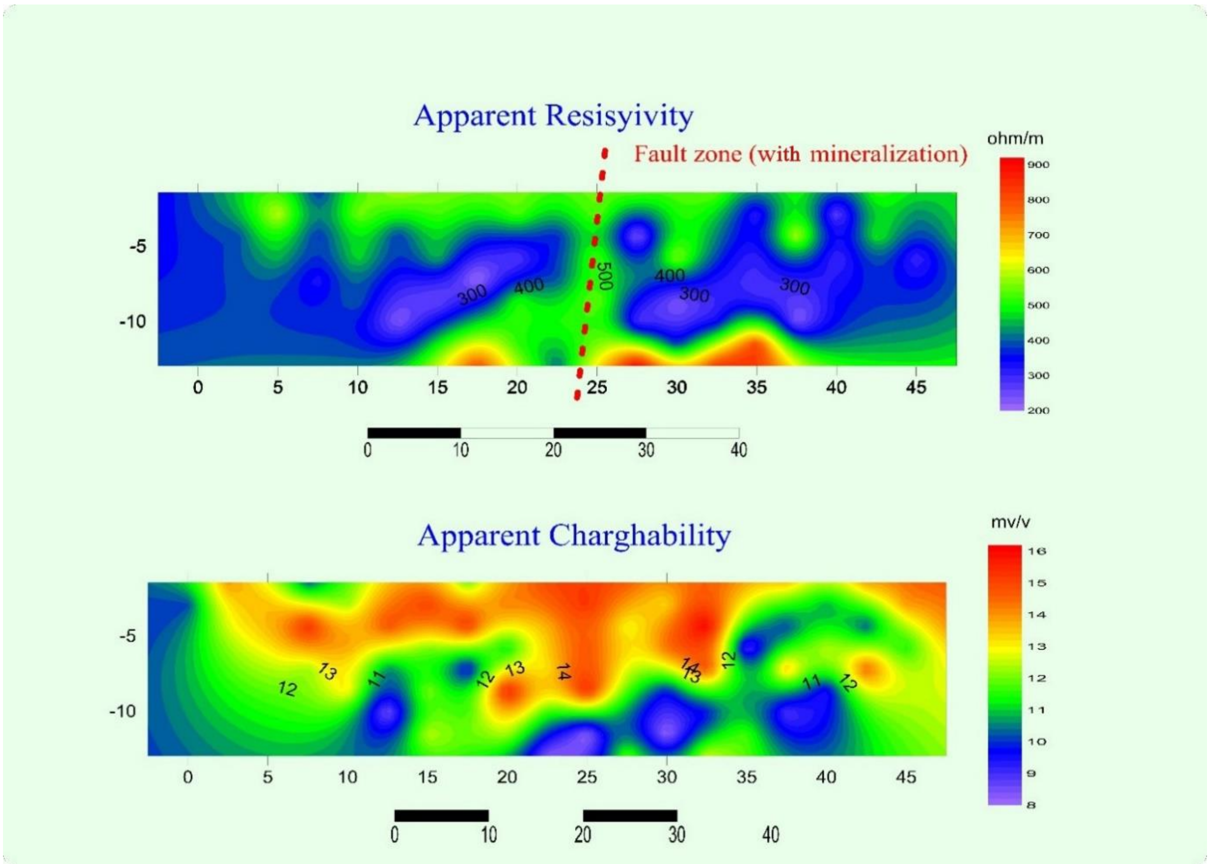


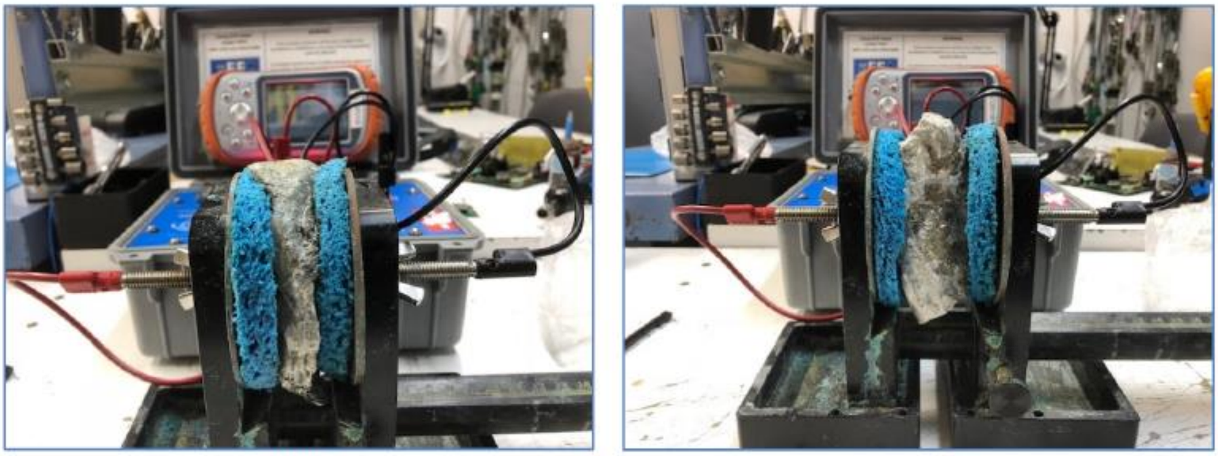
Figure 4. Apparent Resistivity and Chargeability Section

Also after geoelectric surveys, it was found that the vein length obtained from geological studies (red line in Fig. 5) is along the blue line that was obtained from the IP survey and Geological information is completely compatible with the information obtained from the IP method.

**Figure 5. The result of IP survey (blue line)
is compatible with the result of geological studies (red line)**

Physical property investigation

GDD has performed physical property measurements on two rocks samples. The SCIP Tester and the MPP Probe were used to define their geophysical properties.



Sample #1 Sample #2

Figure 6. **Samples picked from the pit**

SCIP measurements

The Sample Core IP Tester (SCIP) manufactured by Instrumentation GDD Inc. is an innovative way to measure the electrical properties of drill cores, samples and outcrops. The SCIP is a portable, reliable, battery operated instrument for evaluating the resistive properties and IP response of your cores. With this instrument, you get the information that a geophysicist needs to design an appropriate geophysical survey. In other words, you can validate if a Resistivity/IP survey would be suitable to detect the targeted rocks. The SCIP will also help you to better define IP inversions. Table 1 show SCIP result for 2 rock samples.

Table 1. SCIP result for sample #1

Mode	CoreID	I (mm)	S (mm²)	Contact (kOhm)	Rho (Ohm*m)	M (mv/v)	I (µA)	Vp (mv)
3V	#1	20	5000	13.966	3563.968	12.786	196.18	2796.75
6V	#1	20	5000	13.609	3456.004	12.358	402.36	5562.24
9V	#1	20	5000	13.241	3351.966	11.852	621.86	8337.78
12V	#1	20	5000	12.92	3251.841	11.431	852.17	11084.5
0.5µA	#1	20	5000	12.536	3212.462	13.092	0.493	6.338
5µA	#1	20	5000	12.278	3180.272	13.38	4.968	63.197
50µA	#1	20	5000	12.031	3097.983	13.293	50.121	621.096
500µA	#1	20	5000	11.765	2968.712	12.082	500.48	5943.1
Average				12.8	3260	12.5		

Table 2. SCIP result for sample #2

Mode	CoreID	I (mm)	S (mm²)	Contact (kOhm)	Rho (Ohm*m)	M (mv/v)	I (µA)	Vp (mv)
0.5µA	#2	30	6400	154.199	36416.629	38.442	0.496	84.711
5µA	#2	30	6400	153.597	36185.568	39.778	4.977	844.143
50µA	#2	30	6400	151.927	33037.932	35.735	49.272	7632.12
500µA	#2	30	6400	149.208	31080.345	32.426	90.073	13122.6
3V	#2	30	6400	145.586	33595.136	37.918	18.901	2976.43
6V	#2	30	6400	145.982	32372.199	36.826	39.06	5927.07
9V	#2	30	6400	144.256	30955.437	35.022	61.341	8900.84
12V	#2	30	6400	142.008	29900.062	33.39	84.588	11855.5
Average				148.3	32943	36.2		

The SCIP serial number 2018 was used for these measurements. The measurements were taken with a 2 seconds time base in arithmetic windows. Each reading was repeated in current and voltage mode. The average chargeability is 12.5 mV/V for sample #1 and 36.2 mV/V for sample #2. The resistivity of sample #1 decreases from 3564 Ohm.m to 2969 Ohm.m. This is caused by the copper sulfate migrating slowly in the sample, which gives a better contact. Its average resistivity is 3260 Ohm.m. The sample #2 reacts the same way as sample #1 with the migration of copper sulfate. The resistivity decreases from 36417 Ohm.m to 29900 Ohm.m for an average of 32943 Ohm.m. We note that sample #1 is less resistive than sample #2 by a factor of 10 (3260 Ohm.m versus 32943 Ohm.m). Sample #1 is less chargeable than sample #2 by a factor of 3 (12.5 mV/V versus 36.2 mV/V).

A Resistivity/IP survey would likely be useful to define different lithologies out of the resistivity contrasts. An IP survey should be appropriate to detect/discriminate this type of mineralization.

MPP measurements

The MPP probe measures the magnetic susceptibility (10^{-3}SI) as well as the relative and absolute EM conductivity (Mho/m) values of small and large objects such as drill cores, samples, outcrops, etc.

With the MPP probe, you can get the information that you need to design an appropriate geophysical survey. In addition, it allows to establish a correlation between your samples and a future EM/MAG survey. The MPP probe will also help you to better define modelled EM plates and MAG inversions.

MPP Results

Sample #1 (Scpt: 0.001 SI) Sample #2 (Scpt: 0.001 SI Table 3. MPP results – Sample #1 and #2 both samples have no EM conductivity response. It would thus be very difficult to detect this type of rock from a ground or airborne EM survey. Samples show very weak magnetic signature.

They are 0.35 10_{-3}SI for sample #1 and 0.24 10_{-3}SI for sample #2. There is therefore limited chance that a total field magnetic survey detects these types of rock. A significant volume of these rocks and a good susceptibility contrast with the surrounding lithology would be required.

Note	Core ID	Date	Position	u	Diameter	HF-Response	Scpt	Cond:Mhose/m
Left	#1	31/10/2018	0	m	Wall	0	0.34	0.0
Left	#1	31/10/2019	0		Wall	0	0.35	0.0
Center	#1	31/10/2020	0	m	Wall	0	0.07	0.0
Center	#1	31/10/2021	0		Wall	0	0.05	0.0
Right	#1	31/10/2022	0	m	Wall	0	0.15	0.0
Right	#1	31/10/2023	0		Wall	0	0.17	0.0
Up	#2	31/10/2024	0	m	Wall	0	0.08	0.0
Up	#2	31/10/2025	0		Wall	0	0.09	0.0
Center	#2	31/10/2026	0	m	Wall	0	0.24	0.0
Center	#2	31/10/2027	0		Wall	0	0.21	0.0
Down	#2	31/10/2028	0	m	Wall	0	0.18	0.0
Down	#2	31/10/2029	0	m	Wall	0	0.19	0.0

CONCLUSION

The EM conductivity of these samples is not present and their magnetic susceptibility is very weak. From an EM and MAG perspective, the mineralization is not conductive nor magnetic enough to be detectable from EM and MAG surveys. These are thus not recommended to detect and delineate this type of mineralization. The SCIP Tester uses the same technology than a Resistivity/IP survey. The contrast of apparent resistivity and chargeability seems to be large enough to allow significant discrimination. A

Resistivity/IP survey should be appropriate to detect and delineate this type of mineralization.

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