USEFULNESS OF PHYSICAL ROCK PROPERTIES MEASUREMENTS TO VALIDATE WHETHER OR NOT IP ANOMALIES ARE EXPLAINED BY DRILLING RESULTS

(CASE STUDY: ASHUANIPI PROJECT, CANADA)

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Summary
This case study presents how physical rock properties measurements can be used to validate drilling results and further defined if the targeted surface IP anomaly can be explained.

During their 2013 drilling campaign, Mines Virginia (now Osisko Redevances Aurifères) targeted the depth extent of surface IP anomaly PP-7, coincident to a Cu-Zn-Au-Ag showing. Physical rock properties measurements were carried out on the fresh core i.e. electrical resistivity and chargeability, magnetic susceptibility and EM conductivity. Results were compared and allowed validating that enough chargeable material was intersected to explain the surface anomaly.

Introduction
The Ashuanipi property (Canada), owned by Osisko Gold Royalties (previously Virginia Mines), lies in the geological province of the Superior and is characterized by the presence of large, well-preserved volcano-sedimentary sequences and by the lower grade metamorphic facies (amphibolite).

Limited reconnaissance programs carried out between 2007 and 2011 guided by airborne EM survey results (VTEM, 2008) have identified several significant showings forming a major mineralized trend that extends for more than 8km on the south block of claims. Among all showings, a few were associated to Cu-Zn-Au-Ag disseminated to semi-massive sulfides (pyrrhotite-pyrite ±sphalerite ±chalcopyrite ±galena) developed in volcanic units. They returned interesting values up to 6.29 g/t Au, 3.92% Cu, 8.94% Zn and 14.30 g/t Ag in selected grab samples.

Surface Resistivity \ IP survey
In 2012, a surface IP survey was carried out over the property to detect anomalies likely associated to the known Cu-Zn-Au-Ag showings.

The survey was carried out by Geosig Inc. using GDD's 5000W IP Transmitter model Tx II and IP Receiver model GRx8-32. A Pole-Dipole configuration (a=50m and n=1-8) was chosen to optimize the detection of large and rooted polarizable and conductive sources.

The Resistivity \ IP survey detected a dozen anomalies including one (PP-7) corresponding to the Eagle Showing (8.94% Zn and 0.57% Cu) and characterized by a strong chargeability (15-24 msec) and a drop of apparent resistivity (750-1700 Ω·m). Refer to figure 1.

2D Inversion and drilling target
To better delineate IP anomaly PP-7 and consequently generate a more reliable drill target, the Resistivity \ IP results were inverted. A 2D unconstrained inversion was performed using DCIP2D developed by UBC\GIF. Results are shown at figure 2.

The inversion has generated a chargeable and conductive geological feature which can be associated to the Eagle showing. The IP anomaly appears to be sub-cropping (buried depth of ~25m) with a depth extent exceeding 200m. Its conductivity seems to rise at depth. The inversion results associated to PP-7 can be divided into two sub-anomalies: (A) a smaller one, less chargeable associated to a subtle drop of resistivity and (B) a bigger one, more chargeable and rather conductive.

During the 2013 drilling program, one hole was planned over anomaly PP-7. Drillhole AH-13-006 aimed directly under the surface showing, at a depth of 120m. At this location, the IP anomaly is chargeable and conductive, increasing chances of intersecting semi-massive to massive sulfides associated to Cu-Zn-Au-Ag mineralization.

Physical Rock Properties Measurements
In order to validate whether targeted surface IP anomalies were explained or not from the 2013 drilling campaign, physical rock properties were systematically collected over the fresh core. Resistivity (Ω-m) and

chargeability (mV/V) measurements were carried out using the GDD SCIP Tester whilst magnetic susceptibility ($x10^{-3}$ SI) and EM conductivity (S/m) were collected using the MPP probe (Instrumentation GDD).

Table 1 presents the physical rock properties results along with the geological logs. For SCIP readings, a piece of core of 10cm long was probed and the corresponding center point location is noted in the "location" column. The "local mineralization" refers to the description of that piece of core. The values collected reflect the properties of the whole 10cm long segment. The MPP readings on the other hand are punctual readings taken at the center point.

Results

The shallowest and weaker IP anomaly (figure 2 (anomaly A)) can be explained by the following two intersections:

The first one corresponds to the chargeability value of 17.85 mV/V collected at 52.6m. It consists in a mafic volcanic unit of 13.3m thick (from 43.9 to 57.2m) of 1% pyrite and 1% pyrrhotite over the whole unit (10-15% pyrrhotite locally over decimetre scale patch). The second one is a very chargeable intersection (reaching 682mV/V) of 10.2m thick from 61.3 to 71.5m. MPP conductivity readings collected on this interval at 68.1 and 70.4m returned values of 352 and 1079 S/m.

Note the very low apparent resistivity value (1 Ω·m) collected at 68.1m (from 63.1m to 73.1m). The intersect consists in centimetre to decimetre scale mineralized zone characterized by 20% pyrrhotite and 5% pyrite and traces of chalcopyrite that occurs in millimetric stringers. These zones are observed locally and represent 10% of the whole unit. The core was also probed at 56m and 65m yielding conductive values of 28 and 68 S/m respectively.

The larger and more conductive portion of anomaly PP-7 was expected around 110-180m in the hole (figure 2 (anomaly B)). The mineralisation at 172.8m yielded a very strong IP response and corresponds well with the IP target (mineralized zone on 35cm at 172.7m characterized by a decimeter scale quartz injection with 7% pyrrhotite, 1-2% pyrite and traces of chalcopyrite. In addition, the core at 107.0 and 123.4m (very local mineralisation) has also yielded strong IP readings.

According to the latter results, there is no doubt that drillhole AH-13-006 has explained the targeted surface IP anomaly, delineated with 2D inversion. Anomaly PP-7 characterized by a chargeability of 15-24 msec can be explained by multiple chargeable sources, ranging from 18 to 682 mV/V (with the SCIP Tester).

Discussion

The background SCIP chargeability values over AH-13-006's core ranged from 3.0 to 8.8 mV/V for rocks containing no sulfides to traces of sulfides. However, the study showed that with 2% to 3% of sulfides content, the chargeability of the core increases significantly. The volume (thickness) of mineralized rock is then key to validating corresponding surface IP anomalies.

Of course, for a given geological unit, these physical properties should be considered as qualitative and specific to this exploration project. Resistivity and chargeability values are influenced not only by the sulfides content but also by chemical composition, porosity, rock fractures, electrolyte saturation, etc.

A few mineralized zones (68.1m, 70.4m & 172.8m) within hole H-13-006 yielded an EM response at the core scale, respectively 352, 1079 & 3 S/m (MPP probe). They correspond very well with the location of the VTEM anomaly (figure 2) and most-likely explain this EM anomaly. Consequently, a borehole EM survey would be an appropriate way to further delineate and drill-test these conductive intersections, if considered promising.

The methodology presented here is also useful in the event that physical rock properties measurements do not match the targeted surface / airborne survey results. In which case, the targeted anomalies are not explained and further exploration work is needed (re-assessment of data, more drilling, etc.).

Furthermore, collecting physical rock properties on outcrops at the early stage of an exploration program will provide a clear picture of the geophysical signature of the geological target and its surrounding.

References

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Acknowledgements

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Figure 1: Surface IP pseudo-sections over survey line 8+00E (Ashuanipi, Canada)

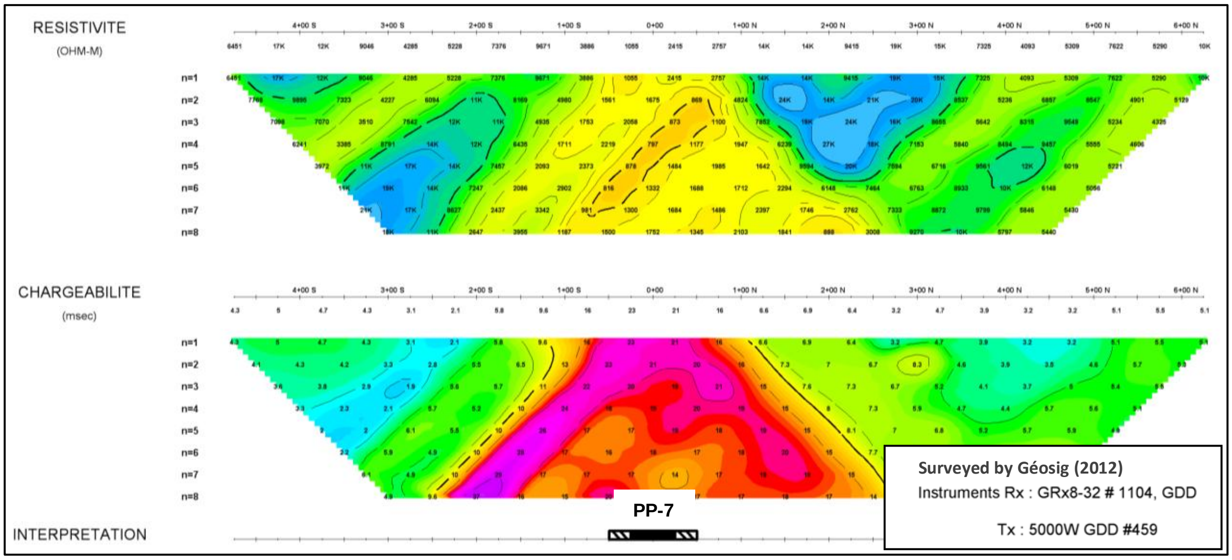

Figure 2: Result of 2D inversion over line 8+00E (Ashuanipi, Canada)

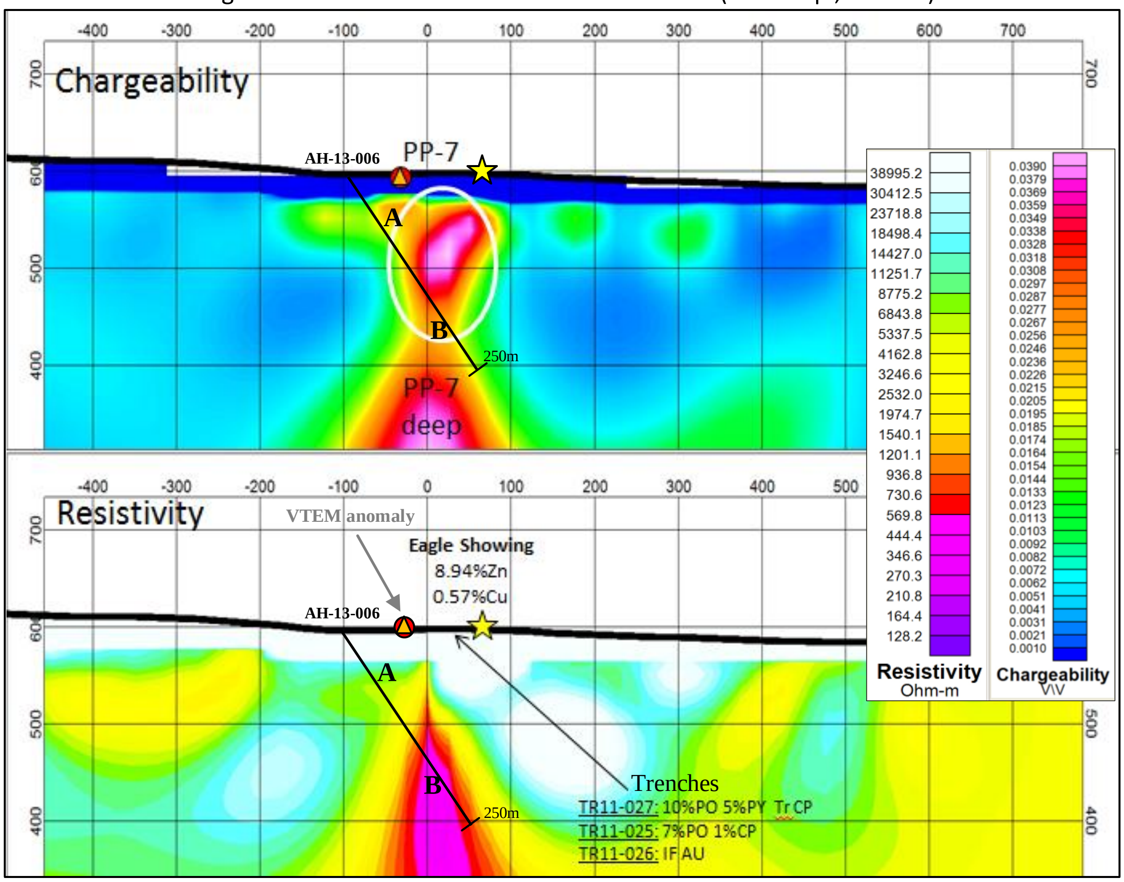

Table 1: Physical rock properties collected on AH-13-006's core (Ashuanipi, Canada)

			SCIP Tester		MPP probe		
Location (m)	Rock type	Local mineralization	Apparent Resistivity (Ω·m)	Chargeability (mV/V)[1]	Magnetic Susceptibility (10^{-3} SI)	Conductivity (S/m)	Notes
8.3	Tonalitic orthogneiss	Trace pyrrhotite	10,462	7.16	3.64	0	
19.9	Tonalitic orthogneiss	Trace pyrite	21,202	6.99	0.32	0	
38.4	Mafic Volcanic	No sulfide	24,546	7.26	0.45	0	
42.6	Tonalitic orthogneiss	Trace pyrite	34,158	5.66	0.00	0	
52.6	Mafic Volcanic	**3-4% pyrite (disseminated and in veins)**	29,660	**17.85**	0.55	0	PP-7 Anomaly A
60.5	Tonalitic orthogneiss	Trace pyrite	44,374	6.49	0.27	0	
68.1	Mafic Volcanic	**Semi-massive sulfides (35-40% pyrrhotite, trace pyrite and chalcopyrite)**	**1**	**682.74**	20.50	**352**	PP-7 Anomaly A
70.4	Highly silicified volcanic	**10-15% pyrrhotite and pyrite in veins (remobilized)**	20,343	**23.58**	47.20	**1079**	PP-7 Anomaly A
78.8	Mafic Volcanic	Trace pyrite	35,499	8.53	2.02	0	
86.5	Mafic Volcanic	Trace pyrite	30,440	10.82	3.29	0	
102.5	Mafic Volcanic	No sulfide	19,016	2.99	0.35	0	
107.0	Tonalitic orthogneiss	**2-3% pyrrhotite and pyrite (disseminated and in veins)**	16,535	**21.94**	4.78	0	PP-7 Anomaly B
123.4	Mafic Volcanic	**15-20% pyrrhotite and pyrite in veins**	4,117	**32.63**	0.42	0	PP-7 Anomaly B
133.7	Mafic Volcanic	Trace pyrite and pyrrhotite	33,951	8.77	0.00	0	
141.6	Highly silicified intrusive gneiss	No sulfide	19,949	6.31	0.32	0	
160.4	Tonalitic orthogneiss	Trace pyrite and pyrrhotite	16,963	6.54	0.17	0	
172.8	Tonalitic orthogneiss	**5% pyrite and pyrrhotite (disseminated and patchy), Trace of chalcopyrite**	8,827	**63.35**	0.22	**3**	PP-7 Anomaly B
182.3	Pegmatite	No sulfide	44,337	3.87	0.45	0	
193.6	Dioritic gneiss	Trace-1% pyrite	11,106	8.18	0.75	0	
205.4	Pegmatite	No sulfide	17,211	7.51	9.73	0	
215.2	Tonalitic orthogneiss	Weak Trace pyrite	21,193	7.67	0.40	0	

[1] Note that both "mV/V" (from the SCIP readings) and "msec" (from the surface IP survey) are equivalent chargeability units.