GEOPHYSICAL INVESTIGATION FOR COPPER-SULPHIDE ORE AT DHUSA, NEPAL

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सारांश

भू-रासायनिक सर्वेक्षण विधिका विभिन्न चरणद्वारा रेखांकित विसंगति क्षेत्रमा (Anomalous zone) गरिएको भू-भौतिक विधिका स्वमित (Self potential) अभिप्रेरित ध्रुवीकरण (Induced polarisation) र चुम्बकीय सर्वेक्षणका नतिजाहरू र भू-रासायनिक नतिजाहरू वीच राम्रो सहवद्धता भएको पाइयो। यद्यपी स्वगर्भित तथा अभिप्रेरित ध्रुवीकरण सर्वेक्षण विधिबाट कम गहिराई सम्म मात्र अनुसन्धान गरिएको थियो, तथापी स्वगर्भित रेखाचित्रको गुणात्मक विश्लेषणवाट दुईवटा अंशहरूको उपस्थिति प्रष्ट देखन सकियो। यी दुवै सर्वेक्षणको संयुक्त नतिजाको अध्ययनबाट ३० मिटर गहिराईसम्म ऋतुक्षरित (Weathered) भएको ध्रुविकृत पिण्डको (Polarised body) उपस्थिति ठम्याउन सकिएको छ। चुम्वकीय सर्वेक्षण विधिबाट भने कुनै सारगर्भित नतिजा देखा परेन।

भू-भौतिक तथा भू-रासायनिक विसंगतिद्वारा इंगित गरिएको क्षेत्रमा खनिएको तीन नलकुपहरूले चाल्कोपाइराइट, चाल्कोसाइट र पाइराइट भएको खनिज पिण्डलाई छेडेका छन्। पिण्डको ३८ मिटर मोटाई भएको खण्डमा औसत ०·१७ प्रतिशत तामा भएको पाइयो। त्यसपछि तीन मध्ये एक नलकुप हुदै तानिएको रेखाको दश ठाउँमा गरिएको अभिप्रेरित ध्रुवीकरण तथा विद्युत प्रतिरोध (Electrical resistivity) विधिले गरेको गहिराई मापनबाट डिप (Dip) दिशाको थप गहिराईमा अझ राम्रो स्तरको खनिज फेला पर्ने सम्भावना देखिएको छ। खनिज पिण्डहरू नेत्राकार रूपमा पाइने अनुमान गरिएको छ।

ABSTRACT

Self Potential, Induced Polarisation and Magnetic Surveys conducted in an anomalous zone delineated by preliminary to advanced stages of geochemical exeploration showed good correlation with the geochemical anomaly. SP and IP survey conducted have a very limited depth of investigation. Qualitative interpretation of SP curves clearly indicated the existance of two faults, whereas combined results of SP and IP showed weathered and "deep-seated" (30m) polarizable body. The magnetic survey did not give any significant result.

Three bore holes drilled in the best geophysical, geochemical anomaly zone intersected mineralization of chalcopyrite, chalcocite and pyrite with an average grade of 0.17% Cu over 38m true thickness. The post drilling IP and resistivity sounding conducted at 10 points along a line passing through one of the drill holes indicated the possibility of better mineralization further down dip. The mineralization is expected to be present in the form of lenses.

INTRODUCTION

The Dhusa Cu-prospect situated (90km) south west of Kathmandu (Fig.1) was indentified by reconnaissance stream sediment survey and was followed-up by detailed geochemical and geological investigation. Geophysical induced polarization, self potential and magnetic surveys were carried out to delineate the bed rock source of the geochemical anomaly zone. Three bore holes were put in the best anomaly zone. Further geophysical investigation was done by conducting IP sounding along the drill section.

GEOLOGY

The prospect area lies just north of the Mahabharat thrust fault which separates the high grade Kathmandu Group (Precambrian) rocks to south from the low grade Nuwakot Group (late Precambrian to late Paleozoic) rocks to north. The area lies on the northern limb of the Mahabharat Synclinorium close to the nose. The Nuwakot Complex consists of pelitic, psammitic and carbonatic metasediment rarely exceeding the sericite-chlorite grade. The Kathmandu Complex comprises a bedded sequence of metasediments and crystalline rocks (granites and migmatites). The metasedimentary sequence consists of high to low grade schists, quartzite and carbonate rocks. The rocks in the prospect area consist of talcosic chlorite schist, quartz/dolomite breccia, graphitic slate, dolomite and quartzite, with a regional N 45^{o} strike and 70^{o} southerly dip. Two cross faults are present in the area (Tamrakar, 1977). Mineralization consists mainly of chalcopyrite associated with pyrite and occurs as dissemination in quartz/dolomite breccia.

GEOPHYSICAL SURVEY

IP,SP and Magnetic surveys were carried out along 16 lines at 40m interval covering the geochemical anomaly zone in Dhusa.

Pole-Dipole profiling was done (forward and reverse direction). The spacing between the "active" current electrodes (the current suite being stationary in a remote place) and each of the potential electrodes was 10m over the whole survey area. The depth of IP investigation was thus very limited($\leqslant$10m). The total profile length was 3670m.

A compilation plan of geogical, geochemical and geophysical results (IP and SP) is presented in Fig. 1. No separate SP survey was conducted but the readings were obtained as a byproduct during IP measurements. The observed SP gradient values were added along each survey line with zero at the north-western end. No attempt was made to relate all SP values to a common datum and so the cummulated values could not be contoured and only gradient SP contour map is presented (Fig. 2).

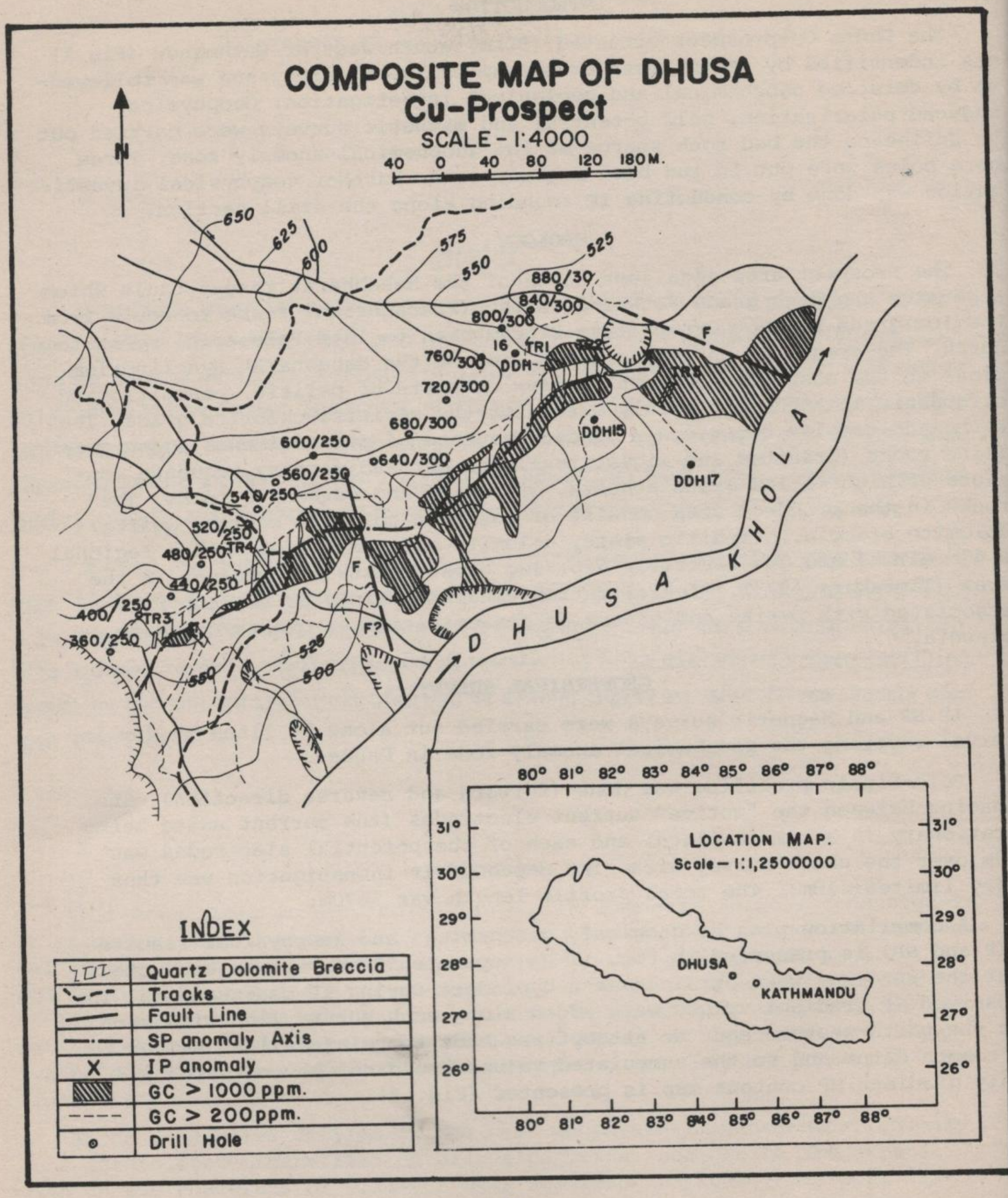
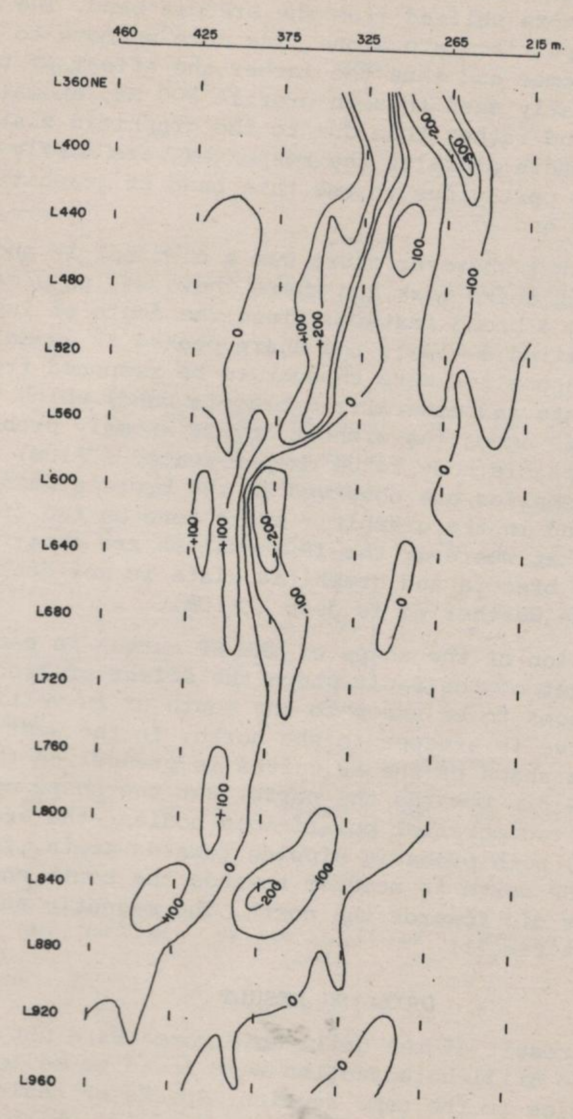

COMPOSITE MAP OF DHUSA
Cu-Prospect
SCALE - 1:4000
40 0 40 80 120 180 M.
N
DHUSA KHOLA
INDEX
Quartz Dolomite Breccia
Tracks
Fault Line
SP anomaly Axis
IP anomaly
GC > 1000 ppm.
GC > 200 ppm.
Drill Hole
LOCATION MAP.
Scale - 1:1,2500000
DHUSA
KATHMANDU

Fig-1

SP GRADIENT CONTOUR MAP OF DHUSA



Fig—2

IP and SP RESULTS INTERPRETATION

SP anomalies could be observed in all the profiles whereas IP anomalies were present only in some. In the profiles west of the postulated fault (which crosses the line 560 NE), the peaks of the SP anomalies were shifted quite a lot (up to 25m) to the south of the centre of the zone of quartz/ dolomite breccia band whereas in profiles to the east, the peaks of the anomalies coincided with the breccia band. The SP anomaly peak in the western most profile is more shifted from the breccia band. The anomaly might be largely due to graphitic slate alone. The more we move to the east the wider the anomaly becomes and thus the larger the effect of the breccia band. It could be clearly seen that in profile 500 NE, anomaly is largely due to the breccia band rather than due to the graphitic slate; on the other hand in the eastern profiles the responses were mostly due to the breccia band and only partly due to the thin band of graphitic slate that exists there (Figs. 3 and 4).

It was observed that wherever there was a distinct IP anomaly, the SP anomaly had a distinct sharp peak and where there was no clear IP anomaly the SP anomaly showed a broad feature. Since the depth of investgation of the IP survey was limited ($<$10m), the sharp peaked SP anomalies accompanied by distinct IP anomalies were thought to be responed from polarizable bodies (graphitic slate and mineralized breccia band) which were shallow ($<$10m). The broad SP anomalies without any IP anomaly probably indicate the responding polarizable body to be deeper seated ($>$10m) or alternatively since the IP anomalies are observed in the breccia band on line 800 NE, 840 NE, 880 NE and in the graphitic slate zone on two lines only, it could be concluded that wherever the IP anomalies are observed the weathering of the zones of breccia and graphitic slate is not deep ($<$10m) and in other profiles the weathering is deep ($>$10m).

A close observation of the shape of the SP curves in each profile shows that in the east of the fault where the effect of breccia band is prominent the dip seems to be steep to the south or is vertical because the shape of the curve is steeper to the north. In the west the dip is doubtful because the shape of the SP curves is steeper on the southern side which indicates dip towards the north. But the shape of the SP curve is here affected by two parallel polarizable bodies, the breccia band and the graphitic slate, both probably dipping towards south, in such a way that the composite SP curve is steeper towards the south and thus erroneously indicating the dip towards the north. The magnetic survey did not give any significant result.

DRILLING RESULT

The analytical result of the drill hole cores were not encouraging. The Cu-values in the drill hole section were found to be lower than that in the channel samples in the same section. Specks of chalcocite were seen between 29m and 37m (inclined depth) in the dolomite which overlies the graphitic slate in DDH-15 (this so called graphitic slate, when tested by

SP-CURVE, DHUSA

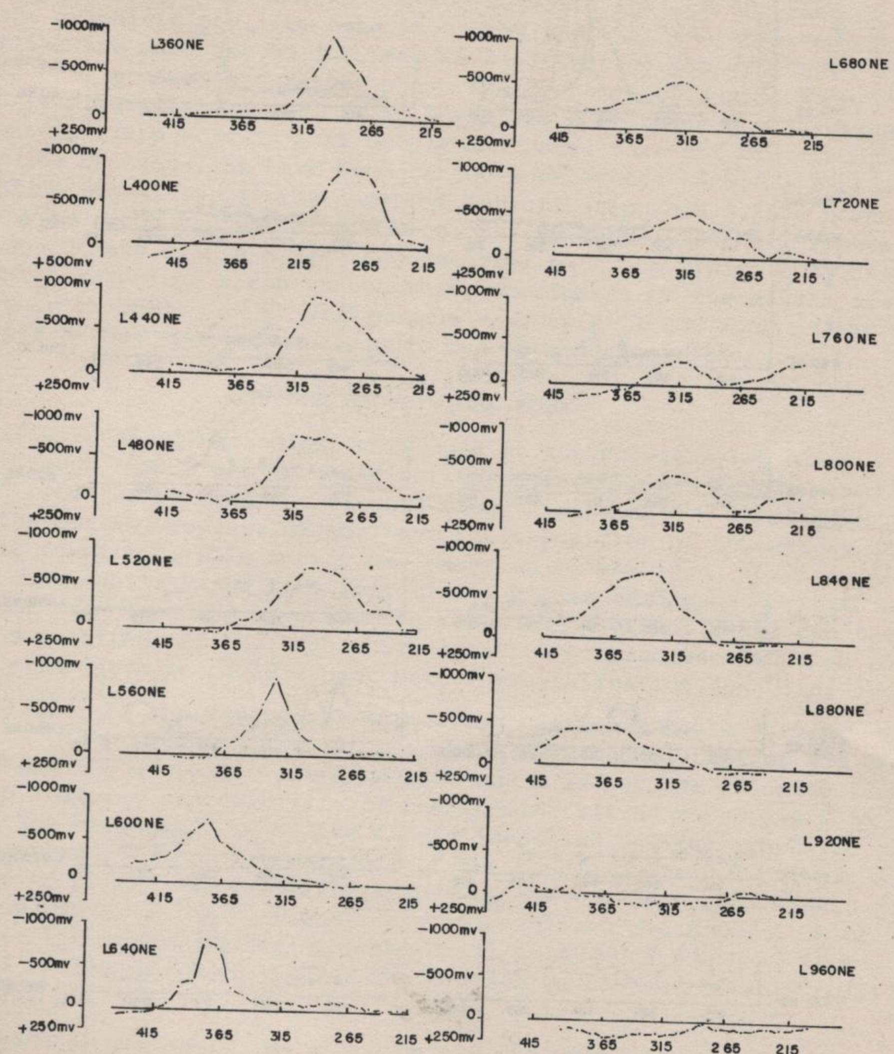


Fig-3

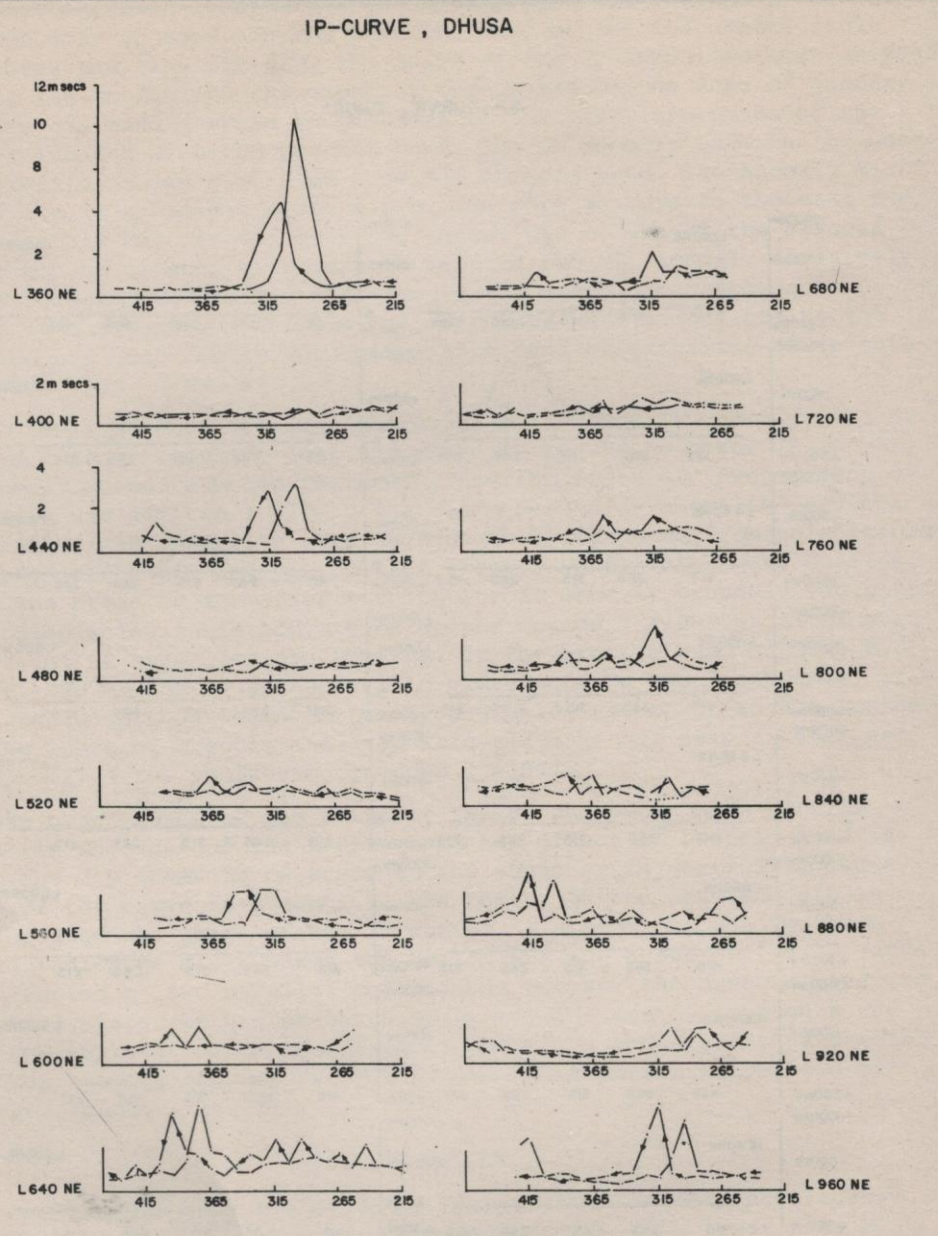


Fig - 4

Vertical Scale:- 1cm = 2 m Secs.

a multimeter did not indicate any conductivity). At little more depth specks of chalcopyrite with chalcocite rims were also observed. The chalcocite is possibly secondary, whose presence, although not visible in the breccia band at the surface, may be the reason for giving high copper value in the surface rock outcrop. This would explain the high soil Cu-vlaue (up to 1% Cu) in the area. Thus there seems to be copper enrichment at the surface.

GEOPHYSICAL EXPLANATION

Though the SP and IP interpretation suggests that to the east of the fault, the graphitic phyllite zone is narrow and that the observed IP and SP anomalies are more due to the breccia band than to the graphitic slate. The drill hole section has rather shown the presence of a wide zone (10m) of slightly minèralized slate. It is therefore considered probably that the graphitic slate zone is more deeply weathered than the breccia band, and that the SP anomalies have been caused more by the breccia band than by the graphitic slate. If the depth of investigation could have been sufficient to reach the unweatherd zone, the SP anomaly as well as the IP anomaly would have been a mixed response from both the mineralized breccia band and the graphitic slate though the predominance of the effect of the latter would be more, and it will not be easy to tell how much of the response would be due to one and how much due to the other formation.

FURTHER GEOPHYSICAL WORK

Resistivity and IP soundings were done at ten points lying along a line passing through DDH 15 and 16 and distributed farther and farther away to the south from the outcropping breccia band, expanding the electrodes parallel to the strike. Because of the favourable position of topography and geological formation, this survey was expected to enable us to calculate the true chargeability and true resistivity values of graphitic slate and breccia for each sounding by using the known thickness of these two formations from drilling. If the true charageability of breccia was found to increase with depth we could expect better mineralization down dip.

Resistivity of the geological formations was found to be varying. The resistivity of the talcosic schist was about 2000 ohm-m, that of the breccia band and the graphitic slate was 200 ohm-m and of the dolomite 1000 ohm-m. The measured chargeability of the un-mineralized rocks was 2 to 5 m secs. The chargeability of the mineralized band and the graphitic slate were similar and varied along the dip of the bands. Between 6 and 15m secs were found to be the chargeability values of the complete polarizable zone of 38m true width, which includes 14m of mineralized dolomite, 6.5m of talcosic schist as calculated from the drill hole section DDH-15 from 26.16m and 79.16m inclined depths. The average Cu content of this polarized zone was 0.17%.

The peaks IP values of the sounding are the responses of the chargeability zone at different depths. The electrical sounding done at a point near DDH-15 is assumed to be the response of known zones of grades of mineralization as intersected by drill holes and therefore using these values as reference attempts were made to calculate the chargeability at different depths penetrated by different soundings using a three layer model with the central layer as polarizable and the upper and lower the unpolarizable layers. Comparing the peak values of measured and the calculated chargeability, it was tried to see how the chargeability is changing with depth. This may indicate the state of mineralization at different depths compared with the state of known mineralization (0.17%) at DDH-15.

It was observed that the chargeability was changing with depth revealing two zones of probably better mineralization with decreasing values further down dip. The mineralization may occur in the form of small lenses at different depths.

CONCLUSION

The IP and SP surveys conducted have a very limited depth of investigation. The presence of graphitic slate zone in contact with the breccia band has made the interpretation of IP and SP results difficult. Mineralization may occur in the from of small lenses at different depth.

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