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A GEOPHYSICAL PROSPECTING USING INDUCED POLARIZATION METHOD ON GOLD-BEARING SULFIDE DEPOSITS AT PASAWAHAN AREA, SIMPENAN SUB-DISTRICT, SUKABUMI DISTRICT, WEST JAVA

PENYELIDIKAN GEOLISTRIK POLARISASI TERIMBAS PADA SEBARAN EMAS DAERAH PASAWAHAN, KECAMATAN SIMPENAN, KABUPATEN SUKABUMI, JAWA BARAT

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ABSTRACT

Induced polarization (IP) is a geophysical imaging technique used to identify sulfidized sedimentary rocks in the form of quartz veins in Pasawahan, Sukabumi District,West Java. The voltage is then monitored through two other electrodes. The sulfide is a lense shape with resistivity of 1 – 10 Ω and induced polarization of 130 – 150 m sec. It is included in a 300,000-ton quartz vein.

Keyword: resistivity, induced polarization, sulfide, lenses, resource

SARI

Penyelidikan geofisika tahanan jenis polarisasi terimbas dilakukan terhadap endapan batuan sulfida berupa urat kuarsa yang ada di daerah Pasawahan, Kabupaten Sukabumi, Jawa Barat. Endapan sulfida tersebut berupa lensa-lensa, dengan nilai tahanan jenis antara 1 – 10 ohm dan nilai polarisasi terimbas 130 – 150 m sec.Sumberdaya endapan sulfida berupa urat kuarsa 300.000 ton.

Kata kunci : tahanan jenis polarisasi terimbas, lensa, sulfida, sumberdaya

INTRODUCTION

Pasawahan at which the gold deposit is available administratively included within Simpenan District of Sukabumi Regency, West Java. Geographycally, the area belongs to 106°49’08” - 106°50’08” east longitude and 07°12,8’26” - 07°14,2’28” south latitude (Figure 2). Sukamto (1975) states that Pasawahan consists of beach sediments (alluvium, sand, gravel and mud), young terrace deposits (gravel, conglomerate), old terrace deposits (sand, gravel, clay), coral reef limestone and volcanic rocks. The volcanic rock includes volcanic breccias; diabase, basalt, andesite, ophiolite and lava of Citirem Formation; dacite and porphyry intrusions and ultrabasic rocks as well (Figure 1).

The fact that Cigendol plantation of Pasawahan area has not operated anymore since 2000 and the area is run by illegal gold mining inspires PT.

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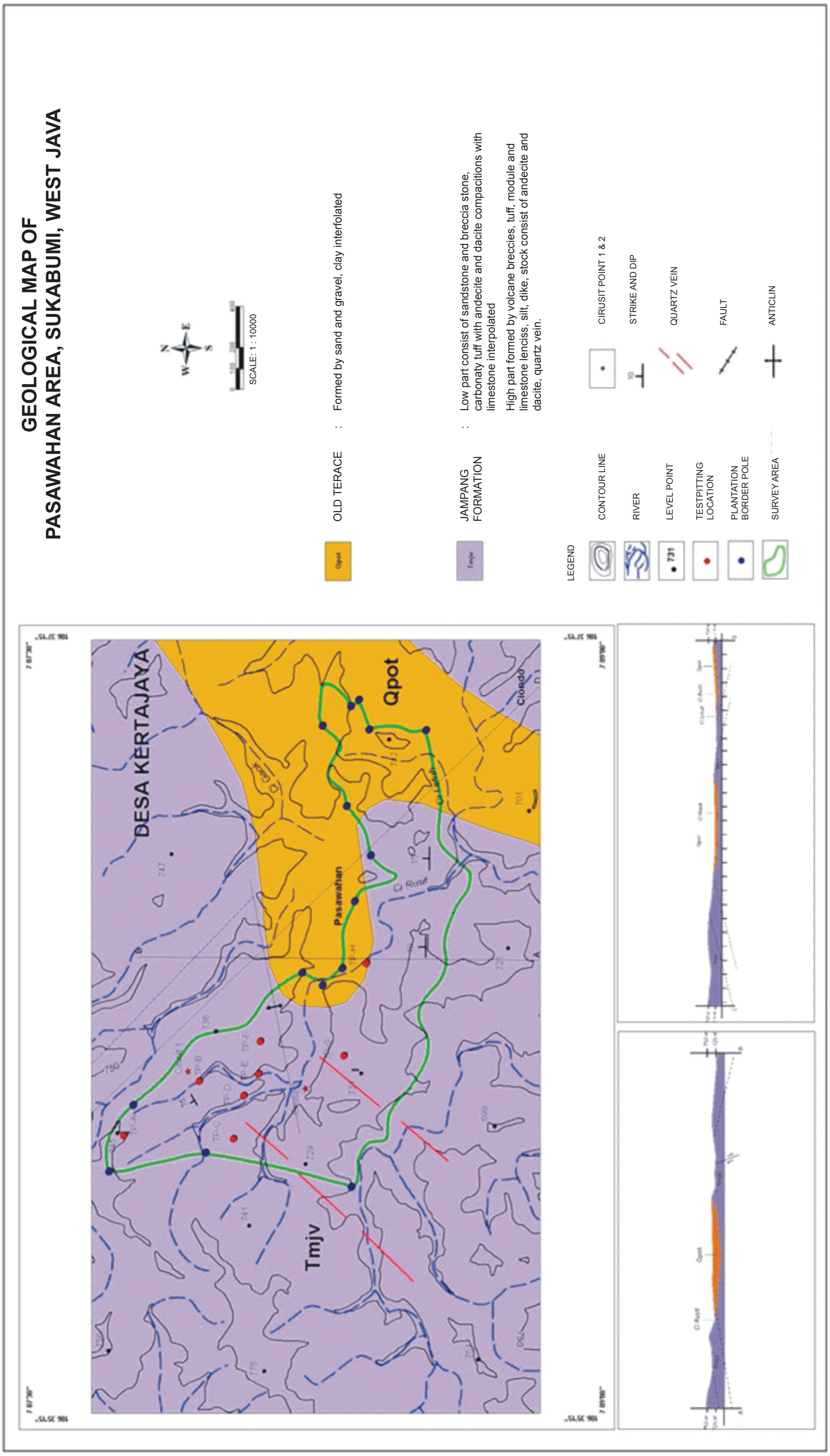

Figure 1. Geological map of Pasawahan area (Sukamto, 1976)

Agritama Mitrasarana to take over the area for mining purpose. Previously, the company had conducted some explorations on this land and found that the area retained gold deposit within quartz veins. The gold-containing area was 115 hectares (Simanjuntak et al., 2005).Detailed investigation was then conducted by PT. Agritama Mitrasarana using induced polarization (IP) method to get information regarding gold deposit beneath the surface. The objective of this study is to delineate gold deposit distribution at Pasawahan area using dipole-dipole configuration of IP method.

Induced polarization (IP) is a geophysical imaging technique used to identify subsurface materials, such as ore. The method is similar to electrical resistivity tomography by which the current is induced into the subsurface through two electrodes. The voltage is then monitored through two other electrodes. Time domain IP methods measure the voltage decay or chargeability over a specified time interval after the induced voltage is removed. The integrated voltage is used as the measurement. Frequency domain IP methods (see Spectral Induced Polarization) use alternating currents (AC) to induce electric charges in the subsurface, and the apparent resistivity is measured at different AC frequencies. (Kearey,1991).

The induced polarization (IP) method is an effective means for exploring disseminated mineralization. This measurement indicates degree at which particular mineralization is present in the rock, grams of metallic sulfide and graphite (Tojo Vicas, 2014) and provides a means of detecting and mapping conductive mineralization as well as alteration. The primary advantage of IP method is its capability to detect the presence of even very small amounts of metallic mineral under favorable conditions (Pars Petro Zagros Co, 2011). Result of the modeling using the finite difference method to interpret IP data was depended on geology and borehole data to examine subsurface structure or Au, Ag, Cu, Pb and Zn metals (http.digilib.itb.ac.id/,2014). Certain minerals have electrical conduction such as pyrite (http://www.epa.gov/esd/cmb/GeophysicsWebsite/, 2014).

METHODOLOGY

Started with literature surveys on related journals, text books and maps (Nurhakim, 2006); the study included outcrop mapping, sampling and geophysical investigation as well making 6 lines of IP investigation. The next step was processing gold-bearing samples by amalgamation to get data about their Au contents while the data from IP investigation was processed by supersting software. Compiling data from ore amalgamation and IP calculation results in gold distribution for such an area. Figure 2 shows the flow chart regarding the conducted research.

RESULTS AND DISCUSSION

Local Geology

Tertiary sediment rocks mostly dominate the study area. Those are Jampang Formation that consists of volcanic breccias, basalt, tuff, limestone and silicified woods as well as quartz veins. The area is also characterized by Quaternary old terrace deposits that compromise sand and gravel with intercalation of clay, andesite fragments, dacite and quartz (Sukamto, 1975). Gold is available in quartz veins. The first quartz vein or known as Cirusit 1 is exposed at 106°36’08,3” east longitude and 07°07’54,4” south latitude performing strike and dip of N125°E/86°and thickness of 10 cm. Cirusit 2 (the second vein) is available at 106°36’05,9” east longitude and 07°08’13,5”south latitude. The Cirusit 2 contains two veins with 1 and 0.2 m in thickness and is separated by 0.8 m in distance. The strike and dip of both veins is N323°E/84° and N323°E/84° respectively. In terms of studying the gold content, some gold-bearing sulfides were sampled from Cirusit 1 and 2 and processed using amalgamation method in a milling drum. The results are shown in Table 1.

Geoelectric Measurement

The applied instrument for measuring rock resistivity and induced polarization is a Super Sting resistivity meter. Using dipole-dipole configuration, the measurement was conducted for 6 lines (Figure 3). Line GL-IP 01 has direction east to west and 1.025 m in distance. The line intersects lines GL-IP 06 at 525 m, GL-IP 02 and GL-IP 03 at 700 m as well. The measurement data were processed by Earth Imager software to illustrate deposition, thickness and shape of sulfide depositions in both two and three dimensions (AGI Earth Imager 2-D-2.2.9 Software and AGI Earth Imager 3-D-1.5.0.333. Software: 2009).

Sulfide depositions (Figure 4) are supposed to be at 300 and 700 m or beneath electrode 13 and

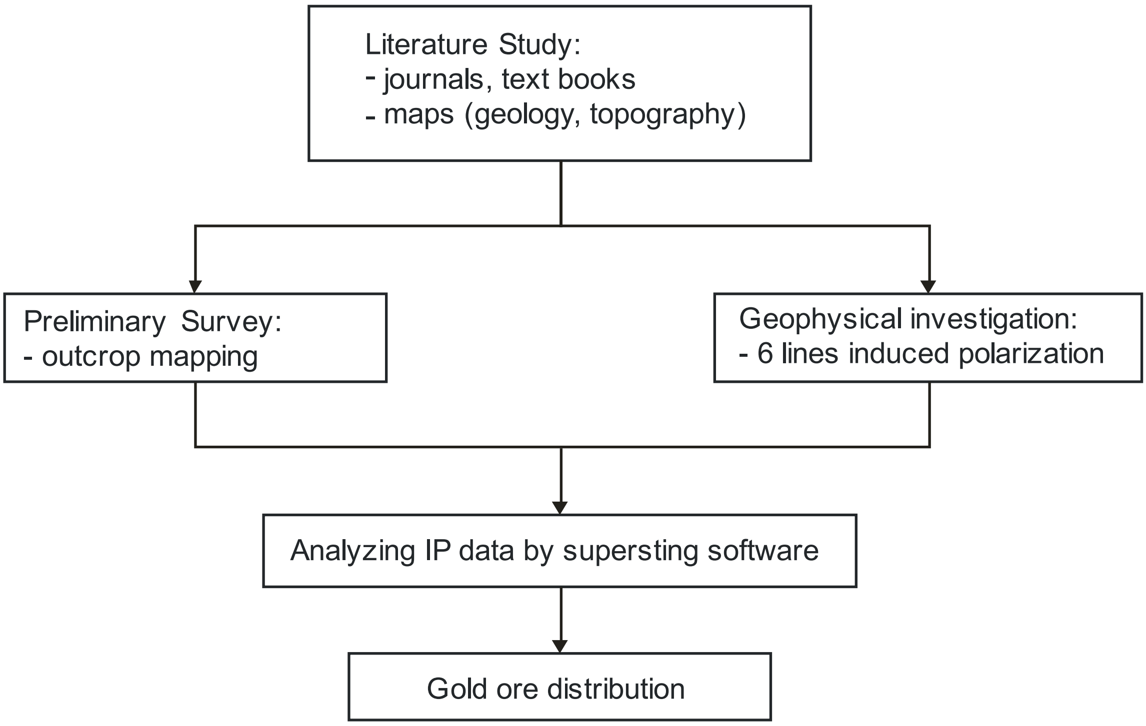

Figure 2. Flow chart of research method

Table 1. The gold content of Cirusit 1 and 2

Sample Origin	Sample Code	Au (g/t)	Average Au (g/t)
	Cirusit 1-1-U	6.310	
Cirusit 1	Cirusit 1-2-MD	6.440	6.4
	Cirusit 1-3-D	6.451	
	A-UP	6.111	
	A-MD	6.300	
Cirusit 2	A-D	6.190	6.2
	B-UP	6.210	
	B-MD	6.390	
	B-D	6.001	

29. The sulfide anomaly is clearly shown at 700 m performing rock resistivity (ρ) of < 5 Ωm and IP of 140-150 m sec. Its shape is thinly elongated with dip varies from 20 to 75°.

Figure 5 illustrates line for measuring rock resistivity and IP (GL-IP 02) that has direction NW-SE. The line intersects line GL-IP 05 at 400 m, GL-IP 01 and GL-IP 03 at 700 m (Figure 3). A 2-D model of both resistivity and IP shows that there are two spots with low resistivity but high IP. Those are available at 300 m (electrode 12) and 850 m (electrode 26). A thin vein occurs at 300 m performing a synistral dip of 45° and dextral dip of 50°. The anomaly that shows sulfide deposits is characterized by ρ of <10 Ωm and IP of 100 – 150 m sec.

Line GL-IP 03 directing NE-SW (Figure 6) intersects the GL-IP 06 at 525 m as well as GL-IP 01 and GL-IP 02 at 700 m. The resistivity along the line is very low, around <10 Ωm. Similar conditions also occur to the IP. It is around 60 - 150 m sec. The sulfide anomaly that shows high IP

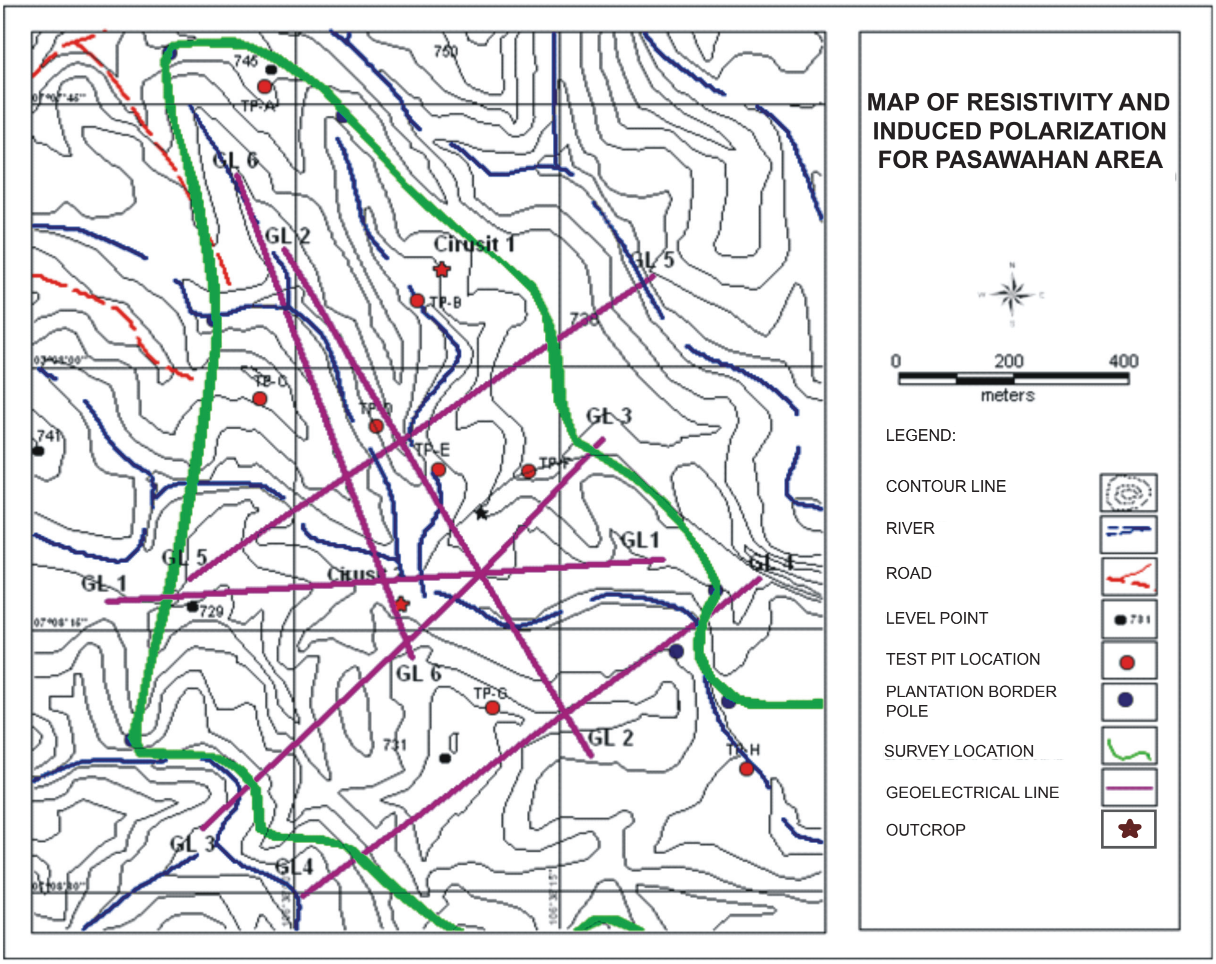

Figure 3. Measurement lines for Resistivity and IP

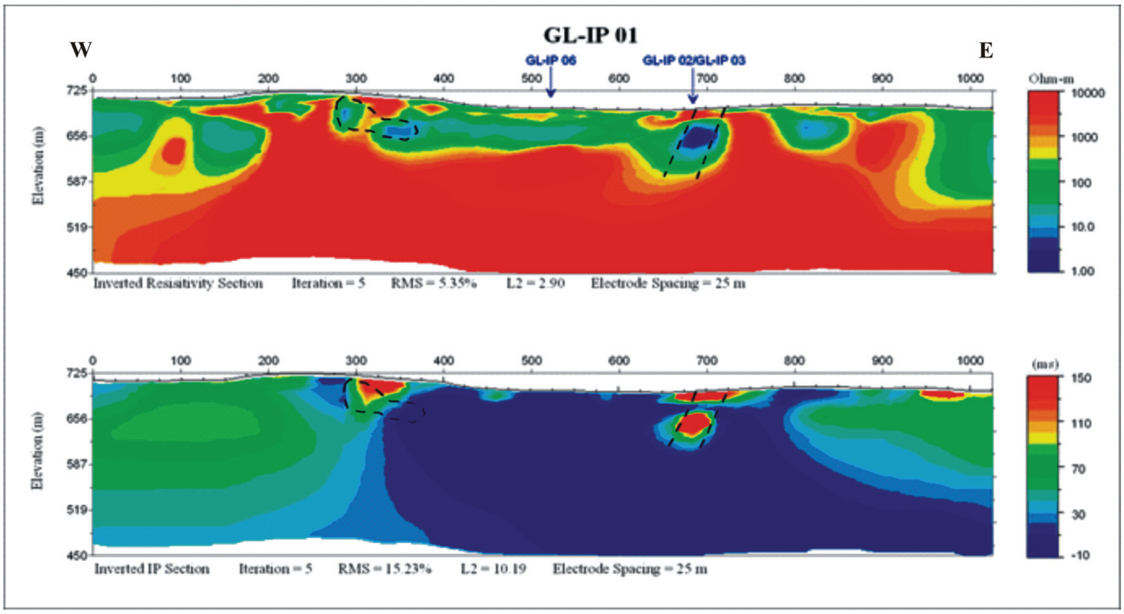

Figure 4. A 2-D model of resistivity and IP for line GL-IP 01

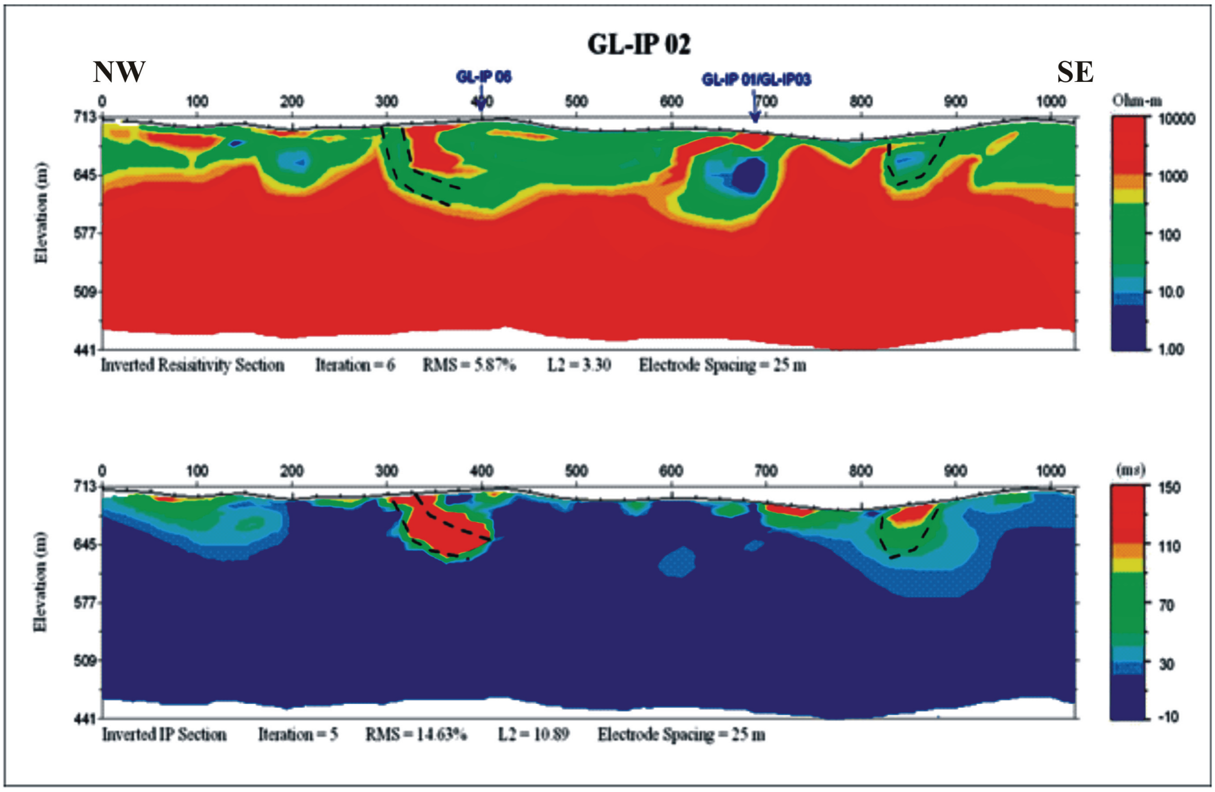

Figure 5. A 2-D model of resistivity and IP for line GL-IP 02

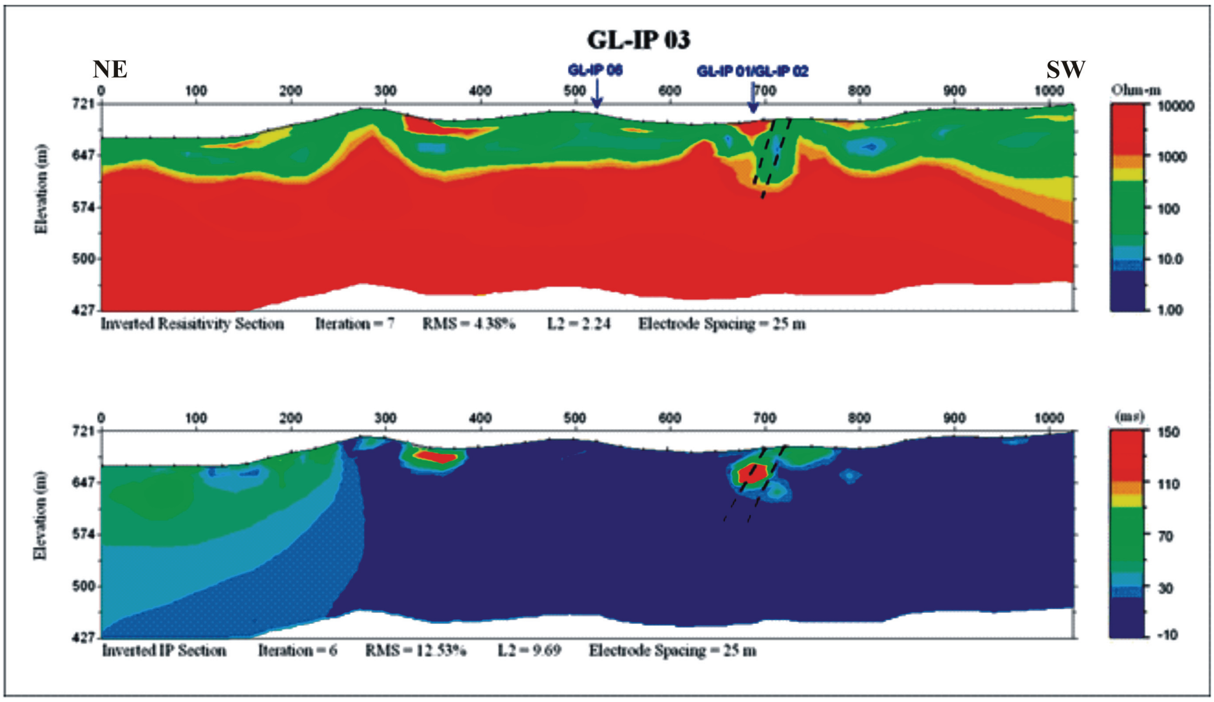

Figure 6. A 2-D model of resistivity and IP for line GL-IP 03

and coincides with low resistivity takes place at electrode 30 or at a distance of 725 m. Such an anomaly dimension is small performing synistral dip around 35°.

Figure 7 shows the GL-IP 04 lines. It is located at the most southern part of the area and retains direction of SW-NE as well as almost parallel with the GL-IP 03. The GL-IP 04 only intersects one line, namely the GL-IP 02 at 900 m. The highest IP at this line occurs at electrode 27 but its resistivity is low. Sulfide deposits perform synistral dipping around 30°.

The GL-IP 05 line comprises NE-SW direction (Figure 8). The line is parallel with GL-IP 04 as well as intersects GL-IP 06 and GL-IP 02 lines at a distance of 325 and 450 m respectively. The sulfide within the line is noted by the presence of low resistivity anomaly around less than 10 Ωm with the IP value of 120-150 m sec. The anomaly occurs at electrode 11 retaining distance of 275 m. As a vein, such an anomaly performs dextrally dip around 45°.

Figure 9 illustrates the GL-IP 06 that has N-S direction. The line is across three lines, namely GL-IP 05 at 700 m, GL-IP 01 at 850 m and GL-IP 03 at 1000 m. High IP anomaly coincides with low resistivity occurs at electrode 12 performing a distance of 300 m. However, the sulfide anomaly in a vein-like takes place at a distance of 675 m (electrode 28). Its dip is relatively upright with resistivity of 1 - 12 Ωm and the IP of 140-150 m sec.

All 2-D sections for resistivity and IP illustrate the sulfide deposit in quartz veins. The anomaly grouping presents elongated, thin shape with low resistivity and high IP values. There are two gold-containing sulfide mineralization identified from these geo-electric measurements. The first one is a lane that intersects GL-IP 01, GL-IP 05, GL-IP 06 and GL-IP 02 with strike and dip around N35oNE/35-80o; the second is the lane that meets GL-IP 04, GL-IP 02, GL-IP 01 and GL-IP 03 with strike and dip around N160°NE/40°.

3-D Model for Resistivity

The objective of 3-D model constructions is to evaluate distribution and geometry of gold-containing sulfide deposits. To achieve this objective, the anomaly is selected only for low resistivity (0.5 – 20 Ωm). The result shows that the shape of sulfide deposits includes spherical, flat and

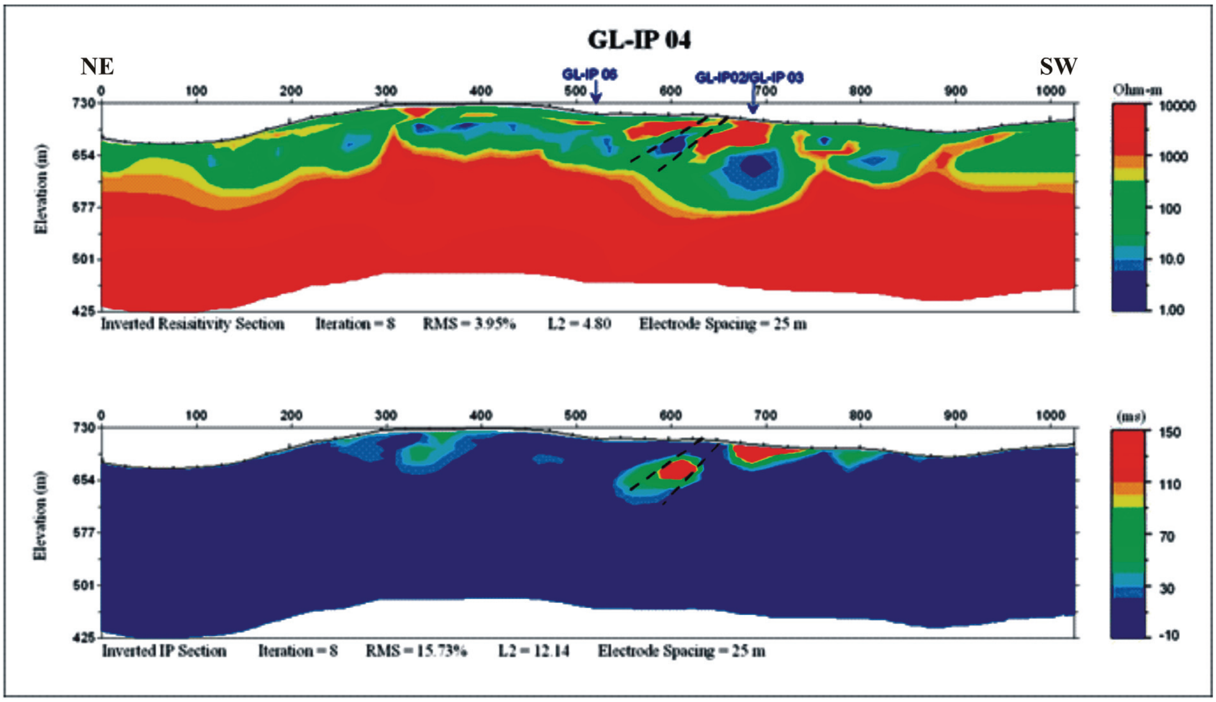

Figure 7. 2-D model of resistivity and IP for line GL-IP 04

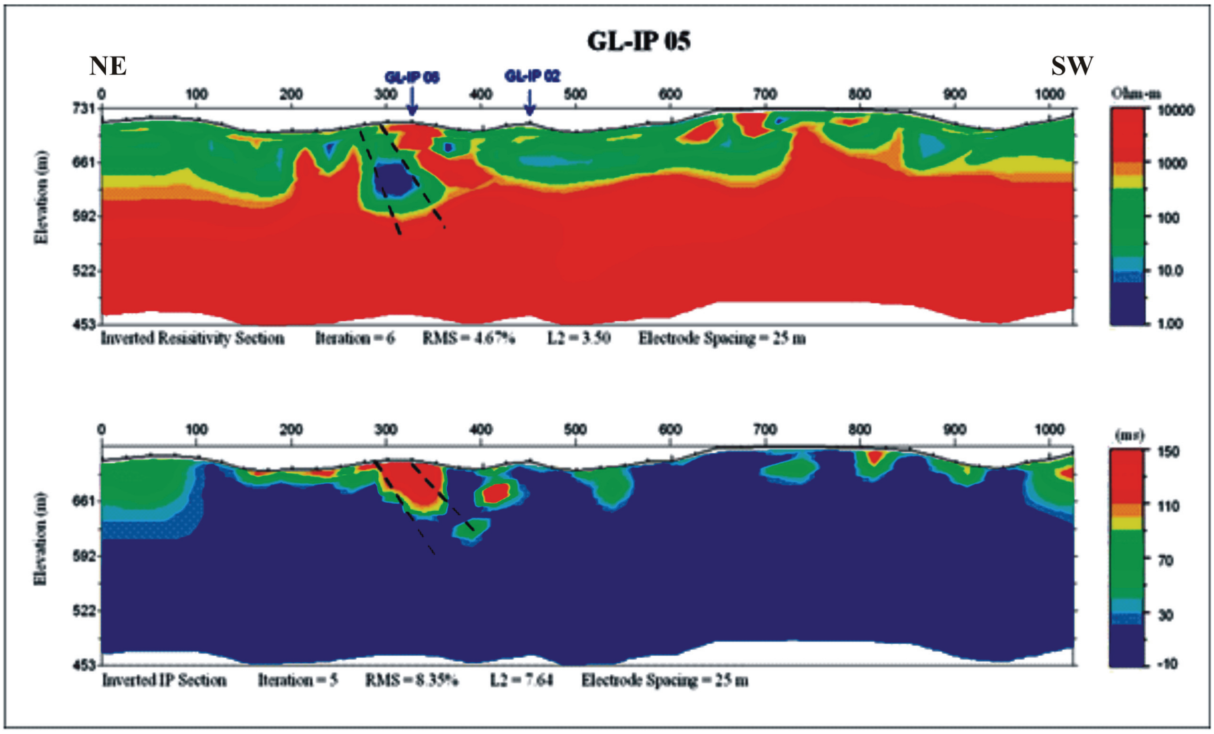

Figure 8. A 2-D model of resistivity and IP for line GL-IP 05

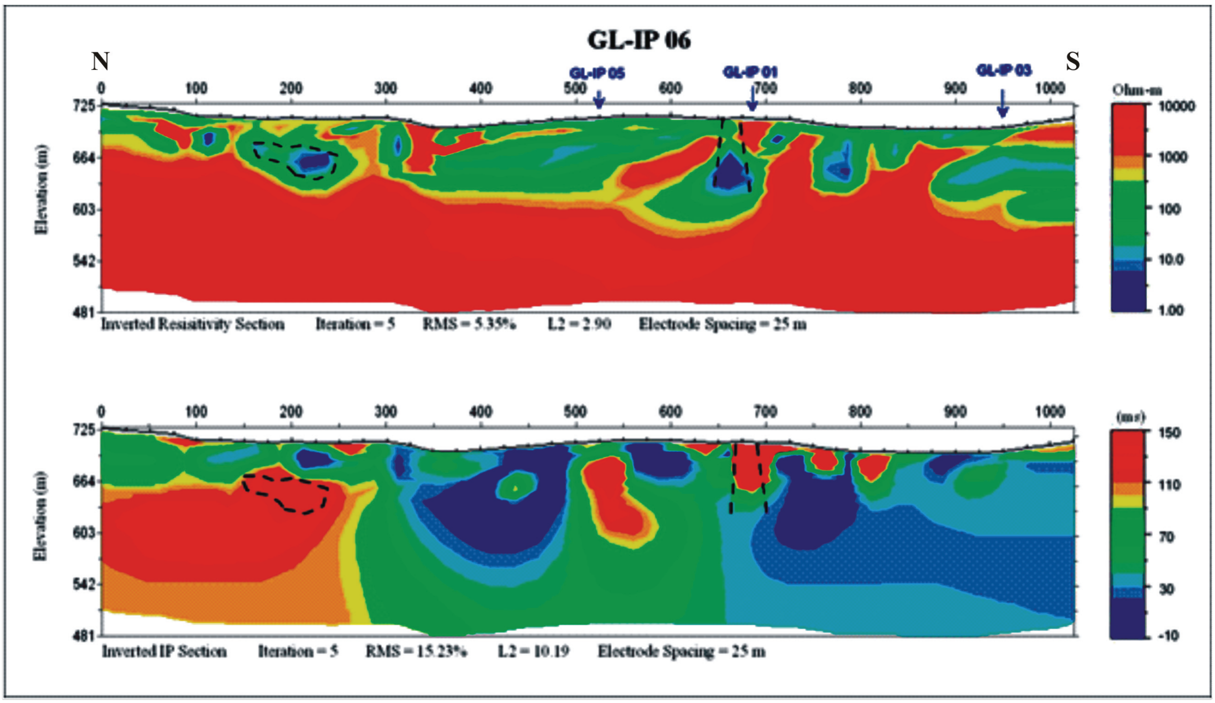

Figure 9. A 2-D resistivity and IP models for line GL-IP 07

oval. Although its existence seems separate, the deposit shows continuous pattern. Figure 10 and 11 show lateral distribution of the deposit in 3-D model. Information derives from 2-D and 3-D models can be used as a recommendation for borehole point determination to check the ac-

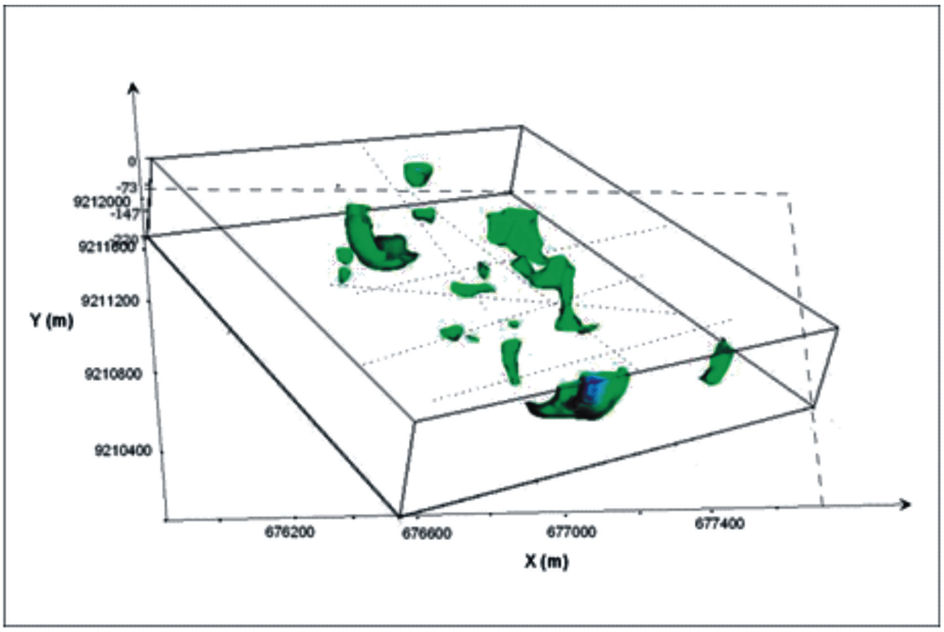

Figure 10. A 3-D model for sulfide-bearing rocks, results from IP measurement

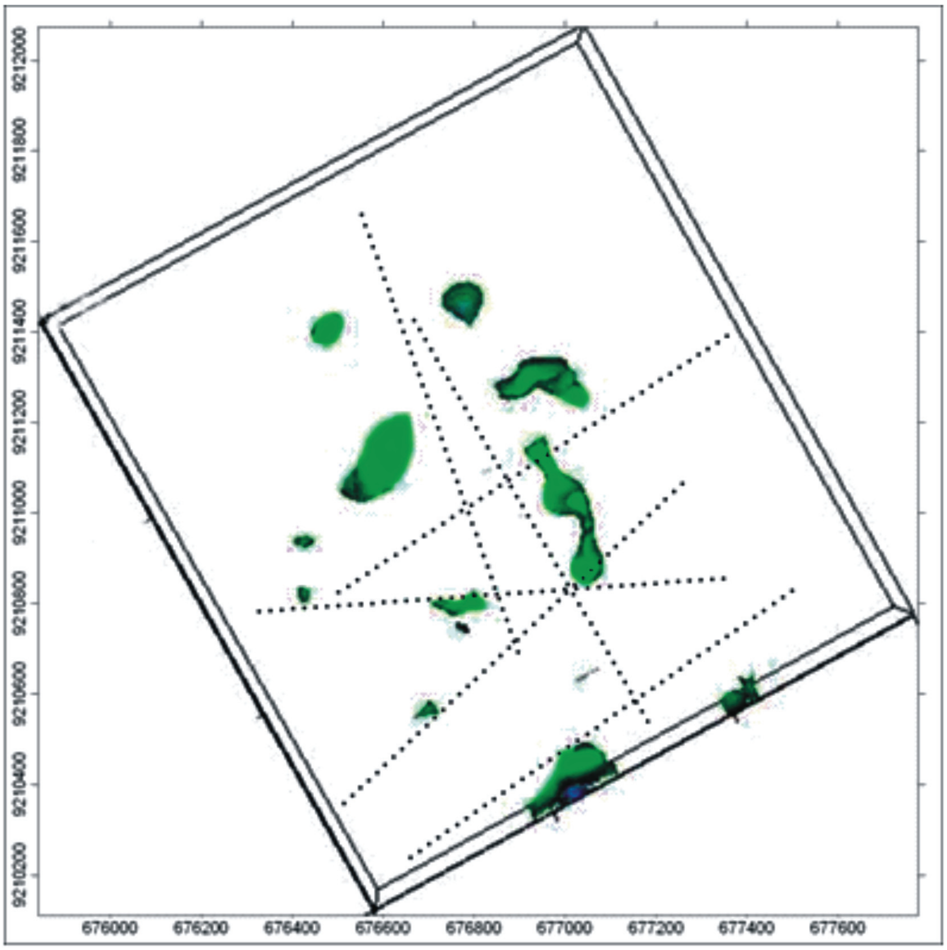

Figure 11. Top view of 3-D model for sulfide-bearing rocks, results from IP measurement

curacy of geo-electric survey result.

Geological survey combined with geophysical prospection confirms that the study area consists of volcanic breccias, sandstone and basalt. The resistivity (ρ) value for rocks at study area varies from 1 – 10.000 Ωm performing low, medium and high anomalies. Low anomaly relates to ρ<10 Ωm while the medium possesses ρ from 10 – 500 Ωm. The highest one owns ρ >500 Ωm. Telford (1976) stated that the ρ for gold-bearing sulfide should be 1,2 x 10-5 – 1,5 Ωm and the IP >50 m sec with frequency effect > 10 % / decade and metal factor >1000 mhos / m.

Lithology at GL-IP 01 line (1,025 m) comprises volcanic breccias, sulfide-bearing rocks, sandstone and basalt. Similar condition also occurs at GL-IP 02 and GL-IP 06 lines. Indication of sulfide-bearing rocks takes place at 300 and 700 m from the early measurement point (Table 2).

Table 2. Illustration of sulfide-bearing rock condition at 6 survey lines

Line	Distance from early point (m)
GL-IP 01	300 and 700
GL-IP 02	300 and 850
GL-IP 03	725
GL-IP 04	650
GL-IP 05	275
GL-IP 06	675

CONCLUSIONS AND SUGGESTION

Pasawahan area is characterized by – from top to bottom – sulfide mineral-bearing volcanic breccias, sandstone and basalt. The sulfides are exposed in the form of quartz veins. It is suggested accomplishing such a drilling at the intersection of prospect geo-electric lines. The average gold content of Cirusit 1 and 2 are 6,2 g/ton and 6,4 g/ton.

Referring to the results of geological survey 2 quartz vein outcrops (Cirusit 1 and 2); then correlated with a geophysical survey, it is found that Pasawahan plantation is a prospect area for gold-bearing sulfide notably, that is passed by GL-IP 06 line at the intersection with GL-IP 03 or outcrop Cirusit 1 and 2.

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