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Estimation of the Potential Gold (Au) Mineral with a Resistivity Approach

Akroma Hidayatika [1], Arif P Prabowo [1], Syamsurijal Rasimeng,[1] Medi K Putri [1], and Suharno [1,*]

[1] *Department of Geophysical Engineering, Faculty of Engineering, Universitas Lampung, Jl. Prof. Soemantri Brodjonegoro no. 1, Bandar Lampung 35143, Indonesia*

* Corresponding Author: suharno.1962@eng.unila.ac.id

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Abstract
This research was conducted in Pesisir Barat Regency of Lampung. The purpose of this study is to estimate gold mineral reserves gold mineral is a mineral that is formed when magma is heading to the surface at very high temperatures and pressures. The gold mineral in this area is a low sulfidation hydrothermal gold that deposit epithermal type or in the form of quartz veins, with carrier minerals containing metals and non-metals. This research uses resistivity method. Interpretation is done by analyzing the resistivity 2D cross section. The interpretation of the gold mineralization zone is associated with the source rock (volcanic) which has a resistivity value of ≥550 Ω.m. Based on resistivity modeling, assuming the source rock is an andesitic-basaltic igneous rock with a density of 2.8 g/cm^3 and a maximum depth of 30 meters. Based on calculations from resistivity and geological models, it is estimated that gold reserves reach 0.3 – 1.5 tons

Keywords: resistivity, gold, interpretation, geophysics

1. Introduction

Gold (Au) is one type of mineral that has a high economic value, it is interesting to study. So, it is necessary to estimate the initial potential, which is careful and environmentally friendly. Because the Pesisir Barat regency is a relatively densely populated area and has good tourism potential [1,2]. Resistivity of geophysical method is a method that does not damage the environment. This method can be used as a basic reference for determining the potential of minerals in rock formations, such as gold. Physiologically and morphologically this area has similarities in the data in the Tanggamus study. the area has been proven to have gold [3].

This research covers geoelectrical resistivity measurement, by injecting electric current, until the rock resistivity is known. Then the 2D inversion modeling and interpretation of the model quantitatively and qualitatively from the geological data of previous researchers. The purpose of this study was to obtain data on the calculation of the potential for gold minerals contained in the research area. The data used only covers the Sukabanjar Village, Ngambur District, Pesisir Barat Regency.

2. Material and Methods

2.1 Geology of Research Area

The regional geology of the research area consists of Hulusimpang Formation (Tomh), Seblat Formation (Toms), and Simpangaur Formation (Tmps) is the order of age from youngest to oldest. They can be seen in Figure 1. The youngest is the Hulusimpang, age of the late Oligocene. This formation consists of volcanic breccia lithology, lava, andesitic-basalt tuff, found in a hydrothermal altered state with quartz veined sulfide minerals. There are porphyry basalt, porphyry andesite, basaltic andesite, hornblende andesite, porphyry trachite, porphyry latit, rock tuff/breccia tuff, porphyry dacite [4].

The second youngest is Seblat Formation (Toms). This formation is in the late Oligocene to early Miocene. This formation consists of a lithology of claystone, sandstone, tuffaceous sandstone, shale, siltstone, generally limestone, and a thin layer or pile of limestone. This formation has a strike/dip tending to the southwest-west with a slope value ranging from 23-30 degrees. In some places can be found at 75 degrees. The second oldest is the Bal Formation, which is in the early Miocene to Middle Miocene [5]. This formation consists of volcanic breccia lithology composed of dacite, dacitic tuff and sandstone inserts. The oldest formation in this area is Simpangaur from the late Miocene to early Pliocene. This formation consists of tuff-sandstone lithology, tuff-siltstone, tuff, conglomerate containing mollusks and shells, thin inserts of lignite [6].

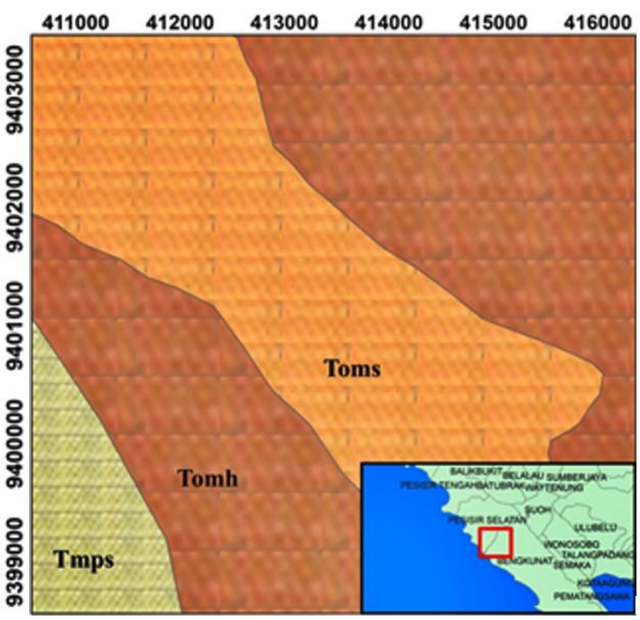

Figure 1. Research geological map which has been modified from a map with a scale of 1:250.000. Research area in red box. Pesisir Barat Regency, Lampung Province. Coordinates in UTM [5].

The upper part of the Hulusimpang Formation is aligned with the lower part of the Seblat Formation which is of Early to Middle Miocene age. Deep intrusive rocks (granite and diorite) of Middle Miocene age intrude the Hulusimpang Formation and the Seblat Formation [6]. The Middle Miocene Lemau Formation is unconformably superimposed on the Seblat Formation. Then, the Lemau Formation was unconformably overlain by the Late Miocene-Pliocene Simpangaur Formation, and deposited in the transition area. The Bintunan Formation is Plio-Plistocene in age which was deposited in fresh to brackish water and local shallow seas, overlapping the Simpangaur Formation unconformably. After the earthquake 02 August 2019 there was deformation in the Pesisir Barat Regency [7].

2.2. Resistivity Data Acquisition

Resistivity geophysical method is one of the efficient methods for gold potential exploration [1,7]. Resistivity data used in this study was taken directly from the field using an Ares Resistivity meter. To perform resistivity data acquisition, battery is needed to be a voltage source that will be injected below the surface through the current electrode. The number of electrodes used during measurement is 40 electrodes. Then the main unit is placed at the location of the first point on the path that has been made. After that, install the tool by connecting the battery to the main unit and the Multichannel cable. Multichannel cable used 5 cables with a stretch of 200 m to the east following the acquisition design, then attach each electrode to the probe provided on the Multichannel cable.

After installing the tool, calibration is carried out on the main unit to check whether all electrodes are properly connected. If all electrodes are connected, perform manual operation of the tool to take measurements. Measurement time is ±40 minutes. During measurement the tool will inject current and capture electric current at each electrode automatically. After the measurement is complete the tool will inform automatically with a sound. Measurement of resistivity data in this study was carried out for 3 days of effective time, with a target of 1 pass per day. The length of time of measurement is due to the terrain that has a fairly dense topography and quite dense forest vegetation. In the last 2 days during the measurement, it rained quite heavily. If the electrode is submerged by water, the data quality will be disturbed, so the measurement is postponed until the next day.

Measurement's resistivity method with the Wenner-Schlumberger configuration in the research area consisted of 2 measurement lines, with a track length of 200 m. The electrodes for each measurement path are 5 m.

3. Result and Discussion

The measurement results obtained from the field in the form of resistivity data that are stored automatically on the Ares Resistivity meter tool are then transferred from the tool in the form of a "dat" file to a laptop after it is processed using the Res2Dinv software. The steps for using the Res2Dinv program to process geoelectrical data.

The measurement data in the form of type (dat. file) that has been transferred from the tool is then processed with the excel program to see the track name, apparent resistivity, number of datum points and others after that add topographic data and measurement coordinates that have been obtained with GPS (Global Positioning System). Next, input the data into the Res2Dinv software, by first using a text editor with the input format for each measurement path. So that 2D inversion modeling can be processed.

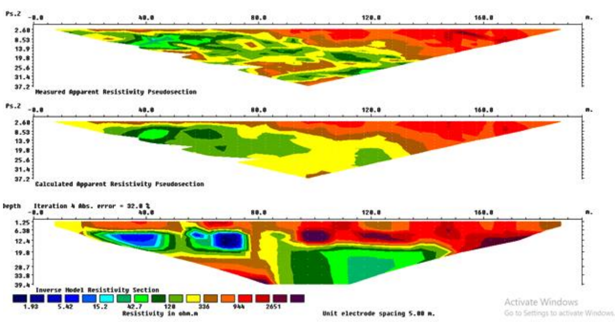

Figure 2. 2D inversion models results resistivity cross section without topography.

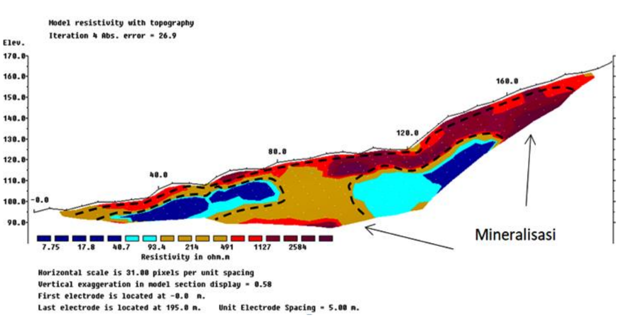

Figure 3. 2D inversion models results resistivity cross section with topography in track 1.

The results of the 2D resistivity cross-section on track 1 (figure 3) using 4 iterations obtained an RMS error of 26.9%. From the results of the inversion, the resistivity value is obtained with a relative west-east direction on a topography with a moderate slope having a distribution of resistivity values of 7.75 to 7. 2584 Ωm., shown in blue to purple. This trajectory shows the intrusion pattern of the host rock that extends along the measurement trajectory. The depth of the rock is about 5 meters and is covered by clay (dry) rock and shattered rock that is not compacted so that it produces a high resistivity value. In addition, there are rock contacts with low resistivity values (<100 Ωm) at a distance of 105 to 120 meters from the start of the measurement trajectory which is estimated to be a layer of crushed rock and infiltrated by water.

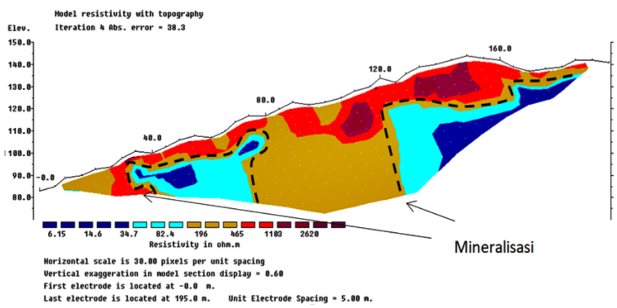

Figure 4. 2D inversion models results resistivity cross section with topography in track 2.

The 2D resistivity cross section of track 2 obtained a subsurface layer with a stretch of about 200 meters (electrode spacing 5 meters) with a depth of approximately 40 meters. The results of the 2D resistivity cross-section on track 2 using 4 iterations obtained an RMS error of 38.3%. From the results of the inversion, the resistivity value is obtained with a relative west-east direction on a topography with a moderate slope having a distribution of resistivity values of 6.15 to 6.d. 2620 Ωm., shown in blue to purple. This trajectory shows the intrusion pattern of the host rock that extends along the measurement trajectory. The depth of the rock is about 5 meters and is covered by clay (dry) rock and shattered rock that is not compacted so that it produces a high resistivity value. In addition, there are rock contacts with low resistivity values (<200 Ωm) which are estimated as layers of crushed rock and are infiltrated by water. This can also be supported by geological and GIS data from West Lampung and its surroundings [6-8].

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Interpretation of resistivity data based on the geology data, as presented elshere [1,5]. Variations in resistivity values show that the source rock distribution pattern is dominated by a relatively north direction, then in the eastern part there are several distribution blocks of source rock. 2D modeling results are then reconstructed roughly in volume interpretation of the presence of altered source rock. Resistivity data modeling obtained the estimated value of potential reserves at depths of up to 30 m. Assuming the source rock is an andesitic-basaltic igneous rock with a density of 2.8 g/cm^3 and a maximum depth of 30 meters, the calculation results are obtained as an illustration of the estimated mineral content (Au).

4. Conclusion

The 2D resistivity model shows that the subsurface lithology is generally divided into 4 parts, resistivity of sandy-clay 32 to 50 Ωm. (conditions infiltrated by groundwater), then resistuvuty of clay about 50 to 100 Ωm. (saturated with water), volcanic tuff and breccia 100 to 550 Ωm., volcanic rock/ source rock >500Ωm. Then, based on calculations using a 2D model that is correlated with the presence of mineralization to a depth of 30 m, it is estimated that the potential volume of gold minerals reaches 0.3 tons - 1.5 tons. Suggestions for further research, researchers should consider the Pesisir Barat area that has experienced landslides and earthquakes.

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