

# The Initiation Study on the Gold Potential Resources at West Coast Area in Lampung Province, Indonesia

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## Abstract

Gold mineral (Au) is formed due to an increase in the residual solution of magma deposited at high temperature and pressure. This study aims to estimate the potential of gold minerals in the west coast area in Lampung Province. This initiation study was using a geophysical resistivity model. Based on geological data, gold minerals in the West Coast are classified as epithermal hydrothermal deposits in the form of low sulfide quartz veins. The results of the subsurface interpretation were identified as a gold mineralization zone associated with the rock in the form of volcanic rock which has a resistivity value of  $400\Omega.m$ . The source rock volume has been estimated at  $130,000 m^3$  and  $\leq 133,000 m^3$ . So that the Au mineral content in the study area is estimated at 0.5-2.09 tons. A future study should be conducted in relation to the development of gold mining industry in Lampung West Coast area, that may integrate more engineering experts.

**Keywords:** gold resources, geophysical resistivity, volcanic rock, mineralization.

## I. INTRODUCTION

The research area in Pesisir Barat Regency is suspected to have gold mineral content. Gold mineralization in Pesisir Barat Regency is found in volcanic rocks composed of volcanic breccia, tuff, andesite lava. The gold content of the West Coast area is an epithermal type of hydrothermal gold deposit in the form of quartz veins and including epithermal low sulphidation [1].

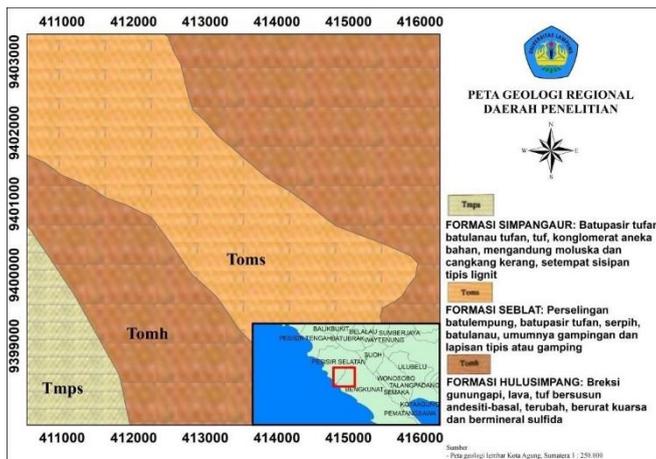
The resistivity geoelectric method is one of the geophysical methods that calculates the ability to conduct electricity from rock layers in the earth. This method works by injecting an electric current into the earth through two current electrodes and measuring the potential difference through two potential electrodes, the result is a potential difference measured at the electrode on the surface. From the measured potential difference, the resistivity variation of each layer under the measurement point can be determined.

Obtaining field data in the form of subsurface resistivity values. Based on these data, an inversion calculation is then carried out so that the resistivity variation of a soil layer system is calculated which is associated with the geological structure below the surface. This study aims to present a preliminary review for the initiation of geophysical survey to estimate the gold resources at Lampung West Coast area. Some critical review on theoretical background will be also highlighted to strengthen the area of interest and the method used.

## II. MATERIALS AND METHODS

The research area of interest of this research is in the West Coast area that have been suspected as a potential gold resource in Lampung Province. Gold mineralization in that area was assumed to be from the volcanic rocks that composed of volcanic breccia, tuff, andesite lava. West Coast area of Lampung is located in the regional geology of Kota Agung. The study areas included in the 1:250,000 Scale Regional Geological Map of the City of Agung Sheet [2].

The regional rock compositions are, The Hulusimpang Formation of Late Oligocene-Early Miocene age is the oldest rock exposed around the study area. The upper part of this formation is aligned with the lower part of the Seblat Formation which is of Early to Middle Miocene age. The deep breakthrough rock (granite and diorite) of Middle Miocene age broke through the Hulusimpang Formation and the Seblat Formation. 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-Pliocene in age which was deposited in fresh to brackish water and local shallow seas, unconformably overlapping the Simpangaur Formation. They are shown in figure 1.

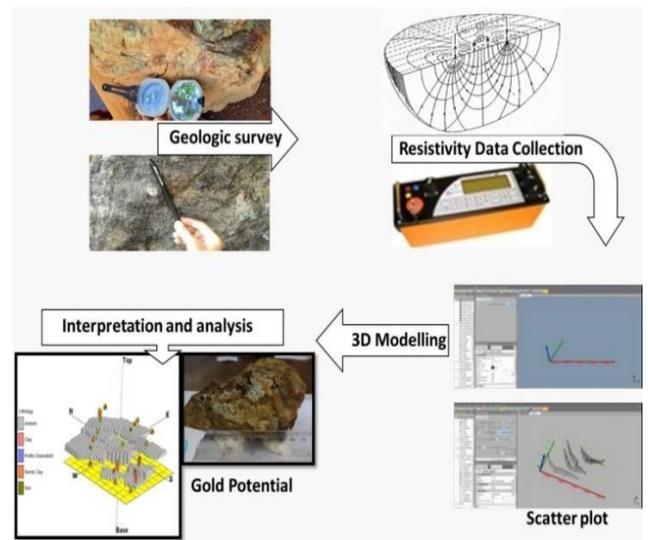


**Figure 1.** The geological map of the study area with modification [2], where the research area consists of the Simpangaur Formation, the Seblat Formation and the Hulusimpang Formation.

Methods for measuring the estimation of gold resources was using a geoelectric method of resistivity with the Wenner-Schlumberger configuration in the research area consist of 1 measurement lines, with a track length of 200 m [2]. The electrode for each measurement path is 5 m. 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. From the 2D cross-section it is known that the distribution of resistivity values is influenced by variations in subsurface rocks, then data samples are taken from the 2D cross-section which is considered to represent the subsurface rock

structure of the study area. After that, analyze the resistivity value at the point of the geological 3D model [2,3].

The model is processed using 3D geophysical software, namely rockwork. Based on the point data of the 3D geological model, 3D-lithology modeling was reconstructed according to the coordinates and elevation of the research area. The selection of 3D geological model points is done based on the pattern of resistivity values that are considered representative of the lithology so that the accuracy of the model to be made is good and makes it easier for interpretation.



**Figure 2.** Research flow for the modeling and estimation of gold mineral resources.

### III. RESULTS AND DISCUSSIONS

The resistivity method basically utilizes electrical conductivity which can be used for various problems in mineral exploration. This method can be used to describe geological structures associated with mineralized zones. The resistivity method is an effective method for determining the position and depth extension of gold-bearing quartz veins [3].

The resistivity model was able to detect the rock response thought to be associated with gold-bearing quartz veins and these results were compared with geological data to infer quartz vein levels. Surveys of surface dipoles have been successfully carried out delineating the main geological structures associated with gold bearing quartz veins (Jong-oh et al 2009). Gold carrier minerals are usually associated with gangue minerals, which are generally quartz, carbonate, tourmaline and small amounts of non-metallic minerals. Below will be presented in table 1.

**Table 1.** Gold mineral properties [1]

Physical properties	Value
crystal shape	cubical
color	Yellow gold, white silver,
orange, red melting point	1064,43 °C (1948 °F)
hardness	2,5 – 3 Mohs scale
density	19,3 (pure)
resistivity	2,2. 10 <sup>-8</sup> Ωm
susceptibility	Low
ductility	Hi
luster	Metallic

According to other result [4], the factor that controls the concentration of metal minerals (especially gold) in a mineralization process is influenced by the presence, differentiation process. This differentiation process can be caused by crystallization, gravity, liquid separation and assimilation (reaction or dissolution process between magma and wall rocks). This process will form magmatic Sulphide and oxide mineral deposits which are usually dispersed. The depositional environment of gold can be classified based on the process of its formation, which can come from hydrothermal processes, metasomatism processes and other surface processes that cause the formation of placer deposits. In this study, the focus is on the target of the subsurface gold environment formed as a result of the hydrothermal process.

This relates to controlling structures such as faults, intrusions, wall rocks and so on. The hydrothermal process associated with the controlling structure can form a gold depositional environment in the form of porphyry deposits, high sulphidation epithermal deposits, low sulphidation epithermal deposits, massive sulphide deposits. Differences between low and high sulfide systems shown in the table 2 [5].

**Table 2.** Differences between low and high sulfide systems [5]

Properties	Low sulfide	High sulfide
Alteration	Sericite/illite-argillic-propylitic Urate is dominated by quartz ± carbonate	Residual quartz (vughy)-alunite-kaolin minerals-illite minerals-propylitic
Ore Minerals	Pyrite, electrum, gold, galena, sphalerite, chalcopyrite, arsenopyrite	Pyrite, enargite-luzonite, covellite, chalcopyrite, tennantite, gold
Mineral Gangue	Quartz, chalcedony, carbonate, adularia, illite, kaolinite (as overprint), chlorite	Quartz, alunite, kaolinite, dickite, pyrophyllite Dissemination dominance, generally in the form of replacement with little stockwork
Precipitation Form	Dominant veins, with little dissemination and replacement	Replacement of wall rock, breccia and veins
Texture	Veins, cavity filling (bands, colloform, druses), breccias	Au ± Cu, As, Te
Economical Metal	Au ± Ag, Pb, Zn, Cu, As, Hg, Sb, Te	

From the 2D cross-section, it is known that the distribution of resistivity values is influenced by variations in subsurface rocks, then sample data is taken from the 2D cross-section which is considered to represent the subsurface rock structure of the study area. After that, analyze the resistivity value at the point of the 3D geological model. O find out the lithology of the rock, the lithological data obtained is estimated at the total depth and elevation to then be compiled and processed using 3D geophysical software, namely rockwork [4].

Determination of the types of constituent rocks in the geological 3D model is obtained based on the resistivity value indicated by the color image gradation in the 2D modeling results of the inversion and the resistivity value with reference to the resistivity table [5]. It can be seen from the 3D geological model that there is a gradation of color images which means that there are

different lithologies below the surface, for the gray color is indicated andesite lithology, then pink is indicated for clay lithology, then blue is indicated for porphyry granodiorite lithology, then for orange color is indicated. Sandy clay lithology and the green color indicates the dominant soil lithology on the surface.

The same resistivity values can be owned by different rocks, this happens because the resistivity values of the rocks have a range of values that can overlap each other. This research focuses on finding the source rock (volcanic) which is suspected to be associated with gold minerals. The gold content of the research area is a low sulphidation epithermal type hydrothermal gold deposit (in the form of quartz veins), with carrier minerals containing metals and non-metals. Interpretation is done by correlating the results of software data processing in the form of information (resistivity values, depth, thickness) with basic knowledge of rock type resistance aspects, geological information, information on the condition of resident wells (depth and taste) around, knowledge of hydrogeology, referring to rock resistivity tables and references related to geothermal research using geoelectric methods that have been carried out [4,5].

The 2D resistivity cross section of track 1 obtained a subsurface layer with a stretch of about 200 meters (electrode spacing 5 meters) with a depth of about 40 meters. The results of the 2D resistivity cross section on track 1 using 4 iterations obtained an RMS error of 26.9%. Results of the inversion shown the resistivity value is obtained with a relative west-east direction on a topography with a moderate slope having a distribution of resistivity values ranging from 7.75 to 2584 m, shown in blue to purple (fig. 3). This path shows the intrusion pattern of the source 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, resulting in a high resistivity value. In addition, there are rock contacts with low resistivity values (<100m.) 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.

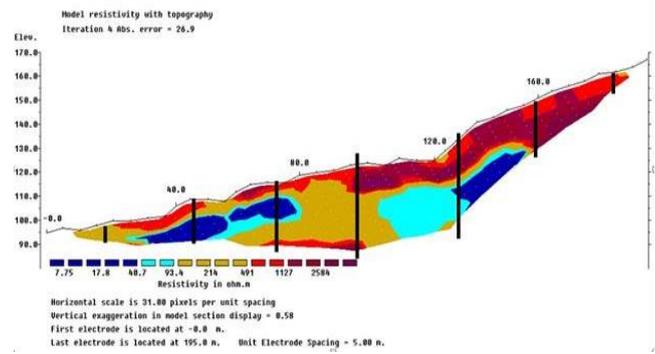


Figure 3. Resistivity map in research that has been overlapped with topography

So that the estimation of the actual rock structure information is obtained. From the interpretation results by correlating all aspects, the volume value of the source rock (volcanic) is 140,000 m<sup>3</sup> and 158,000 m<sup>3</sup> and then the estimated potential (Au) based on the results of laboratory tests is 5 g/ton. From the modeling, it is found that the estimated mineral content (Au) in the study area is 0.7 to d. 2.09 tons, as presented on fig. 4.

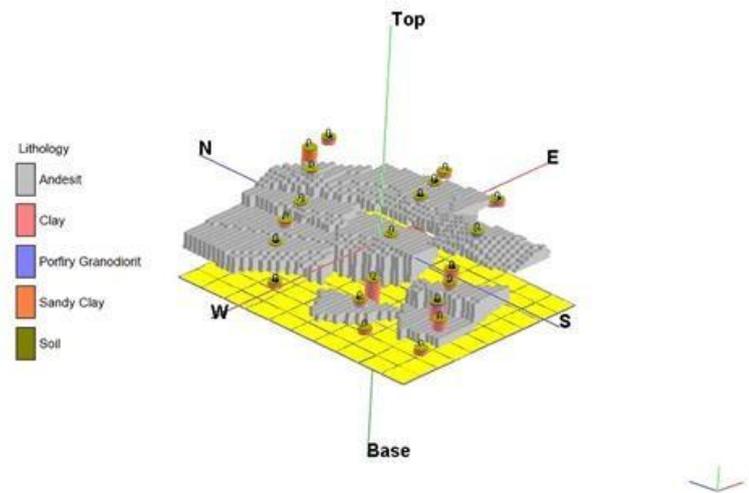


Figure 4. Reconstruction of 3D geological model of andesite lithology distribution using rockwork.

#### IV. CONCLUSIONS

The gold content in this research area is quite economical (5.06 g/ton). However, the economic level of gold to be mined also depends on many factors, one of which is access to the area being mined. If the access is easy, it will certainly be more economical compared to areas with difficult access. Another factor is the amount of

reserves and the depth of gold to be mined. The variation of the resistivity value shows the distribution pattern of the source rock is dominated by a relatively north direction, then in the eastern part there are several distribution blocks of the source rock. Estimation of gold mineral content based on the results of resistivity data modeling, the estimated value of potential reserves at depths of up to 40 m is 0.7 - 2.09 tons. The estimated gold potential is based on the resistivity value of the andesite rock which is the rock followed by several economic minerals in the study area. which then carried out data modeling by considering the volume of Au mineral composition from rock samples in the study area. Furthermore, more geophysical and geological data are needed for vein samples and drilling. so that the status of potential gold in this area can be increased.

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