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Characteristic and Estimated Distribution of Iron Ore in the Bayang Area, Donggala, Central Sulawesi

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ABSTRACT

Fault trending north-south and NNE-SSW is a weak zone that allows the magmatism in the form of magma intrusion passed through older rocks. Magma intrusion occurred in several phases, namely andesite, diorite, and syenite. Donggala iron ore mineralization as a result of the intrusion is accompanied by contact metasomatism. Boulder is dominated by iron ore (magnetite and hematite) occur along the hills and rivers range from 0.5 to 0.2 m. The purpose of this study was to determine the extent of the prospect area iron ore carrier rock based on anomaly geomagnetic field laterally and vertically. The results of the magnetic measurements correction value calculation of show strongly anomalous local magnetic field in 2D. The depiction of the model is based on the depth of the approach used by the inversion method which produces a 3D cross-section. The final result of the evaluation of secondary data, geological, geophysical methods of geomagnetic for minerals iron ore around the Damsol sub distric, Donggala, Central Sulawesi province show that the potential iron ore resources ± 21,5 Ha for Area Bayang, and still have spreads constantly to all extents area.

Keywords: Iron ore, geomagnetic, ground magnetic, inverse method, Area Bayang

1. INTRODUCTION

The process of the minerals iron ore deposits in the Donggala related to the tectonics and mineralization [1]. Formation as a result of tectonic fault structures allows the magmatism in the form of intrusive granitoid rocks (gr) in Formation Tinombo (Tts). The process of magma intrusion in this weak zone until crystallization generally was accompanied by metasomatism to contact metamorphism. Fluid from magmatic contacts is rich in base metals, one of which iron ore. A mineral containing iron ore mainly magnetite (FeO.Fe2O3) containing 72.4% Fe, hematite (Fe2O3) 69.94% containing Fe, goethite (FeO.OH) 62% Fe, siderite (FeCO3) 48.2% Fe and ilmenite (FeO.TiO2) 36.8% Fe. Other iron-containing minerals such as pyrite (FeS2) 46.5% Fe, pyrrhotite (FeS) 63.5% Fe, cannot be regarded as a major source of iron because it is difficult in the technical processing [2].

This study is part of the research phase of the evaluation and validation of the advanced secondary data field magnetic geophysical method, which has been done before in the Bayang village, Damsol sub-distric, Donggala distric, Central Sulawesi Province. This research was conducted as a preparatory step before the area is declared valid for actionable and feasible to be upgraded to the exploitation phase openly, with respect to natural resources potential carrier rock formations of iron ore. The main objective of this research is to direct the activities of geology to determine the location and position drilling plans in the area of the potential area based on the data of geomagnetic data interpretation.

The magnetic properties describe the behavior of any substance under the influence of magnetic field. The magnetic properties of rocks arise from the magnetic properties of the constituent mineral grains and crystals [3]. The values of magnetic susceptibility depend on the grain size, the presence of minute crystal lattice, such as dislocations, lattice vacancies, impurities, and an amount of iron ore in a outcrop [4].

2. REGIONAL GEOLOGICAL

The oldest rocks in the area of investigation in the form of complex metamorphic rocks, covering most areas of the investigation area, consisting of amphibolite schist, mica schist, gneiss and marble, estimated pre-Tertiary age. Diorite and granodiorite intruded complex metamorphic rocks. These rocks are unconformably overlain by Tinombo Formation which consists of metamorphic rocks, shales, sandstones conglomerates, chert, limestone and volcanic rocks deposited in the marine environment. Mollasse rock of Celebes Sarasin and Sarasin contain in lower elevations near the coast, unconformably overlain Tinombo Formation and metamorphic complex (Figure 1) [5].

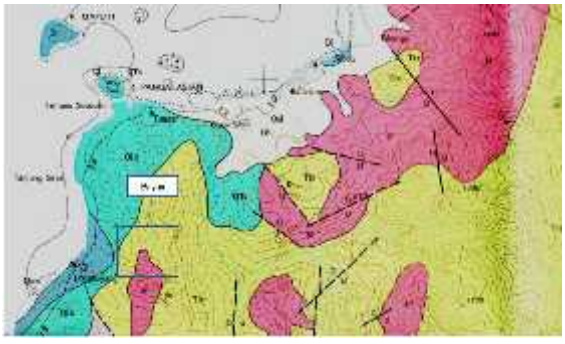

Figure 1. The area of research on regional geology Toli-Toli Quadrangle [5]

2. METHOD

Stage of the research is preparation, execution, data processing, and analysis. Early preparation is the study of literature in the form of a collection of secondary data from previous research results directly related to the use of geophysical methods around the survey area. To know the general picture of the geology of the region carried out directly in the field orientation. It is as part of the planning and preparation of the team, especially to create a framework geophysical field.

The experiment was conducted using the method of field observations to perform magnetic measurements on each track that has been prepared in advance. On each track, data collection or acquisition magnetic value of the observation stations.

3.1 Geomagnetic method

Geomagnetic method is one of geophysical exploration method that utilizes the phenomenon of magnetism of the earth to estimate the structure or geological conditions below the surface (subsurface). Earth's magnetic field globally oriented toward the North - South. Rock magnetism is generally assumed as a result of the induction process with the same direction as the main magnetic field of the earth. The main magnetic field induces earth minerals are magnetic contained in certain rock formations [6].

In the survey measurements of a geomagnetic total magnetic field is a superposition of the Earth's magnetic field and induction in the rocks. Observation points are located on the track trending north - south. The distance between the measurement points

should be spaced closely enough to detect any anomalies, while the distance between the trajectories can be made relatively rare [6][7].

Based on that, the rock formations cause magnetic anomalies and can be detected by a geomagnetic survey which is primarily a longitudinal formation (elongated) in the direction West - East. To cover the survey area as a whole it is suggested trajectory measurements trending North - South by the distance between the track about 25 meters while the distance between the observation point in one track is 10 meters. Data that has been recorded on a magnetometer were used for measurements at the observation point at the base station and transferred to a computer. Diurnal correction is the first step in the processing of magnetic data. Diurnal correction aims to correct the measurement results at the point of observation of their daily magnetic field variations (temporal variation) so that the measurement results in a pure describe spatial variations or anomalies due to the rock structure.

After correction diurnal (IGRF and Variations daily) have been completed, the next step is to perform the interpolation of the data Intensity Magnetic Total (TMI) for all of the tracks that are, by using the method of gridding (ie. Minimum curvature, rigging etc.), in order to produce a general description of the intensity values in a 2D map.

3.1.1 IGRF Correction and Daily Variation

Correction of the data of the geomagnetic field aims to eliminate the influence from the main magnetic field and the external magnetic field of the earth. The original purpose of the survey is to obtain geomagnetic anomalies local magnetic field (monopole). Data obtained from measurements of the total magnetic field is the result of three basic components of the magnetic field (poly-pole), which is the main field, the external field, and the observation of local terrain. It is necessary to remove the influences that come apart from the local magnetic field anomalies.

3.1.2 Filtering (FFT 2D)

If the value of a magnetic field on a surface is known, it can be determined that the magnetic field on the surface of another, if there is no mass between the surface (Laplace law). Magnetic data processing stages of this phase is more focused on the application of filtering method (2D) of the potential field data from magnetic readings on the surface. The filtering method is generally used to separate a local anomaly of the regional anomaly. Regional anomalies associated with the dominant general geological conditions in the measurement area are characterized by the low-frequency anomaly. Local anomaly or often also referred to as anomalies affected the rest of the local geological conditions that have deviated from its regional conditions. The condition is generally at shallow depths [7][8].

3.1.3 3D Modeling

The current computational resources are appropriate to handle such inversion modeling routinely, even with a large number of grids. The extension of the algorithm to solve more complex 3D structures is currently underway based on existing 3D gravity and magnetic modeling algorithms [9]. The development of the algorithm for 3D inversion

of magnetic data is crucial since magnetic data are used more frequently in mineral exploration [10].

4. RESULT AND DISCUSSION

4.1 *Local Geological*

Morphology of the Bayang area is classified in the undulating hills with an altitude ranging between 200m – 420 m occupies the north-western part of the map. River flow pattern is radial and dendritic, represented by Bayang River, River Sinabung, Ogololo River and Ou River. Profile rivers here in the downstream section resembles the letter "U" and on the upstream still resembles the letter "V" and the steep of the ridge. Based on the characteristics of the dominant vertical erosion and exposure of bedrock those still compose the river, the research areas included in the young stadia.

Lithologies from old to young are a unit of phyllite, andesite unit, coral limestone unit, the unit of dacite and granite units. Phyllite unit in dominance by phyllite and quartzite composed. Phyllite unit occupies the south along the river Bayang and Sinabung. Phyllite rocks are gray, textured foliate trending N 115˚ E / 30˚, composed of mineral-containing mineral mica, chlorite, fluorite, sericite, quartz, and pyrite. Quartzite colored light gray, massive, granoblastic texture, and partly foliate, composed of mineral mica, feldspar, pyrite, and ilmenite. This unit is compared with Tinombo Formation.

Basalt unit is dominated by basalt rocks and consists of andesite and diabase rock. Basalt Unit revealed at the Bayang River upstream. Basalt is gray-black, forming pillow lava structure, composed of mineral pyroxene, olivine, and plagioclase. Andesite gray, structured flow and partly shows the amygdaloidal structure by the mineral quartz. Diabase rock light green to dark green, there is iron ore mineralization. This unit is compared Formation Tinombo Ahlburg.

Coral limestone lithologies shows brown, yellow and gray. Characteristics of limestone containing corals and shells of mollusks, pisolitic-oolitic, compact-brittle, the composition of the fragment consist of coral and mollusk shells, cement form of dolomite, decompose calcite and chalcedony. Exposed area of close to Downstream section of River Bayang. There is a clear limit contact with phyllite-schist in Bayang River cliffs. Lithology be compared Molasa Formation.

Dacite lithologies consist of dacite and andesite exposed in the upstream Sinabung River, Ogololo and Ogololo Village and at the top of the hill to the hillside. Dacite show light brown, yellowish to dark brown and light gray, textured porphyritic, massive structure, composed of K-Feldspar mineral, oligoclase, biotite, muscovite, quartz, and glass volcanic. Andesite dark gray, amygdaloidal and massive structure, texture porphyritic, composed of mineral plagioclase, biotite, hornblende, pyroxene and volcanic glass groundmass. These rocks are commonly exposed as a boulder, bomb and lapilli along the Ogololo, Ou River and disseminated mineral containing iron ore, in part upstream Ogololo found bomb-lapilli accumulation rather a lot.

The units consist of granite rocks granite and andesite. Sill granite colored light gray, white to pink, texture holocrystalline, equigranular. The mineral composition consists of quartz, plagioclase, biotite, mica, ilmenite, pyrite and magnetite. These rocks are widely exposed in conditions of strong weathered along the road from the village of Ou Downstream S.Ogololo (Figure 2a).

The topography study area is at an altitude of 40-450 meters above the sea. It surfaces morphology study area consists of steep hills. While the results of morphological observation show the morphology of isolated and circular reinforcing the interpretation of the spread of igneous rocks are intrusive rocks and not the result of lava flows. Description observations of rocks on the track geomagnetic measurements are as follows:

- Hematite and magnetite were discovered in andesite. Rocks were exposed on the slopes and partly in the form of lumps. Mineral hematite and magnetite are distinguished by the rock by its metallic luster (Figure 2b).
- Along the path on the river found a lump of andesite rock angular forms indicate that the origin of these rocks closes to the source. Andesite is gray-black and contains mineral magnetite.
- The content of mineral elements silica will be higher in the samples containing samples of iron minerals.
- The zone of rocks containing iron minerals will disappear because it has been replaced by ultramafic rock composition into the intermediate to acid rock chemically contains a small element iron.

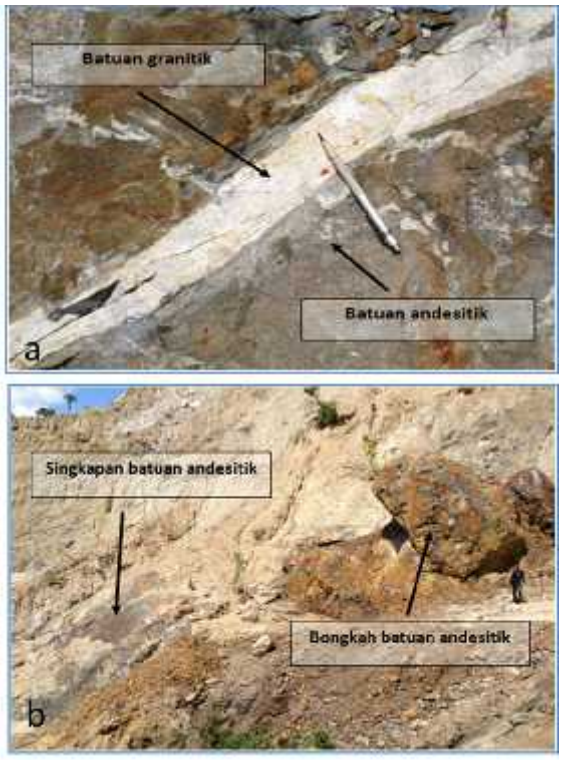

Figure 2. Outcroup of granite intruding andesitic rocks (a) and andesitic rocks rich in hematite and magnetite (b)

The indication of the existence minerals containing iron ore were contained in the contact between intrusive rocks granite and andesite. These rocks contain minerals magnetite and hematite that have strong magnetic field susceptibility (Figure 3). The content of the iron ore in the rock economically dominated by the mineral magnetite and hematite, such as those found in the area Sojol, Donggala [11]. Intrusive rocks are granite and andesite just intruded Tinombo Formation-Schist and phyllite ie unit rocks Andesite volcanoes, so the possibility of contact between the mineralized rocks is formed between the form the vein and can be caving. But on the

ground in well encountered several mineralized outcrops on andesite, dacite, and diabase. Hematite and magnetite are also found in the form of cavity filling and disseminated leads to replacement. Based on analysis of rocks and minerals then determined the location of geophysical measurements with the method of geomagnetic.

Figure 3. Hematite (a, b) and magnetite (c, d) on andesite and granite rocks

4.2 *Magnetic Anomalies*

Once the entire magnetic data is completed corrected, then the data were analyzed with the aim to see the trend of the general pattern of local magnetic anomalies. Zoning local magnetization value high enough to dominate in some parts especially apparent in the northern part and a fraction longer in the southern part of the study area. On the map of magnetic anomalies and magnetic intensity map (Figure 4) visible magnetic intensity is quite strong. It is characterized by anomalous values of negative and positive are not much different from -2100 to +500 nano-Tesla (nT) (Figure 4b) or magnetic intensity values that are in the local magnetic intensity values research areas 38900 to 41500 nT (Figure 4a).

Although the magnetic intensity is strong enough, but in the study area tend to be dominated by negative magnetic intensity around -400 to -1200 nT. In general, the pattern of the value of magnetization has a pattern of multiple anomalies are a negative and positive anomaly. The positive anomaly with a high range of +100 to +500 nT (purple) and an area of anomalies are 68.200 m² or 6.8 Ha. While the value of negative anomalies low range - 400 to - 2100 nT (green - blue) and an area of 215,000 m² or 21.5 hectares (Figure 4b) is suspected as iron ore prospect areas. Based on the results of the simulation conducted in the study area iron ore body is in the area of negative anomalies ranging between - 400 to - 6000 nT.

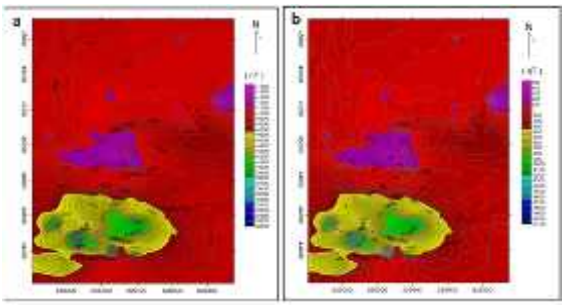

Figure 4. (a) Map of Total Intensity Magnetic on Bayang area; (b) Map of magnetic anomalies on Bayang area

In order to see the whole pattern of restriction zones total magnetic prices in this area, all data within the limits of anomalous zones were then separated by its magnitude and then assigned a weighting corrections based on actual topography using inversion method approach to 3D modeling. It is

intended to determine the direct effect of high and low due to the Earth's surface as well as the position of the zone formed by the value of the total magnetic anomaly previously obtained from the results of interpretation. The final results will be obtained 3D models for interpretation.

From the results of 3D modeling (Figure 5), the region appears to result formation the magnetic anomaly zone around the survey area is strongly influenced by the topography (morphology) local. Interpretation of 3D modeling is used to determine the exact positions of the drilling plans are carried out at a later stage. The simulation results The following is an overview of the planned drilling that will be done at a later stage. To gain the certainty of the area the dimensions of the target zone to be searched based on the interpretation of the 3D picture (Figure 6).

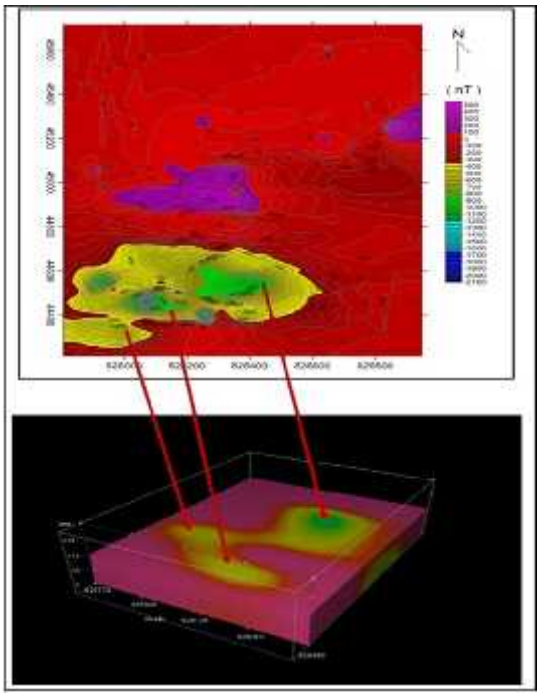

Figure 5. Three dimension modeling results based on the value of the magnetic anomaly zone the Bayang area

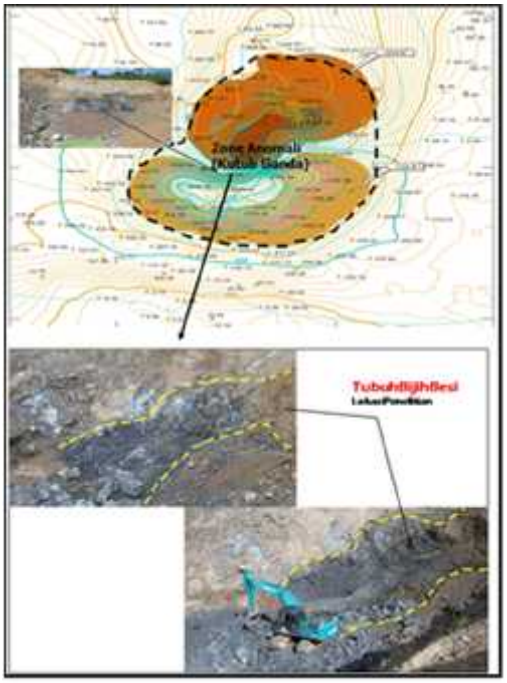

Figure 6. Simulation results in geomagnetic research areas

5. CONCLUSION

Based on the results and discussion, we conclude as follows:

1. Intrusive rocks occurred in several phases, namely andesite, diorite, and dacite, accompanied by metasomatism contact.
2. The indication of the existence of minerals containing iron ore contained in the contact between intrusive rocks granite and andesite.
3. The rocks in the study area that have strong magnetic susceptibility are in andesite and dacite, which is dominated by hematite and magnetite minerals
4. Iron ore body was identified in one negative magnetic anomaly zone with a range - 400 until - 2100 nano-Tesla (nT), an area of 215,000 m² or 21.5 Ha.

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