PROCEEDING
1st EARTH SCIENCE INTERNATIONAL SEMINAR
YOGYAKARTA, 29th - 30th NOVEMBER 2012

"INCREASING ROLE OF EARTH SCIENCE AND TECHNOLOGY TO SUPPORTING ACCELERATION OF MINERAL AND ENERGY RESOURCES CONSERVATION"

Faculty of Mineral Technology UPN "Veteran" Yogyakarta, Indonesia
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Theme:
“INCREASING ROLE OF EARTH SCIENCE AND TECHNOLOGY TO SUPPORTING ACCELERATION OF MINERAL AND ENERGY RESOURCES CONSERVATION”

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Faculty of Mineral Technology
UPN “Veteran” Yogyakarta
2012
Foreword

The first International Earth Science Seminar 2012 of Faculty of Mineral Technology of UPN "Veteran" Yogyakarta and 5th Indonesia – Malaysia Joint Geoheritage Conference with its theme "Increasing Role of Earth Science and Technology to Support Acceleration of Mineral and Energy Resources Conservation" is a collaboration of FTM UPN "Veteran" Yogyakarta Indonesia – UKM Malaysia, held in Yogyakarta at FTM seminar room UPN Veteran Yogyakarta 29-30th November 2012.

The Seminar exposes a discussion fair which will integrate earth science, technology and business opportunities. The exposition offer a unique opportunity for technical and business discussions amongst participants from leading oil and mineral companies, government representative and academia. It also enables a dynamic interaction between all of participants.

In addition to the above seminar, it gives me a great pleasure to introduce you the technical papers of the seminar in a format on Proceeding. We received over 60 abstracts from operating companies, service companies, government agencies, universities and students for evaluation and 48 outstanding papers have been selected for inclusion in this year's technical program. The technical committee for this seminar has strived very hard to select the best and highest quality papers that are relevant to the International Earth Science and Technology. The selected papers have special emphasis on case studies and best technology practices applied in the Earth Science technology.

In closing, I would like to recognize the great efforts, dedication and hard work of the 2012 International Earth Science Seminar committee who tirelessly worked with the authors and editors to make this year’s technical program an outstanding success.

I hope you will find the technical papers in the proceeding useful and helpful in establishing a better understanding of the Earth Science development.

Sudarmoyo
Chairman,
Yogyakarta 2012 International Earth Science Seminar
Gubernur
Daerah Istimewa Yogyakarta

Sambutan
SEMINAR INTERNASIONAL KEBUMIAN
“PENINGKATAN PERAN IPTEK KEBUMIAN DALAM MENDUKUNG AKSELLERASI
KONSERVASI SUMBER DAYA MINERAL DAN ENERGI”
Yogyakarta, 29 November 2012

Assalamu’alaikum Wr. Wb.
Salam sejahtera bagi kita semua,

Yth. Rektor Universitas Pembangunan Nasional "Veteran" Yogyakarta, Prof. Dr. H. Didit Welly Udjianto, MS. yang diwakilkan oleh Wakil Rektor III, Bapak M. Nurcholis.


Hadirin serta peserta seminar yang berbahagia.

Mariilah kita senantiasa mengucapkan syukur kehadirat Allah Subhanahu Wata’ala, atas limpahan karunia-Nya, sehingga pada hari ini kita dapat hadir dalam keadaan sehat wal’afiat.


Adapun filosofi pembangunan di Daerah Istimewa Yogyakarta, diambil dari filosofi Jawa yaitu Hamemayu Hayuning Bawono. Filosofi ini menekankan adanya keselarasan antara manusia dengan manusia, manusia dengan alam, serta manusia dengan Tuhan. Ternyata, apa yang diajarkan nenek moyang kami, memiliki persamaan dengan tiga pilar pembangunan keberlanjutan, yaitu menguntungkan secara ekonomi (economically viable), diterima secara sosial (social acceptable), dan ramah lingkungan (environmentally sound). Dengan adanya keselarasan antara manusia dan alam, pembangunan dapat terus berjalan tanpa mengurangi kemampuan alam dalam menyediakan segala sumber dayanya untuk generasi sekarang dan yang akan datang.

Hadirin yang saya hormati,

Sumber daya mineral dan energi, mempunyai peranan yang sangat penting dan menjadi kebutuhan dasar dalam pembangunan ekonomi yang berkelanjutan. Oleh karena itu, keduanya harus digunakan secara hemat, rasional dan bijaksana agar kebutuhan energi pada masa sekarang dan masa yang akan datang dapat terpenuhi.

Efisiensi adalah salah satu langkah dalam pelaksanaan konservasi energi, sebab cadangan energi fosil yang merupakan salah satu sumber daya mineral nonlogam, jumlahnya terbatas dan sifatnya tak terbarukan. Dengan mengurangi penggunaan energi fosil, tentunya lingkungan kita juga semakin sehat karena polusi dan emisi gas rumah kaca bisa ditekan. Industri barang dan jasa akan lebih produktif dan kompetitif jika biaya pemakaian energi dapat diminimalkan. Begitu pula dengan penghematan energi di sektor rumah tangga, akan memungkinkan alokasi dana untuk kebutuhan rumah tangga lainnya.


Hadirin yang saya hormati,

Untuk itulah peranan ilmu pengetahuan dan teknologi kebumian tentu sangat diperlukan dalam mendukung akselerasi konservasi sumber daya mineral dan energi tersebut. Tentunya saya sangat berharap saudara-saudara disini yang memiliki disiplin ilmu kebumian, dapat menyumbangkan berbagai ide inovatif dan kreatifnya pada seminar bertaraf internasional ini.


Sekian dan terima kasih atas perhatiannya.

Wassalama’alaikum Wr. Wb.

Yogyakarta, 29 November 2012

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DAERAH ISTIMEWA YOGYAKARTA

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Mapping Of Lateritic Nickel Deposit Using Resistivity Method At Gunung Tinggi Talaga Piru, Western Seram Regency, Mollucas Province

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Abstract

A geophysical research has been done by using resistivity method at Gunung Tinggi Talaga Piru, Western Seram Regency, Mollucas Province. This research aims to find out the existence of latentic nickel deposit and resource estimation of latentic nickel deposit in the research area. The data were processed by using Res2Dinv software to generate information about the true resistivity in 2-D section. Then the data were analyzed and correlated to the results of petrography analysis, geochemical analysis, and geological surface data. Furthermore, the 3-D modeling was made using the Oasis montaj software ver 6.4.2 to estimate the volume of latentic nickel deposit.

The results of samples analysis indicate that the average content of elements for Co, Fe, and Ni were 0.02%, 4.70%, and 1.29%. The value of latentic nickel resistivities in this area are 40-150 ohm meter for limonite zone and 150-400 ohm meter for saprolite zone. From result of the 3-D combined sections of limonite and saprolite, it can be known that the measurable potential model for latentic nickel was 326.673 m³, so the total of estimated latentic nickel resources in the research area was 638,672,77 tons at the concentration of 1.29%. The measurable potential amount of latentic nickel covers only the research area.

Keywords: resistivity, lateritic nickel, 2-D and 3-D models.

I. Introduction

Nowadays mineral resources are evolving in industry in Indonesia is nickel which used for stainless steel production. Nickel ore comes from latentic nickel deposits were formed by weathering of ultramafic rock which contain nickel about 0.3%. Lateritic Nickel mostly founded in tropical region because one of factors which support weathering is climate, besides topography, drainage, tectonic, source rock and geological structure. Nickel ore spread out in some area in Indonesian, those are Kalimantan, Sulawesi, Oli Maluku, Seram Maluku, Halmahera, and Papua.

Mollucas potentially of kinds of mining materials which undeveloped optimally. Mollucas province is placed among three main plate of earth crust, those are Eurasian plate, Indo-Australian plate, and Pacific plate. The boundaries of those plate potentially for the forming of mineral resources trap, geothermal, and hydrocarbon basin. One of the raw materials in Gunung Tinggi, Talaga Piru, Western Seram Regency, Mollucas Province is lateritic nickel. But the dispersion of lateritic nickel in that area has not known yet.

Resistivity method is applied to know the distribution of lateritic nickel deposit. This method is applied to observe the subsurface by using electricity properties of rocks and medium, that is resistivity. According to the parameters, the result of resistivity method qualitatively and quantitatively can be identified the distribution pattern of lateritic nickel because the existences of nickel in the rocks will give resistivity contrast from surrounding rocks. The distribution of lateritic nickel then can be used to determine the potential of lateritic nickel in research area by doing resistivity survey laterally (mapping).
II. BASIC THEORY

2.1 Resistivity Theory

The relationship between potential difference ($\Delta V$) with current flowing through the conductor which has a resistance $R$ (Lowe, 2007) are:

$$\Delta V = I \cdot R \quad (1)$$

When a resistor-shaped beam with length $L$ and surface area $A$ is connected to the source voltage, electric current will flow in the direction parallel to and with a uniform charge distribution, as shown in figure 2, so that the resistor can be translated into, $A$ and $p$ (resistivity) which is to physical quantities of materials (Robinson, 1988) as written below:

$$R = \rho \frac{L}{A} \quad (2)$$

![Figure 1. Resistivity Measurements of A Medium](image)

where,
- $\rho$ = Resistivity, ($\Omega$·m)
- $R$ = Resistance, ($\Omega$)
- $A$ = Cross sectional area, ($m^2$)
- $L$ = Length of material, (m)

2.2 Electrode Geometry Factor of Configuration dipoles

This research used dipoles configuration (Figure 2), where the electrode potential is beyond the current electrode. The distance between the two electrodes flows equal to the distance between the electrode potential of a. While the current electrode and the inner electrode potential (B and M) is na, with $n = 1, 2, 3, 4, \ldots$ So the geometry factor for dipoles electrode configuration (Milsom, 2003) is:

$$K = \pi a \frac{(n+1)(n+2)}{n} \quad (3)$$
Figure 2. The Dipoles Electrode Configuration

So the apparent resistivity values for the dipoles configuration is written as:

$$\rho_a = (\pi a n(n + 1) n + 2)) \frac{\Delta V}{I}$$ (4)

Data on each measurement dipoles configuration is expressed in the form of data points as shown as figure 3. Each measurement points are at the intersection of 45° from the center of the dipole potential and current (z = ½ distance with the current dipole potential), (Loke, 2004).

Figure 3. Measuring The Position of The Point Dipoles Configuration

III. Research Method

The research was conducted in Gunung Tinggi Talaga Piru, Western Seram Regency, Mollucas Province (Figure 4). In a survey nickel laterite search on Gunung Tinggi Talaga Piru, Distric, Kabupaten Seram Bagian of West Seram, Western Seram Regency, used equipment GL-4100 Resistivity meter.

Figure 4. Map of Research Gunung Tinggi Talaga Piru, Pulau Seram Bagian Barat
For acquisition data, firstly we do some preparation such as:

1. Literature study about the condition of the research area to obtain the information of rock types, and to determine the focus area.

2. Field Orientation to look in detail areas of research, to determine the layout of resistivity lines survey and some observation points.

After the line and the observation point were determined, then the field data were taken. Resistivity data in the field were taken using a dipole-dipole configuration. The data measured in the field were the potential difference (ΔV) and electrical current into the ground (I). Research area has an area of (220x500) m² distributed into 7 (seven) lines dipole-dipole with direction of the lines was northwest-southeast. The distance between the line ± 50 m with electrode spacing, a = 10 m.

Processing and data analysis for 2-D resistivity modeling is done by Res2dinv software (Loke, 1999), then the next process is to create 3-D modeling using Geosoft Oasis Montaj Version 6.4.2 software that will be used to calculate the volume of lateritic nickel.

IV. Result And Discussion

Based on geological data, the research area is an prospect area of lateritic nickel deposit. This deposit is common in areas which the source rock is ultramafic rocks, then controlled by intense fracturing and faulting, and the areas have undulating topography.

4.1. Petrographic Analysis

Petrographic analysis was done for seven selected samples points, the results of petrography observation from the seven samples show similar mineralogical characteristics, but the difference is the percentage of each minerals and then from the percentage of minerals in the rock will determine the name of its rock.

The petrographic analyzes by using a polarizing microscope show that the minerals which present are dominated by pyroxene group (such as enstatite, hypersthen, diopside) olivine group and serpentine group such as chrysotile and antigorite. The composition of sertentinized peridotite are pyroxene (enstatite, hyperstene, diopside), serpentine (antigorit and chrysotil) and olivine, and other minerals are like magnetite, and so on in small amounts. When the metamorphism process these minerals will be altered into serpentine group such as antigorit and chrysotil. The result of petrographic analysis show that there are the addition and elimination of minerals.

4.2. Geochemistry Analysis

Geochemical analysis was done by using Atomic Absorption Spectroscopy method to determine the metal content (Co, Fe and Ni), and calculate the average of metal content (Co, Fe and Ni). The result of analysis shows that the maximum percentage of Fe is 7.375% found in GT-03 line at 10 m distance, the maximum percentage of Ni is 2.613% found in GT-06 line at 180 m distance, and the maximum percentage of Co is 0.021% in GT-03 line at 10 m distance. Ni with high concentration (2.61%) distributed in the southwest and some places in the east and northeast such as shown in Figure 5.
4.3. 2-D Resistivity Modeling

The result of processing resistivity data is the layers pattern of lateritic nickel. There are three layers in lateritic nickel deposit, these are limonite zone, saprolite zone and bedrock zone. Lateritic nickel layer (limonite and saprolite zones) as a research object has lower resistivity value than overburden and bedrock layer. It is because the lateritic nickel layer is produced by intense weathering process so the resistivity value is going to be lower than bedrock which solid and compact. The Lateritic nickel layer is divided into limonite and saprolite zones. The limonite zone has the resistivity value is 40 to 150 ohm.m and the saprolite zone has the resistivity values is 150 to 400 ohm.m. While the resistivity value of the host rock or bedrock is greater than 450 ohm.m.

Line GT-04 has northwest-southeast trend (Figure 6). From the measurement of geomorphology profile, the topography is categorized into high undulating plain which maximum height difference is 14 m.

![Figure 6. Profile of The 2-D Section of GT-04 Line](image)

Line GT-04 is the next line from the line GT-03, so this line has similarities because they are too close together. In the GT-04 line, the resistivity value of saprolite is shown by the green - yellow color spread on distance 20-160 m with the thickness 5-22 meters. In the distance 15 m and 175 m, the bedrock outcrops was found that located near the surface. While the resistivity value of bedrock is the yellow-red colors which spread from distance 20 to 90 m and from distance 140 to 200 m with thickness 5-15 m from the surface. In this line, the limonite zone is estimated through many times erosion process and transported to another place so that its presence was minimal on the surface.

In fact that the lateritic nickel layer is overlap with other layers that contain a lot of iron known as limonite zone. This layer is thin on the steep areas, and had lost due to erosion. Below this zone there are nickel deposits which resulted by the precipitation of nickel from above zones that carried by water to the zone known as saprolite zone. Saprolite zone, a zone of nickel enrichment and mixture of the remnants of rock which is sandy, and the transition zone from limonite to bedrock. The structure and texture of initial rock was still visible. Figure 7 shows the distribution of saprolite zones that seen all around the lines in the area of research.
4.4. Resource Analysis of Lateritic Nickel

The calculation of the lateritic nickel volume is obtained from each voxel box made in Geosoft Oasis Montaj version 6.4.2 software, using the box (cube) for three-dimensional display. Lateritic nickel is divided into zones of lateritic nickel limonite and saprolite zones. The Limonite zone has the resistivity values between 40 to 150 ohm.m whereas the saprolite zone has the resistivity values between 150 to 400 ohm.m.

Almost every line can be found limonite and saprolite zone presence that indicates the distribution of lateritic nickel. Limonite zone in the figure 7 indicated by a green color scale. Meanwhile, for the saprolite zone indicated in yellow. Based on the modeling with Geosoft Oasis Montaj version 6.4.2 software, measurable potential lateritic nickel consisting of measurable potential limonite and saprolite measurable potential of 3-D volume can be calculated. From Voxel Statistics obtained a large of limonite volume was 108.054 m³, while saprolite volume was 218.619 m³.
V. Conclusion
Lateritic nickel profile in the research area consists of limonite zone, saprolite zone and bedrocks zone with the value resistivity is 40-150 ohm.m for limonite zone, 150-400 ohm.m for saprolite zone and more than 450 ohm.m for bedrocks zone. The distribution of lateritic nickel in the research area are in limonite and saprolite zones.

The percentage of Fe disperse in the southeast to southwest, with the maximum percentage is 7.37% found in the GT-03 line distance 10 m, and then the Ni disperse in the southwest and northeast with the maximum percentage is 2.61% found in the GT-06 line distance 180 m and Co disperse in the south east with the maximum percentage of 0.02% found in the GT-03 line distance 10 m, so the average total content of elements in all lines for Co, Fe, and Ni were 0.02%, 4.70%, and 1.29%.
The potential lateritic nickel resources in the research area is 658.572 tons.

VI. References


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