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Geochemical Analysis of Metal Minerals on Kuantan Singingi Regency, Riau Province as a Connection part of Bukit Barisan Mountain, West Sumatera, Indonesia

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Abstract— The research area is located in Muara Lembu Village, Singingi District, Kuantan Singingi Regency, Riau Province. Located at coordinates 0°25'40.85"S - 101°17'50.82"E and 0°26'45.50"S - 101°19'27.81"E. The research area's landform consists of slightly structural steep, structural sloping hills, and low denudational hills. The study area consists of a rock unit, which is claystone units indicated by a thin layer that formed metal minerals because of the erosional process in several places, which the erosion process transported to the research area. It is supported by thrust slip fault, resulting in gaps at the weak zone and eroded minerals filling and changing the claystone composition. At the same time, the oxidation process occurred in the research area. The geomorphology and stratigraphy analysis results show three types: Slightly Structural Steep, Structural Sloping Hills, and Low Denudational Hills. The results of Genesis and Potential Minerals in the study area consist of carrier rocks from the Claystone Unit. The deposition process can be called Sediment Genesis. The results of X-Ray Fluorescence (X-RF) and X-Ray Diffraction (X-RD) tests showed that the highest minerals are silica (SiO₂) with metal mineral potentials such as pyrolusite (MnO₂), Muscovite (H₂KAl₃Si₃O₁₂), Graphite (C), Hematite (Fe₂O₃), Aluminum Oxide / Corundum (Al₂O₃), Manganese (Mn), Silver (Ag), and Titanium (Ti). This research showed the economic value in the form of iron and steel.

Keywords— Muara Lembu; metal minerals; oxidation; X-Ray Fluorescence (XRF); X-Ray Diffraction (XRD).

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I. INTRODUCTION

Metal mineral resources, as one of the natural wealth owned by Indonesia [1] – [5], if it managed properly, will contribute to the economic development of the country. Metal minerals play an essential role in the life of modern technology nowadays. In 2014, Indonesia, according to the United States Geological Survey (USGS) ranked 6th as a rich country in mining resources [6]. If managed properly, it will make the mining sector contribute to Indonesia's gross domestic product (GDP), open up many jobs, and even create Indonesian mining professionals. One of the areas consist of abundant minerals (based on geological condition) [7] is in Muara Lembu Village, Kuantan Singingi Regency, Riau Province, which aligns continuously to the Bukit Barisan Mountain, West Sumatera, Indonesia (Figure 1).

II. MATERIALS AND METHOD

A. Materials

1) *Stratigraphy; members of Batusabak and shale tuhur formation (tits):* Tuhur formation [8], [9] is the bedrock Based on its lithological. Tuhur formation's lithology are Batusabak, members of shale, Napalan shale, inserts shale, Radiolarite, a thin layer of metamorphosed greywacke, and a member of the Triassic Limestone.

2) *Metal Mineral:* Minerals that contain one type of metal or several metal associations are called metallic minerals [10], [11]. If the metal content is relatively large and chemically bound to other elements, it is called an ore mineral. Iron is the second most abundant metal on earth. The character of these iron deposits can be metal deposits that stand alone but often found associated with other metal

and Siderite. Sometimes it can be in minerals: Pyrite, Pyrrhotite, Marcasite, and Chamosite [12] – [16].



area's landform is the result of a geomorphological process caused by an endogenous and exogenous force.

4) *Lithology analysis*: The lithology analysis is used to determine the geological unit boundaries for each rock/formation [24]-[26].

5) *X-Ray Fluorescence (X-RF) analysis:* XRF is widely used to determine the elemental composition of material because this method is fast and does not damage the sample [27]-[30]. This method was chosen for application in the field and industry for material control.

6) *X-Ray Diffraction (X-RD) analysis*: XRD is used to determine the minerals contained in mining material and its associations [31]-[35].

III. RESULT AND DISCUSSION

A. Geomorphology and Stratigraphy

1) *Unit of unit of slightly structural steep*: This geomorphological unit is in the Northwest and Southeast parts of the study area, with a 35% distribution percentage in slightly structural areas. It has a 15-30% slope percentage of and with elevation 250 - 300 masl (Figure 2).



Fig. 2 Geomorphological unit of a slightly steep structural hill.

2) *Unit of structural sloping hills*: This geomorphological unit is in the Southwest part of the research area with a 45% distribution percentage found in areas with sloping slopes and has 7-15% of a slope with 100 - 200 masl elevation (Figure 3).

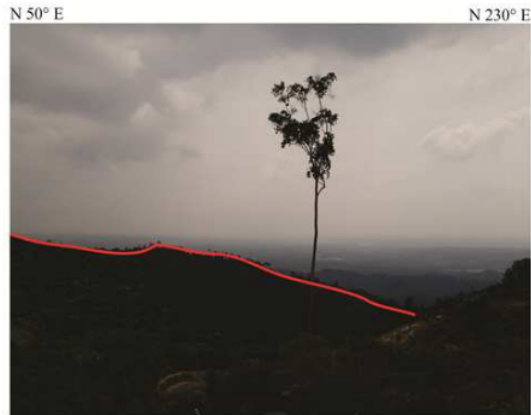


Fig. 3 Geomorphology unit of Structural Sloping Hills.

3) *Unit of low denudational hills*: This geomorphology unit is located in the Northeast area of research with a 20% percentage distribution, which found a low slope with a 07-15% slope with 50-100 masl of elevation (Figure 4).



Fig. 4 Geomorphology Unit of Low Denudational Hills.

Meanwhile, the study area's stratigraphy (Figure 5) consists of clay rock units with lithology consisting of shall-clay with Triassic age. The study area's regional correlation is the member of slate and shale rock from the Tuhur formation.

Age	Rock Unit	Lithology	Regional Correlation
Triassic	Clay Rock	Shale-Clay Rock	Members of slate and Shale of Tuhur Formation

Fig. 5 Stratigraphic Column of Research Area.

B. Genesis and Potential Minerals

1) *Claystone unit*: claystone occupied the whole of the research area (Figure 6). Claystone in the research area shows the characteristics of weathered with grayish-brown and fresh color with gray color. The rock has a clay grain with a closed container, so it is not carbonated with rather hard compactness and has no contact between rocks (Figure 7).

2) *Sediment genesis of metal minerals*: According to observation, calculation, and analysis, metal minerals can be formed and found due to erosion in several places that occur due to weathering of the landform (Figure 8). The erosion is transported to the research area and supported by the presence of metal minerals. A fault that increases the opening of gaps in the weak zone and the eroded minerals enter then changes the composition of claystone minerals so that in the research area, metal minerals can be found. Furthermore, after the eroded minerals come and change the minerals' structure in the clay, then in an oxidation process, this oxidation process is common in weathering, namely iron oxidation.

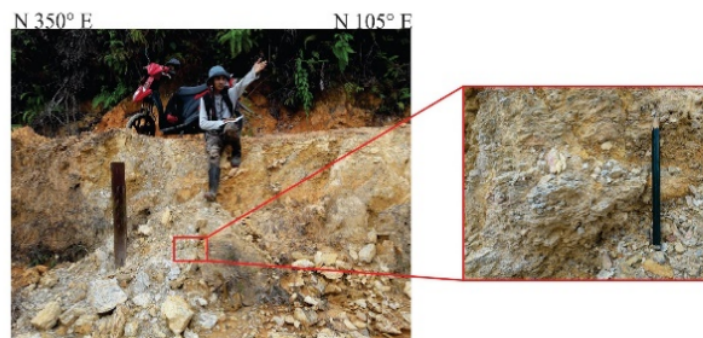


Fig. 6 Claystone Unit in the Research Area.

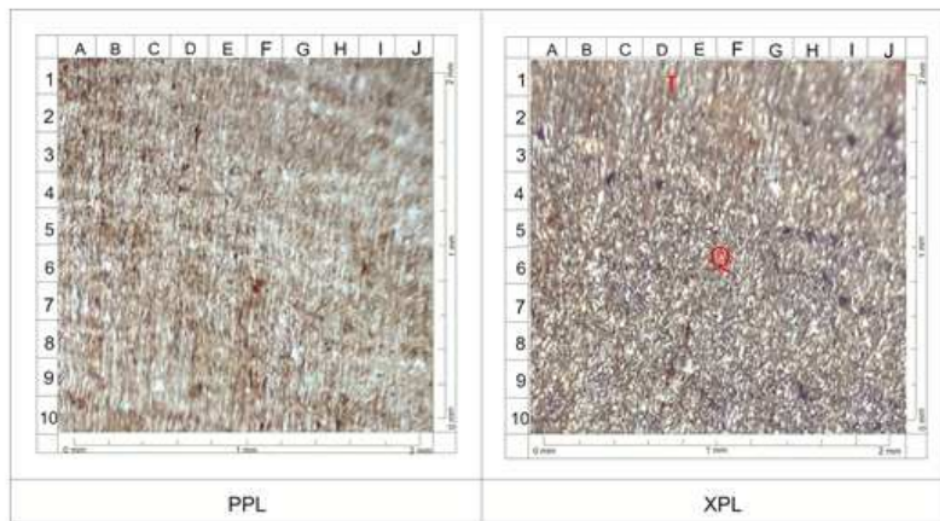


Fig. 7 The Appearance of Claystone Thin Section.

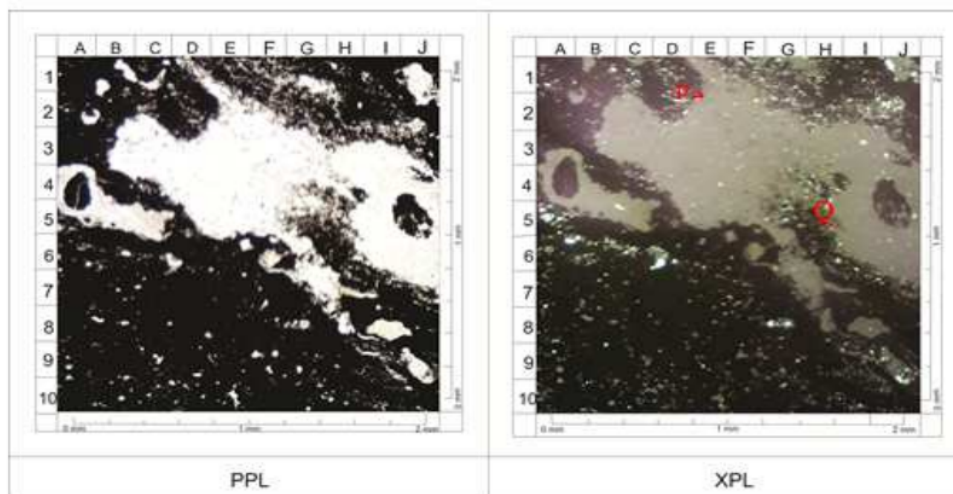


Fig. 8 The appearance of metal minerals thin section shows the erosion process has occurred to this sample.

3) *X-Ray Diffraction (X-RD) result analysis:* The potential area with a high composition of metal minerals has been identified and measured with six (6) samples (for sample distribution, see Figure 1). From Station 03, it can be seen the Pyrolusite mineral deposit (MnO_2) is the lowest peak value while the Silica mineral deposit (SiO_2) is the highest peak value (Figure 9).

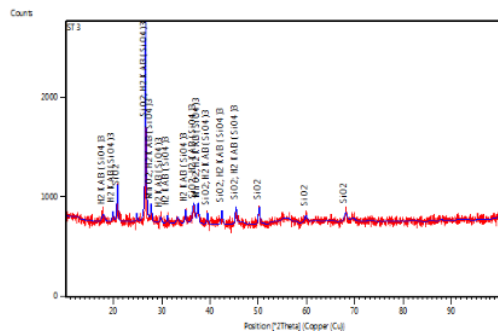


Fig. 9 X-Ray Diffraction Graph from Sample on Location 03.

From Station 04, it can be seen that Muscovite ($\text{H}_2\text{KAl}_3\text{Si}_3\text{O}_{12}$) is the lowest peak value, while Graphite mineral deposit (C) is the highest peak value (Figure 10).

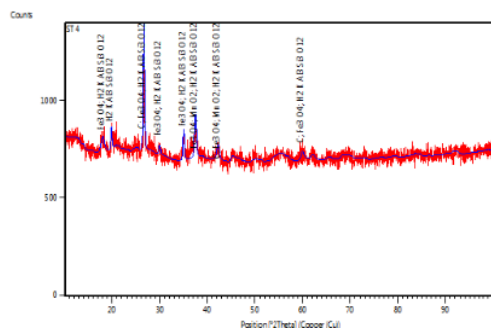


Fig. 10 X-Ray Diffraction Graph from Sample on Location 04.

From Station 09, it can be seen that Muscovite ($\text{H}_2\text{KAl}_3\text{Si}_3\text{O}_{12}$) is the lowest peak value, while the Silica (SiO_2) mineral deposit is the highest peak value (Figure 11). From Station 10, it can be seen Pyrolusite (MnO_2) is the lowest peak value while the silica mineral deposit (SiO_2) is the highest peak value (Figure 12). From Station 12, it can be seen that Muscovite mineral deposit ($\text{H}_2\text{KAl}_3\text{Si}_3\text{O}_{12}$) is the lowest peak value, while silica mineral deposit (SiO_2) is the highest peak value (Figure 13). From Station 13, it can be seen that Muscovite mineral deposit ($\text{H}_2\text{KAl}_3\text{Si}_3\text{O}_{12}$) is the lowest peak value, while Silica (SiO_2) is the highest peak value (Figure 14).

X-Ray Fluorescence (X-RF) result analysis: Based on data from the results of geochemical analysis (XRF) at stations 03, 04, 09, 10, 12, and 13, we obtained several types of metal mineral deposits from the largest to the smallest in the study area (See Figure 1 to see the sampling locations).

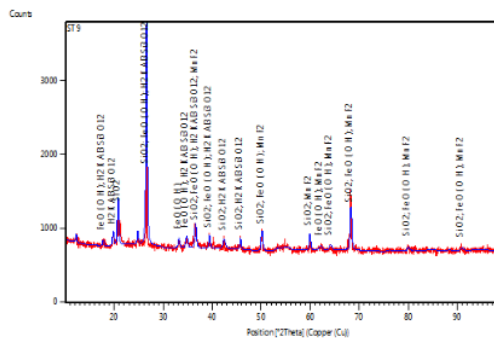


Fig. 11 X-Ray Diffraction Graph from Sample on Location 09.

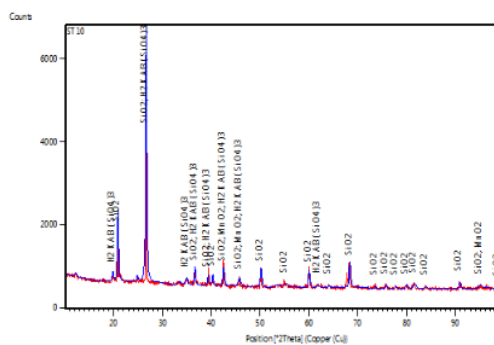


Fig. 12 X-Ray Diffraction Graph from Sample on Location 10.

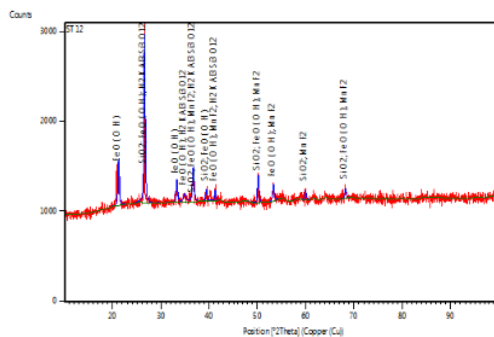


Fig. 13 X-Ray Diffraction Graph from Sample on Location 12.

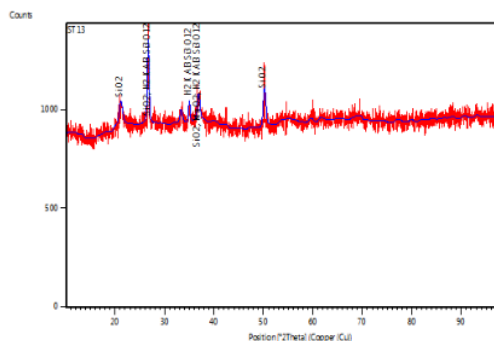


Fig. 14 X-Ray Diffraction Graph from Sample on Location 13.

Hematite (Fe_2O_3) mineral deposits resulted from the sedimentary rock formation, which was found in clay rocks in this research area. These mineral deposits scattered in the northern part of the geomorphological unit of a rather steep structural hill with a percentage distribution of 45% and an average value of weight percent that is 22,674% (Figure 15).

Aluminum Oxide/Corundum (Al_2O_3) mineral deposits resulted from the elements magnetite, hematite, and spinel in the study area and found in claystone. These mineral deposits are scattered in the Southwest part in the rather steep structural geomorphological hills with a percentage distribution of 45% and an average value of percent weight that is 16,688% (Figure 16).

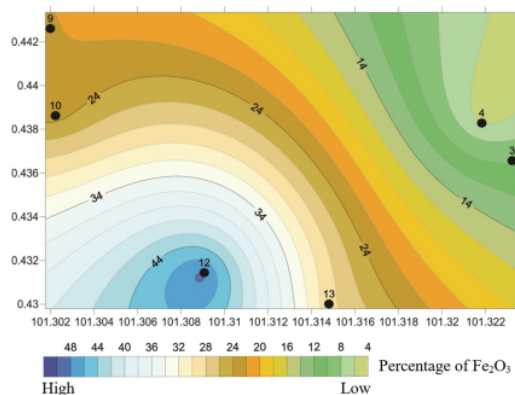


Fig. 15 Hematite (Fe_2O_3) Composition and Percentage from Research Area.

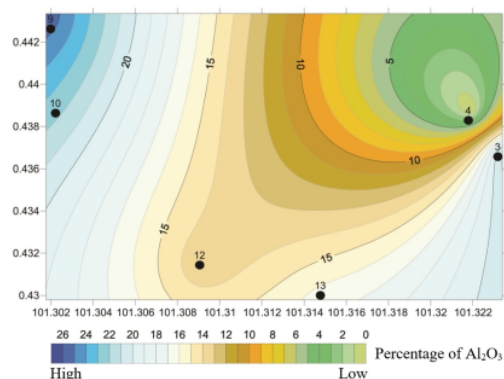


Fig. 16 Aluminum Oxide/Corundum (Al_2O_3) Composition and Percentage from Research Area.

Manganese (Mn) mineral deposits result from iron ore and mineral changes in the study area in claystone. These mineral deposits are scattered in the eastern part of the geomorphological unit of a rather steep structural hill with a percentage distribution of 35% and an average value percent by weight is 11,445% (Figure 17).

Silver (Ag) mineral deposits result from natural formation and other metal minerals such as Nickel and Tin, which are found in the study area in claystone. These mineral deposits are scattered in the northern part of the relatively steep structural hills' structural geomorphology with a percentage

distribution of 15% and an average value of percent weight that is 0.752% (Figure 18).

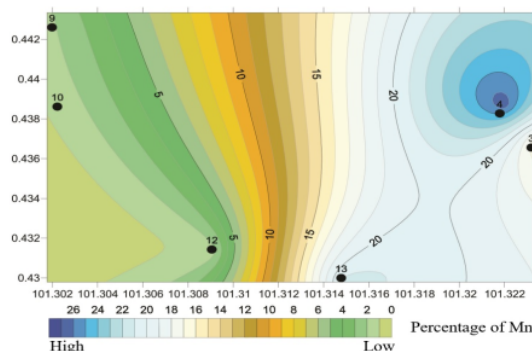


Fig. 17 Manganese (Mn) Composition and Percentage from Research Area.

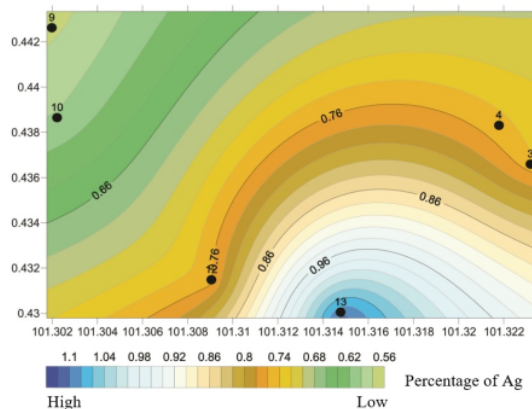


Fig. 18 Silver (Ag) Composition and Percentage from Research Area.

Titanium (Ti) mineral deposits can be associated with Magnetite, Hematite, Spatite, and quartz, which are found in the study area in claystone. These mineral deposits are scattered in the Southwest part in the rather steep structural geomorphological hills with a percentage distribution of 10% and an average value of percent weight that is 0.283% (Figure 19).

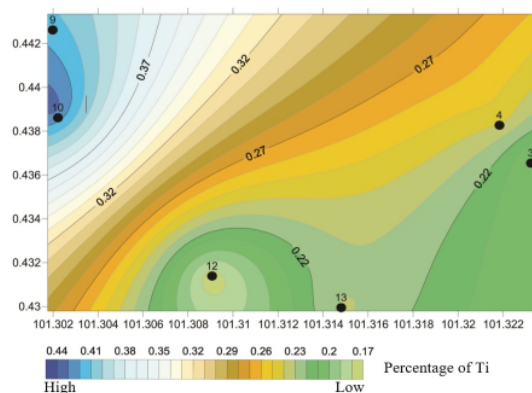


Fig. 19 Titanium (Ti) Composition and Percentage from Research Area.

C. Potential and Utilization of Metal Mineral Deposits

The potential of metal mineral deposits in the research area is quite good because there are several variations of types of metallic mineral deposits. If further research is carried out on a large scale, it will support creating the exploration and exploitation process. Metal mineral deposits in the research area are dominated by Hematite, Manganese, Titanium, and other deposits, which can provide economic value because they are widely used as materials in the manufacture of iron and steel and other industries.

IV. CONCLUSION

Genesis and topography control the deposition of metal minerals in the research area as the deposition environment. Stratigraphically, the study area is composed of a single rock unit, the claystone unit, which is pre-tertiary, with lithology characteristics of flake clay. The genesis and origins of metal mineral deposits in the research area are due to the claystone transformation mineral composition and the oxidation process. Metal mineral deposits in the research area are classified based on genesis or the mineral deposit formation origin. Based on geochemical analysis results (XRF and XRD) obtained various types of mineral deposits, including Hematite, Manganese, Silver, Titanium, Graphite, Goethite deposits.

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