Characterization and utilization potential of basalt rock from East-Lampung district

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Abstract. The aim of this research was to study the petrography and chemical properties of basalt rock from East Lampung district, Lampung province. Petrography analysis was performed using a polarization microscope, and analysis of chemical composition using X-RF method. From the analysis of basalt rock samples, the mineral composition consists of pyroxene, plagioclase, olivine, and opaque minerals. Basic mass of basalt rock samples is, composed of plagioclase and pyroxene with subhedral-anhedral shape, forming intergranular texture, and uniform distribution. Mineral plagioclase is colorless and blade shape, transformed into opaque minerals with a size of <0.2 mm, whereas pyroxene present among the blades of plagioclase, with a greenish tint looked and a size of <0.006 mm. Mineral opaque has a rectangular shape to irregular, with a size of <0.16 mm. The chemical composition of basalt rock samples, consisting of 37.76-59.64 SiO_2; 10.10-20.93 Fe_2O_3; 11.77-14.32 Al_2O_3; 5.57-14.75 CaO; 5.37-9.15 MgO; 1.40-3.34 Na_2O. From the calculation, obtained the value of acidity ratio (Ma)= 3.81. With these values, indicate that the basalt rock from East Lampung district has the potential to be utilized as stone wool fiber.

1. Introduction

Basalt is a common variety of volcanic rocks. It is usually fine-grained due to its rapid crystallization as lava on the Earth's surface. Basalt is mainly used in the form of crushed rock in construction, as well as in industrial and highway engineering[1]. Gabbro-basalt rocks are raw material for production gravel, building stones, mineral fiber, and derivated heat-insulation materials, as well as the products of cast stone material[2], [3]. In the last decade, basalt has emerged as a contender in the fiber reinforcement of composite. These fibers perform more highly than another type of fiber such as glass and carbon fiber. Basalt combines three silicate mineral plagioclase, pyroxene, and olivine. Plagioclase describes a number of triclinic feldspars that consist of sodium and calcium silicates. Pyroxenes are a group of crystalline silicates that contain any two of three metallic oxides, magnesium, iron or calcium. Olivine is a silicate that combines magnesium and iron $(Mg,Fe)_2SiO_4$[4].

Technological processing of basalt into basalt fiber, basalt cast, and basalt ceramic have been developed in some Eastern European countries, China dan Germany. In Indonesia, basalt rock reserves reached > 1 billion tons. Its presence there in various regions in Indonesia start from Sumatera, Java, Kalimantan, Sulawesi and Papua. In the province of Lampung, basaltrock is distributed in sub districts ofMataram baru, Jabung, Bumi Agung, Marga Tiga, Sukadana and Labuhan Maringgai in East Lampung district. The total resources are greater than 10 million m^3. The potential of basalt rock in this location, it has not been used optimally. Results of surveys in mining locations provided descriptions that these minerals were mined with simple methods by people around the locations. There were some companies conducting mining processes, but these mining processes are not done continually. Heavy equipment and processing tools in mining locations were very limited. Even a crushing process was conducted traditionally by using man power. The end products are split rocks, which is used for building or civil construction, thus the added value is very low. The aim of this research was to characterization of basalt rock from East Lampung district, Lampung province. The

results of this characterization will determine what products will be produced and what technology it will be used. This research is expected to give an important contribution to the added value of basalt rock.

2. Methodology

Basalt rock characterized using polarizing microscopy and X-Ray Fluorescence (XRF) method. Six rock samples have been collected from sub district of Mataram Baru, East Lampung district, Lampung province. Thin sections were prepared as follow: a slab of basalt with 30 mm x 20 mm x 10 mm thick was cut, polished using 200, 400, 800 and 1000 silicon carbide powder, in order to get a smooth surface easy to stack with glass slide (26 x 42 mm) using Canada balsam adherent. An automated thin section machine called multiplied Grinder housed was used for making the slide. Approximately the thickness result was 45 microns. Then using heavy duty polishing table and hand polishing with 1000 silicon carbide powder, the sample was ground to 30 microns[5].The next stage is the analysis using an optical polarizing microscope. Nikon optical microscope is used particularly to identify mineral constituents of the studied basaltic rocks and to determine the mineralogical properties and textures.

XRF was performed using an XRF BRUKER S2 Ranger. The process begins with grinding samples until it reaches a size of 100 mesh. Then the sample is formed using a hydraulic tablet press. Samples are heated at temperatures of 1000 ° C in the crucible. Furthermore, the sample is analyzed based on the identification and enumeration of characters of X-rays caused by the photoelectric effect. The photoelectric effect occurs because the electrons in the target atom in the sample exposed to high-energy rays (gamma radiation, X-rays). As a result of the sample exposed to X-ray radiation, the electron vacancy occurs, while the electrons originating from the skin surface samples will fall to fill the vacancy. XRF will use X-rays emitted by the material and arrested detector to be used to analyze the content of the element in the sample. After getting the chemical composition using XRF method, calculated method was performed to determined the modulus of acidity (Ma), where are according to Eqs.1,

$$M_a = \frac{mSiO_2 + mAl_2O_2}{mCaO + mMgO} \quad (1)$$

Where m is the mass content of oxide (%) [3]. The modulus of acidity is the basis for determining whether the basalt rocks that can be processed into basalt fiber, basalt casting or basalt ceramic.

3. Results and discussion

A geological condition of East Lampung was a plateau with an altitude of 0 to 50 meters. In the eastern part was formed from sediment as regosol, in a swamp area as lacustrine sediment (hydromorf soil), and in the rivers as alluvium surface sediment (a mixture of clay and galuh sand). While in the river, there was contained quartz sand. At that altitude, there is an acid lava flow from volcanic rocks, namely Lampung tuffa which covers most of the land area of East Lampung with latosol and podsolic. There are also rock form that belong to basalt type (pleistocene). At an altitude of 50 to 500 meters, there is Lampung tuffa material composed of volcanic sediment (Pleistocene) which is located further to the west was getting higher. In the northern part of this region, there are Palembang bottom formation and top formation. While in the Palembang formation layer contained in Sukadana region was marked by the appearance of acidic deposition tuffa. The Palembang layer is the starter (plateau) which is accompanied by intrusidesit covered by alluvium deposition such as volcanic sand, silt, and clay derived from volcanic ash. Geological formations found in this region include the Alluvium (Qal), deposition swamp (Qs), quartz (Qak), Sukadana basalt (Qbs), Terbanggi formation (QPT), and clay formation (Qti) as seen in figure 1. Alluvium formation (Qal) containss rock which is consist of lump, gravel, and sand. Furthermore, it contains soil, silt and clay. Qs containssand, silt, mud, clay and plant residue. Qak was a rock in the form of fine quartz sand, Qbs was a hollow basalt rock, and QPT was a sand stone with clay stone inserts while Qti was consist ofa pumice stone, clay and sand stones[6].

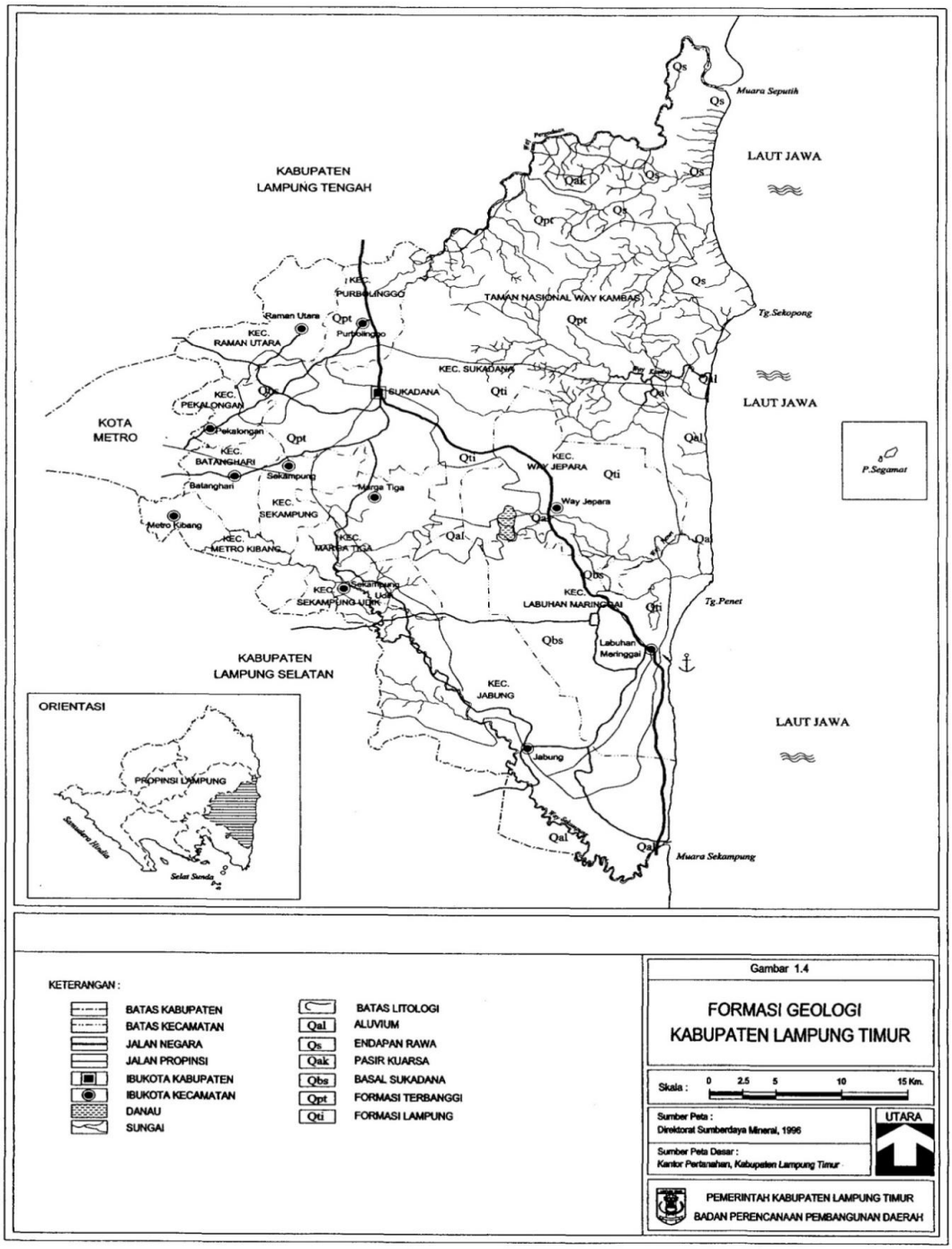

Figure 1. Geological formation map of East Lampung districts[6].

From the description of microscopic, thin section of rock had inter-granular texture holocrystaline, porphyritic, and consist of phenocrysts and groundmass. Phenocrysts composed of Olivine (Ol) with

subhedral-anhedral form, with a size of 0.84 to 3.5 mm and an irregular fracture.Plagioclase was found and present as phenocrysts, with a maximum size of 0.8 mm. Groundmass composed by plagioclase (Pl) and pyroxene (Pi) has a form-anhedral subhedral and forming inter-granular texture with uniform distribution, as seen in figure 2. The appearance of plagioclase (Pl) is colorless, has a blade shape and transformed into opaque mineral, with a size of < 0.2 mm. Meanwhile, pyroxene (Pi) is present between the blades of plagioclase (Pl), greenish, moderate relief, with a size of < 0.006 mm. Isotropic opaque minerals in both the X-Nikol position and // - Nikol. Mineral opaque has a rectangular shape to irregular, with a size of < 0.16 mm. The main mineral consisting of plagioclase (Pl) 50%, olivine (Ol) 8%, pyroxene (Pi) 32%, mineral opaque 5%, and the common cavity 5%.

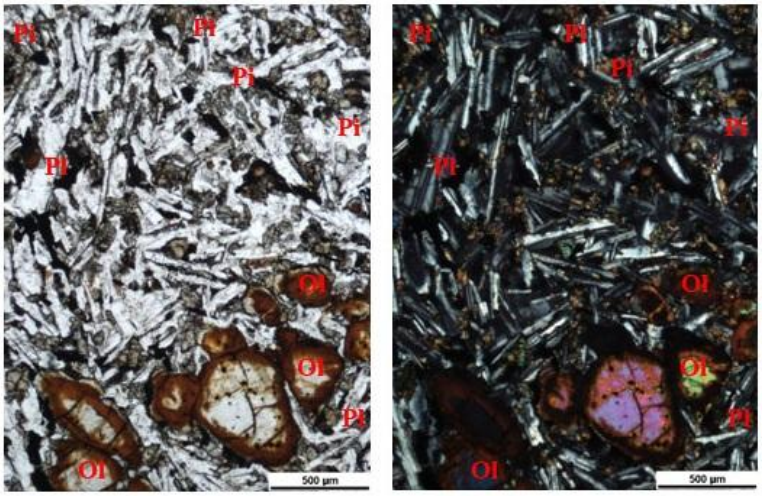

Figure 2. The appearance of petrography microstructure of basalt rock

The chemical compositions of the basalt rock from East Lampung district were analyzed using XRF method. The result of X-RF analysis was presented in table 1.

Table 1.X-RF analysis of basalt rock

Basalt	Mass Content
SiO_2	37,76-59,64
Al_2O_3	11,77-14,32
CaO	5,57-14,75
MgO	5,37-9,15
Fe_2O_3	10,1-20,93
K_2O	1,7-6,69
Na_2O	1,4-3,34
TiO_2	1,81-3,73

Based on the equation 1, the modulus of acidity of the raw materials from Mataram Baru sub district, East Lampung lies in the range (Ma) of 3.09 to 4.53 while the average value (Ma) is 3.81. The acidity modulus (Ma) of the basalt raw material is the main parameter to define the quality of the final fiber product. If the Ma <1.8, the fiber is considered to be a mineral wool for base materials are basic volcanic rock and cider. These fibers are brittle but have acceptable insulation properties. If the Ma > 1.8, the fiber is called rock wool and if its base materials are basalt then it is called basalt wool (basalt fiber, BF). The higher acidity module indicates that the basalt fibers are good quality with excellent

properties, they have a high strength, corrosion resistance, temperature resistance, along with an extended operating temperature range[1].

4. Conclusion

Basalt rocks from Mataram Baru sub-district, Lampung Timur district, Lampung province, could have added value if it processed into products other than rubble stone and macadam. This rock has the potential to be utilized as stone wool fiber.

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