The Potentials of Improving Mineral Source Additional Values in Lampung Province – A Prelimanary Study

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Article Information:

Received:
16 February 2019

Received in revised form:
18 April 2019

Accepted:
30 April 2019

Volume 1, Issue 1, June 2019
pp 1 – 6

http://dx.doi.org/10.23960/jesr.v1i1.2

Abstract

An initial research on non-metal mineral potential was conducted for stones in Lampung Province. Surveys were conducted to some districts/towns in Lampung to take sample materials. Non-metal mineral chemical composition content analysis of stones was conducted with X-RF method. Lampung had mineral potentials of feldspar, zeolite, kaolin, and basalt of 400,500,000 m3; 18,945,000 m3; 9,750,000 m3; 419,071,833 m3 respectively. These mineral source potentials were distributed in eight districts in Lampung. Processing was required to improve additional values for these mineral sources, including crushing, grinding, classifying, and concentration process. Concentration improvements were required for feldspar and kaolin minerals. Wet high intensity magnetic separator process followed by froth flotation process became solutions to reduce high oxide iron content. Feldspar and kaolin could be used for such industries of ceramic, glass, paper, and refractory. Meanwhile, the zeolite mineral from Lampung could be used for agriculture, plantation, and fishery. Basalt stone would have additional values when this was processed into cast basalt, fiber, and ceramic composite.

Keywords: *feldspar, kaolin, basalt, zeolite, Lampung*

I. INTRODUCTION

The Positive national and regional (Lampung province) economy growths has been encouraging the growths of some sectors including industries using minerals. Almost all industries need mineral supplies for raw materials; for main raw materials, intermediary materials, and complementary materials. The needs of these mineral material supplies should have been satisfied by local mineral commodities. In fact, however, the supplies are obtained by importing them. According to Central Bureau of Statistic, the import volumes from 2005 to 2009 for non-metal mineral commodities of feldspar, kaolin, limestone, and quartz sand were 1,066,326 ton; 695,556 ton; 873,883 ton; and 259,088 ton respectively [1]. This is an irony and an opportunity at the same time. Ironically, these mineral sources are scattered in some local regions, especially in Lampung, and they are not yet optimally processed to satisfy domestic demands. This becomes a particular problem when mineral source processing is only conducted for exporting raw materials, and it will turn into an opportunity if we are able to process local mineral commodities with additional values by considering big potentials of domestic markets. At least, it will help to fulfill local industry demands by reducing dependency on import supplies. This is a challenge which needs to answer with real actions as immediate as possible before those mineral commodity potentials run out because of massive exploitations.

Acts, regulations and policies had been published by government to improve mineral additional values (metals, non-metals, and stones). It was started with Act number 4 in 2009 about mineral and coal mining, Government Regulation number 23 in 2010, Government Regulation number 1 in 2014, which then elaborated technically by regulations of Minister of Mineral and Energy resources. All of them are principally series of mineral processing to improve mineral commodity additional values. These value adding in mining sectors in a wide term mean optimizing the processing from upstream to downstream of mining activities including regional development and societies around the mining both directly and indirectly to realize sustainable developments [2]. The pattern changes of mineral commodity processing, which is previously based on raw material exporting, into intermediary raw materials and even final products, surely requires supports from all parties including researchers.

Lampung province is a gate of Sumatera Island and it has an important role for national economy growth and goods distribution (raw materials, products) from Java Island to Sumatera Island. As a province has been conducting developments in all sectors, Lampung province needs descriptions of potentials required by foreign and domestic investors. Therefore, a preliminary study to describe potentials in Lampung province is required. This preliminary study is on the non-metal mineral commodities in Lampung province and their descriptions of processing so that they will have additional values.

II. Materials and Methods

Method to use in this research was according to principles of scientific writing. Literary studies were conducted to obtain information as many as possible about non-metal mineral commodities in Lampung province and their processing descriptions in efforts to improve these mineral commodity additional values. Discussions with businessmen in non-metal mineral mining businesses in Lampung were conducted to collect data. Surveys were conducted to some mining locations to see directly field conditions and to take material samples. These material samples were tested with X-RF method to obtain chemical content compositions. Tested non-metal minerals were feldspar, zeolite, kaolin, and basalt stone.

III. Results and discussions

Non-metal mineral potentials in Lampung province can be found almost in each district in Lampung province. The non-metal mineral commodity distribution in Lampung province is presented in Table 1.

Feldspar, zeolite, kaolin, and basalt stone commodities are found in eight of fifteen districts in Lampung province. Feldspar can be found in Pubian sub district of Middle Lampung district, kaolin can be found in Way Tuba and Blambangan Umpu sub districts of Way Kanan district. Zeolite is distributed in Sidomulyo sub district of South Lampung, Cukuh Balak sub district of Tanggamus district, and Talang Padang sub district of Pesawaran district. Basalt stone is distributed in sub districts of Mataram Baru, Jabung, Bumi Agung, Marga Tiga, and Labuhan Maringgai in East Lampung district. Basalt stone can also be found in Karya Penggala sub district of West Lampung. The X-RF analysis results of non-metal minerals is presented in Table 2.

Table 1. Potentials and distributions of non-metal mineral sources in Lampung province

Commodity	Volume (m^3)	Locations (districts)
Feldspar	400,050,000	Central Lampung
Basalt	419,071,833	East Lampung, West Lampung, Bandar Lampung
Zeolite	18,945,000	South Lampung, Pesawaran, Tanggamus
Kaolin	9,750,000	Way Kanan

source : From various sources and reprocessed

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. Accesses to mining locations were improper for heavy vehicles so that mobility was very limited.

A. Feldspar

Feldspars are essential constituents of igneous rocks, plutonic or extrusive (59.5% of the minerals of magmatic rocks). Analysis of feldspars allows them as more or less homogeneous mixtures of three basic components: $KAlSi_3O_8$; Orthose, $NaAlSi_3O_8$; Albite (Ab) et $CaAl_2Si_2O_8$: Anorthite. They generally occur together with quartz, mica, iron oxides, rutile and hornblende. Basically, the two properties which make feldspars useful for downstream industries are their alkali and alumina contents. Feldspars play an important role as fluxing agents in ceramics and glass applications, and are also used as functional fillers in the paint, plastic, rubber and adhesive industries [3]. Some researches on feldspar ore show that some types of feldspar from various locations in various countries are further processed. This processing can use magnetic separator (wet and dry processes), flotation process (anion and cationic flotation), mixture of magnetic separator and froth flotation, biological and electrochemical processes, and leaching process by using acid medium [4]-[8].

Table 2. X-RF test results of minerals

Code		Feldspar	Basalt	Zeolite	Kaolin
SiO_2	%	67.30	48.56	70.2	67.52
Al_2O_3	%	14.02	14.36	12.37	15.04
Fe_2O_3	%	2.24	11.00	1.59	1.85
TiO_2	%	0.13	1.21	0.13	0.18
CaO	%	2.25	7.79	2.41	0.75
Na_2O	%	3.15	3.05	0.063	0.99
K_2O	%	4.59	0.61	3.12	3.78
MnO	%	0.044	3.51	0.045	0.11
MgO	%	0.059	6.19	0.55	0.21
P_2O_5	%	3.20	0.22	0.024	0.033
SO_3	%	0.069	0.16	0.12	0.085
Cr_2O_3	%	0.015	0.066	0.068	0.030
CuO	%	0.007	0.026	<0.001	<0.001
NiO	%	0.020	0.016	<0.001	0.018
PbO	%	0.006	0.051	0.001	0,005
SrO	%	0.020	0.075	0.026	0.013
ZnO	%	0.010	0.047	0.006	0.019
LOI	%	2.84	3.01	9.24	9.27

Table 2 shows that feldspar mineral from Lampung province has contents of 4.59% K_2O; 3.15 % of Na_2O; 2.25 % of CaO; 14.02% of Al_2O_3; 2.24 % of Fe_2O_3 and 67.30 % of SiO_2. The chemical composition content found in Lampung feldspar is not yet an ideal composition as it is shown in Table 3. Naturally, it is difficult to have an ideal feldspar composition shown in Table 3.

Table 3. Ideal feldspar chemical composition

Feldspar	Formula	Theoretical Chemical Composition				
		K_2O	Na_2O	CaO	Al_2O_3	SiO_2
Orthoclase	$K_2O.Al_2O_36$ SiO_2	16.9	-	-	18.4	64.7
Albite	$Na_2O.Al_2O_8$ $6SiO_2$	-	11.8	-	19.4	68.8
Anorthite	$CaO.Al_2O_82$ SiO_2	-	-	20.1	36.62	43.28

sources: industry mining materials (BGI) [9].

Almost all potassium feldspar contains of natrium (sodium) element either it is inclusive or interlocked with albite which is called as perthitic feldspar. Meanwhile, albite always contains of few of sodium and calcium element mixtures. Oppositely, anorthite (Ca-feldspar) never associates with sodium element. Perthitic feldspar and albite feldspar are commercial feldspar. According to Indonesia Industrial Standard Classification (SII) No.1145-1984, standard of feldspar as raw material for ceramic is K2O+Na2O = 6-15%; Fe2O3 max = 0.5%. The content of K2O+Na2O feldspar from Lampung is 7.74% and this has fulfilled determined standard. The content of Fe2O3 is 2.24% and this exceeds determined standard. High content of iron oxide results in color change in ceramic body during burning process. Feldspar from Lampung is recommended to have processing with magnetic separator and then to continue with froth flotation considering its high content of iron oxide (2.24%). It will be very difficult to process iron content reducing by only using magnetic separator. It is recommended to use Wet High Intensity Magnetic Separator with magnetic induction of >12000 gauss. Wet process is used by considering that impurities (clays) washing process can run in parallel. It is then followed by froth flotation. The results of these processing can be used as raw materials for ceramic, glass, and filler industries. Principally, the feldspar processing for industry scales to have additional values include crushing, grinding, classifying, attrition, scrubbing and concentration processes.

Feldspar processing results in sufficiently high economic value improvements. Ngurah (2009) in his research suggested 5 folds of economic value improvement for main product o feldspar concentrate. Resulted side products such as quartz with feldspar and clay with feldspar also have economic values [2]. Considering these high economic values, feldspar potentials in Lampung province should be processed to have similar qualities with imported feldspar. Regional government is expected to be able to invite either foreign or domestic investors to build feldspar processing industry.

B. Basalt

Basalt is a mafic extrusive rock, the most widespread of all igneous rocks, and it comprises more than 90% of all volcanic rocks. It is usually fine-grained due to its rapid crystallization as lava on the Earth's surface. It has a crystalline structure that varies based on the specific conditions during the lava flow at each geographical location. 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 $(Mg,Fe)_2SiO_4$ [10].

Because of good hardness and thermal properties, basalt has been used in the construction, industrial and highway engineering, in the form of crushed rock. It is used as surfacing and filling in roads, the floor tiles in the construction and as the lining material in the pipes for transporting the hot fluids. This can be major replacement to the asbestos, which possess health hazards by damaging respiratory systems. However, it is not commonly known that basalt can be used in manufacturing and made into fine, superfine ultrafine fibers. Basalt is an alternative raw material for fiber forming because of its relatively homogeneous chemical structure, its large scale availability throughout the world, its freedom from impurities and of course, its ability to form fibers in the molten state. Basalt fiber offer prospect of completely new range of composite materials and product. Low cost high performance fibers offer potential to solve the largest problem in the cement and concrete industry, cracking and structural failure of concrete. They have potential to high performance and cost effectively replace of fiberglass, steel, fiber, polyamide fiber and carbon fiber product in many applications. 1 Kg basalt fiber replaces 9.6 Kg steel reinforcement [11].

With abundant basalt stone potential in Lampung province, study and research should be done to improve its additional values. Basalt stone in Lampung is possible to have processing to be cast basalt product, fiber and ceramic composite materials, by smelting basalt stone in a blast furnace. The smelting process is done in temperatures between 1200oC to 1350oC. To produce cast basalt only requires casting process into desired forms. Spinning process is required to produce basalt into fiber products. The resulted products will have additional economic values when processed. According to Vishal (2014) the production cost for the raw material required for the basalt fibers production, viz., basalt rock, single material, is inexpensive and readily available in the world (mainly in India). The required energy for melting basalt rock in fiber formation is higher than E-glass fiber and similar to S2-glass fiber (E-glass fiber and S2-glass fiber are types of glass fiber). The bushing of platinum-alloy used in process is very costly. And productivity of fiber is low during learning. Thus basalt fiber cost somewhere between E-glass and S-glass fiber but should come down [11].

C. Zeolite

Zeolite is a mineral from silicate group. Being different from other silicate minerals like feldspar, quartz, and other which have massive structures, zeolite mineral structure is porous. This porous structure result in lower weight than other silicate minerals. In its formation process, silicon element with valency 4 partially is replaced by aluminum with valency 3 and this results in excessive negative charge. By this substitution the basic frame in zeolite mineral is aluminum-silicate. The sum of negative charge is known as cation exchange capacity (CEC). This negative charge excess is neutralized by cations which are dominated by potassium (K), sodium (Na), calcium (Ca) and magnesium (Mg) [12]. The formation of natural zeolite, because of its environment of formation, varies in compositions and qualities. Being distinctive with other minerals, natural zeolite exists with other mineral or compound mixtures and it is chemically difficult to separate. Other minerals will influence zeolite quality and usage ability [13].

According to SNI 13-3594-1994 about zeolite classification and test, zeolite is classified into 4 types: type A (zeolite content of > 90%), type B (zeolite content of > 70%), type C (zeolite content of > 50% and <70%), and type D (zeolite content of < 50%). Zeolite has been widely used in some fields including agriculture, farming, natural environment, engineering and manufacture. Zeolite potential in Lampung can be processed for these types of industries. Lampung zeolite is commonly klinoptilolit and mordenite types. The distributions are 39% klinoptilolit and 7.7% mordenite in Sidomulyo, 35.30% klinoptilolit and 29.9% mordenite in Talang Padang, and 18.20% klinoptilolit and 30.50% mordenite in Cukuh Balak. According to SNI 13-3594-1994, Lampung zeolite belongs to type C [14].

Zeolite processing for industry commodities in common is started with zeolite stone mining, zeolite drying, crushing and sieving. Zeolite is sieved into desired product sizes according to demands and then packed. Lampung zeolite is recommended to have processing for agriculture and farming considering Lampung province is producer of agriculture products (rice, corn, and cassava) and biggest plantation products (rubber, sugarcane, oil palm and pineapple) in Indonesia.

Lampung province is also has center of farming (fowl and beef) and fishery (shrimp cultivation). Lampung zeolite can be processed to improve its additional value to be slow-release fertilizer into granular form for agriculture field.

D. Kaolin

Kaolin [Al2Si2O5(OH)4] is a common phyllosilicate mineral, which belongs to a large general group known as the clays. Its structure is composed of silicate sheets (Si2O5) bonded to aluminum oxide/hydroxide [Al2 (OH)4] layers. It is a conventional raw material for ceramics, porcelain, paper, coatings, rubber, plastics, fire-proof materials, chemicals, pesticides, medicines, textiles, petroleum, and building materials [15]. In particular, it is an important material of a catalyst support or catalyst for hydrogenation due to its specific characteristics such as high versatility, wide range of preparation variables, use in catalytic amounts, ease of set-up and work-up, mild experimental conditions, gain in yield and/or selectivity, and low cost [16].

Some researches on kaolin processing has been done, especially on reducing iron and titanium oxide by using chemical substances such as using sodium bisulfate, metallic zinc, sulfuric acid, and by leaching with oxalic acid or organic acid. The process of reducing impurities is commonly done by using magnetic separation, froth flotation, selective flocculation, and size separation by hydrocylone and leaching [17-19].

Table 2 shows that kaolin mineral from Lampung has a high level of iron oxide (1.85% of Fe2O3). It has SiO2 and Al2O3 contents of 67.52% and 15.04% respectively. Standard of kaolin used for varying industries is shown in Table 4. To obtain kaolin standard, Lampung kaolin needs to be processed (iron oxide content reducing). The process of either improvement or reducing of iron oxide impurity level in Lampung kaolin can be done by processes of grinding, magnetic separator and froth flotation. Kaolin processing results have a high additional value improvement. Quantitatively, the kaolin additional value improvement after processing is 78.13% per kg or 3 folds improvement compared to sell kaolin as raw material [2].

Table 4. Chemical composition for Industrial Kaolin

Code		Agriculture	Pharmacy	Textile industry	Brick industry for construction	Ceramic	Refractory
SiO_2	%	49.88	47.00	45.00	48.67	67.50	51.70
Al_2O_3	%	37.65	40.00	38.10	19.45	26.50	25 - 44
Fe_2O_3	%	0.88	-	0.60	2.70	0.50 – 1.20	0.5 – 2.4
TiO_2	%	0.09	-	1.70	-	-	-
CaO	%	0.03	-	-	15.85	0.18 – 0.30	0.1 – 0.2
Na_2O	%	0.21	-	-	2.76	1.20 – 1.50	0.8 – 3.5
K_2O	%	1.60	-	-	2.76	1.10 – 3.10	-
MgO	%	0.13	-	-	8.50	0.10 – 0.19	0.2 – 0.7

source: Abel O Talabi, 2012 [20]

IV. CONCLUSION

Non-metal mineral and stone potentials in Lampung province are very possible to be processed to create additional values. Feldspar and kaolin minerals in Lampung contains of iron and titanium oxide impurities. These impurities can be reduced by using magnetic separator and froth flotation processes, and the resulted products are used in glass and ceramic industries. Zeolite in Lampung is suggested to be added value products for agriculture, farming and fishery fields. Lampung basalt stone will have additional value by processing into cast basalt, composite ceramic and fiber products. To realize all of these need supports from varying stakeholders. Regional government can have a role to make regulation and to provide supporting infrastructures without ignoring roles of public around mining locations. Researchers, academicians and local entrepreneurs to have synergies to realize mining mineral management according to Act No. 4 in 2009 about minerals and coal.

ACKNOWLEDGMENT

This work was supported by Research Unit for Mineral Technology, Indonesian Institute of Sciences

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