RARE EARTH ELEMENT PRELIMINARY STUDY ON BOBONARO SCALY CLAY MÈLANGE IN OBEN VILLAGE, SUBDRISTRICT OF NEKAMESE, DISTRICT OF KUPANG, EAST NUSA TENGGARA PROVINCE

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ABSTRACT

The location of the investigation area is in Oben Village, Nekamese District, Kupang Regency, East Nusa Tenggara Province with coordinates 123° 40'40" E - 123° 41'20" E and 10° 16'0" S - 10° 16'40" S. The geology of the study area is generally occupied by mixed rocks dominated by a gray clay, blackish brown, reddish brown, with foreign chunks consisting of peridotite, sedimentary rock consisting of brown and reddish reddish limestone, silt, micaceous sandstones, metamorphic rock: chlorite schist, with quartzite veins. Of the five samples analyzed, namely four samples of soil matrix and one sample of Peridotite, the following results were obtained: six rare earth elements were contained in 4 samples of the soil matrix, namely Yttrium (Y): 3.63 – 68.75 ppm, Praseudymium (Pr): 7.38 – 38.38 ppm, Scandium (Sc): 4.83 – 4.93 ppm, Lanthanum (La): 21.48 – 91.03 ppm, Cerium (Ce): 32.48 – 184.85 ppm, and Neodymium (Nd): 9.4 – 57 ppm specifically for sample 1 also contains 3 rare earth elements, namely: Gadolinium (Gd): 3.48 ppm concentration the average is lower than its abundance in nature, Samarium Sm: 13.1 ppm, and Dysprosium: (Dy): 6.88 ppm. For rock samples only contain Praseudymium (Pr): 7.78 ppm and Cerium (Ce): 87.88 ppm.

Keywords: kupang, clay, rare earth element, melange,

INTRODUCTION

Currently, the role of Rare Earth Element which will become a very strategic commodity for future technological advancements, therefore the systematic search/exploration of Rare Earth Element resources in the short, medium and long term is very important to do to reveal the potential of Rare Earth Element resources, in an area, especially in East Nusa Tenggara. Gradual exploration of rare earth elements with various methods is needed to get an overview of the vertical and horizontal distribution of rare earth elements in an area.

Based on the modified geological map of Audley-Charles (1968), Rosidi et al. (1979), Suwitodirjo and Tjokrosapoetro (1979; 1996), Barber et al. (1986), Bachri (1994) and Partoyo et al. (1995), the Bobonaro Complex (Rosidi et al., 1979; Suwitodirjo and Tjokrosapoetro, 1979) or Bobonaro Scaly Clay (Audley-Charles, 1968) occupy about 40% of the area of 40% of Timor Island. Areas with this kind of geological formation look dry and generally are poor in nutrients.

Geologically, the Bobonaro Complex is a chaotic rock composed of a scaly clay matrix containing chunks of older rocks, ranging from Perem to Early Miocene (Audley-Charles, 1968). The name Bobonaro Complex is currently used for all mixed rocks found on the island of Timor, taken from the type location located in the Bobonaro area (currently part of the Democratic State of Timor Leste). Until now, there are several hypotheses about the origin of the Bobonaro Complex, namely (1) as an olistostrom (Audley-Charles, 1968), (2) a tectonic collapse or mélange (Hamilton, 1979), and (3) is the result of a shale diapir breakthrough (Barber et al., 1986).

The Bobonaro complex, which looks barren, actually contains various types of mineral commodities with high economic value. Examples include manganese and radioisotopes (Tay et al., 2018). Research by Lisboa, et al (2019) shows the presence of rare earth elements in the sample of mixed rock (mélange) of the Bobonaro Complex in the western part of Timor Leste.

There are 17 elements listed on the periodic table of chemical elements (Ministry of Energy and Mineral Resources, 2019), which are called rare earth element, which are a collection of elements: scandium (Sc), lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), lutetium (Lu) and yttrium (Y). These seventeen rare earth elements have many similar properties and are often found together in geological deposits. Calling rare earths is not actually a rare earth element, but the use of the term "rare" is meant as something "uncommon". This rare earth element in Indonesia in general and Timor Island in particular, is not widely known and its distribution and resources are not well known. Rare earth element are currently found in large quantities in China, the United States and Australia. In terms of production, currently China still dominates, supplying approximately 90% of the world's demand for rare earth element (Ministry of Energy and Mineral Resources, 2019).

In the future rare earth element will be one of the strategic minerals. These rare earth element are needed by almost all types of industries such as agriculture, food, telecommunications, transportation, chemical, housing, and energy supply industries. The latest thing in the development of environmentally friendly energy is using minerals as an energy source (electric batteries) and energy conversion (solar cells, wind turbines, etc.), which require several types of minerals, one of the important ones being Rare Earth elements. The presence of this rare earth mineral commodity significantly will play a role in improving modern technology that is around us and this commodity will play a role in responding to the need for

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environmentally friendly and efficient energy sources as well as the needs of civil and military needs for defense systems of countries. This study was the design to determine the geological character and the contents of rare earth elements of the mixed rock (melange) of the Bobonaro scaly clay Complex.

METHODOLOGY

Study Area and Sampling Location

The location of the investigation area is in Oben Village, Nekamese District, Kupang Regency, East Nusa Tenggara Province with coordinates E: 123° 40'40" - 123° 41'20" and S: 10° 16'0" - 10° 16'40" (Figure 1). Five samples were collected from different locations in the area (Figure 2): four were soil matrices and one was a rock sample.

Sample locations were determined based on most probable geological appearance of the rare earth elements occurences that is based on the various color (such as maroon, light grey, and dark grey) of the clay containing soil matrices. Since this geological characteristic is observed on the surface, the soil and rock samples were taken from the surfcae of 0-10 cm.

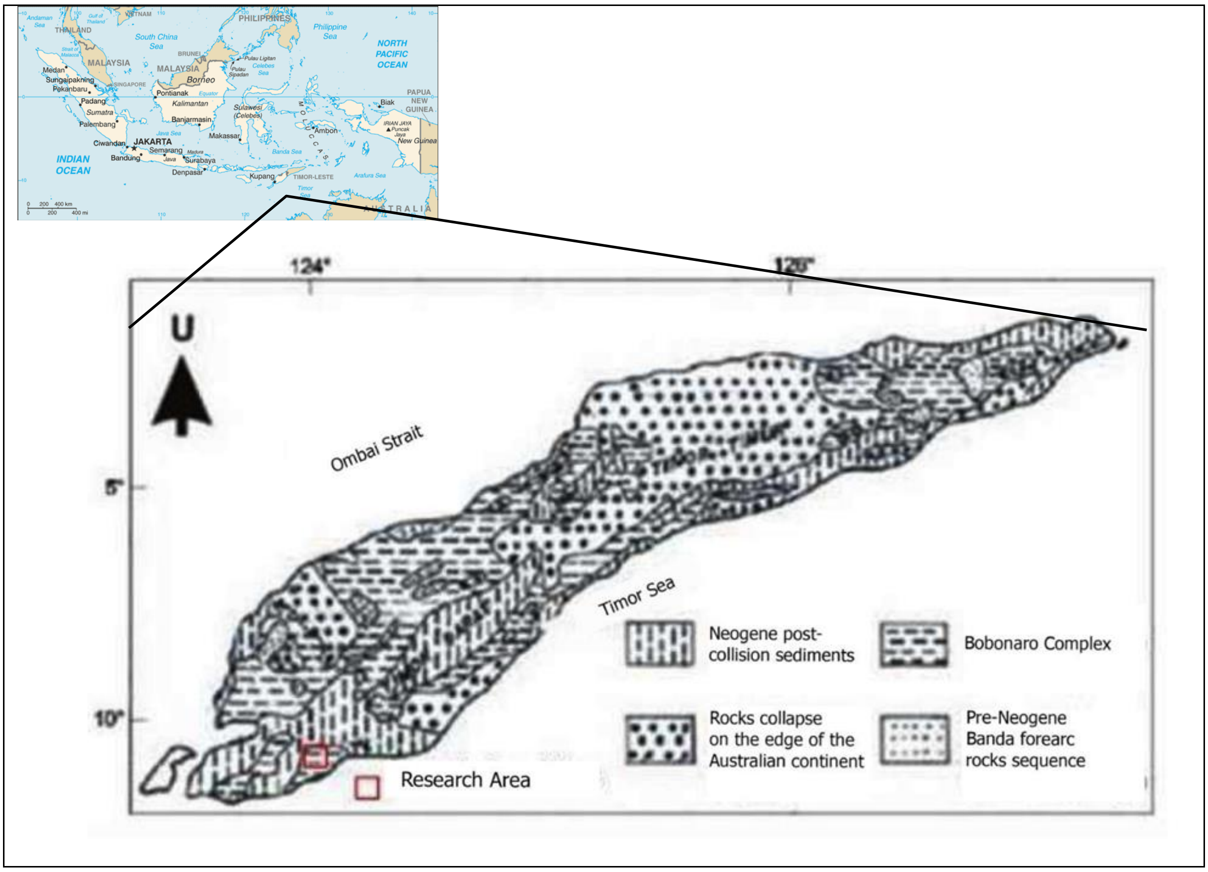

Figure 1. A sketch of the geological map of Timor, taken from Audley-Charles (1968), Rosidi et al. (1979), Suwitodirjo and Tjokrosapoetro (1979), Barber et al. (1986), Bachri (1994) and Partoyo et al. (1995). Study location is shown as red square.

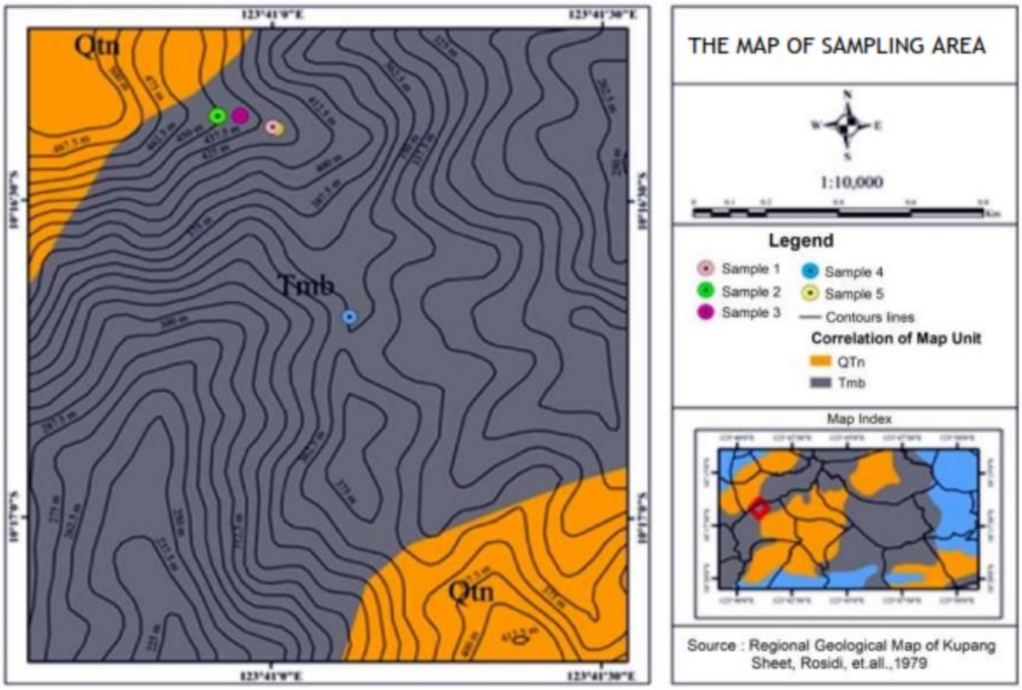

Figure 2. Sampling location. Sample 1 to 4 are the soil matrix samples and sample 5 is a rock sample.

Sample Analysis

Sample destruction: soil matrix and rock samples were carefully weighed then put in a digestion vessel (PTFE digestion vessel), then added 3 mL of 65% HNO_3, 0.5 mL of 30% H_2O_2 and 40% HF. The digestion container was closed with a lid, then put in a microwave oven and started the digestion with the program conditions (1) 25 % power for 5 minutes, (2) 0% power for 30 seconds, (3) 50 % power for 2 minutes and (4) cooling (vent) for 10 minutes. After cooling, it was filtered through Whatmann No 42 filter paper, put in a 25 mL volumetric flask and diluted to the mark with distilled water.

The samples from the destruction were then analyzed for the content of rare earth elements, which included 17 elements, namely: Sc, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y. Analysis using ICP-OES with Argon gas carrier at the Minerals Testing Laboratory - Center for Nuclear Minerals Technology (PTBGN) South Jakarta.

RESULTS RESEARCH

Geology of the Area

Morphology of Study Area

The morphology of the research area is in the form of gently undulating hills and elongated hills, composed of clay rocks with foreign boulders consisting of igneous, sedimentary and metamorphic rocks. The places have steep slopes with narrow valleys. The unit of undulating hills extends from the western part of the study area and is interspersed by elongated hills. The unit of undulating hills is characterized by low hills or a collection of hills separated by valleys around the highlands of elongated hills. This morphological expression shows the physical properties of rocks and geological structures in the study area which are geologically mélange deposits of the Bobonaro Complex, a Pre-Tertiary rock group of various types and ages of different rock components (ranging from 120 – 65 million years).

Lithology

The lithology in the study area is dominated by a scaly clay matrix, shiny, gray-black in color with foreign lumps consisting of igneous rocks (peridotite), sedimentary rocks: calcilutite limestones, micaceous sandstones, silts, and metamorphic rocks: chlorite schist containing veins quartzite. The surface shows the flow structure of the influence of rainwater, there are also flow- type avalanches. The characteristics of the mélange (mélange) of the Bobonaro Complex in the study area are shown in Figures 3 and 4.

Figure 3. a. showing the mélange clay of the Bobonaro Complex with a scaly clay structure; b. mixed rock clay surface with flow structure influenced by rainwater and c. flow-type avalanche grooves.

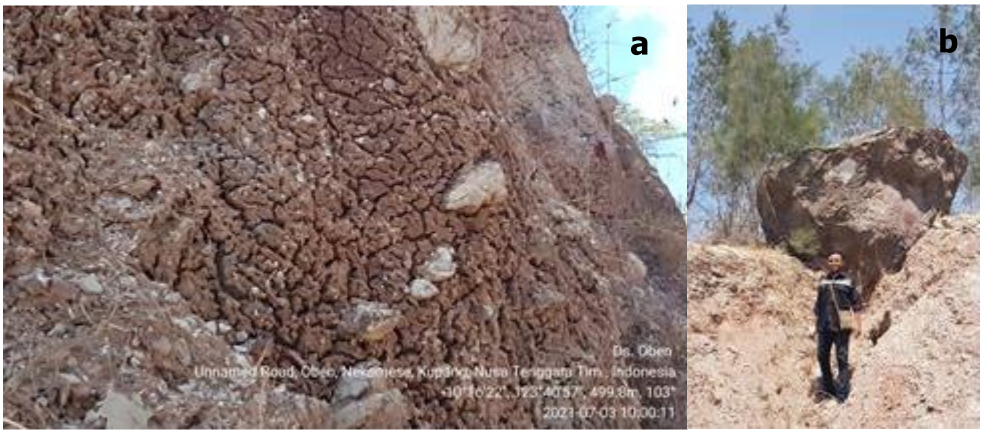

Figure 4. a. shows a reddish-brown mélange clay that has decreased due to reduced water, as well as the presence of foreign boulders in the form of calsilutite limestone; b. shows one of the boulders in the form of ultra-alkaline igneous rock (peridotite) in the mélange clay of the Bobonaro Complex.

Rare Earth Element Concentration

Rare earth element analyzed from five samples in the form of four soil matrix samples and one rock sample are presented in Table 1. Analysis of the rare earth element shows that:

1. Six rare earth elements are found in all soil matrix samples, namely Yttrium (Y), Praseudymium (Pr), Scandium (Sc), Lanthanum (La), Cerium (Ce), and Neodymium (Nd).
2. The four elements in the soil matrix sample have concentrations close to or higher than the natural abundance concentration values, namely Yttrium (Y), Praseudymium (Pr), Lanthanum (La), Cerium (Ce), Neodymium (Nd), Dysprosium (Dy), and Samarium (Sm). As for Y, Nd, Dy, and Sm, although the average is lower than the abundance in nature, there are samples that have concentrations above the abundance value.
3. Sample no. 1, contains Y, Pr, La, Ce, Nd, Sm, and Dy whose concentrations are much higher than their respective abundance values.
4. The element Gadolinium (Gd) is only found in sample 1 with an average concentration lower than its abundance in nature.
5. Sample 5 is a peridotite rock containing only Pr and Ce.
6. Sample 5 is a peridotite rock containing Pr whose concentration is almost the same as its abundance value but contains Ce with a higher concentration than its abundance.
7. Elements Eu, Tb, Yt, Ho, Tm, and Lu were not detected at all in all samples.
8. The content of rare earth element was more found in clay samples (sample 1-4) than in rock samples (sample 5).

Table 1. Results of Analysis of Five Sample Rare Earth Element (Four Soil Matrix Samples: 1-4 Samples and One Rock Sample: Sample 5)

Elements	Concentration, ppm							Natural abundance, ppm
	Sample 1	Sample 2	Sample 3	Sample 4	Average	Standard deviation	Sample 5	(Lide, 1997)
Y	68.75	11.03	3.63	5.53	22.23	31.16	0	33
Pr	38.38	7.38	7.88	11.93	16.39	14.80	7.78	9,2
Sc	4.83	7.48	4.93	6.98	6.055	1.37	0	22
La	91.03	28.8	26.45	21.48	41.94	32.87	0	39
Gd	3.48	0	0	0	0.87	1.74	0	6,2
Ce	184.45	63.38	58.45	32.48	84.69	67.87	87.88	66,5
Nd	57	12.23	9.73	9.4	22.09	23.31	0	41,5
Sm	13.1	0	0	0	3.28	6.55	0	7,5
Eu	0	0	0	0	0	0	0	2
Tb	0	0	0	0	0	0	0	1,2
Dy	6.88	0	0	0	1.72	3.44	0	5,2
Ho	0	0	0	0	0	0	0	1,3
Tm	0	0	0	0	0	0	0	0,52
Yb	0	0	0	0	0	0	0	3,2
Lu	0	0	0	0	0	0	0	0,8

Although it is noted that there are some elements whose concentration is lower than their abundance, according to Voncken (2016), rare earth elements are actually not rare at all. Ore deposits of rare earth elements are quite limited in number, but the abundance of the elements is quite large. The most common rare earth element is cerium (Ce), that is, with an abundance in the earth's crust of 60 ppm, the 27th element in the earth's crust, but having a greater abundance than, for example, lead (Pb), the 37th element, which has a crust abundance of 10 ppm. One of the most common rare earth elements (lutetium, 0.5 ppm crustal abundance), has a crustal abundance of about 200 times that of gold (0.0031 ppm). Voncken also said that the above is in accordance with the Oddo-Harkins rule that states that elements with even atomic numbers have a higher abundance than elements with odd atomic numbers.

CONCLUSION

Based on field observations, it is known that the characteristics of the Bobonaro Complex in the field, consisting of a clay matrix of gray, blackish brown, reddish brown, with foreign lumps consisting of ultra-alkaline igneous rock (peridotite), sedimentary rock consisting of colored calsilutite limestone. reddish brown, silt, micaceous sandstone, metamorphic rock: chlorite skiss, with quartzite veins.

Of the five samples analyzed, namely four samples of soil matrix and one sample of ultra-alkaline igneous rock (Peridotite), the following results were obtained: six rare earth elements were contained in the four samples of the soil matrix, namely Yttrium (Y) (3.63 ppm – 68.75 ppm), Praseodymium (Pr) (7.38 ppm – 38.38 ppm), Scandium (Sc) (4.83 ppm – 4.93 ppm), Lanthanum (La) (21.48 ppm – 91.03 ppm), Cerium (Ce) (32.48 ppm – 184.85 ppm), and Neodymium (Nd) (9.4 ppm – 57 ppm). Sample 1 also contains 3 rare earth elements, namely: Gadolinium (Gd) (3.48 ppm the average concentration is lower than its abundance in nature), Samarium (Sm) (13.1 ppm), and Dysprosium (Dy) (6, 88 ppm). For the rock sample containing only Praseudymium (Pr) (7.78 ppm) and Cerium (Ce) (87.88 ppm).

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