PHILLIPSITE MINERAL IN DEEP SEA SEDIMENT FROM SINGLE CORE IN ROO RISE, INDIAN OCEAN

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ABSTRACT

During the MD III - IMAGES IV Expedition, one of the cores that has length around 30.30 m below sea floor (bsf) was obtained using gigantic piston corer from the depth of 3,884 m below sea level (bsl). This core (MD982156) is located in Roo Rise, Indian Ocean, south of East Jawa, outer part of Jawa Trench. The sediment consists of abundance planktonic foraminifera in the upper part while in the lower part, there is no planktonic one. The latter is mostly composed of phillipsite-rich sediment (± 40%) that is possibly derived from tephra. The base of the core between the depths of 30 – 30.30 m bsf is composed of clay sediment, consisting of minerals derived from zeolite group (phillipsite), gibbsite, and other cryptocrystalline masses. Phillipsite was deposited as an authigenic deep sea sediment, whereas gibbsite is usually deposited within bodies of water. Besides, there are also nanno-plankton accumulated in the crystal of phillipsite. This part has an age of Late Miocene or older. This fact is supported by the overlain layer containing planktonic foraminifera species Sphaeroidinellopsis seminulina *of Late Miocene age (N17). The thickness and the lateral continuity of this layer are still unknown.*

Keywords : Phillipsite, deep sea, Roo Rise, south of East Java, Indian Ocean

1. INTRODUCTION

The MD III - IMAGES IV Expedition was prepared in the framework of the IMAGES (International Marine Global Changes Study) program, the drilling program from IGBP-PAGES (International Geosphere – Biosphere Program Past Global Changes) affiliated to SCOR (Scientific Committee on Oceanic Research). The expedition used Research Vessel Marion Dufresne, having the unique capability of sampling using giant piston core. This vessel belongs to IFRTP (French Institute for Polar Research).

The main aim of this investigation was to collect the sea floor sediment in Indonesian water by using giant piston core. Some samples, especially in Banda Sea, were taken by dredging technique, as a part of geodynamic study proposed by the University of Western Britany, Brest.

The cruise implemented in Indonesian waters (Leg 1) was started from Jakarta and was ended in Bitung (Manado) as seen in Figure 1. The Chief Scientist of the cruise was Dr. Franck Bassinot, assisted by Co Chief Scientists François Guichard and Luc Beaufort from French side, and Dr. Safri Burhanuddin from Hasanudin University, Makassar from Indonesian side.

In this cruise, twenty nine samples taken by giant piston core were obtained, with the average length of the sediment covering is more than 35 m. Three of them, are more than 50 m, with the longest core is 55.40 m (MD 982172).

The sample core of MD982156 studied, is located at 11 33,31’S and 112 19,72’ E, in Roo Rise, Indian Ocean, South of East Jawa.

2. METHODS

Twenty one samples from 1.5 m interval of core

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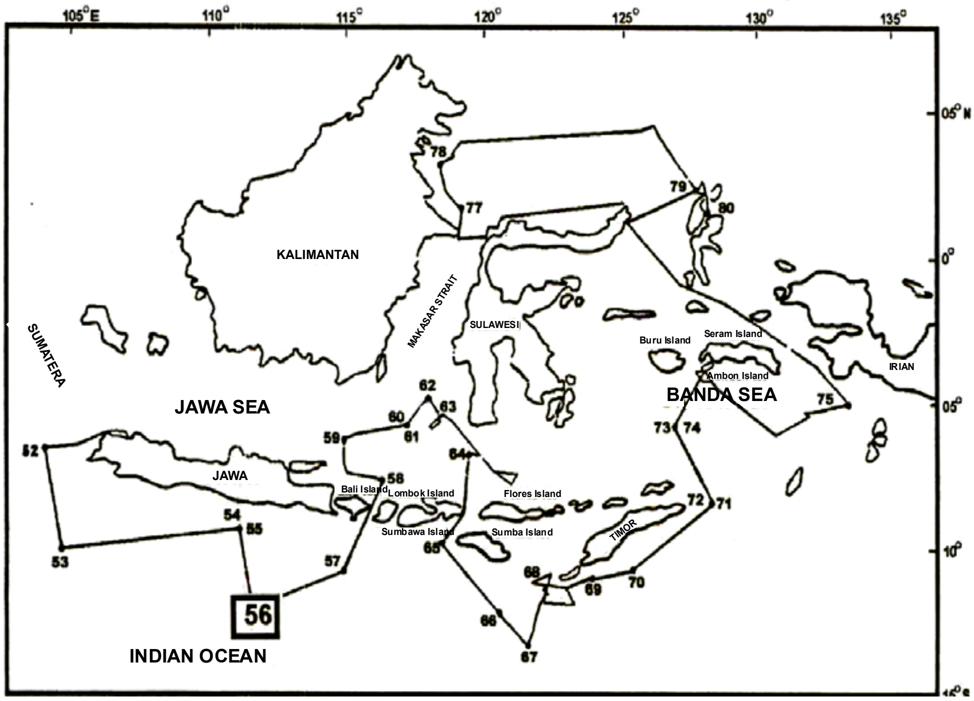

Figure 1. Track lines of IMAGES EXPEDITION (1998) 56, Sampling location (MD 982156)

MD 982156 were weighed before and after treatment, then wet sieved on a 150 mì screen and dried at 50°C. Each sample was taken from their tops respectively. The code of the sample is T-1 for Top section 1, T-2 for Top section 2, etc. Photographs were taken by using the Scanning Electron Microscope (SEM) that belongs to the Centre of Geological Survey, Bandung.

3. RESULTS

The location of the core is at 11°.33.31 S and 112° 19.72 E (Figure 1), above Roo Rise, south of East Jawa, Indian Ocean, the outer part of Jawa Trench. The depth of the sea floor is 3,884 m bsl, and the length of the sediment covered is 30.30 m. There are twenty one samples from core MD 982156 analysed.

In general, the sediment consists of calcareous clay and silt, brownish white, or greyish white colour, containing benthic- and planktonic foraminifera, radiolaria and pteropods. Most of planktonic foraminifera dominates the sediment (from 70 to almost 100%), except at the base of the core to the top of section 21. Above sample T-21, the sediment is composed of planktonic foraminifera ooze. Benthic foraminifera and radiolaria are only found as minor elements.

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From the base of the core (30.30 m) to the top of section 21 (T-21, 30.00 m bsf), is composed of clay sediment. The sediment in this part consists of phillipsite minerals (± 40%), which are derived from the Natural Zeolite Group that vary in shapes and other cryptocrystalline masses such as gibbsite or hydrargillite. Besides, there are also nannoplanktons accumulated in the Phillipsite crystal. The thickness and the lateral continuity of this layer are still unknown. This can be traced by taking other drilling samples closer to the Java Trench, east of Roo Rise.

According to Hardjatmo and Husaini (1997, in Husaini, 2006), the phillipsite mineral is one of the members of Natural Zeolite Group that has an important role in industry amongst four others, namely clinoptilolite, cabazite, mordenite and ironite. Zeolite itself can be divided into three types

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that are Natural-, Modified- and Synthetic Zeolite Groups. The Natural Zeolite Group has 40 types, but only 9 of them are commonly mined: analcime, clinoptilolite, heulandite,laumontite, phillipsite, cabazite, erionite, mordenite and ferrierite. However, (Suyartono and Husaini, 1992 and Iwasaki *et al.* 1995, in Husaini, 2006) stated that in Indonesia only two types of them (clinoptilolite and mordenite) were found. Actually Adisaputra and Hartono (2004) have firstly found this mineral in Roo Rise, Indian Ocean. This sediment was deposited in Late Miocene age or older, suggesting that the volcanic activity occurred at that time. In this case, this discovery is not well known yet. Although this information is not directed to the economic industry, at least that this mineral is present in the Indian Ocean sediment. The previous authors seemed not to reach the proper depth for the growth of the phillipsite mineral, as this mineral is found in deep sea sediment (3,884 m bsl; 30 m bsf).

According to Betekhtin (1960) and Read (1970), phillipsite has different shape from straight (columnar), T-shapes, cruciform twinning to radiating aggregates (Figure 2), reddish white to grey colour.

In sample MD 982156 phillipsite minerals vary in shapes such as straight (columnar) –Figure 2, Photos 1-2, cross in different angles (Figure 2, Photos 3-6), T-shapes (Figure 2, Photos 7-8), twinning to radiating aggregates (Figure 2, Photos 9-14). Bonatti (1963) suggested that well-formed crystals indicate in-situ growth. Crystals may be complexly intergrown (Cronan,1980). This mineral occurs especially in regions with low sedimentation rates below the calcium compensation depth. It is especially common in altered tephras. Kolla and Biscaye (1973) and Stonecipher (1976), stated that phillipsite appears to be a function of geological age, it is far less common in pre-Miocene sediments. They suggest that this mineral is more abundant in the Pacific and Indian Ocean sedi-

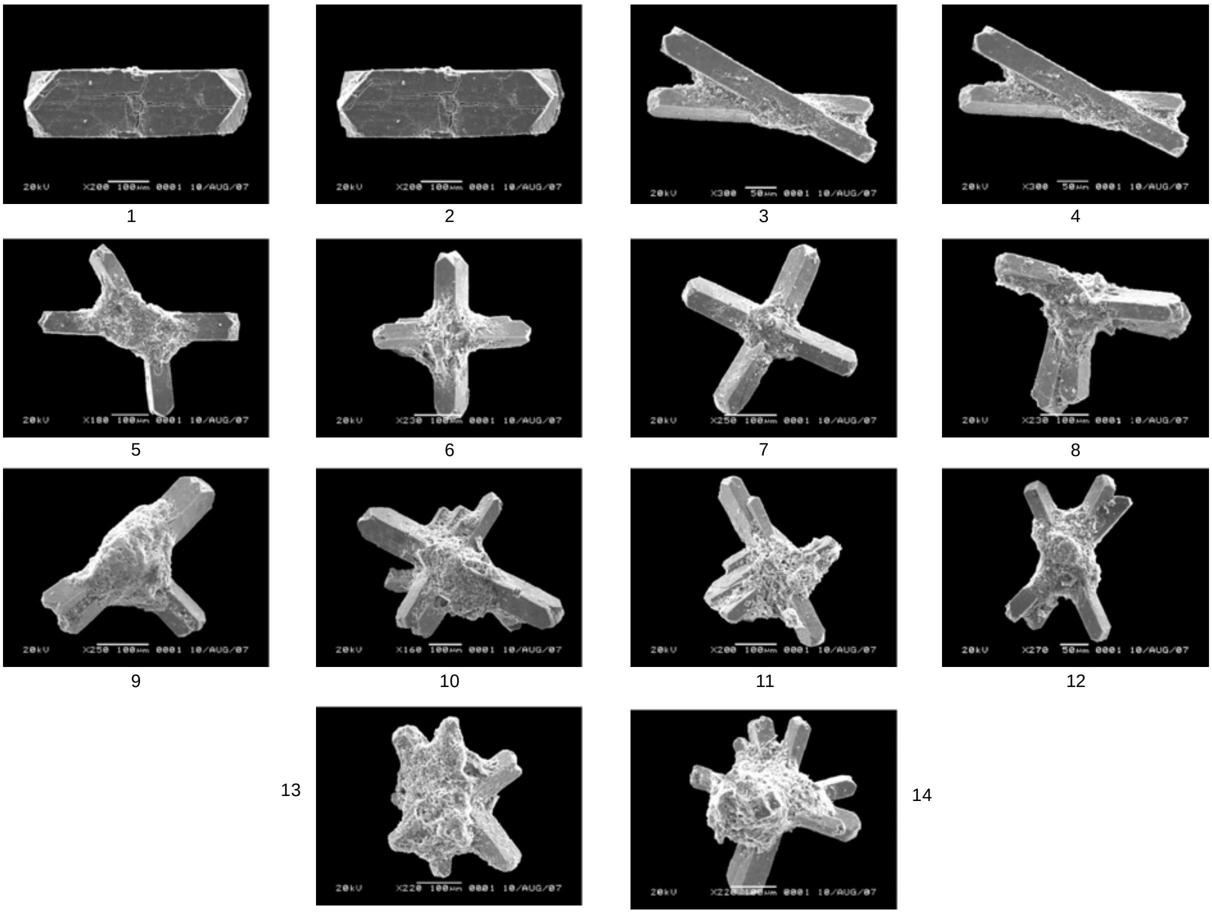

Figure 2. Phillipsite minerals discovered (Adisaputra and Hartono, 2004) in Roo Rise during IMAGES EXPEDITION
1-2. Straight (columnar); 3-6. Cross in different angles
7-8. T-shapes; 9-14. Twinning to radiating aggregates

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ments than in those of the Atlantic. Petzing and Chester (1979) recorded high concentrations from the Pacific and Bonatti (1963) has recorded sediments containing over 50% phillipsite on a carbonate-free basis from the central and southern Pacific. In the Indian Ocean, the main occurrences recorded so far are from Central Indian and Warton Basins and from parts of the Mid-Indian Ocean and Ninety-East Ridge (Kolla and Biscaye, 1973). According to Kastner and Stonecipher (1978), Iijima (1978) and Honnorez (1978), phillipsite is believed to be derived from extreme alteration of small basaltic glass shards on the sea floor, through a solution-precipitation step, probably smectite or palagonite. However, Petzing and Chester (1979), considered the ultimate precursor of phillipsite to be glass shards derived from terrestrial volcanoes. Their proposal was based on a correlation between the distribution pattern of phillipsite in the Pacific and present-day global volcanicity.

Gibbsite (Figure 3) or hydrargillite in the study area forms cryptocrystalline masses, white colour and pearly luster. It was derived from the decomposition and hydrolysis of aluminium-bearing silicates, partly in the course of hydrothermal process (at a comparatively low temperature), but chiefly from surface weathering, mainly under tropical and subtropical climate conditions (Betekhtin, 1960).

Another cryptocrystalline masses are considered as ferromanganese aggregates because of having characteristics of black colour, opaque, and submetalic luster. They originate as an authigenic genesis. Ferromanganese oxides will not precipitate in reducing environments and therefore, it will not be found in stagnant basins. Ferromanganese micronodules may occur in both shallow and deep sea sediments and may be distributed throughout the sediment column, although generally, they are more common near the sediment-water interface. They have been described from both lacustrine and marine deposits (Rothwell, 1989).

4. DISCUSSION

The fact that phillipsite mineral is firstly found in the study area by the first author, has not well known yet. It is proved by the statement that according to Suyartono and Husaini (1992) and Iwasaki *et al.* (1995), there are only two types of Natural Zeolite Group found in Indonesia, namely clinoptilolite and mordenite.

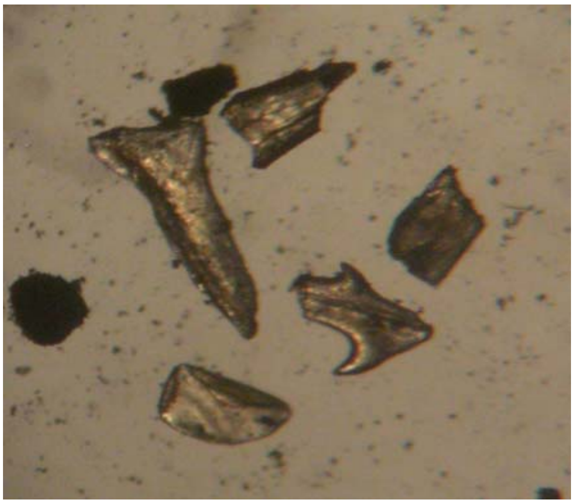

Figure 3. Gibbsite mineral found in the studied area

Besides, according to Kolla and Biscaye (1973), the main occurrences so far recorded in the Indian Ocean, are from Central Indian and Warton Basins and from parts of the Mid-Indian Ocean and Ninety-East Ridge.

However, in Indian Ocean, especially in sample MD982156, at the base of the core, phillipsite mineral is found together with nannoplankton. Although Kolla and Biscaye (1973) and Stonecipher (1978), stated that phillipsite appears to be a function of geological age in pre-Miocene sediments, in the study area this mineral is found in Late Miocene or older. This fact is supported by the overlain layer containing planktonic foraminifera species *Sphaeroidinellopsis seminulina* of Late Miocene age (N17).

Husaini (2006) has described in detail the benefit of the mineral Phillipsite as one of the member of Natural Zeolite Group. It is used for agriculture-fishery and husbandry industries.

5. CONCLUSIONS

The phillipsite mineral as one of the member of Natural Zeolite Group is firstly discovered in Indian Ocean (Roo Rise) during the MD III - IMAGES IV Expedition, at the depth of 3,884 m bsl.

In the upper part of the core (above 30 m bsf), the sediment consists of abundance planktonic foraminifera; while in the lower part, there is no plank-

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tonic foraminifera. The latter is mostly composed of phillisite-rich sediment (± 40%) that is possibly derived from tephra.

To the base of the core between the depth of 30 m – 30.30 m bsf the sediment is composed of clay, consisting of phillipsite gibbsite minerals, and other cryptocrystalline masses. Phillipsite is deposited as an authigenic deep sea sediment, whereas gibbsite is usually deposited within bodies of water. Besides, there are also nannoplanktons accumulated in the crystal of phillipsite. This part has an age of Late Miocene or older, because the overlying layer contains Late Miocene age NN.17) by the presence of *Sphaeroidinellopsis seminulina*. The thickness and the lateral continuity of this layer are still unknown.

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