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THE POTENTIAL OF ATEDAI GEOTHERMAL FIELD BASED ON GEOLOGICAL, GEOCHEMICAL AND GEOPHYSICAL STUDIES, LOMBLEN ISLAND-EAST NUSATENGGARA

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ABSTRACT

From the preliminary geological, geochemical and geophysical studies, the potential of Atedai Geothermal field estimated between 30 to 40 MWe. The potential of the energy resources more than enough to fulfill electricity demand of 1266 km square of the island with population about 86 000 people.

The thermal features in this area associated with post volcanic activity and controlled by a couple near parallel NE-SW faults. The geothermal discharge consists of hot spring, hot ground, fumarole and altered rock.

The hot spring mostly near neutral pH bicarbonate type water. Only two springs with low pH sulfate type. The spring temperature about 40^{o}C while the fumarole temperature up to 98^{o}C. Alteration type is argillite to advanced argillite with altered minerals including Kaolinite, Halloysite, Alunite, Smectite, Dyckite and Phyropillite. Those minerals analyzed by using Portable Infrared Minerals Analyzer (PIMA).

The geochemical soil survey data shows that there are two areas of anomaly for Hg (Mercury). The maximum Hg contents up to 2522 ppb. From electrical resistivity data, there are three areas of low resistivity (less than 10 Ohm). The areas are Watu Wawer (14.5 km2), Wolo Kebingin (0.25 km2) and Waru (1.5 km2). The thickness of the low resistivity area is about 600 to 650 m.

1. INTRODUCTION

The electricity demand in Lomblen Island will increase since the island become a district few month ago. At present, the electricity power generated by motor diesel available in the island only 1.3 MW per year or about 111,99 kWh per month. Therefore only 0.0013 kWh per person per month.

As most of area in East Nusatenggara Province, including Lomblen Island, there are no cheap energy resources such as coal or hydropower available. In contrast, the island rich of geothermal surface discharge. Therefore, introducing geothermal energy as energy resources is an important aspect for the island.

The Lomblen Island probably the second largest of geothermal discharge in East Nusatenggara Province after Flores Island. Based on geothermal inventory carried out by Volcanological Survey of Indonesia in 1977, there are 24 geothermal discharge around the island. According to the survey, the most promising area is mainly at SW of the island that is called Atedai Geothermal Field.

The Atedai Geothermal Field situated in the Southern part of Lomblen Island **(Fig.-1)**. The thermal features in this area associated with post volcanic activity where the geothermal discharge including fumarole/steaming ground, hot spring and altered rock. The temperature of fumarole or steaming ground up to 98^{o}C while the temperature of hot spring only about 40^{o}C.

This paper will describe the potential of the Atedai geothermal field as an energy resources for the island based on geological, geochemical and geophysical study. The study done by Volcanological Survey of Indonesia (VSI) during year 2000.

2. GEOLOGY.

During field work on May 2000, more than 100-km^2 area around Atedai geothermal field have been mapped. The area mostly covered by Quaternary andesite volcanic. The volcanic product including lava, pyroclastic and lahar. In general, the deposits can be divided into two groups; the old volcanic mostly crops out at northern and southwest part of the study area. The eruption center of the unit are not known, the unit form high-dissected terrain and covered by thick brown soil. The young volcanic form cones at the eastern part of study area along main lineament with direction almost N-S. The cones mostly consist of andesite pyroxene lava and pyroclastic (flow and fall).

Two NE-SW fault control the geothermal surface manifestation in this area. The fault recognized as Lewo Kebingin Fault and Mauraja Fault.

3. GEOTHERMAL MANIFESTATION.

The geothermal manifestation in this area consists of hot spring, hot ground/steaming ground, fumarole and altered rock. The hot spring known as Wai Keti, Karumatek, Wae Teba, Kowan, Tupat, Wae Mata and

Wae Krata while the hot ground/steaming ground and fumarole are called Lewo Kebingin, Watu Wawer and Lewokeba **(Fig.-2)**. The hot spring mostly near neutral pH bicarbonate type water, only two spring with low sulfate water **(Fig.-3)**. The last type of hot spring occurs near steaming/hot ground and solfatare area.

The spring temperature are low (40^{o}C) and there is no altered rock around the spring. In addition, the location of the spring discharge is at low level compare to location of fumarole and steaming ground. The spring might be the out flow of the main geothermal system in this area such as Lewo Kebingin and Watu Wawer.

Because of the temperature of the spring only 40^{o}C and SiO2 content in the water mostly low, the temperature below the surface can not be calculated by using the SiO2 geothermometer. In this case, the temperature below the surface calculated by gas geothermometer where the methane gases taken from fumarole in Watuwawer and Wolo Kebingin. From the data, the temperature of the system estimated between 178^{o}C to 225^{o}C.

4. ALTERATION.

The altered rocks crop out in wide area around Atedai geothermal field. The altered rock not only found around active geothermal areas such as Lewo Kebingin and Watu Wawer but also in non active geothermal area such at Waeteba **(Fig.-4)**

From 60 altered rock samples analyzed by using Portable Infrared Mineral Analyzer (PIMA), the altered minerals found in this area predominantly Kaolinite, Halloysite, Montmorilonite and Alunite. The high temperature clay minerals such as Dickite and Pyrophillite found as relic in Watu Wawer and Lewokebingin prospects. Even those minerals not common appear in surface geothermal manifestation, the occurrence of those minerals in that area indicates that previous temperature of the area higher than present temperature. Therefore, those minerals might be appear to the surface by erosion.

From the clay minerals identified above, the alteration type of this area is argillite to advanced argillite, which is associated with low pH fluid.

5. GEOCHEMISTRY

In order to understand the area related with hydrothermal system, 64-soil samples have been collected from study area for mercury analysis. The samples where taken from about 1 meter below the surface by using hand auger.

From analyzed samples by using Rigaku Mercury Analizer, the mercury content in the soil vary from 96 ppb to 2566 ppb. The statistical study of the data shows that the background value is below 500 ppb. Therefore the anomaly area correspond with area of active geothermal such as Watu Wawer and Wolo Kebingin.

6. ELECTRICAL RESISTIVITY

About 15 km electrical resistivity survey line have been measured to recognized horizontal low resistivity area and vertical low resistivity zone. From the horizontal electrical mapping, there are three low resistivity area. The area coincident with present active geothermal area such as Watuwawer (4.5 km2) and Wolo Kebingin (0.25 km2). The Waru (1.5 km2) probably similar with both active geothermal area. How ever, there is no geochemical data available for that area.

The vertical electrical sounding shows that the Watuwawer geothermal area and Wolo Kebingin geothermal area are come from similar hydrothermal system. In addition the thickness of conductive or clay cap layer in that area estimated between 500 to 600 m below the surface.

7. DISCUSSION

From the data above, the Hg anomaly and the low resistivity area coincident with alteration and active geothermal surface manifestation of Watuwawer and Wolokebingin **(Fig.-5)**. Therefore both prospect not only supported by surface manifestation also supported by geochemical and geophysical survey.

The possible potential of the area calculated by using gas geothermometer and area of low resistivity anomaly. Because of the thickness of reservoir estimated 1 km, the conversion factor is half of conversion factor in West Java.

Based on both parameter above and using Lump parameter equations:

$$Q(Mwe) = k \times A \times (T_{res} - T_{cut\text{-}off})$$

Where:
k : conversion factor = 0.11585
A: Area prospect (<10 Ohm)
Tres: temperature reservoir = 225^{o}C
Tcut-off = 180^{o}C (for high entalphy area)

The potential of Watu Wawer area is 23.5 Mwe, Lewo Kebingin is 1.3 Mwe and Waru 7.9 Mwe. Therefore the total potential of the area at least 32.6 Mwe.

8. CONCLUSSION

From the geological, geochemical and geophysical study can be concluded that the Atedai geothermal field very promising as source of energy for Lembata Island. The 30 Mwe of geothermal energy resources more than enough to fulfill energy demand of the island.

The Watu Wawer prospect and Wolo Kebingin prospect are two main targets for next exploration or

exploitation programs. Those area not only become high priority because of the surface manifestation, geochemical and geophysical data but the more important is the area lies about 40 km from Lewoleba the capital city of Lembata District and only about few hundreds meter from the main road Lembata – Lerek.

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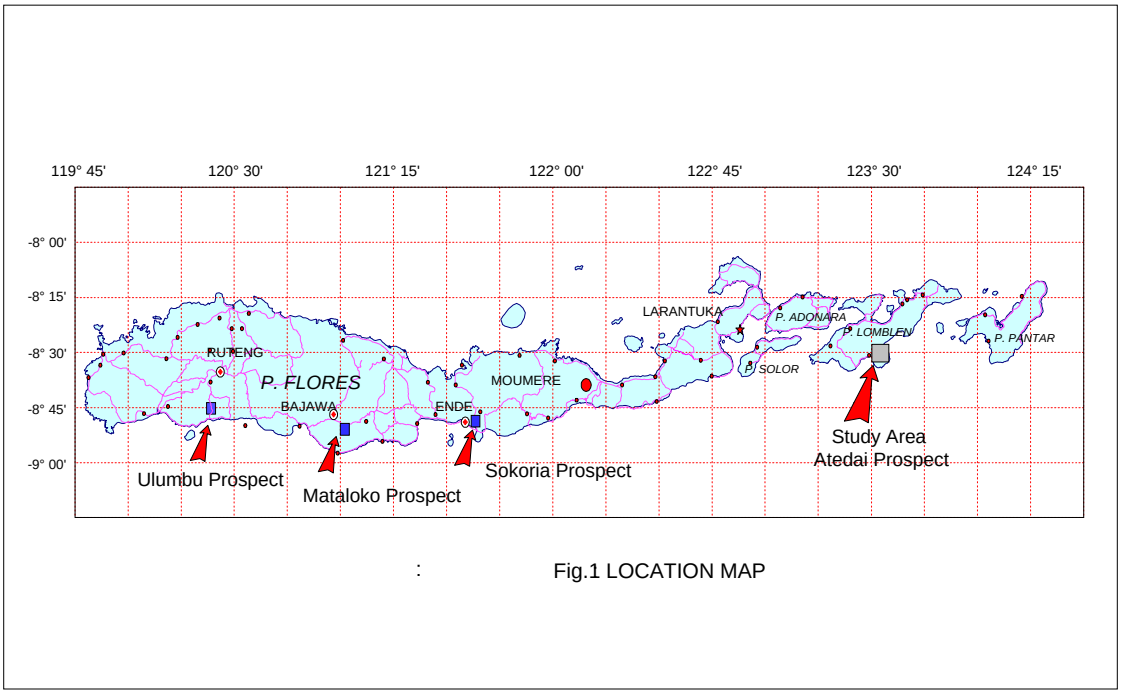

Figure-1
Location of Study Area

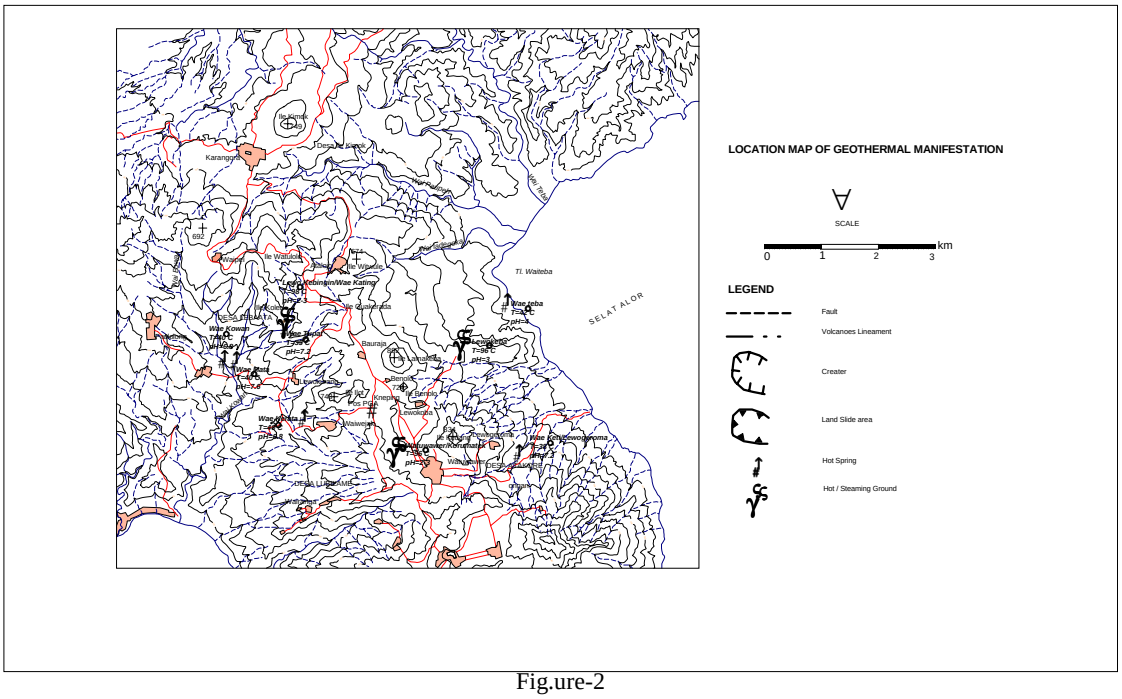

Fig.ure-2
Location of geothermal manifestation

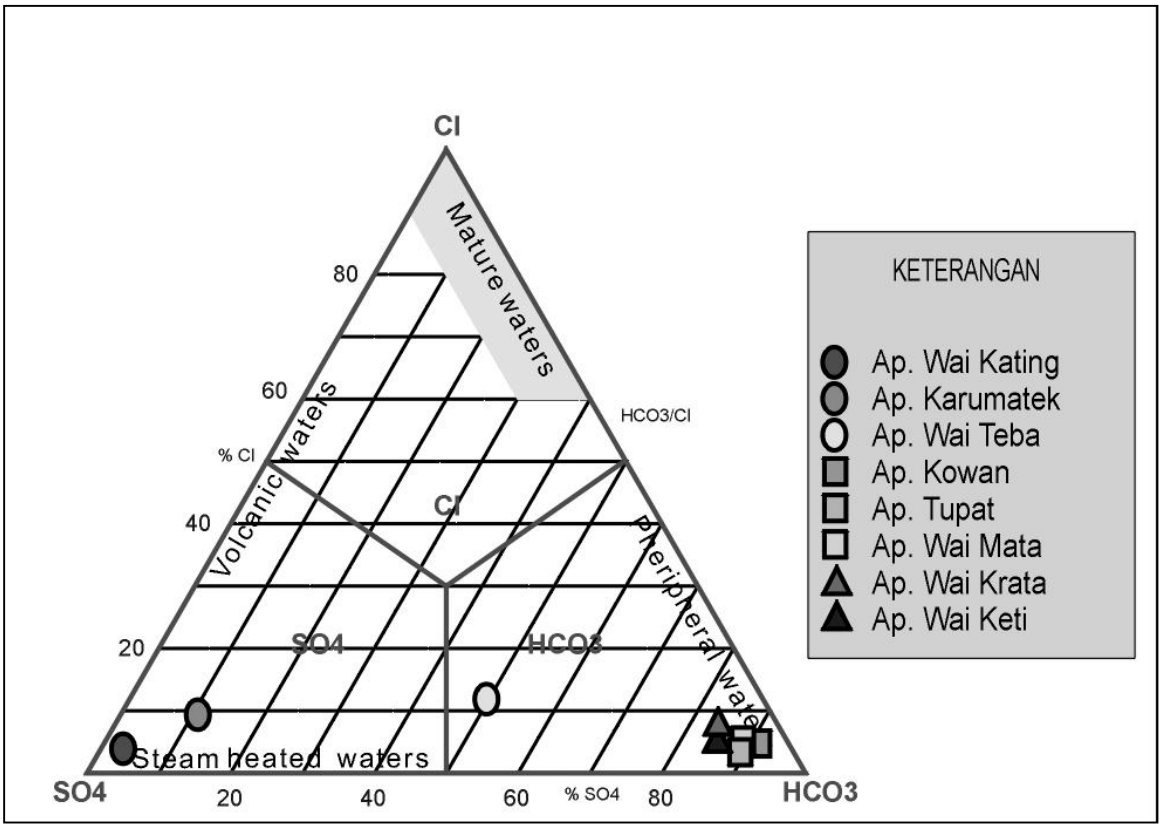

Figure-3
Tripot of Type of Spring Water

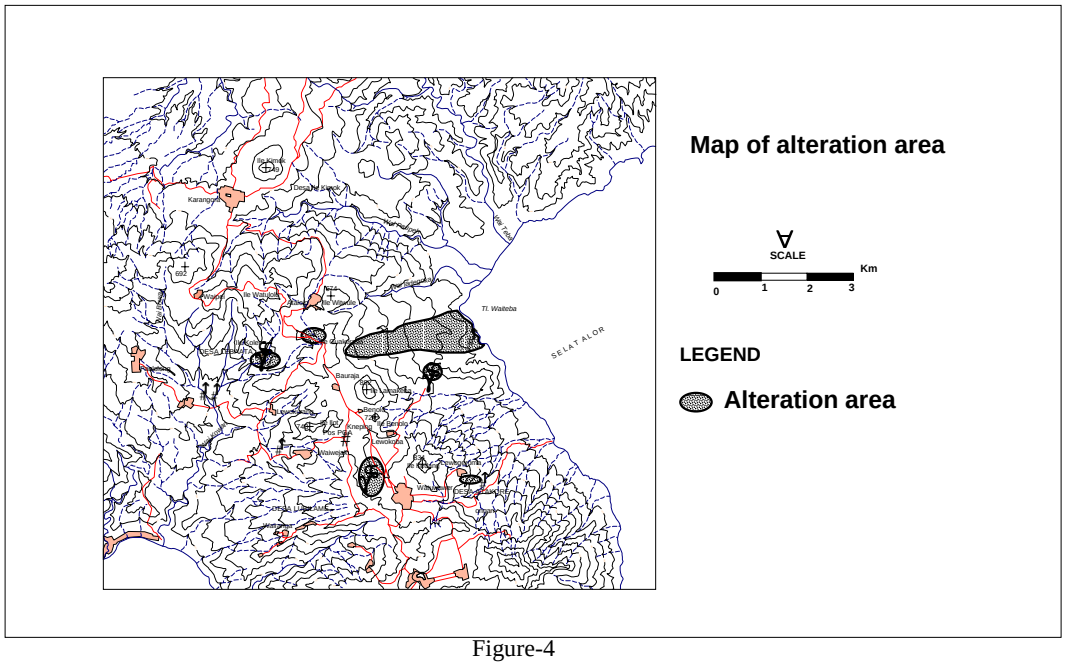

Figure-4
Altered rock area

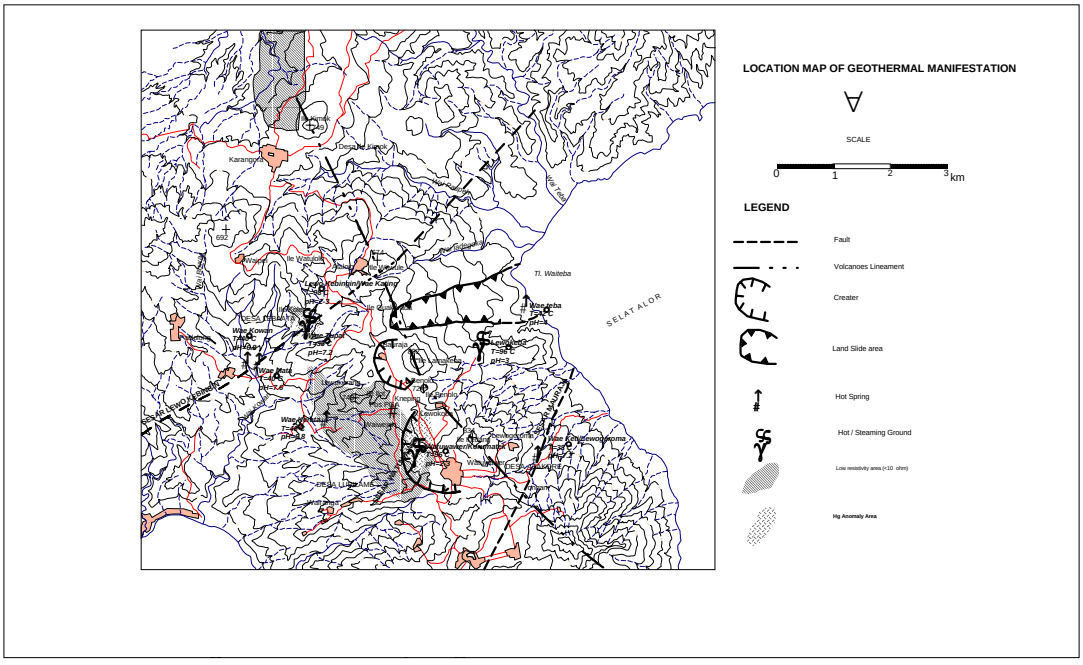

Figure-5
Anomaly Resistivity and Anomaly Hg Area