Identification of rocks based on rock's structure in Blawan-Ijen, East Java, Indonesia

S Astutik1* and S L Nisa1
1 Physics Education, University of Jember, Kalimantan Street No.37, Jember, East Java 68121, Indonesia

* tika.fkip@unej.ac.id

Abstract. Ijen Complex is the area that became part of Mount Ijen. In morphology, Ijen complex has Kendeng caldera the diameter of 14-16 km in the North whereas in the southern part of forming a row of mountains. The northern part of Mount Ijen as Blawan–Ijen is the area has the potential of geothermal. Blawan-Ijen becomes the gathering place for the volcanic materials since this region is a region which has low topography. Volcanic materials collected form a rock after experiencing cooling and in a long time. This research was conducted to identify the rocks in the area of Blawan-Ijen. The process starts with a sampling of rocks. Then the rocks are identified based on the structure of the manifest and differentiated according to the origin. Based on the identification process can be known that at Blawan-Ijen, found some sort of rock like a rock breksi, lava stones, silt stones, basalt stones, pumice stone and limestone. So it can be inferred that in Blawan-Ijen there are two types of rocks that is igneous and sedimentary rocks.

Keyword: Rocks, Rock’s Structure, Blawan-Ijen

1. Introduction

Population growth in Indonesia is increasing every year, consequently energy demand is also increasing. Energy that is often used by the community is energy derived from fossil materials, namely gas oil and non-oil gas. Because energy is a major requirement in everyday life, humans often do not consider the importance of energy from fossil materials continuously [1]. The increasing energy needs, causing the government to strive for energy saving in Indonesia. The business carried out by the government by using alternative energy is geothermal. Geothermal energy was chosen because it is an environmentally friendly energy and is a relatively inexpensive energy compared to energy derived from fossil fuels [2].

Geothermal is heat energy that is under the layers of the Earth. According to Ilyas in the 2012 VIII National Seminar on Human Resources for Nuclear Technology, geothermal is a result of heating the geothermal system, namely heating between rocks and water along with other elements in the earth. In Indonesia there is a lot of geothermal energy that can be utilized in everyday life. Geothermal sources in Indonesia are recorded as many as 256 regions including the Quaternary Volcano line region which is 203 and the outer area of the Quaternary Volcano line which is 53 [3].

One area in East Java that has geothermal potential is Blawan Village, Sempol District, Bondowoso Regency and is known as Blawan-Ijen. Geothermal potential in Blawan-Ijen is characterized by the distribution of hot springs which have temperatures around 39 °C - 51 °C. Based on the Ministry of Energy and Mineral Resources in 2017, Blawan-Ijen has a reservoir peak depth of around 1200-1400 meters with a temperature of 250 °C - 300 °C so that there is a geothermal source. The reservoir is composed of rock types in the proximal-medial facies, namely the dominant tuff pyroclastic rocks and lava rocks. In addition, in Blawan-Ijen there are various types of old rocks such as breccias bricks, basaltic-tuff rocks and lava rocks [4].
Rock is a material which is verified to be solid and hard through a scientific process where similar and disparate minerals gather and form solids. Rocks can be divided into 3 types namely igneous rocks, sedimentary rocks, and metamorphic or metamorphic rocks. These rocks have compact and solid properties, but there are several types of rocks that do not have compact properties [5].

The rocks on this earth are formed because of a process or cycle. This cycle reflects the beginning of the formation of rocks to become rock formed or intact. The rock cycle begins in the form of magma, then undergoes modification, transportation, decomposition, until it turns into another type of rock and returns to magma again, and so on. This process or cycle involves three main types of rocks, namely igneous rocks, sedimentary rocks, and metamorphic rocks. These three types of rocks turned out to occur in the same cycle, in other words, these three rocks formed together. Various types of rocks are given below:

a) Igneous Rock is rock formed from cooling of hardened magma without the crystallization process occurring below the earth’s surface (intrusive rocks) and above the earth’s surface (extrusive rocks). The main ingredient of igneous rock formation is magma derived from melting rocks found in the mantle or crust of the earth. Melting of rocks occurs as a result of temperature rise, pressure drop and composition change. Igneous rocks are classified into plutonic igneous rocks, hypabyssal rocks and volcanic igneous rocks [6].

b) Sedimentary rocks are rocks that occur as a result of mechanical, chemical and organic deposition. Rock deposition mechanically occurs when igneous rock carried away by water, wind or melting ice then settles in a relatively long time. And chemical rock deposition occurs as a result of a chemical process which then produces chemical sedimentary rocks. Whereas deposition of rocks organically occurs organically with the help of organisms. According to [10] sedimentary rocks are grouped into 3 types of sedimentary rocks namely clastic sedimentary rocks, non-clastic sedimentary rocks, and carbonate sedimentary rocks.

c) Metamorphic rocks are the existing rock originating from the metamorphism process. Metamorphism is a process of changing the mineral content, texture, and structure of rocks into solid forms without being accompanied by increased chemical elements in rocks. This process occurs because of changes in pressure and changes in temperature [10]. Metamorphic rocks can be divided into several types, namely amphibolite, eclogite, granulite, hornfels, milonite, serpentinite and skarn.

Physical properties of rocks are properties possessed by each type of rock after a test but the rock is not damaged or remains in its initial condition [5]. The physical properties of rocks are very important to know, because they can know the origin of the formation of a rock and can recognize the type of rock and its geological structure. One of the physical properties of a rock is a rock structure. The structure is the parts of a rock that can be observed using the senses, namely the shape of the rock, rock composition and position of a rock [11]. Observation of the structure of rocks can be done directly in the field by taking rock samples in the area to be carried out research.

The location of this research is in Blawan, Sempol District, Bondowoso Regency. The Blawan-Ijen region has a geographical location which is located at 7° 59′ 9″ S - 114° 10′ 32″ E. Blawan-Ijen is located in the Ijen Complex area. Morphologically the Ijen Complex is characterized by the presence of the Kendeng Caldera with a diameter of 14-16 km in the North and in the South marked by a series of mountains [4]. Mount Kendeng volcanic activity did not occur even stopped, when the formation of the Ijen caldera and in the North formed faults on the walls of the Ijen Caldera [7]. The topography of the Ijen Caldera contains volcanic cones, which indicate that the Ijen Caldera region has magmatic activity [8].
The study area is divided into 3 locations for rock sampling, namely: Limestone Cave, Blawan Waterfall and along the Road leading to the Limestone Cave and Blawan Waterfall. The determination of the research area is based on the location considered closest to the Blawan-Ijen geothermal center. So that rocks taken from the three regions are considered quite representative as a sample.

2. Methods
The research method used with direct observation and measurement in the field. The method used to collect research data is direct field survey methods. The direct method is a method of collecting data...
that is carried out directly in the field. The stages in data processing consist of two stages, namely the selection of rock samples and grouping of rocks in Blawan-Ijen based on certain criteria.

Data collected in the study include (a) Selection of rock samples, at this stage, rock samples were taken at Blawan-Ijen. The rock samples chosen are rocks of various shapes and sizes; and (b) Rock grouping, at this stage, a grouping of rocks is carried out based on direct observation using the senses with the aid of a magnifying glass. Rocks are grouped based on the shape of the arrangement or patterns that appear on the rock and grouped according to their origin. The grouping of rocks based on their arrangement aims to identify the type of rock and the name of the rock. While the grouping of rocks based on the origin of the formation of rocks aims to determine the type of rock.

![Figure 3](image1.jpg)

**Figure 3.** (a) Rocks in the Ijen Caldera area (b) Rocks along the road to Blawan-Ijen

The rocks observed in the Blawan-Ijen area are found in the northern Ijen caldera wall area as shown in Figure 3a. In addition, observations of the rocks were taken along the road to Blawan-Ijen as shown in Figure 3b. Along the road to Blawan-Ijen there are often silt rocks which are sedimentary rocks.

3. **Results and discussion**

From the results of data processing carried out in the field, it can be identified that there are two types of rocks found in Blawan-Ijen namely igneous and sedimentary rocks. Types of igneous rocks in Blawan-Ijen are lava, basalt and pumice. From these three rocks the rock structure can be seen. Lava rock has a perforated structure but is not too large, has a black color and is light in nature. While pumice has a hollow or porous structure with a bright color. This color is what distinguishes between lava rock with pumice. Basalt stone has a massive structure and gray or black. Of the three types of rocks, it can be seen that the three rocks are extrusive igneous rock types.
Figure 4. (a) Extrusive Igneous Rock which is basalt rock
(b) Extrusive Igneous Rock which is pumice
(c) Extrusive Igneous Rock which is lava rock

Basalt rock is formed by cooling lava containing gases but the gas has evaporated. The characteristics of basalt stone consist of crystals that are very small, grayish green and perforated (Figure 4a). Pumice is formed from cooling the bubbly magma of gas. The characteristics of pumice are grayish color, porous, bubbly, light weight and floating in water (Figure 4b). Lava rock is formed from the cooling of magma that reaches the earth's surface. Characteristics of lava rock has a hollow structure but not too large, has a black color and is mild (Figure 4c).

While the types of sedimentary rocks in Blawan-Ijen are breccia, silt and limestone. The structure that can be observed from breccia is that the structure is not layered because of the presence of fragments of large rocks of about 2 mm. While the structure of silt stone is multi-layered and has a brownish-gray color even reddish brown depending on the composition of its constituents. Breccia and siltstone are clastic sedimentary rocks. While limestone or better known as limestone has a structure that is not layered and white or bright. And limestone contains calcium carbonate so it is called carbonate or non-clastic sedimentary rock (Figure 5a).

Figure 5. (a) Carbonate or non-clastic sedimentary rocks are limestone
(b) Clastic sedimentary rocks are silt rocks

Limestone is formed from the shells of soft animals such as snails, shells and dead sea animals. The frame made of lime will not be destroyed, but solidifies and forms limestone. The characteristics of this limestone are rather soft, grayish white and forming carbon dioxide gas when acid drops. Siltstone is formed where water, wind, or ice deposits carry silt-sized material and then accumulate, compact and cemented into rock. Silt-sized particles are usually called mud (Figure 5b). Sludge can accumulate in sedimentary basins throughout the world. Mud represents the level of currents, waves, or wind energy, so that it can be anywhere like in a fluvial, aeolian, tidal, coastal, lacustrine, delta, and glacial environment. Sedimentary structures in siltstones are often in the form of
layering, cross-bedding, ripple marks and contact erosion. In addition, fossils are also found in this rock which can provide evidence of their depositional environment.

4. Conclusions
Identification of rocks in Blawan-Ijen based on the structure of rock that appears and is distinguished based on the origin of the formation of rocks are there are two types of rocks in Blawan-Ijen namely igneous and sedimentary rocks. Igneous rocks include basalt, lava, and pumice. While sedimentary rocks include breccia, silt and limestone.

Acknowledgements
The author’s gratitude goes to brother Suhriadi Efendi who helped in preparing rock samples at Blawan-Ijen. Likewise, the author's gratitude goes to the University of Jember, State Blawa-Ijenn of Regency of Bondowoso, that have provided collaborative research opportunities. The results of the research that has been done, are expected to be used as a source of information about the rock structure contained in Blawan-Ijen so that it can be the basis of further research.

References
[1] Raehanayati R, Rachmansyah A and Maryanto S 2013 STUDI POTENSI ENERGI GEOTHERMAL BLAWAN-IJEN, JAWA TIMUR BERDASARKAN METODE GRAVITY J. NEUTRINO 31
[2] Azhar M and . S 2015 ASPEK HUKUM KEBIJAKAN GEOTHERMAL DI INDONESIA LAW REFORM 11 123
[3] Afandi A, Maryanto S and Rachmansyah A 2013 IDENTIFIKASI RESERVOAR DAERAH PANASBUMI DENGAN METODE GEOMAGNETIK DAERAH BLAWAN KECAMATAN SEMPOL KABUPATEN BONDOWOSO J. NEUTRINO 1
[4] Azhari A P, Maryanto S and Rachmansyah A 2016 IDENTIFIKASI STRUKTUR GEOLOGI DAN PENGARUHNYA TERHADAP SUHU PERMUKAAN TANAH BERDASARKAN DATA LANDSAT 8 DI LAPANGAN PANASBUMI BLAWAN J. Penginderaan Jauh dan Pengolah. Data Citra Digit. 13
[5] Rahman A, Triantoro A and Mustofa A 2017 PENGARUH PELAPUKAN TERHADAP SIFAT FISIK BATUAN DAN TANAH RESIDUAL BREKSI VULKANIK J. GEOSAPTA 3
[6] Noor D 2012 PENGANTAR GEOLOGI Progr. Stud. Tek. Geol. Tek. – Univ. PAKUAN,Jalan Pakuan, PO. Box 452, Bogor.Edisi Kedua. 2 1–334
[7] Dewi C N, Maryanto S and Rachmansyah A 2015 SISTEM PANASBUMI DAERAH BLAWAN, JAWA TIMUR BERDASARKAN SURVEI MAGNETOTELURIK J. Ris. Geol. dan Pertamb. 25 111
[8] Juniarti E, Maryanto S and Susilo A 2017 Pemetaan Suhu Permukaan Tanah Daerah Kawah Wurung, Kabupaten Bondowoso, Jawa Timur dalam Penentuan Manifestasi Panas Bumi Natural-B 4 65–72
[9] van Hinsberg V, Berlo K, van Bergen M and Williams-Jones A 2010 Extreme alteration by hyperacidic brines at Kawah Ijen volcano, East Java, Indonesia: I. Textural and mineralogical imprint J. Volcanol. Geotherm. Res. 198 253–63
[10] Zaika Y, As'ad M 2019 Mekanika Tanah Dasar Malang UB Press
[11] Chaerul M 2005 Pengantar Ilmu Batuan Sulawesi Tenggara YCAB