

## ROCK CHARACTERISTICS AS THE BASIS OF AQUIFER DETERMINATION IN CIANJUR SUB-WATERSHED, CUGENANG DISTRICT, CIANJUR REGENCY, WEST JAVA PROVINCE

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### ABSTRACT

*Based on Presidential Decree Number 12 of 2012, this research area is part of the Upstream Citarum watershed and part of the Citarum River Basin. The boundary of this research area is the Cianjur Sub-watershed which has an area of approximately 41.0 km<sup>2</sup>. The research area is the eastern part of Mount Gede. This study aimed to determine the characteristics of the lithology as the basis of aquifer determination that composed the research area based on the results of surface geological mapping and supported by petrographic analysis. This research used a method split into several stages, namely the stages of fieldwork, rock sampling, and laboratory analysis. At the fieldwork stage, geological mapping of the surface was carried out by observing rock outcrops in the research area. At the sampling stage, it is done by taking rock samples representing each rock unit in the research area. As for the last stage, laboratory analysis is performed using the petrographic analysis method, namely the analysis of thin sections on rock samples to observe each of the mineral contained and porosity characteristics in the rock samples. The results of the thin section analysis are then compared with the existing classifications. Based on the results of the analysis, the research area is composed of igneous rocks, volcanic rocks, and pyroclastic rocks which are divided into three (3) units, namely the Volcanic Breccia Unit (SBv), Volcanic Tuff Unit (STv), and Volcanic Lava Unit (SLv). Based on these three units of lithology, SBv which is a unit of volcanic breccia is an aquifer.*

**Keywords:** Geological mapping, rock characteristics, petrographic analysis, Cianjur sub-watershed.

### 1. INTRODUCTION

Geology is a science of rocks studies, including the sequence of their formation, the relationship between rock bodies, the development of geological structures that affect the distribution pattern of rocks, volcanism activities, and geological processes that influence them. To produce an overview of the genesis of their formation, the process of their formation, geological history, geological conditions, potential geological hazards, and natural resources that humans can utilize.

The surface geological mapping in this study was carried out to know the characteristics of the rocks in the research area. For further characteristic analysis, petrographic analysis was also carried out on representative samples from each of these rock units.

Based on Presidential Decree Number 12 of 2012, this research area is part of the Upstream Citarum Watershed and part of the Citarum River Basin. The boundary of this research area is the Cianjur Sub-watershed which has an area of approximately 41.0 km<sup>2</sup>. The research area is the eastern part of Mount Gede. This research is conducted as an effort to obtain information related to rock characteristics in the research area.

### 2. METODOLOGY

This research used a method split into several stages, namely the stages of fieldwork, rock sampling, and laboratory analysis. At the fieldwork stage, geological mapping of the surface was carried out by observing rock outcrops in the research area. At the sampling stage, it is done by taking rock samples representing each rock unit in the research area. As for the last stage, laboratory analysis is performed using the petrographic analysis method, namely the analysis of thin sections on rock samples to observe each of the mineral contained and porosity characteristics in the rock samples.

The results of the thin section analysis are then compared with the existing classifications. In igneous rocks, the classification used Streckeisen classification (1976), while for the analysis, results from volcanic rock incisions are classified based on the classification of Schmid (1981).

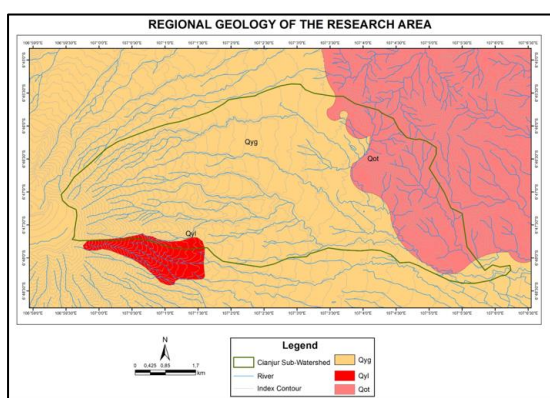
Characteristics results are used to determine which rock units can be used as aquifers in the research area. Aquifers are rock formations that can store and drain sufficient amounts of water (Todd, 1980; Fetter, 1988). Examples of aquifers are unconsolidated sand, gravel, volcanic breccia, sandstone, limestone,

dolomite hollow (porous), basalt flow, metamorphic rock, and plutonic with many cracks (Fetter, 1988).

The research area is included in the regional geological map of the Cianjur sheet with a scale of 1:100,000, which was mapped by Sudjarmiko (1972) (figure 1). Based on this regional geology, the research area is composed of various rocks from old to young, namely:

#### a. The Oldest Volcanic Product (Qot)

The oldest volcanic product (Qot) has a thickness of about 0-550 m in the Early Quarter and comprises breccia and lava. Pyroxene andesite breccia are interlaced with andesitic lava. Generally, there is propilation. It is Form a separate broad hilly area, surrounded by the Qyg near Cianjur.



**Figure 1.** Regional of Geological Map of the research area (Sudjarmiko, 1972)

#### b. Lava (Qyl)

The thickness of this unit ranges from 0-150 m and it is a young lava flow from Mount Gede, exposed on the west side of the map sheet, especially in the research area.

#### c. Breccia and Lahar deposit from Gunung Gede (Qyg)

The thickness of this unit ranges from 0-100 m. It consists of tuffaceous sandstones, tuffaceous shales, tuffaceous breccias and tuffaceous agglomerates. Forming the Cianjur plain of Quaternary age.

### 3. RESULT AND DISCUSSION

The results of geological mapping and petrographic analysis of several samples representing each rock obtained the following characteristics

#### a. Volcanic Tuff Unit (STv)

The spread of this unit occupies about 30% of the research area. This unit is spreading to the

east of the research area, located in Ciputri Village, part of Cigedil Village and part of Cibeureum Village. This unit is well exposed on hillsides and rivers with high weathering intensity. The distribution of this unit is limited by lithological differences in the research area.

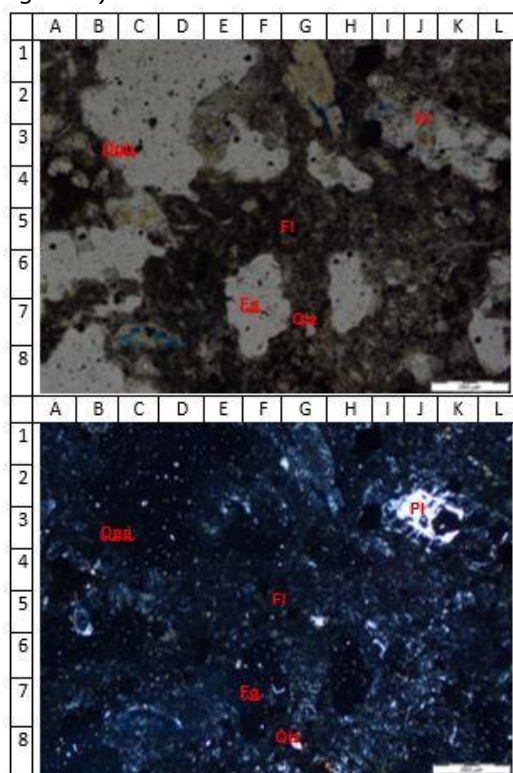
Tuff is a pyroclastic rock resulting from volcanic eruptions. In this unit, the characteristics of this rock are a fresh yellowish-grey color, a weathered color of blackish grey, a slightly angular grain shape, a medium-fine ash grain size with a dominance of fine ash, slightly hard-brittle hardness, poor sorting, the relationship between grains are open, and massive structure. It has a thickness ranging from 2-10 m.



**Figure 2.** The lithology of the tuff unit (STv) of the study area, the tuff outcrop at station AG-40 exposed on the river wall.

Microscopically, this unit is represented by the AG-40 station, which has the characteristics of brownish-white (PPL) and blackish ash (XPL), sub-angular to sub-rounded grain shape, the relationship between grains are open and poor sorting. The composition consists of glass (40%), lithic fragments (30%), minerals (10% quartz and 5% plagioclase), and other minerals in the form of 5% opaque minerals. Based on this percentage, these rocks are

grouped into **Vitric Tuff** (Schmid, 1981) (Figure 3).



**Figure 3.** The results of the petrographic analysis of AG-40 lava samples exposed on the river wall, with the information: Pl: Plagioclase, Qtz: Quartz, Fg: Glass Fragment, Fl: Lithic Fragment, Opq: Opaque Mineral

Based on the characteristics of the rock samples, this unit is compared with Qyg (Sudjatmiko, 1972) which is Quaternary ages. Determination of the depositional environment in this unit considers the rock characteristics, including mineral content and rock texture. Based on the characteristics and distribution of rock outcrops, this unit results from a land volcanic eruption.

#### b. Volcanic Breccia Unit (SBv)

The spread of this unit occupies about 60% of the research area. This unit is spreading dominantly from the north to the south of the study area, located in Ciherang, Galudra, Nyalindung, Sukamulya, and part Ciputri, Cibeureum, and Mangunkerta villages. This unit is well exposed on river walls and the hillsides. The distribution of these rock units is limited by the lithological differences in the study area that following the contours.

Volcanic breccias result from volcanism identified as having grain-supported characteristics, generally have fresh light grey color, weathered reddish-brown color, coarse tuff matrix, andesitic components cobble-boulder rock size, poor sorting, the

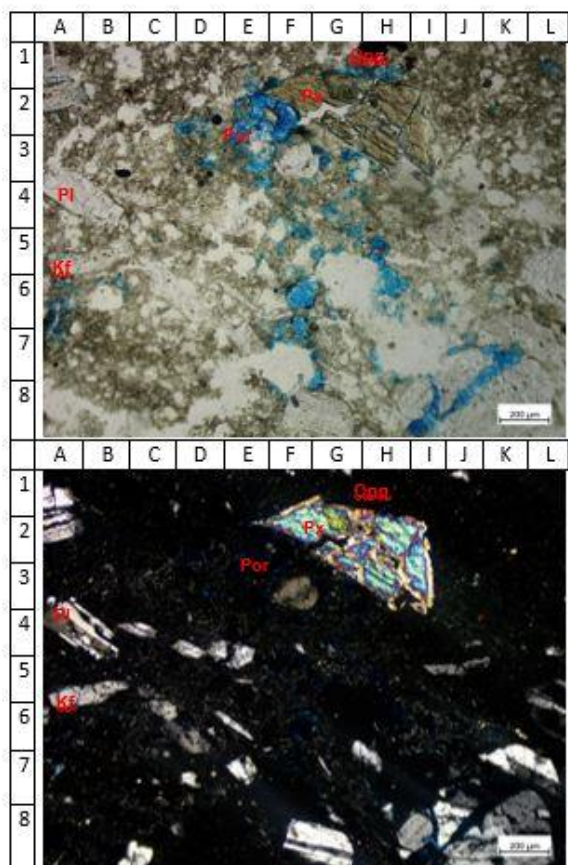
relationship between grains are open, and massive structure. Coarse tuff matrix with fresh brown color, dark brown weathered color, slightly angular grain shape, soft hardness, and massive structure. The andesite component has a fresh dark grey color, weathered cream color, mesocratic, porphyritic, and inequigranular. The observed mineral compositions are quartz, plagioclase, and pyroxene (Figure 4).



**Figure 4.** Lithology of the volcanic breccia unit (SBv) of the study area. Outcrop of volcanic breccia at station AG-28 with fragments composed of andesite rock with pebble-boulder size and matrix composed of coarse tuff.

Microscopically, this unit component is represented by the AG-30 station, which has the characteristic brown color (PPL) and brownish-black color (XPL). Porphyritic granularity, hypidiomorphic mineral form, uniformity of crystal size is inequigranular, degree of crystallization is hypocrySTALLINE, with 37% phenocryst composition (in the form of 5% quartz, 20% plagioclase, 2% K-feldspar, 10% pyroxene), 45% base mass (in the form of microcrystalline plagioclase), porosity 15% and secondary minerals in the form of 3% opaque minerals. Based on the mineral composition, this rock belongs to the **Andesite rock** (Streckeisen, 1976) (figure 5).



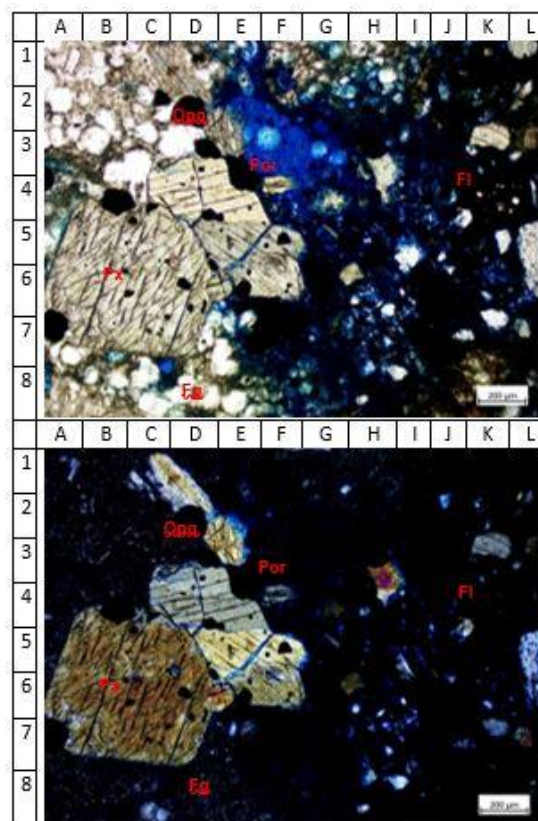


**Figure 5.** The results of the petrographic analysis of AG-30 lava samples (components) exposed on the valley walls, with the information: Px: Pyroxene, Pl: Plagioclase, Por: Porosity, Opq: Opaque Mineral, Kf: K-feldspar

Microscopically, the matrix of this unit is represented by the same station, namely AG-30, which has the characteristics of white brown (PPL) and brown-black ash (XPL), the relationship between grains is open, with poor sorting. The composition consists of glass (20%), porosity (20%), lithic fragments (30%), crystals (10% plagioclase, 10% pyroxene, and 5% quartz), and secondary minerals in the form of opaque minerals (5%). Based on the mineral association, this rock belongs to the **Lithic Tuff** (Schmid, 1981) (Figure 6).

Based on the characteristics, these rocks are compared with Breccia and Lahar from Mount Gede (Qyg, Sudjatmiko 1972). Determination of the depositional environment in this unit considers the rock characteristics, including mineral content and rock texture. This unit results from a land volcanic eruption with andesite composition as a fragment and coarse tuff pyroclastic rock as a matrix based

on the characteristics and rock outcrops distribution.



**Figure 6.** The results of petrographic analysis of volcanic breccia samples at station AG-30 exposed on the valley wall, with the information: Px: Pyroxene, Fl: Lithic Fragment, Fg: Glass Fragment, Por: Porosity, Opq: Opaque Mineral.

### c. Lava Unit (SLv)

The spread of this unit occupies about 10% of the research area. This unit is spreading to the south of the research area, located in Sukamulya Village. This unit is well exposed on the river floor. The distribution of these units is limited by the lithological differences in the study area that following the contours.

This rock unit has the characteristics of fresh grey-black rock, weathered grey-brown color, has a mesocratic, porphyritic granularity, inequigranular grain uniformity, massive structure, and is composed of quartz, plagioclase, and mafic minerals such as pyroxene and amphibole (Figure 7).

Microscopically, this unit is represented by station AG-25, which has blackish brown (PPL) and blackish grey (XPL). It has porphyritic, hypidiomorphic, inequigranular, and the type of crystallization degree are holocrystalline. It

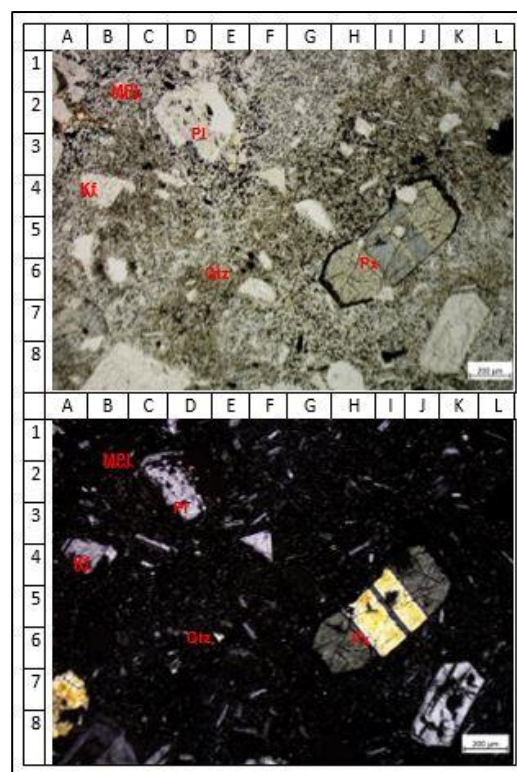
has a phenocryst percentage of 40% and a base mass of 60%.



**Figure 7.** Lithology of the lava unit in the study area, lava outcrop at station AG-25

The mineral composition is composed of quartz (2%), plagioclase (25%), k-feldspar (3%), pyroxene (10%), and the base mass consists of microcrystalline plagioclase (60%). There is a secondary mineral in the form of opaque mineral (5%). There is a trachytic texture on the groundmass, which is microcrystalline plagioclase. Based on the mineral association, this rock belongs to the Andesite rock (Streckeisen, 1976) (Figure 8).

Based on the characteristics of these rocks, this unit can be compared with Qyl (Sudjatmiko, 1972) which is Quaternary ages. Determination of the depositional environment in this unit compared with regional geology and rock characteristics, including mineral content and rock texture.



**Figure 8.** The results of petrographic analysis of AG-25 lava samples exposed on the river wall, with the following information: Px: Pyroxene, Pl: Plagioclase, MPI: Plagioclase microlite (trachcyt texture), Qtz: Quartz, Kf: K-Feldspar

The results of petrographic analysis of lava samples at station AG-25 exposed in the river, composed of volcanic minerals and based on the comparison of the Regional Geological Map of Sheet Cianjur, result from a terrestrial volcanic eruption.

The following table shows the comparison of lithological characteristics in the research area and the lithological characteristics based on Sudjatmiko (1972).



**Table 1.** Comparison of lithological characteristics in the study area with Sudjatmiko, 1972

Rock Characteristics of Research Area	Rock Characteristics (Sudjatmiko, 1972)	Age (Sudjatmiko, 1972)	Precipitation Environment Interpretation
<b>STv:</b> Tuff is a pyroclastic rock resulting from volcanic eruptions. In this unit, megascopic tuff has the characteristics of a fresh yellowish-grey color, a weathered color of blackish grey, a slightly angular grain shape, a medium-fine ash grain size with a predominance of fine ash, moderately hard-brittle hardness, poor sorting, poor correlation, between open grains, and massive structures. It has a thickness ranging from 2-10 m.	The thickness of this unit ranges from $\pm 0$ -100m. It consists of tuffaceous sandstones, tuffaceous shales, tuffaceous breccias, and tuffaceous agglomerates. It is forming the Cianjur plain of the Quaternary age	Quaternary	Terrestrial
<b>SBv:</b> Volcanic breccias are the result of volcanism identified as having grain-supported characteristics, generally having fresh light grey color, weathered reddish-brown color, coarse tuff matrix, andesitic components, with cobble-rock size, poor sorting, the relationship between grains are open and massive structure. Coarse tuff matrix with fresh brown color, dark brown weathered color, slightly angular grain shape, soft hardness, and massive structure. The andesite component has a fresh dark grey color, weathered cream color, mesocratic color index, porphyritic granularity, inequigranular uniformity, and massive structure. The observed mineral compositions are quartz, plagioclase, and pyroxene.	The thickness of this unit ranges from $\pm 0$ -100m. It consists of tuffaceous sandstones, tuffaceous shales, tuffaceous breccias, and tuffaceous agglomerates. It is forming the Cianjur plain of the Quaternary age.	Quaternary	Terrestrial
<b>SLv:</b> This rock unit has the characteristics of fresh grey-black rock, weathered grey-brown color, has a mesocratic color index, porphyritic granularity, inequigranular grain uniformity, has a massive structure, and is composed of quartz, plagioclase, and mafic minerals such as pyroxene and amphibole.	The thickness of this unit ranges from 0-150 m and is a young lava flow from Mount Gede, exposed on the west side of the map sheet, especially in the map area.	Quaternary	Terrestrial

## CONCLUSION

Based on the results of surface geological mapping and petrographic analysis, the rock characteristics in the research area were obtained as follows:

The Volcanic Tuff Unit (STv) is a unit composed of pyroclastic rocks resulting from volcanic eruptions. In this unit, megascopic tuff has the characteristics of a fresh yellowish-grey color, a weathered color of blackish grey, a slightly angular grain shape, a medium-fine ash grain size with a predominance of fine ash, slightly hard-brittle hardness, poor sorting, grain supported, and massive structure. It has a thickness ranging from 2-10 m. Quaternary age and deposited in a terrestrial depositional environment.

The Volcanic Breccia Unit (SBv) is the result of volcanism identified as having grain supported characteristics, generally having a fresh light grey color, weathered reddish-brown color, coarse tuff matrix, andesite component, with a size of gravel-boulder, poor sorting, the relationship between grains are open and massive structure. Coarse tuff matrix with fresh brown color, dark brown weathered color, slightly angular grain shape, soft hardness, and massive structure. The andesite component has a fresh dark grey color, weathered cream color, mesocratic color index, porphyritic granularity, inequigranular uniformity, and massive structure. The observed mineral compositions are quartz, plagioclase, and pyroxene. Quaternary age and deposited in a terrestrial depositional environment.

Lava Unit (SLv), this rock has the characteristics of fresh rock blackish grey,

weathered grey-brown color, has a mesocratic color index, porphyritic granularity, uniformity of inequigranular grains, has a massive structure, and is composed of quartz, plagioclase, and mineral quartz. Mafic minerals such as pyroxene and amphibole. Quaternary age and deposited in a terrestrial depositional environment.

Furthermore, based on Todd (1984), one of the rocks that can become an aquifer is volcanic breccia. So that SBv unit can be an aquifer.

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