

Application of Geology in Studying Groundwater System Beneath Gunung Kendil and Umbul Ponjong in Ponjong District, Gunungkidul

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ABSTRACT

Gunung Kendil is one of the karst hills located in the district of Ponjong, Gunung Kidul regency (8°00'56.64"S, 110°44'18.32"E). This hill is situated approximately 400 meters north of Ponjong District and about 20 km east of Yogyakarta.

Gunung Kendil is composed of bedded-limestone in the bottom part, chalky limestone, massive limestone with conduits, and reef limestone at the top. These rocks are included in Wonosari Formation, which is formed in Middle Miocene age (10-16 million years).

Groundwater system beneath Gunung Kendil is controlled by fractures, faults and bedding. The normal faults below Gunung Kendil are northeast-southwest trending almost facing each other forming a large subsidence. Cross cutting of the two normal faults and the bedding that is gently sloping to the north beneath Gunung Kendil form an underground river flowing toward the southwest and out as springs at the front of the Village Ponjong, called Umbul Ponjong (Sumbergiri) (7°58'34.39"S, 110°44'06.89"E).

The spring is very beneficial to people's lives in the village of Ponjong. At this time Umbul Ponjong already managed by the Regional Government of Gunung Kidul as a unique and interesting tourist area and geological heritage.

Key words: Gunung Kendil, groundwater system, fault, Umbul Ponjong.

RESEARCH BACKGROUND

Gunung Kendil is one of the karst hills located in the district of Ponjong, Gunung Kidul regency (8°00'56.64"S, 110°44'18.32"E). This hill is situated approximately 400 meters north of Ponjong District and about 20 km east of Yogyakarta (Figure 1).

Gunung Kendil is composed of bedded-limestone in the bottom part, chalky limestone, massive limestone with conduits, and reef limestone at the top. These rocks are part of Wonosari Formation, formed in Middle Miocene age (10-16 million years).

Ground water in Gunungkidul, specifically in Gunung Kendil is generally hard to find, especially in long dry season. Therefore, it is necessary to discover groundwater channels to help the people of Gunung Kendil, Desa Ponjong, Kecamatan Ponjong, Kabupaten

Gunung Kidul. This is needed for drilling so that the water can be utilized by its people.

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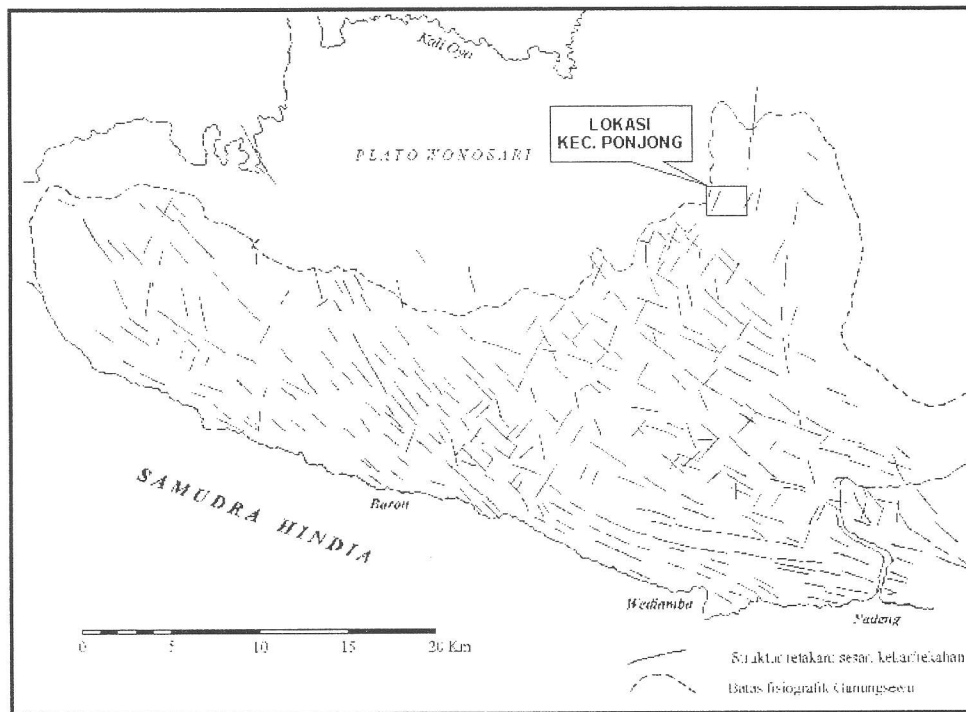


Figure 1. Location of Ponjong District, Gunungkidul

OBJECTIVES

The goal of this research is as follows:

1. To study the groundwater system beneath Gunung Kendil
2. To determine drilling location of well
3. To help developing Gunung Kendil area as a Tourism Village

LITERATURE REVIEW

Gunungsewu

Gunungsewu is the largest tropical karst landscape in Northeast Asia. This area is part of East Java Southern Mountains, in Gunungkidul Regency (DIY), Wonogiri and Pacitan Regency (Central Java). Geographically, Gunungsewu is situated between 6° 10' to 6° 30' LS and 99° 35' to 100° BT, approximately 25 km southeast of Yogyakarta, 109 km north-northwest of Pacitan, and 20 km southwest of Wonogiri. Gunungsewu has a total area of approximately 800 km². This area can be easily accessed from Yogyakarta-Wonosari, Wonogiri and Pacitan, and also established as one of tourism destinations, by Regional Government of DIY as well as Central Java (Figure 2).

Gunungsewu area has an interesting geological phenomenon, a beautiful karst geomorphology, a unique hydrogeology, a breathtaking view, and also a number of geology heritage sites supporting a geopark area. This is what encourages this paper to be written, based on the research supported by LPPM UPN “Veteran” Yogyakarta, to understand the groundwater system specifically in Gunung Kendil, and generally in Southern Mountains.

GEOLOGY OF GUNUNGSEWU

According to van bemmelen's physio-graphical map (1949), gunung sewu is part of east java southern mountains, which is divided into baturagung, panggung, and plopoh in the north, wonosari in the middle, and gunungsewu in the south (figure 3). Geology of gunungsewu is generally composed of volcanic rocks at the lower part and carbonate rocks at the upper part, formed in tertiary period. Geological map of gunungsewu is shown in figure 4.

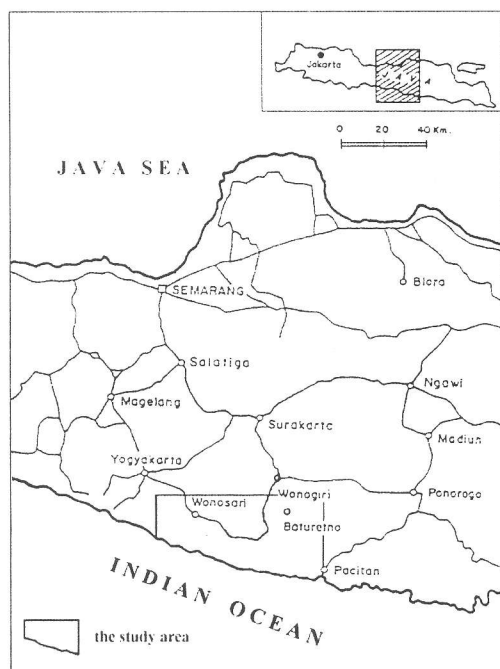


Figure 2. Gunungsewu Location Map

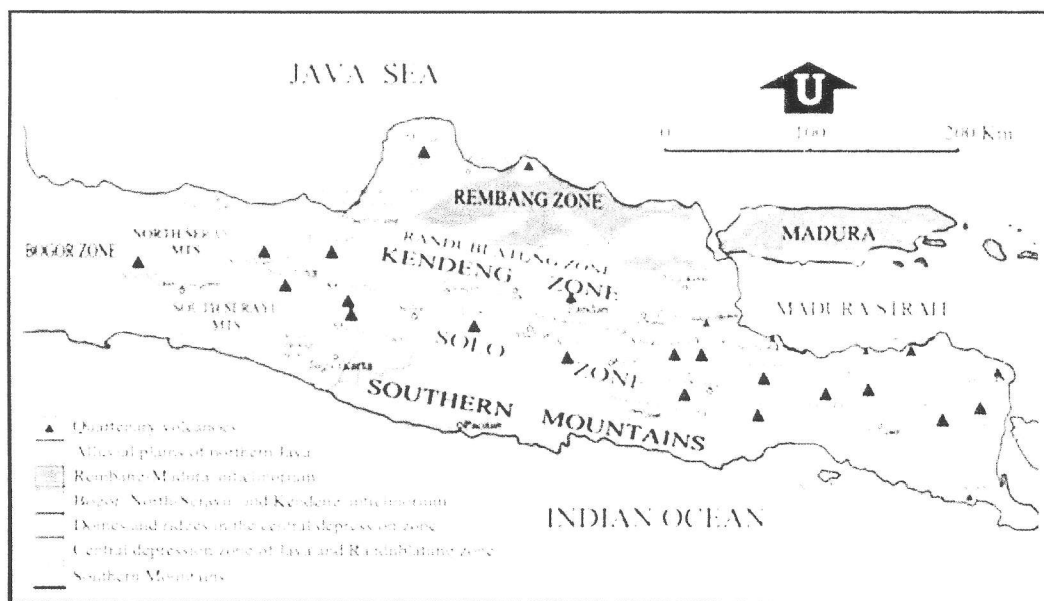


Figure 3. East Java Physiography Map (Van Bemmelen, 1949)

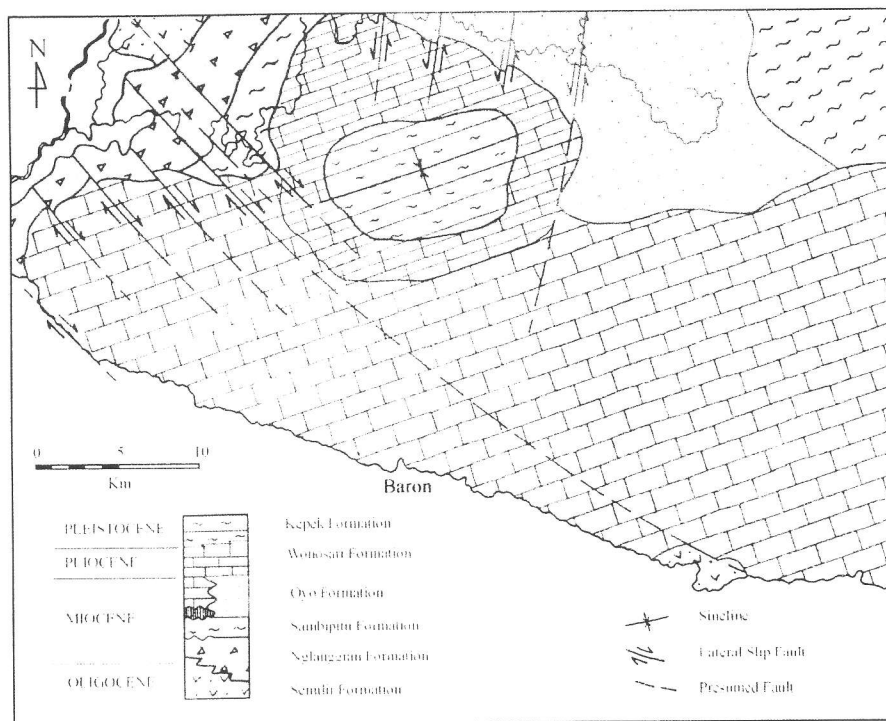


Figure 4. Geological Map of Gunungsewu (Kusumayudha, 2000, 2005)

Stratigraphy

Stratigraphy of Southern Mountains in DIY according to Toha et al (1994) and Suyoto (1994), from the oldest to the youngest is as follows:

Semilir Formation: Semilir Formation is composed of dasitic tuff, sandstone, tuffaceous sandstone, glass volcanic, agglomerate, claystone, siltstone, shale, and breccia. Semilir Formation is formed in Oligocene to Early Miocene period.

Nglanggran Formation: Nglanggran Formation has conformity at the top, or interfingering with the upper part of Semilir Formation, composed of volcanic andesitic breccia, lava, agglomerate, polyimic breccia, and tuffaceous sandstone. This Formation is deposited in Oligomiocene to Middle Miocene Period.

Sambipitu Formation: Sambipitu Formation is composed by intercalation of marl, claystone, carbonate sandstone, tuffaceous sandstone above Nglanggran Formation. Except in some places, where interfingering with Nglanggran Formation can be found. This Formation is formed in Middle Miocene.

Oyo Formation: Oyo Formation is composed of sandy carbonate, calcarenite, carbonate

sandstone, and tuffaceous sandstone. According to Suyoto (1994), its contact to Sambipitu Formation is unconformity. Oyo Formation, with its type location in Oyo River, is formed in Middle Miocene to Mio-Pliocene.

Wonosari Formation: Wonosari Formation is composed of carbonate, massive carbonate, and reef. This Formation sometimes shows conformity and different facies with Oyo Formation. An unconformity can even be found in Semin area, formed in Middle Miocene to Pliocene.

Kepek Formation: Kepek Formation is mainly composed of interbedded claystone, marl, and carbonate, which is deposited in isolated shallow-sea environment, in Late Pliocene to Pleistocene period.

Terarosa Sediment and Merapi Sediment: Terarosa sediment, alluvial and Merapi sediment is the youngest lithology of Gunungsewu. Alluvial sediment is composed of dark clay, siltstone, sand, gravel and part of plant, whereas Merapi sediment is composed of sand and volcanic ash. Terarosa is formed of molded limestone, combined with volcanic ash.

Geological Structure

The Southern Mountains area is regionally a high zone. A sincline trending in N75°E - N255-E (northeast - southwest) direction can be found in Wonosari Plato, with the slope angle of its wings is less than 10°. In Baturagung and Gunungsewu, the bedding structure generally forms a slanted homoclinal to the south. In Gunungsewu, the slope of bedding ranges from 5° to 15°. Fault structure of Gunungsewu is trending in northwest-southeast direction. Gunungsewu area is divided into several blocks, separated by faults. These faults also control the hydrogeologic system in Gunungsewu.

Gunung Kendil

Gunung Kendil is located in Ponjong District, approximately 500m from Regional Government office. Gunung Kendil site began to be managed by its owner (Mbah Moyo) for tourism object, bathing area, fishing area, and health therapy as well as geology/hydrogeology nature laboratory.

At the peak of Gunung Kendil, wells have been drilled in two places, producing water with relatively high pressure. The source of the water is an underground river beneath Gunung Kendil. This water fulfills drinking water quality, and has been used in drinking water production, as well as bathing area and health therapy. The groundwater system beneath Gunung Kendil is presumably controlled by fractures, faults, and bedding. Normal faults under Gunung Kendil trending northeast-southwest face each other, forming a large subsidence.

RESEARCH METHOD

Location and Time of Research

This research will be conducted in Gunung Kendil, Ponjong Village, Ponjong District, Gunungkidul Regency. The hill is located

approximately 400 m north of Ponjong District, about 20 km east of Yogyakarta City. The research is planned to start from June until October 2014.

RESEARCH METHOD

This research will use Field Detail Mapping Method and Laboratory Analysis Method.

Field Mapping Method

Field detail mapping in Gunung Kendil is done using tools as follows:

- Geological compass
- Geologist hammer
- GPS
- Base Map
- Clipboard
- Protractor
- Geological field book
- Measuring tape

The data recorded in detail mapping include:

- Lithology/rock types
- Developing geology structure type
- Measurements of layers position and geological structures (fractures, faults, bedding)
- Hillside slope
- Surface situation data and settlement
- Rock samples for laboratory analysis
- Water samples

Laboratory Method

This method is done to analyze rock samples, structure type and water sample.

TIME OF RESEARCH

One day of each week from June to October is allocated for detail research, as seen in Table 1.

Table 1. Field Research Activity Time

No	Activity	JUNE	JULY	AUG	SEPT	OCT
1.	Proposal	■				
2.	Proposal Presentation		■			
3.	Field 1		■			
4.	Field 2		■	■		
5.	Field 3			■	■	
6.	Field 4				■	■
7.	Analysis		■	■	■	
8.	Report Writing		■	■	■	■
9.	Final Presentation					■
10.	Final Report Submission					■

FIELD DATA

Field data obtained include rock type data, fracture data, fault data, morphology data, rock samples, and water samples. Those data is organized as shown below.

Gunung Kendil and Umbul Ponjong Morphology

Gunung Kendil is one of the hills in Gunung Sewu scattered in Southern Mountains of Yogyakarta Special Region, located 400 m north of Ponjong District Government office and 30 km east of Yogyakarta City. It lies in coordinates 8°00'56.64"S, 110°44'18.32"E (Figure 5). A large spring can be found at the southwest side of Regional Government office, its water is collected in two large ponds named Umbul Ponjong (Figure 6).

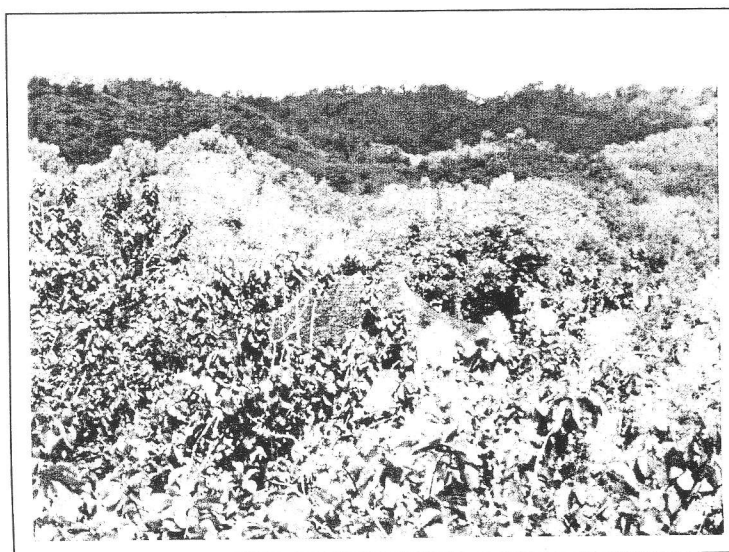


Figure 5. A photograph of Gunung Kendil taken from west direction.

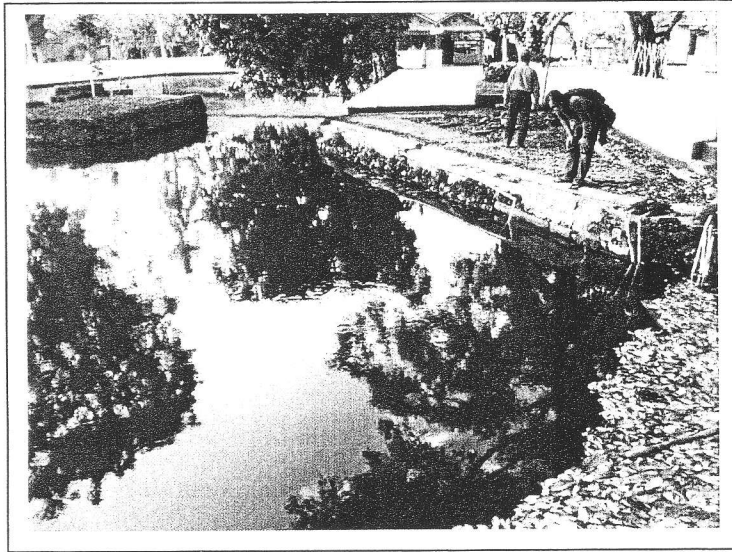


Figure 6. Tuk Umbul Ponjong taken from northwest direction

Geology of Gunung Kendil

Gunung Kendil is composed of bedded-limestone in the bottom part, chalky limestone in the middle (Figure 8), massive limestone

with conduits, and reef limestone at the top (Figure 9). These rocks are part of Wonosari Formation, formed in Middle Miocene age (10-16 million years).

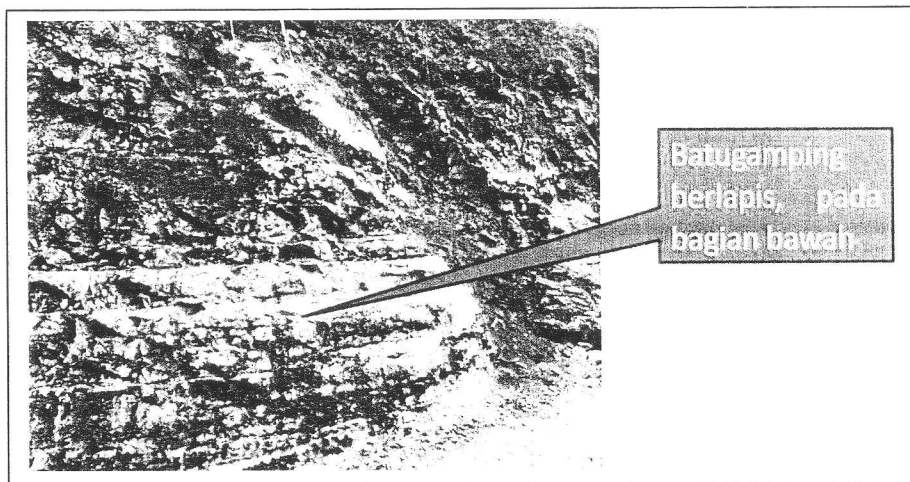


Figure 7. Bedded-limestone in the bottom part of Wonosari Formation



Figure 8. Chalky limestone in the middle

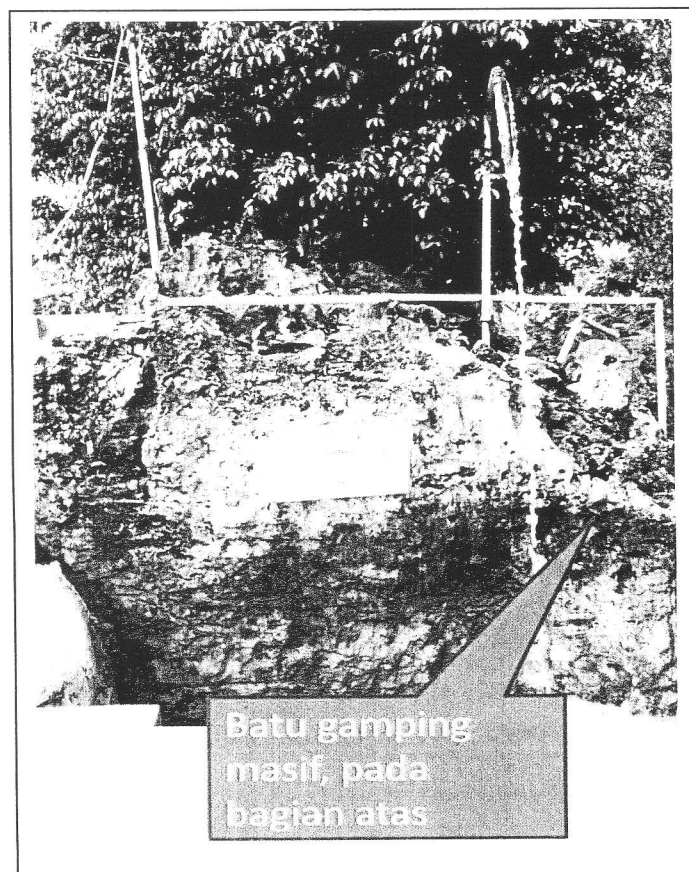


Figure 9. Massive limestone with conduits and reef limestone
at the top part of Wonosari Formation

Geological Structure

Measurements of fractures and faults done in Gunung Kendil to understand ground water

flow pattern resulted in flow pattern following structure pattern as seen in Figure 10.

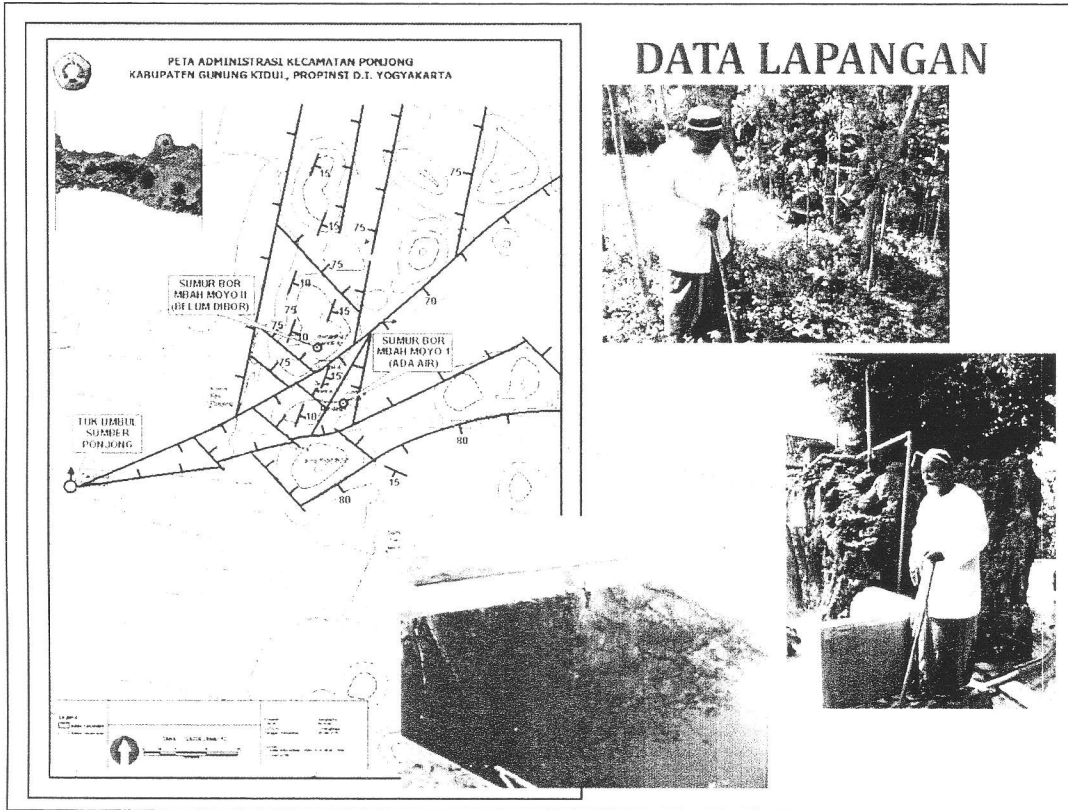


Figure 10. Structure pattern controlling water flow beneath Gunung Kendil up to Umbul Ponjong

Ground Water beneath Gunung Kendil and Sumber Ponjong Spring

At the peak of Gunung Kendil, wells have been drilled in two places for approximately 60 m deep. It connected to an underground river, forming artesian water as seen in Figure 10 and 11.

DISCUSSION

Underground river system beneath Gunung Kendil is controlled by normal faults trending nearly north northwest-south southwest slanted in west-northwest direction with an angle of 75-80 degrees meets with limestone bedding of n20e/15 and fracture of n31e/75. This activated dissolution caused by

infiltration of groundwater passing the meeting point of fault, fracture, and fault, forming an underground river trending nearly north-south. The drilled Mbah Moyo 2 Well penetrates this system in 66 meters deep.

This system meets the underground river flowing southwest, controlled by two normal faults trending northeast-southwest which form a grabben. This underground river flows out, forming a spring named tuk umbul sumber panjong.

The drilled well mbah moyo 1, 66 meters deep, with coordinates 110 43'141,467e and 7 58'490,798s exactly cut through the underground river flowing to tuk umbul sumber ponjong.

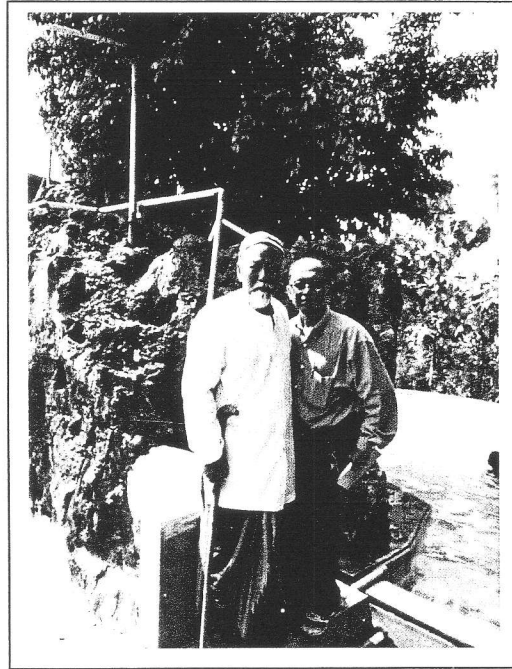


Figure 10. First drilling location for Mbah Moyo Well 1

Ground Water Usage beneath Gunung Kendil

The water from drilling in Gunung Kendil is used for:

1. Fulfilling water needs in Gunung Kendil
2. Water therapy (health)
3. Water tourism area (swimming and recreation)
4. Healthy drinking water

The ground water is used for drinking, washing, and field irrigation.

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