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Groundwater quality in Ponjong Karst, Gunungkidul Regency, Special Region of Yogyakarta

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Abstract

The hydrogeological condition of a region is determined by the type of lithology, morphology, and subsurface conditions where the condition is very helpful in the study of groundwater exploration. Especially when we encounter interesting geological conditions when the groundwater exploration in the karst area in which volcanic rocks are resulting from the activities of the active volcano in the past. Groundwater exploration at Ponjong area and surrounding does have its special characteristics, because it has 2 different rock characteristics where the northern part of the research area in the form of a karst area (limestone of Wonosari Formation) while the southern part is an area of ancient volcanoes with dominant volcanic rocks from Wuni Formation, As for the research on the above and subsurface research area where the research is conducted based on surface geology mapping, geoelectric data collection, and groundwater sampling. Geological mapping includes geomorphological data, stratigraphy, and geological structure. The aquifer system of the research area can be divided into two systems, inter-grain aquifer systems, and fracture aquifer systems. Overall quality groundwater in the research area is quite good. Ponjong District there are mining activities that have resulted in changes in the land use system in the area. This can cause changes in the water surplus in the area due to the changing catchment area.

1. Introduction

Hydrogeological conditions of a region are determined by the type of lithology, morphology, and subsurface conditions where the condition is very helpful in the study of groundwater exploration. Especially when we encounter interesting geological conditions when the exploration of groundwater in the karst area in which volcanic rocks are resulting from the activity of mount active fire in the past. Judging from the availability of groundwater, not all rocks in Gunungkidul Regency, especially Ponjong Districts have aquifers. While the area with good groundwater condition is bad depends on permeability. Groundwater exploration in Ponjong District does have its special characteristics, while the research here uses top and bottom surface research where the research was conducted based on surface geology mapping, data collection, and groundwater sampling. Geological mapping includes geomorphological data, stratigraphy, and geological structure. Study Area Located in Ponjong District, Gunungkidul Regency, Yogyakarta, Indonesia (Figure 1).

Limestone mining activities large and small scale are still the biggest threat to the preservation of karst areas. The destruction of limestone mining can be seen in the karst landscape appearance. The hills will be cut in many places. The mining process by dredging the karst area is taking the main part of water storage in the karst hills and damaging the existing hydrological system. The impact that occurs is an increase in the quality and quantity of water demand as well as a decrease in water availability in terms of quality and quantity in the area of land conversion.

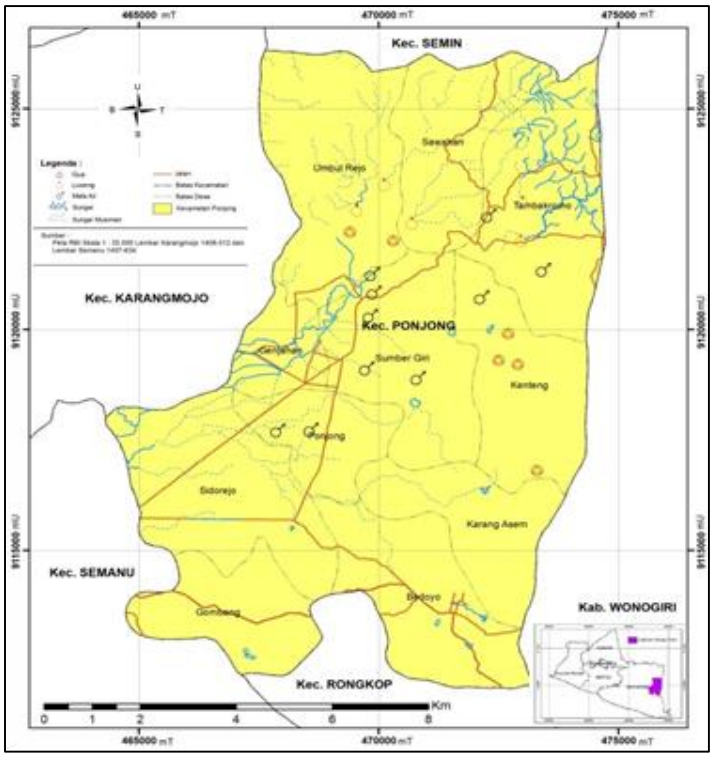

Figure 1. The study area

2. Methodology

This research was conducted based on surface geology mapping, data collection, and groundwater sampling. Geological mapping includes geomorphological data, stratigraphy, and structural geology.

3. Result and discussion

Groundwater exploration at the Ponjong area and surrounding does have its special characteristics because it has 2 different rock characteristics where the northern part of the research area in the form of karst area (limestone of Wonosari Formation). Formation (Figure 4).

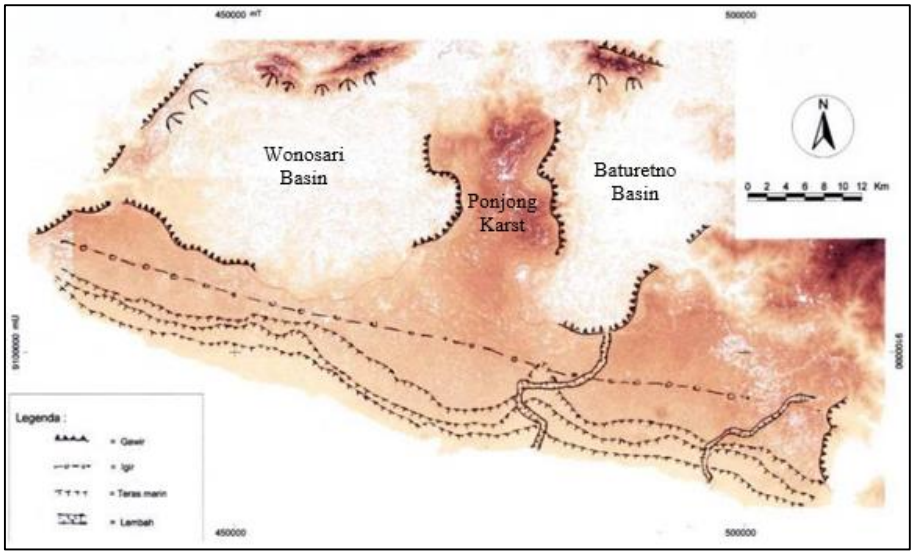

Figure 2. The location of Ponjong Karst

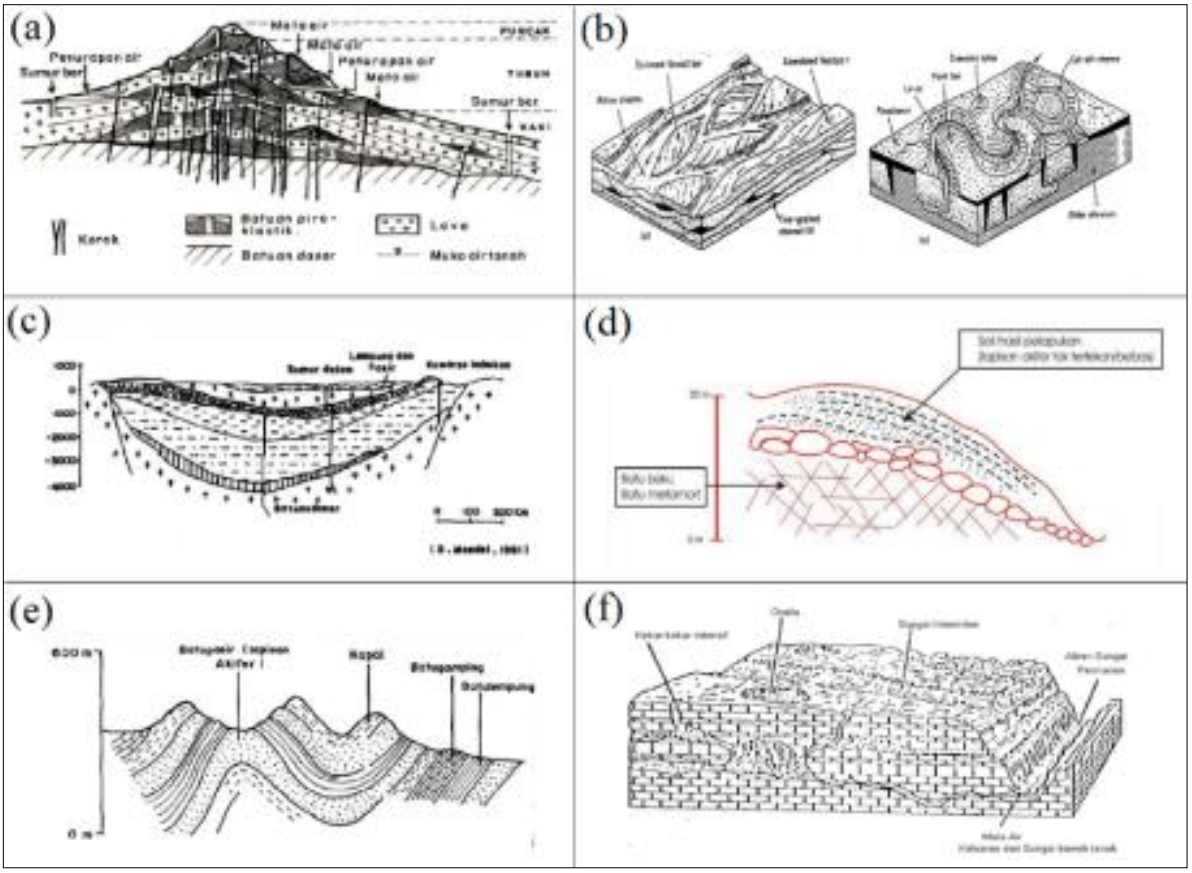

Figure 3. Model aquifer typology: (a) Typology of aquifer system of volcanic sediments [1], (b) Typology of alluvial sedimentary aquifer systems, (c) Typology of sedimentary aquifer systems, (d) Typology of crystalline aquifer systems [2], (e) Typology of a folded sedimentary aquifer system, (f) Aquifer typology of karst [3]

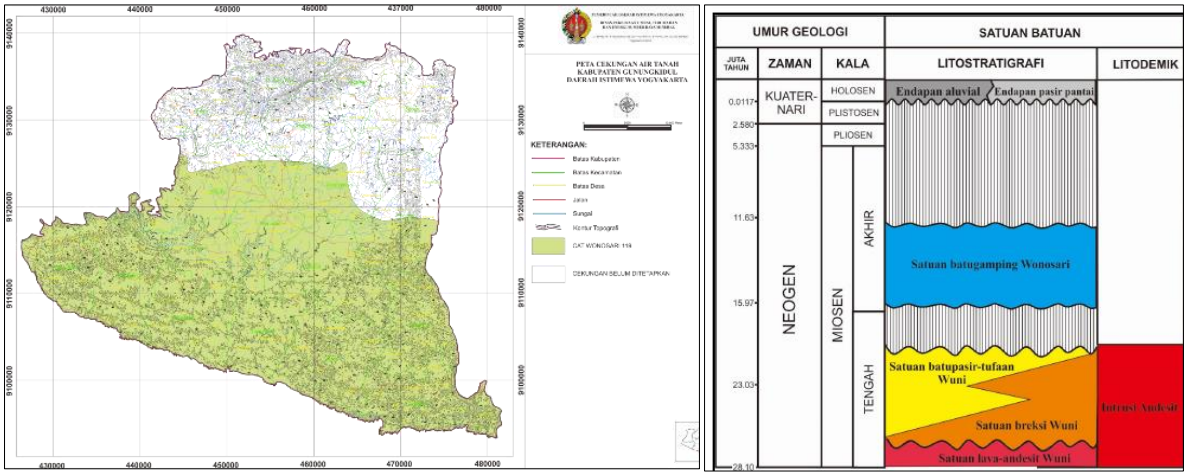

Figure 4. Groundwater Basin of Gunungkidul Regency (left) [4], Stratigraphy of Study Area (right) [5]

3.1. Chemical water quality in limestone

Limestone is a sedimentary rock [6]that is chemically composed of calcium carbonate (CaCO3). Based on laboratory tests, limestone contains ingredients as shown in table 1 below.

Table 1. Limestone chemical analysis laboratory Ponjong District

No.	Sample code	Laboratory analysis							
		X = East Y = North Z = Elevasi	**DHL (Umhos/Cm)**	**TDS (mg/l)**	**pH**	**Fe (mg/l)**	**CaCO3 (mg/l)**	**Ca (mg/l)**	**Mg (mg/l)**
1.	SM 01	X = 0468355 Y = 9114414 Z = 311	408	196	6,77	0,07	145,5	11,64	27,936
2.	SM 02	X = 0468418 Y = 9114397 Z = 307	760	370	6,61	0,06	212,43	52,768	19,3224
3.	SM 03	X = 0468469 Y = 9114438 Z = 307	627	304	6,73	0,03	172,66	48,8888	42,292
4.	SM 04	X = 0468543 Y = 9114393 Z = 310	430	208	6,75	0,02	142,56	42,292	9,0792
5.	SM 05	X = 0468330 Y = 9118330 Z = 312	487	236	6,83	0,01	129,98	26,772	15,132
6.	SM 06	X = 0468269 Y = 9114084 Z = 305	521	252	6,61	0,00	193,03	61,304	9,5448
7.	SM 07	X = 0467670 Y = 9114182 Z = 276	345	166,2	7,01	0,02	148,41	28,712	18,3912
8.	SM 08	X = 0467425 Y = 9113790 Z = 285	427	206	6,69	0,06	142,59	32,204	14,8992
9.	SM 09	X = 0469586 Y = 9114348 Z = 353	577	280	6,89	0,00	141,62	7,76	29,3328
10.	SM 10	X = 0469659 Y = 9114273 Z = 351	437	211	6,53	0,02	202,73	29,876	30,7296
11.	SM 11	X = 0469339 Y = 9119339 Z = 346	505	244	6,89	0,00	203,7	6,984	44,6976

Table 2. Water quality criteria of class B

No	Parameters	Average (%)
1	SiO_2	0.048571
2	Al_2O_3	0.16587
3	Fe_2O_3	0.123302
4	CaO	54.11147
5	MgO	0.300962
6	Na_2O	0.037527
7	K_2O	0.034752
8	TiO_2	0.028919
9	MnO_2	0.0288
10	P_2O_3	0.044258
11	$CaCO_3$	166.83
12	$MgCO_3$	0.600577
13	H_2O	0.775687
14	HD	42.79076

No	Parameters	Unit	Maximum value
1	Physical		
a	Total dissolved (TDS)	mg/l	1.000
b	Temperature	°C	Deviation 3
2	Chemical		
a	pH	-	6,5 – 9
b	Zinc (Zn^{2+})	mg/l	0,05
c	Fluoride (F^-)	mg/l	1,5
d	Arsenic (As)	mg/l	1
e	Carbonate ($CaCO_3$)	mg/l	500
f	Magnesium (Mg)	mg/l	-
g	Nitrat (NO_{3-})	mg/l	10
h	Nitrit (NO_{2-})	mg/l	0,06
i	Sulphate ($SO_{4\ 2-}$)	mg/l	400
j	Copper (Cu^{2+})	mg/l	0,02
k	Chloride (Cl^-)	mg/l	600
l	Manganese (Mn)	mg/l	-
m	Iron (Fe)	mg/l	-
3	Biology		
a	Coliform total	MPN/100 ml	Not pipeline water: 50

4. Conclusions

- The aquifer species based on aquifer analyses data indicate unconfined aquifer and semi-distorted aquifers. The aquifer system of the research area can be divided into two systems, inter-grain aquifer systems, and fracture aquifer systems.
- The aquifer system of the research area can be divided into two systems, inter-grain aquifer systems, and fracture aquifer systems. Overall quality groundwater in the research area is quite good.
- The groundwater quality in the karst Ponjong can be used as an irrigation and shows a value that is safe enough for consumption by the water quality criteria of class B.

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