Analysis Water Quality of Springs on the East Slope of Mount Sumbing, Central Java, Indonesia for Sanitation Hygiene Purposes Based on the Physical and Chemical Properties

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Abstract. The eastern slope of Mount Sumbing has many springs used as a source of raw water for hygienic sanitation purposes. However, there has been no scientific research showing the quality of springs. Therefore the purpose of this study is to analyze the quality of springs on the eastern slopes of Mount Sumbing for community sanitation hygiene purposes based on water physical and chemical properties. Water samples were taken from several points in the study area and observed for physical parameters (TDS, smell, taste, and temperature) and chemical parameters (acidity, nitrate, fluoride, and sulfates). The results showed that from 30 samples of springs, only one spring fulfilled the Indonesia Minister of Health Regulation No. 32 in 2017. The spring located at STA 51 Kaliloro, Krajan, Kaliangkrik, Magelang Regency. There was a spring classified as deep geothermal groundwater and the others classified as shallow groundwater. Based on the acidity of water, most of the springs on the eastern slopes of Mount Sumbing could be used as hygiene sanitation by treating the water acidity and regulating the purposes of springs.

keywords: springs, water quality, sanitation hygiene.

1. Introduction
Springs are groundwater that collects in aquifers where groundwater discharges can directly affect surface and river flows and all ecosystems that depend on them, including all the ecosystems dependent [1]. Moreover, springs are sites where groundwater is naturally found and classified into two types [2]. First is non-gravitational springs, including volcanic springs, fissure springs, warm springs, and hot springs. The second is gravitational springs. Gravity springs are classified into four types, namely depression springs, contact springs, artesian springs, and turbulent springs. Depression springs form when the groundwater surface is cut off by topography. Contact springs are formed when the permeable layer lies on top of the impermeable layer. Artesian springs form when groundwater is coming out of a confined aquifer. Turbulent springs are formed when natural channels crust formations, such as lava caves or joints [3]. One of the areas that have many large springs is the slopes of the volcano. Among the volcanic areas with a relatively abundant distribution of springs are the slopes of the Sumbing
Volcano [4]. These springs are used for daily raw water by the community, including cooking, bathing, washing, and others [5].

The east slope of Sumbing Volcano has an elevation between 235 – 3.371 masl and including to the quarter volcanic zone [6] that produces andesite to basalt rock composition, either in the form of fine to coarse rock (pyroclastic) or solid or decomposed rock in the form of flows or lava domes. The deposition of these materials forms an aquifer with high porosity and permeability [7].

Based on the regional geology map (Figure 1), the study area is on two sheet maps consisting of Semarang-Magelang [8] and Yogyakarta [9]. The lithology is dominated by the Sedimentary Rocks of Mount Sumbing Muda (Qsm), and the appearance of springs can be found easily around the fracture. The existence of fracture causes the rock layer that acts as an aquifer to experience discontinuity and affects groundwater flow so that many springs are found. The distribution pattern of springs in young stratovolcano types, including Mount Sumbing, generally is around the body of the volcano and forms a belt-like pattern, so it is called the spring belt. A belt-like pattern is a symptom of the appearance of springs that are typical and common in stratovolcanoes on the island of Java. At certain heights, a spring belt is related to its hydrological properties and changes in slope caused by changes in the structure of the rock that forms [4].

![Geological Map of the East Slope of Mount Sumbing, Central Java, Indonesia](image)

**Figure 1.** Geological maps on east slope of Mount Sumbing, Central Java, Indonesia

Indonesia Minister of Health Regulation No. 32 of 2017 concerning to Environmental Health Quality Standards and Water Health Requirements for Sanitation Hygiene Needs, Swimming Pools, Solus Per Aqua, and Public Baths, water for sanitation hygiene is used for maintaining personal hygiene such as bathing and brushing teeth, as well as for washing food, eating utensils, and clothes and can be used as raw water for drinking. Water quality standard parameters for sanitation hygiene purposes include physical, biological, and chemical water parameters [10].

The springs on the east slope of Sumbing Vulvano are used for sanitation hygiene purposes, but there is not yet scientific research showing the quality of these springs. Therefore, the purpose of this study is to analyze the quality of springs on the eastern slopes of Mount Sumbing for community sanitation hygiene purposes based on water physical and chemical properties, which consist of pH, total dissolved solids (TDS) value, temperature, smell, taste, fluoride, nitrate, and sulfate.
Acidity or pH is an index for the acidity or alkalinity of a liquid [2]. If the pH is less than 4.0, then the solution is corrosive and could dissolve metals and other substances in contact with [3]. However, the research on natural acidity or anthropogenic acidification found a decrease in the pH value from 6.4 to 4.6 due to the activity of organic acids coming from the soil and dilution by low ionic strength snowmelt water [11].

Total Dissolved Solids (TDS) is the number of minerals dissolved in water, which is useful for evaluating water quality [3]. The classification of water based on the TDS value as pure water (0-1.000 mg/l); brackish water (1.000-10.000 mg/l); brine (10.000-100.000 mg/l); and saltwater (>100.000 mg/l) [12]. Another water classification was used to classify the salinity of groundwater (Table 1) in specific classification [13].

| Type of water   | TDS (mg/l) | EC (µS/cm) |
|----------------|------------|------------|
| Fresh          | <1.000     | <1.500     |
| Slightly brackish | 1.000-3.000 | 1.500-5.000 |
| Brackish       | 3.000-10.000 | 5.000-15.000 |
| Saline         | 10.000-35.000 | 15.000-50.000 |
| Brine          | >35.000    | >50.000    |

Salty tasted water may have an electrical conductivity of more than 5000 µS/cm (high salinity), chloride concentration of 1.275,5 mg/l, and classified as Na-Cl water type [14]. The salinity of water could be found in the sedimentary rock aquifer, namely halite dissolution, connate water, and geological filtration. In addition, the residence time of water in the groundwater system is thought to be a factor affecting groundwater salinity. Moreover, the emergence of salty water in the anticline relates to the well-developed vertical fractures between stratigraphic layers of anticline structure [15].

Depending on aperture, roughness, material filling, orientation, and forming stress, fracture in rock generally becomes a path for groundwater flow [16]; [17]. The emergence of saline and salty spring can occur due to faults and geological anticlines, the combination of anticlines and faults, and contact between different lithology strata. There are different characteristics between salty tasted groundwater due to the closed/trapped groundwater flow system and since upwelling of the deep groundwater system via fault or fractures in the buried anticline [17].

In brackish water, they are Na-Cl water facies may be found in groundwater which is typical water chemistry facies related to or originated from deep geothermal fluids [18], deep groundwater system [2], seawater intrusion, and brine water [19]. One of the unique conditions in groundwater is the geothermal condition. The geothermal water has a significant number of chloride. Meanwhile, the sulfate and bicarbonate concentrations are similar to chloride concentrations according to the waters they are coming from. Geothermal water has temperatures around 50-80°C while the salinity is caused by the mineral, like calcium, bicarbonate, sulfate, and silica. The mineral had boiled and lost the steam in the interface zone. In the end, they become mineral deposition and develop to the brine zone [18].

Nitrate and sulfate had the most influence on groundwater pollution [20]; [21]; [22]. Nitrate is generally sourced from synthetic or organic fertilizers, wastewater or manure, leakage from sewer systems, septic tanks, municipal and industrial landfills, soil nitrogen, atmospheric deposits, and mine tailings [23]; [24]. Nitrate concentration’s pattern starts from point to strip and from shallow to deep groundwater [25]; [26]; [27]. Thus, shallow groundwater is more susceptible to contaminated by nitrate than deep groundwater. However, the lower nitrate concentration may be found in wells with thick clay layers above the well screen.

Nitrate can indicate groundwater pollution, especially in shallow groundwater. Generally, the nitrate concentration is less than 5 mg/l, but in rural areas with high fertilization intensity in the agricultural sector, the nitrate content can reach more than 600 mg/l [28]. Besides nitrate, sulfate in groundwater generally comes from natural sources such as the dissolution of sulfur-containing minerals like gypsum or pyrite. Sulfate reduced to carbon dioxide and sulfide, which is the decreasing sulfate ion concentration caused enhancement of bicarbonate concentration. If the
bacteria of reducing sulfate are active, the sulfate concentration in water could be less than 1 mg/l. However, the sulfate concentration in water generally is less than 100 mg/l [1].

Fluoride is generally found in rocks and groundwater, although in small concentrations or less than 1 mg/l. The type of rock that contains fluoride is a crystalline rock such as granite. Furthermore, volcanic rocks have a reasonably high fluoride concentration and affect the characteristics of aquifers, especially in arid and semi-arid areas [29].

2. Material and Method
The research method conducts field observations and data collection, laboratory analysis, data processing, and interpretation. The research was conducted from March to May 2021. Observations and data collection was carried out at 30 springs spread over the research location (Figure 2) with 500 ml of groundwater sample for each point. Observations were made by taking water samples and data on the physical properties of the springs, such as TDS, DHL, pH, temperature, and odor. The water samples were tested using the Methrohm 850 IC Professional to determine the chemical content of the 20 samples of springs consisting of fluoride, nitrate, and sulfate. The results of measuring the physical properties and testing of the chemical properties of the springs are then analyzed based on their ranking as community sanitation hygiene based on the Minister of Health Regulation Number 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for Sanitary Hygiene, Swimming Pools, Solus Per Aqua, and Baths. General. The physical and chemical parameters of water in environmental health quality standards for sanitation hygiene purposes showed in Table 2.

| No | Physical Required | Unit | Quality Standards (Max) |
|----|-------------------|------|-------------------------|
| 1  | Muddiness         | NTU  | 25                      |
| 2  | Colour            | TCU  | 50                      |
| 3  | Total Dissolved Solid | mg/l | 1000               |
| 4  | Temperature       | ºC   | Air temperature ± 3    |
| 5  | Taste             |      | Tasteless               |
| 6  | Smell             |      | Odorless                |

Chemical Required

| No | Parameters                          | Unit | Quality Standards (Max) |
|----|-------------------------------------|------|-------------------------|
| 1  | pH                                  |      | 6.5 – 8.5               |
| 2  | Iron (Fe)                           | mg/l | 1                       |
| 3  | Fluoride                            | mg/l | 1.5                     |
| 4  | Calcium Carbonate (CaCO<sub>3</sub>) | mg/l | 500                     |
| 5  | Manganese                          | mg/l | 0.5                     |
| 6  | Nitrate, as N                      | mg/l | 10                      |
| 7  | Nitrite, as N                      | mg/l | 1                       |
| 8  | Sianida                            | mg/l | 0.1                     |
| 9  | Detergent                          | mg/l | 0.05                    |
| 10 | Pesticide                          | mg/l | 0.1                     |

Chemical Additional

| No | Parameters                          | Unit | Quality Standards (Max) |
|----|-------------------------------------|------|-------------------------|
| 1  | Mercury                             | mg/l | 0.001                   |
| 2  | Arsenic                             | mg/l | 0.05                    |
| 3  | Cadmium                             | mg/l | 0.005                   |
| 4  | Cadmium (valensi 6)                 | mg/l | 0.05                    |
| 5  | Selenium                            | mg/l | 0.01                    |
| 6  | Zinc                                | mg/l | 15                      |
| 7  | Suphate                             | mg/l | 400                     |
| 8  | Lead                                | mg/l | 0.05                    |

Source: [10]
Figure 2. Distribution of spring samples on the east slope of Mount Sumbing, Central Java, Indonesia

3. Result and Discussion
Based on on-site testing and laboratory measurements, the quality of springs on the east slope of Mount Sumbing is shown in Table 3.

a. Total Dissolved Solids
Based on water quality standards for sanitation hygiene purposes in the Regulation of the Minister of Health of the Republic of Indonesia No. 32 of 2017, 29 springs (96.67%) meet the requirements for a TDS content under 1.000 mg/l. The lowest TDS content <100 mg/l is located around the summit of Mount Sumbing to the east at Tlogomulyo and Tembarak sub-districts, Temanggung Regency. The elevation is about 700-3,125 masl. The average TDS value in springs on the eastern slope of Mount Sumbing is 229 mg/l. The TDS distribution map is shown in Figure 3.

On the other hand, one spring (3.3%) exceeds the TDS threshold, which is >1.000 mg/l. The spring is STA 33 Kasinan Spring located in Sumberarum Village, Tempuran District, Magelang Regency. This spring has a TDS content of 1.680 mg/l, which salty taste and hot temperature of about 37.1oC. From the analysis results, it can be concluded that STA 33 Kasinan spring is a brackish spring classified explicitly to slightly brackish groundwater with TDS around 1.000-3.000 mg/l. The salinity of water could be found in the sedimentary rock aquifer, which is a light Sumbing vulcanic deposit (Qsm) shown in Figure 1.

STA 33 Kasinan spring is far from the Indian Ocean and the Java Sea based on geographic location. By the fact that, it can be estimated that the source of salinity does not come from intrusion. The spring comes from a deep groundwater system and deep geothermal fluids.

b. Temperature
Based on the water quality standard for sanitation hygiene purposes, the temperature of the water is air temperature ± 3 °C. Based on the analysis, 29 springs (96.67%) on the eastern slope of Mount Sumbing have met the standard. The distribution maps of temperatures are shown in Figure 4. The spring that did not meet the quality standard for the temperature is STA 33 Kasinan Springs which has 37.1 °C.
Table 3. Physical and chemical properties springs on the east slope of Mount Sumbing for hygiene sanitary based on Indonesia Minister of Health Regulation No. 32 in 2017

| No | Name of Sample Spring | Physical Required | Chemistry Required | Additional Required | Final Result |
|----|------------------------|-------------------|--------------------|---------------------|--------------|
|    |                        | TDS (mg/l)        | Temperature (°C)   | Taste               | Smell        | pH          | Fluoride (mg/l) | Nitrate (mg/l) | Sulphate (mg/l) |               |
| 1  | Sta 1 Putat            | 250               | 27.7               | T                   | O             | 6.2         | 0.281          | 23.29           | 17.174         | NO            |
| 2  | Sta 5 Glapansari       | 100               | 27.2               | T                   | O             | 5.5         | ~              | ~               | ~             | NO            |
| 3  | Sta 7 Gondosuli        | 110               | 28.1               | T                   | O             | 5.4         | ~              | ~               | ~             | NO            |
| 4  | Sta 8 Tuk Budoyo       | 140               | 25.5               | T                   | O             | 2.9         | 0.028          | 56.7            | 10.332         | NO            |
| 5  | Sta 9 Tuk Kaliringin   | 110               | 26                 | T                   | O             | 4.8         | 0.037          | 70.33           | 17.573         | NO            |
| 6  | Sta 10 Tuk Nurcalho    | 110               | 27.4               | T                   | O             | 5.2         | ~              | ~               | ~             | NO            |
| 7  | Sta 11 Walitis         | 30                | 28.2               | T                   | O             | 5.1         | ~              | ~               | ~             | NO            |
| 8  | Sta 12 Legok           | 130               | 29.8               | T                   | O             | 6.1         | 0.055          | 11.14           | 2.146          | NO            |
| 9  | Sta 13 Tirtolanggeng   | 130               | 29.6               | T                   | O             | 5.3         | 0.077          | 30.31           | 4.897          | NO            |
| 10 | Sta 16 Tuk Mulyo       | 150               | 28.8               | T                   | O             | 5.5         | 0.057          | 45.76           | 15.934         | NO            |
| 11 | Sta 18 Banyu Kembar    | 150               | 32.5               | T                   | O             | 5.3         | 0.086          | 8.898           | 13.876         | NO            |
| 12 | Sta 20 Kerokan         | 120               | 30.8               | T                   | O             | 5           | 0.124          | 21.73           | 16.545         | NO            |
| 13 | Sta 21 Kerokan 2       | 120               | 33.1               | T                   | O             | 5.4         | 0.078          | 21.83           | 17.818         | NO            |
| 14 | Sta 22 Pikatan         | 180               | 28.7               | T                   | O             | 5.2         | ~              | ~               | ~             | NO            |
| 15 | Sta 30 Banyu Urip      | 160               | 29.1               | T                   | O             | 5.9         | ~              | ~               | ~             | NO            |
| 16 | Sta 33 Kasinan         | 1.680             | 37.1               | S                   | O             | 6.7         | 0.063          | 0               | 116.754        | NO            |
| 17 | Sta 35 Tuk Dimajar     | 160               | 31.8               | T                   | O             | 4.5         | ~              | ~               | ~             | NO            |
| 18 | Sta 36 Rejomulyo       | 160               | 32.2               | T                   | O             | 4.9         | 0.058          | 6.511           | 5.521          | NO            |
| 19 | Sta 38 Gilirejo        | 110               | 27.8               | T                   | O             | 4.9         | ~              | ~               | ~             | NO            |
| 20 | Sta 39 Johon Bandongan | 190               | 31.8               | T                   | O             | 5.4         | 0.084          | 1.336           | 2.152          | NO            |
| 21 | Sta 42 Kaliangkrik     | 170               | 28.1               | T                   | O             | 5.1         | 0.094          | 2.01            | 2.016          | NO            |
| 22 | Sta 43 Mbesaran        | 160               | 26                 | T                   | O             | 5.3         | ~              | ~               | ~             | NO            |
| 23 | Sta 44 Gianti          | 180               | 27                 | T                   | O             | 5.3         | 0.09          | 7.513           | 1.615          | NO            |
| 24 | Sta 47 Muning          | 290               | 30.1               | T                   | O             | 5.3         | 0.073          | 0.76            | 1.187          | NO            |
| 25 | Sta 49 Penjullinan Kajoran | 220              | 31.4               | T                   | O             | 5           | ~              | ~               | ~             | NO            |
| 26 | Sta 50 Sangan          | 230               | 30.9               | T                   | O             | 5.5         | 0.062          | 5.576           | 2.609          | NO            |
| 27 | Sta 51 Kaliloro        | 370               | 32.5               | T                   | O             | 6.6         | 0.203          | 2.567           | 10.093         | YES           |
| 28 | Sta 52 Tuk Semar       | 230               | 28.4               | T                   | O             | 5.2         | 0.026          | 20.78           | 1.067          | NO            |
| 29 | Sta 55 Silin 1         | 370               | 32.7               | T                   | O             | 5.9         | 0.053          | 7.809           | 0.643          | NO            |
| 30 | Sta 56 Candisari       | 360               | 30.9               | T                   | O             | 6.1         | 0.046          | 2.12            | 0.814          | NO            |
|    | Average                | 229               | 30.14              |                     |               | 5.4         | 0.084          | 17.35           | 13.038         |               |

Tasteless (T); Odorless (O); Salty (S)
Source: Analysis

Due to the STA 33 Kasinan spring having a high TDS of 1.680 mg/l and temperature of 37.1 °C, the spring can be categorized as a geothermal spring associated with a deep groundwater system where the water in deep aquifers may flow through faults and contact between different types of lithology strata.

c. pH
Based on the water quality standard for sanitation hygiene purposes, the acidity of the water is 6.5-7.5. Based on the test results, 93.33% of the springs on the eastern slope of Mount Sumbing have an acidic pH between 4.5-6.5 (Figure 5). The springs that meet the quality standard for the pH value are 6.67%, namely STA 33 Kasinan Springs with pH 6.7 and STA 51 Kaliloro Springs with a pH of 6.6. There is one spring at STA 8 Tuk Budoyo where the pH of the water is very acidic, which is 2.9. However, the water can still be consumed and used for religious activities with a particular belief as holy water. It contradicts that if the pH is less than 4.0, then the solution is corrosive to dissolve metals and other substances in contact with [3].
This phenomenon can be caused by the presence of peak flow which causes a decrease in pH value to 2.9 due to the activity of organic acids originating from the soil and dilution by the low ionic strength of water. It is supported by the fact that the time sampling of STA 8 was carried out around an hour after rain.

d. Smell and Taste
Based on observations, the smell of water springs is quite good and did not have any smell. Based on water taste, there was one sample of spring that had a salty taste. It occurred on STA 33 Kasinan Springs located in Sumberarum Village, Tempuran District, Magelang Regency. The taste has associated with total dissolved solids (TDS).

e. Sulfate
The maximum limit of sulfate content in water for sanitation hygiene purposes is 400 mg/l. Based on the results of laboratory tests on 20 samples of springs, 100% of the samples showed that the springs on the eastern slope of Mount Sumbing met the requirements. The highest sulfate content is STA 33 Kasinan Spring, located in Sumberarum Village, Tempuran District, Magelang Regency. This spring has a sulfate content of 116.75 mg/l. The spring is located at an elevation of 642 masl (Figure 6). The average sulfate content of springs on the eastern slope of Mount Sumbing is 13.04 mg/l and is far below the maximum quality standard for sulfate content in water for sanitation hygiene purposes.

The results of the relatively low sulfate content in groundwater indicate that the research area is not located in an area with minerals that make up gypsum and pyrite rocks. However, the STA 33 Kasinan’s sulfate content is 116.75 mg/l, exceeding the average sulfate content in general water, under 100 mg/l. One of the characteristics of geothermal water is a large number of sulfate. The geothermal fluids system comes from a fracture zone system where there is deep groundwater formed.

f. Nitrate
The maximum limit of nitrate content in water for sanitation hygiene purposes is 10 mg/l. Based on the laboratory testing results, of the 20 samples of springs tested, 45% of the samples of springs did not meet the specified quality standards. The springs are STA 1 Putat (23.29 mg/l), STA 8 Tuk Budoyo (56.7 mg/l), STA 9 Tuk Kaliringin (70.33 mg/l), STA 12 Legok (11.14 mg/l), STA 13 Tirtolanggeng (30.31 mg/l), STA 16 Tuk Mulyo (45.76 mg/l), STA 20 Kerokan (21.73 mg/l), STA 21 Kerokan 2 (21.83 mg/l), and STA 52 Tuk Semar (20.78 mg/l). The highest nitrate content was 70.33 mg/l and was at STA 9 Tuk Kaliringin in Lamok Village, Tlogomulyo District, Temanggung Regency. This spring is at an elevation of 1.208 m (Figure 7). The average nitrate content of springs on the eastern slope of Sumbing Mountain is 17.36 mg/l. This value exceeds the water quality standard for sanitation hygiene purposes which is set at 10 mg/l.

Based on the analysis results, several springs are located around agricultural lands, such as at STA 8 Tuk Budoyo and STA 12 Legok. Meanwhile, several other springs are located around residential areas such as STA 1 Putat, STA 9 Tuk Kaliringin, STA 13 Tirtolanggeng, STA 16 Tuk Mulyo, STA 20 Kerokan, STA 21 Kerokan 2, and STA 52 Tuk Semar. Based on the high enough nitrate content at this location, it can be estimated that springs are part of shallow groundwater. The source of nitrate pollution can be formed due to chemical fertilizer from the agricultural sector and wastewater or mature.

The STA 33 Kasianan, which has 0 mg/l nitrate content, has shown that the spring occurs from deep groundwater with low nitrate pollution.

g. Fluoride
The maximum limit of fluoride content in water for sanitation hygiene purposes is 1.5 mg/l. Based on the laboratory tests of 20 spring samples, all samples (100%) showed that the springs on the eastern slope of Mount Sumbing met the requirements. The highest fluoride content was STA 1 Putat Spring in Putat Village, Bulu District, Temanggung Regency, which was 0.281 mg/l and still matches with the standard. The spring is located at an elevation of 642 masl (Figure 8). The average fluoride content of
springs on the eastern slope of Mount Sumbing is 0.084 mg/l and is far below the maximum quality standard.

Based on these results, it can be concluded that the fluoride content on the eastern slope of Mount Sumbing is in a low category (<1 mg/l) due to the rocks at the study site are not composed of crystalline basement rocks, especially those of granitic composition. Furthermore, even the study area is on volcanic rock.

Figure 3. TDS distribution map of springs
Figure 4. Temperature distribution map of springs
Figure 5. Acidity or pH distribution map of springs
Figure 6. Sulphate distribution map of springs
Figure 7. Nitrate distribution map of springs
Figure 8. Flouride distribution map of springs
4. Conclusions

Based on results and discussion, it can be concluded that only one spring (3.3%) on the east slope of Mount Sumbing meets the water quality standard parameters for sanitation hygiene purposes (TDS, Temperature, Smell, Taste, pH, Fluoride, Nitrate, Sulfate) do to Minister of Health Regulation No. 32 of 2017, Indonesia. The spring is STA 51 Kaliloro Village, Bandongan District, Magelang Regency. This spring has a TDS value of 370 mg/l; temperature 32.5 °C; tasteless; odorless; pH 6.7; fluoride content is 0.203 mg/l; nitrate is 2.57 mg/l; and sulfate 10.09 mg/l.

The 29 springs (96.67%) on the eastern slope of Mount Sumbing did not meet the quality standards of water quality for sanitation hygiene which is one spring (3.33%) did not meet the quality standards of TDS, taste, odor, and temperature; 28 springs (93.33%) did not meet the pH quality standard; and 9 springs (45%) did not meet the quality standard for nitrate content due to agricultural sector and wastewater. The average of TDS of all springs sample is 229 mg/l; temperature is 30.14 °C; pH is 5.4; Fluoride is 0.084 mg/l; nitrate is 17.35 mg/l; and sulfate is 13.04 mg/l. These 29 springs are classified as shallow groundwater because their characteristics are low TDS, low temperature, low sulfate, and high nitrate content.

STA 33 Kasinan Spring which has 37.1 °C temperature; 1.680 mg/l TDS content; Salted; Odorless; pH 6.7; 0.063 mg/l Fluoride; 0 mg/l nitrate; and 116.75 mg/l sulphate,

Based on the discussion, the STA 33 Kasinan Spring is classified as deep geothermal groundwater due to the characteristic of high TDS, high temperature, high sulfate, and low nitrate.

Based on the acidity of water, most of the springs on the eastern slopes of Mount Sumbing could be used as hygiene sanitation by treating the water acidity and regulating the purposes of springs.

Acknowledgment

We thank the Ministry of Public Works and Housing, Indonesia, which has funded this study in Magister by Research Program. Department of Geological Engineering Faculty of Engineering Gadjah Mada University allows us to operate Methrohm 850 IC Professional in Getln CICERO Laboratory. To Ms. Lestari Simamora and Ms. Margaretha Aditya Kurnia Purnaningtyas, who have assisted during laboratory geochemistry analysis.

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