CONTROL OF GEOLOGICAL STRUCTURE ON THE SPRINGS DISTRIBUTION AND THEIR PHYSICAL PROPERTIES. CASE STUDY: SOUTHERN SLOPE OF MT. LAMPOBATTANG, SOUTH SULAWESI

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ABSTRACT

The study area is located at Southern Slope of Mt. Lampobattang, South Sulawesi. According to Armstrong (2012), Sulawesi is controlled by a complex geological structure. This condition can affect the characteristics of subsurface groundwater (Ismawan, 2013) specifically on the distribution and physical properties of springs. So, this research is needed to do. The aim of this study is to know the effect of geological structure on the distribution and physical properties of springs in the study area. This research was conducted with a qualitative analysis method of field data which resulted by geological and hydrogeological mapping at the study area. Based on the analysis results, the study area is consisted of 7 rock units consist of tuff, breccia and lava. There are 6 faults that control the study area with SW-NE and SE-NW trend. The study area is divided into 3 fracture density zones, those are low fracture density (0-500 M^{-1}), medium fracture density (500-950 M^{-1}), and high fracture density (950-1200 M^{-1}). The geological structure affects the distribution of springs and their physical characteristics. This is evidenced by the appearance of springs along the fault and in the medium to high density zone. The characteristics of the Physical Properties of springs are influenced by the occurrence of faults and fractures in the study area that make the low values of EC and TDS. TDS values of springs have a vulnerable value of 0-193 ppm and EC values 0-357 µS. Therefore, the fracture and fault as the geological structure affect the distribution and physical properties of springs in the study area.

Keyword: fault, fracture, groundwater, groundwater physical characteristic, Mt. Lampobattang, springs distribution

INTRODUCTION

Sulawesi is an area that controlled by a complex geological structure as a result of 3 large plates collision, they are Pacific Plate, Indo-Australia Plate, and Eurasia Plate (Armstrong, 2012). Therefore, Sulawesi Island has unique geological and hydrogeological conditions. Geological structures have an important role on surface water conditions (Somantri, 2008) and groundwater characteristics (Ismawan, 2013). Therefore, the research about control of geological structures on the distribution and characteristics of springs in the study area is very important to do.

Study area is located in the Southern Slope of Mt. Lampobattang, South Sulawesi (Figure 1). Administratively it is located in 3 sub-districts which are Bissapu, Bantaeng, and Eremerasa District. The northern part of the study area is the mountain slopes of Mt. Lampobattang and in the southern part is the plain area down to the Flores Sea.

The aim of this study is to determine the effect of geological structures on springs distribution and their characteristics in the study area.

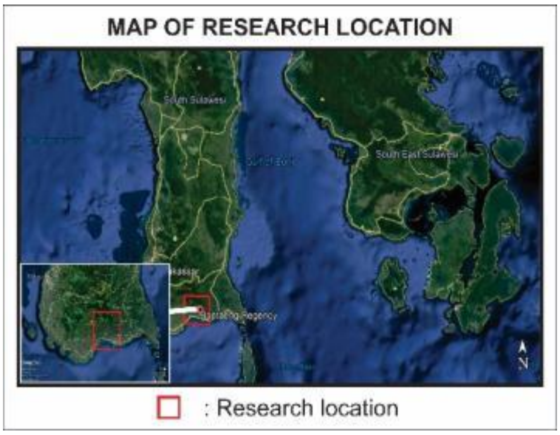

Figure 1. Map of Research Location

GEOLOGICAL SETTING

The study area is composed by rock formations from the oldest are volcanic product of Lampobattang Formation (Qlv,

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Qlvp and Qlvb) and Alluvium, Swamp, and Beach (Qac) Deposits (Sukamto, 1992). The proximal Lampobattang formation consists of lava, agglomerates, breccia, lava deposits, and tuff (Qlv). While areas far from the center of the eruption are composed of breccia, lahar deposits, and tuff (Qlvb). In some locations there are volcanic parasites (Qlvp). At the top of this formation is composed by gravel, sand, clay, and mud deposits, and coral limestone that formed in the depositional environments of rivers, swamps, beaches and delta (Qac) (Figure 2).

Figure 2. Geological Map of Study Area (Sukamto, 1992)

The fault that controls the study area are en echelon strike-slip faults that were formed after the Lampobattang Formation Deposited (Sukamto, 1992).

Fractures or faults can control the appearance of several springs that are parallel (Ismawan, 2013). According to Claudia (1997) revealed that in fault zone the springs will appear along the fault or on the fault surface. The physical properties of springs will also have low value of TDS and EC (Ismawan, 2013).

METHODS

The study was conducted using a qualitative analysis method of field data. The study begins with an analysis of the valley lineament density to estimate the existence of faults (Thanoun, 2013) and estimates the springs appearance in the study area.

The next stage is field observations that consist of geological and hydrogeological mapping. Geological mapping to determine rock lithology and geological structure of the study area. The hydrogeological mapping to determine the appearance of springs and their characteristics.

Then, the final analysis was carried out to determine the effect of the geological structure on springs distribution and their physical properties of the study area.

RESULTS AND DISCUSSION

Stratigraphy

Based on geological mapping analysis, the study area is divided into 7 rock units (Figure 5) volcanic products of Mt. Lampobattang. The oldest unit is the Porphyritic Lava Unit (Qplv3) which is composed by porphyritic lava rock which deposited in the southwest part of the study area.

Furthermore, polymic breccia as a Pyroclastic Fall Products (Qpbr3) deposited above the Porphyritic Lava Unit. This unit occur along the southwest to the northeast of the study area.

The Altered Lava Unit (Qplv2) flows and is deposited above the Qpbr3 unit. This unit consists of aphanitic to porphyritic lava which is altered by fault. The distribution of this unit is in the northern part of the study area. Then the Breccia With Tuff Intercalation Unit (Qpbr2) as a fall pyroclastic product which is deposited above Qplv2. This unit consists of breccia and tuff that occur in the northwestern part of the study area.

Furthermore, the Aphanitic Lava Unit (Qplv1) is deposited above Qpbr2. Then The Monomict Breccia Unit (Qpbr1) is deposited as a fall pyroclastic product. These two units were deposited in the northwestern part of the study area.

Then, the youngest is Laharic Breccia Unit (Qpbl). This unit is composed by laharic breccia as a derived product of lava and breccia. This unit occur in the southeastern part of the study area. Figure 3 shows the rock unit stratigraphy column in the study area.

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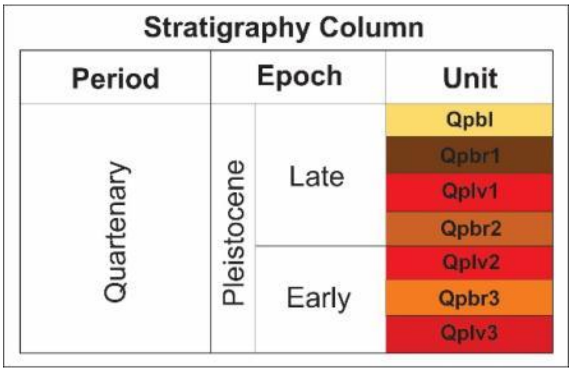

Figure 3. Stratigraphy Column of Study Area

Valley Lineament Density (Ld)

The results of valley lineament density analysis (Ld) shows that the study area is divided into 3 zones. Those zones are low lineament density (0-8 Km-1), medium lineament density (8-18 Km-1), and high lineament density (18-24 Km-1). According to Thanoun (2013), the area that have high lineament density are commonly located close to the geological structures.

Thus, the occurrence of faults is estimated to have a southwest-northeast and southeast-northwest trend which is at high lineament density (Figure 6). This is evidenced by the occurrence of a slicken side in the field that has the same trend as the estimated fault of the lineament density analysis.

Fracture Density

According to the analysis of fracture density, the study area was divided into 3 zones, which are low fracture density (0-500 M-1), medium fracture density (500-950 M-1), and high fracture density (950-1200 M-1) (Figure 7). Low and medium fracture density spread throughout the study area, especially in the north to south. While the high fracture density, located in the southwest, east, and northwest of the study area.

Fault Analysis

There are 6 faults that control the study area which is trending southwest-northeast and southeast-northwest (Figure 8). The fault was evidenced by the occurrence of 5 slicken side and one fault of them is an indication of the valley lineament density, deflection of faults, and topographic changes. The SW-NE trending fault in the south is a strike-slip thrust fault and in the north is an indication of strike-slip faults. Then, the SE-NW trending parallel fault (en-echelon) is a type of normal fault and strike-slip fault.

Springs Distribution

Springs commonly occur almost in whole of the study area (Figure 9). Distribution of springs starts from the north to southwest of the study area. Springs distribution generally is along the fault zone. This shows that faults control the occurrence of springs.

Distribution of springs that are not in the fault zone is estimated to be caused by truncated topography and high fracture density. There are depressed springs and fractured springs that are not in the fault zone is the evidence of it.

Groundwater Flow

The groundwater flow is estimated flows from the northwest and northeast of the study area to the Flores Sea. This is indicated by an isophreatic map that describes the direction of groundwater flow in the study area (Figure 10).

Groundwater is estimated to flow in breccia and also lava which has a high fracture density. The source of the groundwater flow comes from Mt. Lampobattang and causes the occurrence of springs along the flow.

Physical Properties of Spring

Based on the analysis of its physical properties, the springs of the study area have relatively low EC and TDS values. Springs TDS values have a vulnerable value of 0-193 ppm and EC values 0-357 µS (Figure 4). This is because springs are controlled by geological structures.

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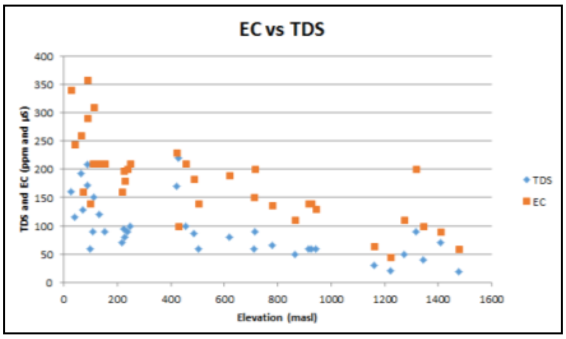

Figure 4. Graph of relatively low TDS dan EC values that shows springs are controlled by geological structures

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Fault can cause the regional or deep groundwater flow out to the surface. Regional or deep groundwater has low EC and TDS values because it does not interact much with various rocks. Therefore, the springs that are located along the fault have a low range of EC and TDS values (Ismawan, 2013).

The Effect of Geological Structure on Springs

The occurrence of geological structure such as a fault or fracture has an influence on the distribution of springs in the study area. This is evidenced by the appearance of springs that are along the fault zone and in medium-high fracture density. Fault will make a pathway for groundwater to come out to the surface along the fault (Claudia, 1997). Moreover, the high fracture density will flow out the springs through the fractures.

The geological structure also affects the physical characteristics of springs which will have low EC and TDS values. This is evidenced by the low physical properties values of springs in the study area. It is caused by the regional or deep groundwater which only interacts slightly with rocks flow out to the surface as springs.

CONCLUSION

From the research analysis, it can be concluded that:

The research area consists of 7 rock units which are Breccia Laharic Unit (Qpbl), Monomict Breccia Unit (Qpbr1), Aphanitic Lava Unit (Qplv1), Breccia with Tuff Intercalation Unit (Qpbr2), Altered Lava Unit (Qplv2), Polymict Breccia Unit (Qpbr3), and Porphyritic Lava Unit (Qplv3).

There are 6 faults that affect the study area with the SW-NE and SE-NW trend. Fracture density is divided into 3 zones, which are low fracture density (0-500 M^{-1}), medium fracture densitiy (500-950 M^{-1}), and high fracture density (950-1200 M^{-1}).

Geological structures such as faults and fractures have an influence on the distribution of springs in the study area. This is evidenced by the appearance of springs along the fault and in high fracture density zones.

The geological structures affect the physical properties that makes a low EC and TDS values. TDS values of springs have a vulnerable value of 0-193 ppm and EC values 0-357 µS. This is due to regional or deep groundwater flow out to the surface as a spring.

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APPENDIX

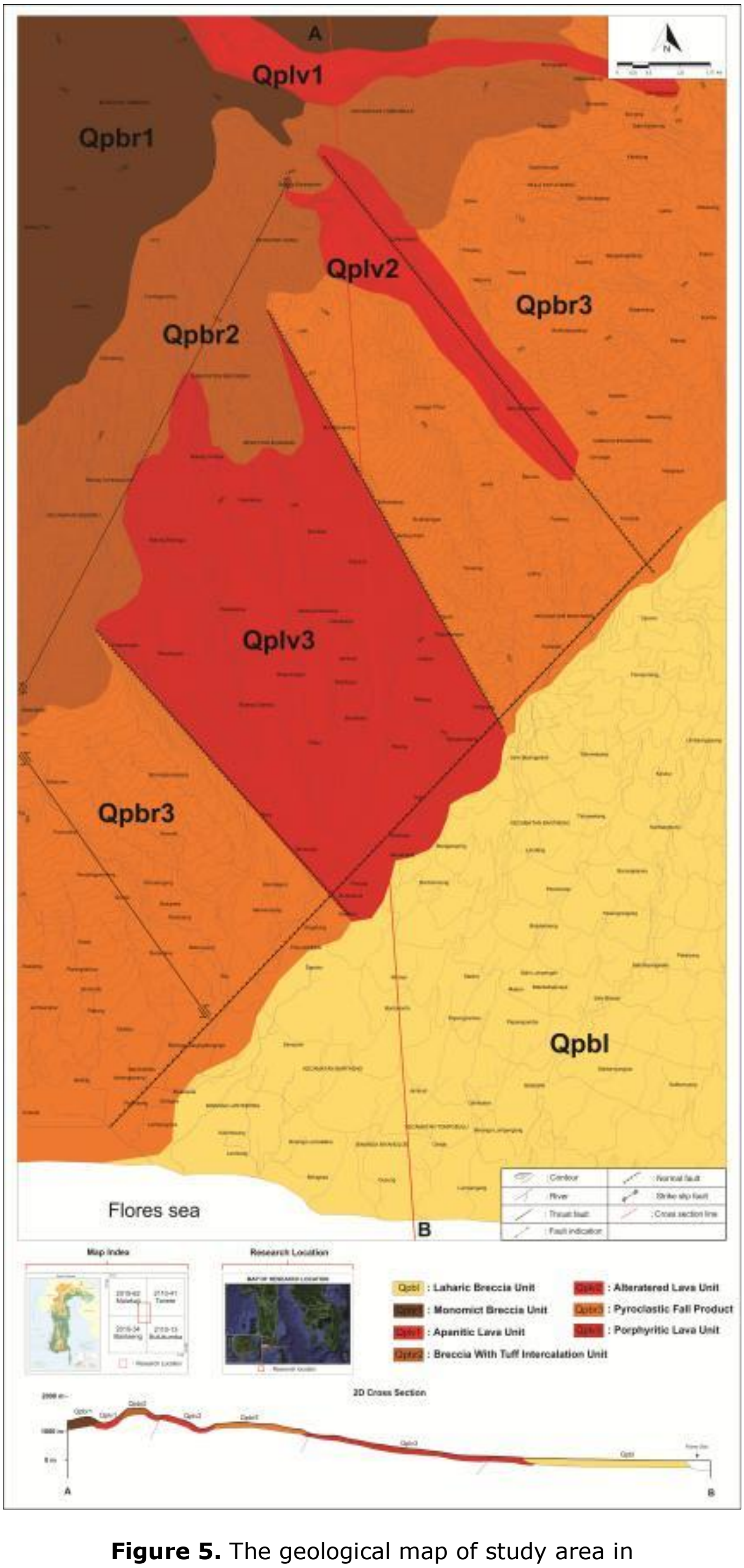

Figure 5. The geological map of study area in Southern Slope Mt. Lampobattang, South Sulawesi

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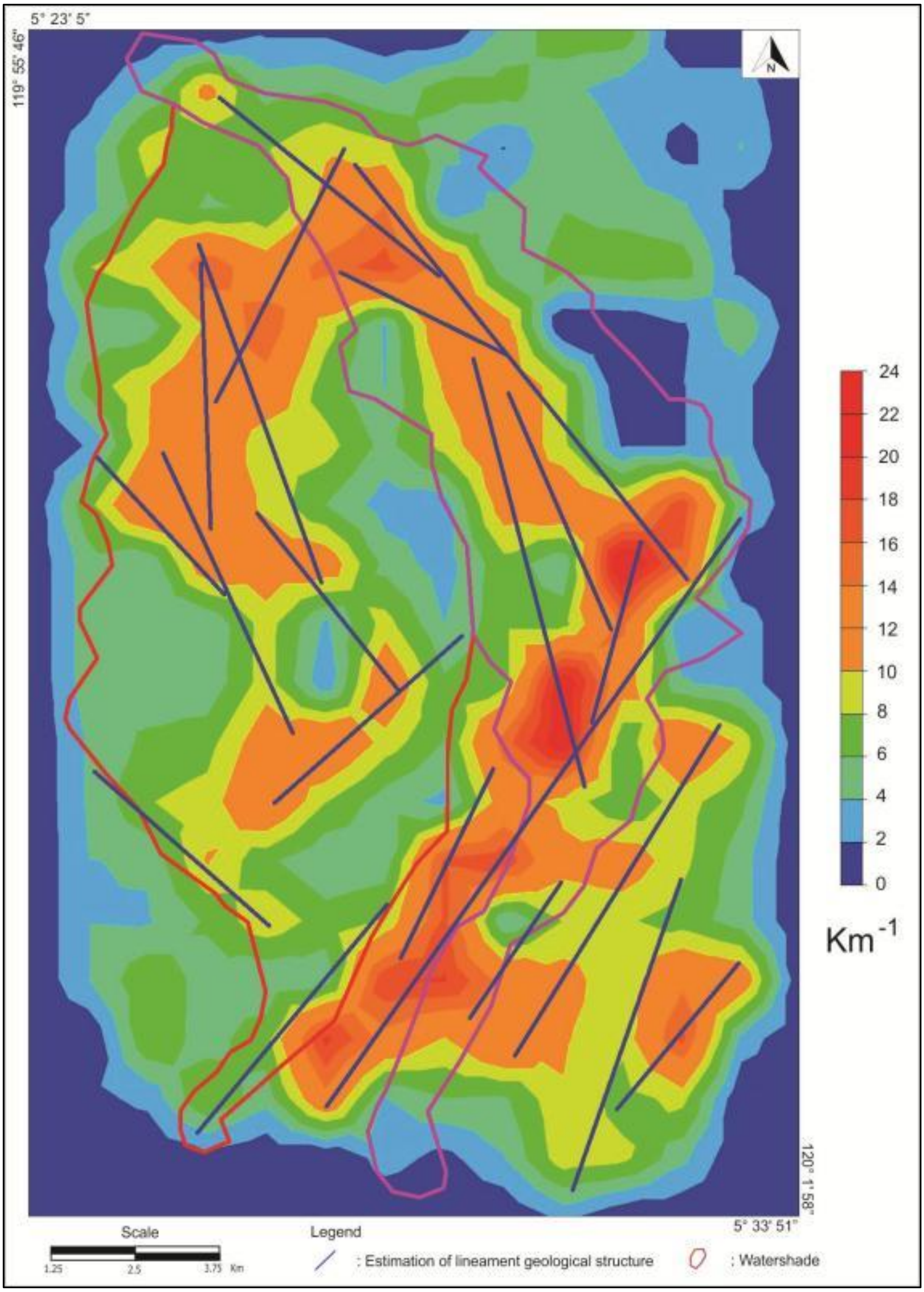

Picture 6. Lineament density map of study area

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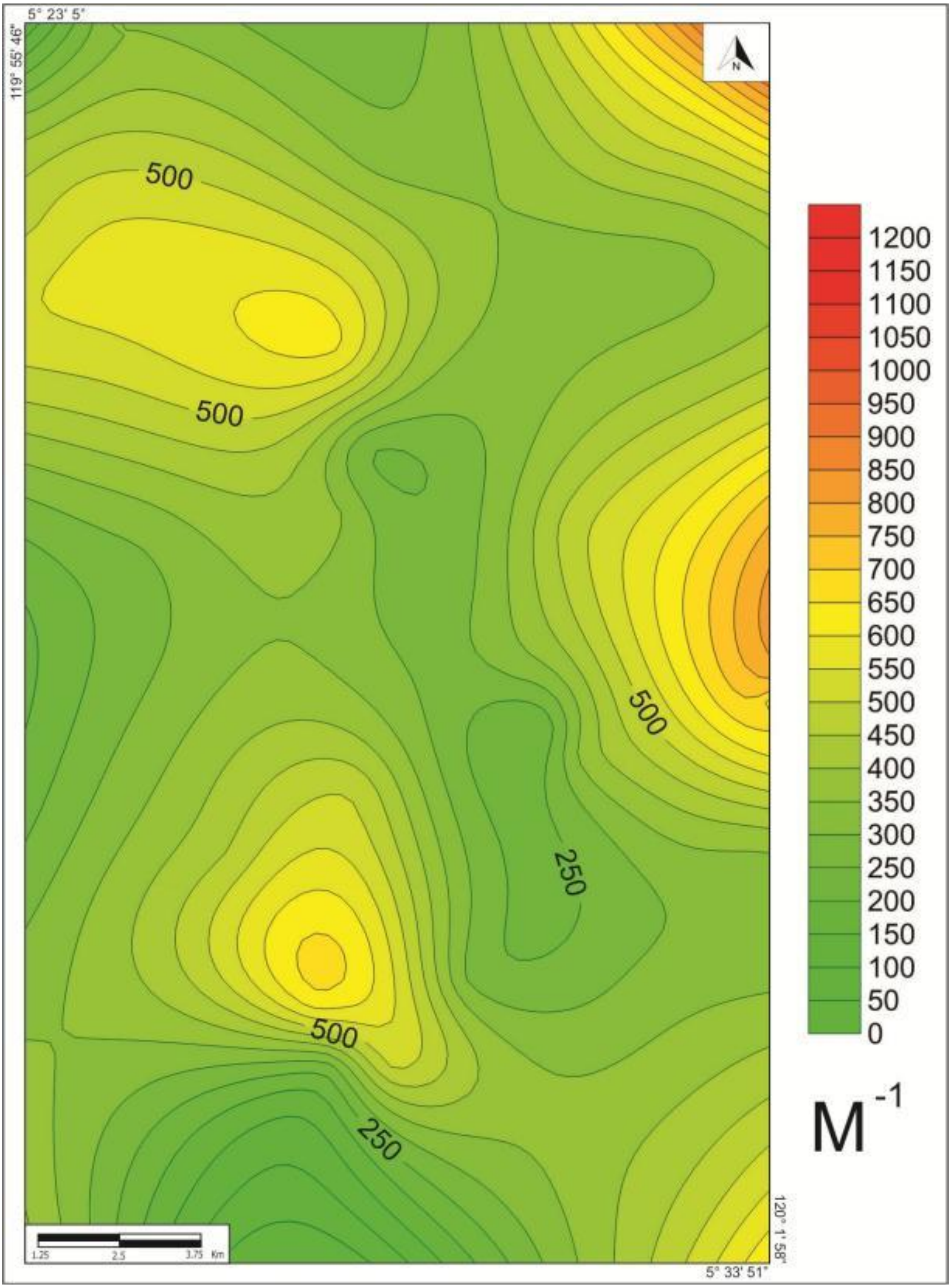

Picture 7. Fracture density of study area

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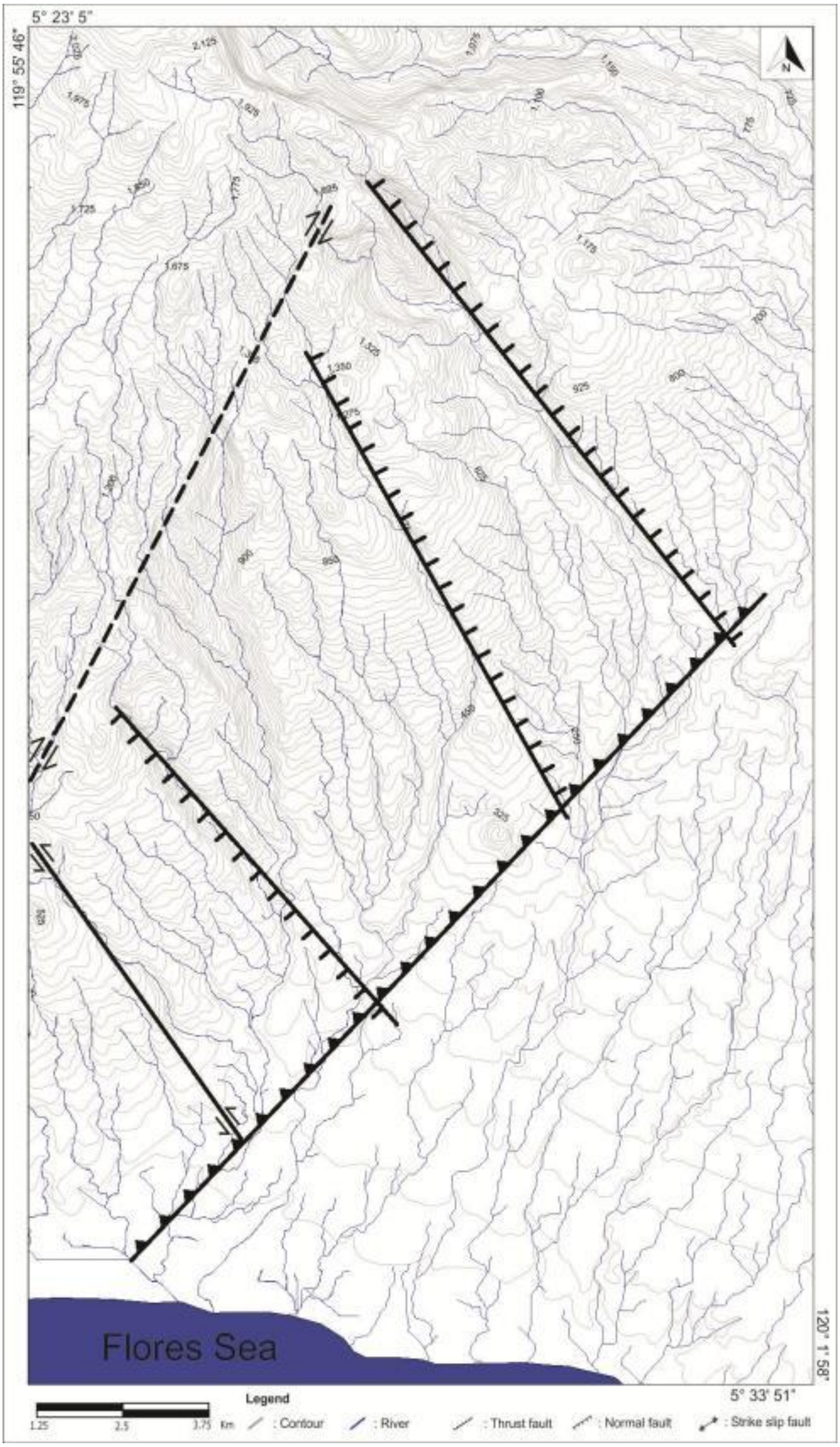

Figure 8. Geological structure that control the study area

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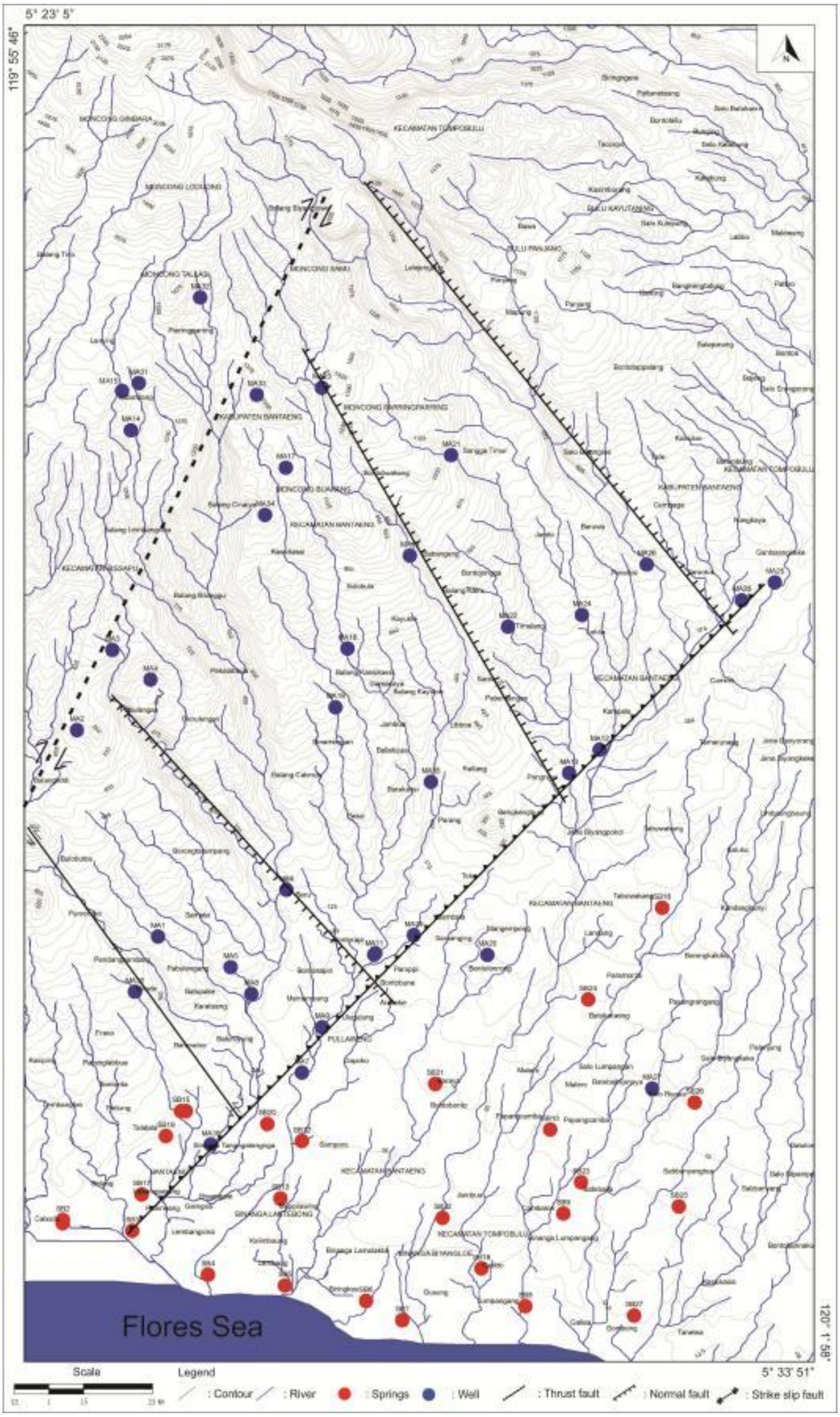

Picture 9. Hidrogeology Mapwork

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Picture 10. Iso Phreatic Map of Study Area

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