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Drainage Pattern Significance in Geological Interpretation of Bantarujeg Area, Majalengka Regency, West Java

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Abstract: The research area is located on Bantarujeg District, Majalengka Regency, West Java. The purpose of this research is to determine the drainage pattern characteristics on the interpretation of geological characteristics. This research was conducted through studio analysis using remote sensing and Geographical Information System (GIS). Several media such as drainage pattern, slope, and geological map, and satellite images were used in this research. Indonesia Topography Maps and Digital Elevation (DEM) were used to obtain stream network and slope data. Based on the drainage pattern analysis, it can be identified rectangular, trellis, subdendritic, subparallel, and radial drainage pattern in the researh area. Rectangular and trellis drainage pattern can be identified in the north of the research area which indicates the presence of geological structures in the area, especially fault and fold structures, and also sedimentary rocks dominance. Radial drainage pattern can be identified in the central of the research area which indicates the topography of the Mt. Sireum, volcanic rocks, and slightly steep to steep slope. Subparallel drainage pattern can be identified in the south of the research area which indicates the slope topography of the Mt. Cakrabuana in the southwest of the research area, volcanic rocks, and geological structure indication whereas subdendritic indicates the foot of slope of the Mt. Cakrabuana, sedimentary and volcanic rocks, and geological structure indication. Slope characteristics identified through drainage pattern analysis are also supported by slope map and satellite images of the research area which show the same characteristics. On the other hand, the initial geological characteristics interpretation of the research area which is identified through drainage pattern analysis is also supported by previous geological research data in the geological map of the research area. Hence, it can be concluded that the drainage pattern analysis can be used for geological interpretation of a particular area and assist researchers to plan field activities properly.

Key words – Bantarujeg, drainage pattern, geology, slope, structure

I. Introduction

The research area is located on Bantarujeg District, Majalengka Regency, West Java (Figure 1) at coordinates 6°53'32,8" S - 7°4'20,3" S and 108°11'18,0" E - 108°20'32,5" E. The purpose of this research is to determine the drainage pattern characteristics on the interpretation of geological characteristics. Identification of drainage patterns can help interpret the regional geological characteristics of an area properly (Hills, 1963; Howard, 1967; Friend et al., 2009). Likewise, understanding the geological history of an area can help interpret the development of drainage pattern (Schumm et al., 2000; Twidale, 2004; Clark et al., 2004; Mejia and Niemann, 2008; Burbank and Anderson, 2011). Therefore, it is important to conduct research examining drainage pattern as a part that is closely related to the interpretation of the geological characteristics of an area.

The spatial arrangement of streams is also known as river or drainage pattern (Twidale, 2004). It is formed by streams, rivers, and lakes in a particular drainage basin (Zhang and Guilbert, 2013). The classification of drainage pattern was proposed by examining the geometry of the stream network on a map (Zernitz, 1932). Research on drainage pattern was then carried out using aerial photograph media (Parvis, 1950). Then, research on drainage pattern classification was further developed by investigating several basic and modified patterns (Howard, 1967). An area has its own unique geological characteristics so that the drainage patterns in that area will also vary. Drainage pattern analysis can provide important informations about underlying rock, regional slope, and structural types in a particular area (Zernitz, 1932; Howard, 1967; Abrahams and Flint, 1983; Morisawa, 1985). Hence, drainage pattern analysis is important aspect in understanding the geological characteristics of an area.

Analysis of drainage pattern can use remote sensing technology (Abdullah et al., 2013) and various media such as topograhical map, Digital Elevation Model (DEM), satellite images, etc. Several researchers have studied drainage pattern using topographical map, Digital Elevation Model (DEM), and satellite images (Mesa, 2006; Kaliraj et al., 2015; Kumar et al., 2018; Panda et al., 2019). Drainage pattern can be observed and identified properly through visual appearance from both maps and satellite images.

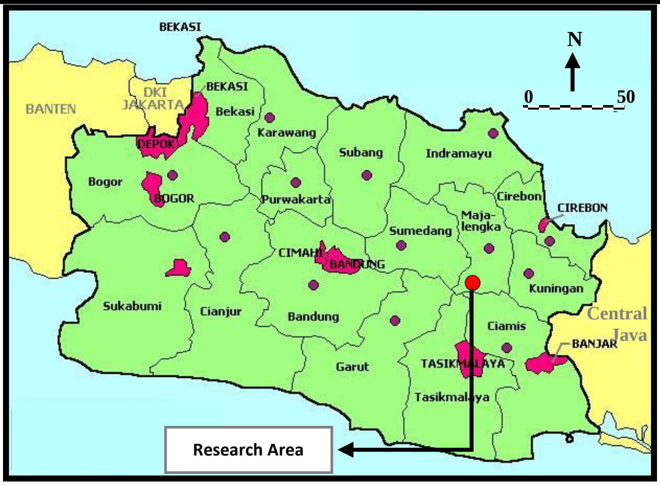

Figure 1. The research area in Bantarujeg District

II. Method

This research was conducted through studio analysis using remote sensing and Geographical Information System (GIS). Several media such as drainage pattern, slope, and geological map also satellite images were used in this research. Indonesia Topography Maps and Digital Elevation (DEM) were used to obtain stream network and slope data. Stream network data is obtained by digitizing the stream network on Indonesia Topography Maps whereas the slope of the research area is obtained from Digital Elevation Model (DEM) with spatial resolution of 30 meter. In addition, the geological data of the research area were obtained from the results of previous of geological research (Budhitrisna, 1986; Djuri, 1995). The stream network data created in the drainage pattern map is then identified and analyzed using drainage pattern classification (Zernitz, 1932; Howard, 1967; Twidale, 2004). Shape and texture are important aspects in determining a drainage pattern in relation to slopes and structures (Zhang and Guilbert, 2013)

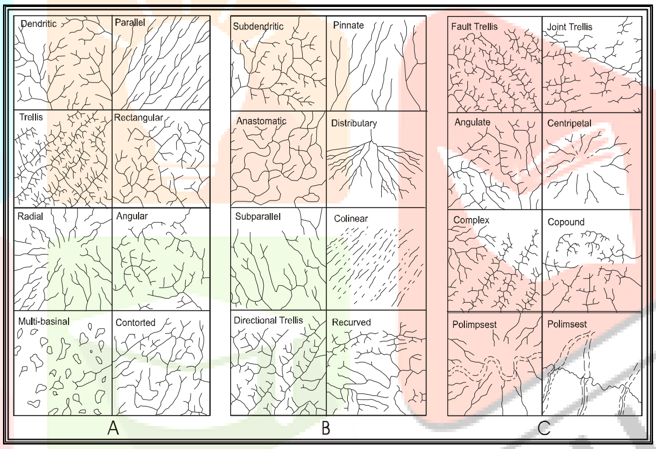

Figure 2. Drainage pattern classification (Howard, 1967): (A) Basic drainage pattern; (B and C) Modified basic drainage pattern

III. Results and Discussion

There are five drainage patterns identified in the research area, namely rectangular, trellis, subdendritic, subparallel, and radial drainage pattern in the researh area (Figure 3). Rectangular and trellis drainage pattern can be identified in the north of the research area which indicates the presence of geological structures in the area, especially fault and fold structures, and also sedimentary rocks dominance. The rectangular drainage pattern is identified by a number of right angle bends and tributaries whereas the trellis drainage pattern is identified by its lattice-like appearance (Zernitz, 1932; Howard, 1967). Radial drainage pattern can be identified in the central of the research area which indicates the topography of the Mt. Sireum, volcanic rocks, and slightly steep to steep slope. The stream network radiate from the top a dome mountain (Zernitz, 1932; Howard, 1967). Subparallel drainage pattern can be identified in the south of the research area which indicates the slope topography of the Mt. Cakrabuana in the southwest of the research area, volcanic rocks, and geological structure indication whereas subdendritic indicates the foot of slope of the Mt. Cakrabuana, sedimentary and volcanic rocks, and geological structure indication. Subparallel drainage pattern shows less parallelism than the parallel drainage pattern but it is also controlled by slopes almost similar to parallel drainage pattern whereas subdendritic drainage pattern is almost similar to the dendritic drainage pattern but it influenced by structure (Zernitz, 1932; Howard, 1967).

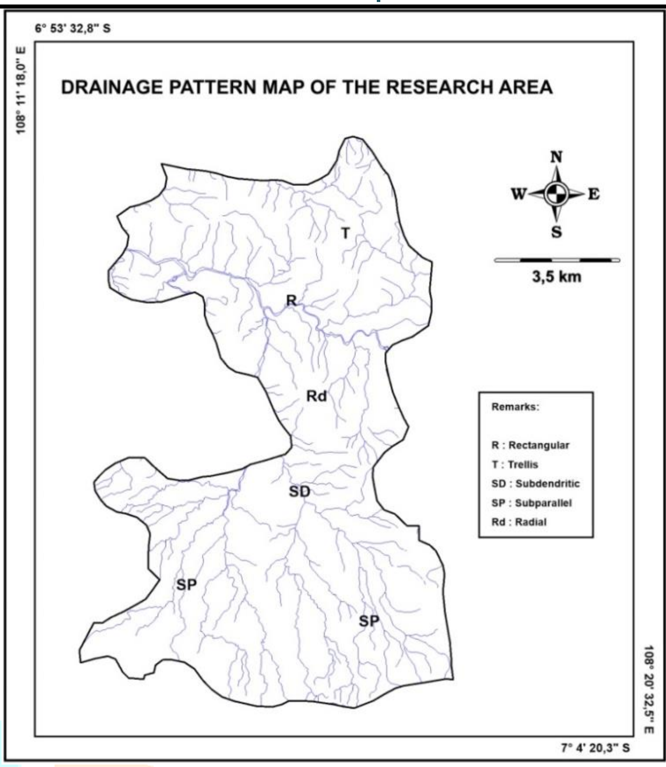

Figure 3. Drainage pattern map of the research area

Slope characteristics identified through drainage pattern analysis are also supported by slope map and satellite images of the research area which show the same characteristics. Based on the slope map (Figure 4A), the research area has a fairly large slope range. It can be seen in Figure 4 that there are gentle to very steep slopes in the north of the research area, rather steep to steep slopes in the middle of the research area, and gentle to steep slopes in the south of the research area. These various slope characteristics are related to drainage pattern analysis. Based on the satellite images (Figure 4B and 5), it can be seen that the surface appearance of the research area is relatively the same as the slope characteristics that have been previously identified. For example, it can be seen that the gentle to very steep slopes in the north of the research area are elongate landforms, the rather steep to steep slopes in the middle of the research area are conical shape of Mt.Sireum, the gentle to steep slopes in the south of the research area are elongate landforms. Both slope map and satellite images of the research area are able to support the previous drainage pattern analysis argument.

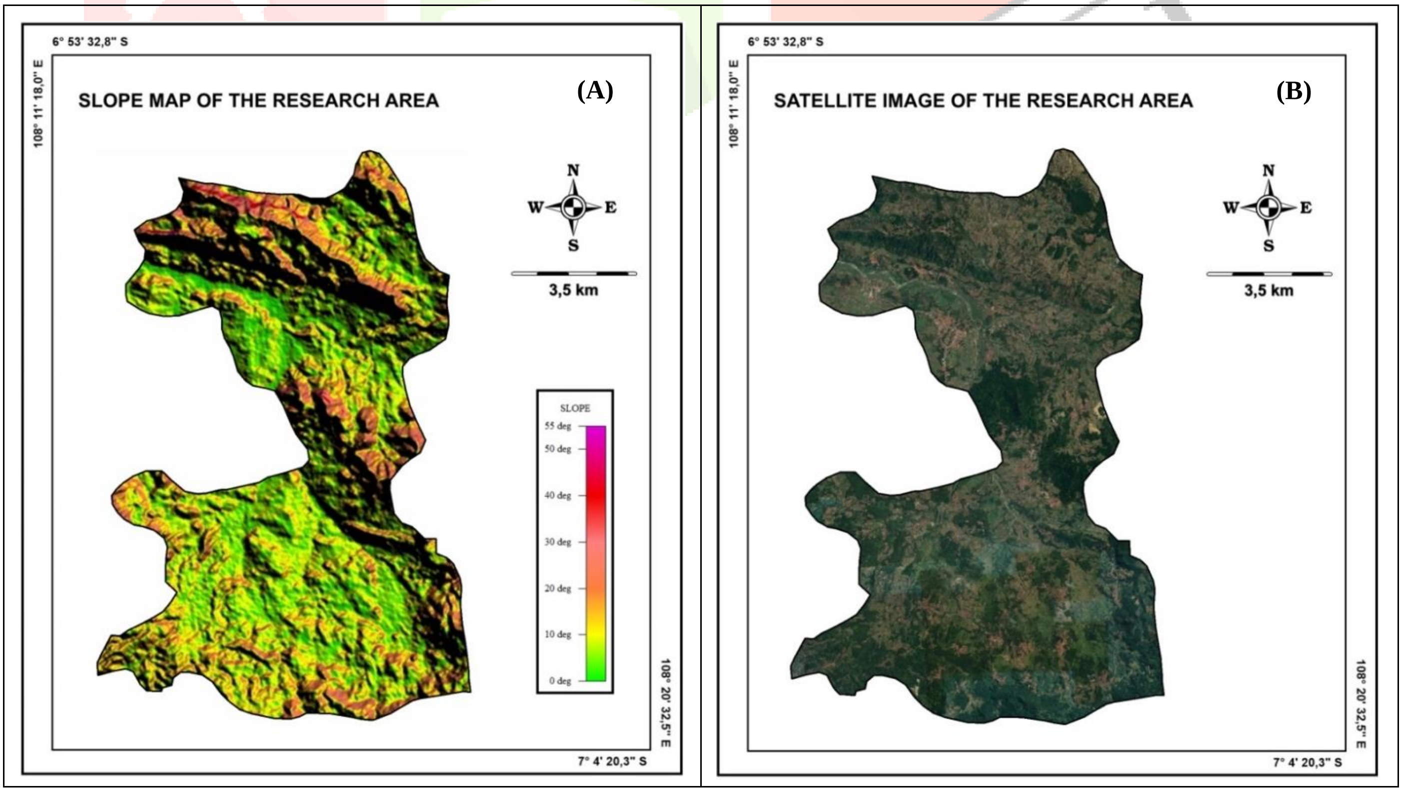

Figure 4. (A) Slope map of the research area; (B) Satellite image of the research area

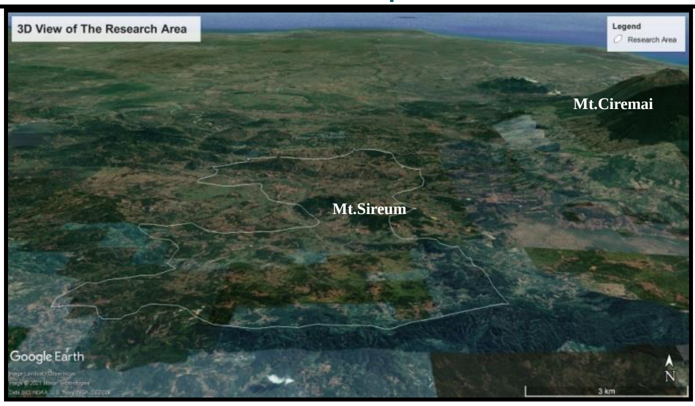

Figure 5. 3D view of the research area (source: Google Earth)

The initial geological characteristics interpretation of the research area which is identified through drainage pattern analysis is also supported by previous geological research data in the geological map of the research area (Figure 6). Based on the geological map of the research area, it can be seen that the research area has quite complex geological characteristics. The research area is composed of sedimentary, volcanic, and igneous rocks (intrusive rock). The northern part of the research area is composed of sedimentary rock dominance and fold structure. The central part of the research area is composed of volcanic rock dominance and igneous rock (intrusive rock). The southern part of the research area is composed of volcanic and sedimentary rocks, also fold and fault structure indication. These geological characteristics indicate an association with drainage pattern of the research area. For example, the rectangular and trellis drainage pattern identified earlier is related to the fold structure in sedimentary rock, radial drainage pattern is related to the volcanic landform, whereas subparallel and subdendritic drainage patterns relate to both volcanic and sedimentary rocks with the geological structure indication.

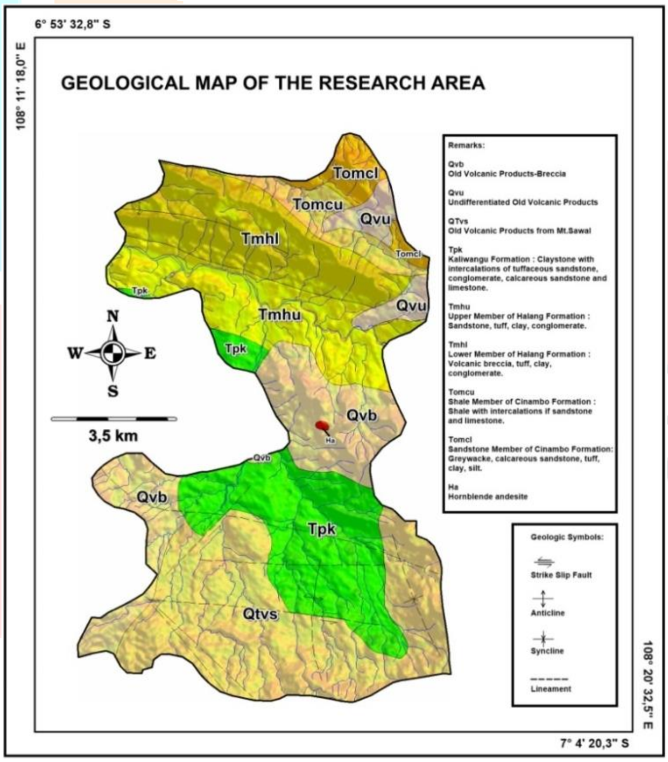

Figure 6. Geological map of the research area (modified after Budhitrisna, 1986 and Djuri, 1995)

IV. Conclusion

Based on the research results, it can be concluded that the drainage patterns in the research area consist of rectangular, trellis, subdendritic, subparallel, and radial. The drainage pattern in the research area can indicate the geological characteristics. Several aspects such as rock types, slope, and geological structure existence can be determined through drainage pattern analysis. It is further clarified through identification using slope and geological map, and also satellite images of the research area. Hence, it can be concluded that the drainage pattern analysis can be used for geological interpretation of a particular area and assist researchers to plan field activities properly.

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