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Morphostructure Analysis of Sapaya Ancient Volcanic Area Based Lineament Data

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Abstract. Morphostructure of Sapaya ancient volcanic have been analysis by using lineament models. In this models, two methods of retrieval data have been used. First, the field survey of the area, second, the satellite images analysis. The morphostructure of Sapaya ancient volcanic contribute to the crater, caldera, and shown an eroded cone morphology. The directions of eruption from Sapaya ancient volcanic have identified in region of Jeneponto and Takalar, which is had east – west and northeast – southwest structure. These eruptions also give contribution to the character of river in Jenelata watershed, by the presence of tuffs, pillow lava, basalt, andesite, diorite, granodiorite, granite, and gabbro, respectively.

INTRODUCTION

Geological setting Sulawesi Island and its surrounding area is a complex region. The complexity was caused by convergen beetween three lithospheric plates: the northward-moving Australian plate, the westward-moving Pacific plate, and the southeast-moving Eurasian plate [1]. So, it gives impact to the mountain establishment located in South Sulawesi, one of them is Sapaya Volcano.

Tectonostratigraphycally, Sulawesi island and its surrounding are divided into 5 tectonic provinces, which are: the Tertiary Western Sulawesi Volcanic Arc; Quartenery Minahasa-Sangihe Volcanic Arc; Cretaceus-Paleogen Central Sulawesi Metamorphic belt; Cretaceus Eastern Sulawesi Ophiolite Belt; and Paleozoic Banda Micro Continental fragment derived from the Australian Continent [2]. The Tertiary Western Sulawesi Volcanic Arc to build the south arm of Sulawesi. This arc is influenced by subduction system from east in Neogene era. This is indicated by the presence of widespread Camba, Baturappe-Cindako, and Lompobattang Formation.

The simplified geology of the region is shown in Figure 1. The rock units present are predominantly of Tertiary age, with outcrops of Tertiary sedimentary and Quaternary volcanic rocks.

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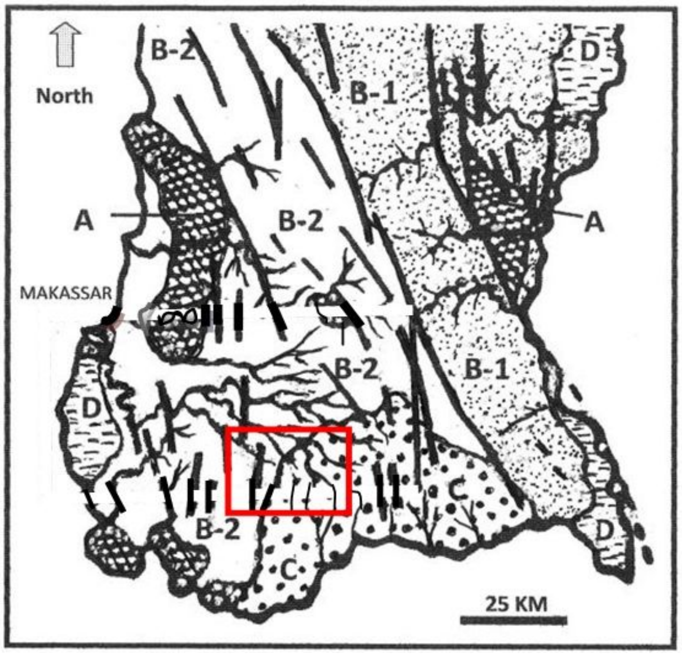

FIGURE 1. Map shows the investigated area (*square*) and the simplified geologic map. A, indicates Pre-Tertiary and Paleogene rocks, B-2, Middle to Upper Miocene volcanic products consisting of breccias, lava flows and volcano clastics, B-1 marine clastic sediments of Upper Miocene, C, Lower Quaternary Lompobatang volcanic products and D represents alluvial and coastal deposits (Modified from [3] and [4]).

Many geologists interisted in examining geology of southern Sulawesi. Tectonically, this region is a part of the Sundaland join with other continent in Sulawesi. North arm of Sulawesi from Eurasian continent, Central and Southeast arm of Sulawesi from Australian continent [5].

Satellite imageries can visualize the morphological apperance and able to recognize the ancient volcanic rocks in Sapaya and its surroundings. The landscape of crater morphology shows an appearance of a volcano. Sapaya ancient volcano phenomenom marked with particular characteristic turned into a problem which has to be analyzed. This research is limited in morphology study, structure and the direction of eruption in Sapaya ancient volcanic using ASTER GDEM data. Specifically, this research explains : morphology, structure and eruption direction of Sapaya ancient volcanic.

DATA AND METHOD

The research object is Sulawesi Island and some small island around it. The research object limited by Latitude: 5°19'0"S - 5°36'0"S and Longitude: 119°30'0"E - 119°50'0"E. The study applied the morphostructure approach to reveal the tectonic activities in the area.

The morphometric analysis includes the interpretation of processed satellite imageries, the field measurement of morphologic elements such as structure, morphology and the eruption direction, and the topographical maps analysis. The field measurements produced the data of azimuth of lineament segments highlands and lowlands. Measurement result processed by DIPS. The analysis of the structure patterns provides the information on the direction of the tectonic compression.

RESULT AND DISCUSSION

Lineaments Pattern Structure and Morphology of Sapaya Ancient Volcanic

The ASTER DEM image digitization generate data lineaments of highland and lowland areas. The results digitization highlands showed some area form plateau geomorphology identified as the mountains and the hill. The Lowland areas identified as rivers, valleys and small basins. The Lineaments map of highland and lowland areas are showns in Figure 2.

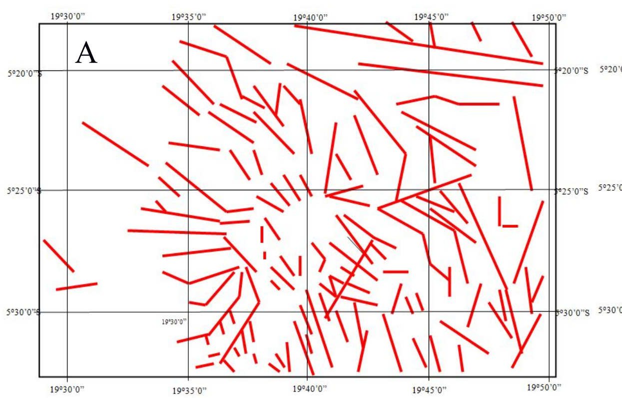

FIGURE 2. (A) Lineament of highland of Sapaya ancient volcanic, (B) Lineament of lowland of Sapaya ancient volcanic

The following figure obviously demonstrates the details of lineaments in the region. Highland pattern (Figure 2A) consists of 79 segments of lineament. While the pattern of lowland regions (Figure 2B) has 37 lineament segments. Lineament data of highland and lowland shows the effect on the appearance of the mountains and the valleys.

Lineaments dominant for each of highland and lowland regions can be averaged so, it obtains the direction of forming the morphology of Sapaya ancient vulcanic. This can be seen through the reading of a Rosette Diagram in Figure 4.

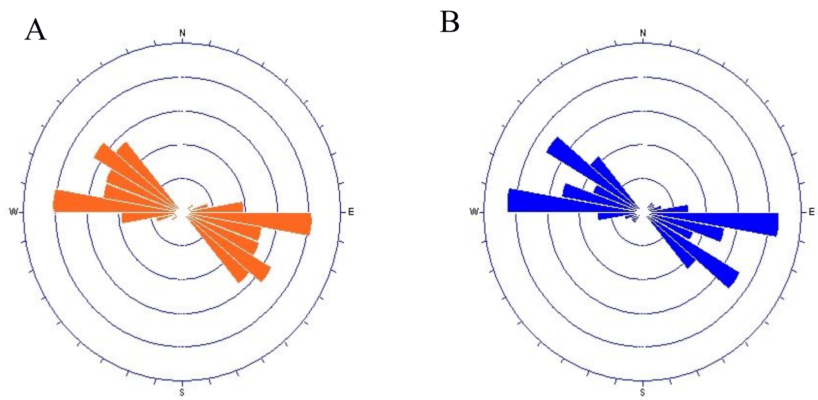

FIGURE 3. (A) Rosette diagram of Lineament of highland areas, (B) Lineament of lowland areas.

Pattern on the Rosette diagram (Figure 3A) on the show lineaments highland areas predominantly oriented towards S95ºE and N275ºW or approximately east-west. While N45ºE and S225ºW or around northeast-southwest is less dominant. Likewise in Figure 4b lowland is dominated direction of the lineament around the east – west or worth S95ºE and N275ºW. While the less dominant around northeast-southwest or worth N45ºE and S225ºW.

The analysis on lineaments pattern of highland and lowland in Sapaya ancient volcanic area are divided into two structural domains; east-west and northeast-southwest. In this case, structural domains contain facies that are the lineaments to the same direction formed through the same tectonic process.

The lineament pattern of highland demonstrates a fold, while the lowland shows of fault stucture. The Rosette diagram (see Figure 3) can be used to determine the direction of the formation highland and lowland areas. Lineaments pattern and C14 dating around volcanic rock of Sapaya can be seen in the area of Tertiary age.

Sapaya Volcano showed of crater structure. Crater is shape of negative morphology occurring because of volcano activation and its shape is relatively round [6]. The structure of crater in Sapaya volcano can be seen at Figure 4, wich is indicated by a red box.

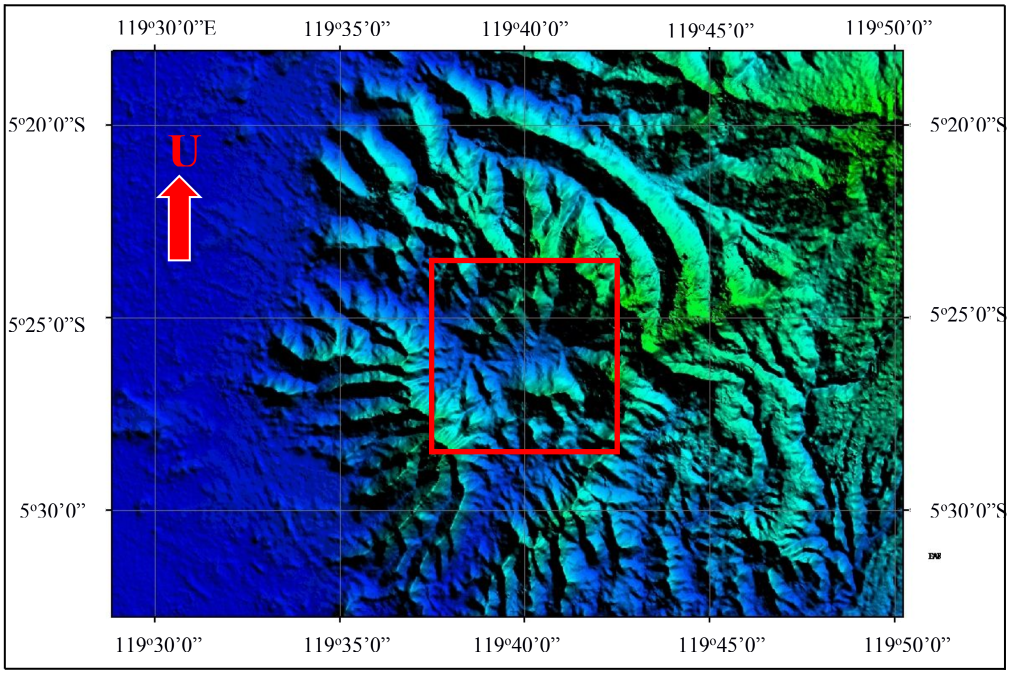

FIGURE 4. The crater structure of Sapaya volcano (square)

Sapaya ancient volcanic is Miosen-age and shows the eroded cone morphology [7]. The morphology of Sapaya anchient volcanic is different from the morphology in northeast of South Sulawesi land**.** This differences caused by morphology of Sapaya ancient volcanic that goes to east-west, while the morphology in northeast area goes to north-south [8].The Northeast morphology of Sulawesi is morphology of Lompobattang volcano that goes to north-east. This difference illustrates the age of these two volcanoes as well, where Sapaya ancient volcanic is Tertiary age but Lompobattang volcano is Quaternary age.

Eruption Direction of Sapaya Ancient Volcanic

The eruption direction of Sapaya ancient volcanic is identified in 2 (two) regions as shown in Figure 6, which are in the area towards Takalar, and the area towards Jeneponto as well as influencing to the formation of Jenelata watershed.

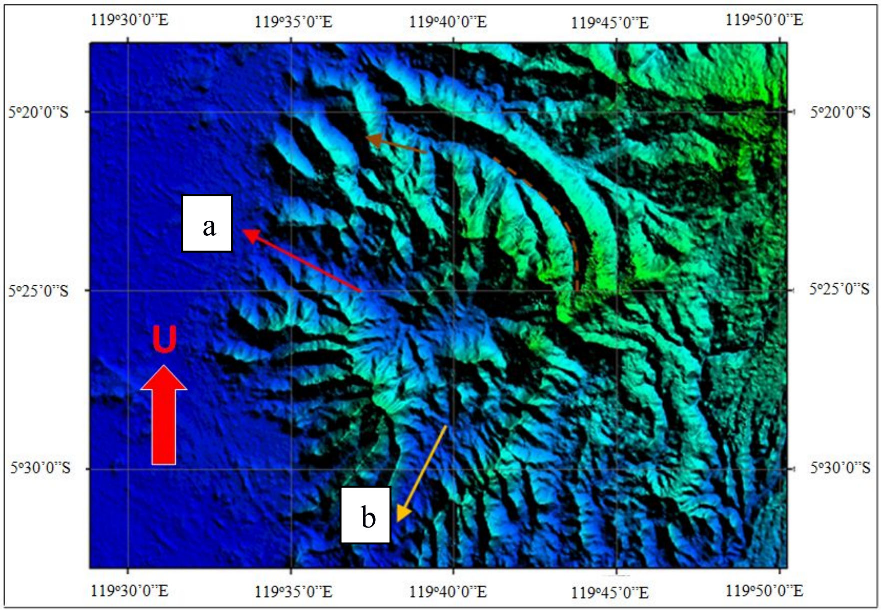

FIGURE 5. The eruption of Sapaya ancient volcanic (a) to Takalar and (b) to Jeneponto

The Direction of Sapaya Ancient Volcanic Eruption Towards Takalar

Takalar regency has a geographical situation that consists of beach, land and hills. This area is included in the category of fairly arid, but still can be found the area that is overgrown with greenery and trees.

The eruption direction of Sapaya ancient volcanic that leads to Takalar indicated by the red arrow (a) in figure 5 with the direction N155,2W. Being identified with direction towards Takalar is strengthened by the discovery of several types of igneous rocks in this area. Among them, they are the basalt rock, tuff units and granite.

The Direction of Sapaya Ancient Volcanic Eruption Towards Jeneponto

Jeneponto regency has morphology that consists of steep hills in the north, undulating hills in the middle and plains in the south to the coast. This area is included in the category of very arid area and dry weather which is extremely hot compared to the conditions in the district Takalar. It is very difficult to find an area that is full of plants or trees

It occurs because this area is passed by lava of Sapaya volcano with higher level of eruption when happening where the direction of eruption can be seen in Figure 5 (b) that is S234,7W. It is further enhanced by the discovery of old rocks which has age generally not been found basalt rock with Tertiary age**.**

The volcanic rocks in this area has gone through the change of andesite-composed until basalt, consisting of tuffs, breccias and lava, having old grey until greenish. The activation of volcano still occured during Pliocene era and produced Baturappe-Cindako volcanic rocks. The breakthrough of igneous rocks taking place in this area is closely related to volcano activation. Intrusion shapes like stock, sill and dyke are arranged from basalt, andesite, trachyt, diorite and granodiorite [9]. It is proven when discovering kinds of igneous rocks in the field like diorite, basalt, granite, gabbroic, tuff, breccia and lava complex.

The Influence of Sapaya Ancient Volcanic Eruption Towards the Establishment of Jenelata Watershed

Jenelata is a river located in Jenelata watershed. The width of watershed is 220 km^2, dominated by aluvial sediment which has relief like lowland marking the morphology body of Jenelata river (see Figure 6). Volcanic rocks are spreading in that area establishes Baturappe-Cindako Formation.

FIGURE 6. The appearance of body morphology of Jenelata river in Baturappe-Cindako Fm.

The eruption of Sapaya ancient volcanic goes to Jenelata river area with direction of N144,6987W. It is proven by the existence of intrusion rock (dyke instrusion). Intrusion is a process occuring caused by a magma activation (plutonism) located under the earth surface which attempts to come out but it does not appear on the surface due to very high pressure and temperature from inside, by breaking through the rock previously existed, so it produces some shapes of igneous rocks.

In geology, dyke is a kind of instrusion of sheet-shaped igneous rock that touches soil layer. Dyke is one of instrusion body which is small dimension. The tabular-shaped, as the sheet having two equal sides, cuts the structure (the layers) of rock it breaks through. Occasionally, the contact is almost equal but the comparison between the length and the width is not equal. The appearance in dyke field can be very small and it can be very huge as well [10].

FIGURE 7. The appearance of dyke intrusion rock at Jenelata river

Jenelata river is lava track from Sapaya ancient volcanic when the eruption happens. In the field, the result of eruption of Sapaya ancient volcanic is similar to that of igneous rock like basalt, andesite, gabbro and granodiorite.

CONCLUSION

1. Based on the lineament analisys of lowland it states that there is fault structure while lineament of highland states that there is fold.
2. The structure of Sapaya anchient volcano which is Miosen age is morphology of crater dan caldera.
3. With the Rosette diagram, the pattern of lineament of highland of Sapaya ancient volcano has the direction of lineament totaled S95ºE and N275ºW. Also, the lineament of lowland river has the same dominant direction with S95ºE and N275ºW.
4. The pattern forming highland and lowland (river) are established simultaneously in Tertiary era.
5. The eruption direction of Sapaya ancient volcano identified in 2 (two) areas are Takalar and Jeneponto and it influences the establishment of Jenelata watershed strengthened with the invention of of igneous rock which is the result of the eruption like basalt, andesite, diorite, granite, granodiorite.

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