Identification characteristics of volcanic deposits in Cimarga, Southeast Banten

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Abstract. Volcanic eruption(s) in the past occurred around rawa danau volcanic complex is marked by the presence of a caldera and widespread volcanic deposits in the Banten Province as Tuff Banten. This study aims to determine the possible mechanism of the eruption based on volcanic deposits. Moreover, this study will also present the prolonged research process to understand the dynamics of volcanic deposits in Banten. Field study and sampling of volcanic deposits were completed followed by thorough petrographic analysis. There are three outcrops all with different characteristics. There are 6 layers in outcrop 1. Out of six layers, layer 1 (P1) until layer 5 (P5) appear similar, consisting of pumice rich (as fragment) and lapilli layer, while layer 6 (P6) consists of massive ash. In outcrop 2, there are 5 layers, which show cross and parallel laminations in each layer. Outcrop 3 contains 3 layers with the top and bottom layers consisting of lithic and pumice lapilli that are medium in size. Based on grain size from each outcrop, grain size from outcrop 1 until outcrop 2 progress into finer grains. From these characteristics outcrops 1 indicated flow deposits, outcrop 2 indicated surge deposits, and outcrop 3 indicated flow deposits. Therefore the facies from all three outcrops lean towards medial to distal with outcrop 3 as a distal facies.

Keywords: Volcanic deposit, flow deposit, surge deposit, rawa danau volcanic complex, volcanic facies

1. Introduction
History marked a huge volcanic eruption around Banten, Indonesia, centralizing in Rawa Danau. Volcanic eruption(s) in the past occurred around Rawa marked by the presence of a caldera and widespread volcanic deposits in Banten Province as Tuff Banten. Caldera size is around 11.7 km x 8.4 km (figure 1) and volcanic deposits were categorized by Rukmana et al. (1992) as Tuff Banten (in Lembar Serang geological maps) [1].

There were three outcrops studied, all of which were in Cimarga District, Lebak Regency, Southeast of Banten Province (figure 2). This study aims to determine the possible mechanism of the eruption based on volcanic deposits. Moreover, this study will also present the prolonged research process to understand the dynamics of volcanic deposits in Banten.
2. Tectonic settings and general geology
The subduction process between the Indo-Australian plate and Eurasia causes magmatic formation followed by rows of volcanoes that are scattered in Indonesia, especially along Sumatra, Java, to Banda Sea [2]. Katili (1979) stated that the subduction zone in Indonesia is a dynamic zone occurring from 300 million years ago until present day [3].

The depth of the hypocenter between Java and Sumatra varies; wherein Java it is > 500 km, while in Sumatra it is < 300 km. Rawa Danau itself is one of the volcanoes located on the tip of Java Island. This volcano has a hypocenter around 200–400 km with a very steep subduction angle (figure 3) [4].

![Figure 1](image1.png)
**Figure 1.** Morphology and study area location (modified from USGS’s data).

![Figure 2](image2.png)
**Figure 2.** Outcrop location in research site.
Figure 3. Cross-section of the subduction zone in Rawa Danau volcanic complex [4].

Rawa Danau is surrounded by volcanic rock products, both in the form of lava flows or rocks that are erupted during volcanic eruptions such as breccias, tuffs, and lava. Referring to the Lembar Serang Geological Map. The study area is composed of rock units from the oldest to the youngest: 1. Genteng Formation (Tpg); 2. Cipacar Formation (Tpc); 3. Karang Volcanic Products (Qvk); 4. Banten tuff (Qvpb); 5. Bojong Formation (Qpb); and 6. Alluvial (Qa). Rusmana et al., reported that Genteng Formation was deposited during the Miocene period, which was then deposited on top of the Cipacar formation, with conformity, while the other rock units were the result of volcanic eruptions during the Pleistocene period which were composed of both formations, Cimapag and Cipacar [1].

3. Sampling site and analysis method
The research was completed in Cimarga District, Rangkas Bitung, Southeast of Banten Province. We used Google Earth to identify possible locations of the outcrops that would be visited. After we found possible outcrops locations, field survey was carried out to identify lithological units of the deposits. The combined geological data were studied further using petrographic analysis.

4. Results and discussion
The three outcrops are widespread across Southeast Banten Province (figure 3). All three outcrops will be discussed below respectively.

4.1. Outcrop 1
There are 6 layers in outcrop 1. Out of six layers, layer 1 (P1) until layer 5 (P5) appear similar with consist of pumice rich (as fragment) and lapilli layer, while layer 6 (P6) consists of massive ash (figure 4).

Outcrop 1 in majority consists of pumice fragments ranging from 1 cm until 15 cm where these fragments are found at the top of each layer. The occurrence of pumice fragments are due to ejected pyroclastic rocks during eruption(s) and later carried out via fluids with density relatively higher than these fragments. Thus, during deposition pumice fragments are deposited at the top of each layer (P1–P5).

4.2. Outcrop 2
Outcrop 2 is very different from Outcrop 1. There are 5 layers from this outcrop that show repetition (figure 5). In this outcrops there are structures such as cross and parallel laminations in each layer.
Repetitions can be found in Layer 1 and Layer 3 with Layer 2 and Layer 5 with various components such as clay, sand, lapilli, and pumice. Interestingly enough, the pumice fragments tend to lack uniform positioning in each layer.

![Figure 4. Outcrop 1 with component and structures. P1: reversely graded pumice-rich ash, lapilli, bomb. P2: lapilli, reversely graded to bomb. P3: pumice-rich pyroclastic lapilli to bomb. P4: lapilli, reversely graded to bomb. P5: pumice-rich pyroclastic lapilli to bomb. P6: massive ash.](image)

![Figure 5. Outcrop 2 with component and structures. P1: parallel lamination of alternating lithic and pumice lapilli. P2: cross-lamination of alternating lithic and pumice deposits. P3: parallel lamination of alternating lithic and pumice lapilli. P4: cross-lamination of alternating lithic and pumice lapilli, grade into parallel lamination. P5: cross laminated graded into parallel laminated of lithic and pumice. Anything above P5 weren’t identifiable.](image)
4.3. Outcrop 3
Outcrop 3 contains 3 layers with the top and bottom layers consisting of lithic and pumice lapilli that are medium in size. On the other hand, the middle layer (4 m in thickness) consists of massive ash-lapilli (figure 6).

Distributions of the three outcrops show differences in the deposition mechanism. Outcrop 1 generally consists of lapilli layers that are dominated by lithic pumice fragments. It can be concluded from its eruption mechanism that this volcanic deposit resulted from flow deposit. On Outcrop 2 cross laminations are found as well as layers that are irregular when compared to Outcrop 1. Cross-lamination found here indicate volcanic deposition from surge deposit. The last outcrop tends to be composed of pyroclastic ash with smaller pumice fragments compared to the first outcrop, where in general Outcrop 1 and 3 tend to have similarities from appearance, what differs between them are the sizes of pumice fragments contained in them. There are also lithological logs from each outcrop attached in the image below (figure 7).

![Figure 6. Outcrop 3 with component and structures (P1: parallel lamination of lithic and pumice lapilli. P2: massive ash – lapilli. P3: parallel lamination of lithic and pumice lapilli).](image)

![Figure 7. Lithological log of each outcrop.](image)
From the characteristics that have been explained, Outcrop 1 and 3 fits into the flow deposit characteristics. Flow deposits are relatively thick, poorly sorted, commonly without containing internal bedding. This deposit is formed as a result of volcanic eruptions that forms a flow, where outcrops 2 is surge deposits, that is relatively thin, better sorted than flow deposits, and tends to form a cross bedding. These three outcrops have characteristic consisting of pyroclastic ash that is dominated by lithic components and a variation of pumice fragments. From those characteristics, the research site is part of medial to distal facies zone, which means that it is far from the volcanic eruption source that caused the deposits to form. Facies grouping is based on qualitative data from outcrop spreadings that were found.

5. Conclusion
All three outcrops have contrasting characteristics which may be resulted from different deposition mechanisms that occurred during the eruption. Three outcrops have a difference of deposition mechanism, which outcrop 1 and 3 are flow deposit, but in outcrop 3 is surge deposit. These three outcrops have characteristics that consists of pyroclastic ash that is dominated by lithic components with a variation of pumice fragments, therefore it can be said that the research site is part of the medial-distal facies (far from the volcanic eruption source. This research is the initial research of a series to determine the complexity of Tuff Banten deposits, perhaps follow-up research will be focused on grain size and granulometric analysis.

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