The Understanding of Volcanoclastics Model in Tebing Breksi Geotourism By Digital Outcrop Model

Muchamad Ocky Bayu NUGROHO[1], Muhamad SYAIFUDIN[1], Bambang YUWONO[2], Basuki RAHMAD[1]

[1]Department of Geological Engineering, Faculty of Technology Mineral, University of Pembangunan Nasional "Veteran" Yogyakarta, Indonesia
[2]Department of Informatics Engineering, Faculty of Industrial Technology, University of Pembangunan Nasional "Veteran" Yogyakarta, Indonesia
Email the first author: bayu.ocky@gmail.com ; bayu.ocky@upnyk.ac.id

ABSTRACT

Tebing Breksi Geotourism Object is one of geotourism object in Yogyakarta which part of UNESCO Gunung Sewu Geoheritage. Geologically, Tebing Breksi is included in Semilir Formation that consists of volcanoclastic sediments such as Tuff, Tuffaceous sandstone, Tuffaceous claystone and lapilli (Surono, 2009). This research is trying to apply digital technology to geological science through 3D Outcrop Model in order to understanding history, sedimentary process and depositional environment easier. The Digital outcrop model was build up by photo that acquired by drone with systematic captured. Sedimentology data was captured by conventional method and measuring section that represents all layers. Based on model and data, it shows the dynamics of sedimentary process from bottom to top and could be identified from sedimentary structures and lithofacies. Bottom part shows bedding structures that describe grain size changing from sandstone to conglomerate and refer to model (Kendall, 2004) match on Supra Fan Lobes, the middle part displaying a bedding structure and coarsening upward stacking pattern and interpreted as inner fan channel facies and the upper part is new sequence package interpreted as basin plain. As a whole, the volcaniclastics sediment in Tebing Breksi area was from great Semilir Eruption in Early Miocene (Smyth, 2011) which was deposited in submarine fan system to basin plain (Kendall, 2004). This model is being developed with additional data to be an Augmented Reality (AR) smartphone application for other purposes.
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***Keywords**: Tebing Breksi, Digital Outcrop Model, Volcanoclastic, Geotourism..*

INTRODUCTION

The application of technology in geological science is very useful both in academic and industrial terms. DOM (Digital Outcrop Model) or VOM (Virtual Outcrop Model) is one of the examples. DOM is a surface outcrop that represents 3D view mostly in a form of textured polygon mesh. DOM allows for interpretation and measurement of different geological features, e.g. orientation of geological surfaces, width and thickness of layers (Bellian et al., 2005). The quantity of identifiable and measurable geological features highly depends on the outcrop model resolution and accuracy (Buckley et al., 2008). DOM is helping a geologist to imagine and interpret a outcrop easier because it geometry and resolution that completely covered.

Semilir Formation is known widely as volcaniclastic deposit that well outcropped in Tebing Breksi geotourism object Yogyakarta. Formed from rock mining remnants which makes a good shape and geometry in a cliff. This research addresses the field scale architecture and dimension of volcaniclastic deposits into DOM and the objective is to utilize a model for the understanding of volcaniclastic deposits easier.

GEOLOGICAL BACKGROUND

Indonesia archipelago is well-known for great volcanic activity due to plate activities. Java island has a row of volcanoes elongates from west to east called "volcanic arc" that formed of subduction slab since the Early Cenozoic (Hall, 2002; Smyth et al., 2008b). The Eocene to Early Miocene Volcanic arc in East Java is parallel to and south of modern/present volcanic arc (Smyth et al., 2011) where Semilir Mountain was present (Fig. 1). Southern Mountain volcanic arc has produced thick volcanic and volcaniclastic deposits that well preserved in Central Java and East Java, one of them is in Tebing Breksi. According to volcanic activity which had been started in Early Miocene, the Southern Mountain Volcanic Arc was a small volcanic island surrounded by carbonate volcaniclastic shelves separated by intra-arc basin (Smyth et al., 2011).

Volcanoclastic Deposits of Semilir Formation

Semilir Formation is well preserved and outcropped in several spots in Southern Mountain Area, such as Baturagung, Wonogiri, Tepus, and Candi Ijo. Several authors notes if in each spot of Semilir Formation has specific sedimentation character that representing volcano facies. Semilir volcanic activity was extensive, explosive and of Pillian Type with andesite-rhyolite composition include thick ashes, pumice lithic, breccias, lava flows and crystal lithic tuff (Smyth, 2005). The volcanic rocks are characterized by features typical of terrestrial air-fall, pyroclastic surge and flow deposits, crystal layering, well-sorted granular laminations, diffuse bedding, breccias (with metre-scale pumice blocks), thick mantling ashes, and abundant fragments of charcoal. Some places there are found flame, traction, irregural bases and slump folds indicating an unstable marine slope, so it could be interpret was erupted in subaerial setting in which pyroclastic flow entering the sea and some redepeosited as lahar in distal settings (Smyth et al., 2011).

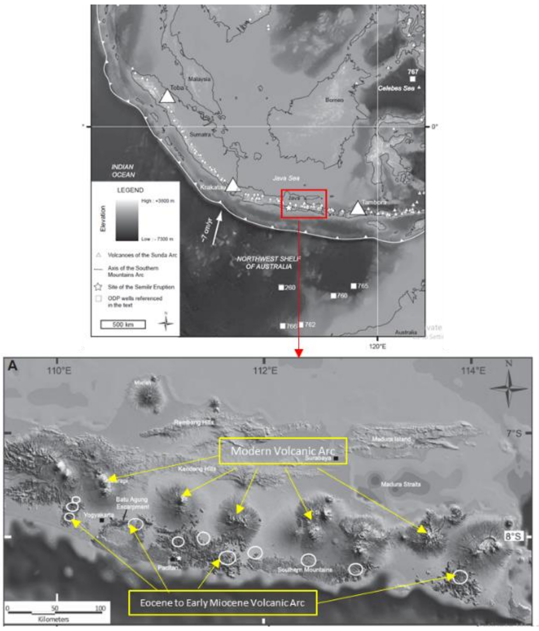

Figure 1. Modern Volcanic arc and Southern Mountain Volcanic Arc (Smyth et.al, 2011)

METHOD

This research use the integrated method of references review, fieldwork and information technology. References review was very important due to imagine a historical geology for model building while fieldwork was conducted to characterise the outcrop deposits include litology, sedimentary structure and layer position. Using information technology in term “DOM” makes Understanding more easier and comprehensive. Aquisition data using professional UAV have been done with horizontally and vertically schematic capture (Fig.2). Editing, compiling and proccessing graphic are the next step that supported with several software such as *Adobe Photoshop*, *CorelDraw* and *Zephyr 3D*.

The model or DOM has been integrated with field data and then be analyzed and compared with volcanoclastic model from refecences.

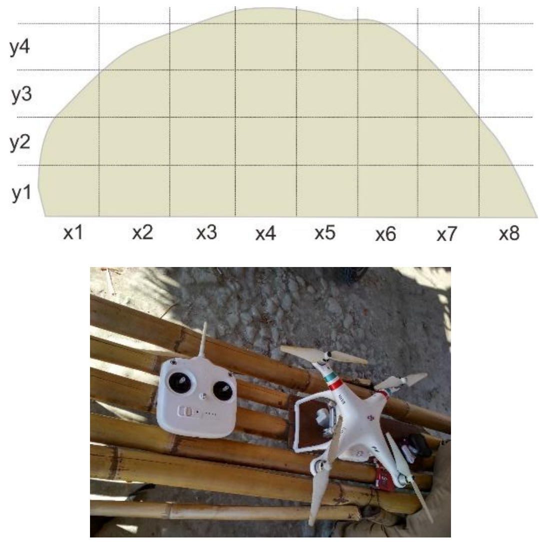

Figure 2. Schematics Capturing of Tebing Breksi and Professional UAV (Nugroho et.al, 2019)

DISCUSSION

Stratigraphic Analysis

Stratigraphic section has covered all layer that shows several sequences of sedimentation event. Sedimentary structure, texture and material composition is the main parameter that will be integrated with DOM. Semilir Formation in Tebing Breksi area is epiclastics deposit that formed by reworking pyroclastic or epiclastic previous deposit with a submarine-fan deposit system. Major portions of submarine-fan sequences are composed of turbidites that occur as channel-fill, lobes, and sheet sands (Shanmugam, 1988).

As shown in Fig. 3, the stratigraphic section of Tebing Breksi can be divided into 2 depositional sequences that interpreted from sediment supply due to subaqueous condition.

The lowest part of section domintaned with conglomerate and massive tuffaceous sandstone. Pararel lamination and graded bedding are sedimentary structures that dominant in sight addresess to lowstand system tract that interpreted as suprafan lobes facies (Kendall, 2004). In the middle part shown as stacking tuffaceous sandstone interbedded with tuffaceous claystone that dominantly massive, gradded bedding and pararel lamination sedimentary sturctures. The section is clearly display about transgressive system tract on middle chanell fan facies (Kendall, 2004). Over previous section is quite clearly showing a high system tract deposits that characterized by coarse to medium tuffaceous sandstone with fining upward stacking's trend and interpreted as boundary of sequence. Wavy lamination is shown in upper part of section, pararell lamination, gradded bedding and masive structures are dominantly shown in almost every beds, so section could be predicted as Inner channel facies (Kendall, 2004).

Above the sequence boundary, we find more dominant tuffaceous claystone, layer of tuffaceous breccia and tuffaceous pebbly sandstone. It could be interpreted as transgressive system tract due to stacking pattern was finning upward and deposited in basin plain facies.

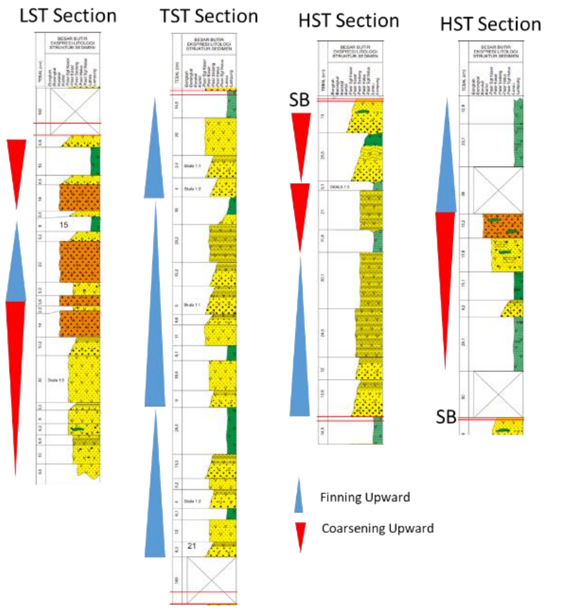

Figure 3. Stratigraphic Section of Tebing Breksi from bottom to top (from left to right)

DOM Integration and Volcaniclastic Model

The model has a minimum sedimentary structures due to resolution that difficult to paleocurrent interpretation, but the dipping average of bedding plan about 10-13° with dominantly east direction concluding if paleocurrent direction is N 270°-320° E and correlated with sedimentary structure field data.
Volcanoclastic model of Tebing Breksi Area was builded from DOM integrated with stratigraphic section and refferences. We divided Tebing Breksi into 4 stacking sequences and have each depositional mechanism. Overall, we selected 1 DOM from the best one because another DOM have minimum resolution due to weathering and discoloration.

On Figure 4, Red line shows bedding structures that describes grain size changing from sandstone to conglomerate and refer to model (Kendall, 2004) match on Supra Fan Lobes, (Wood, 2017). Yellow line in above, has minimum structure in lower part but lamination and bedding structure in upper part. Two kind of that structure separated with tuff layer (clay size) in mean massive transgressive moment. Generally, this section has finning upward stacking pattern and it correlates to middle fan channel facies (Kendal, 2004) and yellow circle on (Wood, 2017) model.
On Blue line overall there is no specific structure and rather difficult identified from DOM, but in detail, we can see a vague parallel bedding and color gradation. Related with field data in the upper part that has graded bedding structure and coarsening upward stacking pattern, so it displaying inner fan channel facies (Kendall, 2004) and blue circle on (Wood, 2017) model. The top section (green line) look very different compared and clearly showing a bedding structure although has been discoloration. Generally, it shows a special sedimentary package that could be mean as a new sequence.

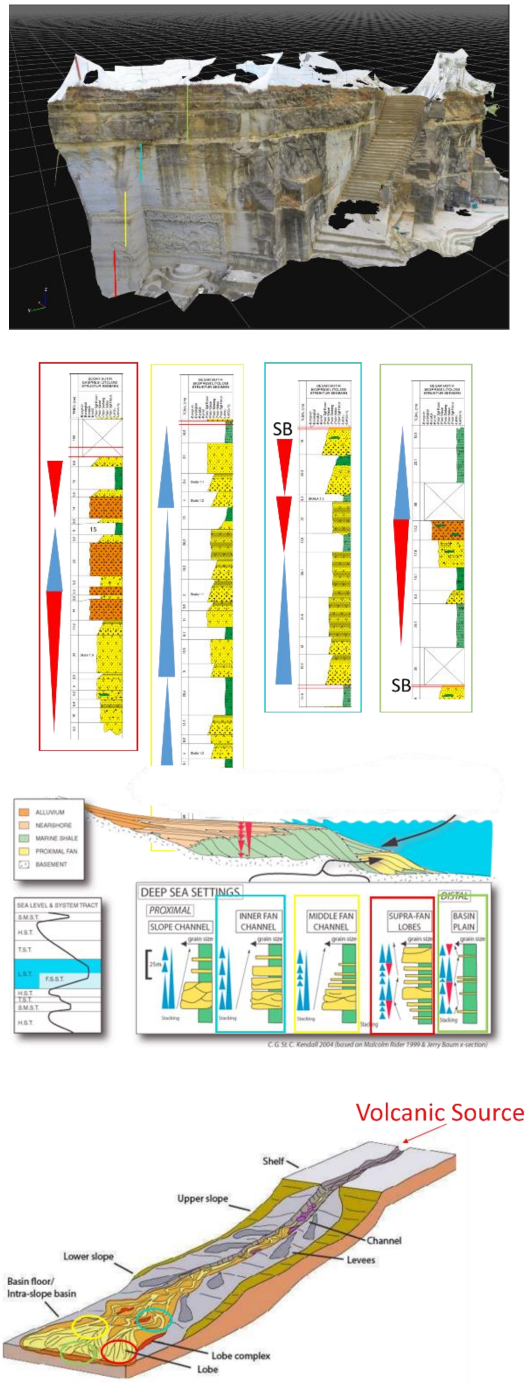

Figure 4. DOM integrated with Volcaniclastic Submarine Model (Kendall, 2004 & Wood, 2017)

CONCLUSION

DOM (Digital Outcrop Model) is one of tools that can use for geosciences purposes recently and for example is building geological model in some areas. Building a DOM using a UAV through several stages, they are data acquisition, proccesing and vizualisation. UAV DOMs are not a replacement for field observations, although, they can efficiently provide supplemental measurements and enable guided interpretation data (i.e., sedimentary logs, cross-section sketches). In this study, we used field data (stratigraphic section) to improving and detailing geologic information for building a model.

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