

# Development of Dieng Volcano Complex as Geoheritage and Tourism Education of Volcano, and Geothermal Energy, Banjarnegara, Central Java

*by Dwi Fitri Yudiantoro*

---

**Submission date:** 19-Dec-2022 12:21PM (UTC+0700)

**Submission ID:** 1984287620

**File name:** 2\_Artikel\_ICEMINE\_Dieng-28\_Okt\_2021.pdf (2.6M)

**Word count:** 3322

**Character count:** 17827

# Development of Dieng Volcano Complex as Geoheritage and Tourism Education of Volcano, and Geothermal Energy, Banjarnegara, Central Java

<sup>a)</sup>Intan Paramita Haty, <sup>a)</sup>Dwi Fitri Yudiantoro, <sup>a)</sup>Siti Umiyatun Choiriah,  
<sup>a)</sup>Muhammad Dzakiya Mukhlis, <sup>a)</sup>Elisabet Magdalena, <sup>a)</sup>Armala Putri,  
<sup>a)</sup>Dimas Anugrah Pratama

<sup>a)</sup>*Department of Geological Engineering, Faculty of Mineral Technology, University of Pembangunan Nasional "Veteran" Yogyakarta.*

<sup>a)</sup>[Corresponding author: dzaki.mukhlis@gmail.com](mailto:dzaki.mukhlis@gmail.com)

**Abstract.** Dieng is a plateau with an elevation of  $\pm 2000\text{m}$  consists of several volcanic edifices, known Dieng Volcanic Complex (DVC). DVC is the backarc-side of the NW-SE across-arc Quaternary Volcanoes. DVC has a potential location for learning about volcanoes. The potential locations include Sheeted Lava in Sikunir, Mount Pakuwaja, Mount Kendil, Watu Lancip, Telaga Merdada, and Mount Batur. Autobreccia Lava Mount Prau, Petarangan Mountain Massive Lava, Cebong Lake, Sedringo Lake, Color Lake, Viewpoint, Pangonan Mountain Savanna, Lumping Waterfall, Hotspring in Sikidang, Sileri, Sipandu, Bitingan, and Candradimuka. Also found geothermal manifestations, includes Mount Pagerkandang fumarole and Sibanger Crater. The methodology used in this study is section/profile, outcrop observation, petrographic analysis, and literature study. This study aims to provide insight into potential locations as Geoheritage and places to learn about volcanoes. It is hoped that the development of proposed tourist sites can be optimized to support the welfare of the surrounding community.

Keywords: education, geoheritage, geothermal, tourism, volcano

## INTRODUCTION

The study area is a plateau with an elevation of  $\pm 2000\text{m}$  consists of several volcanic edifices, known as the Dieng Volcanic Complex (DVC). The Dieng area is known for its cultural tourism with various historical relics such as Arjuna Temple, Bima Temple, etc., also known for its agricultural products, especially potatoes. In addition, this area is a volcanic complex consisting of volcanic edifices in a caldera structure of  $14 \times 6 \text{ km}^2$  [1].

Looking at this aspect, the Dieng area also has the potential as a learning tourism area for volcanic rocks as well as its potential as a producer of geothermal energy. Locations that have the potential for tourism include Mount Sikunir, Mount Pakuwaja, Cebong Lake, Viewpoint, Stone of View Ratapan Angin, Watu Lancip, Mount Pangonan, Lumping Waterfall, Mount Prau, Lake Warna, Sikidang Crater, Mount Pagerkandang, Lake Merdada, Sileri Crater, Sipandu, Bitingan, Sedringo Lake, Sibanger Crater, Candradimuka Crater, Mount Batur. To reach the Dieng tourist location, you can use car or motorbike from Wonosobo City for  $\pm 1$  hour. The road is paved and easily accessible. The development of this tourist area is expected to bring prosperity to the community around the tourist location.

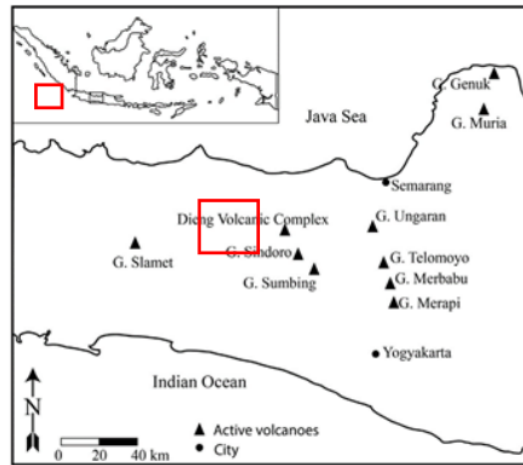


FIGURE 1. Research Site Map[2]

## LITERATURE REVIEW

Dieng Volcanic Complex (DVC) is physiographically located in the North Serayu Zone and is part of the Quaternary Mountains in Java (Salihin, 2020). DVC is the backarc-side of the NW-SE across-arc Quaternary Volcanoes, which includes the young cones of Sindoro and Sumbing to the south[2][3]. DVC is the result of compressional forces on Java Island which is the result of the Sunda Orogeny in the late Neogene which causes plutonic intrusion and volcanic arc uplift. (Salihin, 2020). DVC stratigraphy based on radiometric age data determined by the K-Ar dating method[1] was divided into three stages. The pre-caldera stage consists of Prahua, Rogojembangan and Telerejo. The peak of magma evolution is the explosive eruption of the caldera structure that formed Prahua. The second period or post-caldera stage I consisted of Nagasari (2.99 Ma), Bhishma (2.53 Ma), Sidede, Bucu, and Jimat. The last period or Post Caldera II includes Pagerkandang (0.46 Ma), Panganan Merdada (0.37 Ma), Butak, Kendil (0.19 Ma), Pakuwaja (0.09 Ma), Prambanan, Seroja (0.07 Ma). ), and Sikunir.

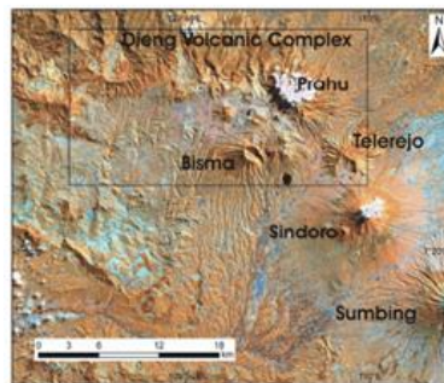
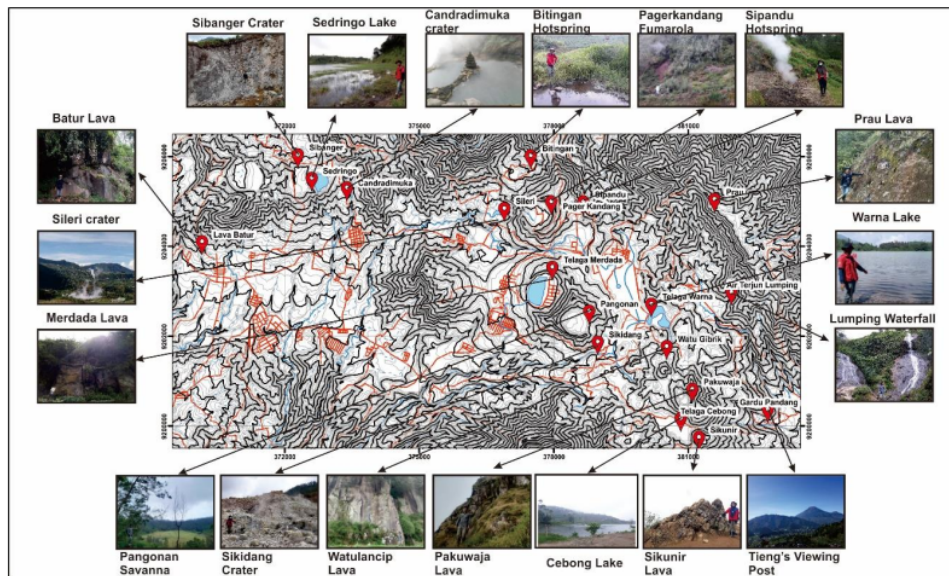


FIGURE 2. Satellite image of Dieng Volcano Complex and its surroundings[2].





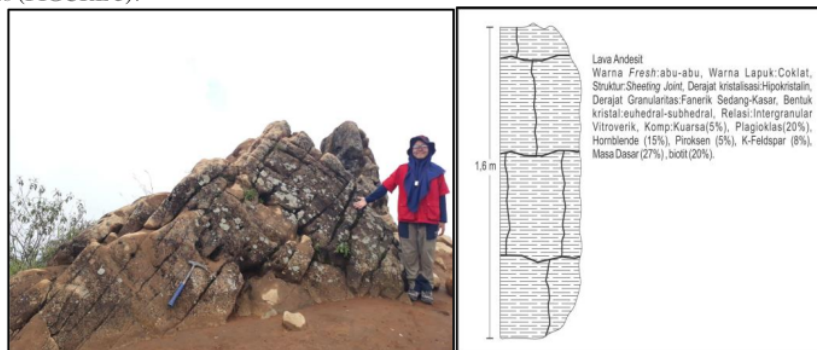


**FIGURE 4.** Topographic Maps and Observation Locations. Observation Locations are the potential locations of Geoheritage Tourism Education of Volcano, and Geothermal Energy.

## Volcano Tourism

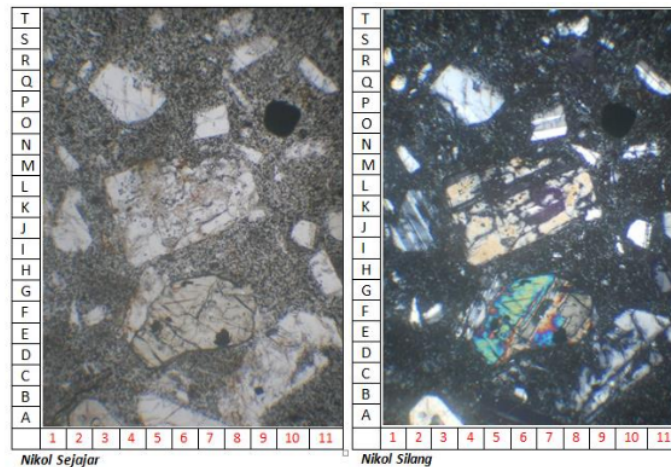
### *Sikunir Lava*

Mount Sikunir is located in Sembungan Village, Kejajar District which is a mountain that has a panoramic view of a beautiful sunrise. Sunrise at this location is one of the mainstay tours in Dieng plateau. At the peak found lava. This lava is found at an elevation of 2,263 masl, and can be accessed by trekking on foot for 15 minutes (**FIGURE 5**).



**FIGURE 5.** Andesite Lava outcrop with Sheeting Joint Structure at the peak of Sikunir (Left) and its profile (Right).

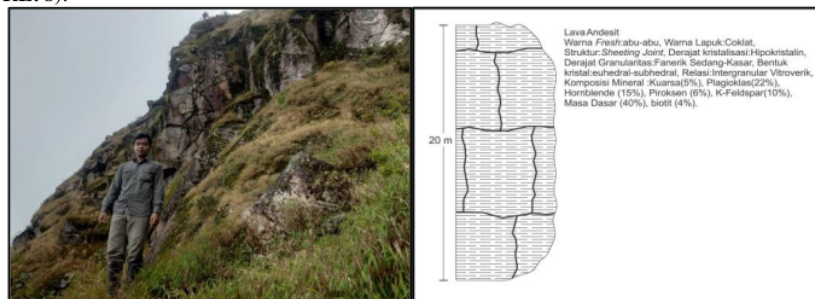
Andesite pyroxene incision with sheeting joint structure, weathered rock condition, gray-greenish-brown color, porphyritic texture (phenocrysts embedded deep by fine grain base mass of plagioclase, pyroxene, opaque and glass), subhedral-anhedral shape, mineral composition consisting of plagioclase minerals (60%), quartz (1%), pyroxene (20%), opaque minerals (2%), and glass (15%). The Pyroxene Andesite Petrographic Section showed on **FIGURE 6**.



**FIGURE 6.** Pyroxene Andesite Petrographic Section showing the presence of phenocrysts (plagioclase, pyroxene, and opaque minerals) surrounded by volcanic glass groundmass. Rock's sample are collected on Mount Sikunir.

### *Pakuwaja Lava*

Mount Pakuwaja with an altitude of 2421 meters above sea level is located in Tieng Village, Kejajar District, Wonosobo Regency, Central Java Province. Mount Pakuwaja (**FIGURE.7**) is one of the favorite climbing spots in the Dieng plateau because it has a very beautiful view that displays various morphologies of the surrounding volcanoes, the path taken by climbers to the top of the mountain is not too far, not too long and not too challenging. The top of the mountain has a fairly large peak area. In the area of Pakuwaja peak itself, igneous rock lithology in the form of Andesite is found with a large size and is often used as a photo spot by climbers. In addition, on the northern slopes of Mount Pakuwaja there are also alterations (**FIGURE. 8**).



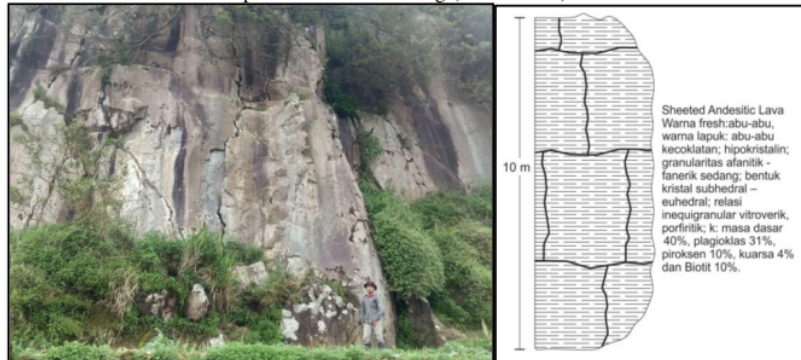
**FIGURE 7.** Andesite Lava with Sheeting Joint Structure outcrop with a thickness  $\pm 10$  at the peak of Mount Pakuwaja (Left) and its profile (Right).



**FIGURE 8.** Alteration on the northern slope of Pakuwaja (Photo taken from the peak of Mount Pakuwaja)

### *Kendil Lava*

Lava Kendil is located in Jojogan village, Kejajar sub-district, Wonosobo district. Watulancip is a massive lava with a height of 10 meters and a width of 15 meters. This lava shows a sheeting joint structure with a porphyritic texture and a degree of hypocrySTALLINE crystallization. The composition of this lava consists of 40% base mass, 31% plagioclase, 10% pyroxene, 10% biotite, and 4% quartz. Because of its dimensions, Lava Kendil has become a favorite place for rock climbing (**FIGURE 9**).

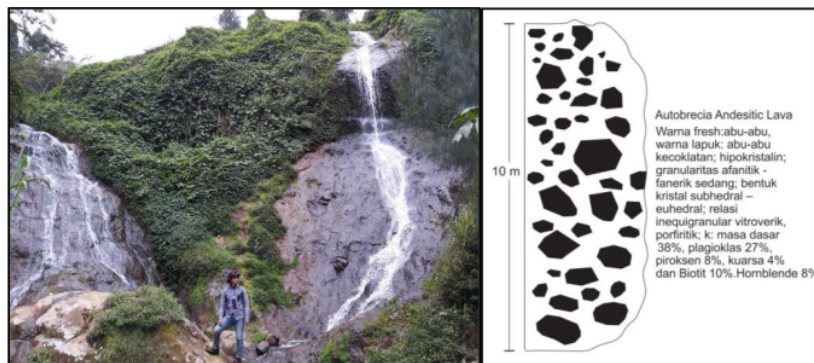


**FIGURE 9.** Andesite lava outcrop or called Watulancip in the village of Jojogan (left) and its profile (right)

### *Watulumping Andesite Waterfall*

Lumping waterfall is located on the slopes of Mount Prau, precisely in Patakbanteng Village. This waterfall can be accessed by 2-wheeled vehicles for 5 minutes from Patakbanteng basecamp, Gunung Prau. Lumping waterfall is an interesting place to enjoy the fresh water of Mount Prau, because at this location 2 waterfalls are found side by side and unite into one river downstream (**FIGURE 10**). The rock that composes this waterfall is lava with autobreccia structure, porphyritic texture and degree of hypocrySTALLINE crystallization. The composition of this lava consists of 38% ground mass, 27% plagioclase, 8% pyroxene, 10% biotite, and 4% quartz.

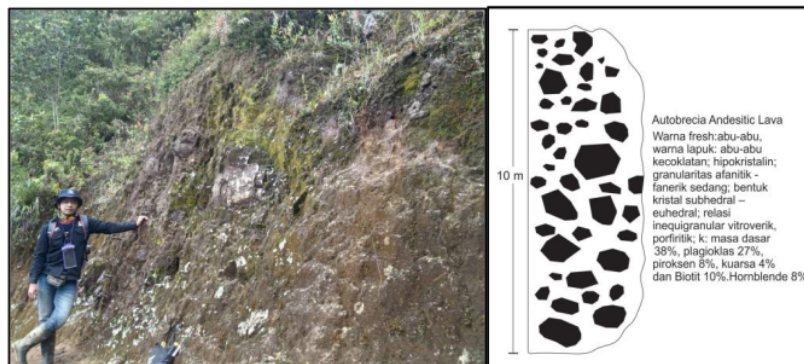




**FIGURE 10.** Lumping Waterfall located on Patak Banteng Village with a thickness  $\pm 10$  (Left) and Andesite Lava Profile with Autobrecia Structure (Right).

### *Prau Lava*

Mount Prau is a former Dieng ancient caldera (according to x, year x). This location offers beautiful views of the Dieng plains and surrounding mountains (Sindoro, Bhishma, etc.), as well as being a favorite place to enjoy the sunrise. At this location also found exposed lava as thick as 10 m (**FIGURE 11**). This lava is found at an elevation of 2320 masl, and can be accessed by trekking on foot through the Dieng Wetan route for 1.5 hours. autobrecia structure, porphyritic texture and degree of hypocrySTALLINE crystallization. The composition of this lava consists of 38% ground mass, 27% plagioclase, 8% pyroxene, 10% biotite, and 4% quartz.

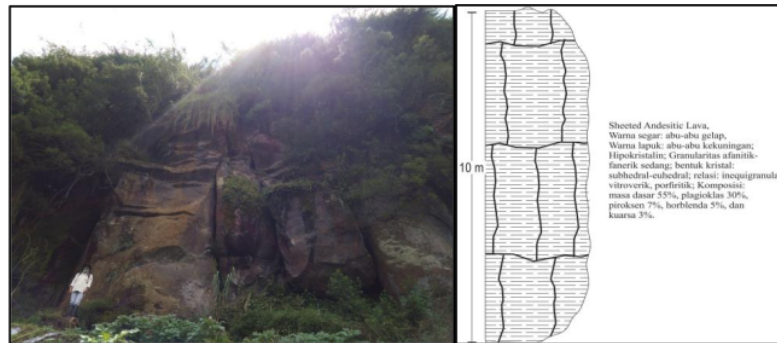


**FIGURE 11.** Prau Andesite Lava with Autobrecia Structure outcrop with a thickness  $\pm 10$  (Left) and its profile (Right)

### *Merdada Lava*

Merdada Crater is located in Karangtengah Village, Batur District, Banjarnegara Regency. This crater is an integral part of Mount Pangonan-Merdada. This crater does not show any geothermal activity, but there are traces of volcanic activity in the form of lava rock exposed on the crater wall. So, Merdada Crater is very interesting to learn about volcanoes. Most of the crater of Merdada is used as agricultural land.

Merdada lava was exposed as high as 10 m in Karangtengah Village, on the slopes of Mount Pangonan-Merdada (**FIGURE 12**). This lava shows a sheeting joint structure with a porphyritic texture and a degree of hypocrySTALLINE crystallization. The composition of this lava consists of 55% base mass, 30% plagioclase, 7% pyroxene, 5% hornblende, and 3% quartz.



**FIGURE 12.** Merdada Andesite Lava outcrop with a thickness  $\pm 10$  meters (Left) and Andesite Lava's Profile with Sheeting Joint Structure (Right)

### *Sedringo Lake*

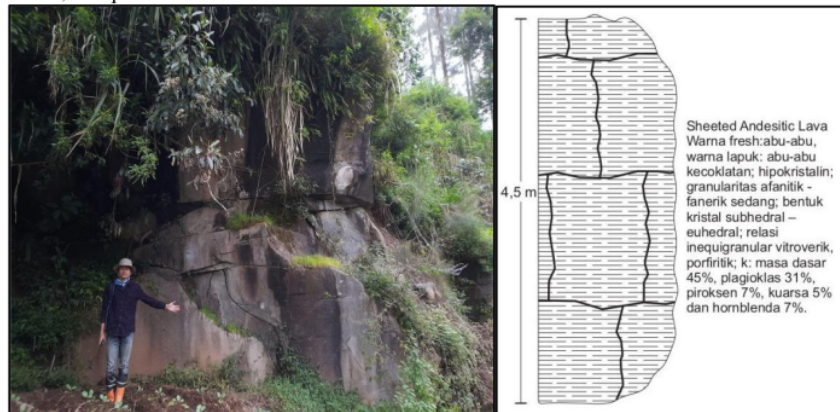
Sedringo lake is located in Pekasiran Village, Batur, Banjarnegara, which borders Gerlang District, Batang. This lake is a lake resulting from volcanic activity that was formed within the caldera structure. Sedringo lake is a tourist destination because of its beautiful landscape to enjoy the sunset and sunrise. Water from this lake is also used by the community for agriculture. Besides these things, this lake is interesting for volcano studies because at the lips of the lake, agglomerates and pyroclastic falls are exposed with a thickness of  $\pm 1.5$  m. The exposed agglomerates have a massive structure with fragments of andesite, oxidized andesite, and also pumice embedded in the tuff matrix, and are poorly sorted (**FIGURE 13**).



**FIGURE 13.** Agglomerate outcrop with a thickness  $\pm 1.5$  meters on Sedringo Lake (Left) and its profile (Right).

### *Batur Lava*

Batur Lava exposed 4.5m high in Batur Village, on the slopes of Mount Butak-Petarangan. This lava shows a sheeting joint structure with a porphyritic texture and the degree of crystallization is hypocrySTALLINE (**FIGURE 14**). The composition of this lava consists of 45% glass groundmass, 31% plagioclase, 7% pyroxene, 5% quartz and 7% hornblende.



**FIGURE 14.** Andesite Lava outcrop with Sheeting Joint structure on Batur Village (Left) and its profile (Right)

## Nature Tourism

### *Cebong Lake*

Cebong Lake is located in Sembungan Village, which is the tallest village in Central Java. Tourists who come to this place usually have visited the peak of Sikunir which is located not far apart. Through this location we can enjoy the natural beauty of the lake which is surrounded by agricultural land owned by residents which adds to the beauty of this Cebong Lake (**FIGURE 15**). With its location above 2300 m above sea level, Lake Cebong is known as the lake above the clouds.



**FIGURE 15.** Cebong Lake's view on Sembungan Village.

### *Tieng's Viewing Post*

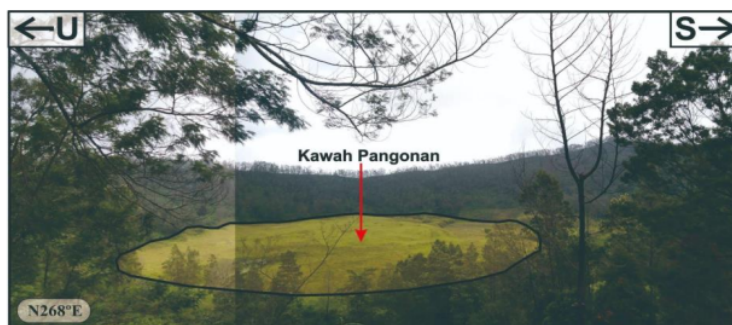
Tourist attractions Tieng's viewing post is a building located on the edge of the highway in the Dieng area. This building is used as a place to enjoy the breathtaking scenery of the Dieng area. The view from this spot is very interesting, especially in the morning, namely at sunrise or sunrise (**FIGURE 16**). This viewing post in Dieng has a height of about 1700 meters above sea level. From this location, you can see views of Mount Sindoro and Mount Kembang, as well as calming views of the countryside.



**FIGURE 16.** View of Mount Tlerop (Left-side mountain) and Mount Sindoro (Right-side mountain) from Tieng's Viewing Post.

### *Pangonan Savanna*

Mount Pangonan is located in Bakal village, Batur sub-district, Banjarnegara district. This mountain is a unit with Merdada which is often called Mount Pangonan-Merdada, Mount Pangonan has 2 craters, a crater in the form of a lake, namely Telaga Merdada, and a crater overgrown with grass which is often called the Savanna or Sumurup Valley. The term "Sumurup" comes from English, namely "Summer Up" which means that when the summer season is an extreme phenomenon in the savanna, which was originally green grass, it turns dry and brightly lit (**FIGURE 17**).



**FIGURE 17.** Pangonan Crater's landscape. Photo taken with camera facing east.

### **Geothermal Energy Tourism**

#### *Warna Lake*

Telaga Warna is located in Dieng Wetan Village, Kejajar District. This lake is known for its beautiful scenery and unique color changing water (**FIGURE 18**). In addition, the color lake of Dieng is also a manifestation of geothermal in Dieng. In this lake, bubbles were found indicating that this lake is geothermally active. The water of this lake has a temperature of 28°C and a pH of 4. On the side of the lake, massive alteration rocks with a thickness of  $\pm 5\text{m}$  are found which are also rich in sulfur. The location is named the Sikendang Crater.





**FIGURE 18.** Warna's lake. Photo taken with camera facing north.

### *Sikidang Crater*

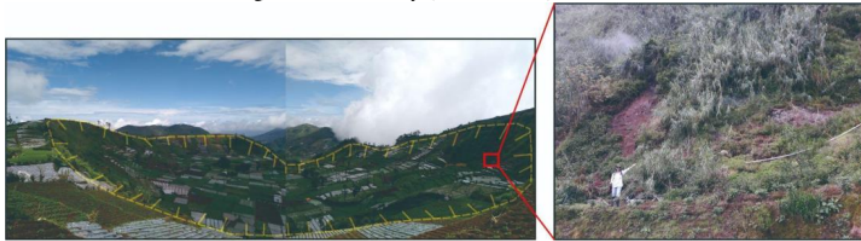
Sikidang Crater is located in Bakal Bunu village, Dieng Kulon district. Sikidang Crater is a volcanic crater that is still actively releasing gas, water vapor and volcanic material. This crater has its own uniqueness, one of which is the location of the crater which moves around. At the front of this location there is a large hole former crater. This crater seems to still emit a thin layer of smoke. The large holes seen in the front are the former main craters in the past. Meanwhile, the main crater, which is still active today, is about 1 (one) kilometer from the entrance. The rocks around the crater have generally been strongly altered, the water around the crater has a temperature of 94 Celsius and a pH of 4 (**FIGURE 19**).



**FIGURE 19.** Altered Rocks in Sikidang Crater shows that the location is an active geothermal area.

### *Pagerkandang Fumarola*

Pagerkandang Crater is located in the village of Kepakisan, Batur sub-district. This crater merges with Mount Sipandu which is in the northeast of Mount Pagerkandang. Almost all the sides of the crater pagerkandang have been used as agricultural land. In the northeastern part of this crater, several fumaroles were found which indicated geothermal activity (**FIGURE 20**).



**FIGURE 20.** Pagerkandang Crater with its Fumarole (Left figure show the crater's landscape and Right Figure shows the Fumarola)

#### *Sileri Crater*

Sileri crater is an active crater located in the village of Kepakisan, Batur district. In the area around the crater exposed massive alteration rock with a thickness of 3 m which is dominated by clay minerals (**FIGURE 21**). On April 29, 2021 ago this crater issued a phreatic eruption. At this location there are hot springs that have a temperature of 58 Celsius and a pH of 6.



**FIGURE 21.** Sileri Crater on Kepakisan Village. Photo taken with camera facing north.

#### *Sipandu Hot spring*

Sipandu hot spring is a hot spring located in Kepakisan village, Batur district. On the slopes of Mount Sipandu there is warm soil, precisely above the hot springs. These hot springs are generally used by residents for their daily bathing and cooking needs. The Sipandu hot spring has a temperature of 60 C and a pH of 6 (**FIGURE 22**).



**FIGURE 22.** Photo showing of Sipandu Hot Spring. It shows that this location is an active geothermal area.

### *Bitingan Hot spring*

Bitingan is a hot spring located in Bitingan Hamlet, Kepakisan Village, Batur District, Banjarnegara Regency. Most of the people in Bitingan hamlet use this hot spring for tourism in the form of hot springs. In this location also found hot springs that have sprung up along the river, this hot spring has a temperature of 45 C and a pH of 7 (**FIGURE 23**).



**FIGURE 23.** Photo showing of Bitingan Hot Spring.

### *Sibanger Crater*

Sibanger is a former active crater in Batang Regency. At this location, massive alteration rock with a thickness of 8 m is exposed, which is dominated by clay minerals (**FIGURE 24**). In this location also found springs that appear with a strong smell of sulfur, with a temperature of 18 C with a pH of 3. By previous researchers, the Sibanger crater was stated as a trace of past geothermal in the Dieng area.



**FIGURE 24.** Photo showing Sibanger Crater. It shows a massive body of alteration rocks.

### *Candradimuka Crater*

Candradimuka Crater is located in Pekasiran Village, Batur, Banjarnegara. This crater is famous for folklore which says that this is where Gatot Kaca was born. In this area there are 3 hot springs (Candradimuka Crater, Kemanten Spring, Wedukuro Spring) (**FIGURE 25**) and 1 cold spring (Sendang Adem Semar) which are located close together. The highest water temperature in this area is 70 C with a water pH of 6. Rocks The area around the crater has generally changed and also clay rocks resulting from hydrothermal activity. The existence of this active crater indicates that this area has geothermal potential.



**FIGURE 25.** Photo showing Candradimuka Crater.

### CONCLUSION

The DVC area has potential as a place for learning about volcanoes, geothermal energy, and natural geotourism. DVC's volcanic products are sheeting joint lava and autobreccia lava found on the lips and peaks of the mountain. In addition, DVC has a geothermal energy potential estimated at 400 MW. Geothermal manifestations are found in the form of hot springs and fumaroles. DVC also has tourist sites with interesting views, including the Tieng Viewpoint, Padang Sabana Pangonan, and Telaga Cebong. It is hoped that the development of proposed tourist sites can be optimized to support the welfare of the surrounding community.

### ACKNOWLEDGMENT

The authors would like to thank the Institute for Research and Community Service at Universitas Pembangunan Nasional Veteran Yogyakarta, Indonesia, for providing funds for this research.

### REFERENCES

- [1] A. Harijoko, R. Uruma, H. E. Wibowo, L. D. Setijadji, A. Imai, and K. Watanabe, "Long-Term Volcanic Evolution Surrounding Dieng Geothermal Area, Indonesia," *Proc. World Geotherm. Congr. 2010 Bali, Indones. 25-29 April 2010*, no. 2, pp. 25–29, 2010.
- [2] A. Harijoko *et al.*, "Geochronology and magmatic evolution of the Dieng Volcanic Complex, Central Java, Indonesia and their relationships to geothermal resources," *J. Volcanol. Geotherm. Res.*, vol. 310, pp. 209–224, 2016, doi: 10.1016/j.jvolgeores.2015.12.010.
- [3] M. G. J. Shalihin, P. Utami, and M. I. Nurpratama, "The Subsurface Geology and Hydrothermal Alteration of the Dieng Geothermal Field, Central Java: A Progress Report," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 417, no. 1, 2020, doi: 10.1088/1755-1315/417/1/012010.
- [4] O. Prambada, A. Zaenuddin, Iryanto, I. Santosa, N. Nakada, and M. Yoshimoto, "Peta Geologi G." 2011, [Online]. Available: <https://vsi.esdm.go.id/gallery/picture.php?/70/category/8>.
- [5] B. Setiawan, "PaperSeminarPangkatBudhiSetiawanPSTG," 2019.
- [6] Pusat Survei Geologi, *Petunjuk Teknis Asesmen Sumberdaya Warisan Geologi Petunjuk Teknis Asesmen Sumberdaya Warisan Geologi*. 2017.
- [7] D. F. Yudiantoro, P. Pratiknyo, and D. S. Sayudi, "Development of Ngebel Volcano as Geoheritage and Tourism Education of Volcano, Electric Energy and Geothermal, Ponorogo, East Java," 2020,

[Online]. Available:

[http://proceeding.researchsynergypress.com/index.php/ess/article/view/90/38%0Ahttps://www.academia.edu/45150020/Development\\_of\\_Ngebel\\_Volcano\\_as\\_Geoheritage\\_and\\_Tourism\\_Education\\_of\\_Volcano\\_Electric\\_Energy\\_and](http://proceeding.researchsynergypress.com/index.php/ess/article/view/90/38%0Ahttps://www.academia.edu/45150020/Development_of_Ngebel_Volcano_as_Geoheritage_and_Tourism_Education_of_Volcano_Electric_Energy_and).

# Development of Dieng Volcano Complex as Geoheritage and Tourism Education of Volcano, and Geothermal Energy, Banjarnegara, Central Java

## ORIGINALITY REPORT

0%

SIMILARITY INDEX

0%

INTERNET SOURCES

0%

PUBLICATIONS

0%

STUDENT PAPERS

## PRIMARY SOURCES

Exclude quotes Off

Exclude bibliography Off

Exclude matches < 30%