P-ISSN: 2541-6960; E-ISSN: 2549-8754
Yupa: Historical Studies Journal
Vol. 8 No. 2, 2024 (250-262)
http://jurnal.fkip.unmul.ac.id/index.php/yupa

The Use of Andesite Rocks in the Hindu-Buddhist Kingdoms in Indonesia

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Submitted	Revised	Accepted
02/11/2022	27/01/2024	01/02/2024

Abstract *This research aims to explain the reasons for choosing andesite igneous rock as building material from Hindu-Buddhist kingdoms. The research method in this article uses four stages of historical research, namely; heuristic techniques, source criticism techniques, interpretation techniques, and historiography techniques. Data sources were collected through primary and secondary data. The four stages of this historical research method together with secondary primary data are then analyzed using a combination of historical geography to obtain an in-depth study. The results of the research illustrate that the use of andesite igneous rock was used for temple buildings, statues, relief sculptures, and writing from Pallawa to Ancient Java. The choice of andesite igneous rock during the Hindu-Buddhist kingdom was based on the quality of the rock. The quality of this andesite rock has high artistic value, gray in color, hard, chemical composition and specific texture that can be carved. The chemical composition is 57% -63% silica content with 6% alkali metal oxide content. The silica content of andesite igneous rock makes this rock material resistant to weathering.*

Keywords: *andesite rock, history, Hindu-Buddhist kingdom, Indonesia*

Abstrak *Penelitian ini bertujuan untuk menjelaskan alasan pemilihan batuan beku andesit sebagai bahan bangunan kerajaan Hindu-Buddha. Metode penelitian dalam artikel ini menggunakan empat tahapan penelitian sejarah, yaitu; teknik heuristik, teknik kritik sumber, teknik interpretasi, dan teknik historiografi. Sumber data dikumpulkan melalui data primer dan sekunder. Keempat tahapan metode penelitian sejarah ini bersama-sama dengan data primer sekunder kemudian dianalisis menggunakan kombinasi geografi sejarah untuk memperoleh kajian yang mendalam. Hasil penelitian menggambarkan bahwa pemanfaatan batuan beku andesit digunakan untuk bangunan candi, arca, pahatan relief, dan tulisan mulai dari Pallawa hingga Jawa Kuno. Pemilihan batuan beku andesit pada masa kerajaan Hindu-Buddha didasarkan pada kualitas batuan tersebut. Kualitas batuan andesit ini memiliki nilai seni yang tinggi, warnanya abu-abu, keras, susunan kimianya dan tekstur tertentu yang dapat diukir. Komposisi kimianya adalah kandungan silika 57% -63% dengan kandungan oksida logam alkali 6%. Kandungan silika pada batuan beku andesit menjadikan material batuan ini tahan terhadap pelapukan.*

Kata kunci*: batu andesit, sejarah, kerajaan Hindu-Budha, Indonesia*

INTRODUCTION

History is marked by the existence of human cultural heritage in the form of writing (aksara). The existence of this writing embodies a literacy message conveyed by historical actors to subsequent generations. Through written remains (aksara) in the form of inscriptions, the current generation obtains information related to historical events that have occurred thousands of years ago. This information with historical value is used as a treasure of knowledge in modern life regarding the conditions of society at that time.

Apart from writing, this form of historical information also takes the form of sculpture in the form of temple architecture and reliefs. The information presented through this sculpture is the beauty of the sculpture, its subtlety, ideas and the story it wants to convey. In general, the information depicted through this sculpture is the condition of society in the past, including the royal family, the epic story Ramayana or Mahabaratta, socio-economic conditions of society, heaven and hell, and images of gods and goddesses.

These historical relics can still be seen today due to the durability of the materials used. In the past, people used materials for temples, inscriptions and reliefs that were relatively resistant to tropical environmental conditions that were susceptible to weathering. This material is hard igneous rock which is the product of volcanic events. The use of this igneous rock material if we go back further in time is a continuation of the megalithic tradition in prehistory.

This scientific article that explores the use of igneous rock in the history of the Hindu-Buddhist Kingdom will be directed at uncovering the reasons for choosing certain types of igneous rock to be used as a medium for sculpture and writing. Researchers feel it is necessary to raise this theme because it is felt that historical study articles still do not discuss themes related to historical geography. Therefore, this article will describe several selected historical relics from the Hindu-Buddhist Kingdom in Indonesia (Nusantara) which used igneous rock materials.

METHOD

This article uses historical research methods that are standard in historical science. The historical research method used is four stages, namely; heuristic techniques, source criticism techniques, interpretation techniques, and historiography techniques. The researchers then combined these four stages with historical geographic analysis to obtain an in-depth study.

The data sources for this research consist of primary and secondary sources. This primary data source was taken from visual observations of andesite rock samples from the Geography laboratory. This andesite rock sample was obtained from the eruption product

of Mount Kelud in 2014. The sampling on the slopes of Mount Kelud was due to researchers considering that there are many Hindu-Buddhist sites around the slopes of Mount Kelud such as Penataran Temple, Kalicilik Temple, Petirtaan Geneng and Gambar Wetan Temple. Secondary data sources were obtained from literature studies of several previous research results. These secondary sources are then sorted for relevant information to support research studies. The relevance of this secondary source is the characteristics of andesite rock and its use during the Hindu-Buddhist Kingdom era.

First, the heuristic technique, namely the step of collecting historical sources. The researcher then collected various sources from historical books, library sources, references and previous scientific journals. This collection aims to look for data and facts in the form of relics from the Hindu Buddhist Kingdom that used igneous rock materials.

Second, source criticism techniques, namely verifying or checking historical sources. The source is verified for the authenticity/legitimacy of the literature and also the degree of credibility of the information. The validity of this literature is determined by the information presented according to aspects of space (location) and time (chronology).

Third, interpretation techniques, namely interpreting or giving meaning to historical facts and sources. In this step, historical events are analyzed as to how they were processed and how to understand the process by which these historical events occurred. This interpretation is expected to describe existing facts from past historical events. This event is related to the interpretation of the location of historical heritage in terms of the spatial aspect of geography.

Fourth, historiography techniques, namely writing history that contains three main elements, namely introduction, research results and conclusions with a discussion that is easy for the general public to understand. This article is written using an analytical description method that discusses the use of igneous rocks in the history of the Hindu Buddhist Kingdom in the archipelago.

RESULT AND DISCUSSION

Relics in the Form of Characters on Igneous Rock

The use of igneous rocks is believed to have existed since prehistoric times in the archipelago. The existence of these igneous rocks in prehistoric times has been known since the Paleolithic-Neolithic-Megalithic era. In particular, during the megalithic period, the use of igneous rocks was widely used. The results of this prehistoric civilization were stone tombs, stepped punden, sarcophagi, dolmen and menhirs. These megalithic remains are entirely in the form of large igneous rocks influenced by Austonesian and Melanesian culture (Djami, 2017:14).

The influx of Hindu-Buddhist influence at the beginning of AD gave a new historical color to the archipelago. This influence reaches various aspects of life, including social, economic, and religious. down to the political system of government. This is confirmed by Nastiti (2014:37) that the influence of Hinduism and Buddhism from India has had a significant impact on the development of social conditions and religious systems of the people of the archipelago (Indonesia).

The manifestation of the influence of foreign nations, especially India, can be seen in sculpture and writing. In the past, Indonesian people knew that writing was written on a piece of natural stone. This can also be seen from the architectural art of sculptures on temples, statues and other artifacts. The results of the next research describe several examples from time to time where this particular type of igneous rock was used to carve and write to record events and historical actors.

The Yupa Kutai Martapura inscription is the oldest inscription found in Muara Kaman, East Kalimantan. This inscription was carved on an andesite igneous rock pillar (Vogel, 1918:38). This inscription in Pallava script and Sanskrit tells the story of King Mulawarman's family and the situation of the Kutai Martapura kingdom in the fourth century AD (Sarip, 2020). The andesite-type igneous rock pillars in this Yupa have no real rock counterparts found in nature around the Muara Kaman discovery location. The location of the Yupa discovery is geologically an alluvial rock area. This alluvial rock was deposited by the main Mahakam river. The regional strata of this area includes alluvium (Qa) which consists of mud, clay, sand and locally gravel, deposited in river and swamp environments along the banks of the Mahakam River and its tributaries (Directorate of Land Water Damage Control, 2019). An overview of the location of Muara Kaman can be seen on geological map 1 below.

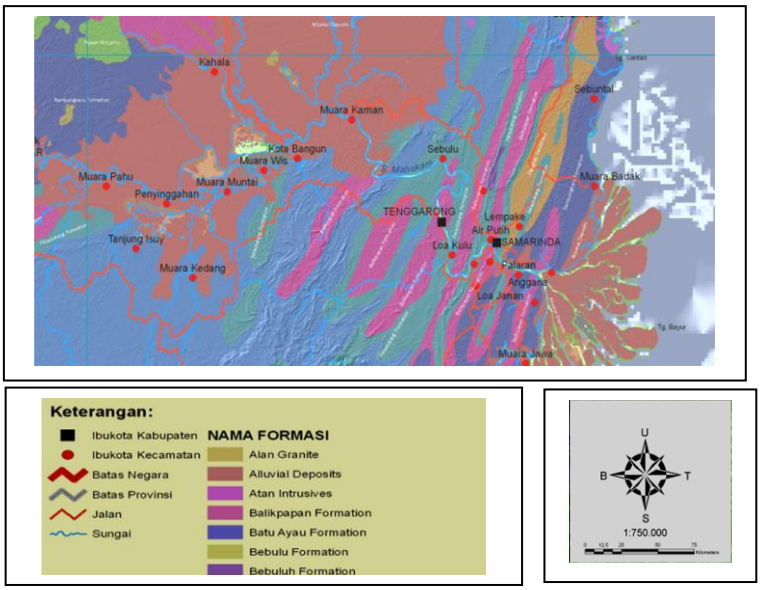

Figure 1. Section of a map of the geological condition of the Muara Kaman site, East Kalimantan, showing the alluvial plains of the Mahakam watershed (brown).
Map source: Aryanto, S.Hut, M.Si 2018

Other written inscriptions were found in the Java Island area. The inscription was written on andesite igneous rock. These inscriptions include the Tugu Inscription, Kebon Kopi I Inscription, Ciaruteun Inscription, Pasir Awi Inscription, Jambu Inscription, Cidanghiang Inscription. All of these inscriptions are a legacy of the Tarumanegara kingdom. All of these inscriptions are carved on natural andesite stone. Apart from the Pallawa script in Sanskrit, some of the inscriptions include images of human feet, elephant feet, leaves with earrings and fruit.

The uniqueness of the use of andesite igneous rock in the Tarumanegara Kingdom inscriptions is its natural formation in nature. One of the inscriptions found in nature is the Ciaruteun Inscription in 1893. This inscription was found in a tributary of the Cisadane River in Bogor, namely Ciaruteun. The discovery site of this inscription is seen from the river aspect as being in the upstream part of the river. The categorization of this location is seen from the physical condition of the river which has many rocky rapids and high erosion power. The condition of the rocky rapids and the condition of the slopes which are prone to erosion is reinforced by Widiyanto (2018:66) that land management in the upper reaches of the Cimanuk watershed is important because it will affect the rate of erosion and the quality of river water. An overview of the location of the discovery of the Ciaruteun inscription can be seen in Figure 2, where the Ciaruteun River, which is part of the upstream river from Cisadane, is occupied by many natural rocky rapids.

Figure 2. Photo from 1893 The Ciaruteun inscription was turned upside down due to the flooding of the Ciaruteun river
Source: http://cagarbudaya.kemdikbud.go.id/

Inscriptions in the form of other writings (scripts) were also written on andesite igneous rocks in the younger AD. The Hantang (Ngantang) inscription left by the Kediri Kingdom is one of these inscriptions. This inscription was found in Ngantang village, Ngantang District, Malang, East Java, dated 1135 AD. Rambe et al (2019:72) explain that this inscription is in Old Javanese letters and contains writing that reads Panjalu Jayati, which means Panjalu wins. This inscription was issued as a certificate confirming the gift from Jayabaya to the residents of Hantang Village who were loyal to Kediri during the war against Jenggala.

This inscription is carved on a stone board made of andesite rock. This andesite rock is known as a product of volcanic events. Ngantang District, Malang Regency is a highland area in the Solo zone on Java Island. The Solo Zone is occupied by an active Quaternary volcano. The volcano consists of the Arjuno-Welirang, Kawi-Butak-Panderman, Ajasmoro, Kelud complexes. Bemmelen (1949) described Kelud, Kawi and Butak as a group of mountain structures that are younger in the Holocene range. This volcanic structure covers older volcanic structures (upper Pleistocene) and buries part of the escarpment of the Southern Mountain Zone of Java.

Andesite rock material as material for making Hantang (Ngantang) inscriptions is widely available around the Konto river. The flow of the Konto river carries avalanches of volcanic material from several volcanoes around Ngantang. Some of these volcanoes include Anjasmara, Butak-Kawi, and Kelud. These three volcanoes which are the headwaters of the Konto river are the Anjasmoro volcano. Apart from the Anjasmoro volcano, andesite rock material is enriched from the eruption products of Mount Kelud in the past. Mount Kelud has erupted 30 times since the 11th century AD. The last eruption of

Mount Kelud in modern times occurred in 2014. The appearance of the eruption products can be observed in figure 3 below. Utama (2016:87) and Sidiq (2018:96) confirmed in their research that the Sudamanik Cigudeg Bogor Volcano and the Arjuno-Welirang Complex (Arjuno-Welirang-Butak-Kawi-Kelud-Anjasmoro) produce various natural resources in the form of rocks in the form of andesite lava- basaltic andesite, pyroclastic flows.

Figure 3. The form of andesite rock produced by the 2014 Mount Kelud eruption
Source: Authors' Personal Documentation

Heritage in the Form of Architecture and Sculpture

The use of this type of andesite igneous rock also appears in the fields of architecture and sculpture. Several temples, statues and other artifacts were built from igneous rocks obtained from nature. The next explanation will discuss several historical relics related to building materials, namely andesite igneous rock. This type of andesite rock was chosen as building material during the Hindu-Buddhist kingdom

Prambanan and Borobudur temples are Hindu and Buddhist temples built during the Ancient Mataram period. Both temples are located in Central Java Province. Prambanan and Borobudur temples were built from thousands of andesite igneous rocks. This andesite igneous rock in Borobudur has various colors which are related to the level of susceptibility to weathering. Haldoko (2014:39) describes that from field observations, the andesite that makes up Borobudur Temple can be grouped into 5 types of colors, namely: gray, brownish gray, blackish gray, reddish and black. Alam (2020:36) describes the use of andesite rock at Prambanan Temple. Andesite stone has high artistic value because it has a specific composition and texture that can be carved. These rocks are usually found in tectonic subduction environments in areas with high volcanic activity.

The existence of igneous rocks around the Borobudur and Prambanan temple building areas cannot be separated from the location setting. If studied from a geographical aspect, the location where these two temples were founded is in the volcanic land area of the Solo Zone. The Solo Zone in Central Java is occupied by young quaternary volcanoes,

namely the Merapi, Merbabu, Sumbing, Sindoro, Slamet and Dieng Plateau volcanoes. The eruption products from several volcanoes provided volcanic material which became the building material for the Borobudur-Prambanan Temple. Bemmelen (1949) and Bronto (2014: 176) describe the flow of material and volcanic ash from Merapi, including deposits of large blocks of andesite in the Sedayu area which form the Sentolo Formation. This deposit of andesite type rock material was then carved out for the foundation and stone bricks of the temple. The location of this andesite rock material can be observed on the site.

Other building architecture that uses igneous rock materials is found in the East Java area. Lutfin (2020:108) describes that the form of this building is a temple made from andesite igneous rock which comes from the legacy of the Kanjuruhan Kingdom. This kingdom is thought to be centered in the western part of Malang City on the slopes of Mount Kawi-Butak, to be precise, administratively located in the Karang Besuki sub-district, Sukun District, Malang City, East Java. Badut Temple is the oldest temple in East Java which was built in 682 Saka or 760 AD in the middle of the 8th century by the second King, namely King Gajayana Setiawan (2019:38), Yusran et al (2022:38).

The location of Badut Temple is on a volcanic plateau at an altitude of 507.96 meters above sea level. This volcanic plain is part of the slopes of Mount Kawi to the east of Oktavianto (2013:197) and Setiawan (2019:38). Soviyani et al (1995:2) further describe that the surface type of soil is relatively yellowish in color while the layer below contains solid granules. Badut Temple and its surroundings are precisely located to the west of the Metro River, which is a dry area. The new spring was found at a depth of 17 meters, even at the temple site as deep as 24 meters. Kali (River) Metro, which is east of Badut Temple, contains many andesite river rocks. The Metro River is part of the Brantas watershed which originates in Junrejo, Batu City. These andesite rocks are the product of eruptions from volcanoes around Malang. The volcano spews volcanic material, one of which comes from Mount Kawi. Nuha (2012: 180) confirms that the Batu area and its surroundings are included in the mountains and volcanic hills in the form of the quaternary hills of Mount Kawi-Panderman, especially andesite and pyroclast lava rocks with several breakthroughs of young andesite domes that cut continuously to the east.

Characteristics of Andesite Igneous Rocks and Their Places

The products of volcanic eruptions vary from volcanic ash, lapilli, pyroclastic material, lava, lava flows and hot clouds. The lava flow from this volcano then forms igneous rocks with certain characteristics. These characteristics are determined based on the degree of freezing, the constituent mineral content and acid-base-intermediates of the magma, as well as the location of the freezing. Based on these characteristics, various types of igneous rocks will form, including andesite, diabase, rhyolite, basalt, diorite, obsidian,

pumice, gabbro, granite and pumice.

Various types of igneous rocks resulting from volcanic eruptions in the history of human civilization have been used for building materials, cooking utensils, jewelry, hunting tools, statues, relief sculptures and temples. Igneous rocks that color human civilization include andesite types of igneous rocks. This type of andesite igneous rock was widely used, especially as the main material for buildings during the Hindu-Buddhist kingdom.

This type of andesite igneous rock is specifically associated with civilization during the Hindu-Buddhist kingdom in Indonesia (Nusantara). The uses of this igneous rock include basic materials for temple buildings, relief carvings, and inscription writing. The previous discussion has raised several relics of Hindu-Buddhist kingdoms made from andesite rock. These relics are in the form of Yupa inscriptions from the Kutai Martapura kingdom, Ciareteun inscriptions from the Tarumanegara kingdom, Prambanan and Borobudur temples from the Ancient Mataram kingdom, and Badut temples from the Kanjuruhan kingdom.

Andesite rock was chosen as the main material for temple buildings, sculpture and writing due to the quality of the rock. Andesite is a type of extrusive volcanic rock with a medium composition, with an aphanitic to porphyritic texture. Sidiq (2018:98), Lutfin (2020:108). Andesite stone is characterized by a chemical composition of 57%-63% silica (SiO2) content with 6% alkali metal oxide content. This silica mineral is known in another form, namely quartz as in Figure 4, both of which are not easily weathered. The main mineral content of andesite consists of plagioclase feldspar, pyroxene and hornblende in small amounts. This places andesite in the O2 field of the TAS classification. Basaltic andesite, with a silica content of 52% to 57%, is represented by field O1 of the TAS classification but is not a distinct rock type in the QAPF classification. This QAPF diagram can be seen in Figure 5 below.

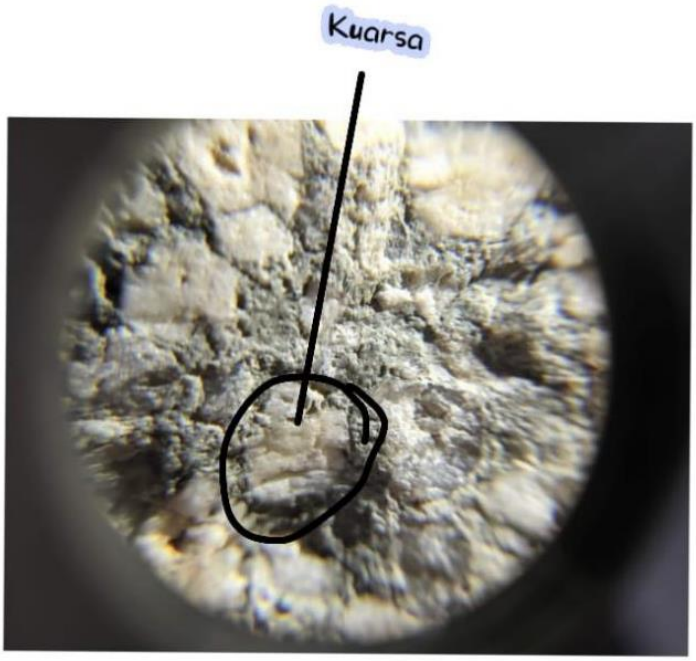

Figure 4. The appearance of weathering-resistant mineral quartz in igneous rocks
Source: Authors' Personal Documentation

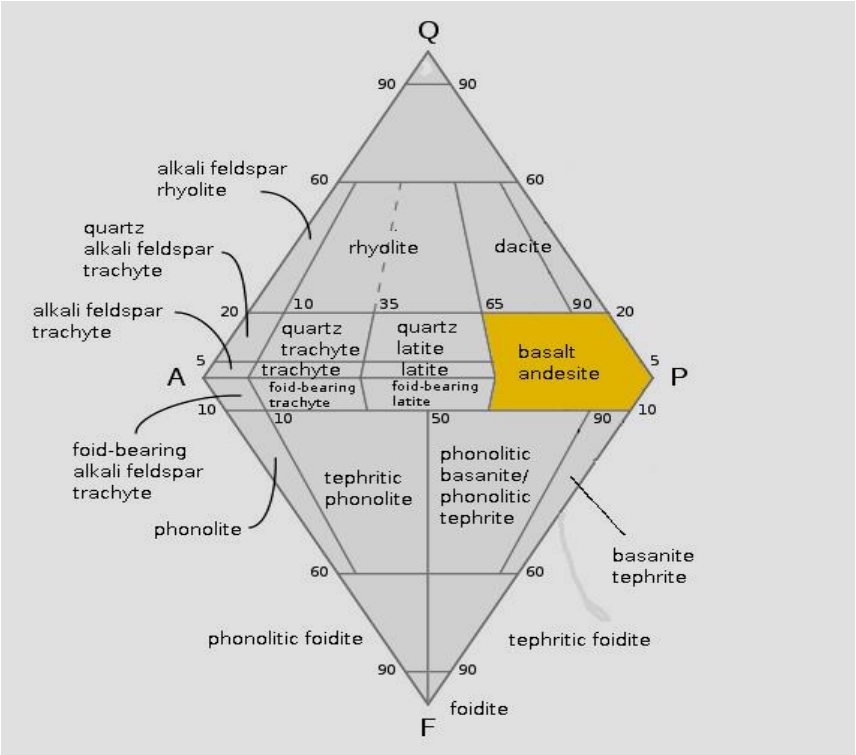

Figure 5. QAPF diagram showing the position of andesite rock and andesite basalt
Source : https://upload.wikimedia.org/wikipedia/commons/e/ec/Basalt_qapf.jpg

The mineral content in this type of andesite igneous rock makes it resistant to weathering. The main mineral, namely silica content in the range of 57%-63%, strengthens andesite rock from the weathering process caused by tropical weather in Indonesia.

Trianasari et al (2017: 180) added that silica has non-conducting properties, has good resistance to oxidation and thermal degression. The silica mineral content in andesite rock in the Bowen reaction diagram shows the type of material that is resistant to weathering. Aini et al (2016: 86) confirmed that the Bowen reaction is also closely related to the weathering stability of the minerals contained in rocks. Kurniawan (2020:47) further describes that andesite rock is also an intrusion of lafili tufa rock - tufa, light gray in color, hard, aphanitic porphylitic, consisting of feldspar and amphibole, massive, medium fine grain size, the base mass consists of silica very smooth. Tamanak et al (2020:600) emphasize that the use of andesite rock on the slopes of Merapi has a very high iron ore content and is very good for use as construction material.

This andesite rock is generally found along rivers or in river basins. The locations of the historical sites from the Hindu-Buddhist Kingdom era discussed in this article are found around the banks of rivers and inside the river itself. This river flows with water from volcanic ridges which surround historical sites in the form of temples with reliefs or stones with inscriptions. Like the Badut Temple which is located on the banks of the Metro river which is part of the Brantas watershed. Hardaningrum (2016:171) confirms that Malang City was mostly built by Holocene-aged volcanic tuff deposits which are composed of fine coarse tuff, pumice rock and andesite rock fragments, while the Southeast and North-Western parts of Malang City are Holocene-aged Middle Quaternary volcanic deposits originating from from Buring Volcano and Kawi-Butak Volcano.

Other andesite rock materials such as at the Borobudur and Prambanan temple sites along with other sites in Central Java were identified as originating from deposits of volcanic material. This volcanic material comes from eruptions in the past and then descends the slopes into basins in the form of rivers. In principle, this river springs from the body of the volcano. These temples made from andesite rock in Central Java and DI Yogyakarta come from the eruption of Mount Merapi. Hartanto et al (2015:200) added that the products of the eruption of Mount Merapi which occurred in 2010, resulted in cold lava flows carrying volumes of material which were scattered in the rivers that originate at Mount Merapi. The cold lava flow leads to the South and Southwest. The lava flow to the South settles in the Gendol River, while the one to the Southwest settles in the Pabelan River, Blongkeng River, White River and Krasak River. The lava flow flows downstream and enters the Progo River basin.

CONCLUSIONS

Andesite rocks are often found in river flows near heritage sites from the Hindu-Buddhist kingdom. The river flows upstream in volcanic ridges spread across the Solo zone, East Java

and Central Java. These igneous rocks have accompanied human life since prehistoric times. Entering the historical era of the Hindu-Buddhist Kingdom was marked by the existence of inscriptions and building art visualized on a piece of rock. The choice of this type of andesite rock is due to the quality of the rock which has high artistic value, gray color, hardness, chemical composition and a specific texture that can be carved. The chemical composition is 57% -63% silica content with 6% alkali metal oxide content. This places andesite in the O2 field of the TAS classification. Basaltic andesite, with a silica content of 52% to 57%, is represented by field O1 of the TAS classification but is not a distinct rock type in the QAPF classification. The strength of andesite rock is also proven by the Bowen reaction which shows the silica mineral content is resistant to weathering.

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