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IT'S TIME TO LOOK TO THE WEST: A NEW INTERPRETATION ON *HOMO ERECTUS* FINDINGS DISTRIBUTION OF JAVA

SAATNYA MENENGOK KE BARAT: SEBUAH INTERPRETASI BARU TENTANG DISTRIBUSI TEMUAN *HOMO ERECTUS* DI JAWA

Harry Widianto[1] and Sofwan Noerwidi[1]
Regional Agency for Archaeological Research in D.I. Yogyakarta Province[1]
harry.widianto@kemdikbud.go.id

ABSTRAK

Data paleontologis menunjukkan bahwa awal penghunian Jawa terjadi pada batas Plio-Plestosen sekitar 2.4 juta tahun lalu, namun fosil *Homo erectus* tertua yang ditemukan di Sangiran, berasal dari lapisan 1.5 juta tahun lalu. Belakangan ini, ditemukan situs-situs Plestosen, dari bagian barat Pulau Jawa, yaitu Rancah, Semedo, dan Bumiayu. Tulisan ini bertujuan untuk menampilkan signifikansi data arkeologi, paleontologi dan terutama paleoantropologi dari situs-situs tersebut, serta implikasinya bagi penentuan strategi penelitian prasejarah kuarter di masa depan. Metode pengumpulan data meliputi studi pustaka, dan survei pada ketiga situs tersebut. Analisis data dilakukan pada data geologis, arkeologis, paleontologis dan paleoantropologis. Hasilnya, distribusi lateral *Homo erectus* semakin luas di bagian barat Jawa, dengan kronologi 1.8-1.7 juta tahun, lebih tua dibanding *Homo erectus* tertua dari Sangiran. Sebuah jendela baru tentang kedatangan *Homo erectus* di Pulau Jawa telah teridentifikasi. Implikasinya, sudah saatnya penelitian prasejarah kuarter intensif dilakukan di bagian barat pulau ini.

Kata Kunci: Persebaran; *Homo erectus*; Jawa; Awal Plestosen; Rancah; Semedo; Bumiayu

ABSTRACT

Palaeontological data indicate that the beginning of Java Island's occupation occurred at the Plio-Pleistocene boundary, around 2.4 Mya. However, the oldest *Homo erectus* fossil was found in Sangiran, around 1.5 Mya. Recently, Pleistocene sites were discovered from the western part of Java, e.g. Rancah, Semedo, and Bumiayu. This paper describes the significance of archaeological, palaeontological, and especially palaeoanthropological data from the new sites, and their implications to the future Quaternary prehistory research strategies determination. Data collection methods include literature study and surveys, while analysis is carried out on the geological, archaeological, palaeontological, and palaeoanthropological data. The result shows the dispersal of *Homo erectus* is extended to the western part of Java, between 1.8-1.7 Mya, older than the oldest *Homo erectus* of Sangiran. A new window of the human arrival on this island is identified. So, it is time to look to the west, and intensive research should be carried out to those areas.

Keywords: Dispersal; *Homo erectus*; Java; Early Pleistocene; Rancah; Semedo; Bumiayu

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INTRODUCTION

From south to north, the Java Island configuration consists of the Southern Mountains, the Solo Basin, the Bogor-North Serayu-North Kendeng hills series, and the alluvial plains of the north coast (see Figure 1, van Bemmelen, 1949). This physiographic is the result of a long process of the emergence of Java Island from sea level. The movement of the four tectonic plates, including the subduction of the Indian Ocean plate under the Eurasian plate, is one of the natural agencies that led to the lifting of the island of Java 2.4 million years ago. It is also significantly influenced by volcanic eruptions, mountains orogeny, or sea-level fluctuations due to glacial-interglacial processes. The process has occurred for at least more than 2 million years since the end of the Pliocene (Hall, Clements, and Smyth, 2009).

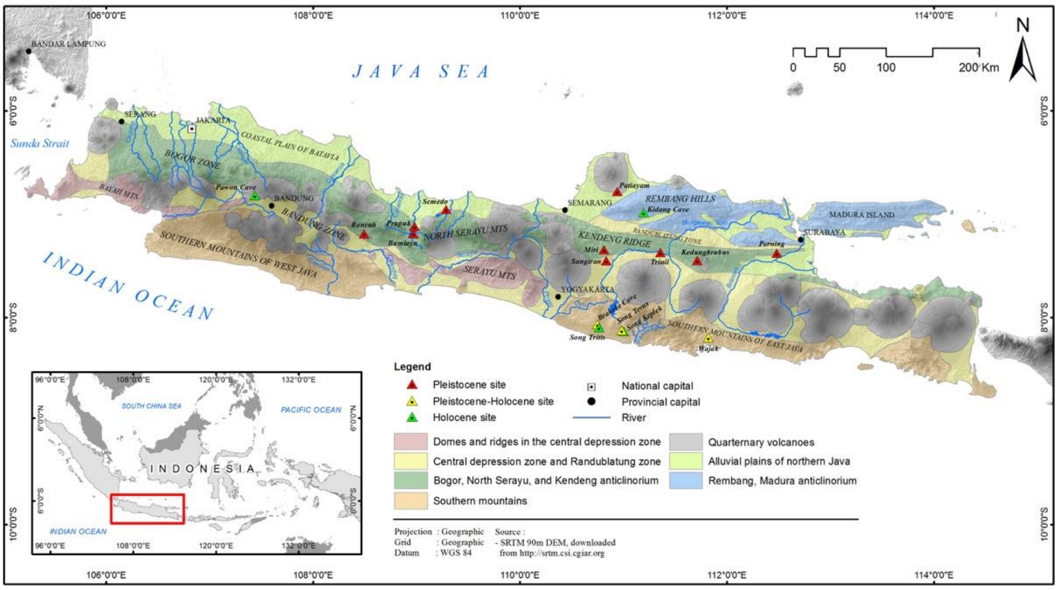

Figure 1. Physiographic Conditions and Distribution of Palaeoanthropological Sites in Java Island (Source: Van Bemmelen, 1949 with modifications)

Quaternary glaciation at high altitudes such as North America and Europe have caused variations in sea level around the world, including the Indonesian Archipelago. The glacial period is parallel to the marine's regression which can sometimes lower sea level by 100 meters. Shallow seas will disappeared and turn to land during the Ice Age, such as the Java Sea (40 meters) and the South China Sea (60 meters). The cycle has occurred several times along with eustatic oscillations allowing partial rises in the Sunda Shelf. The process has led to the widening of the land, connecting Java Island with Sumatra, Kalimantan, and mainland Southeast Asia (Hall, 2009). The land bridge has allowed the migration of mammals, including humans, from mainland Asia to Java and other islands. The separation of Java Island from Southeast Asia mainland occurred during the re-raising of sea levels during the Holocene transgression, about 11,000 years ago (Cohen, Finney, and Gibbard, 2013).

The migration is predicted to occur in the first glaciation around 2.4 million years ago. However, Sémah (1986) noted that the hypothesis that at that time the island of Java was only partially emerged, and only since about 1.65 million years ago totally lifted and gave the configuration as today (Faylona, 2019; Sémah, 1984). Therefore, the 2.4 million-year-age for such migration is the maximum theoretical age. The presence of mammals, and then humans on the island of central and eastern Java, is very certain to have happened afterward. The geographical situation presents various interpretations of the existence of the oldest insular fauna in the Bumiayu area at three main sites (Kali Glagah, Cibiuk, and Cisaat), which have been intensively built by the research of HG Stehlin (1925), FH van der Maarel (1932), and GHR von Koenigswald (1935), whose faunal succession was later renewed by John de Vos (1995).

Palaeontological data show that the occupation of Java Island is thought to have occurred in the late Pliocene, long before Sumatra, Kalimantan, Sulawesi, and other parts of eastern Indonesia were occupied by humans. The evidence in the direction is based on the discovery of the ancient elephant, *Archidiskodon,* which is based on biostratigraphy estimated from the Upper Pliocene, about 2 million years ago, at the sites of Bumiayu, Central Java (van Den Bergh, 1999). The first fossils have been found during the 1920s in the Kaliglagah Formation and show genus and species that can penetrate the sea barrier, characterized by the discovery of the ancient elephant *Mastodon sp* and *Tetralophodon bumiayuensis*, about 1.5 million years old. Other types are the water horse *Hexaprotodon simplex*, Cervidae, and the giant tortoise, *Geochelon*e (de Vos, 1995; Stehlin, 1925; van der Maarel, 1932; von Koenigswald, 1935). The fauna shows an isolated, insular environment. Absolute dating through paleomagnetism methods carried out recently in Kali Glagah, Kali Biuk, and Cisaat shows that the oldest mammals in the area are between 2.15 and 1.67 million years ago (Sémah, 1986).

Whereas in Bumiayu, the oldest fauna has been found since the 1920s, in other parts of Java, namely in eastern Central Java and in East Java. The discovery of hominid fossils with the context of *Homo erectus*, has been started since the second half of the 19th century, when Eugène Dubois discovered *Pithecanthropus erectus* at Trinil (Ngawi, East Java) in 1891 (Dubois, 1894). The discovery was preceded by the discovery of a mandibular fragment from Kedung Brubus (Madiun, East Java) in 1890, and was followed by the discovery of other hominid sites, namely in Ngandong (Blora, Central Java) in 1931-1933, Sangiran (Sragen and Karanganyar, Central Java) in 1934, Perning (Mojokerto, East Java), Sambungmacan (Sragen) in 1974, Patiayam (Kudus, Central Java) in 1979, and Selopuro (Ngawi) (Widianto, 2011).

The oldest *Homo erectus* fossils - archaic *Homo erectus*- have only been found in Sangiran, in the oldest palaeontological layer, namely the black clay of the Pucangan Formation lithology. There is a skull cap of a child from Mojokerto which is often thought to be part of the archaic *Homo erectus*, but its evolutionary position is doubtful because there are no parameters that can be used to determine its antiquity. Until now, the oldest *Homo erectus* with archaic morphological characters was found only in Sangiran. *Homo erectus* found outside Sangiran is typical *Homo erectus* (Trinil, Kedungbrubus, and Patiayam), which was also found in Sangiran in the Kabuh Formation (Bapang). Meanwhile, the youngest evolutionary phase -progressive *Homo erectus*- so far has only been found in Sambungmacan, Ngandong, and Ngawi (Widianto, 2001).

Geographical distribution data, evolutionary levels, and chronological period show the position of Sangiran as the location of the first arrival of *Homo erectus* on the island of Java about 1.5 million years ago, which then shows mobility to the east, to Mojokerto. The interpretation is in line with the discovery of the oldest vertebrate fossils, also found in Sangiran at the bottom of the Pucangan Formation breccia. It is also supported by the discovery of the oldest *Homo erectus* artifacts in ancient river deposits that flew in the middle of the swamp landscape in Sangiran, predicted to be in a period of about 1.2 million years ago (Widianto *et al*., 1999).

The scenario of *Homo erectus*' first arrival in Sangiran is in accordance with the migration theory model "*Out of Africa*". The model shows the stepping out of *Homo erectus* from Africa about 1.8 million years ago, wandering into cold, temperate, and hot regions, before they finally arrived on the island of Java about 1.5 million years ago. The extrapolation of the migration route to Java Island indicates that the Sangiran site was the first site where *Homo erectus* landed. They first came to Java about 1.5 million years ago, then immediately spreaded eastward to East Java. Thus, the interpretation of Sangiran as the first site in the context of the "*Out of Africa*" model is confirmed by palaeoanthropological, palaeontological, and archaeological data (see Figure 2).

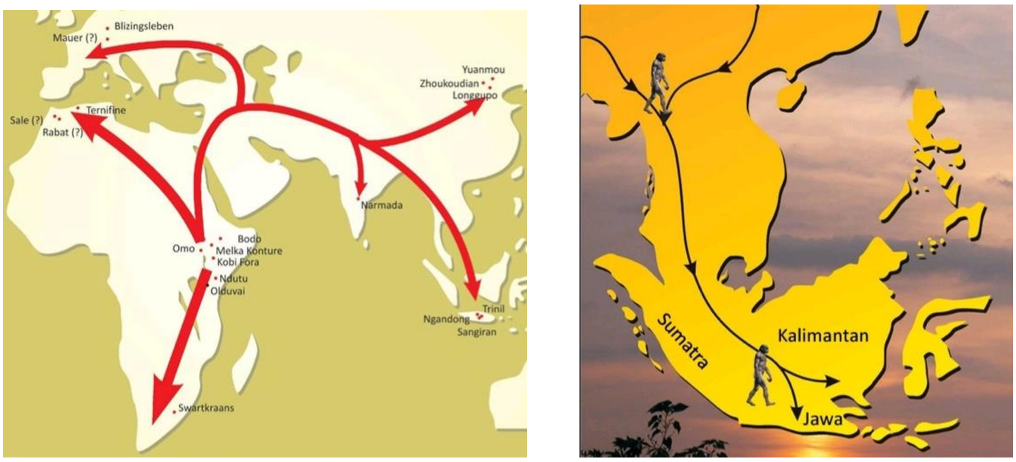

Figure 2. Sites Representing the "Out of Africa" Migration (left) and the Migration of *Homo erectus* to the Indonesian Archipelago During the Glacial Period (right)
(Source: Howell, 1965; Widianto and Simanjuntak, 2010)

Data compiled from Sangiran to the area to the east is conventional data, most of which do not add qualitative information for nearly the past two decades, except only adding quantity, representing the "*eastern region*" of Java Island. Recently, however, other new palaeontological and hominid sites have emerged during the last two decades as well, from areas further west, representing the "*western region*" of Java Island. The new sites are - the Rancah Site (Ciamis, West Java), the Semedo Site (Tegal, Central Java), and the Bumiayu Site (Brebes, Central Java). Various problems that arise are: what is the potential of these sites, and what are the implications for the prehistoric quaternary research strategy - especially in Java - in the future?

The paper presents the potential of archaeological, palaeontological, and especially palaeoanthropological data from Pleistocene sites in western Java, and their implications for determining the direction and strategy of quaternary prehistoric research on the island. From a geographic distribution perspective, the emergence of these three new hominid sites has very important implications for the arrival and distribution of *Homo erectus* on the island of Java, which so far has only been known to be in the "*eastern region*". The serious implications for the process and mechanism of migration in Java Island will be discussed in more detail after the description of the new sites of *Homo erectus* discovery in the "*western region*".

METHODS

The research scope includes sites in the western part of Central Java and West Java that have potential rock outcrops from the Quaternary period, such as the Serayu Mountains and the Bogor Zone, including the Rancah Sites in West Java, Semedo and Bumiayu in Central Java. Data collection methods include a literature study on the results of previous research, and direct observation through surveys at the three sites studied. Sources of literature on Rancah Site come from Van Es (1931), Von Koenigswald (1934), Hetzel (1935), and Kramer *et al*., (2005). Then regarding Bumiayu comes from van der Maarel (1932), Ter Haar (1934), Sondaar (1984), de Vos (1985), Van Den Bergh, (1999), van der Meulen (1999), and Setiyabudi (2009). Recent research on Bumiayu was carried out by the Regional Agency for Archaeological Research in D.I. Yogyakarta Province in 2019 (Widianto, 2019), while in Semedo it was carried out by the same institution since 2005 (Widianto, 2011).

Data analysis was carried out on geological, archaeological, palaeontological, and especially palaeoanthropological data found. Geological data analysis was carried out on the stratigraphy related to the finds to understand the depositional process, then stratigraphic correlation was carried out to determine the relative chronological age (Herz and Garrison, 1998; O'Brien and Lyman, 1999). Archaeological data analysis on artifact findings aims to determine aspects: raw materials, applicated lithic techniques, morphology, and metrics, to understand stone tool manufacturing technology and its typology. The outline of the analysis is to understand the raw materials-technology-typology aspects (Sellet, 1993). Palaeontological and palaeoanthropological data analysis focused on morphological and biometric aspects. Morphological descriptions will be applied to obtain a description of morphological characters as qualitative data. Meanwhile, biometric analysis is applied to the discoveries that have a measurement reference as quantitative data. The elaboration of the analysis of morphological and biometric characters is a determinant for determining the anatomical part and taxonomic position (family, genus, and species) (France, 2009; Henke, Tattersall, and Hardt, 2014; Lewin and Foley, 2004).

The study is to reveal the significance of geological, archaeological, palaeontological, and especially palaeoanthropological potentials contained in the

Rancah, Semedo, and Bumiayu Sites. The implications of the results of the study then become the prospects for prehistoric quaternary research in Java in the future.

RESEARCH RESULTS

Three *Homo erectus* sites have recently been discovered in western-Central Java (Semedo Sites in the North Serayu Mountains and Bumiayu Sites in the eastern boundary of the Bogor Zone Mountains), and in West Java (Sites Rancah part of the Banyumas Sub-Basin). These sites are located away from other similar sites to the east, in the Kendeng Mountains Ridge and Central Depression Zone. Therefore, two groups of hominid sites on the island of Java can be seen (see Figure 3), which of course will tell a different story about the arrival and dispersal of *Homo erectus* in the Indonesian archipelago.

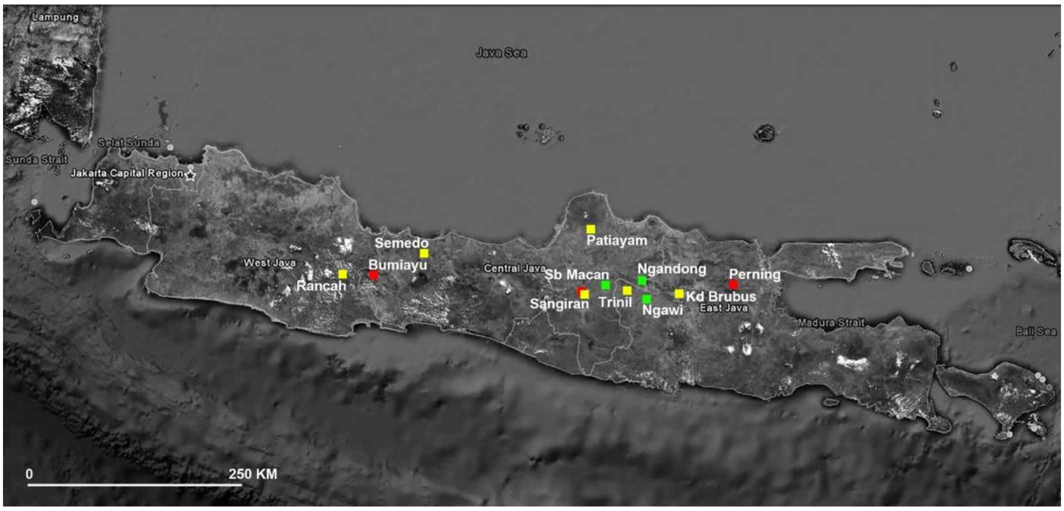

Figure 3. Distribution of Two Groups of Pleistocene Sites in Java.
Note: Red = Early Pleistocene, Yellow = Middle Pleistocene, Green = Late-Middle Pleistocene
(Source: Noerwidi, 2020 with modifications)

Rancah Site, Ciamis, West Java

The site is located in Rancah Village, Rancah District, Ciamis Regency, near to the border of West Java and Central Java. Its palaeontological potential has actually been identified since the 1920s, resulting from various ancient outcrops of Kali Cijulang, in which vertebrate fossils were later defined by Koenigswald as Cijulang Fauna (von Koenigswald, 1935). It is on the fossilized land that dominates the Rancah Village that Kramer *et al.* (2005) conducted excavations in two places in 1999, in Kali Cipasang and Kali Cisanca. Various fossil fauna fragments were found during the excavation, and the most important finding was a human tooth which was a lateral, lower, right incisor, which was a dental crown, without a tooth root. The finding- codenamed RH1, which means Rancah Hominid 1- is an *in situ* excavation at Cisanca, associated with the top of the blue sandstone, at a depth of more than 3 meters below ground level (Kramer *et al.*, 2005). Conglomeratic sandstone layers with a cross-bedding and graded-bedding structure dominate the upper layer of the discovery position of human teeth. Further down at the base of the blue sandstone layer, there are also collections of obsidian stone tools and fossils of Cisanca vertebrates.

Radiometric dating by *electron Paramagnetic resonance spectroscopy* (EPR) technique has been applied to the maximum age of these human incisor, through samples of Bovidae teeth located at the base of the layer. The dating result or the maximal age of the human teeth is 606,000-516,000 years. Comparing with the morphological and metric characters of similar incisors from *Pongo sp*, *Macaca sp*, *Homo erectus* Sangiran, China, and Africa, as well as incisors of *Homo sapiens*, it is concluded that RH1 from Rancah is a *Homo erectus*' incisor from the Middle Pleistocene. (see Figure 4, Kramer *et al.*, 2005). There is a possibility, the age of these incisors could be even older, because they are in secondary deposits or post-deposition. Kramer *et al.,* (2005) states that the RH1 specimen was hominid, based on the morphological aspects of the *buccal*, *lingual*, and *occlusal* faces and chronological position.

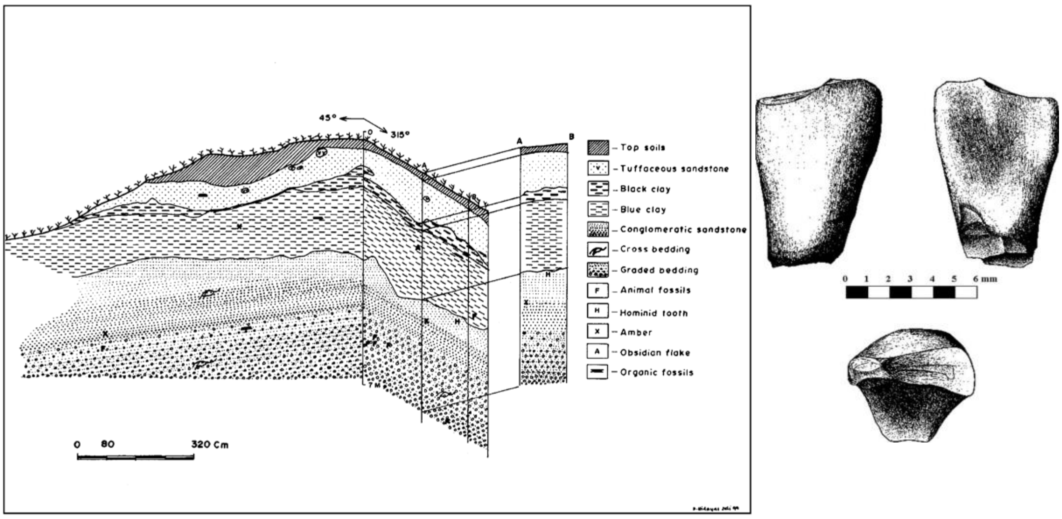

Figure 4. Stratigraphical Profile (left) and RH1 Dental Specimen
(Source: Kramer et al. 2005)

The authors basically agree with the previous identification by Kramer *et al.,* (2005) which states that RH1 incisors are hominid, lower, right, and temporarily time is assigned as *Homo erectus* ("*... should be provisionally assigned to Homo erectus*"(Kramer *et al.,* 2005)). The RH1 specimen previously conserved at Balai Arkeologi Bandung (now known as Regional Agency forArchaeological Research in West Java Province), submitted by Dr. Tony Djubiantono, Kramer's *co-partner* research in Rancah. It was then received by the author on January 13, 2014, so that since that date, the RH1 specimen has been in the author's hands. Therefore, the authors had the opportunity to re-examine the specimen, and apparently, there were differences in the identification results.

Kramer *et al.,* (2005) identify RH1 as lateral (I2), lower, right incisors. However, the authors believe RH1 is the first incisor (I1). The second lower incisors have two asymmetrical lateral sides, tilted towards distal, which RH1 does not have. In this respect, the RH1 specimen has a very symmetrical lateral side, both mesial and distal. Therefore, in the morphological perspective of the lower human incisors, RH1 is not the second incisor (I2) as suggested by Kramer, but is the first incisor (I1), bottom, right.

The comparative analysis performed by the authors towards RH1 morphology with similar teeth (Bs 9706 from Bukuran, Sangiran), actual *Homo sapiens*, *Pongo palaeosumatraensis*, and *Macaca fascicularis* (Figure 5), shows that the lateral orientation of the proximal human teeth tends to tilt distally, in contrast to the *Pongo* which is straight from the proximal, slightly enlarged slightly distally, and ultimately narrows to the extreme cervical direction. *Macacas* incisive lateral teeth orientation tend to be straighter than *Pongo*'s teeth, but more slanted, smaller in size, and very tall (*occlusal-cervical*) compared to similar teeth in humans.

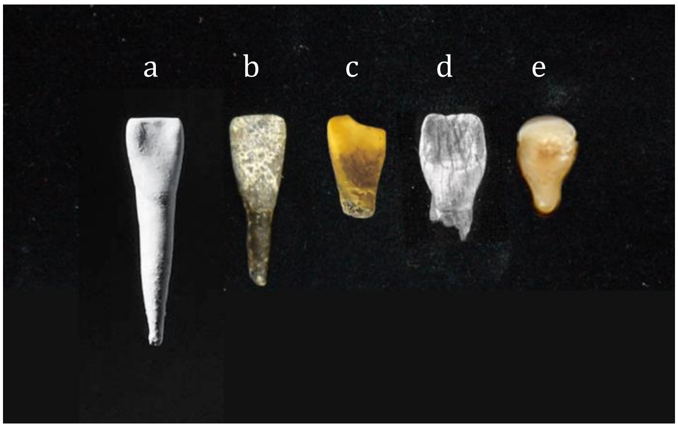

Figure 5. Morphological comparison of the lingual side of the first incisors a. Actual *Homo sapiens*, b. Specimen Bs 9706, c. RH1, d *Pongo paleosumatraensis*, and e. *Macaca fascicularis*. *(Source: Authors, except 'A' from White and Folkens (2005) and 'D' from Hooijer (1948).*

Morphology of the lingual side of a human tooth I1, lower, right, tends to be plain with a slight protrusion of margins on either side of the lateral at the corner near the occlusal part. the contrasts with similar teeth from *Pongo* which show both firm lateral margins extending from the proximal side to the distal. *Pongo* also has a complex lingual morphology with a cingulum located distally, the lingual ridge (essential ridge) being cut off by the lingual fossa, as well as mesio-lingual and disto-lingual fossae. Whereas, human incisors tend to be plain. In addition, at the peak of the occlusal *Pongo*'s incisive teeth, there were still some protrusions of very obvious talons, whereas in humans they tended to be flat. On the other hand, the ornamentation of the lingual side of the *Macaca* incisive teeth appears simpler than *Pongo*'s teeth. However, it still has prominent distal ridges on both marginal sides, with narrow and long lingual *fossa* indentation, different from human incisors.

The morphological comparison between RH1 and the teeth mentioned above has underlined the human character of RH1. The re-analysis by the authors of RH1's morphological character confirmed its position as a human tooth (I1, bottom, right), and not a *Pongo* tooth nor a *Macaca* tooth. Until now, in the Middle Pleistocene period in Java, there were no other hominid species apart from *Homo erectus*. Therefore, even though it was only a loose tooth, the RH1 finding from

Rancah was an important finding because it was the first evidence of the human presence in West Java.

Semedo Site, Tegal, Central Java

The Semedo site is located on lateritic sand volcanic material deposit, which is part of the North Serayu Mountains, located in Semedo Village, Kedungbanteng District, Tegal Regency, Central Java. The discovery of the site for the first time was reported in 2005. Intensive research in the form of surveys and excavations was then carried out by the Regional Agency for Archaeological Research in D.I. Yogyakarta Province and the Conservation Office of Sangiran Early Man Site. New data collections on vertebrate fossils have been found sporadically in a site area of at least 3 x 3 square kilometers, in Middle Pleistocene volcanic deposits (Widianto and Hidayat, 2006; Widianto, 2016).

The types of animal fossil finds include *Stegodon sp.* and *Elephas sp.* (a type of elephant), *Rhinoceros sp.* (rhino), *Hippopotamus sp.* (water horse), Cervidae (a type of deer), Suidae (pig), and Bovidae (cow, buffalo, bull). The fauna characteristics show similarities to the HK Trinil Fauna, which once lived on Java Island between 1.2 and 1.0 million years ago (Widianto, 2011). One of the families of terrestrial vertebrates whose fossils are most abundant in Semedo belongs to the family Proboscidea. Based on the results of the morphological and morphological character analysis conducted by Siswanto and Noerwidi (2014), it can be seen that, in Semedo, there are very diverse species of probos animals, namely *Sinomastodon bumiayuensis*, *Stegodon trigonocephalus*, *Stegodon sp* (pygmy), *Stegodon hypsilophus*, *Elephas* (*Archidiskodon*) *planifrons*, and *Elephas hysudrindicus*. The presence of *Sinomastodon bumiayuensis* in Semedo indicates the chronological range of the site, from at least of 1.6 million years ago to the Middle Pleistocene after the presence of *Elephas Hysudrindicus* (Siswanto and Noerwidi, 2015).

The most recent surprising discovery was a fragment of the *Gigantopithecus blackii's* mandibular and teeth (Noerwidi, Siswanto, and Widianto, 2016). The specimen is the first discovery of the genus *Gigantopithecus* in Indonesia, outside its main habitat in sub-tropical forests in China and the Himalayas; it was also found in Vietnam (Zhang and Harrison, 2017). These findings indicate that *Gigantopithecus blackii* has lived on the island of Java, far beyond the interpretation of experts. Based on these findings there are opportunities for future research into: when and how did the species migrate to Java? How did they adapt to tropical environments, did they cohabit within *Homo erectus*, and how did they become extinct?

An important element of the finding, a marker of the presence of early humans at the Semedo site, is the discovery of paleolithic tools especially in terrace deposits in various river flows and also outcrops of terrace sediment due to agricultural activity and erosion. The main material of Semedo paleolithic instruments is very distinctive, namely silicified corals, dominating 80% of the number of artifacts. Other materials include silicified limestone and silicified basalt. So far, the dominance of silicified coral as a material for paleolithic tools has only been found in Semedo. Most of the material in the Semedo Site is silicified-stones, very hard, dark, and yellow to brown in color with a predominance of brown. The tipo-technology of the collection of stone artifacts from Semedo was analyzed by Noerwidi and Siswanto (2014). In general, these artifacts can be grouped into three types, namely: massive tools, non-massive tools, and debitage.

Early humans once lived in the Semedo Site, interact with various animals, and make silica stone tools. Excavations carried out at the site indicate that the animal fossils were deposited in lateritic sandstone layers, while many artifacts were found in river terrace deposits, including the Kali Jolang, Watu Rajut, Kalen Kawi rivers, and the Rengas and Glethek moorlands.

In May 2011, the first ancient human remains were found by Dakri - a local people who has a strong dedication to Semedo antiquity - in a basin of the Kali Kawi, in the Waturajut area. The shape is a fragment of posterior part of the skull-cap which conserves the *parietals* right and left, and the upperpart of *occipital*. The outer surface is firmly attached to the hard concretion of gravel sand deposit, so what is visible now is the inner surface, which shows some morphology of the *occipital* part associated with the brain imprint of the *lobe cerebral*. Although the inner surface is sufficiently eroded, the junction of the two parietal bones - the *sutura sagittalis* configuration is still clearly visible. The structure of the skull section still very clearly shows the *diplöe* structure in the middle, as an indicator of skull structure (see Figure 5), called Semedo-1 (Widianto, 2011; Widianto and Grimaud-Hervé, 2014).

One fundamental thing that must first be stated here is, finding no longer be in the location of the primary deposition, but has been transported from their origin place by natural factors *(natural agency)*, such as by erosion or transportation. In this case, the lithological series at the Semedo Site has a very potential property of the deformation action, because it is located on the peaks of folded hills. Observation of the stratigraphy in the study area shows that there are two main components of rock layers, namely: (1) dry land which is intensively the result of rock weathering, and (2) the main rock which is a layer of yellowish-brown lateritic sand, hard, compact, and in lumps.

In the area of Waturajut, where the Semedo-1 skull cap was discovered, a concretion layer of pisoid limestone was found, which consisted of sand, gravel, and limestone. Due to the presence of compounds between volcanic rocks (sand and gravel) and limestone, very hard pisoid limestone is created. Based on the rock matrix covering the Semedo-1 skull cap, it is interpreted that the concretion layer is the layer containing the Semedo-1 fossil (Widianto and Grimaud-Hervé, 2014). The hypothesis is strengthened by the results of lithological observations on the northern slopes of Bukit Tirem. In the future, intensive excavation can be carried out in these potential locations (Siswanto, 2014).

The question that then arises is: what is the evolutionary level of the Semedo-1 skull cap, given the position of the finding which is completely out of the stratigraphic context? To answer the important question, it is necessary to compare the roof of the *Homo erectus* skull from Grogol Wetan, Manyarejo, Sangiran, which was found in October 1993. At the time of the discovery of the skull of Grogol Wetan, the first author - along with the discoverer, Sugimin - conducted an observation of the lithological aspects of the depositional layer of the human fossil, which was in Sugimin's courtyard. These initial observations were then followed by the creation of a measured stratigraphic column (Widianto *et al.*, 1997), and it was identified that the Grogol Wetan skull was deposited at the very lower part of the Kabuh Formation, which is equivalent to the early Middle Pleistocene. These fossils were found in the fluvio-volcanic layer of gravel sand with a blueish-black color, very loose, about 1 meter above the base. Also found in the lithological layer are silicified fragments, other vertebrate fossils, and also chalcedony fragments.

Figure 6. Comparison of the endocranial morphology of the skull cap of Grogol Wetan (left) and Semedo 1 (right), without scale
(Source: Widianto and Grimaud-Hervé, 2014)

On the other hand, when viewed from morphological aspect and is compared to the skull of Grogol Wetan in Sangiran (see Figure 6), it appears that the morphology of Semedo-1 is identical to that of the Grogol Wetan *Homo erectus* skull, especially in the orientation and thickening of the temporal and parietal parts, both on the right and left. The similarity of these morphological aspects is also shown by the orientation and position of the *indinion* to the *sagittalis suture*. In the supra-structural development and evolutionary features of the skull among *Homo erectus* of Java, the similarity of features in the two skull caps provides a further important understanding, that the skull cap of Grogol Wetan and Semedo-1 show the same evolutionary stage, a variant of typical *Homo erectus*. Therefore, the morphological aspects and stratigraphic position possessed by *Homo erectus* Grogol Wetan have been very useful for determining the evolutionary position of Semedo-1, both interpreted to have originated from the early Middle Pleistocene.

Based on the discovery of *Homo erectus* human fossils, the Semedo Site has complete potential of human fossils, fauna fossils (marine and terrestrial vertebrates), and paleolithic artifacts, which were deposited in ancient rock formations millions of years ago. This is one of the locations where *Homo erectus* lived on the island of Java and has its own significance because it opened new perspectives for understanding the presence of *Homo erectus* on the island of Java. In fact, this Pleistocene human not only wandered in eastern Central Java and East Java but also stepped out their path at the western region, a mountainous area far from the territories of his brothers in the east (Widianto and Grimaud-Hervé, 2014).

Bumiayu Site, Brebes, Central Java

To fill in the gaps in the research conducted by Stehlin, van der Maarel, and Koenigswald in the 1920-1930s, as well as intermediate research conducted by Sémah, Simanjuntak, and Bartstra in the 1980s on the extraordinary ancient deposits in Bumiayu, intensive research was carried out by the Regional Agency for Archaeological Research in D.I. Yogyakarta Province in July 2019. The aim is to understand the arrival and dispersal of the oldest fauna (and humans) on Java Island. The results of this study underline the importance of Bumiayu for information on the oldest fauna, which is related to the emersion of the area from sea level around the Plio-Pleistocene, 2 million years ago. Several new site locations containing very old vertebrate fossils have been recorded, which complements the biostratigraphic succession that von Koenigswald (1935) has formulated for this area of Bumiayu.

A total of 41 fauna fossils were produced from the survey activity process. Most of the fossils were found out of stratigraphical context, namely in the riverbed. Only 5 fossil specimens were found still attached in the layer on the outcrop wall. In the upper Kaliglagah Formation, the material collected is relatively abundant, especially from the Kali Saat and Kali Biuk sites. Meanwhile, for the Gintung Formation, the material is relatively abundant, especially from the Kali Jurang Site and its surroundings. The taphonomic conditions of fossil preservation of the Lower and Upper Kaliglagah Formations cannot be separated, because the fossils from these two stratigraphic units are in almost similar strata facies. Generally, these fossils are in a relatively well-preserved condition and are brownish in color, and majority do not show any weathering or rounded processing on the bone surface due to the transportation. On the other hand, preservation of the Gintung Formation generally shows the formation of bone edges and fractures due to weathering, and many of them are still covered in conglomerate matrices and coarse sand, which are firmly attached to fossils. Another taphonomic feature seen in these formations is of significant *manganese and* iron oxide on most of the fossil assemblage.

A number of new faunas can be placed in the chronology of Javanese fauna succession representing the Satir Zone (lower Kaliglagah Formation) and Cisaat (upper Glagah Formation) (see Table 1). A new assemblage of fauna appears in the faunal biostratigraphic scheme in the Bumiayu area, namely the Gintung Fauna (Widianto, 2019). Among the fauna originating from the Kaliglagah Formation and the Gintung Formation, there are types of fauna that come from transitions between the two field research formations. In more detail, the types of fauna for the three fauna horizons produced in the 2019 study are as follows:

Table 1. Faunal Types From Three Main Horizons in Bumiayu

FORMATION	LOCALITY				
	Kali Jurang	**Kali Gintung**	**Kali Igircabe**	**Rodiq Collection**	**Kali Cacaban**
Gintung	Bovidae (indet)	Proboscidea (indet)	Proboscidea (indet)	Bovidae (indet)	*Elephas sp.*
	Rusa sp.	Bovidae (indet)	Bovidae (indet)	*Bibos palaesondaicus*	*Stegodon trigonocephalus*
	Hexaprotodon sivalensis	*Bubalus palaeokerabau*	*Bubalus palaeokerabau*	*Rusa sp.*	
	Proboscidea (indet)		Suidae (indet)	*Elephas hysudrinidicus*	
	Testudinata (indet)		Trionychidae (indet)	*Hexaprotodon sivalensis*	
	Bubalus palaeokerabau		*Rhinocero sondaicus*		
	Duboisia (antelope) saatensis		*Cervus (Rusa) zwaani*		
	Muntiacus muntjak				
	Elephas hysudrinidicus				
	Stegodon trigonocephalus				
	Primata (indet)				
	Macaca sp.				
	Kali Bodas	**Kali Patujah**	**Penglosoran**		
Gintung and **Kaliglagah** (mixed)	Proboscidea (indet)	Proboscidea (indet)	Proboscidea (indet)		
	Bovidae (indet)	Bovidae (indet)	Bovidae (indet)		
	Elephas hysudrinidicus	Cervidae (indet)	Cervidae (indet)		
	Cervus (Rusa) zwaani	*Elephas hysudrinidicus*	*Elephas hysudrinidicus*		
	Rusa sp.	*Cervus (Rusa) zwaani*	*Hexaprotodon sivalensis*		
	Aves (indet)	Suidae (indet)	*Cervus (Rusa) zwaani*		
	Megachiroptera (indet)	*Duboisia santeng*	*Stegodon trigonocephalus*		
	Rattus sp.	*Bubalus palaeokerabau*	Testudinata (indet)		
			Brotia sp.		
	Ci Saat	**Kali Biuk**	**Taslam Collection**	**Kali Slatri**	
Upper Kaliglagah	Proboscidea (indet)	Proboscidea (indet)	Proboscidea (indet)	Bovidae (indet)	
	Bovidae (indet)	*Hexoprotodon sivalensis*	*Stegodon trigonocephalus*		
	Bibos palaesondaicus	Rusa sp.	*Hexaprotodon sivalensis*		
	Cervidae (indet)	*Bubalus palaeokerabau*	*Rusa sp.*		
	Hexaprotodon sivalensis	*Bibos palaesondaicus*	*Cervus (Rusa) zwaani*		
	Bubalus palaeokerabau		*Rhinoceros sondaicus*		
	Duboisia santeng		Suidae (indet)		
	Suidae (indet)		*Geochelone*		
	Testudinata		Trionychidae (indet)		
	Crocodylus sp.				
	Trionychidae (indet)				
Lower Kaliglagah	**Kali Glagah**				
	Sinomastodon bumiayuensis				

Source: Widianto, 2019

The new elements of the discovery are paleolithic tools from this Bumiayu Site. Although there are only 5 pieces, the discovery of paleolithic tools from the bottom of Kali Gintung, Kali Bodas, and Kali Cisaat is a very important because it is the first paleolithic implements reported from ancient deposits on Bumiayu. The three artifacts of Kali Gintung were a chopper of silicified limestone, a chopping tool made of dark brown chalcedony, and a big flake made of fossilized wood. On the other hand, a chopper of silicified limestone was discovered from Kali Bodas, and a chopping tool of silicifed andesite was found at the basin of Kali Cisaat.

The appearance of these stone tools has been largely preceded by the discoveries of vertebrate fossils in the last 90 years. Therefore, the discovery of these paleolithic stone tools has become a very important element in this research, which ensures the presence of humans in the Bumiayu area, at least since the Pleistocene. As has so far the characteristic of the discovery of paleolithic implements in Indonesia, most of them - as is the case with the paleolithic of Kali Gintung and Kali Cisaat (see Figure 7) - were found on riverbeds outside the context of stratigraphy, and therefore, their chronology became uncertain.

Figure 7. Andesite Chopper From the bottom of Cisaat River (left, without scale) and Chalcedony Chopper From the Bottom of Gintung River (right)
(Source: Widianto, 2019)

The technology demonstrated from this series of artifacts is very significant and has been identified as part of the *traditional chopping tool complex*, which is characterized by mono facial chipping technology in the manufacture of the chopper, and the bifacial chipping in order for making the chopping tool. Together with the two lithic technology, it is also demonstrated that there is a technology for making flakes, through simple flaking on the dorsal part of a wood fossil, leaving a large cortex, without flaking in the ventral part. This flake tool is large in size, parallel to the *Clactonian* type. The chopping tool made of chert was found on the surface of the Kali Gintung River shows a very advanced technological aspect. This artifact shows an intensive chipping and use-wear based on the sharp edge. This condition is seen also in other artifacts.

Masterpiece findings are 2 human *caput femoralis,* they were found by local residents -Karsono- in February 2019 from the base of Kali Bodas, its stratigraphic position has been identified based on the correlation of various measured stratigraphic columns (Widianto, 2019). Both are specimens of Bumiayu 303 and Bumiayu 311. The state of conservation of these two human bones are only leaving the head (*caput*) of the thigh bone, with a little part of the neck (*column*), and without the *diaphysis*. The femoral head is the proximal part of the femur that is round and joint the *acetabulum* in the *pelvis*. Then, the *femoral column* is the part that connects the femoral head with the *diaphysis*.

The condition of the fossilization of the two human femurs has reached an advanced level, which is indicated by changes in bone weight caused by the bone mineralization process, namely the replacement of organic elements with inorganic elements (minerals). Changes also occur in the color of the bone at the surface and the internals of the bone, which is originally light in color but have turned to black or dark. This condition is caused by taphonomy of *manganese* comes from its sedimentary sediments and entered to the bone.

There are not many morphological aspects that can be explored from the specimens Bumiayu 303 and Bumiayu 311, due to the very limited conserved material of these specimens. Broadly speaking, the shape of the *caput femoralis* is perfectly round, with a long *femoral column*, allowing for folding, widening, inward and outward rotation. The morphology of such *femoral column* for these types of locomotion is usually owned by the thighbones of apes and humans. In comparison, animals with an anterior-posterior locomotion pattern and limited rotation usually have *caput femoralis* with flattened-shape and oval, with a short *femoral column* even fused with the *head* at its superior part, so that the shape of the femoral head *is* not perfectly round. The latter shape of the femoral head is owned for example by Artiodactyla and Perissodactyla (see Figure 8). In the medial part of the specimens Bumiayu 303 and Bumiayu 311 there are traces of *fovea capitis*. This anatomical trait is a small non-articular depression around the middle part of the femoral head, where the *ligamentum teres* is connected between the femoral head and the *acetabulum* at the *os coxae*.

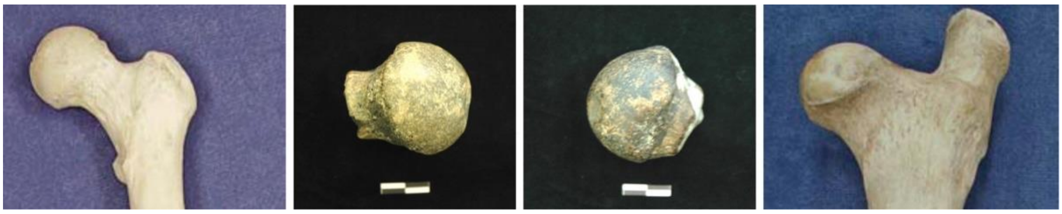

Figure 8. Comparison of the Morphology of the Femoral head (from left to right), *Homo sapiens*, Bumiayu 303, Bumiayu 311, and *Cervidae*
(Source: Widianto, 2019)

A comparative morphometric analysis was carried out to determine the taxonomic identity of the femoral head from Bumiayu. This analysis was carried out by comparing the measurement variables with the populations of *Homo sapiens* (39 specimens), *Homo erectus* (2 specimens), *Homo neanderthalensis* (5 specimens), *Paranthropus robustus* (2 specimens), *Australopithecus africanus* (1 specimen), and other groups *non-human primates* found in Indonesia, such as *Pongo* (2 specimens), *Macaca* (1 specimen), and Gibbon (1 specimen). Meanwhile, several measurement variables in the specimens of Bumiayu 303 and Bumiayu 311 (see Table 2) can be made based on the morphometric method proposed by Martin and Saller (1957).

Table 2. Measurement Results of Femoral head Variables of Bumiayu Specimens

No.	Abb	Variable	Bumiayu 303 (mm)	Bumiayu 311 (mm)
1	M15	Vertical column diameter	28	34.8
2	M16	*Sagittal column* diameter	25.5	31.5
3	M17	Maximum circumference of column	85	102
4	M18	Vertical *caput* diameter	46.5	48
5	M19	*Sagittal caput* diameter	46.8	45
6	M20	Maximum circumference of *caput*	145	142

Source: Widianto, 2019
Note: (Abb = Abbreviation, mm = millimeter, M(number) = Martin's variable (number))

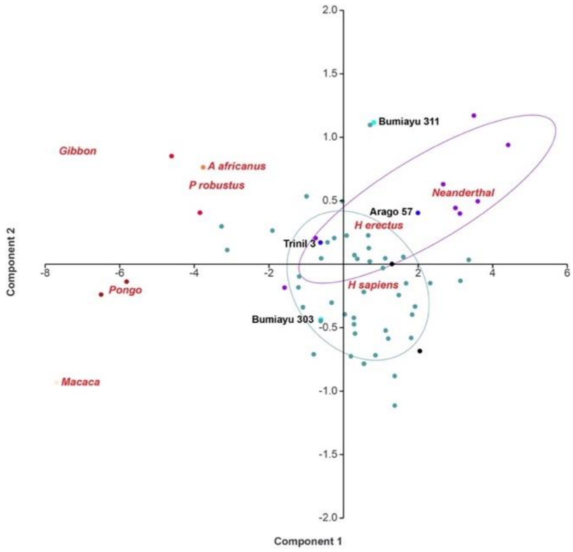

Figure 9. PCA Plot Comparison of Bumiayu 303 and Bumiayu 311 Specimens with Hominid Populations and *Non-Human Primate*
(Source: Widianto, 2019)

The results of the six anatomical variables measurements are used as material for *multivariate* analysis using *Principal Component Analysis* (PCA) technique. Such analysis compares the specimens of Bumiayu 303 and Bumiayu 311 with several samples of anatomical variables measurements from *Homo erectus*, *Homo sapiens*, Neanderthals, *Paranthropus robustus*, *Australopithecus africanus*, *Pongo*, *Macaca*, and Gibbon (Widianto, 2019).

Based on the results of morphological (Figure 8) and morphometric analysis (Figure 9) above, it is concluded that the specimens Bumiayu 303 and Bumiayu 311 have a femoral head shape and size that is close to the human population. Among the hominid populations in the chart, it can be seen that Neanderthals have a relatively larger femoral head than the other hominid populations. The Bumiayu 303 specimen is in the variation of the *Homo sapiens* population, while Bumiayu 311 is outside the variation of the two hominid populations, closer to the Neanderthal population, including *Homo heidelbergensis* Arago 57.

The size of Bumiayu 303's femoral head is similar to the average population of *Homo sapiens',* but smaller than the average of Neanderthal population. On the other hand, the size of Bumiayu 311's femoral head was larger than the entire hominin population, but close to the Neanderthal population. The results of the identification above place the two femoral head of the specimen from Bumiayu as belonging to a hominid, a human femur (Widianto, 2019).

DISCUSSIONS

Say that the *Homo erectus* fossils from Rancah (RH-1) are about 600 thousand years old, and Semedo (Semedo-1) are identical and are in the same evolutionary level as the Grogol Wetan skulls from early Middle Pleistocene formations, then, what is the relative age of the hominid from Bumiayu? This discovery of human remains shows the complete fossilization process. All components of the organic bone have been completely replaced by minerals from the sedimentary rock. Both cortical and spongy bones have completely replaced by minerals, giving them a hard and massive texture. Black in color, indicating similarities with various fauna fossils found in Kali Bodas or similar sites on Bumiayu. Black in color, hard, and complete fossilization are physical features commonly seen in animal fossil assemblages, observed also in Bumiayu 303 and Bumiayu 311. Based on these physical characteristics, it is almost certain that the two human bones also have the same significant antiquity, parallel to the age of local vertebrate fossils. What is the possible dating of these two *caput femoralis?*

It is known that the two fragments of the human thigh bone originated from a location with the coordinates 7 ° 14 '31.9 " (South Latitude) and 108 ° 59' 16.2" (East Longitude) and are in a low to moderate undulating geomorphological environment. The main surface irrigation system is the Bodas River, which is *intermittent* (watery during the rainy season), with separated tributaries running down to the Bodas River. The flowing surface water carries sedimentary rocks and other materials, including vertebrate and hominid fossils, which then deposited in the Bodas River basin and its surroundings.

Geologically, the research conducted by Dr. Agus Tri Hascaryo, ST, SS, MSc as a member of the 2019 research team, the lithology around the location where Bumiayu 303 and Bumiayu 311 were found are sandstone and silt rock units. The sandstone unit consists of two groups. The first group is tuffaceous sandstone units containing silica cement, while the second group is sandstone units containing iron oxide cement. Apart from that, silt rock units are divided into two groups: The tuffaceous silt and carbonate silt units also called as marl. Identification of local lithology shows that rock units with tuffaceous elements are members of the Kaligintung Formation, while iron oxide and marl sandstone units are members or part of the Kali Glagah Formation.

A very valuable clue is found in Bumiayu 303 and 311: these two finds contain a matrix, very thin, well attached to its cortical and spongy surfaces, in the form of layers of white limestone. The results of the HCl / 0.5 molar test against the thin matrix attached to Bumiayu 303 and 311 show a chemical reaction as a carbonic material. This test proved that these two human fossils came from the silt-carbonate rock unit. The investigation of the geological deposits in Bodas River as the location of the discovery of these two human thigh bone fragments, based on the diagenesis of sedimentation and deposition, shows that the only sediment with silt and carbonate rock elements is the iron oxide sandstone unit and marl, a lithology member of the Kaliglagah Formation. Thus, based on chemical analysis, lithological units, and diagenesis of river deposition processes, the stratigraphic positions of Bumiayu 303 and 311 are interpreted as coming from marl rock units, members of the lower part of the Kaliglagah Formation. The river flow of Kali Bodas from upstream to downstream has horizontally cut the lithology from the Kaliglagah Formation to the Gintung Formation.

Experts note, among others, Sémah (1986), that the ancient deposits at this location are very old deposits, which are related to the genesis of Java Island during the Plio-Pleistocene, for example in Kali Biuk, dated to between 2.1 and 1.7 million year. Based on research on foraminifera in the deposits of the Kalibiuk and Kaliglagah Formations, it is known that changes in the marine environment into a terrestrial environment occurred at the boundary between the Kalibiuk Formation and Kaliglagah, namely during the Late Pliocene, the upper part of N20-N21 (Sudijono, 2005). Meanwhile, still related to ancient formations at Bumiayu, Prasetyo *et al*., (2012) states that N22 is equivalent to the early Pleistocene.

Statements from geologists who have dated the Kalibiuk and Kali Glagah Formations lead to the same conclusion, that the Kalibiuk Formation is the result of the deposition of the marine facies, and the Kali Glagah Formation is the first land deposit on Bumiayu, shortly after emerging from sea level. The boundaries of these two formations were fixed at the end of the Pliocene, and the age of the Kali Glagah Formation itself is the beginning of the Pleistocene. Thus, dating of these two hominid fossils has placed them in a very old period, about 1.8 million years ago (see Figure 10), far beyond the oldest age of *Homo erectus* from Sangiran which is the middle Lower Pleistocene, around 1.5 million year ago. If these dating of two *caput femoralis* are confirmed, the human fossils from Bumiayu are a *Homo erectus* thigh bone fragment and could be the oldest *Homo erectus* on the island of Java.

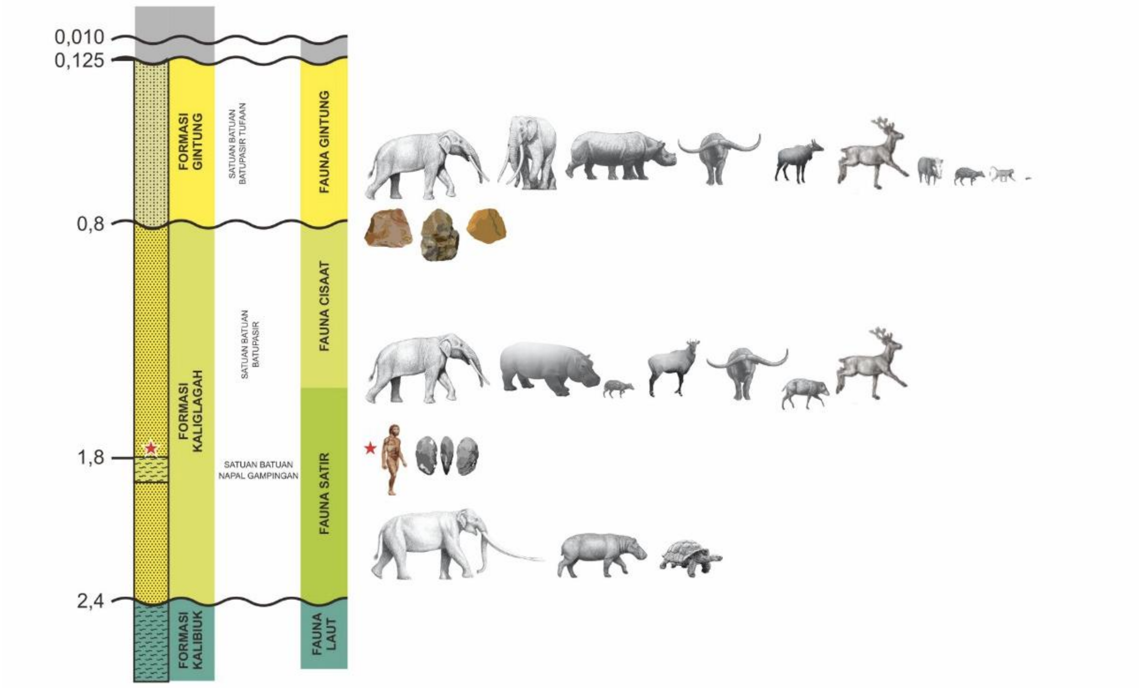

Figure 10. The bio-chronological context of the findings of the femoral head and a collection of artifacts in Bumiayu
(Source: Widianto, 2019)

CONCLUSIONS

Based on the stratigraphic identification carried out in the previous discussion, these two femoral heads show a very old age at about 1.8-1.7 million years ago. If this reconstruction is correct, it will have tremendous implications for the arrival and dispersal of humans in the Bumiayu area, as well as in Java Island. The finding of these two heads of human thigh bone are the first evidence on the discovery of human fossil on Bumiayu, and is the first indicator of human arrival in the area. Therefore, this finding is very important for understanding human migration, because it has emerged from an area that is quite separated from the common dispersal of early man known in eastern Central Java and East Java only. Bumiayu is an opened new window to review the earliest human arrival in Java.

Various new discoveries also prove the presence of the oldest fauna on the border of West Java and Central Java, interpreted as an insular environment at that time, when this region was still namely "*the east coast of West Java*" at the beginning of the Lower Pleistocene. Theoretically, when the presence of this fauna became dominant, West Java was further occupied by a variety of mammals. However, research in this area has not been too advanced, although in Cijulang (in the northeast of Rancah, Ciamis, West Java), very fragmentary mammal fossils were found, consisting of oldest water horses *Merycopotamus*, *Stegodon*, and *Hexaprotodon*, whose ages have not yet to be determined. However, the presence of humans in West Java is coming to light, through the discovery of incisor excavated in Rancah dated to 606,000–516,000 years ago based on the 40Ar / 39Ar date (Kramer *et al.*, 2005). The results of this study on the quaternary deposits in West Java have provided encouraging prospects for the distribution of mammals and hominids, at least during the Plio-Pleistocene period, so as to alter the broader geographic distribution than had been expected before.

This situation provides two new insights: (1) a wider lateral distribution in western-Central Java, not only eastern Central Java and East Java, but (2) also a significant vertical chronology: based on the stratigraphic positions in the discussion above, possibly the age of the hominids from Bumiayu is older than the oldest *Homo erectus* from Sangiran. Coupled with the presence of *Homo erectus* in Semedo (Tegal) and Rancah (Ciamis, West Java), the results of this study have widened the lateral distribution of *Homo erectus* in Java Island: it is not only present in Central Java and East Java but has been occurred in three provinces of Java Island. They have been present on the island of Java since at least the early Pleistocene, disappeared around 110,000 years ago as recently confirmed by Rizal *et al.*, (2020), represented by the most advanced form, *Homo erectus* progressive, from Ngandong, Sambungmacan, and Ngawi (see Widianto, 2010).

RECOMMENDATIONS

Based on several recent discoveries that have been described above, it is time for researchers to look west. Quaternary prehistoric research includes Pleistocene sites and ancient humans which in the past only focused on the eastern part of Java Island, based on the results of this study, more intensive research should be carried out in the western part. This new perspective of *Homo erectus* dispersal in Java also opens opportunities for cross-agency research between the Regional Agency for Archaeological Research in D.I. Yogyakarta Province and the Regional Agency for Archaeological Research in West Java Province.

Several strategic steps that need to be taken by Quaternary prehistoric researchers to investigate the potential sites of western Java include: 1) inventorying all locations with the Quaternary deposits, or those suspected of containing rock formations from that period in western Java, 2) conducting intensive and structured field surveys at the locations that have been inventoried, 3) carrying out systematic excavation at the most potential locations based on the survey results, 4) conducting an in-depth analysis of the findings of excavation results, especially radiometric dating in order to find a more empirical chronology of the site, and 5) conducting collaborative research between the Regional Agency for Archaeological Research in D.I. Yogyakarta Province and the Regional Agency for Archaeological Research in West Java Province, and with the Bandung Geological Museum and the Sangiran Early Human Site Conservation Center.

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