ON THE GEOMORPHOLOGY AND TECTONIC POSITION OF CILETUH-JAMPAH AREA
WEST JAVA, INDONESIA

Nana Sulaksana1, Iyan Haryantho2, Emi Sukiyah2 and Adjat Sudradjat2

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2 Lecturers at the Faculty of Geology, Padjadjaran University, Bandung Indonesia
Jalan Raya Bandung-Sumedang Km 21, Jatinangor, 45363
Email ftg@unpad.ac.id

Abstract

The Ciletuh-Jampang area is located in the western tip of the Southern Mountain of West Java, Indonesia. The area is presently well publicized in an effort to bring the unique geological characteristics exposed in this particular place to become the national inharitage. Ciletuh area exhibits a rare mega-amphitheater morphology.

Stratigraphically West Java composed of clastic sediments of continental and volcanic island arcs origin with the interruptions of sub-aerial volcanic rocks and the coral reefs banks developed along the coasts both in the north and the south. The age of the rocks range between Eocene and the present volcanic deposits. The analysis of regional structure shows that a set of deep seated faults was recognized dominating the area in NNW-SSE and NNE-SSW directions. The released faultings occurred in E-W direction. The low angle shallow upthrustings facing north of skin structure in E-W direction predominate the upper part of the rock sequence. The structural analysis revealed the continuous prevailing stress field in SSW-NNE direction since Eocene time.

The advancing landslides are readily observable in the rim of the amphitheater of Ciletuh. This phenomenon seems to demonstrate the initial stage (primarumpf) of the geomorphologic cycle taking into account the flat surface of Jampang area in the surroundings. Further investigations revealed the geomorphologic evidences of the formations of plateau, namely the flat erosion surface, old terraces, mountain tables, old beach ridges and the characteristics of drainage pattern. Two remnants of ancient erosion surfaces were recognized in Ciletuh-Jampang area, namely Jampang Plateau and the homoclinal South Jampang surface. Further investigations showed that at least five locations of plateau were identified in western part of Java Island, namely Dieng Plateau (+ 2000 m), Pangalengan Plateau (+ 1300 m), Jongrangan Plateau (+ 850 m), Jampang Plateau (+ 700 m) and South Jampang homoclinal surface (+ 500 m). A rough estimation reveals the annual rate of uplifting in Java Island in the last 50 Ma ranges most likely between 1.0 to 1.2 mm.

Keywords: amphitheater, initial stage, plateau, regional structure, rate of uplifting

INTRODUCTION

Ciletuh-Jampang area is located in the southern part of West Java. The terrain mostly consists of rugged topography, geologically known as Southern Mountains. It composes of Miocene volcanics with the interruptions of clastic sediments deposited in the shallow marine environment. The lithologic and topographic conditions of the area resulted in a rather isolation and hardly accessedesed. The off-road vechicle is the mode of transportation
from Pelabuhan Ratu, a local fisherman harbour located about 25 kilometers NNE of the investigated area. The other access is by fisherman boat directly from Pelabuhan Ratu to Ciletuh. In the rough sea at the western monsson however, the sea transportation might be unconvenient.

Geographically the investigated area extends from the longitudes of 106° 20’ to 107° 00’ East and the lattitude of 07° 00’ to 07° 45’ South (Fig. 1). However for the seek of regional analysis particularly concerning the tectonics, the investigated area was extended as far as the entire zone of West Java. The evidence of plateau features was compiled from western part of Java Island from West Progo in the east and Pelabuhan Ratu in the west.

Ciletuh-Jampang area is presently intensively publicized to obtain the recognition as the candidate of national geopark. Although it is at the very initial state, many people and the local government, support the proposal, taking into account the beautiful panorama available in this area. A mega-amphitheater, surrounded by waterfalls, presents the impressive view rarely found. Furthermore, from the geological point of view, the typical rocks of oceanic crust exposed in this area indicate the boundary between the continent and the ocean in the Eocene time about 50 Ma ago. The melange assemblages strongly support the evidence of the ancient subduction in this area, hence the tectonic boundary might locate. The rocks date back to Eocene time represent the oldest and become the base of Java Island, where a pile of younger rock sequence of Tertiary age laid on.

The Ciletuh-Jampang area has recently been investigated by Abdurahman and Rosana (2014) who published their account about the unique geological phenomena associated with Eocene rocks. Earlier Sukamto (1975) described the melange assemblages and the Eocene the rocks in the systematic geologic map. Later Suparka (1996) published a comprehensive discription of the rocks as the key role to reveal the tectonic evolution of western part of Java. Haryanto several times investigated the area and published his findings leading to the synthesis of the tectonics of West Java. He analyzed the evolution of the uplifting of this area resulting in the deep seated faultings and followed by the development of shallow tectonic features called skin structure. The first geomorphologic account appeared in the publication of van Bemmelen (1949) quoting the results of Pannekoek (1946) who identified the formation of the ancient peneplaination of Pliocene age. The present authors investigated the area to clarify the geomorphology and tectonic
positions of Ciletuh-Jampang area in the contribution to the understanding of tectonic evolution of Western part of Java.

**METHODODOLOGY**

The systematic geologic maps guided the present authors in the interpretation of the geomorphology and tectonic position of Ciletuh-Jampang area. The RSTM satellite image provides the synoptic view reflecting a clear picture of the geomorphologic and structural phenomena. The field work particularly carried out by the second author and his team who collected detail information on the geological evidences.

The extended investigation area covering the mid zone of West Java, provides a better picture of the regional tectonics processes operating in this area the last 50 Ma since Eocene age. The fracture patterns observable on the topographic map and the satellite image guided further investigation in the field to collect the ground truth data. Micro-tectonic structural features confirmed the delineation of interpreted faults. The combined field findings and satellite image interpretation thus, significantly contribute to the regional tectonic analysis. Similarly with the detailed petrographic descriptions carried out in the laboratory supported the tectonic interpretation, particularly concerning the boundary of the Eocene continent.

The measurement on the topographic map and satellite images provides the information on the position of the slope and the altitude of the plateau. The available data on the age of the rocks involved in the formation of the plateau resulted in the estimation of the uplifting rate of the plateau since Pliocene time. The sample area of the plateau covers the western part of Java island, the conclusion drawn might reflect the rate of uplifting might of the western portion of Java Island. It concludes that the investigation applied the conventional geologic mapping with the emphasis on the analysis of the development of geomorphological and tectonic processes.

**RESULTS AND DISCUSSIONS**

The lithology of Ciletuh-Jampang area consists of the oceanic crust and the assemblage of melange deposits. The rock determinations revealed the age of Eocene (Sukamto, 1975). It
is therefore many authors concluded that the ancient subduction of Eocene age took place in this region. The rocks resemble that of Lok Ulo area in Kebumen, Central Java. Many authors among others Sukendar (1974), speculated that melange of Lok Ulo Ulo strongly correlates with that of Meratus Mountain in Southeast Kalimantan. Hence it concluded that the boundary of the Ancient Eurasian continent extended from Ciletuh-Lok Ulo area to Kalimantan. The open sea existed Southeast of the boundary and the ancient continent occupied the north.

The rocks of oceanic crust compose of basalts and peridotites in intimate relation with deep marine deposits. The pillow lava structure appears in some places at the beach cropping out due to the seawater abrasion. The volcanic materials consist of breccia, sandstone and graywacke. The components of the clastic materials namely schist, quartzite, mica, tourmaline and garnet reveal the source of metamorphosed rocks of high pressure. This evidence support the interpretation of the ancient subduction locating in this area.

Reddish quartzitic layers alternated with fine grained sandstones commonly expose. The strong tectonics taking place in this area resulted in the steep dips of the layers. In some places the angle reaches almost vertical. Such structural position creates beautiful alteration between hard red oxidized layers and white soft sandstone producing an exotic surface expression. It might be one of the unique geomorphic phenomena rarely found. Local people use to call it the back of the sea dragon (Figure 2).

The younger rock sequence of Tertiary age composes of predominant clastic materials alternating between fine and coarse grainsizes. The volcanic materials present in the clastic sediments. Marl and calcareous fine grain sandstone alternating with clays and mudstone are common. In general it shows the characteristic of flysh facies. Martodjojo (2003) described the rock sequence and found out that the rocks were deposited under fan-like environment. Perhaps the rocks is presently known as turbidites.

Dam (1994) concluded that the rock sequence might have been deposited in the elongated narrow basin located south of the Eurasian continent. The materials initially came from the continental crust located in the North and followed the volcanic materials produced by the volcanic arc in the South most probably at the end of Eocene and Early Oligocene. Further, at this stage the materials came from both sides. The volcanic activity continued to take place at the island arc, and at the later became the presently known Southern Mountain.
The rocks in Southern Mountain consist of andesites and in some places intruded by dacitic and basaltic rocks. In places mineralization occurred. The subaerial volcanic rocks deposited in the island arc supplied the materials to the closed basin in the North. In the shallow sea environment in the continent’s coast in the North, the coral reefs developed. On the other side, the reef grew earlier however it did not develop further because of contamination of volcanic materials supplied by the island arc.

During the deposition, the tectonic activity took place and continued from Oligocene to present times. Syngenetic and post genetic structural features thus, developed in the Tertiary rocks. The first phase produced a set of faultings in Early Miocene which at present appear as deep seated faults (Haryanto, 2005). The second phase of the tectonic activity resulted in the shallow foldings and faultings. The deep seated faults predominated the NNW-SSE and NNE-SSW directions. The shallow or skin structure consisting of faultings and foldings involved the younger rocks of Late Miocene to Pliocene. The tensional faulting and folding mechanism formed majors low angle thrustings facing North, namely Baribis, Cipelang, Jatigede, Cinambo and Bantarujeg (Haryanto, 2014).

The Ciletuh-Jampang area lies in the southern flank of the major anticline with an E-W axis. The area is relatively stable during the tectonic uplifting. Timely the activity ceased which provide sufficient time for the peneplanation. Based on the topographic map and the satellite images interpretation, the remnant of peneplains were readily identifiable. Field verification particularly based on the geomorphologic map prepared among other by Pannekoek (1946 in van Bemmelen, 1949) found out the existense of the remnant of the Pliocene peneplains. The tectonic activities uplifted the rocks after their deposition at Late Miocene time. The activity most likely continue to Pleistocene and Resen and uplifted the peneplains in various altitudes, hence the plateau came into being. Those plateaus locate at various levels of altitude. Dieng plateau lies at the altitude of +2000 meters, Pangalengan +1300 meters, Jongrangan +850 meters, Jampang +700 meters and South Jampang erosion surface +500 meters (Table 1). In South of Jampang the inclined peneplain or homoclinal surface developed, indicated by the uplifted rows of old beach ridges containing titano magnetite sands similar to that deposited in the present beach.

Terraces are also found among other in Cikaso river demonstrating the uplifting. Tabel mountains in South Jampang represent the remnant of peneplain surface . Based on the age of the rocks involved in the uplifting of Pliocene age, it is interpreted that the annual rate of
the lifting most likely ranged between 1.0 to 1.2 millimeters. Ciletuh-Jampang plateau locates at the southern flank of the anticline. The intensive eroded valleys delineate the plateau (Figure 3).

At the west edge of South Jampang inclined peneplain surface, the initial stage (primarumpf) of the erosion took place. It expresses the beginning of the new geomorphologic cycle after the formation of Jampang plateau at Pliocene time. The erosion activity produced mega-amphitheater of Ciletuh area. The upstream erosion activities took place in the rivers drain to the amphitheater. Water falls at the edge of the peneplain surface indicate the upstream erosion. The scars representing the fracturing related to the development of the erosion can be observed in the curvilinear features surrounding the amphitheater. The upstream erosion phenomena were also observed by Sukiyah et al. (2006) in the edge of Pangalengan Plateau. In this area the beginning of the new cycle, resulted in very intensive erosion which cause flood and heavy siltation at the down stream Citarum river, particularly in Saguling, Cirata and Jatiluhur water dams.

CONCLUSIONS

In the investigated area the remnant of the plateaus of Pliocene surface are identified in Jampang and South Jampang. An inclined peneplain surface developed facing south indicating the continuing uplifting until present. The plateau also occur in Pangalengan, Dieng and Jongrangan at various levels of altitude. This phenomena indicate the interruptions of the uplifting of Java island.

The Ciletuh-Jampang area is tectonically located at the south flank of the E-W trending anticline dominating the southern part of Java Island. Jampang plateau developed in Pliocene time and uplifted to the present altitude of 700 meters. The annual rate of the uplifting therefore might range between 1.0 to 1.2 millimeters. The activity continues until present time indicated by the incline South Jampang surface and the formation of old beach ridges. The unique Ciletuh mega-amphitheater reflects the initial phase of the geomorphologic cycle, where the slidings and the circular extension of the rim takes place which might continue in the future.
Further investigation is needed to carefully examine the occurrence of the plateau in the entire part of Java. The information might significantly contribute to the understanding of the tectonic development of Java Island.

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REFERENCES CITED

Asikin, Sukendar, 1974, The Geological evolution of Central Java and the vicinity in light of New Global Tectonic Theory, Doctorate dissertation, Bandung Institute of Technology, in Indonesian, unpublished

Dam, M.A.C., 1994, The Late Quaternary evolution of the Bandung Basin, West Java, Indonesia, Department of Quaternary Geology, Faculty of Earth Sciences, Vrije Universiteit, Amsterdam, 252 p.

Haryanto, Iyan, 2005, The collision of tectonic plates in Java Island, the re-interpretation of the subduction position, Bulletin of Scientific Contribution, Faculty of Geology, Padjadjaran University, in Indonesian

---------------, 2014, Tectonic evolution of Western Java in Cenozoic Time, Doctorate dissertation, Padjadjaran University, in Indonesian, unpublished

Martodjojo, Suyono, 2003, The Evolution of Bogor Basin, West Java, Bandung Institute of Technology Press, in Indonesian, 238 p.

Pannekoek, A. J., 1946 in van Bemmelen, 1949, The Geology of Indonesia and Adjacent Archipelago, Martinus Nijhoff, The Hague, pp 617-619

Sukamto, R., 1975, Geologic map of the Jampang and Balekambang quadrangle, Java, scale 1:100,000, Geology and Development Center, Bandung, 11 p.
Sukiyah, Emi, Adjat Sudradjat, Febri Hirnawan and Dicky Muslim, 2006, Watershed morphometry on Quaternary volcanism terrain in Southern margin of Bandung Basin: its implication to the distribution of flood, Map Asia Conference 2006 Bangkok.

Suparka, R. E., 1996, Petrology and chemical characteristics of volcanic rocks in Citirem Formation: an important key to reveal the synthesis of the tectonic evolution of West Java, Research Institute, Bandung Institute of Technology, in Indonesian.

Figure 1. Satellite image shows the location of the investigated area in Ciletuh-Jampang, West Java, indicated by the quadrangle. The regional tectonic analysis covers the entire western part of Java
Figure 2. The photograph shows the exotic expression of Eocene sedimentary rocks exposed in Ciletuh area. The alternation between hard quartzic layers and relatively soft sandstones produced the such a unique surface local people called the back of sea dragon (photograph by Deni Sugandi, 2014)

Table 1. The reconized plateau and ancient erosion surface in western part of Java

| Name of plateau and erosion surface | Locations   | Elevation (meters) | Evidence                                             |
|-----------------------------------|-------------|--------------------|------------------------------------------------------|
| Dieng Plateau                     | Central Java| 2000               | Flat and denudated surface                           |
| Pangalengan                       | West Java   | 1300               | Denudated surface, volcanic remnants                 |
| Jongrangan                        | Central Java| 850                | Flat erosion surface, sandstone                      |
| Jampang                           | West Java   | 700                | Flat erosion surface, sedimentary rocks              |
| South Jampang erosion surface     | West Java   | 500                | Homoclinal, titano-magnetite old beach ridges, terraces, table mountains |
Figure 3. The sketchmap illustrates the delineation of the Pliocene Plateau in Ciletuh-Jampang area. It notes also the occurrences of titano-magnetite old beach ridges (dotted lines) in homoclinal erosion surface of South Jampang. The curvilinears close to the rim of Ciletuh amphitheater indicate the growing slidings of the rim representing an early stage of the new geomorphologic cycle. The South Jampang erosion surface gently inclines to the south due to the uplifting of Java Island. The investigated area locates in the south flank of the geanticline of Java.