PALEOVOLCANIC KARING RECONSTRUCTION IN THE MERANGIN JAMBI UNESCO GLOBAL GEOPARK TERRITORY BASED ON PETROLOGICAL AND GEOCHEMICAL APPROACH

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ABSTRACT

The presence of lava and pyroclastic sequences in the Karing River on the Merangin Jambi UNESCO Global Geopark territory provides information about the existence of ancient volcanoes. The absence of confirmed rock formations from the distribution of volcanic rock products that have been mapped nationally and also the shape of this ancient volcanic body, is an important reason for this research to be carried out using a petrological approach using petrography and XRF gochemical methods. Petrographic analysis is an appropriate method to determine the mineralogy consist, textures and particular textures, rock structures that are confirmed from field data. Meanwhile, a geochemical approach is used to determine rock oxide compounds. This method aims to reconstruct the shape and type of volcanoes. Research data shows that there are four lava sequences, with Sequence 1 having an entablature structure, Sequence 2 and Sequence 3 having a flow structure, and Sequence 4 having a vesicular-flow structure. The petrography results show that Sequence 1 and Sequence 2 are composed of phenocrysts and microliths of plagioclase, olivine, clinopyroxene, orthopyroxene. Meanwhile, in Sequence 3, hornblende is present, and in Sequence 4, the mineral olivine is absent. The results of geochemical analysis from the four lava sequences are in basalt rocks with 40%-50% Silica content, Calk-alkali basalt magma series, petrogenesis interpreted from the convergence of oceanic subduction beneath continent. The pyroclastic rocks found at the bottom of the lava sequence are evidence of the stratigraphic structure that makes up a volcano originating from the Karing Paleovolcanic, while the pyroclastic rocks found at the top of the lava sequence are believed to originate from other ancient volcanic eruptions. With the stratigraphy composed of lava and pyroclastic sequences, it can be concluded that this ancient volcano is a strato volcano type which is relatively sloping and almost resembles a shield volcano.

Keywords: *Geochemistry; Paleovolcanic Karing; Petrology; Pyroclastic; Basalt lava sequences*

INTRODUCTION

The presence of igneous lava rock covered by a layer of meta-sedimentary rock in the Karing River provides information about the existence of ancient volcanoes in the area. The latest research conducted by (Crow et al.,2019; Metcalfe, 2017; 2011; 2010) explained that this area is the remains of an ancient volcano called Mount Karing. The name Karing refers to the location of the type of rock outcrop found which indicates the existence of this ancient volcano in the Karing River or also known as Muara Karing, Merkeh and Air Batu Village, Renah Pembarap Subdistrict, Merangin Regency, Jambi (Figure 1). The presence of surrounding rocks shows the distribution of pyroclastic rocks, volcaniclastic sediments or epiclastic sediments that preserve fossils that were in a lacustrine environment, such as ferns and ferns. Until now, the mapped formation of this Karing Volcano product has not been confirmed.

Geological previous research explained that the presence of pyroclastic rocks and epiclastic sedimentary rocks around these igneous rocks was produced from the same eruption center, namely Mount Karing (Van Waveren et al.,2018; Crow et al., 2019; Metcalfe, 2009). However, if you look at the stratigraphic position, there are layers of pyroclastic and epiclastic sediment at the top and also at the bottom of the meta-sediment layer. This means that the two pyroclastic layers originate from different volcanic centers. Results of age dating carried out by (Van Waveren et al.,2018) on pyroclastic rock samples zircon from lithic tuff crystals using the method U^{238}-Pb^{206}, it was found that the age of the pyroclastic layer was susceptible about 303.88 Ma, 297.07 Ma, 296.93 Ma, 296.77 Ma, 296.14 Ma, 295.58 Ma (Crow et al.,2019; Van Waveren et al.,2018; Barber, 2000; Metcalfe, 1984, 2013, 2000; 2009). The pyroclastic age about 303.88

Ma included in Pennsylvanian Carboniferous, which means the age of this pyroclastic layer is the same as *inherited* zircon about 304 Ma is Pennsylvanian Carboniferous obtained from basalt xenoliths in the Dusunbaru Plutonic granitoid intrusion aged 209 Ma of the Late Triassic (Van Waveren et al.,2018; Suwarna et al.,2000; Crow et al.,2015). Thus the pyroclastic layers range in age about 297.07 Ma - 295.58 Ma on Cisularian Permian derived of young volcanic central eruption than Paleovolcanic Karing. The existence of lava and pyroclastic outcrops in the northern part of the distant Muara Karing location <10 km, believed to be the main actor in the presence of these pyroclastic rocks. This evidence considers the age of the volcano as the eruption center is old Cisulairan Permian (Barber et al., 2005; Barber and Crow, 2003; Zahirovic et al., 2016; 2015; 2019). The volcano in question is called Mount Palepat which is confirmed to be in the Palepat Formation.

The interesting evidences of the existence of the stratigraphic position of lava and pyroclastics in the Karing River has been previous debated, so it requires reconstruction based on petrological and geochemical data as well as geomorphological information to reveal the order of Mount Karing as an ancient volcano that was active in 304 Ma of Pennsylvanian Carboniferous in the Merangin Jambi UNSECO Global Geopark (Van Waveren et al., 2018; Booi et al., 2014; 2008; 2009). In evidence, apart from having indications of ancient volcanoes, this geopark area also has contemporary volcanoes in its southern part, such as Mount Sumbing which is associated with the Grao Sakti geothermal area. (Utama et al., 2021; 2023; Siregar and Utama, 2021), but it also has a caldera, namely the Masurai Caldera (Said and Utama, 2021; 2023), as the last caldera discovered on the Sumatra Island. The results of this research certainly aim to provide important information regarding the unique geological setting in the geopark area with the presence of ancient volcanoes located on the Karing River.

METHOD

Carrying out research requires systematic stages to obtain information from the ancient volcanic setting in the research area. Starting with remote sensing geological studies, then field investigations, analysis and interpretation based on petrological and geochemical approaches.

Remote Sensing Geology

Remote sensing geology begins by analyzing the morphology and flow of rivers, as well as the alignment of identified geological structures. The liniament of the geological structure indicates the permeability zone or valley morphology of a volcanic morphological setting. Drainage pattern is important information regarding the characteristics of the rocks and morphology formed, generally in volcanic areas characterized by radial pattern (Utama, 2020; Zahirovic et al., 2019; Mulyasari et al., 2019). This radial pattern can change to radial-centrifugal or radial-centripetal for volcanoes that have been eroded or deformed to form a caldera, but in areas of volcanoes that have been deformed by tectonics they can form rectangular, annular, and parallel pattern (Kale, 2014; Utama, 2023; Nabella et al., 2019; Syaifullah and Utama, 2021).

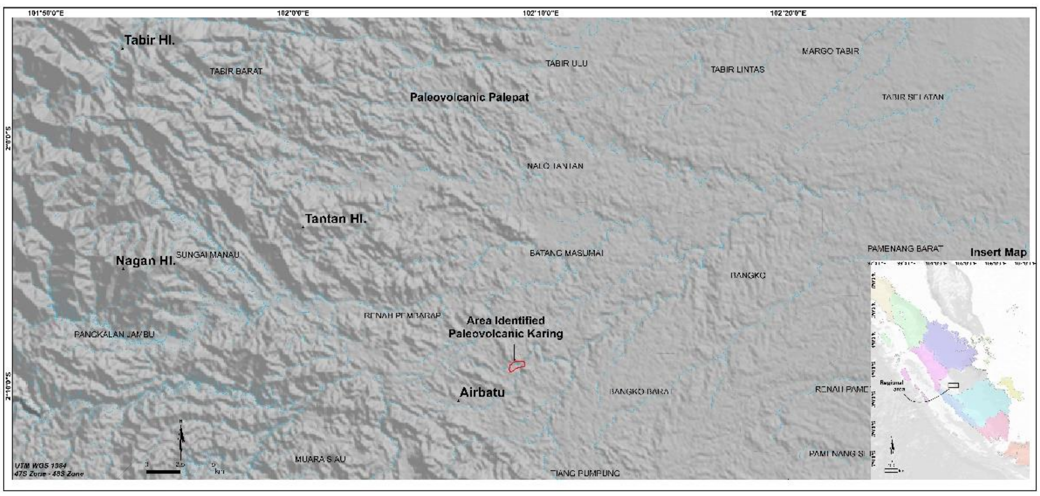

Figure 1. Located of research area, consisting of Barisan Range and Bangko Sub-basin. Area identified of Paleovolcanic Karing is in the southern part of Paleovolcanic Palepat as a large volcano than the Paleovolcanic Karing

In addition to taking several selected rock samples, field investigations also carried out stratigraphic profiles measured on rock layers from ancient volcanoes. The profile section represents the exposure of lava and pyroclastic in the Karing River. Sequence stratigraphic profiles will help to determine the geological processes that influence ancient eruption products and also the morphology of the volcanic facies.

Petrology

The petrological approach using the petrographic method is a method that can be believed to be able to identify rock types with mineral content, texture, structure and petrogenesis of a rock (Ariani and Utama, 2022; Winter, 2010). Petrographic analysis which is part of the petrological approach will help in identifying detailed rock mineralogy and particular textures as indicate of the petrogenesis. This approach is integrated with geomorphological studies to provide an overview of the shape of ancient volcanic facies. Integration of natural landscape, drainage pattern, petrological characteristics of lithology exposed, control of geological structure is an approach to reconstruct the Paleovolcanic Karing.

A total of eight selected rock samples representing each existing lava sequence. Rock samples that had been prepared in the form of thin sections were observed using a polarizing microscope to identify the mineralogical composition, texture and special texture, and detailed of rock name. The observations were carried out in the Earth Engineering Laboratory, Faculty of Science and Technology, Universitas Jambi. This observation aims to determine of petrogenesis and resource potential.

Geochemistry

The rock geochemical method is one of the basics for knowing the petrogenesis of a rock. This method is carried out on selected lava rock samples with the aim of knowing the chemical types of rock compounds, magma series, the tectonic setting of the formation of igneous rocks, and the tectonic evolution that occurred (Winter, 2010). The samples analyzed in Earth Engineering Laboratory, Faculty of Science and Technology, Universitas Jambi with eight selected sample of lava sequence with the same sample from the petrographic sample. There were only found to be oxide compounds using the method X-Ray Fluorescence (XRF).

RESULT AND DISCUSSION

The results of the field investigation were observed in the Karing River and Merangin River. The section track on the Merangin River obtained four basal lava intervals, while the Karing River obtained two intervals with details in the form of basalt lava entablature and basalt lava flow. The research focused on the lava interval in the Karing River to reconstruct Mount Karing with the presence of lava, pyroclastics and volcaniclastic sediments. Thus, taking profile measurements in the field can be divided into four lava sequences which are included in the Karing River interval (Figure 2). These samples will be analyzed using Petrographic and XRF geochemical methods approaches.

Petrology of the Paleovolcanic Karing

In previous research conducted by (Crow et al.,2019; Van Waveren et al., 2018) divides the basal lava outcrops into six intervals with Interval 1, Interval 2, Interval 3, and Interval 4 in the Merangin River with basalt lava having a flow structure, with the other two intervals being in the Karing River. The results of research carried out at this time confirm that the basalt lava exposed in the Karing River is evidence of the existence of the Paleovolcanic Karing which was previously located in the vicinity of the Karing River. Interval 5 and Interval 6 presented by previous research, are classified into four lava sequences by the current research. Rock samples were taken from the four lava sequences for mineralogical analysis using the petrographic method (Table 1). This method is believed to be able to determine the details of the presence of minerals based on the optical characteristics of the minerals contained in a rock.

Table 1. Selective sample of basalt lava sequence, pirocalstic, and epiclastic petrographic analysis

Sample	Petrographic	Mineral Assemblages		Detailed Texture
		Phenocryst	Microlite and associated minerals	
Seq. 1	Basalt	Pl-Ol-Cpx	Pl-Ol-Cpx-Chl	Poikilitic of olivine and clinopyroxene
Seq. 1	Basalt	Pl-Ol-Cpx	Pl-Ol-Cpx-Chl	Poikilitic of olivine
Seq. 2	Basalt	Pl-Ol	Pl-Ol-Cpx-Chl	Poikilitic of olivine

Seq. 2	Basalt	Pl-Ol	Pl-Ol-Cpx-Chl	Poikilitic of olivine
Seq. 3	Basalt	Pl-Ol-Cpx-Hbl	Pl-Ol-Cpx-Opx-Chl	Poikilitic of mafic minerals
Seq. 3	Basalt	Pl-Ol-Cpx-Hbl	Pl-Ol-Cpx-Opx-Chl	Poikilitic of mafic minerals
Seq. 4	Basalt	Pl-Cpx-Hbl	Pl-Cpx	Poikilitic of clinopyroxene
Seq. 4	Basalt	Pl-Cpx-Hbl	Pl-Cpx	Poikilitic of clinopyroxene
Seq. 1 Piroclastic	Lithic-crystall tuff	Lf-Qz-Ol	Cpx-Ol-Chl-Vg	Welded
Seq. 2 Piroclastic	Tuffaceous sandstone	Qz	Chl-Cly-Vg-Opq	Volcanic glass and clay as matrix

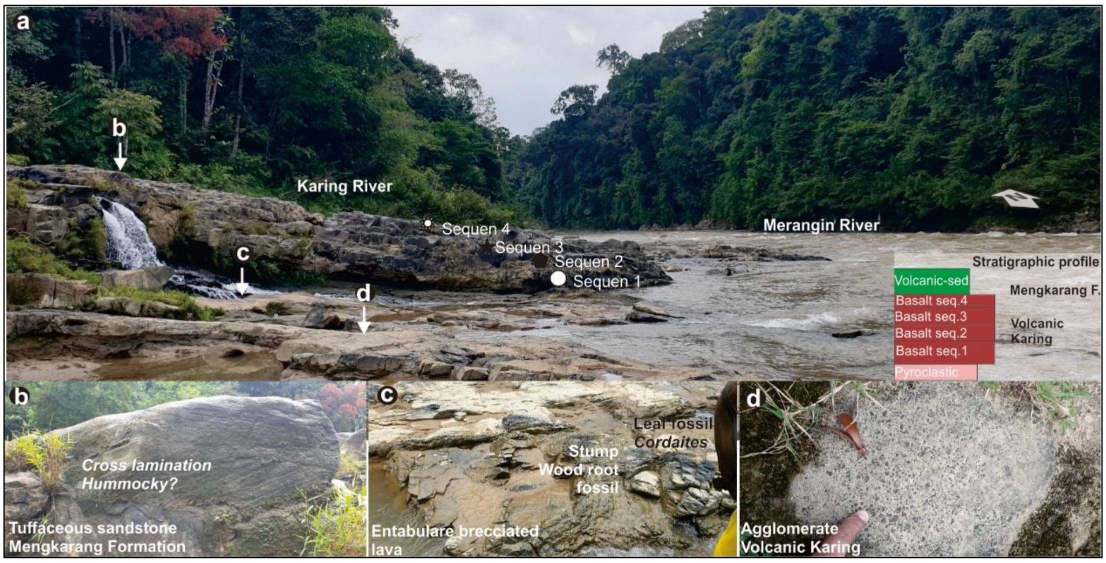

Figure 2. View of the Karing River with lavas sequence. a) landscape of Karing River and Merangin River which consist of lavas sequence, b) tuffaceous sandstone of Mengkarang Formation with tuff properties originate from other ancient volcano, c) entablature structure of Sequence 1 lava, d) agglomerate with lithic-crystal tuff of Paleovolcanic Karing product

Petrological characteristics in the field show that the Karing River Interval with four lava sequences shows that, in Sequence 1 it is grayish brown; entablature and brecciated irregular structures; hypocrystalline, medium-aphanitic phaneric, inequigranular; plagioclase, pyroxene, olivine, and volcanic glass. Sequence 2 is grayish brown; flow structure, hypocrystalline, medium-aphanitic phaneric, inequigranular; plagioclase, pyroxene, olivine, and volcanic glass. Sequence 3 is grayish brown; flow structure, hypocrystalline, fine-aphanitic phaneric, inequigranular; plagioclase, pyroxene, olivine, and volcanic glass. Sequence 4 is grayish brown; flow structure slightly visible vesicular, hypocrystalline, fine-phaneric-aphanitic, inequigranula; plagioclase, pyroxene, olivine, hornblende, and volcanic glass.

The lithology of the lava sequence from the Paleovolcanic Karing was also observed using petrographic analysis to confirm the properties of the lava sequence based on petrological characteristics in the field and rock optics features (Figure 3). Sequence 1 optically has a gray-brown rock color; entablature-brecciation structures destroyed; hypocrystalline, medium-aphanitic phaneric, subhedral-anhedral, vitropheric inequigranular; olivine, clinopyroxene, plagioclase, volcanic glass, and chlorite secondary minerals; basalt. Sequence 2 with grayish brown rock optics; flow structure; hypocrystalline, medium-aphanitic phaneric, subhedral-anhedral, vitropheric inequigranular; olivine, clinopyroxene, plagioclase volcanic glass, and secondary mineral chlorite; pilotaxitic flow texture; basalt. Sequence 3 with grayish brown rock optics; flow structure; hypocrystalline, medium-aphanitic phaneric, subhedral-anhedral, vitropheric inequigranular; olivine, clinopyroxene, orthopyroxene, oxi-hornblende, plagioclase, volcanic glass, and secondary mineral chlorite; pilotaxitic flow texture; basalt. Sequence 4 with grayish brown rock optics; flow structure; hypocrystalline, medium-aphanitic phaneric, subhedral-anhedral, vitropheric inequigranular; clinopyroxene, orthopyroxene, oxi-hornblende, plagioclase volcanic glass, and secondary mineral chlorite; pilotaxitic flow texture; basalt.

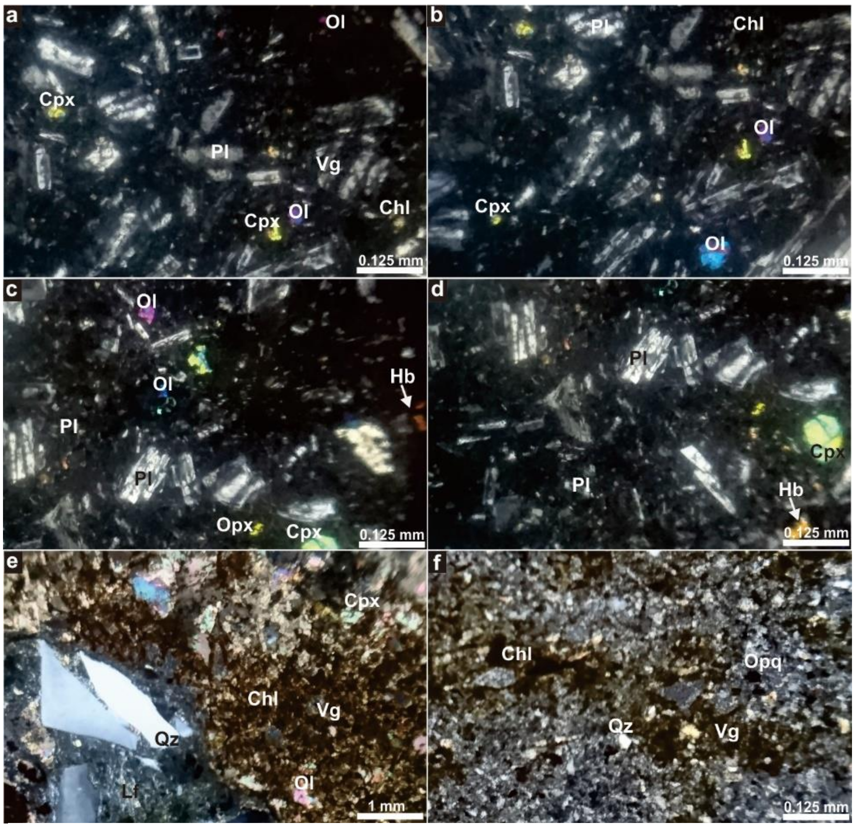

Figure 3. Selective samples of lavas sequnce analysis. a) Sequence 1 is basaltic lava, b) Sequnce 2 is basaltic lava, c) Sequence 3 is basaltic lava, d) Sequence 4 is basaltic lava. All thic minerals composition of olivine (Ol), plagioclas (Pl), clinopyroxene (Opx), hornblende (Hbl) as phenocryst and microlite, and also presence of chlorite (Chl), volcanic glass (Vg). Representative pyroclastic with e) Lithic-crystal tuff of Paleovolcanic Karing, meanwhile f) tuffaceous sandstone of Mengkarang Formation with tuffaceous from Paleovolcanic Palepat surge deposits. Minerals abbreviation according to (Whitney and Evans, 2010)

Analysis of pyroclastic rock samples was also carried out, both on pyroclastic rocks identified as products of the Paleovolcanic Karing and also on pyroclastic products or epiclastic rocks or sedimentary volcaniclastics resulting from other ancient volcanic eruptions. The results of analysis on two samples of pyroclastic rocks and volcaniclastic or epiclastic sediments in the layers below the lava sequence and above the lava sequence were found to show different grain characteristics and minerals composition. In Pyroclastic Sequence 1, there are pyroclastic rocks believed to be from the Paleovolcanic Karing with a characteristic gray-brown color; irregular graded structure; lapillus-bomb granules and slightly ash-sized, rounded, welding; lithics or andesite-dacite rock fragments, plagioclase, clinopyroxene, olivine, chlorite as secondary minerals, volcanic glass; pyroclastic airfall mixed to pyroclastic flow; lithic-crystal tuff. In Pyroclastic Sequence 2, covering tha lava sequences, which was identified as originating from an ancient volcanic eruption, the rest is present as epiclastic rock or volcaniclastic sediment characterized by a gray color; mashed cross lamination; ash equivalent to sand, rounded, poor sorting, open packing; quartz, chlorite, volcanic glass, clay and ash matrices; tuffaceous sandstone (see Figure 2b).

Geochemistry of the Paleovolcanic Karing

Based on geochemical analysis of rocks using the XRF method, it only focuses on the main oxide compounds (Table 2). Rock samples were obtained from four lava sequences, with each sequence consisting of two rock samples. This rock sampling represents every lava sequence exposed in the Karing River.

Table 2. Analysis of sequence lava samples of Paleovolcanic Karing

Sample	Seq. 1	Seq. 1	Seq. 2	Seq. 2	Seq. 3	Seq. 3	Seq. 4	Seq. 4
Oxide Element (wt%)								
SiO_2	50.44	50.42	50.11	50.08	49.36	49.25	49.82	49.78
K_2O	0.6465	0.6263	0.6264	0.7261	0.8911	0.892	0.817	0.815
Na_2O	2.83	2.81	3.41	3.38	3.29	3.32	3.54	3.58
Al_2O_3	24.86	24.84	25.24	25.14	28.22	28.29	28.02	28.01
CaO	7.252	7.251	7.121	7.131	6.74	6.742	6.552	6.559
P_2O_5	0.3377	0.3372	0.1122	0.1112	0.3	0.3	0.2	0.2
Fe_2O_3	9.808	9.802	9.202	9.221	7.822	7.811	7.834	7.835
MgO	2.994	2.944	2.244	2.212	1.504	1.502	1.578	1.577
MnO	0.1634	0.1632	0.1112	0.1212	0.0902	0.0904	0.095	0.098
TiO_2	0.9985	0.9982	0.9112	0.9212	0.8074	0.8078	0.8012	0.8025
Total	100.3301	100.1919	99.088	99.0437	99.0247	99.0052	99.2572	99.2565

Based on the geochemical analysis of each lava sequence, two analyzes were carried out with the aim of determining the margin of error and also the magnitude of the oxide compound value. Based on the eight samples in the four lava sequences, there were changes in the total oxide compounds produced. In Sequence 1 the total number of oxide compounds exceeds 100%, while in the other sequences it is <100%. This is still a normal condition for a rock sample. Normally, if we consider oxide compounds in igneous rocks, it is around 99%-100%. This advantage is believed to be due to the binding of oxide compounds during the analysis process in the tool used (non-helium XRF). In detail, the geochemical compounds obtained were in rock conditions in the range of alkaline igneous rock types (Figure 4).

Plotting on the graph was carried out to determine the type of igneous rock from the total alkali-silica with the type of rock obtained from the four sequences being basalt rock. Meanwhile, using the silica-potassium graph to determine the magma series, it is obtained from the four rock sequences, the Calc-alkaline (CA) or Medium-K Series. In the Titanium oxide vs Manganese oxide vs Phosphorus pentoxide diagram, to determine the tectonic setting of the magma series, the four rock sequences are found in Calk-alkaline basalt convergence.

Magma evolution plays an important role in understanding the process of change that occurs during the formation of igneous rocks, even though the rocks obtained are in the basalt rock series, which means these rocks are frozen in the condition of the main magma or primary magma which has not undergone a differentiation process. The evolution of this magma can be identified using the ratio of oxide compounds to the ratio of silica to other oxide compounds (Figure 5). From these four sequences it is found that from Sequence 1, Sequence 2, Sequence 3, Sequence 4 are where the changes in oxide compounds are not very significant. In compounds of Al_2O_3, Fe_2O_3, MgO, MnO, TiO_2 to SiO_2 there is a decrease from Sequence 1 to Sequence 2 and to Sequence 3, but increases to Sequence 4. In compounds NaO_a to there is an increase from Sequence 1 to Sequence 2 and Sequence 3, while Sequence 4 is in the same position as Sequence 1. The position of the oxide compound is relatively stable in each sequence under conditions of CaO, P_2O_5 to SiO_2.

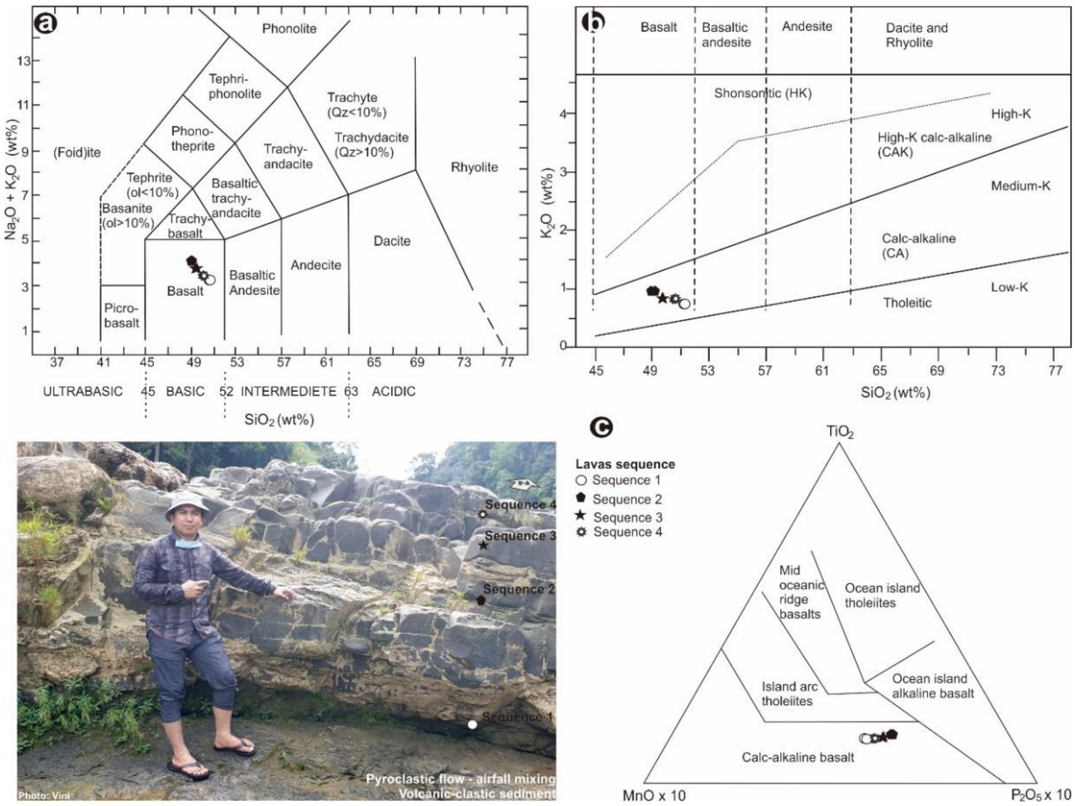

Figure 4. Oxide compound of lavas sequence, a) $Na_2O + K_2O$ vs SiO_2 (wt%) igneous rock classification of (Le Maitre et al., 1989) for the Paleovolcanic Karing is basalt, b) K_2O vs SiO_2 (Le Bas et al., 1986) it can be seen that the type of rock is basalt with Calck-alkaline basalt, c) diagram of (Mullen, 1983 in Winter, 2014) TiO_2 vs P_2O_5 vs MnO it can be obtained Calc-alkaline basalt with active continental margin

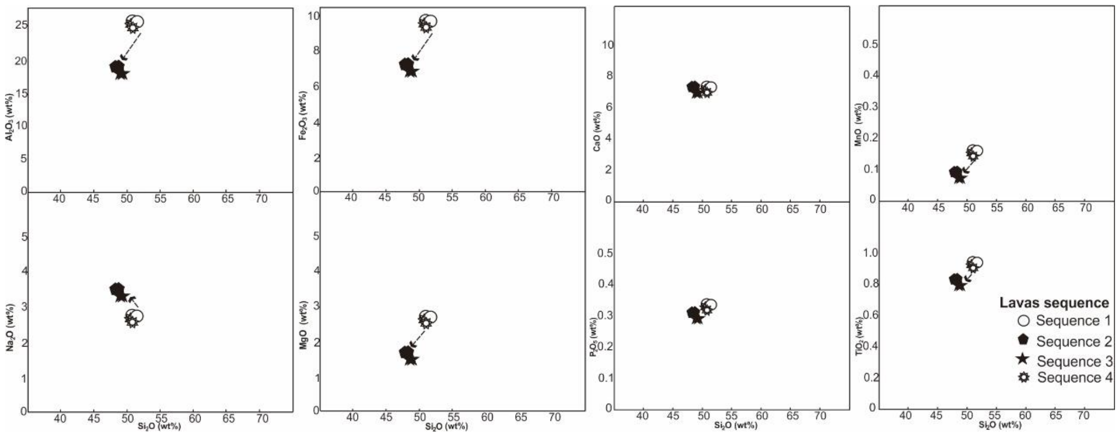

Figure 5. Degree of magma evolution based on sequence lava samples of Paleovolcanic Karing. The ratio of the element silica to other elements in oxide compounds. The magma evolution shown in the graph is not very significant. Looks like only less changes on Al_2O_3, Fe_2O_3, MgO, MnO, and TiO_2

Stratigraphy of Paleovolcanic Karing

The existence of the Paleovolcanic Karing has not yet been mapped as a separate rock formation or special stratigraphic unit of the ancient volcanic group. Based on field investigations by measuring stratigraphic profiles on lava outcrops, then petrological analysis using petrographic methods on each lava sequence exposed in the Karing River, confirmed by XRF geochemical data from each lava sequence. The results of this research are strengthened by age dating which has been carried out by (Van Waveren et al.,2018).With this evidences, it can be said that the Paleovolcanic Karing is a separate formation whose age is estimated 304 Ma – 297 Ma. This age range follows the range of age dating results for inherited zircon in basalt xenoliths and also in pyroclastic zircon, and is confirmed by field data showing traces of debris which are believed to have occurred from this ancient volcanic product. Thus, this product is categorized as an Karing Formation Karbon aged about Pennsylvanian Carboniferous – early of Cisuralian Permian (PCk). This rock formation is composed of basaltic lava, pyroclastic flows and pyroclastic airfalls which consist of agglomerate, lithic-crystalline tuff, and volcaniclastic sediments such as tuffaceous sandstone, tuffaceous claystone, some of which have been partially metamorphized or meta-palimsest (Figure 6).

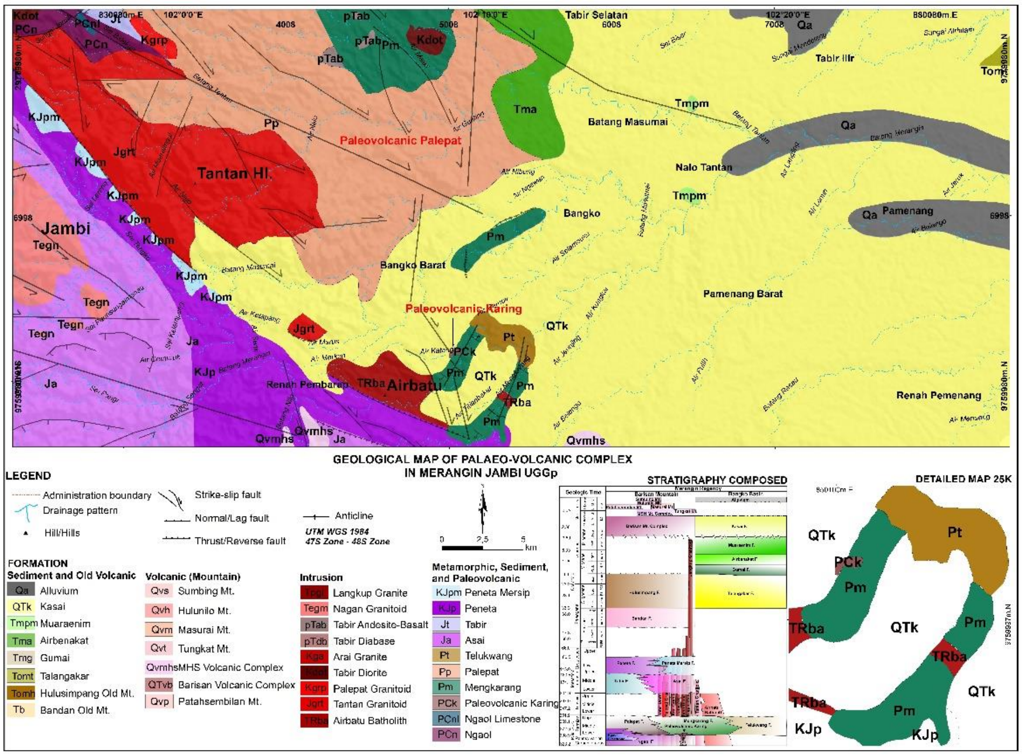

Figure 6. Geological map of research area Paleovolcanic Karing and surrounding in MJUGGp, after (Suwarna et al., 1992). The new formation of Karing Formation (Paleovolcanic Karing) is submitted with formation boundary revised based on geological aspect and scale maps on 1:50.000. In detailed map insert depicted on a scla 1:25.000

In the lava sequence that is present in the Karing River, the stratigraphic position of the lava can be determined based on the eruption phase of a volcano which identifies the position of cooling magma towards the magma source from the extrusion process that occurs. This lava stratigraphic position approach aims to ensure that the outcrops in the lava sequence in the Karing River do originate from a separate volcanic system. This means that the existence of a lava sequence with its characteristic lava structure indicates the facies of a volcano. The lava sequences in the Karing River are detailed with Sequence 1 having an entabular structure with brecciated at the fourth lava stratigraphic position, Sequence 2 and Sequence 3 having a flow structure at the sixth lava stratigraphic position, and Sequence 4 with a flow and slightly vesicular structure which is significant at the sixth lava stratigraphic transition and seventh (Figure 7). Entablature structure is formed in transitional magma conditions from the initial source of extrusive magma to the surface. Conditions like this provide a narrow space for magma to cool, thereby causing an increase in pressure. This pressure causes the igneous rocks that are formed to have a structure like cap rock on top of a pillar from a columnar structure below the type of structure from lava stratigraphy. The flow structure indicates that the remaining magma that flows to the surface forms a thin mass of magma with low viscosity, namely in the vesiculation phase and approaching diffusion. In the final phase of gas release from the remaining magma, it will form a vesicular structure and scoria, followed by lava with a massive block structure.

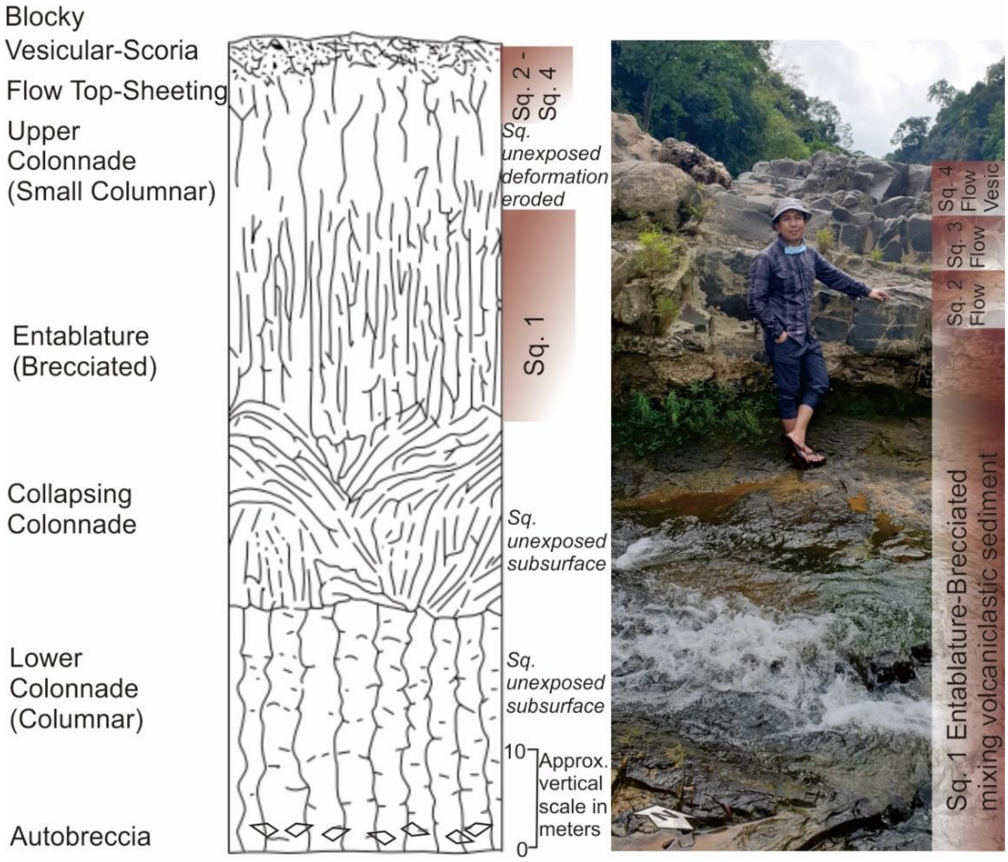

Figure 7. Modeling of Paleovolcanic Karing lavas sequence based on lavas structure, modified from (Winter, 2010). Paleovolcanic Karing with entablature, flow, and vesicular structure

Integration of petrological data, rock geochemistry, field investigations, rock age dating data by (Van Waveren et al.,2018then a reconstruction of the evolutionary process of the Paleovolcanic Karing can be carried out (Figure 8). This reconstruction also considers the morphological form of the exposed lava sequence in the Karing River. Thus, the evolution of this ancient volcano is described into several episodes until the basement of Sumatra Island was formed.

1st Episode. West Sumatra Basement which originates from the Devonian and Cathaysialand Gondwana fragments with granitic-gneiss rock properties is believed to be the basement of the Paleovolcanic Karing (Advokaat et al., 2018; Metcalfe, 2017; Liu et al., 2021; Crow et al., 2019; Barber and Crow, 2009; Crow and Van Waveren, 2010). Paleo-Pacific subduction which occurred in the northeastern part of the West Sumatra Block in the Pennsylvanian Carboniferous was the beginning of the formation of this volcano (Hennig et al., 2017). The process of volcanic formation is accompanied by volcanic eruptions that occur and produce basalt lava, which means it has magma with low viscosity with primary magma that has not magma differentiation.

This evidence is proven by the lava sequence exposed in the Karing River as the focus of research, and also the lava outcrop interval exposed in the Merangin River (see Figure 2). The pyroclastics present around the Karing River are dominated by pyroclastic flow and pyroclastic airfall with relatively low energy. The identification of pyroclastic energy is based on the alkaline nature of the lava, then also the pyroclastic material which preserves several fossils at the time of the eruption. In this episode, it is believed that the Paleovolcanic Karing formed a relatively sloping strato volcano type and almost resembles a shield volcano, as evidenced by the basaltic lava alkaline. In this volcanic facies, the morphology of a volcano can be seen from the central, proximal, medial, and distal facies. This ancient volcano is believed to be located on the edge of an active continent with a transitional environment approaching shallow marine, meaning that this volcano in the distal facies section is in below sea levek, with this characteristic, this volcano is features to be a sub-aquos volcano.

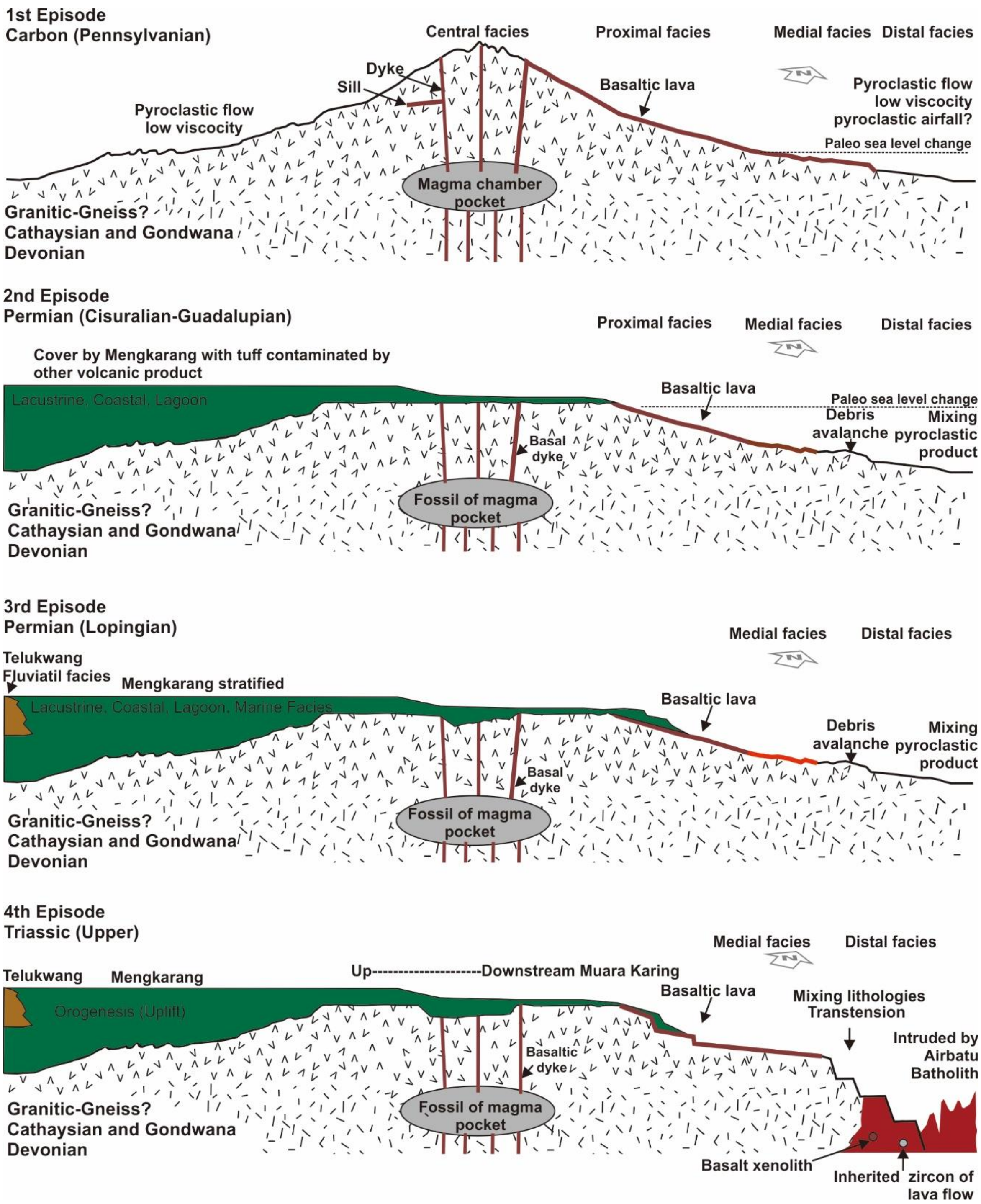

Figure 8. Reconstructions of Paleovolcanic Karing. a) 1st episode Paleovolcanic Karing forming of subduction convergence of Paleo-Pasific beneath of West Sumatra Block, refer to (Metcalfe, 2017; Crow and Van Waveren, 2010), b) 2nd episode the cessation of volcanic activity and the continued of Mengkarang Formation and Paleovolcanic Palepat, c) deformation of Paleovolcanic Karing continued structural, d) deformation, eroded, and cross cutting by Airbatu Batholith or Dusunbaru Pluton (Crow et al., 2019)

2nd Episode. The subduction process that continues to occur has the consequence of the formation of an ancient volcano that is younger than the Paleovolcanic Karing, namely the Paleovolcanic Palepat (see Figure 1 and see Figure 6). This ancient volcano's current position is in the northern part of the Paleovolcanic Karing. If consider the widespread distribution of volcanic products in the Tabir area (north of the Paleovolcanic Karing), it is believed that the eruption and the body of this volcano are very large than the Paleovolcanic Karing. Meanwhile, at the same time, the Paleovolcanic Karing experienced an evolution in volcanic morphology, due to the change in volcanic activity which was increasingly northward (towards the Paleovolcanic Palepat), causing the Paleovolcanic Karing to stop its volcanic activity, so what occurred was a deformation process. and followed by erosion. At the same time, it is followed by a sedimentation process that occurs in a lacustrine environment, transitioning to a shallow marine that is formed from sediments containing dominant flora fossil and several fauna fossil from the Permian-aged Mengkarang Formation (Van Waveren et al.,2018; Booi, 2017). The episode that occurred during the Cisuralian-Guadalupian Permian was also followed by volcanic avalanches forming debris avalanches which were also followed by transitional sedimentation characterized by the presence of sedimentary structures of hummocky-cross lamination structure (see Figure 2b). The existence of Mengkarang Formation sediments comes from the sedimentation of the Paleovolcanic Karing and also pyroclastic tuff from the eruption of the Paleovolcanic Palepat. This statement is supported by the results of pyroclastic age dating in the range about 297.07 Ma-295.58 Ma (Van Waveren et al., 2018). This means that the tuffaceous features in the Mengkarang Formation is dominated by the eruption of the Paleovolcanic Palepat. With evidence it can be explained that the pyroclastic properties or pyroclastic products in the rocks around the Karing River lava originate from the Paleovolcanic Karing at the bottom of the lava and the upper part comes from the Paleovolcanic Palepat eruptions.

3rd Episode. The episode that occurred in the Permian Lopingian was an advanced deformation stage of the Paleovolcanic Karing along with the continuing sedimentation process of the Mengkarang Formation. This sedimentation process continued to the mainland part of the fluviatile system to form a conglomerate with sandstone inserts which is described as the Telukwang Formation with facies relationships fingering at the end or upper part of the Mengkarang Formation and overlying unconformably to the Karing Formation of the Karing Paleovolcanic. Structural processes occurred on the Paleovolcanic Karing to form a half terban or half graben. Conditions like this provide accommodation space for sedimentation covering the lava sequences from the Paleovolcanic Karing products. In the Early Triassic-Middle Triassic phase there was horizontal movement of the trunscurrent system from the West Sumatra Block towards the Sibumasu Block (Metcalfe, 2017; Hall, 2012; 2013; 2008; Hutchison, 2014; 2010; 2005; 2009). This phase causes deformation and metamorphism in rocks from the Paleovolcanic Karing and rocks from the Mengkarang Formation.

4th Episode. During the Late Triassic, the magmatism process occurred which formed the Airbatu Batholith or Dusunbaru Plutonic which formed the granitoid series and the grabbroid series. In this intrusion, basaltic xenoliths to basaltic andesite were found. On this xenolith by (Van Waveren et al., 2018) age of use is determined of zircon inherited identified aged about 304 Ma. This is a great justification, the lava sequence from the Paleovolcanic Karing is of Pennsylvanian Carboniferousiferous age. Teluk Gedang in the southern part of the Karing River at a distance of about 5 km is where this intrusive rock is exposed. In this condition on the Paleovolcanic Karing. The occurrence of a structural process that uses a transtension mechanism to form a normal fault. The deformation process of Paleovolcanic Karing continues to this day, so that less lava and pyroclastic sequences are exposed. The morphology of the Karing River is clearly evidence that the sloping direction of the lava sequence found shows that the sequence was once not very far from the main eruption source of the volcano and currently only medial facies and a few distal facies remain from the Paleovolcanic Karing.

CONCLUSION AND SUGGEST

Based on the results of research using a petrological and geochemical approach to the reconstruction of the Paleovolcanic Karing, it can be explained that this ancient volcano was composed of basalt and pyroclastic lava of Pennsylvanian Carboniferousiferous age until it was close to the beginning of the Permian Cisuralian which was confirmed from volcanic debris. The lava sequence shows that phenocrysts are generally present in the form of plagioclase, olivine, clinopyroxene, orthopyroxene, hornblende with microlite composed of plagioclase, olivine, clinopyroxene and orthopyroxene, with basalt rock types. The results of geochemical analysis on the four lava sequences show a silica range of 49% -50%, which indicates a basalt rock type. This data strongly confirms the rock type from the results of petrographic analysis. The Calk-alkaline basalt magma series is interpreted as the process of volcanic formation resulting from plate convergence, this fact confirms that the West Sumatra Block as the basement of the Paleovolcanic Karing has continental crust with subduction from the Paleo-Pacific oceanic plate. The lava and priocalcistic sequences found in the Karing River can be interpreted as meaning that this ancient volcano is a strato volcano type of volcano, but if you pay attention to the alkaline nature of the rock, the viscosity of the magma is thin, so it will form a shield volcano type of volcano. Thus, it can be concluded that the Purba Karing Volcano is a type of strato volcano with low energy to a shield volcano.

Further research requires subsurface geology of geophysical methods. The aim is to determine the subsurface model of the Paleovolcanic Karing.

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