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THE CHRONOLOGY OF THE VOLCANO SURONDING THE ULUBELU GEOTHERMAL SYSTEM

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ABSTRACT

The Ulubelu geothermal system surrounding by ring of volcano such as Mts. Sulah, Kukusan, Duduk, Kabawok, Tanggamus, Rendingan and Kurupan. Mts. Sulah, Kukusan (3,9 Ma) and Duduk (3,9 Ma) consist of the Pliocene andesitic, basaltic and dacitic volcanoes respectively. These are located in the middle of the study area but their products extend to the west and northwest. Mt. Rendingan pyroclastics within a graben. The Mt. Kukusan lavas are possibly underlain by the Mt. Sulah lavas, aged about 4.5 Ma. Mt. Duduk (3,9 Ma) is a volcano that rises in the center of the Ulubelu caldera. It may be a resurgent dome that was covered by the Rendingan pyroclastics. Mts. Kabawok (1,7 Ma), Tanggamus (1,5 Ma), Rendingan (1,4 Ma) and Kurupan (1,4 Ma) are Pleistocene volcanoes. These occur within the southeast, east, north and northeast parts of the study area respectively. The Mt. Kabawok pyroclastics extend from its summit north and west and partly overlie the Mt. Kukusan lavas. The Mts. Tanggamus laharic breccia and andesite lavas occur in the upper and southeast parts of the area. The Mt. Rendingan pyroclastics and andesite lavas, in the north and northwest, overlie the Mts. Sulah, Kukusan and Duduk lavas that derive from northwest of the central area. The Dacite Tuffs overlie the Mt. Rendingan pyroclastics, the Mt. Kabawok pyroclastics and the Mt. Tanggamus lahars in the north and east sections, but are overlain by the Mt. Kurupan rhyolite lavas close to the Mt. Kurupan summit in the northeastern area.

Key word: geothermal system, ring volcano

INTRODUCTION

The Ulubelu geothermal field occurs near the southern end of the chain of the Bukit Barisan volcanoes that are associated with the Sumatra Fault Zone (Suharno, 2003). It was formerly known as the Ulubelu geothermal prospect (Hochstein and Sudarman, 1993). However, further investigations carried out by Pertamina (unpublished reports) indicate that the prospect extends to the north beneath Mt. Rendingan and southwest of Mt. Waypanas. Suharno (2000) showed there are signs that the hydrothermal system extends beneath Mt. Rendingan and Mt. Waypanas.

The volcanism of the field occurs with volcanic centers aligned NW-SE at the southeast end of the Sumatra Fault Zone. The volcanic rocks derived from a ring of volcanoes comprising Mts. Tanggamus, Kabawok, Waypanas, Kukusan, Sulah, Rendingan and Kurupan; Mt. Duduk is in its center. The field lies in steep terrain between 300 m and 1600 m above sea level (a.s.l.), but the summit of Mt. Rendingan is close to 1700 m. The lowest place, around 300 to 400 m, is located in the southern part of the field, and southern of Mt. Kukusan. The most elevations in its central part are about 700 to 800 m (a.s.l.), the higher volcanic terrains of Mts. Kabawok, Kurupan, Rendingan, Sula and Kukusan (Figure 1) surrounded it.

DATA AND METHOD

Geology and Manifestations

The surface geology in the study area is mostly dominated by products of Quaternary and Tertiary volcanism that are collectively called the Tanggamus volcanics. Alluvium and altered rocks also occur in the southwest of the study area. Most of the surface has been affected by weathering but areas of surface hydrothermal alteration are present in the middle part of the

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study area, close to Pagaralam village within the Ulubelu caldera. These trend from north to south and southwest, parallel to the Belu and Ngarip rivers (Figures 1).

Thermal surface manifestations in the Ulubelu geothermal field consist of fumaroles, hot springs, mud and hot pools. The fumaroles are present at higher elevations in the central part of the area. They are situated close to Mt. Duduk and the villages of Muaradua and Pagaralam (Figure 1). The alkali chloride hot springs are present at lower elevations, from 700 to 400 m (a.s.l.), in the southern part. They are widespread on the southern side of the Ulubelu River and extend to the southwest on the southern slope of Mt. Kukusan. Ulubelu Lake is located in the central part of the prospect area, at mean elevations of about 700 m (a.s.l.), it is outlined by Mt. Duduk and the villages of Muaradua and Pagaralam.

Method

Investigation method conducted due to studied the literature, such as analysis the regional Geological Map. The detail geological survey due to mapping the detail the geological information to classified the lithology and staratigraphy. the gravity analysis using gravity anomalies, first and secondary derivative analysis for indentifying chronologies of lithology and volcanism deposition.

RESULT AND DISCUSSION

Result

The geology of the Ulubelu geothermal system is shown on Figure 1. The surface lithology and stratigraphy comprises Tertiary and Quaternary rocks. The Tertiary consist of Miocene and Pliocene volcanics rocks and the Quaternary consists of Pleistocene and Holocene volcanics deposits see Table 1.

Table 1. Lithology and stratigraphy of the Ulubelu geothermal field.

Relative Ages	Relative Ages	Ages (Ma)	Geology Unit	Association and summary lithology
QUATERNARY	HOLOCENE	± 0.01	Qa	Alluvium (unconsolidated material), boulders, silt, sand & clay
			QAtr	Suficial altered rocks
			QTr	Ranau Formation
	PLEISTOCENE	1.4	Qhkp	Mt. Kurupan pyroclastics
		1.4	Qhdt	Dacite tuff
		1.4	Qhrv	Mt. Rendingan andesite lava
		1.4	Qhrp	Mt. Rendingan pyroclastics
		?	Qhrtv	Mt. Tanggamus andesite lava
		1.5	Qhtb	Mt. Tanggamus laharic breccia
		1.7	Qhkbp	Mt. Kabawok pyroclastics
TERTIARY	PLEINOCENE	3.9	Tpdv	Mt. Duduk dacite lava
		3.9	Tpkv	Mt. Kukusan basaltic lava
		4.5	Tpsv	Mt. Sulah andesitic lava
	MIOCENE	14.7	Tmgr	Granodiorite
		19-20	Tomh	Hulusimpang Formation

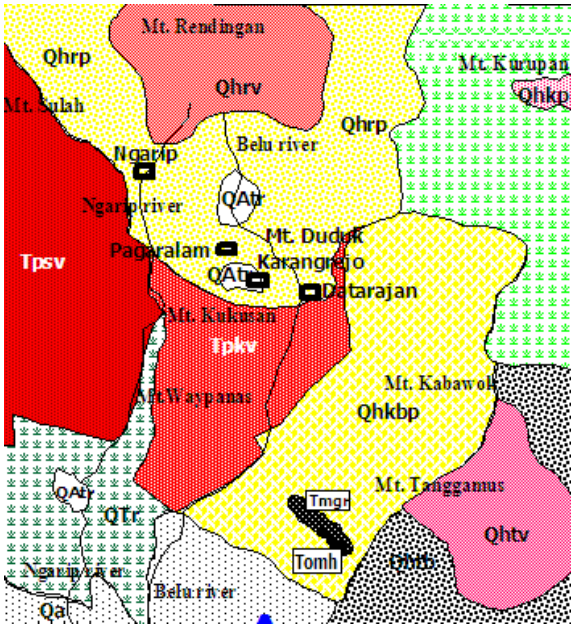

Figure 1. Geological of the Ulubelu geothermal field. Mt. Tanggamus at approximately 2000 m, Mt. Kabawok, at close to 1600 m. The summit of Mt. Rendingan, 1700 m, The Mt. Waypanas is around 300 m. The coordinates are expressed in terms of the Indonesian map (m) standard metric grid referred to as Dittop TNI-AD (1980).

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Discussion

Lithology and Stratigraphy

The lithology of the Ulubelu geothermal field comprises Tertiary and Quaternary rocks. The Tertiary consist of Miocene and Pliocene volcanics rocks and the Quaternary consists of Pleistocene and Holocene volcanics deposits.

The Miocene succession comprises the Hulusimpang Formations (Tomh) and granodiorite (Tmgr) that are widespread below the Kabawok pyroclastics (Figure 1). The Hulusimpang Formation (Tomh) is about 19-20 Ma (Amin et al., 1994) and is inferred to be local basement in this area (see Figure 1). An intrusive granodiorite (Tmgr) is about 14.7 Ma old (Masdjuk, 1997). The Pliocene succession comprises the Mt. Sulah andesite lavas (Tpsv) (4.5 Ma), Mt. Kukusan basaltic andesite lavas (Tpkv) (3.9 Ma) and the Mt. Duduk dacite lavas (Tpdv), 3.9 Ma. These occur in the western and central areas.

The Pleistocene succession is widespread within half of the study area and to the north and northwest. It consists of the Mt. Kabawok pyroclastics (Qhkbp), Mt. Tanggamus laharic breccia (Qhtb), Mt. Tanggamus andesite lavas (Qhrv), Mt. Rendingan pyroclastics (Qhrp Mt. Rendingan andesitic lavas (Qhrv), dacite tuff (Qhdt), and the Mt. Kurupan rhyolitic lavas (Qhkp) (Table 1). Pumiceous tuffs of the Ranau Formation (QTr) are probably of Pleistocene to Holocene age. The Holocene deposits occur in the southwestern part of the area, as indicated by widespread alluvium (Qa).

The Volcanism

The Ulubelu volcanic rocks derived from a ring of volcanoes comprising Mts. Tanggamus, Kabawok, Waypanas, Kukusan, Sulah, Rendingan and Kurupan; Mt. Duduk is in its center (Figure 1). The highest part of the study area is in the southeast, with the summit of Mt. Tanggamus at approximately 2000 m, and nearby the summit of Mt. Kabawok, at close to 1600 m. The summit of Mt. Rendingan, 1700 m in height, is located in the northern part. The lowest area is around 100 to 300 m, southwest of Mt. Waypanas (Figure 1). Most of the central part of the study area is about 700 to 800 m above sea level within the volcanic terrains of Mts. Tanggamus, Kabawok, Waypanas, Kukusan, Sulah, Rendingan and Kurupan.

Mts. Sulah, Kukusan and Duduk consist of the Pliocene andesitic, basaltic and dacitic volcanoes. These are located in the middle of the study area but their products extend to the west and northwest. Suharno (2000) suggested that the Mt. Sulah lavas lie below the Mt. Kukusan lavas, which in turn are buried by Mt. Rendingan pyroclastics within a graben. The Mt. Kukusan lavas are possibly underlain by the Mt. Sulah lavas, aged about 4.5 Ma (Masdjuk, 1997). Mt. Duduk is a volcano that rises in the center of the Ulubelu caldera (Suharno, 2003); it may be a resurgent dome that was covered by the Rendingan pyroclastics.

Mts. Kabawok, Tanggamus, Rendingan and Kurupan are Pleistocene volcanoes. These occur within the southeast, east, north and northeast parts of the study area respectively. The Mt. Kabawok pyroclastics extend from its summit north and west and partly overlie the Mt. Kukusan lavas. The Mts. Tanggamus laharic breccia and andesite lavas occur in the upper and southeast parts of the area. The Mt. Rendingan pyroclastics and andesite lavas, in the north and northwest, overlie the Mts. Sulah, Kukusan and Duduk lavas that derive from northwest of the central area. The Dacite Tuffs overlie the Mt. Rendingan pyroclastics, the Mt. Kabawok pyroclastics and the Mt. Tanggamus lahars in the north and east sections, but are overlain by the Mt. Kurupan rhyolite lavas close to the Mt. Kurupan summit in the northeastern area.

The local basement rocks (Amin et al., 1993), consisting of the breccias and lavas of the Hulusimpang Formation, (Tomh) are widespread in the southwest, southeast and northwest Tanggamus volcanic zone (Figure 1). Their surface distribution in the southwest section is affected by the Semangka fault. Amin et al. (1994) suggested that volcanic rocks are about 1000 m thick cover the basements. These

comprise the Mts. Sulah andesite lavas, Kukusan basaltic andesite lavas, Mts. Kabawok and Tanggamus units, which together are products of Tanggamus volcanism, Rendingan pyroclastics and andesite lavas, and another younger unit, the Mt. Kurupan rhyolite lavas close to the Mt. Kurupan summit in the northeastern area.

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CONCLUSION

The Ulubelu geothermal system is located within high terrain composed of Tanggamus volcanic rocks. It lies along a N-S volcanic trend, from the southern slope of Mt. Rendingan to southwest of Mt. Waypanas, as is indicated by its surface manifestations. These extend to the estuary of the Belu and Ngarip rivers, where outflows of thermal water occur.

The effective basement is early Miocene andesite breccia and lavas of the Hulusimpang Formation (Tomh) which are relieved to be buried by about 1000 m thick products from Pliocene and Pleistocene volcanoes. Granodiorite (Tmgr), of about Mid Miocene age (14.7 Ma), intrudes the basement in the area close to Mts. Kukusan and Waypanas. A hiatus followed deposition of the Mt. Sulah andesitic lavas (Tpsv), (4.5 Ma) shown by the present of a layer of black clay (Kemah, 2001). This ended with deposition of either the Mt. Kukusan basaltic andesitic lavas or younger material. Trending structures, mostly NW-SE and NE-SW, are dominated by strike slip and normal faults.

The primary minerals of several lithologies in the Ulubelu is, mostly andesitic rocks, some rocks have altered hydrothermally, but almost all are weathered. Surface thermal manifestations extend from southern Mt. Rendingan to southwest of Mt. Waypanas (Suharno, 2003).

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