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Radiometric age of Kampung Awah andesite

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Abstract: The age of andesite from Kampung Awah in particular and the Peninsular Malaysia in general, is reported as Upper Permian. A sample from Kampung Awah andesite was sent for K-Ar radiometric dating. The result obtained is 269±46 Ma or Middle Permian age. The result indicates that contrary to earlier belief, the andesite of Kampung Awah was extruded earlier, viz. in Middle Permian and that limestone was subsequently deposited on the cooled andesite much later, in the Upper Permian period. An older age for the andesite is also supported by field and petrological evidences.

Abstrak: Usia andesite Kampung Awah khususya dan bagi Semenanjung Malaysia umumnya dianggap sebagai Perm Atas. Suatu sampel andesit dari Kampung Awah telah di hantar untuk di buat penentuan usia secara radiometri K-Ar. Hasil diperolehi ialah usia 269±46 juta tahun atau Perm Tengah. Hasil ini menunjukkan, berbeza daripada pandangan lalu, bahawa andesit Kampung Awah menerobos ke permukaan lebih awal iaitu pada Perm Tengah, diikuti kemudian dengan pengendapan batu kapur di atas andesit yang telah sejuk, pada Perm Atas. Usia lebih tua bagi andesit ini disokong oleh bukti-bukti lapangan dan juga petrologi.

INTRODUCTION

Andesite is a grey to black volcanic rock with between 52 and 63 weight percent silica (SiO_2). It contains crystals composed primarily of plagioclase (andesine) feldspar and one or more of the pyroxene minerals (clinopyroxene and orthopyroxene) and lesser amounts of hornblende (USGS Photo Glossary, 2004). It is abundant in collision zones such as in the Andes (hence the name andesite), Japan and the Western Pacific islands. In Peninsular Malaysia andesite distribution is widespread, from Kuala Krai in Kelantan in the north, through Pahang, to Kluang in Johor in the south.

The Kelantan andesite, according to MacDonald (1967), is porphyritic, green and purple with grey-green and black variety, generally fine-grained and containing abundant pyroxene penocrysts, or both pyroxene and feldspar phenocrysts, or more rarely, feldspar phenocrysts only, set in a groundmass, usually holocrystalline, of feldspar, pyroxene and opaque minerals. MacDonald (1967) did not give a specific age for the Kelantan andesite but he included them in Triassic to Carboniferous sedimentary sequences. The andesite of Kelantan and Trengganu is remarkably uniform and shows no essential difference from the same type of rocks found in central and north Pahang.

In Pahang, andesite occurrences are found in the north, central and the western parts. Richardson (1950) mentioned andesite occurrences at Sungai Kasai Kechil and Kuala Medang in North Pahang. At the former site, andesite was described as massive, fine-grained jointed rock, traversed by veinlets of calcite and quartz. In Central Pahang, andesite can be found between Temerloh and Maran, with the Kampung Awah quarry as a typical example (Figure 1). The Kampung Awah andesite quarry is a readily accessible locality well-known among local geologists. Several outcrops of andesite can also be observed along the Maran-Jerantut road.

Andesite from Kampung Awah quarry is a dark green, medium-grained porphyritic rock, with phenocrysts of plagioclase, pyroxene and hornblend. Microscopic study shows the presence of plagioclase, sometimes zoned, pyroxenes, hornblende and calcite in a fine-grained groundmass. Calcite is present in two forms. In the first form it occurs as irregular masses of late mineral replacing earlier-formed minerals or as infilling in between grains of earlier minerals (Figure 2). In the second form calcite occurs as tiny veinlets cutting through earlier minerals.

An analysis of major element percentages in the Kampung Awah andesites is provided in Muhammad Barzani *et al.* (2003) giving the composition as follows: SiO_2(48.03-50.24), Fe_2O_3 (11.48-12.69), Al_2O_3 (13.66-17.95), CaO (5.96-11.64), MgO(5.53-7.53), Na_2O (2.85-3.40), TiO_2 (0.85-1.25), K_2O(1.00-2.14) and P_2O_5(0.20-0.36).

REPORTED AGE OF ANDESITES IN PENINSULAR MALAYSIA

In their schematic correlation chart of volcanic and pyroclastic activities in Peninsular Malaysia, Gobbett and Hutchison (1973) gave three distinct ages for the andesites. The oldest is the andesite agglomerate of Genting Sempah, assigned to Lower Paleozoic (Ordovician) age. The Kampung Awah, Central Pahang, Kelantan and Terengganu andesites are assumed to be of Upper Permian age whilst

Table 1. Results of the age determination ($^{40}Ar^*$: as diogenic ^{40}Ar).

Rock	Dated mineral	K (%)	$^{40}Ar^*$(∞1.E-10 Mol/G) $^{40}Ar^*$ / ^{40}K	Age m.y.±STD	Geological Age
Kampung Awah Andesite	Pyroxene	0.0299	0.015068±17.12390% 0.016869	269.17±46.11	Middle Permian Wordian stage

those related to the Gagau Group are Mesozoic (Jurassic) in age. These ages have not been determined by radiometric dating and are based on fossil evidences. The Upper Permian age is based on fusulinid fossils found in the limestone of Kampung Awah quarry and its neighbouring outcrops. " At Kampung Awah, limestone and andesite have intimate relationship. Small fragments of limestone and individual fossils occur in the lava, and blebs of lava appear to be contained within the limestone. Thus it would be seen that the lava was extruded onto the sea bed during the deposition of limestone (Gobbett, 1973). The limestone, based on *Pseudofuslina gobetti* fusulinid evidence, was established as Upper Permian (Igo, 1967). Malayan fusulinids in general, from the Geological Survey of Malaysia's fusulinid collections, were Middle to Late Permian in age (Toriyama, 1984). Based on the andesite from Kampung Awah, the general age of the andesites in Peninsular Malaysia was then taken as Upper Permian.

RADIOMETRIC AGE DATING OF THE KAMPUNG AWAH ANDESITE

During a recent visit to the quarry, a sample was collected for radiometric dating. The sample was crushed into fine fractions and then sieved using –36 mesh sieve. The fractions retained were then recrushed and cleaned using sieves of –72 ± 150 and –100 ±150 mesh sizes. Pyroxene was obtained from the fraction using a magnetic separator and heavy liquid, giving a final sample of 96% purity.

Age determination of the andesite was performed in the Geochronology Laboratory, Geological Research and Development Centre, Research and Development Agency and Mineral Resources of the Ministry of Energy and Mineral Resources, Bandung, Indonesia. The dating was based on the K-Ar method, by measurement of K and Ar from pyroxene.

Potassium content in the pyroxene was measured by flame photometer M7D in duplicate, which has the ability to measure potassium concentrations up to 15% following the method described by Cooper (1963). Argon was extracted from the mineral sample by fusion in a high vacuum system, and measured by VG 3600 Isotech mass spectrometer.

RESULTS AND DISCUSSION

From the K-Ar radiometric age determined in the present work, the age of the Kampung Awah andesite is now found to be 269±46.11 Ma (Table 1). According to the 2002 International Stratigraphic Chart of the IUGS, 269

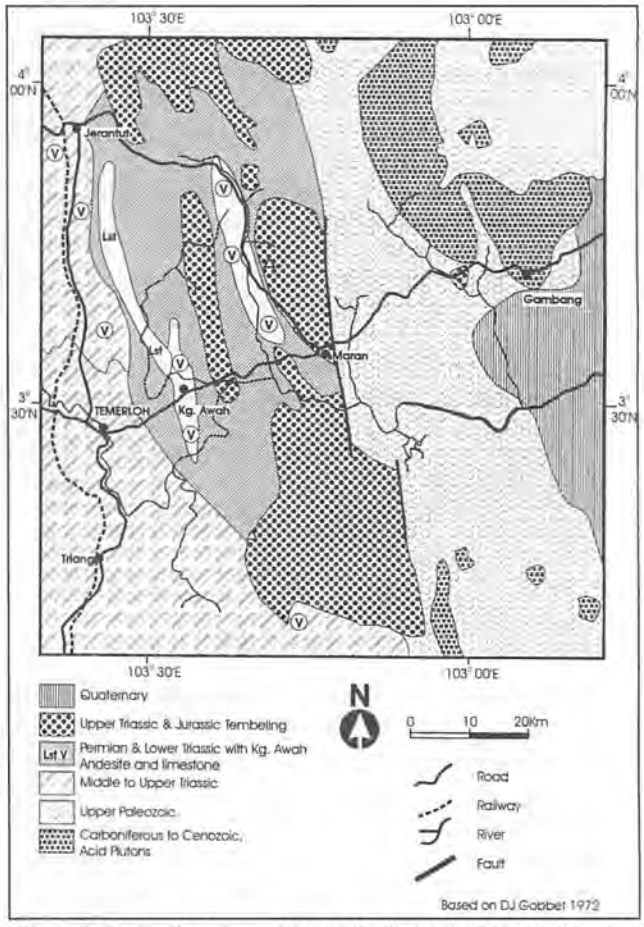

Figure 1. Geological map of Central Pahang showing the location of Kampung Awah (Kg. Awah) andesite quarry.

Ma can be further narrowed down to Wordian stage. It now appears that the andesite was extruded much earlier, in Middle Permian, rather than Upper Permian, through Lower Permian sediments. The limestone, from fossil evidence is found to be of Upper Permian age, was deposited after the andesite extrusion had ceased and cooled in the Middle Permian. It infilled the undulating andesite surfaces and the void spaces between the andesite clasts. Further mixing of andesite and the limestone possibly by talus movement would render the two rock types very intimate. The small limestone fragments and individual fossils occurring in the lava described by Gobbett (1973) could be lime mud or fossil accumulations in the voids of the uneven andesite surfaces and fracturing at certain directions makes it looks like an included piece.

Furthermore, field evidences suggest that the andesite is earlier. The Kampung Awah limestone is dark coloured, fine-grained and show very little signs of being metamorphosed. The limestone-andesite contact is always

sharp and the limestone grains immediately along the contacts are usually fine grained (Figure 3). Had the limestone been deposited earlier and extruded by the hot andesite some form of metamorphism such as recrystallization or the formation of skarn minerals would be expected. Signs of metamorphism or development of skarn minerals are both lacking. It would be expected that the fusulinids and other fossils would be badly deformed or recrystallized if the limestone had been extruded by the hot andesite, but Igo (1967) did not mention any deformation of the fusulinids. Calcite replacing earlier formed minerals, as observed under the microscope and mentioned above is another evidence suggesting that the limestone is later than the andesite.

Volcanic rocks that were extruded in Upper Permian Pahang are chemically different, being more acidic. For example, the volcanics of Lanchang is rhyolitic in composition closer to the Triassic granites. The Kampung Awah andesite, with 48-52% SiO_2 is more likely to be affiliated to an older volcanic activity.

With respect to the chemical composition of the Kampung Awah andesite, analysis by Muhammad Barzani *et al.* (2003) reported that SiO_2 contents of 48 to 52 weight percent is too low for andesite. This composition is nearer to that of basalt. When plotted on the TAS diagram of Le Maitre *et al.* (1989), the Kampung Awah andesite actually falls into the basalt field (Figure 3).

CONCLUSION

Radiometric K-Ar dating reveals that the age of the Kampung Awah andesite is 269 Ma corresponding to Middle Permian rather than Upper Permian as previously believed. Field and petrological evidences also indicate that the andesite extruded earlier than the limestone.

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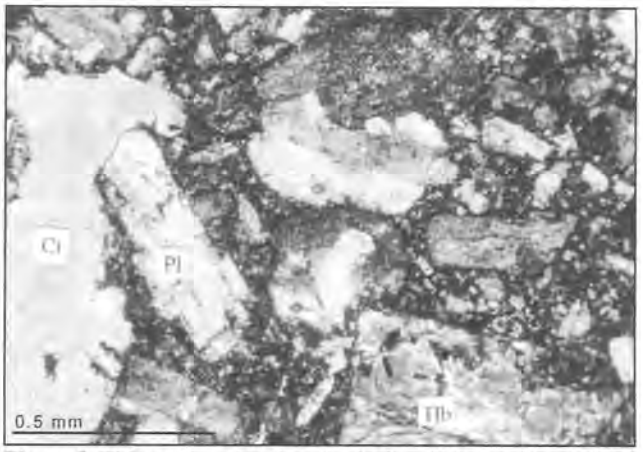

Figure 2. Thin section showing plagioclase (Pl), hornblende (Hb) and calcite (Ct) in a fine-grained groundmass. Note the irregular calcite masses replacing earlier-formed minerals. Crossed nicols.

Figure 3. Limestone (Lst) - andesite (And) contact is sharp and show no sign of recrystallization or the formation of skarn minerals.

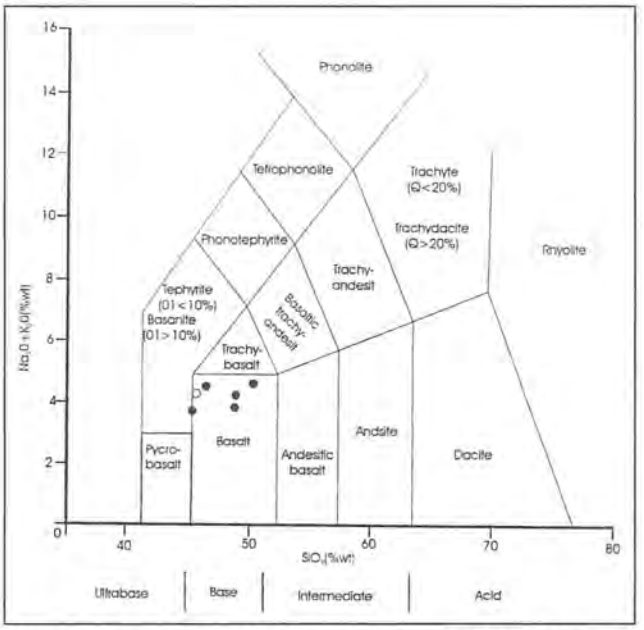

Figure 4. Composition of the Kampung Awah andesite plotted on TAS diagram of Le Maitre *et al.* (1989) showing a basaltic composition of the andesite.

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