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Age Determination on the Bukit Paloh Adamellite

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Abstract: K-Ar and Rb-Sr age determinations on the Bukit Paloh adamellite, which occurs near Sungei Lembing in Pahang, have given widely discordant results indicating a complicated tectonic history but suggesting that the adamellite was emplaced into Lower Carboniferous (Viséan) strata during Upper Carboniferous time.

INTRODUCTION

A large number of age determinations on West Malaysian rocks by both the K-Ar and Rb-Sr methods have been made by the Isotope Geology Unit of the Institute of Geological Sciences (London) in co-operation with the Geological Survey of Malaysia, and a small group of samples was also dated by the Australian Bureau of Mineral Resources at Canberra. The results of some of these determinations have been listed in the Annual Reports of the Institute of Geological Sciences (Anon., 1966) and of the former Overseas Geological Surveys (Snelling, 1965). The results of K-Ar and Rb-Sr determinations performed since those listed in these two annual reports have not been published. However a summary of the more recent data has recently been given by Snelling *et al.* (1968) who have shown, largely on the basis of Rb-Sr whole rock determinations, that major episodes of granite emplacement occurred during the Upper Carboniferous at 285 ± 7 m.y., during the Upper Permian - Lower Triassic at 230 ± 6 m.y. (Webb and McDougall, 1967), and during the Upper Triassic at 200 ± 3 m.y., and that granite intrusion also occurred during the Upper Cretaceous at 75 ± 1 m.y.. More recently Burton and Bignell (1969) have shown that granite of similar age occurs in peninsular Thailand where, in addition, there also appears to have been an intrusive event at 112 m.y..

Alexander (1962) published the results of West Malaysian monazite, galena and lepidolite determinations made by the National Physical Laboratory, Pretoria, South Africa, and by the Atomic Energy Establishment, Harwell, England.

A small number of age determinations have also been made on rock samples submitted to the Isotope Geology Unit of the Institute of Geological Sciences by members of the department of Geology of the University of Malaya, and some of these results have been published (Dhonau and Hutchison, 1966; Anon. 1966). The purpose of this note is to record the results of age determinations on a sample of the Bukit Paloh adamellite, collected by Mr. C.W.E.H. Smith of the Pahang Consolidated Co. Ltd., Sungei Lembing, and now forming part of the collection of the Geology Department of the University of Malaya (specimen no. 3963). This specimen was obtained by blasting a core boulder of size $8 \times 8 \times 2$ feet in the Sungei Linchong (Bukit Paloh) to the north of Sungei Lembing in the district of Kuantan, Pahang. The exact location is:

N. 4° 03′ 45″, E. 103° 03′ 00″. Grid reference on the 1:63,360 topographic map L7010 edition I-DNMN, sheet 72, is E. 275, N. 075.

RADIOMETRIC RESULTS

Age determinations were made on the rock itself, on its K-feldspar, and on its biotite; the analytical data are given in table 1 and an $^{87}Sr:^{86}Sr$ ratio evolution diagram in fig. 1. Also listed in table 1 are the various apparent Rb:Sr ages that can be calculated for a selection of different initial $^{87}Sr:^{86}Sr$ ratios. It will be seen that the whole rock and K-feldspar Rb-Sr apparent ages are very dependent on the assumed initial $^{87}Sr:^{86}Sr$ ratio. Using an initial $^{87}Sr:^{86}Sr$ ratio of 0.708 (a reasonable assumption for Malayan granites; see Snelling *et al.*, 1968) strongly discordant ages are obtained suggesting that there has been movement of Rb and/or Sr from one mineral to another since cessation of magmatic crystallisation. However the K-Ar result on the biotite sets a relatively unambiguous minimum age of 240±8 m.y. to this granite. Viewed in the context of the plutonic history outlined by Snelling *et al.*, (1968), it would appear that this granite could well belong to the Upper Carboniferous intrusive episode and, assuming initial $^{87}Sr:^{86}Sr$ ratios in the range 0.708–0.710, the whole rock apparent ages that can be calculated are not inconsistent with this view.

Table 1. Age Determination on The Bukit Paloh Adamellite
I.R. = Initial $^{87}Sr:^{86}Sr$ ratio.

Rb:Sr results

Sample	Rb ppm.	Sr ppm.	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	Age m.y.		
					I.R. = 0.710	I.R. = 0.708	I.R. = 0.705
Total rock	214.0	231.8	2.676	0.7207	270±60	320±60	395±60
K-Feldspar	371.2	156.0	6.912	0.7312	210±35	225±35	255±35
Biotite	633.9	12.19	156.7	1.1418	186±5	188±5	189±5

K:Ar results

Sample	%K	ppm. rg^{40}Ar	Age m.y.
Biotite	6.51(5)	0.118	240±8

Despite fairly extensive sampling, no granite samples unambiguously older than Upper Carboniferous have so far been dated from the Thai-Malay peninsula and, pending evidence to the contrary, the assumption is here made that the Bukit Paloh adamellite belongs to the Upper Carboniferous intrusive episode. The Rb-Sr mineral ages and the K-Ar biotite age are assumed to reflect movement of the respective parent and daughter isotopes initiated by thermal effects of the later granite intrusions (at *circa* 230 & 200 m.y.). The intersection of the biotite, K-feldspar, and total rock

FIGURE I

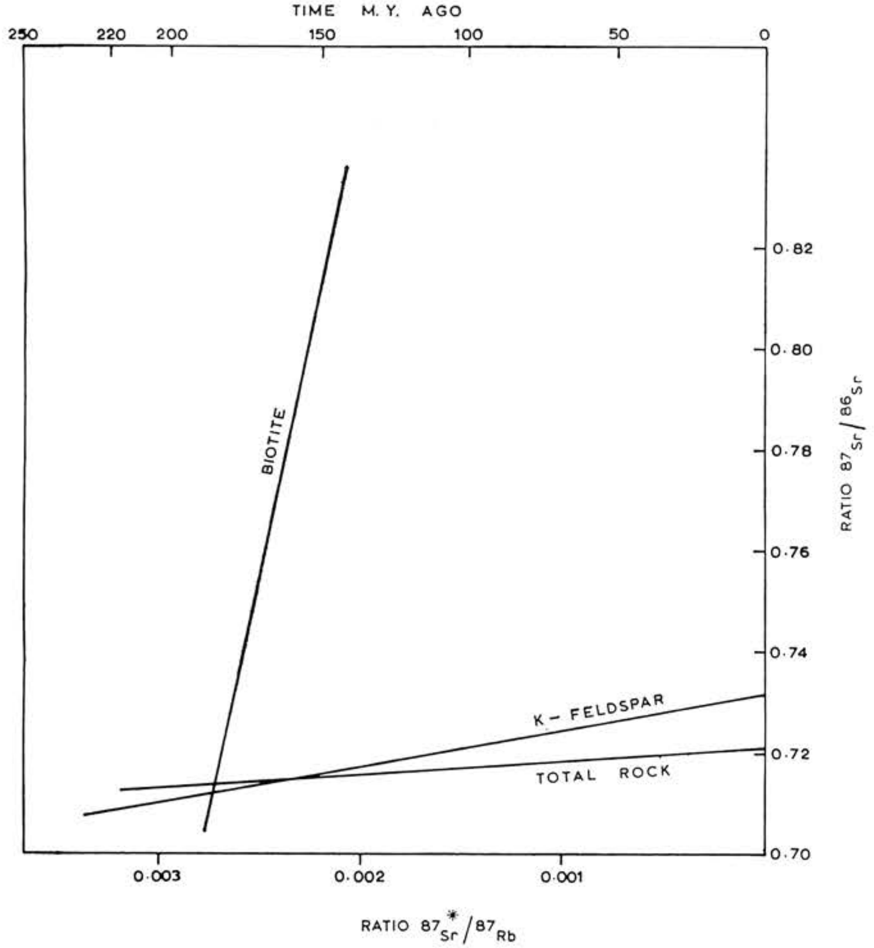

Fig. 1. Strontium isotope evolution diagram for analysed material from the Bukit Paloh adamellite. The asterisk implies radiogenic ^{87}Sr. The ^{87}Sr*/^{87}Rb ratio is linear. The time scale is not linear, but in this age-range the departure from linearity is minimal.

^{87}Sr:^{86}Sr growth lines at about 180 m.y. indicates that movement of Rb and Sr continued until this time. Cessation of Rb and Sr movement at about 180 m.y. must thus correspond approximately to the time of unroofing of many of the Malayan granites, an event which in effect marks the end of the geosynclinal sedimentation and the onset of deposition of the molasse-like Tembeling Formation.

PETROGRAPHY

The rock is a *porphyritic micro-adamellite* (quartz monzonite), grey coloured, not obviously porphyritic in hand specimen, but clearly porphyritic in thin section. Phenocrysts are up to 4 mm long and are abundant in a fine grained groundmass of about 0.3 mm grain size. The largest phenocrysts are of plagioclase. Alkali feldspar is usually confined to the groundmass. Plagioclase averages An_{20} in composition and is strongly zoned. Some plagioclase is sericitised, but only in the centres of the crystals. The alkali feldspar is orthoclase or untwinned microline and is only slightly micro-perthitic. Biotite is only slightly chloritized. There is a trace of apatite.

mode: Volume %: 14,180 points counted on slides stained by the method of Bailey and Stevens (1960): plagioclase 32; sericite formed from plagioclase 3; (total plagioclase 35): K-feldspar 26; quartz 29; biotite 10; apatite 0.2; opaque minerals trace.

CHEMICAL ANALYSIS (Weight %)

SiO_2 67.5; TiO_2 0.37; Al_2O_3 15.6; Fe_2O_3 0.45; FeO 3.91; MnO 0.09; MgO 0.53; CaO 2.74; Na_2O 3.02; K_2O 3.97; H_2O+ 0.60; H_2O- 0.28; CO_2 0.26; P_2O_5 0.17 Total 99.49 (analysis by the Geological Survey of Malaysia, Ipoh).

GEOLOGICAL SETTING

The Bukit Paloh adamellite is shown as intrusive into a sequence of shale with subordinate siltstone and quartzite on the 1:63,360 geological map of the Bundi area (Accompanying Fitch, 1952). Several fossil collections from this shale sequence, and from intercalated limestone lenses only a short distance to the south and southwest of Bukit Paloh prove conclusively that the strata are of Lower Carboniferous (Viséan) age (Fitch, 1952).

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