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A Note on some K/Ar Ages of Biotites from the Granites of Penang Island, West Malaysia.

by *Tai-Seong, Kwan**

Abstract

Two plutons have been distinguished in the granites of Penang Island, West Malaysia, according to the findings of a recent field survey carried out in 1982. The results of K/Ar analyses of thirty-one samples of biotites from these rocks indicated the influence of rejuvenation on a regional scale. A general decrease of apparent biotite ages in a south-southeasterly trend from 209 ± 2 Ma to 160 ± 2 Ma is evident. K/Ar ages of micas from the previous work of BIGNELL and SNELLING (1977) agreed generally with those of the present study. Comparison of these K/Ar ages with published Rb/Sr data show that for the younger granite, results from the present study support the Rb/Sr age of 200 ± 7 Ma. For the older granite, the newly determined K/Ar ages between 180 and 199 Ma are substantially younger than the published Rb/Sr whole-rock isochron age of 286 ± 10 Ma. This lack of concordance of K/Ar and Rb/Sr ages suggests that the Rb/Sr systems may have been affected by the observed widespread hydrothermal and localised pneumatolytic activities, as demonstrated by BIELSKI et al. (1979) in Southern Sinai. Further investigation involving U/Pb analysis on zircons and fission track work on zircons and apatites and Rb/Sr analysis on minerals would permit a detailed resolution of the thermal history of the study area.

Keywords: K/Ar Ages of biotites, granites, West Malaysia

INTRODUCTION

The island of Penang is situated just off the northwest coast of West Malaysia. It is bounded by latitudes 5° 15'N and 5° 29'N, and longitudes 100° 10'E and 100° 21'E. Granites represent the only type of bedrock on the island, and these exhibit both textural and mineralogical variations. A team comprising geologists from the Institute of Geological Sciences, London, and the Geological Survey of Malaysia carried out a reconnaissance survey in 1982 and suc-

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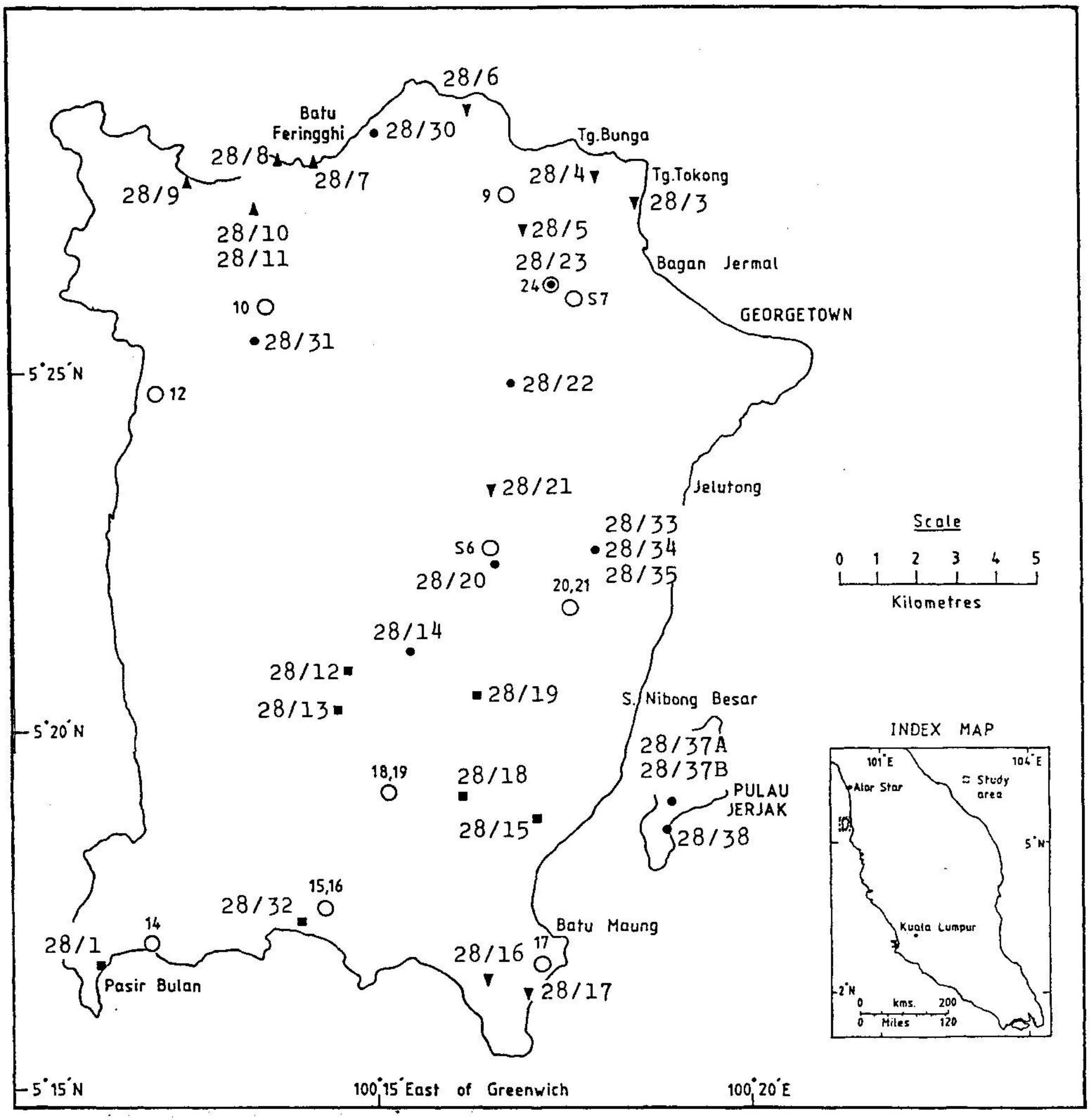

Fig. 1 Location map of Penang Island showing sample sites, numbers, and granite types. Filled inverted triangles denote the Bunga type, filled upright triangles the Feringghi type, and filled circles, the Bunga/Feringghi gradational type. Samples of the two-mica granite are represented as filled squares. Samples 28/11, 28/18, 28/33, and 28/37A are finer grained varieties. Open circles show the sample locations and numbers of BIGNELL and SNELLING (1977).

ceeded in dividing these rocks into two main plutons (personal communications, Mr. F.L. YAP) (see Fig. 1).

The southern half of the island, except for the southeastern protrusion is predominantly made up of a medium to coarse-grained, megacrystic muscovite-biotite granite which exhibits a crude, subparallel orientation of the feldspar megacrysts. From field evidence, this two-mica granite appears to be the older of the two plutons in the study area.

The second pluton occupies the northern half of the island, and the southeastern protrusion of Penang in addition to Pulau Jerjak, a small island off its southeastern coast. Although this body shows considerable textural variations, two end members are distinguishable. In the northeastern portion and the southeastern tip, a coarse-grained megacrystic biotite granite predominates. The distinctive texture of this so-called Bunga type is manifested by the linkage of large quartz globules to form chains. The other granite type has a more restricted distribution in the northwestern part where it is represented by a medium to coarse-grained, sparsely megacrystic biotite granite with traces of muscovite. This is referred to as the Feringghi type, and differs from the Bunga type in that the quartz tend to form isolated grains within the groundmass. Apart from these type localities, elsewhere on Penang and Pulau Jerjak, this pluton outcrops as a gradational type between the Bunga and Feringghi end members.

The influence of hydrothermal activity is widespread as is evident from the chloritisation of biotites to varying degrees. Pneumatolysis, indicated by the presence of tourmaline is more localised.

Structurally, two major trends of faulting have been noted, viz. north-south and northeast-southwest.

PREVIOUS GEOCHRONOLOGICAL WORK.

BIGNELL, J.D. and SNELLING, N.J. (1977), included the Penang granites in their overall geochronological study of the Malayan granites. Analytical data for both K/Ar and Rb/Sr were presented for a total of fourteen samples from eleven localities on the island (see Fig. 1).

Two isochrons were defined from the Rb/Sr analyses, viz. (i) 286 ± 10 Ma, Ri = 0.7105 ± 0.0026, and (ii) 200 ± 7 Ma, Ri = 0.7088 ± 0.0038. The older age was obtained from four total rock samples from the southwestern block while the younger isochron was defined from three total rock and mineral samples from the eastern block. The remaining Rb/Sr data plotted between these two isochrons, and were interpreted as indicative of either one or two intrusive events at about 245 Ma and 220 Ma or a younger intrusion at about 200 Ma characterised by high and variable $^{87}Sr/^{86}Sr$ ratios ranging from 0.71 to 0.72.

Most of their K/Ar apparent ages on biotites and muscovites were found to centre around 190 Ma. This observation was considered to further substantiate their views of an important intrusive episode during the Triassic/early Jurassic period.

METHODOLOGY

For the present study, a total of thirty-one samples (30 kg. each) were collected and conventional methods of sample treatment involving heavy liquids and magnetic separation were employed to obtain biotite concentrates. The 60 to 80 ASTM mesh size was selected for radiometric age determinations. Potassium analyses were carried out in duplicate using a Beckmann flame photometer (PURDY and JÄGER, 1976). The argon isotopic compositions were measured by the isotope dilution technique with a MM 1200 mass spectrometer operating in the static mode (FLISCH, 1982), employing an enriched ^{38}Ar spike. K/Ar ages were computed using the IUGS recommended constants (STEIGER and JÄGER, 1977). The error on the potassium determinations is about 1% while that for the K/Ar age computations is less than 1.5%.

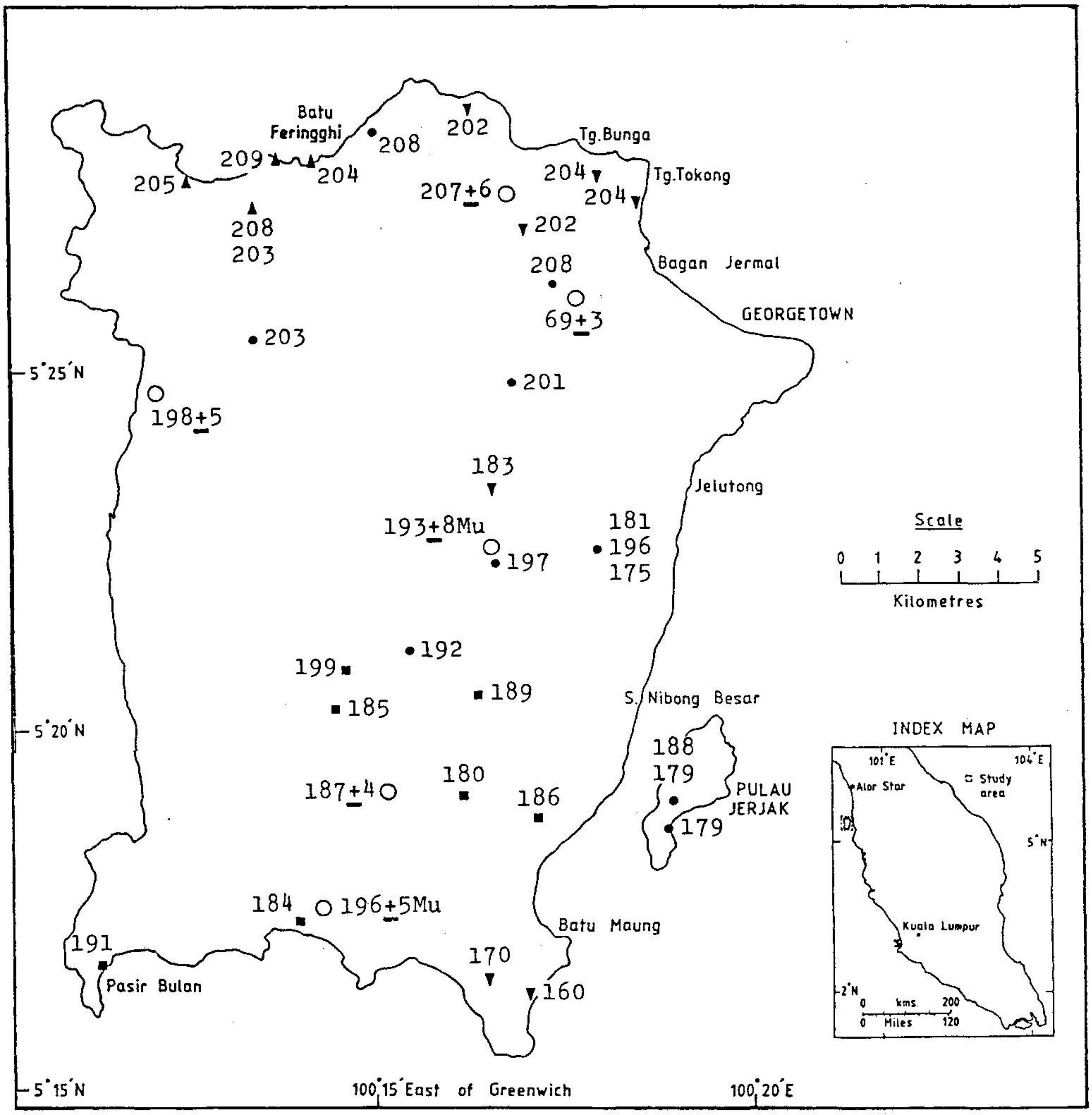

Fig. 2 Distribution map of K/Ar ages on micas. Symbols similar to those used in Figure 1 denote the different types of samples. Figures indicate the apparent mica ages in Ma. Unless otherwise shown, the error in the age computation is ± 2 Ma. The letters Mu appearing at the end refer to a muscovite age. All other ages are of biotites. Mica ages from BIGNELL and SNELLING (1977) have been recalculated using the new constants recommended by STEIGER and JÄGER (1977).

Table 1 Analytical data and K/Ar biotite ages of granites from Penang Island, West Malaysia.

Sample No.	% K	ppm $^{40}Ar_{rad}$	% $^{40}Ar_{rad}$	Age in Ma (± 1σ)
BUNGA TYPE				
28/3	7.39	0.1106	96	204 ± 2
28/4	7.30	0.1091	95	204 ± 2
28/5	7.26	0.1074	97	202 ± 2
28/6	7.26	0.1075	97	202 ± 2
28/16	6.97	0.0864	97	170 ± 2
28/17	7.17	0.0832	94	160 ± 2
28/21	6.44	0.0861	95	183 ± 2
FERINGGHI TYPE				
28/7	6.75	0.1012	93	204 ± 2
28/8	6.37	0.0980	96	209 ± 2
28/9	6.52	0.0981	95	205 ± 2
28/10	5.99	0.0917	97	208 ± 2
28/11	6.24	0.0929	97	203 ± 2
BUNGA/FERINGGHI GRADATIONAL TYPE				
28/14	6.77	0.0949	96	192 ± 2
28/20	5.95	0.0861	93	197 ± 2
28/22	6.18	0.0912	96	201 ± 2
28/23	6.56	0.1005	94	208 ± 2
28/30	6.67	0.1019	97	208 ± 2
28/31	6.80	0.1014	96	203 ± 2
28/33	5.34	0.0705	94	181 ± 2
28/34	6.27	0.0902	96	196 ± 2
28/35	6.56	0.0837	95	175 ± 2
28/37A	6.57	0.0901	97	188 ± 2
28/37B	6.81	0.0890	96	179 ± 2
28/38	5.80	0.0759	90	179 ± 2
TWO-MICA TYPE				
28/1	7.35	0.1025	94	191 ± 2
28/12	6.52	0.0951	95	199 ± 2
28/13	4.60	0.0621	94	185 ± 2
28/15	7.17	0.0974	95	186 ± 2
28/18	5.74	0.0754	95	180 ± 2
28/19	6.58	0.0911	96	189 ± 2
28/32	6.95	0.0932	95	184 ± 2

RESULTS

Table 1 summarises the K/Ar analytical results, and the areal disribution of the apparent biotite ages is shown in Figure 2.

The spread of the biotite ages, considered collectively, suggest a regional influence resulting in a general decrease of ages in a south-southeasterly direction (see Fig. 2). In the northern third of the island, apparent ages of between 201 ± 2 Ma and 209 ± 2 Ma were measured, whereas lower values ranging from 191 ± 2 Ma to 199 ± 2 Ma were obtained in the middle third and the southwestern coast, except for sample 28/21 which gave an apparent age of 183 ± 2 Ma. Apparent ages for the remaining southeastern portion including Pulau Jerjak fall between 160 ± 2 Ma and 189 ± 2 Ma.

The K/Ar ages of micas from this study generally agreed with those of BIGNELL and SNELLING (recalculated using the new constants of STEIGER and JÄGER, 1977), except for their anomalously young biotite age of 69 ± 3 Ma for sample S7.

Comparing with their Rb/Sr results, concordant K/Ar biotite ages were encountered only in the northern part where they have defined a 200 ± 7 Ma isochron. It is pertinent to point out here that a similar isochron of 200 ± 17 Ma was defined for fine to medium-grained biotites in the adjacent part of the mainland (Penanti/Bt. Mertajam) just east of the study area. However, no K/Ar biotite ages comparable to their older 286 ± 10 Ma isochron have been measured in the southern portion of the island, thus suggesting the effects of total rejuvenation of the K/Ar system in this older two-mica pluton.

One may be tempted to state that there is evidence now that the 200 ± 7 Ma isochron represents the true age of the younger pluton, but the widespread influence of hydrothermal activity necessitates a more critical review of the validity of this conclusion. The effects of hot fluids on the Rb/Sr system have been shown for the Wadi Kid Pluton of the Iqna Granite in Southern Sinai (BIELSKI, M., JÄGER, E. and STEINITZ, G., 1979). The mineral isochron from any given granite sample yielded a lower age and a higher $^{87}Sr/^{86}Sr$ ratio when compared with the total rock isochron.

In the light of these findings, it is doubtful now that the 200 ± 7 Ma isochron of BIGNELL and SNELLING which was defined using mixed data (total rock and mineral) actually reflect the true age of the younger intrusion in tha study area.

CONCLUSIONS.

The overall pattern of distribution of K/Ar ages of biotites is suggestive of the imprint of a later event on a regional scale. Widespread chloritisation of biotites and their generally low %K support this observation. Under these condi tions, the Rb/Sr system can be affected, thus creating an uncertainty in the validity of intrusion ages given by the resultant isochrons. There is clearly a need, therefore, to include other methods of investigation such as U/Pb on zircons and fission track work on zircons and apatites in order to gain a better insight into the temporal aspects of events in the study area. Rb/Sr analysis of minerals is equally important in dating the time of the regional influence.

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