Malaysian Journal of Science **27** (3): 7 - 11 (2008)

Field and Petrographic studies of Granite from Pulau Jarak and Pulau Sembilan, Peninsular Malaysia

Azman A. Ghani

Department of Geology, Faculty of Science, University of Malaya 50603 Kuala Lumpur
azmangeo@um.edu.my

ABSTRACT Jarak and Sembilan islands are the westernmost islands off the mainland of Peninsular Malaysia. Both islands are underlain by granitic rock. Field and textural characteristics of the granites are similar to the tin bearing Main Range granite of Peninsular Malaysia. Structural features such as occurrence of tourmaline pods, accumulation of the large pegmatitic K-feldspar and occurrence of aplopegmatite complex suggest that the granite magma is highly evolved. Both islands are made up of porphyritic to coarse grained biotite granite. The grain size of K-feldspar phenocryst can be up to 4 cm across. The granite is made up of quartz (35%), plagioclase (19%), K-feldspar (43%), biotite (4.5%) and can be classified as monzogranite to syenogranite. Subhedral to anhedral biotite is the main mafic phase. The granitic rocks from Jarak and Sembilan occupy a central area of the QAP diagram. Granites plotting in this area have been regarded as crustal melts and this suggests the importance of crustal material in the source rocks of those plutons. The importance of crustal material in the source rock is supported by the occurrence of metasedimentary enclave. This may suggest that the Jarak and Sembilan magmas are derived from partial melting of the sedimentary rock e.g. pelitic rocks.

ABSTRAK Pulau Jarak dan Pulau Sembilan adalah pulau Semenanjung Malaysia yang paling ke-barat. Kedua-dua pulau ini dilapisi oleh batuan granit. Ciri-ciri lapangan dan tekstur menunjukkan batuan granit di kedua-dua pulau ini adalah sama dengan batuan granit kaya timah Granit Banjaran Utama. Struktur seperti pod tourmalin, pengumpulan K-feldspar dan aplopegmatit mencadangkan bahawa magma untuk batuan granit Jarak dan Sembilan adalah sangar terevolusi. Kedua dua pulau ini dibentuk oleh batuan granit biotit berbutir kasar ke porfiritik. Saiz butiran fenokris K-fedlspar boleh mencapai sehingga 4 sm. Mineralogi batuan granit ini terdiri dari kuartz (35%), plagioclase (19%), K-feldspar (43%), biotit (4.5%) dan boleh dikelaskan sebagai monzogranit dan syenogranit. Biotit subhedral ke anhedral merupakan fasa mafik yang utama. Batuan granit dari Pulau Jarak dan Sembilan diplotkan dibahagian tengah dalam gambarajah QAP yang mencadangkan magma batuan granit ini berasal dari leburan kerak. Kepentingan bahan kerak di dalam batuan punca disokong oleh kewujudan enklaf metasedimen. Ini mencadangkan magma batuan granit Pulau Jarak dan Sembilan berasal dari leburan separa batuan sediment contohnya batuan pelit.

(petrographic, granitic rocks, metasedimentary enclaves)

INTRODUCTION

The study area included the Jarak and Sembilan islands which are located off the west coast of Peninsular Malaysia. Jarak Island, located about 32 km southwest of Pangkor Island, is a tiny island that rises 50 m above sea level and is covered with lush green vegetation. On the other hand, Pulau Sembilan is a group of islands situated about 20 km off the southwest coast of the Pangkor Island. Among the islands in the Sembilan group are Rumbia, Lalang, Saga, Buluh, Black Rock and White Rock. This paper outlines the geology of both Jarak and Sembilan islands and classifies the islands' tectonic setting in term of Southeast Asia granite provinces.

REGIONAL SETTING

The Jarak and Sembilan islands are underlain by granitic rock similar to those found in the Western Belt of Peninsular Malaysia. The intrusion is the westernmost igneous bodies of the Main Range granite.

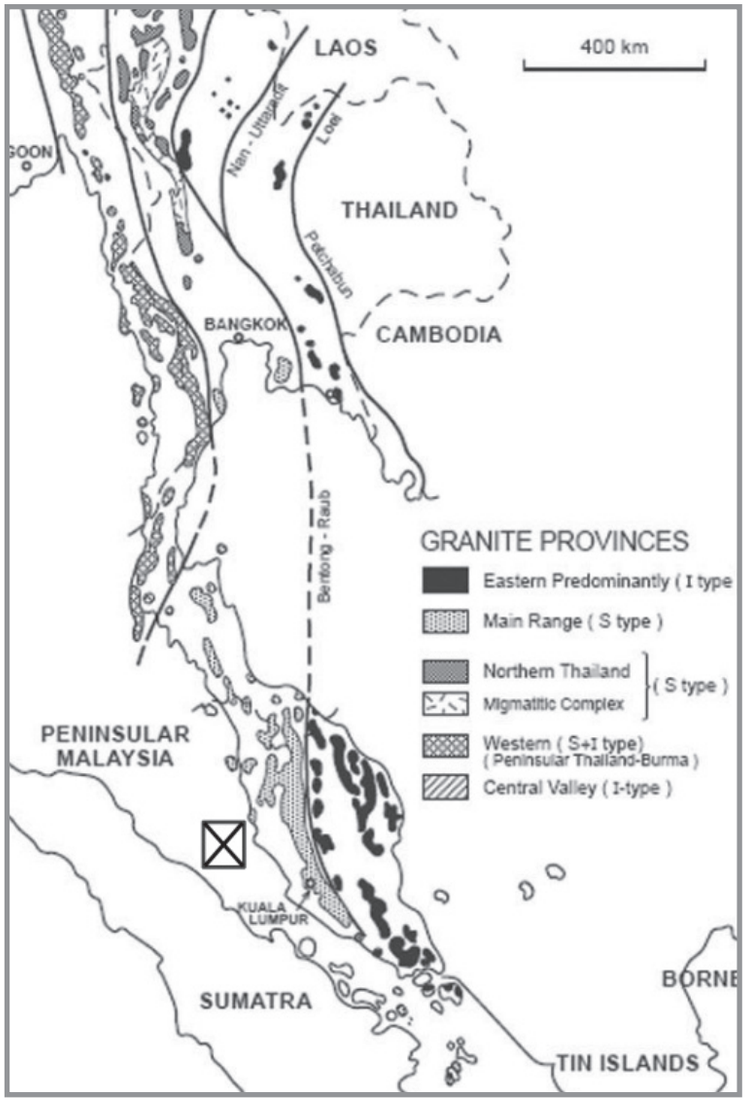

Figure 1. Location of Jarak and Sembilan granite (X) in relation to the granite province in Southeast Asia. Blue box is the location of both Jarak and Sembilan granites. Modified from Cobbing et. al. 1992.

The granitoids of Malaysia, Thailand and Myanmar have petrographical and geochronological features which permit them to be put into belts (Figure 1) [1]. The Peninsular Malaysia granites have been divided into two belts i.e the Western province and the Eastern Province. The Main Range Granite forms a main batholith in the Western Belt granite. The batholith extends through Peninsular Thailand as far as the latitude of Bangkok. In the mainland of Peninsula Malaysia, the westernmost granitic body that belongs to the Main Range Granite can be found along the coastal area of Perak, Penang and Selangor. Examples of the coastal granitic body are Dinding [2] and Mertajam–Kulim granites [3]. Less than 10 km off the mainland, the Pangkor and Penang island granites are the best examples. Although both Jarak and Sembilan islands are located more than 10 km off Peninsular Malaysia coast, clearly, the granitic rocks from these islands represent part of the Main Range Granite. The Main Range granites have a more restricted composition (SiO_2 > 65%). The granites that are responsible for the tin mineralization are exclusively of the S–type formed by continental collision. The

'S' type features [4] in the granites have: (a) high initial $87_{Sr}/86_{Sr}$ isotope ratio of > 0.710, (b) low Na_2O content of < 3.2% in rocks with ~ 5% K_2O, (c) narrow range of felsic rock (65.95 to 77.4% SiO_2), (d) high K_2O/Na_2O ratio of 1.4 - 2.8 ('S' type: 0.9 - 3.2), (e) usually ilmenite bearing and (f) pelitic or quartzose metasedimentary xenoliths.

FIELD CHARACTERISTICS

Both Jarak and Sembilan granites consist of homogeneous to porphyritic rocks. The Jarak granite grades from equigranular to porphyritic coarse grained granite (Figure 2) whereas the Sembilan granite is dominated by equigranular medium to coarse grained granite (Figure 3). Various types of enclaves occur on the southwest of Jarak island. Among the enclave types are metasedimentary, surmicaceous (Figure 4) and mafic microgranular enclaves. The occurrence of metasedimentary enclaves may suggest that the Jarak granite magma is closely associated with the metasedimentary source. Surmicaceous enclaves are spherical and are not spatially restricted to any particular granite variety. The enclave is less than a meter in length and melanocratic containing quartz, K-feldspar and biotite. Flow foliation defined by alternating bands of quartzo-feldspathic and micaceous minerals are also observed in this rock (Figure 5). Pegmatitic K-feldspar pods/irregular bodies can be up to 1 m in length. K-feldspar and tourmaline aplopegmatite vein, both zoned and unzoned, is also common (Figure 6).

PETROGRAPHY

Both Jarak and Sembilan granites consist of primary textured granite [1]. The only difference between these two granites is that the Jarak granite tends to be coarser grained compared to the Sembilan granite. They also share the same mineralogy content. The mineral composition of both Jarak and Sembilan granites in decreasing abundance are K-feldspar, quartz, plagioclase, biotite, zircon and apatite. In terms of Quartz–Plagioclase–K-feldspar classification [5] the granites can be classified as biotite monzo to syenogranite. The granitic rocks from Jarak and Sembilan granites occupy a central area of the QAP diagram. Granites plotting in this area have been regarded as crustal melts [6] and this suggests the importance of crustal material in the source rocks of these plutons.

Large K-feldspar phenocrysts up to 3 cm long are common in the Jarak granite. The K-feldspar in the Sembilan granite is more equigranular with other mineral phases. The main K-feldspar type of both Jarak and Sembilan granites is orthoclase. Plagioclases usually occur as discrete phenocrysts or as glomeroporphyritic aggregates showing resorbed outlines in the mafic members of the granites. The most common plagioclase type is oligoclase. Thin late albitic rim sometimes can be found surrounding the plagioclase crystal. Quartz is mostly anhedral and sometimes occurs as subgrains. In some places the quartz crystals in the Jarak granite are bluish in colour. Quartz is generally interstitial to all the other minerals, especially plagioclase and to a lesser extent to the orthoclase. It also occurs as small round crystals at the margins of the plagioclases. The only primary mafic rock-forming mineral is biotite, which occurs as plates up to 1 cm in diameter. In hand specimen, fresh biotite crystals are black and glossy. Chloritized biotites are dark green and have a dull luster. It may occur as discrete plates, as ragged shreds in mafic clots and as small flakes associated with granoblastic aggregates of quartz and plagioclase. The pleochroism scheme is typically pale brown to dark brown. Tourmaline commonly occurs as large crystals in the leucogranitic either as tourmaline rossette or as tourmaline pods. Zircon and apatite are ubiquitous accessory phases.

CONCLUSION

Both the Jarak and Sembilan granites have textural and mineralogical features which are characteristic of the Main Range granite and which distinguish them from the granite of the Eastern Belt granite. Their location suggested that they may represent the westernmost granitic bodies of the Main Range granite. The mineralogical character of the Jarak and Sembilan granites are similar to the Penang and Pangkor granites which is also part of the Main Range granite. These preliminary conclusions need to be investigated by geochemical and isotopic method. A detailed study of geochemistry and mineralogy of the individual Jarak and Sembilan plutons with more careful, controlled sampling using a greater number of samples has to be done in order to understand fully the petrochemistry of each of the plutons. Detailed study of radiogenic isotope especially Sr, Nd, Sm and Pb should be undertaken to determine the source region and other processes such as mixing and high level interaction.

Figure 2. Coarse to medium grained equigranular biotite granite of the Jarak island. Note the bluish colour of the quartz crystal.

Figure 3. Granitc rock from Lalang island (Sembilan group). The main rock type is coarse to medium-grained equigranular biotite granite. Note that the granitic rock from Lalang island is leucocratic compared to the Jarak granite.

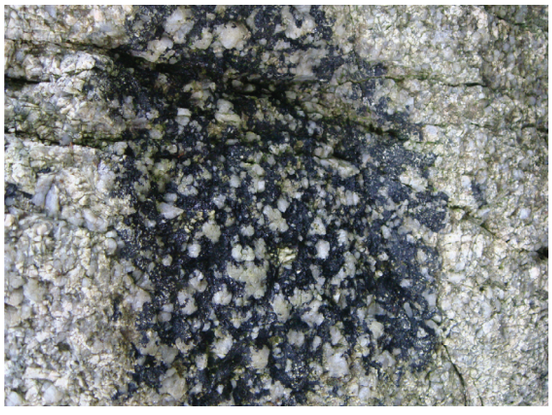

Figure 4. Surmicaceous enclave formed by accumulation of biotite. Location: Jarak Island.

Figure 5. Sclieren structure formed by alignment of biotite crystals in the Jarak granite.

Figure 6. Feldspar-tourmaline pegmatite cut through the Jarak granite.

The various types of enclaves that occur in the Jarak granites should be studied in more detail because they may provide information on the mode of emplacement, the origin of the granitic magma and the dynamics of magma chambers including magma interaction.

REFERENCES

1. Cobbing, E.J., Pitfield, P. E. J., Darbyshire, D.P.F., Mallick, D. I. J. (1992). *The granites of the South-East Asian tin belt.* Overseas Memoir 10, British Geological Survey.
2. Pitfield, P. E. J., Teoh, L. H. and Cobbing, E. J. (1990). Textural variation and tin mineralization in granites from the Main Range province of the Southeast Asia tin belt. *Geological Journal* **25**: 419 - 430.
3. Azman A. Ghani, Borhan M. Doya and G. H. Teh (2000). Age, petrochemistry and modelling of the Bukit Mertajam-Kulim granite, Northwest Peninsular Malaysia. *Bull. Geol. Soc. Malaysia* **44**: 129 - 150
4. Chappell, B.W. and White, A.J.R. (1974). Two contrasting granite types. *Pacific Geology* **8**: 173 - 174
5. Streckeisen, A. L. (1976). To each plutonic rock its proper name. *Earth Sci. Rev.* **12**: 1 - 33.
6. Bowden, P., Batchelor, R. A., Chappell, B. W., Didier, J. and Lameyre, J. (1984). Petrological, geochemical and source criteria for the classification of granitic rocks: a discussion. *Phy. Earth Planet. Int.* **35**: 1 - 11.