Arc related dioritic–granodioritic magmatism from southeastern Peninsular Malaysia and its tectonic implication

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ARTICLE INFO
Article history:
Received 1 December 2015
Received in revised form 15 September 2016
Accepted in revised form 10 October 2016
Available online 24 October 2016
Keywords:
Arc island
Peninsular Malaysia
Cretaceous magmatism
Arc related diorite

ABSTRACT
In Peninsular Malaysia, Late Cretaceous (95–76 Ma) plutons are found within the Eastern Belt. Their compositions are diverse, ranging from basic gabbro, hornblende granodiorite, diorite, and gabbronite. The Arrhenius plot is the orientation body and is exposed in the Johor Arc Complex, southeast of Peninsular Malaysia. The rocks vary from diorite, quartz monzonite, and granite. The Ar-Ar step-heating age of the diorite and zircon U-Pb age of the granodiorite yielded ages of 72 ± 2 Ma and 79 ± 0.7 Ma, respectively. The overall major and trace element trends are consistent with two magma pulses, i.e., diorite–quartz monzonite and granodiorite. The diorite–quartz monzonite is characterized by high FeO, (67.7–83.3), K2O (5.5–7.6), MgO (2.9–4.1), and high but variable Sr concentration (1090–1390 ppm). The granodiorites have significantly lower total alkali content (2.6–8.1%) with high SrO concentrations (1.3–4.6%), and low FeO (47.6–65.8), K2O (2.7–3.9%), and MgO (4.1–2.03) concentrations. Low Nb/Na and distinct Pb anomalies suggest that both rock types are likely derived from the crust. Furthermore, elevated Ti, Zr, and trace element contents for the granodiorites, e.g., Nb (10–20 ppm), Pb (15–30 ppm), and U (2–5 ppm), also indicate that upper crustal components are involved in the magma generation. The diorite rocks are chemically classified as calc-alkaline volcanic arc (WAG) rocks, but they also have field relationships and mineralogy typically associated with an active continental margin (ACM).

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1. Introduction
Cretaceous granitoids are widely distributed in Southeast Asia, especially throughout Myanmar, Thailand, and Malaysia. They form a well-defined group of granitic complexes that primarily occur in the western and eastern granitic provinces of the region (Cobbing et al., 1992; Fig. 1). The ages of these plutons range from 100 to 50 Ma with initial 87Sr/86Sr ranging from 0.706 to 0.754 (Cobbing et al., 1992). In Thailand and Myanmar (Western province), the Cretaceous granitoids predominately have I- and S-type characteristics. The granites present in Peninsular Malaysia lie within the eastern granitic province, east of the Bentong-Raub Suture (Cobbing et al., 1993; Fig. 2). They range in age from 95 to 76 Ma (Oliver and Gupta, 2017) and are mainly I-type. Different models have been proposed to explain the occurrence of Cretaceous magmatism in Peninsular Malaysia. Searle et al. (2012) suggested that the magmatism may have resulted from either the continuation of Late Triassic subduction, the southwest to southeast subduction system within the southeast Borneo block, or an undefined subduction system with the Java block, or an undefined subduction system within South Asia. Tjia (1998), in his "Yoked Triple Junction model" for the development of the Malay Peninsula and West Borneo Basin, off the east coast of Peninsular Malaysia, suggested that the Uda Cretaceous granite magmatism in northern Sundaland was initiated by a mantle plume beneath the Sulawesi Sea plate. This plume was created by high heat flow beneath the Molucca Sea plate. This model was supported by high heat flow during the Late Cretaceous (Tjia, 1998).

This paper presents the results from an ongoing study of the Late Cretaceous rocks in Peninsular Malaysia. In this contribution, we report the detailed geochemical characteristics of the Cretaceous arc granodiorite–diorite located in southeastern Peninsular Malaysia, and we discuss potential tectonic scenarios of Cretaceous magmatism for the area.

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http://dx.doi.org/10.1016/j.cretres.2016.08.006
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