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Petrogenesis of Zeiatit gabbroic rocks in the Southern Eastern Desert of Egypt: Discrimination of arc-related Neoproterozoic gabbros

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ABSTRACT

The area of Gabal Zeiatit, South Eastern Desert, Egypt represents one of a series of ophiolitic-island arc complexes found within the Arabian–Nubian Shield (ANS). The present study introduces new major, trace, and rare earth element analyses and mineral composition data of gabbroic rocks encountered in this area with the goal of constraining their geotectonic setting. The investigated area consists of two types of gabbroic rocks. The Zeiatit ophiolitic metagabbros (ZMG) are always associated with serpentinites of ophiolitic affinity and were subjected to metamorphism of greenschist to lower amphibolite facies and exhibit tholeiitic affinity and MORB-like characters. Serpentinites and metagabbros are tectonically thrusted over a thick pile of metavolcanic rocks. The Zeiatit intrusive gabbros (ZIG) are related to Egyptian Alaskan-type mafic-ultramafic complexes and intrude the studied ophiolitic rocks and island arc rocks. Geochemical data reveal that both studied gabbroic types originated in sub-arc setting. Mineral chemistry data for the two types of the studied gabbroic rocks indicate that they possess different characteristics. The NiO (< 0.15 wt%) and Fo (< 83 mol.%) contents of olivine from the investigated ZIG are lower than those of the Egyptian ophiolites. The clinopyroxene composition of the ZIG show arc related cumulate. Geochemically, the ZMG exhibit MORB-like and arc-like signatures as they display Ti/V ratios ranging from 14.52 to 21.09. Such phenomenon of hybrid mixture between island arc tholeiite (IAT) and MORB is generally acknowledged being unique to forearc tectonic regime. Moreover, depleted LREE and HFSE and relatively high CaO in the studied ZMG suggest derivation from Cpx-rich mantle at forearc tectonic setting. The ZIG have Nb/Yb (0.28–1.04) and Th/Yb (0.1–0.42) which are typical for oceanic island arcs. The ZIG are highly depleted in Nb, Ta, and Zr, but enriched in Ba, Pb, Sr, U and Th suggest their derivation from a metasomatized lithospheric mantle source that modified by hydrous fluids derived from the subducting slab in a subduction zone. ZIG have Th/Ta (0.69–2.05) and Ta/Hf (0.16–0.28) indicating that they were mainly derived from partial melting of a depleted mantle source, being mixed with crustal material. The present geochemical and mineralogical studies revealed that, the investigated ZMG are fragment of oceanic lithosphere probably developed in a supra-subduction zone environment and originated by 10–30% partial melting of a spinel lherzolite mantle in a sub-arc (forearc) setting at shallow depth which consistent with the most recent conclusions of the Egyptian ophiolitic metagabbros. However, the investigated ZIG are akin to the Alaskan-type rocks.

1. Introduction

The Pan-African rocks are widespread distributed throughout the Arabian-Nubian Shield (ANS), which constitutes the northern segment of the East African Orogeny, one of the largest exposures of Neoproterozoic juvenile continental crust on Earth. It is believed, that the Pan-African represents a period in which the Gondwanaland was formed by accretion of various terranes. The crustal evolution of the ANS is currently interpreted as the accretion of island arcs and oceanic terranes (e.g., Kröner, 1985; Kröner et al., 1987; Greiling et al., 1994; Stern, 1994; Abdelsalam and Stern, 1996). Vail (1983), demonstrated that the ANS represents a good model for the crustal growth through the accretion of intra-oceanic mantle-derived magmas, initial island arcs and micro-continents during the Pan-African event. ANS is generally characterized by the association of ophiolitic and voluminous calc-alkaline components, which gave the opportunity for many searcher to conclude that the ANS evolved by the contiguity of series of island arcs with continental magmatic arcs (e.g. Abdel-Rahman, 1990; Patchett and Chase, 2002; Stoeser and Frost, 2006).

The basement rocks of Egypt consist parts of the ANS and older crust. They cover an immense zone in the Eastern Desert, which stretches out southward to the Red Sea Hills of northern Sudan and a southern segment of the Sinai Peninsula, and smaller areas in the southern part of the Western Desert. Gabbroic rocks constitute an

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