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Late Neoproterozoic adakitic lavas in the Arabian-Nubian shield, Sinai Peninsula, Egypt

Khaled M. Abdelfadil[a], Mohamed A. Obeid[b,c,*], Mokhles K. Azer[d,e], Paul D. Asimow[e]

[a] Geology Department, Faculty of Science, Sohag University, Sohag, Egypt
[b] Geology Department, Faculty of Science, Fayoum University, P.O. Box 63514, Fayoum, Egypt
[c] Faculty of Petroleum and Mining Sciences, Alexandria University (Matrouh Branch), Egypt
[d] Geological Sciences Department, National Research Centre, 12622 Dokki, Cairo, Egypt
[e] Division of Geological & Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA

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ABSTRACT

The Sahiya and Khashabi volcano-sedimentary successions are exposed near the southern tip of the Sinai Peninsula, the northernmost segment of the Arabian-Nubian Shield (ANS). These Neoproterozoic successions include a series of intermediate to acidic lavas and associated pyroclastic deposits. Field observations and geochemical data reveal two distinct eruptive phases. The lavas representing each phase are intercalated with volcaniclastic greywackes and siltstones. The first eruptive phase, well exposed at Wadi Sahiya, includes basaltic andesite, andesite and dacite with minor rhyolite. The rocks of this sequence are at most weakly deformed and slightly metamorphosed. The second eruptive phase, well exposed at Wadi Khashabi, includes only undeformed and unmetamorphosed dacite and rhyolite. The two volcano-sedimentary successions were separated and dismembered during intrusion of post-collisional calc-alkaline and alkaline granites.

Geochemical compositions of the Sahiya and Khashabi volcanic rocks confirm the field data indicating discrete phases of magmatism, however all the compositions observed might plausibly be derived from a common source and be related to one another dominantly through fractional crystallization. The low and variable Mg# values (55–33) measured in the basaltic andesites and andesites preclude their equilibration with a mantle source. Rather, even the most primitive observed lavas are already the products of significant fractional crystallization, dominated by removal of amphibole and plagioclase. Continued fractionation eventually produced dacite and rhyolite marked by significant depletion in Y and HREE. The gradual appearance of negative Nb-Ta anomalies with increasing SiO_2 through both suites suggests at least some component of progressive crustal contamination.

The medium- to high-K calc-alkaline character of the Sahiya and Khashabi volcanics could be explained either by their formation at an active continental margin or by a two-stage model that appeals to re-melting of arc material in a post-collisional setting. The Wadi Sahiya basaltic andesite and andesite samples exhibit the defining chemical characteristics of adakites: high Sr (> 700 ppm), low Y (< 16 ppm), high Sr/Y (> 20) and low Yb (< 1.8 ppm). Although this signature can be associated with slab melting, here we show that it reflects partial melting of lithospheric mantle beneath thickened continental arc crust. The early eruptive phase, exposed at Sahiya, was erupted on an active continental margin, whereas the later Khashabi succession marks the transition to a post-collisional stage.

1. Introduction

The southern Sinai Peninsula contains the northernmost exposures of the Arabian-Nubian Shield (ANS). The ANS is a juvenile crustal tract whose formation recorded events associated with several phases of the East African Orogeny (900–530 Ma; Stern, 1994), including protracted accretion of island arc terranes (~700 Ma), late Neoproterozoic continental collision (~640–650 Ma), and post-collisional (~640–580 Ma) stages (Bentor, 1985; Stern, 1994, 2002; Stein and Goldstein, 1996; Meert, 2003; Stoeser and Frost, 2006, Be'eri-Shlevin et al., 2011). A transition from convergence to extension occurred at ~600 Ma (Garfunkel, 1999) and was followed by establishment of a stable craton and platform setting by ~530 Ma (Garfunkel, 1999; Genna et al., 2002).

* Corresponding author at: Geology Department, Faculty of Science, Fayoum University, P.O. Box 63514, Fayoum, Egypt.
E-mail address: mobeid_2000@hotmail.com (M.A. Obeid).

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