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ORIGINAL PAPER

Pan-African adakitic rocks of the north Arabian–Nubian Shield: petrological and geochemical constraints on the evolution of the Dokhan volcanics in the north Eastern Desert of Egypt

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Abstract The Precambrian basement of Egypt is part of the Red Sea Mountains and represents the north-western part of the Arabian–Nubian Shield (ANS). Five volcanic sections are exposed in the Egyptian basement complex, namely El Kharaza, Monqul, Abu Had, Mellaha and Abu Marwa. They are located in the north Eastern Desert (ED) of Egypt and were selected for petrological and geochemical studies as they represent the Dokhan volcanics. The volcanics divide into two main pulses, and each pulse was frequently accompanied by deposition of immature molasse type sediments, which represent a thick sequence of the Hammamat group in the north ED. Compositionally, the rocks form a continuum from basaltic andesite, andesite, dacite (lower succession) to rhyodacite and rhyolite (upper succession), with no apparent compositional gaps. These high-K calc-alkaline rocks have strong affinities to subduction-related rocks with enriched LILEs (Rb, Ba, K, Th, Ce) relative to high field strength elements (Nb, Zr, P, Ti) and negative Nb anomalies relative to NMORB. The lower succession displays geochemical characteristics of adakitic rocks with SiO_2 >53 wt%, Al_2O_3 >15 wt%, MgO >2.5 wt%, Mg# >49, Sr >650 ppm, Y <17 ppm, Yb <2 ppm, Ni >25 ppm, Cr >50 ppm and Sr/Y >42.4. They also have low Nb, Rb and Zr compared to the coexisting calc-alkaline rhyodacites and rhyolites. The highly fractionated rhyolitic rocks have strong negative Eu anomalies and possess the geochemical characteristics of A-type suites. Trace element geochemical signatures indicate a magma source consistent with post-collisional suites that retain destructive plate signatures associated with subduction zones. The adakitic rocks in the northern ANS are generated through partial melting of delaminated mafic lower crust interacting with overlying mantle-derived magma. The Dokhan volcanics were likely generated by a combination of processes, including partial melting, crystal fractionation and assimilation.

Keywords Neoproterozoic · Arabian-Nubian Shield · Dokhan volcanics · Calc-alkaline · Adakite · Egypt

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Introduction

The Precambrian complex in the Eastern Desert (ED) constitutes, together with the basement rocks of Sinai, the north-western corner of the Arabian–Nubian Shield (ANS). The Neoproterozoic rocks of the ANS evolved as a result of the East African Orogen (900–530 Ma; Stern 1994). It is a collage of Neoproterozoic juvenile arcs, younger sedimentary and volcanic basins, voluminous granitoid intrusions, and enclaves of pre-Neoproterozoic crust (Stern 1994; Stoeser and Frost 2006). The ANS represents the largest tract of Neoproterozoic juvenile continental crust on Earth (Patchett and Chase 2002). One of the most striking features of the northernmost segment of the ANS is the abundance of post-collisional plutons and associated volcano-sedimentary sequences, whereas older rocks, now comprising parts of metamorphic complexes are scarce, and ophiolites are completely absent (e.g. Bentor 1985; Stein 2003; Azer and El-Gharbawy 2011). In the ED especially in its northern part (Fig. 1), the Dokhan volcanics are abundant and comprise mostly high-K calc-alkaline