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Late Neoproterozoic post-collisional mafic magmatism in the Arabian–Nubian Shield: A case study from Wadi El-Mahash gabbroic intrusion in southeast Sinai, Egypt

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ABSTRACT

Late Neoproterozoic gabbroic intrusion of Wadi El-Mahash lays in the northwestern sector of the Arabian–Nubian Shield (ANS) which is exposed in the Sinai Peninsula, Egypt. It occurs as small undeformed mafic body intruding metamorphic rocks and truncated by alkali granites. Field relations, mineralogical characteristics and chemical data indicate that Wadi El-Mahash mafic intrusion is unmetamorphosed. The intrusion consists of medium- to coarse-grained gabbroic rocks. The medium-grained one (hornblende gabbro) formed nearly simultaneous with, or slightly later than, the coarse-grained rock (pyroxene-hornblende gabbro). Geochemically, the gabbroic samples are characterized by enrichment in LILE relative to HFSE and LREE relative to HREE [$(La/Yb)_n$ = 4.52–6.35]. They show geochemical signature similar to other post-collisional gabbroic intrusions of south Sinai. The subduction-related geochemical characteristic of the gabbroic intrusion of Wadi El-Mahash can be explained by partial melting of a relatively enriched lithospheric mantle source following a previous subduction process in the ANS. The gabbroic rocks crystallized at pressures between 6.2 and 6.5 kbar (~15–20 km depth) with crystallization temperature ranging from 750 to 970 °C. Lithospheric delamination model is suggested for the mafic magma of Wadi El-Mahash since delamination of lithospheric mantle allowed asthenosphere to rise rapidly causing partial melting and generating gabbroic melts. The produced melts then infiltrated the base of the crust to induce the post-collisional magmatism in south Sinai.

1. Introduction

The Arabian–Nubian Shield (ANS) represents the northern segment of the East African orogen (900–530 Ma, Stern, 1994). The crust of the ANS is essentially juvenile formed solely by protracted accretion of island arc terranes (Patchett and Chase, 2002; Stoeser and Frost, 2006). Island arc accretion is thought to have ended in the ANS by ~700 Ma and followed by continental collision at 640–650 Ma (Stern, 2002). The post-collision event (630–580, Eyal et al., 2010; Be'eri-Shlevin et al., 2009a, 2011; Farahat and Azer, 2011; Azer et al., 2014) is marked by the emplacement of calc-alkaline and alkaline magmatism during late Neoproterozoic period. Petrogenetic studies of post-collisional magmatism can provide constraints on the geodynamic processes responsible for the cessation of collision and onset of extensional collapse. Also, it reveals changes in magma source regions associated with such processes.

The basement rocks of Egypt include parts of the ANS and also older crust. They cover a huge area in the Eastern Desert which extends southward to the Red Sea Hills of northern Sudan as well as a southern sector of the Sinai Peninsula and smaller areas in the southern part of the Western Desert. The Neoproterozoic crust of the southern Sinai Peninsula (Fig. 1, insert) is part of the northernmost sector of the ANS. One of the most striking features of south Sinai 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). Previous studies of post-collisional magmatism in south Sinai have been mostly focused on granites and their volcanic equivalents (Be'eri-Shlevin et al., 2009a, 2011; Farahat and Azer, 2011; Azer et al., 2014), while post-collisional mafic intrusions have received minor attention.

The mafic intrusion of Wadi El-Mahash is one of many mafic intrusions in south Sinai, and hence its petrological and geochemical features can represent the main characteristics of such magmatism during the late Neoproterozoic period. It was mapped

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