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An example of post-collisional appinitic magmatism with an arc-like signature: the Wadi Nasb mafic intrusion, north Arabian–Nubian Shield, south Sinai, Egypt

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ABSTRACT

We present new data for the Neoproterozoic mafic intrusion exposed in Wadi Nasb, south Sinai, Egypt (northernmost Arabian–Nubian Shield; ANS). The Nasb mafic intrusion (NMI) intrudes metasediments, Rutig volcanics, and diorite/granodiorite, and is intruded in turn by younger monzogranite and quartz-monzonite. Available geochronological data for the country rocks of the NMI provide a tight constraint on its age, between 619 and 610 Ma, during the hiatus between the lower and upper Rutig volcanics. The NMI is neither deformed nor metamorphosed, indicating post-collisional emplacement, and uralitization by late-magmatic and sub-solidus alteration is restricted to the margins of the intrusion. A quantitative fractionation model indicates a fractionating assemblage of 61% primary amphibole, 10% clinopyroxene, 28% plagioclase, 1% biotite, 0.4% apatite, and 0.15% Fe-Ti oxide. Contrary to the recent studies, we find that the nearby diorite of Gebel Sheikh El-Arab is not co-genetic with the appinitic gabbro of the NMI. Although there are volcanic xenoliths in the NMI, we find no chemical evidence requiring contamination by continental crust. A subduction-related signature in a post-orogenic intrusion requires the inheritance of geochemical tendencies from a previous subduction phase. Given that the fine-grained gabbro of the NMI is consistent with a near-primary mantle melt, we attribute this inheritance to persistence and later melting of the slab-modified mantle domains, as opposed to partial melting and assimilation of the juvenile continental crust. The fine-grained gabbro composition indicates derivation at temperature and pressure conditions similar to the sources of mid-ocean ridge basalts: mantle potential temperature near 1350°C and extent of melting about 7%. Such temperatures, neither so high as to require a plume nor so low as to be consistent with small degrees of melting of a volatile-rich source, are most consistent with a lithospheric delamination scenario, allowing the upwelling of fertile, subduction-modified asthenosphere to depths ≤ 50 km.

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1. Introduction

The northernmost Arabian–Nubian Shield (ANS) underlies and outcrops across the Eastern Desert of Egypt, the Sinai Peninsula (Egypt), southern Israel, southwestern Jordan, and the Midyan terrane of Saudi Arabia (Figure 1). It represents the northernmost part of the East African Orogen, which formed in the late Proterozoic (900–550 Ma; Kröner 1984). The ANS evolved through several tectono-magmatic stages, from the formation of ophiolites and island arcs to their amalgamation, continental collision, and post-collisional magmatism (Stern 1994; Stein and Goldstein 1996; Jarrar *et al.* 2003, 2008; Stoesser and Frost 2006; Azer and Farahat 2011; Johnson *et al.* 2011; Fritz *et al.* 2013; Robinson *et al.* 2015, 2017). The final evolutionary stage of the ANS included stabilization of the shield,

followed by large-scale erosion and the formation of a vast peneplain by Cambrian time (Bentor 1985; Garfunkel 1999; Avigad and Gvirtzman 2009).

The late stages of the long-lived evolution of the ANS are marked by abundant post-collisional magmatism (e.g. Be'eri-Shlevin *et al.* 2009a, 2009b; Eyal *et al.* 2010; Be'eri-Shlevin *et al.* 2011; Farahat and Azer 2011; Khalil *et al.* 2015; Moreno *et al.* 2016; Jarrar *et al.* 2017) commencing at ca. 630 Ma (e.g. Stern 1994; Garfunkel 1999; Genna *et al.* 2002; Be'eri-Shlevin *et al.* 2009a) and continuing through stabilization of the shield at ca. 530 Ma (Garfunkel 1999). The post-collisional stage in the north ANS is characterized by the emplacement, in some cases simultaneously, of calc-alkaline and alkaline intrusions and lavas (Eyal *et al.* 2010). Therefore, petrogenetic investigation of post-collisional magmatism can