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REVIEW ARTICLE

Geochemistry and petrogenesis of post-collisional alkaline and peralkaline granites of the Arabian-Nubian Shield: a case study from the southern tip of Sinai Peninsula, Egypt

A. E. S. Khalil[a], M. A. Obeid[b], M. K. Azer[a,c] and P. D. Asimow[c]

[a]Geological Sciences Department, National Research Centre, Cairo, Egypt; [b]Geology Department, Faculty of Science, Fayoum University, Fayoum, Egypt; [c]Division of Geological & Planetary Sciences, California Institute of Technology, Pasadena, CA, USA

ABSTRACT

The southern Sinai Peninsula, underlain by the northernmost extension of the Arabian-Nubian Shield, exposes post-collisional calc-alkaline and alkaline granites that represent the youngest phase of late Neoproterozoic igneous activity. We report a petrographic, mineralogical and geochemical investigation of post-collisional plutons of alkaline and, in some cases, peralkaline granite. These granites intrude metamorphosed country rocks as well as syn- and post-collisional calc-alkaline granitoids. The alkaline and peralkaline granites of the southern tip of Sinai divide into three subgroups: syenogranite, alkali feldspar granite and riebeckite granite. The rocks of these subgroups essentially consist of alkali feldspar and quartz with variable amounts of plagioclase and mafic minerals. The syenogranite and alkali feldspar granite contain small amounts of calcic amphibole and biotite, often less than 3%, while the riebeckite granite is distinguished by sodic amphibole (5–10%). These plutons have geochemical signatures typical of post-collisional A-type granites and were most likely emplaced during a transition between orogenic and anorogenic settings. The parental mafic magma may be linked to lithospheric delamination and upwelling of asthenospheric mantle material. Differentiation of the underplated basaltic magma with contributions from the juvenile crust eventually yielded the post-collisional alkaline granites. Petrogenetic modelling of the studied granitic suite shows that pure fractional crystallization cannot quantitatively explain chemical variations with the observed suite, with both major oxides and several trace elements displaying trends opposite to those required by the equilibrium phase assemblage. Instead, we show that compositional variation from syenogranite through alkali feldspar granite to riebeckite granite is dominated by mixing between a low-SiO_2 liquid as primitive or more primitive than the lowest-SiO_2 syenogranite and an evolved, high-SiO_2 liquid that might be a high-degree partial melt of lower crust.

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1. Introduction

The basement rocks of Sinai constitute the northernmost outcrops of the Arabian-Nubian Shield (ANS). They represent juvenile crust of the East African Orogeny and formed during the late Proterozoic Pan-African events (900–550 Ma) by accretion and assembly of oceanic and continental magmatic arcs (Bentor 1985; Jarrar *et al*. 2003; Johnson 2003; Meert 2003; Stoeser and Frost 2006; Ali *et al*. 2010). In the northern part of the ANS, syn-orogenic and late- to post-orogenic granitoids are widely distributed (Jackson *et al*. 1984; Garfunkel 1999; Jarrar *et al*. 2008; Azer 2013). Towards the end of the Pan-African Orogeny (650–550 Ma), syn-orogenic calc-alkaline magmatism representing subduction and collision events was followed by post-collisional magmatism (Jarrar *et al*. 2003; Moussa *et al*. 2008) that produced high-K calc-alkaline, alkaline and peralkaline rocks.

Regionally, the Egyptian basement complex is dominated by granitoids that constitute about 50% of all intrusive rocks therein. Egyptian granitoids are traditionally divided into two main chronological, petrographic and geochemical groups, the older and younger suites (El-Ramly and Akaad 1960; Hussein *et al*. 1982). El-Gaby *et al*. (1988) defined the older suite as grey, calc-alkaline, syn-tectonic, I-type intrusions. They range in composition from diorite to granodiorite and rarely granite. The younger suite, by contrast, contains abundant granite, typically pink to red, calc-alkaline to alkaline, late to post-tectonic, I- and A-type granites.

Several previous studies of the granitic rocks near the southern tip of Sinai (e.g. El-Rahmany 1987; Khalaf

CONTACT M. A. Obeid maa21@fayoum.edu.eg Geology Department, Faculty of Science, Fayoum University, P.O.Box 63514, Fayoum, Egypt
The supplemental data for this article can be accessed here