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Post-accretion magmatic events in the Arabian Shield: insights from the Neoproterozoic Khamal intrusive complex

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The Arabian-Nubian-Shield (ANS) represents one of the planet's largest tracts of juvenile Neoproterozoic crust. Its geologic evolution developed in the span of ~500 million years, from ensimatic island-arcs growth to microplate accretion and later epicontinental subsidence. The magmatic activity throughout these events formed numerous heterogeneous intrusive complexes. Between these bodies in the northwestern part of the ANS, in proximity of the Yanbu suture zone that separates the Hijaz and Midyan terranes, outcrops the Khamal anorthosite-gabbro association. This complex was the focus of several studies due to its related mineral deposits and geodynamical significance, but its origin is still debated. Formerly thought to be part of an ophiolitic complex, recent investigations either interpret it as a massif-type anorthosite [1] or a layered intrusion [2].

This contribution presents a detailed petrological and geochronological study of the Khamal intrusive complex providing new insights on its petrogrenesis and source. It is composed of an association of four intrusive lithologies ranging from anorthosites, olivine and oxide-bearing gabbronorites, granites and Fe-Ti ore layers. The anorthosites display restricted variation in both major and trace elements whole-rock compositions (i.e., Mg# = $[Mg^{2+}/(Mg^{2+}+Fe^{2+})]$ 41-57, Al_2O_3 20-27 wt% and CaO 9-11 wt%), and nearly flat CI-normalized REE patterns. On the contrary, gabbronorites display variabilities in their petrographic characteristics coupled to highly variable chemical composition. Their bulk Mg# varies between 40 and 70, the Al_2O_3 13-18 wt% and the CaO 9-13 wt%. In addition, their bulk-rock CI-normalized REE patterns display marked variations in the LREE/MREE fractionations (La/Sm = 0.1-1.8). Such variability, however, is not displayed mineral phases compositions, suggesting a genetical link between anorthosites and gabbroic rocks. This indicates that the Khamal intrusive complex formed by multiple melt injections evolving through fractional crystallization processes from a basaltic parental melt. Based on the trace element geochemical signature of the clinopyroxene and plagioclase we suggest that the parental magmas derived from an asthenospheric mantle source, melted at high melting degrees.

References

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