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Petrology of the Genina Gharbia mafic-ultramafic intrusion, Eastern Desert, Egypt: insight to deep levels of late-Precambrian island arcs

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The Arabian-Nubian shield represents one of the most important sites of juvenile crustal growth during the late Proterozoic. The Pan-African grew more than 2 million square kilometers during the period 800-600 Ma. A large percentage of this growth is derived from the mantle by subduction accretion and arc collision. The Genina Gharbia (GG) intrusion, located in the Eastern Desert of Egypt along one of the deep fracture zones trending ENE, is interpreted be the remains of a magma chamber that crystallized at the base of a mature interoceanic island arc. It is one of a number of isolated masses of zoned peridotite-gabbro complexes that recur along the major fracture zones. These masses, the roots of late Precambrian island arc, were uplifted during the Pan-African Orogeny. In this contribution we present petrographic, chemical and mineralogical characteristics of the (GG) mafic-ultramafic plutonic rocks as insights to deep levels of Precambrian island arcs for the purpose of constraining the evolution and compositions of their parental melts. The GG mafic-ultramafic intrusion is located about 140 km southeast of Aswan. It covers an area of 9 km long and 3.5 km wide and comprises olivine diorite (in the margin), gabbros, pyroxenites, hornblende pyroxenites, and hornblende-bearing peridotite (in the core). The contacts between different lithologies within the intrusion are either gradational or tectonic. This association intruded Precambrian metasedimentary and island arc volcanic rocks. The intrusion is non-metamorphosed and show cumulate textures. Massive and disseminated Cu-Ni sulfide ores are found in hornblende gabbro and hornblende-bearing peridotite. Both mafic and ultramafic rock units are characterized by high modal content of hornblende and abundant biotite and apatite indicating hydrous nature of the parent magma. Mafic minerals in the peridotite core are more magnesian than those in the margin rocks (Mg# Ol 85-73, Opx 83-68, Cpx 87-79, Hbl 87-73). Two types

of spinel are identified; Al-rich and Fe-rich spinel, with extensive solid solution between them reflecting extensive sub-solidus equilibration. Orthopyroxene is enstatite with high Al_2O_3 (1.93) and Cr2O3 (0.6 wt.%) contents. Amphiboles of the ultramafic cores have constantly high Cr_2O_3 contents (1.1 wt.%). Reaction between olivine and plagioclase to form hornblende is common. The variations in modal abundance and mineral chemistry throughout the intrusion are consistent with fractional crystallization and accumulation. The compositions of olivine, spinel and pyroxenes are used to constrain the evolution of the parental magma and to estimate the temperature and oxygen activity in the melt. The major and trace elements whole rock chemistry is consistent with evolution by fractional crystallization from a mantle-derived arc magma where the Mg-number decrease and REE and HFSE increase with differentiation. The different lithologies at GG have high 147Sm/144Nd (0.132 - 0.186) and high initial 143Nd/144Nd ratios (0.5125 - 0.5128). The rocks exhibit positive åNd values (+4.8 to +6.7) very similar to other zoned and island arc complexes from the Eastern Desert. Based on textural relationships and chemical trends it is concluded that the GG rocks originated by igneous accumulation from a hydrous magma at the base (ca. 30 km depth) of a mature island-arc before being emplaced along the fault zones during the Pan-African Orogeny. The parental magma has been derived from a mantle source that was previously contaminated by subduction of Mozambique oceanic crust.