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Petrogenesis and evolution of the Nuweibi rare-metal granite, Central Eastern Desert, Egypt

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Abstract

The Nuweibi rare-metal granite in the Central Eastern Desert of Egypt is highly evolved fine- to medium-grained leucogranite affected by pervasive albitization and greisenization. The intrusion holds an important tin–tantalum resource in the Egyptian Eastern Desert. Columbite–tantalite and cassiterite disseminations occur within the granite body, while the quartz ± feldspar veins cutting across the Nuweibi granite host only cassiterite disseminations. Microscopically, quartz and alkali-feldspar are the essential mineral constituents of Nuweibi granite, with minor mica (muscovite + rare biotite), while cassiterite, columbite–tantalite, zircon, allanite, beryl, tourmaline, titanite, and fluorite are accessories. Whole-rock geochemistry and micoanalytical data together with laser ablation inductively coupled plasma mass spectrometer (LA-ICP-MS) dating of zircon and columbite have been used to constrain the evolution of the granite intrusion and associated mineralization. The Nuweibi granite is weakly peraluminous with extremely low MgO, CaO, TiO_2, P_2O_5, Ba, and Sr contents and elevated Sn, Ta, Nb, and Rb contents. The REE patterns exhibit distinct tetrad effects, as well as negative Eu and Y anomalies. Also, the bulk rock Zr/Hf ratios are consistently < 10. The Nd isotopic system is disturbed and ε_{Nd} values suggest a juvenile mantle and/or Neoproterozoic crustal source. The U–Pb system in zircon is disturbed and leaked continuously, while the U–Pb age of columbite is ~ 620 Ma. The geochemical and isotopic systematics of the Nuweibi intrusion reflect very advanced degree of fractionation combined with late magmatic fluid overprint which redistributed Sn and other mobile elements, while Ta still characterizes the igneous system.

Keywords Nuweibi · Rare-metal granite · Isotopic dating · Tin–tantalum

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Introduction

The Nuweibi rare-metal granite is part of the basement complex of the Arabian–Nubian Shield (Fig. 1). The latter is the largest tract of Neoproterozoic juvenile continental crust on Earth (e.g., Patchett and Chase 2002) formed by accretion of several Neoproterozoic volcanic arcs along suture zones marked by discrete ophiolitic nappes (Stoeser and Camp 1985; Vail 1985; Pallister et al. 1988; Johnson 1998; Al-Saleh et al. 1998). The accretion event took place as East and West Gondwana collided and the Mozambique Ocean closed (Stern 1994). The late stages of crustal evolution of the Arabian–Nubian Shield in Egypt were characterized by emplacement of granitic rocks, some of which are highly fractionated rare-metal granites hosting tin and tantalum resources (e.g., Igla, Nuweibi, Abu Dabbab, and Humret Waggat; Sabet and Tsogoev 1973). The origin, age, and evolution of these systems are still a matter of discussion. A number of detailed studies have ascribed the rare-metal enrichment to

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