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Hf-Nd constraints on the early Archaean evolution of the Ancient Gneiss Complex, Swaziland

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The processes leading to the formation and stabilization of the early continental crust are controversial in spite of a large and comprehensive geochemical and isotopic data base. The Ancient Gneiss complex (AGC) in Swaziland comprises units representing the oldest continental crust in Africa (e.g., Hunter 1970; Kröner, 2007). The AGC is predominantly composed of ∼3.68–3.2 Ga old granitoids of tonalite-trondhjemite-granodiorite (TTG) composition, younger ∼3.3–2.7 Ga granitoid batholits and remnants of pre-3.45 Ga greenstone belts. The TTGs were multiply deformed and partly migmatized at upper amphibolite-facies conditions.

We present whole-rock ^{176}Lu-^{176}Hf, ^{147}Sm-^{143}Nd and Hf-in-zircon data for 25 fresh and geochemically well characterized TTGs along with zircon ages. ^{176}Lu-^{176}Hf and ^{147}Sm-^{143}Nd isotope data as well as Lu, Hf, Sm, and Nd concentrations measured by isotope dilution using MC-ICP-MS and TIMS in Cologne/Bonn and Munich. Zircon ages were determined on SHRIMP II and Hf isotope compositions of zircons by laser ablation MC-ICP-MS in Beijing for some of the samples.

εHf(t) and εNd(t) of the whole-rock samples are well correlated, following an array similar to the modern MORB-OIB array of Vervoort et al. (2011). Between 3.64 and 3.43 Ga the initial εHf(t) of the whole-rocks vary from -0.3 to +5.0, and εNd(t) values vary from -1.7 to +3.6. However, the initial εHf(t) of concordant and near-concordant zircons for some samples yielded variably negative to slightly positive values ranging from -5.1 to +1.3.

The large variation in the initial whole-rock εHf(t) values may have been caused by disturbance of the ^{176}Lu-^{176}Hf isotopic system through fluids and melts during migmatization at ca. 3.2-3.1 Ga, when large volumes of granitic magma were emplaced in the AGC. Back-calculation to the magmatic emplacement ages inferred from zircon chronology leads to unrealistically high initial εHf and εNd values. We suggest that the variable zircon εHf(t) values are due to generation of the TTG melts from isotopically heterogeneous crustal protoliths,variably mixed with juvenile melts.

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