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Eo- to Mesoarchaean crust formation in the Nuuk region, southern West Greenland. Constrains from combined U/Pb, Hf and O isotopes in zircon

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This study combines U/Pb, Hf and O isotope data from zircons to constrain the evolution of the continental crust in the Nuuk region in southern West Greenland. Zircon data from Eoarchaean tonalite-trondhjemite-granodiorite (TTG) gneisses from the Itsaq Gneiss Complex (e.g. Nutman et al., 1996), with protolith ages ranging from 3870±7 to 3677±9 Ma have slightly sub-chondritic εHf(t) values from -0.01±0.33 to -1.33±0.46. The combined U/Pb and Hf isotope data from the TTG gneisses define a wide array in a εHf(t) versus age diagram that can be enveloped into an overall trend that developed with an initial $^{176}Lu/^{177}Hf$ value of 0.024. This suggests that the ca. 300 Ma of TTG formations can be related to a common basaltic proto-crust, and that little or no juvenile input was mixed with the TTGs. Oxygen isotope compositions from zircon core domains in TTGs have $\delta^{18}O$ values ranging from 4.76±0.34 to 5.82±0.28 ‰ SMOW. These values are within the range of igneous rocks derived from the mantle, and there is thus no evidence for substantial recycled 'high $\delta^{18}O$' supracrustal components in the TTG gneisses. Considering that the petrogenesis of TTGs in general are related to remelting of basaltic rocks (e.g. Martin, 1999), the combined U/Pb, Hf and O isotope data are consistent with a scenario, where TTGs are related to remelting of a long lived Hadean basaltic proto-crust. Mesoarchaean TTG gneisses from the Akia and Tasiusarsuaq terranes (e.g. Friend and Nutman, 2005) are discussed together with data from detrital zircon grains from a metasedimentary quartzite within the Storø supracrustal belt (e.g. Nutman et al., 2007). The Mesoarchaean TTGs formed during a prolonged period from ca 3250 to 2840 Ma and when the TTG data are combined with data from the detrital grains it appears, that TTG formation occurred during four episodes at ca. 3250, 3050, 2900 and 2850 Ma. The initial Hf isotope composition of the TTGs in the three youngest formation events shows large variations (εHf(t) ranging from -3.14±0.96 to +1.74±0.24) implying that several sources contributed to their formation. Detrital zircons with ages falling in between the events of TTG formation have the most radiogenic Hf composition which indicates that juvenile magmatism occurred in these intermediate periods. Likewise, for the Eoarchaean TTG gneisses, $\delta^{18}O$ values (from 5.49±0.17 to 6.59±0.31 ‰ SMOW) are within the range of igneous rocks derived from the mantle and there is thus no evidence for substantial recycled 'high $\delta^{18}O$' supracrustal components. The patterns observed from the combined U/Pb and Hf isotopes are interpreted to reflect, that TTG formation occurred in a subduction related environment, and that during the periods of TTG formation melting/reworking was focused into pre-existing basaltic crust. The presented data suggest that there is a development in the geodynamic setting of crustal formation during the Archaean eon. The earliest crust formed during the Eoarchaean era can be related to a setting dominated by stable basaltic crust, which in a dynamic sense might resemble a stagnant lid regime (Sleep, 2007). During the Mesoarchaean era a subduction regime was initiated, and the TTG formation seemingly relate to periods where melting/reworking was focused into pre-existing basaltic crust.

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