Differences in the composition of ancient gneiss complexes – a matter of crustal level?

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The 3.6-3.9 Ga Itsaq Gneiss Complex (IGC, southern West Greenland) and the 3.45 to 3.64 Ga components of the Ancient Gneiss Complex (AGC, Swaziland) are typical high-grade gneiss terranes exhibiting up to 90 % of tonalite-trondhjemite-granodiorite (TTG) components as well as fragmented greenstone belts. However, concerning their geochemical composition, the TTGs and the greenstones in both terranes differ significantly. Whereas the Hf-in zircon isotopes from TTGs of the IGC preserve a signature of continuous reworking of Hadaean/Eoarchaean mafic protocrust up to the Mesoarchaean (Naeraa et al., 2012), most TTGs of the oldest unit of the AGC, the Ngwane gneisses, have strongly variable Hf-in-zircon isotopic compositions ranging from juvenile values of up to +2 to strongly negative values to -4 at ca. 3.64 Ga. The Hf-isotope signatures of the Ngwane gneisses either reflect reworking of older mafic/felsic crust by the addition of juvenile (mantle-derived) components or felsic crustal melting in the presence of zircon. The latter interpretation is also supported by the major and trace element geochemistry of the Ngwane gneisses.

Typical greenstone fragments within both gneiss complexes are tholeiitic amphibolites. The IGC tholeiites exhibit arc-like PRIMA-normalized trace element patterns and are interpreted to be the source rocks of the TTGs. In contrast, the amphibolites of the AGC do not show arc patterns, and greenstone remnants such as the Dwalile Greenstone Belt contain komatiites and tholeiitic amphibolites that reveal crustal contamination with slightly older felsic crust.

Altogether, these differences may have resulted from exposed palaeo-crustal levels in each gneiss complex. Whereas the IGC clearly exposes lower-to-middle Archaean crust with a comparatively simple history of reworking, the AGC exposes ancient middle to upper crustal levels and reflects a highly complex reworking history, culminating in cratonization at about 3.1 Ga ago.