6.2.14

3850 Ma felsic crust in the Itsaq Gneiss Complex, West Greenland: The good, the bad and the ugly

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Directly constraining crustal evolution relies on identifying the oldest, most pristine crust and extracting maximum chemical information. Intensive combined field and geochronologic studies have now identified a number of gneiss suites within the early Archaean terranes of the extensive ~3000 km^2 Itsaq Gneiss Complex. The oldest orthogneiss components in the southern exposures of the Complex are 3850-3840Ma tonalites and quartz-diorites. These have now been identified in a number of localities, and are the remnants of a significant 3850 Ma crust forming event. Heterogeneous strain and variable amounts of *in situ* anatexis and veining in later tectonothermal events means that these components show different degrees of preservation. At one end of the spectrum are (rare) homogeneous, non-veined rocks, with simple populations of primarily oscillatory zoned prismatic zircons. The best example of these yet found is a homogeneous tonalite with a zircon age of 3844±6 Ma. At the "ugly" end of the preservation spectrum, migmatites have been identified in Ittilleq, 75 km east of Akilia. Zircons from these migmatites contain a ca. 3850 Ma igneous component, as well as a ca. 3650 Ma igneous and metamorphic components, probably coinciding with incipient partial melting under early granulite facies metamorphism. Previously widespread ca. 3850 Ma felsic crust in the region is further reflected by abundant ca. 3850 Ma detrital zircons in rare ca. 3810 Ma metaquartzites in the Isua supracrustal belt, plus 3850 Ma inherited zircons in ca. 3660 Ma anatectic granites. Significantly, no zircon evidence for >3850 Ma crustal components has been identified.

Four best-preserved ca. 3850 Ma tonalites represent the world's oldest-known non-migmatised felsic crustal components and yield the earliest direct contraints on crustal compositions. Although showing compositional diversity, the characteristics of these samples e.g. high La/Yb-n, are indicative of high degrees of partial melting of a mafic source with residual garnet and with little mantle interaction, as for example evidenced by low relative MgO and Ni. Other trace elements (e.g. high Rb and Cs) argue for the role of fluids in early crustal genesis. This early felsic crust likely formed by melting of hydrated basalt at the base of a section of tectonically thickened crust. These samples extend the continuum of crust formation processes to pre-Isuan times.

6.2.15

Crustal evolution of the Inukjuak Domain and the ca. 3.8 Ga Nuvvuagittuq Sequence, Superior Province, Canada

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Geochemical and Nd isotope data are presented for the Early Archean (3.8 Ga) Nuvvuagittuq (formerly Porpoise Cove) supracrustal sequence and Late Archean (2.7-2.9 Ga) granitoid rocks of the Inukjuak Domain in the western Minto Block of the northeast Canadian Superior Province. The Nuvvuagittuq sequence consists of mafic and felsic volcanic units, sedimentary units, ultramafic sills and tonalitic geniss and pegmatites. The sedimentary rocks consist of conglomerate and metapelite schists as well as banded iron formation. The semi oval Nuvvuagittuq is enveloped by granitoid rocks of the Inukjuak Domain that include biotite, amphibole or orthopyroxene-bearing tonalites, granodiorites and granites.

The broad range of Inukjuak granitoid compositions from tonalitic to granitic reflects the effects of feldspar and Fe-Ti-oxide fractionation. High La/Yb(n) and Sr/Y ratios, low heavy Rare Earth element abundances and positive Eu anomalies characterize the least fractionated tonalitic compositions and likely reflect initial melt compositions. The isotope compositions range from εNd values of +2 to -10 at 2.8 Ga and is the largest range of values found among granitoids of the Minto Block. The range reflects the presence of both juvenile Late Archean crust as well as an early Archean (ca. 3.8 Ga) crustal contaminant, suggesting the recycling of early Archean crust from the Nuvvuagittuq sequence.

Nd isotopic data obtained from Nuvvuagittuq sequence is isotopically distinct and much older than the surrounding Inukjuak Domain. Tonalitic gneisses within the sequence have isotopic compositions indicative of a 3.8-3.9 Ga source and are characterized by light REE enrichment but lack the heavy REE depletion found in many Archean TTG suites. The amphibolitic units and ultramafic sills of the Nuvvuagittuq sequence have flat to light REE enriched profiles and Nd isotopic compositions ranging from depleted to slightly enriched at ca. 3.8 Ga. Numerous isotopic and geological similarities with the Isua sequence of Greenland are evident.