Introduction: We present new ion microprobe U-Th-Pb zircon geochronology, geochemistry and mapping for a recently discovered [1] Eoarchean (ca. 3850-3600 Ma) volcanosedimentary succession from the Nuvvuagittuq belt in northwestern Québec. Currently there are only two well studied locations with supracrustal sequences greater than 3700 Ma: the Isua supracrustal belt in northern Labrador. The Nuvvuagittuq belt now provides a third example for an early Archean supracrustal locality in the North American craton, with a minimum age of ~3760 Ma established by zircon geochronology from structurally discordant granitoid gneiss sheets in the unit.

Background: The Nuvvuagittuq belt is located within the Inukjuak terrane, which is part of the Minto block of the Superior Province (Fig.1). It comprises a ~8 km² volcanosedimentary sequence that includes mafic (basaltic) and ultramafic (komatiitic) schists, putative polymict conglomeratic quartzites, and meta-morphosed banded iron formations, all intruded by orthogneisses. The sequence is multiply deformed and metamorphism has been tentatively assigned to upper amphibolite/lower granulite facies. This study focused on a small portion (130 × 40 m) of the belt, which is itself one of many undocumented enclaves in the Inukjuak terrane. The area was first recognized as a section of early Archean crust by David et al. [2] and described in a provincial geological report by Simard et al. [1].

Fieldwork and geochemistry: In Summer 2005, we undertook a high-resolution mapping project (1:40) of a spectacular shoreline exposure within the belt. Mapping was used to guide sampling; the complex deformation of the units required detailed analysis to identify structures at the appropriate scale and recognize potential cross-cutting relationships key for interpreting the geochronology. There are six main rock types documented within the mapped area:

Amphibolites (Am): Mafic cherts of uniformly tholeiitic composition with flat, 10n-chondrite REE patterns and slightly depleted HFSE and REE on a MORB-normalized multi-element plot. These compositions are indicative of island-arc-type basalts. The Am units range from massive to strongly foliated (mm-scale banding) and are garnetiferous in places with phenocrysts ≤ 40 cm.

Ultramafics (Aum): A ~6m thick ultramafic (basaltic komatiite; Mg# = 56) sequence rich in magnetite is intercalated with the Am units. Magnetite is concentrated in bands that resemble pillow structures.

Banded Iron Formation (BIF; Aqp): Variably deformed quartz+magnetite BIFs outcrop in the western half of the map area. These are mostly SiO₂ (57-62 wt.%) and Fe₂O₃ (32-40 wt.%) with minor Mg and Ca (<3 wt.% and <1.3 wt.% oxide, respectively). Magnetite is preserved in most samples, but is progressively replaced by amphiboles and pyroxenes with increased degree of alteration. Fractionation of 68Fe isotopes [3] supports a sedimentary origin for this unit.

Quartz-pebble conglomerates (Aqc): Units characterized by what appear to be s-deformed polycrystalline quartz pebbles in an amphibolitic matrix (with cordierite ± garnet) are regular features of the map area. Geochemical data show a regular depletion in LILE, REE and HFSE when compared to NASC. This feature, along with larger depletions in Zr, Hf, and Th and enrichments in transition metals, match patterns observed in other detrital Archean sediments [e.g. 4, 5]. However, the highly deformed nature of these units precludes a definitive protolith assignment.

Orthogneisses (Ag): During deformation, narrow orthogneissic sheets can be brought into parallelism with surrounding units making cross-cutting relationships difficult to discern. Nonetheless, one such relationship was observed: Samples IN05011 and IN05012 are from an orthogneiss that structurally cross-cuts and
incorporates xenolithic fragments of the Aqp units. The samples are massive to banded grey gneisses of sodic TTG compositions and trondhjemitic affinity.

Late pegmatites: Early Archean units are disrupted by large, late pegmatites that share the latest deformational history.

Geochronology: Preliminary zircon U-Th-Pb geochronology by TIMS [2] comprised 5 analyses on a single orthogneiss unit (equivalent to our IN05003 & IN05022) with a reported age of 3825±16 Ma when one outlier was excluded. However, if the excluded analysis is used the age reduces to 3805±77 Ma.

To investigate the age of the orthogneisses we used the UCLA Cameca ims1270 ion microprobe in monocollection mode following our usual procedures [6]. Zircons were imaged by BSE to avoid overlapping obvious growth zones with the ~25 µm analysis spot. Four orthogneisses were selected for zircon extraction, including IN05012 which preserves a cross-cutting relationship, to independently constrain a minimum age of the volcano-sedimentary sequence. Two “conglomerate” samples were also prepared in the search for possible detrital zircons. Between 18 and 30 zircons were analyzed from each sample. The best isochron age obtained is 3758±64 Ma (Fig. 2), and the oldest zircon was 3773±10 Ma (99.5% concordant) for the same unit. Other orthogneisses yielded similar, but less precise results due to Pb disturbance and we conclude that the minimum age for the supracrustal sequence is ca. 3760 Ma. A survey of 34 grains from the two conglomerates failed to find any zircons greater than 3735 Ma.

Conclusions: The Nuvvuagittuq belt is a newly discovered, large, Early Archean terrane which contains chemical and possibly detrital sediments which have only begun to be explored. It is comparable in age to the Isua supracrustal belt of West Greenland.

Detailed mapping of a small portion of the belt reveals resolvable cross-cutting relationships exist between intrusive orthogneisses and supracrustal units which provide a minimum age estimate for deposition of the sediments at ca. 3760 Ma. Preliminary geochemical surveys of the principal units in the enclave point to protolith compositions consistent with formation in an arc-like setting.

If the establishment of the continental-oceanic crust dichotomy was an early and widespread phenomenon on the Hadean Earth [7], we expect the inventory of Eoarchean supracrustal rocks to continue to grow as ancient gneiss complexes are investigated in increasing detail. Such ancient rocks provide the only direct window into geologic processes that governed the young Earth and have the potential to greatly expand our knowledge of environmental conditions for the emerging biosphere. The Nuvvuagittuq belt is but one of many early Archean enclaves locked within the Inukjuak terrane that await further study.


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