Zircon U-Pb geochronology of the Nuvvuagittuq Greenstone Belt

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The Nuvvuagittuq Greenstone Belt in northern Québec is a rare ~10 km^2 fragment of the Earth's early crust. The belt contains metamorphosed supracrustal rocks that are at least 3.77 billion years old [1,2], and amphibolites (the Ujaraaluk Unit) that may have protoliths as old as 4.3 Ga [3]. Primary contacts and relative age relationships have been obscured by multiple episodes of intensive ductile deformation, however the geological history of the belt is beginning to be unraveled via geochronology and geochemistry.

In this study we have undertaken SHRIMP U-Pb analysis of zircons from key meta-igneous and meta-sedimentary units of the belt. The analysed samples fall into three categories: (a) felsic bands (0.5 to 1 m in width) and tonalitic orthogneiss interlayered with the Ujaraaluk Unit; (b) fuchsite-bearing quartz-rich bands and a newly identified metasedimentary unit; (c) garnet-biotite amphibolite from the Ujaraaluk Unit and a meta-gabbro.

The felsic lithologies place contraints on the minimum age of the supracrustal assemblage. Oscillatory zoned zircons separated from a plag-qtz-bt schist form a discordant array with an upper intercept of 3774 ± 32 Ma, consistent with previous analyses of similar lithologies [1,2]. The tonalitic orthogneiss yields concordant zircon ages between 3740 and 3800 Ma, consistent with the observation of oscillatory zoned cores and rims from CL imaging.

Zircons from the fuchsite-bearing quartz band are subrounded and have oscillatory zonation textures very similar to the orthogneiss zircons, with little textural variation, and concordant ages of between 3750 and 3800 Ma, similar to the orthogneiss. In contrast, a quartz-albite-clinozoisite dominated metasediment identified within a lower strain domain, interfolded with amphibolites, has highly variable zircon CL textures. The zircons are dominated by concordant ages of 3630 to 3680 Ma, similar to the age of nearby tonalites [2], with minor concordant populations at ca. 3800 and 3500 Ma. Accordingly, the belt must have been exhumed following intrusion of the ca. 3660 Ma tonalite [2], and prior to high-T metamorphism and deformation.

Electron microscopy of polished thin sections was used to locate zircons within 4 samples of the Ujaraaluk Unit mafic amphibolites. Large (≤ 500 μm) zircons separated from a gt-bt rich sample, together with those from the meta-gabbro sample, are sector zoned and yield metamorphic ages of ca. 2700 Ma.

Although unequivocal constraints on the primary age of the Ujaraaluk Unit amphibolites remain elusive for now, continued geochronological studies are revealing that the belt contains a detailed record of Eoarchaean to Paleoarchaean crustal processes.

[1] Cates and Mojzsis (2007) *EPSL* **255**, 9-21
[2] David et al. (2009) *GSA Bulletin* **121**, 150-163
[3] O'Neil et al. (2008) *Science* **321**, 1828-1840

Zircon-adhering, crystallized melt inclusions in peritectic garnet from the western Adirondack Mountains, New York State, USA.

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Micrometer-scale, multiple-solid inclusions occur in garnet from metapelitic gneiss extracted from the hydroelectric plant on the Black River at Port Leyden, NY (western Adirondack Highlands). The garnet host grains are small (0.5-1.0 mm diameter), euhedral neoblasts that formed peritectically during biotite dehydration melting accompanying the Ottawan phase of the Grenville Orogeny (ca. 1040 Ma; [1]). Partial melting conditions of 4 to 6.4 kbar and 735^{o}C, and a peritectic reaction of bio + sil + vapor = gar + melt, or bio + sil + qtz = gar + melt ± K-feldspar have been proposed for these rocks [1].

The inclusions are typically 10-20 μm in diameter and occur randomly in garnet. Both negative crystal and irregular inclusion morphologies are present. Many, if not all, of the inclusions contain a large (5-8 μm), often euhedral, zircon grain surrounded by finer-grained (some less than 1 μm) phases with EDX spectra consistent with biotite, K-feldspar, quartz, and albite. The inclusions are similar in size and composition to those described in garnet from other migmatites (e.g. [2], [3], [4]) and are similarly interpreted as anatectic melt inclusions.

Low Zr solubility in silicate melts [5] indicates the large zircon grain in each inclusion is a trapped phase. Therefore, it appears that micrometer-scale droplets of anatectic melt adhered to refractory zircon grains while peritectic garnet grew around them.

[1] Florence et al., 1995, CMP, v. 121, p. 424-436. [2] Hartel, et al., 1990, GAC-MAC Program Abs. v. 15, p. A54-A55. [3] Cesare et al., 2009, Geology, v. 37, p. 627-630. [4] Ferrero et al., 2012, J. Meta. Geology, (in press). [5] Watson and Harrison, 1983, EPSL, v. 64, p. 295-304.