

Nitrogen and noble gas isotopes of Eoarchean Nuvvuagittuq rocks

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The Nuvvuagittuq greenstone belt is an Eoarchean volcano-sedimentary sequence located in northern Quebec. Rocks are gabbroic intrusions, volcano-sedimentary silicic rocks and banded iron formation (BIFs), enclosed by 3.66 Ga tonalitic gneiss. Rocks are metamorphosed to amphibolite facies and zircon U-Pb ages give a minimum age of 3.75-3.82 Ga to the belt. A deficit in ¹⁴²Nd compared to the terrestrial Nd standard found in some igneous rock which were dated possibly at 4.28 billion years ago, making this rock suite one of the oldest on Earth. Characterization of the fluids in silicic rocks and BIFs, identified by previous works as chemical precipitates in seawater, might give precious constraints on the Earth superficial conditions in Late Hadean, following the Late Heavy Bombardment.

A preliminary survey intended to analyze the fluids trapped into several lithologies of the belt on the noble gas and nitrogen isotopic compositions. Selected samples are an ultramafic intrusion (POR21), a tonalitic gneiss (POR23), three felsic to intermediate silicic volcanoclastic rocks (POR27b, 28c, 28h), a meta-conglomerate (POR29) and a plagioclase-rich amphibolite (POR30). Preliminary noble gas isotopes were carried out at GEOTOP by using a quadrupole mass spectrometer. ⁴He, ²²Ne, ³⁶⁻⁴⁰Ar, ⁸⁴Kr and ^{129,132,136}Xe were analyzed after crushing bulk rock and recovering gases in a purification line. All samples contain radiogenic ⁴He, from 3.7×10^{-8} to 2.5×10^{-7} cm³STP/g_{rock}, although the calculated radiogenic ⁴He/⁴⁰Ar* ratio is only 0.01 to 0.03 against the expected crustal ratio of 4.2. This could indicate large loss of helium during time (which is often observed in Archean rocks) or poor potassium content, the parent element of radiogenic ⁴⁰Ar*. The measured ⁴⁰Ar/³⁶Ar ratios range from 403 to 9635, higher than the atmospheric value of 295.5. The sample that contains most radiogenic noble gas ⁴He and ¹³⁶Xe (from U fission and alpha decay) and ⁴⁰Ar* is the tonalitic gneiss (POR23). All other samples show atmospheric composition of noble gases (except ⁴He and ⁴⁰Ar*) or slight ¹³⁶Xe anomalies.

A new series of noble gas and nitrogen isotopic measurements are under way at Osaka University to determine the origin of gases into the Nuvvuagittuq fluids and try to constrain crustal and igneous sources possibly feeding them.

Keywords: Eoarchean, Atmosphere, Nitrogen, Noble gas