Ferropicrites and Archean crustal reworking in the Northeastern Superior Province of Québec

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The Northeastern Superior Province (NESP) of northern Québec experienced a major episode of crustal reworking beginning at ~ 2.73 Ga (ages by MRNF and GSC) with the widespread emplacement of relatively potassic granitoids into older tonalites and greenstone belts. These younger granitoids are sparsely peppered on a regional scale by small plutonic bodies ranging in composition from peridotite to hornblende websterite and gabbronorite; known in different locations as the Qullinaaraaluk and Couture Suites. Although in places these bodies are little more than tectonic enclaves, they also occur as dyke-like bodies that exhibit an internal zonation from peridotite cores to gabbronorite outer margins, which are characteristically brecciated and re-intruded by the host granitoids. This suggests that the two are approximately coeval, in agreement with U-Pb ages obtained on 5 gabbronorite bodies (2.72-2.70 Ga; data by MRNF). The most striking feature of many of these plutons is that they retain much of their original igneous mineralogy, despite their Archean age. The peridotite core of one of these bodies is dominated by magmatic olivine (~ Fo 80), occurring in hornblende oikocrysts. Such a Fe-rich olivine in a cumulate peridotite requires that the parental magma was ferropicritic in composition, much richer in Fe than modern subduction-related or hot-spot picrites. The widespread distribution of these small plutonic bodies may indicate that the felsic plutonism that stabilized much of the NSEP crust by 2.70 Ga was in part driven by ferropicrite magmatic underplating.

Tracing past ocean circulation with radiogenic and radioactive isotopes

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Reconstructing the variability of ocean circulation in the past has been one of the main foci in paleoceanographic research due to the undoubted strong influence of the ocean on climate. Given that the density of water masses is hard to constrain from the sedimentological record, geochemists have used a number of proxies to make inferences on past water mass advection and mixing. These approaches have mainly been based on proxy tracers of water masses, such as their stable carbon isotope composition or their Cd content recorded by benthic foraminifera for deep waters or Mg/Ca based temperature reconstructions in planktonic foraminfera for surface water masses. Applying these proxies it has been possible to shed light on major oceanic changes in the past on different timescales. It has, however, proven difficult to reach quantitative reconstructions of past water mass mixing.

Two types of new proxies, which potentially offer more quantitative estimates, have received a lot of attention in the recent few years.

The ratio between the U-series radioisotopes ^{231}Pa and ^{230}Th both produced at a constant and well-known rate from radioactive decay of U in seawater, is recorded in sediments and provides information on the flux of ^{231}Pa into the sediments at a particular location over time. Integrated over ocean basins a net loss or gain of ^{231}Pa as a function of advective transport and thus the strength of overturning circulation can be calculated for particular time slices.

The radiogenic isotope composition of elements such as Nd and Hf, which have oceanic residence times near the global mixing time of the ocean, has been proposed as isotopic fingerprint for water mass compositions and thus their mixing and advection in the past. The characteristic radiogenic isotope signatures are introduced by weathering processes of the continental crust. Seawater radiogenic isotope signatures can be extracted from carbonate microfossils, fish teeth, ferromanganese crusts and early diagenetic ferromanagnese coatings of sedimentary particles.

I will discuss the potentials and problems of these proxies related to their present day water mass distribution and endmember water mass compositions, their input sources, as well as the archives. I will also compare the results of the two approaches and will try to assess their potential for consistent and quantitative reconstructions of past ocean circulation.