Towards improved accuracy of SHRIMP zircon ^{207}Pb-^{206}Pb measurements

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SHRIMP and other ion probes are routinely utilized to determine $^{207}Pb/^{206}Pb$ ratios of zircons, but only in special cases can the accuracy of the measurements be claimed to be better than a few ‰. A great deal of attention is placed on calibrating $^{206}Pb/^{238}U$ ratios, yet for $^{207}Pb/^{206}Pb$ this is seldom the case. Any systematic bias in $^{207}Pb/^{206}Pb$ of zircon is considered insignificant relative to the low precision of the individual spot analyses, a reasonable assumption based upon the generally well-known characteristics of the large ion probe. Nevertheless, as several individual $^{207}Pb^*/^{206}Pb^*$ measurements are typically pooled to improve overall precision to the ±1-5 ‰ level for Paleoproterozoic or older zircons, the accuracy of the composite ratio should be a concern.

There are several potential sources of bias in ion probe $^{207}Pb^*/^{206}Pb^*$ measurements of zircon, including instrumental mass fractionation, peak shape, detector performance, isobaric interferences, common Pb correction, and the method of data processing. Although it is important to understand and potentially control these individual factors, it is critical to be able to measure the overall bias. Unfortunately, there appear to be no ion probe zircon reference materials developed expressly for $^{207}Pb^*/^{206}Pb^*$ calibration. Our data obtained from analyzing the Proterozoic U-Pb zircon QGNG suggest that systematic errors of several ‰ may exist between sessions on the same instrument and between different instruments. However, this zircon is not a suitable Pb-isotope standard for several reasons, and the validity of the results is uncertain. We have developed an Archean (ca. 3.5 Ga) $^{207}Pb^*/^{206}Pb^*$ zircon reference material, and TIMS data indicate homogeneity. The goal is to incorporate analyses of this material as a routine part of SHRIMP zircon sessions in order to monitor and potentially correct for any systematic error in the $^{207}Pb^*/^{206}Pb^*$ ages.

Crustal anatexis in the early Archean: Geochemical and isotopic evidence from the ca. 3.66 Ga Nuvvuagittuq Tonalite Suite

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Geochemical and Nd isotope data are presented for a suite of ca. 3.66 Ga tonalites from the 3.8 Ga Nuvvuagittuq supracrustal sequence in the Inukjuak Domain in the western Minto Block, northeast Canadian Superior Province. The Nuvvuagittuq volcano-sedimentary sequence consists of mafic amphibolites with ultramafic lenses, and intermediate and felsic schists dated at ca. 3.8 Ga and interpreted to be of volcanic origin. The sedimentary rocks consist of conglomerate, banded iron formation and quartzitic iron formation. The supracrustal assemblage has a semi-oval form and the tonalite suite both mantles the exterior of the oval and forms the inner core of the assemblage. The exterior sheath of the tonalite is mylonitized and in tectonic contact with Neoarchean (2.7-2.8 Ga) tonalite suites of the Inukjuak Domain. The tonalite core is less mylonitized but both the marginal and core portions of the suite vary from tonalite to granodiorite and granite in composition.

A Lu-Hf isochron mineral-whole rock isochron from the tonalite core yields an age of 3645±26 Ma which is the same age, within error, of the 3.66 Ga U-b zircon age from the tonalite sheath. The tonalite suite is characterized by light Rare Earth element (REE) enriched profiles and variable heavy REE depletion as well as high La/Yb (n) and moderate Sr/Y ratios at low Yb and Y concentrations. Initial Nd and Hf isotopic values are largely negative suggesting that the suite was formed by melting of an older crustal component. Comparison with the isotopic evolution of the Nuvvuagittuq supracrustal sequence suggests that the tonalites may have formed by crustal anatexis of the 3.8 Ga supracrustal sequence. The tonalite suite represents the oldest tonalite suite in the Superior Province and compares in age with anatectic melting events described in the Eoarchean gneisses of West Greenland (e.g. Amitsoq gneisses) and Labrador (e.g. Uivak Gneisses) of the North Atlantic Craton (NAC). The commonality of the ca 3.66 Ga anatectic event may imply a widespread Early Archean migmatization event.