Visualizing organic matter biogeochemistry at the microaggregate scale: Lessons from STXM-SIMS

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Advancing our understanding of soil organic-mineral interactions requires disentangling the complex interactions between soil mineral surfaces, decomposed organic compounds, and soil microbial activity/biomass in both the rhizosphere and bulk soil. To visualize these interactions in intact soil aggregates with limited physical or chemical disruption, we proposed a combination of high-resolution spectroscopy (STXM/NEXAFS), electron microscopy (SEM/TEM) and imaging mass spectrometry (NanoSIMS). By combining these techniques, we have mapped organic carbon (OC) distribution, and imaged associations of organics with specific minerals in soil. Using these approaches with soils has required the development of new preparation techniques for complex organic-mineral samples, along with new ways to navigate and re-locate analysis points. Following isotope labelling experiments, we use both STXM and SIMS to image the same soil microaggregates, thereby generating coherent data on organic matter type and source. This approach allows us to measure role of microorganisms in the formation of protective microaggregates, and examine how differences in organic matter source and environmental controls affect microorganisms and their effects on protected C in microaggregates. These approaches are complementary to more traditional bulk analyses (^{14}C dating, NMR, density fractionation) and ideally will yield mechanistic explanations for the C saturation behaviour of soil fractions crucial to long-term soil C stabilization.

Zircon U-Pb geochronology and trace element chemistry of lower crustal xenoliths, western Churchill province of the Canadian shield

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Here we describe the age and trace element geochemistry of zircon from lower crustal xenoliths, recovered from kimberlite drill core from the Rankin Inlet region, Nunavut, Canada. This is the first stage in a broader effort to characterize the age and petrogenesis of the deep lithosphere beneath the western Churchill province.

We report preliminary results for zircon obtained from four garnet-bearing, mafic granulite xenoliths. In colour SEM-CL, zircon exhibits a wide range of growth morphologies and textures. Mottled to sector-zoned, dark grey metamorphic cores are commonly mantled by uniformly zoned, light grey metamorphic rims. These textures are prevalent throughout the sample suite, with the light grey rims recognized in all samples. Only a small fraction of the suite comprises primary igneous zircon, as determined by the presence of oscillatory, planar growth banding in cores.

U-Pb geochronology and trace element analyses of zircon were conducted using a SHRIMP II at the Geological Survey of Canada, with ages reported here as $^{207}Pb/^{206}Pb$. Primary igneous cores from two samples yield ages of ca. 2.7 Ga and older, while mottled to sector-zoned, metamorphic cores commonly have ages of ca. 1.9 to 2.0 Ga. Uniformly zoned, light grey (in CL) metamorphic zircon rims have ages of ca. 1.7 to 1.8 Ga. Trace element compositions of ca. 1.7 to 1.8 Ga zircon differs significantly from those of older zircon, and are characterized as relatively REE-depleted, with low $(Lu/Gd)_N$ and low HREE. The low $(Lu/Gd)_N$ ratios and relative HREE-depletion suggests garnet crystallization occurred syn- to pre-zircon growth at ca. 1.7 to 1.8 Ga.

Throughout the sample suite, the wide range of SEM-CL textures, and U-Pb and trace element results, suggests multiple zircon recrystallization and growth events in the lower crust. This interpretation is consistent with tectonic models for the Churchill province based on bedrock exposures, which indicate a prolonged, complex tectonothermal history in the Paleoproterozoic [1].

[1] Berman *et al*. (2007) *Geology* **35**, 911-914.