Microbial C and N assimilation in soils and model systems as revealed by ToF-SIMS

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Our research has utilized sub-µm ion probes in conjunction with time of flight secondary ion mass spectrometry (ToF-SIMS) for studying C and N assimilation in soil microbes. Early proof of concept studies using ^{13}C and ^{15}N labelled substrates clearly showed that C and N assimilation are detectable in single microbes using secondary ions of CN^{-} isotopes. Because of practical limitations, high spatial resolution analyses are typically performed at low mass resolution. We were able to use a simple subtraction algorithm to remove $^{13}C^{14}N^{-}$ form the total $^{27}CN^{-}$ peak and quantify organic ^{15}N isotope ratios. We applied this algorithm to region of interest analyses of microbes adhering to Si contact slides from soils and model soil systems. These studies have shown that microsite heterogeneities consisting of concurrent assimilation of inorganic N and rapidly mineralizing-organic-N may exist separated by only tens to hundreds of microns.

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Applications of SIMS Microanalysis at NIST

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Three Secondary Ion Mass Spectrometry (SIMS) instruments have been used for various microanalytical measurements applied to, or have the potential to be applied to geochemically interesting problems. Two of the instruments are dynamic SIMS magentic sector instruments, a Cameca ims-4f and an ims-1270, and one is an IonTof Tof-SIMS IV. In addition to the measurement of sub-micron particles and structures, various cluster primary ion beams have been explored to enhance signals from organic materials as well as to limit damage of sub-surface layers to enhance our ability to obtain ultra-shallow depth profiles and depth profiles of organic materials.

Applications and measurements made with each of the instruments at NIST will be shown and discussed. Measurements of depth profiles, trace element abundances will be addressed, as well as isotopic ratios of natural minerals and anthropogenic materials. The importance of these measurements not only to geochemistry but to industry and international matters will be touched upon. Comparisons and limitations of each of the instruments will be addressed, specifically with respect to spacial resolution, both laterally and as a function of depth. Implications of signal intenstity for hyperspectral analysis from limitations of secondary ionization, increased lateral resolution, and depth resolution will also be discussed.