NanoSIMS: New results of relevance to biomineralization and biology

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The NanoSIMS is a relatively new type of ion microprobe that can deliver a primary beam of Cs^+ or O^- to a sample surface, focused to a minimum spot size of ~50 nanometers and ~150 nanometers, respectively. (On non-conducting materials, bombardment with Cs+ causes strong charging effects. Such positive charge build-ups are compensated by electrons, which can be delivered to the sample surface by an electron gun.) Secondary ions sputtered from the sample surface and charged opposite to the primary beam are transferred with high transmission to a high mass-resolution, multi-collection mass-spectrometer that allows simultaneous collection of five or seven (depending on the model) different isotopes in electron multipliers and/or Faraday cups. This means that five (or seven) different images can be simultaneously recorded from the same sputtered volume. This capability can be used to create images or maps of elemental and isotopic variation within a sample. Such images can be generated from the lightest elements, such as H (D/H ratios), C ($^{13}C/^{12}C$ ratios), N ($^{15}N/^{14}N$ ratios), O ($^{17}O/^{16}O$ and $^{18}O/^{16}O$ ratios) and S (e.g. $^{34}S/^{32}S$ ratios) to the heaviest elements in the periodic table, including uranium.

Ion images of the sample surface are created by a precisely controlled raster of the primary beam across the sample surface. The NanoSIMS is therefore a powerful analytical instrument in conjunction with biological labeling experiments, where high spatial resolution is required and high analytical precision is not a requirement. Importantly, it is possible to do high quality NanoSIMS imaging even on very thin sections prepared for TEM analysis.

This presentation will include examples of the combination between dynamic isotopic labeling experiments, SEM, TEM, STXM, and NanoSIMS imaging to study skeletal formation dynamics and single-cell-level ammonium assimilation in reef-building corals.

Quantification of environmental proxy precision

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The extent and causes of recent environmental variations represent a vitally important problem for scientists, lawmakers and society in general. Essential to the ongoing scientific debate is the development of proxies that can reconstruct environmental change on both short (10-1000 years) and long (i.e. geologic) timescales. However, for every such proxy, a fundamental question exists that is rarely addressed: To what *precision* can the proxy reconstruct environmental variation? Only by answering this question quantitatively is it possible to decide if a given proxy is precise enough to be applicable and useful.

Here, we illustrate and discuss the vital effects that plague the major proxies for e.g. ocean sea-surface temperature. This will be based on recently acquired micro-analytical data, in particular with the NanoSIMS ion microprobe. Subsequently, the precision of linear environmental proxies is quantified with a general and easily applicable method. The precision of a selection of existing proxies is evaluated against the requirements of e.g. anthropogenic global warming.