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Analysis of the Boron Isotope Ratio in foraminiferal Shells with resonant Laser-SNMS

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The isotope ratio of boron incorporated during the formation of the calcite shell of foraminifera depends on the pH-value of the ambient sea water. Therefore measurements of this ratio can provide useful proxy data for palaeoclimate reconstruction.

Since the fraction of boron in these shells is about 5 ppm [1] a highly sensitive technique is necessary to determine the exact boron isotope ratio [2]. A promising tool for this task is resonant laser secondary neutral mass spectrometry (r-laser-SNMS). This technique uses a focused energetic ion beam for bombarding a solid sample, a time-of-flight mass spectrometer for simultaneously analyzing the sputtered particles and a system of tunable dye-lasers for resonantly ionizing the neutral atoms. Since the majority of the sputtered particles is neutral this procedure leads to higher sensitivity than SIMS, which utilizes only the sputtered ions.

Since the energy spectrum of excited states is unique to each element, the selection of a particular scheme of excitation steps for resonant ionization provides high selectivity. Thus, this technique is especially valuable for ultra-trace element analysis in general and for high precision isotope ratio measurements in particular.

For the ionization of boron neutrals a three step ionization scheme was applied. The applied pulsed dye laser system is sufficiently intense to saturate both the bound-bound transitions and the ionization step.

Several measurements on single untreated calcite shells were performed. Although the required accuracy is not reached yet, it could be shown that resonant laser-SNMS is able to determine the boron isotope ratio even of a single foraminiferal shell.

[1] D.W. Lea, in: Modern Foraminifera, ed. B.K. Sen Gupta, Kluwer Academic Publishers (1999), p. 259-277. [2] G. Vering, C. Crone, J. Bijma, and H.F. Arlinghaus, Appl. Surf. Sci. 203-204, 785-788 (2003).