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The Potential of Laser Ablation Multiple-Collector ICP-MS in Strontium Isotope Stratigraphy

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Studies in Strontium Isotope Stratigraphy are often limited by the diagenetic overprinting of seawater $^{87}Sr/^{86}Sr$ signatures, particularly in Palaeozoic sequences. Micro-sampling of shells and limestone components by laser ablation has the potential for the rapid recovery of seawater signals from the least altered parts of such material at sub-mm spatial scales.

In-situ $^{87}Sr/^{86}Sr$ measurements obtained by multiple-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) with laser ablation sample introduction are reported (a Micromass Isoprobe and 266nm Nd:YAG UV laser were used for this study). A method for the in-situ analysis of precise and accurate $^{87}Sr/^{86}Sr$ is presented, which includes new techniques for the correction of tail and background signals. The method gives an average of 0.709134 ±0.000033 (2.s.d., n=10) with a mean internal error of ±0.000028 (2 s.d.) for a modern marine calcite shell with ~800ppm Sr. Unaltered parts of a Lower Jurassic belemnite with ~900ppm Sr yield 0.707072 ±0.000057 (2.s.d., n=6), with a mean internal error of ±0.000027 (2.s.e.). These results are 0.000041 (~57ppm) lower and 0.000003 (~4ppm) lower than TIMS respectively. Each modern shell analysis requires the ablation of ~0.048mm^3 of carbonate, which contains ~100ng of Sr.

The method has been applied to construct reproducible profiles of $^{87}Sr/^{86}Sr$ across heterogeneously preserved belemnites using a 200μm wide track. Elimination of data from known altered areas from such profiles should leave an average $^{87}Sr/^{86}Sr$ value which reflects the value of the contemporaneous seawater. Preliminary analyses from one belemnite sample yield 0.707190 ±0.000022 (2.s.e.) and 0.707191 ±0.000022 (2.s.e.). The accuracy of these results relative to TIMS is 0.000043 and 0.000042 (61 ppm and 60 ppm) lower, though the laser data may provide a better estimate than TIMS for this partially altered sample. It is planned to investigate the potential of laser data for the construction and refinement of standard seawater $^{87}Sr/^{86}Sr$ curves in the Lower Jurassic, and Lower Cambrian.

Another demonstration of the technique is provided by $^{87}Sr/^{86}Sr$ profiles recovered from an exceptionally well preserved Jurassic bivalve. The data show that variations in $^{87}Sr/^{86}Sr$ of 0.000500 in magnitude can be resolved between different growth bands of the shell.

Laser ablation coupled to MC-ICP-MS is beginning to rival TIMS with micro-drilling for the production of quality in situ $^{87}Sr/^{86}Sr$ data from carbonates. The spatial scale of sampling is limited at present by poor transport of material from the laser to the plasma, but the technique is much more rapid than TIMS, with profiles being generated in a matter of minutes rather than days or weeks.