In situ carbon isotope analysis by laser ablation MC-ICP-MS

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Carbon isotopes have been widely used in tracing a wide variety of geological and environmental processes. The carbon isotope composition of bulk rocks and minerals was conventionally analyzed by isotope ratio mass spectrometry (IRMS), and more recently secondary ionization mass spectrometry (SIMS) has been widely used to determine carbon isotope composition of carbon-bearing solid materials with good spatial resolution. Here we present a new method that couples a RESOlution S155 193 nm laser ablation system with a Nu Plasma II MC-ICP-MS, with the aim of measuring carbon isotopes in situ in carbonate minerals (i.e., calcite and aragonite). Under routine operating conditions for $\delta^{13}C$ analysis, instrumental bias generally drifts by 0.8 – 2.0‰ in a typical analytical session of 2-3 hours. Using a magmatic calcite as the standard, the carbon isotopic composition was determined for a suite of calcite samples with δ13C values in the range of -6.94 to 1.48‰. The obtained δ13C data are comparable to IRMS values. The combined standard uncertainty for magmatic calcite is <0.3 ‰ (1s). No significant matrix effects have been identified in calcite with the amplitude of chemical composition variation (i.e., MnO, SrO, MgO, or FeO) up to 2.5 wt%. Two modern corals were investigated using magmatic calcite as the calibration standard, and the average $\delta^{13}C$ values for both corals are similar to the bulk IRMS values. Moreover, coral exhibits significant heterogeneity in carbon isotope compositions, with differences up to 4.85‰ within an individual coral. This study indicates that LA-MC-ICP-MS can serve as an appropriate method to analyze carbon isotopes of carbonate minerals in situ.