

Multielement analyses of single presolar SiC grains from supernovae

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X-type silicon carbide grains isolated from the Murchison meteorite are thought to have formed in ejecta from Type II supernovae, based on their C, Si, Mg and Ca isotopic compositions (Zinner, 1999). Here we expand previous work (Pellin et al., 2000) detailing the heavy element isotopic compositions of ten such SiC grains.

In each grain, the C, N, and Si isotopic compositions along with at least one heavy element isotopic composition have been determined. Remarkably, two of the grains contained sufficiently high trace element abundances to allow determination of all five heavy elements (Sr, Zr, Mo, Fe and Ba). Although supernovae are thought to be the major site for *r*-process nucleosynthesis, it is clear from Mo that heavy element isotopic compositions are not consistent with *r*-process production. The *r*-process signature would be an enhancement in ¹⁰⁰Mo, but the grains are instead most enriched in ⁹⁵Mo and ⁹⁷Mo relative to *s*-process-only ⁹⁶Mo. Such a pattern can be produced by the ~10s neutron burst produced when the supernova explosion shock passing through He-rich zones (Meyer et al., 2000). Enhancements in ⁹⁶Zr/⁹⁴Zr, ¹³⁸Ba/¹³⁶Ba, ⁸⁸Sr/⁸⁶Sr, ⁵⁷Fe/⁵⁶Fe and ⁵⁸Fe/⁵⁶Fe seen in X-grains are consistent with such a neutron burst. Recent detailed calculations of Type II supernova explosions show large enhancements of ⁵⁷Fe, ⁵⁸Fe, ⁸⁸Sr, ⁹⁶Zr, ⁹⁵Mo, ⁹⁷Mo and ¹³⁸Ba in an O-rich zone below the helium-rich zone (Rauscher et al., 2002).

The isotopic compositions of X-type SiC grains require material from several zones in supernovae: large enhancements in ²⁸Si and ⁴⁴Ti (which decayed *in situ* in X-grains to ⁴⁴Ca) must come from Si-rich zones deep in the presupernova star; large ¹²C enhancements must come from He-rich zones; the neutron burst signature seen in the heavy elements appears to come from O-rich zones. Material from all of these zones must mix to form a gas with C/O>1 in order for SiC to condense rather than silicates. These requirements rather tightly constrain mixing processes in supernova ejecta.

Monitoring Sources and Fluxes of CO₂ with High Precision Atmospheric Stable Isotopic Measurements

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Reliable information relating to sources and sinks of CO₂ is essential when monitoring changes in atmospheric emissions, effects of emission reduction strategies and general carbon cycling within a given ecosystem. Studies of CO₂ sampled from atmospheric and soil gases often involve the analysis of large numbers of samples requiring high throughput, automated sample preparation and the ability to deal with trace amounts of analyte. The Micromass TraceGas (TM) inlet allows the analysis of CO₂, N₂O and CH₄ in trace concentrations (ppb level and below). Volumes of less than 100 ml of ambient air can automatically be pre-concentrated, purified and analyzed.

We present the use of the TraceGas to investigate CO₂ cycling in ecosystems, through the measurement of the isotopic signature of soil gases. Emissions of natural CO₂ from an area of seasonal grassland in California are compared to a second plot where the majority of CO₂ is derived from the addition of elevated quantities of bottled gas (manufactured from fossil fuel). Significant shifts in the isotopic signatures were observed between the two plots, thus demonstrating the ability of the technique to identify areas of pollution and anthropogenic influences.

In addition, we present the outcome of a recent study monitoring ¹³CO₂ in atmospheric low pCO₂-samples over a hydroelectric reservoir in Quebec, Canada. In this case, the IsoPrimeTM IRMS configured with the MultiFlowTM sample preparation system has been used to obtain ¹³C measurements in samples stored in 12cc ExetainerTM vials. The study assesses how various factors, such as climatic events, the proximity of riverine vegetation and inputs of dissolved organic carbon influence the ¹³C-CO₂ signature of the overlying air. Benefits of the system for the analysis of ¹³C in CO₂ include full automation, and high sample throughput and capacity (~3 mins per sample; > 250 samples per day).

Combinations of both systems will become essential to monitor Carbon budgets and constrain the models explaining the global carbon cycle.