Multielement analyses of single presolar SiC grains from supernovae

A. M. DAVIS[1,2], M. J. PELLIN[3], C. E. TRIPA[1,3], M. R. SAVINA[3], R. S. LEWIS[1], R. N. CLAYTON[1,2,4], S. AMARI[5]

[1]Enrico Fermi Institute, [2]Dept. of Geophysical Sciences, [4]Dept. of Chemistry, University of Chicago, Chicago, IL 60637 (a-davis@uchicago.edu, tripa@anl.gov, roylewis@uchicago.edu, r-clayton@uchicago.edu)
[3]Materials Science Div., Argonne Nat'l. Laboratory, Argonne, IL 60439 (pellin@anl.gov, msavina@anl.gov)
[5]Laboratory for Space Sciences, Washington University, St. Louis, MO 63130 (sa@wuphys.wustl.edu)

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 ^{100}Mo, but the grains are instead most enriched in ^{95}Mo and ^{97}Mo relative to *s*-process-only ^{96}Mo. 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 ^{96}Zr/^{94}Zr, ^{138}Ba/^{136}Ba, ^{88}Sr/^{86}Sr, ^{57}Fe/^{56}Fe and ^{58}Fe/^{56}Fe seen in X-grains are consistent with such a neutron burst. Recent detailed calculations of Type II supernova explosions show large enhancements of ^{57}Fe, ^{58}Fe, ^{88}Sr, ^{96}Zr, ^{95}Mo, ^{97}Mo and ^{138}Ba 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 ^{28}Si and ^{44}Ti (which decayed *in situ* in X-grains to ^{44}Ca) must come from Si-rich zones deep in the presupernova star; large ^{12}C 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.

References

Meyer B. S. et al. (2000) *Ap. J.* **540**, L49–L52.
Pellin M. J. et al. (2000) *LPS XXXI*, #1969.
Rauscher T. et al. (2002) *Ap. J.,* in press, astro-ph/0112478.
Zinner E. (1998) *Ann. Rev. Earth Planet. Sci.* **26**, 147–188.