Partial condensation of volatile elements in Renazzo chondrules

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Two processes compete to explain the gross features of elemental abundances in chondrites: 1) partial evapora-tion, and 2) partial condensation. In 1), chondrule compositions could be explained in terms of the heating trajectory, while in 2), chondrule compositions would be related to the cooling history of the nebular region these formed in. Siderophile elements condense into a single phase (Fe-metal alloy) over the entire range of condensation temperatures from refractory to volatile. Laser ablation microanalysis of siderophile elements in Renazzo chondrules was performed to investigate the roles of evaporation and recondensation of volatile elements during chondrule formation. Renazzo, an unmetamorphosed CR fall, has three types of metal: isolated grains in the matrix, metal in chondrule cores, and metal on chondrule rims.

Polished section #45 (MNHN) was analyzed by laser ablation ICP-MS using a Finnigan Element™ coupled to a CETAC™ LSX-200. Spot sizes were 25-100 µm in diameter and ablated pit depths were about 15 µm. The following isotopes were determined ^{57}Fe, ^{59}Co, ^{60}Ni, ^{63}Cu, ^{69}Ga, ^{74}Ge, ^{75}As, ^{95}Mo, ^{101}Ru, ^{105}Pd, ^{184}W, ^{185}Re, ^{192}Os, ^{193}Ir and ^{195}Pt. The highly refractory elements Mo, Ru, W, Re, Os, Ir and Pt behaved as a single group, having chondritic abundances in isolated matrix metal, were enriched in chondrule interior metal and were depleted in chondrule rim metal. The elements Fe, Ni, Pd and Cu had been volatilized from chondrules and recondensed onto chondrule rims. The elements Ga and Ge were not measurably enriched in chondrule rim *vs.* core metal, but were highly enriched in Renazzo matrix.

The following scenario is proposed: volatilization of Fe, Co, Ni, Pd, Cu, etc., occurred during chondrule heating, followed by rapid recondensation of these elements on chondrule rims. Recondensation occurred on pre-existing metal nuclei which provided refractory elements in the rim metal. Recondensation of the more volatile Ga and Ge did not occur prior to solidification of the rim metal, but occurred on fine-grained dust that constitutes the matrix. Thus, Renazzo preserves evidence for extensive vaporization of major element constituents of chondrules (Fe, Ni), but indicates that these elements were recondensed before dispersal of the gas phase. This is compelling evidence that partial condensation of volatile elements on to chondrules dominates the chemical record of chondrites. It does not support hypotheses that may require rapid separation of chondrules from nebular gas.

Trace Metal Dynamics in Freshwater Sediment: The Haringvliet

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Geochemical characterization of trace metals in the sediments of the Haringvliet, a coastal lake in the southwestern Netherlands is presented. In 1970 this site was changed from an estuary into a freshwater lake by the construction of a dam. A partial restoration of estuarine conditions will begin in 2005. Possible changes in trace metal speciation and mobility due to increased salinity will be examined in the future.

In November 2001 sediment and sediment porewater was collected and analysed for three sites in the Haringvliet. The total metal concentrations in the sediment, as determined by HF-HNO_3 extraction and corrected for particle size distribution, were similar to the levels found in Rhine river suspended matter, the main source of trace metals at the site. Trace metal levels in Rhine suspended matter declined from 1970 to approximately 1982 in response to environmental protection measures. Similar changes in trace metal concentrations were observed in the bottom of sediment cores collected at Sites 1 and 2. Higher sedimentation rates at Site 3 result in only recent sediments (post-1982) in the top 36 cm. The metal concentrations in the deeper (pre-1982) sediment show a strong correlation with concentrations of organic carbon, this correlation is not found in the more recent sediments (Table 1 example Site 2).

Table 1. Trace metal concentrations and correlation to organic matter concentration (Site 2)

depth	Zn	Cr	Cu	Pb
(cm)	concentration min – max (µmol g $^{-1}$)			
0 - 8	4.0 - 6.7	1.4 – 2.3	0.4 – 0.8	0.6 – 0.9
8 - 28	5.1–16.4	1.7 – 5.2	0.6 – 1.9	0.7 – 2.4
	Correlation with Organic Carbon (r^2)			
0 - 8	0.64	0.41	0.42	0.69
8 - 28	0.95	0.92	0.96	0.97

Concentrations of trace metals are found in a relatively constant rank of abundance: Zn > Cr > Cu ˜ Pb (Table 1). Organic carbon concentrations range from 1 to 4 (wt.%) and oxygen penetration is limited to the upper 1-7 mm of sediment. Concentrations of other redox sensitive species change dramatically over the upper 5 – 10 cm of sediment suggesting substantial organic matter decomposition in the surface sediment. Further analysis will be conducted to obtain information about the trace metal speciation and mobility.