Evidence for a late ^{60}Fe injection into the protoplanetary disk

MARTIN BIZZARRO[1], DAVID ULFBECK[1], ANNE TRINQUIER[1], KRISTINE THRANE[1], JAMES CONNELLY[1,2] AND BRADLEY MEYER[3]

[1]Geological Institute, University of Copenhagen, Øster Voldgade 10, DK-1350, Denmark
[2]Jackson School of Geosciences, University of Texas at Austin, Austin, Texas 78712, USA
[3]Department of Physics and Astronomy, Clemson University, Clemson, SC 29634-0978, USA

Understanding the origin of short-lived isotopes in meteorites can constrain the astrophysical setting of Solar System formation and the earliest evolution of the protoplanetary disk and proto-Sun. Whereas early Solar System abundances of short-lived isotopes with relatively long half-lives like ^{53}Mn and ^{182}Hf broadly reflect input from stellar sources over the history of our Galaxy, the inferred levels of ^{41}Ca, ^{26}Al and ^{60}Fe are too high to uniquely derive from Galactic production. Some of the ^{41}Ca and ^{26}Al may have formed by particle irradiation near the proto-Sun. In contrast, the exclusive stellar origin of ^{60}Fe requires that it was synthesized in a nearby star and injected into the nascent Solar System. Here, we show that meteorites with highly-variable Fe/Ni ratios originating from differentiated planetesimals that accreted within 1 Myr of Solar System formation record identical deficits of ~25 ppm in ^{60}Ni (the daughter product of ^{60}Fe) compared to samples from Earth, Mars and chondrite meteorites. With clear evidence for live ^{60}Fe when the chondrite and eucrite parent bodies formed, our study requires that ^{60}Fe was injected into the protoplanetary disk ~1 Myr after Solar System formation, at a time when ^{26}Al was homogeneously distributed. This decoupling of the first appearance of ^{26}Al and ^{60}Fe indicates that our forming Solar System interacted with massive stars ($\geq 30M_{sun}$) where ^{26}Al was solely expelled by stellar winds of the Wolf-Rayet stage, and ^{60}Fe subsequently injected during the supernova explosion associated with a dying star. Lastly, the terrestrial Ni isotope composition suggests that Earth accreted from material distinct from that of known primitive and/or differentiated meteorites.

Influence of landscape type on trace metals in small boreal catchments

L. BJÖRKVALD[1], H. BORG[2], H. LAUDON[3] AND C.M. MÖRTH[1]

[1]Dept. of Geology and Geochemistry, Stockholm University, Sweden (louise.bjorkvald@geo.su.se)
[2]Dept. of Applied Environmental Science, Stockholm University, Sweden (hans.borg@itm.su.se)
[3]Dept. of Ecology and Environmental Science, Umeå University, Sweden (hjalmar.laudon@emg.umu.se)

We studied temporal and spatial variations of trace metal (TM) concentrations (As, Cd, Co, Cr, Cu, Ge, La, Ni, Pb, Rb, Sc, and Y) in stream water and their correlation with catchment properties (i.e. coverage of wetland and forest), but also with Fe and Mn. During 2004 and 2005 water samples were collected from 10 streams (0.13 km^2 to 67 km^2) in the Krycklan Catchment Study, a boreal stream network in northern Sweden. Since spring snowmelt is the most important hydrological event, the monthly sampling was intensified during spring flood (April-May) when samples were collected every second day. Total and dissolved (<0.4µm) concentrations of Fe and Mn were determined by ICP-OES. Dissolved concentrations of TM were determined by ICP-MS.

Preliminary results show a seasonal variation for all TM, in particular during spring flood. In forested catchments most TM concentrations increased at spring flood, but for Rb and Sc a decrease was observed. Conversely, in wetland influenced catchments the opposite seasonal variation was observed, i.e. concentrations of all TM decreased by a factor of 2 to 3. The seasonal variation of Fe shows a similar pattern to many TM, due to the association of TM to Fe oxyhydroxides. In particular, Fe correlates significantly with Cr and Pb in a forested headwater stream (r^2=0.77 and r^2=0.71, respectively, $p<0.05$). In the wetland headwater stream similar correlations between Fe and TM are found, but DOC also correlates significantly with As, Cd, Ni, and Pb (r^2=0.92, $p<0.05$).

A significant negative correlation ($p<0.05$) was observed between coverage of wetlands and average concentrations of Cr, Cu, Ge, Ni, Sc and Y. The results indicate that wetlands act as sinks for these elements. Alternatively, there is a source limitation in wetlands and that increased concentrations during base flow are due to mineral groundwater influence. Positive correlation with wetland coverage was only observed for Pb (r^2=0.79, $p<0.05$), indicating that wetlands acts as a source for this element. Sulfate concentrations correlated negatively (r^2=0.97, $p<0.05$) with increasing coverage of wetlands, which highlights the importance of sulfate reduction within wetland areas.

This study emphasizes the importance of considering stream water chemistry from a landscape perspective.