Triggered Star Formation and the Injection of Radioactivities into the Presolar Cloud

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Meteorite studies have revealed the presence of short-lived radioactivities in the early solar system. The current data suggests that the origin of at least some of the radioactivities requires contribution from recent nucleosynthesis at a stellar site. This sets a strict time limit on the time available for the formation of the solar system and has led to the formulation of the theory of the triggered origin of the solar system.

According to this scenario, the formation of the solar system was initiated when an interstellar shock wave originating from a nearby explosive stellar event impacted on a molecular cloud core. In addition to triggering the collapse of the molecular cloud core, the shock wave also deposited some of the freshly synthesized radioactivities into the collapsing system. The radioisotopes were then incorporated into the first solar system solids, in this manner leaving a record of the event in the meteoritic material.

The viability of the scenario can be investigated through numerical simulations studying the processes involved in the interaction between an interstellar shock wave and a molecular cloud core. The calculations suggest that star formation can be initiated in this manner and that an appreciable amount of shock wave material – approximately 10% - can be injected into the collapsing system by Rayleigh-Taylor instabilities. The calculations also suggest that temporal and spatial heterogeneities in the abundances of the radioactivities may have existed at the time of their arrival in the forming solar system.

Micro-scale Pb distribution and oxidation in a shooting range soil

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Deposition of shotgun bullets is the major source of lead contamination of soils near shooting ranges. The environmental impacts of shooting range soils contaminated with up to 30’000 ppm Pb has long been ignored, since metallic Pb(0) in shotgun bullets has been regarded highly immobile and inert. However, recent studies found that Pb bullets in soils develop corrosion coatings within a few years (Lin, 1996; Lin *et al*., 1995). Some studies also reported elevated Pb concentrations in the subsoil at contaminated shooting ranges (Murray *et al*., 1997) indicating a potential for Pb mobilization and transport into underlying aquifers. To clarify the mobility of Pb in shooting range soils, we are investigating the spatial distribution and chemical speciation of Pb and other elements in several shooting range soils on a centimeter to micrometer spatial scale.

Undisturbed soil samples were collected from various depths of a shooting range soil in Switzerland. After embedding the samples in resin, ~200 µm thick sections were prepared for micro X-ray fluorescence (µ-XRF), micro X-ray diffraction (µ-XRD), and micro X-ray absorption spectroscopic (µ-XANES) analyses. A preliminary elemental mapping was performed on a laboratory µ-XRF instrument (Eagle-II µProbe, EDAX) using a capillary optics producing a focussed X-ray spot of ~50 µm diameter. Selected areas were then analysed by µ-XRF, µ-XRD, and µ-XANES at beamline X26A of NSLS using a spot size of ~15 µm.

Elemental mapping of soil thin sections including fragments of shotgun bullets showed ~1 mm thick corrosion mantles around the metallic Pb. Analysis of selected areas by µ-XANES revealed that the corrosion mantle consists of a mixture of Pb(0) and Pb(II), while at greater distance from the bullets only Pb(II) was detected. The migration of Pb(II) away from the bullets into the soil matrix was clearly shown by µ-XRF elemental mapping. However, the magnitude of Pb spreading into the soil was rather low, suggesting that Pb is highly immobile in the soils studied.

References

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