

Lifetime of the active solar nebula

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The duration of formation of the very early solar system objects, such as the Ca-Al-rich Inclusions (CAIs) and chondrules, that are considered to be products of high temperature nebular processes, effectively defines the lifetime of the active solar nebula. Most of the CAIs host radiogenic isotopic anomalies from in-situ decay of short-lived now extinct nuclides, while a subset of CAIs are devoid of such anomalies but host large magnitude stable isotope anomalies. The latter group appears to have formed in the solar nebula within the first 10^5 years, prior to the injection of freshly synthesized short-lived nuclide into it [1]. The formation of the CAIs hosting radiogenic isotope anomalies spread over a time scale of a few times 10^5 years [2], although recent data suggest that this could be as short as 5×10^4 years [see, e.g., 3]. There is a general consensus at present that formation of chondrules started about a million years after the formation of the CAIs, and the inferred duration of chondrule formation, based on study of ^{26}Al records, varies from less than a million years to three million years [3]. A detail study of chondrules from unequilibrated ordinary chondrites (UOCs) belonging to the L group and representing various petrologic types, show that the major episode of chondrule formation started ~ 1.5 Ma after CAI formation and lasted < 1 Ma [4]. The longer duration of formation for UOC chondrules, inferred in earlier studies, appears to be an artifact caused by thermal metamorphism affecting some of the chondrules belonging to low petrologic type. In contrast, data for chondrules from carbonaceous chondrites, obtained by us [5] and others, suggest that chondrule formation in the outer region of the inner solar system persisted for a much longer duration of ~ 3 Ma. Plausible scenarios that may accommodate these observations relevant to the lifetime of an active solar nebula will be presented.

References

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Sulfur K-edge X-ray absorption spectroscopy as a tool to investigate microbial triggered sulfate reduction

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Investigation on the chemical states of sulfur is essential to characterize reaction products from microbial catalyzed neutralization of acidic mine waters and from laboratory experiments carried out with the iron and sulfate containing mineral jarosite ($\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$) exposed to sulfate reducing bacteria as a model system. With an element specific technique like the x-ray absorption spectroscopy (XAS), and therein from the near edge structure (XANES) information on the chemical binding form of sulfur can be obtained. XANES spectra at the sulfur K edge (around 2.48 keV) have been recorded at the XAS beamline of the synchrotron radiation source ANKA at the Forschungszentrum Karlsruhe.

Due to the oxidation of metal sulfides (e.g. FeS_2) in coal mining sites metal ions and sulfuric acid are released in the adjacent waters. Thus, the acidic pit lakes that form in abandoned mining sites are an environmental hazard. A stimulation of sulfate reducing bacteria (SRBs) at the sediment water interface might act as a starting point to neutralize such lakes by transforming dissolved iron, metal and sulfate ions as well as the iron sulfate minerals of the lake sediment (e.g. jarosite) back into iron sulfides. Analysis of the sulfur K edge XANES shows in near surface samples of the sediment that was locally covered with calcium carbonate and organic carbon to increase bacterial activity reduced sulfur species (monosulfide). To understand the processes at the sediment water interface synthetic jarosite has been exposed to SRBs in the laboratory. Resonances in the spectra were assigned to monosulfide and disulfide sulfur besides the sulfate of the remaining reactant jarosite. Re-oxidation experiments indicate a similar behavior as for the lake sediments: the decrease of monosulfides to sulfur and to sulfate (Göttlicher and Mangold, 2005).

Reference

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