

Noble gases in chondrules and metal-sulfide rims of primitive chondrites - Clues on chondrule formation.

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Introduction

Chondrules in ordinary chondrites are often surrounded by metal-sulfide (MS) rims, which were possibly formed together with chondrules. Part of the MS rims were formed by expulsion of MS-droplets from molten chondrules and subsequent crystallisation on chondrule surfaces [Rambaldi and Wasson 1981, Alexander et al. 1889, Connolly et al. 2001]. Our noble gas study on trapped Ne and Ar in MS rims and chondrules of Bishunpur (LL3.1), Krymka (LL3.1), and Semarkona (LL3.0) supports this scenario and suggests a fractionation of the Ar-carrier phase Q and the Ne-carrier phase HL during chondrule formation.

Results

Most of the MS rims show high $^{36}\text{Ar}_{\text{tr}}$ but lower $^{20}\text{Ne}_{\text{tr}}$ than the surrounding fine-grained material, resulting in high $(^{36}\text{Ar}/^{20}\text{Ne})_{\text{tr}}$ (Fig. 1). In contrast, several Semarkona and Bishunpur chondrules show very low $(^{36}\text{Ar}/^{20}\text{Ne})_{\text{tr}}$ ratios, indicating preferential depletion of $^{36}\text{Ar}_{\text{tr}}$. We infer that during chondrule formation the $^{36}\text{Ar}_{\text{tr}}$ -carrier phase Q partitioned preferentially into the liquid metal phase, which was subsequently expelled from the chondrule and formed the rim. The residual silicate melt, which is now present as the chondrule interior, shows a corresponding deficiency in $^{36}\text{Ar}_{\text{tr}}$.

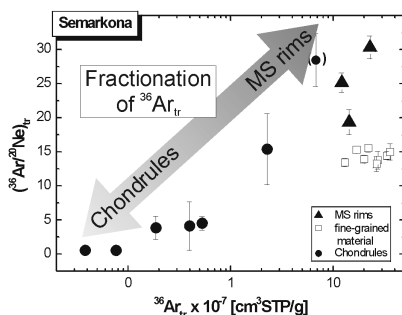


Fig. 1: $(^{36}\text{Ar}/^{20}\text{Ne})_{\text{tr}}$ vs. $^{36}\text{Ar}_{\text{tr}}$ of MS rims, chondrules and fine-grained material of Semarkona as an example. Brackets indicate contaminated samples. Errors

Conclusions

The trapped noble gas signatures of MS rims around chondrules and chondrule interiors support rim formation by expulsion of MS from chondrules during melting. The affinity of the $^{36}\text{Ar}_{\text{tr}}$ -carrier to metal phases provides a tool to fractionate the two carrier phases Q and HL. This study will be extended to the primitive CR2 chondrite Renazzo.

References

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The isotopic composition of sulfates in rivers the Ljubljana and the Sava in Slovenia

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The $\delta^{34}\text{S}_{\text{SO}_4^{2-}}$ in any river represents a mixture of the sulfur derived from the soil, bedrock, and the atmosphere. It can be modified by biotic processes in the river and its watershed. In principle, the $\delta^{34}\text{S}$ measurements can be used to fingerprint the sources of sulfur and the key pathways of sulfur transformation in riverine ecosystem. Combined measurements of the isotopic composition of sulfur and oxygen in sulphate further constrains the possible sources, key processes, and pathways. The Ljubljana river: 1. Underground waters of the mountain massif are characterized by sulfur with $\delta^{34}\text{S}$ value +5,88 permil and by oxygen with $\delta^{18}\text{O}$ value of +7,36 permil. The concentration of sulfate in spring water (Mocilnik) is about 4,8 mg/l. 2. At the sampling point Podpec the increase of sulfate concentration (12,56 mg/l) was observed and small enrichment of sulfates in light isotopes. 3. On the basis of our results it seems that the tap water is coming from source other than the underground waters of the mountain massif. Their sulfates have isotopically lighter sulfur and oxygen ($\delta^{34}\text{S} = +2,00$ permil and $\delta^{18}\text{O} = +5,27$ permil, respectively). The Sava River: 1. the Sava Bohinjka at sampling point Bohinjska Bela practically does not contain sulfates (0,80 mg/l), while the sulfate concentration of the Sava Dolinka at sampling point Dovje was 8,67 mg/l with $\delta^{34}\text{S} = +10,06$ permil and $\delta^{18}\text{O} = +10,64$ permil. 2. Starting from the sampling point Okroglo the systematic enrichment of sulfates in the light sulfur and oxygen isotopes was observed along the course of river. We suggest that the primary source of sulfates was antropogenic sulfur emitted to the atmosphere and circulated in the natural cycles for an extended period of time.