LITHIUM AND LITHIUM ISOTOPE COMPOSITIONS OF CHONDRULES, CAIs AND A DARK INCLUSION FROM ALLENDE AND ORDINARY CHONDRITES

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Introduction: In a previous study we measured bulk Li isotopic compositions of carbonaceous (δ^7Li = +3.2‰) and ordinary chondrites (δ^7Li = +2.2‰) [1]. The observed spread in composition could indicate the existence of isotope heterogeneities in the early solar nebular. Such heterogeneities may be preserved within different components, CAIs, chondrules and matrix, of chondrites of low petrologic grade. For a detailed study of Li isotopes, Semarkona (LL3.0), Bishunpur (LL3.15) and Allende (CV3) were selected because of their low petrologic type and low degree of hydrous or thermal alteration. More equilibrated chondrites Saratov LL4, Bjurböle L/LL4, Bremervörde H/L3.9 were also investigated.

Results: We studied 89 chondrules, 10 CAIs and one dark inclusion (DI) from Allende and their bulk compositions.

Chondrite bulk compositions are δ^7Li = +3.2‰ at 1.1 μg/g (Bishunpur), δ^7Li = +2.3‰, 1.4 μg/g (Semarkona), δ^7Li = +1‰ at 1.3 μg/g (Bremervörde), δ^7Li = +2.1‰ at 1.7 μg/g (Bjurböle), δ^7Li = +2.9‰ at 1.6 μg/g (Saratov), δ^7Li = +2.1‰ at 1.5 μg/g (Allende) consistent with previously reported results [1]. Chondrules from all chondrites studied range in composition from δ^7Li = -8.5 to +10.1‰ at 0.1 to 3.1 μg/g. Most chondrules, however, have Li concentrations that are lower than those of their bulk chondrite. Chondrules with higher than bulk chondrite Li concentrations are exceptions. The Allende DI has higher Li concentrations and is slightly heavier in its Li isotope composition than the bulk. There is no apparent correlation between Li concentration and δ^7Li for chondrules or for CAIs.

Summary: On average, chondrules in primitve chondrites have mean Li isotopic compositions slightly lighter to those of their respective bulk chondrite. Mean chondrule Li concentrations, on the other hand, are consistently lower than those of their respective bulk chondrite. This may be attributed to various processes, such as fractionation during condensation, melting and evaporation during chondrule formation, and/or precursor materials affected by pre- and early solar nucleosynthetic processes. Based on our results we conclude that (1) chondrules from all chondrites have similar Li compositions, implying that there are no significant compositional differences between sources. (2) Higher Li abundances and slightly heavier Li isotopes in bulk chondrites compared to chondrules and CAIs require the presence of another component that is enriched in Li and heavier in δ^7Li. Allende DI, which has high Li concentration and a heavier Li isotope composition than bulk Allende, may be such a complementarity. It remains unclear at present whether Li isotopes are fractionated as a consequence of condensation, high temperature thermal processing or whether observed signatures are a result of various nucleosynthetic processes. (3) The lighter bulk Li-isotope compositions observed in ordinary chondrite groups [1] are likely to be controlled by the proportions of CAI's and chondrules in the bulk chondrite.

References: [1] Seitz et al. (2007) *Earth & Planetary Science Letters 260*, 582-596.