The boron isotopic composition of chondrules

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Introduction

Spallation reactions between energetic (GeV) protons and alpha particles in the Galactic Cosmic Rays and C-N-O nuclei in the interstellar medium are the main pathway to synthesize boron isotopes in the universe [1]. However, this process produces a characteristic $^{11}B/^{10}B \sim 2.5$ [2,3], too low to account for the Solar System $^{11}B/^{10}B = 4.04$ [4]. One hypothesis aiming to solve this long standing issue involves spallation of hydrogen in the molecular cloud by low (MeV) energy ^{12}C and ^{16}O, which favors the production of ^{11}B over that of ^{10}B [5]. While the existence of such low energy ions has not been observationally confirmed, measurements of chondrules showing large ^{11}B-excesses (up to 50‰) correlating with the B contents have led [6] to argue that low-E spallation could have been responsible for additional ^{11}B that the Solar System incorporated. Interestingly, a similar study by [7] found no $\delta^{11}B$ variations in chondrules outside the analytical uncertainties of ~25‰. These controversial results beg the question of how widespread the boron isotope heterogeneity is, as this signature could shed light on the origin of Solar System boron. In this work, we performed isotopic measurements of boron in a chondrule using the UCLA CAMECA ims-1290 ion microprobe.

Result and Discussion

The boron isotopic analysis of olivine in a type-I chondrule from the Allende meteorite revealed a ~10% variation, albeit most of the data points are consistent with the chondritic value within 2σ errors. The most ^{11}B-enriched spot has $\delta^{11}B = 73\pm44$‰ (2σ), similar to that found by [6], but its B content is among the lowest ever reported, contrary to the finding in [6]. The inverse relationship between $\delta^{11}B$ excesses and B abundances can be understood as a result of isotopic fractionation associated with evaporation, or of irradiation of chondrule (precursor). More data and a detailed irradiation model will be presented in the meeting.

[1] Reeves et al. (1970) *Nature* **226**, 727-729 [2] Meneguzzi et al. (1971) *A&A* **15**, 337-359 [3] Gibner et al. (1992) *ApJL* **39**, L89-L92 [4] Zhai et al. (1996) *GCA* **60**, 4877-4881[5] Ramaty et al. (1979) *ApJS* **40**, 487-526 [6] Chaussidon and Robert (1995) *Nature* **374**, 337-339 [7] Hoppe et al. (2001) *MAPS* **36**, 1331-1343