SEARCHING FOR EXTINCT CHLORINE-36 IN ENSTATITE CHONDRITES: NEW CONSTRAINTS ON THE DISTRIBUTION OF SHORT-LIVED NUCLIDES IN THE SOLAR NEBULA.

Y. Lin[1], F. Gyngard[2], and E. Zinner[2]. [1]Key Laboratory of the Earth's Deep Interior, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China. Email: LinYT@mail.igcas.ac.cn. [2]Laboratory for Space Sciences, Washington University, St. Louis, USA.

Introduction: The origin of short-lived nuclides in the solar nebula is a long standing controversial issue. There are two major explanations: injection from neighboring supernovae or AGB stars [1-3], or in situ irradiation of nebular dust and gas by solar energetic particles (SEP) [4-7]. The distribution of short-lived nuclides in the solar nebula is a key test of these models. Unlike ^{41}Ca, ^{26}Al and other short-lived nuclides, ^{36}Cl ($T_{1/2}$=0.3 Ma) is highly volatile. A search for excess ^{36}S due to the decay of ^{36}Cl in various types of chondrites might give information on its spatial distribution in the solar nebula. Here, we report preliminary results on enstatite chondrites.

Samples and experiments: Ca-, Al-rich inclusions (CAIs) are very rare in enstatite chondrites, except for Sahara 97159 (EH3). Sixty-eight CAIs and fragments were found in two sections [8]. All of the CAIs had been altered under extremely reducing conditions. In this study, we measured several grains (3-5 μm) of sodalite ($Na_8Al_6Si_6O_{24}Cl_2$) without inclusions of troilite in two of the CAIs. Negative ions of ^{33}S, ^{34}S, ^{36}S and ^{35}Cl were counted with electron multipliers in multi-collection with the Cameca NanoSIMS 50 at Washington University. A Cs^+ primary beam of a few pA was rastered over the analyzed areas, and secondary ion signals were counted in ~50% of the area, in order to avoid possible contamination from surrounding sulfides. Troilite was analyzed as a standard.

Results and discussion: In our analysis, we did not detect any excess of ^{36}S, within the analytical errors, but could set an upper limit of 4×10^{-6} for the initial $^{36}Cl/^{35}Cl$ ratio of the sodalite grains. Previous work found a ratio of 3.8×10^{-6} (calibrated by a RSF of 0.8) in sodalite from CAIs in the carbonaceous chondrite Ningqiang [9]. If sodalite-related alteration of Sahara CAIs took place not much later (*e.g.* < 1Ma) than that of Ningqiang CAIs, this result disagrees with expectations for the in situ irradiation scenario, because the EH-forming region was likely to have been closer to the Sun and should have seen a much higher SEP flux than carbonaceous chondrite-forming zones. $^{36}Cl/^{35}Cl$ ratios up to 1.4×10^{-6} were predicted for SEP irradiation with a flux enhanced by a factor of 5×10^3-10^4 during the T Tauri stage of the Sun [6]. However, we note that the sodalite formed at least 1.5Ma after the host CAIs based on their different $^{26}Al/^{27}Al$ ratios [9,10]. When calibrated to the time when CAIs formed, the nebular initial $^{36}Cl/^{35}Cl$ ratio is $\sim1.1\times10^{-4}$, about two orders of magnitude higher than the predictions. The recent discovery of a $^{36}Cl/^{35}Cl$ ratio of $17.2\pm2.5\times10^{6}$ in secondary wadalite from Allende CAIs [11] exacerbates the difficulty of the irradiation models. In contrast, the observed variation in $^{36}Cl/^{35}Cl$ ratios [9-15] can be explained by different times for the alteration events. However, more analyses are required in order to clarify the distribution of ^{36}Cl in the solar nebula.

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