ION-PROBE STUDIES OF EFREMOVKA CGIs - I : MAGNESIUM ISOTOPIC COMPOSITION. J.N. Goswami and G. Srinivasan, Physical Research Laboratory, Ahmedabad 380 009, India. A.A. Ulyanov , Vernadsky Institute of Geochemistry and Analytical Chemistry, Moscow 11795, USSR.

A set of petrographically well characterized coarse-grained-refractory-inclusions (CGIs) from the Efremovka CV3 chondrite has been selected for studies of magnesium, calcium, titanium and oxygen isotopic compositions using the ion-probe. The lack of secondary alteration products in the Efremovka CGIs [1] compared to those in Allende, makes them one of the most pristine solar system material available for laboratory analysis. We report here the results on magnesium isotopic compositions.

The six CGIs analysed in this work include three type B1 (E 40, E 44, E 65), one type B2 (E 60), one compact type A (E 2), and a hibonite-rich inclusion (E 50). Electron-probe data show variations in pyroxene compositions in the B1 inclusions (TiO_2 content varies from 2.5% in E-65 to 14.5% in E 40), and also suggest the presence of Ti^{3+} at a significant level. The composition of the melilite grades from 55-70% Ak^o in the core to 20-30% Ak^o near the periphery, with the rim melilite being most gehlenitic. The spinels are almost pure and are poikilitically enclosed in pyroxene and melilite. Metal grains and rare anorthites are present near the pyroxene core. The rim sequence in these inclusions follow the usual pattern with the outermost layer being spinel (± perovskite), followed by melilite and Ti-Al rich pyroxene that is continually replaced by diopside. CGI E60 is a typical B2 inclusion with a single layer diopside rim. The compact type A inclusion E2 contains large melilites with poikilitically enclosed spinels and rare high-Al-Ti-pyroxenes, and is surrounded by a thick multilayered rim. The magnesium isotopic composition in this inclusion was studied earlier [2]. The inclusion E 50 is a rare multizoned hibonite-rich inclusion that has a spinel-rich core, followed by a hibonite-rich zone, a melilite-spinel zone, a melilite zone and a melilite-perovskite zone near the multilayered complex rim.

The magnesium isotopic compositions in the different mineral phases of these inclusions are determined by a Cameca IMS-4f Ion-probe at a nominal mass resolution of $\sim 4,000$. The reproducibility and the precision of the instrument in determining magneisum isotopic compositions were determined by analysing terrestrial hibonites, spinels and melilites and a set of isotopically spiked anorthositic glasses provided by the Caltech group. A measurement precision of ≤ 2 ‰ ($2\sigma_m$) could be achieved during these analyses.

Non-linear effect in ^{26}Mg ($\delta^{26}Mg$) is present in all the Efremovka CGIs studied in this work. Further, all of them yield well-defined Mg-Al isochrons irrespective of inclusion type. This is unlike the case in Allende, where except for the type B1 inclusions, the Mg-Al correlation is mostly disturbed [3]. The isotopic data for the Efremovka CGIs must be a reflection of their pristine nature as inferred from their petrographic characteristics. The Efremovka data do show a spread in the initial ($^{26}Al/^{27}Al$) ratio [$(3.6\text{-}5.9)\times10^{-5}$] around the canonical value of $\sim 5\times10^{-5}$. The initial ($^{26}Mg/^{24}Mg$) ratios for the source material of the Efremovka inclusions are higher than the normal solar system value (0.13932) for atleast three CGIs [E 40: 1.3 ± 0.6‰, E 65: 1.0 ± 0.3‰; E 60: 2.0 ± 0.9‰ ; all errors are $2\sigma_m$]. These excesses cannot be fractionation residuals [4] as the three inclusions are characterized by positive magnesium

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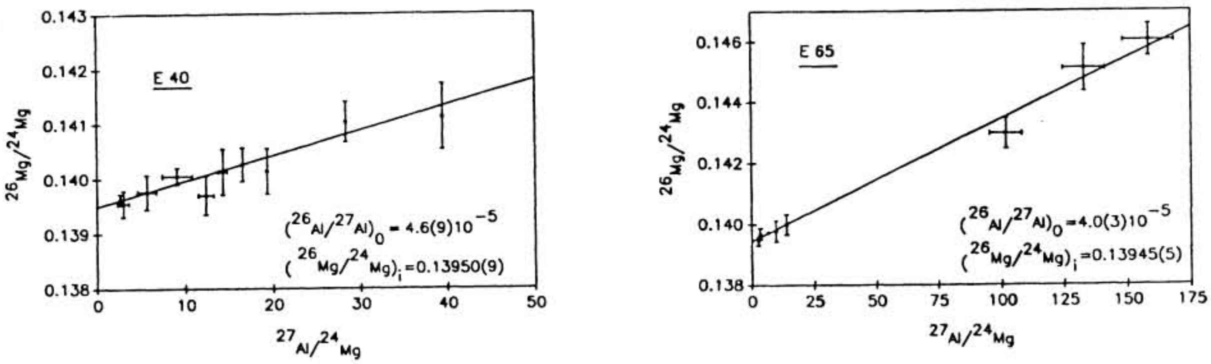

Fig.1. Mg-Al isochron for two type B1 Efremovka CGIs. Error are 2 σm.

fractionation. The variations in both the initial Al and Mg isotopic compositions in the Efremovka CGIs therefore support the presence of isotopic inhomogeneity over small scale-sizes in the solar nebula.

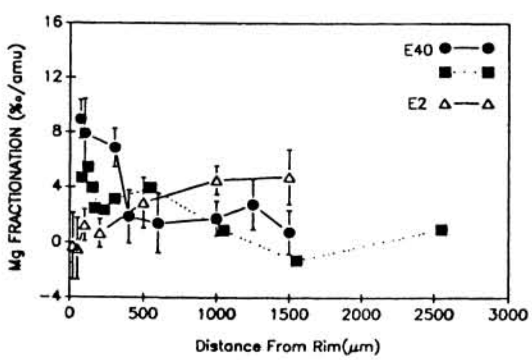

Fig.2. Magnesium isotopic fractionation in E 40 and E 2. The two set of data for E 40 refer to two traverses. Error bars are 2σm.

The magnesium isotopic fractionation in both melilite and spinels from the inclusions favours the heavier isotopes as is expected for CGIs in general. However, the fractionation trend varies from inclusion to inclusion. The intrinsic fractionations in melilites from E 2 and E 40 show completely opposite trend (see fig. 2) as one moves from the rim towards the interior of the inclusions. E 65 shows a flat pattern, while no specific trend can be discerned in E 50. The results from E 2 are similar to those reported earlier [2]. Of particular interest is the pattern seen in E 40 which has been observed for the first time for a non-FUN inclusion [c.f. 5]. The chemical composition of melilite in this inclusion grades from 10% Ak^o near the edge to 80% Ak^o in the core, and, both the fractionation trend and the compositional variation can be best explained by postulating rapid volatilization loss during soiidification of this inclusion from a melt droplet. Another interesting feature noticed during intercomparison of intrinsic magnesium fractionations in different mineral phases of individual inclusion is a hint for a mineralogical control on fractionation. Further work to check whether this is a general trend or inclusion specific is in progress.

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