High precision ^{26}Al-^{26}Mg systematics of type I and type II chondrules from Semarkona (LL3.0)

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The ^{26}Al-^{26}Mg system, because of the short half life of ^{26}Al (0.73Myr), is a potential chronometer of early Solar system evolution, provided that the level of homogeneity of ^{26}Al in the accretion disk can be quantified precisely. One key process in this early evolution is chondrule formation. Earlier studies of ^{26}Al in chondrules [1,2] suggested that they formed ≈ 2 Myr after Ca-Al-rich inclusions (CAIs) considering an initial ^{26}Al/^{27}Al ratio in CAIs of $5.23(\pm0.13)\times10^{-5}$ [3] or of $5.85(\pm0.05)\times10^{-5}$ [4] . However the precision of existing data is not sufficient to be able to resolve possible time differences between different chondrules or different chondrule types (e.g. reduced-type I and and oxidized-type II) and the data set may be biased towards chondrules having glassy mesostases with extremely high Al/Mg ratio.

High precision analyses of the ^{26}Al-^{26}Mg system were developed with the CRPG Cameca IMS 1270 ion microprobe in order to be able to measure radiogenic ^{26}Mg excesses in "normal" chondrules' glasses with low ^{27}Al/^{24}Mg atomic ratios (less than 10). The simultaneous measurement of ^{24}Mg, ^{25}Mg, ^{26}Mg and ^{27}Al in multi-collection mode on Faraday's cups allows the ^{26}Mg excesses and the ^{27}Al/^{24}Mg ratios to be measured with a precision (±2 sigma) of 0.05-0.2‰ and 7%, respectively.

Chondrules from the Semarkona LL3.0 chondrite were studied because the very low degree of parent body thermal metamorphism registered by Semarkona is favorable to a good preservation of the Al-Mg isotopic system in chondrules since their formation. Among the 20 "normal" Semarkona type I and type II chondrules (with low Al/Mg ratios) selected by SEM and analyzed, 8 showed well resolved ^{26}Mg excesses, with inferred initial ^{26}Al/^{27}Al ratios ranging from $(1.40 \pm 0.39)\times10^{-5}$ to $(0.60 \pm 0.21)\times10^{-5}$.

The ^{26}Al/^{27}Al ratios obtained in this study for Semarkona chondrules are in agreement with previous data [1, 2, 5]. In the hypothesis of a homogeneous ^{26}Al distribution in the accretion disk, they would confirm the suggestion that chondrules formation began at least 1.5 Myr after CAIs. These preliminary results suggest a very short duration for chondrule formation of less than 0.9 Myr. However, lower initial ^{26}Al/^{27}Al ratios from 3×10^{-6} to 6×10^{-6} have also been reported in Semarkona and Bishunpur [2, 6]. These data would argue for an extended duration of chondrule formation, unless the ^{26}Al-^{26}Mg was partially reset by parent body metamorphism or alteration. In opposition to data from CO chondrules [7, 8], our preliminary results show no significant formation age difference between Semarkona type I and type II chondrules, suggesting that an oxidized and a reduced environment for chondrules formation coexisted in the protosolar nebula.

References : [1] Kita N. et al. 2000. GCA 64, 3913. [2] Mostéfaoui S. et al. 2002. MAPS 37, 421. [3] Thrane K. et al. 2006. Ap. J. 644, L159. [4] Jacobsen B. et al. 2008 EPSL, in press. [5] Rudraswami N.G. & Goswami J.N. 2007. EPSL 257, 231. [6] McKeegan K. et al. (2000) 31st LPSC, abstract # 2009, [7] Kunihiro T. et al. (2004) GCA, 68, 2947, [8] Kurahashi E. et al. (2007) Workshop on the Chrono. of MESS, abstract #4027.