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Mn-Cr isotope study of ordinary chondrites: new information derived from chromites and bulk meteorites

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Ordinary chondrites (OC) witness the early formation of planetary bodies in the asteroid belt. OC chondrule ages are 1.2 to 3 Myrs years younger than CAIs, which represent the oldest Solar System material [1,2]. The thermal metamorphism of the OC parent body started shortly after accretion and lasted for ~100 Myrs [3]; metal-silicate fractionation occurred 2 Myr after CAIs [4]. However, these ages are in conflict with mineralogical observations, and it is not possible to set up a model for the internal structure of OC parent bodies and their thermal history.

We separated 12 chromite fractions from OC and investigated their Mn-Cr systematics. An approach similar to the so-called 'Sr initial method' was applied to these chromites [5]. Beside chromites we also analyzed the corresponding bulk meteorites. The most salient results of our investigation are:

•) The Cr initial ages of chromites from H-, L-and LL-chondrites lie between 4564.1 and 4559.7 Myr. These ages clearly correlate with the metamorphic degree of the host meteorite.

•) The 'two point isochrons' between chromites and the corresponding bulk meteorites in the Mn/Cr evolution diagram indicate that the Mn-Cr system has been preserved mainly in type 4 chondrites. In contrast, it has been partially reequilibrated in other chondrites.

•) The comparison between the Cr initial ages and the ages calculated from the two point isochrons shows that the age information derived from chromites is robust.

•) We identify shock events as beeing responsible for the deviation of bulk OCs from the trend defined by carbonaceous chondrites in the Mn-Cr versus ^{53}Cr evolution diagram.

•) The U-Pb ages of phophates are 1.2-58 Myrs younger than the Cr initial ages of chomites, in agreement with the lower closure temperature of phosphates. Mn-Cr and W-Hf ages are identical, reflecting similar closure temperatures of both systems.

References [1] Villeneuve et al. (2009) Science **325**, 985-988. [2] Connelly et al. (2012) Science **338**, 651-655. [3] Göpel et al. (1994) EPSL. **121**, 153-171. [4] Kleine et al. (2008) EPSL **270**, 106-118. [5] Sanz et al. (1969), EPSL 7, 33-43