MANGANESE-CHROMIUM AGES OF CARBONATES IN AQUEOUSLY-ALTERED CARBONACEOUS CHONDRITES AND CLASTS.

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Introduction: Recent studies show great improvements in the understanding of xenolithic material that can be found in various achondrites (HED, ureilites) and chondrites (ordinary chondrites, CR, CB, CH chondrites) [1,2]. This xenolithic material shares similarities with CI and CM chondrites but might represent material that has not yet been identified as bulk meteorites. So far, previous work shows that C1 clasts (previously referred to as CI-like) and CM-like have a very similar mineralogy to CI and CM chondrites [e.g., 1]. Apart from the mineralogy, peak temperatures experienced by clasts and chondrites are also coherent with each other [3]. However, recent isotope studies [4,5] show evidence for differences between C1 clasts and CI chondrites. Isotope signatures of CM clasts and CM chondrites overlap. The differences in isotopic compositions between C1 clasts and CI chondrites might have been caused by sampling spatially different reservoirs or a difference in timing of parent body formation resulting in sampling of differently evolved reservoirs. To evaluate whether the timing of formation is a factor that might have caused sampling of different isotopic reservoirs, the Mn/Cr system is used. Its short half-life (3.7 Ma [6]) makes it suitable to date processes active at the early stages of the solar system evolution [e.g., 7, 8]. In this study, Mn/Cr ages of carbonates in CI and CM chondrites as well as those in CM-like and C1 clasts are determined, to investigate the timing of the aqueous alteration forming these carbonates.

Methods: Mn/Cr ages of calcite and dolomite in 7 carbonaceous chondrites; Ivuna, Alais, Orgueil (all CI), Murchison, Murray, LON94101 (all CM), Essebi ($C2_{ung}$) and ~10 xenolitic clasts (C1 and CM-like) in Kaidun, DaG 319, Sahara 98465, NWA 7542, PRA 04401, PRA 04402 were obtained using an ims1280 secondary ion mass spectrometer at NORDSIMS, Stockholm. The analytical methods used in this study are similar to those of [9] and a San Carlos olivine as well as a synthetic calcite standard (produced by P. Donohue from the Hawai'i Institute of Geophysics and Planetology) were used to correct for instrumental mass fractionation (IMF) and to determine the relative sensitivity factor (RSF). All analyses were anchored to the D'Orbigny angrite (4563.4 ± 0.27 Ma; [10]) to obtain the absolute ages.

Results and Discussion: Mn/Cr ages of carbonates in CM2 chondrites [11], CI chondrites [12], and CR chondrites [9] have been constrained in literature. Preliminary results of this study show that Mn/Cr ages for dolomites in Ivuna ($4562.8^{+0.8}_{-1.1}$) and Orgueil ($4563.4^{+1.3}_{-1.7}$) are coherent to ages previously determined [12]. A newly constrained Mn/Cr age of dolomites in Alais appears to be within the same range ($4564.2^{+0.8}_{-1.0}$). Mn/Cr ages of carbonates of C1 volatile-rich clasts in DaG 319 and Sahara 98465 however, could not be constrained even though compositional analyses show similar Mn and Cr concentrations to dolomites analysed in the CI chondrites. Possibly, the carbonates were formed after the extinction of the short-lived ^{53}Mn meaning that the aqueous alteration happened at least 15 Ma after that of CI chondrites. Alternatively, the carbonates could also have formed due to terrestrial weathering on Earth. Both possibilities will be investigated as well discussing Mn/Cr ages of carbonates in CM-like clasts and different CM and C1 lithologies in Kaidun. Ultimately, we are trying to resolve any differences between the Mn/Cr ages of carbonates in CI chondrites and C1 clasts.

Conclusion: Mn/Cr ages of carbonates in aqueously-altered carbonaceous chondrites agree well with previously published ages. Extending the dataset with more Mn/Cr ages of carbonates in CI clasts could potentially resolve the question of whether there is an actual difference in timing of the aqueous alteration event between the parent bodies of CI chondrites and C1 clasts.

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