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イヴナ CI コンドライト中のドロマイトの Mn-Cr 年代測定
Mn-Cr dating of dolomite in the Ivuna CI chondrite

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CI chondrites are compositionally the most primitive rocks among the solar system materials, although they experienced pervasive aqueous alteration. In order to decipher their geological history, it is important to determine the timescale of the aqueous activity in the CI chondrite parent body.

^{53}Mn-^{53}Cr systematics (^{53}Mn decays to ^{53}Cr with a half-life of 3.7 Myr) of dolomite and breunnerite measured with ion probes have been reported for the Orgueil CI chondrite (e.g. Hoppe et al., 2007). For the Ivuna CI chondrite, there is only one report on dolomite. Hence, further investigations are needed for the accurate Mn-Cr age determinations. Here we report Mn-Cr systematics of six dolomite grains in Ivuna.

Six dolomite grains in Ivuna were analyzed for Mn-Cr systematics with the NanoSIMS installed at Atmosphere and Ocean Research Institute, the Univ. of Tokyo. Their Mn concentrations range from 0.7 to 2.7 wt.%. $^{53}Ca^{+}$, $^{52,53}Cr^{+}$ and $^{55}Mn^{+}$ were measured with the O^{-} primary ion beam (~5 micrometers in diameter, ~1 nA). The ^{55}Mn/^{52}Cr relative sensitivity factor (RSF) of 0.690 is determined using a synthetic calcite standard doped with Mn and Cr (Sugiura et al., 2010). Errors on ^{53}Cr/^{52}Cr and ^{55}Mn/^{52}Cr ratios are based on the counting errors. ^{53}Cr excesses of the Ivuna dolomite are represented as permil deviations from the ^{53}Cr/^{52}Cr ratio of the standard assumed to be 0.1134 (Lodders et al., 2009).

Obtained ^{53}Cr excesses are well correlated with ^{55}Mn/^{52}Cr, which indicates the in-situ decay of ^{53}Mn. All data lie on a single regression line in the isochron diagram (i.e., no difference is found among slopes of the six grains) and the slope of the best fit line for the whole data corresponds to $(^{53}Mn/^{55}Mn)_0$ of (2.64 +/- 0.44) x 10^{-6}. Then an absolute age of 4562.5 +0.8/-1.0 Ma is calculated for dolomite in Ivuna using the LEW86010 angrite as a time anchor (Amelin, 2008; Lugmair and Shukolyukov, 1998).

The present data for dolomite in Ivuna gives a younger age than that in Orgueil reported by Hoppe et al. (2007) and Petitat et al. (2009). However, these studies used silicate standards for calibration of ^{55}Mn/^{52}Cr ratios of dolomite, which resulted in systematic errors in the obtained ages. If the RSFs are corrected, then the Mn-Cr ages of the Orgueil dolomite become consistent with that of the Ivuna dolomite. The Ivuna dolomite in this study is older than the Orgueil and Ivuna dolomite reported by Endress et al. (1996), which is unlikely due to the difference in the RSFs used. The reason for this discrepancy is unknown at this time.

Fujiya et al. (2011) reported Mn-Cr ages of calcite and dolomite in four CM chondrites, indicating that calcite and dolomite in CM and CI chondrites formed around the same time. Because calcite precipitation appears to have preceded dolomite formation (de Leuw et al., 2010), our data imply contemporaneous accretions of the CI and CM chondrite parent bodies and dolomitization occurred soon after calcite precipitation.

On the other hand, it seems that individual breunnerite grains in Orgueil show variable and younger ages than those of dolomite grains (Hoppe et al. 2007; Petitat et al., 2009). Therefore, we conclude that the breunnerite formation persisted for at least 7 Myr following dolomite formation. Given that the Mn-Cr ages in Petitat et al. are biased due to the RSFs, breunnerite formation (and therefore, aqueous alteration) in Orgueil lasted until ~4553 Myr (at least 10 Myr after dolomite formation in Ivuna).

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