THE EFFECT OF AQUEOUS ALTERATION ON PRIMORDIAL NOBLE GASES IN CM CHONDRITES.

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Introduction: Like most primitive carbonaceous chondrites, the CM chondrites experienced varying degrees of aqueous alteration that probably occurred *in situ* after the formation of the CM parent body(ies) [e.g., 1, 2]. Working from the first petrologic classification scheme for chondrites [3], several higher resolution aqueous alteration scales have been proposed [e.g., 4-7]. Secondary processes in the chondrite parent bodies often caused changes in their volatile contents, including their noble gases [e.g., 8]. Given the possibility that the intensity of aqueous alteration is recorded in the primordial noble gas contents, here we aim to further constrain the modification of the CM parent body(ies) after accretion and independently assess the various proposed alteration classification schemes.

Methods: To date, we have analyzed 32 CM chondrites (bulk samples of ~20 mg) with variable characteristics (petrologic sub-types, heating history, weathering grade, and falls/Antarctic finds) for their noble gas compositions. Each sample, preheated at 110°C for several days, was degassed in a crucible in one step at ~1700°C. The gases were analyzed for all isotopes with a custom-built sector-field noble gas mass spectrometer equipped with a Baur-Signer ion source [9]. Blank corrections were low (<1.6%) except for the relatively gas-poor sample PCA 02010 (He: ~3%, Ne: ~17%, ^{36,38}Ar: ~5%, Kr-Xe: ~4%). From the measured noble gas compositions, we have determined the relative abundances of the trapped and cosmogenic components, as well as calculated CRE ages for all the samples.

Results and discussion: The Ne isotopic ratios in a three-isotope plot reveal a wide distribution, due to varying relative abundances of trapped and cosmogenic Ne. Six of the CM2 chondrites contain solar wind (SW). However, most samples show a trapped endmember Ne composition between Q, HL, and Ne-E, suggesting minor to negligible SW-Ne. Many CM chondrites form a well-established mixing line between cosmogenic Ne and Ne slightly below Ne-HL. This suggests a similar abundance ratio in these CMs of diamonds carrying HL and Ne-E bearing graphite and SiC [10,11]. That most samples do not show detectable SW-Ne is in disagreement with an earlier study, in which all 19 of the CM chondrites in the sample suite were determined to contain SW [12]. This led the authors to conclude that all CMs are regolith breccias or carry SW-Ne from a pre-accretion irradiation phase. However, when we apply our criteria to define the presence of SW in CMs, only ~50% of the CMs presented in [12] incorporated SW.

We find a clear correlation between the trapped Ar concentrations and the petrologic type assignments of [6] based on bulk H isotopic compositions combined with the petrologic criteria of [5]. Trapped Ar concentrations decrease with increased aqueous alteration, presumably because one carrier of trapped Ar is susceptible to parent body aqueous alteration. A comparison with CR chondrite data [13] illustrates this; type 2 and 2-3 CRs have much higher Ar concentrations than type 1 CRs and CMs. There are no apparent correlations between terrestrial weathering and noble gas contents and compositions.

Preliminary, currently determined ^{21}Ne-based CRE ages (production rates are based on average CM chemistry [14], typical cosmogenic ^{22}Ne/^{21}Ne ratio [15], and the models by [16]) are lower than 0.6 Ma for all but one CM chondrite. This is in agreement with a distinct peak (~0.25 Ma) in the age distribution [e.g., 17]. Sample EET 83355 shows the highest relative amount of cosmogenic ^{21}Ne and a CRE age of ~2.5 Ma. None of the samples in this study shows a CRE age of >5 to ~8 Ma, such as Erakot, Santa Cruz, Y-793321 [18], and Jbilet Winselwan [17] that may be connected to the Veritas break-up [19].

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