

Carbon and Oxygen Isotope Measurements of Ordinary Chondrite (OC) Meteorites from Antarctica Indicate Distinct Carbonate Species using a Stepped Acid Extraction Procedure

The purpose of this study is to characterize the stable isotope values of terrestrial, secondary carbonate minerals from five OC meteorites collected in Antarctica. These samples were identified and requested from NASA based upon their size, alteration history, and collection proximity to known Martian meteorites. They are also assumed to be carbonate-free before falling to Earth. This research addresses two questions involving Mars carbonates: 1) characterize terrestrial, secondary carbonate isotope values to apply to martian meteorites for isolating in-situ carbonates, and 2) increase understanding of carbonates formed in cold and arid environments with Antarctica as an analog for Mars.

Two samples from each meteorite, each $\sim 0.5\text{g}$, was crushed and dissolved in pure phosphoric acid for 3 sequential reactions: a) Rx0 for 1 hour at 30°C (fine calcite extraction), b) Rx1 for 18 hours at 30°C (course calcite extraction), and c) Rx2 for 3 hours at 150°C (siderite and/or magnesite extraction). CO_2 was distilled by freezing with liquid nitrogen from each sample tube, then separated from organics and sulfides with a TRACE GC using a Restek HaysSep Q 80/100 6' 2mm stainless column, and then analyzed on a Thermo MAT 253 IRMS in Dual Inlet mode. This system was built at NASA/JSC over the past 3 years and proof tested with known carbonate standards to develop procedures, assess yield, and quantify expected error bands.

Two distinct species of carbonates are found: 1) calcite, and 2) non-calcite carbonate (future testing will attempt to differentiate siderite from magnesite). Preliminary results indicate the terrestrial carbonates are formed at approximately $\delta^{13}\text{C} = +5\text{‰}$, which is consistent with atmospheric CO_2 $\delta^{13}\text{C} = -7\text{‰}$ and fractionation of $+12\text{‰}$ based upon polar temperature of -20°C . The oxygen values fractionate $\delta^{18}\text{O} = -10\text{--}20\text{‰}$ lighter between the Rx0 and Rx1 reactions at 30°C . The carbonate oxygen isotope measurements are consistently heavier than expected with meteoric water and temperatures from Antarctica, perhaps due to secondary carbonate formation during curation in Houston, Tx.

