INTRODUCTION: Carbonate minerals in carbonaceous chondrites are useful tools to investigate the details of aqueous alteration on meteorite parent bodies early in the Solar System’s history. Because carbonate minerals precipitate from water and strongly fractionate Mn from Cr, the short-lived $^{53}$Mn-$^{53}$Cr chronometer can be used to date carbonate formation events and constrain the timescales of aqueous activity.

Accurate measurements of carbonate Mn-Cr ages by ion probe require calibration of relative sensitivity factors by using standards of known Mn/Cr with similar chemical composition (in particular regarding the Fe content of the carbonate). This task is complicated by the strong exclusion of Cr in terrestrial carbonate and challenges associated with synthesizing homogeneous synthetic calcite and dolomite standards with sufficient Mn and Cr concentrations \[1\]. Here, we present measurements of Mn-Cr ages of carbonates in CM and CI chondrites made using well-matched terrestrial calcite and dolomite standards implanted with $^{52}$Cr.

METHODS: We investigated dolomite in 3 polished sections of the CI chondrite Alais and Type 2, Mn-bearing calcite and dolomite in 1 polished section of the highly altered CM breccia Boriskino, on loan from the Field Museum of Natural History. We also targeted dolomite in a thin section of ALH 84034, classified as CM1/CM2.0. Carbonate grains were identified by SEM-EDS mapping and characterized by backscattered electron and cathodoluminescence imaging for petrographic characterization. Each target carbonate was measured using EPMA or SEM-EDS to determine its chemical composition.

$^{53}$Mn-$^{53}$Cr analysis. The $^{53}$Mn-$^{53}$Cr ages of the carbonates were measured using the Cameca ims-1290 ion microprobe at UCLA equipped with an Oregon Physics Hyperion oxygen plasma source. We used a 500 pA O$_3^+$ primary ion beam focused to a 3 µm spot, sputtered over a 5 µm raster during presputtering to remove terrestrial Cr contamination.

Standards and correction for the matrix effect. The relative sensitivity factor (RSF) for the Mn/Cr ratio during the analysis session was determined as a function of Fe content in dolomite using measurements of a suite of dolomite and calcite standards implanted with $^{52}$Cr as described in \[2\] using a 2 nA primary O$_3^+$ beam rastered over 50 x 50 µm. Other than the primary beam intensity, all other tuning parameters were held constant between the RSF determination and Mn-Cr analysis. Variations in instrumental mass fractionation (IMF) were monitored by periodic analyses of San Carlos Olivine. Analyses of San Carlos Olivine under O$_3^+$ primary beam intensities of 150 pA and 500 pA showed no difference within error in either IMF or RSF, lending confidence to our use of RSF measurements determined under different beam intensities than the analysis.

RESULTS: Type II calcite in the Boriskino meteorite occurs replacing mesostasis within pseudomorphed chondrules and refractory inclusions; it does not show any resolvable $\delta^{53}$Cr excess. Type I calcite is abundant in some less-altered Boriskino lithologies but was not measured due to its low Mn content. Dolomite in Boriskino, while rare, has a resolvable $\delta^{53}$Cr excess.

Analyses of dolomite in ALH 84034 revealed two distinct dolomite populations. Dolomite occurring within a pseudomorphed refractory inclusion and as isolated grains within the matrix show resolvable $\delta^{53}$Cr excesses, and the fractured dolomite aggregates described by \[3\] show no $\delta^{53}$Cr excess despite containing Mn.

Dolomites in Alais were petrographically similar to one another and often associated with magnetite. Fe and Mn contents of dolomite were clustered at about 3 mol %, and all displayed $\delta^{53}$Cr excesses.

Further details will be shared at the conference.