OXYGEN ISOTOPIC COMPOSITIONS OF MINERALS IN CHONDRITIC AND ACHONDRITIC LITHOLOGIES OF THE CB CARBONACEOUS CHONDRITE SIERRA GORDA 013.

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Introduction: The CB metal-rich carbonaceous chondrites show large variations in Fe,Ni-metal abundances (40–80 vol%), chondrule sizes and textures, and are subdivided into two subgroups – CB_a and CB_b. The CB_a chondrites consist of cm-sized Fe,Ni-metal±sulfide nodules and Mg-nonporphyritic chondrules having skeletal olivine (SO) and cryptocrystalline (CC) textures. The CB_b chondrites are finer-grained, and in addition to the CB_a-like components, contain chemically-zoned and unzoned Fe,Ni-metal grains and rare Ca,Al-rich inclusions, porphyritic chondrules, and hydrated chondritic clasts [2–6]. The SO and CC chondrules in both subgroups have a very limited range of $\Delta^{17}O$, –2.2±0.7‰ (2SD) and are interpreted to have formed in an impact-generated gas-melt plume 4562.52±0.44 Ma [5–7]. The observed range of major elemental compositions of these chondrules was reproduced by equilibrium condensation from a spatially heterogeneous impact plume that sampled different proportions of differentiated planetesimals composed of Fe,Ni-metal core, Ca,Al-poor mantle, and Ca,Al-rich crust enriched in later accreted water [8]. Trace element abundances recorded chemical evidence for igneous differentiation of the CB chondrule precursors and for evaporation and recondensation of chondrule melts in the CB plume [9]. The metal-rich carbonaceous chondrite Sierra Gorda (SG) 013 is a recently classified anomalous CB_a meteorite that consists of two texturally distinct lithologies – chondritic and primitive achondritic [10]. Here we report on the mineralogy, petrography, and O-isotope compositions of individual minerals in both lithologies measured with the UH Cameca ims-1280 SIMS.

Mineralogy and Petrography: The *chondritic lithology* is composed of Fe,Ni-metal nodules (~ 80 vol%) up to 0.9 mm in size, and Mg-chondrules/clasts having barred olivine (BO), SO, and porphyritic (PO, PP, POP) textures; daubréelite, schreibersite, and Cr-spinel are minor. Most chondrules contain Cr-spinel that occurs as euhedral grains and as symplectitic intergrowths with high-Ca and low-Ca pyroxenes. The peripheral parts of SO, BO, and PO chondrules are enriched in low-Ca pyroxene and tiny Cr-spinel grains, indicative of gas-melt interaction while freely flowing in space. The *achondritic lithology* contains a lower abundance of Fe,Ni-metal nodules, ~25 vol%, which are evenly distributed between coarse-grained olivine, low-Ca pyroxene, and Cr-spinel, and interstitial high-Ca pyroxene and anorthitic plagioclase. Both lithologies have similar compositions of olivine ($Fa_{\sim 3}$, 0.25±0.14 wt% Cr_2O_3), low-Ca and high-Ca pyroxenes ($Fs_{3.5\pm0.2}Wo_{1.4\pm0.2}$, ~1 wt% Cr_2O_3 & $Fs_{\sim 2}Wo_{\sim 45}$, ~1.2 wt% Cr_2O_3), Cr-spinel (in wt%, ~14, Al_2O_3; 6, FeO; 18, MgO; 60, Cr_2O_3), and plagioclase/mesostasis ($An_{96}Ab_4$) [10].

Oxygen isotopic compositions: On a three-isotope oxygen diagram, $\delta^{17}O$ *vs.* $\delta^{18}O$, compositions of olivine, low-Ca pyroxene, and Cr-spinel in SG 013 chondrules plot along the Primitive Chondrule Mineral (PCM) line [11] and have nearly identical (within uncertainties of our SIMS measurements) $\Delta^{17}O$ values: –2.4±0.5‰ (2SD, n=34), –2.1±0.5‰ (n=27), and –2.3±0.4‰ (n=5), respectively. O-isotope compositions of the SG 013 chondrules are similar to those of Mg-non-porphyritic chondrules in CB_a and CB_b chondrites suggesting formation in a similar gaseous reservoir, most likely an impact plume. In achondritic lithology, O-isotope compositions of olivine and low-Ca pyroxene ($\Delta^{17}O$ = –2.6±0.5‰, n=11 and –2.4±0.5‰, n=11, respectively) are similar to those in the chondritic lithology.

We conclude that (*i*) the Mg-non-porphyritic and porphyritic chondrules in SG 013 formed in the CB impact plume resulted from a collision between planetesimals. (*ii*) High fraction of porphyritic chondrules in SG 013 compared to those in typical CBs reflects variations in thermal history in different plume regions. (*iii*) The similar O-isotope compositions of the texturally distinct SG 013 lithologies suggest they formed from the isotopically similar precursors but experienced different formation histories. The achondritic lithology formed by thermal annealing and recrystallization of a metal-rich chondritic precursor, probably on one of the colliding bodies. Chondrules in the chondritic lithology formed from melt-droplets ejected into an impact plume followed by gas-melt interaction. Physical modeling of impact plume evolution and measurements of bulk Cr and Ti isotopic compositions of CB_a and CB_b chondrites, and both lithologies of SG 013 will provide additional constraints on their genetic relationship. This work is in progress.

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