^{16}O-RICH ANHYDROUS SILICATES IN CI CHONDRITES: IMPLICATIONS FOR THE NATURE AND DYNAMICS OF DUST IN THE SOLAR ACCRETION DISK

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Introduction: CI chondrites have nonvolatile chemical compositions closely resembling that of the Sun's photosphere and are thus considered to have the most primitive compositions of all known solar system materials [1]. They have, however, experienced pervasive parent-body alteration processes that transformed their primary constituents, obscuring the nature and origin of primordial CI dust [2-3]. We used *in situ* quantitative microprobe and secondary ion mass spectrometry techniques to characterize the chemistry and oxygen isotopic compositions of anhydrous silicates in two sections of the CI chondrites Ivuna and Alais which contain higher abundances of those than other CI samples. The data will be used to discuss the nature of CI protolith and the implications for the dynamic of dust in the early solar system.

Samples and methods: We examined olivine and pyroxene crystals in two thin sections of the CI chondrites Alais (PL92478) and Ivuna (PL92533) provided by the Institut für Planetologie of the University of Münster. Anhydrous silicate minerals were characterized by scanning electron microscopy (SEM) using a JEOL JSM-6510 and a CAMECA SxFiveTactis EPMA. Oxygen isotopic compositions were measured by secondary ion mass spectrometry (SIMS) using a CAMECA IMS 1270 E7 at CRPG-CNRS [4]. $^{16}O^-$, $^{17}O^-$, and $^{18}O^-$ ions produced by a Cs^+ primary ion beam (~4 µm, 500 pA) were measured in multi-collection mode using two off-axis Faraday cups (FCs) for $^{16,18}O^-$ and the axial electron multiplier (EM) for $^{17}O^-$.

Results: The Ivuna and Alais thin sections show a wide variety of clasts embedded in a fine-grained phyllosilicate-rich matrix. Olivine and pyroxene grains are notably more common within these clasts. Although olivine and pyroxene grains in Ivuna are variably sized and shaped, they are all smaller than 30 µm and often occur as aggregates within sub-mm Fe-rich clasts [5-6]. Some anhydrous silicates also appear as isolated olivine/pyroxene grains in direct contact with the fine-grained interclast matrix in both Ivuna and Alais. Pyroxene and olivine grains are Mg-rich (Mg# ≥ 97) with low abundances of TiO_2, Cr_2O_3, NiO, and MnO (Table 1). We did not encounter any FeO-rich (Mg# < 90) olivine or pyroxene such as those reported by numerous authors [2, 3]. Our data reveal mass-independent oxygen isotopic variations with $\Delta^{17}O$ values ranging from −23.63 to −0.57‰, representing rare evidence of extremely ^{16}O-rich ($\Delta^{17}O < -20‰$) olivine and pyroxene grains in CI chondrites. Two of these olivines are characterized by MnO/FeO ~ 1, typical of low-iron, Mn-enriched silicates commonly observed in amoeboid olivine aggregates (AOAs, [7]). Other anhydrous silicate grains have $\Delta^{17}O$ values ranging from −6 to 0‰, probably representing chondrule fragments [8].

Discussion: Combined, these results indicate that CI anhydrous silicates likely derived from chondrules and AOAs that were accreted (either intact or fragmented) onto the CI parent body(ies) and experienced *in-situ* fluid alteration. The presence of refractory inclusions in CI chondrites is consistent with recent models suggesting that refractory inclusions formed farther from the Sun than previously thought during the concomitant injection of material from the molecular cloud and outward viscous spreading of the disk [9]. Similarly, CI olivine grains with $\Delta^{17}O$ values similar to those of CC chondrules suggest that chondrule formation occurred throughout the CC reservoir. CI chondrules presumably formed locally in the outer disk and had an affinity to those of the CR clan of carbonaceous chondrites. This suggests that chondrule formation occurred throughout the CC reservoir. Our results thus demonstrate that high-temperature objects were non-negligible constituents of the CI protolith(s).

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