Revisting the apparent elemental complementarity between chondrules and matrix in carbonaceous chondrites

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Chondrites represent remnant building blocks of the Solar System and provide clues to the initial make-up of the terrestrial planets. Although there may be some consensus about the accretion regions of chondrites relative to Earth's orbit [1], it is still highly debated where, when and how chondritic components, such as chondrules and matrix, are formed and accreted. Even so, this issue is of upmost importance to understand the dimensions of mass transport in the protoplanetary disk. In one view, chondrules and matrix within a chondrite group are genetically related and formed from a single, initially CI-like, reservoir [2]. Elements lost during chondrule formation are re-absorbed by CI-like dust, generating elemental ratios which are subchondritic in chondrules and superchondritic in matrix (e.g., observed for Fe/Mg and Si/Mg). However, it has been suggested that this supposed complementarity is the result of secondary alteration processes on the chondrite parent bodies [3]. Elemental exchange during fluid mobilization may create complementary patterns, whereas the initial composition of the matrix was CI-like. Finally, the observed complementarity in chondrites may simply reflect a generic process of chondrule formation that does not require formation of chondrules and matrix from the same reservoir [4].

To distinguish between these different models, we have investigated major, minor and trace element compositions of chondrules and their fine-grained dust rims from altered and relatively unaltered CV (Leoville, Vigarano and Allende), CM (Maribo and Cold Bokkeveld) and CR (NWA801) chondrites using SEM/EDS and LA-ICPMS. We will discuss the effect of aqueous alteration and thermal metamorphism on the composition of chondrules and surrounding matrix and, finally, a mechanism to unify the apparent elemental complementarity of chondrules and matrix [2] with observed isotope heterogeneities and ages of individual chondrules [4].

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