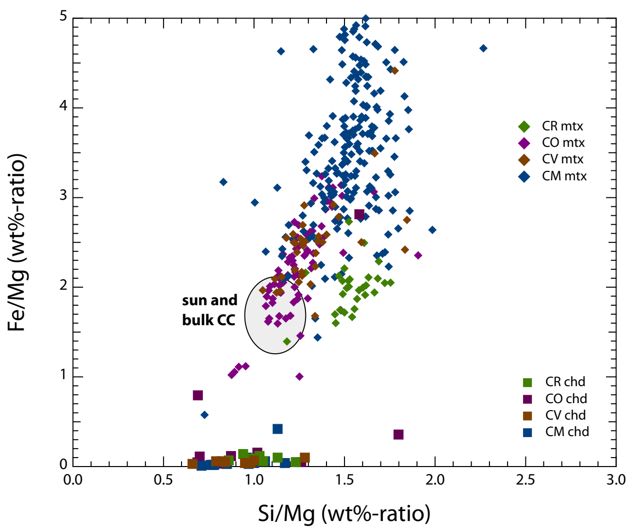
THE CHONDRULE-MATRIX COMPLEMENTARITY. D. C. Hezel[1,2], H. Palme[3], P. A. Bland[4] and E. Jacquet[5], [1]University of Cologne, Department of Geology and Mineralogy, Zülpicher Str. 49b, 50674 Köln, Germany, [2]Department of Mineralogy, Natural History Museum, Cromwell Road, London, SW7 5BD, UK, [3]Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, D-60325 Frankfurt am Main, Germany, [4]Department of Applied Geology, Curtin University, Perth, WA 6845, Australia, [5]Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie, Muséum National d'Histoire Naturelle, CP52, 57 rue Buffon, 75005 Paris, France.

Chondrules are found throughout the solar system, in chondritic meteorites, but also in comets [1]. Chondrules mark a significant step in protoplanetary disk evolution, when interstellar dust grows to planetesimals and finally to planets. The mechanism of chondrule formation is, hence, not only vital for planet formation, but also an integral part of protoplanetary disk evolution. Chondrule formation is therefore a prerequisite of building planets, but also important for understanding protoplanetary disk formation in general.

Unfortunately, and despite many decades of efforts, the search for the mechanism of chondrule formation remains inconclusive, and still a significant number of hypotheses of how chondrules formed compete [e.g. 2].

Chondrules and matrix together account for typically >95 vol.% of a chondrite. Despite the large structural variations, bulk chondritic meteorites are chemically similar. Understanding the relationship of chondrules and matrix, and a potential genetic link between these two components, will provide conclusive and unequivocal constraints that any suggested mechanism of chondrule formation has to meet.

The majority of chondrules and matrix in a single meteorite formed either in the same region or in spatially separate regions. A significant number of hypotheses on how chondrules formed require that chondrules and matrix formed in spatially separated regions. Therefore, the answer to the question whether chondrules and matrix of a single meteorite formed in the same or in separate regions will allow to either support or discard a potentially large number of suggestions regarding chondrule-forming mechanisms.



Chondrules and matrix have different element compositions. For example, chondrules in carbonaceous chondrites typically have higher Mg/Si ratios than matrix (figure). Together, chondrules and matrix represent the bulk chondrite Mg and Si content, hence, the bulk chondrite Mg/Si ratio is the combination of chondrules and matrix. It is then a critical observation that the bulk chondrite Mg/Si ratio is not just any such combination, but exactly the ratio of CI chondrites. The fact that chondrules and matrix have different element ratios while the bulk has an CI chondritc element ratio is called chondrule-matrix complementarity. Such complementarity has now been reported for a number of element pairs (e.g. Mg/Si, Al/Ca, Al/Ti, Fe/Mg), and isotope systems (e.g. W, Mo) in different carbonaceous chondrites [3-10].

It is difficult to achieve such complementarity by mixing chondrules and matrix of different compositions from different regions of the solar nebula, resulting in a CI chondritic bulk composition. Hence, any model requiring mixing that cannot explain complementarity must be excluded. Still, some recent theoretical calculations invoking radial [11] or vertical [12] transport may reconcile complementarity with a plurality of sources in the limit of tight coupling of chondrules and dust with the gas.

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