MODAL ABUNDANCES OF CAIS: IMPLICATIONS FOR BULK CHONDRITE ELEMENT ABUNDANCES AND FRACTIONATIONS.

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Introduction: Modal abundances of Ca,Al-rich inclusions (CAIs) are poorly known and reported data scatter across large ranges [1-16]. We show that this spread is the result of a Poisson distribution of the CAIs within the chondrites. We provide a new set of CAI modal abundances, considering the Poisson distribution and that we obtained for all carbonaceous chondrites except CH and CI chondrites. Beside this 'classical' approach of simply counting the number of CAIs in a chondrite, we also theoretically calculate their modal abundances from (i) bulk chondrite element-concentrations and (ii) element-concentrations of individual chondrite components.

Results: We combine our own set of CAI modal abundances with reported ones and get the following results (in area%): CV: 2.98, CM: 1.21, Acfer 094: 1.12, CO: 0.99, CK/CV (Ningqiang & DaG 055): 0.77, CK: 0.2, CR: 0.12 and CB: 0.1. Our calculated CAI modal abundances are ~10-50% below these measured values. The CAI size distributions follow log-normal distributions, however, there are a few large CAIs that are not part of these distributions [17].

Conclusions: Our new CAI modal abundance data and approach to recognise them as Poisson distributed as well as our theoretical calculations show that CAI modal abundances are much smaller than previously thought. The data reduction process is crucial when obtaining CAI modal abundances. As CAIs are Poisson distributed, it is required to study larger areas (>1000, better >2000 mm^2) in order to obtain modal abundances with a small error. The CAI modal abundances we provide for CC are in good agreement with their calculated Al overabundance when compared to the CI-chondritic composition. We find a correlation between this excess and CAI modal abundances and conclude that the excess Al was delivered by CAIs. Our results support the model that CAIs did not form in the same chemical reservoir as chondrules and matrix, but have later been added to this. The Al delivered by CAIs is only a minor fraction (~10%, and 25% in case of CVs) of the bulk chondrite Al and cannot have contributed much ^{26}Al to heat the chondrite parent body. Ordinary, enstatite, R- and K-chondrites have an Al deficit relative to CI chondrites in accordance with their very low, if any, CAI modal abundances. Carbonaceous chondrites also had an initial Al deficit if the contribution of Al delivered by CAIs is subtracted. Therefore all chondrites probably lost a refractory rich high-T component explaining this Al-deficit. Our calculations show that CAIs contributed only minor amounts to chondrules and matrix. Most CAI size distributions contain more than one population, indicating that CAIs of one meteorite group had different origins.

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