MATRIX COMPOSITIONS IN ANTARCTIC AND NON-ANTARCTIC CM CARBONACEOUS CHONDRITES. Harry Y. McSween, Jr., Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996

The matrices of carbonaceous chondrites were particularly sensitive to aqueous alteration processes on their parent bodies, because their fine grain-sizes made them permeable to fluids and thus highly reactive. TEM and X-ray diffraction studies have identified an assortment of intergrown phyllosilicate phases, but their relative proportions in these complex mixtures have been difficult to determine.

The bulk compositions of matrices in eleven Antarctic and four non-Antarctic CM chondrites have been determined using microprobe defocused beam techniques. When combined with similar results for eleven non-Antarctic CM chondrites determined previously (1), this constitutes a significant database for interpretation of matrix mineralogical variations. The results of these analyses in terms of Fe, Si, and Mg are presented in Figure 1. Shown for reference are the compositions of PCP (defined as a mixture of cronstedtite and tochilinite, the compositions of which (2) are joined by a tie-line) and SERP (coexisting serpentines, the compositions of which (3) are joined by a tie-line). Virtually all of the bulk matrix analyses fall within a narrow triangle whose corners are defined by the two serpentine compositions and PCP containing cronstedtite:tochilinite in the approximate proportions 3:1.

Using mass balance calculations, it is possible to specify the relative proportions of these four phases in the matrix of any meteorite. A mixing line constructed from the PCP apex through the matrix composition can be extended to intercept the SERP tie-line; application of the lever rule to the intercept point gives the ratio of Mg-rich to Fe-rich serpentines. The ratio PCP:SERP can then be determined by applying the lever rule to the location of the matrix along the mixing line. PCP/(PCP + SERP) ratios calculated in this way range from 0.16 to 0.58. These results can be tested using other elements (Al, Ni, S). Agreement between predicted and measured Al concentrations in bulk matrices is fairly good, but S is highly variable and Ni is consistently too high. These results suggest the presence of finely disseminated sulfides, which have been observed in CM matrix (4), as additional components.

The observed Fe-depletion trend (Figure 1) has been interpreted to reflect increasing alteration (5), because it correlates with increasing modal proportions of matrix produced by chondrule alteration. This trend is consistent with a model for progressive alteration of matrix based on TEM textural observations (2). First tochilinite formed from chondrule-associated metal, then cronstedtite formed from tochilinite and Mg-rich serpentine formed from matrix olivine, and finally Fe-rich serpentine formed from cronstedtite and sulfides were added. CM matrix clearly did not behave as a closed system during aqueous alteration.

CI chondrite matrices consist almost entirely of serpentines (and possibly smectites), but without PCP; this may be a natural consequence of the absence of chondrule-associated metal in the precursor material. Not enough mineralogical data on these meteorites exist to perform mass balance calculations for them.

These data and calculations provide a quantitative picture of the mineralogical changes during progressive aqueous alteration. Such information should ultimately be useful in constructing physical and thermal models for carbonaceous chondrite parent bodies.
Fig. 1. CM matrix analyses (each dot is an average of 20 100μm diameter spot analyses) in terms of weight percent Fe, Si, and Mg. Non-Antarctic and Antarctic data are plotted separately. Matrix analysis generally fall within a triangle defined by the compositions of PCP and coexisting serpentines. Abbreviations for non-Antarctic chondrites are: Kivesvaara (Kv), Murchison (Mn), Murray (My), Cochibamba (Co), Mighei (Mi), Pollen (Po), Cold Bokkeveld (CB), Erakot (Er), Crescent (Cr), Boriskino (Bo), Santa Cruz (SC), Nogoya (No), Essebi (Es), Haripura (Ha), and Bells (Be). Prefixes for Antarctic chondrites are all ALHA or ALH, except for EET 83224 and 83226. The compositions of individual clasts in several meteorites are indicated by the suffix cl.

References

(2) Tomeoka K. and Buseck P. M. (1985) GCA 49, 2149.
(4) Barber D. J. (1981) GCA 45, 945.