TEXTURAL CONSTRAINTS ON THE FORMATION OF ALTERATION PHASES IN CM CHONDRITES L. H. Joseph[1], L. B. Browning[2], M. E. Zolensky[3], [1]Department of Geological Sciences, University of Rochester, Rochester, NY 14627, [2]Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, [3]Solar System Exploration Division, NASA Johnson Space Center, Houston, TX 77058.

Although it is generally believed that the secondary alteration phases observed in CM chondrites resulted from parent body reactions [1], the influence of nebular processing can not yet be dismissed [2]. We have analyzed 5 CM falls using optical and electron microscopy to construct a comprehensive pictorial reference set of textural and mineralogical associations bearing on the origin of alteration products in these meteorites. Our analyses support pervasive aqueous alteration on the CM parent body, but do not exclude the possibility of minor nebular alteration.

Most isolated anhydrous silicates display extensive embayments with phyllosilicate infillings that branch into the surrounding matrix (Figure 1). Gradational compositional boundaries between the remnant crystals, adjacent phyllosilicates and surrounding matrix support the production of phyllosilicates by in situ reactions between anhydrous matrix phases and fluid. Isolated anhydrous silicates are also, in general, more extensively embayed than chondrule phases, which supports the infiltration of fluids in a parent body setting because the high permeability of the fine-grained matrix, and high surface-to-volume ratios of the individual crystals would result in preferential alteration of isolated matrix crystals. However, a few fractured chondrules maintain relatively sharp boundaries between chondrule phyllosilicates and surrounding matrix. This distinction between chondrule and matrix phyllosilicates suggests the mechanical mixing of partially altered chondrules with fine-grained matrix. Alternatively, some brecciation may have continued after alteration was complete.

Phyllosilicate- and carbonate-filled veins have been observed in CI chondrites and demonstrate aqueous alteration in a parent body setting [3,4]. We observe phylosilicate veins extending from chondrules into the matrices of several CM chondrules. Vein phyllosilicates typically have a larger grain size than the surrounding alteration products and are oriented with their long dimensions roughly perpendicular to the vein walls. Veins are filled with Mg-rich serpentines, which is also consistent with previously noted trends from Fe to Mg-rich phyllosilicates with progressive alteration [5,6]. Late-stage vein formation which cross-cuts all CM textural components is consistent with fluid flow in a parent body setting.

It is generally believed that the carbonates in CM chondrites probably precipitated from an evolved fluid on the CM parent body because the partial pressure of CO_2 within the solar nebula was probably not high enough to permit the formation of carbonates prior to the accretion of the parent body [4]. We observe phyllosicate rimming calcite crystals, which suggests that phyllosilicates may also have formed on the parent body. Also, embayed anhedral calcite crystals imply in situ dissolution or formation rather than nebular processing.

We observe many fragile features in CM chondrites. Veins, extensions from chondrules, ponded phyllosilicates and other delicate textural components are suggestive of in-situ alteration because it does not seem probable that these fragile products of aqueous alteration would be preserved throughout the rigorous accretion and lithification processes associated with parent body formation.

Although features such as sharp boundaries between isolated olivine crystals and the surrounding matrix suggest that at least some aqueous reactions may have occurred in the solar nebula, the common occurrence of carbonates, veins, degraded remnant matrix silicates and fragile alteration products supports the predominance of parent body alteration.

References: [1] Zolensky, M. E. and McSween H. Y. Jr. (1988) in Meteorites and the Early Solar System (eds. J. F. Kerridge and M. S. Matthews), University of Arizona Press, 114-143, [2] Metzler K. et al. (1992) Geochim. Cosmochim. Acta **56**, 2873-2897, [3] Richardson S. M. (1978) Meteoritics **13**, 141-159, [4] Armstrong J. T. et al. (1982) Geochim. Cosmochim. Acta **46**, 575-596, [5] Browning L., McSween H. Y. Jr., Zolensky M. (1993) LPSC XXIV, [6] Bunch T. E. and Chang S. (1980) Geochim. Cosmochim. Acta **44**, 1543-1577.

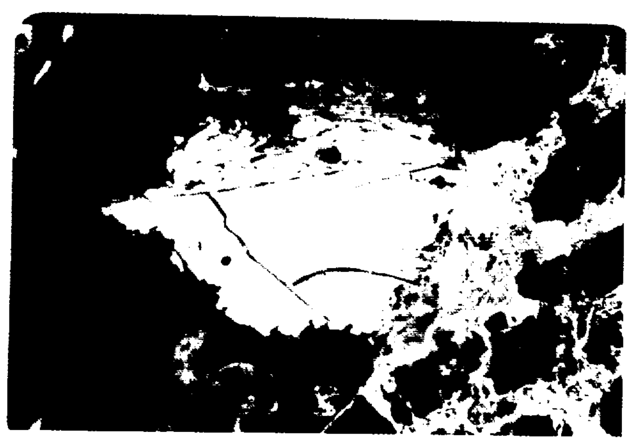

Figure 1: Isolated matrix olivine in Murchison being replaced by phyllosilicates.