CLASTIC RIMS ON INCLUSIONS: CLUES TO THE ACCRETION OF THE ALLENDE PARENT BODY.

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Little direct evidence can be found in chondritic meteorites that bears on the nature of the accretion mechanisms by which these objects formed. Often, metamorphism has largely obliterated any accretionary textures that might have existed. The matrix of Allende, however, is unaltered and unmetamorphosed and may thus contain clues to nebular accretion processes.

When observed in slab surfaces or in thin sections using transmitted light, many inclusions and clasts of various kinds in Allende are mantled by thin (≲ 0.5 mm), ultra-dark rims of matrix-like material [1,2]. The first SEM study of their mineralogy was made by Allen *et al.* [3]. Our SEM studies of dark rims on coarse-grained, Ca-, Al-rich inclusions in Allende reveal that these rims are multi-layered and that not all layers are present on any given inclusion.

The innermost layer, I, directly overlies the Wark-Lovering rim sequence. It has been found in two varieties, never in the same inclusion. One variety, IA, consists mostly of very fine (2-4 μm) hedenbergite needles, with abundant interstitial void space, lesser nepheline and minor olivine and Ni-Fe metal grains. The hedenbergite needles are randomly oriented and show no intergrowths with each other or mutual growth surfaces. This layer is very discontinuous and, where present, seems to be confined to topographic depressions on the surface of the host inclusion. The second variety, IB, consists of scattered patches of coarse (mostly 10-20 μm, but rarely up to ~100 μm), barrel-shaped to blocky olivines of composition Fo ~70-90. Many of these crystals have hollow cores, reminiscent of those found in amoeboid olivine aggregates [4]. Mixed with these are abundant interstitial void space, lesser nepheline and minor Ni-Fe metal. Surrounding Layer I (A or B) is a layer, II, consisting mostly of very fine (1-2 μm) olivine needles (Fo~60), with interstitial void space, nepheline and minor Ni-Fe. Like Layer IA, Layer II is loosely packed with no intergrowths between olivine crystals. Layer II grades outward in grain size to Layer III. This layer contains 2-10 μm-sized, barrel-shaped olivines (Fo~65-70). Accessory phases and textures are otherwise identical to Layer II. Layer III is more continuous than I or II, commonly enclosing the entire host inclusion. Like the inner layers, however, III is thickest where it fills topographic depressions in the underlying surface. Mantling the outer surface of Layer III is a discontinuous series of aggregates, Layer IV, of blocky andradite and hedenbergite crystals (10-20 μm) and intimately associated patches of 2-10 μm-sized diopside needles. Layer IV separates Layer III from the Allende matrix which is identical in texture to Layers IA-III, but contains olivines that are more iron-rich (Fo~50) and a higher proportion of metal and sulfide grains than the rim layers.

The highly porous textures of these rim layers and the absence of intergrowths or interlocking textures between most of the constituent crystals suggest the possibility that the crystals did not nucleate and grow in place. Rather, the textures are strongly reminiscent of clastic sedimentary deposits, except that most of the grains are euhedral crystals. We suggest that the olivines and pyroxenes in these rims and also in the texturally-identical Allende matrix formed independently elsewhere prior to accretion. Since it is hard to imagine how each of so many tiny crystals could have solidified from separate liquid droplets or how any precursor solid could have been completely fragmented into its constituent euhedral crystals, we interpret these crystals to be vapor-solid condensates. The fact that individual rim layers differ in texture, mineralogy and mineral chemistry from one another indicates that the host inclusions had access to assemblages of condensates which formed under different physico-chemical conditions from one another. The sequence of rim layers suggests either that the inclusions passed through successive regions containing different assemblages or that a sequence of such assemblages was carried to the vicinity of the inclusions.

The increased thicknesses of rim layers where they fill depressions on inclusion surfaces suggests that such pockets were sites of preferential accumulation of crystals. Accretion of these rim materials onto irregularly-shaped objects had the effect of filling in the irregularities and creating larger, but more rounded, objects. The mantles produced in this way may have served to protect extremely fragile objects such as "fluffy" Type A inclusions from disruption during collisions and accretion into the meteorite parent body. The mantles also may have had the important effect of increasing the sticking probability between colliding objects, since "fuzzy" balls are more likely to stick together than smooth, hard ones. Thus, formation of these rims may have been important in promoting the accretion process. We envision accretion of the Allende meteorite as an extension of the rimming process which we have described. Formation of the Allende parent body occurred when a region of the nebula became densely crowded with mantled inclusions and with tiny olivine crystals which had not yet become incorporated into mantles and which now comprise the bulk of the Allende matrix.

Finally, we note that such features as the existence of variations in the composition of micron-sized olivine grains between adjacent rim layers, the marked variation in grain size of olivine both within and between different rim layers and the side-by-side coexistence of euhedral, micron-sized hedenbergite and diopside crystals all argue strongly against significant bulk metamorphism of the Allende parent body. This is in stark contrast to the claims of Bunch and Chang [5] and McSween [6] who have proposed varying degrees of post-accretionary thermal recrystallization and equilibration of the components of Allende.

References: [1] Grossman L. (1975) *GCA* 39, 433-454. [2] Fruland R.M., King E.A. and McKay D.S. (1978) *Proc. 9th LPSC*, pp. 1305-1329. [3] Allen J.M., Grossman L., Davis A.M. and Hutcheon I.D. (1978) *ibid.*, pp. 1209-1233. [4] Bar-Matthews M., MacPherson G.J. and Grossman L. (1979) Abstract. *Meteoritics* 14, 342. [5] Bunch T.E. and Chang S. (1979) *LPSX*, pp. 164-166. [6] McSween H.Y., Jr. (1979) *Rev. Geophys. Space Phys.* 17, 1059-1078.