MAGNETITE-BEARING LAYERS IN ALLAN HILLS 84001 CARBONATE GLOBULES: BULK AND MINERAL COMPOSITIONS.

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Introduction: Controversy surrounds the origin of submicron magnetite grains in the carbonate globules of ALH 84001. The magnetites may have been emplaced *chemically* by decarbonation/oxidation of original Fe-rich carbonates [1], or *physically* by concentration of grains formed elsewhere [2]. The validity of these mechanisms can be tested through chemical analyses of bulk magnetite-rich (mt-rich) layers and of minerals within the layers.

Analyses: "Bulk" compositions were analyzed by electron microprobe (SX-100 at JSC) for Ca, Mg, Fe, and Mn (3 nA focussed beam, 15 kV, 30–40 s on peak). Mt-rich layers are fine-grained compared to the path lengths of electrons and X-rays, so that φ-ρ-Z corrections can be applied. TEM analyses of carbonate grains (10 nm probe diam.) and "bulks" (0.5µm probe diam.) were from a ~70-nm thick ultramicrotomed section (JEOL 2010 at MVA; 200 kV; Noran thin window EDS). Counting statistical errors were <3%; Cliff-Lorimer k-factors were derived from well-characterized standards.

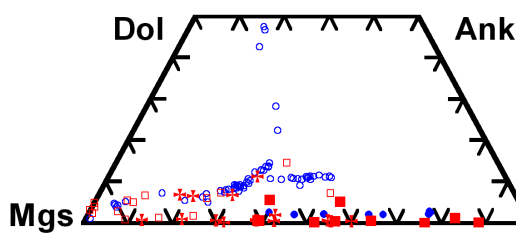
Results: Microprobe analyses (TS ,145), as in earlier reports [3], give low-Ca carbonates in a linear array from ~$Fe_0Mg_{95}Ca_5$ to ~ $Fe_{50}Mg_{39}Ca_{11}$ with nearly constant Ca/Fe. TEM analyses (split ,255) of carbonates outside mt-rich layers are consistent with EMP data (Fig. 1).

TEM analyses of individual carbonate grains within the mt-rich layers fall in two groups: most are nearly Ca-free (and Mn-free) from $Mg_{86}Fe_{14}$ to $Mg_{40}Fe_{60}$; a few are like carbonates outside mt-bearing layers ~$Ca_7Mg_{65}Fe_{28}$ (Fig. 1). Other phases in the mt-rich layers include Ca-bearing brucite (outer mt-rich layer), a Fe-S mineral, Mg-Fe phyllosilicate (smectite?), and Fe-rich amorphous material containing Si and S (latter two in inner mt-rich layer). Ca-rich phases were sought and not found.

TEM "bulk" compositions of mt-rich layers are qualitatively consistent with mixtures of these phases. Re-examination of EMP data showed several analyses (earlier rejected for high S and/or Si contents) which qualitatively match the TEM "bulk" analyses (Fig. 1). The concordance of TEM and EMP analyses suggests that they approximate the true bulk compositions of the mt-rich layers.

Inferences: The mt-rich layers are not merely mixtures of magnetite and magnesian carbonate, and so cannot be explained by simple physical <u>or</u> chemical emplacement of the magnetites. The presence of brucite is most easily explained as the hydration product of Ca-bearing periclase. Perhaps this hydration episode also involved deposition of the clay(?) and amorphous Fe-rich material. But the putative periclase could have formed during decarbonation/oxidation of ferroan carbonate (chemical emplacement mechanism) or during decarbonation of calcian magnesite adjacent to nanophase magnetites (physical emplacement mechanism).

Figure 1. Chemical compositions in Ca-Mg-Fe. Circles are by EMP; angular symbols are by TEM. Open symbols are 'massive' carbonate; filled symbols are 'bulk' of magnetite-rich layers; crosses are carbonates within magnetite-rich layers.



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