EVOLUTION OF MELT COMPOSITIONS IN SEMARKONA TYPE II CHONDRULES.

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Introduction: With chondrule condensation to melts in mind [1,2], we extended a study of melt inclusions in Semarkona chondrules [3] to track chondrule melt changes.

Observations: Melt inclusions are common in Types IIA, IIAB and intermediate IIA(B) chondrules in Semarkona. We used SEM, EMP and STEM to analyze bulk chondrules, primary glass inclusions, melt channels, and mesostasis, to search for evidence of fractional crystallization or open systems. Most inclusions we studied are glass, sometimes with sulfide blebs, shrinkage cavities and strain effects in the surrounding olivine. The melt inclusions are generally richer in Si, Al, Ca, Na and K than the initial liquid, but poorer than the mesostasis, consistent with the entrapment of liquid during the growth of the olivine.

Calculations: We have used PETROLOG [4] to model the fractional crystallization of liquids of bulk chondrule compositions. For IIAB chondrules, melt inclusion compositions are quite well explained by crystallization of olivine, and mesostasis compositions by crystallization of olivine + pyroxenes. For IIA and IIA(B) chondrules, crystallization of olivine does not reach the low Fe and high Si contents of the inclusions. This could be explained by Fe-Mg exchange between olivine and inclusion after olivine crystallization [4] and the replacement of Fe by Mg atoms may be sufficient to boost the wt.% of other constituents like SiO_2. However, some addition of SiO from the gas [2] may also be required. The Ca/Al ratio of the bulk chondrules is CI, as it is for most of the early-trapped inclusions (<11% Al_2O_3). This is surprising because crystallization of olivine must lower the Ca/Al ratio below the initial value. Late trapped inclusions and melt channels (11-12% Al_2O_3) are somewhat depleted and mesostasis (12-16% Al_2O_3) strongly depleted in Ca and enriched in Na. Late crystallization of augite lowers Ca and raises Na in the melt, but is inadequate to explain the abrupt change of Ca/Na ratio at 11-12% Al_2O_3. A replacement reaction is more plausible, especially considering the presence of pentlandite or magnetite in some melt inclusions. Thus melt composition trends in Semarkona Type II chondrules can be largely explained by fractional crystallization, but there is evidence of some open system behavior.

References: [1] Varela M.E. et al. (2002) *Geochim. Cosmochim. Acta* 66, 1663-1679. [2] Libourel et al. (2006) *Earth Planet. Sci. Lett.* 251, 232–240. [3] Tronche E. (2007) Ph.D. thesis MNHN, Paris. [4] Danyushevsky et al. (2000) *Contrib. Mineral. Petrol.* 138, 68-83.