VAPOR/LIQUID/SOLID EQUILIBRIA WHEN CHONDRITES COLLIDE. D. S. Ebel*, Dept. Geophys. Sci., 5734 South Ellis Ave., University of Chicago, Chicago, IL 60637. *after 1-July-2001: Dept. Earth & Planetary Sciences, American Museum of Natural History, New York, NY, 10024 (debel@amnh.org).

Introduction: The theory of chondrule and CAI formation by collision of molten planetesimals was vehemently discussed at this meeting last year [1]. To test the theory, calculations were done to simulate the equilibrium condensation at various total pressures (P^{tot}), of a vapor having C1 carbonaceous chondrite composition, and so predict the mass transfer expected between vapor and liquid, if such collisions produced liquid droplets in vapor. Even in conditions where kinetic processes are influential, such as rapid cooling, it is likely that an equilibrium chemical state would have been closely approached by the objects resulting from the supposed collisions, particularly in the high temperature (at least above 1500 K) portion of the cooling trajectory.

Technique: Condensation codes developed by [2] for the investigation of dust-rich nebular systems [3] were used. The model incorporates the 'MELTS' description of activity-composition relations for silicate liquid [4], and thermodynamic data for several hundred gaseous species and numerous solid phases, all referred to a 23-element compositional basis of the system. The algorithms are based on those of the 'MELTS' program. The bulk composition of Orgueil [5] was used, because it is likely to represent the composition of undifferentiated planetesimals in the early accretion disk.

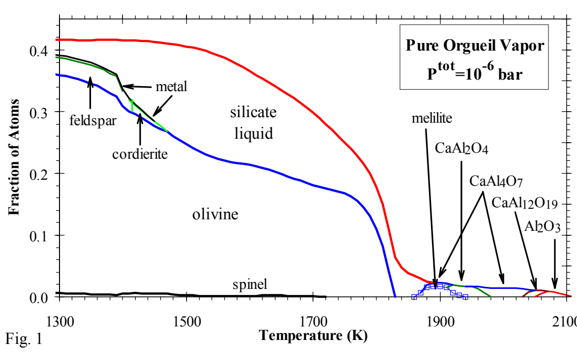

Fig. 1

Results: In fig. 1, the distribution of atoms, for one mole total atoms in initial vapor of Orgueil composition, is shown for a representative $P^{tot} = 10^{-6}$ bar, as a function of decreasing temperature (T). At high T, calcium aluminates condense, followed by silicate liquid and olivine, which reaches 8 mol% fayalite by 1700 K, 25% by 1550 K, and 35% by 1400 K. Liquid has 8 wt% FeO at 1700 K, 28% at 1600 K, and 38% by 1500 K. Liquid crystallizes to olivine, cordierite, then feldspar above 1300 K. A very small amount of Ni-rich (>70 mol% at $-8<\log(P^{tot})<-4$) metal alloy appears at 1450 K. Cr-rich spinel coexists with olivine over most of its stability range.

Compared with condensation from a vapor of solar composition, pure C1 chondrite vapor is a very oxidized system. In oxygen fugacities *versus*. T space, for $-8<\log(P^{tot})<-4$, condensation of C1 vapor begins near the iron-wüstite buffer, and rises above it with cooling. A vapor of solar composition at $P^{tot}=10^{-5}$ bar follows a trajectory some 3 log units below iron-wüstite.

Conclusions: If chondrules were produced by splashing in the collision of undifferentiated molten planetesimals, then their chemistry should reflect some degree of equilibration with the vapor which should have been an accessory to the collision process. Calculations of vapor/liquid/solid equilibria in chondritic systems yield vapor so oxidizing that Fe enters abundant silicate phases, and trace metal alloy is Ni-rich. Some modification of planetesimal collision chemistry must be invoked for the splashing hypothesis to fit the facts: chondrule metal contains less than 15 mol% Ni, and chondrule glass and olivine are not so rich in FeO.

References: [1] Lugmair G. (2000) Leonard Medal Lecture at 63rd Meteoritical Society meeting. [2] Ebel D.S. *et al*. (2000) *J. Computational Chem., 21*, 247-256. [3] Ebel D.S. & Grossman L. (2000) *GCA, 64*, 339-366. [4] Ghiorso M.S. & Sack R.O., (1995) *Contrib. Mineral. Petrol., 119*, 197-212. [5] Anders E. & Grevesse N. (1989) *GCA, 53*, 197-214.