EVIDENCE FOR FRACTIONAL CRYSTALLIZATION OF WADSLEYITE AND RINGWOODITE FROM INDIVIDUAL OLIVINE MELT POCKETS IN CHONDRULES ENTRAINE IN SHOCK MELT VEINS.

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Introduction: Ringwoodite and rare wadsleyite were reported from olivines in shock-melt veins in shocked chondrites [1-4, 7]. Ringwoodite was interpreted to have resulted from shock-induced solid-state phase transformation [1-4, 7]. This agrees with experimental results when both olivine and ringwoodite have identical compositions [e.g. 1]. Many grains however, contain chemically different ringwoodite and olivine [3, 4]. Formation of chemically different polymorphs via solid-state transformation imposes unrealistic time scales (17-500 seconds) to achieve encountered chemical equilibrium [3]. We investigated squeezed porphyritic olivine chondrules in shock-melt veins in the Peace River L-6 chondrite depicting concentric wadsleyite and ringwoodite intergrowths within parental olivine grains enclosed in unmelted pyroxene (CPX).

Results: Mg-rich wadsleyite (Fa06-10) occupies the cores of the former olivines and is surrounded by zoned Mg-poor ringwoodite (Fa28-38) belts. Wadsleyite cores and ringwoodite belts consist of polygonal crystallites (≤ 600 nm) of both phases, whereby wadsleyite is much more abundant in the cores than in the ringwoodite belts. ATEM study of FIB-slices reveal no zoning in wadsleyite or ringwoodite crystallites and a sharp compositional gap of Fa20-32 at their interfaces. Wadsleyite crystallites (Fa19) surrounded by quenched feathery, poorly crystallized objects with olivine composition (Fa24) at the contact to the CPX indicate that the assemblages evolved through fractional crystallization within melted individual olivines (Fa24-26) in the entrained chondrules. CPX does not display evidence of melting.

Conclusions: Calculation of the duration of the shock event using mineral chemistries of wadsleyite and ringwoodite and experimentally determined solid-state diffusion parameters [5, 6] lead to unrealistic time scales (≥ 500 S). Our results are stark evidence for fractional crystallization of both dense polymorphs from olivine melts at P≥ 18 GPa and T≤ 1,900ºC. They also cast doubt on studies of zoned ringwoodite veins leading to time scales of ≥ 17 S [4, 7]. We present here the first evidence so far for formation of wadsleyite and ringwoodite by fractional crystallization from individual olivine melts in chondrules.