**A SHOCKING TALE: TEM OBSERVATIONS OF DEFORMED OLIVINE IN ORDINARY CHONDRITES.**

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**Introduction:** Previous transmission electron microscopy (TEM) work suggested that Portales Valley [H7 (S1)] and MIL 99301 [LL6 (S1)] experienced syn-metamorphic shock deformation at an early stage [1,2]. To better interpret the microstructures of these and other chondrites, we used TEM to study two L6 chondrites with a nominally simple shock history, including Park (S1) and Leedey (S4, revised from a literature designation of S3 based on our optical microscopy data). Our expectation was that these L chondrites could have been shocked to various degrees from a cold starting temperature at a late stage, possibly even in the same, major collisional event that affected the L parent body ~0.5 Ga ago [e.g., 3].

**Results:** Olivine microstructures found for Leedey include: (a) moderately high dislocation densities ($10^9$ -$10^{10}$ $cm^{-1}$); (b) predominantly **b**=[001] dislocations with straight segments oriented along 2 or 3 distinct line vectors, with only occasional bowing of dislocations, suggesting low temperature deformation; (c) rare low angle grain boundaries indicating limited recovery; (d) small (10s of nanometers) **b**=[001] dislocation loops.

Specific microstructures found for olivine in Park include: (a) a moderate dislocation density ($10^8$ $cm^{-1}$); (b) a prevalence of **b**=[001] dislocations, predominantly bowed, with some **b**=[100] dislocations, indicative of deformation at an elevated temperature; (c) occasional tangles formed by intersections of **b**=[001] dislocations with **b**=[100] dislocations; (d) no low angle grain boundaries (subgrain boundaries), indicating limited recovery; and (e) small (10s of nanometers) **b**=[001] dislocation loops, suggestive of dislocation climb.

**Discussion:** Altogether, Leedey appears to be a good example of an S4 chondrite that was relatively strongly deformed from a cold starting temperature. This conforms to the hypothesis that this meteorite could have been affected by the relatively late shock event that affected the L chondrite parent body. Using the data for Leedey as a guide, we suggest that Portales Valley could have been deformed to an S3 shock stage with subsequent annealing to obtain S1 characteristics. In contrast to Leedey, Park appears to have been subjected to low-to-moderate shock pressures at elevated temperatures. There is no evidence that Park was significantly more deformed than it is now, so the low shock stage probably cannot be attributed to an annealing (recovery) process. Instead, we suggest that Park largely escaped the late, strong shock event that affected most L chondrites and instead records one or more, early, relatively weak shock events that occurred while the L chondrite parent body was being metamorphosed. This history of weak shock at elevated temperature is similar to that experienced by MIL 99301 [2]. We now have TEM evidence for early collisions affecting each of the H, L, and LL parent bodies.

**References:** [1] Hutson M. et al. 2007. *Meteoritics & Planetary Science* 42: Abstract #5072. [2] Hutson M. et al. 2009. *40th Lunar & Planetary Science Conference*: Abstract #1081. [3] Bogard D.D. 1995. *Meteoritics* 30: 244-268.