INTERPRETATION OF STRUCTURAL FABRIC IN THE LEOVILLE CARBONACEOUS CHONDRITE. Parham M. Cain and Harry Y. McSween, Jr., Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996.

Carbonaceous chondrites, commonly considered to be pristine chemical relics, are now recognized as having experienced low-temperature aqueous alteration or minor thermal metamorphism (1). We will argue here that some have also suffered structural modification. Preferred orientations of chondrules in CV chondrites have been recognized previously (2,3), but the fact that chondrules must be flattened in order to show preferred orientations has not been generally appreciated. In the Leoville meteorite, flattening is imposed on CAI's and xenoliths, in addition to chondrules, and the ensuing foliation cuts across primary features that we interpret as deformed bedding (fig. 1). Finite strain analysis by the method of (4) indicates Leoville chondrules were originally nearly spherical. Therefore, we interpret the observed fabric as a post-accretional feature due to compaction. Areas of recrystallized matrix in Leoville (3) suggest that deformation was not restricted to chondrules.

This kind of deformation is a complex function of deviatoric stress, strain rate, and temperature (also hydrostatic load, but this is unimportant in this instance as internal pressures in asteroids are less than a few kb). These parameters must be estimated, mostly from induced strain, in order to understand chondrite deformation. The apparent strain ratio in Leoville chondrules measured by two independent methods (5,6) in a two-dimensional slab is approximately 1.9:1 (28% uniaxial shortening), but this is a minimum value for the meteorite because matrix presumably has lower viscosity and higher strain. Strain in matrix, probably an upper limit for the meteorite, may be estimated from the apparent strain ratio (3.3:1, 45% uniaxial shortening) in dark xenoliths composed mostly of matrix material. Combining these measurements with the chondrule/matrix ratio of 65:35 for Leoville (7), we derive an apparent uniaxial strain (flattening) for the rock of 34%. At reasonable geologic strain rates, such deformation would require on the order of 10^4 - 10^7 years for development. The strain mechanism in chondrules appears to be a type of plastic deformation with minor cataclasis. We are presently studying the type and orientation of internal dislocations to understand this mechanism. Comparison of strain mechanism and reasonable strain rates with experimental data will constrain temperature and deviatoric stress.

Uniaxial anisotropy of magnetic susceptibility has been noted previously in carbonaceous chondrites (8); this feature is undoubtedly linked to petrofabrics in these meteorites. Many ordinary chondrites also exhibit chondrule preferred orientation and magnetic anisotropy that are correlated with porosity (9,10) but not with petrologic type (11). Although it is possible that magnetic anisotropy and decreased porosity could result from collisional shock, we do not consider this a viable mechanism for chondrule foliation. Shock experiments on Allende (3) did not produce chondrule flattening, and this feature has not been observed in even severely shocked meteorites. We favor compaction due to burial, in agreement with (3,10). Understanding the deformation that produced chondrite foliation may allow us to calculate such parameters as the depth of overburden (minimum parent body size) and the temperature and rate of burial (accretion).

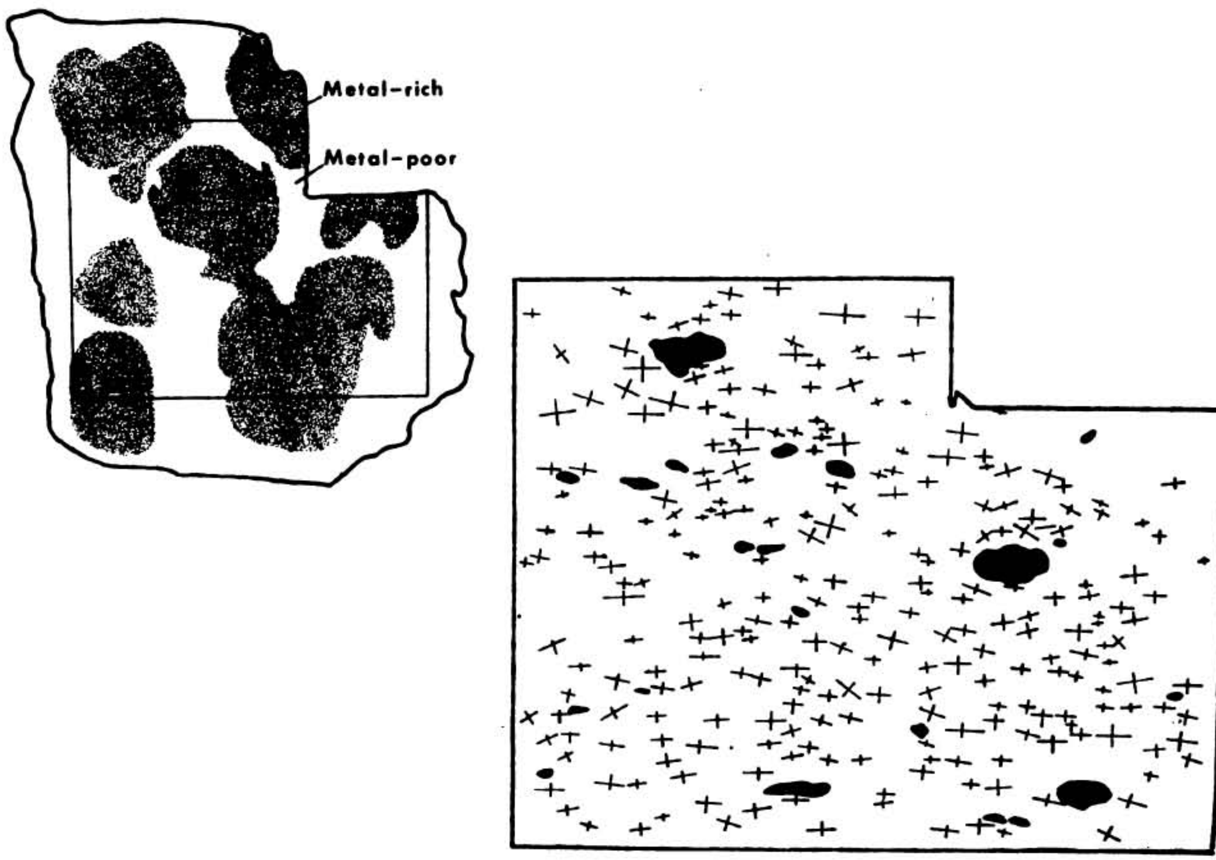

Fig. 1. Sketch of Leoville slab ($\sim 10^4$ cm^2 area) showing prominent metal-rich and metal-poor areas that may represent folded and boudinaged bedding. Area enclosed by the box is expanded on the right. Crosses represent long and short axes of chondrules. CAI's, illustrated in black, are also flattened in the plane of chondrule foliation.

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