X-RAY DIFFRACTION AS A TOOL FOR THE CLASSIFICATION OF EQUILIBRATED ORDINARY CHONDRITES. T. J. Schepker[1] and A. M. Ruzicka[2], [1]Cascadia Meteorite Laboratory, Portland State University, Dept. of Geology. 1721 SW Broadway Portland, OR 97201. schepker@pdx.edu. [2]Cascadia Meteorite Laboratory, Portland State University, Dept. of Geology. 1721 SW Broadway, Portland, OR 97201. ruzickaa@pdx.edu

Introduction: Olivine in equilibrated ordinary chondrites has well-defined compositional ranges that differ between the H-, L-, and LL-chondrite groups (Fa_{16-20}, Fa_{22-26} and Fa_{27-32} respectively) [1]. X-ray diffraction (XRD) studies on synthetic and natural terrestrial olivines established that there is a strong correlation between unit cell parameters and composition [2]. In previous work [3], we demonstrated that this is also true for chondritic olivine and that XRD can be used to distinguish between equilibrated H- and L-group chondrites.

For this study, we extended our previous work to include the LL chondrites, and we also examined the effects of scan time (defined as the time in seconds per unit of 0.02 θ degrees) during scanning. We also compared data for the crystallographic plane (d_{130}) identified in our previous work [3] against one of higher relative intensity identified by others as being useful for XRD work [2].

Methods: Sample material was prepared by hand powdering using an agate mortar and pestle. This powder was then passed through a #325 sieve to ensure particle size of less than 62.5 µm. Powder specimens were packed into a side loading, open topped, aluminum holder for analysis.

A total of 86 x-ray diffraction analyses were performed on three chondrites of different classes for the d_{130} and d_{302} crystallographic planes in olivine. Each analysis was performed using Portland State University's Phillips PW 3040 X-ray Diffractor and Co Kα radiation.

Four separate trials (A, B, C, D) were completed using different scan rates. For trial A, we used scan settings of 0.5 seconds per 0.02 degrees, the same as in our previous study [3], which is the default shortest scan time with the lowest presumed accuracy. As a different detector had been installed since our last experimental work, we utilized these same settings for our first trial (A) as a comparison. Scan time was progressively increased for the other trials: 5 seconds per 0.02 degrees θ for trial B, 30 seconds for trial C, and 45.05 seconds for trial D.

Peak positions and standard deviations of peak positions were determined for d_{302} and d_{130} for all analyses performed on a given chondrite in each trial (A-D). These were plotted by trial grouping using SigmaPlot 11.0. Determinative curves were then derived to relate XRD peak position to olivine composition (Fa content) for each analysis set. Data for d_{302} and d_{130} were then compared in an effort to determine the most accurate and precise peak to be utilized for chondrite classification.

Results and Discussion: Standard deviations (σ values) of measured peak positions provide a metric of the inherent precision of the XRD technique. These σ values varied over two orders of magnitude for the different trials in this study, but in all cases are relatively small (10^{-3}-10^{-5} Å range). For the d_{130} plane, increasing scan time from trials A through C resulted in an overall decrease in σ, with trial C showing the lowest σ value for each chondrite group (Fig. 1). Compared to trial C, a slight increase in σ value for all three meteorites was found for trial D, the longest scan (Fig. 1). The d_{302} interplanar spacing shows a more complex pattern with regard to σ, although trial C again provided the lowest values (Fig. 2).

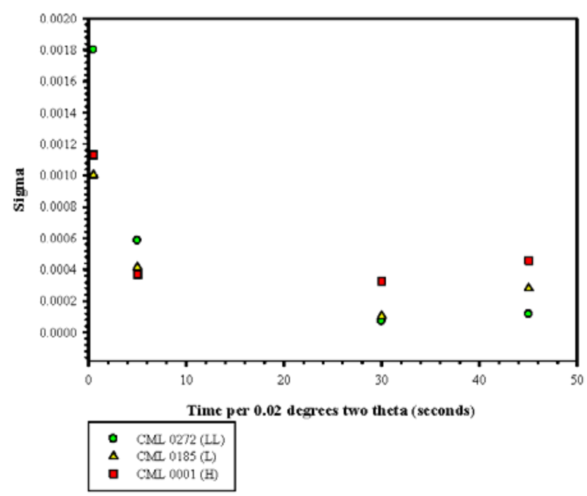

FIGURE 1

The general trend of decreasing σ with increasing scan time observed for the d_{130} plane is what one would expect if precision is limited by counting rate statistics. The slight increase in σ for the longest scan time suggests that another relatively small error of unknown origin affected the longest scans. The more complex relationship between σ and scan time for the d_{302} plane suggests that precision in this case is being controlled by an unknown variable. Based on these results, we suggest that the data for d_{130} are more reliable than for d_{302}.

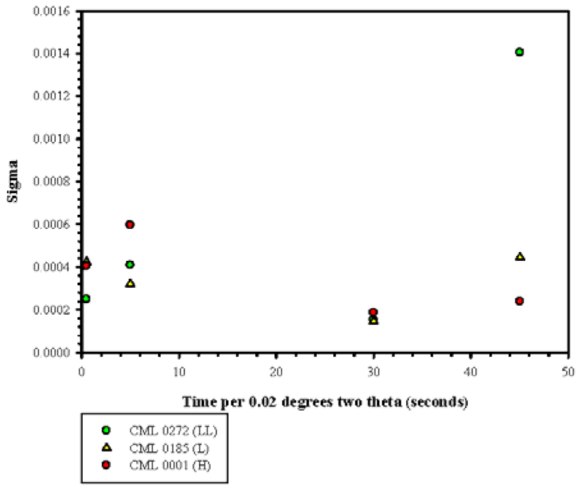

FIGURE 2

Figure 3 compares the relationship between the d_{130} interplanar spacing for trial C, which has the highest precision (lowest σ values) of our measurements, and olivine Fa content as determined based on electron microprobe results. The data imply that the H, L, and LL groups can be readily distinguished using XRD with these scan conditions.

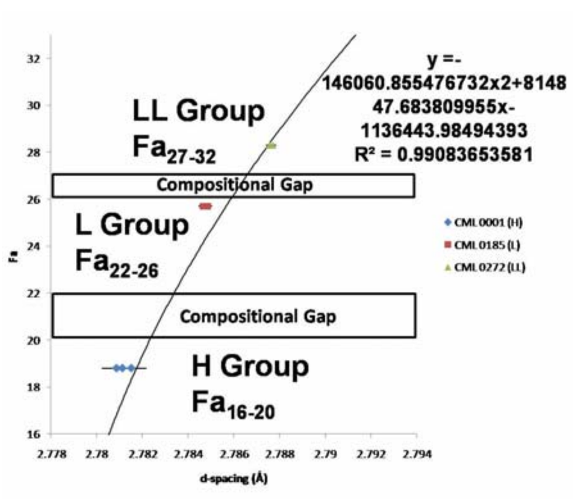

FIGURE 3

Conclusion: This work identifies the d_{130} interplanar spacing in olivine as a generally reliable indicator of olivine composition in these meteorites. Specifically, it appears that XRD-determined d_{130} values can be used with confidence to discriminate between equilibrated ordinary chondrites of different groups, and to estimate olivine Fa contents, provided scan times are sufficiently long (>5 sec/°2θ, with 30 sec/°2θ giving good results). However, analysis of the data suggests that another unknown variable besides scan time may be controlling precision and accuracy of the results.

References: [1] Hutchison R. (2004) *Meteorites. A Petrologic, Chemical and Isotopic Synthesis.* [2] Deer W.A. et al. (1997) *Rock-Forming Minerals: Orthosilicates, 1a, 2nd Ed.* [3] Schepker T. J. and Ruzicka A. M. (2007) *Meteoritics & Planet. Sci., 42,* A136.