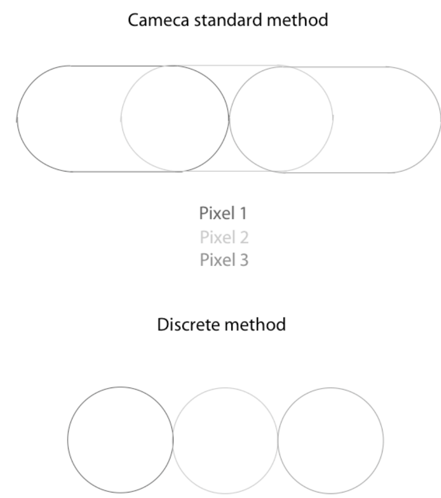
THERMAL METAMORPHISM IN L CHONDRITES: IMPLICATIONS OF PERCENT MEAN DEVIATION IN OLIVINE AND PYROXENE. C. A. Marsh[1], D. S. Lauretta[1], K. J. Domanik[1]. [1]University of Arizona, Lunar and Planetary Laboratory, Tucson, AZ 85721, USA (celinda@lpl.arizona.edu)

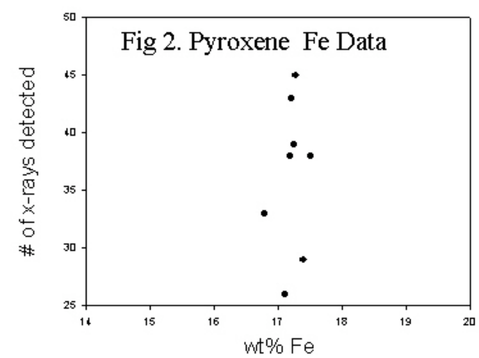
Introduction: We are developing a new technique to quickly and accurately measure the degree of homogeneity in the composition of olivines and pyroxenes in a suite of L-chondrites. Homogeneity of ferromagnesian silicates has been used to measure the degree of heating to which an ordinary chondrite (OC) has been exposed since the introduction of petrologic type [1]. However, even recent publications of the petrologic type classification system have lumped the homogenization of olivine and pyroxene as a single event used to separate type 3 from type 4 OCs. Observations from many authors have noted that pyroxene takes longer to equilibrate than olivine [2, 3], and recent studies of pyroxene in ordinary chondrites have found compositionally defined lamellae in petrologic types 3.8-4 [4, 5]. With our dataset we plan to improve understanding of pyroxene equilibration and the thermal histories of L chondrites.

Analytical Techniques: A Cameca SX50 electron microprobe was used to collect data on ferromagnesian silicate homogeneity through a variety of methods. Initially homogeneity was measured by collecting a large number of Electron Microprobe Point Analyses (EMPAs) in olivine and pyroxene. Then element abundance maps of 11 major elements were collected for each meteorite in an area of 5000 by 5000 microns, using a 10-micron beam. With over 250,000 "pixels" of data, this produces a much more robust histogram of compositions. However the default Cameca mapping routine collects data continuously, binning the data collected over a period of time. This results in a smeared pixel, with a pixel footprint that makes calibration of this data impractical (see Fig. 1).

In response to this difficulty we created a routine in the Cameca task language that allows us to quickly collect raw x-ray counts of Fe, Mg, Ca and Si. This technique takes about 15 minutes to set up and ~5 hours of microprobe time to uniformly cover a region of 1280 by 1280 microns with a 10-micron beam. The footprint of each of the 16,384 pixels collected using this technique is the same as the footprint of a typical EMPA using the Cameca electron microprobe (See Fig. 1). We will refer to our technique as the discrete method, in comparison with the smeared approach that is standard with the Cameca system.

Fig. 1

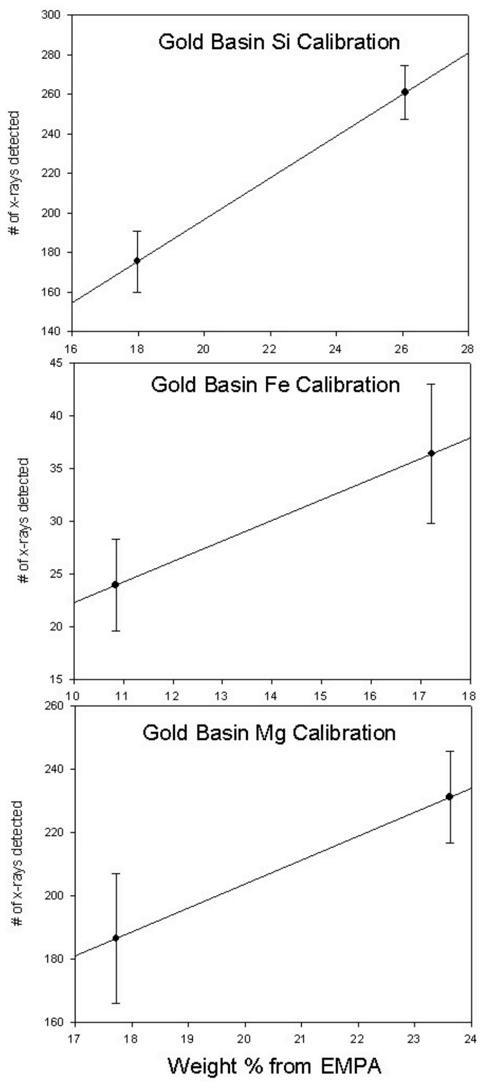




This dataset is calibrated by collecting with a 10-micron beam ~10 EMPAs of both olivine and low-Ca pyroxene within the region mapped by the discrete method. While the data collected by EMPA is much more accurate (see Fig. 2), collecting 20 points takes about one hour to set up and an additional hour of microprobe time. For each point at which a calibration point has been collected, the number of x-rays detected by our discrete mapping technique is compared with the weight percent of that element determined by EMPA (see Fig. 2). The calibration curves were calculated by taking the average of the wt% for each mineral and the average of the # of x-rays detected (see Fig. 3). For Fe in the example meteorite, Gold Basin (L4), the formula of the line between these two points is y = 1.96x + 2.65. An IDL program has been written to apply this calibration curve to the entire dataset, sort olivine and low-Ca pyroxene pixels out from the overall dataset based on their Si abundances, filter out pixels which do not have an accurate total wt%, and construct a histogram of compositional variation in both olivine and low-Ca pyroxene (see Fig. 4). The weight percent data produced in this way can then be used to calculate the Percent Mean Deviation (PMD) using the technique of [2] and related measures of variability.

Results: Using the calibration points from Gold Basin a PMD of less than 1% has been calculated in both olivine and low-Ca pyroxene. The average wt% of Fe in Gold Basin is 17.2 in low-Ca pyroxene and 10.8 in olivine. The results of our discrete method

Fig. 3



and IDL programming yield for Gold Basin an average wt% of Fe of 17.8 for low-Ca pyroxene and 11.5 for olivine. The PMD calculated using the discrete method is ~11% for low-Ca pyroxene and ~13% for olivine (see Fig. 4).

Conclusions: By examining the data collected and analyzed thus far we can tell that Gold Basin (L4) is homogenous in low-Ca pyroxene as well as olivine. The technique we are developing is currently able to reproduce the average composition of the meteorite examined. The spread in composition we are observing using the discrete method is a result of error in the technique.

Future work: While our calibrations still have large uncertainties (see example in Fig. 2), we have had significant improvement from the Cameca standard method. We expect to be able to continue to improve our calibration and decrease the spread we observe in composition. We will test the ability of this technique to distinguish between equilibrated and unequilibrated ferromagnesian silicates by completing the analysis of further meteorites.

References: [1] Van Schmus W. R. and Wood J. A. (1967) *GCA 31*, 747-765. [2] Dodd R. T. et al. (1967) *GCA 31*, 921-951. [3] Freer R. (1981) *Contrib. Mineral. Petrol.76*, 440-454. [4] Tsuchiyama A. et al. (1988) *Proc. NIPR Symp. Ant. Met.1*, 173-184. [5] McCoy T. J. et al. (1991) *GCA 55*, 601-619.

Fig. 4