THE CRYSTAL STRATIGRAPHY OF SHERGOTTY. K. M. O'Sullivan[1] and C. R. Neal[1], [1]Dept. of Civil Eng. & Geological Sciences, Universtiy of Notre Dame, Notre Dame, IN, USA, kosulli4@nd.edu, neal.1@nd.edu.

Introduction: The Shergotty meteorite is an achondrite, and is the type example for shergotite meteorites that form part of the Shergotite, Nakhlite, and Chassignite (SNC) group known to have originated from Mars [e.g. 1]. Shergotty is 165 million years old, and similar in texture and composition to a terrestrial diabase [2]. Shergotty consists of 75% pyroxene, 20% maskelynitized plagioclase, 1% magnetite, 1% whitlockite, 1% silica glass and cristobalite, 1% troilite/pyrrhotite, and 1% illmenite [3]. Pyroxene occurs as euhedral crystals up to 1 cm long that are zoned from pigieonite to augite [4] (Fig. 1 a,b). Shergotty has similar concentrations of siderophile and volatile elements to those of terrestrial basalts, but has lower Fe/Mn ratios [5]. Pyroxene cores and intermediate zones crystallized before plagioclase, as shown by the decrease in Al concentration with regards to increasing Fe/(Fe+Mg) ratios in the rim compositions relative to the interior compositions [4].

a)

b)

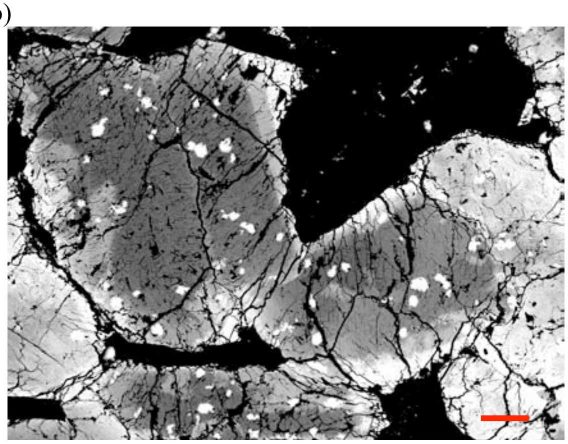

Figure 1. a) Plane polarized light image of Shergotty. b) Electron Microprobe image of zoned pyroxene crystals (gray and white) and maskelynite (black). Bright white spots are holes in the carbon coating. Red bar is 100um.

Methods:

Crystal Size Distributions (CSDs). A CSD is a statistical analysis of the number, size and shape of crystals in a thin section, and when combined with element data, can provide information on the petogenesis of the rock [eg. 6-8]. CSDs are plotted on a log-normal graph, with crystal population on the dependant axis and crystal length on the independent axis. A linear CSD indicates a simple crysatallzation history, and a curved CSD indicates a more complex crystallization history [9]. A concave up CSD indicates accumulation of larger crystals within the magma chamber, and a concave down CSD can be indicative of fractional crystallization [6].

Thin sections were photographed and crystals were traced in *Adobe Photoshop*. Traces were then analyzed using *Image Tool* for roundness and length, processed with *CSDslice* to address for the randomness of a 2D thin section through a 3D rock, and processed with *CSDcorrections* to obtain the CSD plot [12].

Elemental Analysis. Major Elements and X ray images were obtained via JEOL JXA-8200 Electrom Microprobe (EMP) at Washington Univerity. Trace elements will be obtained via Laser Ablation Inductivly Coupled Plasma Mass Spectrometer (LA-ICP-MS).

Results and Discussion:

CSDs. The Shergotty CSD (Fig. 2) is distinctly kinked, indicating two markedly different periods of crystallization, or the extreme loss of smaller crystals (either by eruption or reabsorption accompanied by influx of new magma) at some point in the magmatic history. Each interpretation suggests that Shergotty was crystallizing in an open system.

The CSDs can be used to evaluate residence time of crystals in a magma as the slope is a function of average crystal growth rate (G) and the residence time in the system (τ): CSD Slope = $-1/G\tau$. Several studies (e.g., [7, 8]) have examined the crystal growth rates of a wide range of volcanic systems, and determined that crystal growth rates only vary over an order of magnitude, 10^{-10} to 10^{-11} cm/sec. We calculated residences times for the two gradients represented in the Shergotty CSD (Fig. 2) assuming a crystal growth rate of 10^{-10} cm/sec. For the steeper gradient, representing the smaller crystal sizes (< 11 mm), a residence time of 35.1 years was obtained. For the crystal sizes between

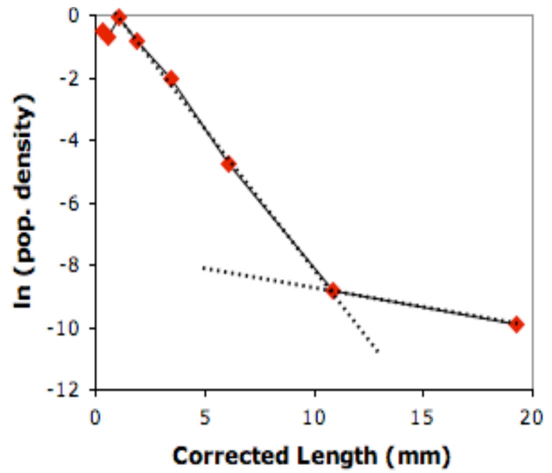

Figure 2. CSD of Shergotty. CSD is kinked, indicating two periods of crystallization. Red squares are data points, dashed lines are the representative slpoes of the two populations.

11 and 19.5 mm, at residence time of 249.7 years was obtained. This demonstrates that the larger crystals will contain more information about how the magma that crystallized Shergotty evolved. Our chemical analyses will investogate this.

Elemental Analysis: Figure 3a shows the major element composistions of five pryroxene crystals from this study. All cores are augite in composisition, and all rims are pigeonite. [13] found augite cores and pigeonite rims to be rare, whereas in this study we found all pyroxenes to have augite cores and pigeonite rims. Figure 3b shows pyroxene composistions in a study by [13] and references therein. Our results indicate the system was evolving to an Fe-rich Ca-poor magma in the later stages of cyrstallization, which is consistant with plagioclase crystallization.

Trace element data and interpretations will be presented at LPSC-40. Trace element data are currently being obtained at the University of Notre Dame using the 213 nm New Wave laser ablation system coupled to the Element 2 high resolution ICP-MS (http://www.nd.edu/~icpmslab). The raw counts will be calibrated using the CaO content determined by EMP as an internal standard and abundance data will be obtained for each spot using the data reduction program *Glitter* developed by Simon Jackson at Macquarie University in Australia (http://www.glitter-gemoc.com/).

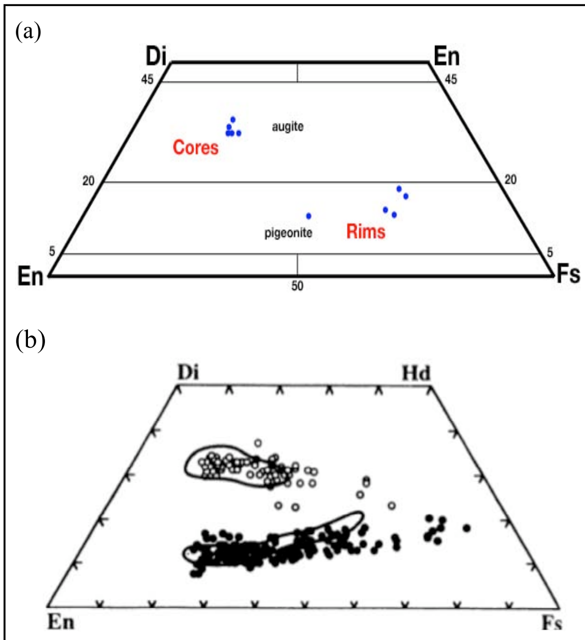

Figure 3. a) Plot of Shergotty cores and rims from 5 pyroxene crystals, b) pyroxene composistions from [13]. Open circles are augtite, closed circles are pigeonite.

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