PREFERRED ORIENTATIONS OF PYROXENE IN THE ZAGAMI SHERGOTTITE: IMPLICATIONS FOR MAGMATIC EMPLACEMENT.

T.E. Becker[1], V.S. Reynolds[1], R.J. Beane[2], T.J. McCoy[3]; [1]Department of Geology, Colby College, 5800 Mayflower Hill, Waterville, ME 04901 (tebecker@colby.edu), [2]Department of Earth & Oceanographic Science, Bowdoin College, 6800 College Station, Brunswick, ME 04011, [3]Meteorites Division, Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, 10th & Constitution NW, Washington, DC 20560.

Introduction: Zagami is a basaltic shergottite rich in pyroxene (pigeonite and augite) and maskelynite glass. It is texturally and chemically heterogeneous, exhibiting three distinct lithologies. The greatest volume of the sample is the normal lithology (NZ), which is the focus of this study. Within normal Zagami, a gradational contact divides the sample into a fine-grained lithology (average grain size of 0.24 mm) and a coarse-grained lithology (0.36 mm) [1]. Previous workers [1, 2, 3] determined that an apparent foliation is recorded by a shape-preferred orientation of elongated pyroxene prisms, with the fine-grained portion recording a strong preferred orientation and the coarse-grained portion recording weak to no preferential alignment. Although [1] concluded that Zagami crystallized as part of a thick (>10m) lava flow, these authors could not rule out crystallization within a shallow intrusive, and noted that the presence or absence of an associated lineation could potentially resolve this ambiguity. Understanding pyroxene textures in 3-dimensions is difficult in meteorite samples due to the small sample sizes, limited sample material, and poorly recorded details of sample orientation during cutting.

The goal of this study is to determine whether planar and/or linear fabrics exist within Zagami to clarify its emplacement as a shallow intrusive or a thick lava flow. We use electron backscatter diffraction (EBSD) techniques to quantify the 3-dimensional crystallographic orientation of the pyroxenes in both the coarse-grained (presented here) and fine-grained (to be presented at the conference) sections of Zagami's normal lithology.

Analytical Methods: Zagami thin section USNM 6545-1 was chosen for this study because it samples both the fine- and coarse-grained lithologies. The benefit of having both lithologies in a single thin section is that their orientation with respect to each other is known, thereby enhancing the textural analysis interpretation. Using EBSD eliminates the need to know the orientation of the thin section with respect to the sample-at-large, making EBSD advantageous for this particular study.

A ~ 50 mm^2 area of the coarse-grained lithology was analyzed using a LEO 1450 VP scanning electron microscope (SEM) at Bowdoin College, which is outfitted with an HKL Nordlys II detector. Preparation involved a colloidal silica polish on an uncoated probe-polished thin section. Diffraction patterns were acquired using Channel 5 software with operating parameters of Hough space resolution of 85, 4x4 binning, 15 micron step size, and 6-7 band edges detection.

Orientation maps were created using Channel 5 software to remove wild spikes and extrapolate points relative to 5 surrounding neighbors (necessary steps to detect grains). To account for the mosaicism prevalent in the shocked pyroxenes, a sample subset of 371 points was created using one point per grain for grains larger than 20,000 μm^2. Grains of smaller area were deemed not to be individual grains, but rather fragments of other grains fractured during shock. Contoured c-axis pole figures were plotted from this data subset.

Results and Discussion: Figure 1 is an equal-area projection of pyroxene c-axes as measured in the coarse-grained lithology of normal Zagami. Higher clustering densities (green to red) define a great circle, which represents variable c-axis orientations within a plane (i.e, a planar fabric). Representative orientations of pyroxene unit cells illustrate how the c-axis varies across the great circle. However, areas of greatest pole densities, known as point maximas (red), are not localized within a single region of the planar fabric. Localization of point maximas would indicate consistent orientations of the c-axes and characterize a lineation. Therefore, pyroxenes in the coarse-grained lithology record a planar foliation without a corresponding lineation.

Results from this study indicate that a planar fabric exists in the coarse-grained lithology, which was previously described as having little to no foliation. We attribute this discrepancy to the difficulties inherent in examining 2-dimensional thin sections to assess a 3-dimensional problem. Although studying thin sections cut perpendicular to each other could alleviate this problem, meteorite samples are rarely cut with this intent, and documentation of the cut orientation is often inadequate.

In addition to identifying a planar fabric, our results indicate that a corresponding lineation does not exist. Therefore, the 3-dimensional textural analysis of pyroxenes in Zagami suggests that a foliation developed in the coarse-grained lithology by a process that did not involve a strong directional flow component.

Additional EBSD data collection is planned for a second area of the coarse-grained lithology and representative areas of the fine-grained lithology. Data will be processed similarly to those presented here. This collective data set will allow evaluation of the most likely emplacement mechanism – lava flow or shallow intrusive – for the fine- and coarse-grained Zagami shergottite.

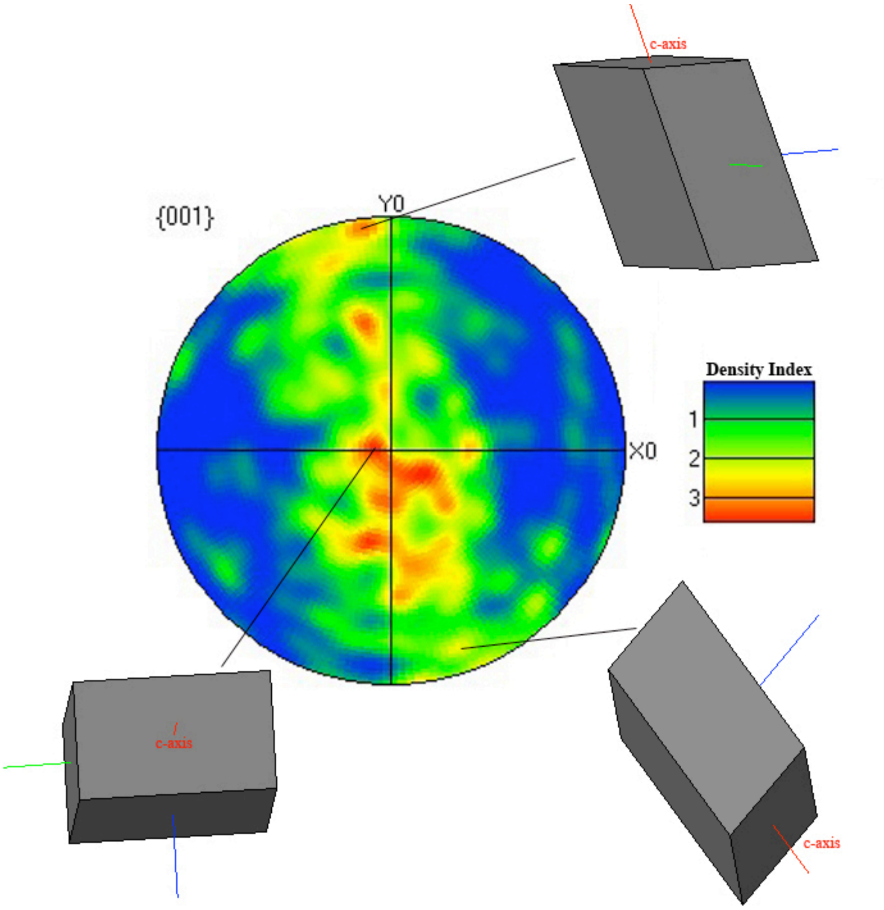

Figure 1. Equal-area, upper hemisphere projection of pyroxene c-axes from the coarse-grained normal Zagami lithology. Representative pyroxene unit cells illustrate the variation in c-axis orientation within the great circle defined by greater pole clustering densities (red).

References: [1] McCoy T. J. et al. (1992) *GCA* 56, 3571-3582. [2] Stolper E. and McSween H. Y. (1979) *GCA* 43, 1457-1498. [3] Treiman A. H. and Sutton S. R. (1992) *GCA* 56, 4059-4070.