Mineralogical Assessment of two Gefion Family Asteroids: 1433 Geramtina and 4182 Mount Locke.

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Introduction: The ordinary chondrites are the most abundant of meteorite falls comprising approximately 80% of the falls [1,2]. From Antarctic meteorite finds, this abundance has been prevalent for the past million years [3]. The ordinary chondrites are subdivided into the H, L, and LL-chondrites with a decrease in metal content from H to LL which reflects the varying redox state at formation. Within the ordinary chondrite falls, about 38% of these are L-chondrites. Due to the percentage of ordinary chondrites of falls, identifying probable parent bodies for these meteorites has been a priority for some time [4]. Identifying parent bodies of meteorites is important in the understanding of the gradients in composition and temperature in the early solar system [4]. Until sample return missions are undertaken to determine unambiguous parent bodies, probable parent bodies for the L-chondrites may be identified. Possible parent bodies have the same mineralogy or are preferentially located to a resonance for delivery to near Earth space; a probable parent body has both characteristics [4].

Fossil L-chondrites have been observed in Swedish Middle Ordovician limestone quarries and also in Middle Ordovician sediments in China and other locations [5-7]. Chromite isotopes of the fossil meteorites match those in the recent falls [5-7]. Shock features and ^{40}Ar-^{39}Ar isochrons from both current and Ordovician L-chondrites indicate a catastrophic breakup of the L-chondrite parent body, the probable formation of an asteroid family, and a short interval from the family forming breakup event to Earth impact [8]. These findings indicate that an influx of L-chondrites above the normal rate was occurring during the Middle Ordovician period which places an age limit on the catastrophic event which formed the asteroid family which may be the source of these meteorites [5-7]. Dynamical families have been investigated and the Gefion family has been selected due to its proximity to a fast acting mean motion resonance, its age as determined by numerical modeling, and the dominant taxonomy of its members [9,10]. Ordinary chondrites fall in the S(IV) subtype of the S taxonomic class [11]. The Gefion family, with the majority of its members of S type (of the members with available taxonomy), is a good source of candidates in the search for the probable parent body of the L-chondrites.

The systematic study of the composition of the Gefion family members has only recently been undertaken. J. Blagen has presented results for the first two Gefion members in the study: 3910 Liszt and 2905 Plaskett [12]. We present the analysis of spectra obtained for 1433 Geramtina and 4182 Mount Locke, two core members of the Gefion dynamical asteroid family. The asteroids of the Gefion family have been proposed as possible parent bodies of the L-chondrites due to both the location to the 5:2 mean motion resonance and that the taxonomy being dominantly S type. However, the background population in Gefion family region suggests that interlopers may be present. Potential interlopers must be excluded before the genetic Gefion family can be tested as the source of the L-chondrites. Spectra for 1433 Geramtina have been analyzed and the surface mineralogy has been determined to be closer in composition to the H-chondrite. Analysis for Mount Locke is currently underway at this time.

Reflectance spectra for this ongoing project are obtained from the NASA IRTF 3 meter telescope on Mauna Kea. Spectra are taken in the low resolution or asteroid mode and in two channels, A and B, and are stored as Flexible Image Transport System (FITS) files.1433 Geramtina was observed on July 20 2011 with good seeing conditions. 4182 Mt Locke was observed on June 4 2012 with poor to moderate seeing conditions. IRAF was used for the initial data reduction in which the background sky was removed as well as read noise and dark current by subtracting one channel from the other and converts the FITS files to a format that SpecPR can read. Wavelength calibration was obtained from the spectra for the argon lamp, peak channel positions are recorded, inputted into Excel and a polynomial is fitted. The final corrected asteroid spectrum is normalized in SpecPR for a given set of intervals (two, one for each band) and band areas/centers are obtained [11]. Band centers are from the best polynomial fit for each band, saved, and band centers recorded. If telluric features are not fully corrected, the corresponding channels for these features are taken from a raw spectrum and then removed from the asteroid spectra for a second set of areas and centers. This is repeated for a set of channels which cover the band intervals. The collection of band

areas and centers provide the errors and the median for the band area ratio (BAR), band 1 and band 2 (B1, B2). These are plotted on a BAR/B1 and B2/B1 charts; the position will indicate which S subtype and where it falls on the Ca pyroxene trend [11]. BAR, B1 and B2 values are also the variables in a set of equations which provide ferrosilite and Wollastonite (Fs, Wo) percentages and also test whether the mineralogy matches a range of permissible values for H, L, or LL-chondrites [13].

Data reduction and analysis has been completed for 1433 Geramtina but is currently in progress for 4182 Mount Locke. The final spectrum for 1433 Geramtina was under-corrected for telluric features and exhibited some noise in the data. 1433 Geramtina BAR/B1 (including error bars) falls within the S(IV) region on the olivine/pyroxene mixing line which is indicative of an ordinary chondrite composition (Figure 1). On the B2/B1 calcium pyroxene mixing line, this asteroid falls within the H-chondrite/HED area (Figure 2). The Fs/Wo percentages do not fall within the permissible ranges for H, L, or LL-chondrites although the olivine percentages are within the range of H/L-chondrites.

At this time, the results for 1433 Geramtina indicate that this asteroid has a composition that falls within the ordinary chondrite range but is inconclusive as to whether or not it is of H, L or other ordinary chondrite composition. Additional observations are needed to provide conclusive results but the analysis does constrain 1433 Geramtina to a general S(IV) ordinary chondritic composition.

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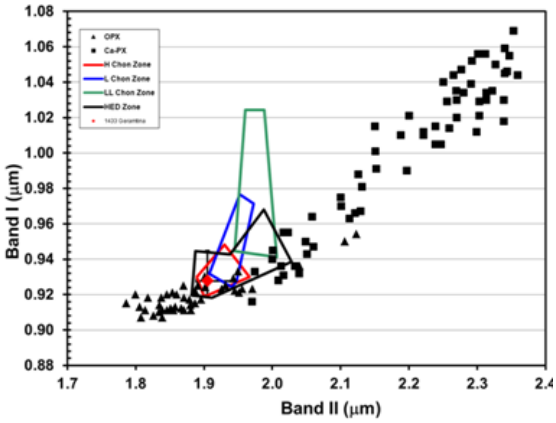

Figure 1 – The red symbol is Band I position versus Band II position for 1433 Geramtina. The red, blue, green, and black polygons are the zones of H, L, LL, and HED meteorites, respectively.

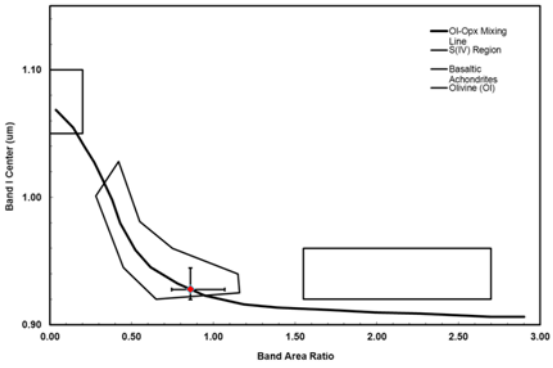

Figure 2 - The red symbol is Band I position versus Band Area Ratio (BAR) for 1433 Geramtina. It falls along the olivine-orthopyroxene mixing line and within the S(IV) subtype.