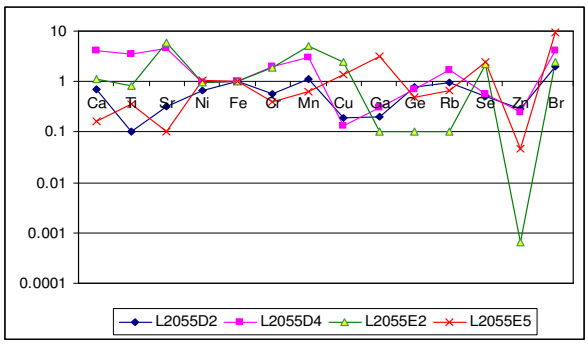
ORGANIC ANALYSES OF PARTICLES FROM THE STRATOSPHERIC COLLECTION COINCIDING WITH THE EARTH'S 2003 PASSAGE THROUGH THE DUST TRAIL OF COMET 20P/GRIGG-SKJELLERUP. G. J. Flynn, and S. Wirick, Dept. of Physics, SUNY Plattsburgh, 101 Broad St., Plattsburgh, NY 12901 (George.flynn@plattsburgh.edu).

Introduction: In 2003 NASA collected particles from the Earth's stratosphere in the time period coinciding with the Earth's predicted crossing of the dust steam from a recent outburst on comet 20P/Grigg-Skjellerup [1]. Most interplanetary dust particles (IDPs), because they spend tens-of-thousands of years in space as small particles, show evidence of solar wind and solar flare exposure. Because these particles are from a recent outburst, they were expected to show minimal evidence of space exposure as small particles (i.e., low solar wind noble gas abundances and no solar flare tracks). Noble gas analyses showed minimal solar wind in several particles [2] and Nakamura-Messenger et al. [3] identified a new mineral, Brownleite, in a particle from this collection that showed no solar flare tracks. Thus, this collection appears to be dominated by particles from the targeted comet, Grigg-Skjellerup.

Flynn et al. [4] have previously reported X-Ray Microprobe (XRM) chemical analyses and X-Ray Diffraction (XRD) mineralogical analyses of seven particles from the L2055 collector, flown during the Earth's passage through the Grigg-Skellerup dust stream. Unlike most IDPs, whose major element chemistry was determined by SEM-EDX prior to allocation by the Cosmic Dust Curatorial Facility at the NASA Johnson Space Center, these L2055 particles were selected and allocated simply based on their morphology and color, not compositional information.

Only four of the seven particles exhibited CI-like element abundances in the XRM examination (Figure 1). Several of these L2055 particles had extremely low fluorescence count rates, an order-of-magnitude or more lower than typical chondritic particles of their size. This indicates that either these particles have an extremely low density or they are composed mostly of non-detectable elements (lighter than S), possibly organic matter. We have now performed infrared spectroscopic analyses on several of the same particles.

Figure 1: Element abundances in the four chondritic particles from the L2055 collector.



Samples and Techniques: The particles were mounted on ~7 μm thick Kapton films for XRM and XRD analyses. Kapton has no features in the aliphatic C-H stretching region, where other IDPs exhibit major absorptions [5], so our initial infrared spectroscopy was performed with the particles mounted on Kapton.

We determine the types and abundances of organic matter using a microscope-based Fourier Transform InfraRed (FTIR) spectrometer on infrared beamline U2B at the National Synchrotron Light Source (NSLS). The high infrared flux from the synchrotron provides high sensitivity and spatial resolution (~5 μm) required for characterization of organic matter in IDPs [5].

Absorption from the C-H stretching vibrations near 3.4 μm are easily detected because this region of the spectrum is generally free from interference by absorptions from other common species. This ~3.4 μm absorption band consists of four distinct absorption features characteristic of aliphatic hydrocarbons. Two absorption features, near 2955 cm^{-1} and 2870 cm^{-1}, are characteristic aliphatic $C-H_3$ absorption, and two features, near 2925 cm^{-1} and 2850 cm^{-1}, are characteristic aliphatic $C-H_2$ absorption. For simple aliphatic molecules, consisting of $C-H_2$ chains terminated by $C-H_3$, the $C-H_2$ to $C-H_3$ ratio is indicative of the chain length.

We have, thus far, obtained infrared spectra (from 4000 to 650 cm^{-1}) on four of the L2055 particles. Three, L2055D1, L2055D4 and L2055D5, were collected as individual particles, while the fourth, L2055E4, is a fragment of Cluster #4 on the collector.

Results: L2055D1 is an opaque particle that exhibited a low fluorescence count rate and a Cr/Fe ratio of ~18.8 [4]. The C-H stretching region of the spectrum of L2055D1 is dominated by silicone oil, in which the particles were collected. This spectrum, shown in red in Figure 2, serves as a reference for silicone oil contamination, having a large aliphatic $C-H_3$ absorption feature near 2950 cm^{-1}, but minimal $C-H_2$, which would show a strong absorption feature near 2925 cm^{-1}.

The other three L2055 particles we examined have spectra distinctly different from the spectrum of silicone oil. The C-H stretching region for each of these particles, L2055D4, L2055D5, and L2055E4, is dominated by a strong $C-H_2$ absorption feature near 2930 cm^{-1} (see Figure 2), indicating that they contain indige-

nous organic matter. In addition, the C-H_3 absorption feature is shifted relative to this feature in silicone oil.

L2055D4 gave a low count rate in the XRM analysis, but its fluorescence spectrum, particularly the Ni/Fe ratio, was consistent with a chondritic composition (see Figure 1). The XRD pattern indicated that L2055D4 is dominated by pyroxene. Our infrared analysis confirmed the identification of pyroxene as the dominant silicate in L2055D4, and showed the aliphatic C-H_2 and C-H_3 absorption features as well (Figure 2). As with other anhydrous IDPs we have examined in prior work [5], the C-H_2 absorption is significantly stronger than the C-H_3 absorption in L2055D4.

The XRM fluorescence spectrum of L2055D5 is dominated by Cr and Ti, not Fe, suggesting this particle is dominated by a non-silicate mineral. Nonetheless, the organic matter associated with this particle has an infrared spectrum that, in the C-H stretching region, is dominated by C-H_2 and is quite similar to the spectrum of L2055D4 (Figure 2).

L2055E4, is a fragment from a cluster particle on the Grigg-Skjellerup collector. Because of the low spatial density of particles on the stratospheric collectors, it is very likely that this particle is associated with the other fragments of the cluster. L2055E4 exhibited a low fluorescence count rate, suggesting it is composed mostly of non-detectable elements (lighter than S) [4]. L2055E4 has strong C-H_2 absorption features (see Figure 2), consistent with a high organic content, but each of the C-H_2 absorption features are shifted to higher wavenumber than in L2055D4 and L2055D5, indicating that the aliphatic chain is bonded differently in L2055E4 than in the other two L2055 particles.

Conclusions: The unambiguously chondritic abundance pattern for elements with Z $\geq$ Ca in L2055D4 demonstrates that this particle is extraterrestrial. This particle has a high content of elements with Z < S, and the strong C-H absorption features demonstrate that organic carbon is a major component of this particle.

Three of the four particles examined thus far from the L2055 collector exhibit large aliphatic C-H stretching features distinctly different from the silicone oil in which these particles were collected. A high abundance of aliphatic hydrocarbon relative to the strength of the silicate absorption distinguishes these three particles from the Grigg-Skjellerup timed collection from the anhydrous and hydrous ~10 μm IDPs previously studied by infrared spectroscopy.

Particles with a high abundance of organic carbon are common on the L2055 collector, targeted to collect dust from comet Gregg-Skjellerup. "Low-Z" particles are found on other Cosmic Dust collectors, but they have generally not been well-characterized in the past.

The C-H stretching spectra of L2055D4, and L2055D5 are quite similar to one another, while the absorption feratures in the cluster fragment, L2055E4, are shifted significantly in energy from the other two, indicating different bonding sites for the C-H_2.

Prior work showed particles from the L2055 collector exhibit a diversity of mineralogies and elemental compositions [4]. These measurements indicate the L2055 particles contain abundant organic matter with variability in the C-H_2 and C-H_3 bonding environments. If these L2055 particles are from the targeted comet, then Grigg-Skjellerup contains abundant organic matter showing diversity at the micro-scale.

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Figure 2: Infrared spectra in the C-H stretching region for L2055D1 (red), L2055D4 (green), L2055D5 (pink), and L2055E4 (blue). The L2055D1 spectrum is dominated by silicone oil, with a large aliphatic C-H_3 absorption, while the other three spectra are dominated by aliphatic C-H_2 absorption features.