A summer of stardust: Micrometeorites and where to find them

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Introduction

Micrometeorites offer a look into our solar system’s past, Earth’s past, our past. They can tell us all about the space we live in before we were even part of it. These particles are coming to rest all over Earth’s surface. Their presence offers a scientific opportunity for anyone with a few rudimentary tools and the will to look. They also provide a unique opportunity to involve the public in primary scientific research. I collected debris from Mitchell Center and Granville Middle School to find potential micrometeorites. The results suggest that there were more micrometeorites found on Mitchell Center rooftop.

Methods

I used a modified version of Jon Larsen’s method in his book On the Trail of Stardust (Larsen, 2019).

Because they are often undisturbed by humans, rooftops are prime candidates for collection (Larsen, 2019). Samples were collected from the roof of Mitchell Center at Denison University and the roof of Granville Middle School in Granville, Ohio. Accumulated sediment was gathered with brushes and a vacuum from 2 rooftops in the area.

- Sample was cleaned, divided into magnetic and nonmagnetic material sifted down into the optimal grain of most micrometeorites (200 µm-400 µm) (Larsen, 2019).
- Aerodynamic particles were then identified using an optical microscope and isolated to 125 candidates.
- Samples were imaged using a JEOL JSM-IT500HR scanning electron microscope (SEM) at Denison University using secondary electron (SE) imaging and backscattered electron imaging (BSE).
- The SEM at Denison University was used primarily to observe and image surface features while the BSE was used to observe and image differences in composition.

Results

Out of 125 candidates, 4-10 barred and porphyritic olivine micrometeorites were found alongside many industrial and terrestrial spherules. Many more grade A-C micrometeorites were found at Mitchell Center versus Granville Middle School based on our rubric. This may be due to a larger sample size or the fact that Mitchell is much bigger. Using observations and data from the SEM imaging, we developed a rubric for identifying micrometeorites. This can be used by both professional and citizen scientists. Prior to this, no such rubric existed.

Discussion

This project was funded by the Arthur Vining Davis Foundations Grant and Provost Summer Scholar Funding. Quintin Cheek helped teach us to operate the SEM and we appreciate that greatly.


Acknowledgements and Literature Cited

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<table>
<thead>
<tr>
<th>Grade</th>
<th>Micrometeorite</th>
<th>Morphology</th>
<th>Composition</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Highly Likely</td>
<td>The object contains a metallic core surrounded by a glassy or crystalline surface with two or more of the following surface features: olivine crystals, recognizable striations, “surfaced” pattern on surface, rounded crystals, smooth, glossy finish, concentric patterns on surface.</td>
<td>The composition reflects the chondritic spectrum (high in O, Mg, Si) with trace elements of Al, Cr, Fe. Some is Ni or Fe surrounded by a Si rich outer layer.</td>
<td>The object has an aerodynamic form - sphere or spheroid, can be elongated. Some include round metal beads on the surface. Round objects with evenly distributed bumps.</td>
</tr>
<tr>
<td>B</td>
<td>Micrometeorite</td>
<td>The object has one or more of said surface features and a metallic core.</td>
<td>The composition has many of the elements in the chondritic spectrum, missing a few.</td>
<td>The object has an aerodynamic form but is not a perfect sphere or spheroid.</td>
</tr>
<tr>
<td>C</td>
<td>Likely</td>
<td>The object has one of said surface features but no visible or recognizable metallic core.</td>
<td>The composition reflects some of the elements in the chondritic spectrum.</td>
<td>The object appears aerodynamic under lower magnification but under higher magnification the object is less so.</td>
</tr>
<tr>
<td>D</td>
<td>Possible</td>
<td>The object has surface features akin to said recognizable surface features but not exactly.</td>
<td>The object does not reflect the chondritic spectrum.</td>
<td>The object is not aerodynamic.</td>
</tr>
<tr>
<td>E</td>
<td>Unlikely</td>
<td>The object has surface features more akin to terrestrial particles -buckling, surface -cracking, fracture -bulling on surface -entirely metallic particles with many flat faces -plashing or twinning.</td>
<td>The object does not reflect the chondritic spectrum.</td>
<td>The object is not aerodynamic.</td>
</tr>
</tbody>
</table>

Figures 1+2. Sample collection and SEM imaging

Figures 3-9. Grade A-E, found on Mitchell Center rooftop.