A summer of stardust: Micrometeorites and where to find them

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Introduction

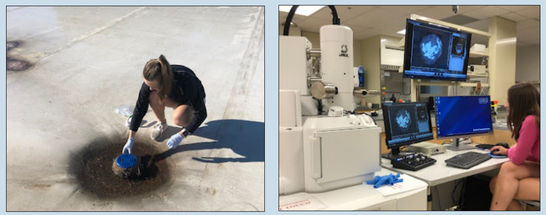
Micrometeorites offer a look into our solar system's past, Earth's past, our past. They can tell us all about the space we live in before we were even part of it. These particles are coming to rest all over Earth's surface. Their presence offers a scientific opportunity for anyone with a few rudimentary 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.



Figures 1+2. Sample collection and SEM imaging

Results

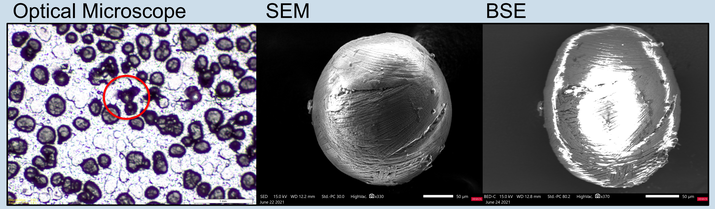


Figure 3. Grade A, found on on Mitchell Center Rooftop, Barred Olivine

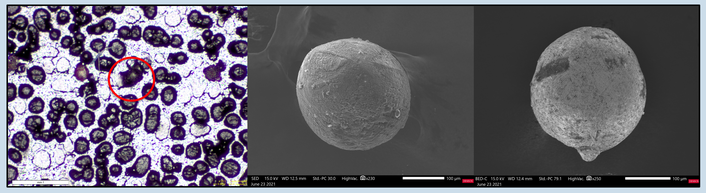


Figure 4. Grade A, found on Mitchell Center Rooftop, Barred Olivine

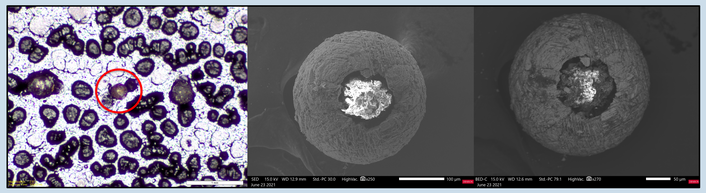


Figure 5. Grade A, found on Mitchell Center Rooftop, Porphyritic Olivine

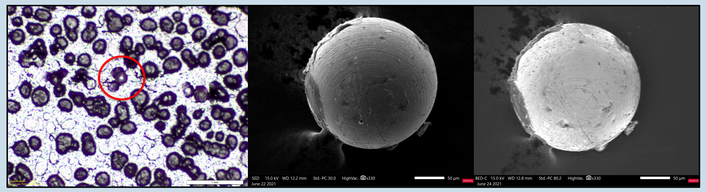


Figure 6. Grade B, found on Mitchell Center Rooftop

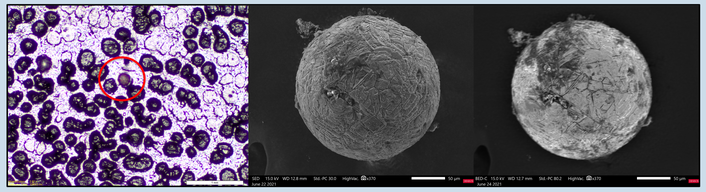


Figure 7. Grade C, found on Mitchell Center Rooftop

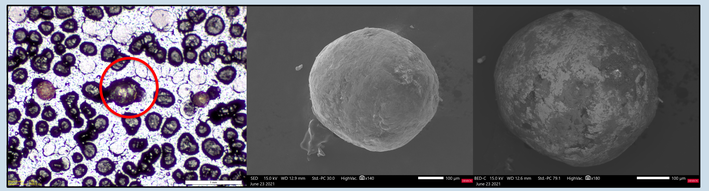


Figure 8. Grade D, found on Granville Middle School Rooftop

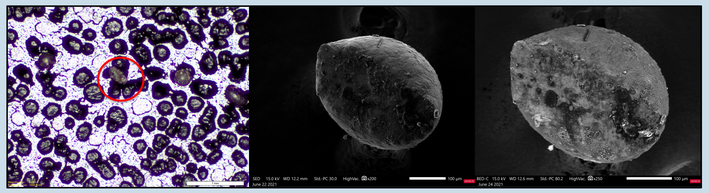


Figure 9. Grade E, found on Mitchell Center Rooftop

Discussion

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 a for identifying micrometeorites. This can be used by both professional and citizen scientists. Prior to this, no such rubric existed.

Acknowledgements and Literature Cited

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Larsen, J. (2019). *On the trail of Stardust.* Voyageur Press

	Grade A: Micrometeorite Highly Likely	Grade B: Micrometeorite Likely	Grade C: Micrometeorite Possible	Grade D: Micrometeorite Unlikely	Grade E: Micrometeorite Highly Unlikely
Morphology	The object contains a metallic core surrounded by a glassy or crystalline surface with two or more of the following surface features: -olivine crystals -recognisable strations -"turtleback" pattern on surface -rounded crystals -smooth, glassy finish -concentric patterns on surface	The object has one of said recognisable surface features and a metallic core.	The object has one or more of said surface features but no visible or recognisable metallic core.	The object has surface features akin to said recognisable surface features but not exactly.	The object has surface features more commonly found in terrestrial particles: -cracking texture -bubbling on surface -entirely metallic particles with many flat faces -splashing or twinning
Composition	The composition reflects the chondritic spectrum(high in O, Mg, Si with trace elements of Al, Ca, Fe). -core is Ni or Fe surrounded by a Si rich outer layer	The composition has many of the elements in the chondritic spectrum, missing a few.	The composition reflects some of the elements in the chondritic spectrum.	The composition reflects very few of the elements in the chondritic spectrum.	The object does not reflect the chondritic spectrum.
Form	The object has an aerodynamic form: -Sphere or spheroid, can be elongated -some include round metal bead on the surface -round objects with evenly distributed humps	The object has an aerodynamic form but is not a perfect sphere or spheroid.	The object appears to have once had an aerodynamic form but there is a chip or hole in the object.	The object appears aerodynamic under lower magnification but under higher magnification the object is less so.`	The object is not aerodynamic.

Figure 10. Rubric developed for grading meteorites. The rubric grades candidates A-E, A being the highest likelihood of a micrometeorite and E being the least likelihood of a micrometeorite.