GEOCHEMISTRY OF GLASSY COSMIC SPHERULES AND MICROTEKTITES FROM THE TRANSANTARCTIC MOUNTAINS, ANTARCTICA. L. E. Angotti[1] and R. P. Harvey[2], [1]Case Western Reserve University (lea33@case.edu), [2]Case Western Reserve University (rph@case.edu)

Introduction: Microtektites are small (generally less than 1 mm in diameter) siliceous glass spherules produced by the melting and vaporization of Earth's crust during an impact [1, 2]. The Australasian microtektites are the most puzzling [3] and intensely studied. The location of the source crater is still unknown even though the strewn field is the youngest (790,000 years old) and most extensive (covering more than 10% of Earth's surface [4]). Recent work has identified Australasian microtektites within Antarctic sediments, dramatically extending the Australasian strewn field, and also has identified new compositional types of microtektites [5, 6]. This research both helps clarify the energy requirements required for Australasian tektite/microtektite formation and expands the utility of Antarctic sediments as reservoirs of ejecta from large terrestrial impacts.

We are currently examining sediment collected from a variety of sites along the Transantarctic Mountains with the goal of independently replicating findings of Antarctic microtektites and further extending the number of sites where microtektites have been found. We are analyzing the full range of glassy spherules found within these sediments to allow a comparison between identifiable microtektites and glassy spherules of other origins (primarily extraterrestrial).

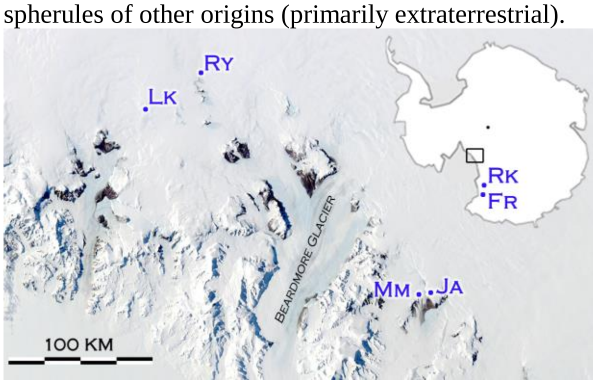

Figure 1. Sites of Antarctic sediment that is explored in this article and discussed in the literature: Meteorite Moraine (MM), Jacobs Nunatak (Ja), Mt. Raymond (Ry), Larkman Nunatak (Lk), Reckling Moraine (Rk), and Frontier Mountain (Fr).

Methods: The sediment samples were recovered from areas along the Transantarctic Mountains by various ANSMET field teams. Sediments from four areas are currently under study including MM, Rk, Ry and Ja (Figure 1). These sediments are aeolian in nature and behind minor barriers (such as boulders within moraines or on mountaintops) with limited exposure of terrestrial outcrops upwind.

In the laboratory the sediment was washed and sieved into 63, 125, 250, 500, 2000, and 4000 µm separates and then sorted under a stereomicroscope. Spherical particles were hand-picked and categorized by luster and color: metallic, rocky, glassy (black, brown, yellow, clear, green, and white). Representative spherules are shown in Figure 2. The particles were sorted and stored in pure ethanol to limit hydration reactions in the lab

Spherules of interest were documented photographically, embedded in epoxy, sectioned, polished, and palladium coated as done in similar studies. Backscattered electron (BSE) images documented texture and energy dispersive x-ray spectroscopy (EDS) elemental mapping provided major element chemistry.

Table 1. Counts to date of spherules (and other ablation shapes) larger than 125 µm in each sediment sample.

	MM	Rk	Ry	Ja
Mass sorted (g)	640.1	498.3	381.5	452.8
1. Metallic	101	0	342	71
2. Rocky	706	9	1034	480
3a. Black glassy	76	1	502	29
3b. Brown glassy	73	1	419	66
3c. Yellow glassy	14	0	476	18
3d. Clear glassy	26	0	57	12
3e. Green glassy	10	0	99	8
3f. White/ anomalous	13	7	60	7

Results: Table 1 describes the relative abundance of spherules of different classes for the sediments in this study. The particles chosen for analysis were smooth, glassy, and visually similar to particles identified in previous studies as microtektites [4-9]. Most particles have a smooth and featureless surface but some show weathering pits and textured surfaces. The SEM BSE images have constant contrast suggesting their chemical compositions are homogenous.

The composition of the 46 spherules was explored through a variety of Ternary and Harker diagrams to establish their relationship to particles from prior studies. Key examples are shown in Figure 2. The chemical composition of each spherule was used to categorize it as a normal cosmic spherule, a CAT cosmic spherule, a high Ca-Al spherule, or a microtektite as described in prior studies [6-14]. Australasian microtektites exhibit a wide range in composition but generally have high silica (SiO_2 ~ 69 wt%), high aluminum (Al_2O_3 ~ 15 wt%), and low iron (FeO ~ 5 wt%) The K_2O/Na_2O is also always greater than one [6].

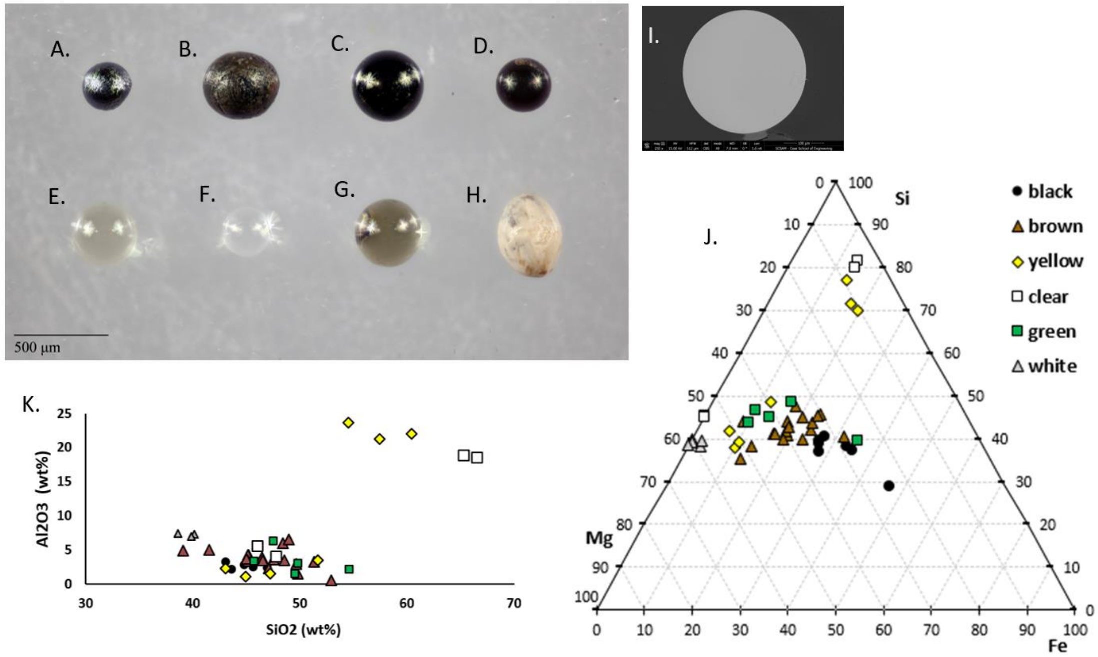

Figure 2. (A-H) Photograph taken using extreme macrophotography at the Cleveland Museum of Natural history of representative spherules in the 250 – 500 µm size range (A) metallic, (B) rocky, (C) glassy black, (D) glassy brown, (E) glassy yellow, (F) glassy clear, (G) glassy green and (H) white. (I) A representative SEM BSE image of a glassy spherule. Glassy spherules plotted on (I) Si, Mg, Fe ternary diagram and (K) SiO_2 vs. Al_2O_3 Harker diagram.

Five spherules have K_2O/Na_2O >1 thus suggesting they may be microtektites. Their visual appearance is also consistent with microtektite descriptions. All five of the white spherules and two clear spherules are compositionally similar to CAT-like spherules. Three spherules are compositionally similar to high Ca-Al spherules.

Discussion: Three yellow and two clear spherules have major elemental compositions consistent with microtektites as identified in the literature. Therefore the number of find sites of microtektites can be expanded to include Mt. Raymond and Meteorite Moraine. The sediment from Jacobs Nunatak does include glassy spherules that appear similar to microtektites but their geochemistry suggests an extraterrestrial origin. Within the microtektite groups clear and yellow glassy spherules appear to form distinct groups, the former with higher silica, higher alkali and lower Al_2O_3 contents than the latter. It is unclear at this point if there is a true compositional gap between groups. The remaining 41 spherules are compositionally consistent with cosmic spherules [10, 11, 15] and thus have an extraterrestrial origin. The color does follow a continuous trend within the cosmic spherule group, as it seems to grade from white to black depending on the amount of iron.

Conclusion: Spherules that are both visually and compositionally consistent with Australasian microtektites have been found in multiple new sediments from the Transantarctic mountains confirming the dramatic southward extension of the Australasian microtektite strewnfield suggested by others [5,6]. Spherules that are visually identical to microtektites but have fully chondritic major element compositions have also been seen. Additional discrete microtektite components have not yet been identified in our samples. The evident utility of Antarctic aeolian sediments as reservoirs of both extraterrestrial and impact-displaced terrestrial materials promises significant new insights as new data is collected.

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