Microtektites from the northern Victoria Land Transantarctic Mountains: Evidence for a new strewn field generated by a catastrophic impact on Earth

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Summary Tektites are natural silicate glasses produced by the melting associated with hypervelocity impacts of extraterrestrial bodies on Earth. They are found only in certain areas of the Earth known as strewn fields, the material being mostly projected melt from target rocks at the site of impact. Microtektites are distal ejecta which are found up to several thousands km from their source crater. Microtektite strewn fields documented in literature include the North American (35 Ma), Ivory Coast (1.1 Ma) and Australasian (0.8 Ma). We report here on the discovery of microtektites from several summit plateaus (~2700 m) of the Transantarctic Mountains in northern Victoria Land. They have a Late Miocene $^{40}Ar/^{39}Ar$ age and identify a new microtektite strewn field associated with an impact crater yet to be located. This finding has important implications for both the collisional history of our planet and for the denudation history of the Antarctic bedrock.

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Introduction

This is the first report of microtektites from Antarctica. Microtektites were discovered on top of Frontier Mountain (~2800 m a.s.l., ~600 m above ice level; 72° 59' S – 160° 20' E) during the Italian 2003 *Programma Nazionale delle Ricerche in Antartide* (PNRA) expedition. They were found in the micrometeorite traps described by Gattacceca et al. (2005) and Folco et al. (2006). These are joints and decimetric-sized pot-hole cavities of flat, glacially eroded granitoid

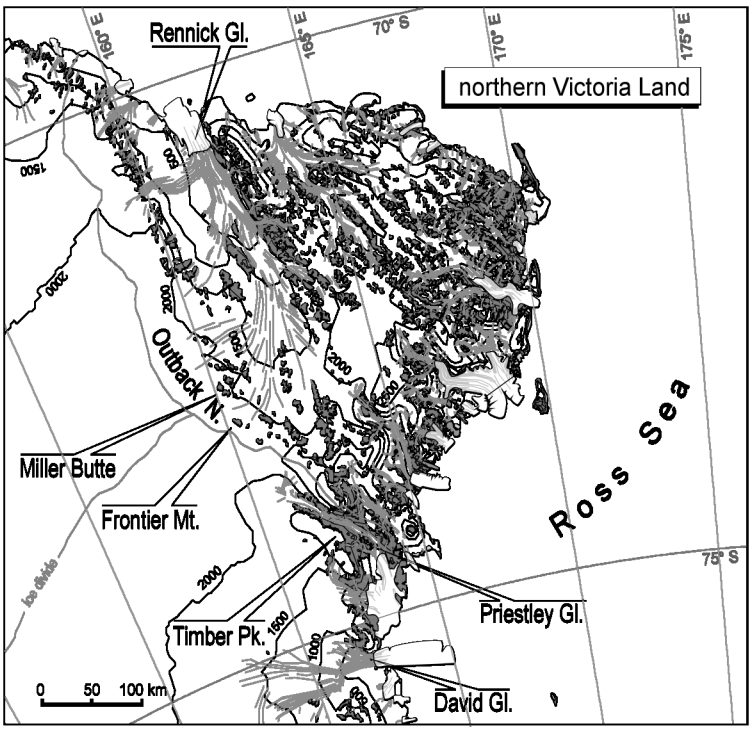

Figure 1. Sketch map of northern Victoria Land showing the location of Frontier Mountain, Miller Butte and Timber Peak where microtektites were found.

surfaces filled in with fine-grained bedrock detritus. During the 2006 PNRA expedition, microtektites were also found in two other glacially eroded granitic summits of the Transantarctic Mountains in northern Victoria Land: Miller Butte (~2600 m a.s.l., ~400 m above ice level; 72° 42' S – 160° 15' E) and an unnamed nunatak in the Timber Peak area (~2600 m a.s.l., ~10 m above ice level; 74° 11' S – 162° 15' E), ~30 km and ~100 km due north and south of Frontier Mountain, respectively.

Description

A total of ~130 microtekites have been so far separated from the host detritus (along with thousands of micrometeorites) in the 400-800 µm size fraction under the stereomicroscope. Their concentration is in the order of 1 particle per 100 g of detritus. Preliminary observations revealed microtektites also in the 200-400 µm size fraction. Microtektites are pale-yellow, transparent, glass spheres. Rare exceptions have oblate to button shapes. Rare particles contain one or two microbubbles. The external surfaces is typically smooth and clean, although some particles are partially covered by Fe,K- and Ca sulphate deposits. Eleven particles analysed by syncrotron X-ray diffraction at the BM8 GILDA beamline (ESRF Grenoble) resulted completely amorphous.

Figure 2. The glacially eroded bedrock surfaces in the Timber Peak area (top). A detail of a micrometeorite trap in which microtektites were found (bottom left). A microtektite within the host detritus (600-800 µm size fraction) as seen under the steromicroscope (bottom right).

Bulk composition

EMP major element composition of 37 particles defines a single coherent population of microtektites. The silica content varies from 64.4 to 77.7 wt%. All major element oxides, except K_2O, show negative correlation with SiO_2. The total alkalies (Na_2O+K_2O) are very low (0.90 – 1.85 wt%) and the K_2O/Na_2O is always >1 (2.7 – 4.4). The trace element composition of 6 particles by LA-ICP-MS appears to be homogeneous and most elements match the average Upper Continental Crust (UCC) composition defined by Taylor and McLennan (1995). Major deviations from the UCC composition include a strong to moderate depletion of Pb, Na, K, U, Rb, V, Co, Sr and Cs which are likely due to high-temperature volatilization during the microtektite-forming process.

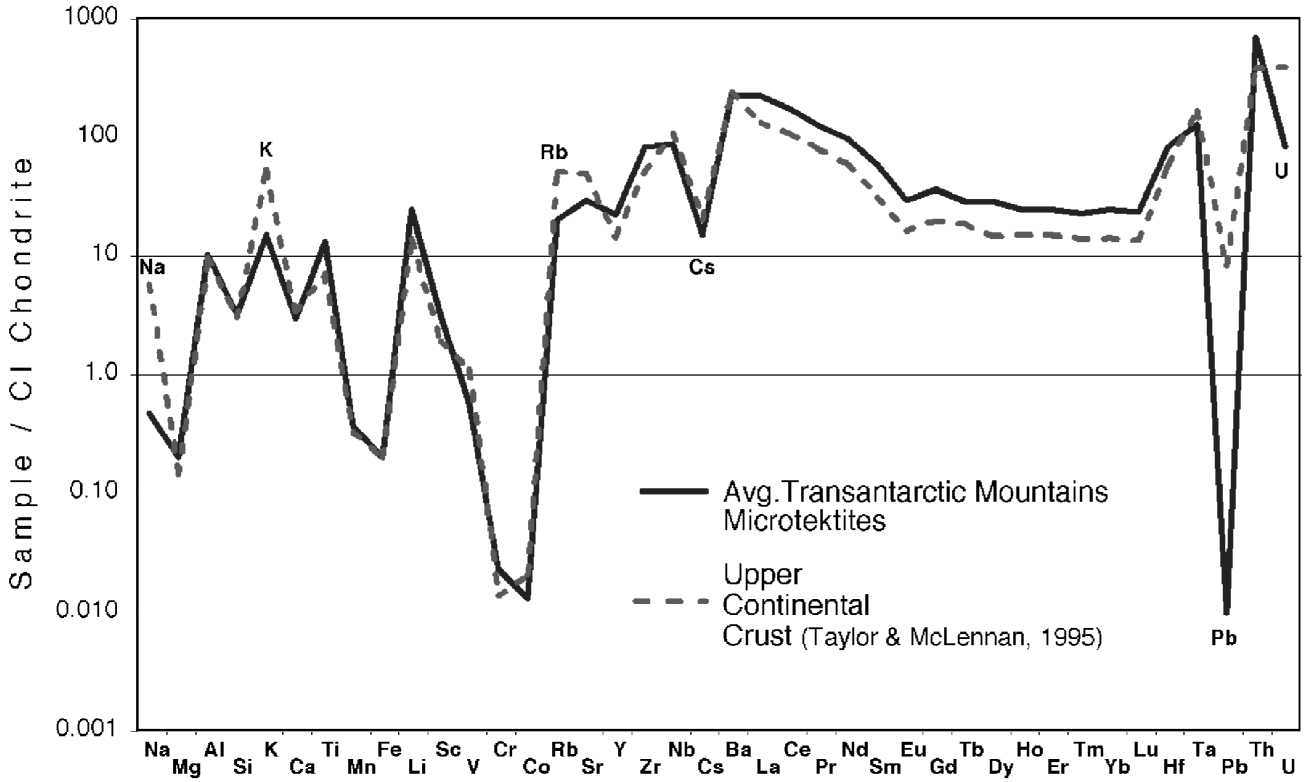

Figure 3. Chondrite normalized spiderdiagramme for Transantarctic Mountains microtektites and average Upper Continental Crust defined by Taylor and McLennan (1995).

$^{40}Ar/^{39}Ar$ dating

Preliminary laser fusion ^{40}Ar-^{39}Ar analyses from the largest particles define a peak in the age distribution of 8.8 ± 0.4 Ma (weighed mean age, 6 particles). This age is distinct from those of the other known microtektite strewn fields, i.e., the North American (35 Ma), Ivory Coast (1.1 Ma) and Australasian (0.8 Ma) strewn fields (e.g., Glass et al., 2004; Montanari and Koeberl, 2002).

Conclusions

Microtektites from the Transantartic Mountains in northern Victoria Land identify a new microtektite strewn field associated with a catastrophic impact on Earth's continental crust in Late Miocene. The impact crater is yet to be located, but future studies of size distribution (and concentration; i.e., following Glass and Pizzuto, 1994) along the ~3500 km long Transantarctic Mountain range may help to predict the source crater location. Note, in fact, that this is the first occurrence of continental microtektites, attesting to the unique storage conditions for such glassy distal ejecta on the Antarctic continent. In addition, the age of microtektites constrains the minimum age of the collection surfaces, with important implications on the Antarctic bedrock denudation history and the age of the micrometeorite traps in which they were found.

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