MICROTEKTITES FROM THE NORTHERN VICTORIA LAND TRANSANTARCTIC MOUNTAINS: AN UPDATE. L. Folco[1], P. Rochette[2], N. Perchiazzi[3], M. D'Orazio[3], M. A. Laurenzi[4] and M. Tiepolo[5], [1]Museo Nazionale dell'Antartide, Via Laterina 8, 53100 Siena, Italy (folco@unisi.it), [2]CEREGE, Université d'Aix-Marseille III, France, [3]DST, Università di Pisa, Italy, [4]IGG-CNR, Pisa, Italy, [5]IGG-CNR, Pavia, Italy.

Introduction: We present an update on the ongoing study of microtektites from the northern Victoria Land Transantartcic Mountains. A more detailed version of the reported results is currently in press [1]. Major changes relative to our preliminary report [2] include enlargment of the strewn field and correction of the formation age based on new Ar-Ar geochronological data.

Samples and find locations: During the 2003 Italian *Programma Nazionale delle Ricerche in Antartide* (PNRA) expedition we discovered eight microtektites ~500 µm in size on top of Frontier Mountain (72° 59' S – 160° 20' E; ~2800 m above see level [a.s.l.], ~600 m above ice level). They were found within the fine-grained bedrock detritus accumulated in joints and decimeter-sized weathering pits of flat, glacially eroded granitoid (Granite Harbour Igneous Complex) surfaces. These structures are extraordinary traps for fallout material, as testified by the thousands of micrometeorites (microscopic extraterrestrial particles) found therein [3].

During the 2006 PNRA expedition, we also found microtektites in similar traps on two other glacially eroded granitic summit plateaus of the TAM in northern Victoria Land: Miller Butte (72° 42' S – 160° 15' E; ~2600 m a.s.l., ~400 m above average ice level) and an unnamed nunatak in the Timber Peak area (74° 11' S – 162° 15' E; ~2600 m a.s.l., ~300 m above average ice level), ~30 km and ~140 km due north and south of Frontier Mountain, respectively. One additional finding can be reported for a sample collected within the fractures of the sandstone (Beacon Supergroup) top of Mistake Peak (77° 26' S - 160° 11' E; ~2500 m a.s.l., ~100 m above average ice level), ~520 km due south of Miller Butte in the Dry Valleys area in central Victoria Land.

So far, a total of ~150 microtektites have been separated from the host detritus in the 400–800 µm size fraction under the stereomicroscope. Their concentration is of the order of 1 particle per 100 g of granitic detritus and per 20 micrometeorites. Preliminary observations revealed microtektites also in the 200–400 µm size fraction

Bulk chemistry: Transantarctic Mountain microtektites (TAMM) are transparent glass spheres with a characteristic pale-yellow color, which is unique to some "normal-type" Australasian microtektites (Glass et al., 2004). Rare exceptions have oblate to lenticular shapes. Some particles may contain microbubbles up to 20 µm in diameter. Their external surface is typically smooth and clean, although some particles may be partially covered by thin jarosite and gypsum encrustations. They are typically devoid of evidence for mechanical chipping, such as impact craters and grooves on their external surfaces, suggesting deposition in situ with negligible subsequent transport.

Eleven particles were analyzed by synchrotron X-ray diffraction at the BM8 GILDA beamline of the European Synchrotron Radiation Facility, Grenoble. All these particles were found to be completely amorphous, as evidenced by their X-ray patterns.

The major element composition of 39 sectioned spherules from the four find sites, obtained by EMPA, is somewhat variable. Most major element oxides show negative correlation with silica which ranges from 64.4 to 77.7 wt.%; exceptions are K_2O, which increases with SiO_2, and Na_2O, which is essentially constant. The total alkali (Na_2O+K_2O) abundances are very low (0.90 – 1.85 wt%) relative to those of volcanic glasses of similar silica content, and the K_2O/Na_2O ratio is always >1 (2.7 – 4.4). These compositional features are characteristically observed in tektites [4].

Overall, major element data define a coherent population of microtektites. With respect to those from the North American, Ivory Coast and Australasian strewn fields [5, 6], the TAMM fall close to the higher and lower compositional extremes for the refractory elements Ti, Al, and Ca, and for the most volatile elements Na and K, respectively, and show a geochemical affinity to Australasian microtektites. The same observations can be made on the basis of the trace element composition obtained by LA-ICP-MS on six spherules.

As characteristically observed in tektites [4], most elements match the average Upper Continental Crust composition [7]. Major deviations from Upper Continental Crust composition include a strong to moderate depletion in Pb, Na, K, U, Rb, Sr and Cs and an enrichment in rare earth elements (REE), Sc, Zr, Hf and Th. Such deviations are likely due to the high-temperature melting and vaporization of crustal target rocks at the time of the impact [4].

^{40}Ar-^{39}Ar analyses: ^{40}Ar-^{39}Ar total fusion analyses of 25 individual spherules (400–600 µm in diameter) from three different sample sites (Frontier Mountain, Miller Butte and Timber Peak) yielded consistent data indicating that the studied spherules belong to a single population and contain excess radiogenic ^{40}Ar. The isochron gives an age of 1.4 ± 1.5 Ma with a trapped initial $^{40}Ar/^{36}Ar$ = 409 ± 28. Subsequent multi-grain stepwise heating ^{40}Ar-^{39}Ar analysis of 11 spherules provided a "Plateau-Isochron" age of 0.76 ± 0.98 Ma with an initial $^{40}Ar/^{36}Ar$ = 422 ± 18. Although poorly resolved, these ages provide evidence that the formation age of the TAM microtektites is essentially Quaternary and compatible with the 0.76 ± 0.05 Ma and 1.10 ± 0.05 Ma ^{40}Ar-^{39}Ar ages for the Australasian [8] and Ivory Coast [5] tektites, respectively.

Table 1. Average bulk composition of TAMM.

Major elements (wt %)					
SiO_2	71.6 ± 3.2				
TiO_2	0.88 ± 0.09				
Al_2O_3	15.3 ± 1.8				
FeO	4.07 ± 0.60				
MnO	0.09 ± 0.02				
MgO	2.91 ± 0.58				
CaO	3.43 ± 0.47				
Na_2O	0.27 ± 0.04				
K_2O	0.97 ± 0.15				
Total	99.5 ± 0.3				
Trace elements ($\mu g\ g^{-1}$)					
Li	36 ± 6		Sm	9 ± 1	
Sc	17 ± 2		Eu	1.6 ± 0.2	
V	32 ± 5		Gd	7.0 ± 0.9	
Cr	60 ± 39		Tb	1.0 ± 0.1	
Co	6 ± 2		Dy	6.7 ± 1.0	
Rb	45 ± 14		Ho	1.3 ± 0.2	
Sr	206 ± 27		Er	3.8 ± 0.5	
Y	34 ± 4		Tm	0.5 ± 0.1	
Zr	307 ± 25		Yb	3.9 ± 0.5	
Nb	20 ± 2		Lu	0.6 ± 0.1	
Cs	2.8 ± 1.0		Hf	8.2 ± 0.9	
Ba	527 ± 60		Ta	1.7 ± 0.2	
La	51 ± 6		Pb	0.02 ± 0.01	
Ce	103 ± 12		Th	19 ± 3	
Pr	11 ± 1		U	0.6 ± 0.2	
Nd	43 ± 5				

Discussion: Based on the geochemical composition and the ^{40}Ar-^{39}Ar data, we conclude that the TAM microtektites identify a portion of a strewn field extending latitudinally for more than 520 km in Victoria Land, associated with a catastrophic impact on the Earth's continental crust in the Quaternary.

TAM microtektites share a number of features with the Australasian microtektites. They have the same color of some "normal-type" Australasian microtektites and overlapping chemical composition of refractory elements, and have compatible age. We therefore suggest that they likely represent the southern extension of the Australasian strewn field. More precise age and Sr-Nd data will confirm this attribution. Meanwhile, however, we cannot rule out that the TAMM identify a new strewn field of Quaternary age. This alternative hypothesis, however, would anomalously increase to three the number of microtektite-generating cosmic impacts in the Quaternary, against the total of four events known from the entire Cenozoic.

There would be a number of fascinating implications should the TAMM indeed belong to the Australasian strewn field. First of all, the margin of the Australasian strewn field is thus shifted southward by ~3000 km, and the maximum distance from the putative parent impact site in Indochina by ~2000 km. This emphasizes the paradox of the missing parent crater of the largest (>10% of the Earth's surface) and youngest tektite strewn field discovered on Earth and the putative southward asymmetry of the strewn field.

TAMM found at the margin of the Australasian strewn field and at the maximum distance from the hypothetical source crater in Indochina are also the most depleted in volatile elements. This suggests a possible relationship between peak temperature-time regimes at the point of impact and/or during atmospheric flight, and high-angle ejection trajectories. Alternatively, one may invoke long trajectories outside Earth's atmosphere and ablation during re-entry. Investigating the possible geographic variation in composition of the Australasian strewn field might therefore contribute to the understanding of the thermal structure of the ejecta plume and ultimately further help to predict source crater location.

Lastly, the age of the Australasian microtektites suggests that the micrometeorite traps in which the TAMM were found [3] have been accumulating infalling extraterrestrial matter over at least the last ~1 million year, thus providing a unique new approach to meteoritic flux studies over the recent geological past.

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Acknowledgments: This work was supported by PNRA. PR was supported by IPEV.