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# Fifteen years of Antarctic micrometeorite research by the Italian Programma Nazionale delle Ricerche in Antartide

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## Abstract

This is an overview of the contribution to cosmic dust studies provided by fifteen years of Antarctic micrometeorite research by the Italian Programma Nazionale delle Ricerche in Antartide (PNRA) since the discovery of the Transantarctic Mountain micrometeorite collection in 2003.

## 1. Introduction

The Earth accretes some tens of thousands of tonnes of extraterrestrial material each year [1]. Most of this is interplanetary dust produced by collisions and evaporation of rocky and icy bodies in the Solar System. A fraction of this dust survives hypervelocity impact with the Earth's upper atmosphere and is collected at the Earth's surface in the form of microscopic particles (<2 mm) called micrometeorites. Significant quantities of micrometeorites are recovered mainly from deep-sea sediments, and snow, ice and loose sediments in polar areas. Micrometeorites are relevant for planetary science because they provide samples of a variety of dust-producing bodies in the Solar System for laboratory analysis, most notably primitive asteroids and comets which allow exploration of the first stages in the evolution of the protoplanetary disk [2]. Furthermore, the systematic study of unbiased and time-constrained micrometeorite collections allows investigation of the cycles of extraterrestrial input to the global geochemical budget of planet Earth, including its bearing on the emergence of life. Lastly, knowledge of the physical and compositional properties of micrometeorites provides constraints for modelling the source regions and dynamic evolution of the cosmic-dust complex in the near-Earth space, as well as for assessing the potential hazard to space activities of dust in the vicinity of the Earth.

During the Italian 2003 and 2006 Programma Nazionale delle Ricerche in Antartide (PNRA) expeditions, we discovered of large accumulations of micrometeorites from the tops of Victoria Land Transantarctic Mountains (TAM) [3]. Since then, four more PNRA micrometeorite collection campaigns led to the collection of thousands of micrometeorites available for cosmochemical studies. This material is under investigation in a collaborative effort by a number of European research teams (Pisa University, INAF and Parthenope, Italy; CEREGE and ISTerre France; Imperial College, UK; Max Plank Institute Mainz, Germany; Vrije Universiteit Brussel, Belgium) with the aim of understanding the composition of the near Earth dust complex - an outstanding issue in Solar System science.

## 2. The TAM micrometeorite collection

TAM micrometeorites are found within the loose fine-grained bedrock detritus accumulated in the joints and decimeter-sized weathering pits of flat, glacially eroded granitoid summits of the TAM - the so called TAM micrometeorite traps [3]. These are windows into the last ~1 million years of micrometeorite flux. This relatively long accumulation time is documented by the occurrence of ~480,000 year old debris from a large meteorite impact over Antarctica [4] and ~800,000 year old Australasian microtektites [5]. As micrometeorites are found within a loose soil, extraction of particles <200 μm in size is difficult, though feasible. Due to the relatively long accumulation time, TAM micrometeorites show variable degrees of alteration [6]. This collection contains thousands of micrometeorites in the 200–800 μm range and hundreds in the 800–2000 μm range with many up to 3000 μm in size. [3] and [7] concluded that the TAM micrometeorite collection is representative of the micrometeorite flux >200 µm in size over the last one million years. This is based on the match with the frequency by type and size distribution of the South Pole Water Well cosmic spherule collection [8], as secondary accumulation processes and weathering act selectively on micrometeorites with different physical properties (mainly density) and compositions.

## 3. Research highlights and outlook

The extraordinarily large number of specimens and their relatively large size which enables investigation through a multi-analytical approach are unique characteristics of the micrometeorites in the TAM collection. Combined petrographic, bulk compositional and oxygen isotopic data has allowed identification of new micrometeorite types from a number of different, primitive and evolved parent bodies [e.g., 9, 10]; in particular, data from cosmic spherules has allowed to establish their relative contribution to the modern composition of the <200 µm dust complex at ~1 AU [11]. Besides evidence of complex exposure histories in some particles, current noble gas research is providing information on the micrometeoroid source regions in the solar system with implications on their orbital evolution (Baecker et al. 2018, GCA, under review).

Future research will focus on i) parent body identification in a statistically representative selection of >200 µm unmelted micrometeorites, combining petrographic, geochemical and oxygen isotopic compositional data; ii) mineralogical and geochemical investigation of the intense acqueous alteration observed in giant fine-grained micrometeorites to explore parent body processes on hydrous C-type asteroids (see Suttle et al., this meeting).

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