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Determining mineralogy, size, and concentration of individual aeolian particles entrapped in Antarctic ice over the last Glacial-Interglacial cycle by single particle inductively coupled plasma mass spectrometry

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There is virtually no data on nanoparticles or microparticles less than 0.5 μm entrapped in ancient Antarctic ice. Until now, size distributions of aeolian dust particles have been measured over a glacial-interglacial time scale using Coulter Counter and Abakus (that only measure particles larger than about 0.5 μm and provide no chemical information). To date, information on the elemental chemical composition of particles in ice cores has come almost entirely from bulk measurement by ICP-MS following acid digestion, making it challenging to differentiate whether the bulk composition is primarily linked to larger micro-particles or many smaller nanoparticles unobserved by other analysis methods. Electron microscopy with Energy Dispersive X-ray Spectrometry can measure the size and elemental chemical composition of individual micro- and nano-particles but typically requires many hours to measure enough particles to obtain a statistically significant sample.

We used Single Particle Inductively Coupled Plasma Time of Flight Mass Spectrometry (spICP-TOFMS) to measure (in a few minutes) a complete elemental mass spectrum for each of *thousands of individual aeolian dust particles* entrapped in a horizontal ice core from the Taylor Glacier (East Antarctica) including the last glacial-interglacial transition (9,000-44,000 years BP). This allowed us to calculate particle number concentration from the number of detected particles and to crudely estimate nano- and micro-particle size from the total mass of detected elements and estimated density. The capabilities and limitations of spICP-TOFMS will be discussed.

The elemental composition of individual aeolian particles obtained by spICP-TOFMS is essential to infer their mineralogy by comparing ratios of detected elements in each individual particle to those in minerals with known chemical composition.Ultimately, identifying minerals in aeolian dust particles will improve simulations of the radiative forcing of Earth's past climate by incorporating the optical properties of different minerals into global climate models. Furthermore, understanding past particle mineral composition, number concentration, and size distribution (especially for particles < 0.5 μm in diameter) is a critical piece in reconstructing environmental changes at the source of emission (tracing volcanic emissions and crustal sources from different continents) over the glacial-interglacial timescale.

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Track Classification: Progress in proxy development and interpretation