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Unravelling the provenance of Antarctic dust: the role of Raman spectroscopy to identify dust glacial sources

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We adopted a new single-grain approach to study the provenance of dust preserved in Antarctic ice cores using Raman spectroscopy, which can be used as a complementary tool to traditional techniques, as radiogenic isotope fingerprint of dust. We used Raman spectroscopy to track the provenance of dust preserved in Dome B ice core, East Antarctica. The grain size of dust ranges from clay to very fine silt, and single detrital minerals of such a fine grain-size range are difficult to determine. We thus developed a new protocol for the preparation and analysis of particles between 1 and 5 μm in diameter, in a clean room at the EuroCold Lab and at the Laboratory for Provenance Studies of Milano-Bicocca University.
The record covers the last 30 kyr, thus encompassing the last glacial period, the Last Glacial Maximum (LGM), the deglaciation and the beginning of the Holocene. Four Dome B ice core samples from the LGM were prepared and analyzed. The dust preserved in the ice core was deposited on a glass slide support in a clean room at the EuroCold Laboratory and analyzed using Raman spectroscopy at the Laboratory for Provenance Studies.
More than 600 Raman spectra were collected and identified. Raman spectroscopy allowed us to identify polymorphs as well, thus representing a key tool to unravel the provenance of dust. The results confirm southern South America as the most likely dominant dust source for Dome B during the LGM. These results, along with microscopic observations, suggested an additional contribution from the exposed Patagonian continental shelf and glacial outwash plains of southern Patagonia during the sea-level low-stand period of Marine Isotopic Stage 2. The proposed method for single-grain Raman counting of such fine and low concentrated samples provides a new tool for future provenance studies of the mineralogy of unexplored Holocenic Antarctic dust.