Researchers use 'comminution dating' to better understand Antarctica's geological and climatic history

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Credit: AI-generated image (disclaimer)

Although scientists have been studying Antarctica for many years, most research has focused on the conditions of Antarctica as they currently are. Based on this information, scientists have been able to make predictions on both what caused these conditions and how they are likely evolve in the future. But because our understanding of the icy continent is essentially limited to what happened over the last 100 years, our overall knowledge is surprisingly limited. To truly understand Antarctica, scientists must 'see' the continent's geological and climatic history dating back to the late Quaternary period – a history that is literally frozen from sight.

Due to the Antarctic Ice Sheet (AIS) that covers the continent, land-based observations into its geological past remain largely unknown. However, scientists from the COMANT (Comminution dating of glacio-marine sediments in Antarctica and the Southern Ocean) project discovered that this geological information can be retrieved by studying the origins and transport times of eroded materials found in the marine sediment cores surrounding Antarctica. With this information, researchers can reconstruct the history of continental weathering, sediment transport mechanisms and timescales.

'This project uses an innovative approach called comminution dating to determine spatial and temporal changes in the transport time of fine clastic sediments produced by Antarctic subglacial erosion during the late Quaternary period, which can be seen in the flux of ice and sediment discharged into the Southern Ocean,' explains Project Lead Adi Torfstein.

Determining the comminution age

The COMANT project builds on recent results coming from the Weddell Sea showing that, depending on glacial-interglacial timescales, sediment transport times range between tens to hundreds of thousands of years. 'Building on these preliminary results, I studied the comminution ages of a large number of glacial-marine deposits at sites across the Southern Ocean,' says Torfstein. 'This in turn allowed me to conduct a comprehensive study of natural and analytical biases on the comminution dating approach.'

The project focused their efforts on U-series disequilibrium in detrital material, which is a measurement of weathering and transport time. Once a rock fragment is ground to a small particle of only a few microns in diameter, which is something that happens very quickly in glacial settings, one of the isotopes of uranium (234U) is continuously lost from the rim of the particle due to radioactive decaying. 'This loss of 234U is measurable and depends, amongst other things, on the known decay rate of uranium isotopes,' says Torfstein.

According to Torfstein, this change, or loss of 234U, is a geological clock that can be used to estimate the age of formation of a particle (rather than the age of formation of a rock or mineral). The time elapsed between the formation of the particle and the present is known as the 'comminution age'.

Better understanding Earth's history

Although the project is ongoing, researchers expect results to provide the first systematic and wide-scale study of comminution ages in the Southern Ocean. As such, the study will expand the possibilities of dating continental deposits, leading to a better understanding of the fundamental aspects of sedimentology, glaciology and landscape evolution.

'This is important because the comminution age of a particle is controlled by the interplay between climate change, the tectonic evolution of the continents and the efficiency of transport mechanisms on the continents and in the oceans,' adds Torfstein. 'Thus, comminution ages reflect the cumulative impact of processes that govern the shaping of the Earth's surface over time, and by reconstructing these ages, we can better understand its history.'

More information: Project page: cordis.europa.eu/project/rcn/109554_en.html

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