Timing is the key to understand what lies beneath: Recent developments in geochronology untangle mysteries in fields from past climate changes to geohazards

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Determining the precise timing of the past events is a pivotal step towards understand mechanisms of environmental change that is relevant to a number of topics including climate, biogeosciences, and geohazards. Methods to analyze radiometric isotopes to determine ages were rapidly developed over the past century. Continued recent work further enables us to conduct increasingly high-precision analyses. Radiocarbon and Uranium series dating are two important methods. The footprint of accelerator mass spectrometers (AMS) continues to decrease without compromising measurement accuracy, precision, and throughput. Ultra small-scale samples (i.e. 0.001-0.05 mg carbon compared to conventional 1 mg carbon) measurements opens up the venue to measure compound specific radiocarbon in geological as well as biological materials. While inductively coupled plasma mass spectrometry can provide reliable U-series ages.

In this presentation, I would like to introduce examples of studies that have advanced our knowledge of geosystems using these methods, such as the melting history of Antarctic ice and geohazard studies.

Accurate Antarctic ice sheet history in the past can contribute to a better understanding of the future behavior of the world's largest freshwater reservoir. Its action and reaction to global climate is pivotal to predicting future changes. The main obstacle to obtaining precise dating is the paucity of foraminifera in sediments. Thus previous studies were forced to rely on bulk sediment to extract carbon to determine retreat history. However relict organic carbon caused results to indicate much older ages than the true sediment age, which confused the view of Antarctic ice sheet behavior. We therefore have developed compound specific radiocarbon dating techniques and applied them to Antarctic sediments. This method successfully reconstructs the timing of the ice sheet and ice shelf retreat, providing insight into the sensitivity of Antarctic ice to climate change.

Understanding of the timing of past events in geohazard areas has also improved due to increased precision and throughput. Radiometric dating of event layers is complicated by preservation state, often producing controversial results. We employ a “big data approach” to overcome these obstacles, and the data can now be treated statistically. This provides uncertainties of events to discuss the mechanisms in a quantitative manner. Our examples include tsunami deposits and volcanic eruption histories. Understanding recurrence of active fault movements also will be discussed.