# Timing and Nature of Late Quaternary Climate Change from Cave Deposits

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Well-chosen cave calcite sub-samples can be dated accurately and precisely by uranium-thorium methods, using mass spectrometric techniques. The current limit is ~700,000 years, although further technical improvements may well expand the range. In a number of caves around the world, it has been established that calcite oxygen isotopic composition represents, in essence, the history of the oxygen isotopic composition of meteoric precipitation.

Using these approaches, we are establishing high resolution, absolute-dated oxygen isotope stratigraphies for meteoric precipitation over the last several glacial cycles. The foci of our work are multiple cave sites in China and Brazil. So far, we have established a 300,000-year record of Asian Monsoon precipitation, with resolutions ranging from 2 years to several decades, and a similar record of southern Brazil precipitation covering the last 90,000 years.

We correlate our records to benchmark records of climate and environmental change. The cave records are correlated to (1) each other through precise dating, (2) Greenland and Antarctic ice core records through atmospheric methane (which responds to changes in the Asian Monsoon), and (3) North Atlantic marine oxygen isotope records (by linking Heinrich Events and intervals of unusually high oxygen isotopic composition recorded in Chinese caves).

Our data and the correlations to other records improve our knowledge of the absolute timing and spatial pattern of late Quaternary climate change. Highlights include: (1) *The discovery of last glacial period Dansgaard-Oeschger (DO) Events in China and Brazil.* Chinese and Greenland events are in phase, whereas Brazilian events are anti-phased, suggesting a N. Hemisphere – S. Hemisphere low-latitude precipitation seesaw, caused by feedbacks between high and low latitude climate. (2) *The discovery and characterization of DO Events in the penultimate and antepenultimate glacial periods in China.* These have approximately the same pacing and amplitude as the last glacial DO events. (3) *Determination of the timing and sequence of events during Termination II.* These observations have led to new ideas about the triggers for glacial terminations.