Climate variability in the southwestern USA over the past half-millennium from high-resolution speleothem data

J. T. RASMUSSEN[1], V. J. POLYAK[2] AND Y. ASMEROM[3]

Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM, 87131, USA ([1]jbtoledo@unm.edu, [2]polyak@unm.edu, [3]asmerom@unm.edu)

Understanding high-frequency climate variability has important scientific interest and significant societal imperative. Here we present an annually resolved record of relative moisture for the last 400 years in the southwestern USA using the growth banding of speleothems from caves in the Guadalupe Mountains of southeastern New Mexico.

The effort to constrain past climate change depends heavily on the availability of high-resolution records; this is especially true in continents, where datable material is scarce. Annual growth banding has been shown to occur in some speleothems (Polyak and Asmerom 2001); this, combined with U-Th ages that have an uncertainty of around 25 years (2-sigma) in clean Holocene samples, suggests that speleothems have the potential to provide robust, quantitative climate data. In moisture-limited regions such as the southwestern USA, stalagmite growth and growth hiatuses, annual band thickness variations and in some cases a change from calcite to aragonite in speleothem mineralogy can be used as a record of regional relative moisture.

For this study we combined numerous band thickness measurements with high-precision U-Th dating techniques. Where we have limited stalagmite data for the 20th century the correlation between the band thickness data and the instrumental precipitation record is comparable to the correlation between the raw tree ring data and the instrumental record. For 300 years beyond the instrumental record the match between stalagmite band thickness and raw tree ring thickness is remarkable.

From the stalagmite data it is clear that this region experienced significant variations in relative moisture over this time period. Wetter periods are indicated by intervals of thicker banding, and drier periods by intervals of thinner banding, hiatus, and in some cases a change in mineralogy. The stalagmite data indicate an increase in relative moisture that is comparable to the early 20th century during the late 1600s and early 1700s AD, specifically from 1670 to 1690 AD, corresponding to a period of cooler temperatures in the Northern Hemisphere known as the Little Ice Age. A sharp decrease in moisture is indicated between 1770 and 1820 AD and again from 1860-1870 AD.

The results of this study show that speleothem data, in conjunction with other proxies, may be useful in reconstruciting high-frequency climate variability well beyond the instrumental record.

References

Polyak, V.J. and Asmerom, Y.,(2001), *Science* 294, 148-151.

Higher plant biomarkers and their _^{13}C in deep sea sediments from Bering Sea and North Pacific Ocean

NALIN P. RATNAYAKE, NORIYUKI SUZUKI[1], AND KEN SAWADA

Division of Earth and Planetary Sciences, Graduate School of Science, Hokkaido University suzu@ep.sci.hokudai.ac.jp[1]

Two piston cores from seamounts representing Bearing Sea and North Pacific Ocean were collected during the Cruise KH-99-3 of the R/V Hakuho-maru. The time series analyses of long chain n-fatty acids (FA) and n-alkanes (n-AL) distributions, and their compound specific $\delta^{13}C$ values were performed to investigate the vegetational changes on land in mid to high latitude of the northern hemisphere during the last 250 kyrs. Because of the controversy concerning the source of long chain fatty acids, we fractionated fatty acids into three groups, which are esterified FA, free FA and FA in polar fraction. Mid chain (C_{22}, C_{24} and C_{26}) esterified FA is characterized by comparatively lighter $\delta^{13}C$ values less than -30‰. In contrast, mid chain free FA and FA in polar fraction generally show comparatively heavier $\delta^{13}C$ more than -27‰, suggesting their mixed source of terrestrial and marine origins. The long chain (C_{28}, C_{30} and C_{32}) fatty acids in three fractions commonly showed lighter $\delta^{13}C$ values less than -30‰.

The $\delta^{13}C$ of higher plant-derived n-AL and FA in core sediments from Pacific Ocean shows a systematic variation ranging from –30 to -35‰, which well corresponds to the glacial/interglacial change during the last 250kyrs. The $\delta^{13}C$ gradually increases in the glacial periods and decreases in the interglacial periods. Several environmental factors can affect _^{13}C of higher plant-derived n-AL and FA. The vegetational change on land associated with glacial/interglacial climatic change can be the major cause of variation of _^{13}C of land plant biomarkers. The sediments from Bering Sea are significantly rich in terrigenous organic matter compared to those from the Pacific Ocean. However, the $\delta^{13}C$ variation of land plant biomarkers from Bering Sea does not necessarily correspond to the climatic change. Various transportation processes such as airborne, local current, and turbidity current transportations in Bering Sea disturb the time sensitivity of $\delta^{13}C$ of land plant biomarkers. A good correlation in North Pacific Ocean core is because it receives terrigenous organic matter mainly through airborne transportation.