Progress and challenges in speleothem-based climate reconstruction

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Two major challenges in continental climate reconstruction are, 1) having proxies that can be absolutely dated at better resolution than the time-scale of variabilities that modulate climate, for example, inter-annual for ENSO, and 2) proxies that provide absolute values for moisture amount and/or temperature. These challenges are now partially solved by developments in speleothem-based climate reconstruction. Speleothems can be absolutely dated at any arbitrary position using the ^{234}U-^{230}Th method. This has been made possible by the availability of multi-collector inductively coupled plasma mass spectrometers providing unprecedented analytical precision due to large ion yields, better determination of the half-lifes of ^{230}Th and ^{234}U, availability of high-purity ^{233}U-^{236}U-^{229}Th spikes and better age fitting algorithms. As a result, in our recent efforts we have been able to obtain age uncertainties in the range of 4-6 years (2σ) over the last 2,000 years and nearly annual age resolution, when combined with seasonally resolved δ^{13}C data. We consider the challenge with the x-axis (time) is mostly solved.

The challenge with the y-axis - amount/degree of change- is more daunting. Here again, our recent efforts in the Americas have provided encouraging results. In a case where we were able to calibrate δ^{18}O data against modern instrumental data (r=0.8) it was possible to infer absolute moisture variability in the Mexican monsoon. Another effort in progress shows excellent correlation between δ^{13}C and trace element data (e.g. δ^{13}C vs. U ppm, r = -0.73), providing confidence that we are looking at robust climate signals. Now that high-resolution speleothem data are becoming more widely available, a coherent picture of regional climate variability across a variety of time-scales is starting to emerge, providing insights into climate dynamics. The challenge of having absolute numbers for the y-axis remains, however.

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