Detecting NAO-mode variability in high-resolution speleothem isotope records

L.M. BALDINI[1] , F. MCDERMOTT[1] AND J.U.L. BALDINI[1]

[1]UCD School of Geological Sciences, University College Dublin, Belfield, D4, IRELAND; lisa.baldini@ucd.ie

Speleothem O-isotope records from mid-latitude sites are typically interpreted to reflect changes between dry/cold and wet/warm climatic conditions. Meteoric precipitation is influenced by water vapour source and air mass trajectory, but there is little understanding of the conditions under which speleothem $\delta^{18}O$ records may record relatively high-frequency variability in atmospheric palaeo-circulation.

To provide these insights, a two-part multi-year investigation was undertaken to determine the extent to which (i) discrete rain event $\delta^{18}O$ and δD values correlate with NAO-driven atmospheric circulation and air mass origin, and (ii) different cave drips (in Crag Cave, SW Ireland), representing a range of hydrological characteristics, buffer the $\delta^{18}O$ of precipitation. The drip sites monitored in this study strongly attenuate the seasonal rainwater $\delta^{18}O$ signal, implying that seasonal cycles are unlikely to be preserved in speleothem calcite at this site.

The $\delta^{18}O$ and δD values from 59 discrete rain events and 22 monthly-integrated rainwater samples collected at UCD Dublin, Ireland, range from –13.9 to –1.4 ‰ VSMOW and –107.9 to –11.6 ‰ VSMOW, respectively. Mean monthly $\delta^{18}O$ and δD values range from –10.2 to –4.8 ‰ VSMOW and –73.0 to –30.7 ‰ VSMOW, respectively. Five-day (120-hour) kinematic back trajectories originating at UCD (53.39ºN, 6.22ºW) were employed to determine the atmospheric circulation pattern and air mass origin associated with each rain event. Trajectories were computed using the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model provided by the National Oceanographic and Atmospheric Administrations's Air Resources Laboratory. Rain events associated with southerly and easterly trajectories exhibited the most negative $\delta^{18}O$ values. Overall, the dominant westerly-derived air masses exhibited the highest $\delta^{18}O$ and δD values compared with the less frequent but more complex trajectories that traversed continental Europe.

The relationship between NAO index and long-term precipitation $\delta^{18}O$ records from several European Global Network of Isotopes in Precipitation (GNIP) sites will be compared to identify the optimum geographical location within the North Atlantic region for future atmospheric palaeo-circulation studies using speleothems. Detection of such signals requires (i) high amplitude seasonality in meteoric water $\delta^{18}O$, (ii) robust correlations between meteoric water $\delta^{18}O$ and NAO index, and (iii) drip sites that exhibit minimal attenuation of the meteoric water $\delta^{18}O$ signal, coupled with high speleothem growth rates.