Ion microprobe analysis of $\delta^{18}O$ in speleothems as a source of sub-annual-resolution climate records

I.J. ORLAND[1], M. BAR-MATTHEWS[2], A. AYALON[2], N.T. KITA[1] AND J.W. VALLEY[1]

[1]Univ. of Wisconsin, Madison, WI, 53706, USA
(*correspondence: orland@geology.wisc.edu)
[2]Geological Survey of Israel, Jerusalem, 95501, Israel

High-temporal-resolution climate proxy records are imperative for studies of abrupt climate change or related shifts in seasonality [1]. Ion microprobe analysis of $\delta^{18}O$ in speleothems provides new information about abrupt climate events and seasonality changes that would not be resolved with standard drill-sampling. We use the WiscSIMS CAMECA 1280 ion microprobe to measure $\delta^{18}O$ at sub-annual resolution (10 μm) with a spot-to-spot precision of ~0.3‰ (2 s. d.) and a confocal laser fluorescence microscope (CLFM) to image growth bands.

Detailed characterization of cave hydrology, regional climate and U-Th-dated speleothems [2, 3] make Soreq Cave (Israel) ideal for high-resolution analysis. Combined $\delta^{18}O$ and CLFM analysis shows that the couplets of bright and dark fluorescent calcite observed in Soreq speleothems are annual growth bands. A quantitative measure of seasonality ($\Delta^{18}O$ (dark-bright) = gradient of $\delta^{18}O$ between dark and bright fluorescent calcite in a single annual band [4]) reveals abrupt changes from year-to-year and longer-term trends. Analysis of $\delta^{18}O$ along a radial traverse (>1100 spots) of Soreq stalactite sample 2N, which grew from ~34-4 ka, reveals significant Eastern Mediterranean climate changes across the last glacial-interglacial transition with sub-annual resolution.

The maximum magnitude of $\Delta^{18}O$ (dark-bright) in sample 2N decreases from ~2.0‰ prior to the termination of the Younger Dryas (YD) to ~1.5‰ for the rest of the Holocene, suggesting a shift in regional seasonality. The change in $\Delta^{18}O$ correlates with CLFM imaging. The fluorescence of calcite prior to the YD is consistently reversed within an annual band (dark before bright) relative to Holocene bands (bright before dark). We propose that the coupled shift in $\Delta^{18}O$ (dark-bright) values and fluorescent banding indicates a change in the local seasonal rainfall pattern, which could change the growing season of predominant vegetation and cause a reversal of fluorescent banding.

[1] Denton *et al.* (2005) *QSR* **24** 1159–1182. [2] Ayalon *et al.* (1998) *J. Hydro* **207**, 18–31. [3] Bar-Matthews *et al.* (2003) *GCA* **67**, 3181–3199. [4] Orland *et al. (*2009) *QR* **71**, 27–35.

Providing solar system water and high planetary angular momentum, using a return to Ringwood's core formation model, supported by the behavioural evolution of the mantle

MILES F. OSMASTON

The White Cottage, Ripley, Surrey GU23 6JT, UK
(miles@osmaston.demon.co.uk)

Longstanding problems of the Solar System are:- the mean specific angular momentum (a. m.) of SS planetary materials is $>10^5$ times the Sun's, and the origin of SS water. I have shown [1] that during a cool secondary stage of SS formation the nebular flow would be outward and could sufficiently build up each protoplanet's a. m. as it grew, moving outward too, in the flow. So attaining the high a. m. requires completion of growth during nebular presence, ruling out the post-nebula growth in cores-by-percolation models.

Those models do nothing for the origin of SS water, which is low in star-forming clouds. Ringwood's model (1960-1978) uses the nebula to reduce hot FeO erupted at the protoplanet's surface; the Fe is then 'subducted' to form the core. For Earth this would generate >400 ocean volumes of reaction water, a SS benefit foreseen by Ringwood. The heat required is internal (accretion, gravitation, radiogenic) so orbital distance is immaterial; important for the cores in the Galilean moons. The inferred outward nebular motion implies the close-in nucleation of protoplanets, shielded from stellar heat by nebular dust opacity. Many exoplanets are close-in too.

Asteroids being too small for convective overturn, meteoritic irons must come from unsubducted positions, not cores. Ringwood-mode core formation made the early-Earth's mantle as wet as it could hold, seen in its behaviour and petrology. But at ~2.5Ga, its drying-out by ocean production reached a critical loss of water-weakening in the presence of interstitial melt [2], halting convective motion for ~270Ma [3, 4], during which oxygenic life won its battle against MOR effusions, depositing BIF and oxygenating the atmosphere, which is why we are here [3, 5]. The restart was in the 2-layer mantle mode that prevails today, with deep-keeled cratonic tectospheres of stiffened mantle [5].

[1] Osmaston (2006) *GCA* **70** (18S) A465, Osmaston (2009) *Geophys. Res. Abstr.* **11**, EGU2009-12204-2, Osmaston (2009) *EPSC Abstr.* **4** EPSC2009-264, Osmaston (2009) *EPSC Abstr.* **4** EPSC2009-266. [2] Hirth & Kohlstedt (1996) *EPSL* **144**, 93–108. [3] Osmaston (2001) *J.Conf Abstr* **6** (1) 417. [4] Condie *et al.* (2008) *GCA* **72** (12S) A175. [5] Osmaston (2009) *Geophys.Res.Abstr.* **11**, EGU2009-6359.