Plenary Talk

Reconstructing hydrological variability using $\delta^{18}O_{diatom}$ records from lake sediments

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The oxygen isotope composition of diatom silica ($\delta^{18}O_{diatom}$) provides valuable information for palaeoclimate studies where carbonate proxies are either rare or absent in lake and ocean sediments. Unfortunately, mineral and rock fragments found alongside diatoms in most sediments can be problematic as the method used liberates oxygen from all components within the sediment, producing both high-frequency noise and low-frequency excursions that can resemble climate signals. Removal of contaminants used to rely on the combination of chemical leaching and physical separation techniques (e.g. sieving, density). This combination can be inefficient however, and often significant proportions of contaminants are still present in 'purified' diatom samples. Using electron optical imaging and X-ray fluorescence spectrometry on previously 'purified' diatom samples, we have developed a mass balance approach to identify the types and proportions of residual contaminants. By integrating this information with measured oxygen isotope ratios of the contaminants, it is then possible to remove contamination effects from the $\delta^{18}O_{diatom}$ record (Brewer *et al.* 2008; Wilson *et al.* 2014a). In this talk we will present palaeoenvironmental records of hydrological variability extracted from tectonic rift lake sediments in southern Siberia (Lake Baikal) and East Africa (Baringo-Bogoria basin). Each record is based on re-modelled $\delta^{18}O_{diatom}$ values of diatom silica ($\delta^{18}O_{modelled}$), where the residual contaminants are identified and compensated for.

We will first of all present records of hydrological variability for both the Late Glacial–Holocene and the Last Interglacial periods in southern Siberia (Mackay *et al.* 2011; Mackay *et al.* 2013). $\delta^{18}O_{modelled}$ interpretations are based on the balance between rivers with high $\delta^{18}O$ values, and rivers with low $\delta^{18}O$ values. Isotopic variability is related to latitudinal differences in precipitation which feed these rivers. The $\delta^{18}O_{modelled}$ record suggests that rather moist conditions prevailed in southern Siberia during the latter stages of the Younger Dryas. Throughout the Holocene, episodes of low $\delta^{18}O_{modelled}$ values are, in general, in good agreement with increases in percentage haematite-stained grains in North Atlantic sediments (indicative of ice-rafted debris events and changing patterns in Atlantic meridional overturning circulation (AMOC). Rivers with southerly catchments dominate fluvial input especially between *c.* 3.3 and 2 cal ka BP, concurrent with high precipitation in the Lake Baikal region. Last Interglacial (127.5–115 ka BP) $\delta^{18}O_{modelled}$ records of hydrological variability show that peak rain-fed discharge occurred *c.* 125.4 ka BP, shortly after July insolation maximum and initiation of Siberian soil development. Between 127 and 119.7 ka BP there are six marked fluctuations in $\delta^{18}O_{modelled}$ values, with a pacing of approximately 1.26 ± 0.3 ka, similar to fluctuations of within-lake productivity. Fluctuations in $\delta^{18}O_{modelled}$ values show good agreement with patterns in AMOC, indicative of strong teleconnections via the Westerlies between the North Atlantic and central Asia. We also compare variability in $\delta^{18}O_{modelled}$ values between the Last Interglacial and the Holocene from Lake Baikal sediments. Millennial-scale variability was significantly more stable during the Last Interglacial, possibly linked to diminished influence of freshwater discharge on AMOC during periods of higher, global mean temperatures.

Finally we present an analysis of Barsemoi diatomites from the East African Rift Valley which contain more than one source of contaminants (tephra and clay). In the Baringo-Bogoria basin, the well-dated sequence of diatomites and fluviolacustrine sediments documents the precessionally forced cycling of an extensive lake system between 2.70 Ma and 2.55 Ma. Here we employed multivariate analyses to develop a three end-member model to successfully resolve climate-driven changes in $\delta^{18}O_{modelled}$ in one of these diatomite sequences (Wilson *et al.* 2014a). $\delta^{18}O_{modelled}$ suggests a rapid onset and gradual decline of deepwater lake conditions, which exhibited millennial-scale cyclicity of ~1400–1700 yr, similar to late Quaternary Dansgaard-Oeschger events (Wilson *et al.* 2014b). These cycles are

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thought to reflect enhanced precipitation coincident with increased monsoonal strength, suggesting the existence of a teleconnection between the high latitudes and East Africa during this period.

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