

Deciphering sedimentary recycling via multiproxy *in situ* analyses

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Sedimentary rocks and modern sediments sample large volumes of the Earth's crust, and preserve units that vary greatly in age and composition. Determining the provenance of component minerals is complicated by the ability of some minerals to be recycled through multiple sedimentary cycles, so minerals from completely unrelated sources may end up in the same sedimentary basin. To untangle these multi-stage signals, two or more chemical signatures measured in minerals with different stability are required. For instance, labile minerals, such as feldspar, can break down rapidly during sedimentary transport, while refractory minerals, such as zircon, can be much more resilient and survive repeated recycling.

One sedimentary succession suitable for testing this hypothesis is the Upper Carboniferous Millstone Grit Group, a fluvio-deltaic, upward-coarsening sequence of mudstones, sandstones and conglomerates deposited in the Pennine Basin of northern England. New data from throughout this sequence clearly indicate two main feldspar populations, consistent with previous work [1], but also a minor third group which may represent an additional source. Since rocks of similar ages typically describe overlapping domains on a $^{207}\text{Pb}/^{204}\text{Pb}$ vs. $^{206}\text{Pb}/^{204}\text{Pb}$ plot, the addition of zircon U–Pb and Hf measurements from the same sediments may help to discriminate between possible source areas.

Previous zircon U–Pb analyses in parts of the sequence have identified three main zircon populations at c. 500, 1000–1800 and 2700 Ma, with the proportion of young to old ages increasing up section [2]. This data set has now been extended to the rest of the sequence to create a statistically significant database covering c. 14 Ma of deposition in the Pennine Basin. With the addition of new Hf isotope data from the same zircons, the combination of all three isotope systems from the same units should fingerprint discrete source terrains within potential source areas, such as Greenland, north-west Scotland and the Southern Uplands of Scotland. As such, these data have significant implications for transport distances of both labile and refractory minerals.

[1] Tyrrell *et al.* (2006) *J. Sed. Res.* **76**, 324–345.

[2] Hallsworth *et al.* (2000) *Sed. Geol.* **137**, 147–185.

Combination of water isotopes to improve temperature reconstruction.

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Introduction

Reconstruction of past temperature from water isotopic records in deep ice cores in remote East-Antarctica is limited by several artefacts such as precipitation seasonality, limited knowledge of water isotopic fractionation at low temperature, temporal changes in hydrological cycle, post-deposition effects and possible input of stratospheric water. In order to address these issues, we present new combined measurements of all water stable isotopes ($\delta^{18}\text{O}$, δD and $\delta^{17}\text{O}$) at the remote East Antarctica site of Vostok (78°27 S, 106° 50 E) at three timescales: seasonal, interannual and over the last 150 kyears Before Present. Indeed, the combination of water isotopes such as d-excess ($\delta\text{D}-8\times\delta^{18}\text{O}$) and ^{17}O -excess ($\ln(\delta^{17}\text{O}+1)-0.528\times\ln(\delta^{18}\text{O}+1)$) are especially sensitive to organisation of the hydrological cycle, changes in kinetic vs. equilibrium fractionations and post-deposition effects.

Results and Conclusion

The relationships between $\delta^{18}\text{O}$, d-excess and ^{17}O -excess display very different patterns on the three different timescales. The results on the seasonal cycle suggest a much more important influence of temperature on d-excess and ^{17}O -excess than previously assumed which is helpful to constraint fractionation conditions at very low temperature. It also shows that seasonality should be taken into account when interpreting deep ice cores isotopic records. On the opposite to seasonal cycle variations, we show that the strong variations of $\delta^{18}\text{O}$, d-excess and ^{17}O -excess observed at interannual timescale can not be explained only by temperature effects but that processes such as post-deposition effects or hydrological cycle reorganizations should be invoked. Finally, we compare these different results with general circulation model outputs including water isotopes to test the capacity of such models to represent water isotopic composition in remote regions of East Antarctica.