

Deciphering sedimentary recycling via multiproxy *in situ* analyses

Penelope J. Lancaster^{1,2}

Shane Tyrrell^{2,3}

J. Stephen Daly²

Craig D. Storey¹

¹ *School of Earth and Environmental Sciences, University of Portsmouth, Portsmouth, UK; pen-ny.lancaster@port.ac.uk*

² *School of Geological Sciences, University College Dublin, Dublin, Ireland*

³ *Department of Earth & Ocean Sciences, NUI Galway, Galway, Ireland*

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. The proportions of each group are unchanged throughout the sequence. 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.

New zircon U–Pb analyses have identified three main zircon populations at c. 450, 1000–1800 and 2700 Ma, similar to previous work in parts of the sequence [2]. However, while the proportion of younger ages increases up section in both studies, the new data indicate a much greater contribution from Archaean material than was previously observed. New Hf model ages indicate only two broad groups at 1500–2500 and 3000–4000 Ma, in nearly constant proportions throughout the sequence.

Combined, these data create a statistically significant database covering c. 14 Ma of deposition in the Pennine Basin. Ultimate source areas most likely include the Caledonian granites of Scotland, western Scandinavia and Greenland. However, the different distributions of zircon ages and Pb ratios throughout the sequence suggest different transport mechanisms for each. As such, these data have significant implications for transport distances and storage 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.