Tracking Sand Grains from Source to Sink Using the Pb-in-K-feldspar Provenance Tool: Examples from Sedimentary Basins on the NW European Margin

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Evaluating sand dispersal and provenance is an important element in basin analysis, particularly in source-to-sink modeling of sedimentary systems and in assessing the role of up-dip sediment supply on stratigraphic development. In-situ analysis of Pb isotopes in detrital K-feldspar provides a powerful means of constraining provenance. K-feldspar grains buried in sedimentary basins retain the Pb signature of their original basement source. Basement Pb isotopic domains with distinctive compositions vary on a broad (>100 km) scale, hence this technique can help to determine the size and geometry of ancient depositional systems. As detrital K-feldspar is generally first-cycle in origin, determining its source can provide complimentary insight alongside provenance methods which utilise signals in more robust, potentially recycled, grains such as zircon.

The Pb-in-K-feldspar tool has been applied to Late Palaeozoic to Mesozoic sandstone intervals, including regionally important hydrocarbon reservoirs, in a range of sedimentary basins on the NW European margin. In Upper Carboniferous sandstones of the Pennine Basin, onshore northern England, the integration of the Pb-in-K-feldspar data with detrital U-Pb zircon geochronological constraints has identified likely recycled grain populations. These datasets suggest that a specific zircon age population, though ultimately derived from a southern source, was recycled from older sedimentary rocks to the north of the basin. The results of Pb analysis of K-feldspars from Triassic sandstones from basins onshore and offshore England (the East Irish Sea and Wessex basins) suggest that the depositional system in these areas was controlled by the Variscan Uplands to the south, with external drainage threading together separate basins at scales in excess of 300 km. However, data from Triassic basins farther to the north and west (the Slyne, Rockall and Faroe-Shetland basins) imply that sediment dispersal was controlled by uplifted Archean and Proterozoic basement blocks, with no discernable Variscan influence. On the scale of individual sedimentary systems, isotopically distinct K-feldspar populations vary with stratigraphy on the margins of the Rockall Basin, implying switching between rivers over time and suggesting that the technique could potentially be used as a correlation tool in barren strata.