Provenance of Nankai Trough sediments: investigation via OH defect content of detrital quartz

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In this study, OH defect content of quartz is under investigation for its potential as a provenance tool. Defect formation in quartz is a function of temperature, pressure, and chemical environment under which the mineral is formed. OH defects can be quickly and easily quantified using IR spectroscopy, enabling us to trace this petrological signal through the sediment record, thereby inferring provenance. As quartz is very abundant in most clastic sediments and not subject to hydraulic sorting and alteration processes, our technique is a valuable addition to well established provenance methods.

The Nankai Trough subduction margin off the coast of southwestern Japan provides an ideal testing ground for our approach: The area shows a quite variable history of sedimentation from multiple source areas that have been thoroughly characterized by other techniques (e.g. Underwood & Pickering, 2018). This allows us to cross-reference our results with previous findings, generating a better understanding of the capabilities of our novel method.

Quartz grains from recent river sands show a general trend along Honshu and Shikoku, from very low, monotonous OH defect values (< 4 wt. ppm water) in the east to moderately high and very diverse values towards the west (up to 200 wt. ppm water). Most distinctively, samples from the Izu-Honshu collision zone are virtually OH defect-free. We suggest that this reflects exhumation and consequent erosion of rocks from relatively low crustal levels following collision of the Izu- and Honshu arcs. This hypothesis is supported by data on regional exhumation rates (Clift et al., 2013).

In trench sediments offshore Honshu, we observe a shift from relatively variable OH defect contents, resembling recent central Honshu river sands, to distributions dominated by low values, similar to sediment from the Izu-Honshu collision zone. This is in accordance with a shift from margin perpendicular to trench-axis parallel sediment transport in the Pleistocene: uplift and increased erosion of the Izu-Honshu collision zone increase sediment transport parallel to the trench axis, while activity of the megasplay fault system traps sediment transported across the accretionary prism in the forearc basins. Previous studies on sand petrography also show this distinct shift in sediment routing (e.g. Fergusson, 2005). We take this as a confirmation that OH defect content is indeed a legitimate tool for provenance analysis in tectonically active settings.