Dependence of ε_{Nd} on sediment grain size, Indus Delta, Pakistan

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Deltaic systems provide some of the principle sections where continental erosion patterns can be evaluated allowing us to test whether sediment delivery and provenance are strongly controlled by the interplay between tectonics and climate. Nd isotopes are commonly used as sediment provenance proxies but may be susceptible to grain size variations in the preserved section. Evaluating ε_{Nd} for different grain size fractions allows assessment of the average composition of the source terrains, the provenance of each size fraction, and whether the sediment record in the delta can be simply interpreted in terms of changing erosion patterns. We analysed Nd isotopes from a composite section in the Indus delta, splitting the sediment in fractions of <63 μm, 63–125 μm, and 125–250 μm.

Sediments show an overall shift to more negative ε_{Nd} from 14.7 ka to Present, interpreted to reflect more erosion of the older crust in the Lesser Himalaya during the Early Holocene, as the summer monsoon strengthened. In this new study we note a marked shift to more positive ε_{Nd} values at 2.7 ka in all grain size fractions. Between the Last Glacial Maximum and ~13 ka, the bulk and <63 μm fraction, and >63 μm fractions, shift equally (ε_{Nd} ±1) toward more negative and positive ε_{Nd} values, respectively. Bulk sediment ε_{Nd} correlate well with the <63 μm fraction, which is expected as bulk sediments were predominantly muddy. The coarsest fraction (125–250 μm) is consistently offset from the bulk values by ε_{Nd} around +1 from ~13 ka to Present, suggestive of more influence from primitive sources in the Indus Suture Zone. Discrepancies in ε_{Nd} values can be as much as ±2.46 between grain size fractions and typically deviate ±0.351 from bulk sediment ε_{Nd}.

While overall trends indicate a compositional shift to negative ε_{Nd} values, or greater erosional flux from the Lesser Himalaya through the Holocene, the differences in ε_{Nd} values for different grain size fractions indicate different source terrains for those size fractions. The coarse fraction likely mostly comes from the Karakoram, not the Himalaya. Coarsening or fining of sediment in the delta could generate trends unrelated to changing erosion patterns but this effect is not dominant in this case.