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Multi-proxy geochemical analyses of Indus Submarine Fan sediments sampled by IODP Expedition 355: implications for sediment provenance and palaeoclimate reconstructions

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The interplay between the development of the Asian summer monsoon and the growth of mountains in South and Central Asia is perhaps the most compelling example of the relationship between climate and the solid Earth. Understanding this relationship is crucial in the context of understanding past changes and for predicting future impacts in the Monsoon region. Both rapid and gradual mountain uplift influence the surrounding environments and regional climate. The sedimentary record of the Indus Fan offers a unique opportunity to study the climatic changes that occurred in South Asia and their link to the intensity of the erosion during the late Cenozoic. Although some paleoclimate reconstructions in the region can be partly addressed by studies onshore, the dominance of erosional processes in such a mountainous region ensures such records are fragmentary and limited in coverage. Thus ocean drilling is the best way to recover long sequences and to test the possible relations among mountain uplift, erosion, sediment deposition and climate (including carbon burial, chemical weathering and CO_2 drawdown).

The sediments and sedimentary rocks from the Indian continental margin, adjoining the Arabian Sea, were drilled during the International Ocean Discovery Program (IODP) Expedition 355. Drilling operations at Site U1456 penetrated through 1109.4 m of sediment and sedimentary rocks. The oldest sediment recovered at this site is dated to 13.5–17.7 Ma, with about 390 m of mass transport deposit. This study provides a multiproxy approach for palaeoenvironmental reconstructions in the Arabian Sea area. We use a wide variety of organic geochemical data coupled with inorganic chemistry, mineralogy, and isotopic analyses. For direct comparison among various data sets, we divided whole round residue from the interstitial water samples among different laboratories, with each receiving 50–300 g (dry mass). The preliminary results include initial sediment provenance data based on bulk petrography and heavy mineral analysis, geochemical data, isotope composition, and biomarker analysis. Preliminary organic geochemistry data suggest an increase of terrigenous organic matter input into sediment starting around 10.5 Ma, with a strong decrease in the last 1 Ma. Moreover, the detailed analyses of the glyceryl dialkyl glyceryl tetraether (GDGT) and alkenone lipids provide the first sea surface temperature (SST) reconstructions in the region. These data indicate decreasing SST from the Middle Miocene Climatic Optimum until today. This research provides an exceptional opportunity to apply a multiproxy approach to understand sediment provenance, erosional processes, and palaeoclimate evolution in the eastern Arabian Sea.