



Evolving Environmental Conditions in the Indus Basin since 11 Ma: Results from IODP Expedition 355

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Sediments recovered by scientific drilling in the eastern Arabian Sea now allow us to constrain the evolution of continental environmental conditions within the Indus basin since around 11 Ma. Combined bulk sediment Nd isotope and U-Pb zircon dating shows a progressive development of provenance with an increasing flux of material from the Lesser Himalayas starting after ca. 9 Ma. Geochemical bulk sediment major element analysis indicates that the Indus is supplied with more altered material than observed in the Bengal Fan. The alteration of material decreased from 11 Ma until ca. 5.5 Ma after which time there is little coherent variation. Clay mineral data also supports this general trend by showing decreasing contributions from kaolinite from 11 to 5.5 Ma, as well as falling smectite/(illite + chlorite) values. However, kaolinite is at least partly provenance controlled. After that time little coherent long-term evolution is observed. From 11 to 5 Ma the relative abundance of hematite increased, implying progressively drier, more seasonal weathering conditions in the Indus flood plain during the Late Miocene. There is a modest decrease in hematite after ~0.9 Ma at the same time that the Chemical Index of Alteration shows sedimentation of generally more weathered material. This is also a time of greater amounts of sediment derived from peninsular India. The records imply a drying, cooling climate from 11 to ca. 5 Ma, consistent with carbon isotope data from leaf wax analysis that shows a shift from C3 to C4 plants. The climatic shift is associated with decreased chemical weathering that stabilized from 5 to 1 Ma. Interestingly, the contrast with the Ganges-Brahmaputra indicates that the link between climate and weathering is not linear and that if the climate is very wet then alteration decreases as transport times shorten.