IODP Expedition 354: Bengal Fan

Site U1449 Summary

Background and Objectives

Site U1449 is part of a six shallow hole transect to document turbiditic transport and deposition processes in the Middle Bengal Fan at 8°N since the Pliocene. Sediments will also be used to trace sources of eroded sediments in Himalaya and to reconstruct erosion rates in order to tie erosion response to climate change. Site U1449 is located at 08°0.419′N, 88°6.599′E in a water depth of 3653 m. The main Hole U1449A penetrated down to 213.5 m DSF and was cored by a combination of APC, HLAPC, and XCB. Hole U1449B was a single APC core from the mudline taken for microbiological studies.

Principal Results

Different structural elements of the sedimentary fan including a more than 40 m thick levee succession, interlevee turbidites and sands and hemipelagic sequences were cored. General lithologic boundaries correlate well with downcore variability in all physical properties and could be attributed to major seismic facies types and reflectivity characteristics. Seismic and average core velocities are in close agreement, which confirmed that the major lithologies had been properly sampled, and non-recovered XCB sections likely contained unconsolidated sands.

Cored sediments allowed us to characterize the sedimentological, physical, and geochemical properties of the material delivered mostly through turbidity currents and likely originating from the source region of the Himalaya. Integration of lithology, physical properties, seismic facies, and geochronological data shows that sedimentation varies over several orders of magnitude between cm/k.y. for hemipelagic units, representing a complete absence of fan sedimentation, followed by episodes with much higher rates (≫10 cm/k.y.), when interlevee units form and levees build up rapidly.

High accumulation rates of turbiditic deposition in the lower 120 m of the hole since ~2 Ma were followed by a low accumulation hemipelagic episode during the Pleistocene around 1 Ma. Then intercalated levee and interlevee deposits formed until 300 ka ago, when hemipelagic sedimentation dominated again.

Operations

Hole U1449A was drilled to total depth of 213.5 m DSF. The full length APC system penetrated a total of 57.1 m of formation and recovered 52.37 m (92%). The HLAPC penetrated 71.9 m of formation and recovered 74.98 m (104%). The XCB system penetrated a total of 83.5 m of formation and recovered only 2.03 m (2%). Due to low recovery with XCB, and because most objectives were achieved, drilling was terminated before reaching the initially planned depth of 300 m in order to save time. Hole U1449B was a single full APC from the mudline taken for microbiological investigations and recovered 7.91 m of sediments.

This first Expedition 354 drilling experience in the fan sediments allowed us to refine the drilling strategy for subsequent drill sites. As expected, recovery of sands intercalated between muddy units was challenging and the HLAPC proved to be particularly efficient to sample both turbiditic sequences and loose sand intervals.

Lithostratigraphy

The predominant lithology is siliciclastic comprised of normally-graded intervals of mica-rich quartz-dominant fine sand, silt, and clay of varying thicknesses (i.e. turbidites). The observed mineralogical assemblage is characteristic of sediments found in Himalayan rivers. Turbidite sequences are generally separated by clay- and silt-sized mottled pelagic and hemipelagic intervals containing foraminifera, and occasionally by glassy volcanic ash layers. Lithological differences between siliciclastic units and variations in grain size and bed thickness reflect cycles of proximal turbidity current channel activity, including activation, flow-stripping, avulsion and abandonment. Bioturbated pelagic and hemipelagic oozes likely represent times of channel-levee inactivity and hence reduced deposition through the settling of suspended sediment from the pelagic zone.

Biostratigraphy

Calcareous nannofossils and planktonic foraminifera provide biostratigraphic constraints at Site U1449. Overall, the abundance and preservation of these microfossils is dependent on the type of lithology recovered. Coarser sandy intervals contain few to barren calcareous nannofossils and barren to less than 0.1% foraminifers, but the abundance and preservation improve considerably in the pelagic and hemipelagic intervals. These intervals were discontinuous at this site due to the regular influx of turbidites and levee

sedimentation. Biostratigraphic controls are based on 53 nannofossils and 34 planktonic foraminifera samples, which provide a total of six biomarker horizons and an early Pleistocene age at the bottom of Hole U1449A.

Paleomagnetics

Thirty of the 38 cores collected from Hole U1449A were studied, avoiding deformed or sandy intervals. Most cores were unoriented, so we used inclination data for core-to-core comparison, and declination data within each core, both from discrete samples and archive section halves. The upper 88 m (CSF-A) in Hole U1449A reveal normal polarity, corresponding to the Brunhes chron (<0.781 Ma). A pelagic deposit between 88 and 97 m (CSF-A) contains several magnetic polarity zones corresponding to the Matuyama chron, and the Jaramillo and Cobb Mountain subchrons. Interpretation of the magnetic polarity beneath the hemipelagic unit is difficult, but there are at least two cores (U1449A-20H and 22H) with reverse magnetization. Correlation between the multiple holes in the Expedition 354 transect, particularly in pelagic and hemipelagic intervals, is expected to clarify the interpretation of the magnetostratigraphy of Hole U1449A.

Physical Properties

Acquired data allow three lithologic groups to be distinguished. Sand-dominated lithologies reveal high acoustic velocity (~1700 m/s), high wet bulk density (~2.1 g/cm^3), generally high magnetic susceptibility (~50–200 SI units), and intermediate levels of natural gamma radiation (NGR) (~70 cps). Silty-clay lithologies show intermediate values of acoustic velocity (~1550 m/s), wet bulk density (~2.0 g/cm^3) and susceptibility (30–100 SI units), and the highest NGR levels (~90 cps). Hemipelagic lithologies are easily distinguished by their low acoustic velocity (~1500 m/s), low wet bulk density (~1.6 g/cm^3), very low magnetic susceptibility (0–20 SI units), low NGR (~25 cps), and the lightest color. Detailed comparisons between lithology and physical properties on selected intervals confirm the predictive capabilities of the physical property data for the high-resolution reconstruction of depositional processes. Also, the data show a particularly high variability in coarser grained intervals, thus deviation from in situ properties cannot be excluded.

Geochemistry

Shipboard sampling allowed analyzing 39 interstitial water samples including a detailed sampling of the upper 9 m in the single core from Hole U1449B. Inorganic and organic

geochemical analyses were acquired on 12 samples for major and trace elements and 37 samples for organic and inorganic carbon. Data from turbidite sediments exhibit geochemical compositions similar to those observed for sediments from Himalayan rivers and from the upper fan levees and shelf. Thirty-one samples were taken for postcruise microbiological research.