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Processes Affecting Sediment Flux and Fate through the Mekong Delta and Continental Shelf
Instrumentation to Support Investigation of Large Tropical Deltas

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LONG-TERM GOALS

The general goal of these projects is to examine the seabed associated with the Mekong sediment dispersal system, quantitatively document the fluxes of fine sediment (over different time scales), and thereby validate localized measurements and numerical models of sediment transport.

OBJECTIVES

The specific objectives are to:

a) document changes in bed elevation (deposition, erosion) on time scales intrinsic to the driving forces; e.g., tidal and wind-driven currents, local waves, river discharge, and interannual variability;

b) measure net accumulation rates over decades at many sites to calculate fine-sediment budgets for intertidal settings in the Mekong sediment dispersal system (distributary channel, mangrove forest, inner continental shelf);

c) examine sedimentation at sufficient locations to characterize spatial variability of grain size and its vertical stratification.

In addition, these grants were responsible for coordination of the ONR DRI investigating the Mekong system.

APPROACH

We completed two field studies of the Mekong system: Feb 2014, Sep-Oct 2014. These were focused on investigation of: a) the Song Hau distributary channel, including the estuarine turbidity maximum, and variations of these on tidal and seasonal time scales; b) intertidal environments (mangrove forest, tidal flats) at the seaward edge of the delta; and c) the clinoform deposits associated with modern sedimentation on the inner continental shelf.

Collaborative research plans were developed with other US and NZ scientists, and withVietnamese scientists who also helped with logistical considerations for the field studies.

WORK COMPLETED

A two-day workshop was held in San Francisco during Dec 2013, in conjunction with the AGU meeting. Final plans were developed for a Feb 2014 orientation visit, and preliminary plans for the Sep-Oct 2014 intense field studies.

The Feb 2014 orientation visit allowed PIs with field studies to meet with Vietnamese colleagues at IMGG, CTU and VNU. It also included a visit to the field sites of the Song Hau distributary channel and the Cu Lao Dung mangrove forest. Subsequently, plans were finalized for the Sep-Oct 2014 intense field studies.

Two scientific expeditions were completed to the Mekong system in Feb 2014 and Sep-Oct 2014. During the first, measurements and sampling were restricted to the Song Hau and the mangrove forest. During the second, intense studies were undertaken in these areas and the clinoform deposits of the inner shelf.

Workshops were held at the AGU meeting, Vietnam National University (in Ho Chi Minh City), Can Tho University (Can Tho), and the VAST Institute of Marine Geology & Geophysics (in Hanoi). In addition, IMGG personnel visited our laboratories at the University of Washington.

RESULTS

Song Hau distributary channel

Bed samples of fine sediment were collected in both low-flow (Feb 2014) and high-flow (Sep-Oct 2014) conditions. The low-flow samples demonstrated the presence of ^{234}Th, which indicates that sediment particles had contact with ocean water and a likely source on the inner continental shelf.

Cu Lao Dung mangrove shorelines

Observations and measurements were made in the mangrove forest and adjacent tidal flat at the seaward end of Cu Lao Dung. We focused on coordinated transects toward the southwest and northeast sides of the forest.

Colleagues made measurements of the hydrodynamics in the mangrove forest, and we coordinated our observations and sampling of the substrate in the same regions and ~2000 m seaward onto the tidal flat. These areas were sampled with grabs, hand cores, and vibracores. The sediment and cores were and will be examined for x-radiographic and grain-size documentation, and for radiochemical measurement of recent sediment deposition (^{234}Th, ^{7}Be) and long-term accumulation (^{210}Pb, ^{14}C). Bed samples were collected in low-flow (Feb 2014) and high-flow (Sep-Oct 2014) conditions. Both sampling periods demonstrated the presence of ^{234}Th, which indicates that sediment particles had contact with ocean water and a likely source on the inner continental shelf.

Preliminary observations from the vast data set include that both surface waves and tidal currents contributed to total water velocity that controlled the sediment distribution. The substrate in the mangrove forest is intensely reworked by benthic animals (e.g., crabs). On the tidal flat, variable flows

are recorded as interlaminated mud and sand deposits. Seaward of the mangrove fringe, a surficial layer (~10-15 cm thick) of soft mud, may be associated with recent discharge of the river.

Mekong inner continental shelf

The focus of shelf studies was in water depths of ~4-20 m, which encompassed the modern clinoform deposit. Properties of the water column and seabed were measured and sampled at 27 stations stretching along ~100 km of coastline, roughly centered at the mouth of the Song Hau distributary. Coordinated seismic surveys by colleagues allowed us to identify locations for sampling that were related to the clinoform morphology and stratigraphy (i.e., topset, foreset and bottomset).

In coordination with studies by Andrea Ogston, the water column was investigated by CTD-OBS profiles and water sampling at the stations mentioned above, and at two 12-h anchor stations during spring tides in topset and foreset regions near the mouth of the Song Hau distributary. At the anchor stations, an instrumented tripod examined hydrodynamic conditions throughout the water column (ADCP, wave gauge) and documented sediment transport in the boundary layer by measuring hydrography (CTD), currents (Aquadopp, ADV) and suspended-sediment concentration (OBS). The seabed was sampled in shore-perpendicular transects, typically with sites on the topset, foreset and bottomset regions. Shipek grabs were collected at most stations, and kasten cores (usually ~300 cm long) were subsequently collected from sites dominated by mud. These were subsampled for x-radiographic and grain-size documentation, and for radiochemical measurement of recent sediment deposition (^{234}Th, ^{7}Be) and long-term accumulation (^{210}Pb, ^{14}C).

We were fortunate to experience the passage of the salinity/turbidity front during both anchor stations, with surface salinities of ≥12 psu. Otherwise, we generally observed surface salinities in the study area of 17-30 psu, and greater values with depth. The foreset anchor station had maximum current velocities of ~65 cm/s (~35 cm/s in the boundary layer). Generally, the topset (<4 m depth) was characterized by fine sand, the foreset by mud, and the bottomset (>18 m depth) by mixed mud and medium sand. The core collection used to investigate long-term sedimentation (decadal to millennial scales) has several sampling gaps that will be filled during the March cruise.

TRANSITIONS

The results of this effort will be transferred to many other investigators interested in seabed processes. Researchers who analyze boundary-layer processes will utilize our data to understand bed erosion and deposition. Accumulation rates, sediment budgets, and grain-size data are key components to input parameters for numerical models. As the Mekong study grows, others are expected to use our observations for ground truth in remote sensing, as well as validation in numerical models.

RELATED PROJECTS

Related Mekong projects are: channel studies by A. Ogston and M. Allison; mangrove studies by J. Mullarney, S. Henderson, S. Fagherazzi, and A. Ogston; shelf studies by P. Liu, D. DeMaster, and A. Ogston; and modeling studies by D. Roelvink.

PRESENTATIONS (oral)

"Dynamics of sediment transport in large tropical tidal rivers via observations in the Mekong and Amazon", AGU Fall Meeting, San Francisco, CA, Dec 2013.

“Tropical River Deltas” presented at IMGG in Hanoi, CTU in Can Tho, and VNU in Saigon, Vietnam, Feb 2014