

Sediment Transport and Strata Formation in the Adriatic Sea

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LONG-TERM GOALS

The long term goal of this project is to develop quantitative models of sediment transport, resuspension, deposition and accumulation on the continental margin.

OBJECTIVES

The objectives of this research program are 1) to characterize the structure of the river plumes and coastal currents in the western Adriatic Sea and their influence on sediment dispersal from Alpine and Apennine rivers; 2) to assess the relative contributions of Alpine and Apennine rivers to the clinoform development in the Adriatic, and to determine the delivery mechanisms of these different sources 3) to determine the mechanisms and rates of sediment resuspension and bottom-boundary-layer sediment transport in the western Adriatic; 4) to determine how bottom-boundary-layer processes influence the patterns of erosion and deposition in the western Adriatic Sea.

APPROACH

The principal activity for the first year of EURO-STRATAFORM has been the planning of the field work and preparation of moorings and tripods for the Fall 2002 deployment. This planning effort has involved two planning meetings, one in Seattle with the North American participants, and one in England with the all of the international participants in the EURO-STRATAFORM program. In addition to this planning effort, we deployed instrumentation at the mouth of the Po River in collaboration with the University of Washington investigators and performed data analysis associated with that deployment.

An important aspect of the planning effort has been to make a general determination of the magnitude of sediment loading from different parts of the Adriatic coast and to estimate the expected sediment transport conditions in different parts of the receiving waters. After extensive literature review as well as analysis of preliminary field data from other investigators, it was determined that, although the Apennine mountains have been a major source of sediment to the western Adriatic clinoform over the last 10,000 years, human activities in the watershed in the last century have greatly reduced their sediment yield. This change is the result both of altering the flow of the rivers with dams and training structures as well as land-use changes that have reduced soil erosion. As a result of these changes, the

Apennine rivers are not likely to produce large sediment transport events during the EURO-STRATAFORM field studies. Under the present regime, the alpine rivers, most notably the Po, provide the dominant source of sediment to the western Adriatic.

In response to this finding, there has been a shift in focus of the field program from one focusing on individual river outflows along the Apennine coast to a broad scale characterization of the sediment transport of the coastal current regime, with particular attention directed at the mechanisms of far-field sediment transport from the Po River. The WHOI effort will be directed at describing the variability of the coastal current system in the along-margin direction, from the Po to the Gargano Peninsula, 400 km to the south. Detailed characterization of near-bed and surface-plume transport processes will be obtained from mooring and tripod arrays at several transects along the coast, deployed by WHOI and EURO-STRATAFORM collaborators. The WHOI instruments will include two tripods close to the mouth of the Po as well as a transect near Ravenna (Fig. 1). These observations will be integrated with the other EURO-STRATAFORM moored observations and shipboard hydrographic observations to address the large-scale transport processes.

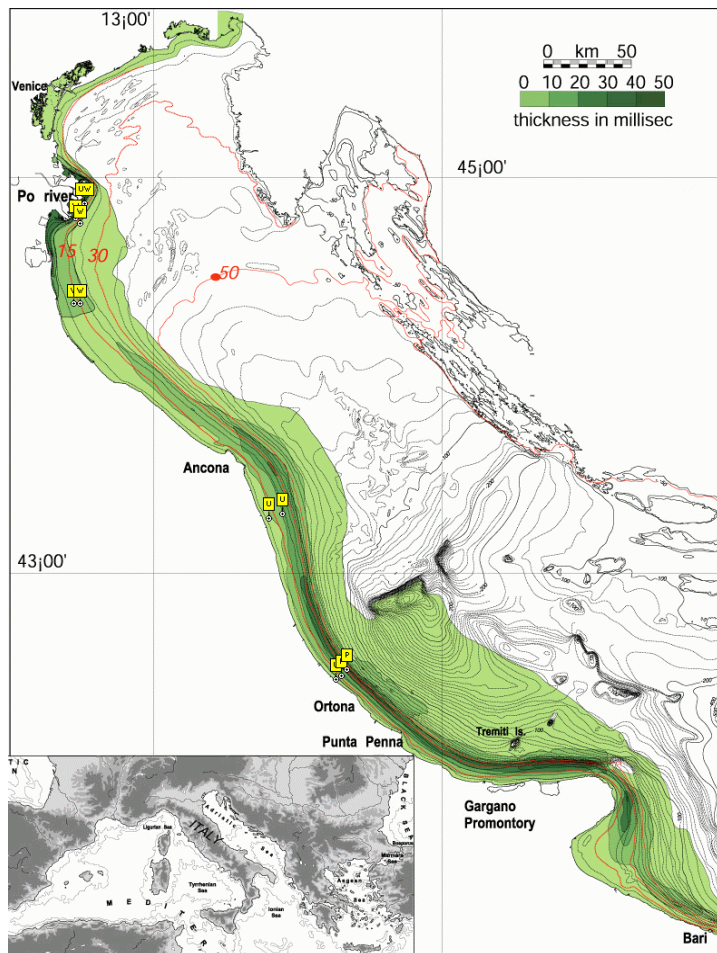


Figure 1. Map of the Apennine Coast of Italy and the Adriatic Sea with superimposed (green) contours of Holocene sediment thickness and EURO-STRATAFORM mooring locations indicated with yellow square (UW, University of Washington; W, Woods Hole Oceanographic Institution; U, United States Geological Survey; and P, Barcelona Institute of Marine Science). Figure courtesy of F. Trincardi and C. Nittrouer.

WORK COMPLETED

All of the gear for the mooring and tripod deployments was shipped in a container on September 20 for a late October deployment. The gear will be turned around in February and recovered in May. There is significant concern about risk to the equipment due to fishing activity. We are working on establishing an outreach effort to minimize the possibility of disturbance of the gear by fishermen.

The shipboard measurements will be performed during cruises in October-November 2002, February and May 2003. The WHOI effort will concentrate on quasi-synoptic surveys of the entire Apennine margin. Near-surface and near-bottom suspended sediment samples will be used for calibration of optical and acoustic suspended sediment sensors. Mineralogical analysis of the suspended sediment samples using Inductively Coupled Plasma Mass Spectrometry (ICPMS) to differentiate sources of suspended sediment.

RESULTS

In response to a large flood of the Po River during the fall of 2000, University of Washington investigators deployed a bottom mounted instrumented tripod several kilometers south of the Po River mouth. We equipped this tripod with an acoustic backscatter system (ABS) which measures bed elevation and vertical profiles of suspended sediment. Unfortunately the tripod was not deployed until several months after the flood events; however, seabed sampling shortly after the flood revealed deposits of 10's of cm of new sediment within the vicinity of the river mouth. The seabed elevation record from the ABS shows deposition in the spring of 2001 following the flood events (Figure 2). We interpret this as a redistribution of the sediment discharged during the fall 2000 flood events. During following winter season (2001-2002) Po sediment input was low and storms are consistently erosional with a decrease of 5 cm. Further analysis will examine the critical stress for resuspension and the erosion rate as function of time to examine if as the bed elevation decrease is accompanied by a decrease in the erodability of the sediment.

A higher time resolution view of storms in spring 2001, and winter 2001-2002 reveals that the depositional events in spring 2001 are marked by high concentrations of sediment trapped within the wave boundary layer (Figure 3). The concentrations are sufficiently high to attenuate the bed return. Based on our Eel Shelf work with the same ABS system this usually indicates fluid mud concentrations in excess of 10 g/l. During the erosional events of winter 2001-2002 concentrations in the wave boundary layer were lower, and did not significantly attenuate the bed return. . These observations provide additional evidence that depositional events are often associated with the presence of fluid mud.

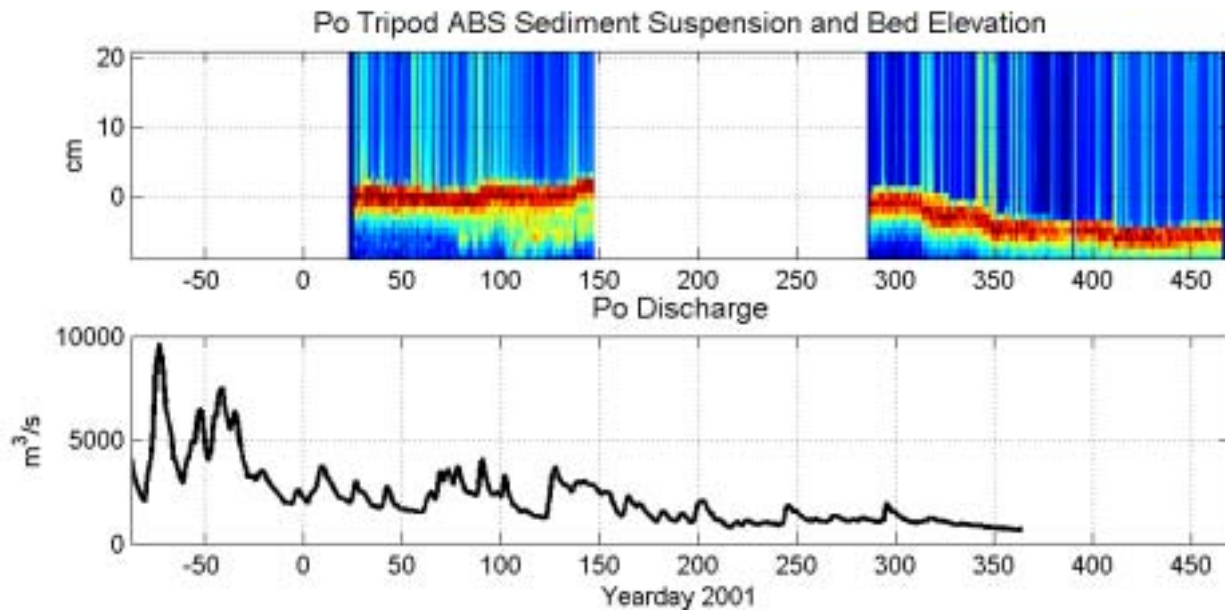


Figure 2. Acoustic backscatter data showing an increase in bed elevation during storms in the spring of 2001 following a large Po River flood in the fall of 2000, and decreases in bed elevation during the winter of 2001-2002.

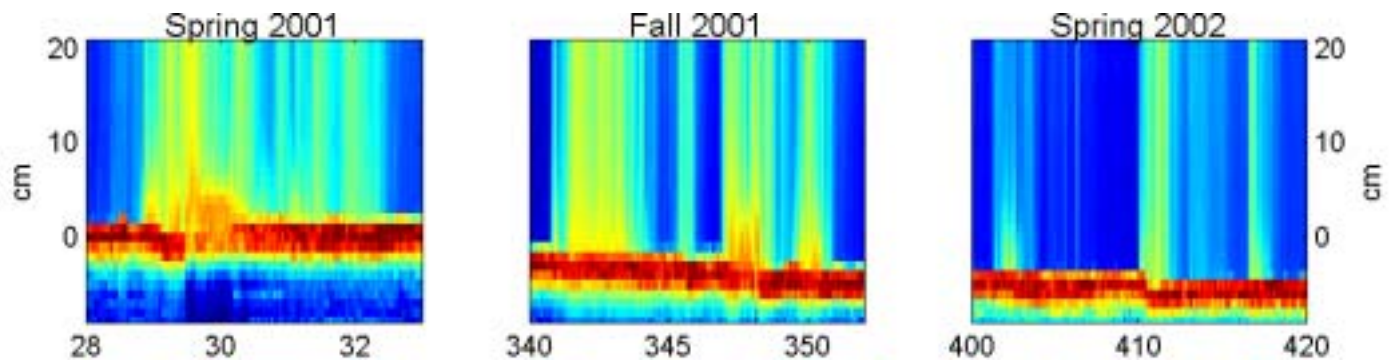


Figure 3. A higher time resolution view of storms during each deployment. During the spring of 2001 sufficient sediment concentrations are resuspended in the wave boundary layer (lower 5cm) to attenuate the acoustic return from the seafloor. These high concentrations do not occur during erosional storms in the winter of 2001-2002.

IMPACT/IMPLICATIONS

The observations and modeling that are being conducted in the Adriatic Sea as part of EURO-STRATAFORM provide an important test of our current understanding of the coupled processes governing suspended sediment distributions, boundary-layer dynamics and temporal evolution of the sea-bed. The combination of advanced observational methods and state-of-the-art regional numerical simulations provides a unique opportunity to assess the skill of our numerical models and our understanding of the mechanisms. The combination of methodologies will lead to significant improvements in our ability to forecast environmental conditions in coastal environments.

TRANSITIONS

Preliminary results of the observational work and detailed plans for the field work were presented at the International EURO-STRATAFORM Meeting in Winchester, U.K. in September, 2002.