ANATOMY OF RECENT FLOOD DEPOSITS IN THE NEARFIELD OF THE PO PRODELTA (NORTHERN ADRIATIC SEA ITALY)

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Abstract
Comparison between stacked flood-event deposits and discharge records represent a new method for interpreting delta stratigraphy and link the delta to active processes. This work demonstrates the potential of prodelta cores to complement and extend the record back in time from gauge stations.
Keywords: Adriatic Sea, Po Delta, Sedimentation

The Modern Age Po Delta is the result of a marked phase of river-dominated growth, where increased sediment flux derived from climatic change and by human impact both on the catchment (deforestation) and on the delta (diversions to the south accompanied by construction of artificial levees to maintain a fixed channel network) [1]. The modern Po delta has an area of 380 km^2 created during the last 500 years [1]. The present Po River has an annual discharge of 1489 m^3/s as measured from 1918 to 2009 at Pontelagoscuro, 90 km from the coast and just before the apex of the delta. Annual floods occasionally reach 10,000 m^3/s. The Po River has two flood periods, June (snow melt) and November (cold frontal rain). Downstream of Pontelagoscuro, the Po forms a delta consisting of five major distributaries: Maestra, Pila, Tolle, Gnocca and Goro. Average suspended sediment delivery is 11.5 MT yr^{-1}, with a range of 2.9 M/yr (1983) to 22.4 M/yr (1937). Bedload is not measured but is predicted to contribute $\approx$2.5% of the total sediment output of the Po River [2]. Two basic types of prodelta deposits occur in high-resolution seismic records: (i) shingled lobes characterized by laterally continuous seismic reflectors consistent with preserved flood layers and (ii) prodelta lobes accompanied by massive cut-and-fill features. The latter may represent past periods dominated by direct hyperpycnal discharge from the river, whereas the former appears more consistent with present-day transport processes, including perhaps wave-supported gravity flows [1]. The October 2000 flood was a 50-year return interval flood resulting in a thick flood deposit (up to 35 cm) close to Pila mouth of the Po River [3].

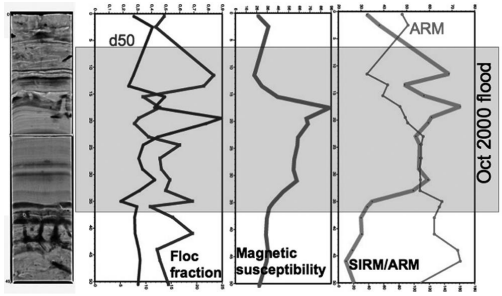

Fig. 1. October 2000 flood deposit recovered at 20m water depth off " Pila" distributary channel. The 35 cm thick flood deposit, observed in Xray image, shows a complex internal stratigraphy also recorded by physical parameters.

Event-response coring on the Po River prodelta coupled with shipboard digital X-radiography, resistivity profiling, and grain-size analyses permitted documentation of the initial distribution and physical properties of the 4 major flood deposits of the last 100 years. From 1994 to 2009 the delta front of the Po river has been sampled and 4 major flood events are recorded in the uppermost unit of the recent deposits occurred in November 1994, October 2000, December 2002 and May 2009. Fine-grained sediment from the Po River settles close to the mouth, leaving only a small amount of material in suspension in the plume for direct deposition onto the prodelta. The Po flood deposit has a complex internal stratigraphy, with multiple layers, laminations, ripple cross bedding, lenticular bedding, soft-sediment deformation structures, and dramatic changes in grain size that imply rapid deposition and fluctuations in energy during emplacement due to ocean weather conditions.
Using the Fall-2000 flood "anatomy" as an example, we demonstrate that it is possible to correlate the associations of benthic foraminifera, thecamoebians, organic carbon content, concentration (X, ARM, SIRM) and grain-size (SIRM/ARM, SIRM X, ARM/X) related magnetic parameters, in prodelta environments to evaluate the discrete unit produced by each flood [4]. In addition a suite a major, minor, and trace elements has been performed on a split core using X-ray fluorescence (XRF) core scanner to provide the variability of bulk-sediment chemistry in each flood deposit. Furthermore the 2009 cores record the 2000 flood layers with the
internal stratigraphy preserved.

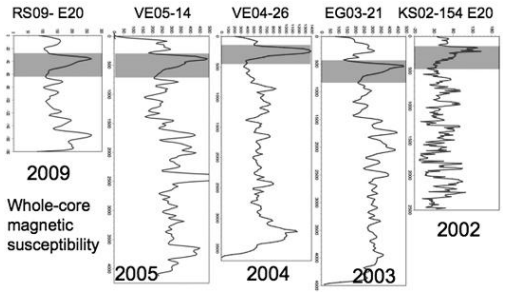

Fig. 2. Magnetic susceptibility record in 5 cores collected, from 2002 to 2009, off *"Po della Pila"* distributary channel. The flood deposit, marked by a shaded area , is preserved after 9 years from the emplacement.

All together these parameters allow to reconstruct the impact of recent and ancient flood events even where sedimentary structures are not unequivocal. An increasing contribution of magnetic minerals with larger grain-size is correlate with minima in the flocculation observed in the sediments.
The recognition of sedimentary structures and textures is important for gaining an inproved understanding of the behaviour and mechanism of sediment deposition from catastrophic flood events. These observations provide insight into nature of large scale flood processes that cannot be measured directly. Moreover a correlation between flood deposit and sediment discharge could define a threshold discharge required to produce sedimentary deposits. To fully appreciate the natural behaviour of shallow-water depositional systems before and under major human impacts, it is necessary to extrapolate time-averaged estimates of changes in sediment supply from indirect data, such as the volume of depositional units (delta lobes) measured from HR seismic profiles [5].

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