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A multidisciplinary approach for tidal palaeochannel reconstruction: a case study from the lagoon of Venice

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Tidal channels are very complex morphologies typical of transitional environments like lagoons and estuaries and they play a key role in their hydrodynamics, geomorphology and ecosystem functioning. Thus, the study and reconstruction of the ancient channel networks is important in order to understand the long term evolution of lagoons and estuaries. The mapping of the palaeochannel position in historical times is also important for archaeological studies and for the localization of early human settlements. However, individual tidal courses extend over relatively small areas and the detailed reconstruction of a buried palaeochannel network can be rather difficult if based only on punctual geological observations. In this regard, the acoustic exploration can be very helpful for the reconstruction of buried morphological features. Up to the last few years, though, the use of acoustic methods have been often restricted to the navigation canals by the shallowness of transitional environments, that, outside the modern navigation canals, can present natural channels and creeks, tidal flats, and intertidal zones with a water depth often shallower than one meter.

As a case study, we focus on the Lagoon of Venice since it represents a unique result of natural and anthropogenic action. In order to study the past and recent changes in the Venice lagoon morphology, a multidisciplinary research project has been carried out in the northern part of the lagoon. An extensive high space resolution acoustic survey in ultra-shallow water (up to a depth 0.5 m) for a total of 580 km, together with the study of 11 cores extracted in the study area, revealed the Holocene sediment architecture. With the help of the information from the cores (lithology, grain size, sedimentary structures, physical properties, Munsell color, radiocarbon ages, the presence of vegetal remains and palaeontological content) we identified the sedimentary the facies typical of the lagoonal environment. At the same time, the high density of the survey lines allowed us to extend the punctual properties of the cores to larger neighbouring areas.

The results of the traditional seismic facies interpretation were successfully compared with the classification of acoustic data parameters by a new algorithm based on wavelet analysis and neural network that allowed the automatic classification and mapping of the buried morphological features. Thanks to this multidisciplinary approach we could reconstruct the paths and history of a large tidal meandering palaeochannel, of a medium size palaeochannel and of a few buried creeks. The reconstruction was confirmed by the comparison with several historical maps available in the area. Overall, in relatively recent times, we observe a trend of filling up of the channels and a general simplification of the lagoon morphology in the area.