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DEFINITION OF A NEW APPROACH IN ANCIENT HARBOR GEOARCHAEOLOGY: GEOCHEMISTRY AND OSTRACOD ANALYSES AT PORTUS (TIBER DELTA, CENTRAL ITALY)

Portus constituted the harbour complex of imperial Rome from the 1st century AD onward.

Located in a deltaic environment, the harbour was subject to influences of the Tyrrhenian marine environment and of the fluvial waters of the Tiber River. Such complex sedimentary processes registered also rapid environmental changes. Our research is based on the study of a sediment core (TR14) drilled in the access channel of the hexagonal basin of Trajan (Fig. 1). The goal of our study is the reconstruction the palaeo-environmental dynamics of the water column of the harbour according to a geochemical and an ostracodological approach.

The analysis of the ostracod assemblage has evidenced several palaeo-environmental phases. These phases could be identified through the autoecological analysis of the 25 recognised taxa and their classification in four ecological groups (Mazzini *et al.*, 2011). The results obtained present a succession of four environments, defined by variations in salinity and oxygenation.

From the bottom to a depth of 643 cm, the environment was a marine to brackish lagoon influenced by strong marine inputs as evidenced by the vicariance of *Cyprideis torosa* and *Pontocythere turbida*. *P. turbida* is a typical phytal ostracod often found together with *Posidonia oceanica* remains. From 600 to 454 cm the coastal marine environment becomes more stable. This could be linked to the establishment of the harbour activities and maintenance. The stability of the environment is still evident in the subsequent group, from 435 to 305 cm, characterised by the dominance of *C. torosa* and the lack of any fresh-

Fig. 1 — Location of the study area and of the TR14 core.

water influence. The increase in salinity could be related to evaporative effects on a closed body of water. From 300 cm the freshwater input becomes clear and constant although the influence of the close sea/brackish body of water is still noticeable. In the last metres a typical freshwater assemblage is represented, dominated by truly freshwater taxa (*Candona* sp. and *Pseudocandona marchica*), evidence for the occurrence of a freshwater marsh.

The geochemical results were analysed by Principal Components Analysis (PCA). The samples were assembled in several groups based on a Hierarchical Ascendant Classification (cluster analysis). Through PCA analysis, the geochemical and ostracological results of the "functional" harbour unit (800-300 cm) were combined. The different elements recorded in the geochemical analysis are distributed according to the main ostracod assemblages (from fresh water to brackish water and sea water). These elements have been grouped according to the model proposed by SAGEMAN & LYONS (2003). An evolution of these deposits in three stages is proposed. While the fluvial environments were quite well oxygenated, the harbour environment was more characterised by an increasing anoxia of the water column as it was observed by ELMALEH *et al.* (2012) in the harbor of Tyre. In a second phase, the variations in salinity distinguished the nature of the fluvial environments and the degree of openness to the sea of the harbour environment. The final phase is specific to a body of water completely isolated from fluviatile and marine

influences and could be well representd by the fresco painted by Danti in 1582 in which the basin of Claudius is dried up, while Trajan's hexagonal basin and its access channel constitute a completely isolated marsh.

One of the objectives of this study was to determine the sedimentary sources of the different granulometric fractions, in order to evaluate their respective role in the sedimentation of the basin of Trajan. Comparison of the geochemical data and the granulometric data has led us to propose a fluvial origin for the fine particles (clays, silts, and very fine sands) and a marine origin for the sandy particles from the harbour of Claudius.

This multi-proxy study also provided the opportunity to identify the sedimentary sources of the fine and sandy particles of the harbour basin originating respectively from the fresh water of the Canale Traverso and the sea water of the port of Claudius.

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