

HOLOCENE PALAEO-GEOGRAPHICAL EVOLUTION OF THE SELE RIVER COASTAL PLAIN (SOUTHERN ITALY): NEW MORPHO-SEDIMENTARY DATA FROM THE PAESTUM AREA

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ABSTRACT: Amato V. et al., *Holocene palaeo-geographical evolution of the Sele River coastal plain (Southern Italy): new morpho-sedimentary data from the Paestum area.* (IT ISSN 0349-3356, 2011)

The Sele River Plain is hosted in a graben along the Tyrrhenian margin of the southern Apennine Chain and is formed of both displaced (Early and Middle Pleistocene) and undisturbed (Late Pleistocene and Holocene) sedimentary units. The strip that was accreted to the Plain during the Holocene high stand is characterized by beach-dune ridges whose sands interfinger –to the rear- with lagoonal and fluvio-palustrine deposits. The evolutionary trend was transgressive during the Early Holocene and progradational during the Mid-Late Holocene. In this work, we present new data about the Holocene evolution of the portion of the Plain in front and immediately north of the Poseidonia-Paestum archaeological area, where the knowledge has been improved by five new cores and by many collected archaeo-bio-tephrostratigraphical data. In the first area (Paestum area), due to a local rise of the ground (made of Late Pleistocene travertines) the Holocene transgression formed cliffs, while the second area (Laura area) was submerged. The tip of the travertine lobe was then cut by a sea cliff, whose correlative abrasion platform rests 7,5 m below the present s.l. The age of this stage can be inferred by the ¹⁴C dated mollusk remains (7.0 ky cal BP) of the beach deposits, found at the same depth in the Laura cores. In mid Holocene times the shoreline shifted seaward and a lagoonal environment – closed by the Laura sand ridge- was established (Fossa Lupata area). Age constraints for this stage are the Agnano M. Spina tephra (4.1 ky BP) and some archaeological remains of the VI cent. B.C. found within the upper part of the lagoonal clays. After this period, and mostly after the deposition of the 79 A.D. tephra, the shoreline shifted further seaward and an additional beach ridge formed, whereas the flat area of Fossa Lupata was rapidly aggraded and dried up.

RIASSUNTO: Amato V. et al., *L'evoluzione paleogeografica olocenica della piana costiera del Fiume Sele (Italia meridionale): nuovi dati morfo-sedimentari dall'area di Paestum.* (IT ISSN 0349-3356, 2011)

La piana del fiume Sele, ospitata in un half-graben del margine tirrenico dell'Appennino meridionale, è costituita da complessi fluvio-transizionali e costieri che appaiono sia dislocati (Pleistocene inferiore e medio) che sostanzialmente indisturbati (Pleistocene superiore ed Olocene). I paleo-cordoni costieri del Tirreniano (OIS 5) decorrono a circa 3 km dalla costa attuale; una distanza pari all'ampiezza della fascia aggiuntasi alla Piana durante l'Olocene. Tale fascia si caratterizza per la presenza di cordoni costieri le cui sabbie passano –verso monte- a depositi lagunari e fluvio palustri. Come mostrano i dati di sottosuolo, la tendenza evolutiva generale è stata trasgressiva nella prima parte dell'Olocene (con migrazione verso terra del sistema barriera-laguna) e progradazionale poi (D'Argenio et al, 2010). In questo lavoro vengono presentati i principali risultati di una indagine sulla evoluzione olocenica del tratto di pianura antistante (Area di Paestum) ed immediatamente a N (area di Laura) l'area archeologica di Paestum (settore SE della Piana del Sele). Nell'area di Paestum la fascia costiera olocenica, composta da più cordoni sabbiosi separati da piatte depressioni limo-torbose, è meno ampia che nell'area di Laura per la presenza di un dosso travertinoso che deve aver costituito un paleo-promontorio durante le fasi culminanti della trasgressione post-glaciale. Al fine di ricostruire in dettaglio le locali morfo-dinamiche costiere oloceniche, sono stati eseguiti 5 nuovi carotaggi in settori strategici, individuati mediante una accurata revisione dei dati archeologici e stratigrafici preesistenti. Sui livelli più significativi delle carote sono state eseguite analisi biostratigrafiche, palinologiche e tephrostratigrafiche supportate da indicazioni cronologiche fornite da datazioni ¹⁴C e da determinazioni archeologiche. I risultati conseguiti dimostrano in modo definitivo che le scarpatine rocciose che a tratti si riconoscono intorno al dosso travertinoso (ben evidente presso la Porta Marina di Paestum) sono la parte ancora emergente di una falesia costiera che si modellò durante la trasgressione olocenica. Circa la successiva fase di progradazione della linea di costa, i dati raccolti mostrano che essa avvenne con la formazione di un esteso cordone dunare (Cordone di Laura), posto circa 1 km più avanti della paleofalesia e recante alle spalle la depressione lagunare di Fossa Lupata. Le analisi biostratigrafiche, supportate da reperti archeologici ascrivibili al VI sec a.C., dal del tephra di Agnano M. Spina (4.1 ka BP), e da datazioni assolute ¹⁴C, eseguite all'interno dei depositi limo-argillosi dei nuovi sondaggi, confermano la presenza di tale sistema morfo-sedimentario di barriera-laguna costiera per l'intervallo di tempo che va da circa 7.000 anni fa alla data di fondazione della città di Poseidonia (540 a.C.). Dopo questo periodo e prevalentemente dopo la deposizione dei prodotti distali dell'eruzione vesuviana del 79 d.C., la linea di costa entrò in una nuova fase di prevalente progradazione. Nel contempo la depressione di Fossa Lupata conobbe una rapida aggrada-

zione ad opera di depositi fluvio-palustri, riducendo fortemente il proprio areale, fino ad essere bonificata dall'uomo nel secolo scorso.

Key words: Holocene, Sea level rise, Sele plain.

Parole chiave: Olocene, Risalita del livello del mare, Piana Sele

1. INTRODUCTION

The glacio-eustatic sea level rise occurred after the Last Glacial Maximum (LGM) led to a worldwide flooding of coastal plains and controlled the evolution of marine embayments, fluvial mouths and rocky coasts. Its significant deceleration in the mid-Holocene often led to overcompensation by sediment supply and shoreline progradation. In the Mediterranean area, progradation was more marked during the last 2.5 ky, when the impact of Man on soils and vegetation covers increased the rates of erosion and, consequently, the solid discharge of rivers toward the coasts (AMATO, 2006 and references therein). This general evolutionary trend has been widely recognized by many multiproxy researches, including geomorphology, geology, palaeobiology and archaeology (PIRAZZOLI, 1996 and references therein). Similarly, it is known that the alluvial-coastal plain of the Sele river was interested by the same morpho-sedimentary behavior during the Holocene, with a transgressive trend during the early Holocene and a progradational trend of shorelines starting from middle Holocene (CINQUE, 2008 and references herein). The Sele river plain is located along the Tyrrhenian margin of the southern Apennine Chain and is formed of both displaced and undisturbed sedimentary units. The former are Early to Middle Pleistocene in age, while the latter span from the Last Interglacial (OIS 5) onwards. The fossil beach ridges of the late OIS 5 run about 3 km inland from the present shoreline; a distance corresponding to the strip that was accreted to the plain during the Holocene high stand. Migrating also upward, the sandy barrier (including a dunal cover) reached up to 4–6 m above the present s.l. in the Middle Holocene (Laura ridge; with shells dated between 5.3 and 3.6 ka; CINQUE, 2008 and references therein). The buildup of this ridge marked the beginning of a prevailing progradational phase that included the construction of two other sand ridges (Sterpina I and II, dated to before 2.6 ky BP and around 2.0 ky BP respectively) and the filling of the back-barrier depression, initially with lagoonal pelites and then with palustrine deposits (CINQUE, 2008 and references therein). In the SE portion of the Sele Plain, the Late Quaternary coastal evolution was affected by numerous generations of travertine deposits. Recently, AMATO *et al.* (2009) have provided a detailed chronological reconstruction of the various stages of the Paestum depositional system: it was active during the Last Interglacial (Tyrrhenian) and

the early Holocene until about 5000 years ago, and in the historical period during the Late-Ancient and Middle Ages (V–IX century AD). In the coastal sector, in front of the archaeological area of Poseidonia-Paestum LIPPMANN-PROVANSAL (1987) proposed, that a coastal lagoon had already established in the Iron Age (3.0 ky ago) while GUY (1990), suggested that, during the Classic period (2.5 ky ago), there was only a small lagoon (pond or artificially preserved and open to the sea). Using geomorphological and integrated stratigraphic methods, we focused the researches on the Holocene morpho-stratigraphy changes of this sector of the Sele plain, in order to reconstruct the paleoenvironmental and landscape changes, and to decipher the local sea level rise history and horizontal shoreline changes.

2. NEW MORPHO-STRATIGRAPHICAL DATA

The coastal strip in front of the archaeological area of Paestum presents a very articulated landscape, consisting in an inner area situated at an altitude between 10 and 20 m a.s.l., some meters higher than the average level of the plain, that does not exceed 5 m a.s.l. Such morphological high, slightly sloping to the sea, appears to be composed of travertine deposits, belonging to different depositional bodies (as previously described). These polyphasic depositional bodies, generated during the late Quaternary, now form self-terraced bodies. Landward, the hanging travertine bodies are connected to the piedmont belt of the Capaccio hills and seaward to the coastal strip by a steep escarpment cut into travertine, whose remains are still visible at Porta Marina of Paestum. This steep scarplet gently downgrades toward a depressed area (Fossa Lupata), situated at ca. 4 m a.s.l. behind a large sand dune ridge, which reaches ca. 6 m a.s.l. and is located about 1 km from Porta Marina. In the sector immediately northward, some units of the polyphased travertine lobe interfinger with barrier-lagoonal systems of the HSSLs of OIS 5. Here, the Holocene coastal strip is wider and, from its inner side down to the present shoreline, is constituted by a great flat depression area (2–3 m a.s.l.), connected with Fossa Lupata, and delimited seaward by two sandy barriers.

In addition to the numerous archaeological and geoarchaeological data obtained from excavations, and to stratigraphic data derived by collected cores, five new cores (S2, S3, L1, L2 and L3) were drilled. S2 and S3 were taken, respectively, in the

area immediately west of the scarplet cut into the travertine of Porta Marina (5.5 m a.s.l.), and in the outer dune ridge, immediately behind the coastal road (2.5 m a.s.l.). L1, L2 and L3 were drilled in the area immediately north of the Poseidonia-Paestum archeological area, where the Laura barrier-lagoon system crop out. The morpho-stratigraphic data, supported by biostratigraphic analyses, by tephra layer correlation, such as the 79 AD, the Agnano Monte Spina (4.1 ky BP), the Neapolitan Yellow Tuff (15ky BP), and the Y3 tephra (30 ky BP), by ¹⁴C dated layers, by layers with archaeological remains, and referring the data to the known Holocene morpho-sedimentary trends, allowed us to outline some important stages of the Holocene palaeogeographical evolution of the SE sector of the alluvial coastal plain.

- The sea level low-stand of the LGM(20 ky BP) led to a strong progradation of the shoreline. Therefore, the whole studied area was interested by fluvial-marshy sedimentation including the Neapolitan Yellow Tuff and the Y3 tephra.

- The rapid sea level rise of the first part of the postglacial period led to a rapid submergence of the coastal plain. In the area of Paestum, the transgressive trend has favored the formation of a cliff cut in travertine, now partly buried by travertine deposits of mostly medieval age.

- As soon as the rate of the Holocene sea level rise decreased, a rapid shoreline progradational trend started, and a barrier-lagoon coastal system formed. The ¹⁴C dating of mollusk remains from the beach deposits (7.0 ky cal BP), the presence of the Agnano M. Spina tephra (4.1 ky BP) and the archaeological remains of the VI cent B.C. into lagoonal deposits allowed us to hypothesize the presence of a barrier-lagoon coastal system during this period.

- Between the foundation of the Greek-Roman town of Poseidonia-Paestum (540 B.C.) and the 79 AD, the lagoonal area was interested by continental deposition (marsh); the shoreline prograded a few hundred meters and an additional sandy dune ridge formed seaward.

- After the 79 AD and up to now, the shoreline progradational trend was emphasized and the flat depression area was interested by a strong aggra-

ation of the ground level due to anthropogenic fills, reworked volcanoclastic deposits of the 79 AD and historical deposition of travertines.

In conclusion, the archaeo-bio-tephra-chronostratigraphic data allowed us to assert that the Holocene sea level rise reached -7,5 m a.s.l. at about 7.0 ky BP and -1.5 m a.s.l. at about 4.1 ky BP. These data, if compared with those about the Holocene sea level rise in the Mediterranean area, suggests that the Paestum sector of the plain has been interested by a substantial tectonic stability.

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