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Sedimentary facies recognition using XRF core scanner, on two former lagoonal systems of western Peloponnese, Greece

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Background

The understanding of palaeoenvironmental changes through sedimentological, palaeontological, geochemical and mineralogical studies provide information regarding depositional environments, elemental fluxes, palaeoclimate reconstruction, sea level fluctuation, tsunamigenic phenomena and tectonic activity (Kontopoulos and Avramidis 2003; Vött, et.al., 2009, 2011; Avramidis et al., 2013; Emmanouilidis et al., 2018). Coastal aquatic systems are considered environmentally sensitive areas formed behind sand or gravel barrier shorelines, at the terminal area of the coastal alluvial plains or at river mouths. They are shallow and highly dynamic ecosystems at the interface between coastal and marine environments, which can be permanently open or intermittently closed off.

The study of sedimentary facies in lagoonal systems reveal transition patterns concerning sediment runoff, physical erosion in the catchment area, human activity etc. High resolution geochemical profiles, relative changes and altering trends of elemental concentration imprint these palaeoenvironmental changes as well as micro facies that would not be detected otherwise. Many researchers use geochemical proxies such as Rb/Sr, Fe/Mn, Ca/Ti, Sr/Ti, Zr/Rb, Zr/Ti to delineate existing physical, sedimentological and geochemical processes such as evaporation, precipitation, dissolution of solid phases, Eh and pH changes, chemical and physical weathering.

Objectives

Mouria and Agoulinitsa lagoons are located in western Peloponnese, Greece. Palaeoenvironmental studies conducted in western Greece, reveal continuous transitions in the geomorphological evolution of coastal aquatic systems. Marine inundations, human activity and fluvial influx comprise major aspects into the lifespan of those systems. In this framework, the present study reveals such sedimentary transitions in both studied sites based on sedimentological and geochemical proxies.

Methods

Two sediment cores were retrieved using an Eijelkamp vibrating corer with closed barrel tubes. After the extraction, the cores were sealed with cling film and transported for analysis in the laboratory of sedimentology, University of Patras, Greece.

Standard sedimentological analyses were carried out, on a total of 80 sediment samples including: (1) grain size analysis and calculation of moment measures such as mean, sorting, kurtosis and skewness, (2) color determination and RGB profile plot, (3) Total Organic Carbon (T.O.C.), (4) Total Carbon (T.C.), (5) Total Nitrogen (T.N.), (6) Calcium Carbonate Content (CaCO3), (7) Total Phosphorus (T.P.) content and (8) Magnetic susceptibility measurements.

U-channels were extracted from the sediment cores for XRF core-log analysis using the Avaatech system at the Institute of Geosciences of Kiel University. Core scanning was performed with a Molybdenum tube set at 10 kV and 30 kV with a step of 0.5 cm and an integration time of 60 second per measurement.

Results

Compiling all the sedimentological and geochemical data, 3 main lithological units were distinguished for Mouria core (Fig. 1) and 2 for Agoulinitsa core.

For Mouria core, Units 1 and 2 consist of coarser material and present the highest values in geochemical ratios Si/Ti, Ca/Fe, Sr, Cl, S, Zr/Rb (Fig. 1). The increase of Cl and S indicate the marine influence in the study area whereas Mn/Fe ratio reflects the oxic conditions (Fig. 1). Magnetic susceptibility is mostly associated with terrestrial input in the study area, thus presenting the lowest values at these units (Fig. 1). Unit 3 consist of fine organic rich sediment. Elemental ratios such as Ti and Rb/Sr are strongly associated with clay minerals and provide a clear signal concerning the physical erosion and fine sediment deposition in the study area.

Concerning Agoulinitsa core, the two sediment units that were recognized, present similar trends with Mouria core. The first two meters of the core, are characterized by organic rich sediment, presenting high values for the terrigenous elements. Mn/Fe ratio, indicates anoxic conditions, validating the high organic content and thus presents a more lacustrine environment. Sandy units at the lower parts of the core (>2 m) present an open lagoonal environment. Higher values of S, Cl and Br indicate constant marine inundations into the system.

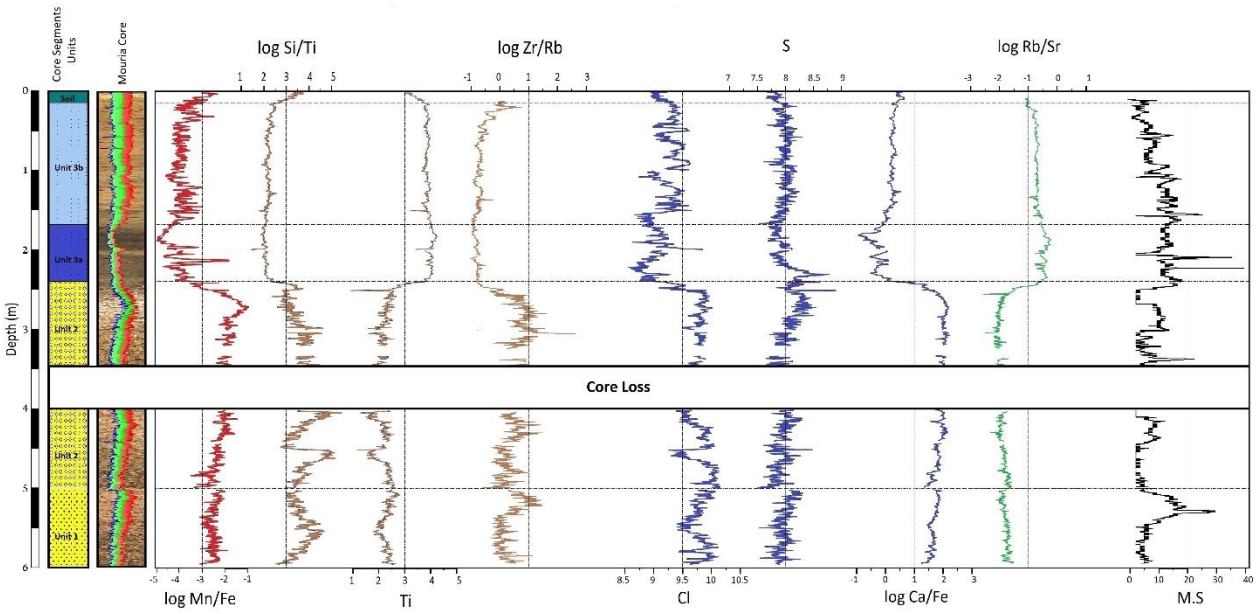

Figure 1. Representative geochemical proxies from Mouria lagoon

Conclusion

The sedimentological, geochemical and magnetic susceptibility measurements from both sediment cores (ML-1 and AG-1), indicate different sediment transport and depositional processes. Non-destructive analysis conducted on both cores, imprints all the palaeoenvironmental and palaeogeomorphological changes that occurred in the study area as well as the interplay between those coastal aquatic systems and marine environment.

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