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IOANNA KOUTSOMICHOU (*), SERAFIM POULOS (*), NIKI EVELPIDOU (*),
CHRISTOS ANAGNOSTOU (*), GEORGIOS GHIONIS (*) & ANDREAS VASSILOPOULOS (*)

THE ROLE OF BEACHROCK FORMATIONS IN THE EVOLUTION OF EMBAYED COASTAL ZONES OF ATTICA (GREECE) IN RELATION TO SEA LEVEL RISE. THE CASE OF KALYVIA BEACH ZONE (***)

ABSTRACT: KOUTSOMICHOU I., POULOS S., EVELPIDOU N., ANAGNOSTOU CH., GHIONIS G. & VASSILOPOULOS A., *The role of beachrock formations in the evolution of embayed coastal zones of Attica (Greece) in relation to sea level rise. The case of Kalyvia beach zone*. (IT ISSN 0391-9838, 2009).

The coastline of Attica incorporates a great number of pocket beaches, which are characterised further by the presence of extensive beachrock formations. The present study concerns the evolution (past, present and future) of the Kalyvia beach zone, located at the western coast of Attica and at a distance of 42 km from the city of Athens. The subaerial part of the beach zone consists of mixed materials (mainly sand, granules and gravel), while extensive beachrock formations exist on its shoreface. The beach is exposed primarily to southern wind-induced waves, the largest of which (offshore wave height up to 6m and period >11sec) begin to break at about 8 m of water depth and have a run-up capability of approximately 1.5 m. Most of the subaqueous part of the Kalyvia beach zone is lithified, as the beachrocks extend from the shoreline down to >8 m of water depth. This part of the beach zone may be subdivided further into three units: the deeper one (water depths >7m), the middle (depths 5-6.5 m) and the upper unit (from 4 m depth up to the shoreline). This almost continuous presence is related to the gradual sea level rise during the upper Holocene (past 6.000 years), indicating also a relative climatic stability and/or homogeneity during this period, although some morphological and structural differences in the beachrock indicate changes either in the rate of sea level rise or in the prevailing climatic conditions. Over the last decades, human activities and constructions have deprived the beach of hinterland sediment supply, changing, therefore, its sedimentological character. During this period, beachrocks have played a 'protective role' stabilizing and reducing substantially the retreat of the beach zone, which on the basis of the landward boundary displacement of the beachrocks has been estimated to be in the order of 30cm per year from 1969 to 2005. This retreat is attributed to the marine erosion of the sediment that used to cover the upper beachrock formations, in combination to the sea-level rise (approx. 18 cm over the past century) and the lack of sediment supply. Moreover, this degradation of the Kalyvia beach zone is expected to be intensified by the potential future sea level rise (approximately 38 cm for the year 2100).

KEY WORDS: South Attica (Greece), Coastal Geomorphology, Beachrock, Coastal erosion.

INTRODUCTION

The coastline of Attica is characterised by the presence of a large number of bays of various dimensions, separated by headlands, which inhibit exchange of sediment between them. Extensive beachrock formations are present in many beach zones formed in bays associated with alluvial plains, e.g. in Anavyssos, Kineta, Kalyvia Bay, Varkiza Bay and in many other sites, either in Greece (e.g. Leondaris, 1986; Plomaritis, 1999; Neumeier & *alii*, 2000; Anagnostou & *alii*, 2005; Fouache & *alii*, 2005; Belias, 2007; Vousdoukas & *alii*, 2007). or the rest of the world (e.g. Russel, 1959; Gewelt & Fierro, 1984; Cooper, 1991; Rey & *alii*, 2004).

Beachrocks are hard, rocky formations, originating from the cementation processes of the beach material (sand and gravel); the latter process is related to the precipitation of carbonates (calcite or aragonite) induced either by physicochemical or biological factors with the first to be associated often with the mixing of fresh and marine (saline) waters. Beachrock formations may occupy large parts of the surf zone and may even extend beyond the breaking point (Russell & McIntire, 1965), while their outcrops may act as barriers trapping the sediments involved in the longshore

(*) *University of Athens, Faculty of Geology & Geoenvironment*.
(**) *Hellenic Centre for Marine Research, Institute of Oceanography*.
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