

BEACHROCKS IN THE MEDITERRANEAN: MORPHODYNAMIC, ECOLOGICAL AND SOCIO-ECONOMIC IMPACTS

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Abstract

Beachrocks are coastal sedimentary structures formed by the lithification of beach material, due to precipitation of mainly carbonate cements from the coastal sea and/or fresh waters. In this contribution a discussion of their morphological, ecological and socio-economic impacts is taking place, based upon information from the literature, results of morphodynamic modelling and detailed field studies, as well as from a questionnaire survey on foreign tourists at a Greek island. The results of the study show that coastal wave dynamics and beach morphodynamics are significantly influenced by beachrock formation. Regarding the ecology, the transformation of sandy beaches to rocky foreshores, leads to the development of new habitats and fauna and flora assemblages. Finally the questionnaire survey showed that beachrocks may also decrease the amenity value of beaches, and potentially harm tourism.

Keywords : Biodiversity, Erosion, Coastal Management, Coastal Models, Monitoring.

Beachrocks are coastal formations resulting from the cementation of beach sediments by mainly calcitic or aragonitic cements. The cementation occurs either on the surface or, more commonly, beneath the littoral/intertidal sediments, and the resulting formations can be kilometres long, attain widths of hundreds of meters and thicknesses of up to several meters. Beachrocks have been thoroughly studied in the 60s and 70s from geologists, mainly regarding their formation mechanism, without reaching to solid conclusions (see [1-4]). On the other hand there are significant indications that they affect beach morphodynamics [5], and they often result to transformation of sandy beaches to rocky ones, followed by significant implications to ecology and socio-economy. However it is very interesting that studies on such impacts are very few and given that Mediterranean Sea is a hot spot for the phenomenon of beachrock formation, of high importance. The objective of the present contribution is to present the impacts of beachrock formation on coastal morphology, ecology and socio-economy.

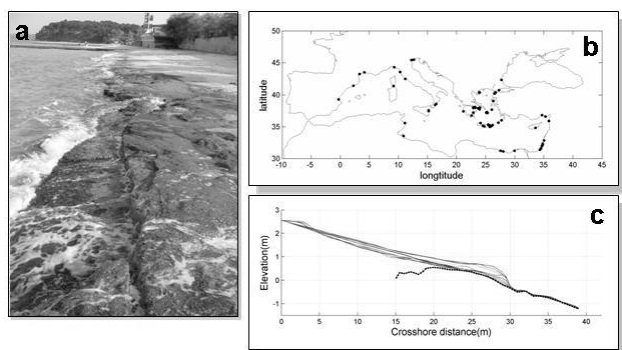


Fig. 1. Typical beachrock formations on Kalithea, Chalkidiki, Greece (a), map of reported beachrock occurrences (from scientific journals) in the Mediterranean (b), beach profile envelopes from Vatera beach, Lesvos Island, Greece, demonstrating the 'reduced' dynamics of the profile, as well as the morphologic control by the beachrock presence.

The 7.5 km long, microtidal beach of Vatera, Lesvos Island, Greece, was chosen as study area, characterized by the presence of extensive beachrock formations. Seasonal ecological sampling, beach levelling and sediment sampling has been carried out all along the beach, while the buried upper beachrock surface was also levelled (after excavation of the beach). A beach profile evolution model based on the Bussinesq equations [6], was specially modified for the case of beachrock infected beaches [8] and was applied in various wave conditions, to compare the morphodynamic response of the beach profile for a 'normal' and a beachrock presence case. Finally in order to investigate the possible impacts of beachrocks on tourism, a questionnaire survey was carried out in the two infected coastal areas of Lesvos Island (Plomari and Vatera).

Regarding beach morphodynamics, the overall analysis of the field data

and the modelling results suggest that: (i) beachrock spatial distribution along the beach is controlled (amongst others) by beach sediment size and wave energy levels; (ii) beachrocks drive the formation of big scour steps (range of 0-1 m) that impede shoreward cross-shore sediment transport, and provoke beach erosion; (iii) beachrocks appear to 'lock' the beach profile and control its final shape which is highly correlated to the one of the formations' upper surface; (iv) affect the waterflows through the porous sediment body in a way that facilitates sediment suspension and transport.

On the analysis of the ecological samples [8], seven algae taxonomic groups were identified as well as 31 invertebrate taxa, most of which are typical of hardbottom communities. Statistical analysis showed decrease in the population density and biomass towards the coastline, as well as an increase of mobile species' population densities with the depth (especially during the spring period).

The questionnaire survey [8] showed that, beachrock presence influences the interviewees beach quality rating in a negative manner; 64 % of the sample considers that the local authorities and the EU should take measures to protect the swimmers from the beachrocks and 51 % of the coast as well. Even though risk perception appears neutral, 55.4 % of the sample is willing to contribute on financial grounds to research, focused on the phenomenon, with widely ranging contributions.

All the above imply that beachrock formation is a natural phenomenon that may have significant impacts, which have not been studied accordingly yet. Particularly in the Mediterranean area, beachrocks are abundant and the latter combined with the intense development of the coastal zone, intensifies the current and anticipated problems due to their presence.

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