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PROCEEDINGS

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IAG GEOMORPHOLOGY

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THE ROLE OF PERMEABILITY AND GEOLOGICAL INHERITANCE IN THE SLOPE OF BOULDER BEACHES ON SHORE PLATFORMS

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It is generally assumed that beachface slope increases with sediment size because hydraulic conductivity enhances onshore flow asymmetry and steepens the beach profile (Masselink and Li, 2001; Bujan et al., 2019). We studied a coastal sector characterized by coarse beaches fronted by rocky shore platforms, developed on shales, gneisses, and granites. The beaches in the studied area can be defined mainly as boulder ridges and, in some places where the shore platform is narrow and low, as composite beaches, according to the classification by Carter and Orford (1993). A distinctive feature is the presence of cohesive, fine-grained sediment at a depth of about 30 cm below the beach surface, with the same slope as the overlying material.

The slopes of the coarse beaches were determined using LiDAR datasets from 2011 and 2015, and field topographic data collected in 2021, 2022, and 2023 with an RTK GNSS receiver. At seven sampling points, the sizes of 20 clasts were measured from the surface to depths of 25–35 cm. A sample of the sand and gravel matrix filling the clasts was also taken at each point, and granulometric parameters and shell content were analyzed. A core of 108 cm was extracted from the sediment below the coarse beach, and particles >0.063 mm were separated into gravels, coarse sands, and fine sands. The fraction <0.063 mm was divided into coarse silts, fine silts, and clays. A permeability test was conducted using the Water Drop Penetration Time method (Doerr, 1988). Two samples from the core were sent to Beta Analytics Laboratory for radiocarbon dating.

The slope of the boulder beachface ranges from 7.13º to 11.3º. Topographic profiles obtained from LiDAR and GNSS data show no significant changes during the studied period, except for the southernmost profiles. The coarse beach has a vertical structure with coarser clasts (D50 of the B axis between 41 and 102 mm) at the surface, and a mix of clasts, sand, and gravel below (D50 = 0.76–12.32 mm). The D50 of the sand fraction ranges from 0.64 to 1.87 mm, similar to the particle size of the sand in the lower section of composite beaches (D50 = 0.6–0.74 mm). The shell content in the infilling matrix ranges from less than 2 % to a maximum of 18.89 %. The sediment below the coarse beach forms a cohesive layer with a high fine-particle content. The proportion of silt and clay ranges from 22 % to 47 %, with a mean of 37 %. Radiocarbon dating places the sediment core's deposition between 9476–9394 cal. yr BP at the bottom and 9128–8986 cal. yr BP in the middle.

The sediment properties reveal that the internal structure of the beach was formed from two sedimentary sources: a gravel fraction of angular particles without evidence of wave reworking, and the <2 mm fraction sourced from the sand of composite beaches. Beneath this layer is a cohesive sediment up to 1 m thick, with two distinct sub-layers: an impermeable bottom layer and an upper layer with some permeability. The slope of the coarse beach aligns with expected values for coarse beaches (7º–11º), considering the upper clasts, the sand and gravel matrix, and the sand fraction (Fig. 1).

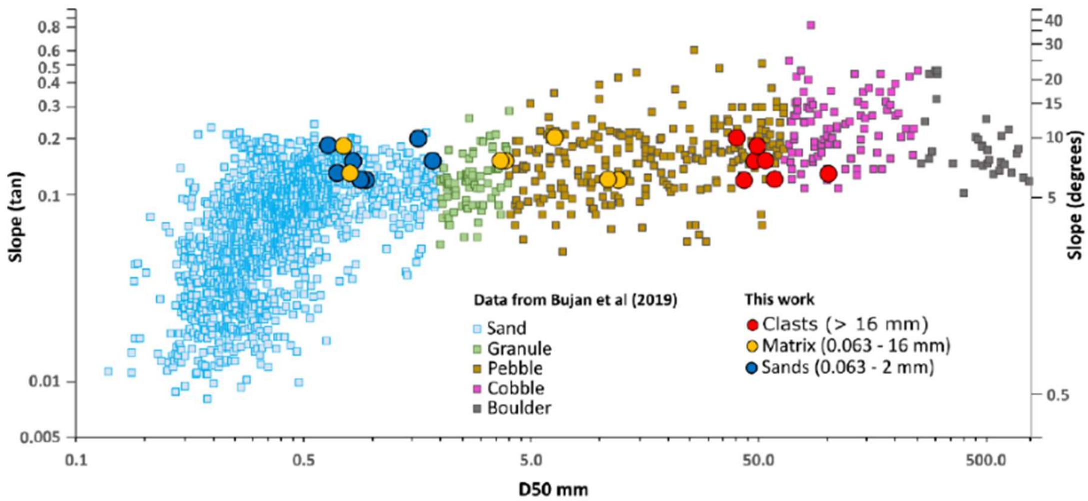

Figure 1. Sediment size and beach slope. Data from Bujan et al (2019) and this work.

The slope of the underlying impermeable sediment matches that of the coarse beach, suggesting that factors other than hydraulic conductivity influenced the system's development. Radiocarbon dates place the deposition of the underlying cohesive layers at the end of the Early Holocene, when sea level was low. On this coast, sea level reached an elevation close to the present around 3.5 kyr BP. The system's evolution suggests that, with the Holocene Sea level rise, continental sediments were eroded, exposing the rocky shore platform and partially eroding an older boulder beach, which supplied clasts that acted as abrasive tools. To achieve an equilibrium profile, an initial phase likely occurred where clast accumulation and cohesive sediment erosion took place simultaneously. Gravel and sand from fluvial sediment erosion were also incorporated into the new beach through processes such as kinetic sieving and infiltration, resulting in a Holocene coarse beach with a matrix of angular gravels and sands.

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