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Sediment Sources and Transport Pathway Identification Based on Grain-Size Distributions on the SW Coast of Portugal

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ABSTRACT

Espichel-Sines is an embayed coast in SW Portugal, consisting of two capes at both extremities, a tidal inlet and associated ebb tidal delta, a barrier spit, sandy beaches, sea cliffs, and a submarine canyon. Beach berm, backshore, near shore and inner shelf sediment samples were taken. Samples were analyzed for their grain-size compositions. This study ranks the hypothetical sediment sources influences on the sediment distributions in the study area using the multivariate Empirical Orthogonal Function (EOF) techniques. Transport pathways in this study were independently identified using the grain size trend analysis (GSTA) technique to verify the EOF findings. The results show that the cliff-erosion sediment is composed of pebbles and sand and is the most important sediment source for the entire embayment. The sediment at the inlet mouth is a mixture of pebbles, sand, silt, and clay, which is a minor sediment source that only has local influence. The overall grain-size distributions on the shelf are dominated by the sand except for the high mud content around the tidal delta front in the northern embayment. Sediment transport patterns on the inner shelf at the landward and north sides of the canyon head are landward and northward along the barrier spit, respectively. On the south side of the canyon head, the prevailing sediment transport is seaward. Sediment transport occurs in both directions along the shore.

Key words: Sediment grain size, Sediment source, Empirical Orthogonal Function (EOF) analysis, Grain size trend analysis (GSTA), Sediment transport pathway

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1. INTRODUCTION

Each year about 28 Gt of sediment is transported from the land into the oceans (Syvitski 2003). Most of the sediment remains at the river delta or deposited on the continental shelf and along the coast (Syvitski et al. 2003). Sediment transport leads to changes in coastal morphodynamics, coastline positions and grain-size patterns on the sea floor.

The grain size trend establishes the sediment transport pathways (Gao et al. 1994). The geochemical properties of sediment, such as the clay minerals, magnetic minerals, heavy minerals and particle adsorbed radioactive elements and organic substances composition may be used as tracers for sediment transport and deposition (Liu et al. 2009; Xu et al. 2009; Carvalho et al. 2011; Horng and Huh 2011; Huh et al. 2011). Liu et al. (2000, 2002) also used a methodology that combines a 'filtering' concept and a multivariate analysis technique EOF (Empirical Orthogonal Function) to verify and distinguish the importance of different hypothetical sources. Because sediment grain-size compositions along a transport pathway may result from the mixing of different sediment sources and transport processes (Russell 1939; Swift et al. 1972; Gao et al. 1994), the net sediment transport direction is inferred from the spatial changes in granulometric parameters (i.e., mean grain-size, sorting, and skweness). Many applications were developed based on spatial changes in a single granulometric parameter to indicate net sediment transport paths (Krumbein 1938; Pettijohn and Ridge 1932; Plumley 1948; Pettijohn et al. 1972; McCave 1978). McLaren (1981) was the first to create a sediment transport model based on combined granulometric parameters. His method is an empirical and conceptual

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