New insights into sedimentary processes and related morphologies in tidal straits: the case of the Rio-Antirio Sill (Greece)

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Straits are crossed by marine currents that are amplified due to the water constriction. These nearshore high-velocity flows are problematic for offshore infrastructures (bridge pillars, cables, pipelines etc), but constitute an under-estimated carbon-free kinematic energy source. Most of the straits are dominated by tidal currents which flow axially to the seaway, with reversal directions and phase difference between the two interlinked basins. These tidal currents interplay with: (i) sediment sources that also includes in situ carbonate production and deltas, (ii) tectonic activity, and (iii) inherited lowstand features, all shaping the sea floor into complex geomorphologies. Previous studies have highlighted a common tidal-strait depositional model with a strait-center zone in erosion and on each side a dune-bedded strait zone with 3D and 2D tidal dunes and tidal ripples.Here, we present an alternative tidal-strait model based on an interdisciplinary approach using high-resolution geophysical and oceanographical data to better constrain the processes acting at the sea floor. We focus on the Rion-Antirion strait in Greece which controls the connection between the Gulf of Corinth and the Mediterranean Sea. Based on high-resolution multibeam bathymetry (MBES) over an area of 211km2, we identify and quantify the morphologies by extracting bathymetric swath profiles. These results are integrated with currents data (ADCP) and CTD profiles. In addition, we use high-resolution Chirp subbottom profiles and high-resolution sparker seismic reflection profiles to document the stratigraphy and morphology of the sedimentary beds and erosional features. To complete this dataset, we use a towed underwater camera to image the sea-floor.We define three zones, each characterized by common hydrodynamics, bedforms and morpho-bathymetric features which reveal an asymmetric strait. (1) The western zone is dominated by tectonics with salt diapirism and faults which interact with bottom currents to form erosional pools and ridge systems. (2) The strait center zone displays abrasion surfaces which consists on a rough rock-paved plateau surface encrusted by living red corals and sponges. Moreover, a moat cuts this plateau that localizes the sill at its eastern tip. This strait center area is dominated by inherited hard-ground fluviatile deposits which are abraded by bidirectional tidal-currents. (3) The eastern zone shows a deeper bathymetry with smoother features. The sediments are veneered on slopes forming plastered drifts and spits while the basin axis presents large chutes and pools. The bottom-currents in this zone, are related to internal tides from the Gulf of Corinth that are delayed with respect to the tidal currents. These internal-tide currents (3m/s) are three times faster than the oceanic tidal-currents in the strait (1m/s).In conclusion, we document a tidal-strait system, which is interacting with active tectonics, and internal-tides along its axis. In results, Rion strait displays complex bathymetric features without any 3D or 2D tidal dunes. Thus, it provides a new end member to the tidal-strait depositional model. This end member is characterized by a re-localization of the erosion, bypass and deposition. It illustrates the key role of internal tides for straits located at the boundary between a confined deep-basin and the open-sea.

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