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Late Miocene to Quaternary Contourites Depositional Systems in the Gulf of Cadiz and West Portugal related to the Mediterranean - Atlantic exchange evolution: decoding bottom currents behaviour and oceanographic processes associated with gateways

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Contourite depositional systems (CDS) represent the sedimentary records of paleoceanographic circulation and paleoclimatic changes throughout the geological timescale. These records offer expanded but contingent information relative to their adjacent marine gateways, documenting changes in the intensity and the direction of modern-day and paleo-current pathways on multi-centennial, millennial and million-year timescales. This study investigates the late Miocene to Quaternary CDSs from the Gulf of Cadiz towards the West Iberian margin after the exit of the past Betic and Rifian corridors and most recent Strait of Gibraltar, the key gateways for the Mediterranean – Atlantic exchange trough time. A summary of the key results is presented as a representative study case for decoding the long- and short-term behaviour of oceanographic processes related to gateways and their associated overflows.

In the study area, it is well known that the Mediterranean Outflow Water (MOW) has generated a complex CDS since the full opening of the Strait of Gibraltar in the early Pliocene (5.3 Ma). Recently, an ancient CDS has also been discovered in the late Miocene, which is separated from the Pliocene-Quaternary CDS by a period of quiescence representing the restriction of bottom

water circulation across the Mediterranean-Atlantic exchange during the late Messinian (~6.4 - 5.3 Ma). The late Miocene CDS was established after the final closure of the Indian Gateway (IG) and the Neo-Tethys Ocean in the Middle Miocene, followed by the inception of the Mediterranean Sea (~13.8 - 11 Ma). The final closure of the IG conditioned a wide gateway configuration for the connection between the Mediterranean Sea and the Atlantic Ocean, with the full establishment of an anti-estuarine circulation similar to the present day as opposed to its previous situation.

Interestingly, both the late Miocene and the Pliocene-Quaternary CDSs have a long common evolution that could be simplified into two stages, with an initial- and growth-drift stages. The late Miocene CDS is then buried under dominantly hemipelagic late Messinian (~6.4 - 5.3 Ma) deposits, whereas the buried-drift stage is absent for the Pliocene-Quaternary system due to the ongoing nature of the CDS's evolution. The long-term development of these CDSs can be correlated with a coeval shallowing of sills, which determined a change from an outflow to an overflow setting across the gateways through time. These long-term variations (>5-10 My) in paleo-circulation are thus driven by the by the tectonic control on the evolution of oceanic gateways. The internal sedimentary architecture of the late Miocene and Pliocene-Quaternary CDSs indicates a complex stratigraphic stacking pattern of deposits bounded by internal discontinuities and hiatuses in response to the intermittent behaviour of the MOW at different temporal scales, which have been attributed to tectonic pulses, climatic and eustatic changes and oceanographic processes that have caused deepening/shoaling or weakening/strengthening of bottom currents through time, exerting a major effect on deepwater sedimentation and the benthic habitat.

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