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The utility of clinothems for discerning paleoenvironmental and paleoceanographic evolution at multiple spatial-temporal scales: the Late Pleistocene to Holocene Adriatic Sea clinothems

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Clinothems are of interest to both industry and academia because they host > 40% of conventional-oil reserves, sequester an estimated 40% of the biogenic carbon in the modern ocean, and are natural archives of paleoenvironmental conditions. Although clinothems have been extensively exploited as resource targets, their study for paleoenvironmental reconstruction has been often left on the back-burner. Clinothems that developed on the Adriatic Sea margin since the late Pleistocene document varying paleoenvironmental regimes and oceanographic configurations through time.
Taking advantage of a regional dataset, we documented clinothem characteristics, stacking patterns, and controls through the integration of seismic-reflection data with sediment attributes, multibeam bathymetry, paleoenvironmental reconstruction by means of microfossils (foraminifera), geochemistry, and radiometric age control. In the Adriatic margin, progradation occurred in three main intervals that spanned the Last Glacial Maximum (LGM), the Younger Dryas (YD), and the late Holocene, respectively. Micropaleontological analyses revealed systematic changes in seawater condition (e.g. temperature, oxygen, turbidity) and nutrient content under the influence of both global and regional controls at centennial and millennial scales. These controls included eustasy, Northern-Hemisphere and regional climate, glacial growth and decay, river discharge, and oceanic circulation. Micropaleontological analysis and age control revealed that each individual clinothem formed in a very short interval, from 0.3 to 5 ky, contemporaneous with significant pulses of increased sediment supply and fresh water into the basin. Sedimentological study along with analysis of the map-pattern distribution of depocenters indicate that the 10's to 100's m-thick clinothems record sediment transport and deposition under the influence, to varying degrees, of both riverine discharges (e.g. hyperpycnal flows) and oceanographic circulation (along-shore sediment transport). Moreover, along-shore sediment transport distances varied systematically: from minimal during the LGM (shelf-edge clinothems), to distances on the order of 50 km during the YD (middle-shelf delta-clinothems) and up to 800 km in the late Holocene (modern delta-clinothems). These changes suggest an increase in the influence of a cyclonic circulation as the Adriatic Sea broadened in response to the post-LGM eustatic rise. The switch from supply-dominated shelf-edge delta to subaqueous progradation occurred at the onset of the eustatic rise and the proportion of coast-parallel growth of subaqueous clinothems increased ever since. Our findings reinforce the concept that, despite their rapid progradation, individual clinothems and clinothems sets represent important archives for reconstructing paleoenvironment and paleoceanographic conditions of sedimentary basins through time and their key controlling factors.