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From stratigraphy to (inferred) processes: development of the late Pleistocene Po Delta clinothems at millennial to centennial scales

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The 350-m thick succession of the late-Pleistocene Po River Lowstand Delta (PRLD) deposited in just 17 k.y. encompassing the Last Glacial Maximum and contains stratal architecture at a physical scale commonly attributed to much longer time intervals, with complex, systematically varying internal clinothem characteristics. We document clinothem characteristics, stacking patterns, and controls through the integration of seismic-reflection data with sediment attributes, micropaleontology, regional climate, eustacy, and high-resolution age control on the PRLD. Within the PRLD, three clinothem types are characterized by distinctive topset geometry, shelf-edge and onlap-point trajectory, internal seismic facies, and interpreted bottomset deposits: Type A) moderate topset aggradation, ascending shelf-edge trajectories, and thin mass-transport bottomset deposits; Type B) eroded topset, descending shelf-edge trajectories, and bottomset distributary channel-lobe complexes; and Type C) maximal topset aggradation, ascending shelf-edge trajectories, and draped concordant bottomsets. Measured sediment accumulation rates suggest that Type A and C clinothems experienced reduced sediment bypass and delivery to the basin, whereas, Type B clinothems were associated with short intervals of increased sediment export from the shelf to deep water and development of distributary channel-lobe complexes. This interpretation is supported by micropaleontological analyses that highlight increased delivery of sediment and fresh water to the basin during the progradation of Type B clinothems, as suggested by the reduced occurrence of *Cassidulina laevigata carinata* and the peak abundance of *Nonion* spp. Each clinothem formed in a very short interval, from 0.4 to 4.7 k.y., contemporaneous with significant eustatic and climate changes. While changes in stacking patterns at these temporal scales have previously been observed in modern deltaic clinothems, the significance of our study is that we have for the first time documented changes to continent-margin-scale clinothems on this time scale. Our observations have two significant implications for interpreting older continental-margin-scale deposits: 1) As allogenic factors at millennial- to centennial time-scales exert a substantial influence on the late Pleistocene continental margin deposits of the PRLD, the deposits of ancient continental-margin-scale systems could also record variations of eustacy and sediment supply at these short time-scales; 2) while previous studies have focused on 100.000 year-scale cycles of glaciation-deglaciation as temporal scale that determines the balance between shelf aggradation and sediment export to the deep basin, data from the PRLD show that sediment export to the basin can be episodic, even over centennial to millennial time-scales.