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Hyperpycnal flow deposits of the Castissent depositional sequence shelf-margin deltas, insights to unravel the detailed tectonic control through a genetic facies analysis (Eocene, South-central Pyrenees, Spain)

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The Castissent depositional sequence is a significant syn-tectonic unit of the South-central Pyrenees, in which the imprint of thrust-and-fold kinematics is not explained in detail yet. It consists of two tectonically-controlled sequences, named Castissent-1 (Cs-1) and Castissent-2 (Cs-2). Both sequences comprise flood-dominated fluvio-deltaic strata in the Ager-Tremp-Graus thrust-top basin, and the genetically related turbidite systems in the Aínsa-Pamplona foredeep. These are the Torla (Cs-1) and Broto (Cs-2) turbidite systems. In each system, a lower sandy stage of growth (basin-floor fan), forming the bulk of the system and extending all over the foredeep, is overlain by an upper muddy stage (prodelta slope wedge), which mostly passes updip into coeval shelf sediments, forming a late lowstand prograding complex (Cs-1) and a transgressive systems tract (Cs-2).

This work is based on detailed mapping and logging and on a genetic facies analysis. It aims at unraveling the control of both the hyperpycnal flow behavior and the tectonics on the transition from the shelf to the prodeltaic slope wedge. This transition takes place in the boundary between the thrust-top and foredeep depocentres, where a thrust system with some minor out-of-syncline thrusts controlled both the shelf-edge configuration and the flow dispersal. Special attention is devoted to (1) the role of hyperpycnal flows in the relationships between the delta-front sandstone lobes and the prodelta slope-fan turbidites, (2) the definition and mapping, from the shelf to the slope, of the facies associations that build high-frequency depositional sequences, and (3) the link of the high-frequency sequences, which form growth strata, to specific tectonic structures.

It can be demonstrated that hyperpycnal flow deposits on the shelf are genetically related to slope turbidites. Soft-sediment deformation layers present in the delta front and the slope, mostly in the Cs-1, are interpreted as seismites related to the activity of thrusts. They vary in rheological type from creep units to cohesive debris flow and sandy mud-flow beds showing evidence that they resulted from flows having undergone flow transformations. Thus, these flows were potentially able to evolve into low-density turbidity currents building the slope strata. However, they played a minor role and hyperpycnal flows provided the most significant volume of turbidites.

The mapping of the high-frequency depositional sequences shows that they are clinothemes bound by clinoform surfaces (their bounding unconformities) and controlled by the tectonic activity. They thus can be regarded as tectono-sedimentary units that allow deciphering the shelf-edge architecture, the high frequency relation between shelf and turbidite systems and the timing of the different thrusts.