

## **Cyclic steps and superimposed antidune deposits: important elements of coarse-grained deepwater channel-levée complexes**

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The facies distribution and architecture of submarine fans can be strongly impacted by erosion and deposition by supercritical density flows. We present field examples from the Sandino Forearc Basin (southern Central America), where cyclic-step and antidune deposits represent important sedimentary facies of coarse-grained channel-levée complexes. These bedforms occur in all sub-environments of the depositional systems and relate to the different stages of avulsion, bypass, levée construction and channel backfilling.

Large-scale scours (18 to 29 m deep, 18 to 25 m wide, 60 to >120 m long) with an amalgamated infill, comprising massive, normally coarse-tail graded or spaced subhorizontally stratified conglomerates and pebbly sandstones, are interpreted as deposits of the hydraulic-jump zone of cyclic steps. These cyclic steps probably formed during avulsion, when high-density flows were routed into the evolving channel. The large-scale scour fills can be distinguished from small-scale channel fills based on the preservation of a steep upper margin and a coarse-grained infill comprising mainly amalgamated hydraulic-jump deposits.

Channel fills include repetitive successions deposited by cyclic steps with superimposed antidunes. The hydraulic-jump zone of cyclic-step deposits comprises regularly spaced scours (0.2 to 2.6 m deep, 0.8 to 23 m wide), which are infilled by intraclast-rich conglomerates or pebbly sandstones and display normal coarse-tail grading or backsets. Laterally and vertically these deposits are associated with subhorizontally stratified, low-angle cross-stratified or sinusoidal stratified pebbly sandstones and sandstones (wavelength 0.5 to 18 m), interpreted as representing antidune deposits formed on the stoss-side of the cyclic steps during flow re-acceleration. The field examples indicate that so-called crudely or spaced stratified deposits may commonly represent antidune deposits with varying stratification styles controlled by the aggradation rate, grain-size distribution and amalgamation. The deposits of small-scale cyclic steps with superimposed antidunes form fining upwards successions with decreasing antidune wavelengths. Such cyclic step-antidune successions are the characteristic basal infill of channels, probably related to supercritical high-density turbidity flows triggered by retrogressive slope failures.