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Sediment waves control origins of submarine canyons

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The paper by Wang et al. (2023) is timely and thought-provoking. They address the role of bottom-current sediment waves as a major control on the initiation and evolution of regularly spaced, unidirectionally migrating submarine canyons (unidirectionally migrating deep-water channels [UCs], *sensu* Gong et al., 2018) (Fig. 1). The primary purpose of this Comment is to highlight different possible origins for the initiation versus the subsequent evolution of UCs. Hopefully, this Comment and its Reply will provide further clarity on the theme of unidirectional channel migration.

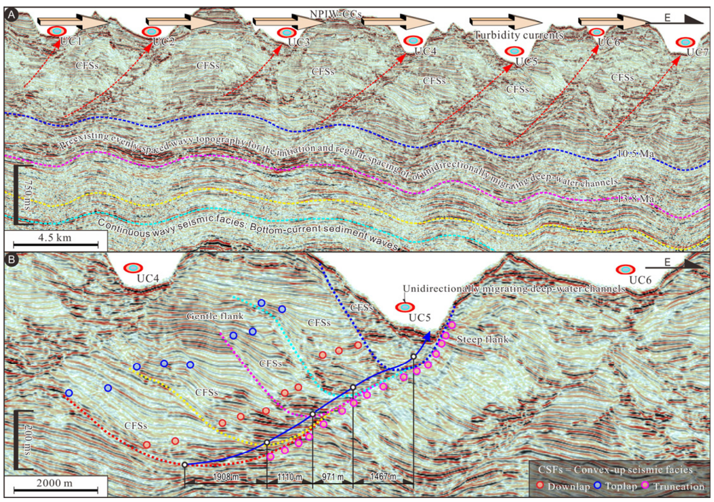

Figure 1. Strike-view seismic line (A) and enlarged seismic transect (B) showing cross-sectional morphology and architecture of UCs on the northern South China Sea margin. The pathway of contour currents resulting from the North Pacific Intermediate Water (NPIW-CCs) is from Wang et al. (2023).

ESSENTIAL BUT MISSING PIECES OF THE PUZZLE

The following points are selected for discussion.

First, inadequate interpretation of the morphology of regularly spaced, convex-up seismic facies: Wang et al. interpreted regularly spaced, convex-up seismic facies shown in Figure 1 as sediment waves generated by contour currents. These convex-up seismic facies display an overall asymmetrical cross-sectional morphology consisting of a thinner, gentler, and shorter upstream flank and a thicker, steeper, and longer downstream flank with respect to contour currents (Fig. 1B), which is in marked contrast with the common recognition criteria of bottom-current sediment waves (i.e., symmetrical cross-sectional morphology) as proposed by Wynn and Stow (2002).

Second, inadequate interpretation of the architecture of regularly spaced, convex-up seismic facies: Bypassing, as indicated by the occurrence of toplap terminations, is dominant on upstream flanks of convex-up seismic facies interpreted as bottom-current sediment waves by Wang et al., whereas sedimentation as suggested by the occurrence of downlap terminations is more evident on their downstream flanks (Fig. 1B). The sedimentation, preferentially on the downstream flanks, is not synchronous on both flanks, resulting in clear downstream deposition and downstream wave-form migration. Such architectural styles are in marked contrast with the recognition criteria of bottom-current sediment waves (i.e., synchronous deposition across both wave flanks and vertical aggregation) as proposed by Wynn and Stow (2002).

Third, inadequate explanation of the migration of regularly spaced, convex-up seismic facies: As highlighted by Wang et al., the documented sediment waves show an eastward migration in the direction of along-slope contour currents. Such a conceptual model of wave-form migration is inconsistent with the lee-wave model. Moreover, these “sediment waves” on time-domain seismic profiles may be seismic artifacts produced by the regularly spaced, rugged seafloor topography research.

Fourth, inadequate explanation of the asymmetric intra-channel deposition of unidirectionally migrating deep-water channels: Wang et al. ascribe origins of UCs to the preferential erosion by turbidity currents along troughs of bottom-current sediment waves, but fail to acknowledge the asymmetric intra-channel deposition. UCs shown in Figure 1 exhibit asymmetrical channel cross sections with steep eastern counterparts that are overall 1.5–3.5× steeper than their western gentle flanks, and contain truncation terminations. These observations suggest an asymmetric intra-channel deposition of UCs as highlighted by Gong et al. (2018), and this plays a key role in forcing individual channel-complex sets (CCS1 to CSS5 shown in Fig. 1B) to migrate in the direction of the steep flanks through time. This was not acknowledged and interpreted by Wang et al. (2023).

ORIGINS FOR THE INITIATION AND EVOLUTION OF UNIDIRECTIONALLY MIGRATING DEEP-WATER CHANNELS

None of the above is meant to deny the novelty of Wang et al. However, we suggest that although the initiation and regular spacing of UCs can be related to bottom-current sediment waves, the subsequent development and evolution of UCs cannot be ascribed to bottom-current sediment waves.

Consistent with Wang et al., bottom-current sediment waves exert preexisting, evenly spaced, wavy topography for the initiation and regular spacing of UCs (Fig. 1A). Continuous wavy seismic facies beneath UCs seen in Figure 1A contains continuous wavy seismic facies that exhibit symmetrical cross-sectional morphology, and display well-layered internal seismic-reflection configurations, all of which are compatible with the recognition criteria of bottom-current sediment waves (Wynn and Stow, 2002). Troughs of these bottom-current sediment waves are spatially consistent with the initiation points of UCs with a regular spacing of ~5.0 km, suggesting that the initiation and regular spacing of UCs are inherited from regular spaced troughs of bottom-current sediment waves (Fig. 1A).

Inconsistent with Wang et al., we, however, suggest that bottom-current sediment waves do not control the development and evolution of UCs. As highlighted earlier, the morphology, architecture, and migration of convex-up seismic facies occurring along gentle flanks of UCs are incompatible with the recognition criteria of bottom-current sediment waves. This, together with inadequate explanation of the asymmetric intra-channel deposition of UCs, suggests that unidirectional channel migration should be related to interaction between turbidity and contour currents (Gong et al., 2018), rather than to bottom-current sediment waves (Wang et al., 2023). This conclusion is evidenced by the fact that UCs documented by Gong et al. (2018) and others are not inherited from troughs of bottom-current sediment waves.

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