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Dynamics of carbonate mass transport complexes along the western slope of Great Bahama Bank

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Sediment instabilities typified by slope failures and Mass Transport Complexes (MTCs) commonly occur in many continental margins and constitute the major process responsible for their formation and dynamic evolution. In contrast to silicoclastic systems and despite the abundant literature existing on the carbonate gravity-flow deposits, the hydrodynamical processes and associated sedimentary products occurring on carbonate platform slopes are poorly documented. The Bahamian archipelago provides excellent quality data to better constrain a stratigraphic and geometric architecture in such a particular setting. New high resolution multibeam and seismic data collection clearly show large slope failures and MTCs associated in the western slope of the Great Bahama Bank. The aim of this study is to better understand the triggering mechanism, the spatial distribution and the forcing parameters at the origin of MTCs deposition. A morphometric and geometric analysis, based on Kongsberg EM 302 multibeam echosounder, echoes sub-bottom profiler (Chirp), high-resolution seismic and Kullenberg cores, was carried out at regional scale.

Seafloor morphology indicates a large sediment failure corresponding to a MTC. The initiation of slope instability starts at 450-550 m of water depth and consists of three distinct failure scarps extending N-S over 9 km. The scar height ranges between 80 and 110 m and extends northward by a deformed area. Small pockmarks (50 m in diameter) are observed at the top of the MTC. The seafloor is covered basinward by a hummocky-like surface extending westward over 20 km which is interpreted as a lateral succession of buried blocks colonized by cold-water carbonate mounds. Massive rectangular blocks, characterized by lengths ranging between 0.8 and 2 km and thicknesses around 50 m terminate the 300 km^2 deformed area.

MTCs are identified by chaotic, low-amplitude seismic facies which represent a failed mass translated above a basal shear surface. Their semi-transparent acoustic signature is interpreted as unstructured, non-stratified sediments, suggesting a significant reworking. Within the MTC, mixtures of semi-deformed low- and high-amplitude reflections can be observed and interpreted as transported blocks. The headwall of the MTC is characterized by tilted blocks. Down slope, the MTC terminates with compression structures such as folds and little thrust systems. Each event is sealed by continuous bed-parallel non-deformed reflection.

The geometry and internal architecture of MTCs result from both the mechanism of failure and the morphology of the slope on which the translation occurs. The mode of deformation is influenced by the rheology of the failed sediment and level of diagenesis. In this context the angular shape of the blocks suggests brittle deformation with collapse rather than folding and account for slightly lithified carbonates.

Since the Middle Miocene, the western slope of the Great Bahama Bank is characterized by multiple phases of sliding, block formation and debris flows sourced from the slope. The sedimentary mechanisms associated to the MTCs can have local and/or external global controls, such as relative sea-level fluctuations, high sedimentation rates, fluid outputs and contour currents. All these parameters can potentially destabilize the upper slope and trigger mass transport processes.