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Morphological and physiographic characteristics of Watu Canyon System, Espírito Santo Basin, Brazil.

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Introduction

Submarine canyons are complex geological features shaped by tectonic, sedimentary, and oceanographic processes, resulting in diverse morphologies and depositional architectures. The Espírito Santo Basin, situated along the southeastern margin of Brazil, offers an ideal setting for canyon formation and development due to its steep continental slope and high sediment supply from the adjacent continent. Within this basin, two major canyon systems have been identified: the extensively studied Rio Doce Canyon, which has been well-documented in scientific literature, and the comparatively lesser-known Watu Canyon System, located in the basin's central region. Despite its pivotal role in channeling sediments from the Doce River - a major onshore drainage system-, the Watu System remains poorly characterized, with only preliminary descriptions available to date. This study aims to conduct a comprehensive morphological and sedimentological analysis of the Watu System, establish its classification, and compare it with global analogues to better elucidate its formation and evolution within the depositional framework of the Espírito Santo Basin.

Method and/or Theory

Industrial 3D seismic data were analyzed to map canyon morphology, characterize associated sedimentary features, and reconstruct the stratigraphic evolution. To accomplish these objectives, the seismic horizon corresponding to the seafloor was mapped and a surface model was generated. Canyon geometry was delineated by extracting geobodies from multiple arbitrary seismic cross-sections. All seismic interpretations were carried out in the time domain, as depth-converted 3D volumes were unavailable for most of the study area.

Results and Conclusions

The Watu System comprises two canyons - Watu Norte (WN) and Watu Sul (WS) - that originate at approximately 200 m water depth and extend downslope with distinct characteristics. WS, the smaller and more linear of the two exhibits minimal sinuosity, indicating lower-energy sediment flows passing through it. In contrast, WN is larger, displays pronounced sinuosity, and undergoes a significant directional shift from NW-SE to N-S at around 1300 m depth. Beyond this inflection point, both canyons converge to form the Golfinho Channel, which funnels sediment outflows from the canyons toward the distal portion of the basin. The physiographies of the two canyons differ significantly: WS retains a consistent U-shaped profile throughout its entire course, showing minimal variation in width or depth. Meanwhile, WN displays variability in both length and thalweg fill, with the eastern levee generally presenting greater sediment thickness than the western levee, likely due to bottom currents reworking. This differential sediment accumulation, on each of the two levees, acted as a structural barrier, redirecting subsequent flows and progressively shaping the canyon's sinuous bends—potentially explaining the abrupt shift observed at 1300 m depth. Due to their distinct characteristics, the two canyons are classified differently: WN incises into the continental shelf and exhibiting both erosional and depositional processes, whereas WS is sediment-starved canyon, confined to the slope.