Are submarine canyons exclusively the product of erosional processes?

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The formation and deepening of submarine canyons are typically attributed to purely erosional processes. Tributary-like channel networks and submarine knickpoints are commonly cited as evidence for this submarine erosion. We present data from an industry-grade seismic volume of submarine canyons located offshore Brunei Darussalam (NW Borneo) illustrating how erosional looking topography can be produced under conditions of net sediment deposition. This data was generated via subsurface mapping of the Quaternary continental-slope stratigraphy covering a growing shale-cored anticline. The shale ridge is located about 20 km down slope from the present-day edge of the continental-shelf in roughly 900 m of water. Its crest line runs for 18 km and is oriented perpendicular to the regional slope. Four canyons traverse the structure at roughly right-angles to the crest line with a maximum canyon relief of 175 m. The subsurface mapping reveals that the entire structure is a site of net sediment deposition and defines a regional or background pattern of sedimentation that decreases gradually with distance from the shelf-slope break. Dip profiles down canyon axes reveal local minima in deposition over the hinge of the anticline and are associated with high downstream gradients. Deposition on ridges adjacent to canyons also shows local minima in sedimentation over the anticline hinge, but these minima are not correlated with gradient. Instead, deposition on the ridges is inversely related to local canyon relief. A comparison of canyon axis and ridge deposition show that slightly higher rates of ridge deposition have resulted in the preservation and growth of these submarine canyons. Seismic horizons that can be traced in the strike direction for many km suggest that the currents forming these canyons were laterally extensive sheet flows. This interpretation is consistent with minima in ridge deposition being correlated with maximal canyon relief. The currents drained into the canyons as they approached the anticline hinge, leaving only a small supra-canyon fraction available to deposit sediment on the non-channelized zones. Using the cross-sectional area of the confined flow over the anticline crest we estimate a minimum thickness of 30 m for the sheet-like currents as they approached the anticline.