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Describing the development of submarine canyons using stream-bed erosion laws

Neil C. Mitchell

School of Earth, Ocean and Planetary Sciences, Cardiff University, Park Place, Cardiff, CF10 3YE, Wales, UK

The problem of how turbidity currents erode their beds is important for understanding how canyons develop, but is complex because flow power also varies as a result of incorporation and deposition of the current's suspended load. In some canyons where the total sedimentary mass passing through the canyon has been much larger than the excavated mass, the loads of the eroding currents changed little during passage down-canyon. Canyon morphology can then potentially reveal how gradient and other factors affect erosion rate, illustrated here with two datasets from tectonically active margins. The first dataset is from Tenryu Canyon off Japan, which was entrenched by up to 1200 m by steepening of the Tokai accretionary prism. Incision depth and channel gradient S data [Soh and Tokuyama, 2002] suggest an erosion law in which incision rate E is proportional to Sˆ0.8, which is remarkably similar to laws for detachment-limited erosion of river beds. In the second dataset, folds of the Barbados prism have created knickpoints [Huyghe et al., 2004]. Numerical modeling reveals that the knickpoints have partly smoothed out, a property of transport-limited erosion, but primarily have translated, a property of detachment-limited erosion. The origin of this mixed style of knickpoint development is unclear. It is speculated that temporary deposition of the heavy loads of turbidity currents in depressions leaves those areas armoured, while the intervening areas (which have negative curvature) are exposed to erosion. Alternatively, the eroded sediments (turbidites and hemipelagic muds) have varied physical properties that allow erosion to occur with transport-limited and detachment-limited erosion, which cause diffusion and advection, respectively.

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