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Basic Types of Submarine Slope Curvature and Their Application to Carbonate Systems

Curve fitting on the first-order morphology of modern, submarine slope profiles shows that only three equations fit nearly 90% of the slopes. They are in order of decreasing abundance: (1) sigmoidal profiles that match half of a Gaussian distribution function; (2) concave profiles with an exponential curvature, and (3) linear profiles. The exponential trend is attributed to the exponential decay of sediment transport with increasing distance from the source. The boundary between the shelf domain, where sediment moves under the influence of waves, and the slope domain, where sediment moves under the influence of gravity, is narrow, the shelf edge sharp, and the curvature exponential if sedimentary base level remains stationary during progradation. Sigmoidal slope profiles develop where the shelfbreaks are rounded off due to erosion and redistribution of sediment during storms and sea-level fluctuations. A straight slope segment at the angle of repose develops where during progradation the slope steepens to the angle of repose and thus reaches a state of self-organized criticality.

The three basic curvatures also apply to carbonate systems. 90% of the rimmed carbonate platforms were exponential or linear. Exponential profiles are common on rimmed platforms because reefs are resistant to erosion and the platform edge therefore relatively stationary vertically. The angle of linear profiles can be used as a guide to sediment grain size. Non-rimmed carbonate platforms, such as cool-water carbonates, generally lack a protecting reef and the slope profiles in these settings are sigmoidal as the shelf break is continually rounded by base-level fluctuations.