Erosion and deposition below the Kuroshio Current: insights from the Penghu Channel and Ryukyu Arc offshore Taiwan

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Ocean currents play a major role in shaping deep-sea environments by eroding, transporting and depositing large volumes of sediment across continental margins. These processes can significantly influence slope morphology and stratigraphic architecture. The Kuroshio Current (KC) is a major western boundary current, that begins east of the Philippines and then flows in a north-eastward direction along the continental margins of Taiwan and Japan. It transports warm subtropical waters from the Indo-Pacific Warm Pool to mid-latitudes, exerting a key influence on both marine sedimentation and regional climate. The KC branches at several points along its path: the Kuroshio Branch Current (KB) flows across the continental shelf west of Taiwan through the shallow Taiwan Strait (Taiwan Strait Current, TSC), while the Ryukyu Current (RC) continues north-eastwards along the Ryukyu Arc at depths greater than 500 m. Taiwan lies in a complex tectonic area, at the boundary between the Philippine Sea Plate to the east and the Eurasian Plate to the west. Thus, it is an ideal area to investigate the interaction of bottom currents with the seabed in an active tectonic setting. Such settings are often characterised by complex and rough bathymetry, that can impact current pathways and velocity, leading to localized erosion or deposition. In this study, we document the impact of the oceanographic currents on the continental shelf, slope and tectonic ridges offshore Taiwan. We focus on two key regions: (i) the Ryukyu Arc and (ii) the Penghu Channel/Taiwan Strait. The analysis integrates high-resolution bathymetric and 2D seismic reflection data with reanalysis ocean circulation models. Near-seafloor current velocities are generally below 0.2–0.25 m/s, but enhanced flows are observed where the seabed is shallow, such as in the Taiwan Strait (<100 m bsl) or locally along uplifted ridges of the Luzon and Ryukyu Arcs (>~1000 m bsl). In the Taiwan Strait, the TSC flows north-eastwards and is characterised by two main cores with velocities ranging from 0.1 to 0.4 m/s. Higher velocities are observed along the flanks of the Penghu Islands, including in the Penghu Channel, and in within the central strait along the two current cores. Seismic analysis of the Penghu Channel reveals a prominent *u*-shaped erosional feature (20–45 m deep, 2–3 km wide) accompanied by asymmetric scours and steep scarps, reflecting strong current activity and sediment remobilization. Erosional bases overlain by inclined reflections consistent with small mounded contourite deposits are observed. Along the Ryukyu Arc, velocities exceed 0.15 m/s and occasionally reach 0.4 m/s. The seafloor changes from a gently dipping (<4°) erosional surface that truncates the underlying seismic sequence to a rougher area with ridges and depressions or erosive channels eastwards. These two sectors are separated by the Ilan Channel (up to 323 m deep, 4.4 km wide). Contourite drifts are observed, comprising elongated sheeted to mounded deposits in larger basins and confined drifts in smaller depressions. These results demonstrate that the interaction between ocean circulation and tectonic relief exerts a strong control on sediment dynamics and seafloor morphology along Taiwan's active margins, providing new insights into margin evolution and implications for offshore infrastructure stability.