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Monsoon control on submarine groundwater discharge in the Gulf of Mannar and Palk Bay over the last 30 years

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Submarine groundwater discharge (SGD) represents a critical but insufficiently constrained pathway of land–ocean exchange, transporting freshwater, nutrients, and dissolved elements that regulate coastal biogeochemistry and reef ecosystem health. This study tracks the temporal variability of SGD along the Indian coastline—Gulf of Mannar and Palk Bay using high-precision strontium isotopes ($^{87}Sr/^{86}Sr$) using a 30-year coral archive. Coral skeletal bands, constrained through X-ray density chronology, record intra-annual variability in $^{87}Sr/^{86}Sr$ (0.709157–0.709228) that departs from the homogeneous marine value, providing a sensitive archive of past SGD fluctuations. These variations correspond to monsoon-driven hydrological forcing, during which enhanced rainfall and catchment flushing intensify the delivery of radiogenic Sr to the coastal ocean.

The combined water-column and coral evidence demonstrates that SGD is the **primary regulator of coastal Sr isotope budgets** in the study region, which in turn is controlled by the monsoon intensity over the last 30 years. The Sr isotope record of coral, along with available rainfall data, demonstrates good correlation with Sr isotope composition. In the absence of any major river in the region, variation observed in Sr isotope composition in the coral record over the last 30 years is interpreted in terms of varying SGD fluxes. Higher Sr isotope composition in excess of uniform seawater composition reflects higher SGD fluxes characterised by more radiogenic Sr. Intense monsoon results in higher recharge, which drives the higher SGD fluxes to the coastal region. This study reinforces $^{87}Sr/^{86}Sr$ as a robust tracer for quantifying SGD and underscores the need to incorporate groundwater fluxes into biogeochemical models of the northern Indian Ocean.