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Depth-dependent geochemical variations and implications for sediment provenance along the northeastern continental margin of Korea

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Sediment provenance varies systematically from coastal to deep-marine environments as a consequence of changes in sediment supply, transport pathways, and depositional processes. Understanding such variations is critical for evaluating sediment redistribution processes that influence the long-term fate of geochemical signals associated with mineral resources and environmental legacies.

This study investigates depth-dependent variations in surface-sediment geochemistry along the northeastern continental margin of Korea, spanning coastal, shelf, slope, and basin environments. A total of 210 surface sediment samples collected between 2016 and 2019 were analyzed for major elements, trace elements, and rare earth elements (REEs). Grain size ranges widely from −1.3 to 8.9 Φ, with sediments becoming progressively finer offshore. Total organic carbon (TOC) increases with decreasing grain size ($r^2 = 0.86$), indicating strong textural control on organic matter preservation.

Major and trace elements show coherent spatial patterns, with mid-shelf enrichment (~80–120 m water depth) and distinct north–south variability. However, Cs–Li relationships reveal a marked transition at approximately 300–400 m water depth. Above this depth, Cs and Li exhibit a strong positive correlation consistent with wave-dominated sorting of non-cohesive sediments. Below this boundary, the correlation weakens significantly, coinciding with increased clay content (>10%) and a shift to bottom-current-controlled sedimentation below the effective wave base. This depth-dependent decoupling indicates a fundamental transition in sedimentary regime rather than uniform provenance continuity.

REE patterns further constrain proximal versus distal sediment sources across the coastal-to-basin transect. The results demonstrate how hydrodynamic sorting and ocean circulation modulate geochemical signatures, providing insight into sediment dispersal mechanisms relevant to marine mineral systems and long-term geochemical baselines in marginal seas.