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XRF Core Scanning Based Chemostratigraphic Correlation for Paleoseismology in the Central Japan Trench

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Megathrust earthquakes in subduction zones, such as the 2011 Mw 9.1 Tohoku-oki earthquake, are rare but pose significant threats to society. Their long recurrence intervals and limited historical records make reconstructing recurrence models challenging. The International Ocean Discovery Program (IODP) Expedition 386 addressed this by recovering over 800 meters of sediment cores from 11 trench-fill basins along the Japan Trench, providing a unique opportunity to extend paleo-earthquake records. Despite this, achieving reliable spatiotemporal correlations of event deposits remains a complex task. Here we show that high-resolution chemostratigraphic correlations using X-ray Fluorescence Core Scanning (XRF-CS), Principal Component Analysis (PCA), and Cluster Analysis (CA) effectively link event deposits across cores M0083D and M0089D in the northern basin and M0090D in the southern basin of the central Japan Trench. We identify eight event deposits in the northern basin, characterized by higher Ca and Sr with upward-decreasing trends, or elevated Si, Rb, and K without such trends, indicating distinct compositional differences and depositional processes of the turbidity currents. Across basins, M0090D deposits exhibit consistent clustering with M0089D but differ in internal structures and elemental trends, suggesting spatially similar sediment sources but varying erosion and transport mechanisms. Temporal chemical variations further suggest surficial sediment remobilization, rather than landslides, as the dominant trigger for turbidity currents, as it transports slope material that evolves compositionally over time. This insight reinforces the reliability of chemostratigraphy for event-stratigraphic correlation. Moreover, the spatial distribution of event deposits further highlights potential rupture areas and turbidity current pathways. Southward thinning of high Si, Rb, and K deposits suggests a northern source, while thicker Ca and Sr deposits in the southern core may imply a southern rupture zone. These findings establish a robust chemostratigraphic framework, enhancing our understanding of paleo-earthquake dynamics along the Japan Trench. The approach provides a valuable tool for reconstructing earthquake histories in other subduction zones, contributing to global paleoseismology research.