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Spaced planar laminations formed by repetitive basal erosion and resurgence to high-sedimentation-rate regime: new insight from a bedform-like structures and laterally continuous exposures

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Spaced planar laminations (SPL), or so-called traction carpet deposits, are frequently observed in deposits of sediment gravity flows. Several sedimentation models for a succession of inversely graded units have been suggested from field observations and flume experiments. The formation of the inversely graded unit could be summarized as follows: (1) abrupt sedimentation on freezing of an inversely graded layer, or (2) interruptions in flow causing a freezing of an inversely graded layer at the most basal part of flow. In either case, traction carpets as a bed load overlying the erosive boundary at the base of flow are required. Although some descriptions have reported SPLs forming antidune bedform-like structures and the association of SPLs with structureless massive deposits have not been clearly explained. In this study, we suggest a novel model of SPL formation by repetition of basal erosion and resurgence to high-sedimentation rates, based on detail examinations of SPLs both showing bedform-like structures and lateral extents of hundreds of meters.

SPLs were investigated in the Mio-Pliocene Kiyosumi Formation in central Japan and the Miocene Aoshima Formation in southwest Japan. In a turbidite in the Kiyosumi Formation, SPLs show three mound-like structures, suggesting antidune bedforms with wavelengths of about 6 to 7 m. On the upcurrent flanks, SPLs show lenticular cross laminations or pinching out of units; those units do not show clear inverse grading. Rip-up mud clasts and relatively high-angle imbrications are also observed. On the other hand, SPLs on the downcurrent flanks show relatively clear inverse grading and transition downcurrent into a massive structureless bed. In the Aoshima Formation, SPLs with ca. 1 cm unit thickness continue approximately 50 m along a palaeocurrent direction without changes in thickness. These SPLs gradually transition upward into a massive structureless unit.

From the observations described above, in addition to descriptions from previous studies, it is suggested that SPLs comprising mound-like bedforms exhibit erosive conditions in the upcurrent flanks and depositional conditions in the downcurrent flanks, whereas SPLs on flat sea-floor extensively maintain their structure. Also, massive structureless beds are observed when erosion did not occur. These facts indicate that SPLs are strongly associated with an erosional process at the base of sediment gravity flows under a supercritical flow condition. The formation of SPLs does not necessary require a traction carpet and they may reflect basal erosion with a lag deposit of fine-grained particles, followed by resurgence to conditions of high sedimentation rates and massive structureless bed deposition. Repetitions of inversely graded units could occur when basal shear stresses are changed by fluctuations of flow depth, such as internal waves in a sediment gravity flow. This model can explain the concurrence of massive structureless beds with SPLs and examples of bedform-like structures without a unit thickness control.