Sedimentary structures within sedimentary gravity flow deposits formed under upper flow regime conditions and their association with sedimentary topography

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Sedimentary structures formed under upper flow regime conditions (Fr > 1), such as massive structureless units, spaced planar laminations (SPLs), and occasionally hummocky cross-stratification mimics (HCS mimics), are observed within the lower portions of sediment gravity flow deposits. These structures are overlain by planar laminations and ripple cross-laminations formed under lower flow regime conditions. The resulting successions of structures, formed under both flow regime conditions, constitute Bouma and Lowe sequences. The lower unit of sediment gravity flow deposits is typically dominated by massive structureless units, and SPLs and HCS mimics are not frequently observed. Additionally, it has been suggested that the structures in the lower unit often change with respect to one another along the lateral or paleocurrent directions, as well as vertical directions. However, the depositional processes responsible for the formation of these sedimentary structures are unclear and detailed descriptions of the transitions are rare, particularly for the lateral and paleocurrent directions. Well-exposed, laterally continuous sediment gravity flow deposits in outcrop can provide insights into the depositional processes that formed the structures in the lower unit. In this study, we carried out detailed mapping of these sedimentary structures and the basal topographies within sediment gravity flow deposits, and determined their transitional patterns.

We investigated the turbidite succession of the Neogene Aoshima Formation, Miyazaki Group, which is well-exposed in the paleocurrent direction along the Nichinan Coast of Miyazaki and Nichinan cities. The studied outcrop, located at Shirahama, shows sediment waves with wavelengths of 300–400 m. The sedimentary structures in the sediment gravity flow deposits, which can be traced for approximately 700 m, were mapped using a series of sequential photographs taken at the outcrop. The sediment gravity flow deposits were selected for mapping based on their basal topographies, which are characterized by moderately undulating, slightly undulating, and relatively flat intervals.

The sediment gravity flow deposit facies of the Aoshima Formation have been subdivided into graded, massive, and inverse graded bed types. These bed types show SPLs and HCS mimics in the basal interval. Paleocurrent directional mapping of the sedimentary structures showed that SPLs are dominant in the relatively flat beds; whereas, in the undulating intervals, HCS mimics and SPLs are observed on the upstream and downstream flanks, respectively. When sediment waves are formed as cyclic steps, it is suggested that massive structureless units can be deposited on the upstream flank due to a hydraulic jump; whereas, SPLs are dominant on the downstream flank due to high shear stress flow. In the Aoshima Formation, HCS mimics on the upstream flanks may have been deposited by relatively erosive flows associated with breaking waves, not only hydraulic jumps, because the basal undulations in the study interval are not large enough to have developed clear sediment wave topographies. In contrast, in the intervals characterized by relatively flat topography, it is suggested that laterally continuous SPLs, which extend for tens of meters, may have been deposited under conditions without the effects of basal topography.

キーワード：重力流堆積物、高流砂階、セディメントウェーブ、堆積構造、青島層
Keywords: sedimentary gravity flow deposits, upper flow regime condition, sediment wave, sedimentary structure, Aoshima Formation

