Threshold conditions for occurrence of tsunami-generated turbidity currents: examination by 2D numerical experiments

Threshold conditions for occurrence of tsunami-generated turbidity currents: examination by 2D numerical experiments

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This study aims to investigate the conditions for generating turbidity currents due to the sediment entrainment by large-scale tsunamis. The occurrence of the tsunami-generated turbidity current was suggested by the sudden displacement of the ocean bottom pressure meter (OBP) which was situated on the sea floor offshore Sanriku-Coast, northern Japan. On the basis of this displacement of the OBP and the observation of the sea floor, Arai et al. (2013) proposed the hypothesis that the 2011 Tohoku-Oki Tsunami generated the turbidity current on the submarine slope. They inferred that the tsunami run-up and backwash flows caused the suspended sediment cloud by entrainment of basal sediment, and that the turbidity current was then developed from the sediment cloud. However, the detailed development processes and conditions for generating turbidity currents by tsunamis have not been clarified yet. Therefore, we conducted the numerical experiments using the two-dimensional RANS model that employed the renormalized group k-epsilon turbulence model. In our experiments, the digital elevation model of the submarine slope offshore Sanriku-Coast was used for the experimental topography. The suspended sediment clouds were initially allocated on the upstream end of the slope, and the time evolution of the flow for 10,000 seconds were calculated by the model. We conducted the experiments repeatedly, changing the initial heights, lengths and sediment concentrations of the suspended sediment cloud. As a result of our experiments, it was suggested that a threshold condition for generating turbidity currents from the suspended sediment cloud clearly exists. The suspended clouds larger than 30 m for the initial height and more than 0.05w.% for the initial concentration produced intense turbidity currents that often exceeded 10 m/s for the maximum velocity. On the other hand, no flow occurred in the cases where the initial heights of the sediment cloud were less than 20 m. These contrasting results were caused by the self-accelerating process of turbidity currents. The suspended sediment clouds above the threshold condition were accelerated by the increase of density due to the entrainment of basal sediment, whereas those below the threshold condition were decelerated because it could not erode substrate sufficiently. Our results suggest that the tsunami-generated turbidity currents also have a threshold conditions for occurrence corresponding to scales of tsunamis. Thus, it is inferred that the tsunami-generated turbidites only record exceptionally large tsunamis beyond the threshold condition, of which recurrence intervals could be in millennial scales.

キーワード：タービダイト、混濁流、津波
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