



Comparison of morphology of active cyclic steps created by turbidity currents on Squamish Delta, British Columbia, Canada with flume experiments

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Upper-flow-regime bedforms, such as cyclic steps and antidunes, have been reported to be formed by turbidity currents. Their formative conditions are, however, not fully understood because of the difficulty of field surveys in the deep sea. Field observations of turbidity currents and seabed topography on the Squamish delta in Howe Sound, British Columbia, Canada have been undertaken which found bedwaves actively migrating in the upstream direction in channels formed on the prodelta slope. Their topography and behavior suggest that they are cyclic steps formed by turbidity currents. Because Squamish delta is as shallow as around 150 m, and easy to access compared with general submarine canyons, it is thought to be one of the best places for studying characteristics of cyclic steps formed by turbidity currents through field observations. In this study, we have analyzed configurations of cyclic steps with the use of data obtained in the field observation of 2011, and compare them with the data from the flume experiments.

On the prodelta slope, three major active channels are clearly developed. In addition to the sonar survey, a 600 kHz ADCP was installed in 150m of water just seaward of the termination of the North Channel. In addition, 1200kHz ADCP and 500kHz M3s are suspended from the research vessel in 60 m of water and 300 m distance from the delta edge. We selected images showing large daily differences. The steps move vigorously at the upper 600m parts of the prodelta slope, so that we measured the steps in this area. From the profiles perpendicular to the bedwave crest lines through the center of channels, wavelength and wave height for each step, mean slope were measured on the software for quantitative image analyses manually. Wave steepness for each step was calculated using the wavelength and wave height measured as above.

The mean slope ranges from $6.8^{\circ} \sim 2.7^{\circ}$ (more proximal, steeper), mean wavelength and wave heights of steps range from 24.5 to 87.6m and from 2.4 to 5.4m respectively. We compare the shape of steps with the upper-flow-regime bedforms, such as antidunes and cyclic steps, obtained from the open channel experiments. Wave steepness of the steps in Squamish ranges from 0.035 to 0.157, which is relatively high and close in value to those of cyclic steps and downstream-migrating-antidunes (DMA) in the open channel experiments. The non-dimensional wave number depends on the estimation of the thickness of the turbidity currents. Based on the optical backscatter profiles, the upper limit of sediment suspension is around 10m. However the maximum velocity is always located within the lower 5m, and higher density layer seems to locate within the lowermost 2 m. For the 10m flow thickness, the wave number is close in value to those of DMA. While for the 0.5m flow thickness, the wave number is close in value to those of cyclic steps. We will discuss about the effect of “density currents” and/or “surge” on the morphology of those steps.