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Evolution of mud profiles under wave action

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The present study offers the results of an experimental and numerical investigation of various features of wave-mud interaction on an inclined bed; i.e. wave height attenuation, wave-induced mud mass transport, gravity-driven flow of fluid mud and the reconfiguration of profile shape.

A set of laboratory experiments were designed to study mud mass transport and profile change. The experiments were carried out in the hydraulic models laboratory of K. N. Toosi University of Technology. The waves were produced in a wave flume of 0.30 m wide and 0.45 m deep in cross-section and 12.50 m in length by an electrically driven piston machine with a paddle at the beginning of the flume. The operating paddle is able to produce both regular and irregular waves. Two electric capacitance wave gauges were employed to examine the wave height attenuation along the flume. The mud section was 8 cm thick and 1 m long. A false bed was placed in the flume to confine the mud section. The confined mixture of commercial Kaolinite and tap water was placed under the continuous wave action for about 1 hour. Since there is no transport through the beginning and the end of mud section, the bottom profile leads to a stable configuration under the continuous wave action. A set of test runs were performed under regular wave action were performed and the corresponding cross-shore mud profiles were measured.

A wave-mud interaction model was used to simulate the wave height attenuation and mud mass transport. The wave energy dissipation term due to mud was introduced in the equation of wave energy conservation to simulate both shoaling and wave attenuation along an inclined bed. Applying the exponential wave height decay over a horizontal mud bed, the relation between energy dissipation rate of mud and wave attenuation rate is derived. The cross-shore mud profile deformation model combines the transport of fluid mud under the wave action; i.e. the Stokes drift and the mean Eulerian velocity, and downward gravity force. The conservation equation of sediment mass is employed to calculate profile changes. Bingham rheological model was adopted for fluid mud behaviour to develop a predictive model for wave-mud interaction. Rheological parameters of the applied fluid mud were obtained from a set of rheological experiments.

The results of the numerical model are compared with the laboratory experiments. It is concluded that the developed model is capable to predict the observed phenomena.