A THREE LAYERS MODEL FOR THE TURBIDITY CURRENT: AN INVERSE PROBLEM TO INFER THE IGNITION CONDITION FROM TURBIDITE DEPOSITS

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Abstract
An innovative approach is here proposed, to use governing equations of a turbidity current (TC) to infer the hydrodynamic ignition conditions (*sensu* [1]) for velocity, height, and concentration of the current. All this is made through the comparison between analytical solutions for change in bed elevation and field data measured in the Messinian turbidite deposits of the Central Apennines, Italy.
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In order to provide a simple model which take into account the features of a TC described in several tank experiment [2-3], a three layers model for a TC is here introduced (Fig. 1). The dynamics of the three layers are represented as a function of the Richardson number *Ri*. From this analysis results that, into the basal layer (Layer 1, Fig.1), under conditions of severe density gradient, damping of the turbulence occurs ($Ri > 1$). This condition causes a net loss of sediments during the current deceleration. All this allows an analytical definition for the change in bed elevation $h(x)$, where x is the downstream coordinate. In order to provide an analytical solution for $h(x)$, the governing equations of a steady-depletive depositional TC [4] has been analytically solved. The analytical solution for $h(x)$ will allow us to infer, as an inverse problem, the ignition condition for velocity, height and concentration (namely U_0, h_0, and C_0 respectively) of a depositional TC. All this is made through the comparison between such analytical solution and stratigraphycal field observations carried out in the Messinian turbidite deposits (Central Apennines, Italy). Practically, it is possible to search for a best-fit of bed elevation field values with those provided by the analytical solutions, varying the ignition conditions U_0 and h_0. As an example, the shape of a single bed elevation as a function of the ignition condition U_0 and h_0 is shown in Fig. 2, for a grain size D = 0.2 mm. In synthesis, the thickness decay as a function of the ignition conditions U_0, h_0 can be summarized as: i) for fixed U_0 and D, increasing h_0 gives an increase of the length of the deposits; ii) for fixed h_0 and D, increasing U_0 gives an increase of the length of the deposits; iii) for fixed U_0 and h_0, increasing D gives a decrease of the length of the deposits.

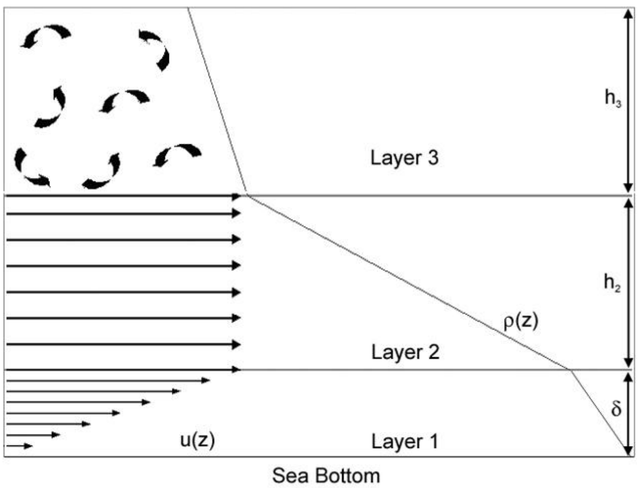

Fig. 1. Three layer model for turbidity current where $d \ll h_2 < h_3$. The stick diagrams represent the velocity $u(z)$ and the line represents the density $r(z)$.

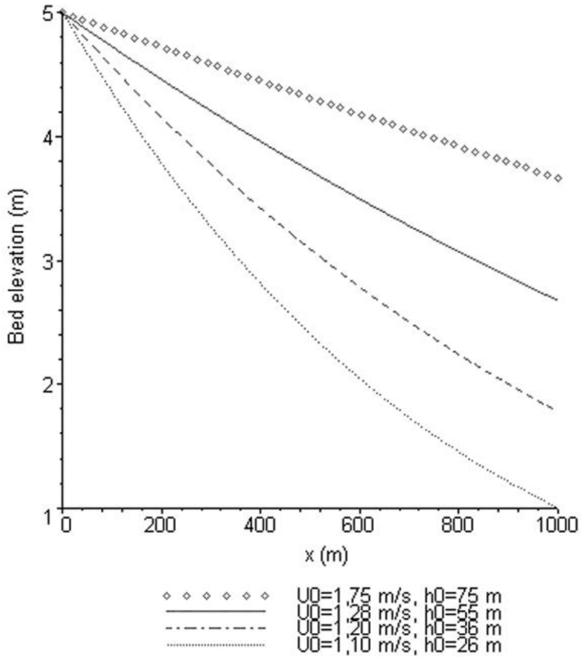

Fig. 2. Analytical decays of the sedimentary body as a function of the ignition condition U_0 and h_0 for the case D = 0.2 mm.

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