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Interaction between volcaniclastic turbidity currents and topography: a physical model based on deposit particle characteristics

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Subaqueous sedimentary density flows represent some of the largest mechanisms of sediment transport on Earth. Large flow-slides can generate a variety of gravity-driven sediment flows, such as debris flows, hyperconcentrated and concentrated density flows, turbidity currents. In this work, I refer to volcaniclastic turbidity currents (VTCs), i.e. the solid load of dilute currents is composed by pyroclasts and the resulting deposits are ash turbidites, or more generally volcaniclastic deposits. The aim is that of reconstructing the VTC physical characteristics and topographic angles by means of actual deposit characteristics. The VTC deposits chosen as case of study are the Craco (Matera, Southern Italy) volcaniclastic deposits (Late Pliocene).

The Craco deposits consist of fining-upward sequences in a series of laminated layers capped by massive layers of very fine ash, and are intercalated to marine clays deposits. Stratigraphic and sedimentological features suggest that the volcanic material was deposited by aggradation of stratified low-concentration density flows. These currents were liquid-solid flows composed by a mixture of sea water and volcanic ash, which remobilized primary pyroclastic fall deposits. The main flow transport mechanism was turbulent suspension.

A fluid dynamic model based on the “turbulent boundary layer shear flow” theory was applied to the Craco VTCs, by starting from the deposit particle characteristics. Briefly, it consisted of calculating the particle settling velocity, which was equated to the flow shear velocity and introduced in a logarithmic law for calculating the flow average velocity. The parameters used in the model were particle grain-size, particle density and particle shape factor, deposit thickness and water density. The model solutions on average flow velocity allowed defining some approximate relationships for calculating flow thickness and topographic angle ranges. These relationships are very interesting because confirm that at low angles depositional processes dominate and at high angles transport processes dominate, by accounting for the interplay between flow concentration and topographic angles.

I am confident that a fluid dynamic approach for studying currents of the Craco type, or more generally turbidity currents, could contribute better understanding the interaction between large subaqueous flows and topography.