Determining How Much Topographic Complexity Must Be Incorporated into Models for Depositional Turbidity Currents Filling Sinuous Submarine Channels and Constructing Channel Levees

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Predicting spatial change in the thickness and grain size of turbidites away from points of well or outcrop control is a primary component of any quantitative model for deep-water stratigraphy. These predictions are often made using a numerical model that couples sediment transport and deposition to the flow field of a representative turbidity current. We present a methodology that can be used to evaluate how precisely this flow field must be described in order to accurately reconstruct thickness and grain size trends, and apply the methodology to the modeling of turbidites filling sinuous submarine channels and constructing levees of submarine channels. To evaluate the control that local flow dynamics and channel topography have on depositional patterns, we calculate a characteristic advection length for every particle size of interest within a transporting turbidity current. This advection length is the horizontal length scale over which a representative particle is transported within the current between contacts with the bed. Its magnitude is the product of a characteristic travel time and a characteristic advection velocity. We estimate the advection time as a characteristic height above the bed associated with the suspended particles, divided by their representative settling velocity. The advection velocity is the average current velocity associated with the portion of the flow through which the grains are settling. We will present laboratory and seismic data to demonstrate that deposit geometries are relatively insensitive to local channel topography and local flow dynamics for that part of the sediment load where the advection length scale is large relative to the imposed spatial changes. We will then present a set of calculations defining the range of flows and particle sizes where depositional models for sinuous submarine channels and levees must include a description for deposition rate that is governed by gradients in local sediment transport capacity, versus flows and particle sizes where deposition rate can be prescribed to non-local sediment advection from upslope. Preliminary investigation indicates that gross depositional trends for turbidites composed of very fine and fine sand can almost always be modeled using a simple advection-settling model, while coarse sand typically requires inclusion of local dynamics; medium-sand turbidites are case specific.