Sub-aqueous sand extrusion dynamics

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Abstract

Extruded sandstone mounds and sandstone sheets are increasingly recognized in the geological record and seismic data, yet the underlying mechanisms that control these features, and determine whether deposits form discrete accumulations or areally extensive sheets, remain poorly understood. Here we address these issues through study of a well-exposed ancient sand sheet in the Shannon Basin, Ireland. Sand volcanoes are shown to have erupted contemporaneously following liquefaction and fluidization of delta-front mouth-bar sands and silts, the expelled sediment forming an extruded sheet of sand. The sand sheet formed during a single prolonged eruption event with the interaction of radial gravity currents from the hundreds of vents exerting control on the internal architecture of the extrudite. Based on our observations, here we develop a process-based model that demonstrates that sand extrusions can form sheets only if (1) multiple vents are extruding coevally, causing gravity currents to interact, or (2) topographic forcing, such as channelling, redirects the otherwise radial gravity currents, resulting in sheet-like deposition of extruded material away from the vent site. This study provides a new model of sand extrudite formation, and examines the potential for identifying extrudites from core and bed-scale studies and differentiating them from liquefied beds.