Simulation of Stratal Architecture in Deep Marine Minibasins: Making it Realistic is Easy — Making it Exactly Right is Not

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9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

Simulation of the stratal architecture using numerical forward modelling can provide insights into how basins develop. For example, simulation of the stratal architecture in salt-floored minibasins in continental slope settings can elucidate the interplay between salt movement and sediment supply. There are several modelling approaches, which include: process-based methods (that numerically simulate gravity currents and their consequent deposits); and geometric methods (that use simple equations to model deposits without modelling the processes that form them). We have developed a geometric model (ONLAPSE) which is appropriate in typical exploration settings, with limited constraining data. ONLAPSE uses a small number of physical inputs (starting seafloor topography, background sedimentation rate, structural growth profile and rate, and variable rate of rise of a clastic-limiting surface), and combines these inputs using simple rules to create realistic-looking basin architectures. Previous studies have used similar geometric approaches to create generic basins to understand general principles. We go one step further, recreating the detailed geometries of real-world minibasins of the US Gulf of Mexico, using an iterative process. Our first target was an apparently simple, near-symmetrical minibasin. The first-pass model matched the general form of the basin, but not the detailed thicknesses or stratal patterns. We progressively tuned the model inputs to reduce mismatch; after four iterations, the output model was optimized. Closest fit was achieved by combining: 1) constant rates of structure growth; 2) highly episodic sediment supply; 3) long periods of depositional hiatus; and 4) brief periods of rapid

deposition. Matching the geometries of some intervals requires extremely fast rates of sedimentation; these appear to correspond to mass-transport complexes. Best fit also required the use of two subtly different structural profiles, indicating progressive evolution of the structural controls. A good match was achieved for most of the basin infill. However, for some key intervals, it is impossible to create a perfect match using the simple simulation. These appear to correspond to extrinsic events (such as collision with adjacent minibasins, and interaction with the base of salt).