The Geologic History of Submarine Fans in the Deep-water Gulf of Mexico: Mesozoic to Modern

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Abstract

Submarine fans are among the most important reservoirs in the prolific Gulf of Mexico Basin and are known from industry drilling and seismic data to be contained within strata extending from the Mesozoic to modern. However, little has been published on how these systems evolve over this time frame, responding to extra-basinal factors like tectonics, climate, sediment discharge, etc. A comparison of Mesozoic age submarine fans with those of the most important Cenozoic fans in the Gulf reveals important new insights into the basin formation and evolution.

We interpret the newly formed basin, just after termination of Callovian salt deposition, to be rather shallow but not entirely terrestrial. The initial Mid-Jurassic low-dipping ramp from land to sea transitioned into a shelf-slope-basinal profile, with sea floor spreading ranging in age from Kimmeridgian to Berriasian. This in turn provided impetus for development of the earliest poorly organized submarine aprons in the late Jurassic and early Cretaceous. These eventually evolved into submarine fans but their sizes were constrained by rather short river lengths until reorganization of North American drainage systems in the Mid-Cretaceous. Mapping major sand-prone fair-ways reveal that most of the Mesozoic slope and basin systems were fed by eastern North American source terranes. Siliciclastic delivery into the basin was also hampered by reef blocking, as large rimmed shelf reef systems of Barremanian to Albian age restricted sediment bypass to a few discrete basin entry points.

The dramatic drainage reorganization in the Cenomanian ushered in the first of the large and extensive submarine fan systems, known from exploration wildcats to have extended nearly 500km from the coeval shelf edge. Deep crustal tectonic events likely played a role in both drainage re-routing but also allowed siliciclastic systems to surmount the rimmed shelf reef systems and develop shelf-edge-slope-basin pathways over broad fairways. The Cenomanian fan systems look more like Cenozoic fan successors, with long run-outs, variable sediment gravity flow products, and tendency to respond to the para-autochonous salt seascape and developing primary basins. The alteration of the seascape caused by the Chicxulub impact event subsequently altered deep-water transport pathways in some areas. But this event did set the stage for Paleogene and later fans that responded to continental scale drainage networks developed with the Laramide orogeny.
Fifteen plus years of deep-water drilling in the northern Gulf of Mexico has defined the scale and extent of Cenozoic deepwater fans. Mapping (using seismic and released well data) has established fan run-out distances that greatly exceed original expectations. The Wilcox deep-water fans clearly match continental scale river systems with source terranes ranging from the Northern Rockies to Mexico. Canyon systems like the Lavaca-Yoakum system of Texas play a role in sediment routing but rivers with large discharge and sediment load are a requirement. Salt tectonics, climate-related sediment discharge variations, volcanism, and eventually the Neogene ice sheets modulated final form, extent, and location of these fans.