Salt-Sediment Interaction During Advance of Allochthonous Salt

Rowan, Mark G.[1]; Giles, Katherine [2]; Lawton, Timothy F.[2]; Hearon IV, Thomas E.[3]; Hannah, Tyler [4] (1) Rowan Consulting, Inc., Boulder, CO. (2) New Mexico State University, Las Cruces, NM. (3) Colorado School of Mines, Golden, CO. (4) Chevron North America, Houston, TX.

Existing models of allochthonous salt advance are largely based on observations and interpretations of the nature, geometry, and internal deformation of strata above, beneath, and in front of sheets and canopies. We use field exposures in the Flinders and Willouran Ranges in South Australia and 3-D seismic and well data from the northern Gulf of Mexico (GoM) to test prevailing ideas and develop a general model for the advance of allochthonous salt and the origin of associated deformation in subsalt strata.

Key observations of subsalt relationships constrain the model. First, sheared strata are absent. Second, preserved thrust faults are rare. Third, strata are sometimes folded and thinned beneath base-salt ramps but undeformed beneath flats. Fourth, small growth anticlines sometimes occur at the tops of halokinetic synclines. Fifth, base-salt flats commonly form during times of slow deposition. Sixth, discrete mass-transport complexes (MTCs) or turbidites containing roof or diapiric material may be intercalated with normal minibasin strata at halokinetic sequence boundaries.

Our model comprises several elements. Basinward salt supply in a sheet or canopy is driven by some combination of upward flow through feeder diapirs, supra-canopy minibasin subsidence, and gravity spreading above the canopy. In all cases, there is a folded roof creating a topographic scarp above the salt tip. Base-salt flats form when salt-supply rate greatly exceeds sediment-accumulation rate and salt advances on a thrust that breaks through a thin roof to the toe of the scarp, resulting in no halokinetic folding. Ramps form when sediment-accumulation rate exceeds salt-supply rate, generating a thicker roof. Salt may simply advance on a steeper thrust, truncating subsalt strata with little deformation. Alternatively, if salt advance is pinned, inflation folds the top salt and onlapping strata into a base-salt and an underlying anticline-syncline pair, respectively. Slump failure of the oversteepened scarp generates MTCs and/or turbidites that contain diapir and/or roof material. Further advance takes place along a thrust that breaks through to the sea floor at the toe of the scarp, in some cases preserving and in others decapitating the anticline. More common development of both thrusts and MTCs in the northern GoM than in Australia is attributed to greater canopy length, large-scale gravity spreading of the canopy overburden, greater roof thickness, and increased scarp relief.