Remobilization of Salt Structures by Sediment Progradation: Experimental Models and Potential Applications to the Gulf of Mexico and Other Continental Margins

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In salt-bearing continental margins, including the northern Gulf of Mexico, a strong correlation commonly exists between the timing of salt movement and that of major regional deposition. Phases of vigorous deformation of the salt and its overburden (including both vertical and lateral movements, such as diapir rise, growth faulting, and growth folding) coincide with phases of rapid aggradation or progradation of clastic wedges. Inversely, phases of tectonic lull correspond to periods of slow sedimentation.

We conducted a series of dynamically scaled tectonic models to better understand how sedimentation may affect or even trigger salt movement. Sediment progradation creates or increases the bathymetric slope of sediment wedges and thereby increases their gravity potential. A sediment wedge resting on thick or thin salt responds to such slope increases by spreading seaward, away form the bathymetric high(s). Spreading deforms the wedge by extending its proximal region and contracting its distal region (Fig.1, top).

Where there are no preexisting salt structures, sediment progradation creates a surface slope that triggers growth faulting and reactive diapir rise in the upper slope and folding or thrusting in the lower slope (Fig. 1, top). Where the sediment wedge has a lobate planform, the wedge spreads radially and deforms in a network of polygonal depocenters bounded by growth faults, grabens, or salt ridges. If sediments prograde seaward rapidly, the toe and the shelf break advance accordingly. Sediments and structures from the older, lower slope are buried under the thick sediments forming the upper slope of the younger wedge. Older, contractional or diapiric structures that initially formed in the lower slope can thereby be later reactivated in extension (Fig. 1, bottom).

Where a wedge progrades over an already structured salt basin comprising preexisting diapirs and depocenters bounded by salt ridges, as in parts of the northern Gulf of Mexico (see Fig. 2), deformation can be far more complex. Progradation distorts the

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sediment depocenters while preferentially deforming the salt ridges and diapirs in extension, strike-slip, and contraction. Progradation thus reactivates previously dormant diapirs and salt ridges and forces them to fall or rise anew, leading to a wide variety of structural geometries (Fig. 3).

In addition, progradation over wide, preexisting salt massifs my remobilize large volumes of salt, which can rapidly extrude at the sea floor and form canopies of coalescing diapir overhangs and salt tongues. Interestingly, the subsalt of such salt allochthons can still be translating, rotating, and deforming during or even after the emplacement of the salt tongues.

We will illustrate the geometry and evolution of such processes and discuss their applicability to exploration in the Gulf of Mexico.

Reference:

Wu, Shengyu, Rice University,1993, Salt and Slope Tectonics offshore Louisiana. Ph.D. Dissertation, Houston, 251 p.

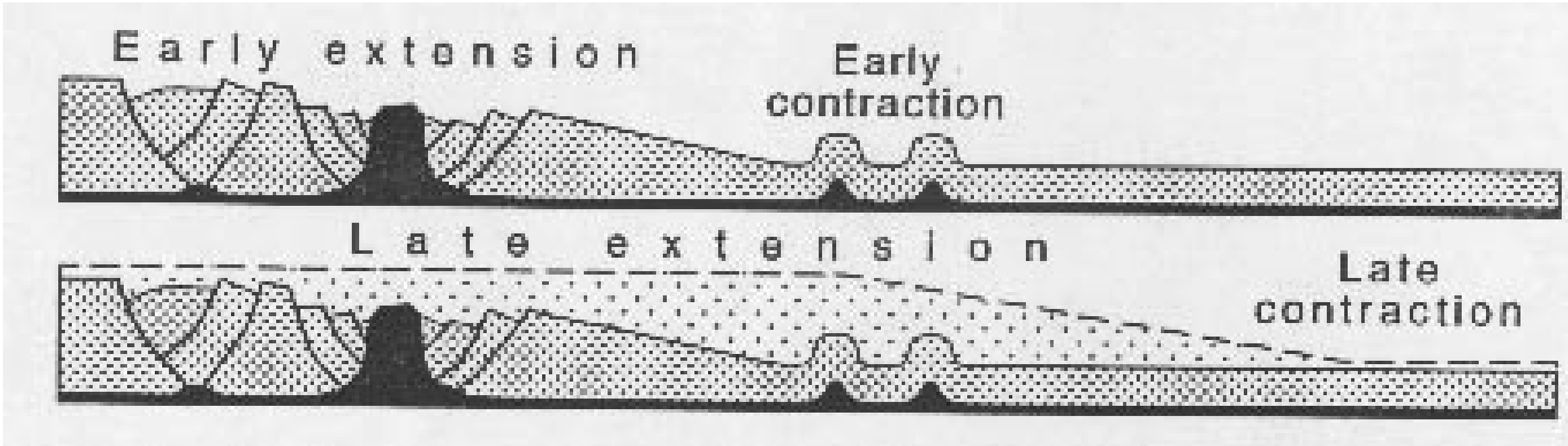

Figure 1: Spreading of a prograding wedge: top: early wedge; bottom: later wedge

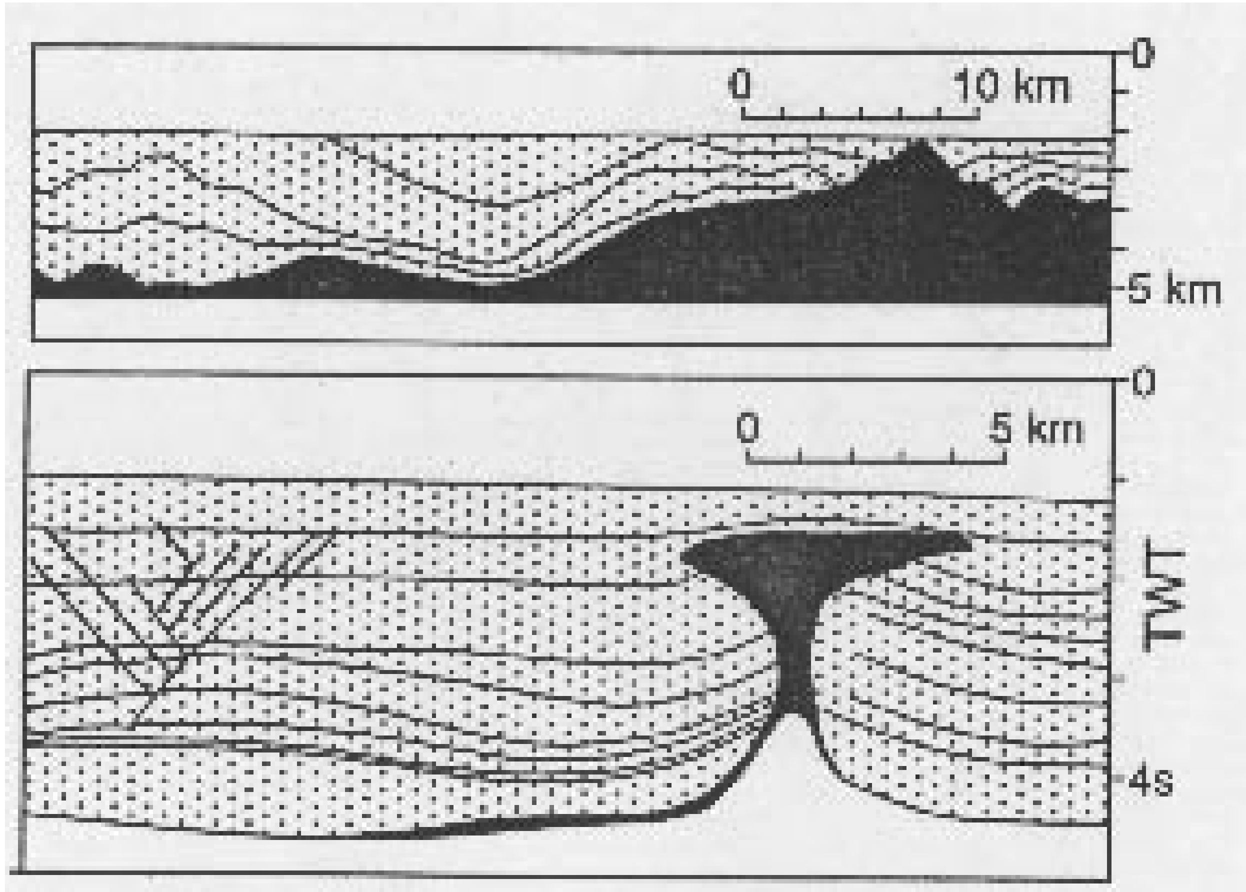

Figure 2: top: depth-converted section from the NE Gulf of Mexico (Atwater Valley area) restored to mid-Cretaceous times (94 ma), showing grounded depocenters adjacent to wide salt massifs; bottom: Two-way travel time section in the same region at present day. The sections shows a salt massif remobilized into rising diapir (right), whereas the depocenter inverted into a turtle structure. From Wu (1993).

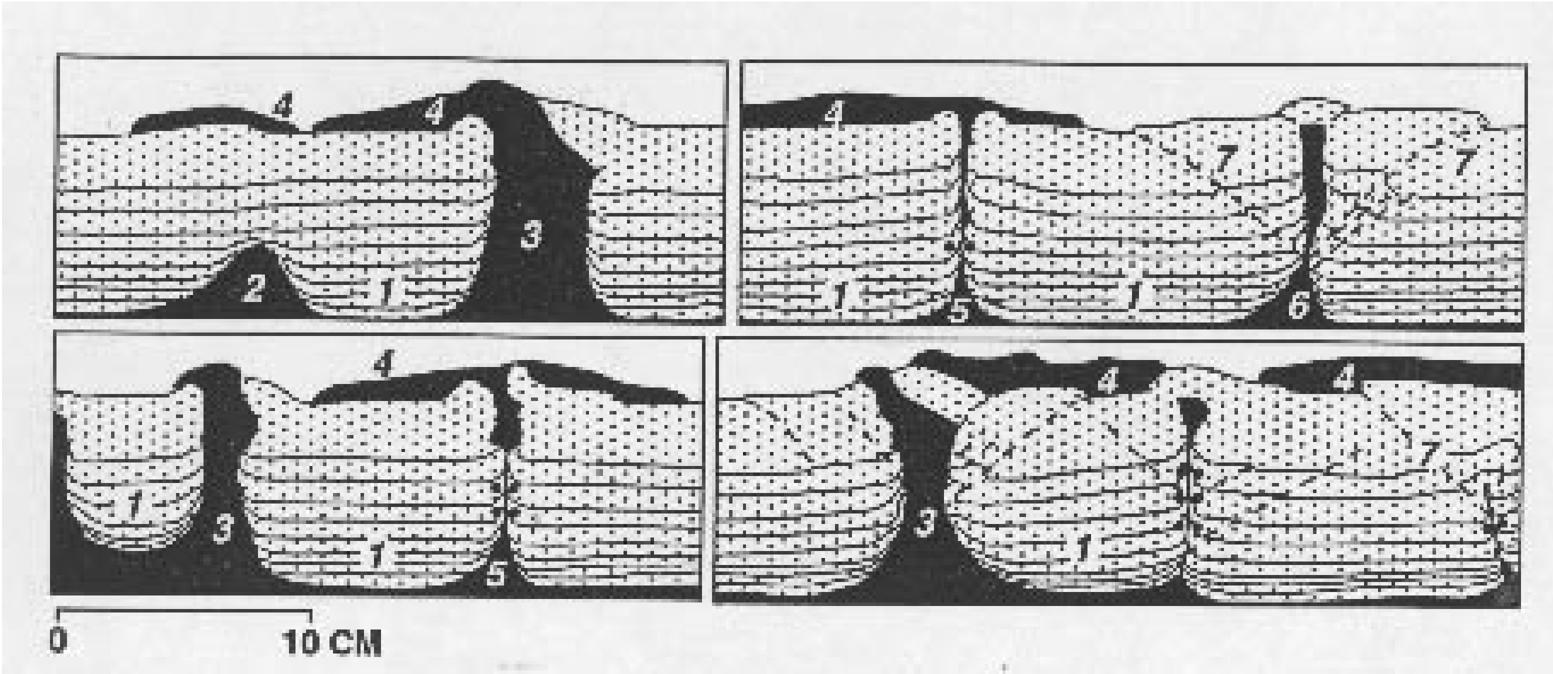

Figure 3: Details form serial sections in a physical model in which early depocenters (1) and salt ridges (2) have later been deformed by contraction. Most initial salt ridges have risen to form diapirs (3,5,6), many of which have emerged and extruded (4). Where contraction has pinched off the stem of some diapirs (5,6), further contraction was accommodated by reverse faulting and folding (7). Elsewhere, contraction was entirely accommodated by narrowing the diapir (3) and was not recorded by folds or faults.