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by Mark G. Rowan,
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Structural Styles of Passive-Margin Deepwater Provinces

Abstract

Passive margins with salt or overpressured shale layers typically undergo gravitational failure above the weak detachment. The deepwater, distal provinces are dominated by contractional tectonics that balances proximal extension and downdip translation of the overburden. Failure is driven by a combination of gravity gliding above a basinward-dipping detachment and gravity spreading of a sedimentary wedge with a seaward-dipping bathymetric surface. Continued deformation is driven primarily by shelf and upper slope sedimentation, which maintains the bathymetric slope and the resulting gravity potential, and by increased basinward tilting. Deformation is retarded or halted by distal thickening of the overburden caused by the folding itself or by lower slope and abyssal sedimentation. Differences in deepwater deformation along various passive margins, such as the northern Gulf of Mexico or offshore west Africa, can be explained in part by differences in sedimentation, loading subsidence, thermal subsidence, and cratonic uplift.

Salt is a viscous material with no effective strength, whereas shale is a frictional material whose strength depends on the amount of overpressure. This rheological difference has several important ramifications. First, salt-cored folds are generally symmetrical with only minor faulting, whereas shale-detached foldbelts typically comprise asymmetric fault arrays with multiple detachment levels. Second, deformation above salt usually occurs immediately, beneath only a thin overburden, whereas shale-based deformation does not happen until there is a sufficient thickness of sediment to create overpressured conditions. Third, the location of salt-cored folds is controlled by the basinward pinchout of the salt, the toe of the slope, and thickness variations within the original salt layer, whereas the location of shale-detached deformation depends largely on the variable build-up and release of overpressure over time.

Salt can also reduce the gravity potential of the failing margin in other ways. The bathymetric slope can be decreased by proximal subsidence into salt and distal inflation of salt. The inflated salt, as well as existing diapirs or salt walls, can be squeezed laterally, thereby accommodating significant shortening. This, in turn, drives further diapirism and/or lateral salt extrusion. Extruded salt may amalgamate to form extensive salt canopies, so that subsequent gravitational failure may take place largely on shallow, allochthonous detachments rather than on the autochthonous salt level.

Biographical Sketch

MARK G. ROWAN is an authority on salt tectonics and the instructor for AAPG's "Practical Salt Tectonics" school, and is a consultant in Boulder, Colorado. Mark received a BS from CalTech in 1976, an MS from U.C. Berkeley in 1982, and a PhD in structural geology from the University of Colorado at Boulder in 1991. He spent 3 years at Sohio Petroleum Co. in Denver (1982–1985), 4 years at Geo-Logic Systems in Boulder (1985–1989), and 3 years at Alastair Beach Associates in Glasgow, Scotland (1989–1992). He then returned to the University of Colorado, and in 1996 he was appointed a Research Assistant Professor and headed up a large industrial research consortium investigating Gulf of Mexico salt tectonics. Mark left this position in 1998 and founded his own company, where he consults and teaches for industry and conducts research on salt tectonics. He is widely published, having authored or co-authored over 40 papers and 75 abstracts. ☐