Rock Deformation Adjacent to Salt Diapirs

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ABSTRACT

Salt diapirs have broadly discordant contacts with their encasing overburden, although younger strata may locally be concordant to the edge of salt. A key question concerns how much strain surrounding strata experience during diapir growth and any associated contraction or extension. Upturned and thinned strata are well known around diapirs, but how much small-scale deformation is present? There is a common perception that the relative movement of upward salt rise and minibasin subsidence causes fracturing and shearing of the surrounding strata, which has important implications for potential drilling hazards, reservoir degradation, and hydrocarbon migration or containment. Because seismic and well data are inadequate to address this question, we turn to outcropping diapirs in La Popa Basin (Mexico), the Paradox Basin (USA), the Basque Pyrenees (Spain), the Zagros Mountains (Iran), and the Flinders/Willouran Ranges (Australia). Folds are common but not ubiquitous, ranging in scale from a few tens of meters in height and width in halokinetic hook folds to kilometers in megaflaps. These folds are associated with thinned strata, but the thinning is caused primarily by deposition onto salt-supported topographic relief rather than bed lengthening or shearing during folding. Salt-edge-parallel structural fabrics are present within diapirs but mostly absent in flanking strata. Micro- and meso-structures (e.g., small faults, fractures, cleavage) are not abundant and result from several common fold-related processes: flexural slip; outer-arc extension; minor (<2%) bed lengthening; and concentric extension (radial faulting) where the diapir edge is curved in map view. In other words, salt rise typically causes drape folding, which in turn causes small-scale deformation. The field observations should provide reassurance to those drilling adjacent to diapirs. Certainly surprises are often encountered, but they usually comprise steeper and older strata than thought, local halokinetic unconformities, and mass-transport complexes related to slumping of the diapir roof. Broad damage zones with sheared and fractured rock should not be expected as long as there is adequate salt to take up the strain. If the diapir becomes welded, however, adjacent strata typically experience more deformation, especially if there is subsequent weld-parallel slip caused by extensional, contractional, or strike-slip tectonics.