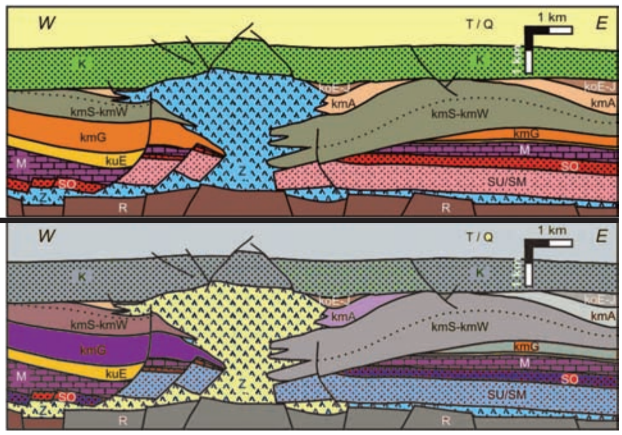
6. Salt tectonics



Salt and evaporites in general deposited as the intermediate layer of passive continental margins (fluvial red beds, evaporites and carbonates). At depth deeper than ca. 1000 m salt rocks are less dense than common sedimentary rocks. This produces buoyancy forces that, when associated to triggering processes (e.g., faulting) may generate the upwelling of salt (figs. 134 - 137). Salt structures may have point sources (producing salt pillows or diapirs) or line sources (producing salt walls or salt anticlines).

Diapirs form in any tectonic environment (fig. 138) (compression, extension, strike-slip) and are longlasting features, being active as long they are loaded and gravitationally unstable. Salt is the component of the sedimentary cover that is characterised by the shallowmost brittle-ductile transition. Salt layers normally behave as detachment layers even at shallow-depth. In passive margins, a basinward tilting of the sedimentary cover resting on salt layers normally induces gravitally driven downslope sliding of the sediment succession. This typically occurs on the two conjugate margins of the Southern Atlantic Ocean (i.e., along the Brazilian Margin and in the Kwanza Basin, in the Angolan offshore) (figs. 139 - 142). Passive

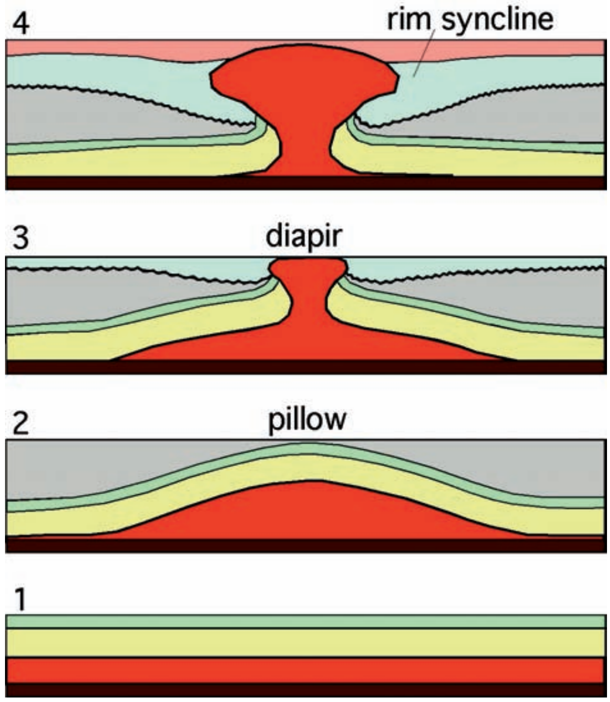


Fig. 134 - Classic model of salt (red layer) evolution when loaded. First it forms a pillow uplifting the overlying cover (2). Then the diapiric piercing starts (3) and the mother salt layer is eventually entirely evacuated (4) to generate a subsidence around the diapir and producing a basin surrounding the diapir (rim syncline). Note the yellow layer which is first uplifted (pillow stage) determining a thinning of the growth (gray) strata. Then it subsides (diapiric stage) forming an overlying thickening of the cover. An unconformity separates the two stages at the base of the azure (after Trusheim, 1960).

margins affected by gravity salt tectonics are characterised by three major domains: 1) raft domain in the internal part (close to the continent), with sedimentary blocks bounded by listric normal faults rooted in a shallow detachment level characterised by the occurrence of remnant bodies of salt; 2) a diapir domain in the middle part, characterised by wide and numerous diapirs; 3) a salt nappe domain, close to the abyssal plain, characterised by trusts and folds, occurring where the sliding sediments accumulate.

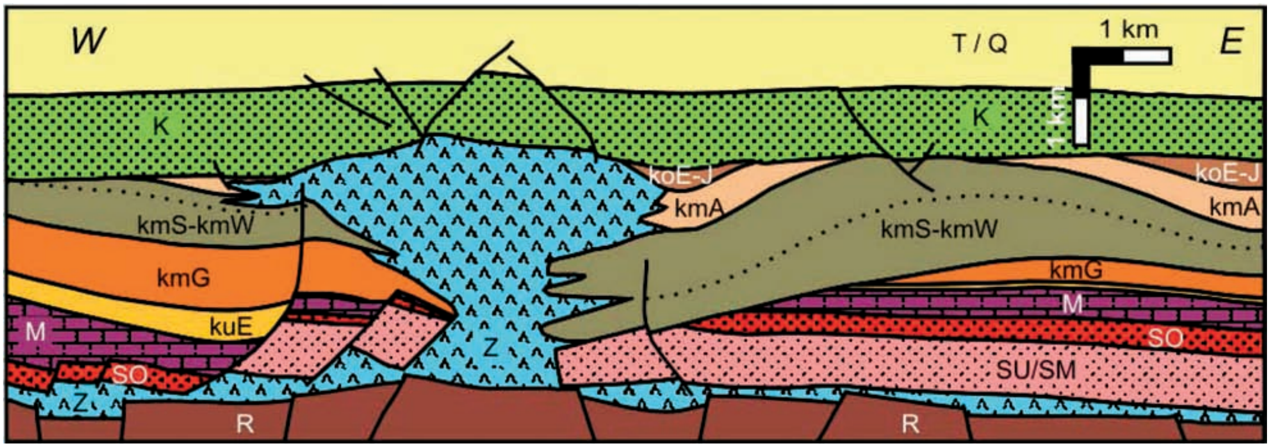


Fig. 135 - Example of diapir from the Permian Zechstein salt in northern Germany after MOHR *et alii* (2006). Note the two major unconformities, one at the base of the Cretaceous (K), and a deeper one at the base of the kmS-kmW, marking the transition between the pillow stage and related uplift producing erosion, followed by the rim syncline which occurred with the evacuation of the salt from the mother layer.

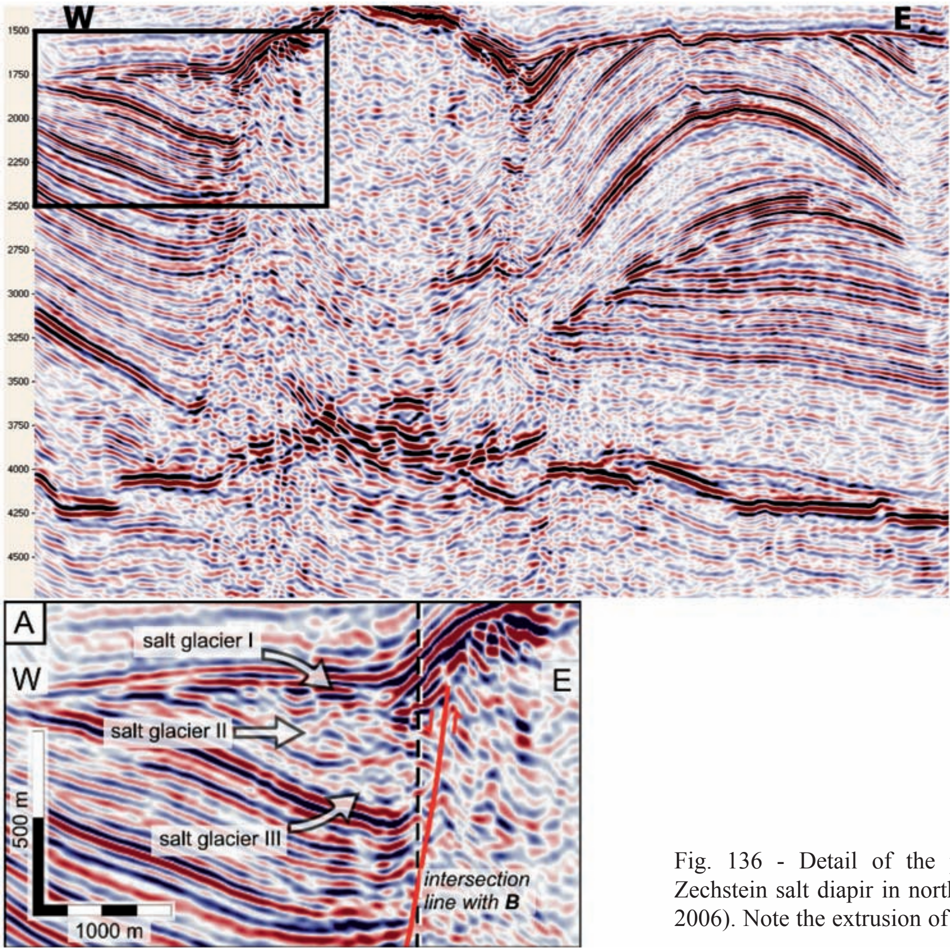


Fig. 136 - Detail of the previous section of the Permian Zechstein salt diapir in northern Germany (after MOHR *et alii*, 2006). Note the extrusion of salt (salt glacier).

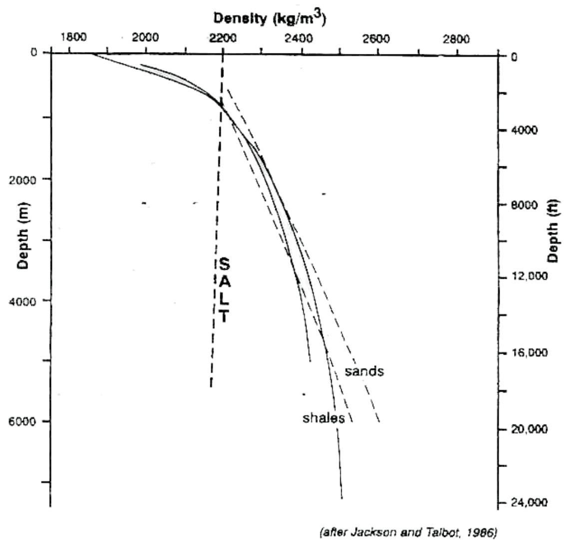
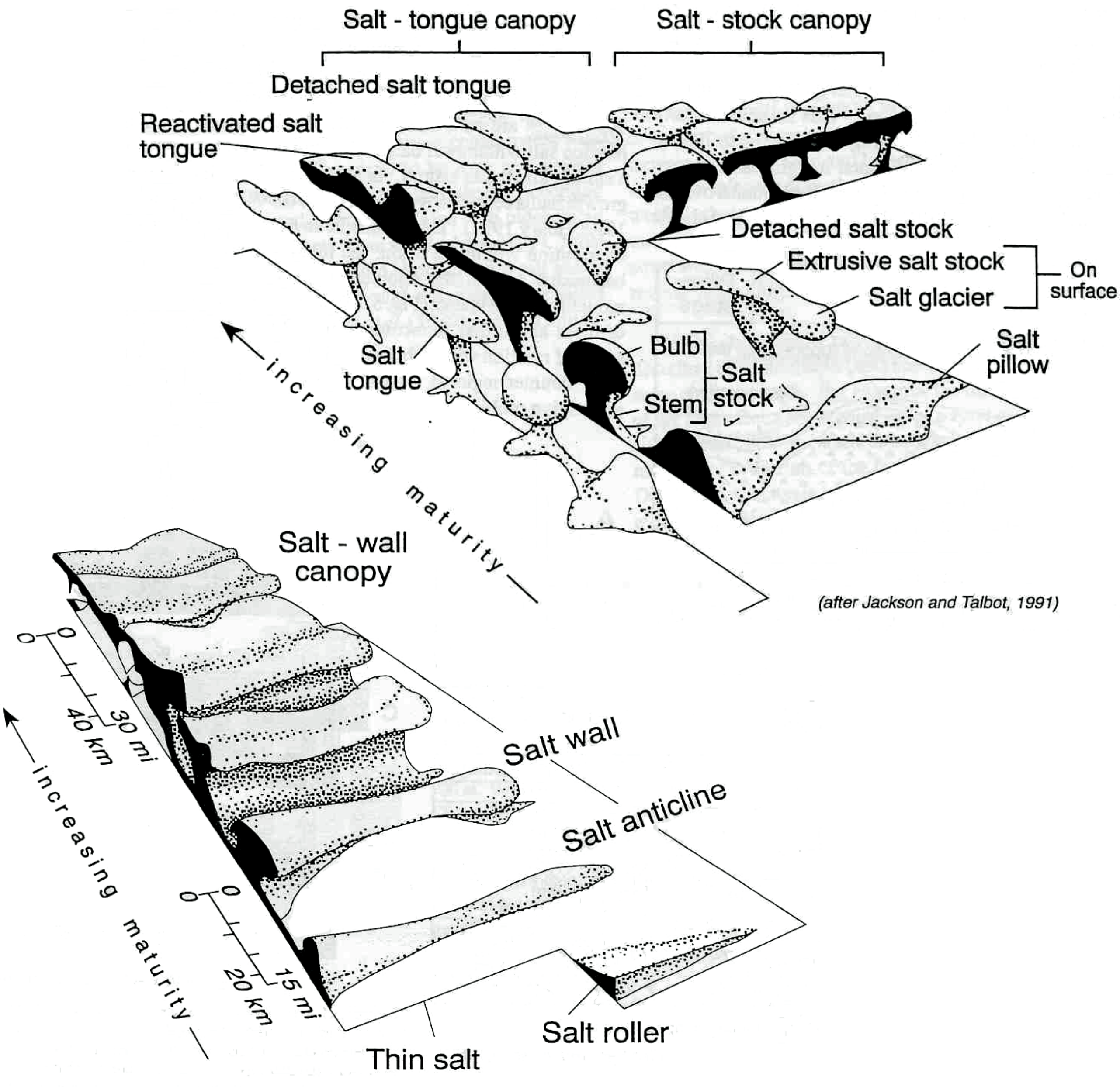


Fig. 137 - At depths greater than 1000 m the density of salt is smaller than that of common sediments (upper panel). This causes the onset of buoyancy forces that may lead to the development of salt diapirs. Salt structures may be punctual (middle panel) or planar (bottom panel). After JACKSON & TALBOT (1991).



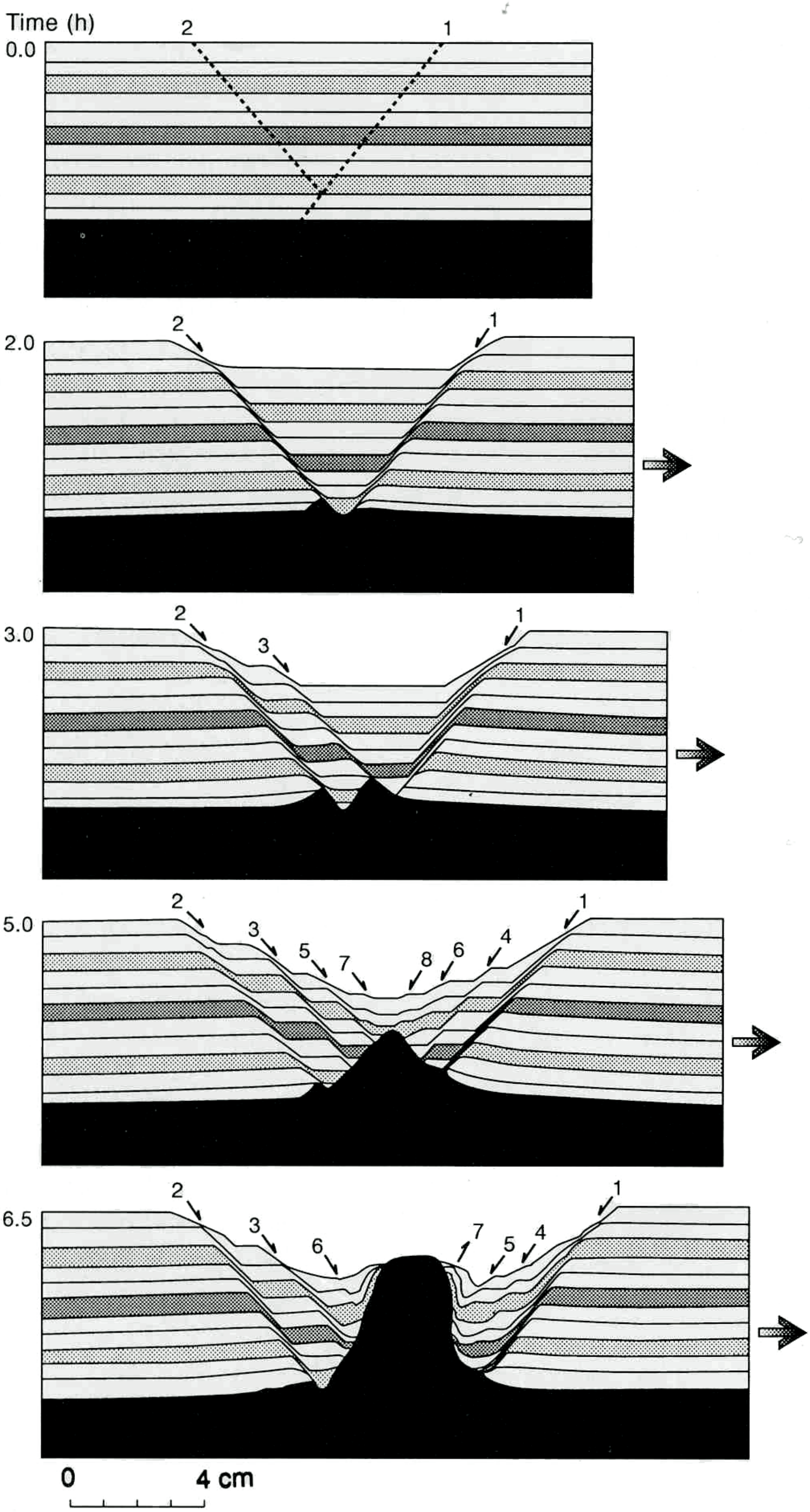


Fig. 138 - Diapirs are normally triggered by local tectonic features, such as normal faults, as in this case. Notice the formation of rim synclines (after JACKSON & VENDEVILLE, 1994).

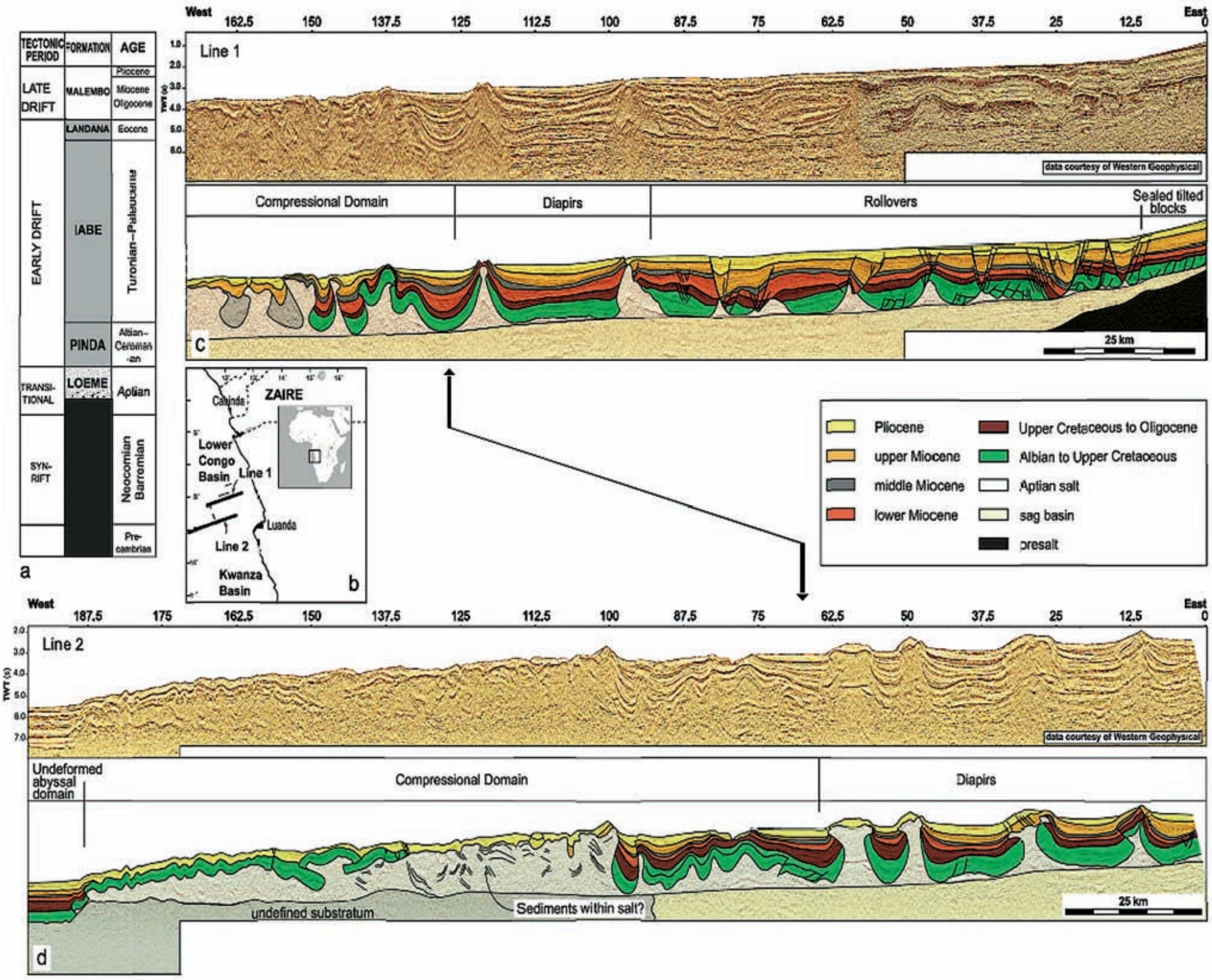


Fig. 139 - Gravity salt tectonics in the Kwanza Basin, offshore Angola. Notice the extensional tectonics in the internal sectors (close to the continent; raft domain) with listric normal faults rooted in a shallow detachment level characterised by the occurrence of remnant bodies of salt. The central part of the section is characterised by wide and numerous diapirs, while the external part is a compressional domain characterised by thrusts and folds. Shortening is due to accumulation of sliding sedimentary cover at the transition between the continental ramp and the abyssal plain (after FORT *et alii*, 2004).

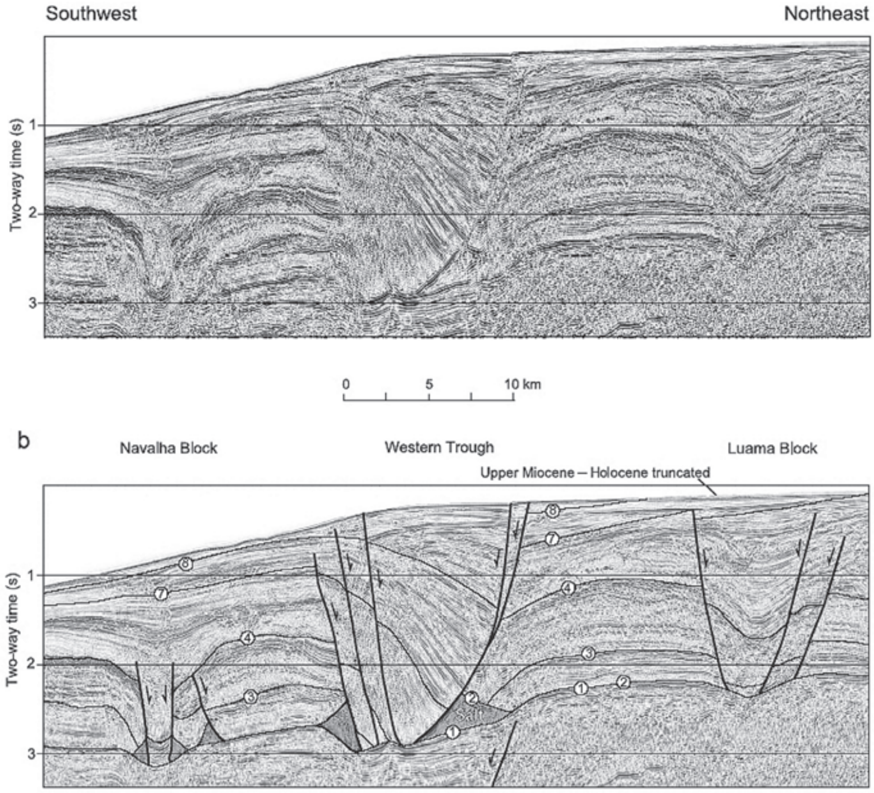


Fig. 140 - Seismic section showing listric faults in the raft domain of the Kwanza Basin, offshore Angola. The raft domain contains large sedimentary depotroughs separated by almost undeformed Cretaceous rafts (after HUDECK & JACKSON, 2004).

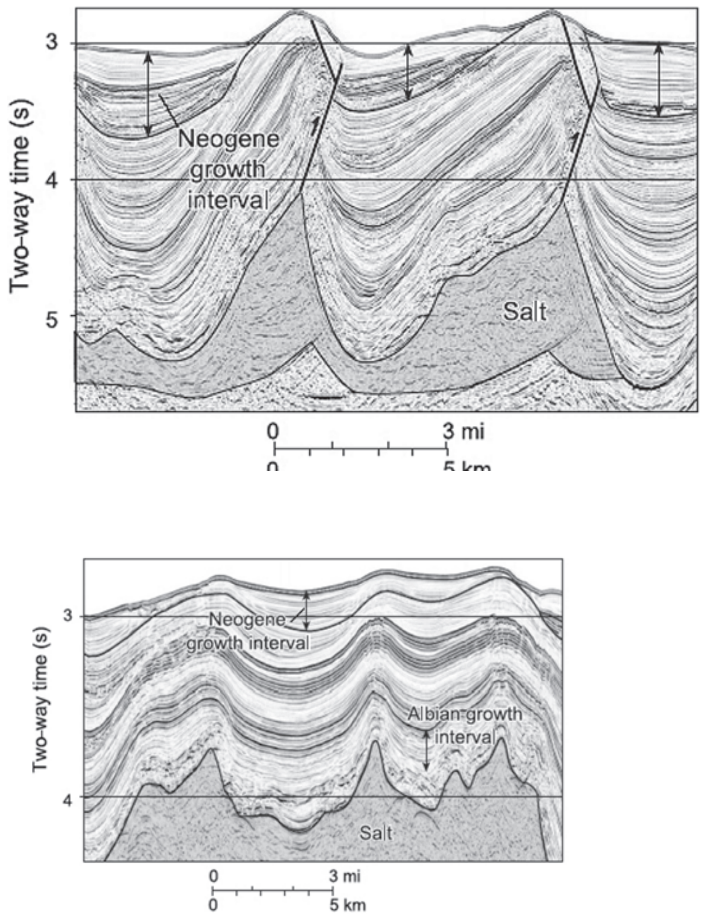


Fig. 141 - Seismic sections from the diapir domain of the Kwanza Basin, offshore Angola. After HUDECK & JACKSON (2004).

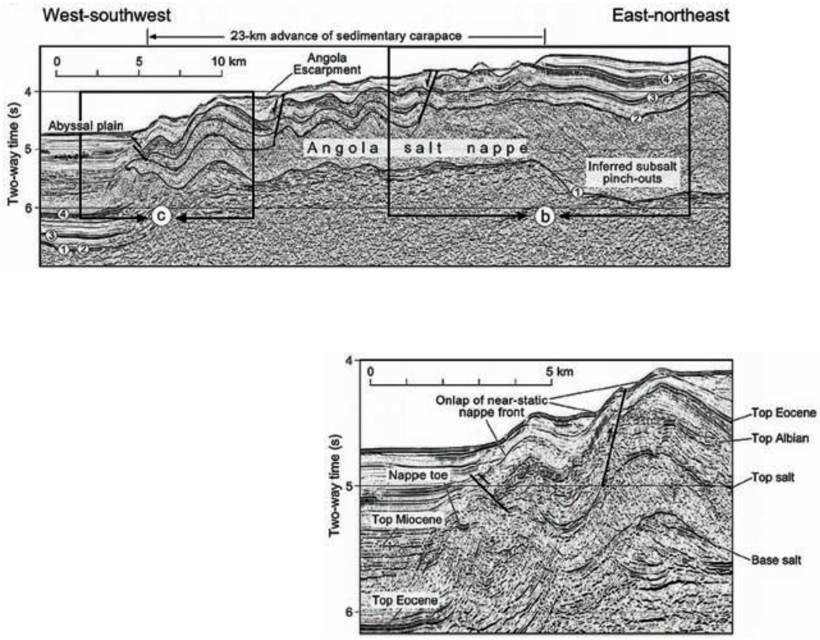


Fig. 142 - Seismic section from the salt nappe domain of the Kwanza basin, offshore Angola. Notice the development of folds and thrust faults. The bottom panel is an enlargment of box C of the upper panel (after HUDECK & JACKSON, 2004).

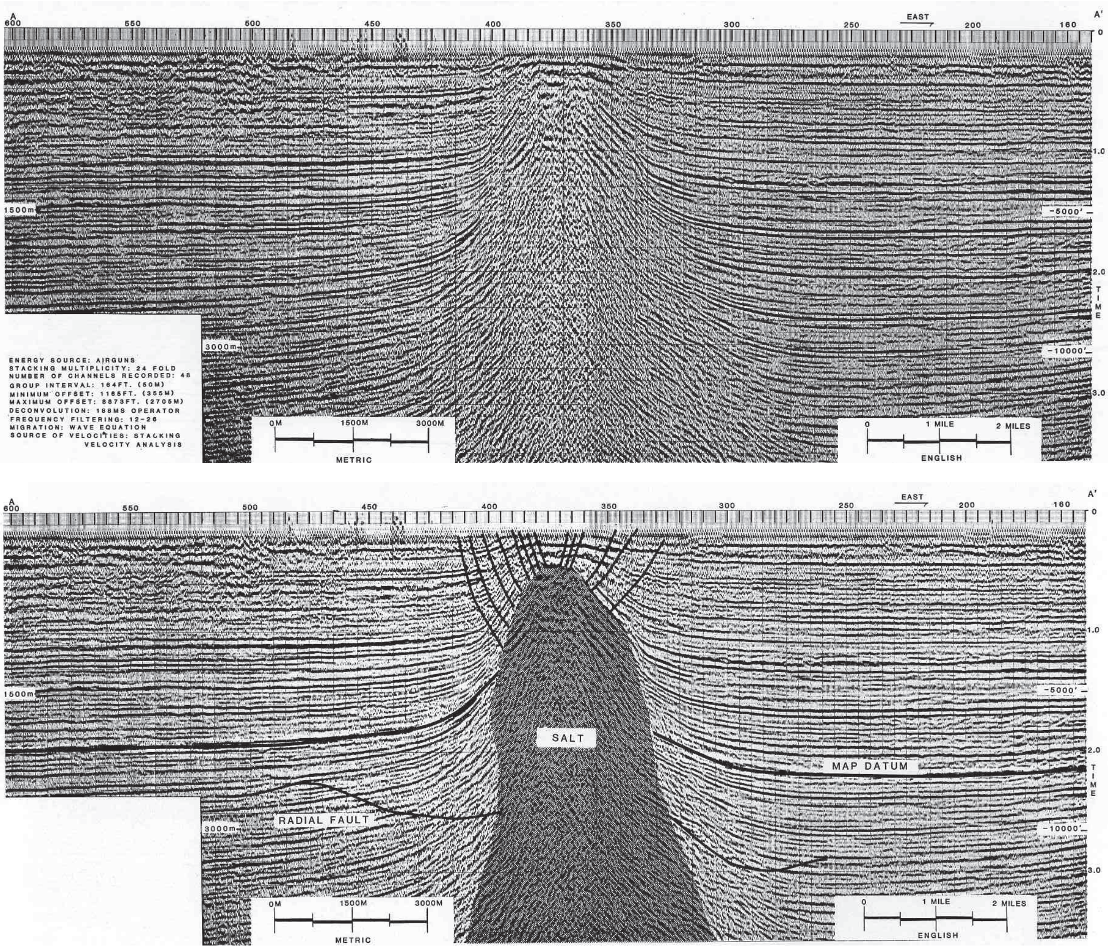


Fig. 143 - Salt diapirs with crestal collapse normal faults from the US Gulf coast (after SUNWALL *et alii*, 1983).