

The 'slope detachment zone' on the western Scotian Slope, offshore Nova Scotia: structural style and implications for margin evolution and hydrocarbon prospectivity

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Introduction

Regional 2D and 3D seismic mapping efforts reveal a ca. 350 km long structurally distinct region that runs parallel to, and outboard of, the Jurassic carbonate bank on the central and western parts of the Scotian Slope, offshore Nova Scotia. This region, defined here as the 'slope detachment zone' (SDZ), covers an area greater than 13 000 km², is ca. 35 to 55 km wide, and is characterized by the distinct absence of allochthonous salt diapirs in present day water depths that are generally between 500 to 2500 m. Because it encompasses roughly 30% of the total area of the Scotian Slope shallower than 2500 m of water, improved understanding of this structural domain is of significant economic (in terms of deep water petroleum prospectivity) and academic (in terms of rifted margin evolution) interest.

Slope detachment zone (SDZ)

The landward edge of the SDZ corresponds to the structural hingeline that parallels the Jurassic carbonate bank, separating a relatively stable platform to the north from significantly attenuated continental crust to the south; its distal limit, as defined here, corresponds to the landward edge of the 'slope diapiric province' (Wade and MacLean, 1990) comprised dominantly of allochthonous salt diapirs. Strong decoupling in the SDZ is recognized between the structural styles above and below a seismically amorphous interval interpreted as a thin autochthonous salt layer. The basement morphology below autochthonous salt (or the associated primary weld) is commonly irregular, with abrupt offsets presumably produced by a complex arrangement of synrift horsts and grabens or half-grabens that developed during rifting. Continued motion on some rift blocks appears to have locally offset the autochthonous salt layer, indicating that thick-skinned deformation continued even as the parent salt accumulated. In contrast, the deformation style above the relatively thin interval of autochthonous salt (and its associated primary weld) is dominated by raft tectonics with thin-skinned detachment. Both extensional and contractional structures are recognized. Jurassic strata are commonly offset along low-angle listric growth faults that sole out in autochthonous salt. These faults define the headward parts of detached 'slabs' of Jurassic strata, and can be correlated laterally into distinct shear zones that define the edges of detached slope strata. Parts of the Jurassic carbonate bank foundered in a similar manner. Detachment is generally toward the south, in a direction consistent with the dip of the present day slope. In the southern parts of the SDZ, there is an increased tendency toward contractional structures, including detachment folds, reverse faults and thrust faults. Such structures continue into the 'slope diapiric province' to the south.

There is little or no allochthonous salt in the SDZ, and little evidence exists to suggest that salt moved seaward from this region towards the 'slope diapiric province' during sediment loading and detachment. Rather, significant sediment down-building took place along the southern boundary of the SDZ in the Jurassic and Cretaceous, accommodated by salt withdrawal along the landward edge of the 'slope diapiric province'. Hence the transition from the SDZ to the 'slope diapiric province' probably corresponds to a seaward increase in autochthonous salt thickness in present day water depths greater than 2000 m. The dramatic increase in the concentration of allochthonous salt diapirs south of the SDZ (within the 'slope diapiric province') supports this interpretation. Such observations help constrain the geometry of the rifted margin and may indicate that the SDZ was structurally elevated compared to areas to the south where a greater thickness of autochthonous salt appears to have accumulated. The SDZ therefore may coincide with the onlap edge of the original autochthonous salt basin. Development of extensional and contractional structures above the autochthonous salt in turn is believed to have been prompted by over-steepening of this region during Jurassic thermal subsidence after(?) continental break-up, with subsidence continuing into the Cretaceous.

References

Wade, J.A., Maclean, B.C., 1990. The geology of the Southeastern Margin of Canada, Chapter 5 , Geological Survey of Canada, Geology of Canada, No.2, pp.224-225