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Passive Margin Fold and Thrust Belts

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Marine fold-and-thrust complexes form extensive belts along ocean basin slopes, and are associated with prolific hydrocarbon provinces particularly in the Atlantic Basin, including the Gulf of Mexico. These systems have common boundary conditions as they are located along passive continental margins, sometimes with syn/post-rift evaporites, followed by Cretaceous to recent, predominately siliciclastic sequences which locally comprise the largest delta systems on Earth. Post-rift tectonic stresses are considered insignificant at passive margins if it is assumed that the underlying oceanic and stretched continental lithosphere have mechanically and thermally re-equilibrated since the onset of seafloor spreading. Therefore the rate of sediment deposition appears to provide the major driving forces that controls the post-rift shelf to basin architecture.

Two end-member modes are suggested for gravity-driven instabilities along these margins: (i) load-driven outflow of soft sediment sequences above an detachment horizon due to progressive sediment input from the prograding delta wedge; and (ii) mass wasting processes dominate, at margins with moderate sedimentation, due to unsustainable slope gradients that result from the basinward subsidence history.

Prograding delta systems drive progressive gravitational collapse in the sedimentary sequence, where shelf sections are dominated by growth faulting, which in turn provides additional sediment accommodation space. Rapid burial in the growing stratigraphic sequence may trigger salt withdrawal and fluid migration, forming significant charged reservoirs and structural traps.

Normal faults commonly bottom out at basal décollements that translate into contractional regimes farther outboard, where thin-skinned folds and imbricates dominate. Regional seismic sections capturing the complete passive margin sequence were used for sequential kinematic restoration, and illustrate equilibrium between the extension in the shelf region and corresponding shortening near the toe of the slope. Horizontal net displacement rates are one order of magnitude less than those in tectonic belts. Though bulk flow is relatively slow it continually fluctuates in these basins due to varying sediment supply.

The mechanics of these passive margin sequences is analogous to gravitational flow in ice sheets, which provide suitable analogs for modeling displacement fields in sedimentary wedges. However, localized dramatically higher flow rates are evidenced by rapid lateral salt extrusion along thrusts and may generate allochthonous salt canopies. In this respect the various styles of salt emplacement are consider a consequence, rather than a control, of the overall deformation and resulting architectural style of these basins.

Mass-wasting complexes are one magnitude smaller in length compared to delta systems, where fold-and-thrust belts may reach 1,000 km. Although they reveal similar morphologies with extension dominating the up-dip concave breakaway zone and down-dip convex contractional domain, mass-wasting processes appear episodic with décollement horizons commonly at a relatively shallow stratigraphic level. Their limited size and depth, as well as relatively short period of activity, may restrict the hydrocarbon reservoir potential of those structures.