Kinematics, Strain-Stress History and Fracture Evolution in Detachment Fold Structures of Deepwater Continental Margins

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The main targets in deepwater exploration around the Atlantic Margin are complex deformed and fractured sediments in the deepwater contractional domain of salt basins. Here, the kinematic evolution of the rifted margin and the post-rift passive margin sedimentary wedge is characterized by thin-skinned extension and contraction on top of the viscous salt layer, e.g. Angolan Margin [1], Gulf of Mexico [2], Scotian margin [3], Brazil margin [4].

The deep-water fold belts commonly are found at the toe of the slope or in a zone just landward of the distal pinch-out of the original salt layer [5]. Shortening in the deepwater fold belts is caused by basinward tilting due to post-rift thermal subsidence or differential loading, contraction can take place continuously or episodically, depending on the basin history [6]. Particularly, early basinward tilting caused gravity-gliding and basinward contractional deformation of post-salt shallow marine sediments, e.g. limestones. Fractured reservoirs in anticlinal structures of the deepwater fold belts, for example salt-cored detachment folds, salt-related fault-bend folds, faulted detachment folds are important exploration targets. To support exploration in these geologically and technically challenging deepwater environments, a better understanding of salt-related folding and faulting processes is necessary to analyse the regional kinematic evolution and mechanics of the fold structures as well as the strain history within the folded layers to simulate the fracture pattern & distribution.

This PhD project will investigate the mechanics of salt-cored folds, fault-bend faults, and salt-detached folds in linked extensional-contractional systems of passive margin salt basins with a combination of seismic interpretation, structural modelling and physical/numerical simulation methods. The main objective is the mechanical analysis of salt-related fold structures with structural modelling methods, scaled analogue experiments, and numerical FE/DE simulation techniques. For all fold development stages high-resolution 3D strain data derived from the analogue experiments by DIC (Digital Image Correlation) will be used as input for further fracture modelling and fracture prediction [7] in the fold structures. The integrated study will allow developing concepts for the timing and mechanism of salt-cored fold structures and their related fault and fracture systems in deepwater fold belts.

This study is part of our industry research collaboration with focus on methodical development and application to applied exploration problems in complex structured and fractured reservoirs. Long-term goal is the development of tools for the mechanical analysis and simulation of salt-related structures and the corresponding fracture systems & mechanism in complex deformed sedimentary rocks.

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