Impact of early salt tectonic processes on Post-Permian Basin Evolution and Mesozoic Petroleum Systems in the Southern North Sea

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Background: The mature Southern North Sea basins act as the main gas-producers from Permian pre-salt strata on the UK continental shelf, whereas the potential of Triassic reservoirs as secondary gas producer or as reservoir for carbon sequestration and storage in support of nearby gas-producing fields is not well understood. Early post-Permian salt tectonic processes during regional extension and their interaction with highly variable palaeo-depositional systems were a major factor controlling on the post-Permian basin history of the Southern North Sea.

Fig.1: Modern-day evaporite deposition, Badwater Basin, Death Valley, US.

Project Approach: Excellent seismic imaging of Triassic sediments in modern merged 3D regional seismic data demonstrates very active Triassic-Jurassic salt tectonics. It is clear that Triassic-Jurassic thick- and thin-skinned salt deformation processes controlled the pre-Cretaceous basin architecture, reservoir distribution, and trap formation of post-salt reservoirs. However, due to thermal doming and regional erosion, Triassic-Jurassic depocentres and their related salt structures are only partly preserved. Their reconstruction is important for understanding this early phase of basin history and its controls on the subsequent basin evolution, salt tectonic structures and petroleum systems.

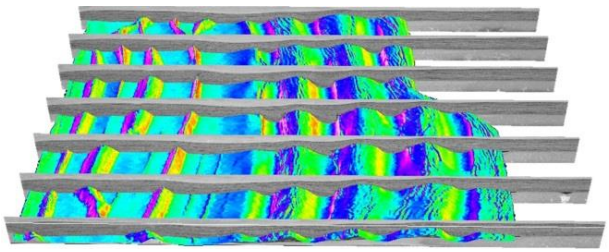

Fig.2: 3D visualisation of top-silicone (aka top-salt) surface and representative cross-sections of a scaled post-rift salt basin experiment.

Objectives: The main objectives of the project are the tectono-stratigraphic analysis and simulation of basement-involved and gravity-driven salt deformation processes in the post Permian salt basin of the southernmost North Sea using 3D seismic interpretation, structural modelling, field studies and scaled analogue experiments. Results from 3D regional seismic data will constrain dynamically scaled 3D analogue experiments. The experiment results and derived 2D/3D full-field strain fields will provide mechanical concepts and constraints of the timing and kinematics of salt tectonic processes from scales of individual structures up to the basin-scale framework. The integration of time-series experiment results with 3D seismic interpretation will enable the kinematic reconstruction of the early basin history and salt tectonic processes during

the Triassic-Jurassic rifting period and forms the basis a 3D petroleum system modelling. Seismic interpretation, analogue modelling and petroleum systems modelling will deliver detailed understandings into the spatial and temporal evolution of the petroleum systems of the Southern North Sea.

Project Outcome: This study will allow the assessment of how different early salt basin scenarios have impacted on basin evolution, providing new insights for alternative exploration strategies in mature fields. The results will provide valuable leads for future exploration work within the mature North Sea basins, and contribute to reducing risk in exploration ventures.

Relevance: The project fits into the CDT Research theme *"Extending the life of mature basins"*. The mature Southern North Sea basins show complex salt structures and basin history. Early Mesozoic salt tectonic processes and their impact on basin formation are not well established. Improved concepts are important for accurate petroleum systems analysis and identification of new plays in mature Southern North Sea fields.

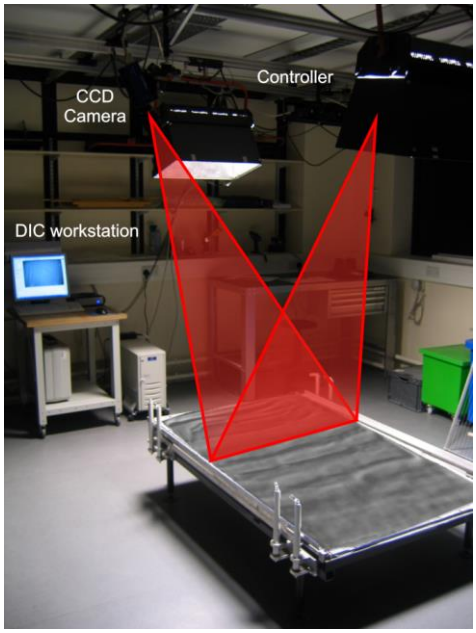

Fig.3: Analogue laboratory setup with salt experiment and 3D deformation monitoring system (DIC – digital image correlation).

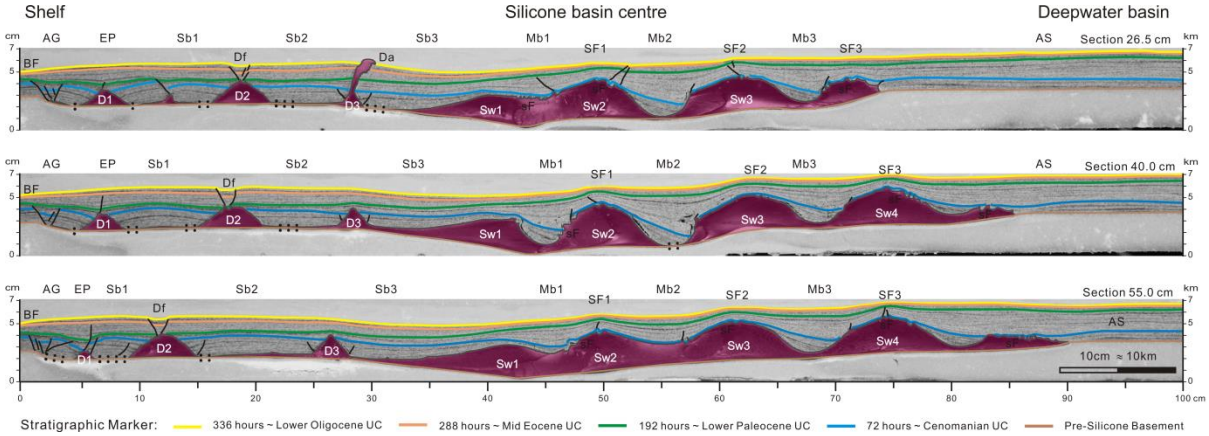

Fig.4: Interpreted serial cross-sections of scaled salt basin experiment showing gravity-driven post-rift salt structures in a passive margin setting with extensional reactive diapirs in the shelf area and contractional detachment folds in the basin centre (Adam et al., 2012).

Research context: This PhD project is fully integrated in the PG Petroleum Geoscience training programme and the Continental Margins Research Group of the RHUL Earth Sciences department. Two PhD students work already on seismic interpretation and structural analysis of the Southern and Central North Sea and several related MSc projects have provided further input.

Career routes: Possible career paths are open to the student within the Oil and Gas sector in the fields of upstream research, exploration, production geoscience and academic research.

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