Specific Play Knowledge of Zechstein Carbonate Reservoirs Applied across the Northern and Southern Permian Basins

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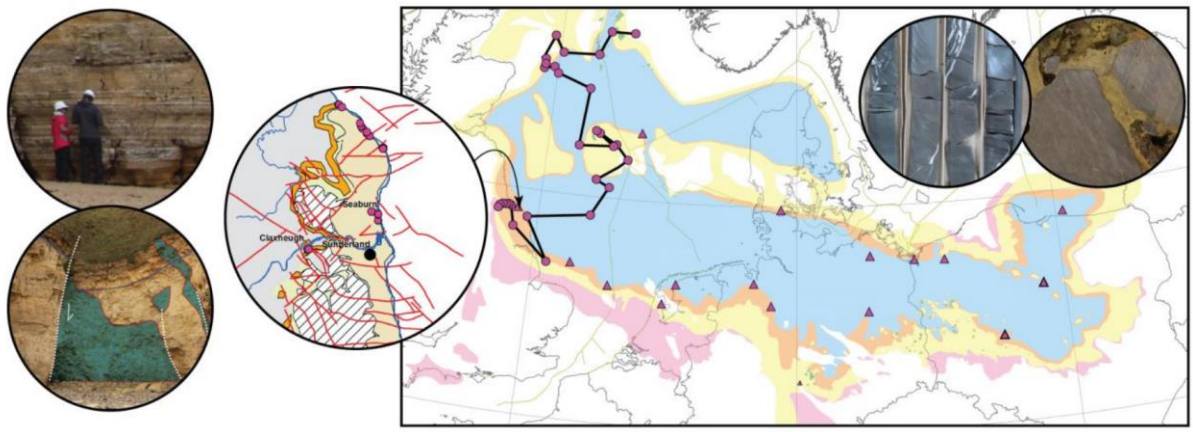
Production from Zechstein carbonates in the UK, Norway, Poland and Netherlands is significant today and has been important since UK offshore oil production began in 1975, the Argyll field having been the first offshore UK field on production. These carbonate reservoirs were deposited in the Permian Basin of NW Europe, which is often separated into the Northern and Southern Basins. We completed a multi-disciplinary project on the Zechstein carbonates of NW Europe in 2016. Across the region, an improved understanding of connectivity within the Zechstein carbonates has been achieved through studies of outcrop, core and the subsurface, and a basin-wide literature review.

A stratigraphic correlation across the Northern and Southern Permian Basins (NPB & SPB) has been established, based on published data for the SPB (data from Poland, Germany, Netherlands, UK, and Norway) and core for the NPB.

To understand the internal connectivity of the carbonates at different locations across the basin, each site was located within its sequence stratigraphic and spatial context in the basin, coupled with a broad understanding of its tectonic and burial history. Knowledge of how these factors will impact matrix and fracture permeability has been derived from detailed outcrop and core studies.



Palaeogeographic map for the Z2 (after Slowakiewicz et al., 2015) showing location of field fracture studies in northeast England (inset map), sequence stratigraphic articles reviewed (triangles) and correlation panel (black path). Blue represents basin, orange represents slope, yellow represents platform, pink represents sabkha and salina, white are highs.

The northeast of England hosts world class exposures of Zechstein carbonates, occurring as primary limestones, dolomites and dedolomites, with bedded, replaced and brecciated textures, from lagoonal to lower slope facies. The carbonates have been subjected to fracturing from depositional times onwards, with some locations experiencing faulting and even collapse due to dissolution of underlying evaporites. These well-studied outcrops were used to characterise fracture properties using lidar, photogrammetric and field measurements. The fracture properties are understood within the context of facies, structural and diagenetic history, and, at some locations, evaporite dissolution, to allow prediction of fracture behaviour within reservoirs across the basin. Comparison of the emergent picture from outcrop studies with core has verified that the interpretation is valid in the subsurface.

The final evaluation has been to consider production data from fields located in the UK CNS and Dutch Drenthe Province, in terms of aquifer support, and the vertical and lateral connectivity of the carbonate reservoirs. There were favourable comparisons of the predictions of fracture and matrix permeability with historical field production behaviour (based on facies, faulting, diagenesis and whether evaporite dissolution has occurred).