The Onshore Structural Geology of Foula, Shetland and Implications for the Devonian-Carboniferous Development of the Offshore Clair Basin

Thomas Utley[1], Robert Holdsworth[1], Eddie Dempsey[1], Kenneth McCaffrey[1], Rob Strachan[2], Richard Jones[3], and Graham Blackbourn[4]

[1]Department of Earth Sciences, Durham University, Durham, United Kingdom.
[2]School of Earth and Environmental Sciences, Portsmouth University, PO1 3QL, United Kingdom.
[3]Geospatial Research Limited, Durham, United Kingdom.
[4]Blackbourn Geoconsulting, Bo'ness, United Kingdom.

ABSTRACT

The Clair Field, west of Shetland, represents the largest remaining hydrocarbon resource in the UKCS. It comprises fractured Devonian-Carboniferous sandstones overlying a fault bounded ridge of Precambrian metamorphic basement. The extensional Orcadian Basin in Orkney and Caithness has long been used as an onshore analogue for the Clair Basin, although it has long been recognised that it may have a somewhat different tectonic setting due to its geographical separation from Clair. Foula, a 13km2 island situated 25km SW of the Shetland Isles may represent the nearest and best onshore analogue to the Clair Ridge, the 2nd phase development of the Clair Field. The island has been relatively little studied with regards to its structural evolution. 1600m of gently folded Middle Devonian sandstones correlated with the Lower Clair Group offshore, are spectacularly exposed in continuous, kilometre-long cliff sections up to 376m high. These rocks unconformably overlie likely Precambrian-age amphibolite facies basement gneisses and schists intruded by sheeted granites of uncertain age and affinity. Here we present an ongoing reappraisal of the structure, stratigraphy and tectonic evolution of the island and surrounding area. This is being achieved through detailed land and aerial (drone) based studies of exposed basement-cover contacts, and the structure and broad stratigraphic architecture of the overlying sandstone dominated sequences exposed in continuous coastal sections. Field data and structural analysis are supplemented by the use of photogrammetry to capture the geology of the inaccessible cliffs. Field data show that faulting and folding were contemporaneous with sedimentation during the earliest stages of basin development. The geometries of the faults and folding on Foula are consistent with models of constrictional strain related to regional sinistral transtention along the Walls Boundary Fault during the Middle Devonian. Our findings suggest that the Devonian basins of Shetland may therefore represent a better surface analogue for the Clair Basin. Here there is widespread evidence of strike-slip deformation preserved in both the basement and Devonian-age cover sequences and associated igneous rocks. This suggests that existing tectonic models for the development of the Clair Basin require revision.