The Leirdjupet Fault Zone, Barents Sea – The Nature and Timing of Deformation in a Complex Fault Zone

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ABSTRACT

The Leirdjupet Fault Zone, located in the Norwegian Barents Sea, forms a broadly N-S trending horst block comprised of a complex series of splaying and anastomosing fault slip surfaces. The fault zone underwent multiple phases of activity, documented in seismically resolvable offsets in a Permian to Recent sedimentary package. Quantification of displacement distributions allows the structural evolution of the fault zone to be evaluated and the nature of faulting to be reconciled with the regional tectonic development of the Barents Sea. This work integrates established structural restoration workflows with fault throw analysis; enabling the temporal variability of displacement to be determined. The results reveal that the fault zone underwent two primary phases of activity during the Early Triassic and Early Cretaceous. Moreover, this analysis demonstrates that the locus of displacement migrated eastwards through time, forming a progressively wider central horst block. 3D throw distribution analysis suggests that displacement transferred between the major horst-bounding faults, forming a ca 10 km wide relay zone. Early displacement within the Leirdjupet Fault Zone principally occurred on N-S trending normal faults situated above reactivated basement structures. This phase of activity is attributed to broadly E-W extension observed across the Artic Sea during the Triassic. Subsequent movement was accommodated on a greater variety of fault orientations, including reactivation of pre-existing N-S faults and the formation of NE-SW trending structures. The latter suggests that the principal stretching direction rotated from E-W extension in the Triassic to a predominantly NW-SE orientation by the Early Cretaceous. Whilst a number minor structures may have accommodated a component of oblique-slip movement, there is no evidence of Cretaceous inversion which has been well documented across the south-western Barents Sea. The results of this work have significant implications for the understanding of across-fault reservoir relationships and the sealing capacity of the Leirdjupet Fault Zone.