

Characterizing Fracture Systems within the Lewisian Gneiss Complex, Northwest Scotland: An Onshore Analogue for the Clair Field?

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Exotic hydrocarbon reservoirs such as crystalline basement are increasingly a target for hydrocarbon exploration in the development of new and existing fields. The Clair field lies in the Faroe-Shetland basin with reservoirs in Devonian and Carboniferous sediments that overlie and onlap a basement high that was up-faulted during the Mesozoic. At Clair the basement is considered an important control on the structural development and fluid flow due to its highly fractured nature. Consequently, it is important to characterise fault networks to assess the connected volume within the basement rocks.

Analyses of fault attributes have been undertaken across a range of scales on both the mainland and Hebridean islands with the aim of characterising fault systems in Lewisian basement and overlying Mesozoic cover sequences as an analogue for the Clair Field. Variations in lithology, metamorphic grade and tectonic setting all influence the fault network characteristics in the mainland and Hebridean terranes. This study included analysis of regional NEXTMap® digital elevation models of the mainland and the Hebrides, along with studies of seismic attribute maps of the Clair top basement horizon, in order to characterise large scale fault patterns including orientation, density and spacing attributes. Fieldwork has been undertaken on the mainland and the Hebrides in order to characterise fault systems and the tectonic history within Lewisian Gneiss and sedimentary cover sequences. This involves 1-D line sample analysis, photomosaic analysis and terrestrial laser scanning (LIDAR) to allow analysis of the fault networks in different dimensions. Thin section analyses augment this study.

1-D and 2-D analyses of regional and outcrop scale data show a dominant NE-SW fault trend within the Lewisian in both the onshore and offshore datasets. Spacing data show variable population distributions with outcrop data on the mainland showing power-law distributions. These distributions allow us to infer that the mainland outcrop data show scale-invariance and that they can be used as an estimate for the fault networks seen at different scales within the Lewisian.

These preliminary results suggest that the Lewisian Gneiss Complex is a suitable analogue for the Clair basement and further analyses will determine whether the mainland or the Hebrides provide the closest match for the fault networks seen within the basement and overlying cover sequences.