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CO_2 Storage Potential of the Eocene Tay Sandstone, Central North Sea, UK

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Carbon Capture and Storage (CCS) is crucial for low-carbon industry, climate mitigation and a sustainable energy future. The offshore capacity of the UK is substantial and has been estimated at 78 Gt of CO_2 in saline aquifers and hydrocarbon fields. The early-mid Eocene Tay Sandstone Member of the Central North Sea (CNS) is a submarine-fan system and potential storage reservoir with a theoretical capacity of 123 Mt of CO_2. The Tay Sandstone comprises of 4 sequences, amalgamating into a fan complex 125km long and 40 km at a minimum of 1500 m depth striking NW-SE, hosting several hydrocarbon fields including Gannett A, B, D and Pict. In order to better understand the storage potential and characteristics, the Tay Sandstone over Quadrant 21 has been interpreted using log correlation and 3D seismic. Understanding the internal and external geometry of the sandstone as well as the lateral extent of the unit is essential when considering CO_2 vertical and horizontal fluid flow pathways and storage security.

3D seismic mapping of a clear mounded feature has revealed the youngest sequence of the Tay complex; a homogenous sand-rich channel 12 km long, 1.5 km wide and on average 100 m thick. The sandstone has porosity >35%, permeability >5 D and a net to gross of 0.8, giving a total pore volume of 927×10^6 m^3. The remaining three sequences are a series of stacked channels and interbedded mudstones which are more quiescent on the seismic, however, well logs indicate each subsequent sequence reduce in net to gross with age as mud has a greater influence in the early fan system. Nevertheless, the sandstone properties remain relatively consistent and are far more laterally extensive than the youngest sequence.

The Tay Sandstone spatially overlaps several other potential storage sites including the older Tertiary sandstones of the Cromarty, Forties and Mey Members and deeper Jurassic reservoirs. This favours the Tay Sandstone to be considered in a secondary or multiple stacked storage scenario. Principal risks include injection-induced pressure-increase limiting injectivity, caused by limited connectivity between sand-rich sequences, up-dip migration to sandstone shelf-facies of the overlying Mousa Formation, or to hydraulically-connected underlying Tertiary sandstones such as the Forties Member which may in places be in hydraulic communication.