

## **Hydrocarbon Exploration in Intra-Basinal Highs: Workflow and Best Practices Learnt from the Johan Sverdrup Giant Oil Field**

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### **Abstract**

Intra-basinal highs have been a classic exploration play as they generate mega-closures and act as hydrocarbon migration centres. The main risk associated to those basinal highs is the prediction of reservoir presence and quality within the mega-closure, as those highs experienced multiple phases of uplift and erosion during their complex geological history. Recent discoveries, like the Johan Sverdrup oil field in the North Sea, revealed that having a detailed understanding of the tectonic and uplift-erosion history is key when predicting reservoir presence and quality.

The giant Johan Sverdrup oil field on the Utsira High (Norwegian North Sea) is an example of a multibillion-barrel oil discovery in a mature and prolific super basin. However, the field remained unnoticed by the oil industry for more than 50 years of exploration in the region. The first significant discovery in the area was not made until 2007 with the Edvard Grieg field, followed shortly after by the discovery of the Johan Sverdrup field in 2010.

These discoveries proved that hydrocarbons had migrated from afar across the basement rocks toward the crest of the southern Utsira High, refuting an old idea whereby the basement high had acted as a barrier for migrating fluids .

Consequently, this major discovery has stimulated interest around other North Sea intra-basinal highs (e.g. the Halibut Horst, the Mandal and the Froya Highs), challenging accepted models and highlighting that a detailed understanding of their uplift and erosional history is crucial to predict preserved lithologies. Understanding the uplift and erosion history on intra-basinal highs, therefore, has an impact on multiple aspects of the petroleum system, allowing us to discern whether structural highs may have acted as: a) either hydrocarbon migration barriers or migration mega-closures (i.e. implications for hydrocarbon migration), and b) either sediment source areas or deposition areas (i.e. implications for reservoir deposition/preservation and hydrocarbon migration), at different times through their geological history.

Key learnings from exploration of basinal highs in the North Sea can easily be extrapolated to other basins around the globe, uplifting the yet to find when exploring these revisited plays. Based on our experience, we present a methodological workflow that includes sequential restoration and back-stripping techniques, as well as interpretation of detailed structural-sedimentary relationships. Our proposed workflow has provided us with an in-depth understanding of the geological history of intra-basinal structural highs in different basins around the world, proving to be an essential tool when assessing prospectivity in these underexplored areas.