



Regressive and transgressive cycles in a rift-basin: Depositional model and sedimentary partitioning of the Middle Jurassic Hugin Formation, Southern Viking Graben, North Sea

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ABSTRACT

The Jurassic Hugin Formation consists of shallow-marine sandstones that belong to a significant hydrocarbon reservoir in the Sleipner area in the Norwegian North Sea. The formation encompasses coarsening-upward units of mouth bar and shoreface facies, interpreted to record delta outbuilding during regression; and fining-upward units with tidal channel, dune, and tidal flat facies interpreted as part of an estuary environment during transgression. The correlations reveal that the studied part of the Hugin Formation consists of 8 sequences, each with a transgressive and a regressive unit, representing the transgressive systems tract and the highstand systems tract respectively. The sequences are stacked retrogradationally landward as a result of rapid tectonic subsidence and rifting of the Viking Graben. Rifting led to the development of an elongate graben where tidal currents were amplified, wave-action damped and longshore drift (as sediments supply) reduced or absent. Lowstand and forced regressive systems tracts are not identified, and their absence is interpreted to reflect suppression of relative sea level falls in a rapidly subsiding basin where the basin subsidence rate outpaced any potential fall in eustatic sea level. Through facies interpretation and sequence-stratigraphic correlations between wells, these regressive and transgressive units are shown to exhibit characteristic thickness trends in the form of sigmoidal-shaped wedges, stacked in an offset manner in a landward to basinward orientation. These thickness trends illustrate sediment partitioning within the sequences and are explained by the relationship between accommodation versus sediment supply in terms of mass-balance. During regression, the focus of sedimentation was pushed basinward, and during transgression it was pushed landward as sediments were trapped there. The mapping of these sequence-stratigraphic units serves as input to reservoir models and to help increase recovery and identify new exploration targets.

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1. Introduction

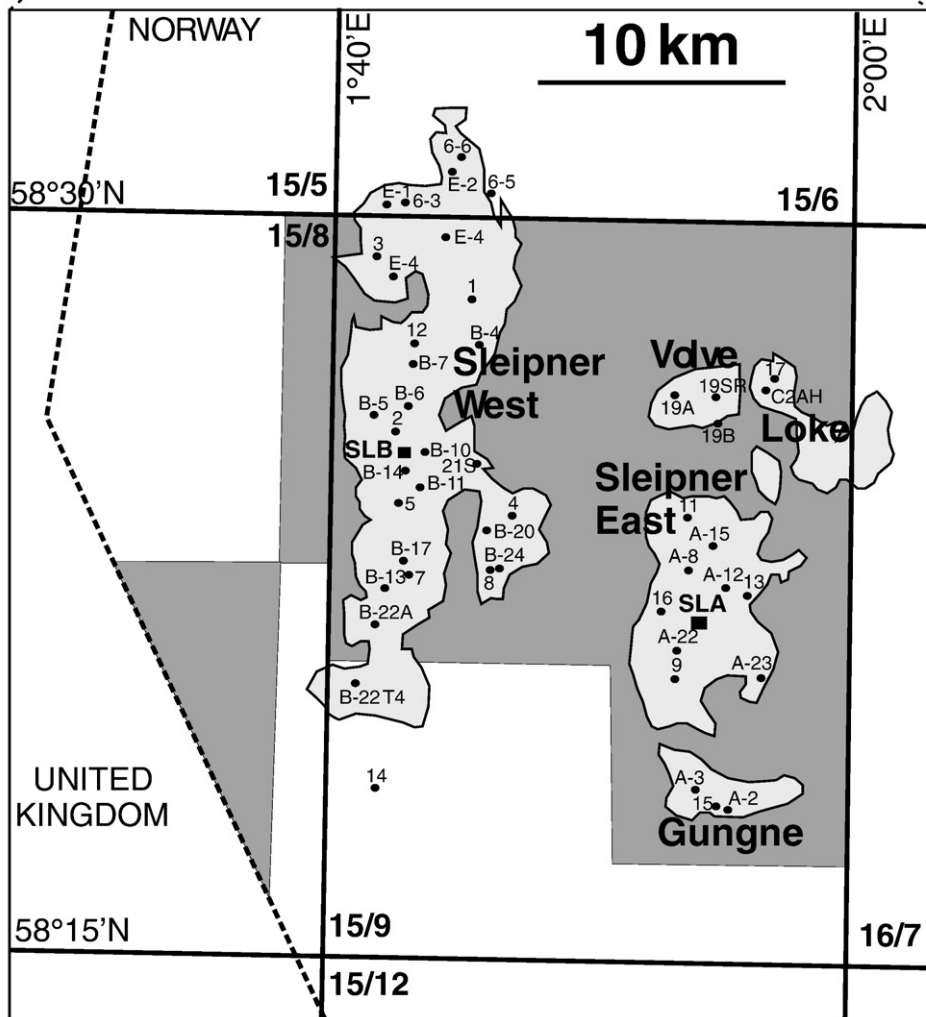
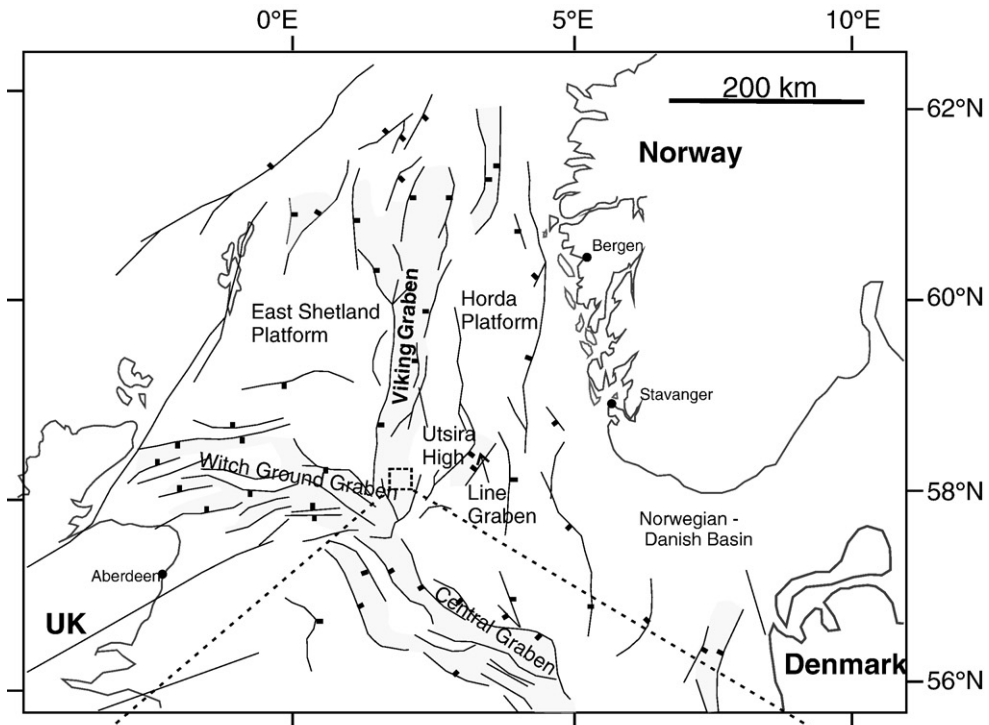
Hydrocarbon production from sandstone reservoirs deposited in transgressive, shallow-marine settings is economically important, for example in the transgressive part of the Brent system (Graue et al., 1987; Fält et al., 1989; Fjellanger et al., 1996; Hampson et al., 2004), the hydrocarbon-bearing, transgressive Stø Formation of the Snøhvit Field in the Barents Sea (Gjelberg et al., 1987), the upper Jurassic Fulmar Formation in the south Central Graben (Howell et al., 1996) and the Sacha Field in Ecuador (Shanmugam et al., 2000). Sedimentological facies analysis followed by the construction of sequence-stratigraphic models of the reservoirs serves as input to drainage strategy-planning, enables more accurate estimates of recoverable reserves and can highlight potential new hydrocarbon prospects.

The Jurassic Hugin Formation (Callovian–early Oxfordian) is a sand-rich, shallow-marine formation (Vollset and Døre, 1984) and forms the main hydrocarbon reservoir unit in the south Viking Graben, productive in the Sleipner area (blocks 15/9 and 15/6; Fig. 1). The Hugin Formation was deposited during a large-scale transgression of the Viking Graben within Middle to Late Jurassic times (Cockings et al., 1992; Sneider et al., 1995; Husmo et al., 2003) (Fig. 2). The Hugin Formation has been linked to the retreat and drowning of the older shallow-marine Brent system in the northern part of the Viking Graben, and the Hugin Formation is interpreted to be the southern extension of the Tarbert Formation of the Brent Group (Graue et al., 1987; Fält et al., 1989; Mitchener et al., 1992; Cockings et al., 1992; Sneider et al., 1995; Milner and Olsen, 1998). The transgression of the Viking Graben was caused by the rapid deepening of a developing rift system initiated in the Late Bathonian (Hodgson et al., 1992; Cockings et al., 1992) and which caused progressive onlap of strata towards the graben margins (Sneider et al., 1995).

The Hugin Formation has previously been interpreted as a marine shoreface with beach barrier, lagoonal and associated coastal plain

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