Correlation of depositional patterns in the Ness Formation, Oseberg area

Alf Ryseth
Geological Institute, Department A, Allégaten 41, 5014 Bergen University, Norway

Facies analysis of the Ness Formation (Middle Jurassic) in four wells in the Norwegian North Sea block 30/6 (Oseberg Field) suggests that deposition predominantly took place in an upper delta plain environment. The Ness Formation forms a heterolithic suite of coal beds, palaeosols, mudrocks, and ribbon- and sheet-like sandstones, and is divided into nine depositional cycles, each reflecting the drowning of peat swamps (coal) and soils, followed by deposition of clastics in submerged overbank areas and fluvial channels, and eventually renewed swamp/soil development.

Theoretical considerations on the significance of coal beds and palaeosols suggest that these, locally, are isochronous markers, and therefore form the principal basis for correlation. Correlation of depositional patterns is further aided by relatively good cycle continuity, and by a larger-scale vertical division of the Ness Formation into three main facies associations. Of these, the lower and upper contain the bulk proportion of coal, whereas the middle association is characterized by the highest density of fluvial channel deposits and the least coal.

Integration of core and wireline log data allows a detailed lateral correlation of cycles, lithofacies and facies associations within distances of a few (<6) kilometres. These correlations permit the construction of a depositional model, and may form a basis for suggesting possible controls upon cyclicity and larger-scale vertical variations in coal content and fluvial channel density.

INTRODUCTION

The Middle Jurassic Brent Group is the most significant reservoir unit in the northern North Sea. The unit comprises five main formations (Broom, Rannoch, Etive, Ness and Tarbert), and is generally interpreted as a wave-dominated delta (e.g. Eynon, 1981). Graue et al. (1987) introduced the sandy Oseberg Formation as an easterly equivalent to the Broom Formation, and included the unit in the Brent Group.

Regional studies indicate that the Oseberg Formation was sourced from the east, and deposited by a fan delta system prograding to the west. The main Brent Delta prograded northwards, with the Rannoch, Etive and Ness Formations forming a marine to continental delta front/delta plain succession, and with the Tarbert Formation representing a terminal transgressive stage (Eynon, 1981; Johnson and Stewart, 1985; Graue et al., 1987). Petrographical studies (Morton, 1985) indicate that the Broom Formation represents a separate unit with limited genetic linkage to the main Brent Delta. The Brent Group is distributed throughout the East Shetland Basin, northern Viking Graben and on the Horda Platform, and pinches out into marine shales to the north between 61°30'N and 62°N (Vollset and Doré, 1984; Graue et al., 1987).

The Ness Formation (Bajocian-Bathonian) was first defined by Bowen (1975), and consists of interbedded coals, mudrocks and sandstones, with coarsening- and fining-upwards sequences being common. Deposition took place in a general coastal/deltaic plain setting, where back-barrier, lagoonal and alluvial depositional environments have been recognized (Budding and Inglis, 1981; Livera, 1989).

This study of the Ness Formation is based on 246 m of core obtained from four wells (labelled A, B, C, and D) in the Oseberg Field offshore Norway (Fig. 1), and on additional data from geophysical wireline logs. Distances between adjacent wells do not exceed 6 km, but one well (C) is structurally separated from the others by a minor normal fault (Fig. 2).

The Ness Formation averages 75 m in thickness in the study wells, and is sandwiched between coarsening-upwards shoreline/delta front sandstones of the underlying Rannoch/Etive Formations and the overlying Tarbert Formation (Fig. 3). The base is defined by a coal bed in direct contact with the Rannoch/Etive sandstone sheet. Heavy-mineral analysis of the Brent Group at Oseberg shows that sandstones from the Ness Formation are petrographically different from those of the underlying formations. This led Hurst and Morton (1988) to suggest that the Ness Formation in this area should not be regarded as part of the same depositional sequence as the underlying Etive shoreline deposits. The Tarbert Forma-
Correlation in Hydrocarbon Exploration

Fig. 1. Structural framework of the northern North Sea, and location of Oseberg and other hydrocarbon fields.

Fig. 2. Location of study wells relative to the local fault pattern.

Fig. 3. Stratigraphy of the Middle Jurassic interval at Oseberg. Modified from Vollset and Doré (1984), and Graue et al. (1987).

SEDIMENTARY FACIES

Nine facies have been defined (Fig. 4), of which two (coal beds and palaeosols; Facies 1 and 2) are significant as correlative marker beds, whereas the others (Facies 3–9) represent sub-environments that interfinger laterally and vertically, and range from quiet submerged overbank areas to fluvial channels.

Facies 1: coal beds

Coal beds and coaly mudrocks are from a few centimetres to a maximum of 2.3 m thick (mean value 55 cm). Basal parts and thinner units are rich in ash, and are characterized by a dull lustre and occasionally a slightly fissile texture, with abundant thin (1–2 cm) clay bands and pyrite nodules. Medial parts of thicker beds are somewhat cleaner, and are composed of dull, banded lithotypes with scattered lustrous and brittle vitrain lenses. Ness coals contain a wide range of terrestrial sporomorphs, including gymnosperm, bryophyte and