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Update of Jurassic Lithostratigraphy, offshore Norway

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The goal of a minor revision of the Jurassic lithostratigraphy for the North Sea has been to unify the nomenclature in order to avoid artificial geographic boundaries that occluded the correlation of the same lithostratigraphic unit from one part of its depositional basin to the other.

A widely mappable unit should not change its name laterally!

Many reservoir sand units within the generally shale prone Viking Group lacked formal lithostratigraphic assignment.

A basic principal, applied in the British, Danish, and Dutch sectors of the North Sea, and adopted also by companies supporting the Norlex Project is to give the shoreline detached sandstone units a member status.

For the synrift succession this also apply for sands fringing isolated fault blocks.

•DUNLIN GROUP
–Retained present scheme
–'Drake sands' –new name and status? –need for resolution!

•BRENT GROUP
–Abandoned the Vestlandet Group and extended the range of the Brent Group
–The formations of the Vestlandet Group substituted by the Ness and Tarbert formations

•VIKING GROUP
–Extended the use of Viking Group by omitting the Boknfjord and Tyne groups
–Extended use of Heather and Draupne Formations north of 62oN
–Status of sandy units: formation status for shoreline attached sands along basin margin, member status for detached isolated sand bodies
–Defined two new sandstone members within the Draupne Formation; names related to Odin as Draupne is an attribute of Odin.
–Defined two new sandstone member within the Heather Formation, names derived either from traditional use of Heather, or from Nordic mythology for affinity to vikings

•REMAINING PROBLEMS
–Sandstone units interfingering or embaked in the Draupne or Heather formations along the Møre margin and in the Mid Norway areas
–The relationship of Upper Jurassic units of the Central Graben and Norwegian Danish Basin to the rest of the North Sea areas.

Munin Member

Viking Group, Draupne Formation

Unit definition

The name Munin has been used in the literature as informal name for intra Draupne sandstones in the Northern North Sea area (Millennium Atlas). Originally the name was introduced by Statoil workers for sands encountered in two wells in block 33/9 on Tampen close to the Statfjord North Field. The unit has not been formally defined previously.

Name

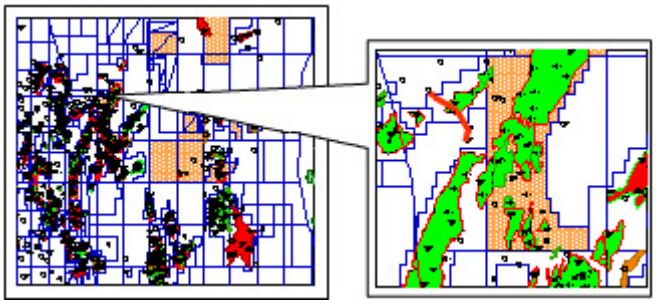
The unit has previously been referred to as 'Intra Draupne Sandstone' or 'Upper Draupne Sandstone' as well as 'Munin Sands' or 'Munin Sandstone'. In publications this unit has been referred to as the informally defined 'Munin Sands' by Glennie (1998) without further reference to source of the name. In the Millennium Atlas the term 'Munin Sandstone Member' has been applied to all intra Heather and Draupne Formations sandstones.

Derivatio nominis

The name of this member derives from the name of one of the two ravens that the Nordic God Odin used for telling him news about the world. The ravens flew across the earth and returned to sit on Odin's shoulders to report news. The other raven was called Hugin. Unfortunately Hugin has been used for one of the formations of the Vestlandet Group.

Type well

Norwegian well 33/9-15. Depth 2743-2841 mRKB. WGS84 coordinates N 61°24'24.67"; E 1°57'15.76". UTM coordinates 6808715.45 N, 444170.28 E, zone 31.



Location of type well.

Core photos from type well (from NPD)

2711-2716 m

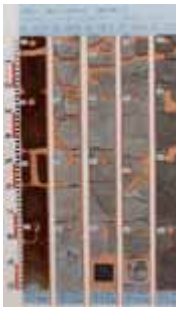
2716-2721 m

2721-2722 m

2723-2728 m

2728-2731 m

2733-2738 m



2738-2743 m

2748-2753 m

2531-2758 m

2758-2763 m

2763-2768 m

2768-2769 m

2770-2775 m

2775-2780 m

2780-2783 m

2788-2793 m

2793-2798 m

2798-2800 m

2801-2806 m

2806-2807 m

2811-2816 m

2816-2820 m

2820-2825 m

2825-2830 m

2830-2835 m

Reference wells

Norwegian well 33/9-16. Depth 2684-2748 mRKB. WGS84 coordinates N 61°23'28.81"; E 1°57'01.93". UTM coordinates 6806990.41 N, 443937.38 E, zone 31.

Norwegian well 33/9-17. Depth 3050-3131 mRKB. WGS84 coordinates N 61°27'18.58"; E 1°50'45.79". UTM coordinates 6814193.73 N, 438481.99 E, zone 31.

Norwegian well 34/7-21. Depth 2508-2569 mRKB. WGS84 coordinates N 61°17'36.84"; E 2°4'21.14". UTM coordinates 6796001.43 N, 450299.76 E, zone 31.

Norwegian well 34/7-21 A. Depth 2874-2920 mTVD. WGS84 coordinates N 61°17'36.84"; E 2°4'21.14". UTM coordinates 6796001.43 N, 450299.76 E, zone 31.

Lithology

The Munin Member consists of interbedded fine to medium grained sandstone and dark grey to black shales. In the type well this member covers two intervals, the lower comprises sharp based sands, the upper gradual coarsening upwards sands. The two units are inferred as a lower gravity flow sand intercalated with the Draupne Formation typical black shales, while the upper unit comprises prograding shoreface sandstones.

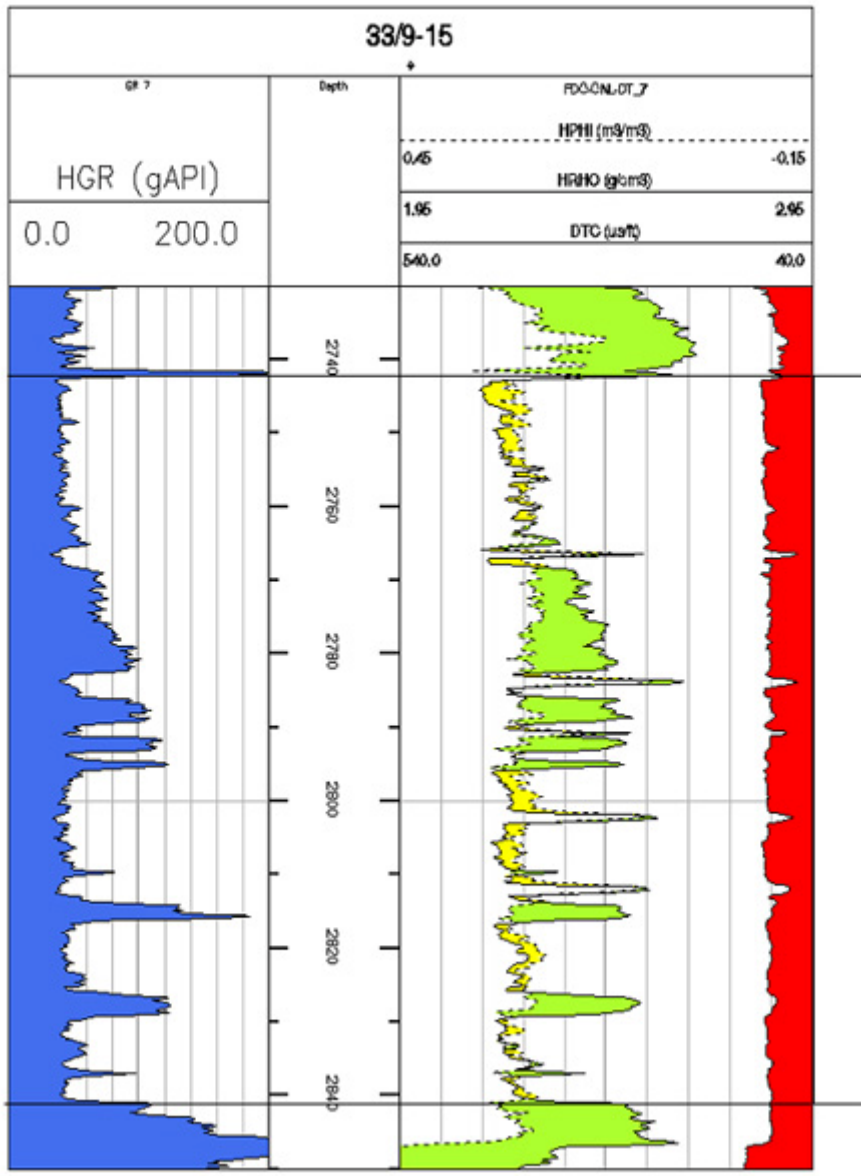
Upper and lower boundaries

In the type well the lower boundary shows a sharp transition from black shales to medium grained sand. Laterally, the lower gravity flow sands may not be developed, and the lower boundary of the Munin Member will show a gradual transition from black shales into sands.

The upper boundary in the type well is marked by a sharp transition from medium grained sand to black shale.

Wireline log characterization

On the gamma ray the base of the Munin Member is characterized by a marked decrease in API from the underlying high gamma shales. The density log shows an abrupt upward decrease. The transit time (DT) shows and upward increase, while there is little change in the Neutron response. Repeated box formed lows with variable thickness in the gamma log separated by high gamma thin intervals haracterise the lower gravity flow dominated unit. The upper unit shows a gradual upward decrease in gamma response into a continous low gamma interval. The top of the member is characterized by a marked increase in gamma response (above 100 API). The density and the inverse transit time logs parallel the gamma log except for scattered carbonate cemented horizons which induce high peaks on the density log and low transit time on the DT log.



Wireline logs of the Munin Member in type well 33/9-15.

Thickness

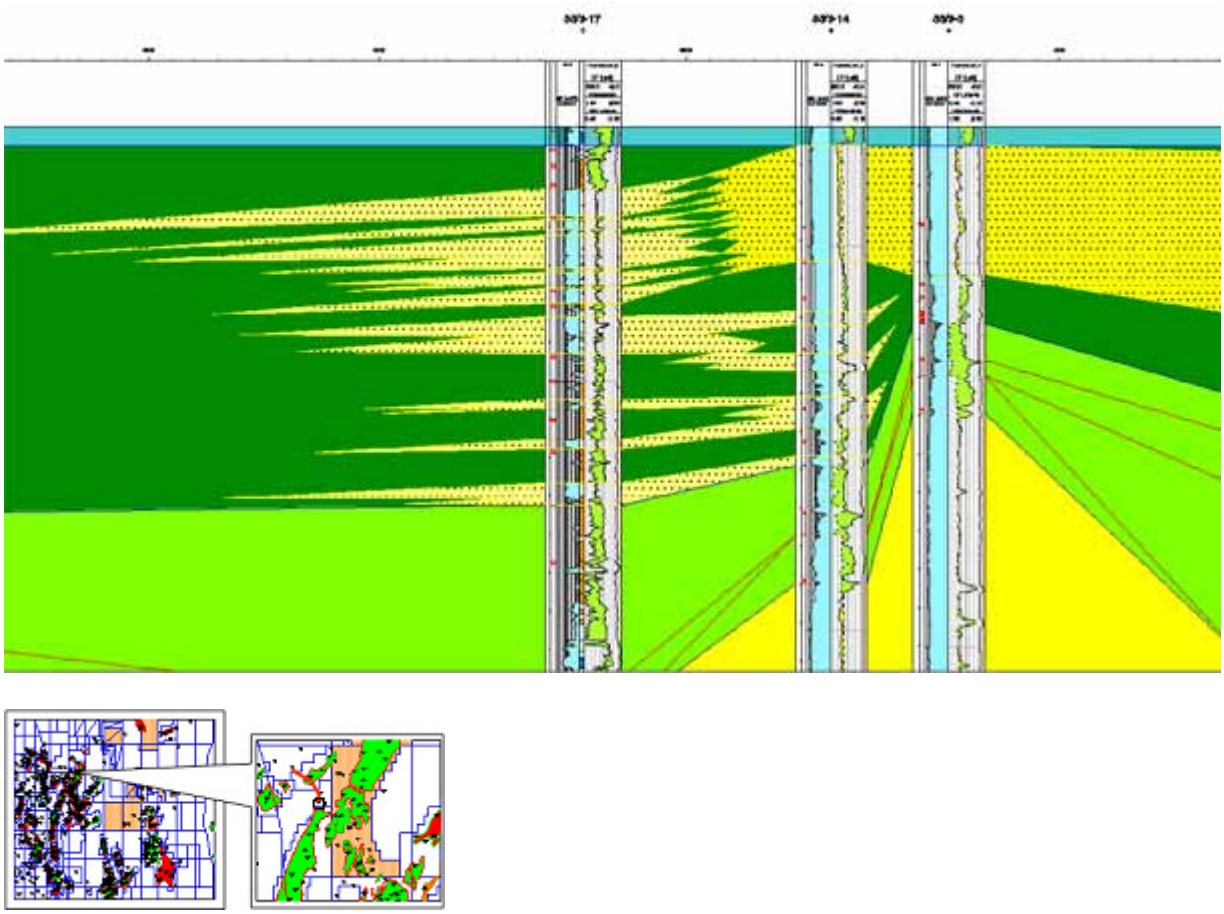
98 m in type well; varies from 46 to 81 m in the reference wells.

Seismic characterization

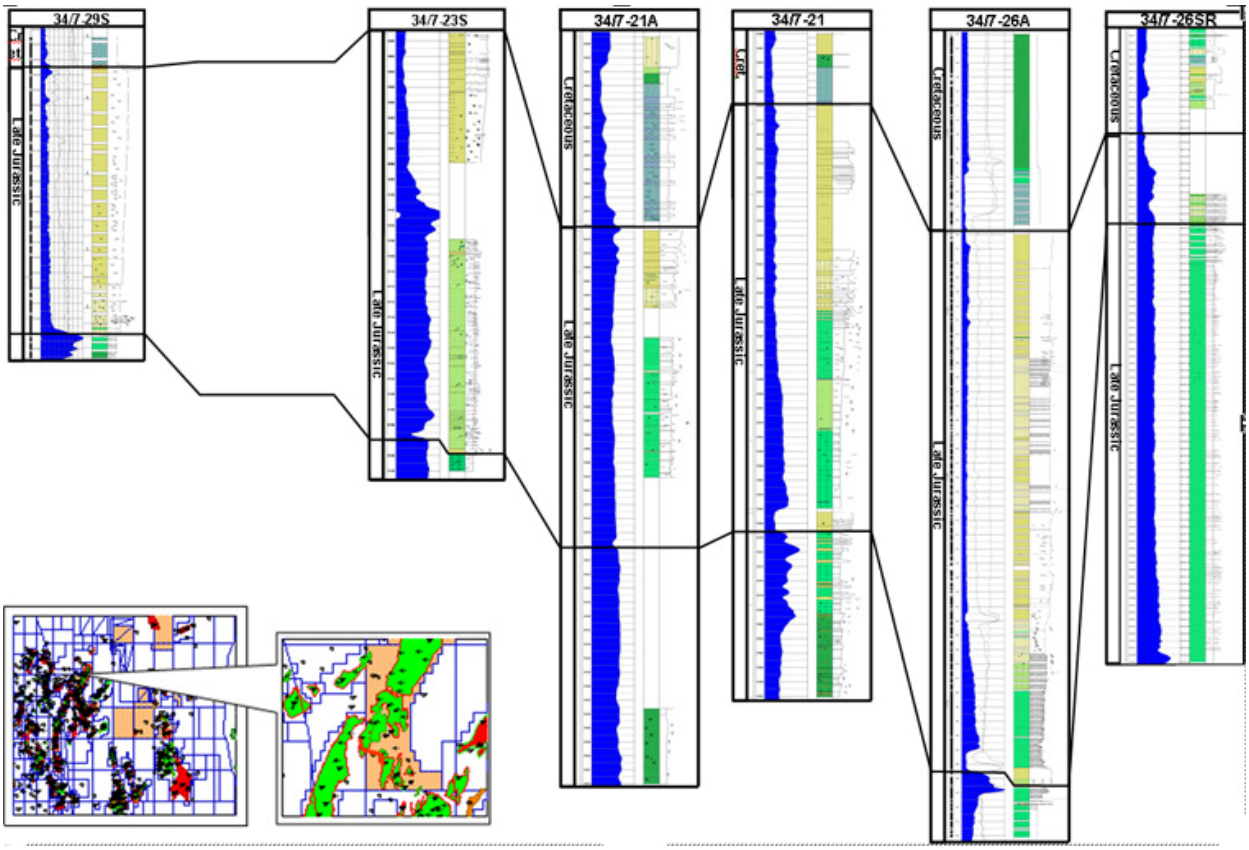
Age

Kimmeridgian to Ryazanian.

Correlation and subdivision



Correlations of the Munin Member.



Correlations of the Munin Member.

Geographic distribution

Shallow marine sandstones occur along the Tampen Spur in the Snorre-Statfjord area as a result of footwall uplift and erosion during the early phase of rifting in the North Viking Graben (Gradijan and Wik, 1987; Solli, 1995; Dawers et al., 1999). The Munin Member is distributed along the gentle limbs of rotated fault blocks in the Tampen area. The lower, gravity flow unit, occurs generally further downflank than the upper shallow marine, shoreface unit. The lower unit is not always present in upflank positions, while the upper unit might be lacking in downflank wells.

Occurrences of member tops in wells

Fraoch Member

Viking Group, Heather Formation

Unit definition

Name

In the Millenium Atlas the sandstones within the Heather Formation are referred to as 'Munin Sandstones'. In informal presentations they have been referred to as Oxfordian and Callovian turbidites.

Derivatio nominis

Name of Scottish ale made from heather. The name is based on the principle of applying the various Scottish names on ales made from heather for the members within the Heather Formation.

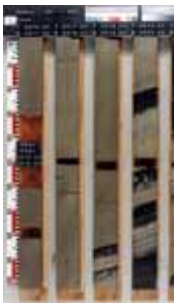
Type well

Norwegian well 35/11-8 S. Depth 2859-2984 m RKB. WGS84 coordinates N 61°5'25.53", E 3°32'14.85". UTM coordinates 6773139.14 N, 528987.44 E, zone 31.

Core photos from type well (from NPD)

2866-2871 m

2871-2876 m



2876-2881 m

2881-2883 m

2884-2889 m

2889-2894 m

2894-2899 m

2899-2904 m

2904-2909 m

2909-2911 m

2911-2916 m

2916-2921 m

2921-2926 m

2926-2931 m

2931-2936 m

2936-2936 m

2938-2943 m

2943-2948 m

2948-2953 m

2953-2958 m

2958-2963 m

2963-2964 m

Reference wells

Norwegian well 35/11-9. Depth 2653 - 2733 mRKB. WGS84 coordinates N 61°3'54.23", E 3°30'06.95". UTM coordinates 6770298.99 N, 527092.97 E, zone 31.

Norwegian well 35/11-11. Depth 2580 - 2727 mRKB. WGS84 coordinates N 61°6'31.42", E 3°33'49.08". UTM coordinates 6775189.73 N, 530381.59 E, zone 31.

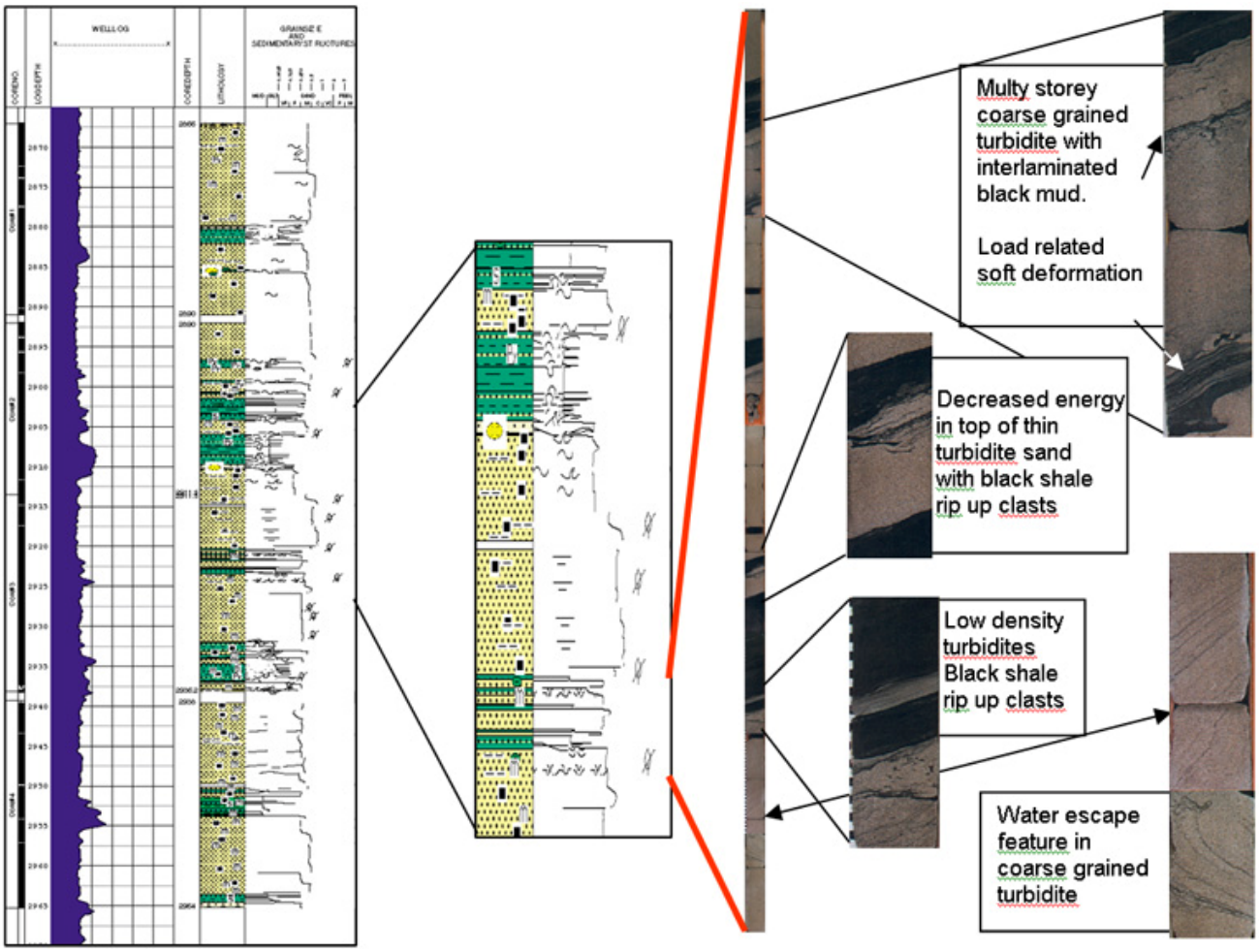
Lithology

The Fraoch Member consists of interbedded medium to coarse sandstone and mudstone.

The sandstones occur interbedded with dark grey to black laminated mudstones, often with low density turbidites organized as heterolthic units of a few meters thickness. In well 35/11-11 the background sediments consist of grey bioturbated micaceous siltstones and mudstones.

The sandstones are inferred as turbidites, and some key features are shown in the figure below. To the left is an overview core description with gamma log and grain size scale. The next to the right is a blow up of the core description. A composite core photograph show the selected interval. The upper photograph to the right shows multiple turbidite sands separated by thin mud laminae, and soft sedimentary deformation of upper part of a turbidite sand. The deformation also affected the overlying mud indicating that the deformation was not related to the deposition of the lower sand but most likely related to loading effects by subsequent deposition. Most sand units within the turbidite succession show sharp contacts both at base and top. The selected unit shows indication of waning energy related to the halt of sand deposition. The origin of the mud clasts near the top is not evident, but most likely they were brought into the turbidity current by local erosion. A typical feature of the dark mud intervals are the lamination and thin graded units normally associated with low density turbidites

(lower left photo). Soft sedimentary deformation caused by water escape from the thick coarse grained turbidite sands are ubiquitous within the succession (lower right photo).



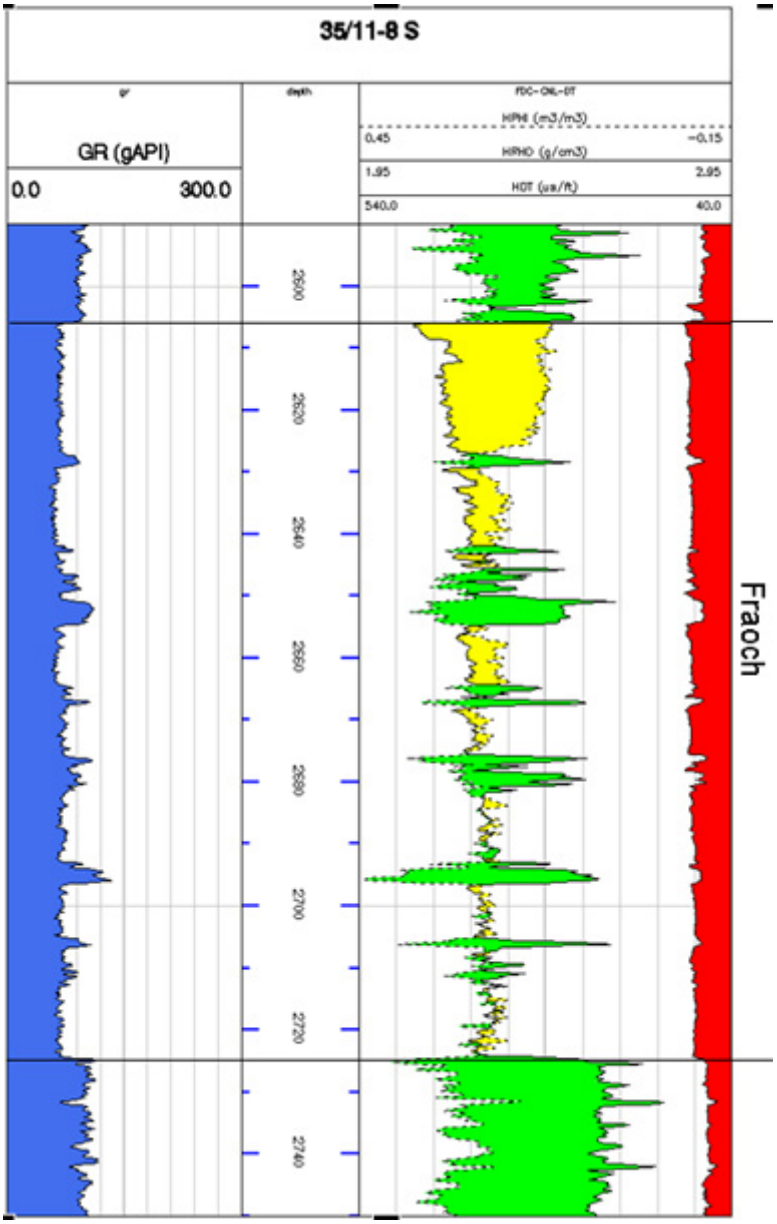
Well 35/11-8 S.

Upper and lower boundaries

In the type well the lower boundary shows a sharp transition from dark grey to black laminated mudstones to medium grained clean sand. The upper boundary in the type well is marked by a sharp transition from medium grained sand to dark mudstone.

Wireline log characterization

On the gamma ray the base of the Fraoch Member is marked by an abrupt decrease in API from the underlying higher gamma mudstones. The density log also shows an abrupt upward decrease. The transit time (DT) shows an upward increase, while there is marked drop in the Neutron response, probably caused by the presence of hydrocarbons. Repeated box formed lows with variable thickness in the gamma log separated by high gamma thin intervals characterise the turbidite dominated interval. The top of the member is characterized by a marked increase in gamma response. The density and the inverse transit time logs parallel the gamma log.



Wireline logs of the Fraoch Member in type well 35/11-8 S.

Thickness

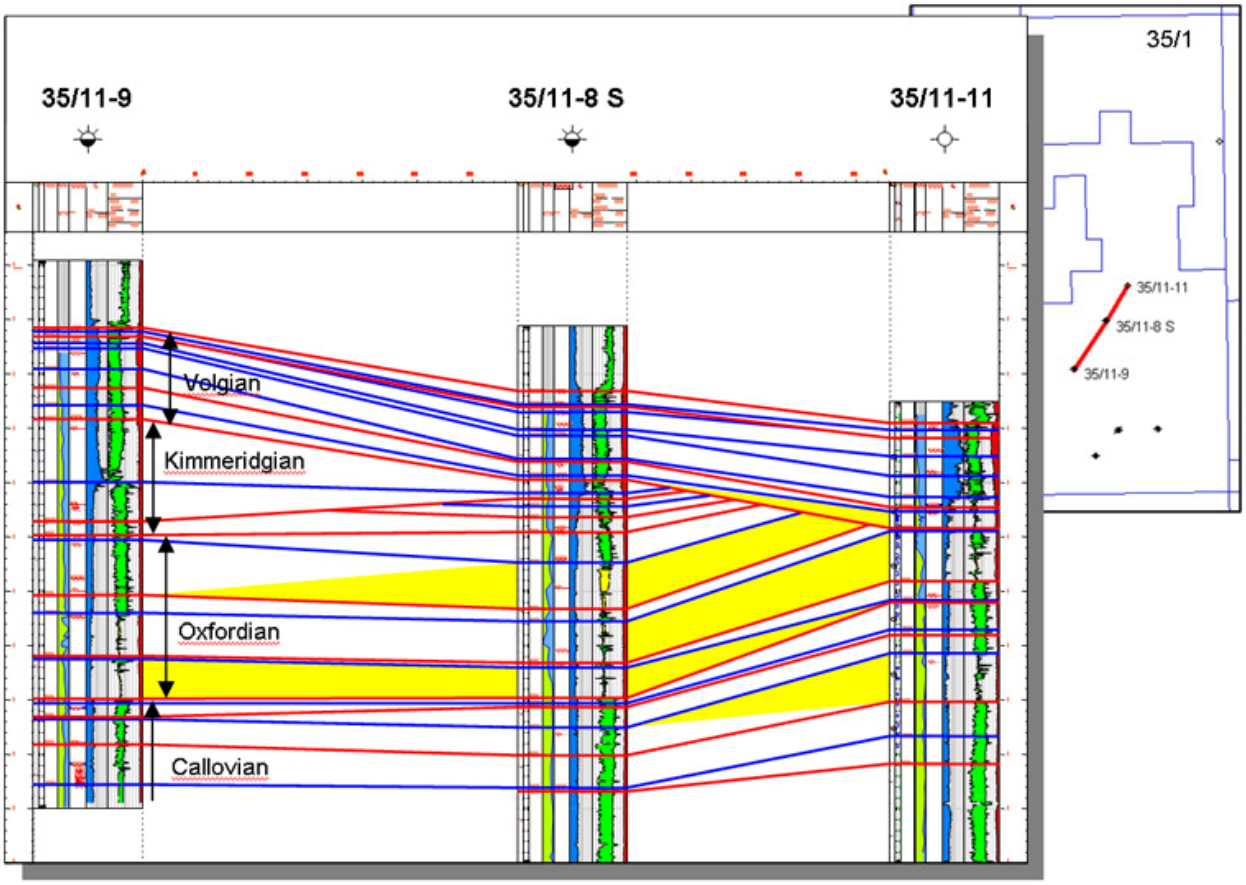
80 - 125 m.

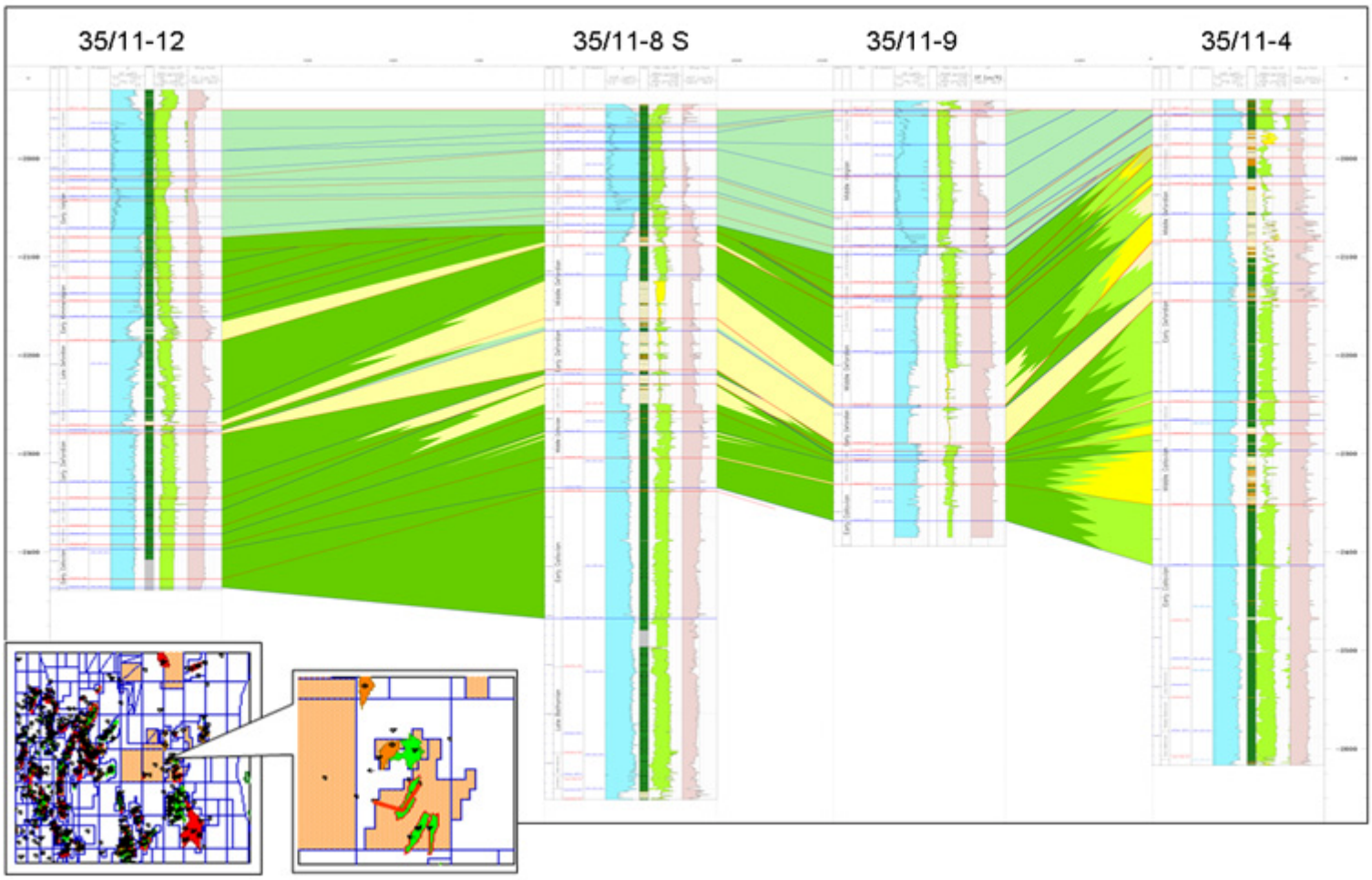
Seismic characterization

Age

Callovian to Early Volgian.

Correlation and subdivision





Correlations of the Fraoch Member.

Geographic distribution

The Fraoch Member occurs downflank to the Kinna Fault on the eastern part of the Lomre Terrace, in blocks 35/8 and 35/12. The sandstones assigned to this member show scattered local development and the name is proposed to be generally applied to units of deep marine sands within the Heather Formation that were deposited as gravity flows or turbidites detached from the shoreline along the eastern side of the Sogn Graben and on the Lomre Terrace.

Occurrences of member tops in wells

Eldfisk Member

(From NPD Bulletin no. 3)

Tyne Group, Haugesund and Farsund Formations

Name

From the Eldfisk Field in Norwegian block 2/7.

Well type section

Norwegian well 2/7-3 (Phillips) from 3626 m to 3695 m, coord N56°23'02.9" E03°14'45.9" (Fig. 40).

Well reference section

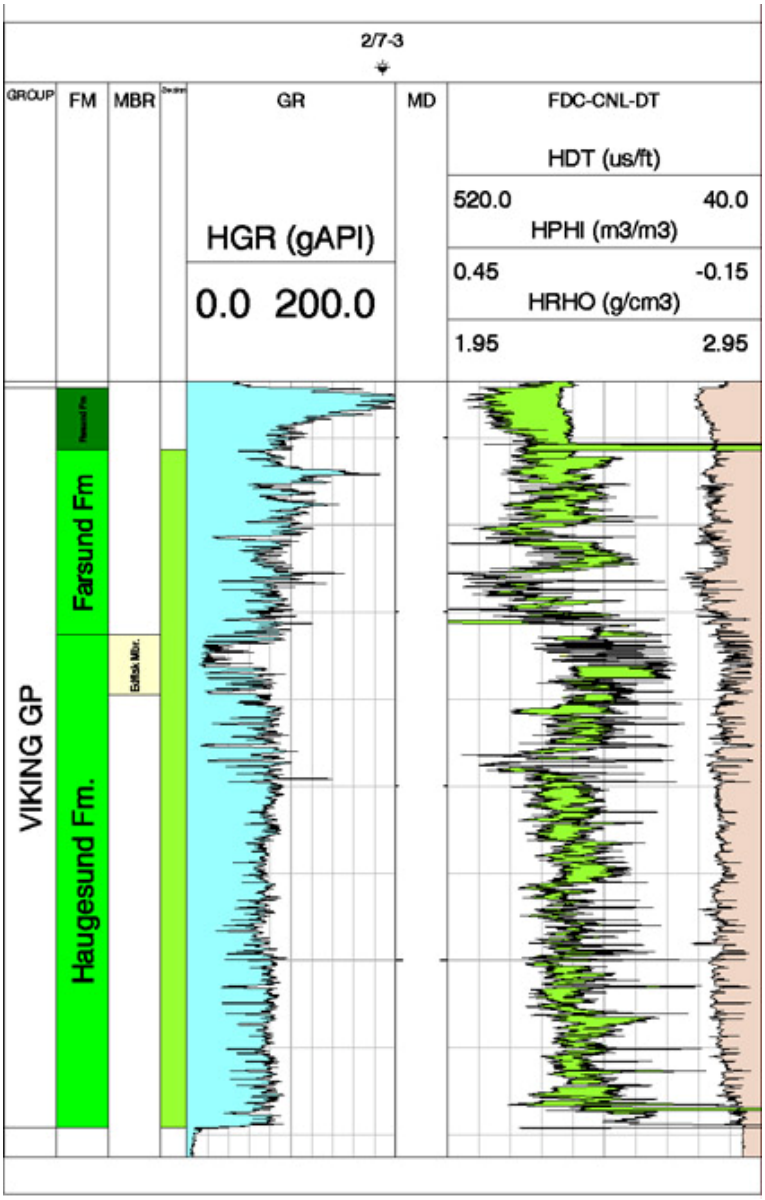
Norwegian well 1/9-3 (Statoil) from 4359.5 m to 4386.5 m, coord N56°24'56.2", E02°54'15.15" (Fig. 43).

Thickness

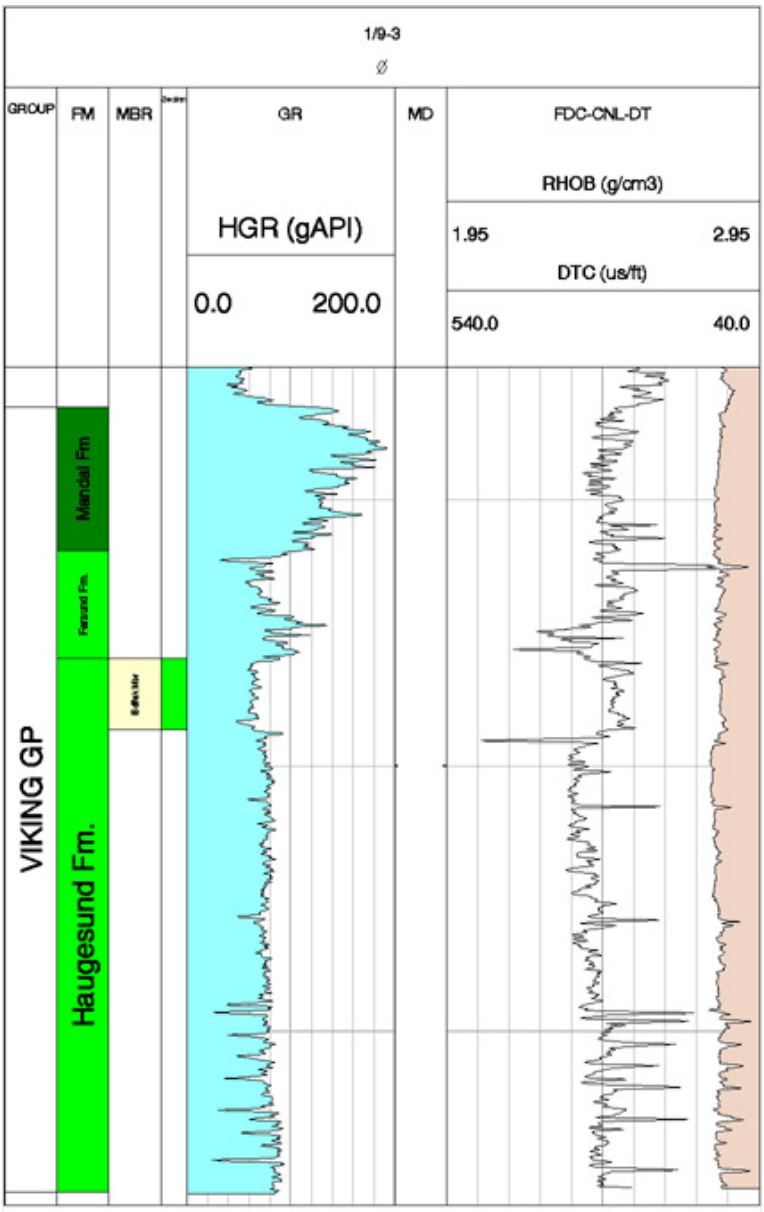
69 m in the type well 2/7-3 and 27 m in the reference well.

Lithology

The Eldfisk Member consists predominantly of sandstone but contains substantial interbeds of shale. In the type well the sandstone is dark yellowish brown, fine to coarse grained, poorly sorted and generally angular, while the shale is medium light grey to dark grey. Both the sandstone and the shale contain calcareous streaks which produce high amplitude peaks on the sonic log.



Well 2/7-3.



Well 1/9-3.

Boundaries

The sands of the Eldfisk Formation are entirely enclosed within the thick upper Jurassic shale sequence of the Central Graben. The Eldfisk Member is therefore easily distinguished from the underlying Haugesund Formation and the overlying Farsund Formation by its lower gamma ray readings.

Distribution

As defined at present, the main development of the Eldfisk Formation is confined to the region of the Eldfisk Field, although thin time equivalent sands are present in other parts of the Central Graben.

Occurrences of formation tops in wells
Isochore map HAUGESUND-ELDFISK

Age

Kimmeridgian

Depositional environment

The Eldfisk Formation represents an influx of sand into the axial portions of the Central Graben at a time of regression, and for this reason it is postulated that the formation is turbiditic in origin. However, no conventional cores have been taken in the sands and there is no definitive sedimentological evidence.