Norwegian Offshore Stratigraphic Lexicon

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Introduction

Since the publication of standard lithostratigraphic schemes for the North Sea and offshore Norway (Deegan & Scull 1977; Vollset & Doré 1984; Isaksen & Tonstad 1989) much new geologic information has accumulated. The direct result is an increasingly outdated lithostratigraphic standard, leading to ongoing dissatisfaction by the petroleum geology community with the existing Formation and Member schemes and nomenclature, involving 95+ units. Since their inception, few existing formational units have been formally updated with new and better information. In addition, confusion exists between the concepts of chronostratigraphy and lithostratigraphy.

One example of this confusion is that the Hordaland and Nordland Groups are defined by age, and not by lithology. Another example is that completion logs of wells may list a series of successive formations that include units with a lithology that strongly deviates from the original concept; a formation in a well is assigned on perceived age of the interval, and not on lithology. These practices lead to a degradation of the use of offshore lithostratigraphy, and decrease insight in the sedimentary succession.

In order to address and alleviate this situation a consortium led by the Natural History Museum of the University of Oslo is proposing to systematically update the existing body of offshore lithostratigraphic information. Rather than generating another set of conventional lexicon and/or atlas-type publications, the revised and expanded lithostratigraphy will be organized and presented in a relational database format, using internet facilities. Between 2001 and 2004 this was successfully accomplished by the NORGES Project for the Mesozoic and Cenozoic exploration biostratigraphy, offshore Norway (see **http://norges.uio.no**). A direct benefit of data on the World Wide Web, other than near-universal accessibility, is also that future updating is relatively easy and cost effective.

Between December 2003 and May 2004 three open meetings were organized to formulate a plan of action for the lithostratigraphy, offshore Norway: One meeting at the Natural History Museum (Geology Department) of the University of Oslo, one at the Norwegian Petroleum Directorate (NPD) in Stavanger, and one at Statoil in Stavanger. The participants in the meetings included the leadership in the Norwegian Stratigraphic Committee, the NPD and the Norwegian Geological Survey (NGU), and geology experts in Statoil, Shell, ENI, RWE-DEA, Hydro, Idemitsu and other key companies. Universally, the participants endorsed the new offshore stratigraphy

initiative. Together, the participants have now formulated the present proposal and plan of action, which is initially scheduled for the period 2004 – 2007. The project is called NORLEX – Interactive Norwegian Offshore Stratigraphic Lexicon (see **http://norges.uio.no**), with vital funding and data support by Statoil, Shell, ENI, RWE-DEA, Hydro and Idemitsu.

Purpose

The purpose of the NORLEX Project (2004-2007) may be summarized as follows:

- Improve and update the Mesozoic and Cenozoic groups, formations and members in the Lithostratigraphic Lexicons (NPD Bulletins 1, 5, etc);
- place all content in a relational (MYSQL) database format
- provide a GIS interface, based on the NPD format and facts;
- create interactive web-based interface with full colour;
- introduce detailed biostratigraphic information on key markers for formations in specific regions;
- update the chronostratigrahic framework using the standard international geologic time scale (Gradstein et al., 2004; http://www.stratigraphy.org)
- provide crossing seismic and log displays of type sections;
- make wheeler-type diagrams of the formation in a regional context;
- show detailed (bio-) stratigraphic distribution of the type sections of the formations and members;
- link wells sections to digital core photographs of formations;
- produce simplified paleogeographic maps for members, formations or groups.

Once all relevant information is properly organised in a relational database, it will be easy to search and interrogate clusters of wells for specific stratigraphic information. One such large well dataset is currently stored in the NORGES system. A hypothetical and simple example of an interrogation is shown in Figure 1.

Responsible agencies and organisations

Responsible agencies and organisations involved in the NORLEX Project are NPD, NORLEX Project, NGU and Norwegian Stratigraphic Committee. Funding and vital scientific input are provided by Statoil, Shell, ENI, RWE-DEA, Hydro and Idemitsu.

All formal lithostratigraphic submissions generated through NORLEX will be reviewed by the Norwegian Stratigraphic Committee; newly assigned Groups,

Formations and Members will go through a standard approval process. Once the revised and updated offshore lithostratigraphy is completed, approved and digitized for internet use, the new website for the Lithostratigraphy of offshore Norway will be hosted on the server of the Norwegian Petroleum Directorate (**http://www.npd.no**), and maintained jointly through the NORLEX Project and NPD. Interim versions of the current activities are maintained on the NORLEX website, and are available to member participants.

Administration

Daily operations, administration, programming and webmaster activities for NORLEX are in the hands of the Natural History Museum (Geology Department) of the University of Oslo.

Overview of current lithostratigraphy

Figures 2 and 3 provide an overview of a majority of formations (95 units) currently in use for petroleum geology purposes in the sedimentary wedges, offshore Norway; these regions include southern and northern North Sea, offshore mid Norway and Barents Sea. Where possible, the maximum local age range of a formation is shown, and the approximate chronostratigraphic position of its type well. The units have a definition of their lower stratigraphic boundary. Several formations are little more than chronostratigraphic 'garbage cans', like Lange and Brygge Formations, without agreed-upon content. Much improved geographic coverage and stratigraphic resolution in regional mapping and fossil zonation will help to rectify such practice.

In this connection it should be noted that understandably petroleum industry focus is on mapping and stratigraphic reconnaissance of the hydrocarbon reservoir units, i.e. sands and limestones. This tends to make an offshore lithostratigraphic framework a bit like inverted 'Emmenthaler' cheese. The holes, represented in our analogy by sands are best known, with the surrounding shales (cheese) given less stratigraphic attention.

A special item under discussion is the concept that assigns reservoir sands lithostratigraphic Member status, taken into account their almost universally limited, non-contiguous mappability. Another item of discussion is the fact that geologic provenance and mappability, rather than national territorial limits should control formation naming. Frequently reference is made to a 'Forties' etc. equivalent unit across territorial limits, obscuring realistic lithostratigraphic content and meaning. Although it is unlikely that the current project will find a universally acceptable solution to these current practices, more and better data help to shine light on these questions.

Lithostratigraphy template

In order to fascilitate standardized reporting of current and new information we attach a lithostratigraphic template (Appendix), that also can be downloaded from

the NORLEX website at http://norges.uio.no. All formal lithostratigraphic information will be adapted to this scheme, that will make extensive use of colour graphics.

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Appendix

Template for description of lithostratigraphic units:

GROUP

FORMATION

1. Name
   1.1. English/ Norwegian and any previous names
   1.2. Derivatio nominis

1.3. Publication
2. Lithology
3. Sample depository
   3.1. Palynological preparations (organic matter depository)
   3.2. Core photographs *[Colour Images]*
   3.3. Thin-section depository
4. Thickness
5. Geographical distribution *[Map]*
6. Type well
   6.1. Well name
   6.2. Location *[Map]*
      WGS84 coordinates:

      UTM coordinates:

      UTM zone:

      6.3. Drilling operator name
   6.4. Completion date
      6.5. Status
   6.6. Interval of type section (m) & thickness in type well (m)
7. Reference well
   7.1. Well name
   7.2. Location *[Map]*
      WGS84 coordinates:

      UTM coordinates:

      UTM zone:

   7.3. Drilling operator name
   7.4. Completion date
   7.5. Status
   7.6. Interval of reference section (m) & thickness in reference well (m)
8. Upper and lower boundaries (in paratype section if type well is insufficient)
9. Well log characteristics *[Figure]*
10. Type seismic section
   9.1. Location of section *[Figure]*
   9.2. Section [Colour Figure]
11. Biostratigraphy *[Figure]*
12. Age
13. Correlation *[Figure]*
14. Depositional environment
15. Remarks References

MEMBER(S)

BED(S)

Figures

Figure 1. Simplified example of questions that can be asked in NORLEX.

Figure 2. Lithostratigraphy of the southern and northern North Sea, with a listing of type wells. Where feasible, the maximum local age range of a formation is shown, and the chronostratigraphic interval thought to be approximately represented by a formation in its type well. The formational listing is incomplete for the southern North Sea ‘chalk province’.

Figure 3. Lithostratigraphy of the sedimentary wedges offshore mid Norway and Barents Sea, with a listing of type wells. Where feasible, the maximum local age range of a formation is shown, and the chronostratigraphic interval thought to be approximately represented by a formation in its type well.

Norlex

Utsira Formation summary

Full definition and description	
Top of unit (age):	Lower Pliocene
Base of unit (age):	Upper Miocene
Top of unit (fossil zone/event):	*Neogloboquadrina atlantica*
Base of unit (fossil zone/event):	*Globorotalia praescitula*
Main lithology:	Sandstone
Author/date/publication:	Deegan & Scull (1977)
Display logs in type well	
Seismic display	
Core photographs in wells	
Search top of unit in selected wells	
Search base of unit in selected wells	
Display correlation diagram	

Lithostratigraphy of the Norwegian margin: North Sea

Timescale after Gradstein et al. (2004)

56° 60° 62°

southern North Sea | **northern North Sea**

Age (Ma)	Era	Period	Epoch	Stage	Central Graben, Vestland Arch	Norwegian-Danish Basin	south Viking Graben, Utsira High, Ling Graben	Horda Platform	north Viking Graben	Tampen Spur, Sogn Graben, Måløy Fault Blocks
0	Cenozoic	Neogene	Pleistocene		undifferentiated		Utsira	NORDLAND GROUP	Utsira	Utsira
			Pliocene							
5			Miocene	Messinian						
				Tortonian						
10				Serravallian						
15				Langhian						
20				Burdigalian			Skade			
				Aquitanian						
25		Paleogene	Oligocene	Chattian	Vade			HORDALAND GROUP		Unnamed
30				Rupelian			Grid		Unnamed	
35			Eocene	Priabonian						
40				Bartonian						
45				Lutetian						
50				Ypresian	Maureen, Andrew, Forties, Vidar, Våle, Lista, Sele, Ekofisk, Balder	Våle, Lista, Sele, Hermod, Balder	Fiskebank, Ekofisk, Balder, Frigg, Våle, Ty, Heimdal, Lista, Sele, Hermod, Balder	Våle, Lista, Balder	Heimdal, Lista, Balder	Våle, Heimdal, Lista, Balder
55										
60			Paleocene	Thanetian				ROGALAND GROUP		
				Selandian						
65				Danian						
70	Mesozoic	Cretaceous	Late	Maastrichtian	Tor, Hod, Blodøks, Hidra	Tor, Hod, Blodøks, Hidra	Jorsalfare, Kyrre, Tryggvason, Blodøks, Svarte	Hardråde, Kyrre, Tryggvason, Blodøks, Svarte	Jorsalfare, Kyrre, Tryggvason, Blodøks, Svarte	Jorsalfare, Kyrre, Blodøks, Svarte
75				Campanian				SHETLAND GROUP		
80										
85				Santonian						
				Coniacian						
90				Turonian						
95				Cenomanian						
100			Early	Albian	Åsgard, Tuxen, Sola, Rødby, Ran Sandstone Units	Åsgard, Tuxen, Sola, Rødby	Åsgard, Sola, Rødby, Ran Sandstone Units	Åsgard, Mime, Sola, Rødby	Åsgard, Sola, Rødby	Åsgard, Mime, Sola, Rødby, Agat
105										
110				Aptian				CROMER KNOLL GROUP		
115										
120										
125				Barremian						
130				Hauterivian						
135				Valanginian						
140				Berriasian						
145		Jurassic	Late	Tithonian	Haugesund, Eldfisk, Farsund, Mandal	Ula, Egersund, Tau, Sauda, Flekkefjord	VESTLAND GROUP, Heather, Draupne	Krossfjord, Fensfjord, Heather, Sognefjord, Draupne	Heather, Draupne	VIKING GROUP, Draupne
150				Kimmeridgian						
155				Oxfordian	TYNE GROUP	BOKNFJORD GROUP				
160			Middle	Callovian						
165				Bathonian	Bryne	Bryne, Sandnes, Sleipner, Hugin		Etive, Ness, Tarbert, Broom, Etive, Rannoch, Ness, Tarbert	Broom, Etive, Rannoch	Etive, Rannoch, Ness, Tarbert
170				Bajocian						BRENT GROUP
				Aalenian						
175			Early	Toarcian	hiatus		hiatus	Statfjord, Amundsen, Johansen, Cook, Drake	Statfjord, Amundsen, Burton, Cook, Drake	Statfjord, Amundsen, Burton, Cook, Drake
180										
185				Pliensbachian						
190				Sinemurian	Gassum	Fjerritslev		DUNLIN GROUP		
195				Hettangian						
200										

Type Wells

Utsira Formation	16/1-1	Maureen Formation	UK 16/29-4	Mime Formation	34/10-18	Heather Formation	UK 211/21-1A
Skade Formation	24/12-1	Ekofisk Formation	2/4-5	Mandal Formation	7/12-3A	Fensfjord Formation	31/2-1
Grid Formation	15/3-3	Tor Formation	1/3-1	Farsund Formation	2/7-3	Krossfjord Formation	31/2-1
Frigg Formation	25/1-1	Hod Formation	1/3-1	Eldfisk Formation	2/7-3	Tarbert Formation	UK 211/29-3
Balder Formation	25/11-1	Jorsalfare Formation	25/1-1	Haugesund Formation	2/7-3	Ness Formation	UK 211/29-3
Fiskebank Formation	9/11-1	Hardråde Formation	30/11-3	Flekkefjord Formation	9/4-2	Rannoch Formation	UK 211/29-3
Hermod Formation	25/2-6	Kyrre Formation	25/1-1	Sauda Formation	9/4-3	Etive Formation	UK 211/29-3
Sele Formation	UK 21/10-1	Tryggvason Formation	25/1-1	Tau Formation	9/4-3	Broom Formation	UK 211/29-3
Lista Formation	2/7-1	Blodøks Formation	25/1-1	Egersund Formation	9/4-1	Drake Formation	UK 211/29-3
Heimdal Formation	25/4-1	Hidra Formation	1/3-1	Ula Formation	17/12-2	Cook Formation	UK 211/29/3
Vidar Formation	2/1-4	Svarte Formation	25/1-1	Sandnes Formation	9/4-3	Burton Formation	UK 211/29/3
Våle Formation	1/3-1	Rødby Formation	DK Rødby-1	Hugin Formation	15/9-2	Johansen Formation	31/2-1
Ty Formation	UK 10/1-1A	Sola Formation	DK I-1	Bryne Formation	9/4-3	Amundsen Formation	UK 211/29-3
Forties Formation	UK 21/10-1	Agat Formation	35/3-4	Sleipner Formation	15/9-2	Statfjord Formation	33/12-2
Andrew Formation	UK 14/25-1	Tuxen Formation	DK I-1	Draupne Formation	30/6-5	Fjerritslev Formation	DK Fjerritslev 2
		Åsgard Formation	2/11-1	Sognefjord Formation	31/2-1	Gassum Formation	DK Gassum 1

KEY

Maximum local age range of formation

Presence of type well

Lithostratigraphy of the Norwegian margin: Norwegian Sea & Barents Sea

Timescale after Gradstein et al. (2004)

62° | Norwegian Sea (mid-Norway) | 67° | Barents Sea | 80°

Age (Ma)	Era	Period	Epoch	Stage	Møre Basin	Vøring Basin	Halten Terrace	Træna Terrace	Trømsøflaket (Hammerfest basin, Troms-Finnmark Platform)	Svalbard
0	Cenozoic	Neogene	Pleistocene		Naust / Kai	Naust / Kai	Naust / Kai	Naust / Kai	undifferentiated	undifferentiated
			Pliocene			NORDLAND GROUP				
			Miocene	Messinian						
				Tortonian						
				Serravallian						
				Langhian						
				Burdigalian						
				Aquitanian						
		Paleogene	Oligocene	Chattian	Brygge	Brygge	Brygge	Brygge	Torsk	
				Rupelian		HORDALAND GROUP			SOTBAKKEN GROUP	
			Eocene	Priabonian						
				Bartonian						
				Lutetian						
				Ypresian						
			Paleocene	Thanetian	Tang / Tare	Tang	Tang / Tare	Tang / Tare		
				Selandian		ROGALAND GROUP				
				Danian						
	Mesozoic	Cretaceous	Late	Maastrichtian	Kvitnos / Nise / Springar	Kvitnos / Springar	Kvitnos / Nise / Springar	Springar	Kveite / Kviting	
				Campanian		SHETLAND GROUP			NYGRUNNEN GROUP	
				Santonian						
				Coniacian						
				Turonian						
				Cenomanian						
			Early	Albian	Lange / Lyr	Lange / Lyr	Lange / Lyr	Lange / Lyr	ADVENTDALEN GROUP	
				Aptian		CROMER KNOLL GROUP				
				Barremian						
				Hauterivian						
				Valanginian						
				Berriasian						
		Jurassic	Late	Tithonian	Melke / Spekk	Melke / Spekk	Melke / Spekk / Rogn	Melke / Spekk	Fuglen / Hekkingen / Knurr / Kolje / Klippfisk / Kolmule / Rurikfjellet / Helvetiafjellet / Carolinefjellet	
				Kimmeridgian		VIKING GROUP				
				Oxfordian						
			Middle	Callovian	Ile / Not / Garn	Not / Garn	Ile / Not / Garn	Ile / Not / Garn	Agardhfjellet	
				Bathonian		FANGST GROUP				
				Bajocian						
				Aalenian						
			Early	Toarcian	Åre / Tilje / Ror	Ror	Tilje / Ror / Tofte	Tilje / Ror	Tubåen / Nordmela / Stø	Kongsøya
				Pliensbachian		BÅT GROUP			KAPP TOSCANA GROUP	Svenskøya
				Sinemurian						
				Hettangian						

Type Wells

Naust Formation	6507/12-1	Lysing Formation	6507/7-1	Garn Formation	6407/1-3
Kai Formation	6407/1-2	Lange Formation	6506/12-1	Not Formation	6507/11-4
Brygge Formation	6407/1-3	Lyr Formation	6506/12-1	Ile Formation	6507/11-4
Torsk Formation	7119/12-1	Kolmule Formation	7119/12-1	Ror Formation	6407/2-1
Tare Formation	6507/12-1	Kolje Formation	7119/12-1	Tofte Formation	6506/12-1
Tang Formation	6407/6-1	Knurr Formation	7119/12-1	Tilje Formation	6507/11-1
Springar Formation	6506/12-4	Hekkingen Formation	7120/12-1	Åre Formation	6507/12-1
Nise Formation	6506/12-4	Fuglen Formation	7120/12-1	Stø Formation	7121/5-1
Kvitnos Formation	6506/12-4	Rogn Formation	6407/9-1	Nordmela Formation	7121/5-1
Kviting Formation	7120/12-1	Spekk Formation	6407/2-1	Tubåen Formation	7121/5-1
Kveite Formation	7119/12-1	Melke Formation	6506/12-4		

KEY

Maximum local age range of formation

Presence of type well