Second Icelandic Licensing Round - Jan Mayen Offshore Exploration: A Status Update

Anett Blischke, Iceland GeoSurvey
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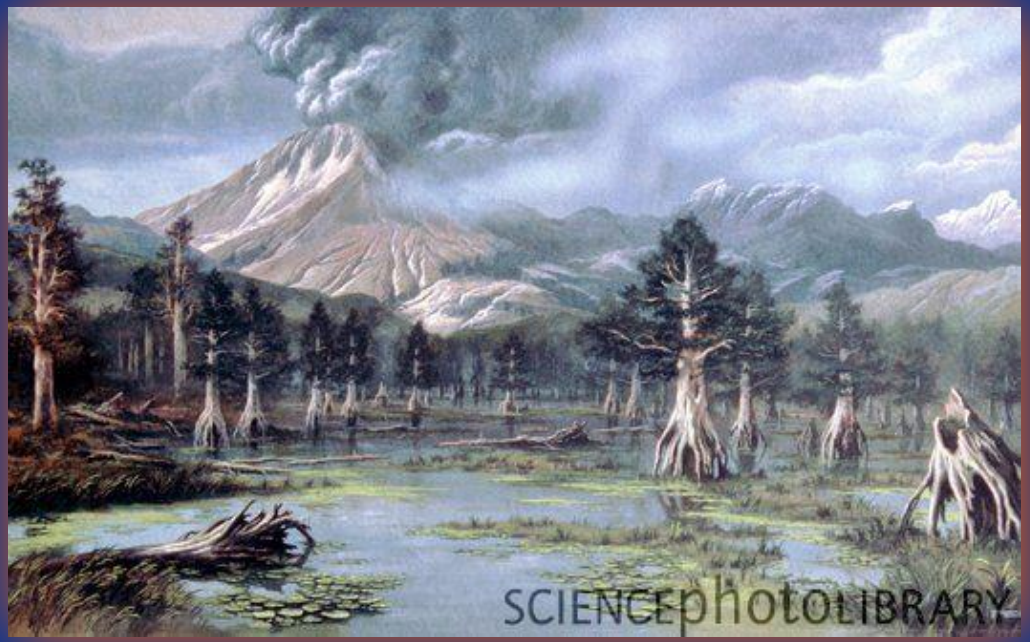
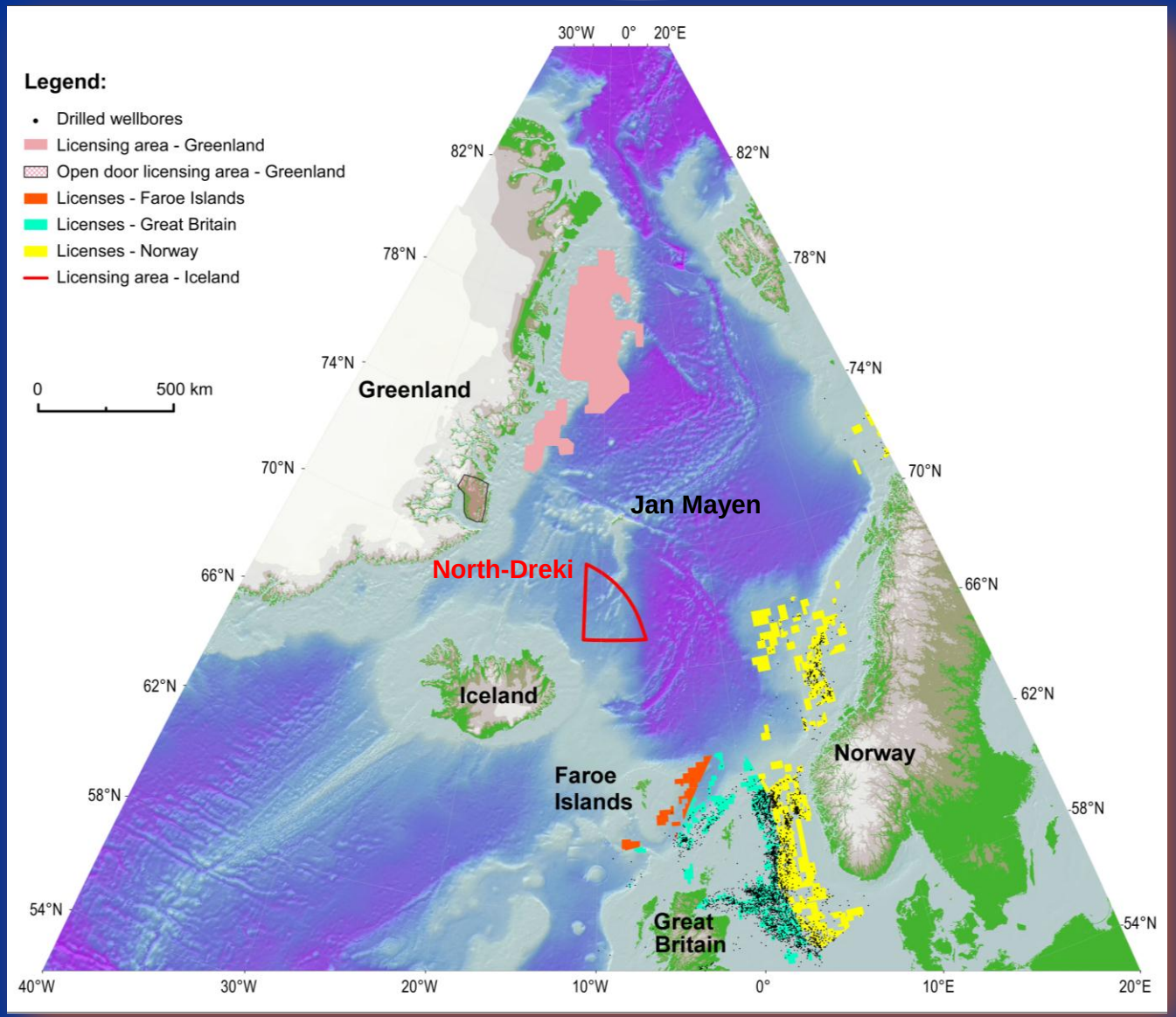


The North-Dreki Licensing Area

Location Reference

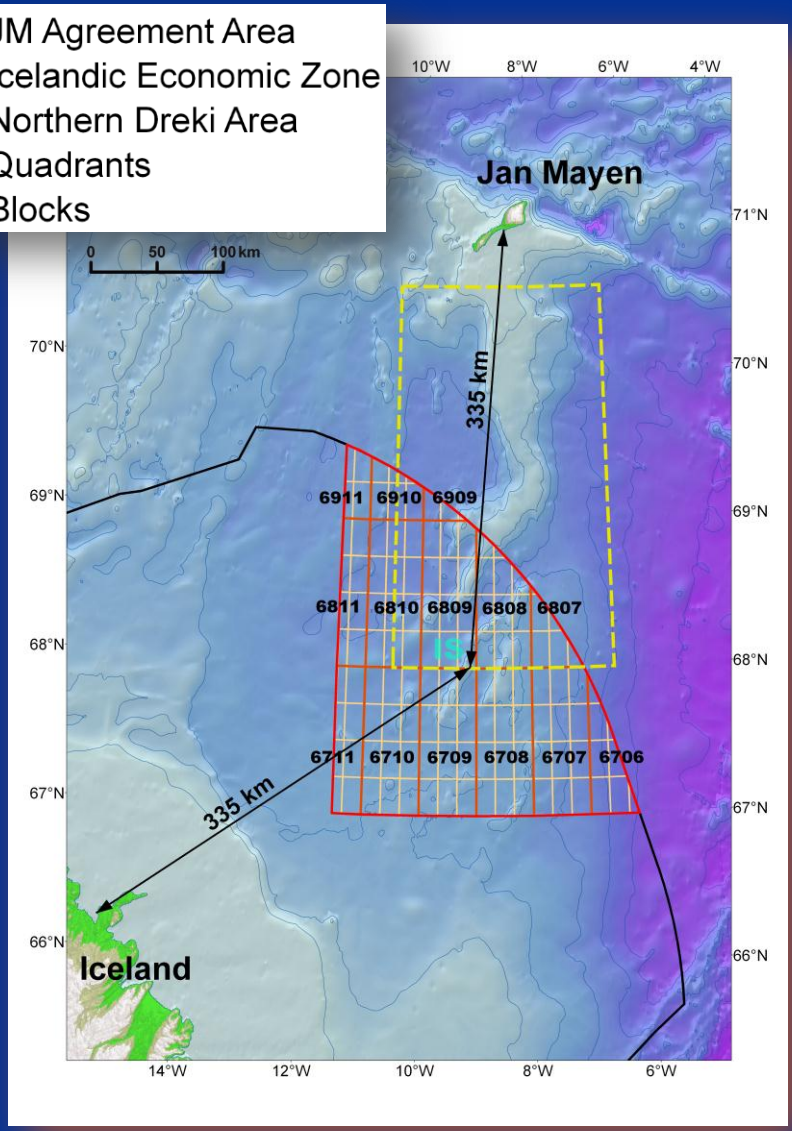
- North-Dreki is part of the Jan Mayen Micro-Continent (JMMC) with indications and evidence of continental strata and suitable structures
- Similarities to licensing areas on- and offshore East-Greenland and offshore Norway, which has a proven hydrocarbon provinces, with analogues, e.g. Møre and Vøring basins.



Second Icelandic Licensing Round

Northern Dreki Area

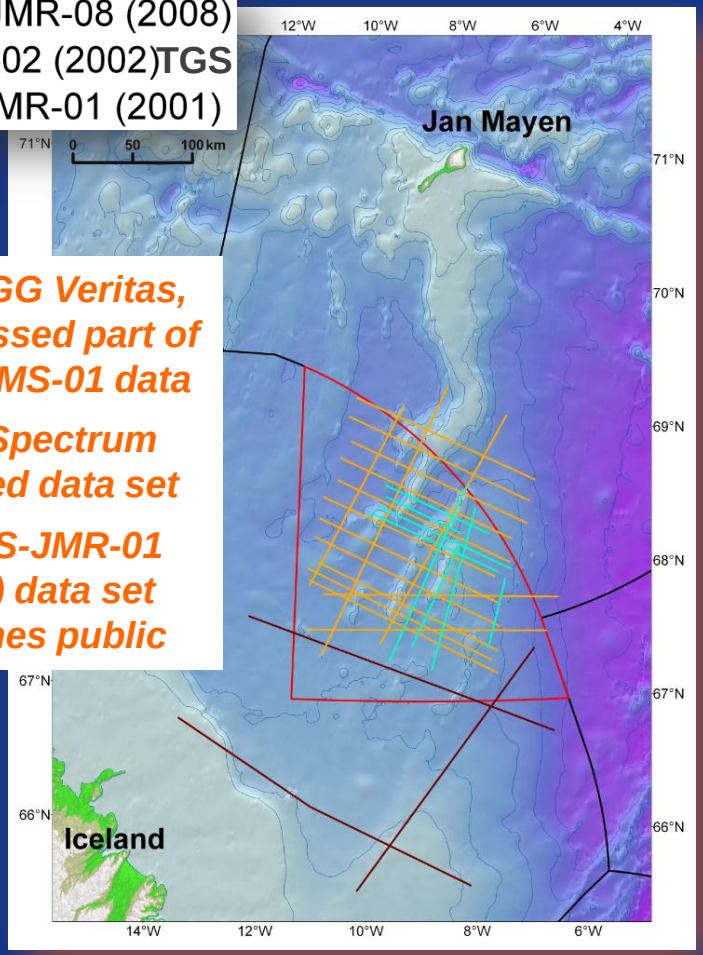
- Licensing Round was opened on the 3rd of October 2011
- Application deadline is on the 2nd of April 2012
- Norway (Petoro) has right to participate up to 25% in licenses granted within the Jan Mayen Agreement Area



2D Seismic reflection data surveys over the Jan Mayen Area

Commercial Surveys

WI-JMR-08 (2008)
ICE-02 (2002)TGS
IS-JMR-01 (2001)



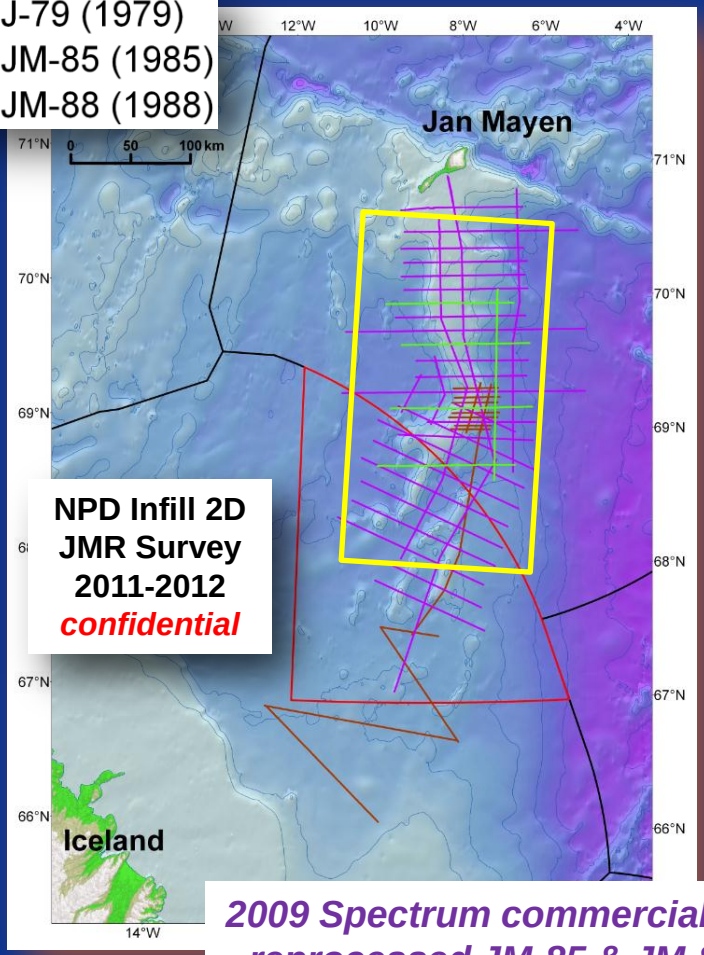
2009 CGG Veritas, reprocessed part of the IS-JMS-01 data

2011 Spectrum acquired data set

2012 IS-JMR-01 (2001) data set becomes public

NPD-NEA Surveys

J-79 (1979)
JM-85 (1985)
JM-88 (1988)



NPD Infill 2D JMR Survey 2011-2012
confidential

2009 Spectrum commercial survey, reprocessed JM-85 & JM-88 data

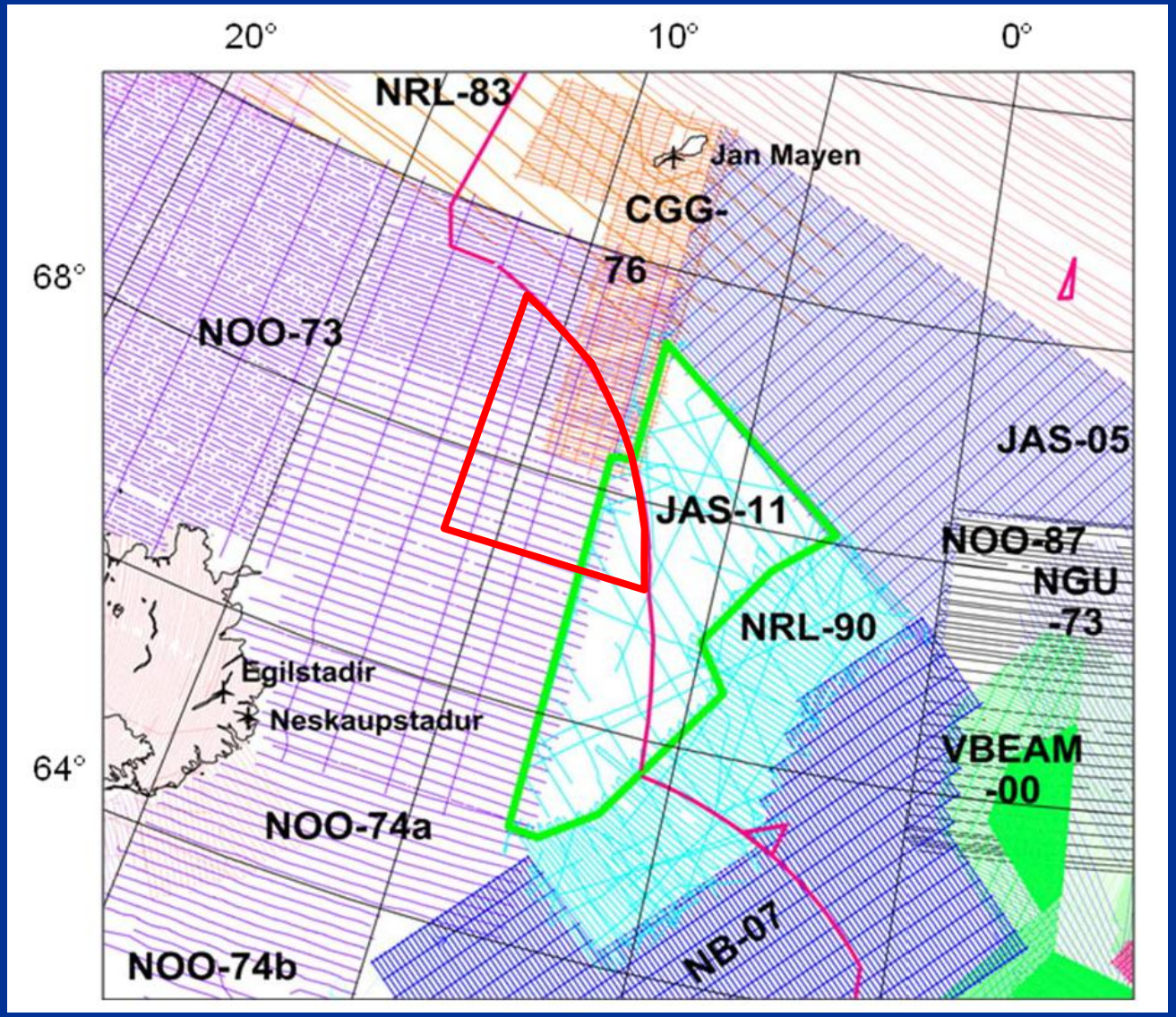
Magnetic Surveys

after Laurent Gernigon, 2011, NGU

Collaboration project NGU, NPD & NEA - Preliminary outline of the aeromagnetic survey

JAS-11

in the western Norwegian Sea (green frame) planned for 2012.

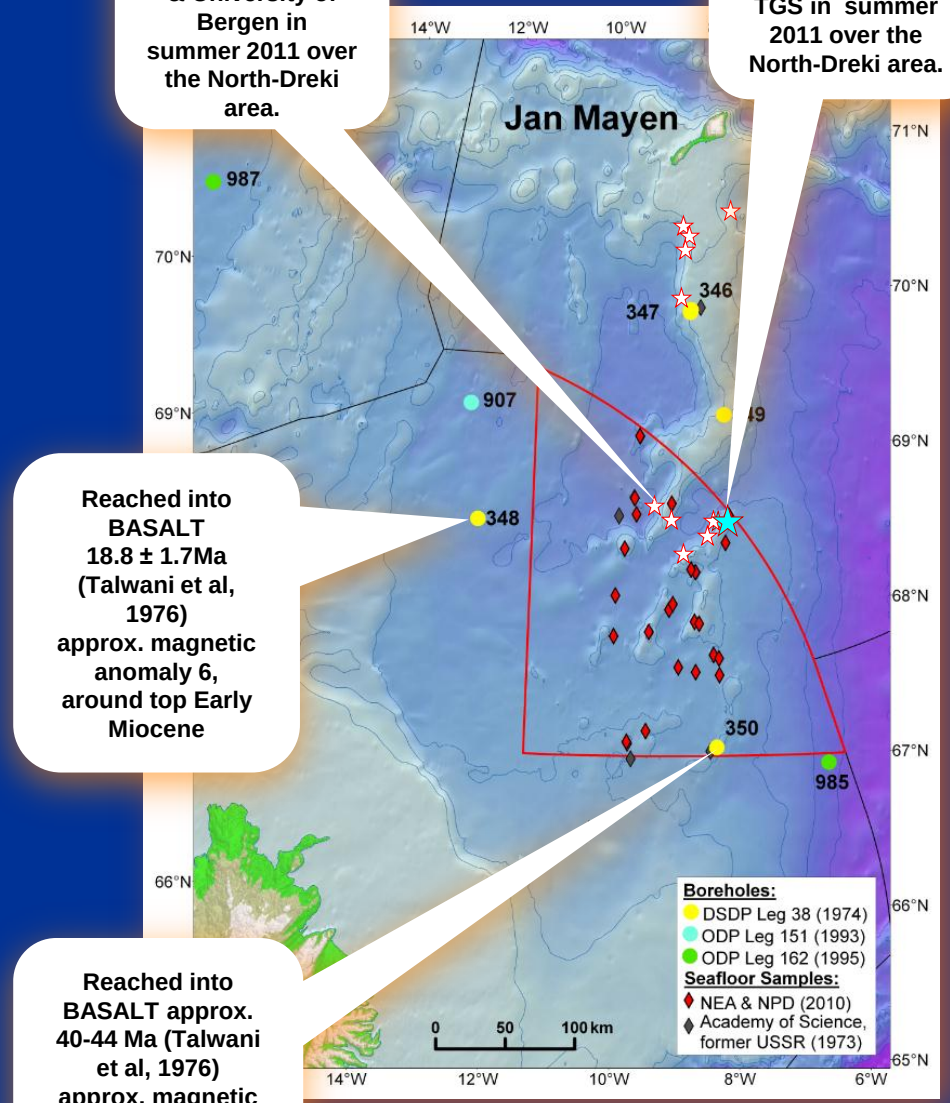


Borehole & Seafloor Samples around the Jan Mayen Area

- DSDP : 5 wells during Leg 38 in 1974
- ODP : 1 well during Leg 151 in 1993
- ODP : 2 wells during Leg 162 in 1995

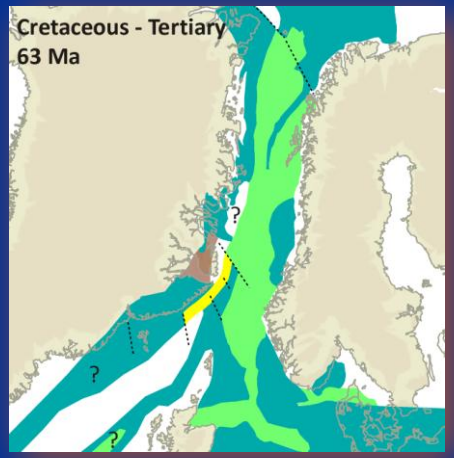
Cores provide density and velocity measurements to enable a depth – seismic tie (TWT) to confirm the Top Eocene marker for 3 wells on the Ridge.

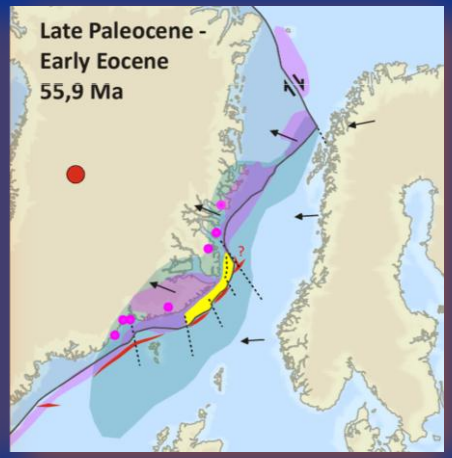
- Seafloor Sampling (Core, Dredge & ROV grab samples)
  - NEA & NPD 2010
  - NPD 2011
  - VBPR 2011

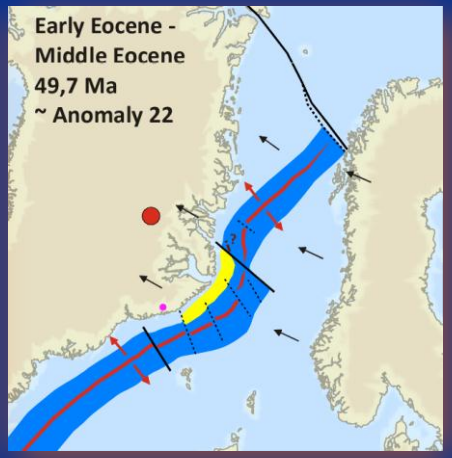


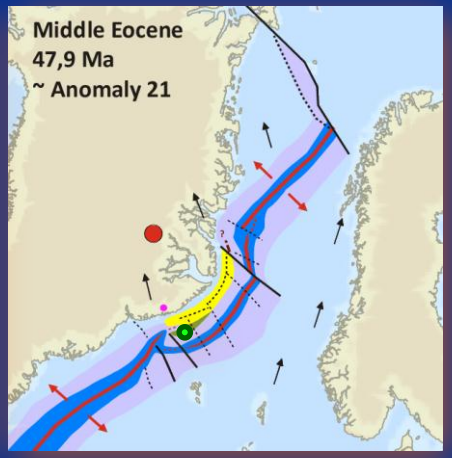
Tectonic History of the JMMC

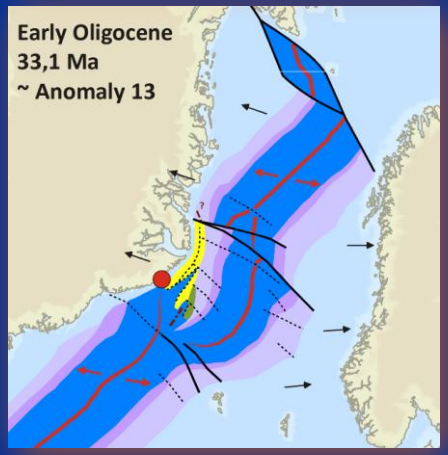
Collage based on results of recent research publications and observations at the JMMC

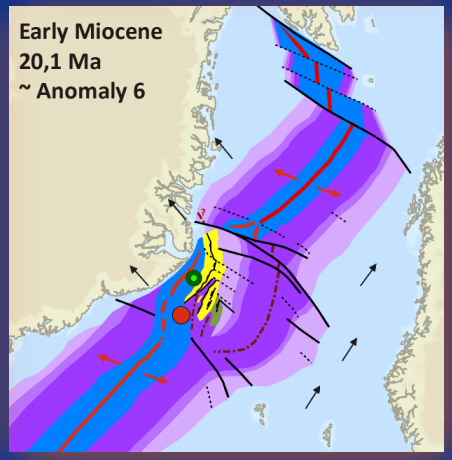


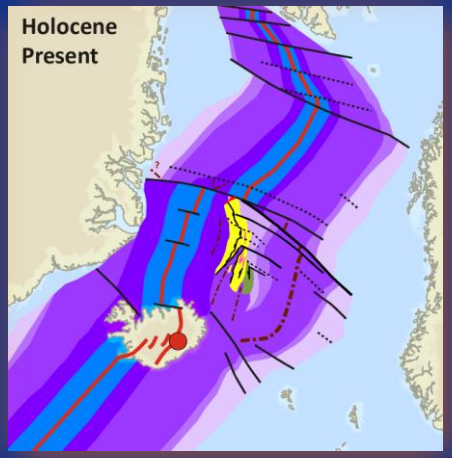


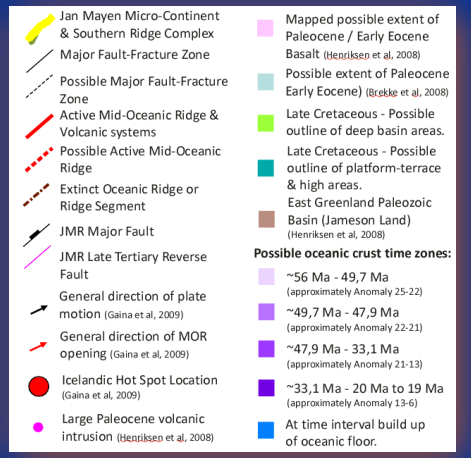












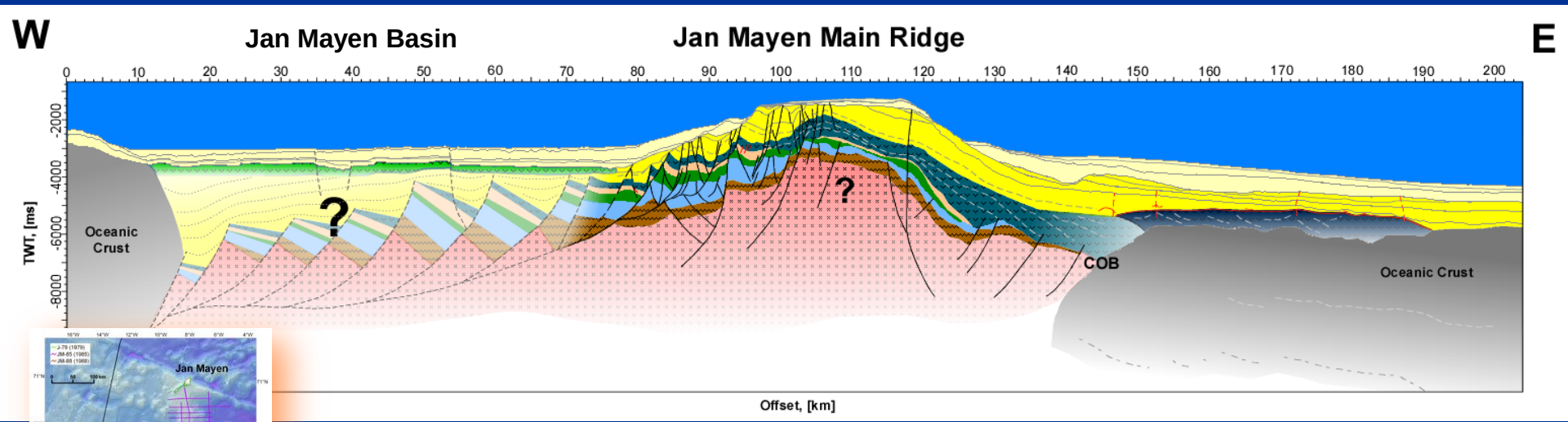
Data Source Reference List:

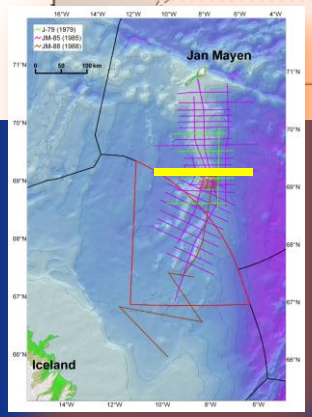
Dinkelman M.G. et al (2010): The NE Greenland Continental Margin. GeoExpro, No. 6. **Gaina, C. et al (2009):** Palaeocene-Recent plate boundaries in the NE Atlantic and the formation of the Jan Mayen microcontinent. Journal of the Geological Society, London, Vol. 166, pp. 1-16. **Gernigon L. et al (2009):** Geophysical insights and early spreading history in the vicinity of the Jan Mayen Fracture Zone, Norwegian-Greenland Sea. Journal of Tectonophysics, Vol. 468, pp. 185-205. **Roberts, A.M. et al (2009):** Mapping palaeostructure and palaeobathymetry along the Norwegian Atlantic continental margin: Møre and Vøring basins. Petroleum Geoscience, Vol. 15, pp. 27-43. **Brekke H. et al (2008):** The Geology of the Norwegian Sea Continental Margin and Probable Similarities with the Jan Mayen Ridge. 1st Petroleum Exploration Conference in Iceland. **Henriksen, N. et al (2008):** Geological History of Greenland - Four billion years of Earth evolution. Geological Survey of Denmark and Greenland (GEUS), Ministry of Climate and Energy, Copenhagen. **Mjelde, R. et al (2008):** Crustal transect across the North Atlanti., Marine Geophysical Researches, Vo. 29, pp. 73-87. **Mueller, R.D. et al (2008):** Palaeo-age, depth-to-basement and bathymetry grids of the world's ocean basins from 140-1 Ma. Science, 319, 1357 (data used in GPlates 1.0 http://www.gplates.org/index.html). **Mosar, J. et al (2002):** North Atlanti sea-floor spreading rates: implications for the Tertiary development of inversion structures of the Norwegian-Greenland Sea, Journal of the Geological Society, London, Vol. 159, pp. 503-515. **Gunnarsson, K. (1990):** Olíuleit á Jan Mayen-Hrygg, Erindi á ársfundi Orkustofnunar. **Gunnarsson, K. et al (1989):** Geology and hydrocarbon potential of the Jan Mayen Ridge. Oljedirektoratet, OD-89-91 and Orkustofnun OS-89036/JHD-07, report, pp. 143.Talwani et al (1976) : Series publications of the DSDP Leg 38 project … http://www.deepseadrilling.org/38/dsdp_toc.htm ; specifically the paper: http://www.deepseadrilling.org/38/volume/dsdp38_34.pdf. Scott, R.A., Lucy A. Ramsey, Steve M. Jones, Stewart Sinclair, Caroline S. Pickles (2005): Development of the Jan Mayen microcontinent by linked propagation and retreat of spreading ridges Original Research Article Norwegian Petroleum Society Special Publications, Volume 12, 2005, Pages 69-82.

Update Key-Section JMR & Conceptual Model of the Jan Mayen Basin

"Jan Mayen Basin" :

Possibly sub-basalt basin containing pre- and post-Paleocene with thinning sequences due west and deepening. Possible also being intersected by igneous intrusions, "feed points" of the youngest rifting attempts.





Legend:

- Late Quaternary - Late Oligocene
- Early Oligocene - Paleocene
- Lower Paleocene
- Paleocene - SDR/Volcanics/Basalt
- Volcanic centre Post-Paleocene
- Oligocene - shallow Basalt Intrusions
- Poss. Low Cretaceous
- Poss. Jurassic/Triassic
- Poss. Paleozoic
- Poss. Caledonian Basement
- Oceanic crust

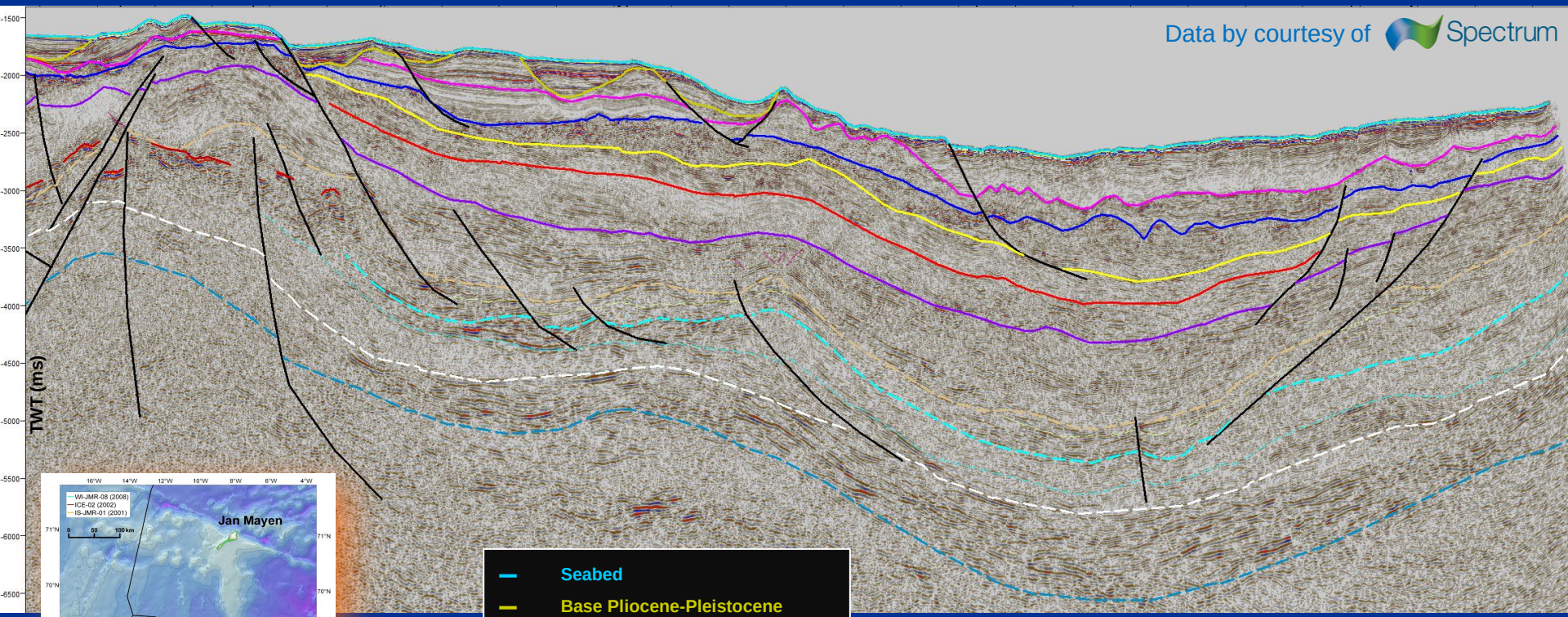
Conceptual model – seismic data comparison

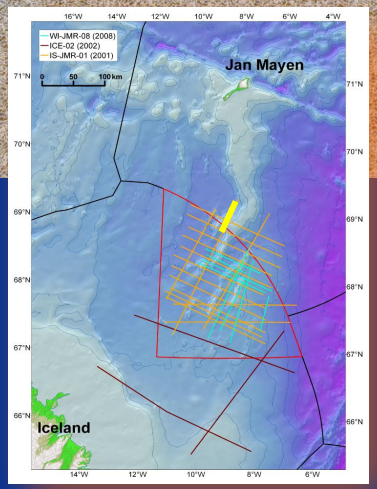
Northern edge of the Dreki Licensing Area

SSW

NNE

Data by courtesy of Spectrum





- Seabed
- Base Pliocene-Pleistocene
- UC Late Oligocene - Miocene
- UC Base Late Oligocene
- Top Eocene
- UC Middle Eocene
- UC Top Paleocene
- Top Paleozoic poss. (or actual Basement ???)
- Top Basement poss. (Crystalline ??? deep reflector)

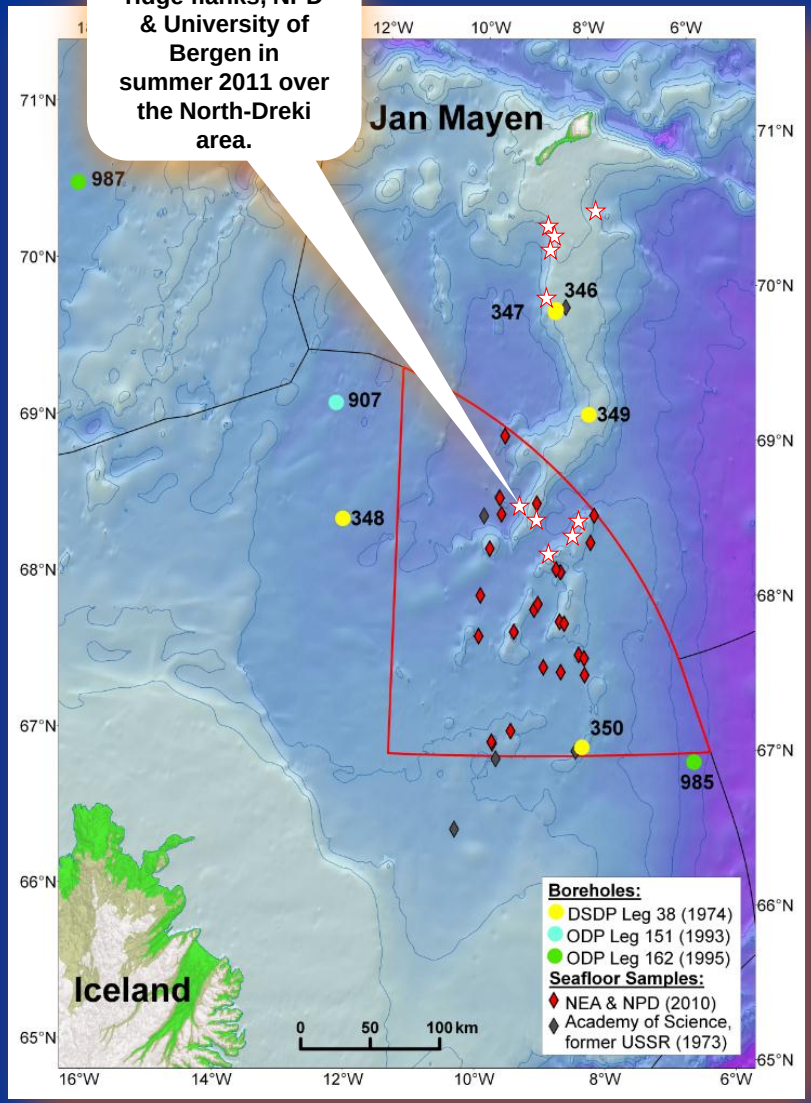
- Top Mesozoic poss. ???
- Top Jurassic poss. ???
- Intrusive

ÍSOR ICELAND GEOSURVEY

ORKUSTOFNUN National Energy Authority

Seafloor Sampling in 2011

- Dredge & ROV grab samples
- Samples indicate pre-Tertiary strata (Early Cretaceous to Late Permian – Early Triassic) with sandstone of good quality that can act as a reservoir rock. In addition, it found rocks of an age that act as source rocks in Greenland.
- Detailed analysis are in progress at NPD & UiB

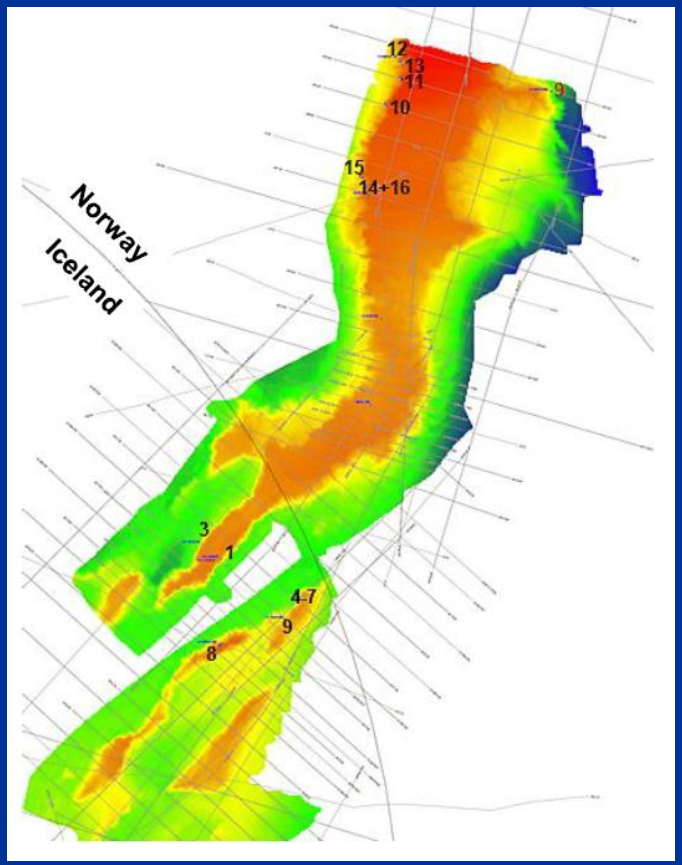


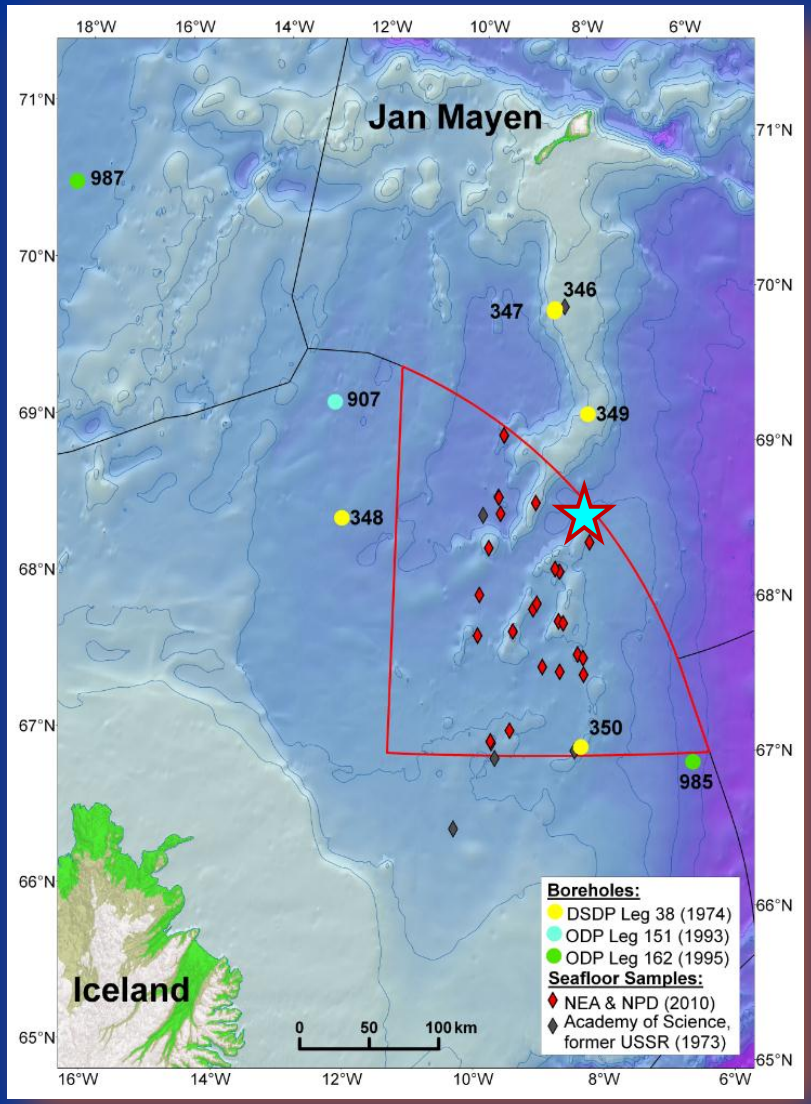
ROV – Dredge Sampling

Nils Rune Sandstå et al., 2012

http://npd.no/no/Publikasjoner/Presentasjoner/Bruk-av-ROV-sommeren-2011-pa-Jan-Mayen-Ryggen/

Sample	Description	Age
1-6	Limestone	Late Permian / Early Triassic (260 -245 ma)
4-1	Limestone	Early Cretaceous (140-136 ma)
6-2	Siltstone	**Oligocene** (34-23 ma)
	Sandstone	
11.3	Limestone	**Late Eocene**
11.6	Limestone	Early Cretaceous
13.5	Claystone	**Eocene (46-48 ma)**
13.6	Claystone	**Eocene/Oligocene**
14.4	Silt-limestone	Early Cretaceous
14.7	Limestone	Early Cretaceous
15.1	Siltstone	**Eocene-Oligocene (50-25 ma)**
15.4	Siltstone	**Oligocene- Miocene (33-22 ma)**





Volcanic Basin Petroleum Research

TGS

JMRS11 sampling project

http://www.tgsnopec.com/_uk/emails/Projects/2012/02_JanMayen_Sampling_Feb12/Jan_Mayen_Sampling_Feb12-2.html

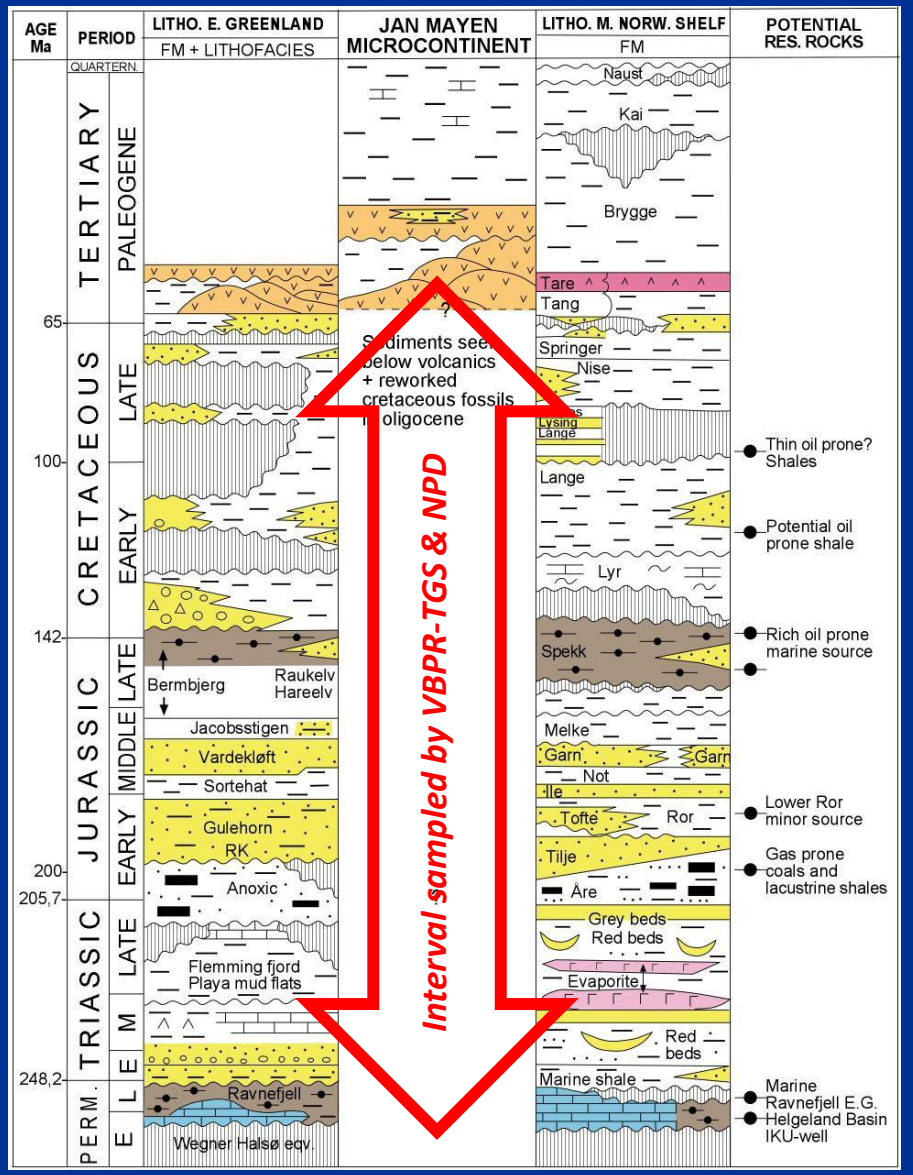
Project aim:

- Recover Tertiary and Mesozoic rocks from the seafloor.
- Improve seismic ties.
- Sedimentologic and geochemical analysis
- Hydrocarbon seep analysis
- Improve the understanding of the Jan Mayen Ridge´s geology and hydrocarbon prospectivity.

Stratigraphy

Sample campaign by NPD
&
1000m Pseudo-Well Interpretation by VBPR / TGS

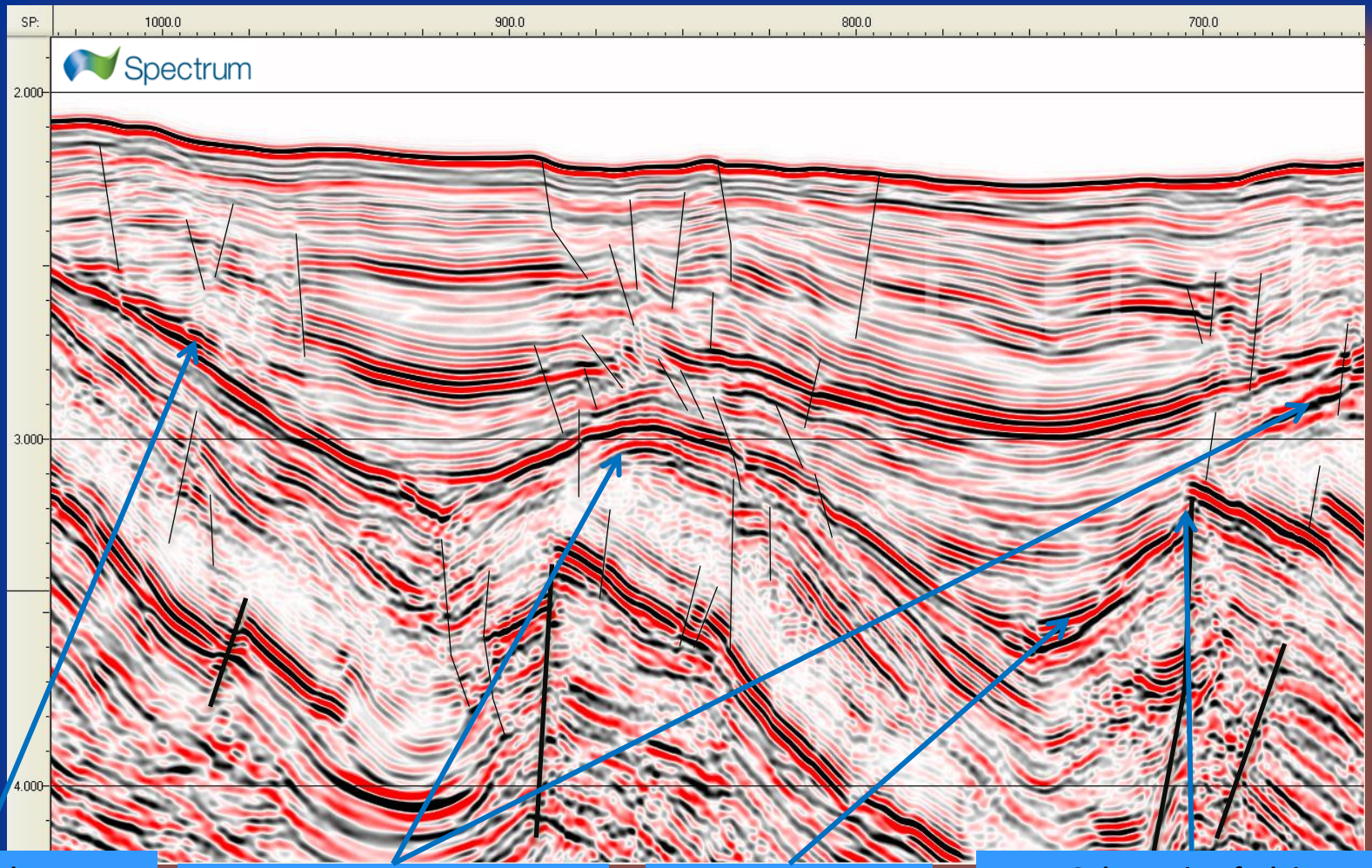
- Samples age ranges from Miocene-Oligocene to Permian-Triassic
- Hard data to substantiate seismic interpretations for Mesozoic basin stratigraphy, lithology and depositional environment of the Jan Mayen Ridge
- Grab sample & core logging, petrography, XRD, SEM, and biostratigraphy



Hagevang et al., 2008

Potential Trap Types

Seismic image courtesy of Spectrum, 2009



Pinch-out, onlap onto unconformity

Tilted anticline closure, above tilted fault block

Basin floor fan, Stratigraphic trap

Onlap against fault in downthrown fault block, unconformity

What do we know?

- Best analogue comparison with East Greenland exploration examples and the central and southern Jan Mayen Ridge with the Møre Basin for the Norwegian side.
- Post Paleocene sedimentary rocks of sufficient thickness and age along the ridge flank areas.
- First evidences of pre-opening sedimentary strata of Paleozoic, Triassic-Jurassic and Cretaceous age – underneath the east flank areas of the ridge.
- Potential reservoir rocks, focus on locally shallow marine to generally marine deposits, especially submarine fans / turbidite deposits for post Paleocene deposits, and from marine and limestone platform to continental deposits for the pre-opening formations.
- Potential traps are present, both structural and stratigraphic.
- Hydrocarbon maturation is probably high close to igneous strata, more gas prone if sufficient source rocks are present and possibly intermediate mature for areas with none-annomalous heat flows.

Thank you very much for your attention !

Acknowledgements:

Nils Rune Sandstå & Morten Sand at NPD - Norwegian Petroleum Directorate
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Mikal Trulsvik at VBPR – Volcanic Basin Petroleum Research AS