History of geology and research of the Jan Mayen Micro-Continent and its associated exploration risks.

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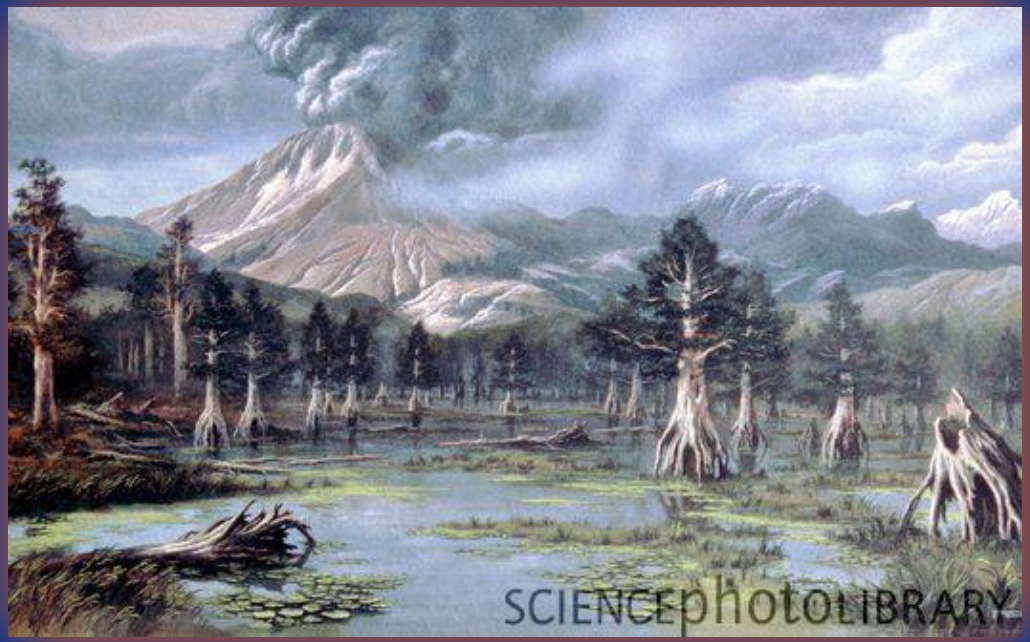
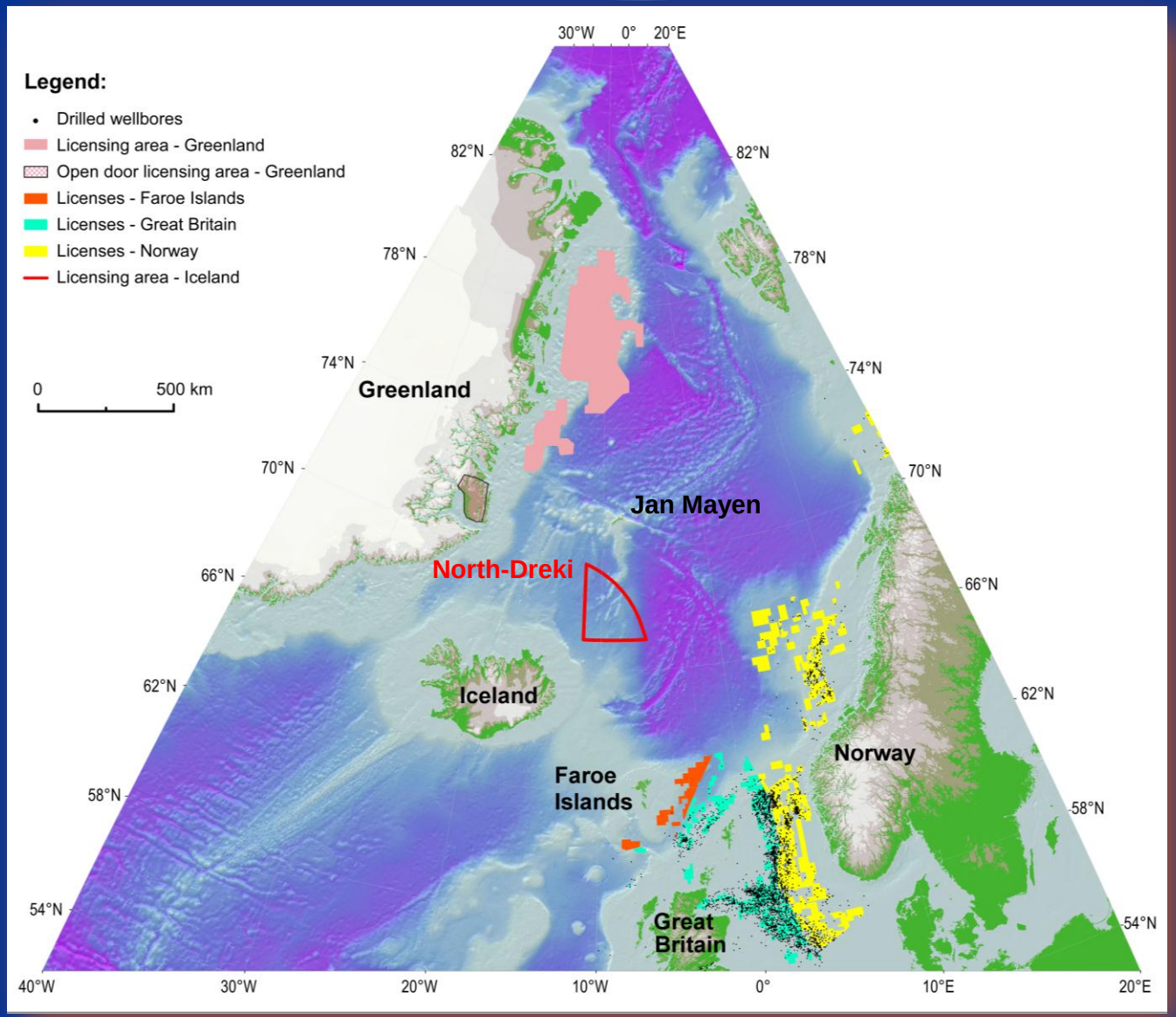


The North-Dreki Licensing Area

Location Reference

- North Dreki is part of the Jan Mayen Micro-Continent (JMMC) with indications of continental strata and suitable structures
- Expected similarities to licensing areas on and off East-Greenland and off Norway (proven hydrocarbon provinces in the Møre and Vøring basins)



Exploration History of the Jan Mayen Area

- Late 1970´s – 1980´s first main phase of exploration activities by Academia and the NPD / NEA, 2D seismic reflection and refraction data acquisition, sea floor sampling and DSDP drilling program.
- Mid 1990´s regional gravity and magnetic modeling project and ODP drilling campaigns.
- Early 2000´s – re-activation of 2D seismic reflection and refraction data acquisitions and re-assessment of JM.
- 2007 – **SEA** „Dreki - Strategic Environmental Assessment“ by the Icelandic Government to re-activate oil & gas exploration activities.
- 2009 – 1st Icelandic Hydrocarbon Exploration Licensing Round
- Since 2008 – Second main phase exploration activities by NEA-ÍSOR / NGU / NPD / Academia & Industry of re-assessing of the Jan Mayen historic- and recent data (2D seismic acquisitions, re-processing and analysis, sea floor core & ROV sampling, seep studies, high resolution bathymetry, aeromagnetic survey, gravity modeling)
- 2011-2012 – 2nd Icelandic Hydrocarbon Exploration Licensing Round

Data Control

- **Vintage, reprocessed and infill 2D seismic or refraction surveys – ongoing acquisitions and research (NPD, Spectrum, TGS).**

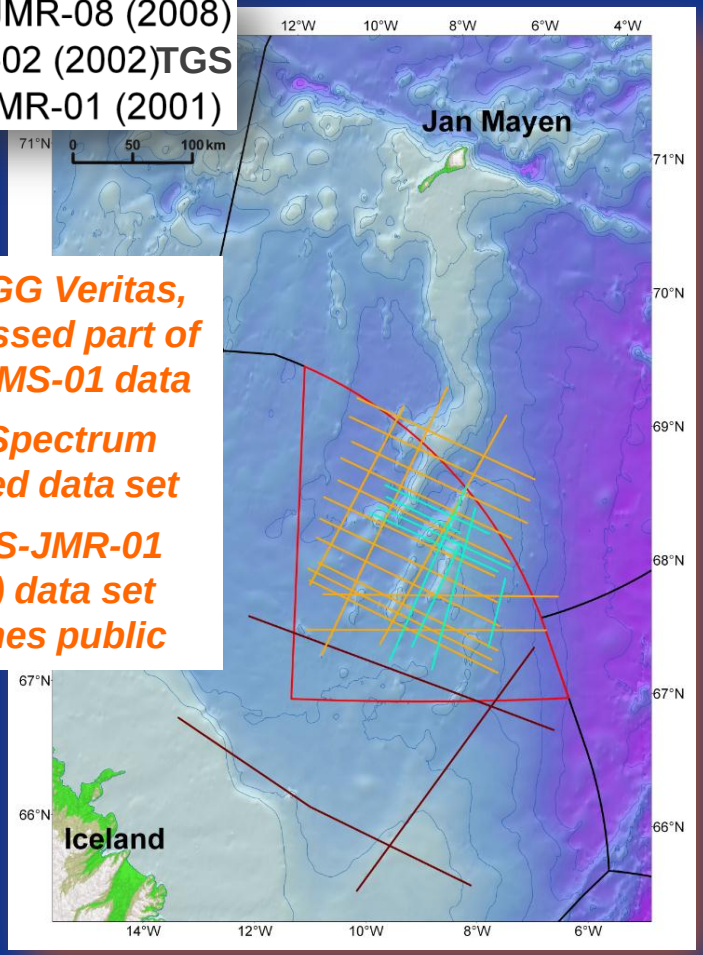
  - Progress : - imaging resolution
    - sub-Paleocene basalt imaging improvements
    - very much improved igneous province interpretations

  - Main Questions : - basin areas still masked by Neogene volcanism
    - lack of deep stratigraphic pre-Paleocene ties and resulting guess-work
    - velocity modeling

2D Seismic reflection data surveys over the Jan Mayen Area

Commercial Surveys

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



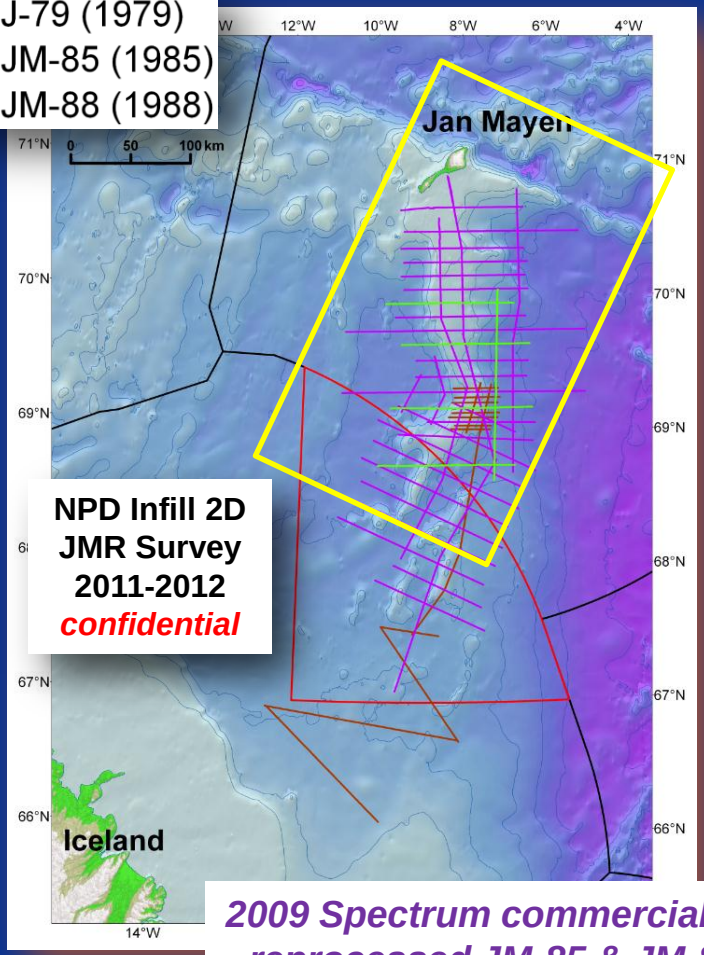
2009 CGG Veritas, reprocessed part of the IS-JMS-01 data

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

Data Control

- **Magnetic and gravity surveying and modeling – ongoing acquisitions and research (NGU, NEA).**

  - Progress : - studies; NEA 1995, Rey S. 2003 UiB
    - NGU compilations of magnetic and gravity data interpretations, dynamic modeling and publications focused on Jan Mayen (in press)
    - refining margins between oceanic plate and micro-continent updated heat flow data estimate

  - Main Questions : - lack of high res surveys for detailed interpretation of complex tectonic and volcanic structures, e.g. igneous vs. stratigraphic areas, possible magnetic anomalies vs. seismic interpretations, etc.

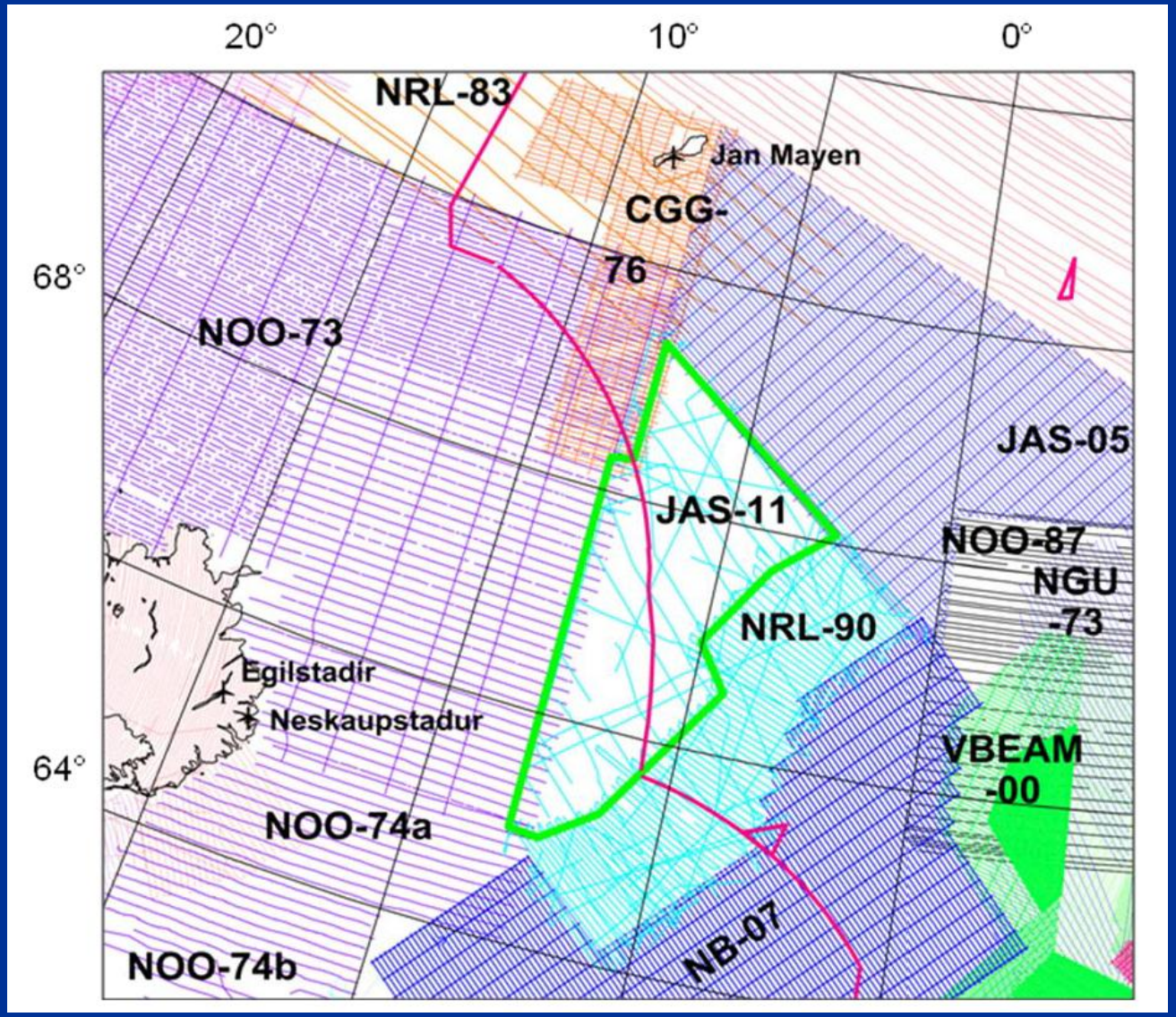
Magnetic Surveys

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.



Data Control

- **High resolution bathymetry surveys (2008 HÍ & NEA, 2010 NPD)**

- **Actual "hard" data – boreholes, seafloor core, grab or dredge samples – ongoing governmental and commercial research (NEA-Fugro, NPD, VBPR-TGS).**

  - Progress : - evidence for presence of pre-Tertiary strata
    - evidence for presence of organic rich shales
    - key markers to define southeastern- and western basalt provinces including updated heat flow data estimate
    - shallow seismic ties down to Middle Eocene at ridges crests

  - Main Question : - lack of deep stratigraphic pre-Paleocene well control with resulting necessary risk mitigating parameters, e.g. age control, reservoir-seal characteristics, basin modeling, velocity modeling, etc.

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

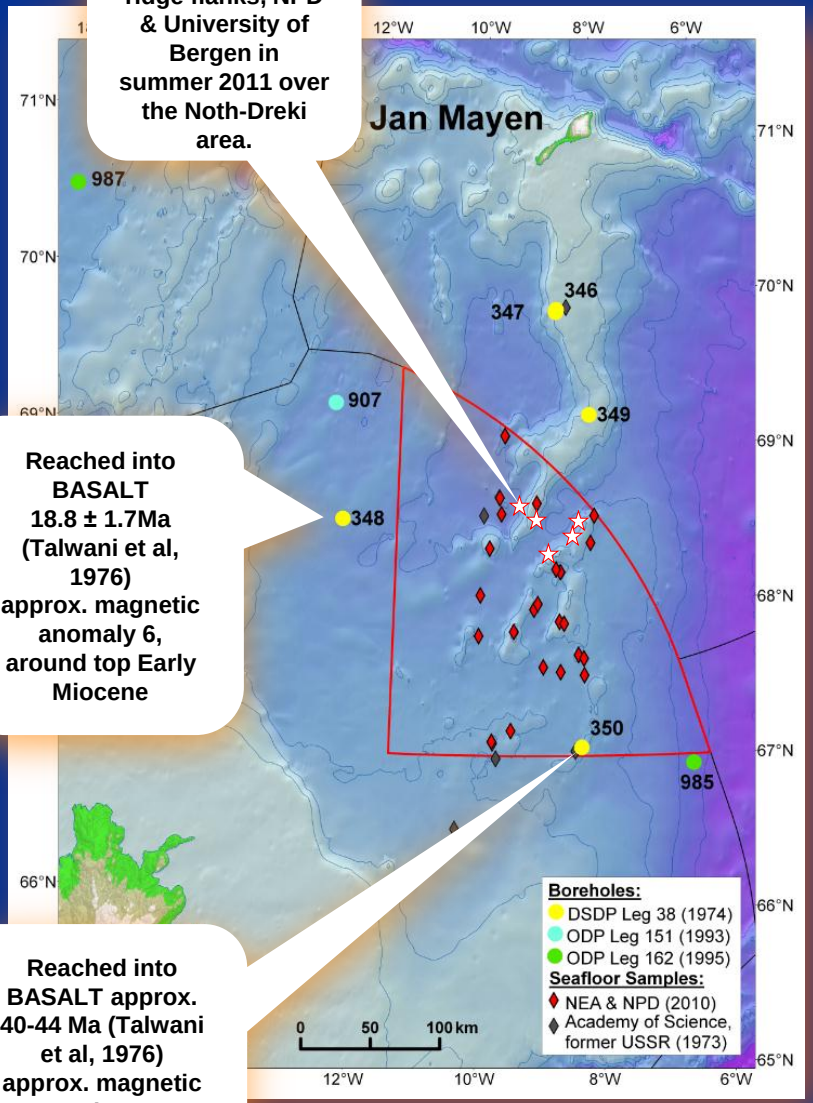
Cores provide density and velocity measurements to enable a depth – seismic tie (TWT) to confirm the Top Eocene marker for 3 wells on the Ridge.

- Seafloor sampling (core, dredge & ROV grab)
  - NEA & NPD 2010
  - NPD 2011
  - VBPR 2011

2011 samples indicate pre-Tertiary strata 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 & VBPR-TGS.

ROV outcrop sampling on steep ridge flanks, NPD & University of Bergen in summer 2011 over the Noth-Dreki area.



Reached into BASALT 18.8 ± 1.7Ma (Talwani et al, 1976) approx. magnetic anomaly 6, around top Early Miocene

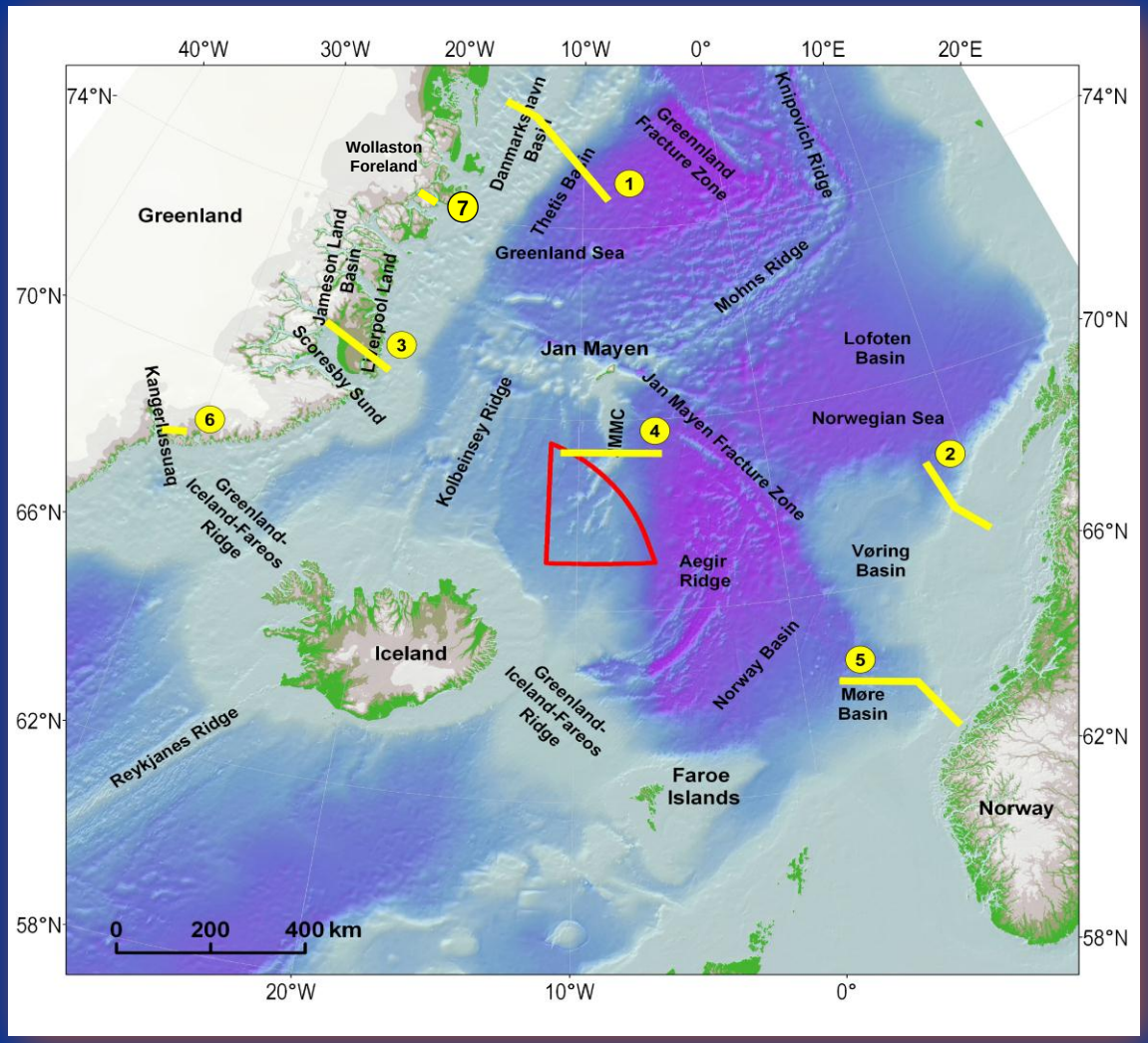
Reached into BASALT approx. 40-44 Ma (Talwani et al, 1976) approx. magnetic anomaly 19-20, Middle Eocene

What do we know?

- Best analogue comparison with East Greenland exploration examples and Møre Basin for the Norwegian side.
- Post Paleocene sedimentary rocks of sufficient thickness and age in the ridge flank areas.
- Indications and first preliminary evidence of pre-opening sedimentary strata of possibly Paleozoic, Triassic-Jurassic and maybe Cretaceous age – especially underneath the west flank areas of the ridge, i.e. Jan Mayen Basin.
- Potential reservoir rocks, focus on locally shallow marine to generally marine deposits, especially submarine fans / turbidite deposits for post Paleocene deposits, and possibly focus on limestone platform to continental deposits for the pre-opening formations.
- Potential traps present, both structural and stratigraphic.
- Hydrocarbon maturation is probably high, more gas prone if sufficient source rocks are present and a more detailed influence of igneous activity needs to be included.

Regional Correlations important for comparison to the history of the JMMC

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



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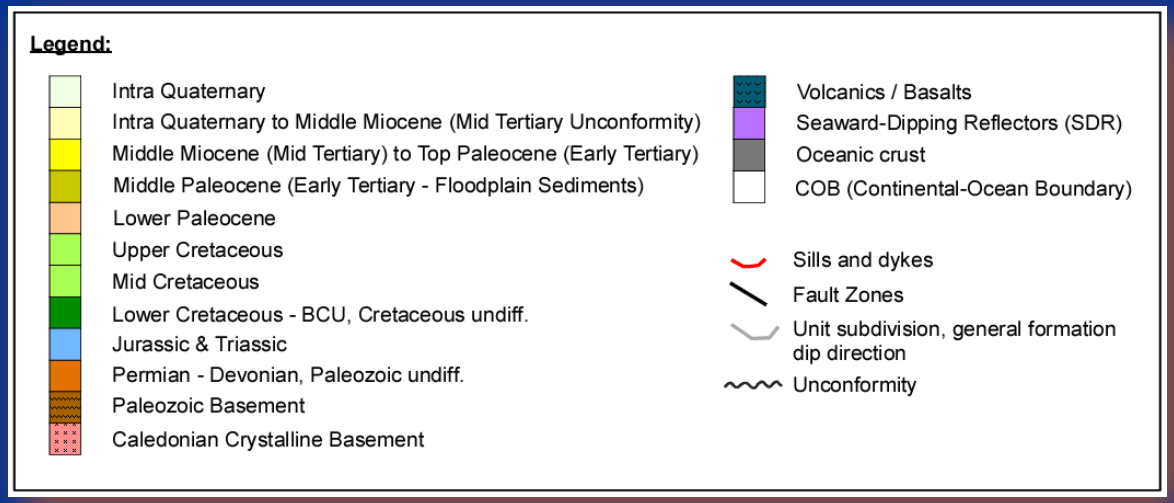

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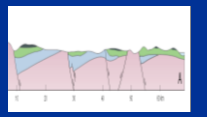
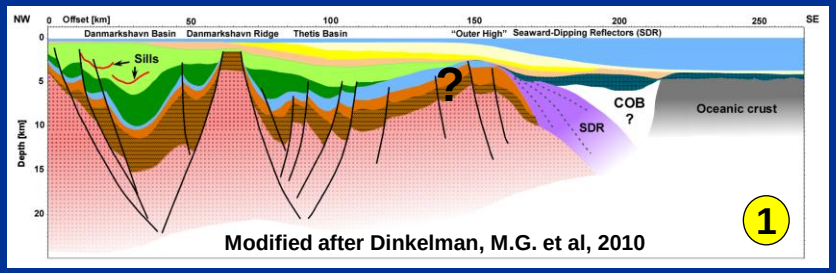
7 Wollaston Foreland



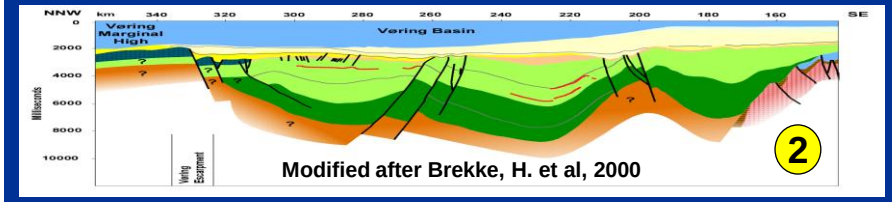
Modified after Henriksen, N. et al, 2009

Danmarkshavn & Thetis Basins



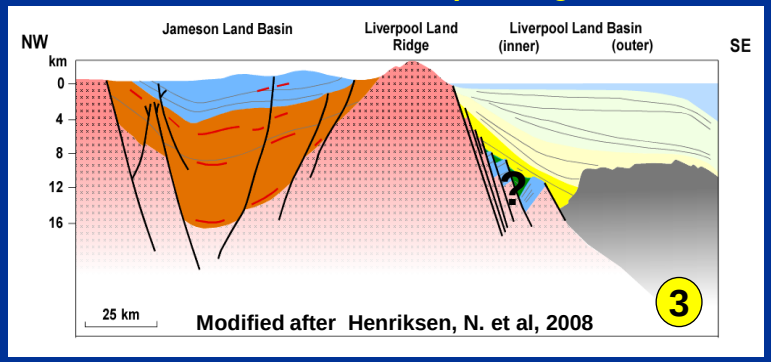
Modified after Dinkelman, M.G. et al, 2010

Møre Basin



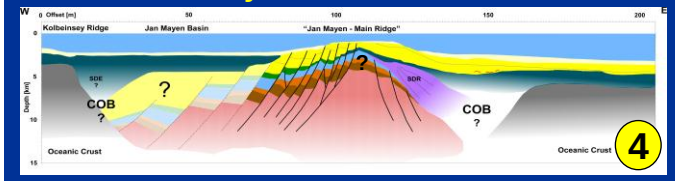
Modified after Brekke, H. et al, 2000

Jameson Land Basin, Liverpool High & Basin



Modified after Henriksen, N. et al, 2008

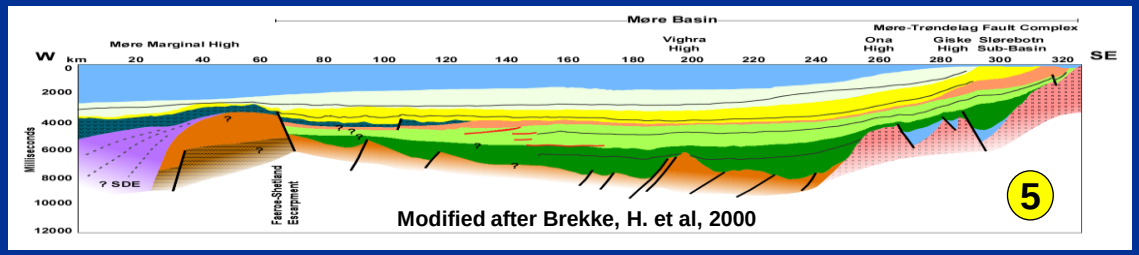
Jan Mayen Micro-Continent



10 km
50 km

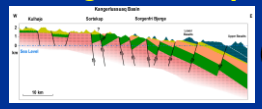
10 ms
50 km

Møre Basin



Modified after Brekke, H. et al, 2000

Kangerlussuaq



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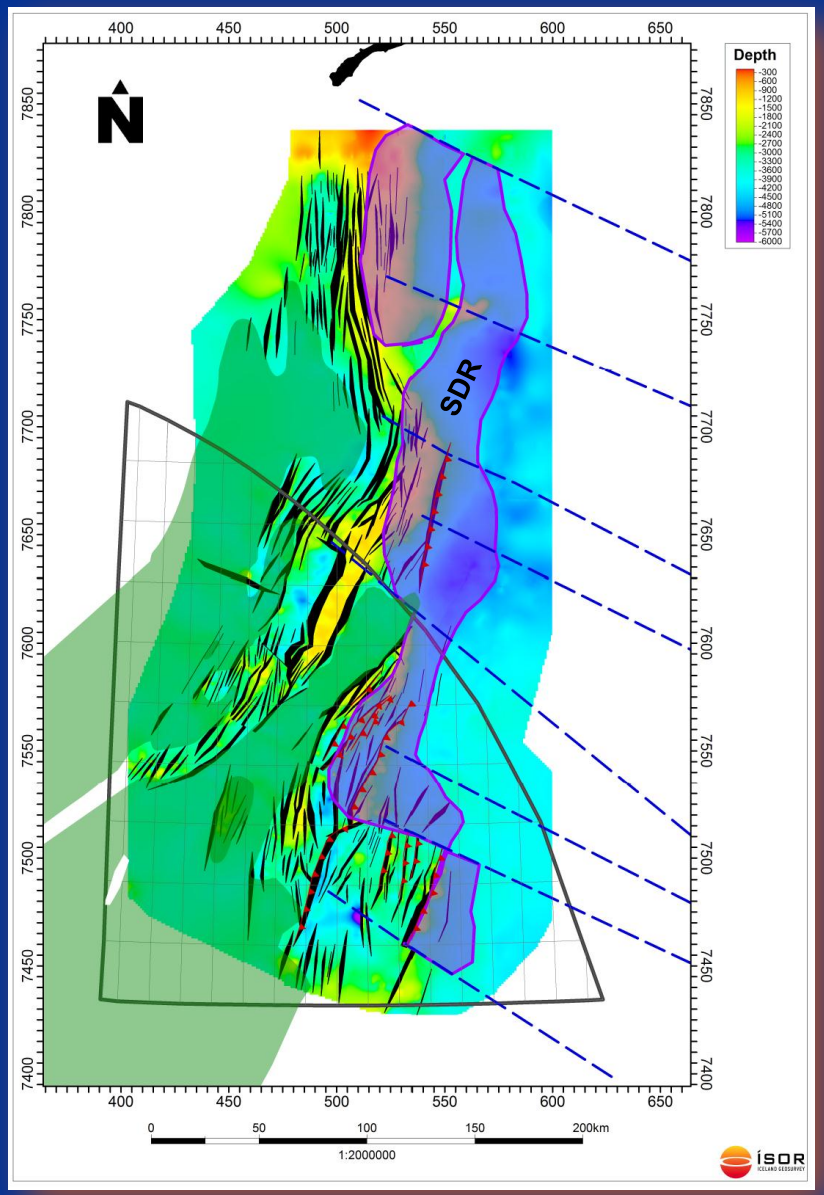
Modified after Henriksen, N. et al, 2008

Top Paleocene Structure Map
(Depth Range: 170m – 6100m)

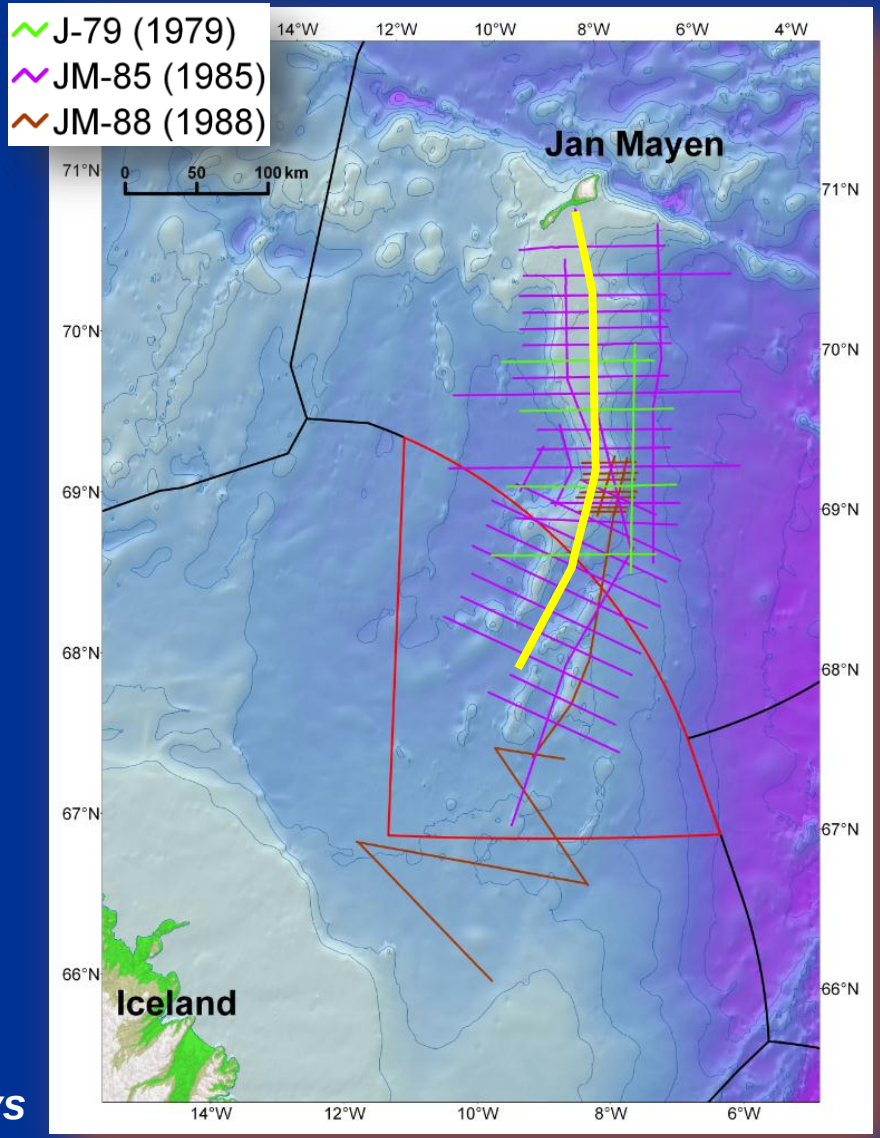
Structural Compartmentalization of the JMMC

- Early to Late Oligocene composite sheet of flat-lying intrusive covering subsided continental crust just before oceanic crust started to form on the Kolbeinsey Ridge and the Iceland Plateau.
- SDR (Seaward Dipping Reflectors)
- Important Fault / Fractures Zones that influence and subdivide the JMR.
- Top Paleocene Faults
- Minor reverse faulting visible (poss. since the Middle Miocene parallel the opening of the Kolbeinsey Ridge)



Conceptual model – seismic data comparison

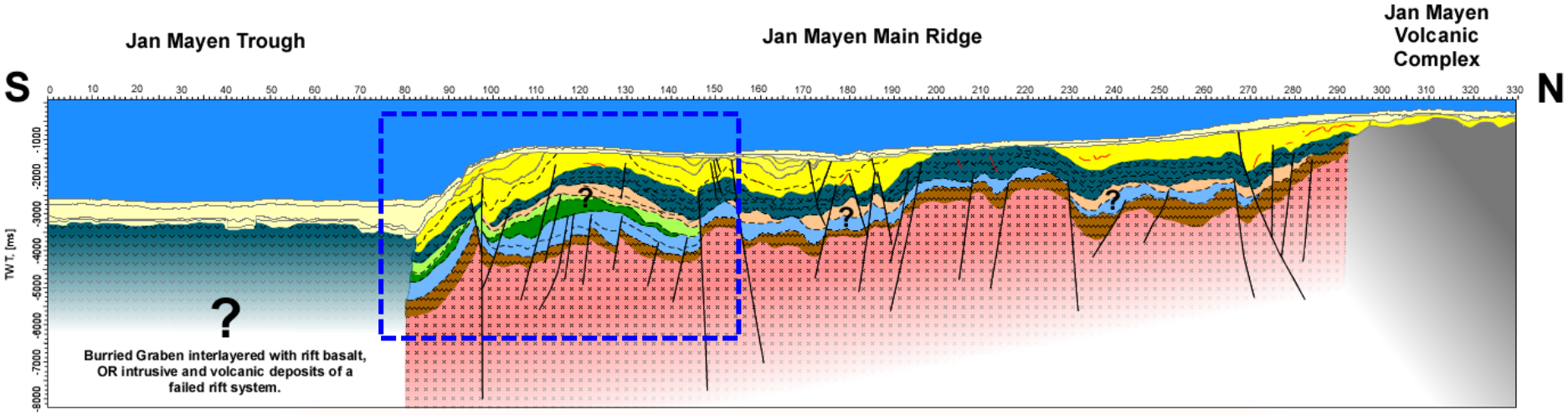
Key line interpretation at the JMMC



NPD-NEA Surveys

Conceptual model – seismic data comparison

Northern edge of the Dreki Licensing Area



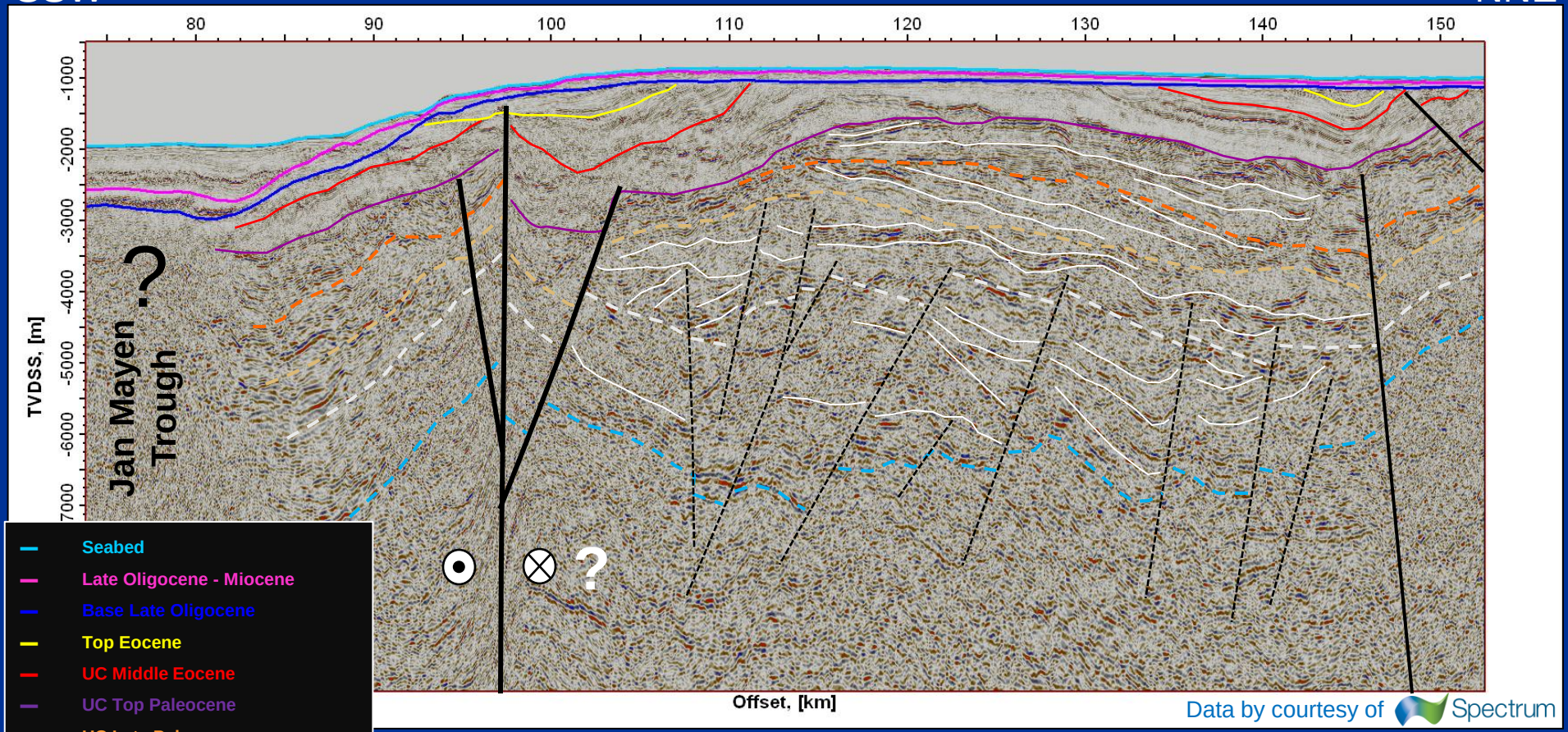
Legend:

- Intra Quaternary
- Intra Quaternary to Middle Miocene (Mid Tertiary Unconformity)
- Middle Miocene (Mid Tertiary) to Top Paleocene (Early Tertiary)
- Middle Paleocene (Early Tertiary - Floodplain Sediments)
- Lower Paleocene
- Upper Cretaceous
- Mid Cretaceous
- Lower Cretaceous - BCU, Cretaceous undiff.
- Jurassic & Triassic
- Permian - Devonian, Paleozoic undiff.
- Paleozoic Basement
- Caledonian Crystalline Basement
- Volcanics / Basalts
- Seaward-Dipping Reflectors (SDR)
- Oceanic crust
- COB (Continental-Ocean Boundary)
- Sills and dykes
- Fault Zones
- Unit subdivision, general formation dip direction
- Unconformity

New 2D Seismic Quality Data = More Possibilities for Data Interpretation

Possible Sub Tertiary unconformities become better visible below the Top Paleocene

SSW NNE



Data by courtesy of Spectrum

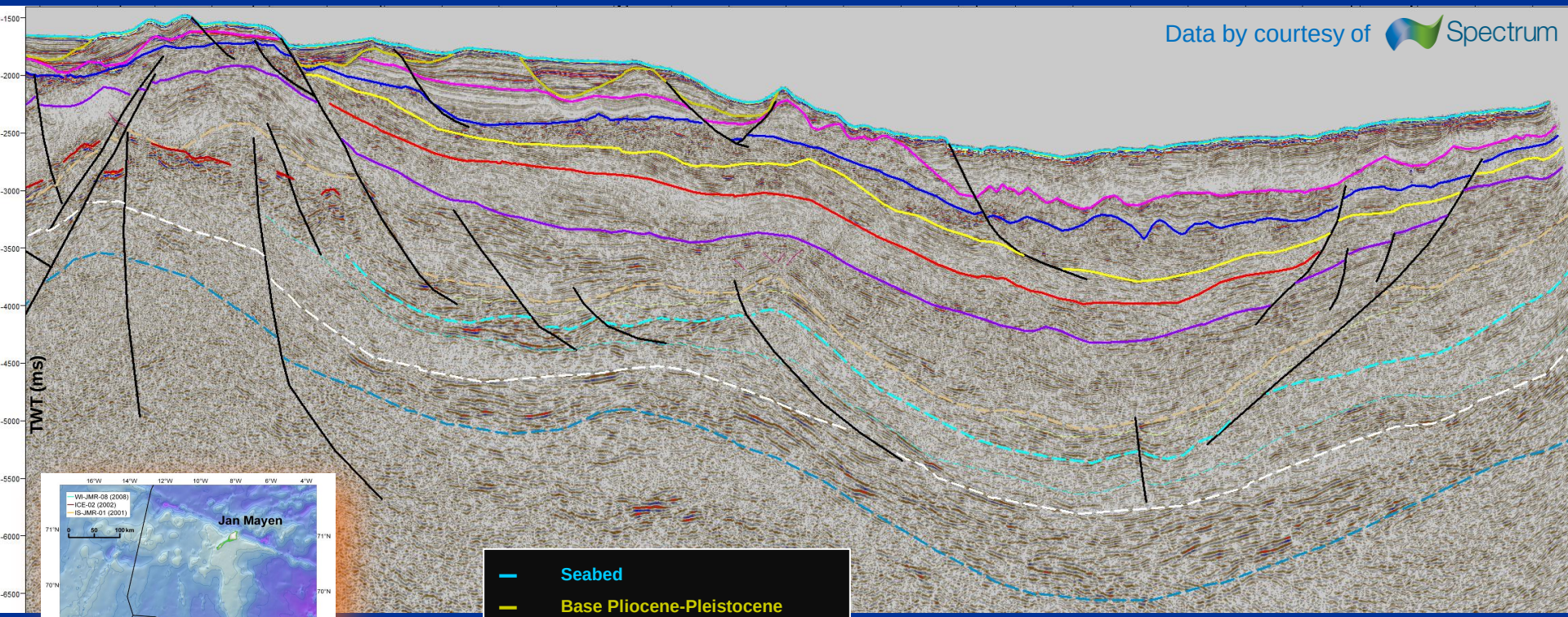
Conceptual model – seismic data comparison

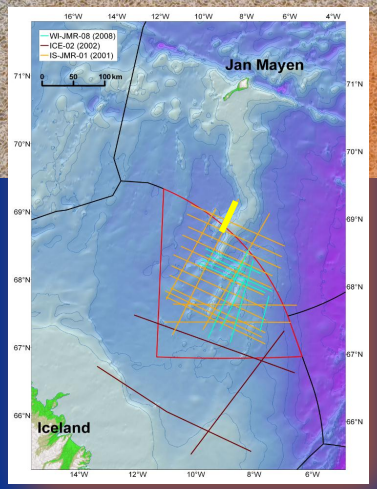
Northern edge of the Dreki Licensing Area

SSW

NNE

Data by courtesy of Spectrum



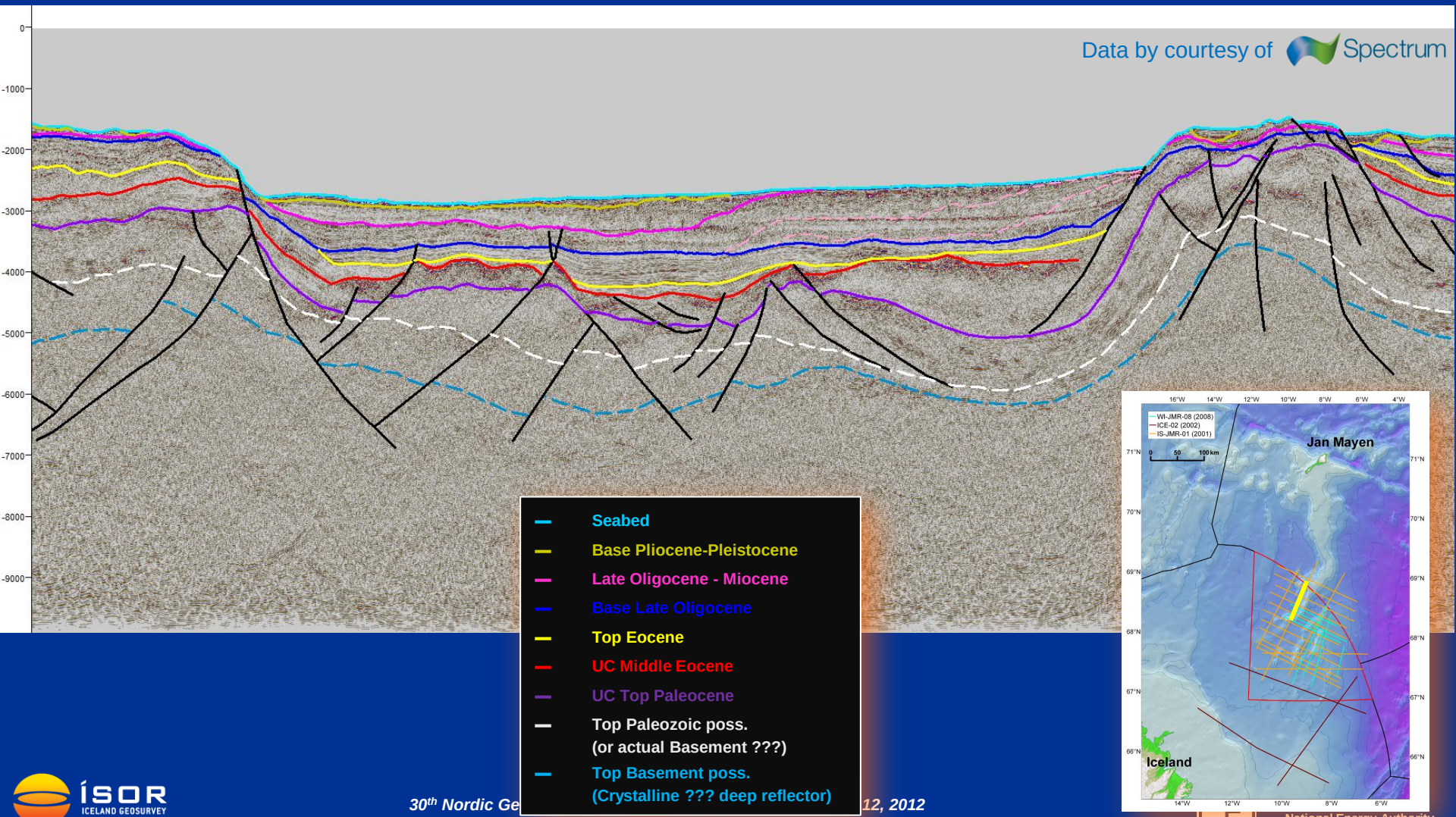


- Seabed
- Base Pliocene-Pleistocene
- UC Late Oligocene - Miocene
- UC Base Late Oligocene
- Top Eocene
- UC Middle Eocene
- UC Top Paleocene
- Top Paleozoic poss. (or actual Basement ???)
- Top Basement poss. (Crystalline ??? deep reflector)

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

Conceptual model – seismic data comparison

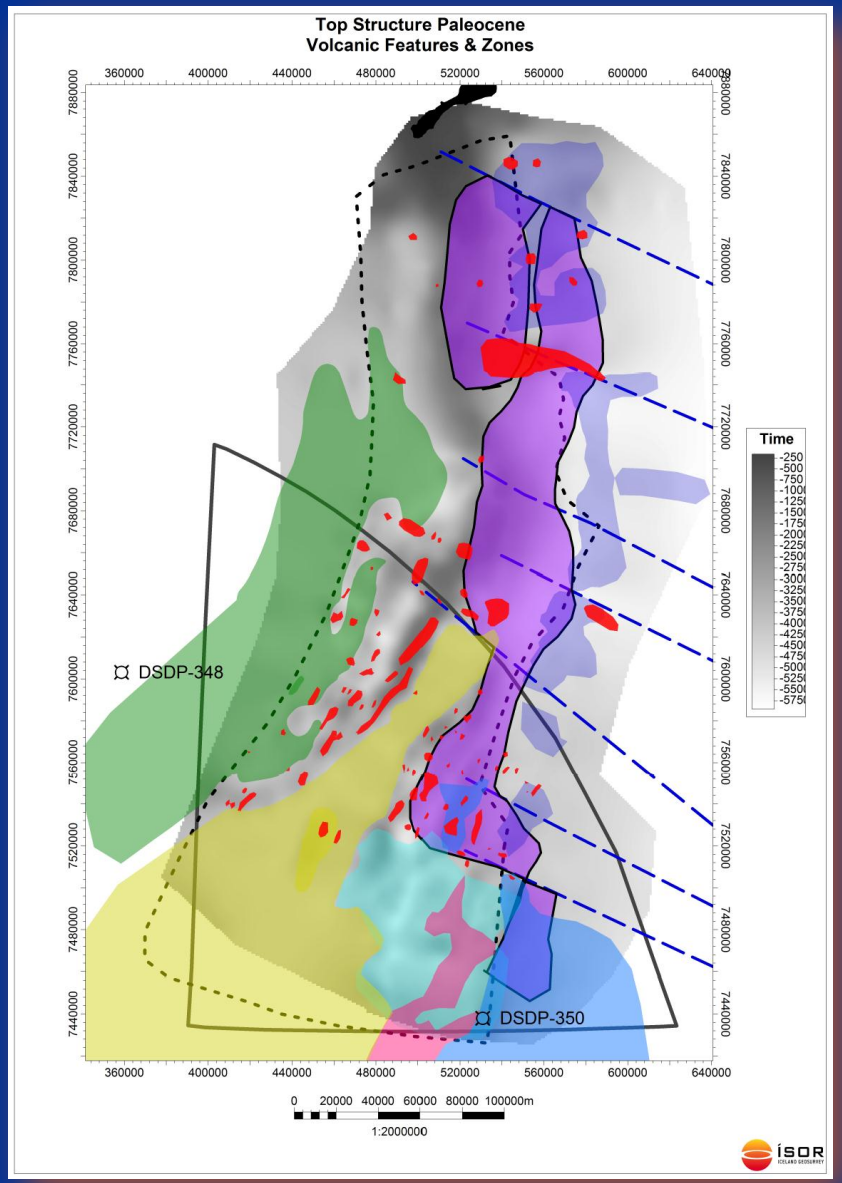
Northern edge of the Dreki Licensing Area



Volcanic Zones of JMMC

Possible scenario

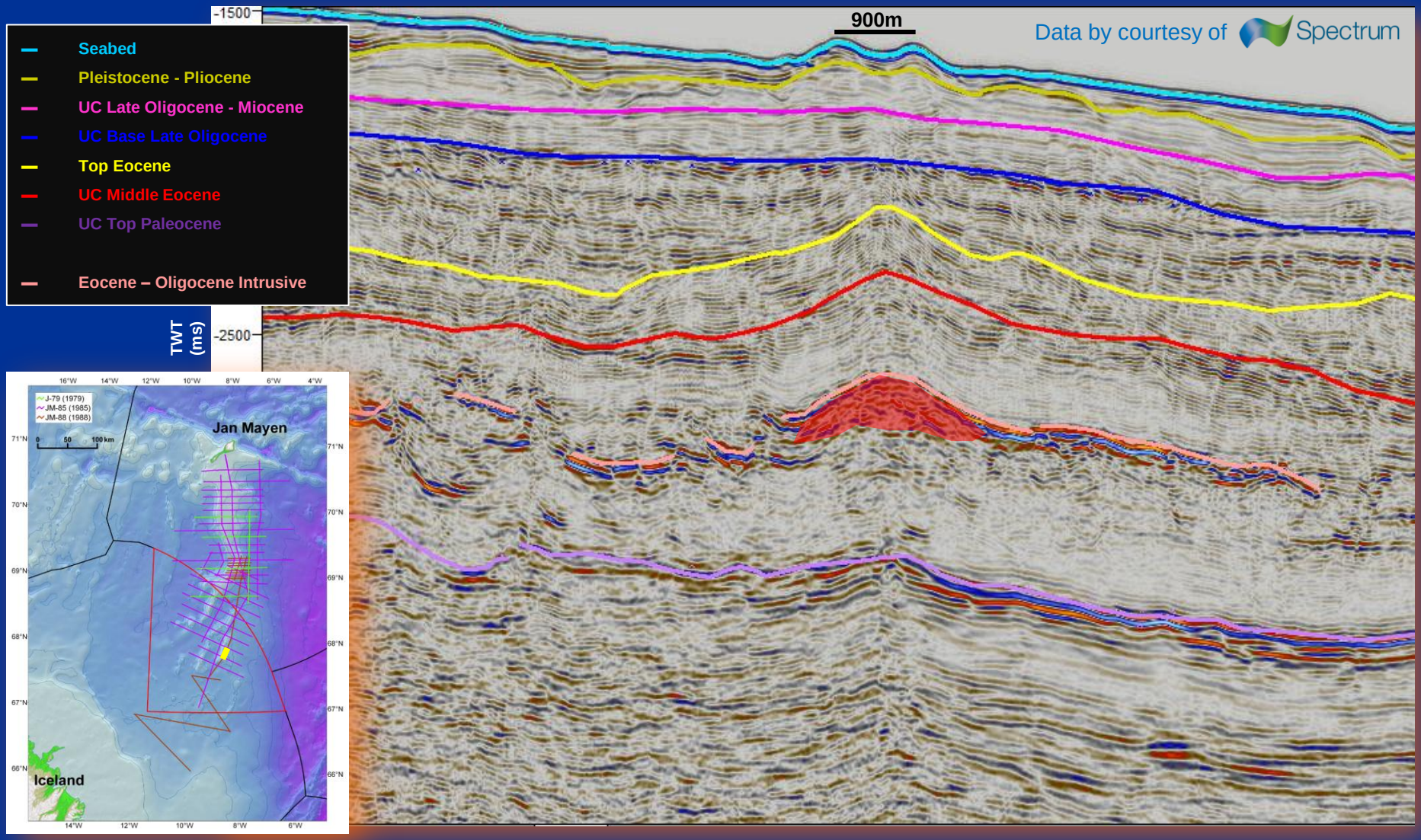
- SDR (Seaward Dipping Reflectors)
- Poss. post break-up, larger intrusions
- Volcanic complexes poss. just above the top Paleocene marker
- 44-40Ma Anomaly 19-20 Basalt province
- Probably oceanic ridges / transition area
- Possible Rift area between Anomalies 20 & 13
- Jan Mayen Trough shallow intrusions
- Early to Late Oligocene composite sheet of flat-lying intrusive (Anomalies >6)
- Important Fault / Fractures Zones that influence and subdivide the JMR.



Seismic data – Timing of Intrusions

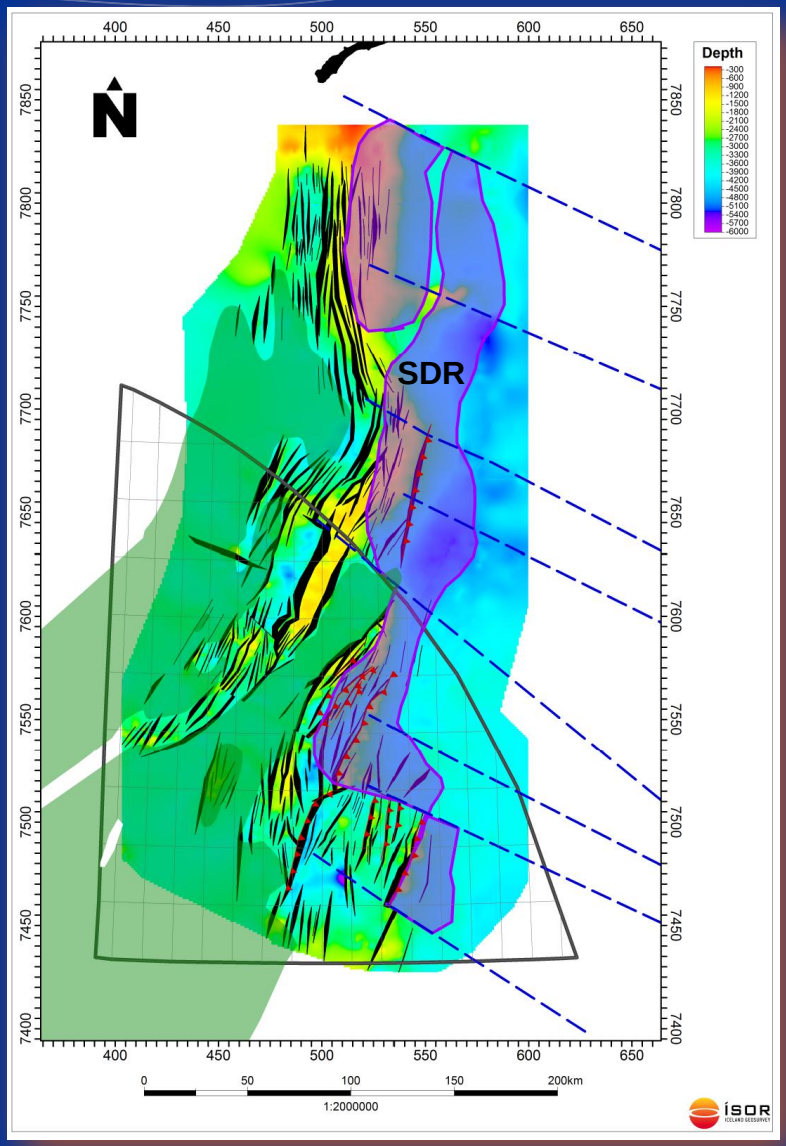
SSW

NNE



Exploration risk factors for prospectivity

- Data – Interpretation certainty
- Pre-Tertiary Strata – Reservoir & Source
- Post-Paleocene Strata – Reservoir & Seal
- Heat Flow – Maturity of Source Rock
- Structure & Timing – Trap & Seal
- Depth & Location – Accessibility



Top Paleocene Structure map, shallow intrusion (green ploy.)

Risk mitigation
for a better understanding of the Jan Mayen Ridge area

- More NNE-SSW 2D seismic lines and denser line grid over areas of interest for a better structural and facies interpretation

  (*NPD is conducting an infill 2D seismic survey that also crosses into Icelandic waters 2011 & 2012.*)

- High resolution magnetic and gravity survey across the complete area of the Southern Ridge complex

  (*NGU is flying a high resolution aerial magnetic survey close east to JMR in 2012.*)

- Additional sea floor sampling campaign (core, grab or dredge sampling) along seismic lines on the western flank of the ridge, preferably on steep ridge flanks that expose older strata.

  (*NPD has completed a ROV sampling campaign in 2011, researching presently the results. VBPR-TGS has completed their sampling campaign in 2011, presently researching the results, open for purchase in February 2012.*)

Risk mitigation
for a better understanding of the Jan Mayen Ridge area

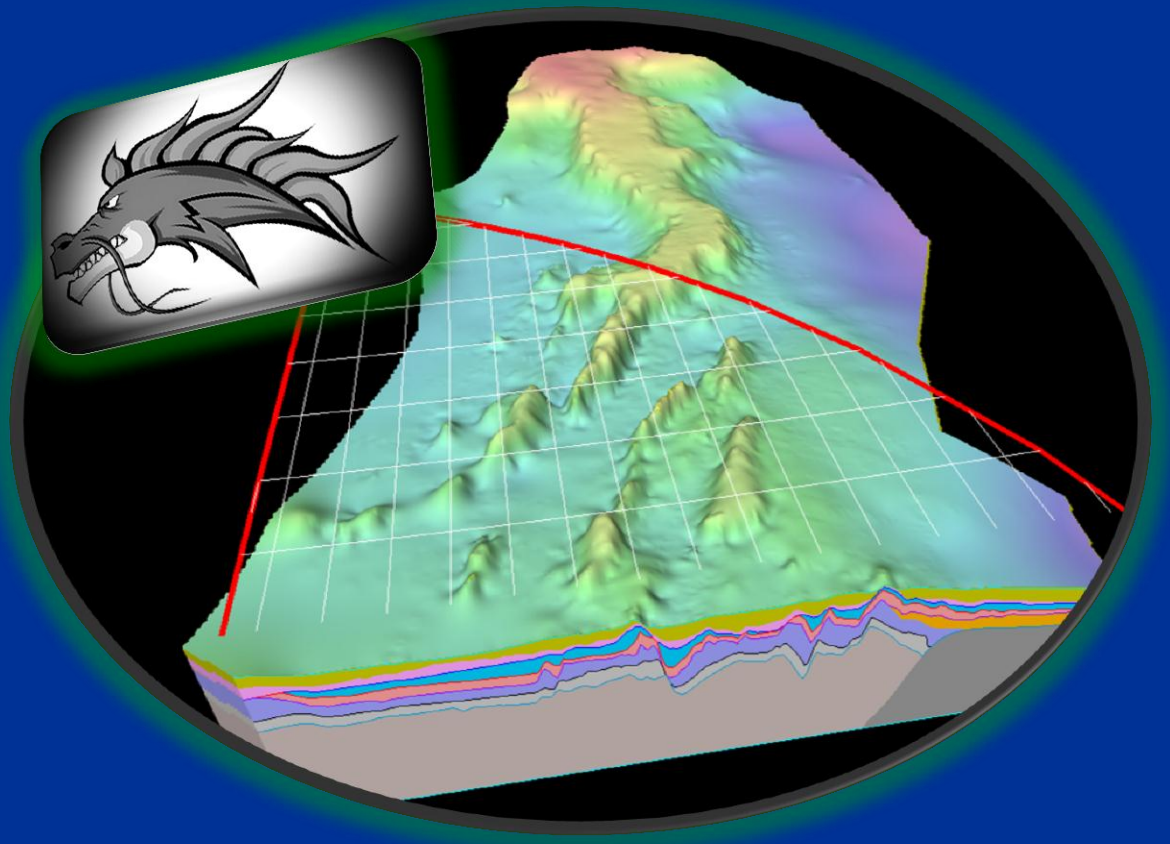
- Basin modeling study using more recent (e.g. Rey, 2003) geothermal gradient model, estimating degree of maturity assuming that source rocks are present, also in direct comparison with studies that have been done for the Jameson Land Basin area in East Greenland.

- New long offset and low frequency 2D seismic survey along the outer coast of the "***Scoresby Sund***" and "***Blosseville Kyst***" along the East-Greenland coast, where the western end of the possible Jan Mayen Basin lies.

- Possibly conduct a more detailed "outcrop" study at the steep Jan Mayen ridges of the southeastern ridge complex to support analogue comparison studies between the JMMC and the Møre basin for the sub-basalt formations, especially for the Mesozoic aged formations.

- Deep stratigraphic well in the shallower waters into the Main Ridge high, to show if a Mesozoic or Paleozoic strata exists of sufficient thickness and quality – or if the complex structures and patterns correspond to primarily intrusive complexes.

Thank you very much for your attention !



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