



Triassic Development & Hydrocarbon Potential in the North-Eastern Barents Sea

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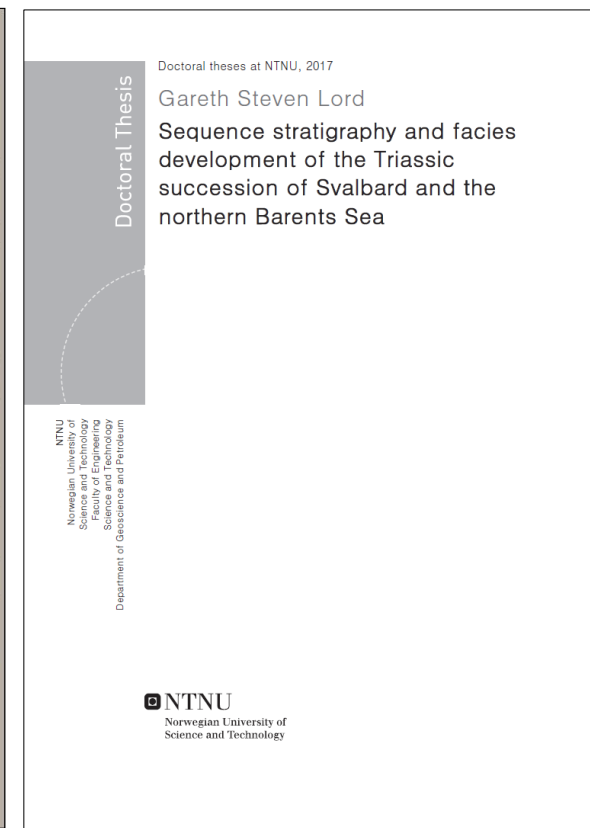
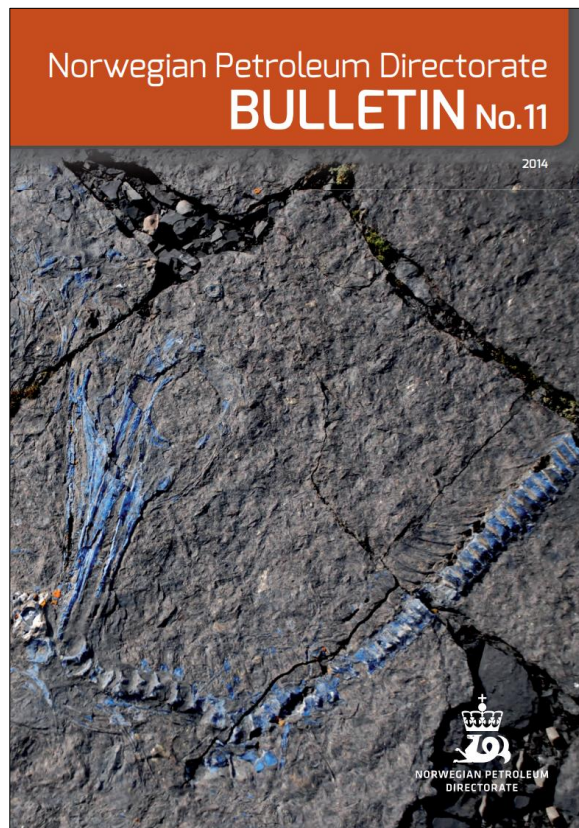
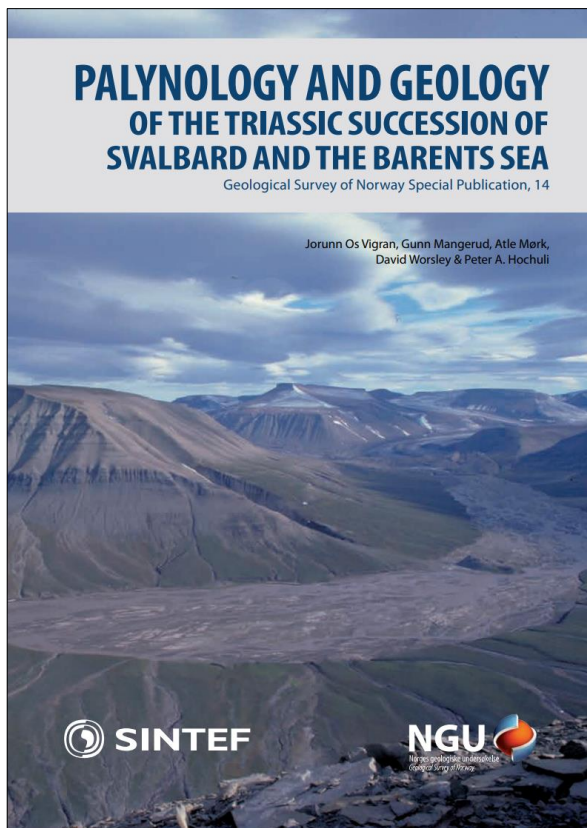
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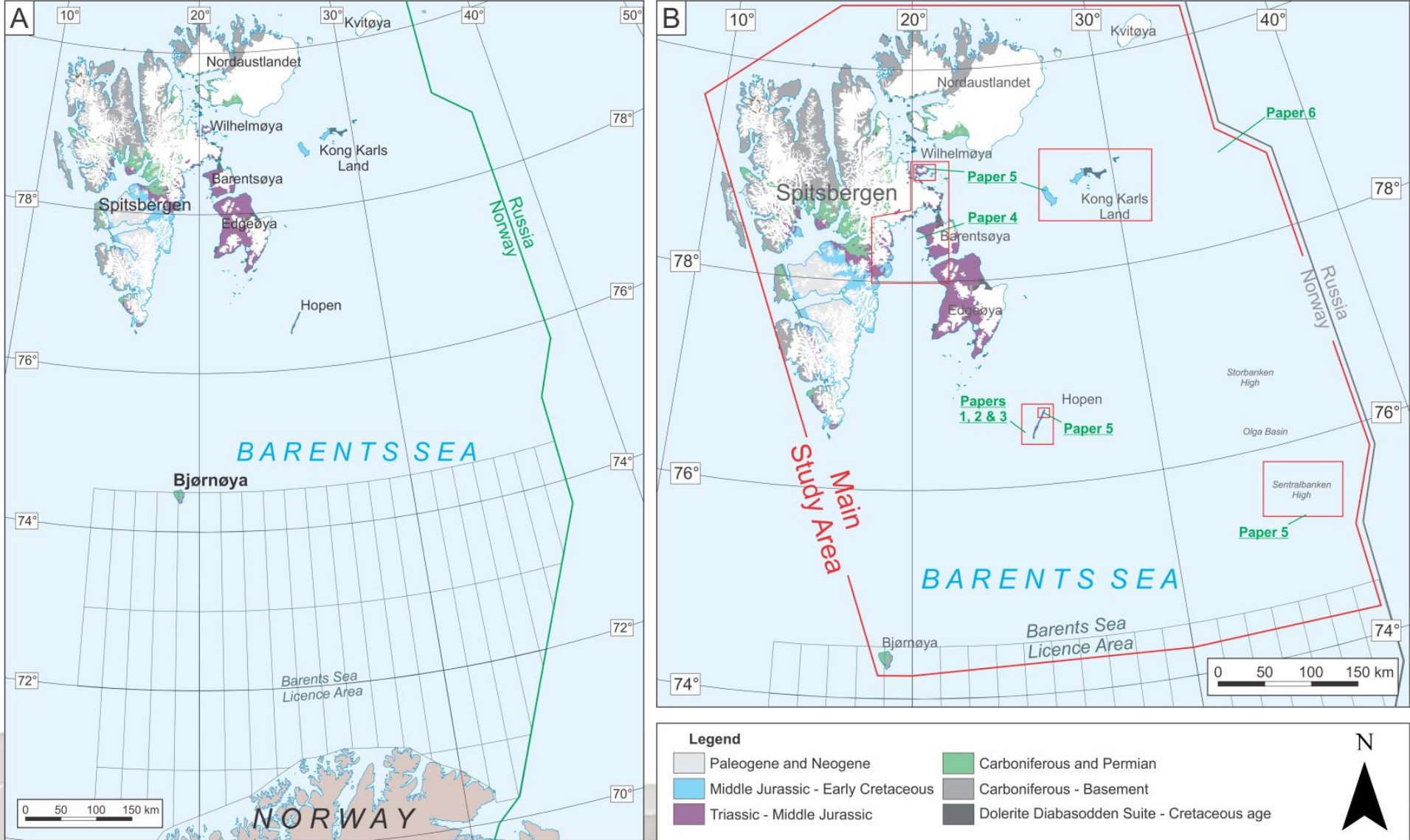
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The Northern Barents Sea



The Northern Barents Sea

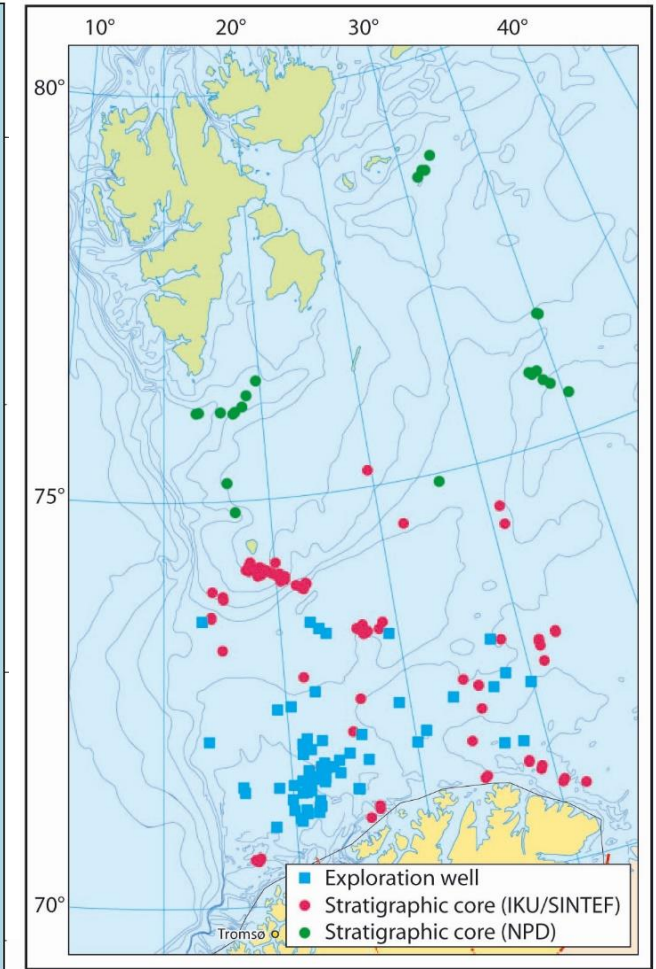
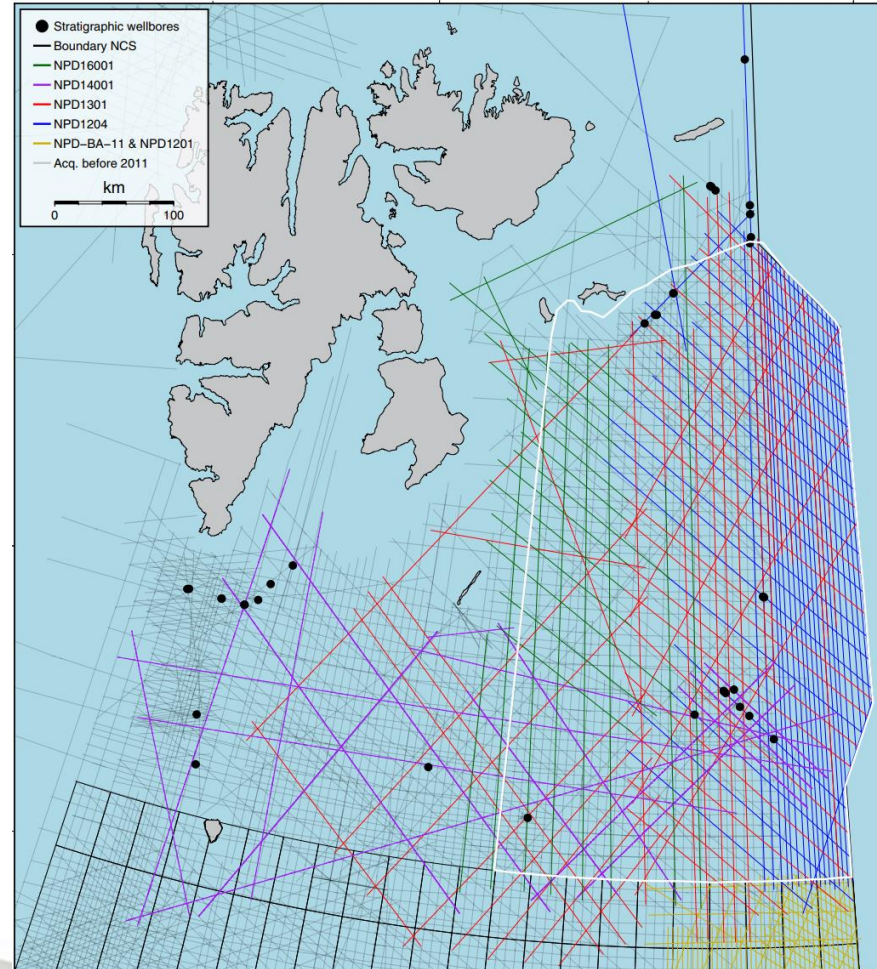


Lord, 2017

Dataset: Offshore



- Extensive exploration well and stratigraphic core database in Southern Barents Sea
- Limited data availability in Northern Areas
 - Primarily IKU/SINTEF and NPD wells
- Limited seismic coverage
 - Poorly resolved 2D datasets from 1970's – 2016
 - 70,000 km from 1970-1996
 - Ca. 39,000 km since 2012
- Poor resolution of seismic data towards Svalbard
 - Hard sea floor
 - Dolerites (Diabasodden Suite, Cret)



Barents Sea North, 2017

Dataset: Onshore



- Detailed sedimentological data collected from Svalbard since the early 1970's
- Augmented by successive generations of geologists and students working in eastern Svalbard
 - Sample collection
 - Biostratigraphy
 - Magnetostratigraphy
 - Palynology
 - Mineralogy & Provenance





**Paleogeography Paleoenvironment
Paleoclimate**

Paleogeography

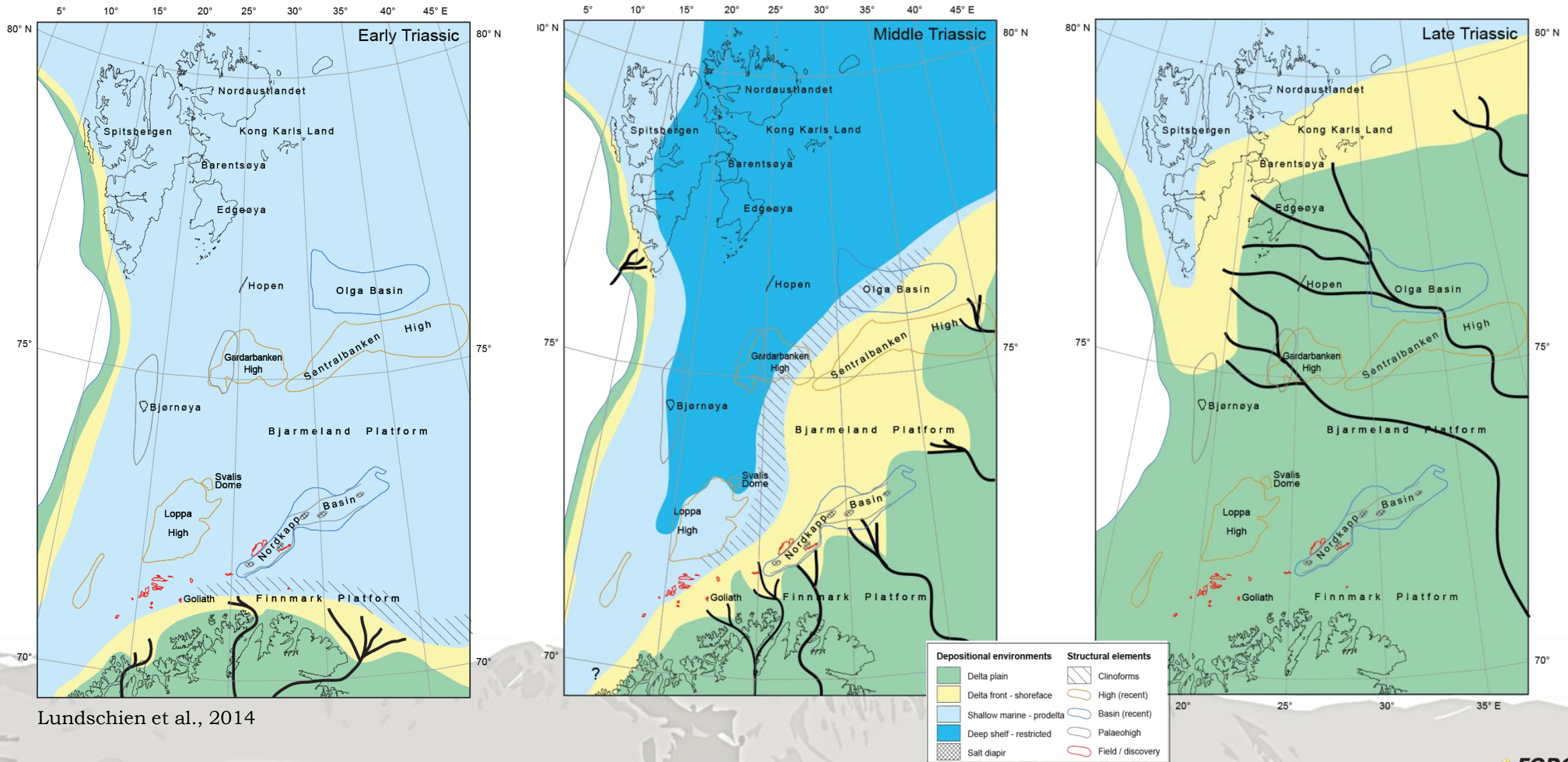


- Barents Shelf situated in a shallow 'embayment' in the northern end of Pangea during the Triassic.
- Surrounded by upland areas of Laurentia (Greenland), Baltica (Fennoscandia) and the Siberian plate.
- Progressive infilling of the 'bay' throughout the Triassic lead to the deposition of open marine shales and paralic deltaic deposits.
- Sediment predominantly derived from Uralide and Timmanide mountains with pulses from zones of active tectonics e.g. Novaya Zemlya.



Torsvik

Paleogeography

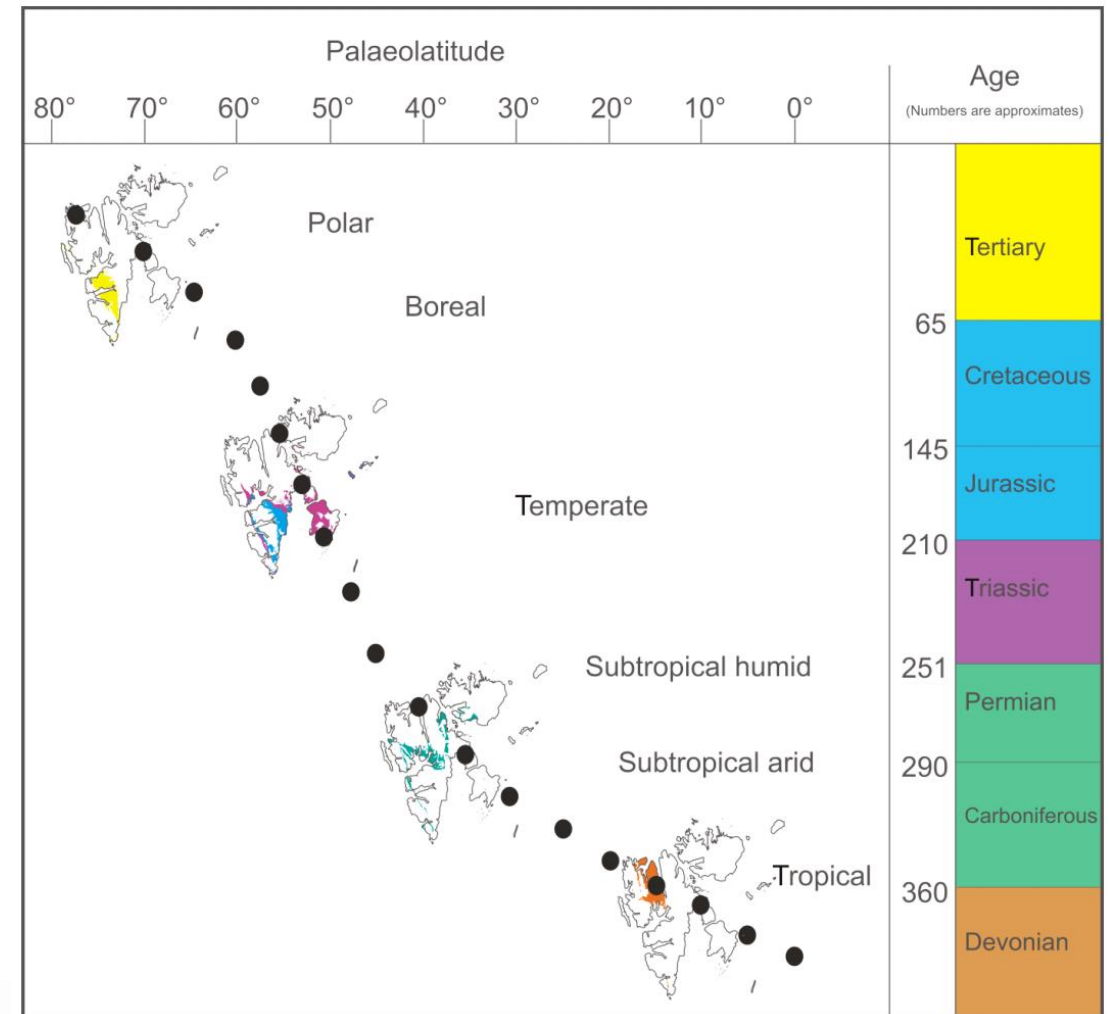


Lundschie et al., 2014

Paleoclimate



- Svalbard and the northern Barents Sea's position has slowly migrated from equatorial to polar since the Devonian.
- Rapid northwards migration from 360-250 Ma.
- Slow stable position during Mesozoic 250-65Ma.
 - Forms the grounds of the tectonically inactive Triassic argument.
- Rapid northwards migration during the onset of the breakup of Pangea and North Atlantic opening.



After Elvevold, 2007

Paleoenvironment - Temperate



Blanknuten, Edgeøya



Russevika, Hopen

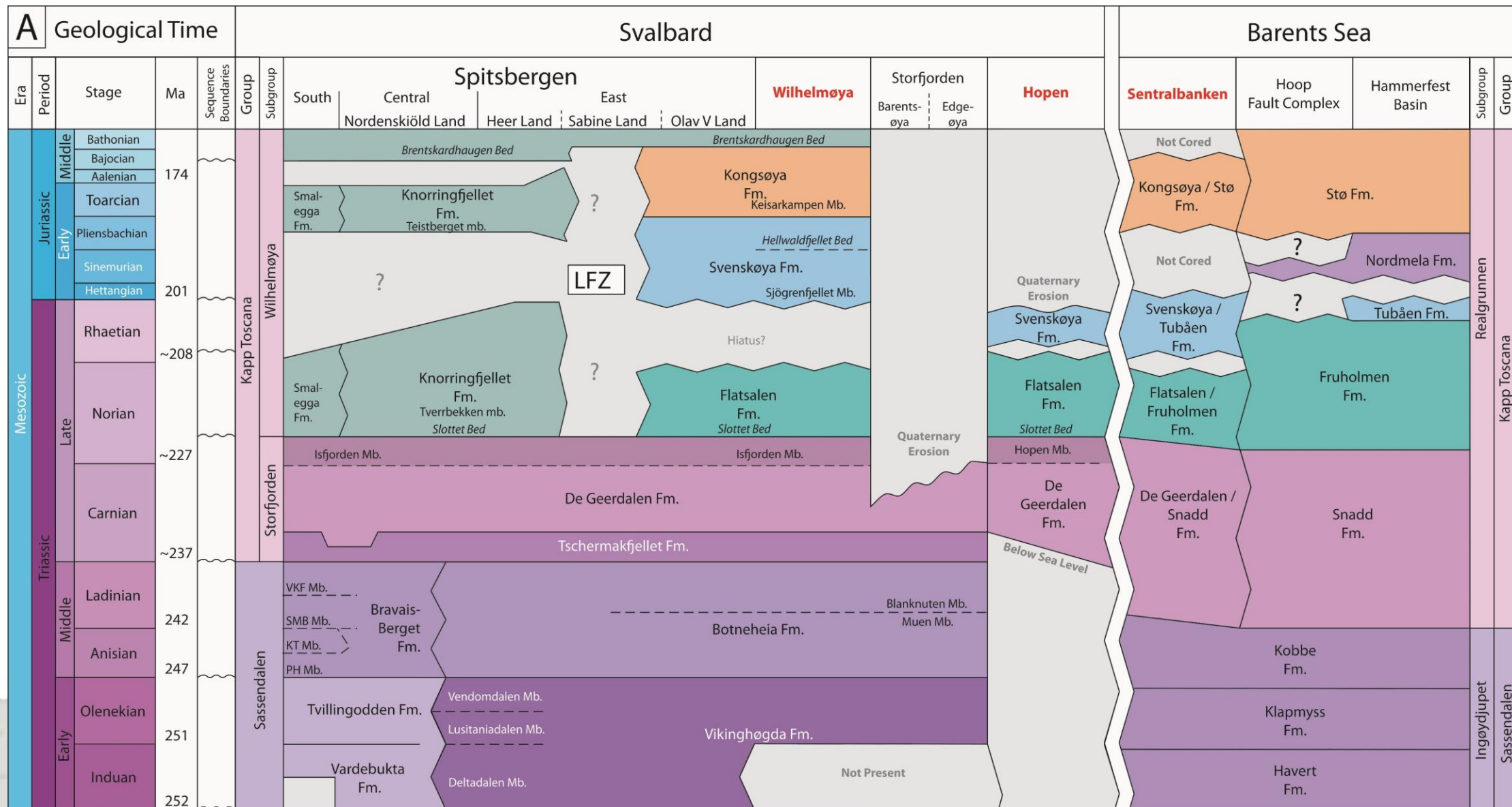
Paleoclimate – Temperate to Arid Shift?



The background of the slide features a film strip at the top, with a series of rectangular frames. Below the film strip is a large, textured, layered surface that resembles a geological cross-section or a stratigraphic column. The layers are depicted in various shades of brown and tan, with some areas appearing more porous or fibrous. The overall aesthetic is that of a technical or scientific presentation.

Offshore Stratigraphy & Architecture

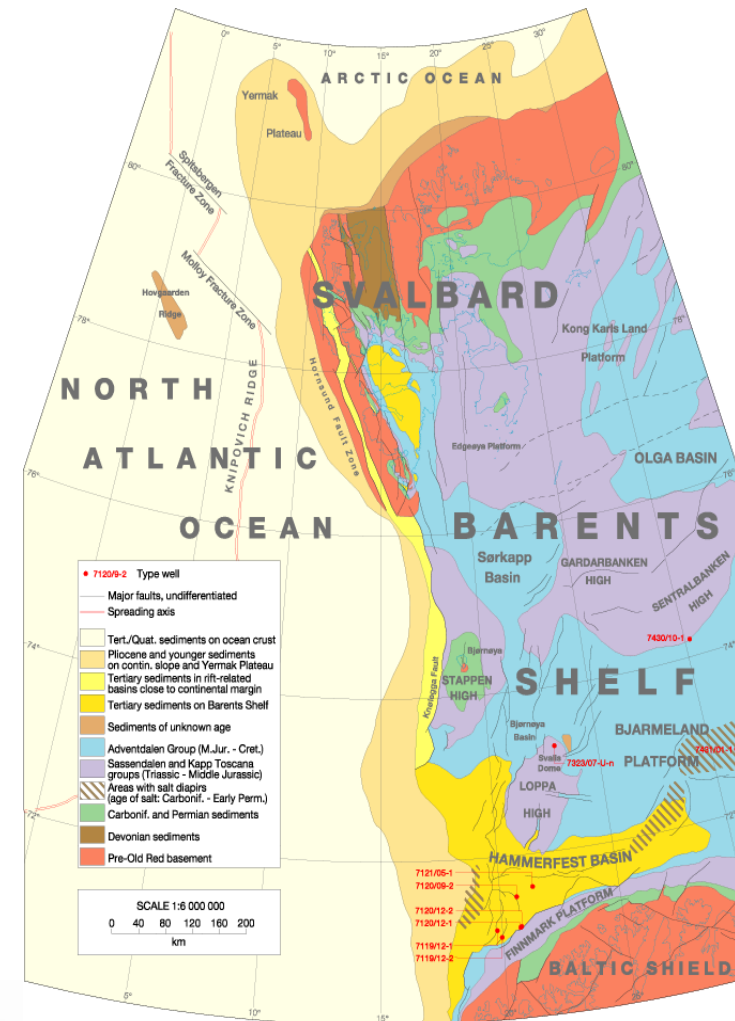
Offshore Stratigraphy



The Northern Barents Sea



- Triassic – Middle Jurassic succession thins towards Svalbard.
- Transpressional regime during the Cenozoic and glacial rebound has resulted in Triassic and Jurassic sub-crops over large areas of the Barents Shelf.
- Extensive exposures of Triassic to Middle – Jurassic strata in eastern Svalbard.

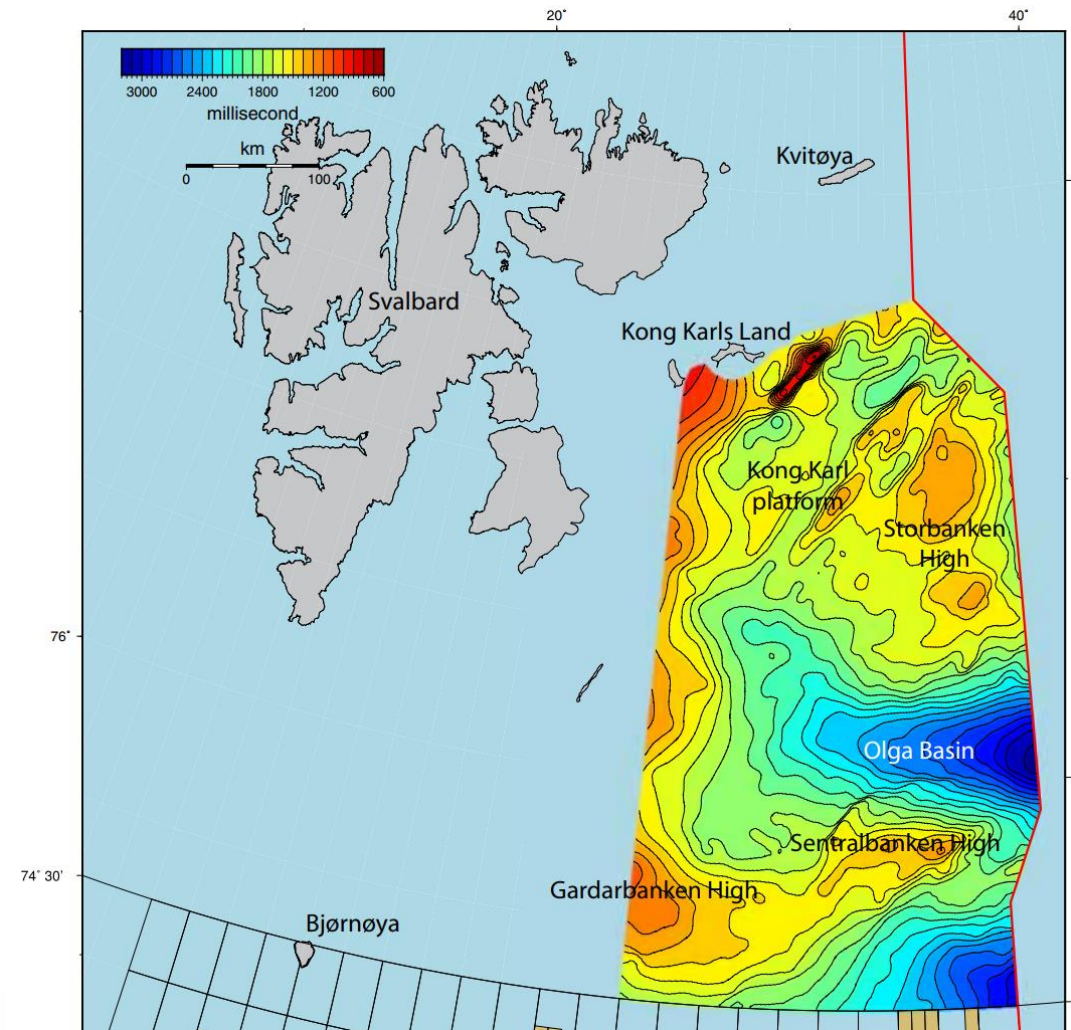


Dallmann, 1999

Offshore Architecture

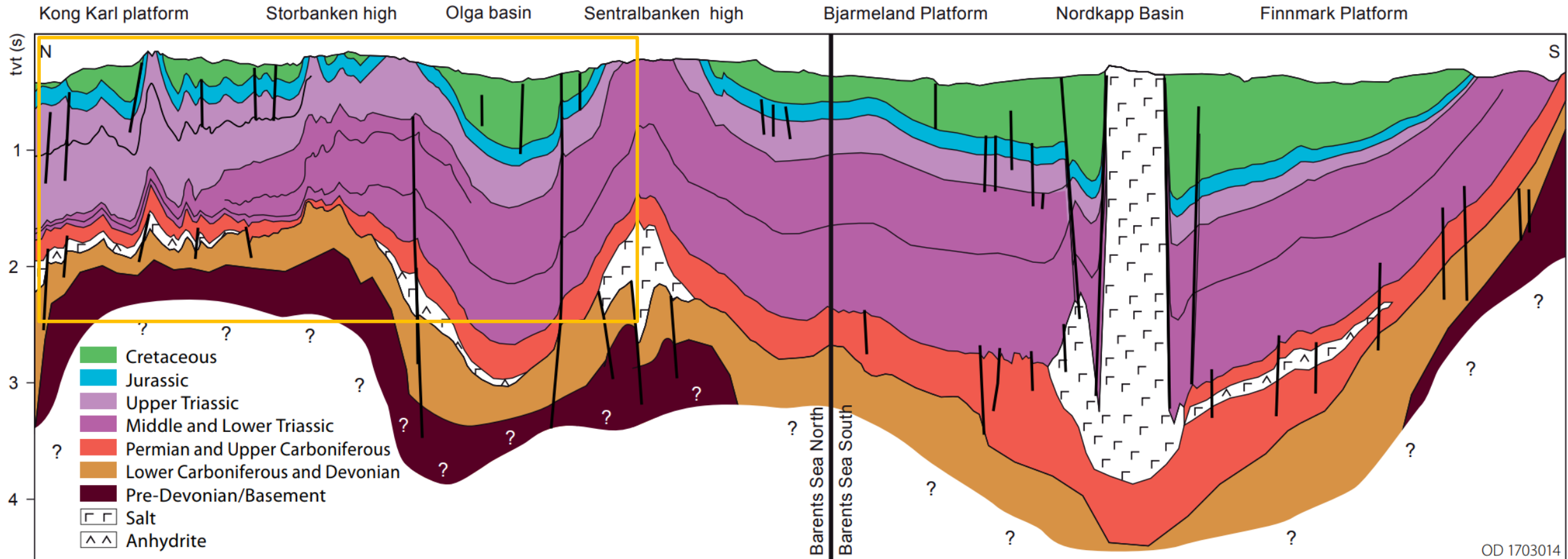


- The north-eastern Barents sea features a series of basins and highs. That typically follow a NE-SW structural trend.
 - Gardarbanken High
 - Sentralbanken High
 - Olga Basin
 - Storbanken High
 - KKL Platform
 - 'Edgeøya platform'
 - Svalbard Platform
- Regional dip is towards the NW exposing oldest rocks in northern Svalbard.



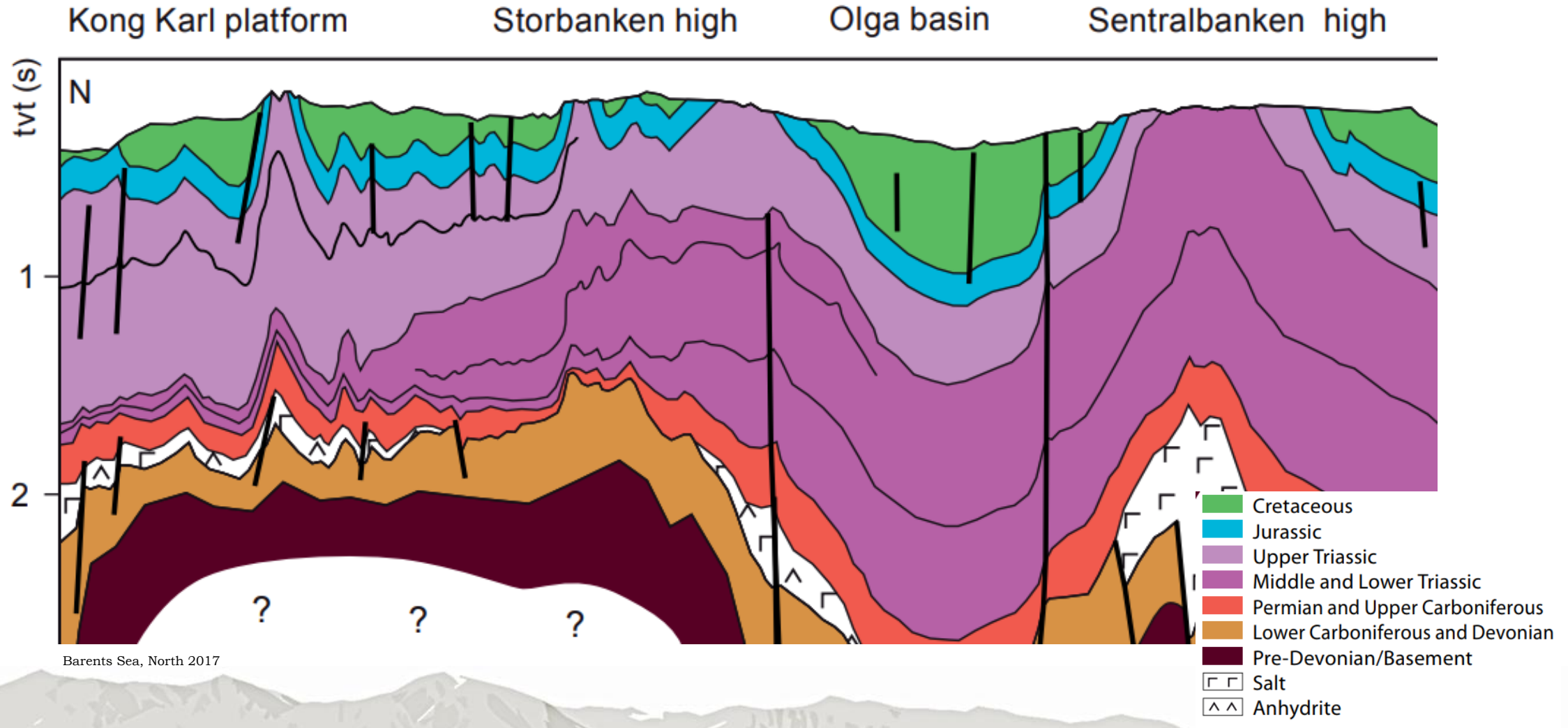
Barents Sea North, 2017

Offshore Architecture

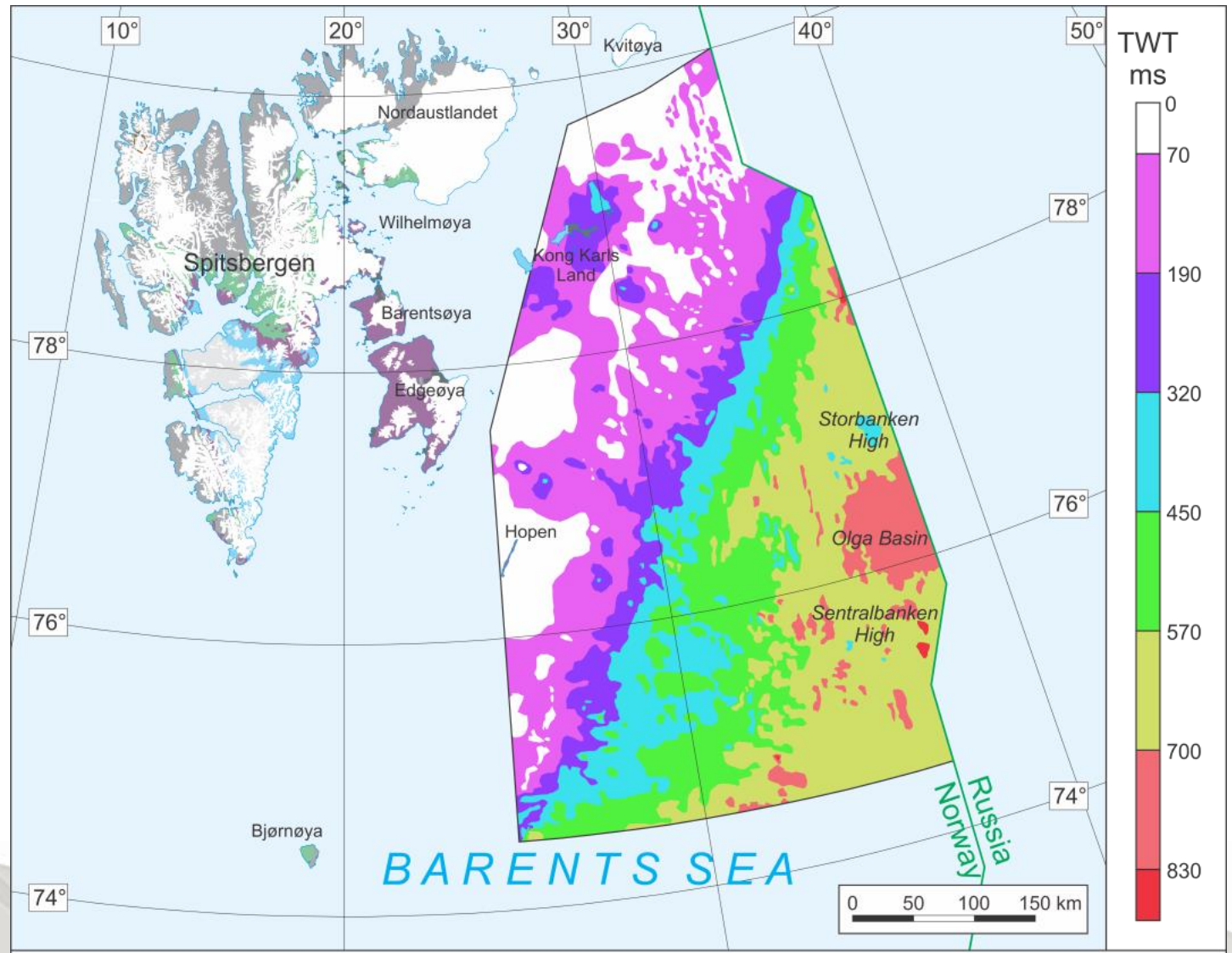
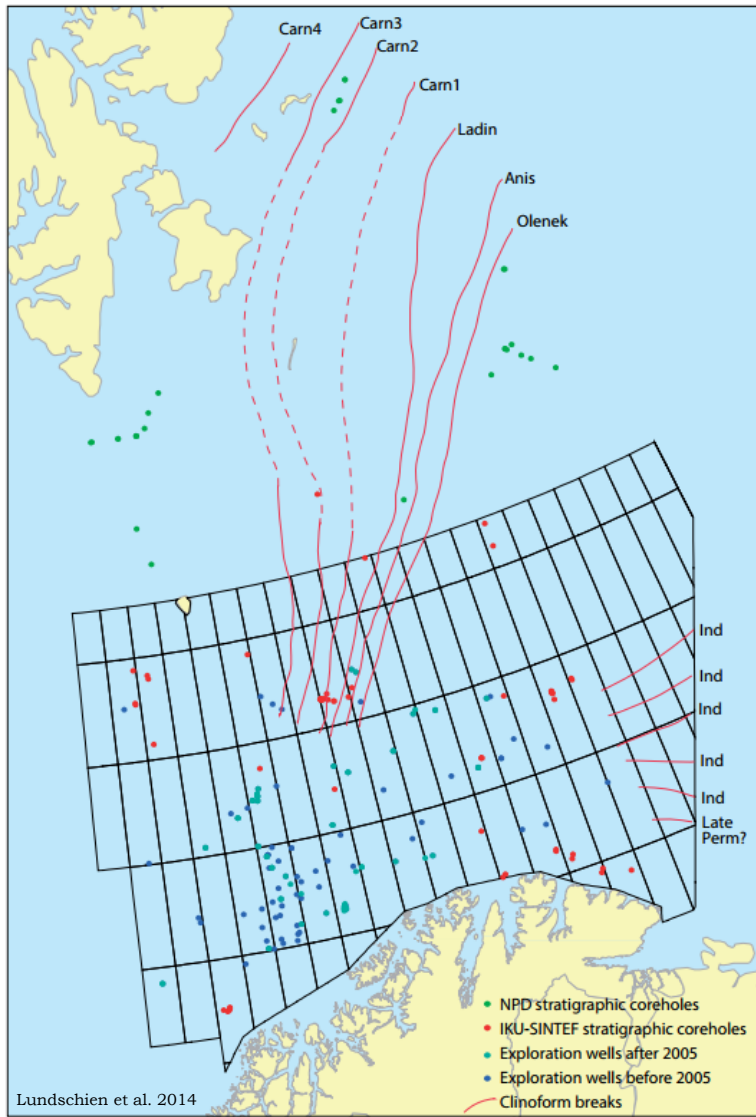


Barents Sea North, 2017

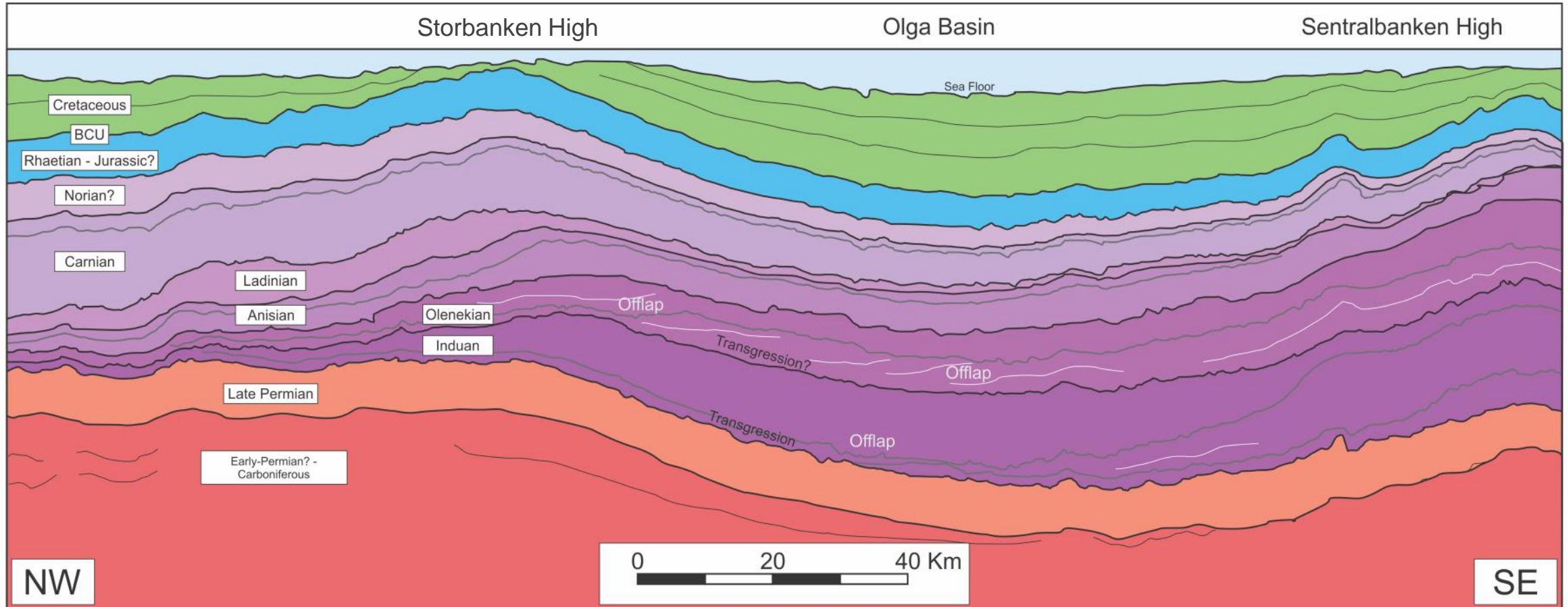
Offshore Architecture



Offshore Architecture

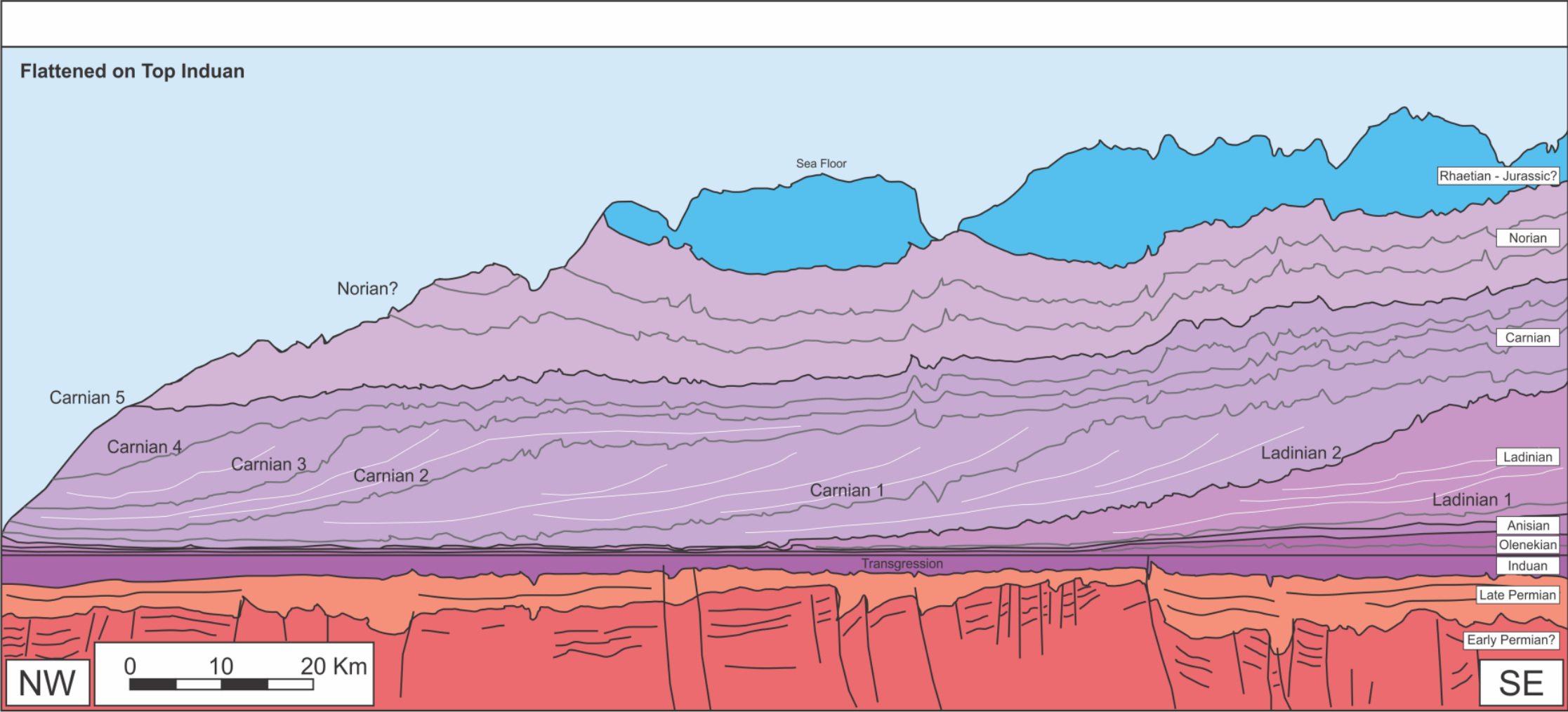


Offshore Architecture



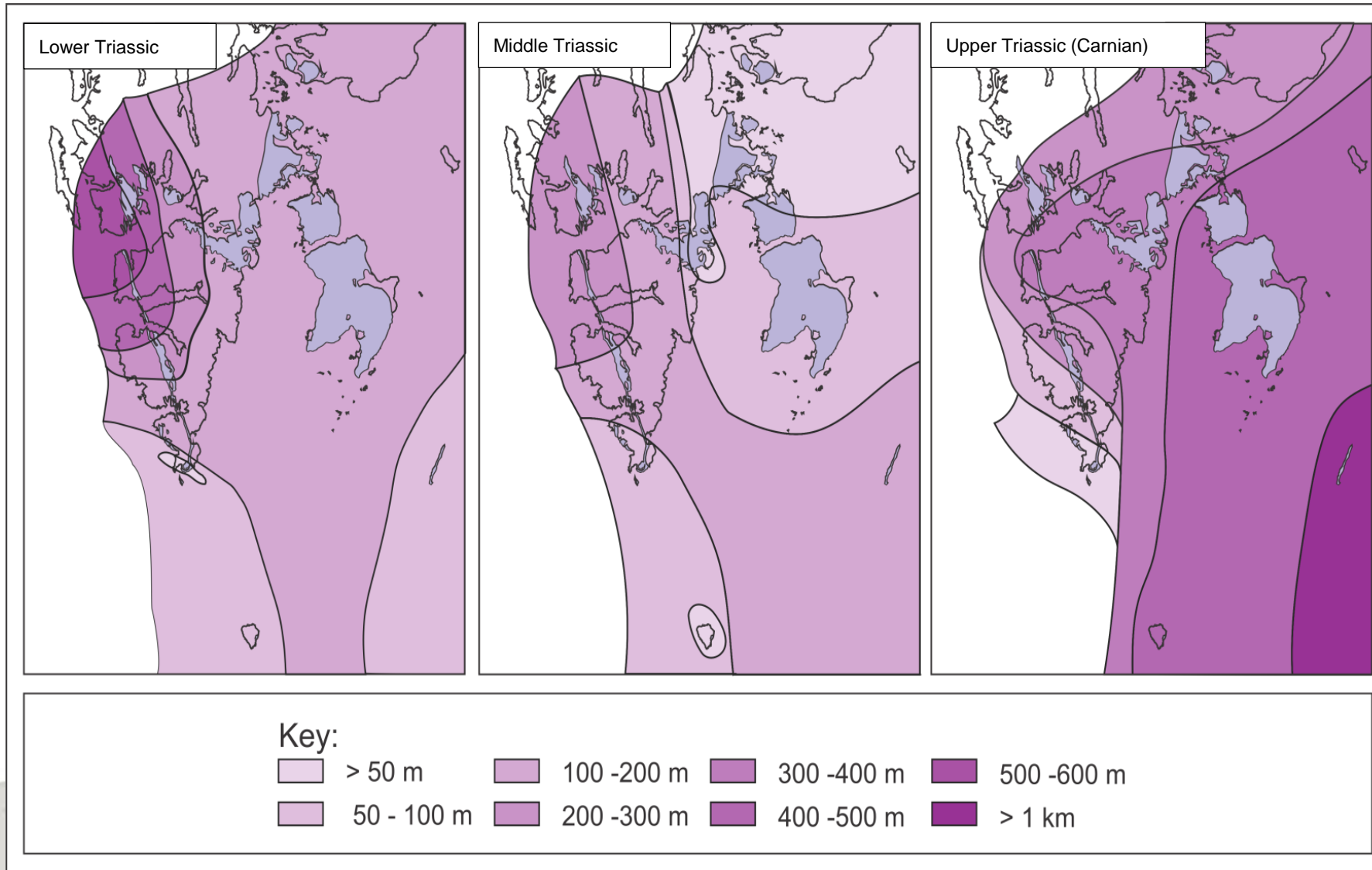
Lord et al. in prep, Lord 2017

Offshore Architecture



Lord et al. in prep, Lord 2017

Triassic Thickness Development



Lord et al. in prep.



Onshore Stratigraphy & Facies Development

Stratigraphy – Lower & Middle Triassic

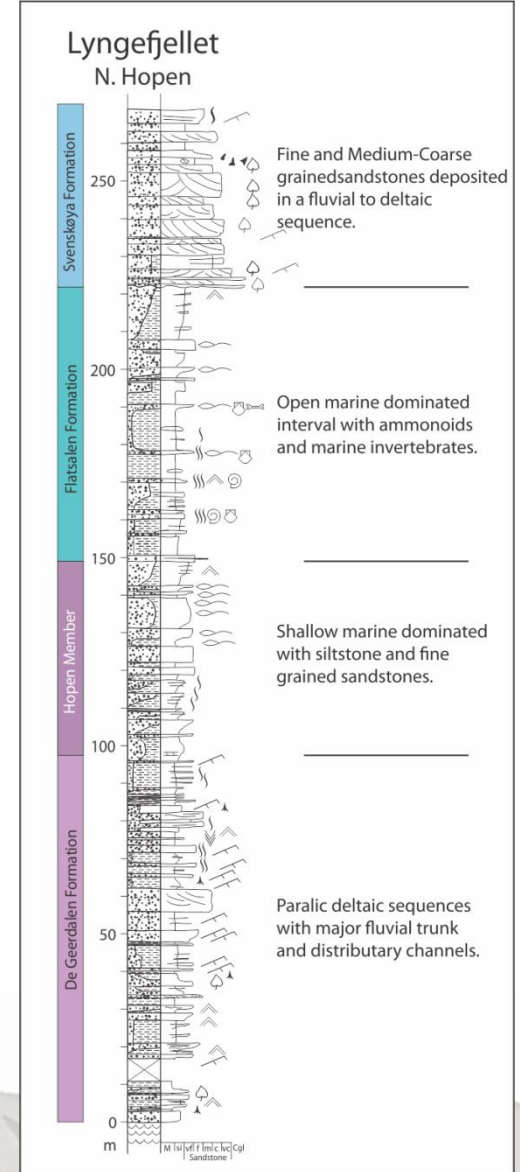
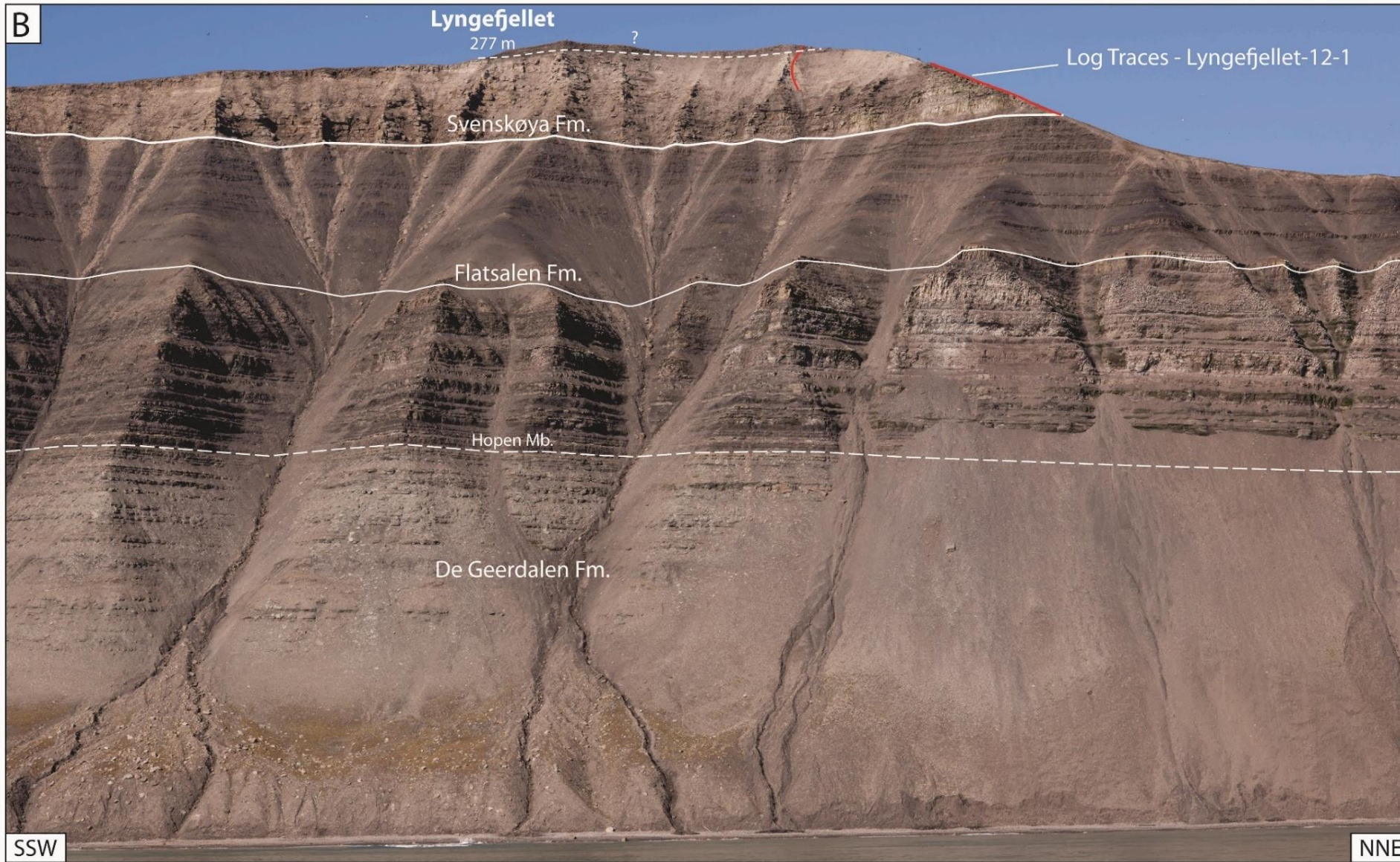


Lord, 2017

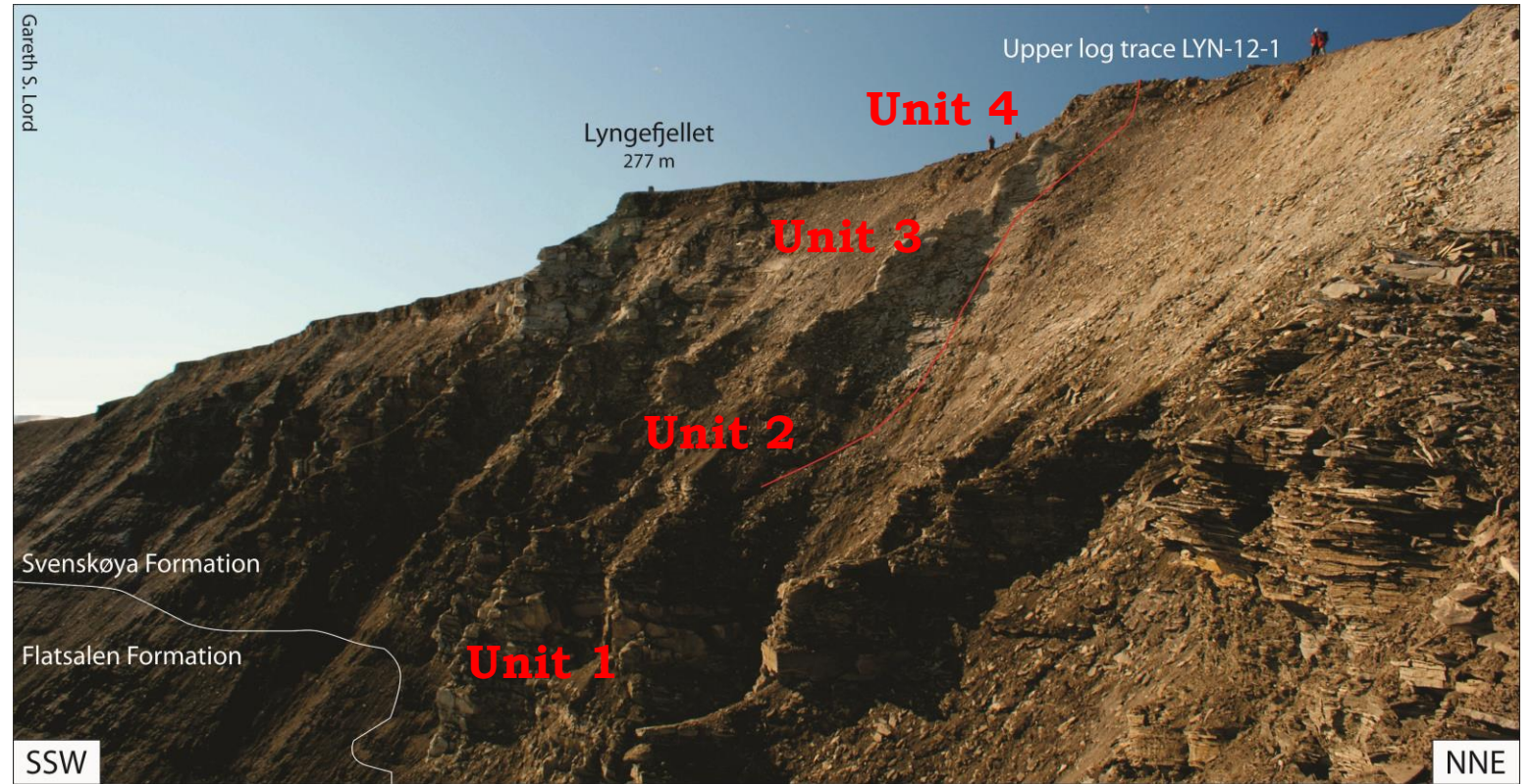
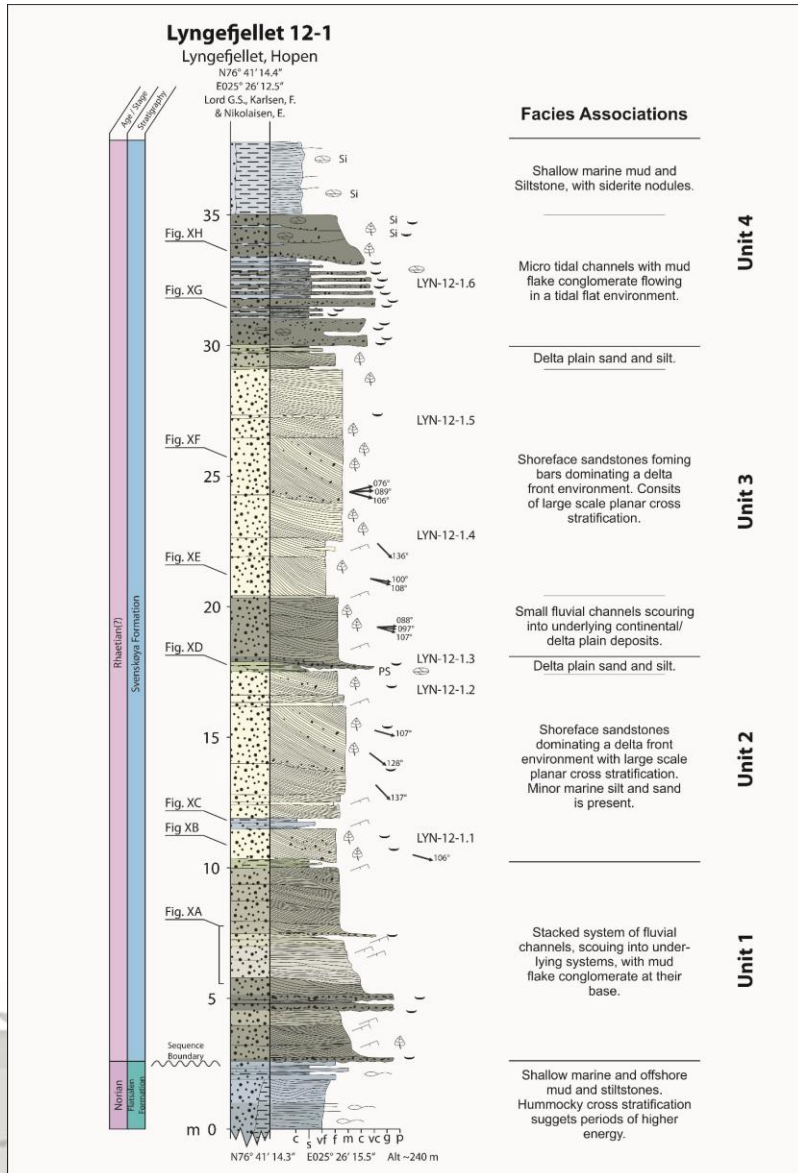
Stratigraphy – Lower & Middle Triassic



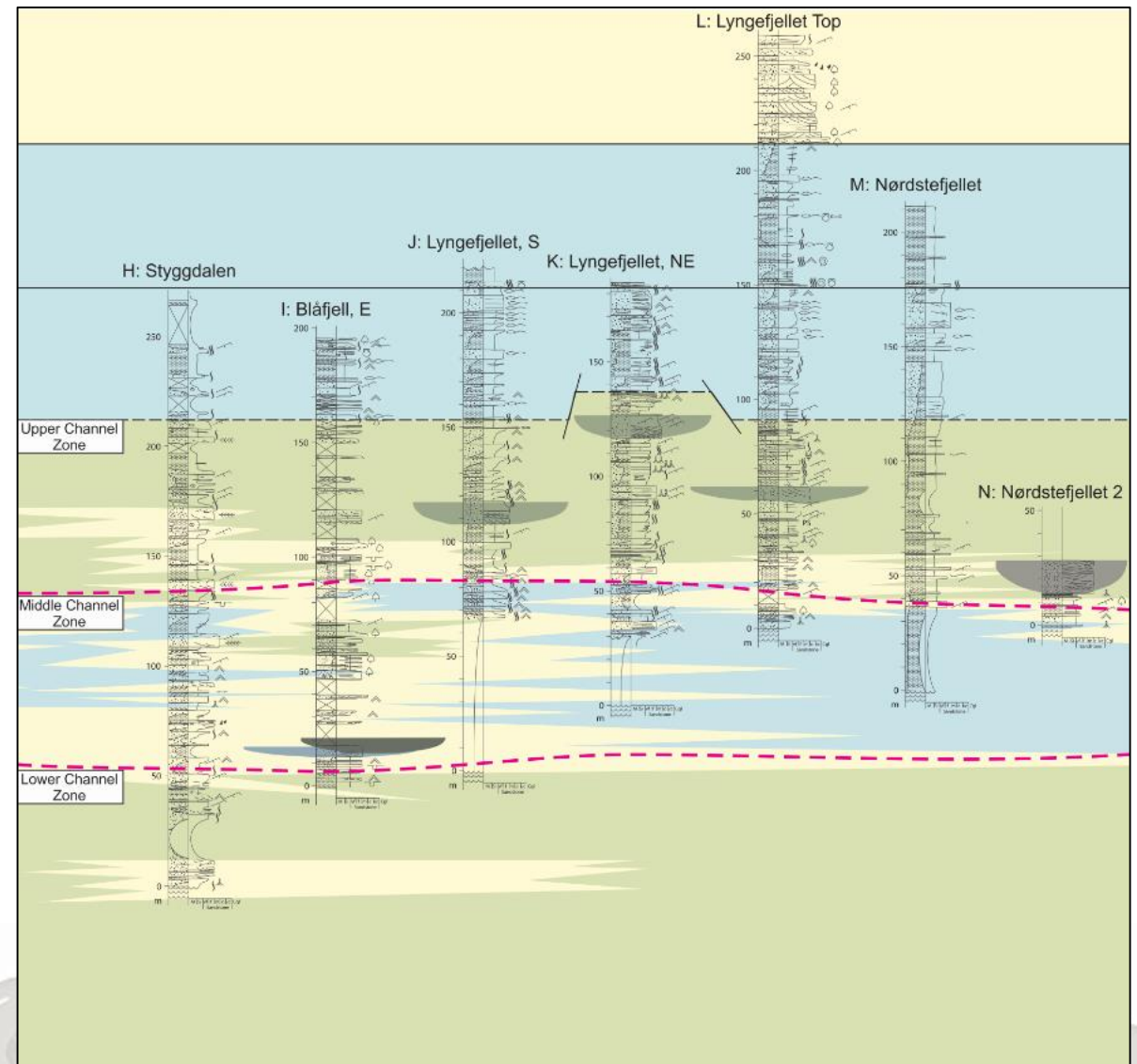
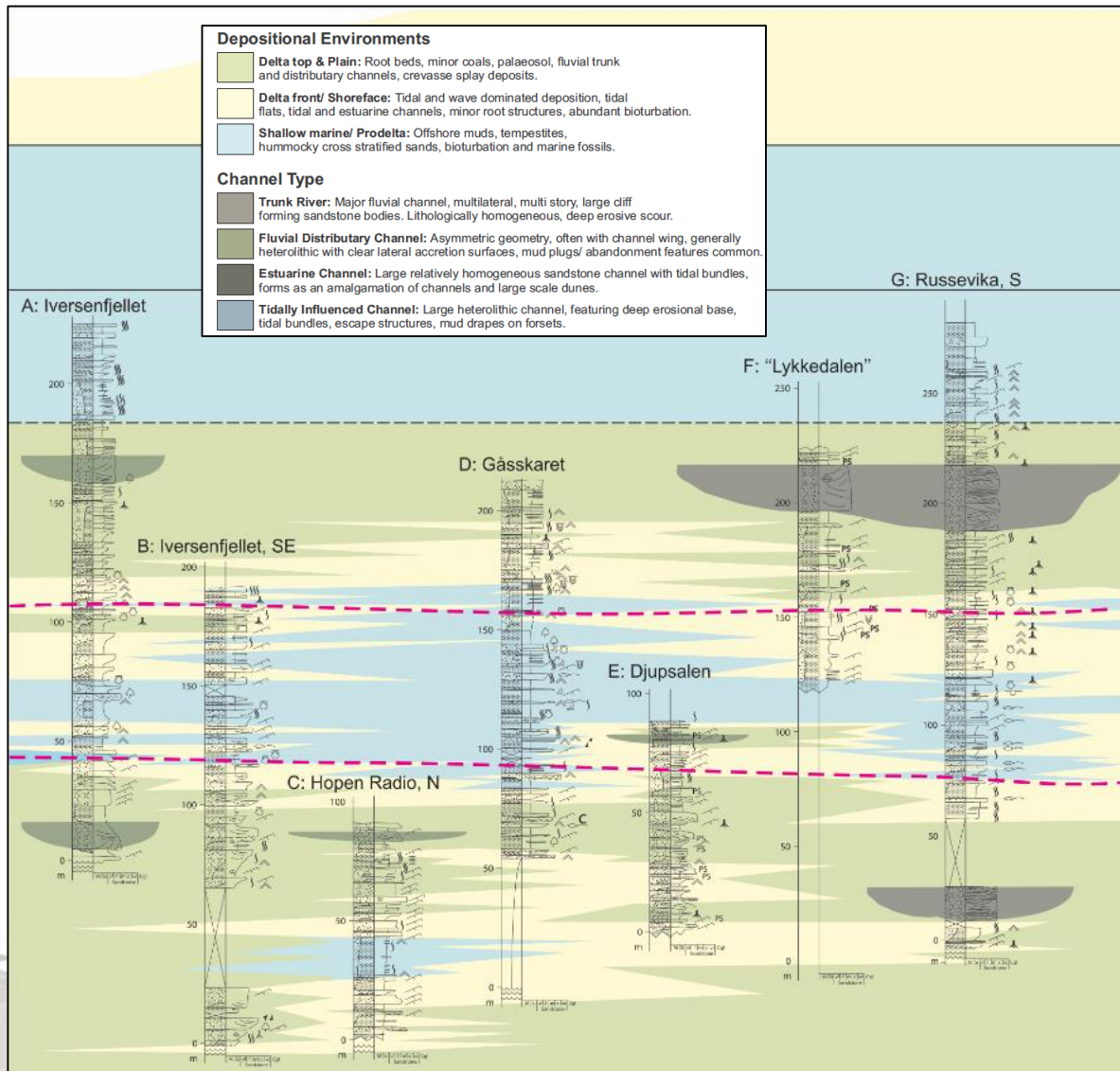
Stratigraphy – Upper Triassic



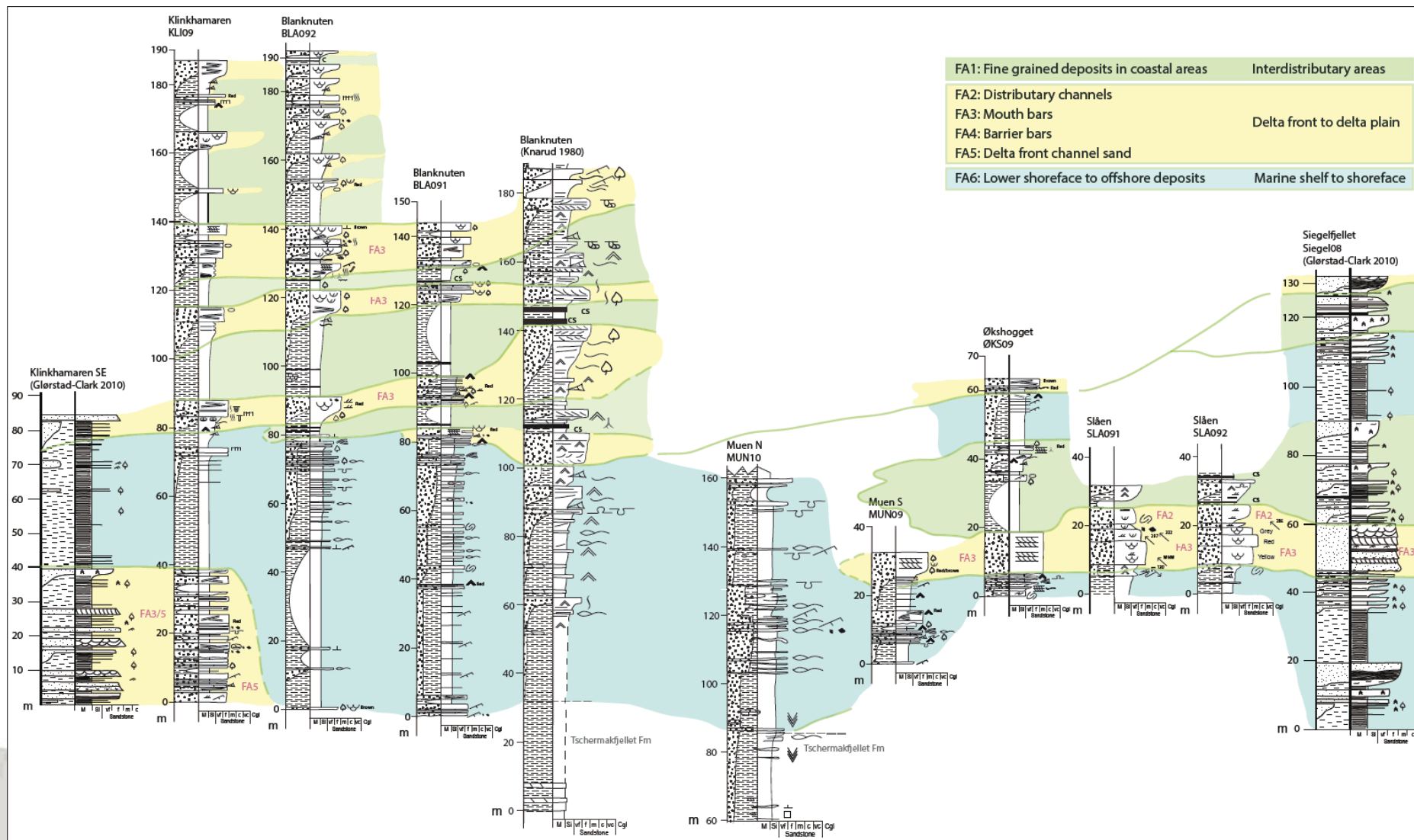
Stratigraphy - Upper Triassic



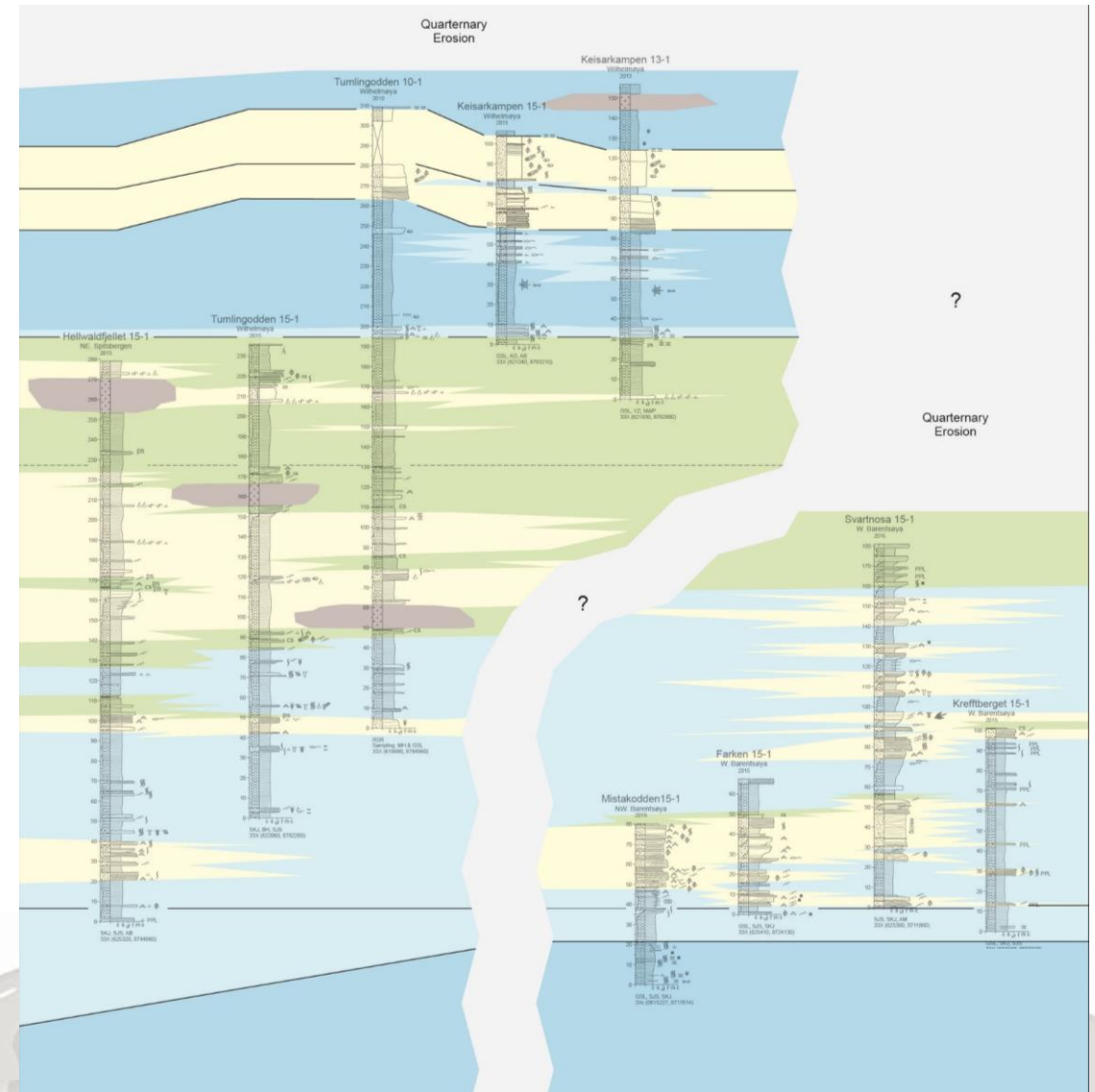
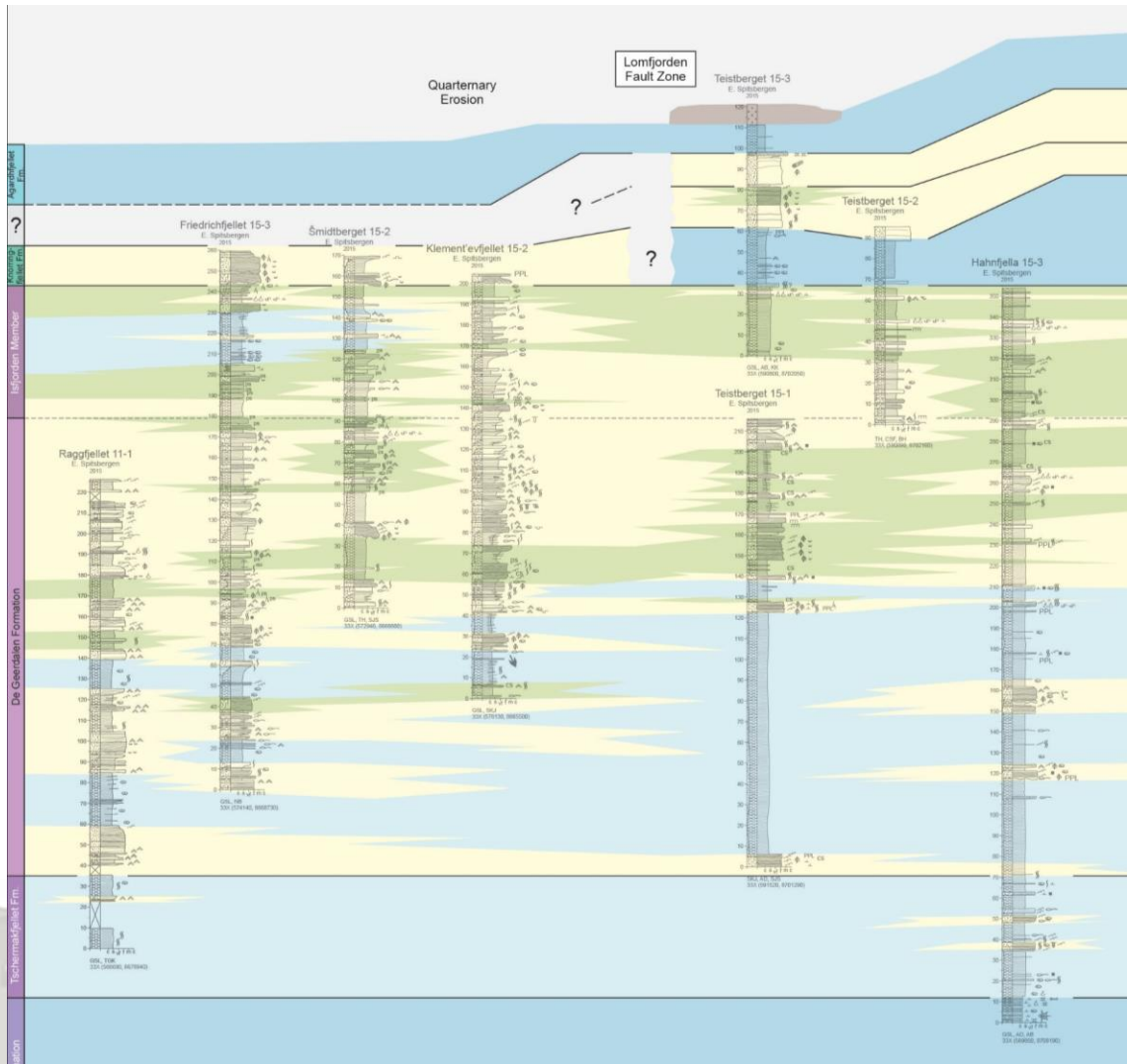
Facies Development – Upper Triassic



Facies Development – Upper Triassic



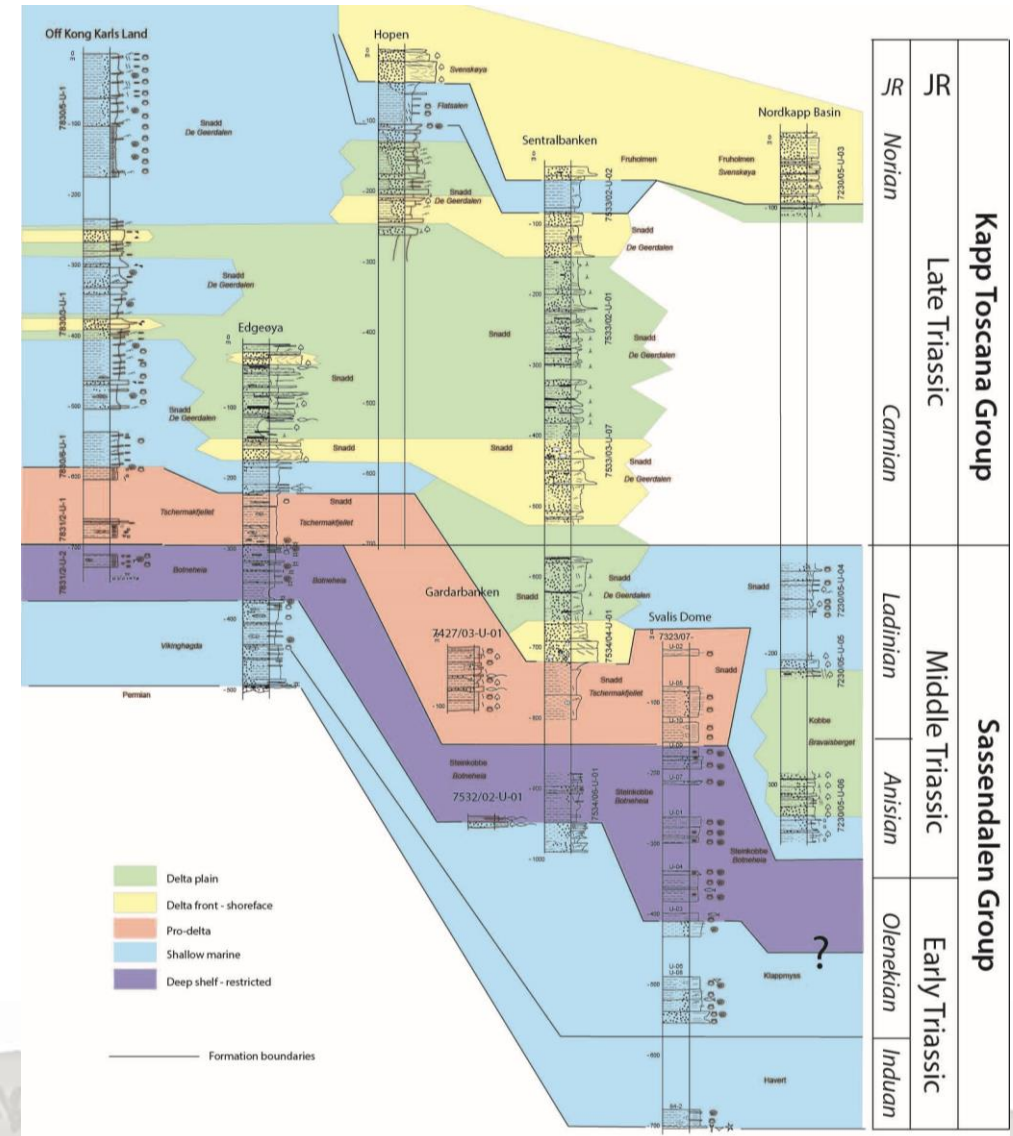
Facies Development – Upper Triassic



Facies Development – Offshore



- Development offshore to Sentralbanken shows similar gross depositional environment distribution throughout the Triassic.
- Deltaic deposits (De Geerdalen/ Snadd Fm) are Ladinian - Carnian in age in the Sentralbanken area.
- Deltaic deposits dominate the Middle Triassic in the southern Barents Sea.
- Organic rich middle Triassic from Svalis Dome.

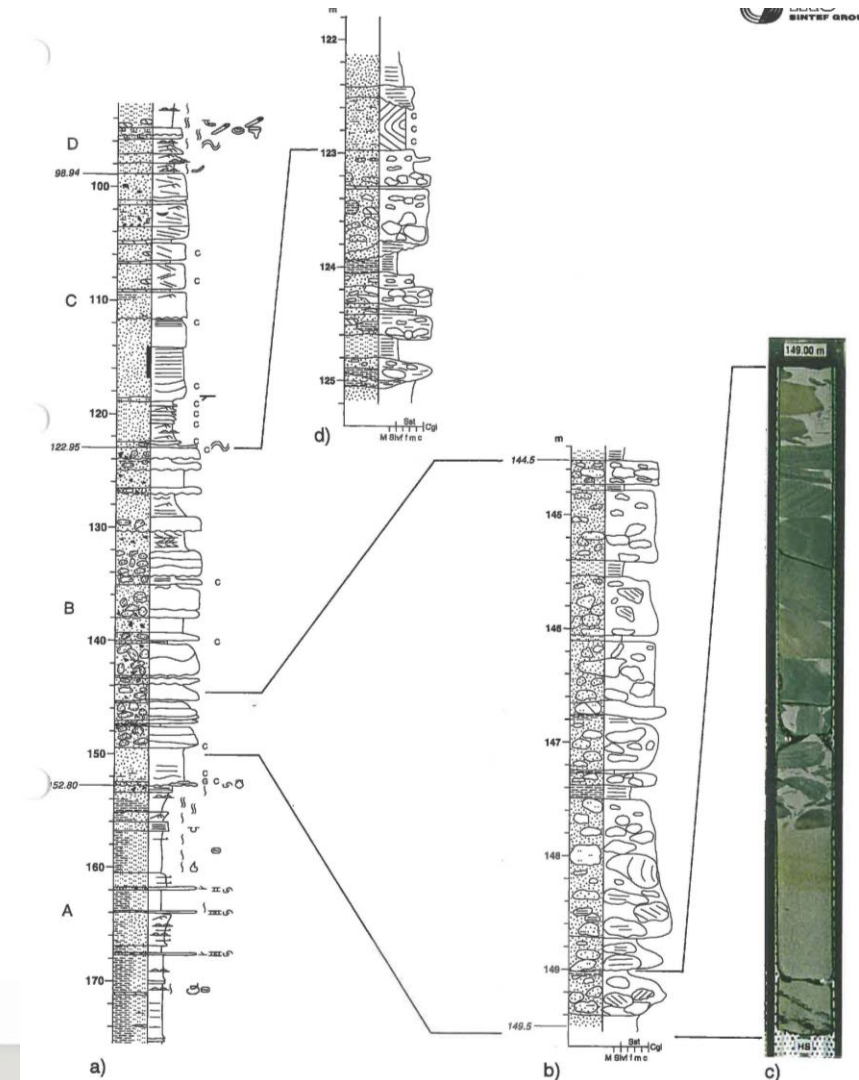


Lundschien et al., 2014

Facies Development – Offshore



- Ladinian - Carnian Snadd/ De Geerdalen Fm in the Sentralbanken area is sand-rich.
- Paralic deltaic deposits overlying pro-deltaic shales.
- Similar facies observed in Svalbard, although far thinner succession.



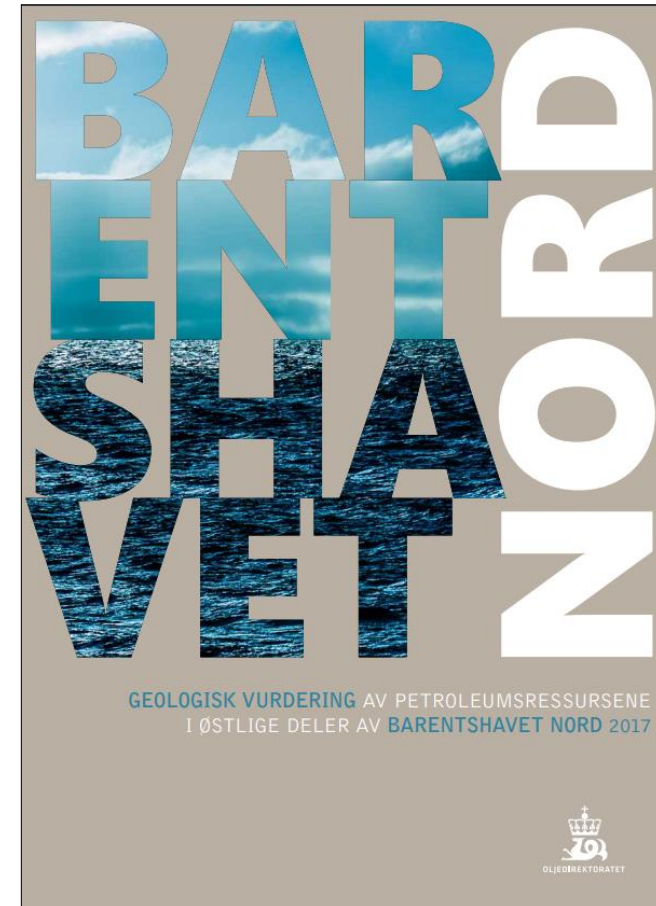


Triassic Hydrocarbon Potential

Triassic Hydrocarbon Potential



- 6th June 2017 NPD released 'Barents Sea North' report.
- Focusing on eastern part of the northern Barents Sea.
- Geological assessment of petroleum resources, north of current exploration area.

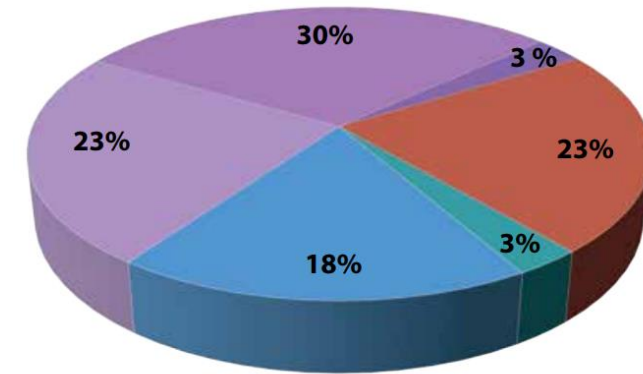


Triassic Hydrocarbon Potential



- The report predicts favorable quantities of hydrocarbon resources in the Triassic succession of the northern Barents Sea.
- 56% of the total resource estimate is believed to lie within reservoirs of Triassic age.

“Expected recoverable resources in eastern parts of Barents Sea North are calculated to be 1 370 million scm oe, with a downside of 350 million scm oe (P95) and an upside of 2 460 million scm oe (P05)”



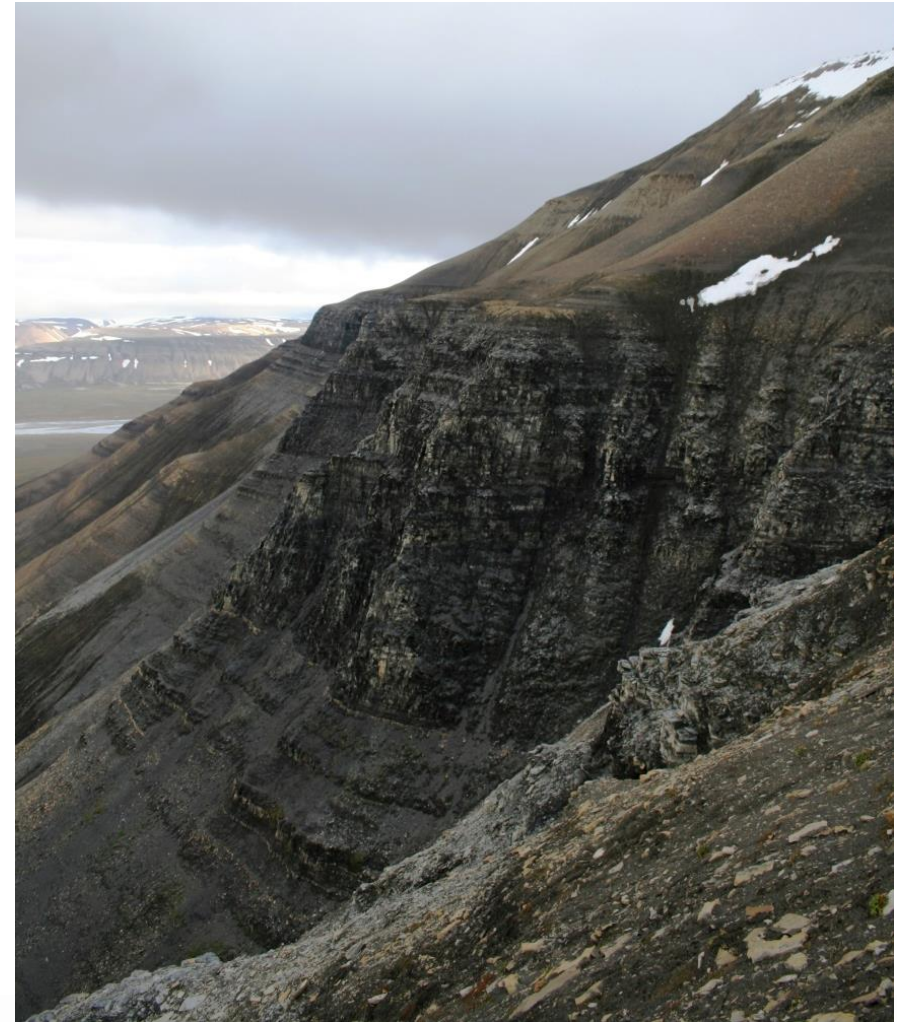
Lower-Middle Jurassic Upper Triassic Lower-Middle Triassic
Lower Triassic Late Carboniferous- Permian Lower Carboniferous

NPD, 2017

Triassic Source Rock Maturity



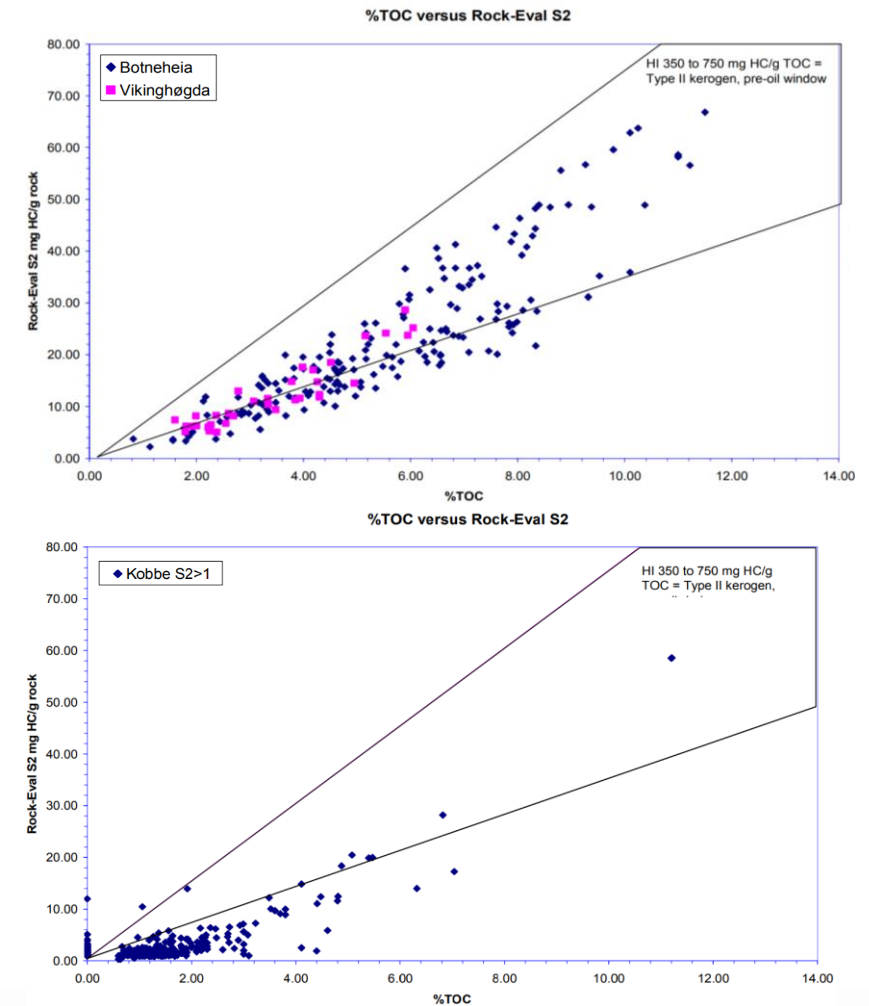
- Thermal maturation is a critical factor in the hydrocarbon potential analysis for the Northern Barents Sea.
- Middle Triassic:
 - 7-10% TOC
 - Over-mature rocks in southern and western Spitsbergen but lie within oil window elsewhere.
 - Low maturity on Edgeøya and Barentsøya.
 - Local maturation by sills and dykes.
- Upper Triassic – Middle Jurassic
 - Up to 7% TOC in Flatsalen Formation (Norian)
 - Organic rich shales in Agardhfjellet Formation



Triassic Source Rock Maturity – TOC vs S2



- Variations in TOC from the Middle Triassic in Svalbard to time equivalent units in Barents Sea.
- Type II Kerogen dominates.
- Upper Vikinghøgda Fm and Botneheia Fm (Muen Member) are the most organic rich with TOC from 1-12%.
- Steinkobbe & Klappmyss fms are the richest intervals in the Barents Sea Triassic.

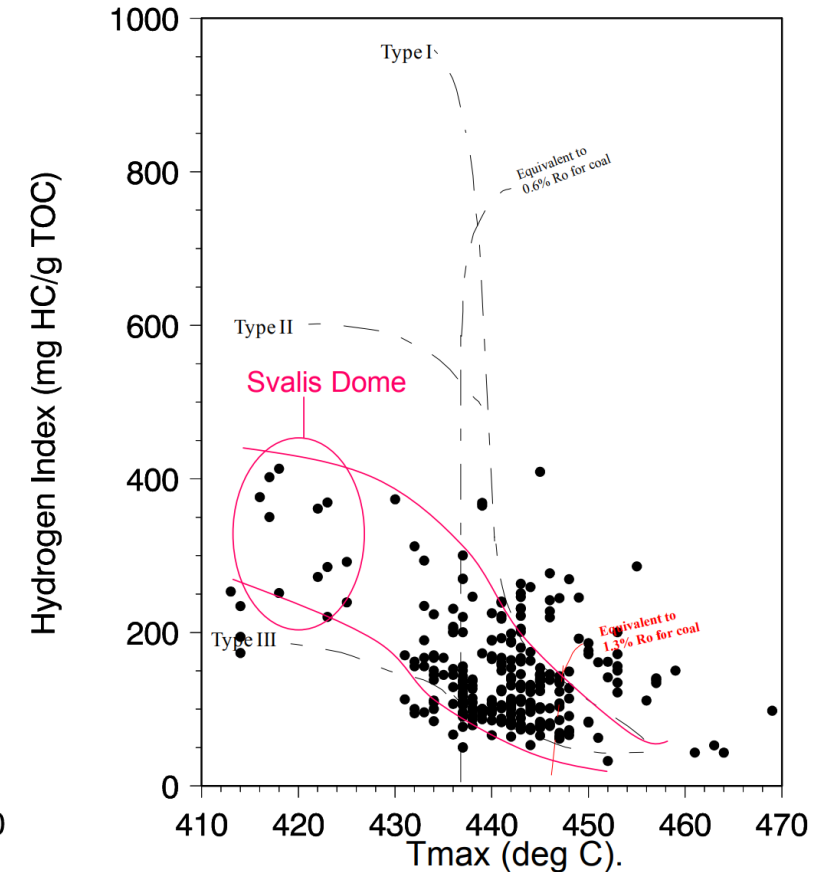
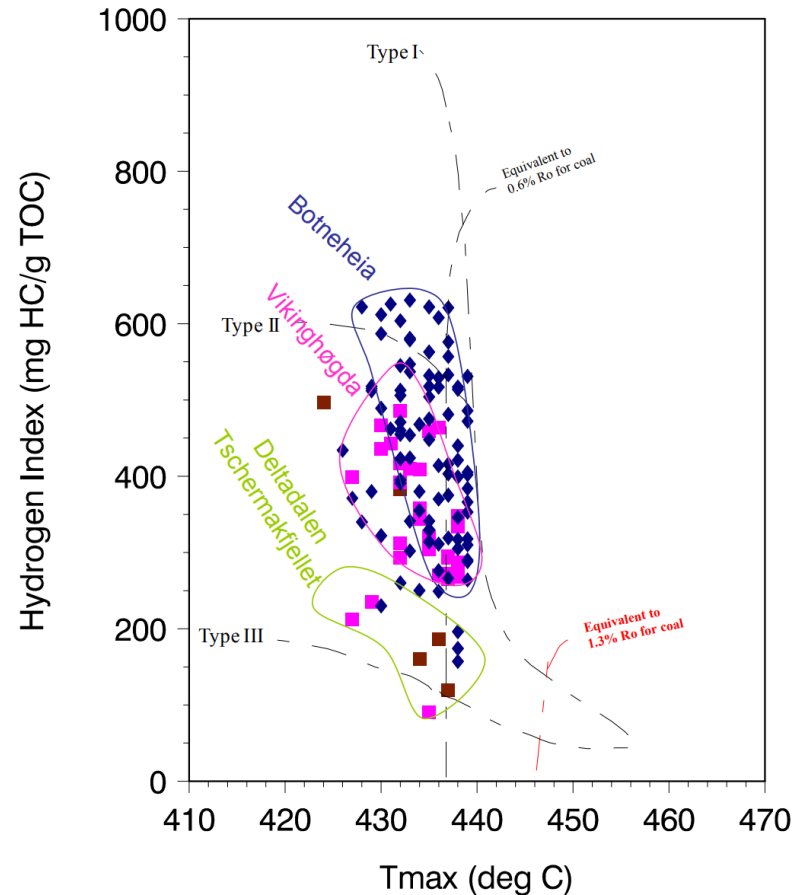


Bjørøy et al., 2010

Triassic Source Rock Maturity – HI vs Tmax



- Maturity of Lower and Middle Triassic is significantly higher in the Southern Barents Sea area.
- Lower and Middle Triassic in Svalbard is marginally mature (late oil window mature)
- Steinkobbe Fm in the Svalis Dome area is likely less oil prone due to deposits being more terrigenous than on Svalbard.



Bjorøy et al., 2010

Proven Hydrocarbon System



- Proven hydrocarbon system onshore in Svalbard.
- UNIS CO₂ wells made a 'technical' gas discovery in recent wells drilled for water injection.
- 25 Bar measured at well top.
- Either shale-gas from Jurassic Agardhfjellet Fm. or conventional gas from the Knorringfjellet Fm.
- Opportunity to model gas movement in the planned CO₂ reservoir.



unis.no

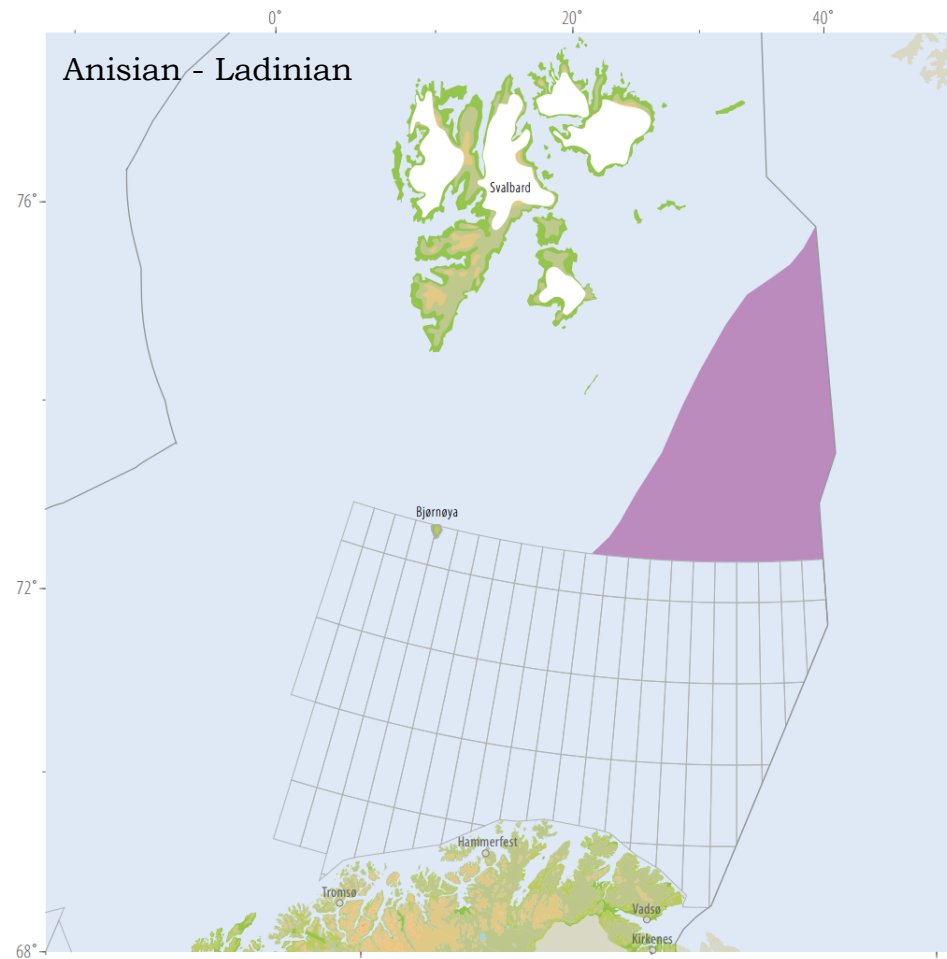
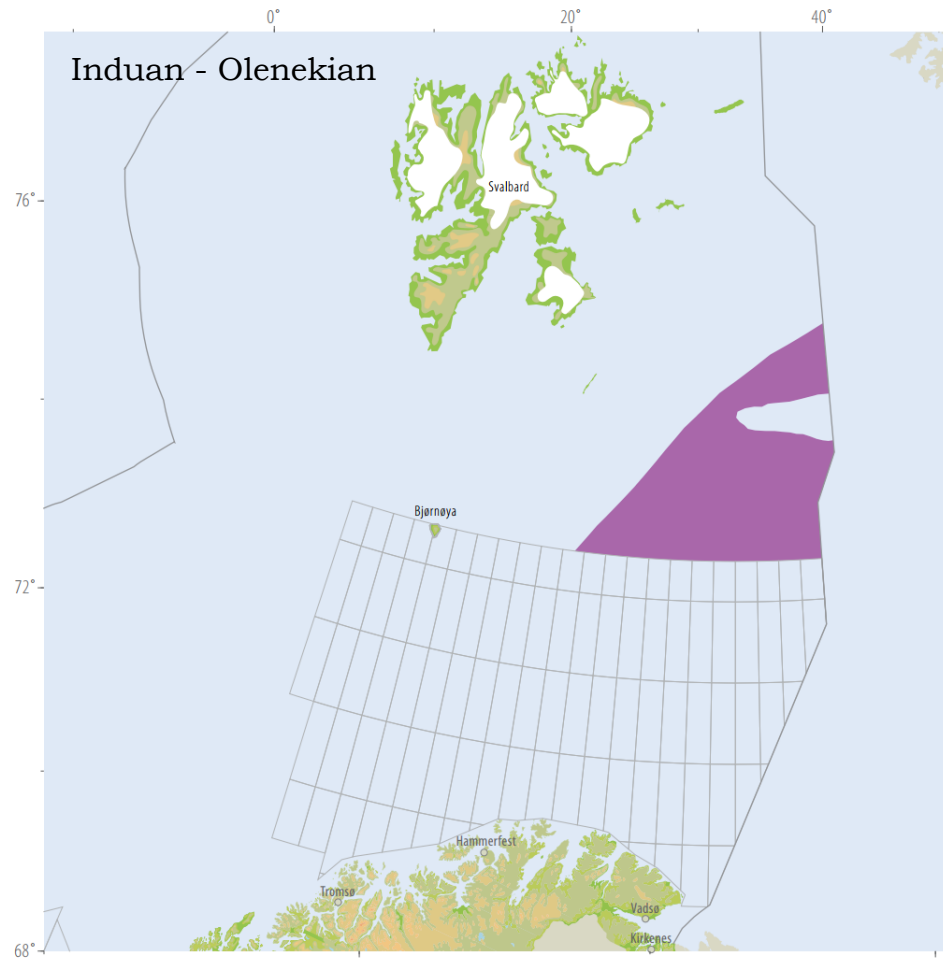
Triassic Hydrocarbon Plays



- Complete hydrocarbon system in Mesozoic stratigraphy:
 - Source rocks in lower and middle Triassic, upper Triassic and middle Jurassic.
 - Reservoir sandstones in Upper Triassic (Carnian – Rhaetian) and Upper Cretaceous.
 - Low reservoir quality from Carnian in Svalbard
 - Fractured
 - Seals in source rock units.

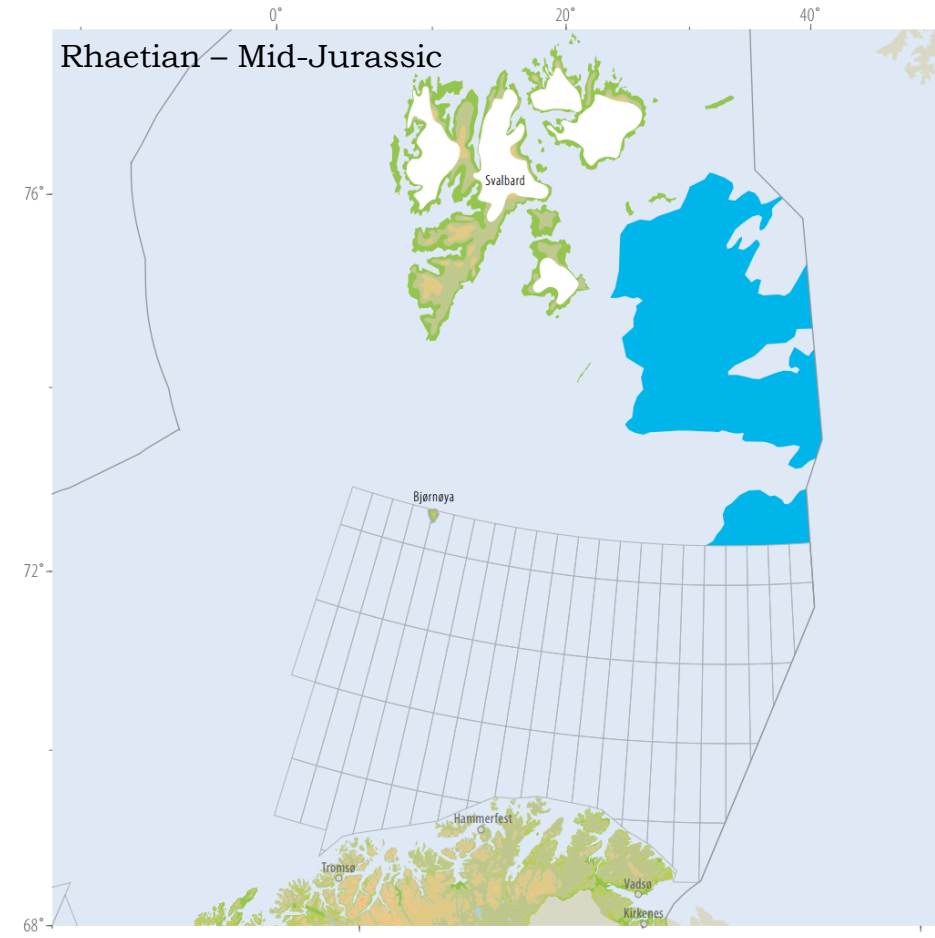
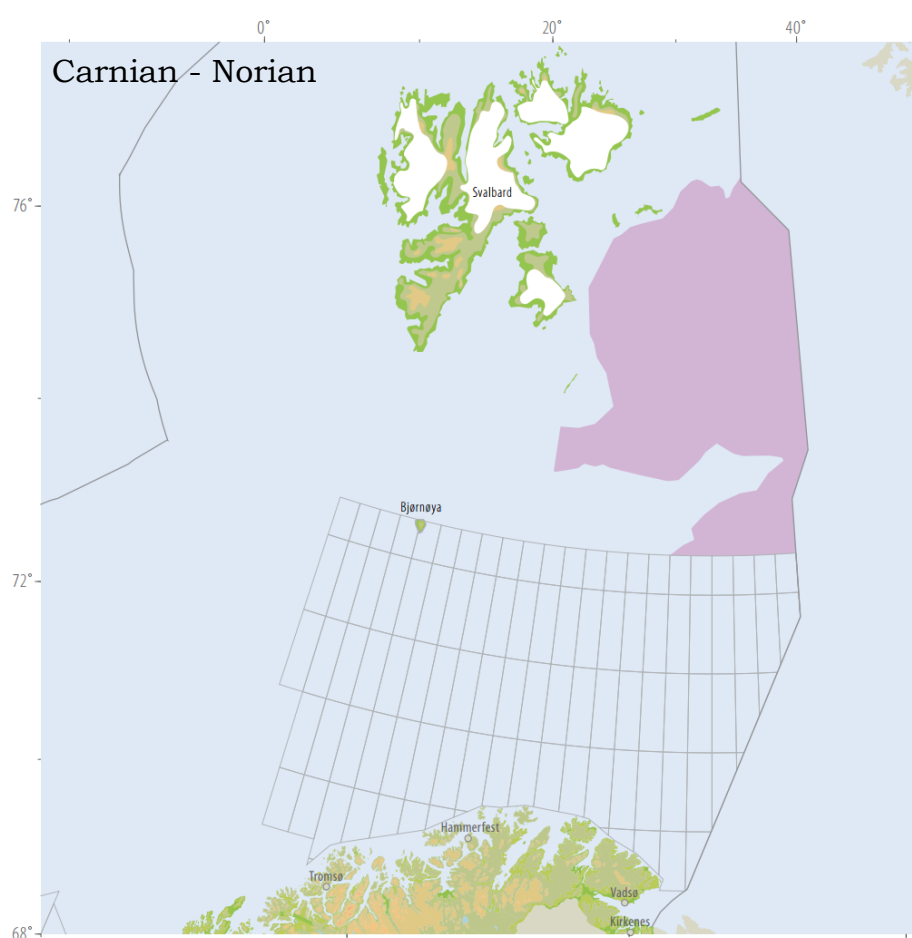


Triassic Hydrocarbon Plays



Barents Sea North, 2017

Triassic Hydrocarbon Plays



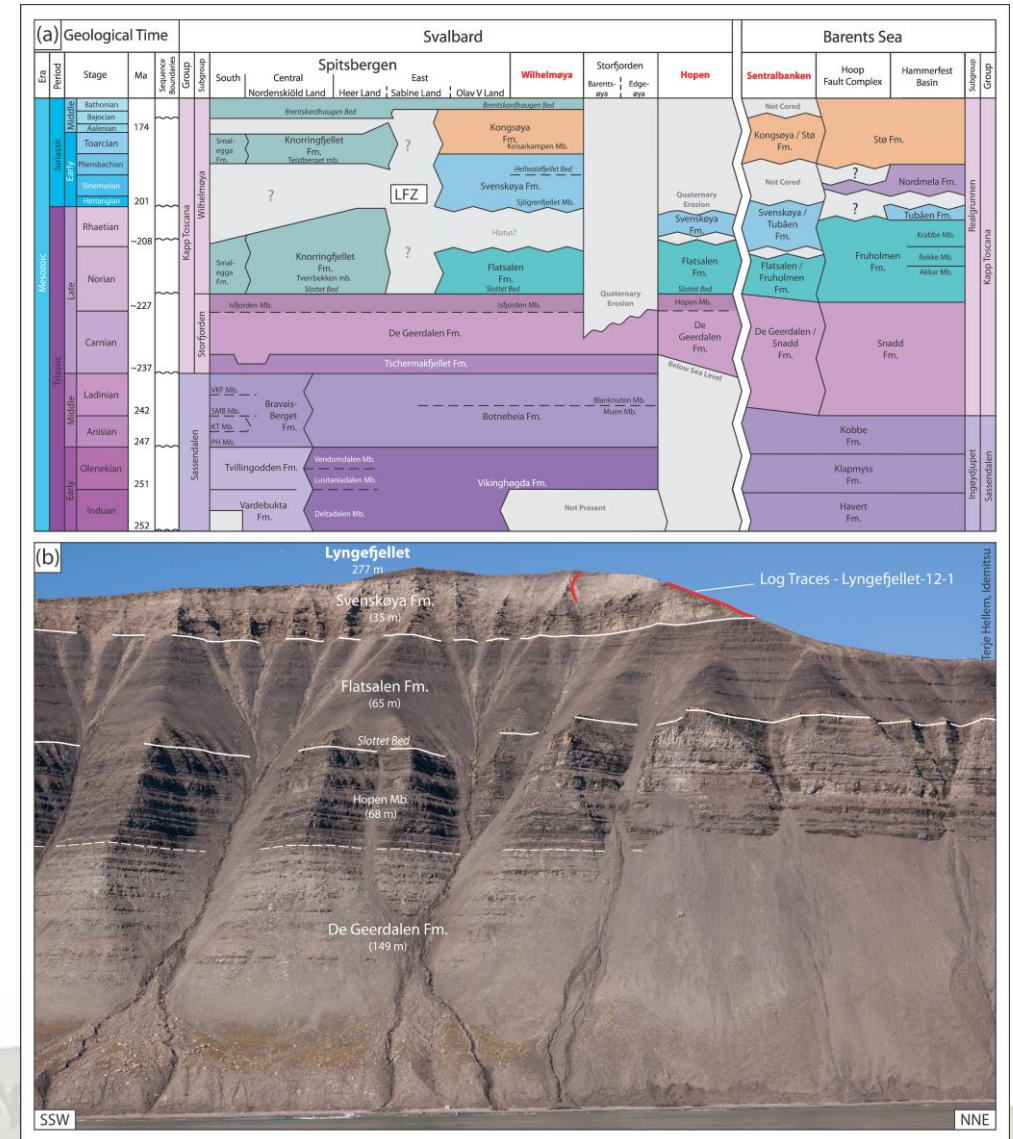
Barents Sea North, 2017



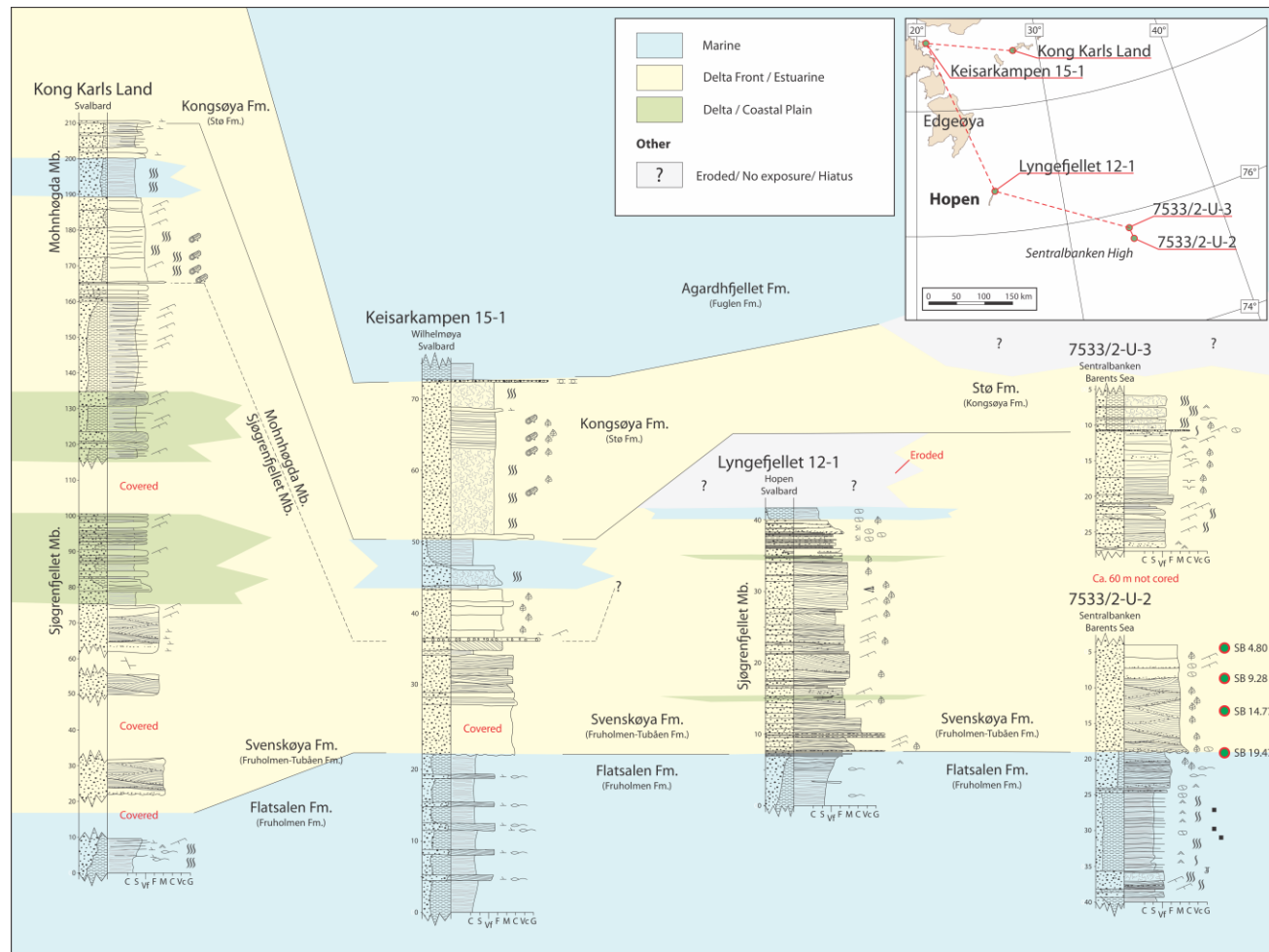
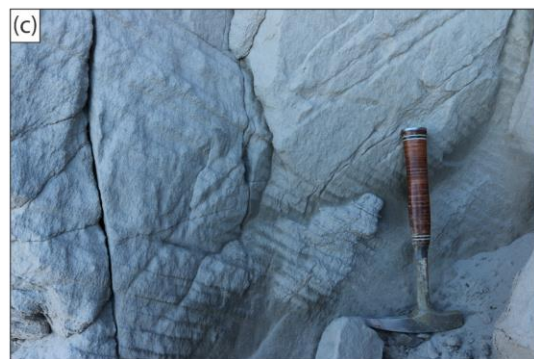
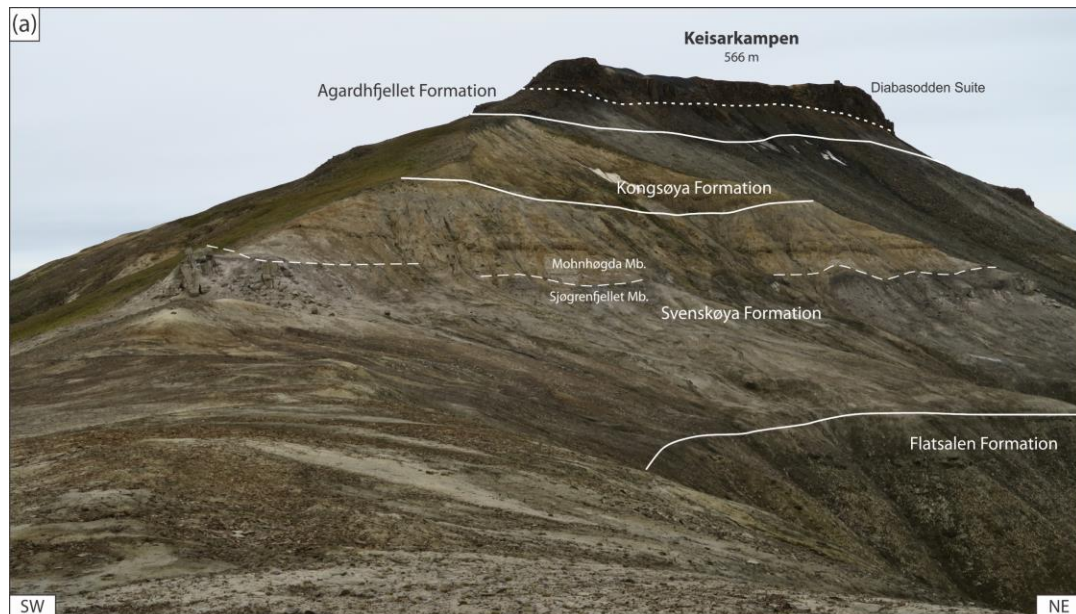
Triassic Hydrocarbon Plays



- Realgrunnen Group equivalent is present on Svalbard as the Wilhelmøya Subgroup.
- Most exciting interval for the Barents Sea Triassic.
 - Fruholmen Fm. – Flatsalen & Svenskøya Fms.
 - Nordmela Fm? (equivalent observed on KKL)
 - Tubåen Fm. – Svenskøya Fm.
 - Stø Fm. – Kongsøya Fm.
- Study comparing the Svenskøya outcrops on Eastern Svalbard to the Sentralbanken wells.



Triassic Hydrocarbon Plays

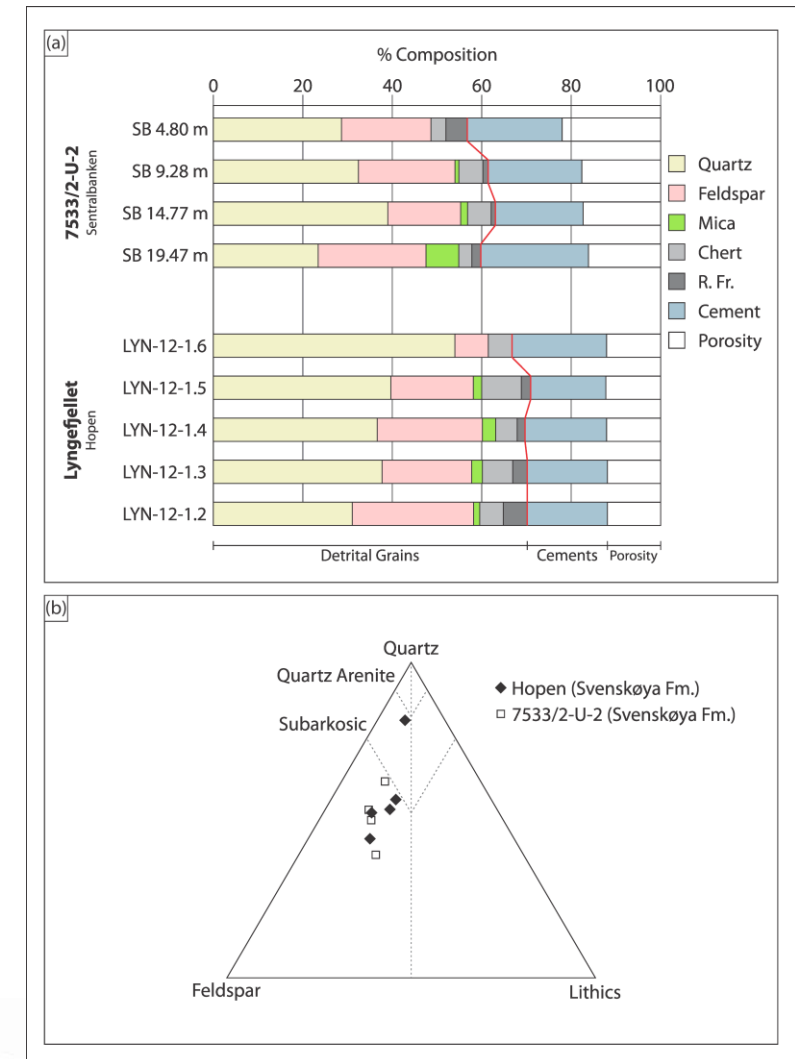


Lord et al. in prep, Lord 2017

Triassic Hydrocarbon Plays

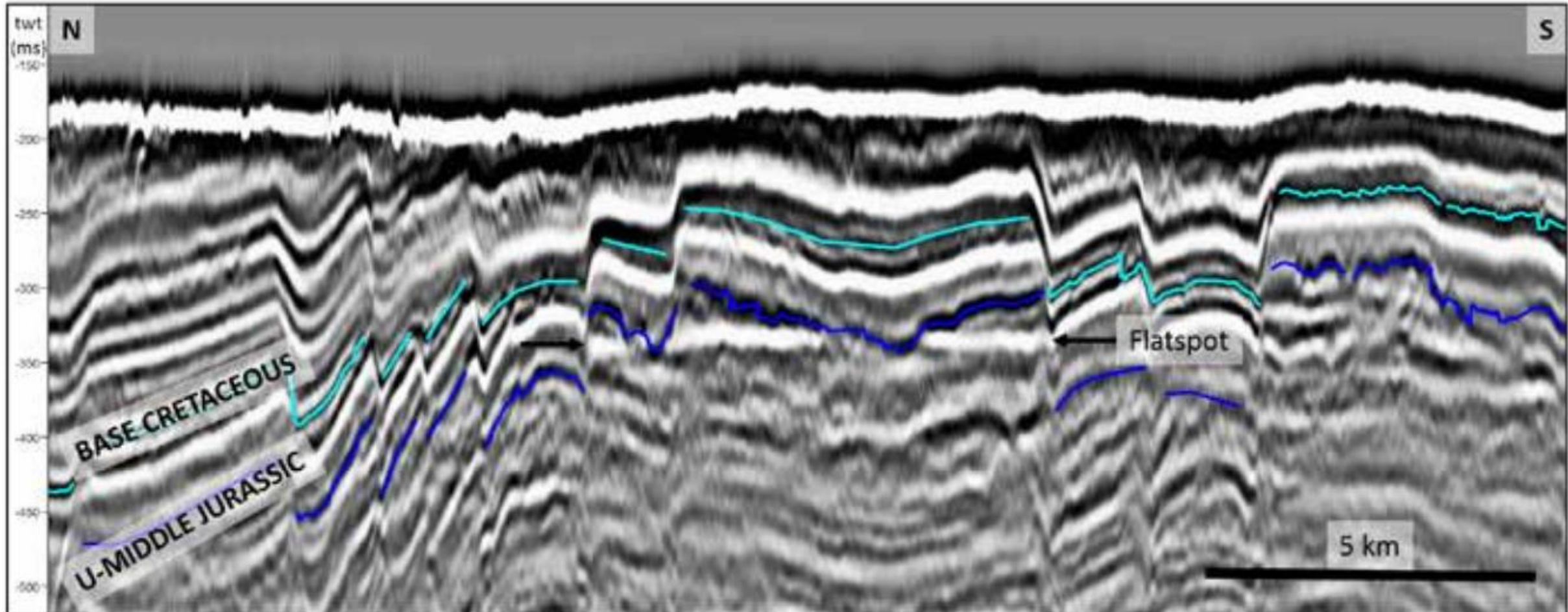


- Composition was largely similar:
 - Quartz, Feldspar, Mica, Chert, Lithic Fragments.
- Cement proportion also largely similar from Svalbard to Sentralbanken.
- Increase in porosity in the Sentralbanken well.
 - 15-20%
 - Ca. 16 mD
- Primarily arkosic sandstones in Svalbard and Sentralbanken



Lord et al. in prep, Lord 2017

Triassic Hydrocarbon Potential





Thank You

- Questions? -

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