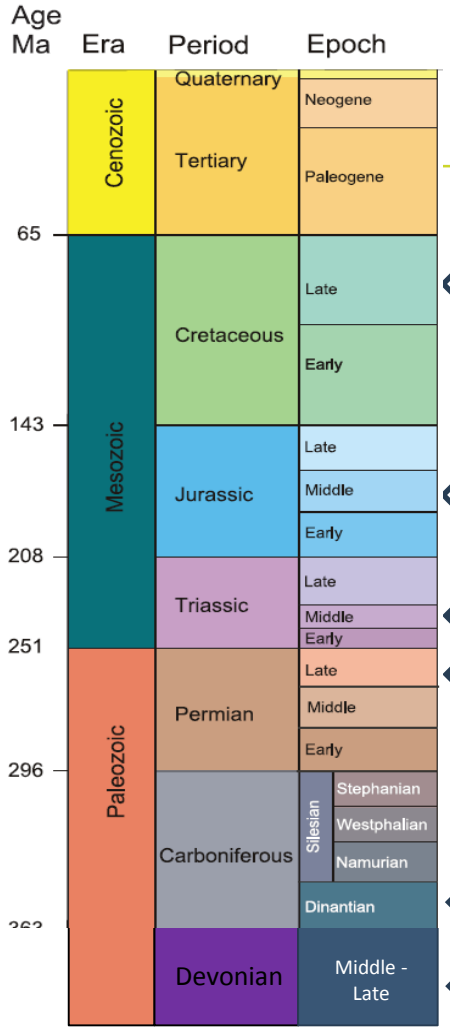
Carbonates in the Dutch subsurface



Chalk Gp

Brabant Fm

Muschelkalk Fm

Zechstein Gp

Zeeland Gp

Kyle Lst Fm

Heterogeneity

- Facies
- Diagenesis
  - Karst / dolomitisation
  - Cementation
- Faults & fractures

Assessing the HC potential of Devonian-Carboniferous Carbonates in the Dutch subsurface – part 1

Dinantian Carbonates of the Zeeland Grp

- Petroleum play producing in Caspian Sea at ~4.5 km depth; eg Tengiz, Kashagan
- NL wells and seismic data show potential for fractured / karstified (producing) reservoir.
- Cluster of sizable leads straddling the UK-NL median line, close to existing infrastructure
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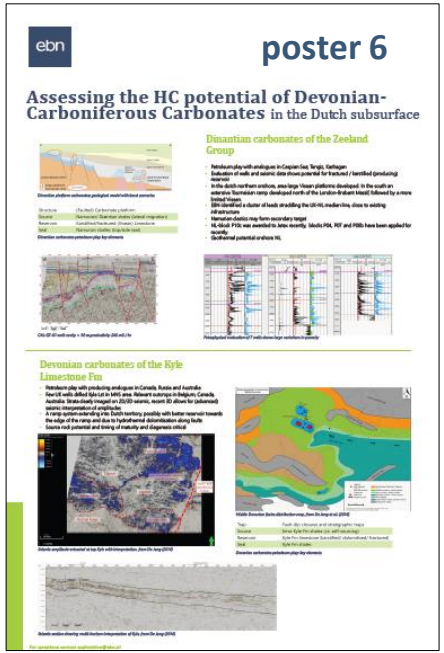
- Geothermal potential onshore NL



- MSc research at EBN by Nynke Hoornveld (‘12-’13) and Jan Schneider (‘13-’14)
- MSc research at TNO by Roy Boots (’13-’14) - TNO-supervisor Johan ten Veen, EBN co-supervisor.
- Prospectivity screening of the Dinantian Carbonates by EBN (supported by PanTerra)
- Data acquisition by EBN at well CAL-GT-01 (‘12) (in corporation with Wijnen Squarecrops)

Dinantian carbonates of the Zeeland Group

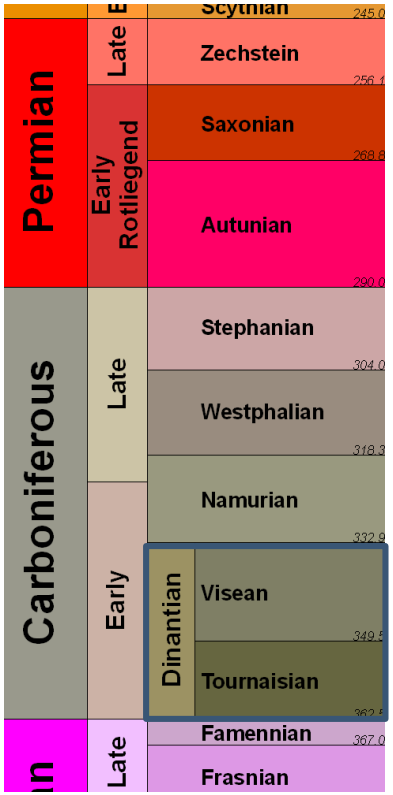
key play elements

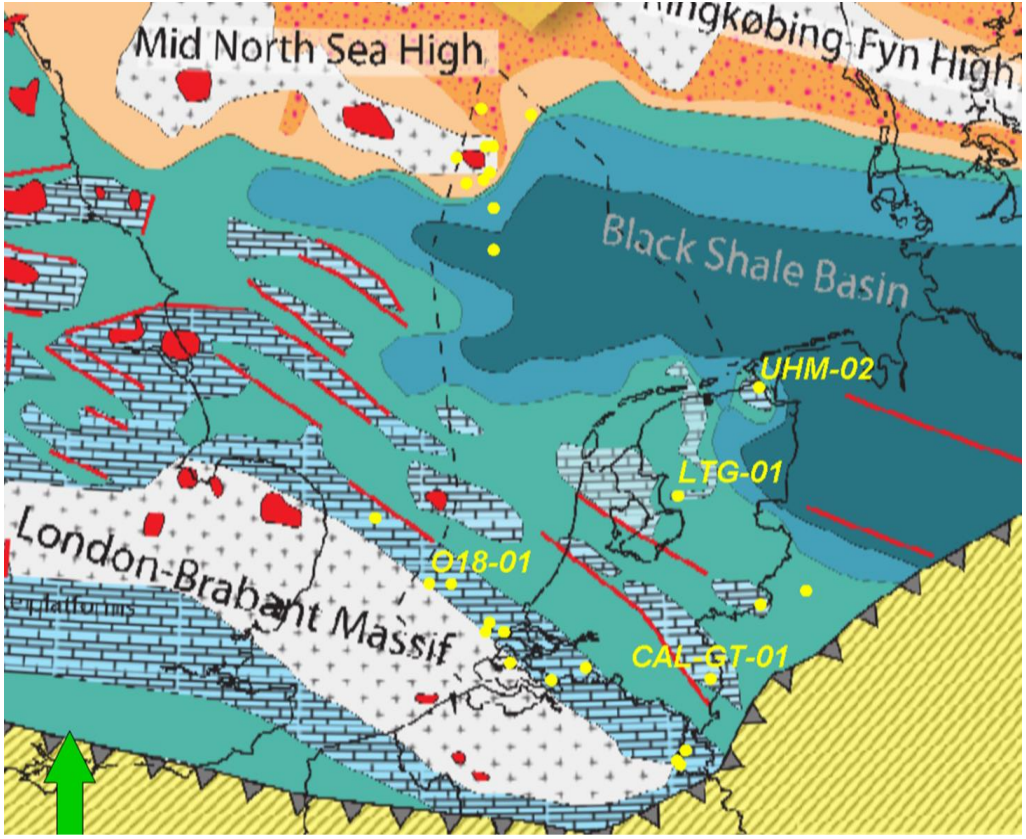
Structure	(faulted) carbonate platform
Source	Namurian / Dinantian shales (lateral migration)
Reservoir	karstified / fractured (Visean) limestone
Seal	Namurian shales (top / side seal)

ebn

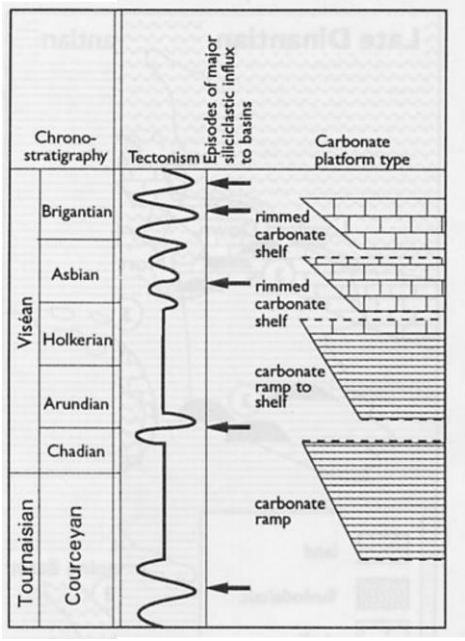
Early Carboniferous Dinantian carbonates

(Visean) paleogeography and changes in carbonate platform type





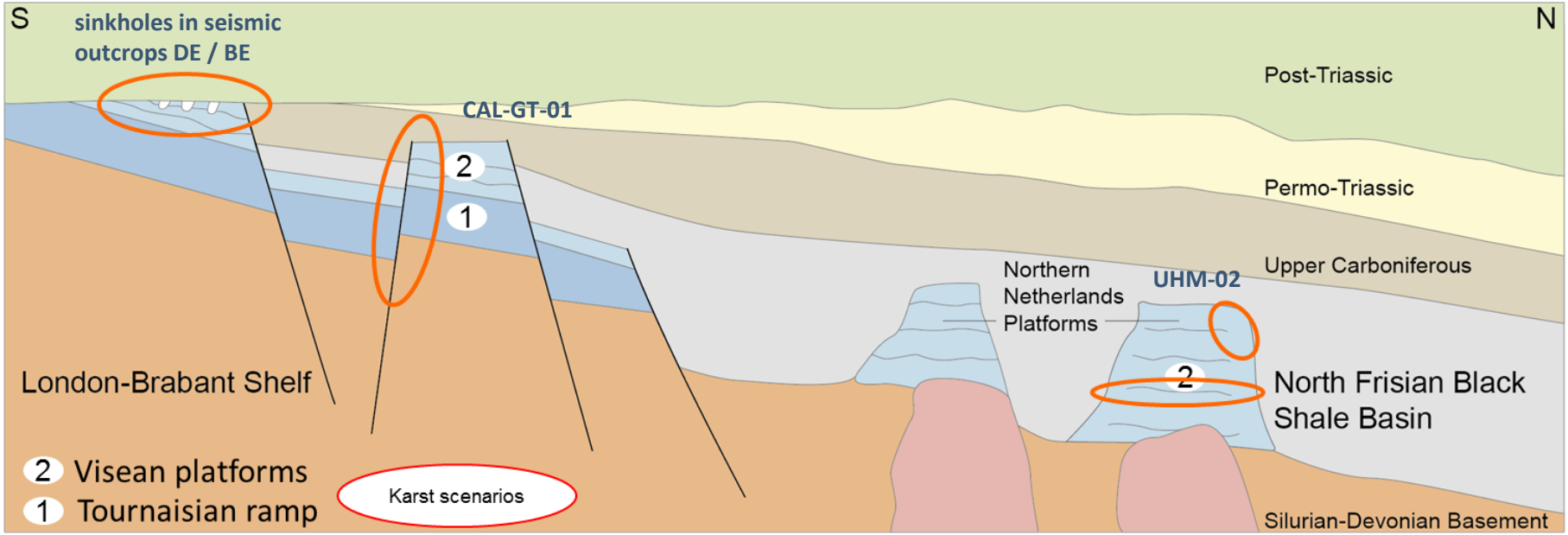
From Van Hulten (2012)



From Bridges et al. (1995)

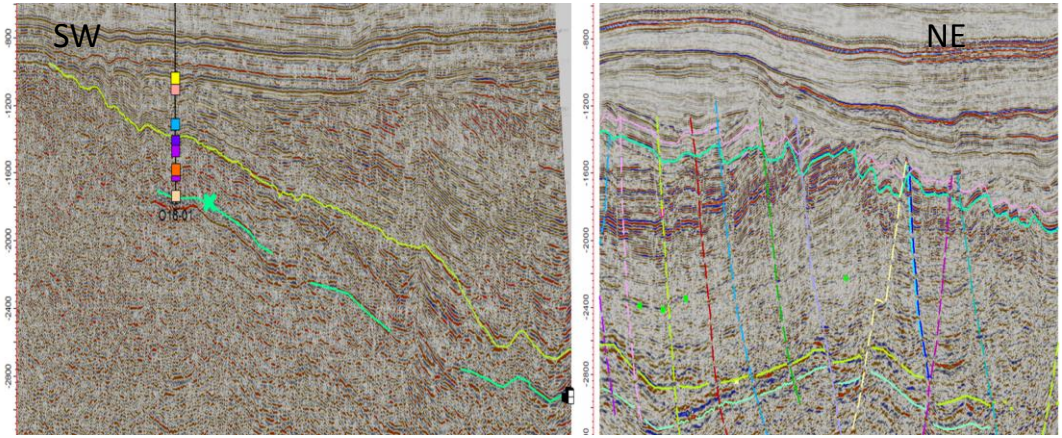
Dinantian platform carbonates – conceptual model

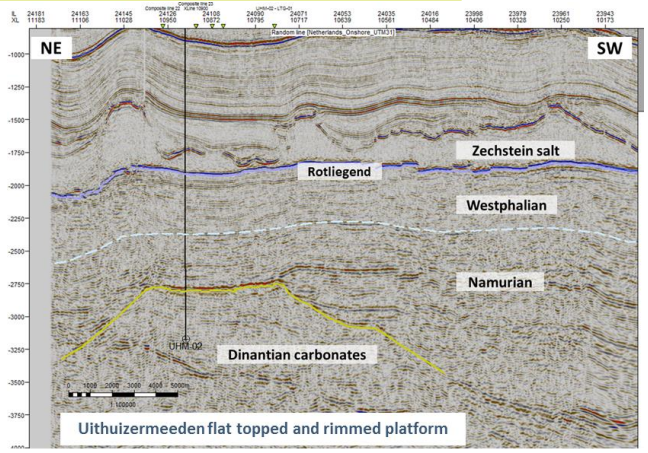
karst scenarios (with examples)



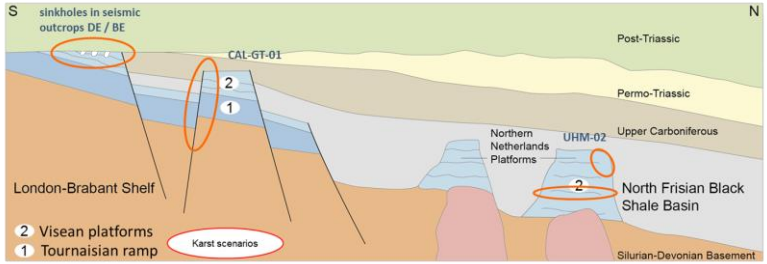
Dinantian platform carbonates in seismic

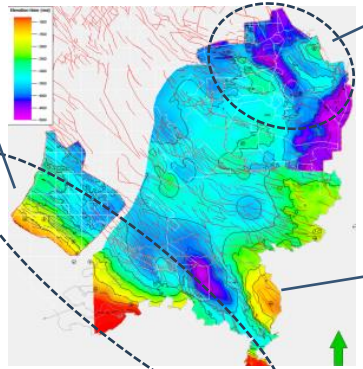
Tournasian ramp and Visean shelf in S, Visean mounds and platforms in North

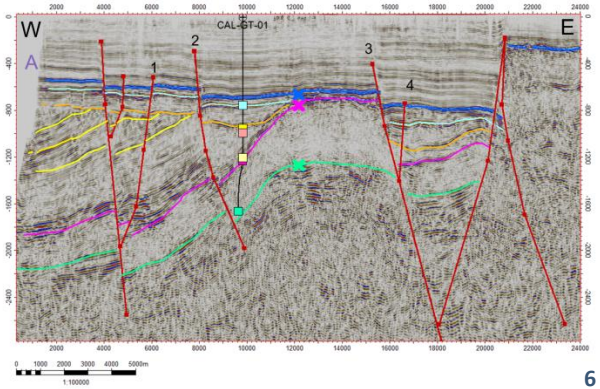




map and sections from Hoornveld (2013)

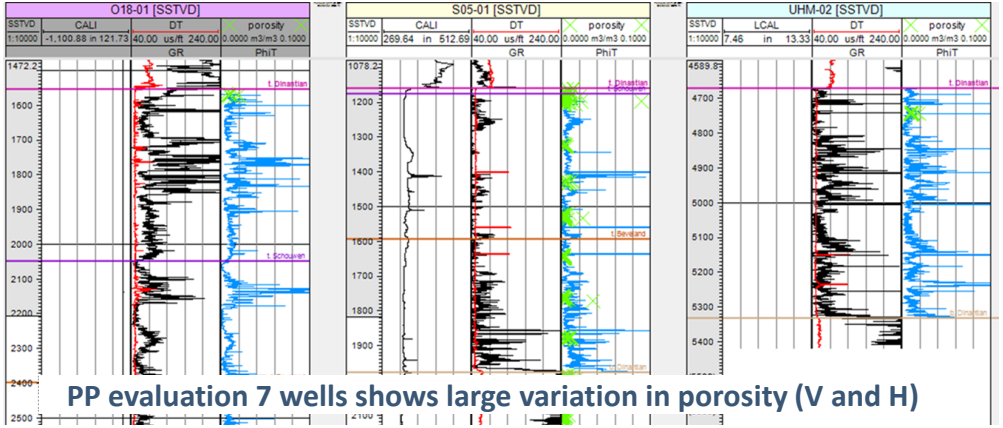




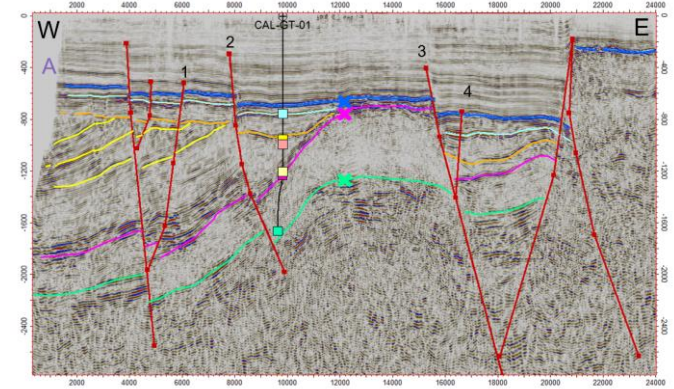


Reservoir quality – from tombstone to cave

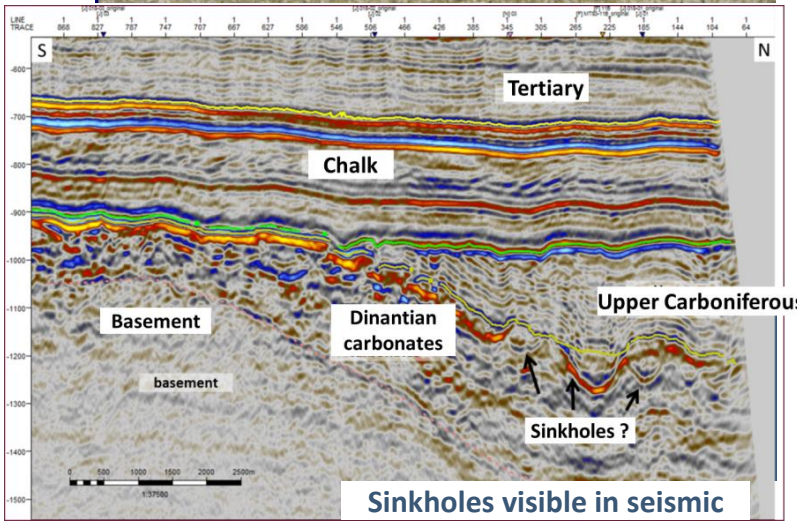
indications for good reservoir quality from well data and seismic



PP evaluation 7 wells shows large variation in porosity (V and H)



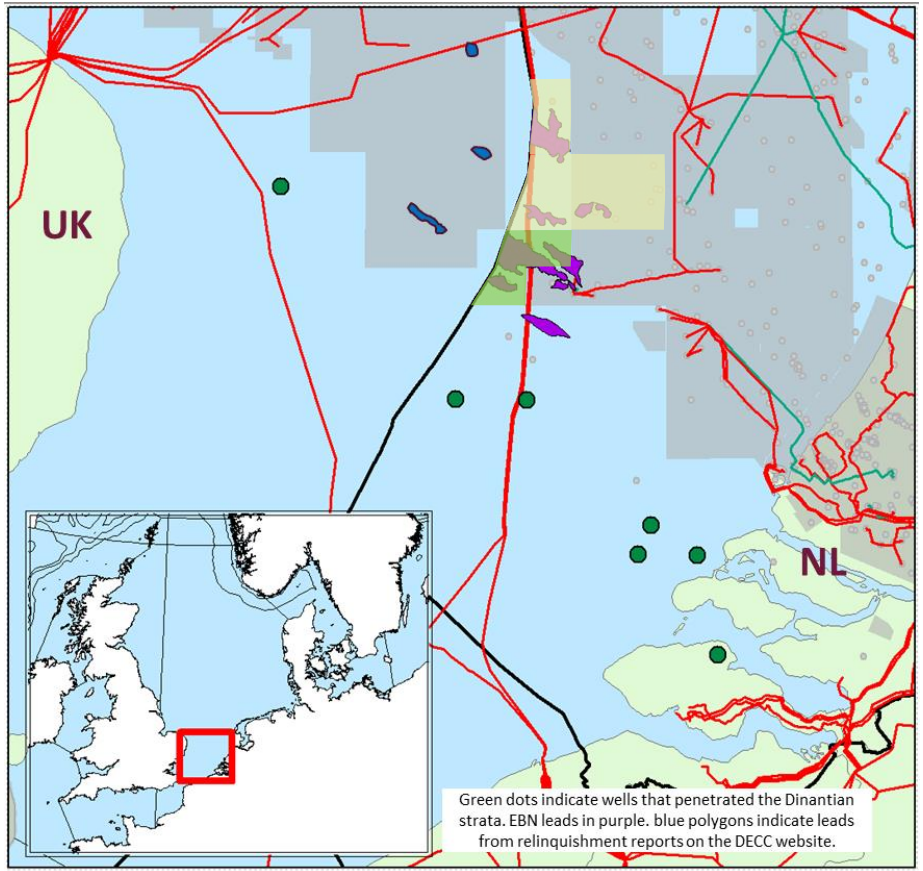
CAL-GT-01 well; cavity > 30 m, productivity 240 m^3/hr



Sinkholes visible in seismic

Dinantian Carbonate play in the SNS

in brief – more details on poster 6



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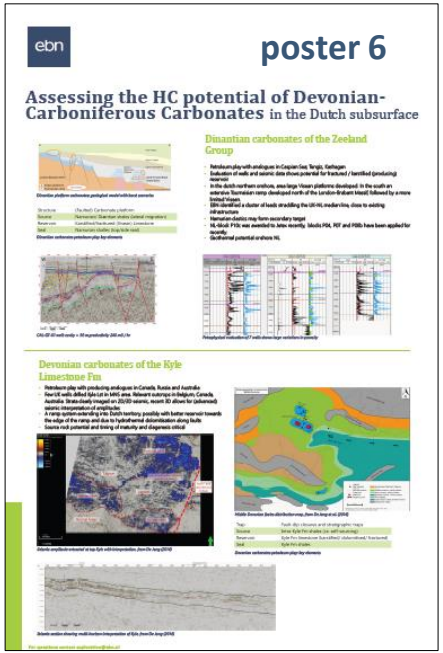
Assessing the HC potential of Devonian-Carboniferous Carbonates in the Dutch subsurface – part 2

Devonian Carbonates of the Kyle Limestone Fm

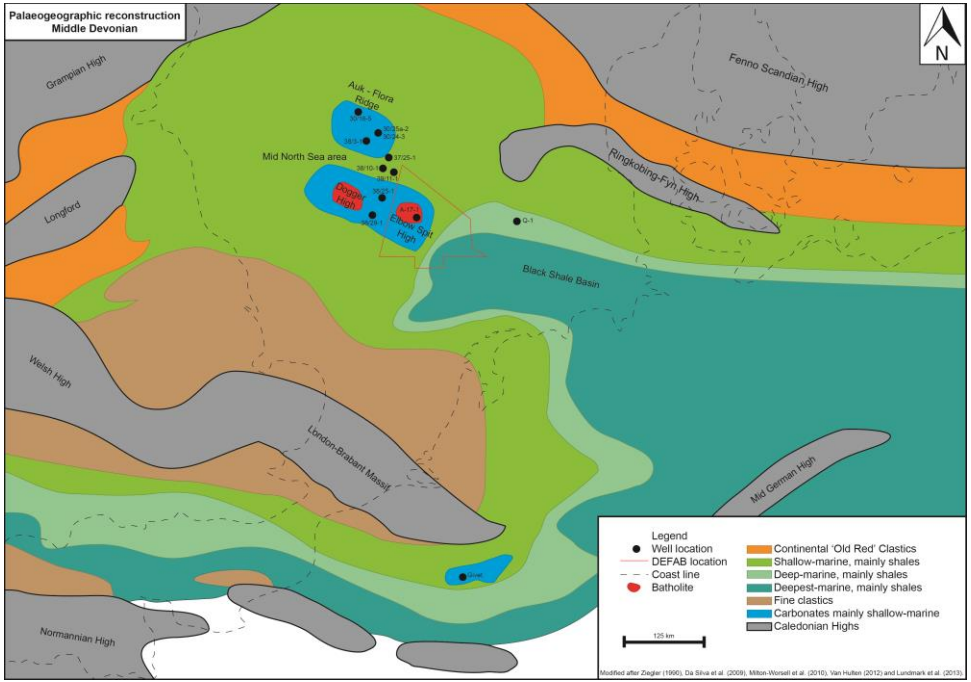
- Petroleum play with producing analogues in Canada, Russia and Australia
- Few UK wells drilled Kyle Lst in MNS area. Relevant outcrops in Belgium, Canada, Australia. Strata clearly imaged on 2D/3D seismic, recent 3D allows for (advanced) seismic interpretation
- A ramp system extending well into Dutch territory, possibly with better reservoir towards the edge of the ramp and due to hydrothermal dolomitisation along faults

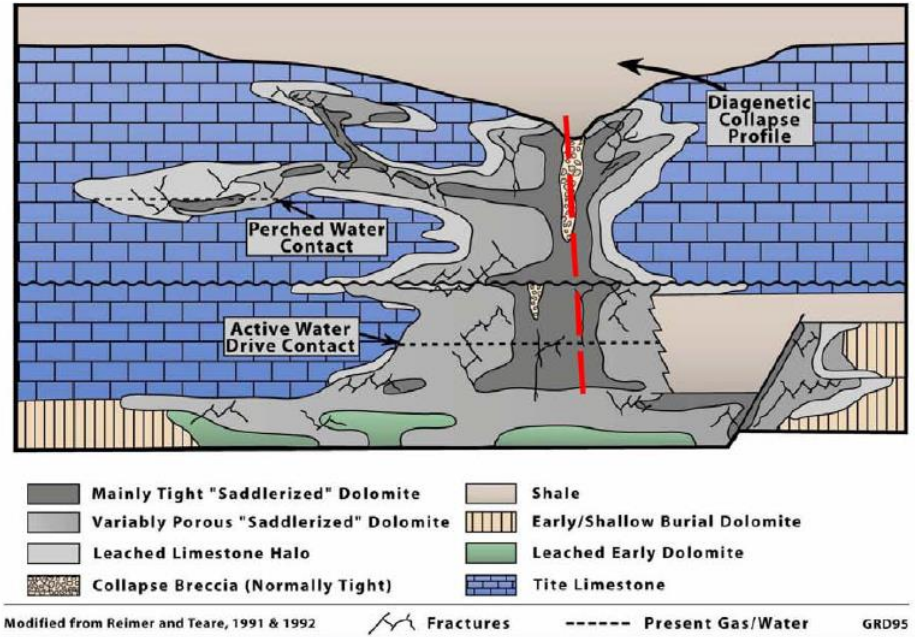


- MSc research at VU / EBN by Koos de Jong, project “Sea-Arm” (‘15-’16)

Distribution of Mid-Upp Devonian Carbonates (3)

recent seismic changes the map, plus indications for HTD reservoir ?

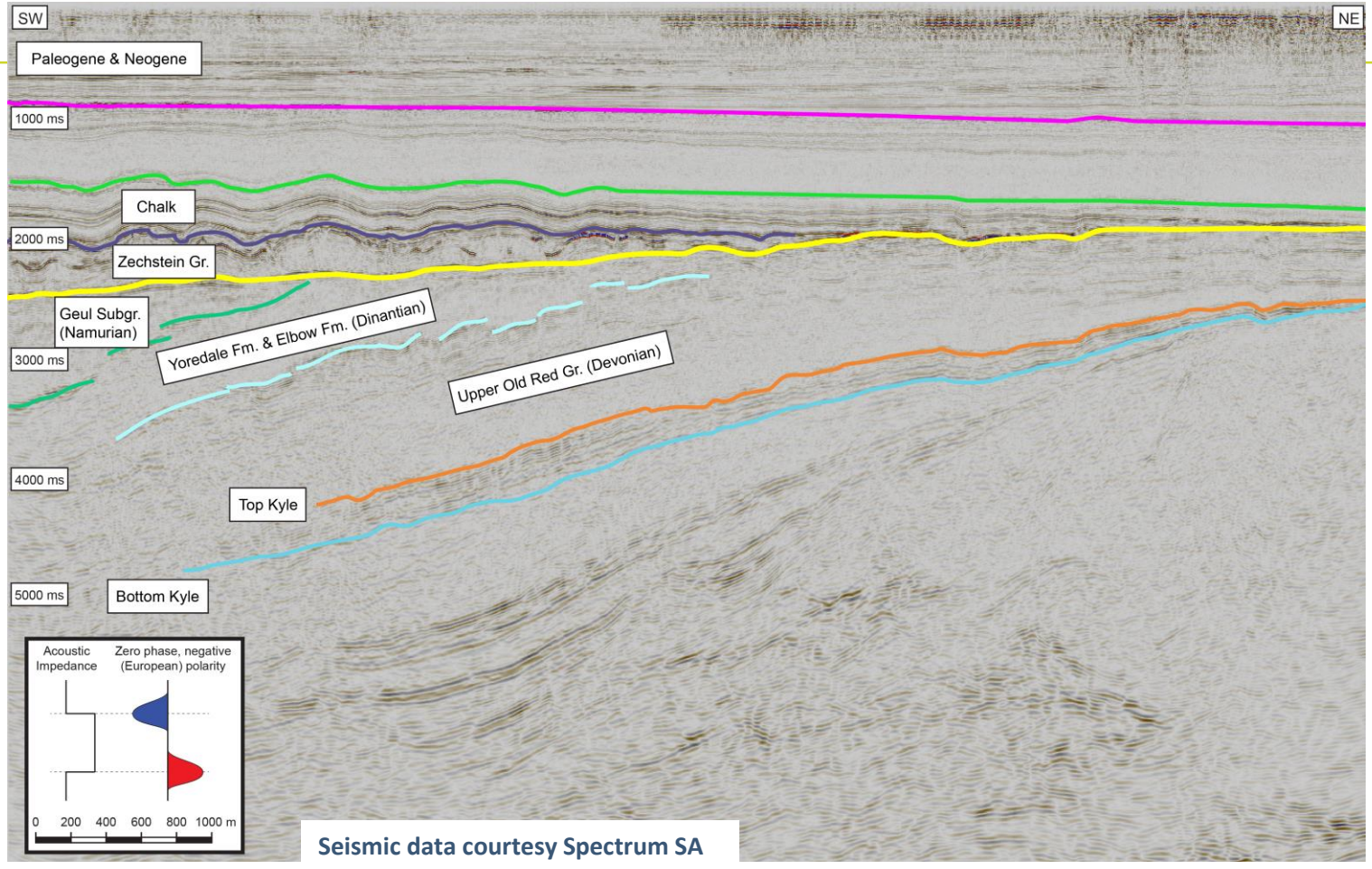




Paleogeographic reconstruction Middle Devonian
From de Jong et al. (2016)

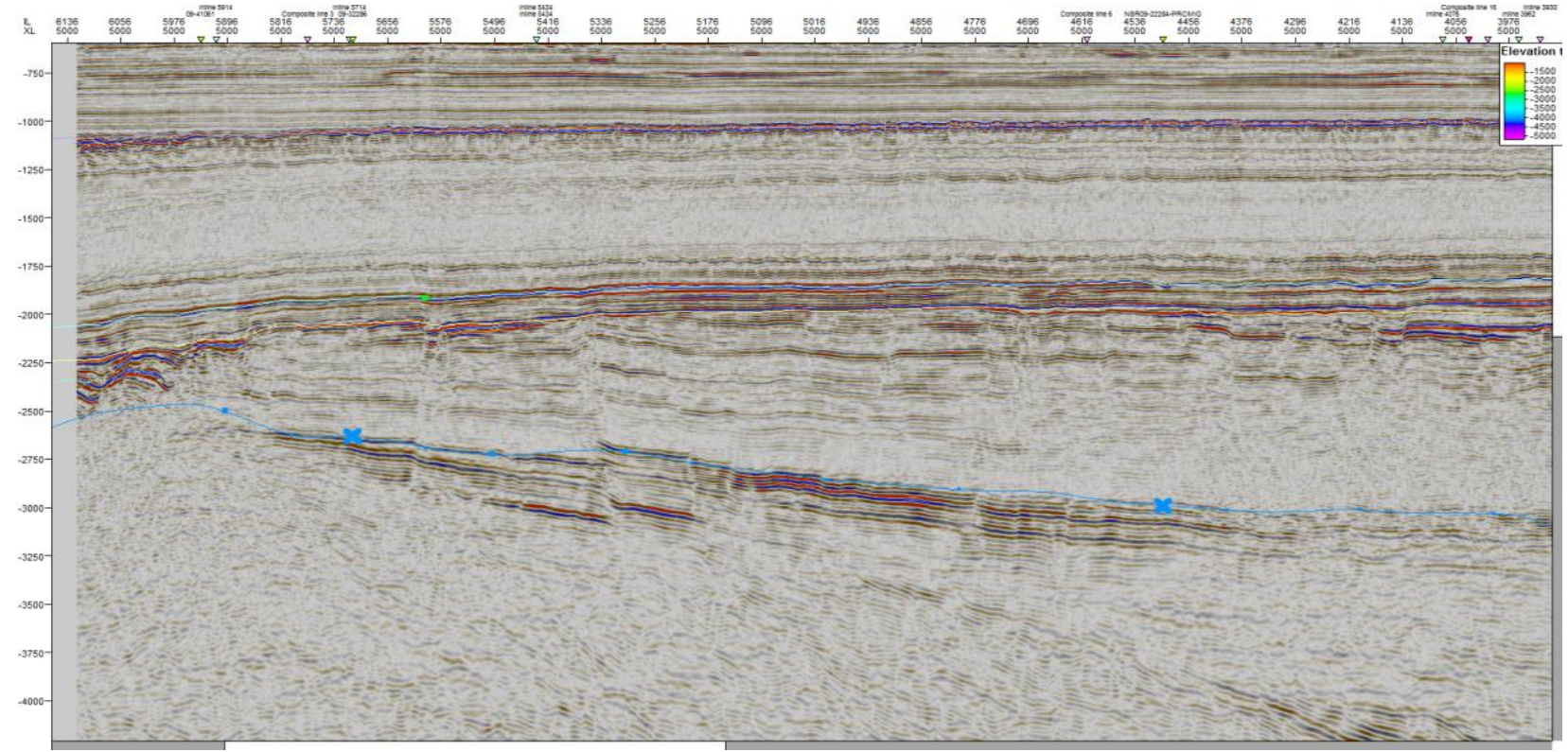
From Grammer et al (2010)
(Devonian Slave Point reservoir, Canada)

Kyle Lst Fm in recent 3D seismic (DEF)



Seismic data courtesy Spectrum SA

Kyle Lst Fm in recent 3D seismic (DEF)



Seismic data courtesy Spectrum SA

Devonian carbonates of the Kyle Limestone Fm

key play elements – similar to other carbonate petroleum plays

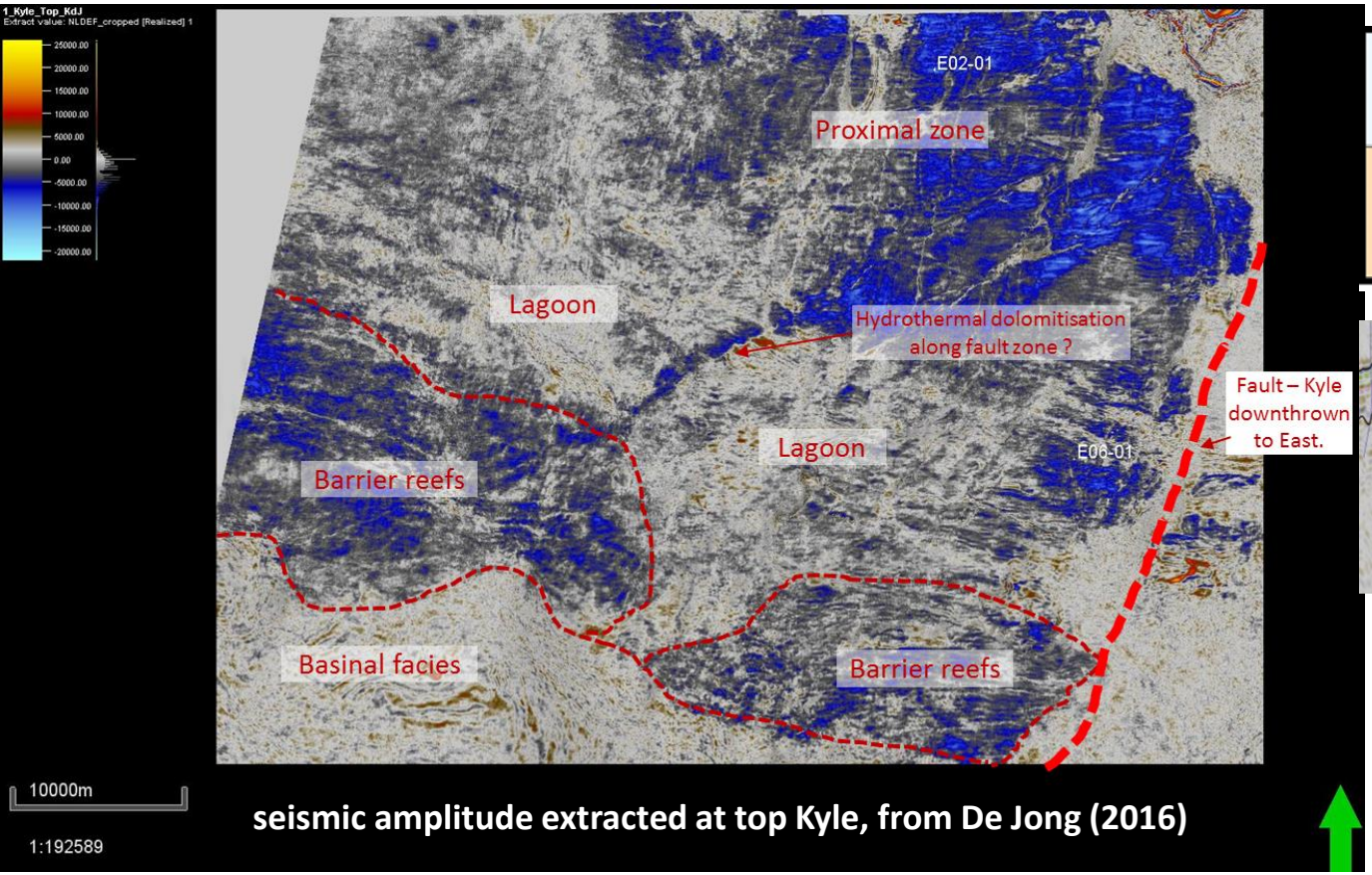
Trap	fault-dip closures and stratigraphic traps
Source	intra-Kyle Fm shales (i.e. self-sourcing)
Reservoir	Kyle Fm limestone (karstified / dolomitised / fractured)
Seal	Kyle Fm shales

Critical factors

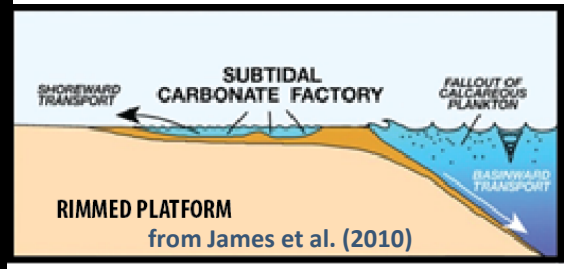
- Timing of karstification / dolomitisation (rifting / heatflow)
- Intra-Kyle source rock potential and timing of maturity
- Retention potential

Kyle Lst Fm (equivalent) in recent 3D seismic

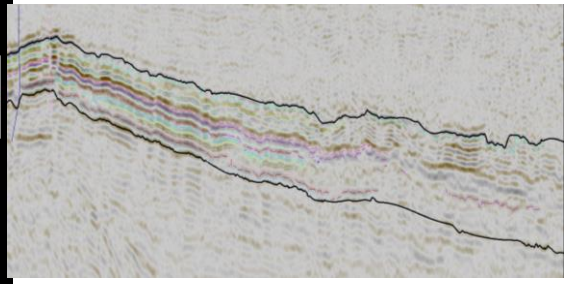
allowing for advanced seismic interpretation as part of project Sea-Arm



seismic amplitude extracted at top Kyle, from De Jong (2016)



from James et al. (2010)



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