Structural Impact of the Yarmouth Arch in the Central Atlantic Opening and on the Southwest Nova Scotian Margin Architecture (Southwest Nova Scotia 2011 PFA Expansion)*

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Abstract

This study on the Shelburne Subbasin is an extension of the Play Fairway Analysis done in 2011 on the Scotian margin. It is located on an under-explored area of the Scotian margin, which is a producing hydrocarbon region. This passive margin results of a complex tectonic evolution since Proterozoic time and the breakup of the Pangea at the end of Triassic (225-220 Ma). It follows the Central Atlantic opening with the rifting between the Nova Scotia and Morocco, the conjugate margin. The Shelburne Subbasin is bounded to the NE by the Georges Banks area which comprises the Yarmouth Subbasin and the Yarmouth Arch. The Yarmouth Arch is the structural high of the Georges Banks area and is a buried complex of approximately N-NE trending basement elements that are probably composed of Paleozoic metamorphic and plutonic rocks. It is bounded by a zigzag pattern of faults with two dominant directions: N-S and NE-SW. Moreover the Arch is oblique to the main extensional direction suggesting a possible right lateral transtensional structure along the East side. The Yarmouth Arch appears to have played an important role during rifting of the Shelburne Subbasin. Two trends of faults are recorded in the Yarmouth Subbasin: NS oriented and NE-SW oriented. From Early to Late Triassic, rifting of the Central Atlantic may have begun in the Yarmouth Subbasin, with the arch acting as a 'locked zone' forcing later periods of rifting to propagate across it. A layer of salt is deposited above the basement and is overlain by a thick carbonate layer. During the Mid-Triassic, the rifting propagates NE of the Yarmouth Arch. Thus, the Arch is segmented during the Triassic as a subaerial horst. From Mid-Triassic to Early Jurassic, the rifting propagates to the Shelburne Subbasin with a NE-SW tilted-blocks trend. Synrift sediments are deposited (Eurydice Formation) followed by a thick layer of salt (Argo Formation). At 200 Ma (Early Jurassic) the rifting decreases and the drifting stage begins. This transition, corresponding to the Breakup Unconformity, is associated with a strong volcanic episode (CAMP volcanics). The passive margin stage begins. The salt starts to creep during the Early to Mid-Jurassic due to sediment load over the entire subbasin. From Early to Late Jurassic, a new set of NW-SE strike-slip faults appear and accommodate the oceanic accretion. These faults will create the NE corner observed between the Yarmouth Arch and the Shelburne Subbasin which will be the Argos salt boundary.

Selected References

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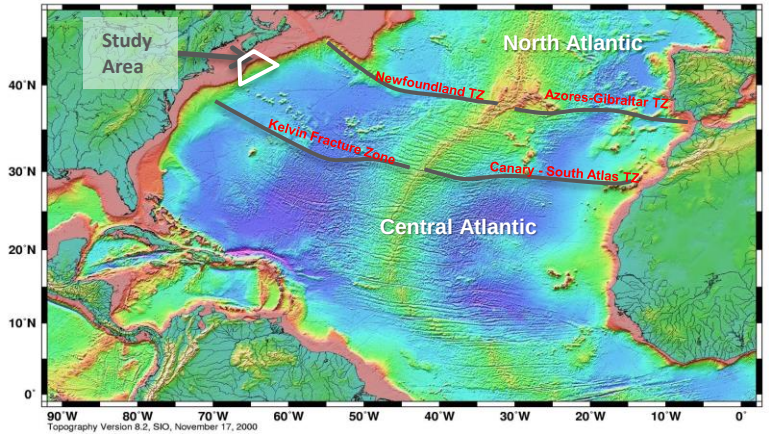
01 • Regional tectonic setting

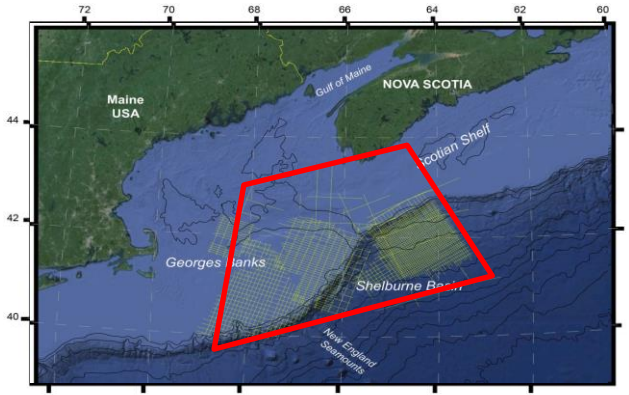
02 • Georges Banks and the Yarmouth Arch area

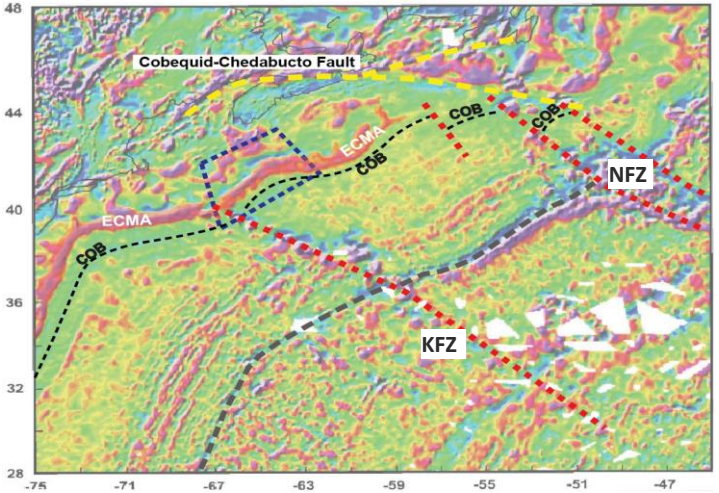
03 • Structural framework

04 • Summary and key messages

Regional tectonic setting



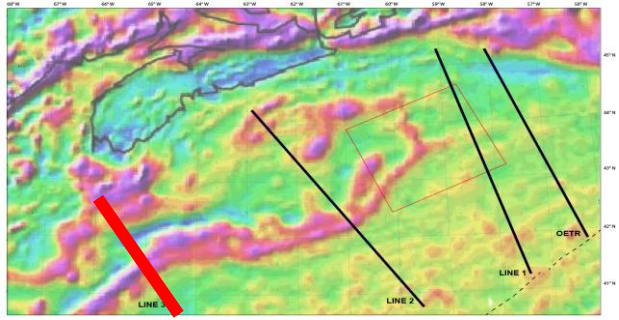




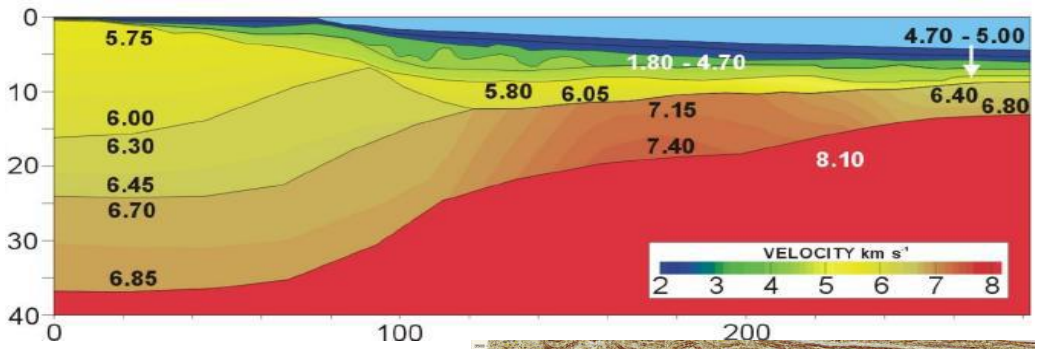
(Boillot & Coulon, 1998; Louden et al. 2010)

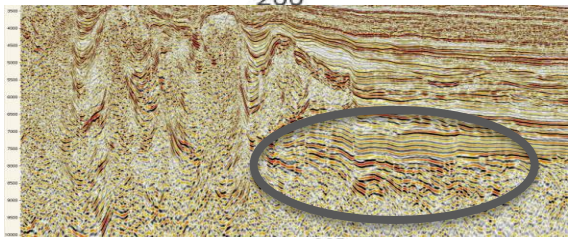
- Study area located between to transfert fault domains in the Central Atlantic (eastern canadian coast)
- Wide & shallow marine platform (50-100m)
- Steep and Narrow slope
- Structurally complex area

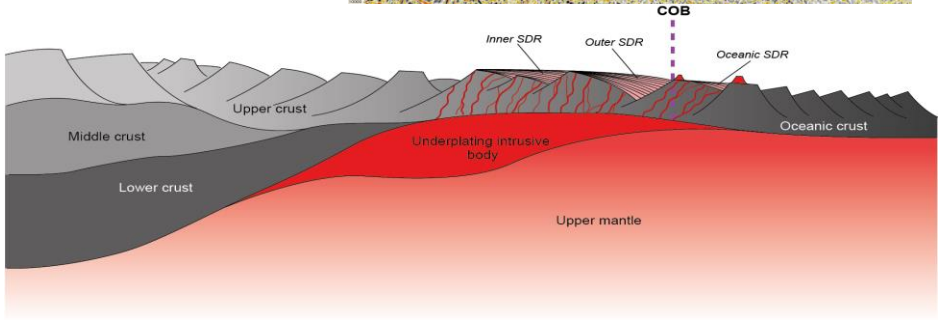
Regional tectonic setting



Magnetic anomaly map (Dehler, 2010)





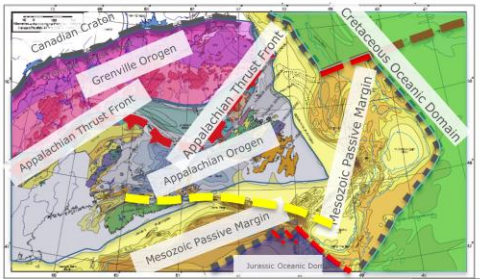


- Continental crust divided in 3 layers.
- Thinning of the continental crust from 36 to 5/6 km over a distance of 110 km
- Oceanic crust 6 km thick
- High velocity body under the ECMA

  → **underplating intrusive body**
- Thick SDR wedge
- **Typical volcanic margin**

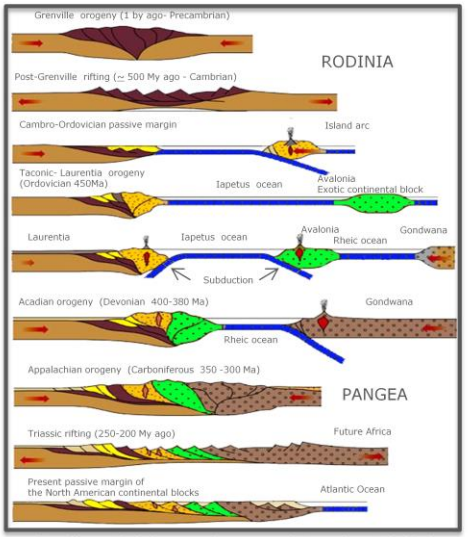
Regional tectonic setting

- Margin inherited from a long story of rifting and orogeny



Modified from Williams & Grants, 1998

- Grenville Orogeny (1000Ma)
  => Rodinia supercontinent
- Post-Grenville Orogenic rifting (~ 500Ma)
  => Iapetus Ocean
- Taconic Orogeny (450 Ma)
  => Beginning of Iapetus Ocean subduction
- Acadian Orogeny (400-380 Ma)
  => Rheic Ocean subduction
- Apalachian Orogeny (350-300 Ma)
  => Pangea supercontinent
- Post Orogenic collapse (250-200 Ma)
  => Atlantic Ocean rifting



https://mountainbeltway.wordpress.com/category/west-virginia/

Presenter's notes: Nova Scotia margin results of a complex evolution since Proterozoic with a succession of orogeny/ rifting stages with the rifting of the Central Atlantic during the Triassic.

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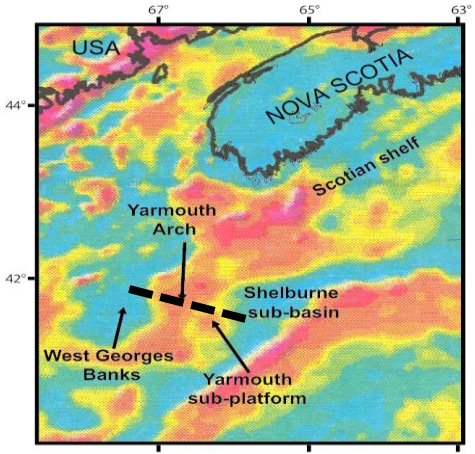
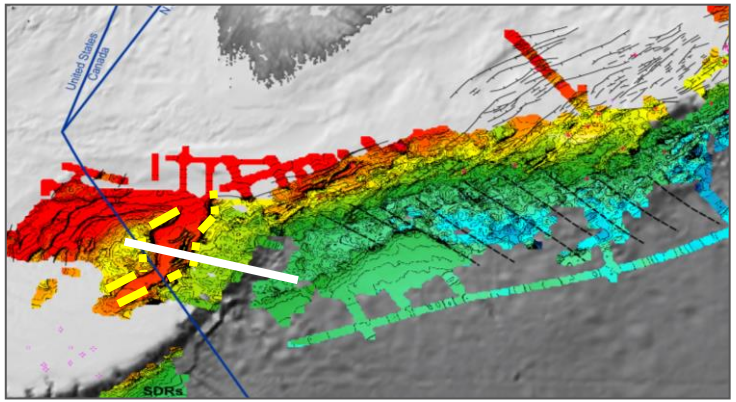
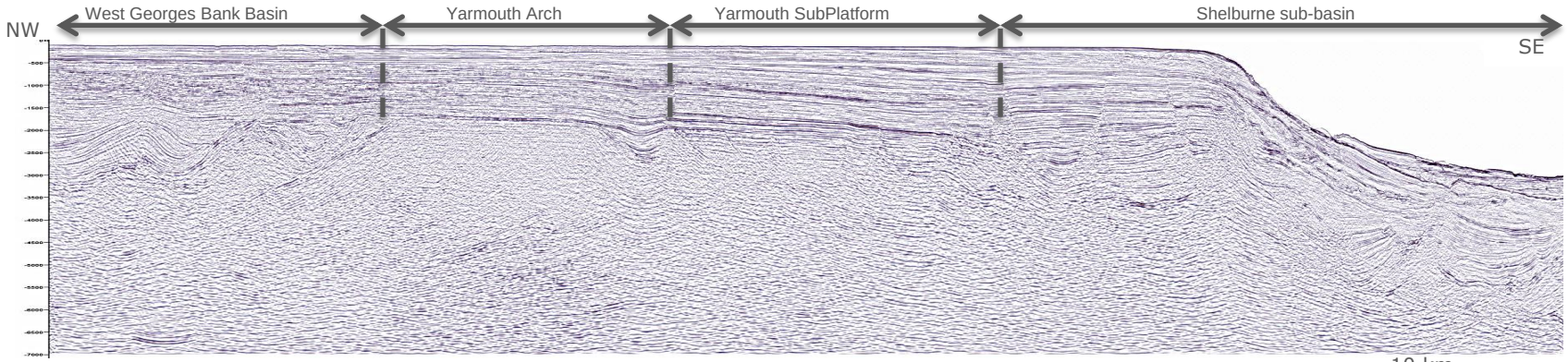
Georges Banks and the Yarmouth Arch framework



Hinze et al., 1998

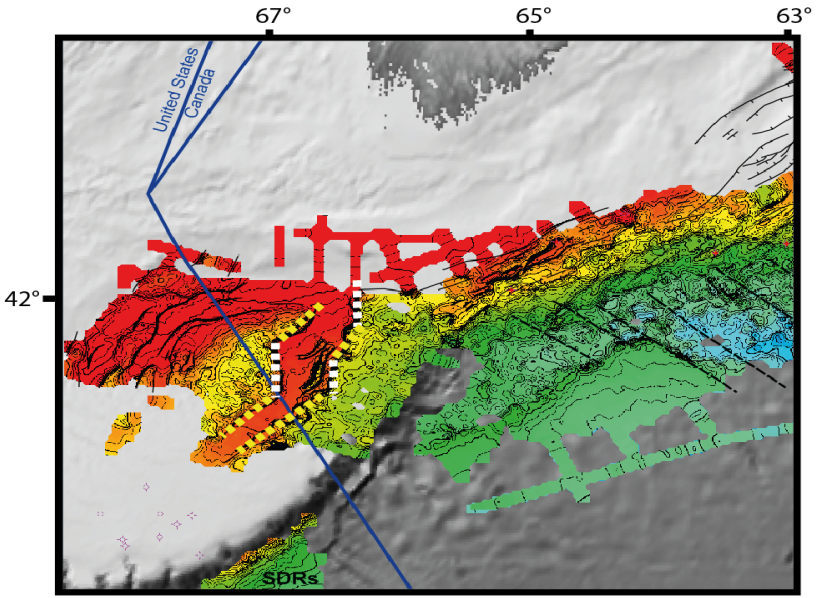


Deptuck & Kendell (in prep)



Line JGM 224

Georges Banks and the Yarmouth Arch framework



- The Yarmouth Arch made of Palezoic Unit

→ **When the arch has been formed?**

- Two direction of faults (zig-zag) bounded the Yarmouth Arch

→ **Pre-existing Faults?**

- Oblique to the main extensionnal direction .

→ **What is the role played by the arch during the Rifting?**

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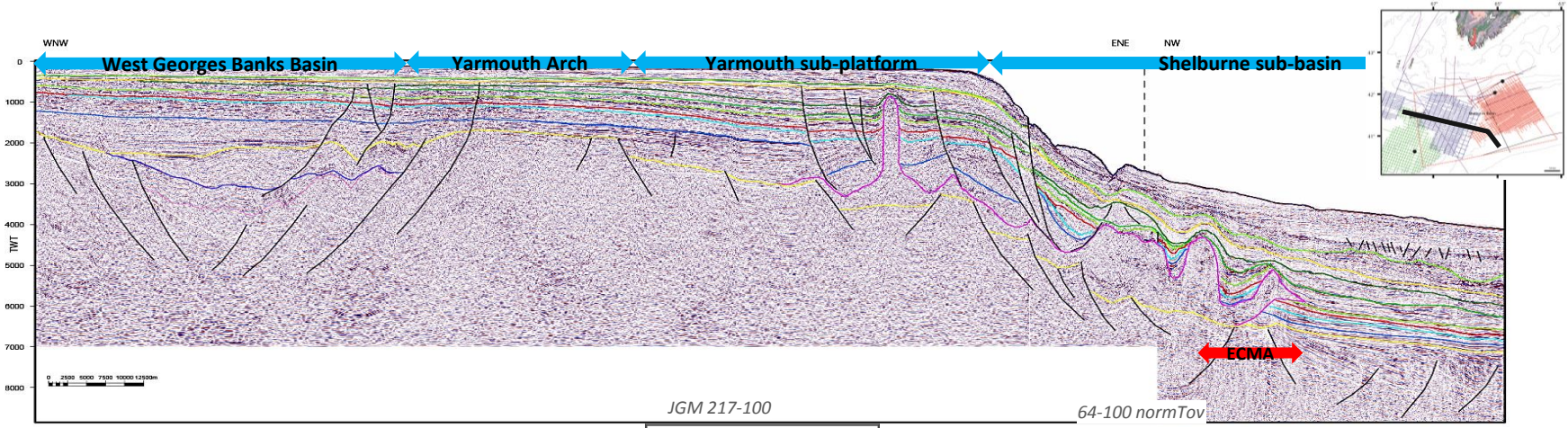
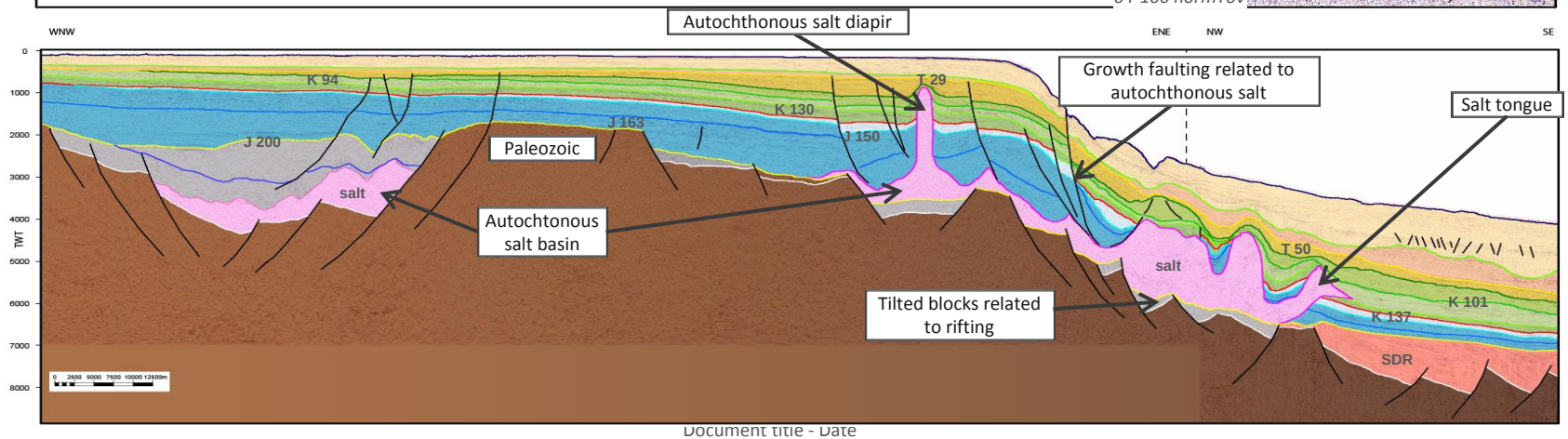
Structural framework





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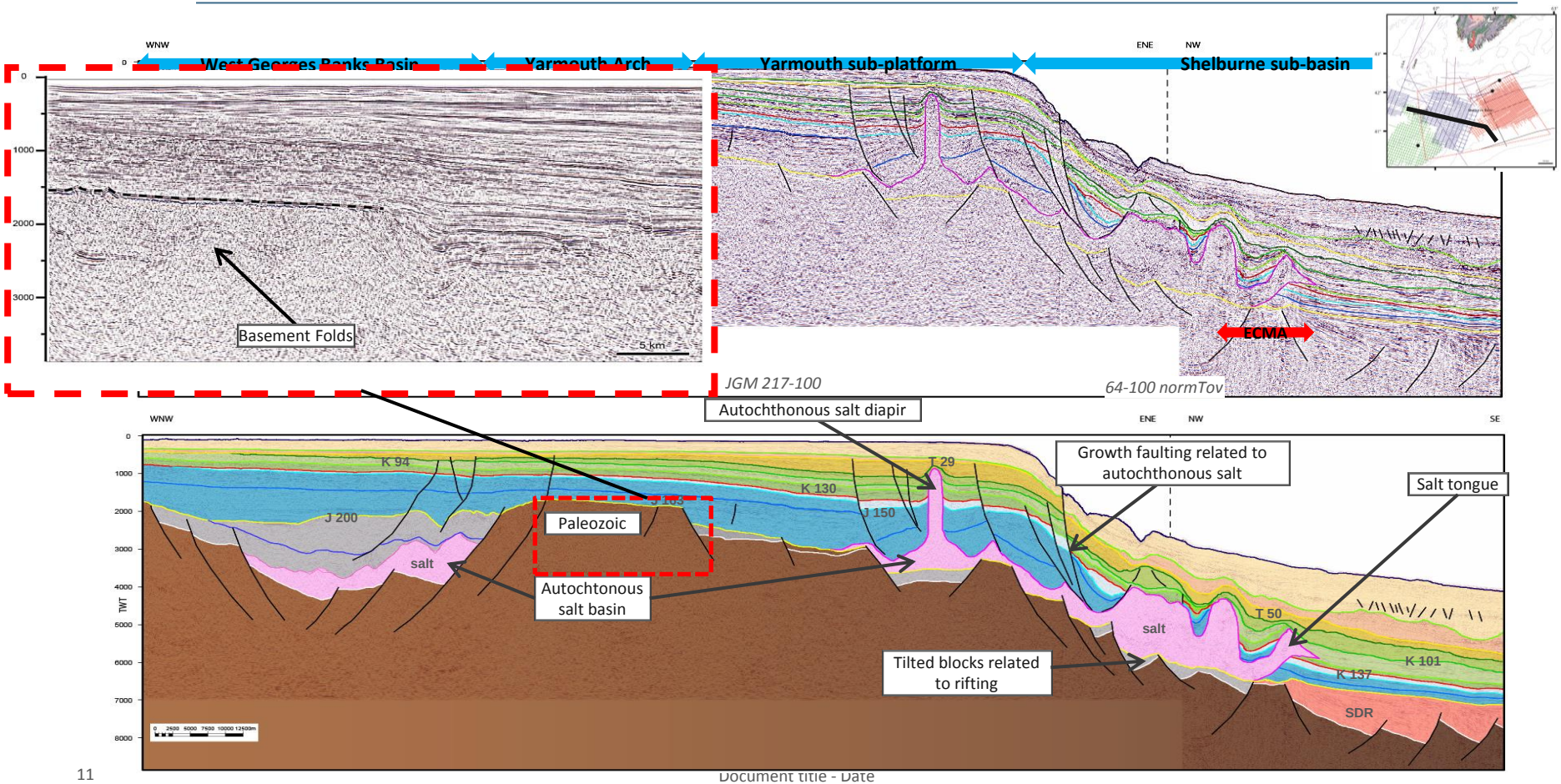
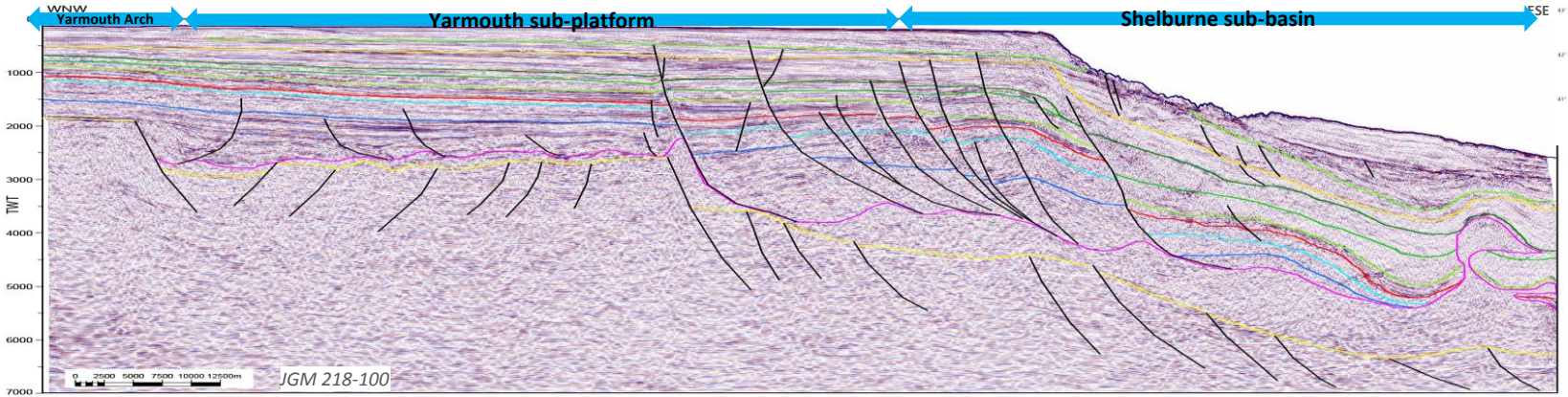
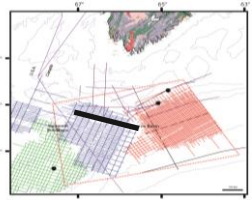
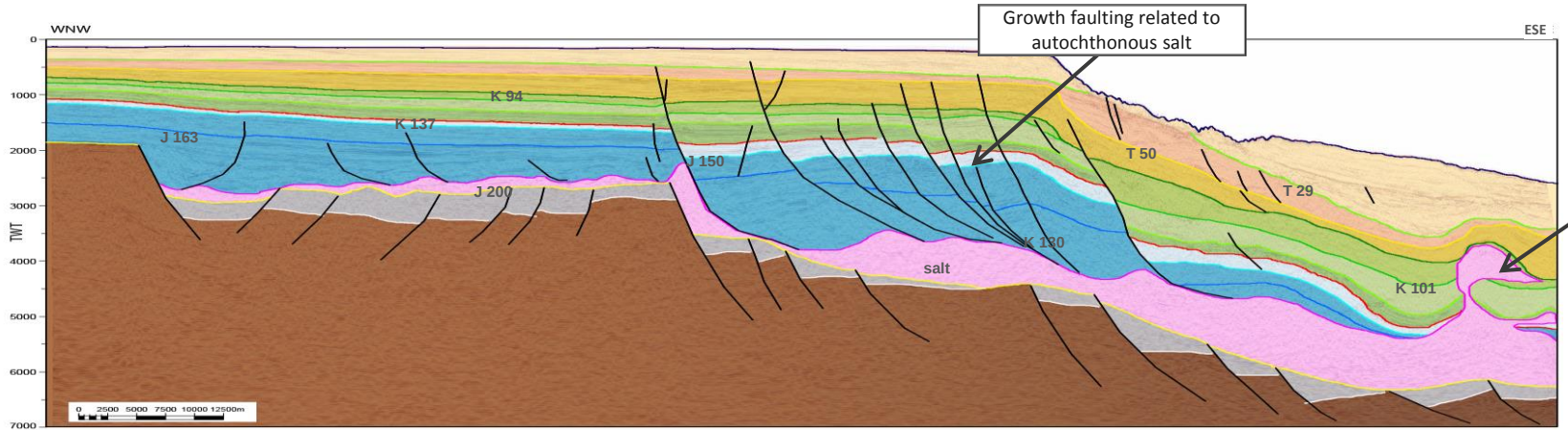


Structural framework







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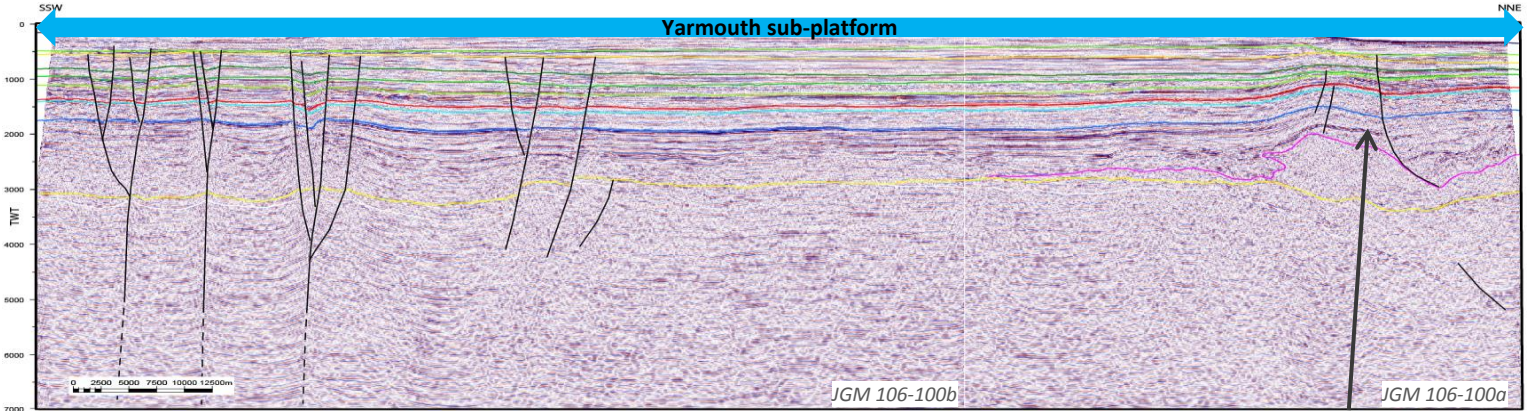

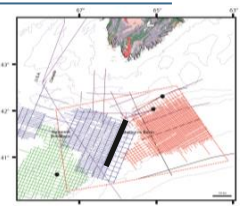

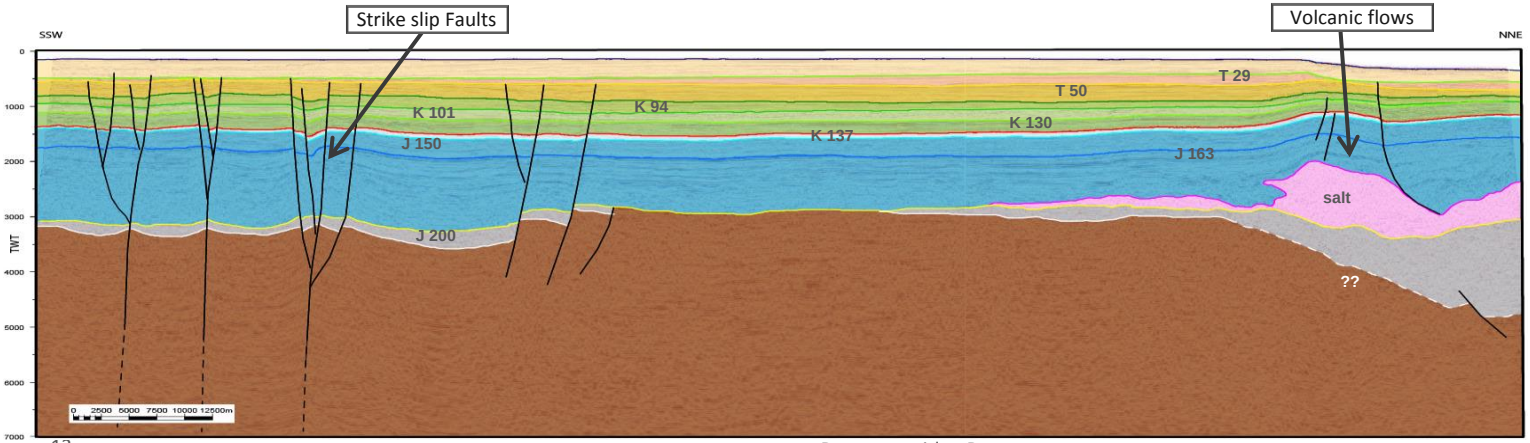

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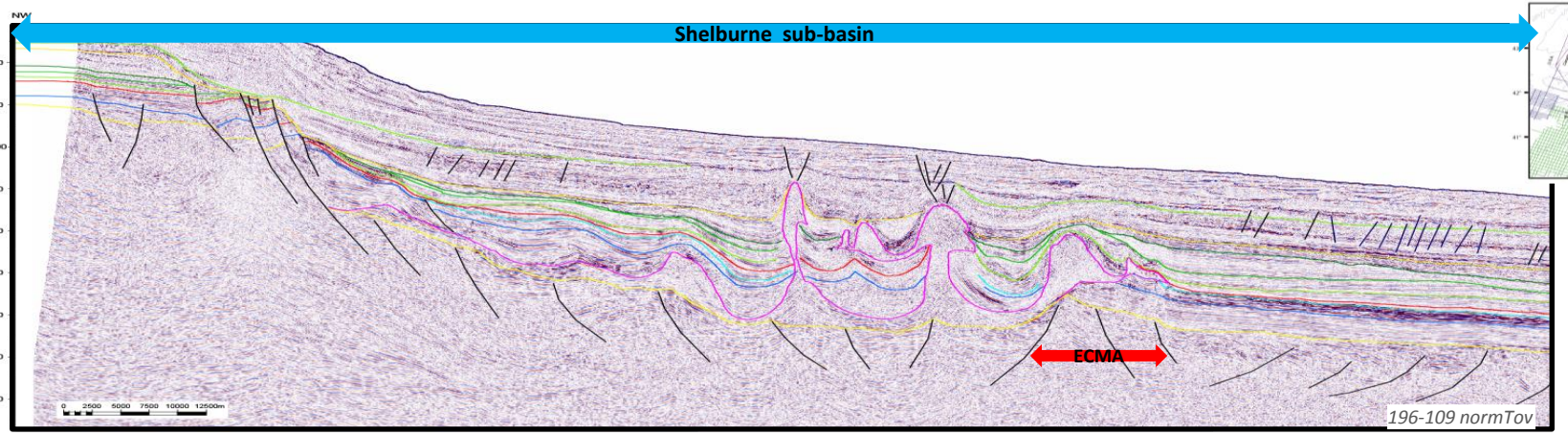

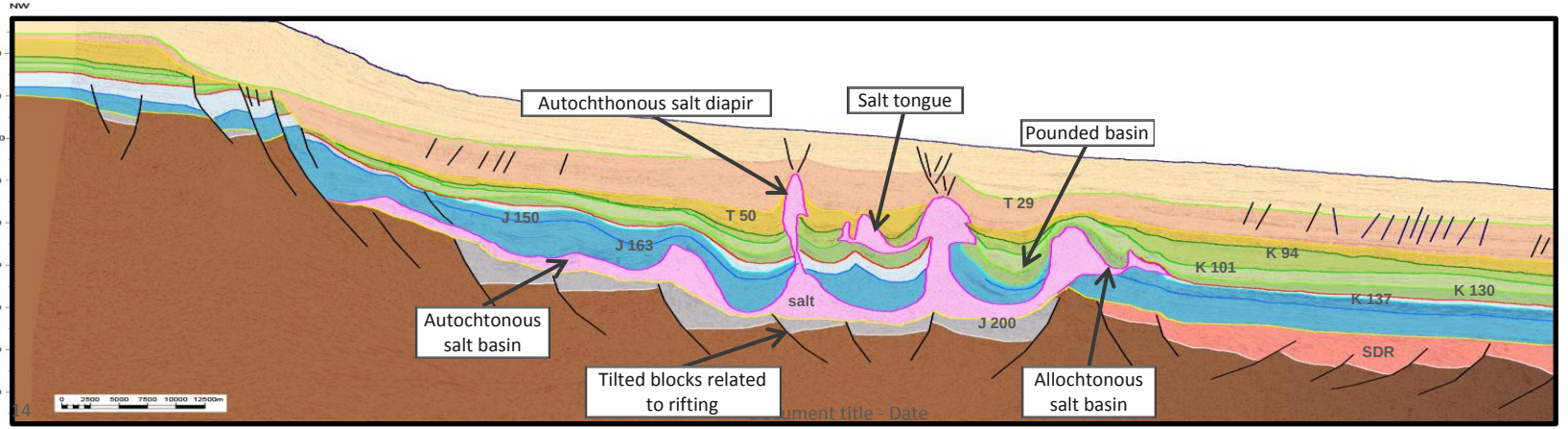

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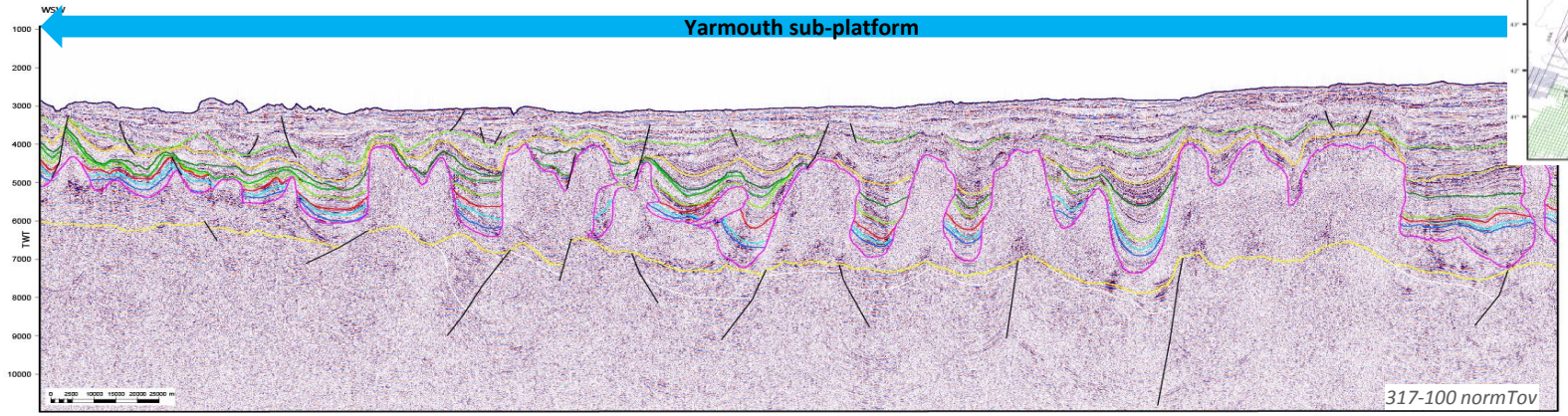

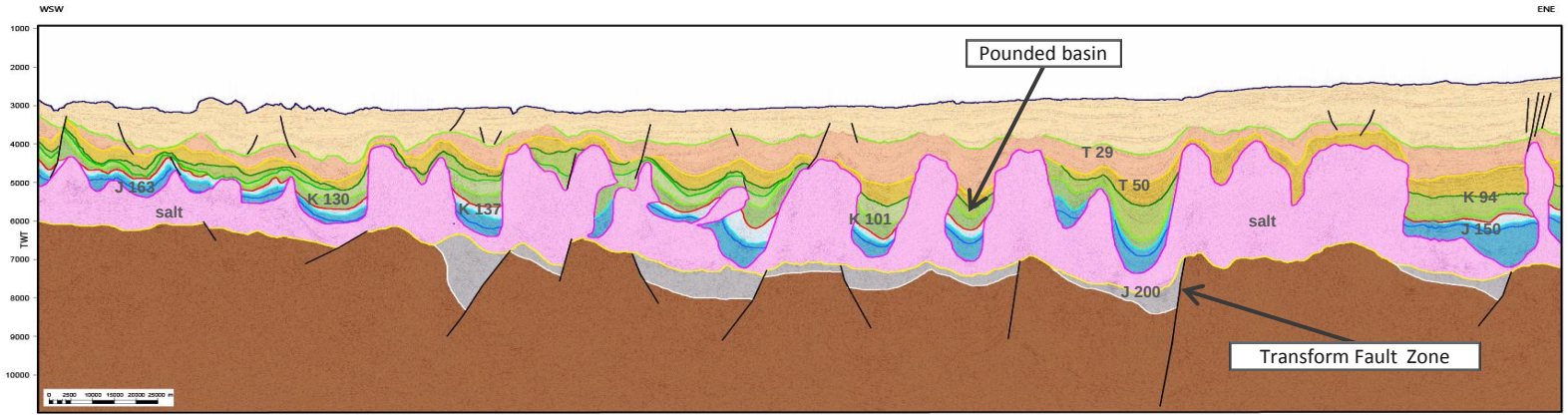

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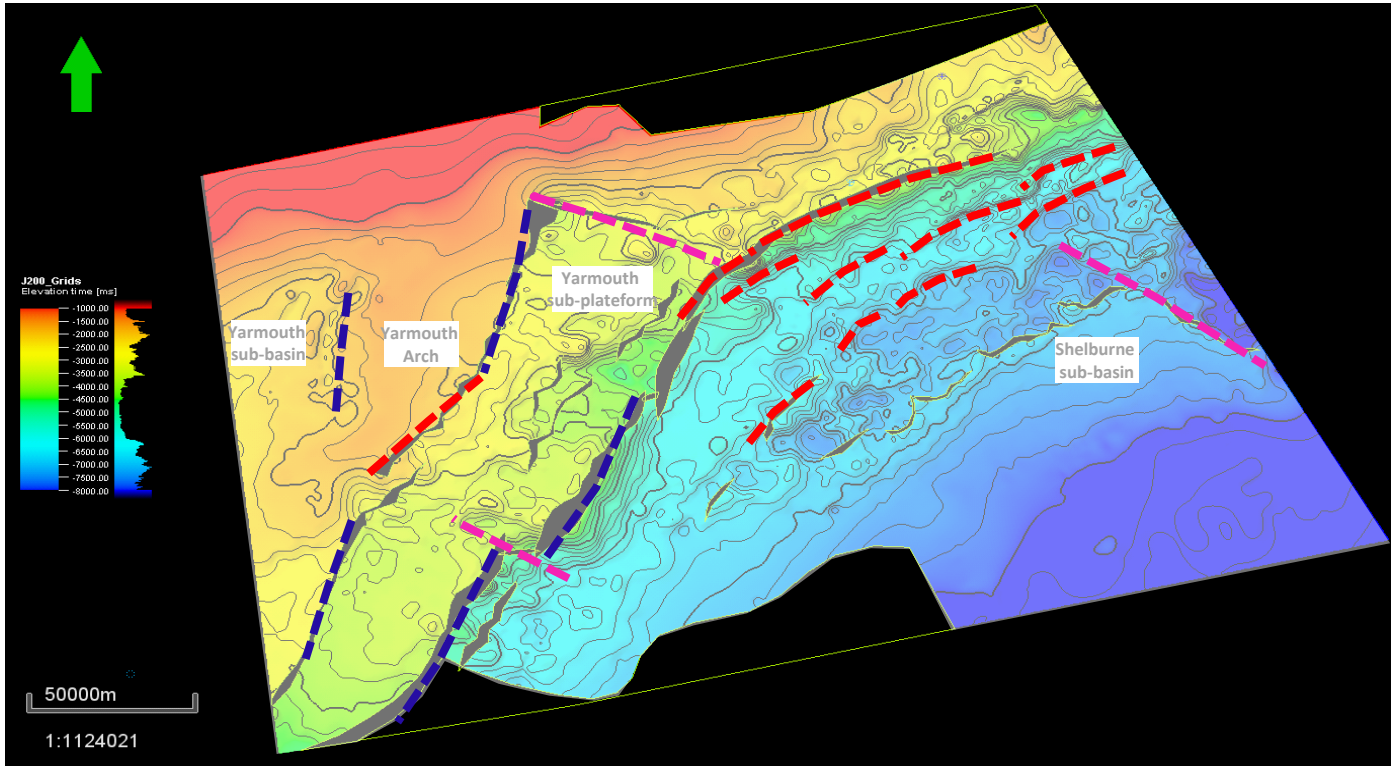

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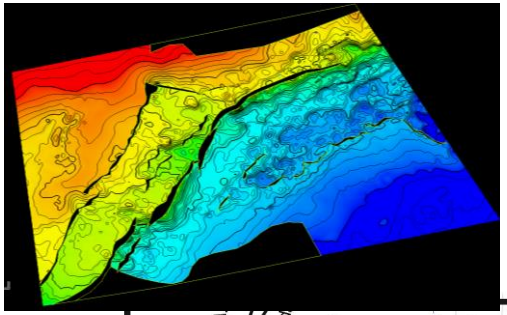
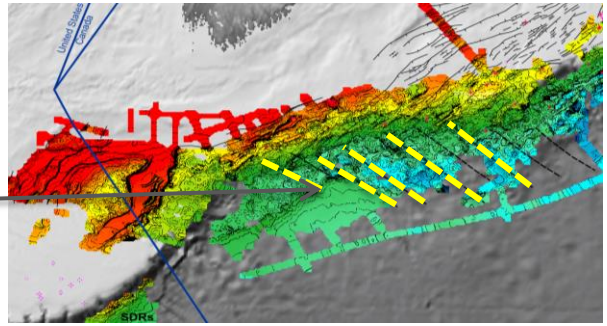
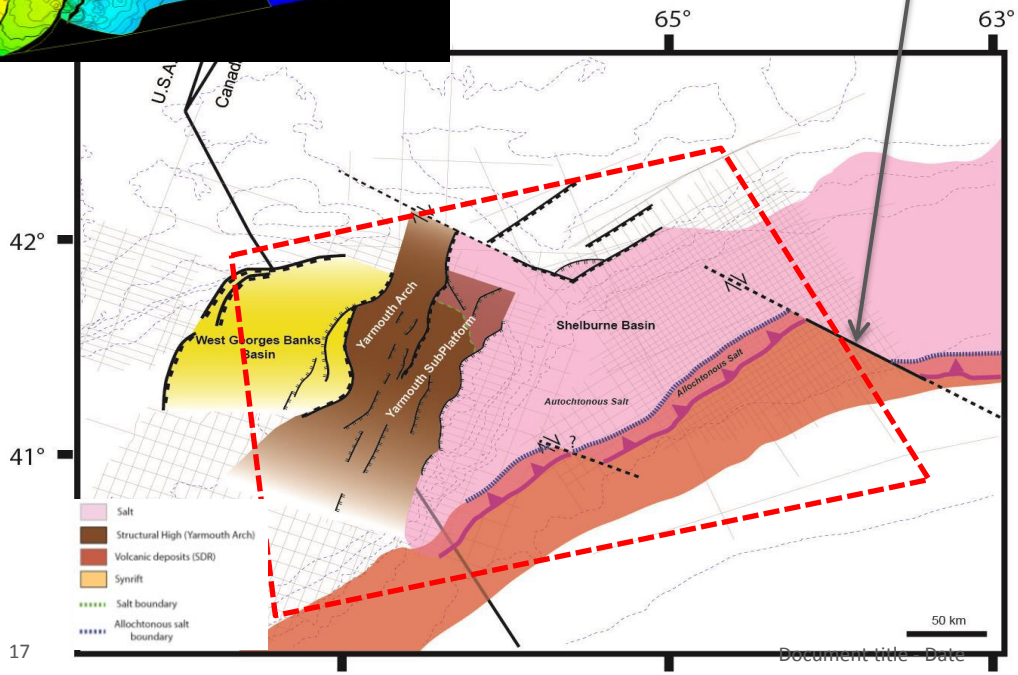




Deptuck & Kendel (in prep)

NW-SE Transform Fault



- **Yarmouth Arch**: structural high bounded by zig-zag faults pattern inherited (N-S) & new-formed (NE-SW)
- **Yarmouth Subplatform**: individualized to the North by Steep fault and partially cover by autochthonous salt.
- **Shelburne sub-basin**: rifted basin with two trend of thick-skinned deformation faults (NE-SW & NNE-SSW) and also affected by thin-skinned deformation (salt creeping)
- **Autochthonous Salt Basin** : highlight the transform faults (NW-SE) inherited from drifting stage

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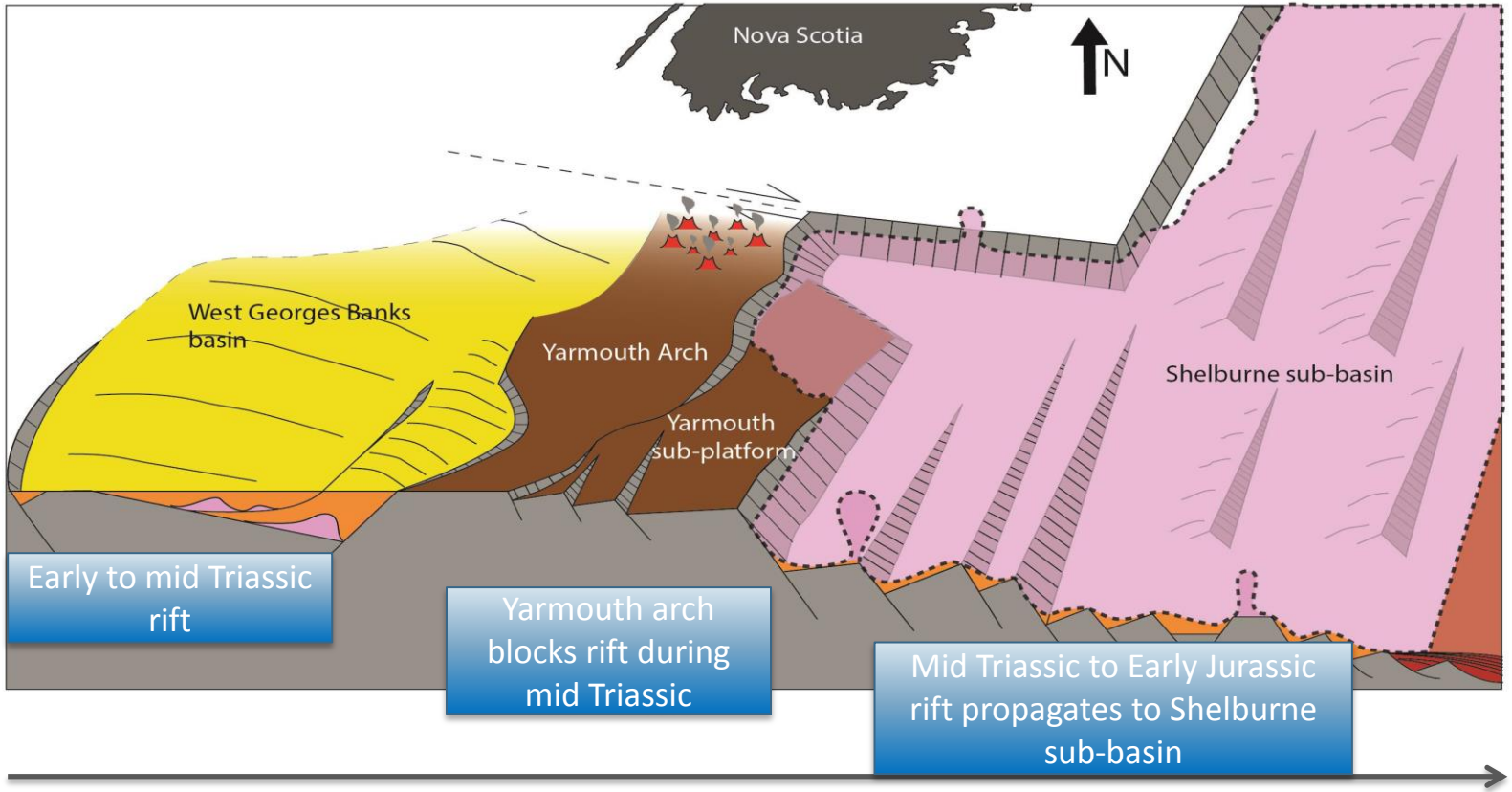
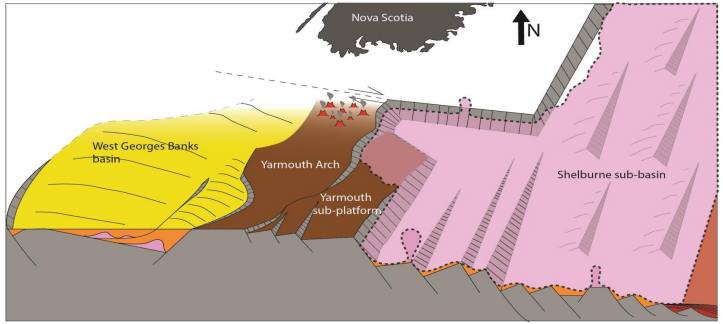
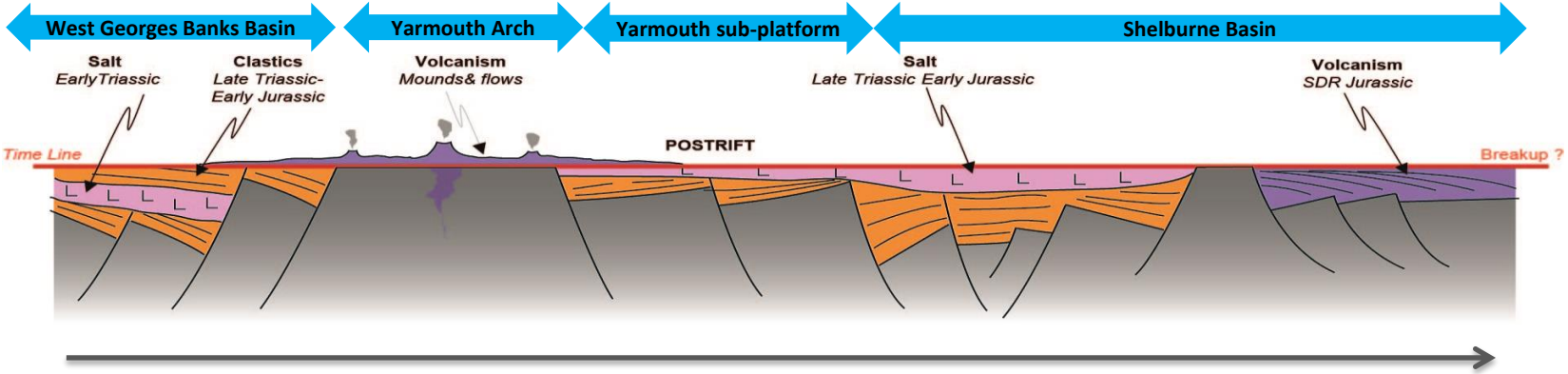
Summary and key message



Summary and key message



- **Early Late Triassic**: beginning of the Central Atlantic rifting (West Georges Banks basin) with to trends of faults (N-S and NE-SW). Thick salt layer deposit above the basement
- **Mid-Triassic:** propagation of the rifting to the North-East. As the Yarmouth is a strong inherited structure (Palaeozoic), the rifting propagate overt it. The Arch acts as a "locked zone" is a subaerial horst.
- **Late Triassic:** end of rifting, beginning of drifting. A strong volcanic episode highlight this transition between two stages.



Propagation of the extension from the SW to the NE.

Summary and key message

- 3 sets of faults have been observed and corresponding to :
  - - N-S pre-existing faults reactivated on right lateral transtensional motion
  - - NE-SW trend due to the Central Atlantic opening
  - - NW-SE trend resulting from the drifting stage
- Propagation of rifting from SW (West Georges banks sub-basin) to the NE (Shelburne sub-basin) between the Early Triassic and Late Triassic
- Yarmouth Arch individualized during the Triassic rifting of the Central Atlantic: at that time is a subaerial horst.
- Yarmouth Arch is a strong structural high which plays the role of a ″locked zone″ (Courtillot,1988): rift propagate on each side.

Thanks for your attention