Numerical Modeling of Cenozoic Basin Inversion of the Western Barents Shelf*

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Abstract

Numerical modeling of inversion and reactivation of pre-existing faults induced by Eocene - Miocene tectonic stress fields is presented. Our goal is to reconstruct stress evolution and to investigate the recorded tectonic inversion events in the western Barents Sea during Eocene and Miocene. We used a finite-element numerical code, ANSYS™, to simulate stress and fault slip patterns based on two 2-D thin plate modeling setups. Following previous works, we assumed two major regional inversion events: dextral megashear plate margin in Early Eocene (Model 1) and NW-SE Atlantic ridge push starting in Miocene (Model 2). The results obtained in Model 1 suggest that the interior of the western Barents Sea was not severely influenced by Early Eocene North Atlantic opening/shearing. The results suggest that Early Eocene sea floor spreading caused stress partitioning along the Senja Fracture Zone. The observed inversion structures may be related to local effects. The results of Model 2 appear to be in agreement with the observed NW-SE contraction, expressed as folds and reverse faults in the study area (e.g. Ringvassøy – Loppa, Bjørnøyrenna, Leirdjupt and Asterias fault complexes). Results of two models suggest presence of compressive structures along the major fault complexes of the western Barents Sea during Miocene but do not favor the development of inversion structure during Eocene.

Selected References

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Tsikalas, F., O. Eldholm, and J.I. Faleide, 2002, Early Eocene evolution of the Vøring and Lofoten-Vesterålen passive volcanic margins in a conjugate setting: Search and Discovery Article #90022, AAPG Hedberg Conference, September 8-11, 2002, Stavanger, Norway, Web Accessed October 21,2018, http://www.searchanddiscovery.com/abstracts/pdf/2002/hedberg_norway/extended/ndx_tsikalas.pdf

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Outline of presentation

Phase I

- Introduction of study area
- Development of structural features
- Multi-stage basin inversion

Phase II

- Methodology & tool
- Results
- Comparison

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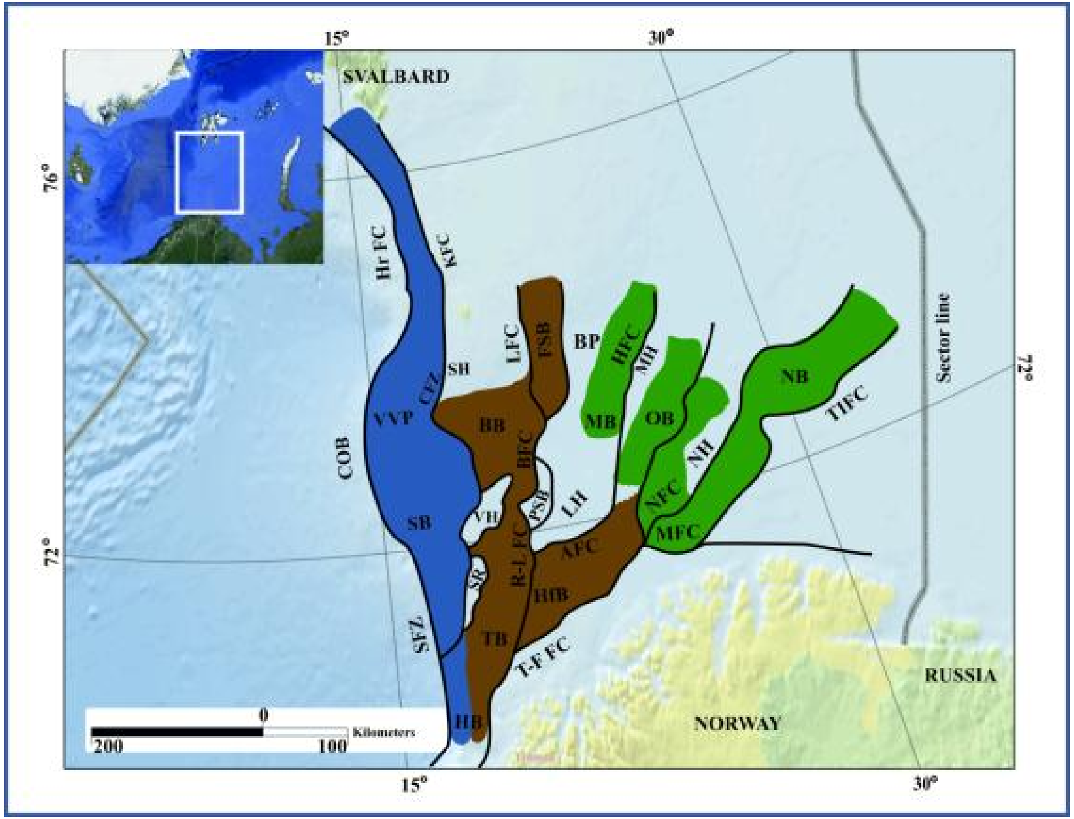
Formation of Geological Structures

- Carboniferous - Permian
- Late Jurassic – Early Cretaceous
- Late Cretaceous - Paleocene



Google maps and NPD fact maps http://gis.npd.no/factmaps/html_20/

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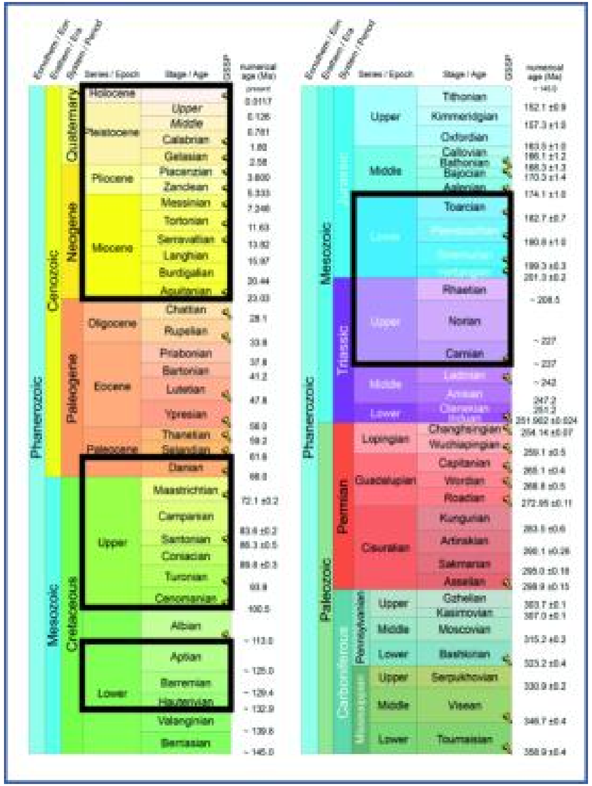
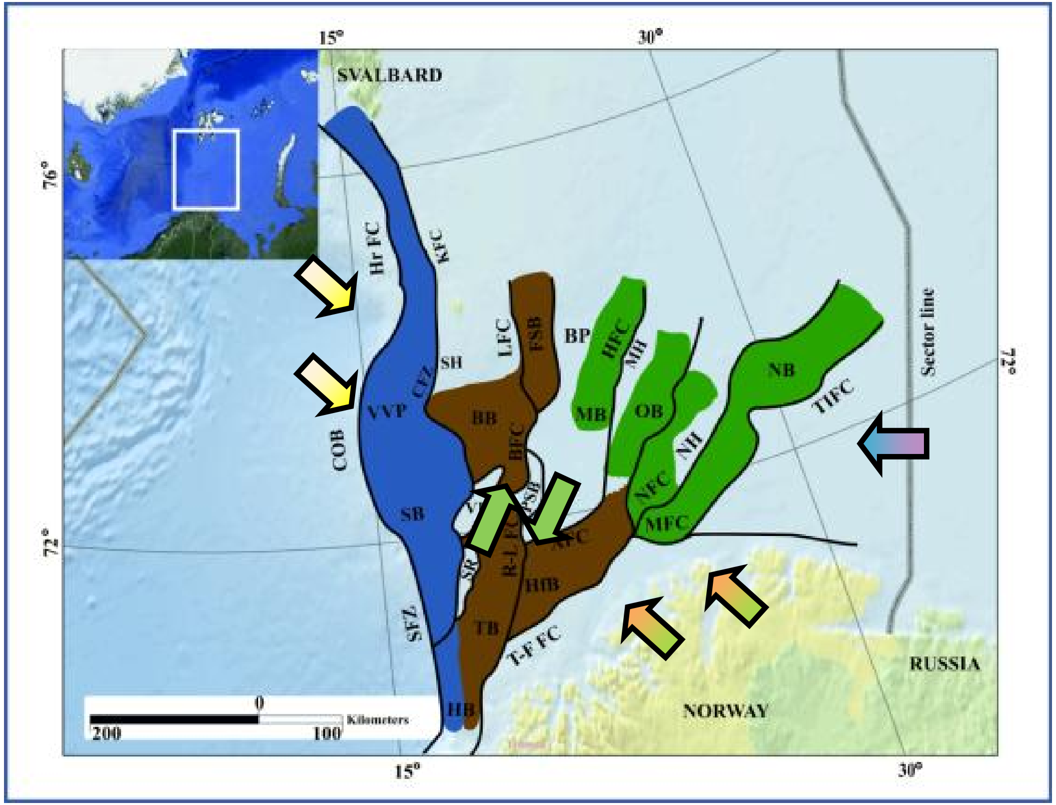
Inversion events in the western Barents Sea





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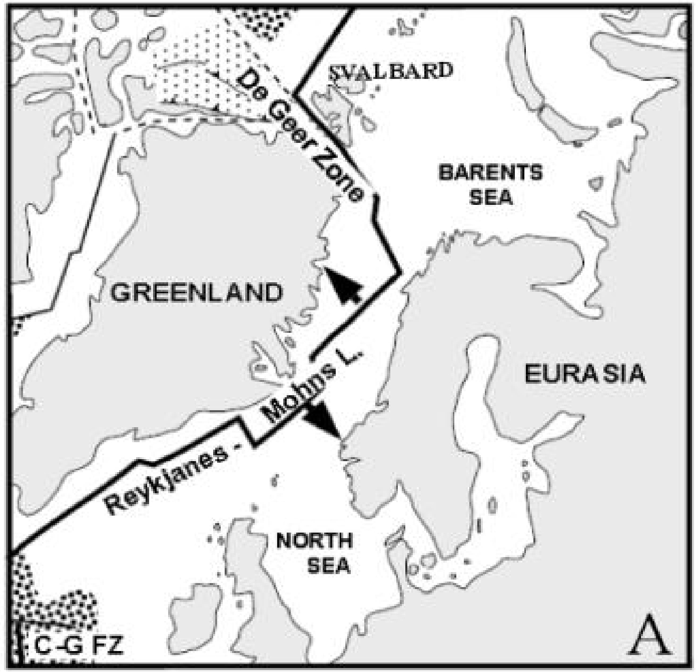
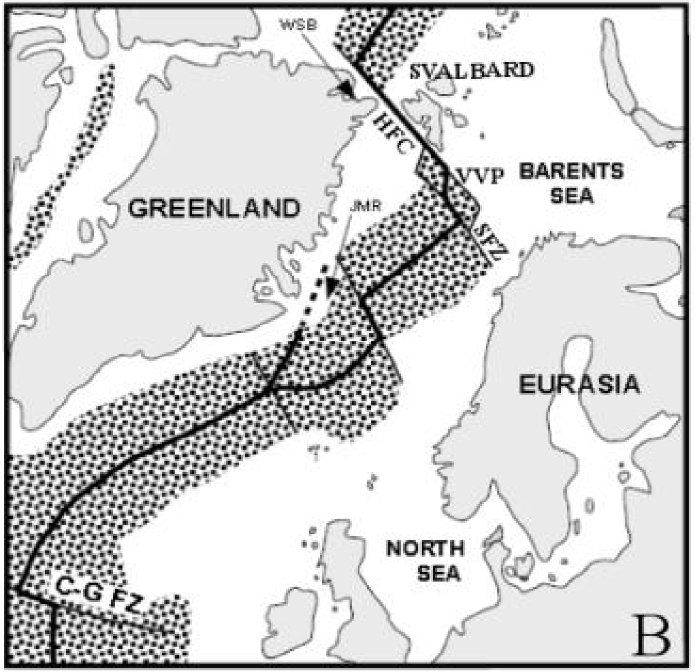
Early Eocene North Atlantic opening



Early Eocene pre breakup



Post Eocene extension

- To investigate the causes and effects of Cenozoic inversion events in the western Barents Shelf.
- To predict stress patterns for tectonic inversion during Early Eocene and Miocene.

Numerical Modelling Approach

- With the purpose of calculating horizontal stress patterns in the study area, 2D linear elastic models involving contact elements were generated using the **ANSYS Workbench**.

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Boundary conditions

Model 1; Early Eocene (Tsikalas et al. 2002)

Model 2; Miocene to recent (Doré and Lundin 1996)

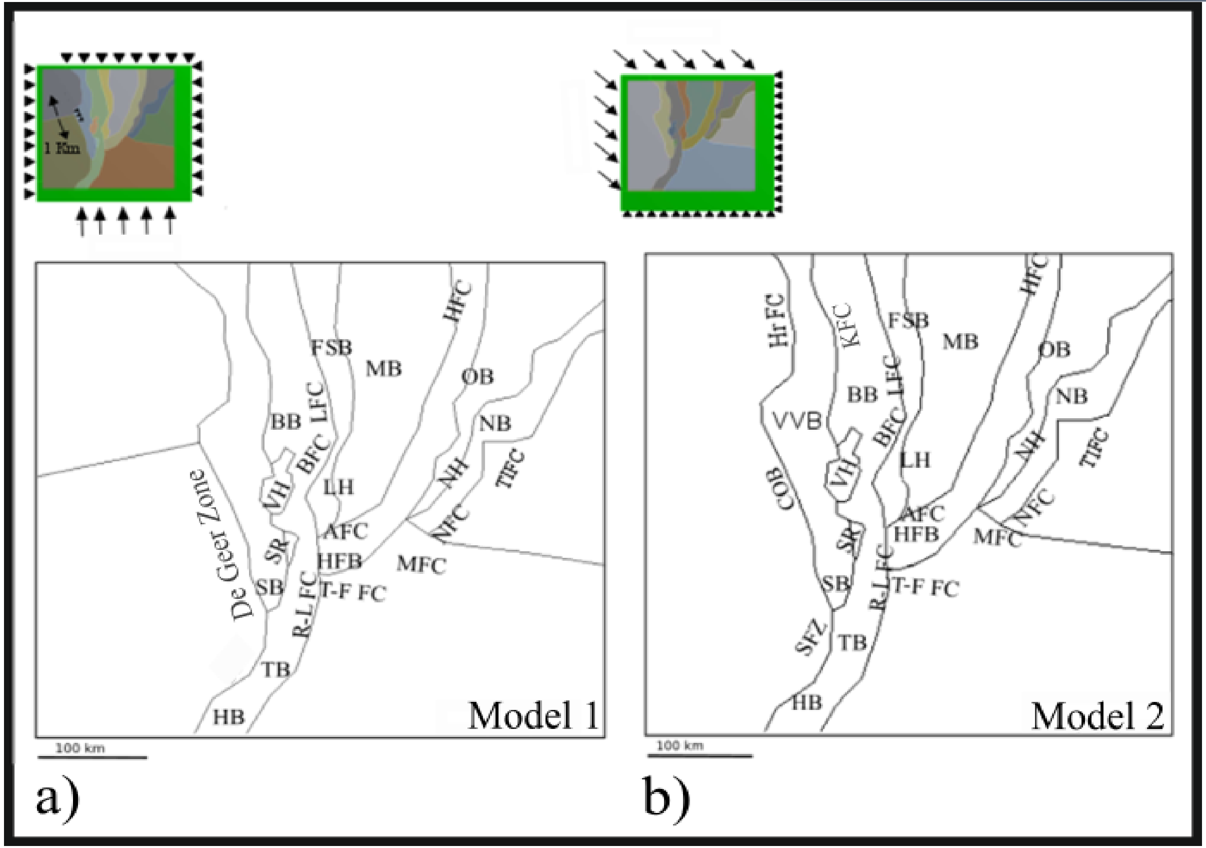
Material properties

Young's Modulus (E) 100 & 60 GPa

Poisson's ratio 0.25

Friction coefficient (μ) 0.1

Normal stiffness (FKN) 1



Pascal and Gabrielsen 2001

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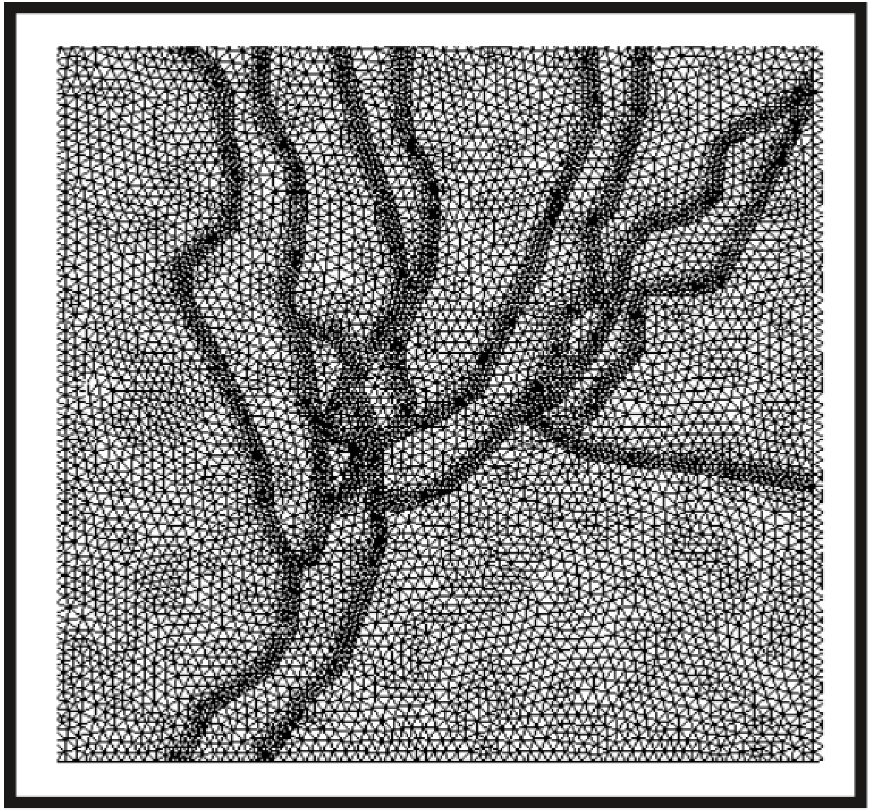
Meshing

Models mesh with refinement along the faults with ~20000 triangular elements with mid-nodes and approximately ~3000 contact elements.



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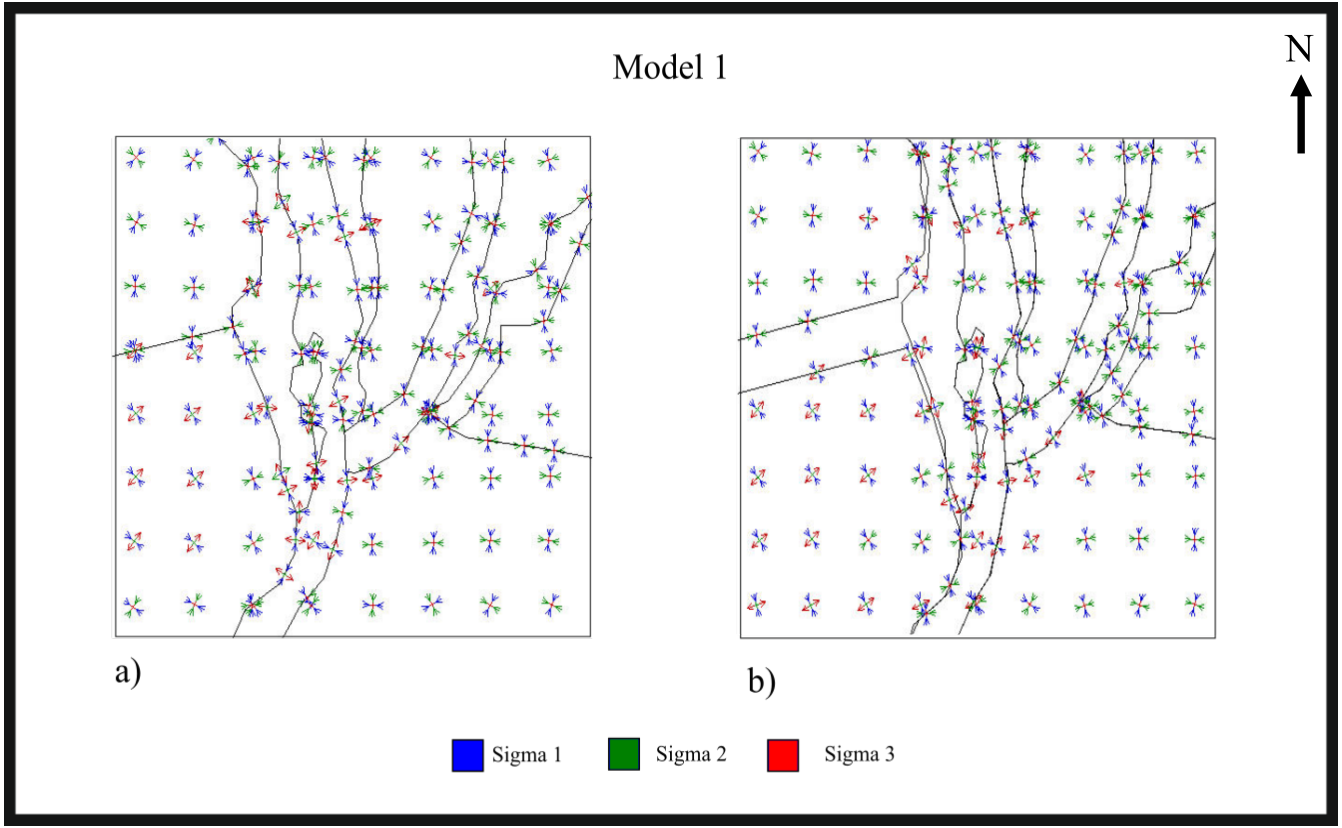
Results (*Model 1)*

Early Eocene



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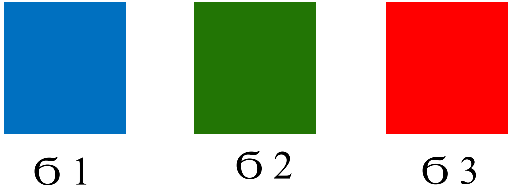
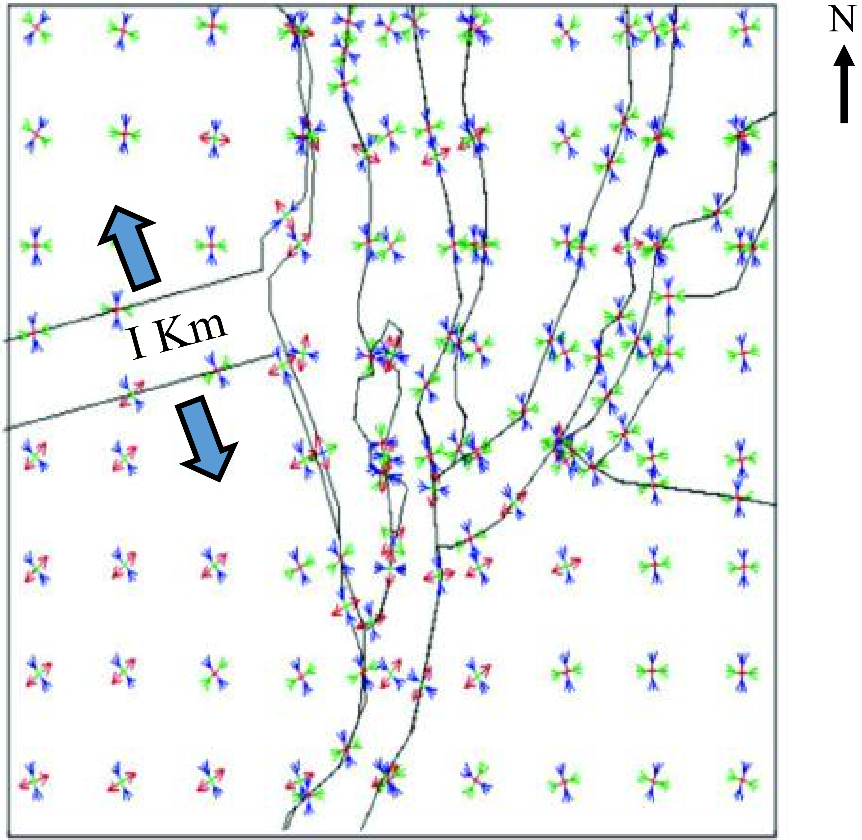
Results (*Model 1)*

Early Eocene





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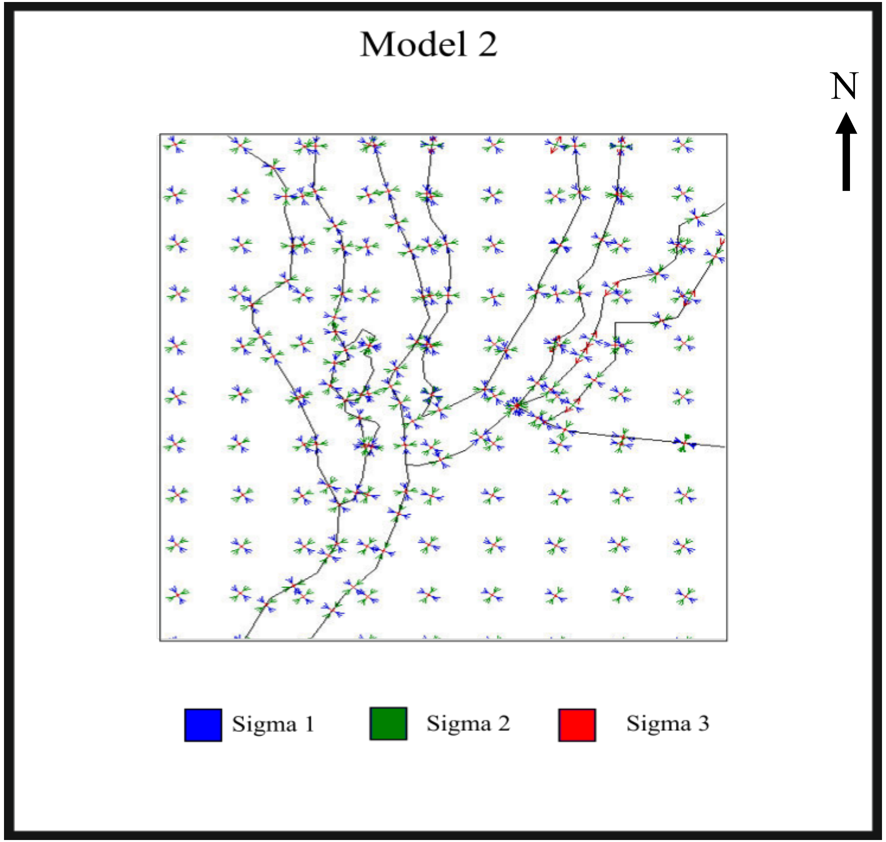
Results (*Model 2)*

Miocene

σ 1 σ 2 σ 3



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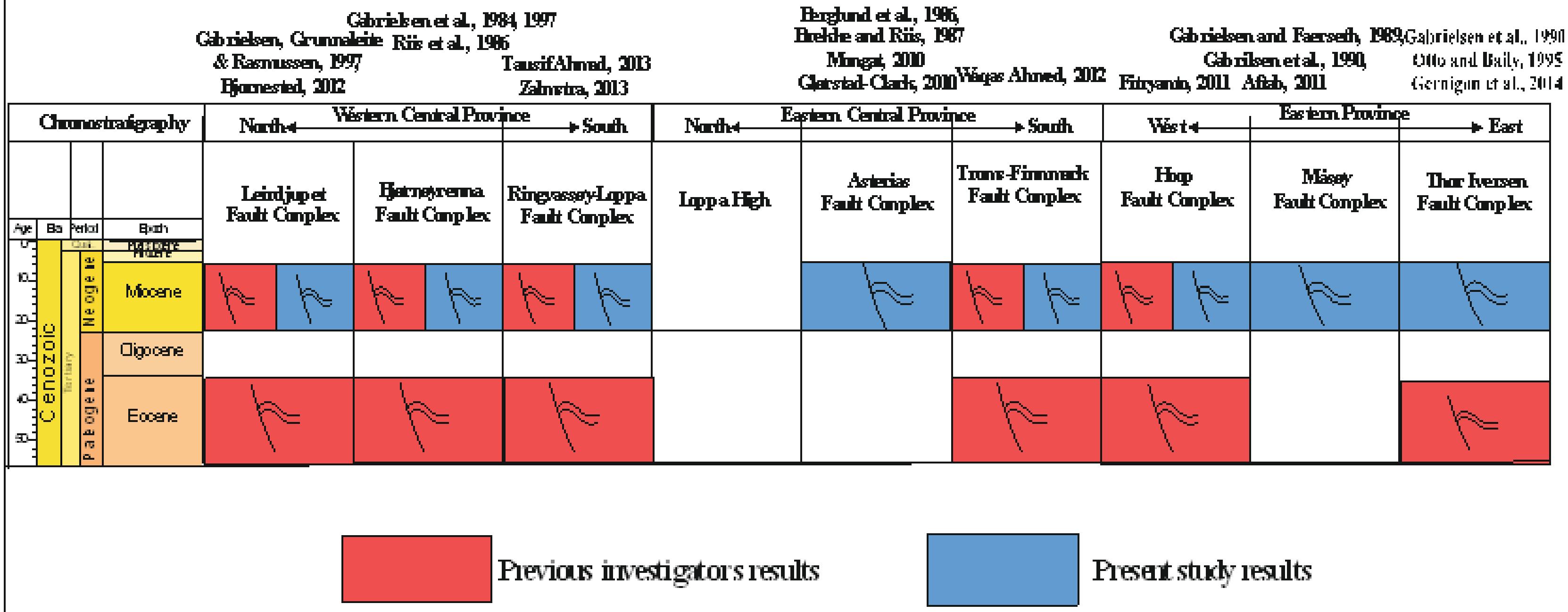

A comparison of present study with previous studies.

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- Model 1 shows no pronounced stress rotations and consequently succeeds in predicting that the study area has no direct effect of NE Atlantic opening during Early Eocene.
- However, simulated stress patterns suggest inversion along major fault complexes during Miocene (Model 2).

Thank you for your attention