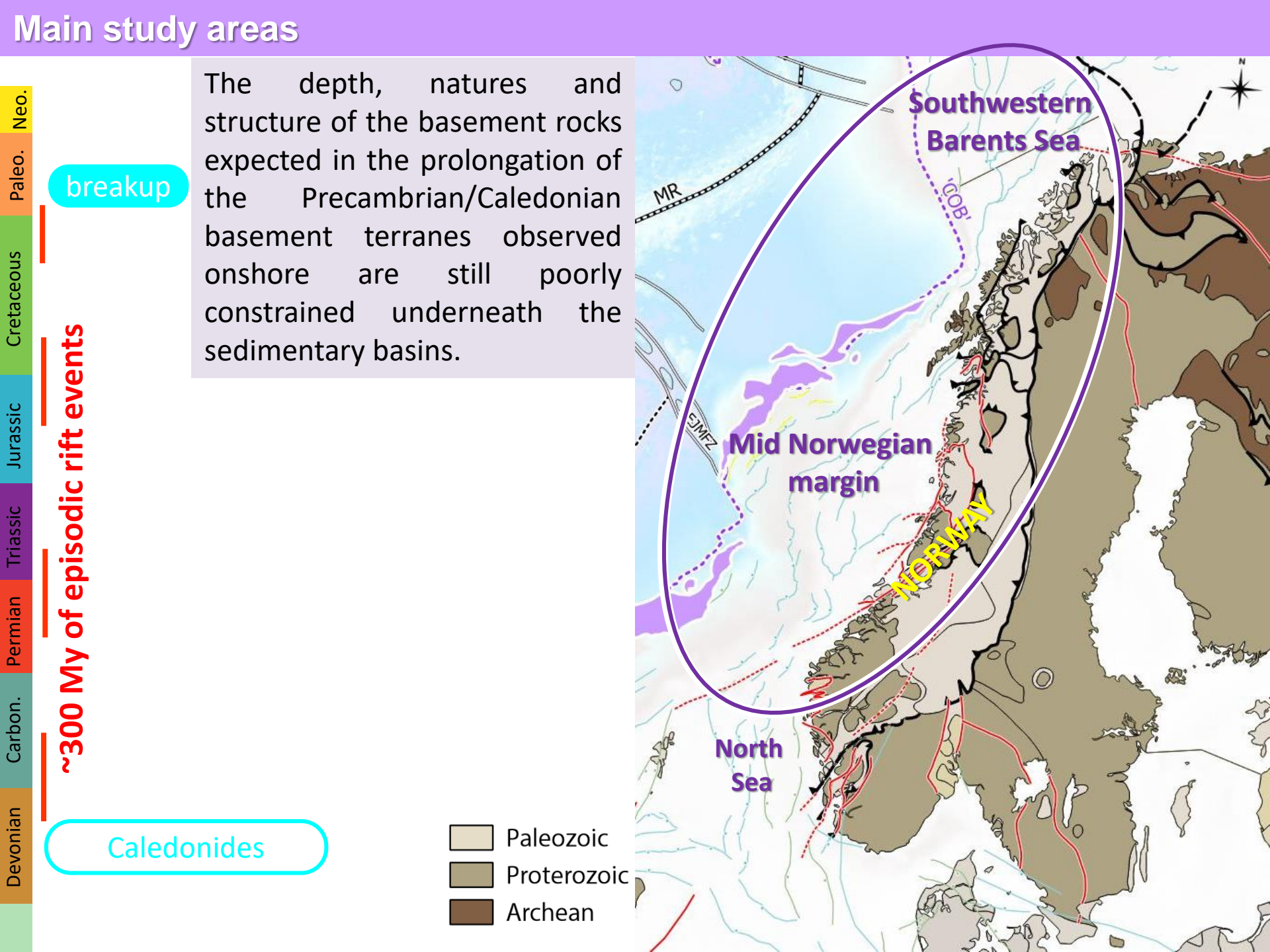


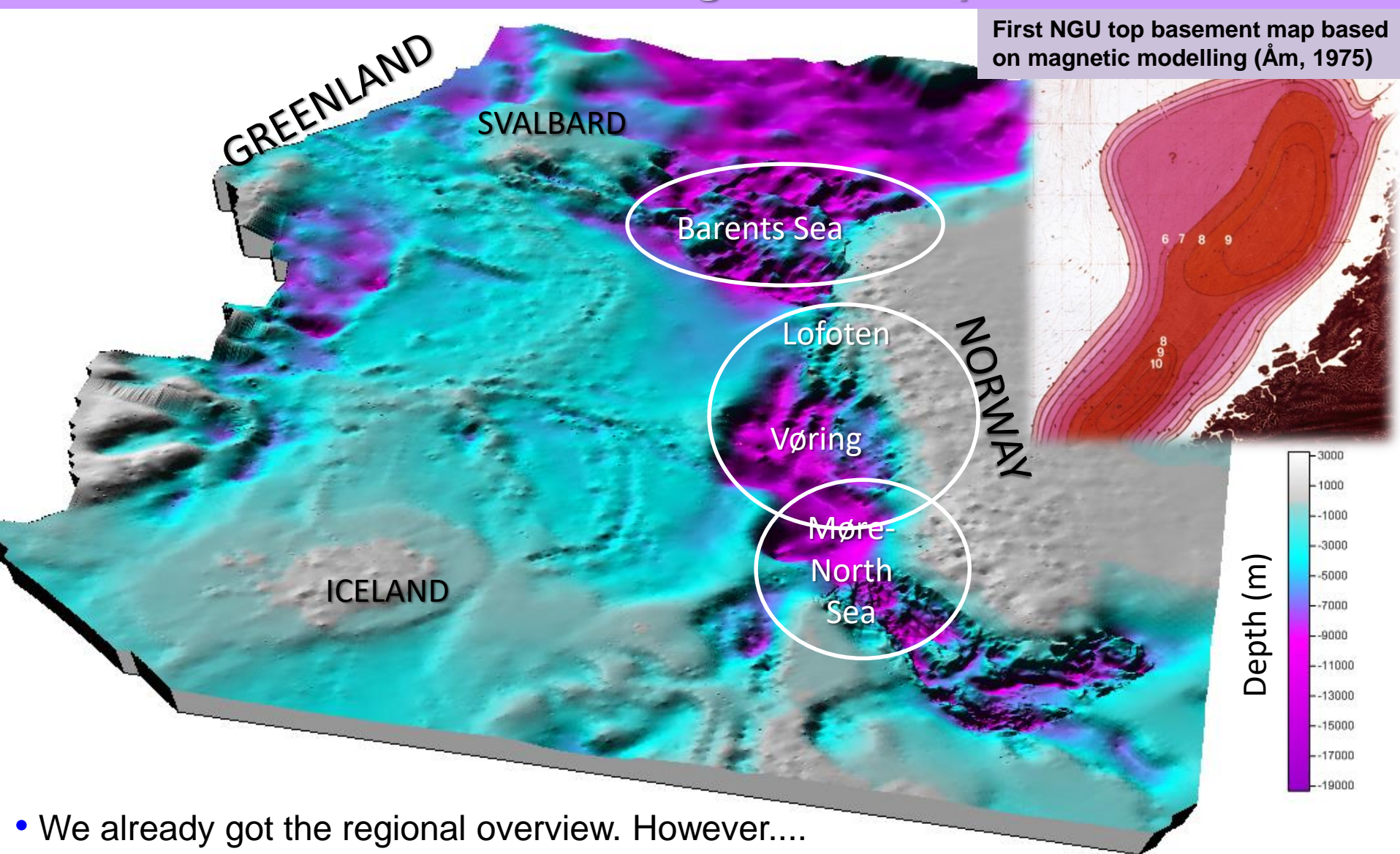
Implications of new long-offset seismic lines on the Norwegian Continental Shelf

L. Gernigon

Continental Shelf Geophysics, Geological Survey of Norway (NGU)



Towards a better understanding of the deep structures

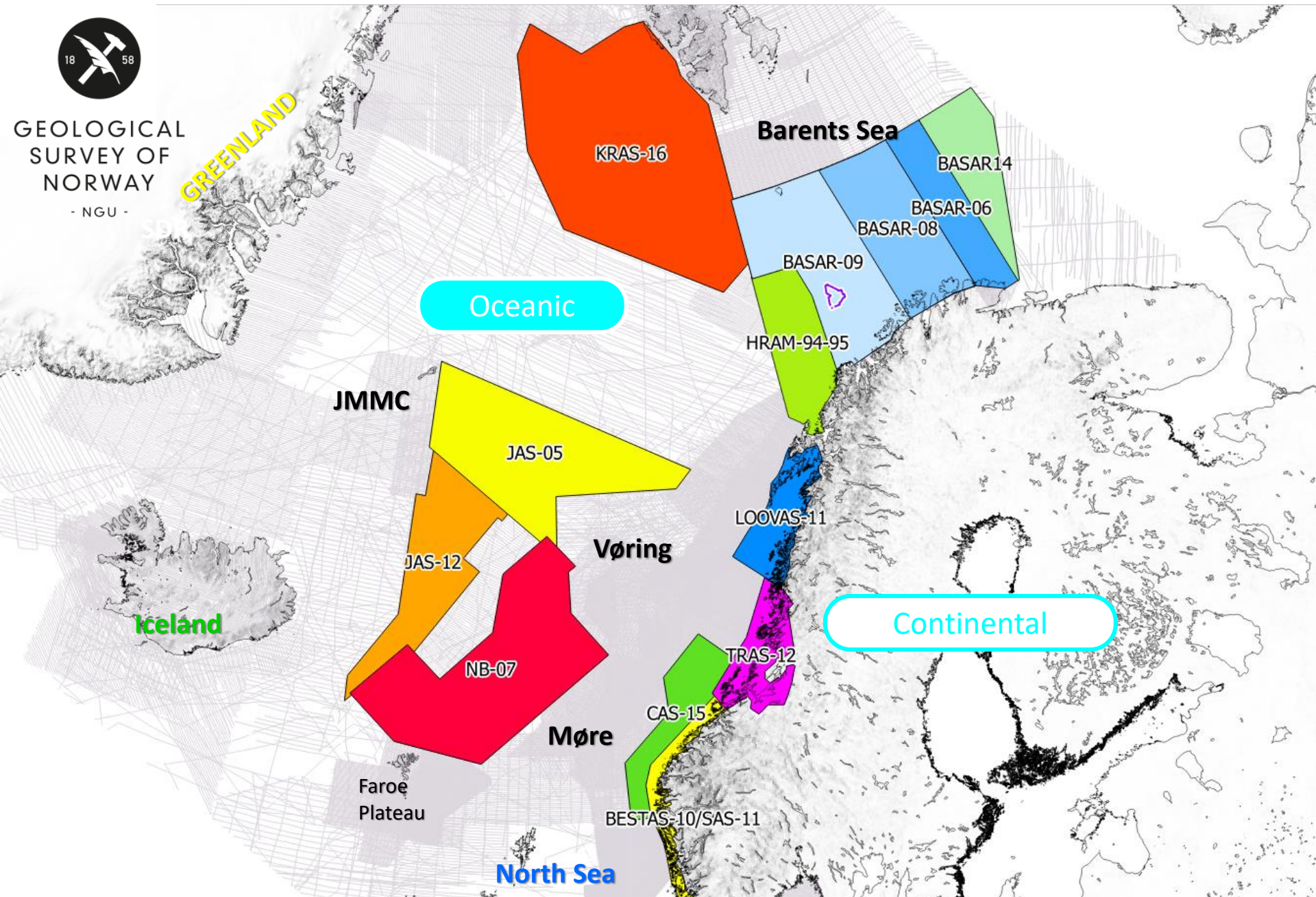


- We already got the regional overview. However....
- ...some estimations (Moho, LCB, top basement) are still questionable locally
- We are looking **now for a better resolution both at margin/basin and prospects scales.**

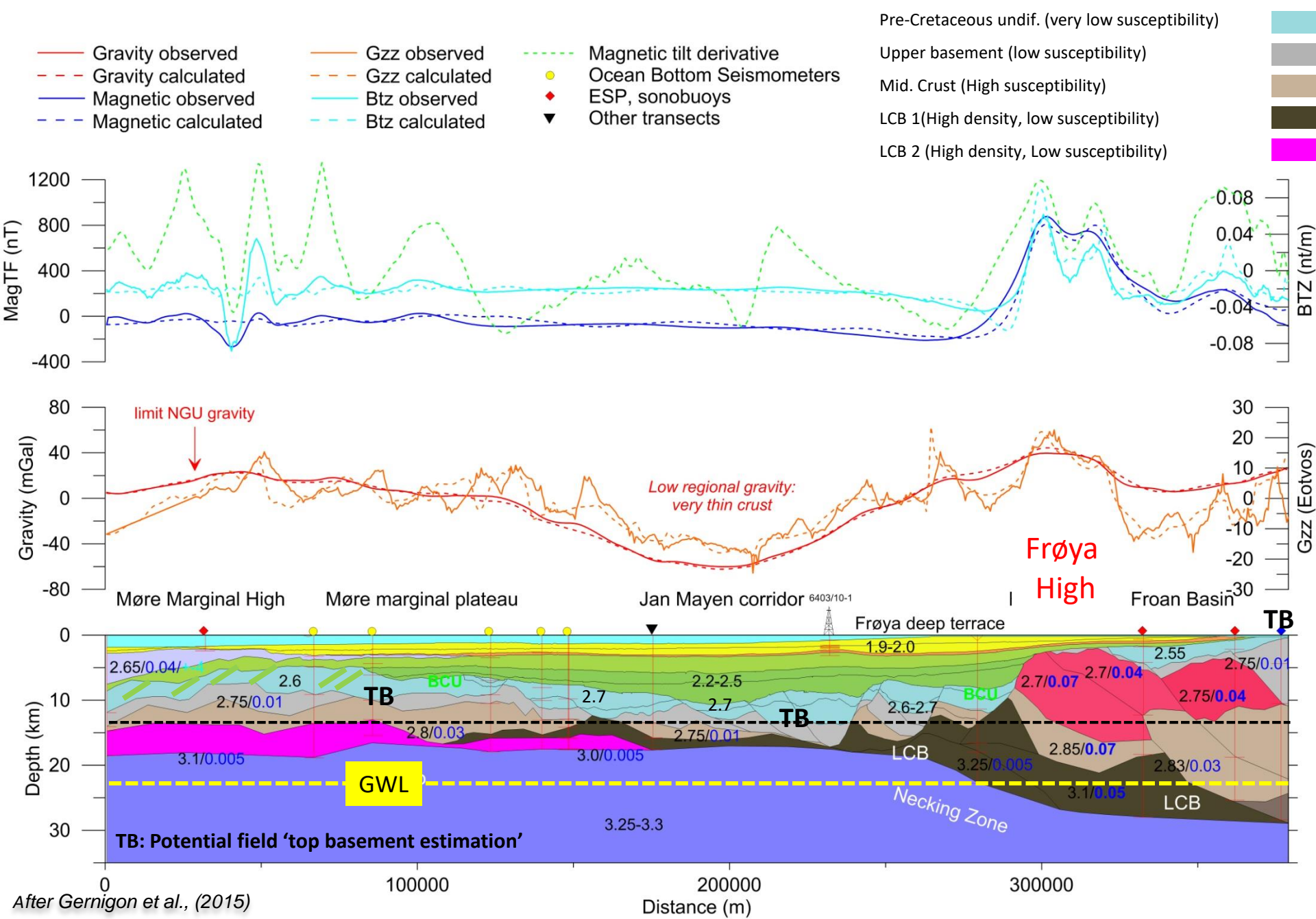
NGU mapping: A decade of new high resolution aeromagnetic surveys



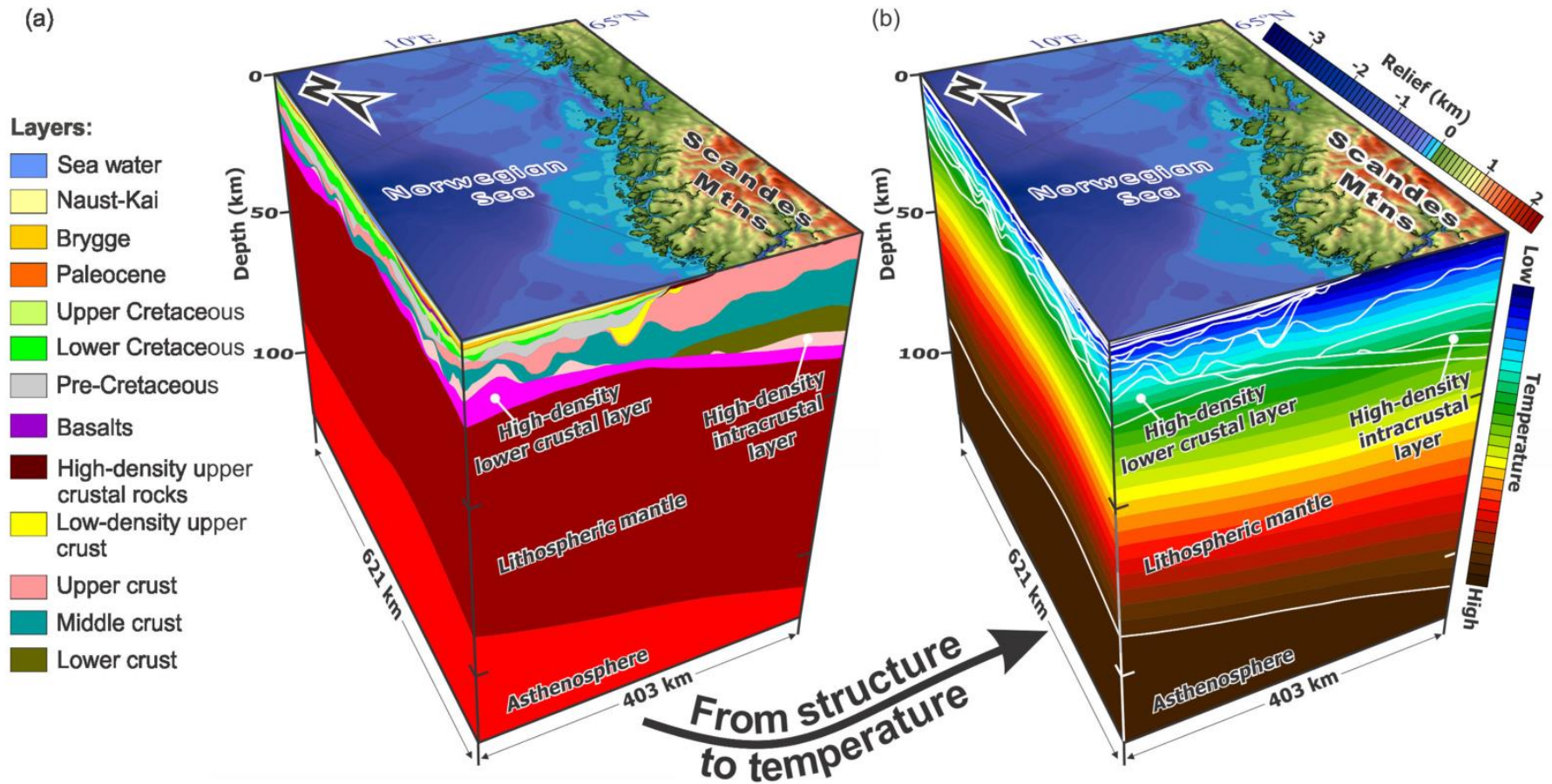
GEOLOGICAL
SURVEY OF
NORWAY
- NGU -



Grav/mag modelling to fill the gaps in between deep seismics

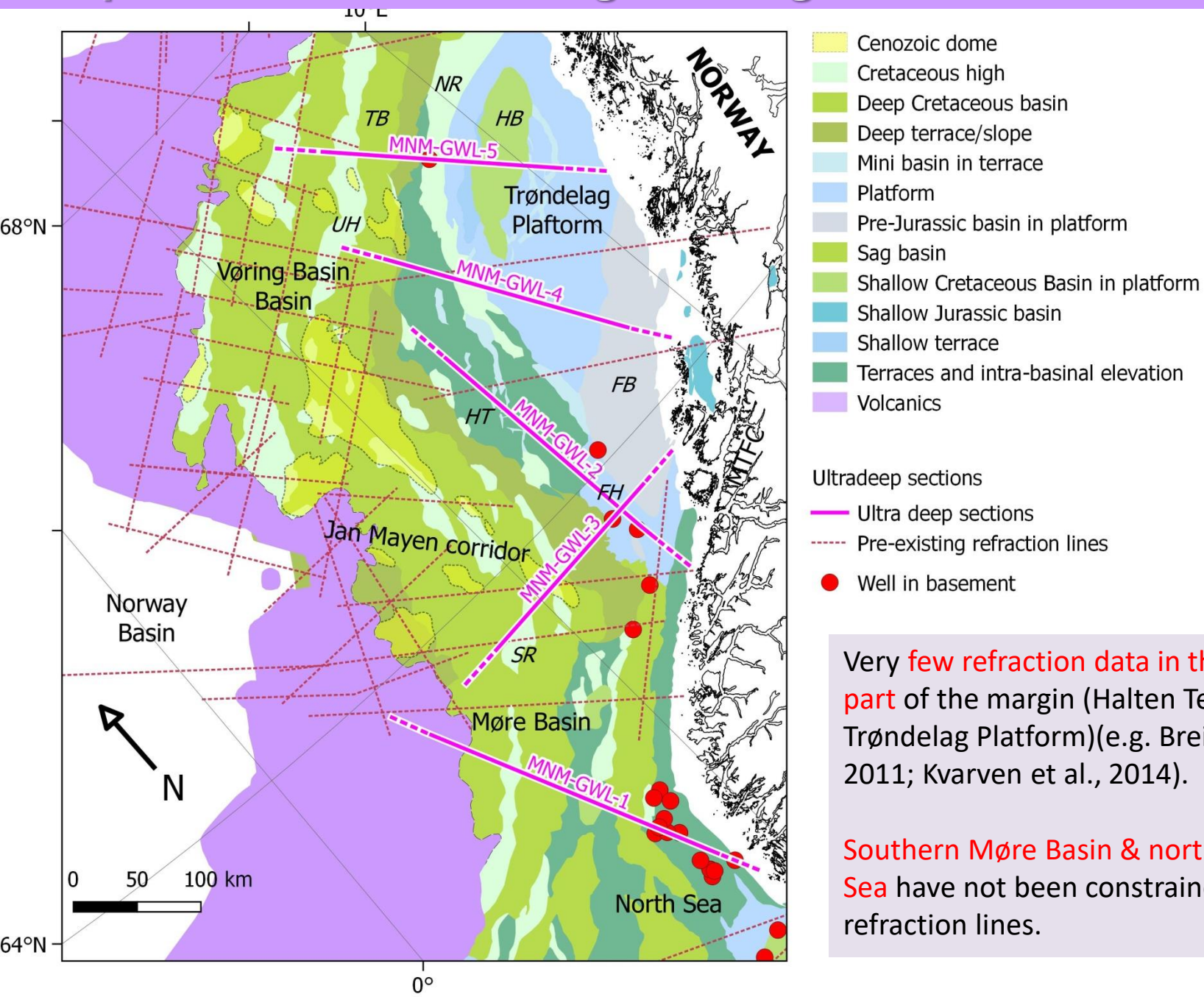


3D crustal model and temperature calculation



(a) The lithosphere-scale 3-D model of the mid-Norwegian continental margin and adjacent areas of the Norwegian mainland (b) 3-D temperature distribution. From Maystrenko and Gernigon, 2018).

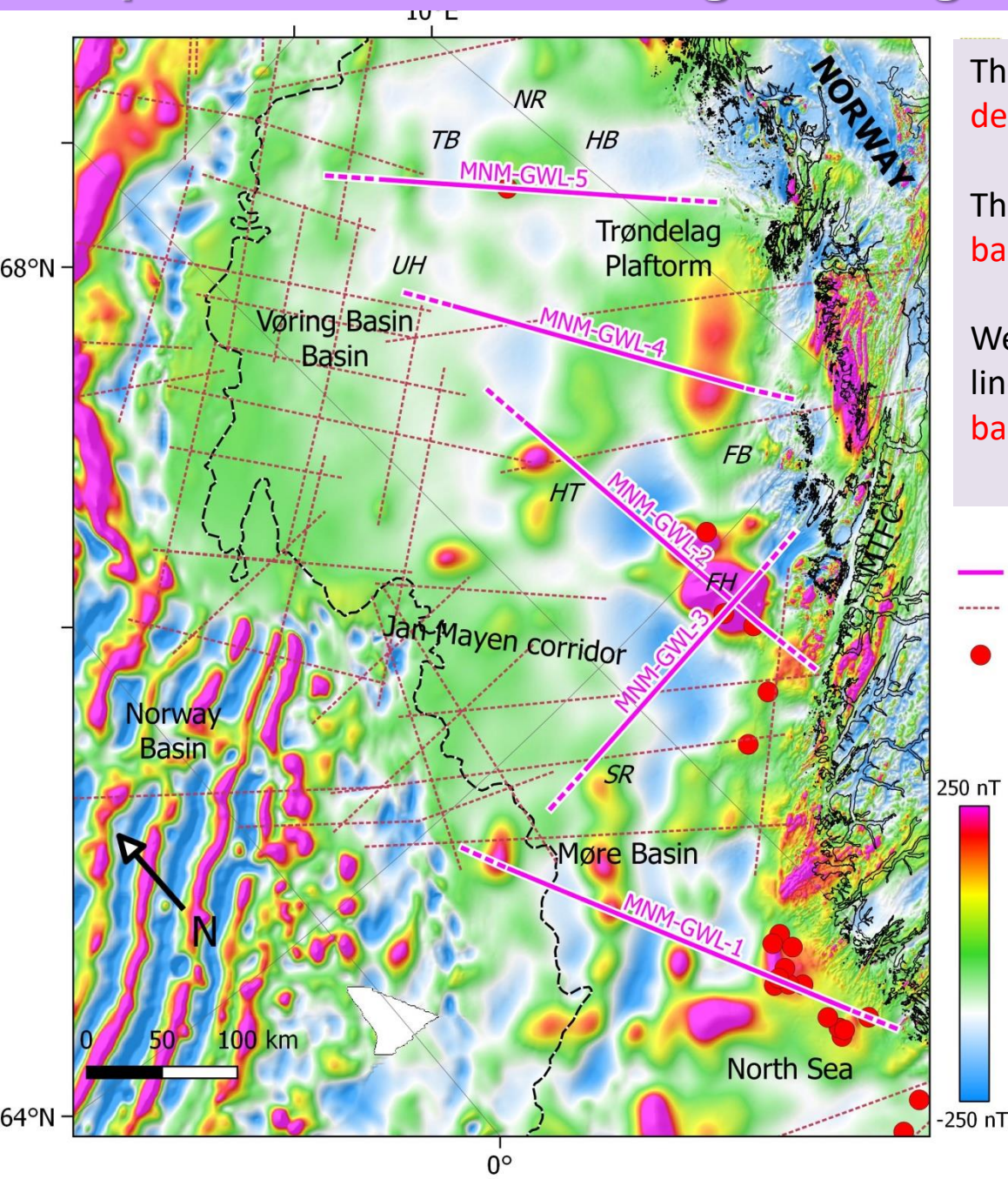
Deep sections mid-Norwegian margin



Very few refraction data in the proximal part of the margin (Halten Terrace, Trøndelag Platform)(e.g. Breivik et al., 2011; Kvarven et al., 2014).

Southern Møre Basin & northern North Sea have not been constrained by any refraction lines.

Deep sections mid-Norwegian margin+magnetic data



The main objective is to shed light on the deep basement structure.

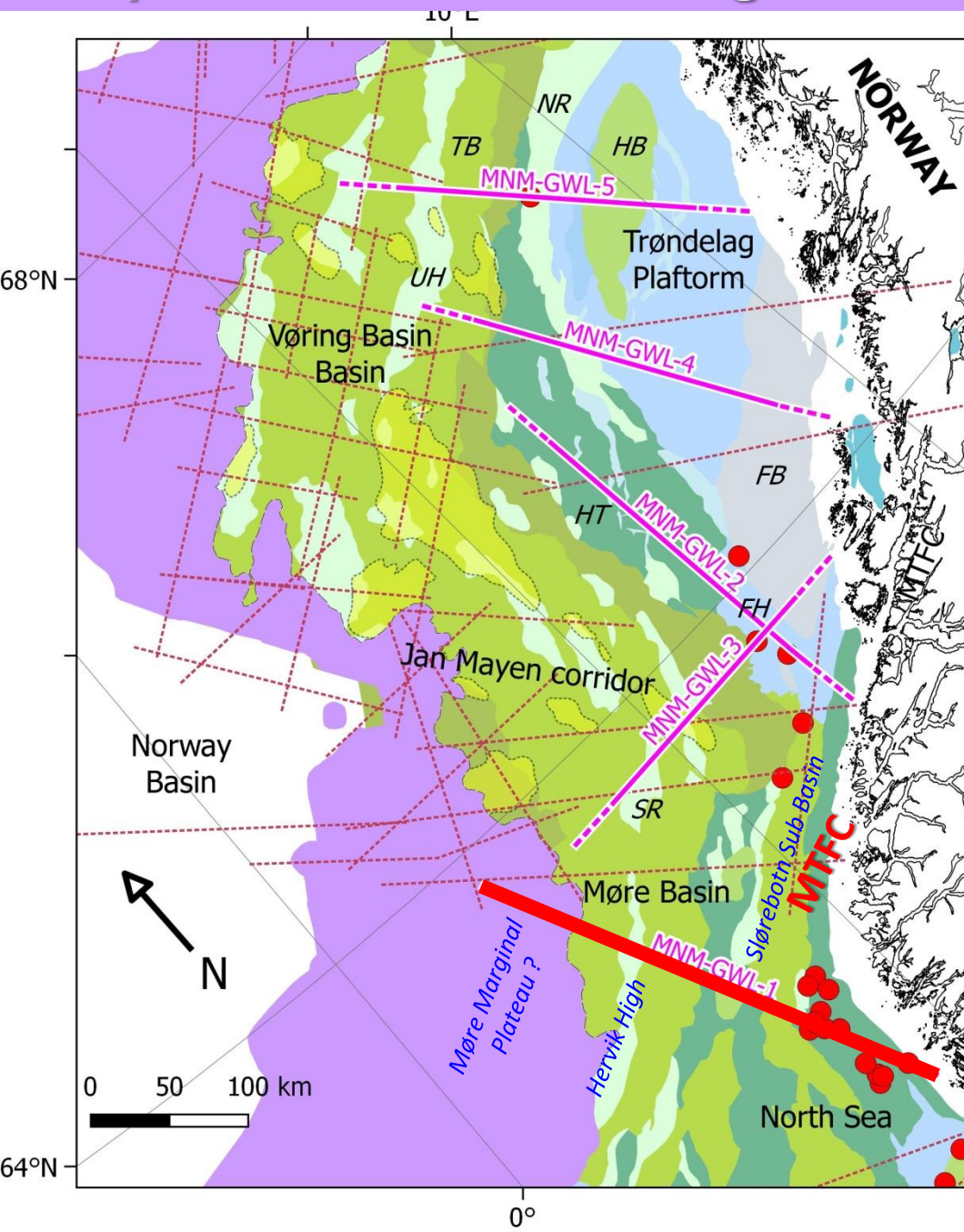
The survey planning considers the basement-related anomalies and trends.

We also consider pre-existing seismic lines for eventual reprocessing and basement wells for calibration.

- Ultra deep section
- - - Pre-existing refraction line
- Well in basement



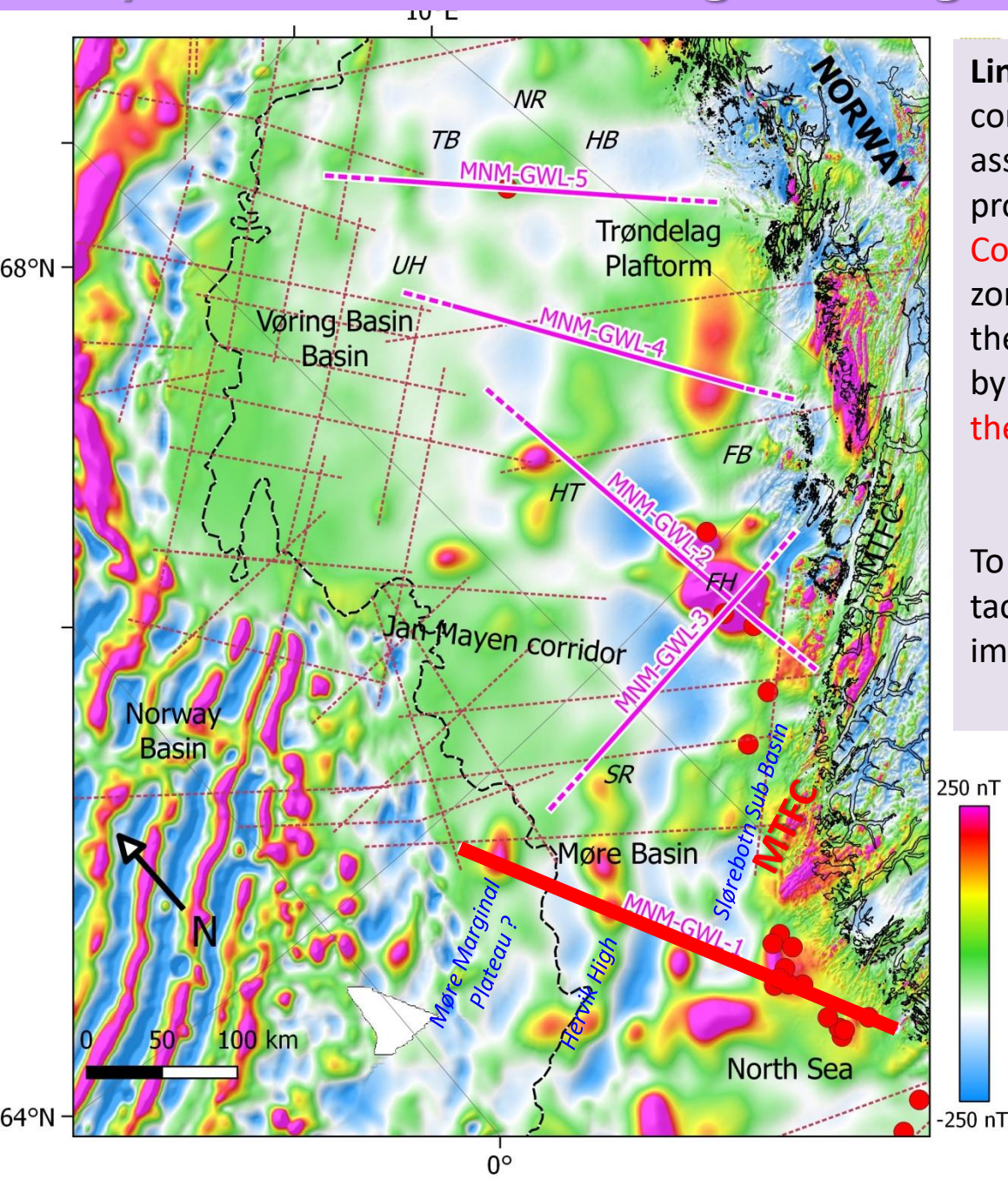
Deep sections Mid-Norwegian margin- MNM-GWL1



Line MNM-GWL-1 attempts to better constrain the basement geometry associated with the offshore prolongation of the **Møre Trøndelag Fault Complex** and the associated transition zone between the platform domain and the deep **Cretaceous sag basin** affected by drastic but **controversial thinning of the crust**.

To the west, the transect will partly tackle an eminent **sub-basalt/sub sills** imaging problem.

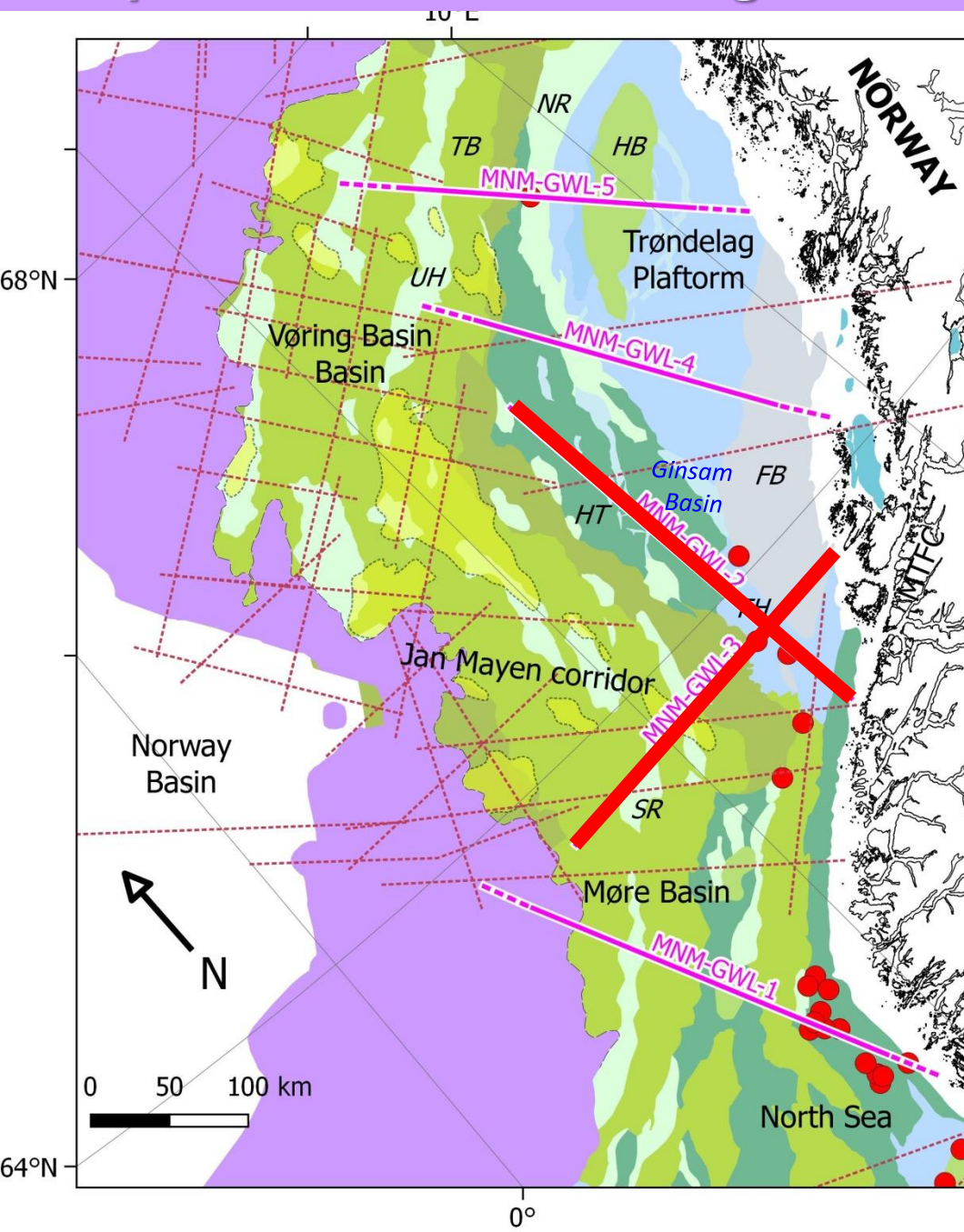
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Deep sections Mid-Norwegian margin- MNM-GWL2/GWL3



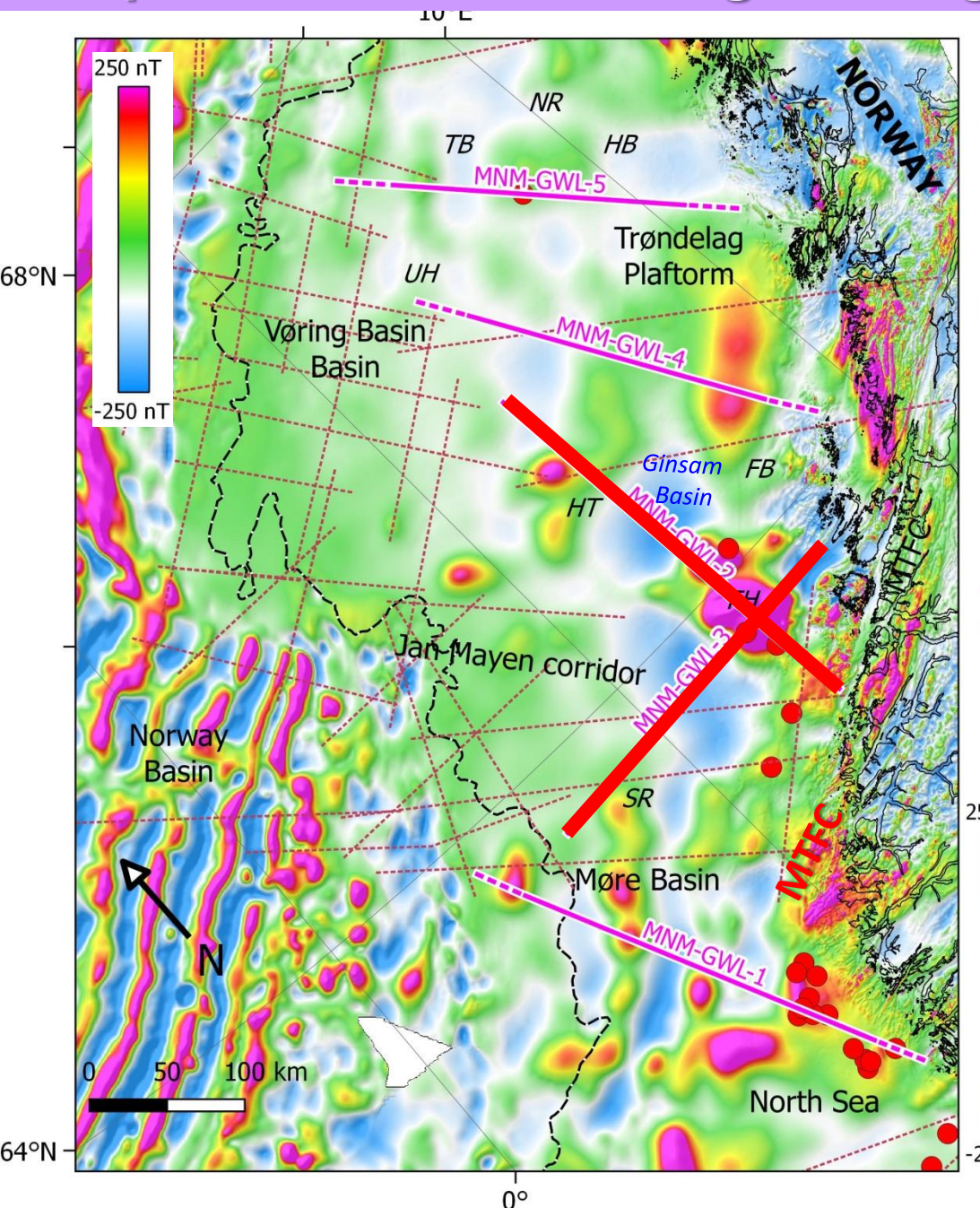
Lines MNM-GWL2 and MNM-GWL3 aim to better constrain the basement nature of the Frøya High and adjacent the deep basins.

The Frøya High region shows a lack of deep relevant seismic data and the origin and nature of the deep crust underneath this prominent magnetic feature is unclear.

The new data should also help to image the contact between the expected Precambrian basement of the overlying Caledonian nappes .

Mapping the nature of the sediments and crust underneath the deep BCU will provide further insight into the controversial necking zone up to the central crustal rafts observed in the central part of the Jan Mayen corridor .

Deep sections mid-Norwegian margin- MNM-GWL2/GWL3



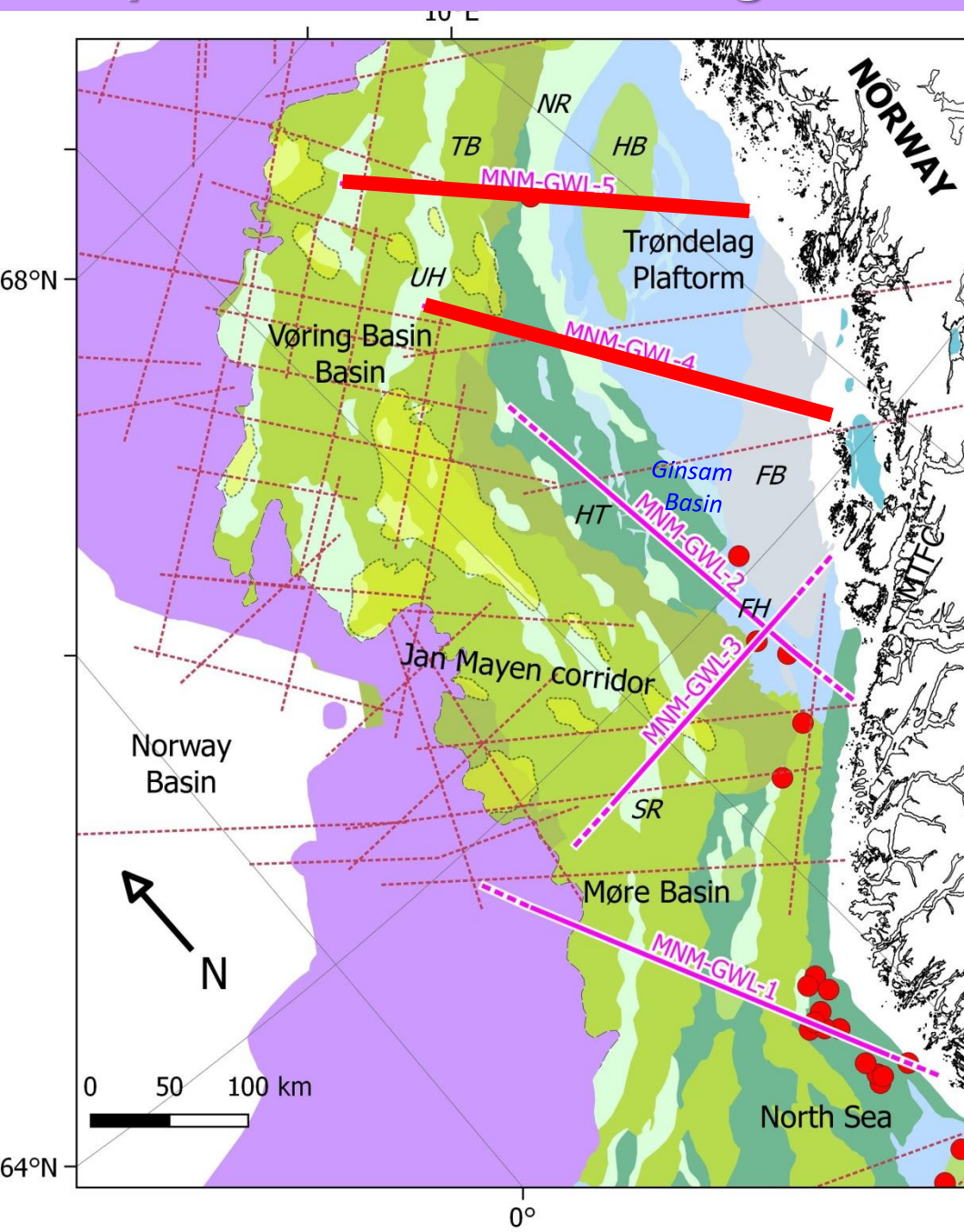
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Deep sections mid-Norwegian margin- MNM-GWL4/GWL5

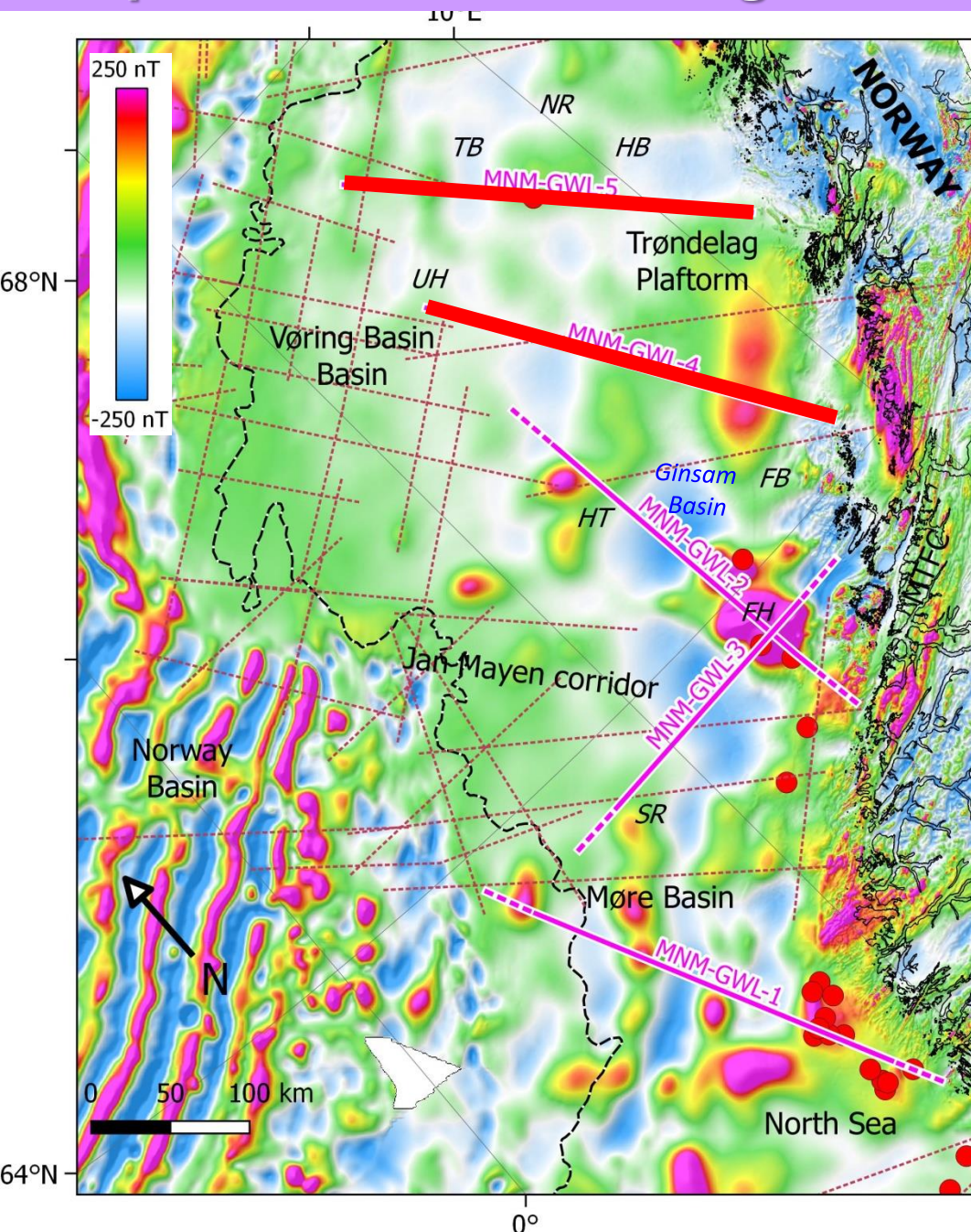


Line MNM-GWL-4 will better constrain the magnetic basement observed between the **Froan Basin** and the **Trøndelag Platform**. To the west MNM-GWL-4 will also constrain the southern part of the **Nordland Ridge** and the deep part of the **Dønna Terrace**.

Line MNM-GWL-5 was specially chosen to image better the basement and deeper structures between the **Helgeland Basin** and the central **Nordland Ridge**.

To the west, we expect to image better the **Utgard High** and the **deep Træna Basin**, where drastic thinning of the crust and possible exhumation of the lower crust directly underneath the deep sediments is expected.

Deep sections mid-Norwegian margin- MNM-GWL4/GWL5

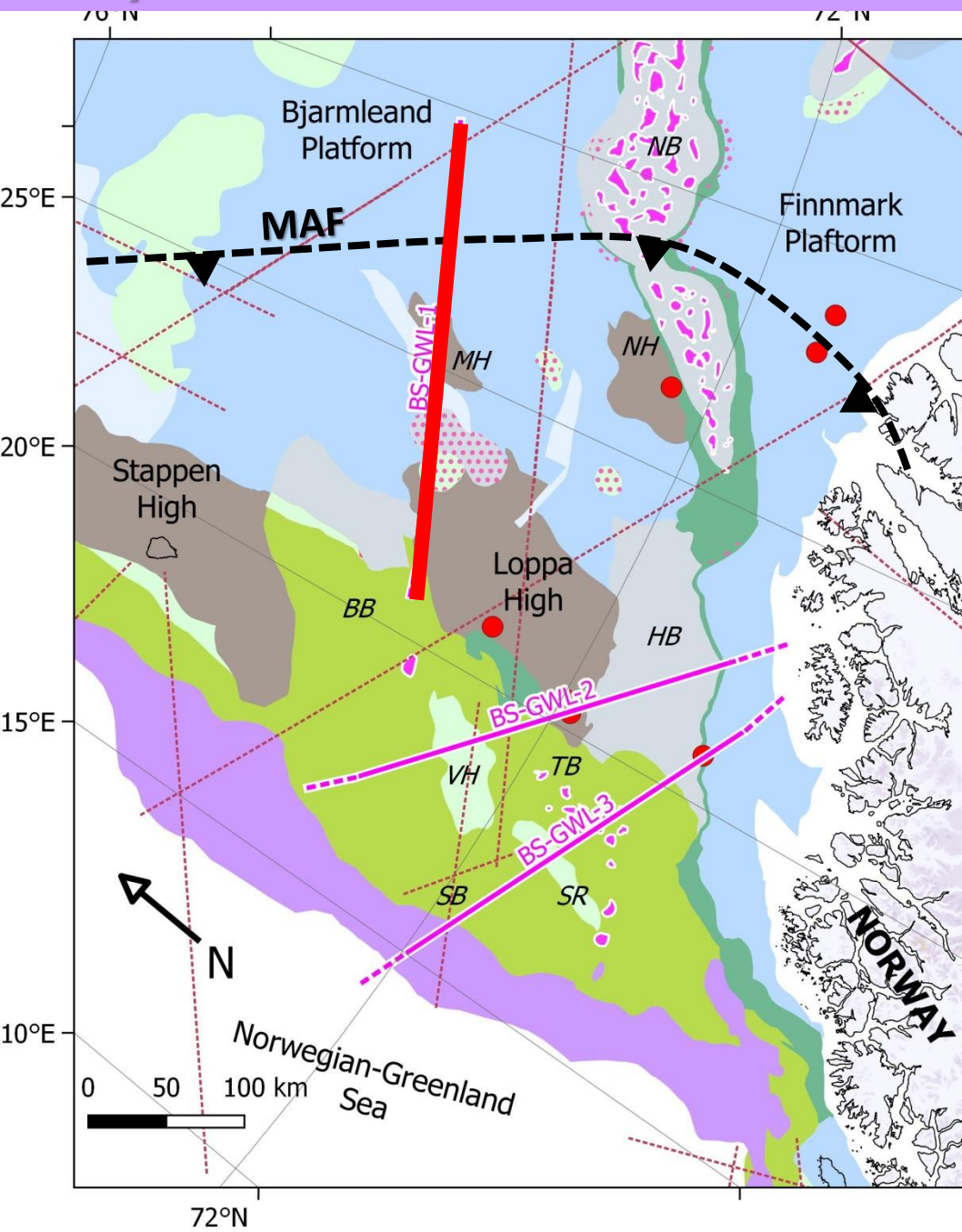


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Deep sections Southwestern Barents Sea- BS-GWL-1

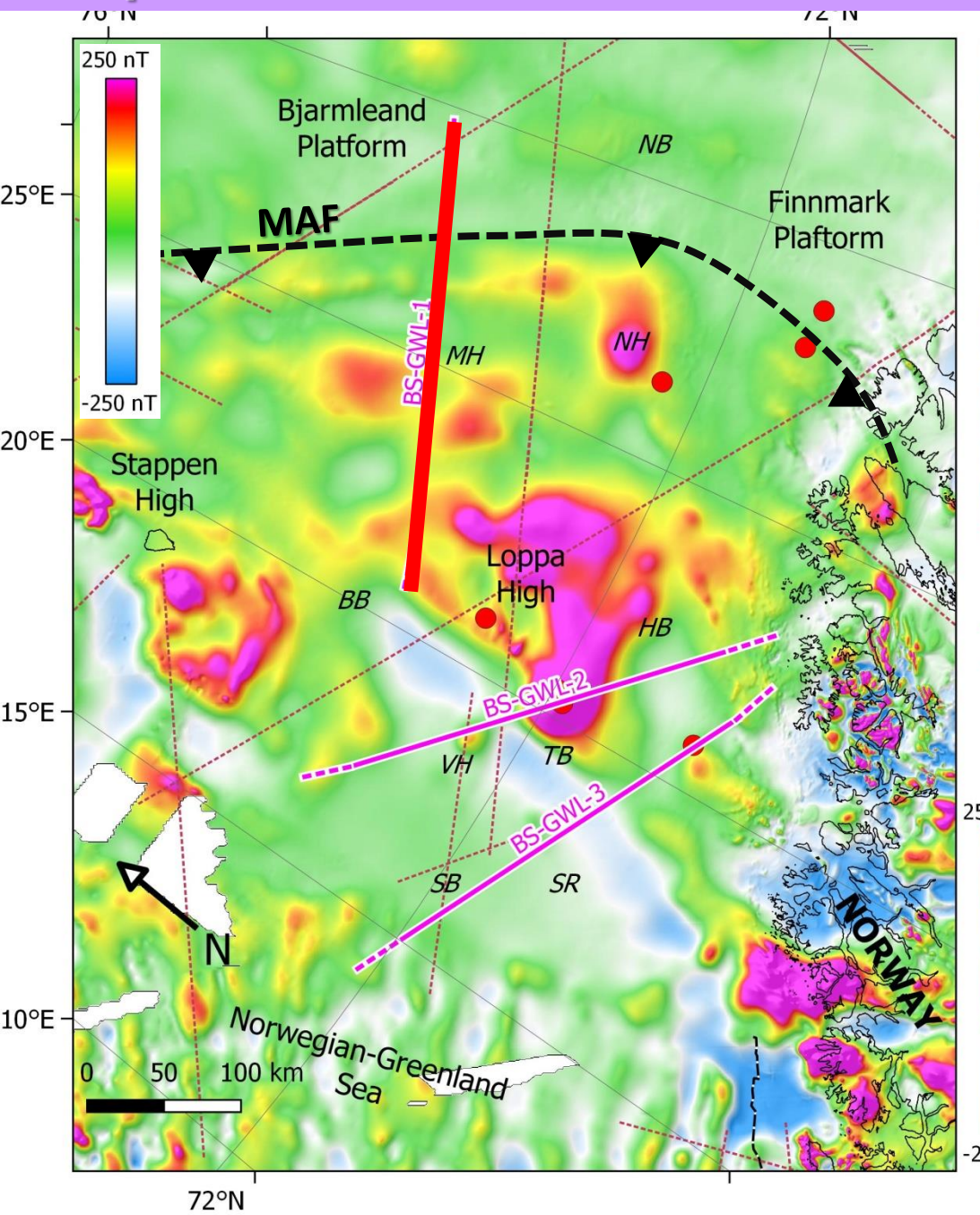


Line **BS-GWL-1** is selected to illustrate the entire basement history of the BS from the **Caledonian Middle Allochthons Front (MAF)** expected at the edge of the prominent NW-SE magnetic anomalies in the **Bjarmaland Platform** to the northern **Loppa High**.

We aim to image the **expected deep NW-SE-oriented Late Palaeozoic basins** (Gernigon and Brönnert, 2012) and resolve its connection to the **oblique trending Mercurius High/Hoop F.C.**

BS-GWL-1 also crosses over the **Svalis Dome** area, where imaging of the **sub-salt sequences** and underlying basement is intended.

Deep sections Southwestern Barents Sea- BS-GWL-1

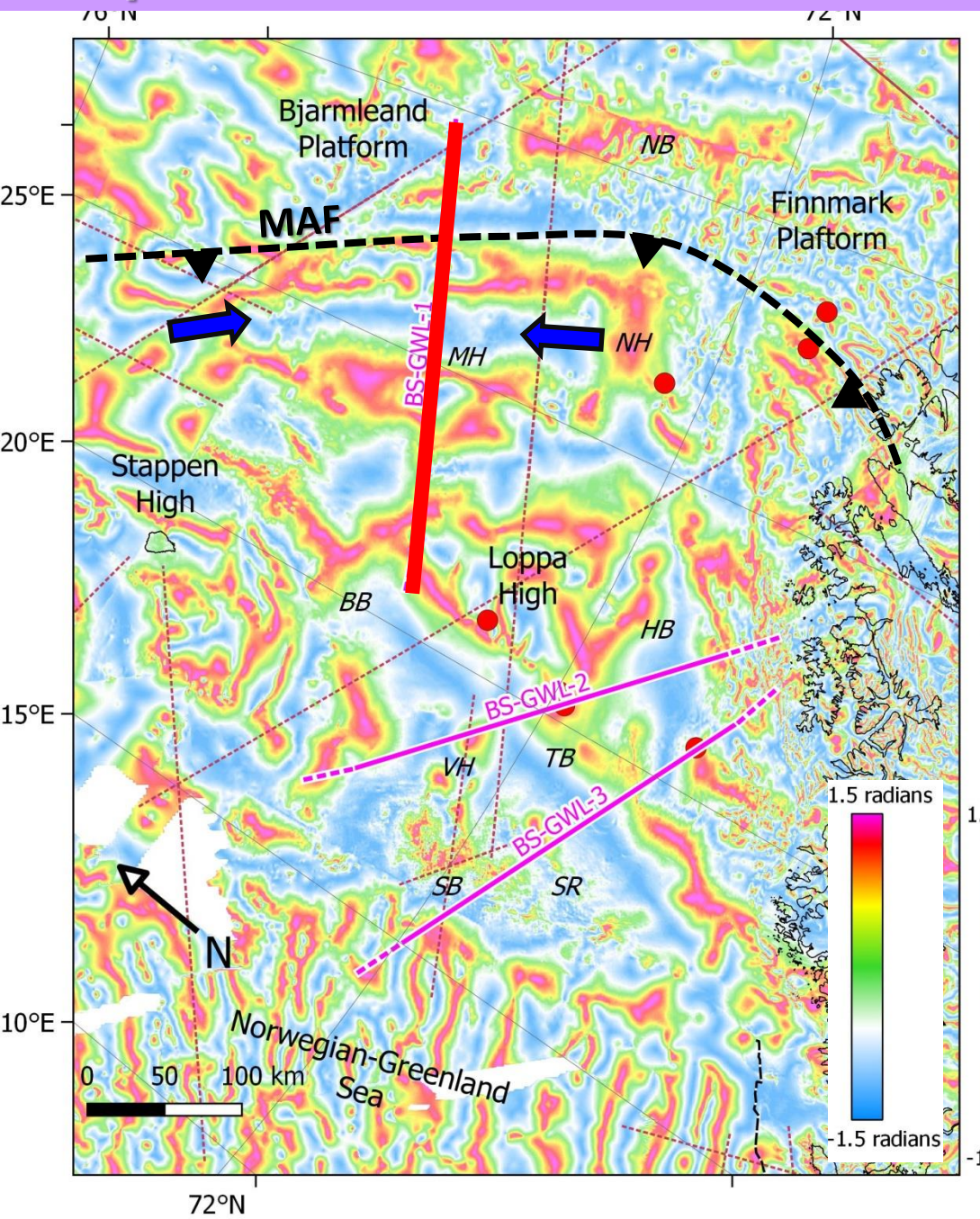


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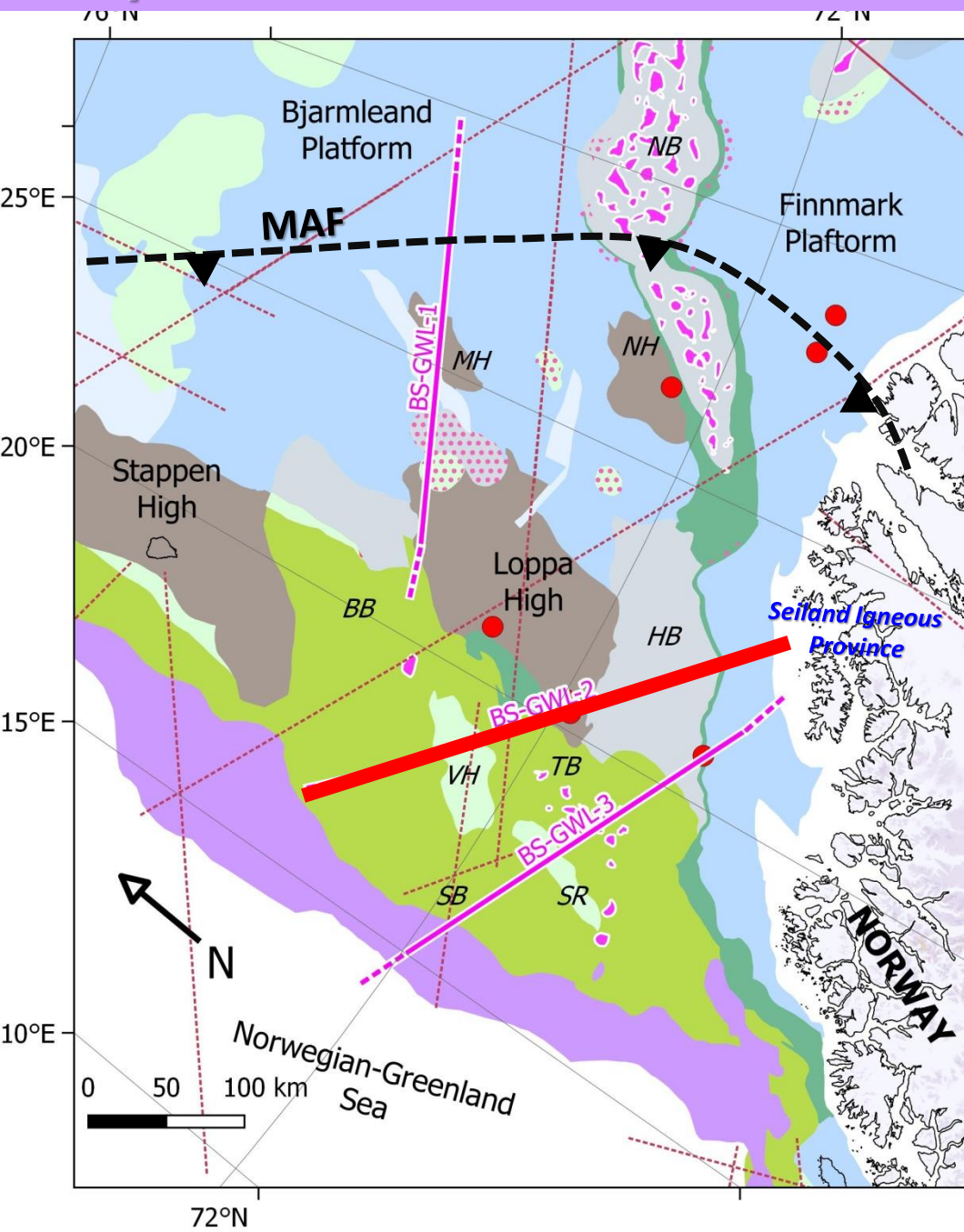


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Deep sections Southwestern Barents Sea- BS-GWL-2

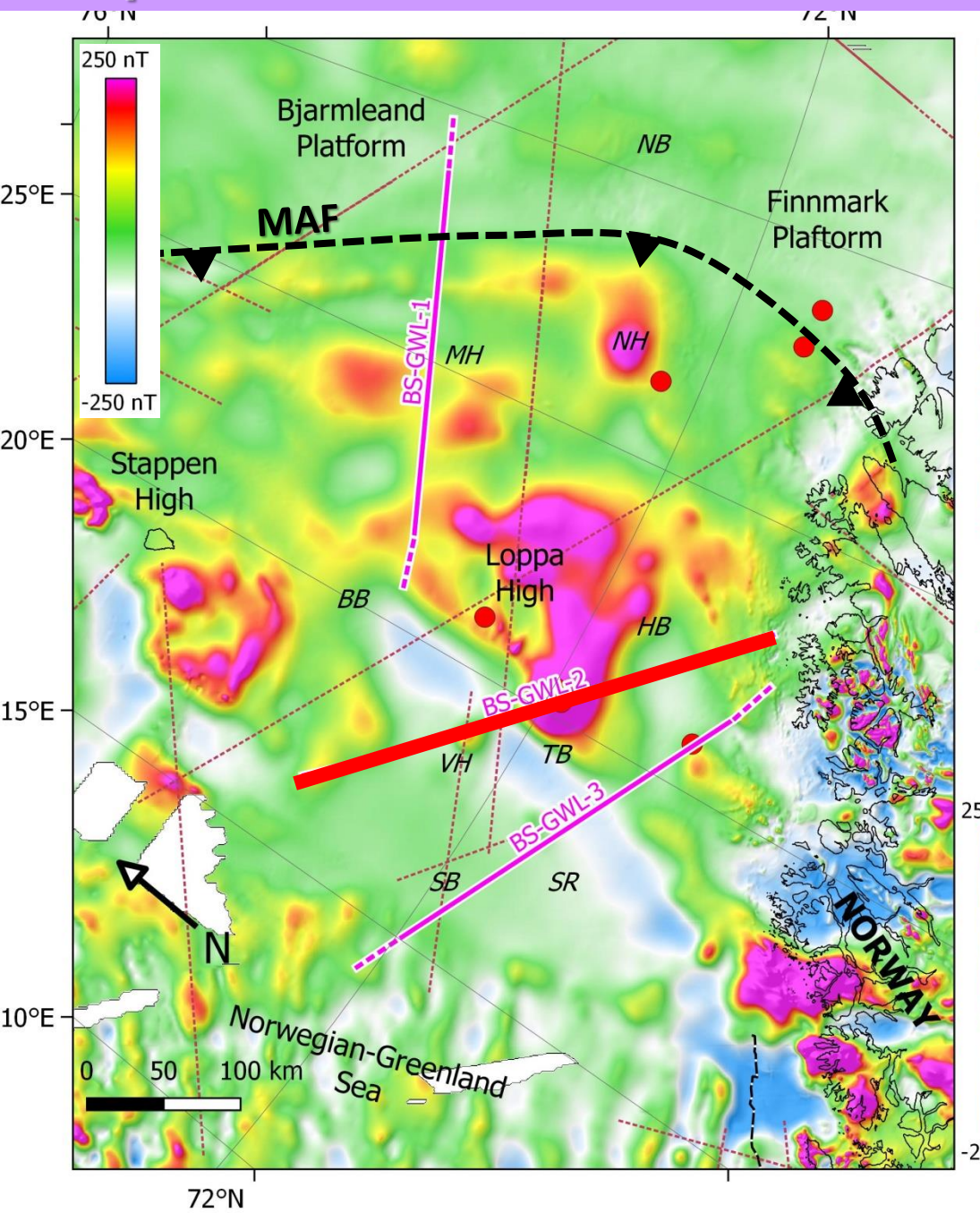


Line **BS-GWL-2** extends from the **Seiland Igneous Province** onshore up to the **Bjørnøya Basin**.

BS-GWL-2 will constrain better the **deep structures of the Hammerfest Basin**. Surprisingly, no refraction data cover this important Mesozoic Basin and the nature and/or depth to the basement are still speculative from the platform to the deep graben.

BS-GWL-2 crosses over the **Gohta High** and the **Veslemøy High**. Both highs are characterised by anomalous upper magnetic basement but their meaning remains unclear (Intrusion?, mafic nappes ? Serpentinised ridge ?

Deep sections Southwestern Barents Sea- BS-GWL-2

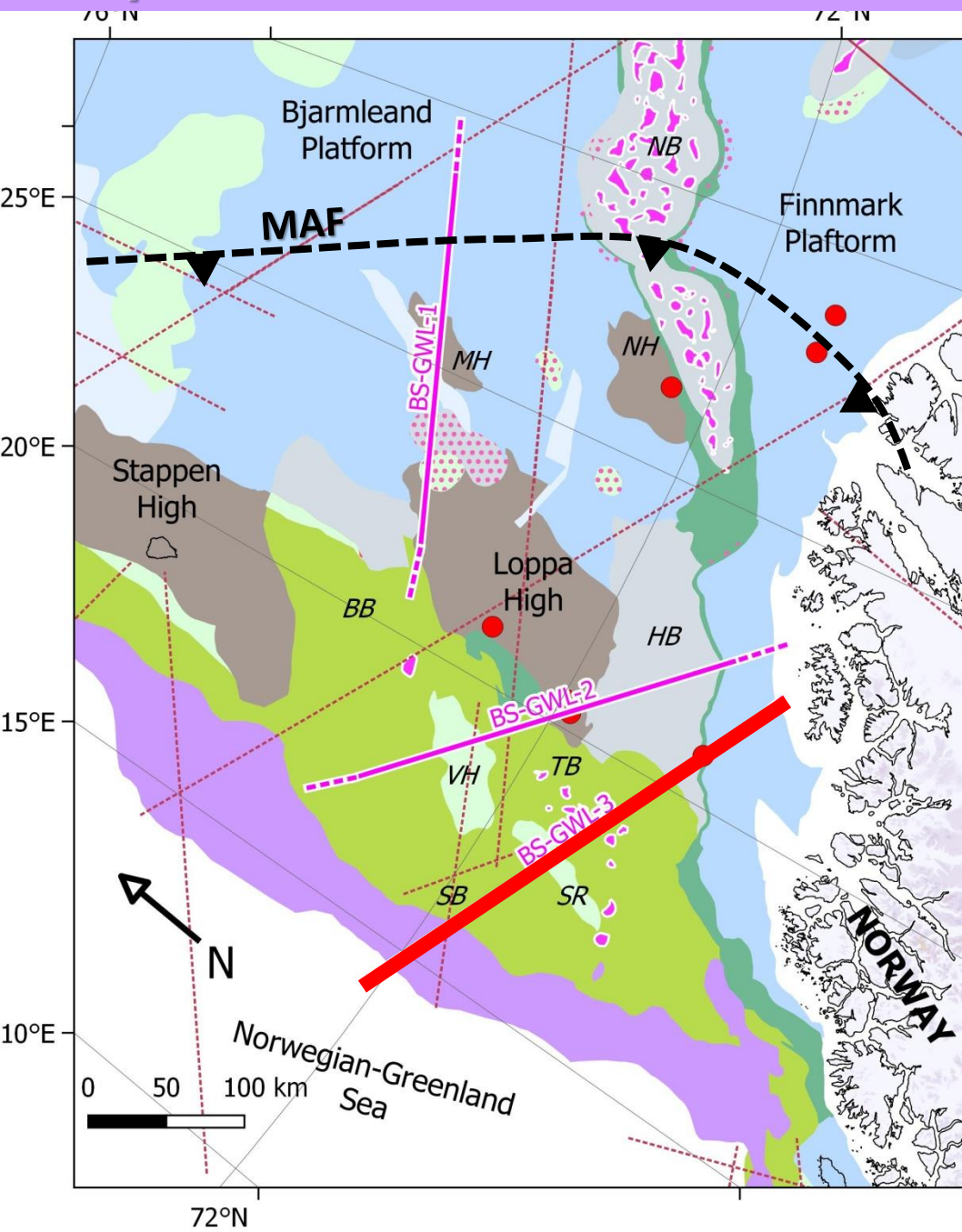


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Deep sections Southwestern Barents Sea- BS-GWL-4



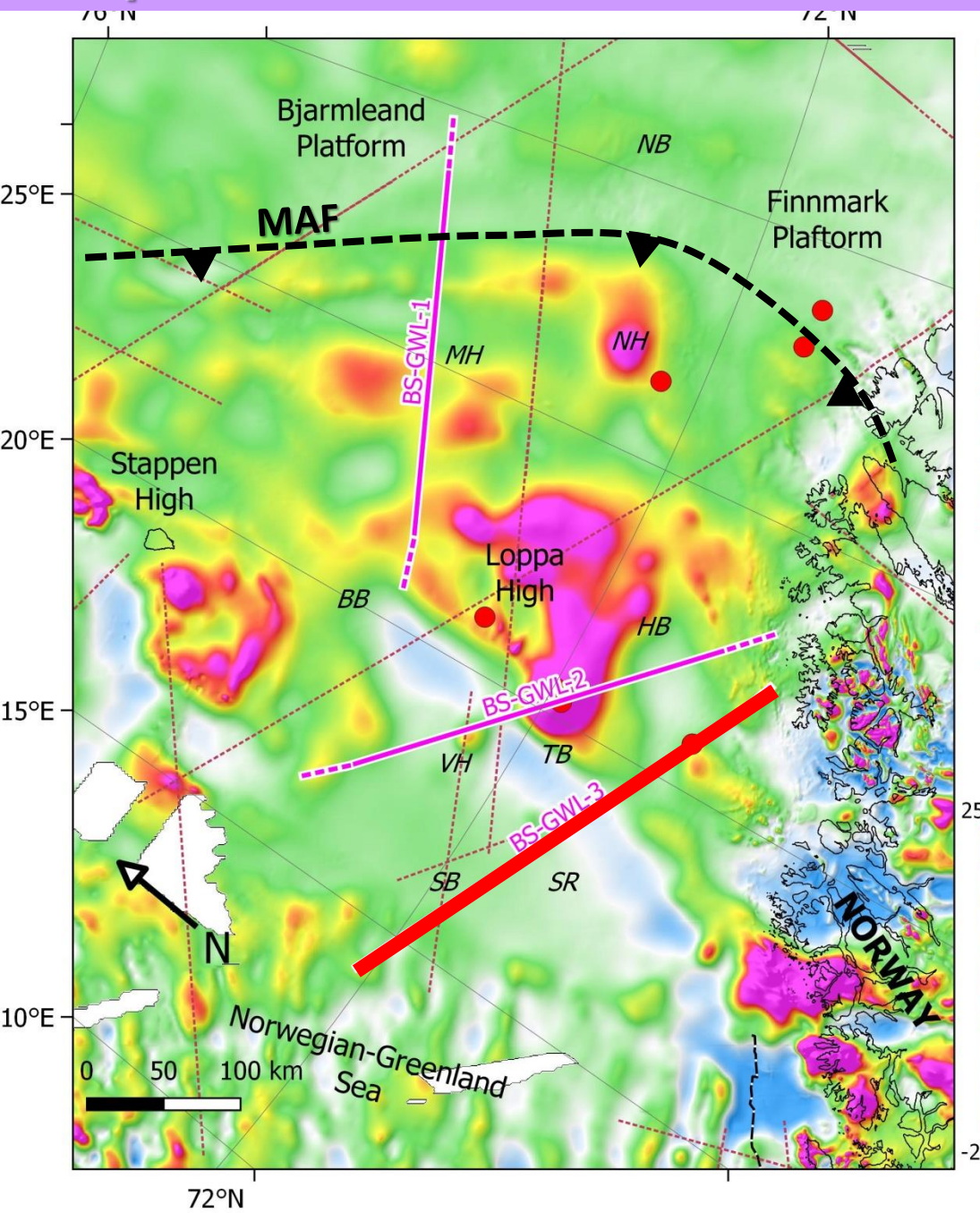
Line BS-GWL-3 plans to constrain a large part of the sheared margin between the Finnmark Platform and the Norwegian-Greenland Sea.

We aim to understand better the meaning of **the necking zone between the Hammerfest Basin and the deep Tromsø Basin**, where a drastic thinning of the crust is also expected.

Here, **imaging underneath local salt domes** also represents a challenging thematic. BS-GWL-3 will also cover the enigmatic and non-magnetic **Senja Ridge**.

The southwestern termination of the profile will also cover the continent-ocean transition in deepest part of the **Sørvestnaget Basin**.

Deep sections Southwestern Barents Sea- BS-GWL-4



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Implication of the new Ultra Deep Seismic profiles

A *regional mesh of refraction data* to improve 2D/3D potential field modelling

New *top basement depth* re-evaluation (qualitative and quantitative interpretations)

Refine distribution, depth and *thickness of the Upper/Lower Crust*

Better depth-converted geometries of the deep basement structures

Nature, petrophysical *properties of the basement rocks* (Precambrian vs. Caledonian Nappes) – *Unclear Paleozoic basins* ?

A better link with the onshore geology – Aeromagnetic data / Land stations ?

Basin dynamics (type of deformation, type of margin, rift history..)

Input for *basin and* petroleum system modelling (*heat flow production*, rocks conductivities, beta factor...)

Definition of petroleum “*basement plays*” (fractured, weathered basement)?

Deep Paleozoic basins in the Southwestern Barents Sea ??

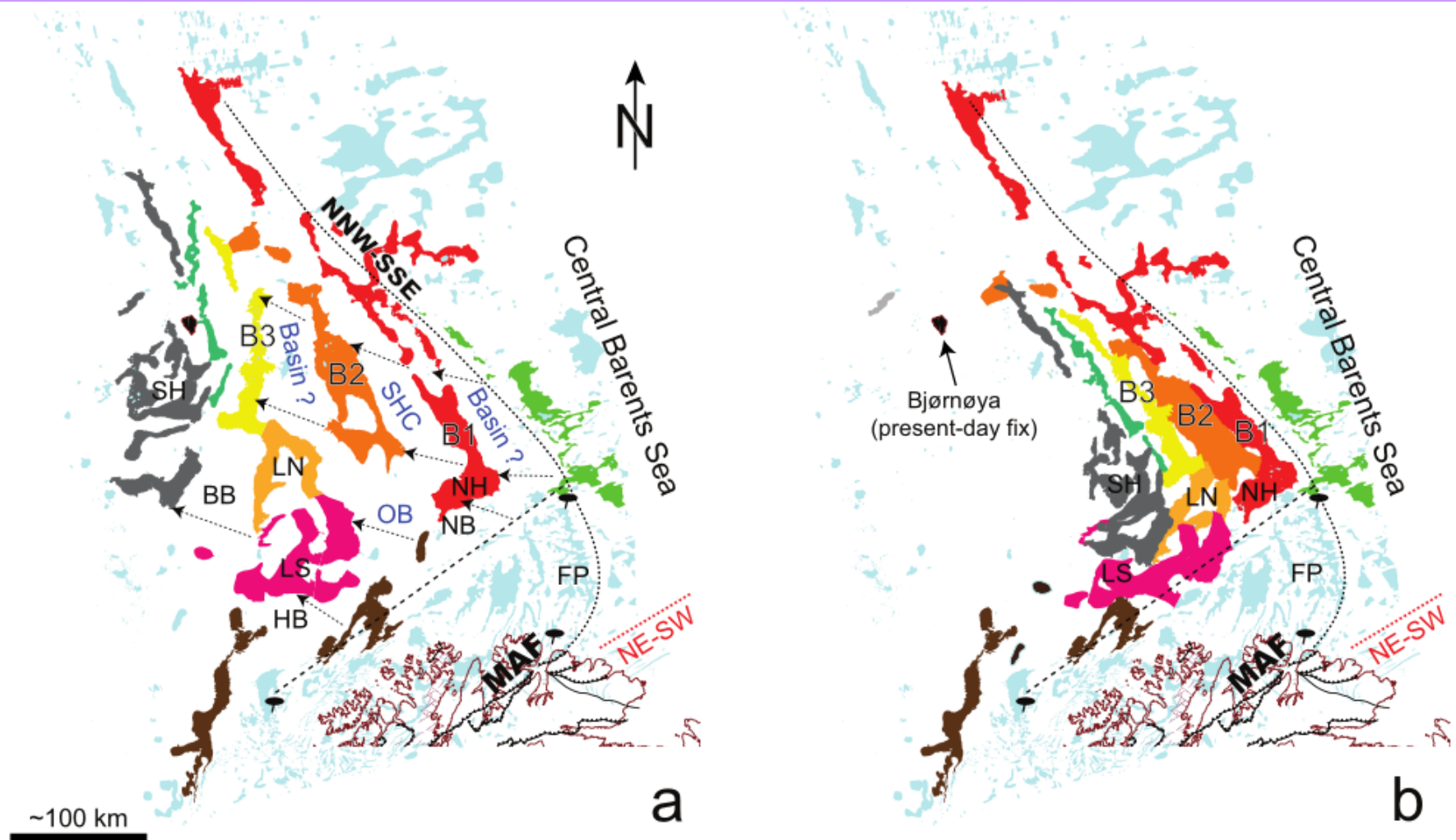
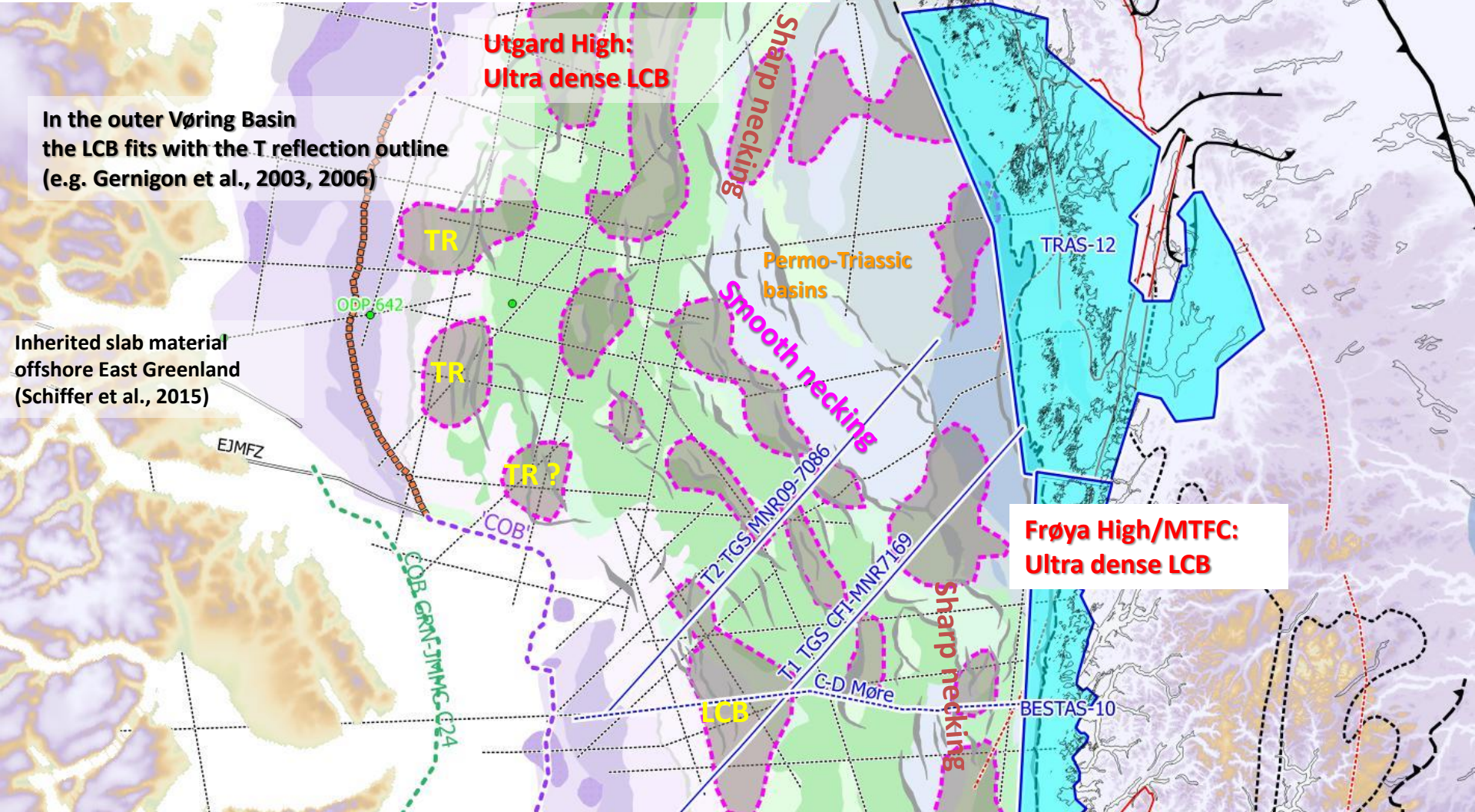


Fig. 7. (a) Main highs observed from the tilt derivative at the present day in the southwestern Barents Sea. (b) Tentative restoration of nappes in arc-shaped Caledonian thrust belt before back-sliding and Late Palaeozoic basin formation. BB, Bjørnøya Basin; B1, B2 and B3, prominent NNW–SSE magnetic anomalies interpreted as basement highs beneath the Bjarmeland Platform; FP, Finnmark Platform; HB, Hammerfest Basin; LN, Loppa High north; LS, Loppa High south; MAF, Middle Allochthons front; NB, Nodkapp Basin; NH, Norsel High; OB, Late Palaeozoic Ottar Basin; SH, Stappen High; SHC, Late Palaeozoic Scott Hansen complex.

Reactivation of ‘curved’ Caledonian nappes hypothesis after Gernigon and Brönnert (2012)

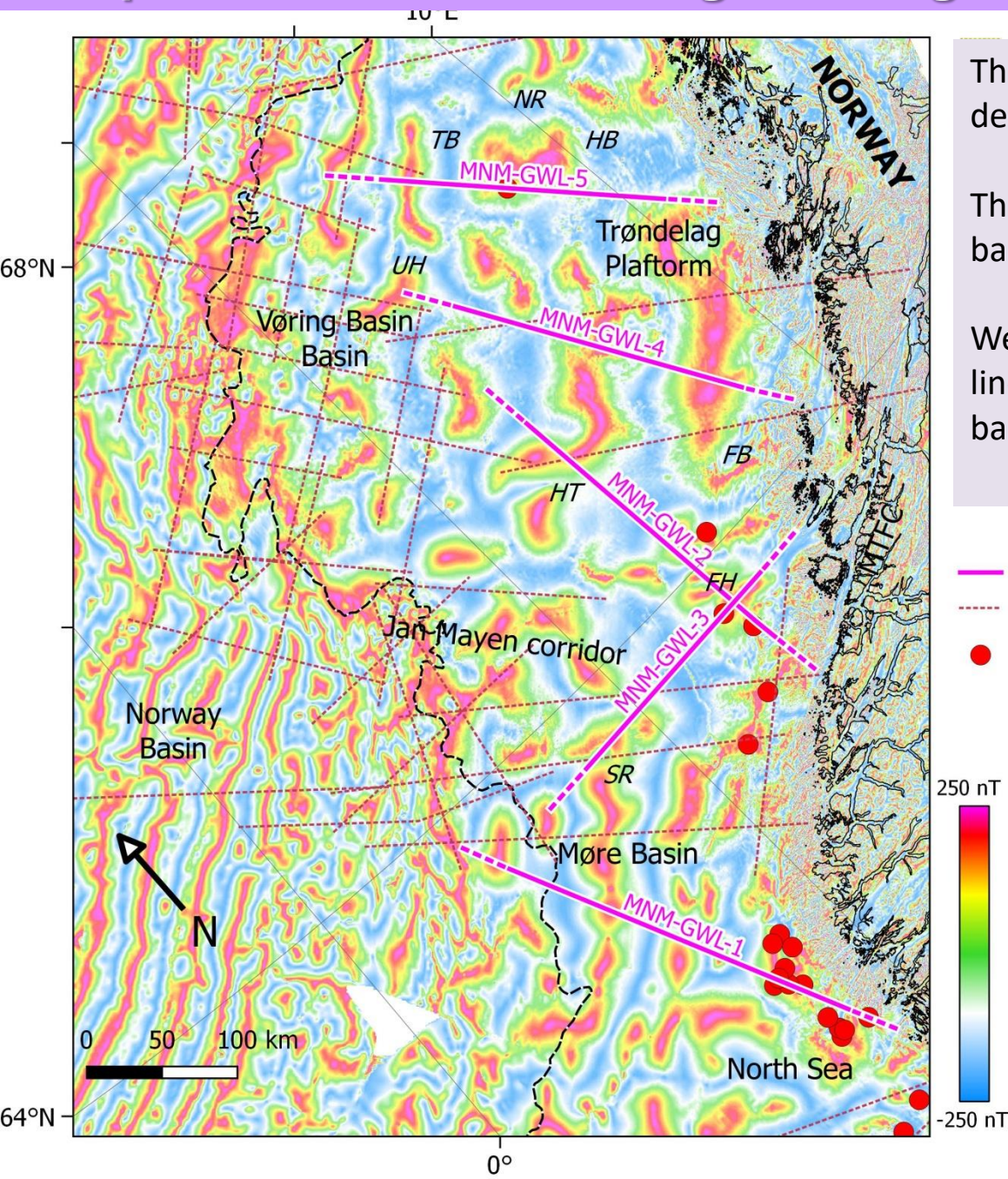
Outline of "inherited" and pre-basalt LCB (thicker than 3km)

- High density/High velocity LCBs are preferentially interpreted as inherited high-grade metamorphic rocks (the deep roots of the collapsed Caledonian orogen ?)



- Inherited LCBs have an influence on the **necking** and rift evolution
- Such root is the preferred site for drastic thinning ?
- The distal LCB are more controversial (underplating? inherited? lower crust exhumed serpentinised mantle ?)

Deep sections Mid-Norwegian margin+magnetic data (TDR)



The main objective is to shed light on the deep basement structure

The survey planning considers the basement-related anomalies and trends

We also consider pre-existing seismic lines for eventual reprocessing and basement wells for calibration

— Ultra deep section

- - - Pre-existing refraction line

● Well in basement

