Durham University

A tale of two terrane boundaries

Variable impact of terrane boundaries on rift geometry in the Great South Basin, New Zealand

Supplementary Material

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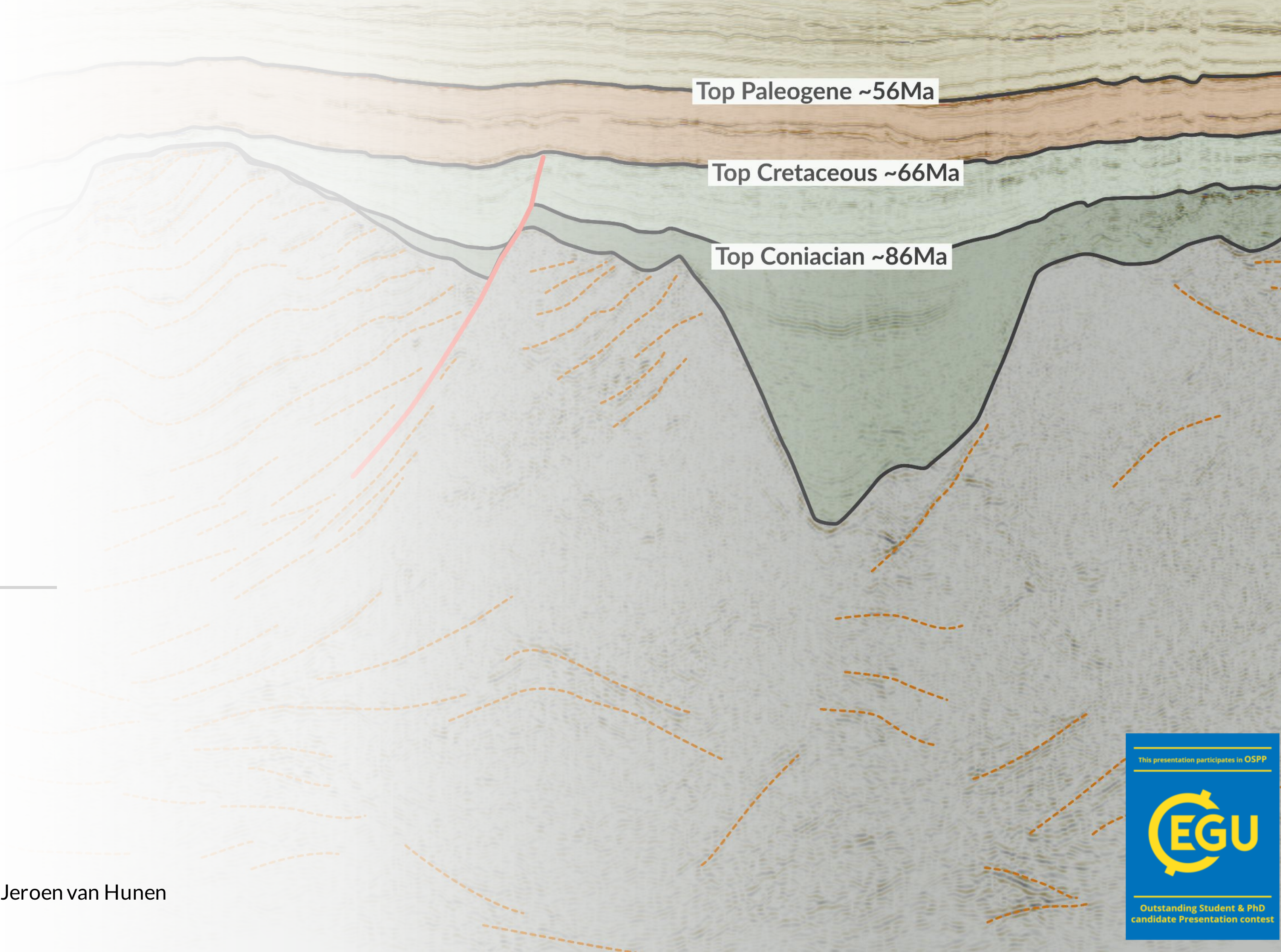

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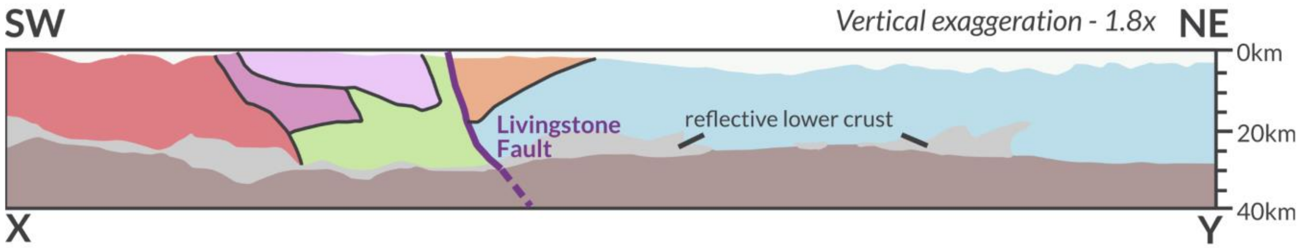
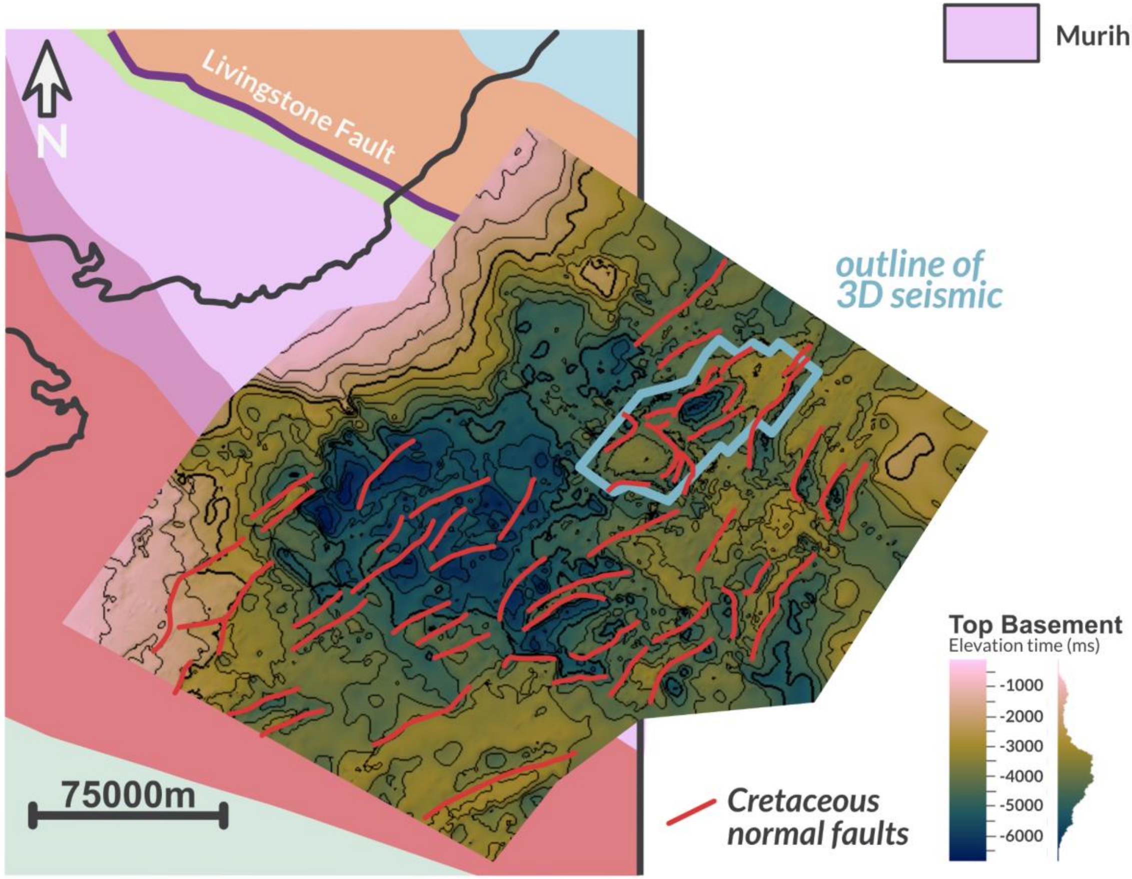
Outstanding Student & PhD candidate Presentation contest

Great South Basin (GSB) is a cretaceous rift system offshore New Zealand. It formed during the breakup of Gondwana between 105-83Ma.



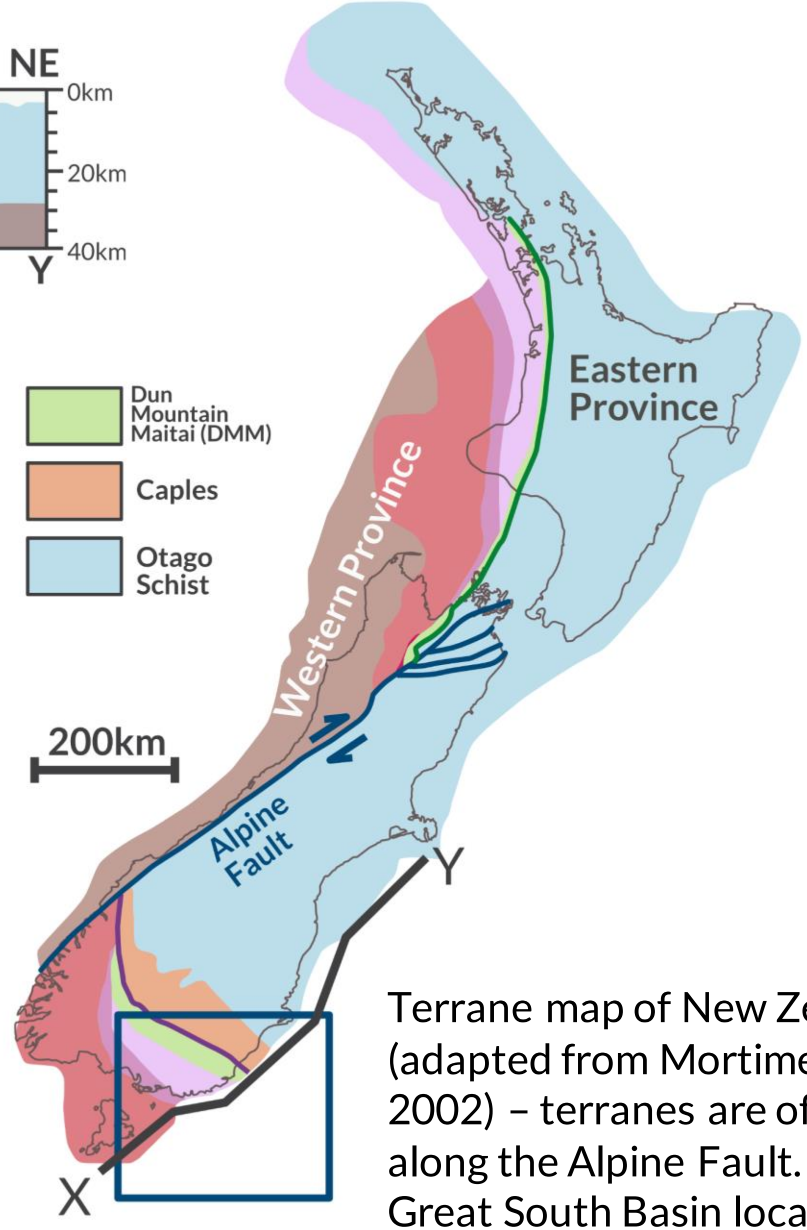
SESI seismic line interpretation (after Mortimer et al. 2002) showing the arrangement of the different terranes



Top Basement of the GSB(after Phillips and McCaffrey, in review) superimposed on the terrane boundaries of the southeast coast of New Zealand.

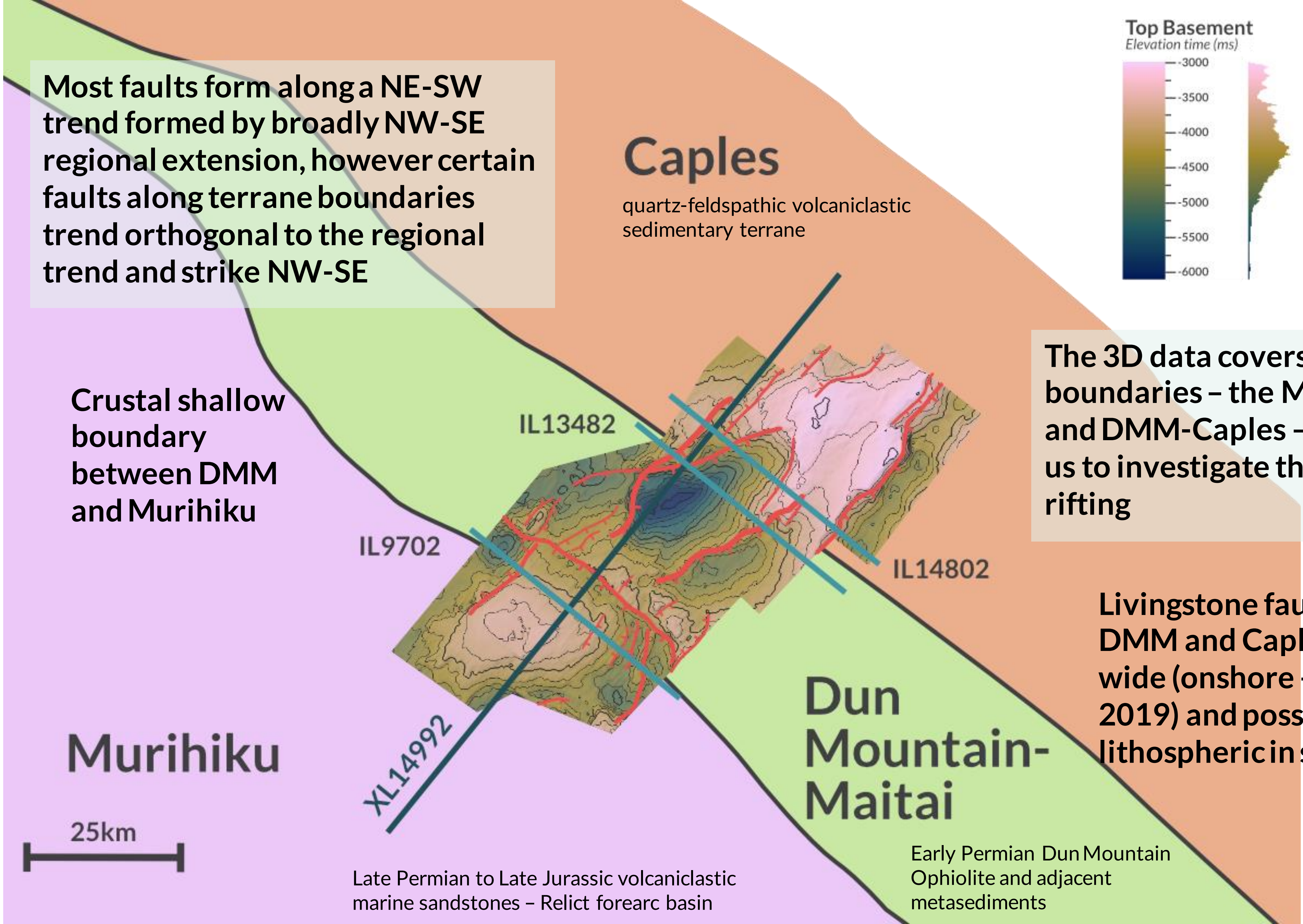
Legend

🟥	Median Batholith	🟩	Dun Mountain Maitai (DMM)
🟪	Brook Street	🟧	Caples
🟪	Murihiku	🟦	Otago Schist



Terrane map of New Zealand (adapted from Mortimer et al. 2002) – terranes are offset along the Alpine Fault. The Great South Basin location is outlined as a blue square and the SESI seismic line is shown in black

Most faults form along a NE-SW trend formed by broadly NW-SE regional extension, however certain faults along terrane boundaries trend orthogonal to the regional trend and strike NW-SE



quartz-feldspathic volcaniclastic sedimentary terrane

Crustal shallow boundary between DMM and Murihiku

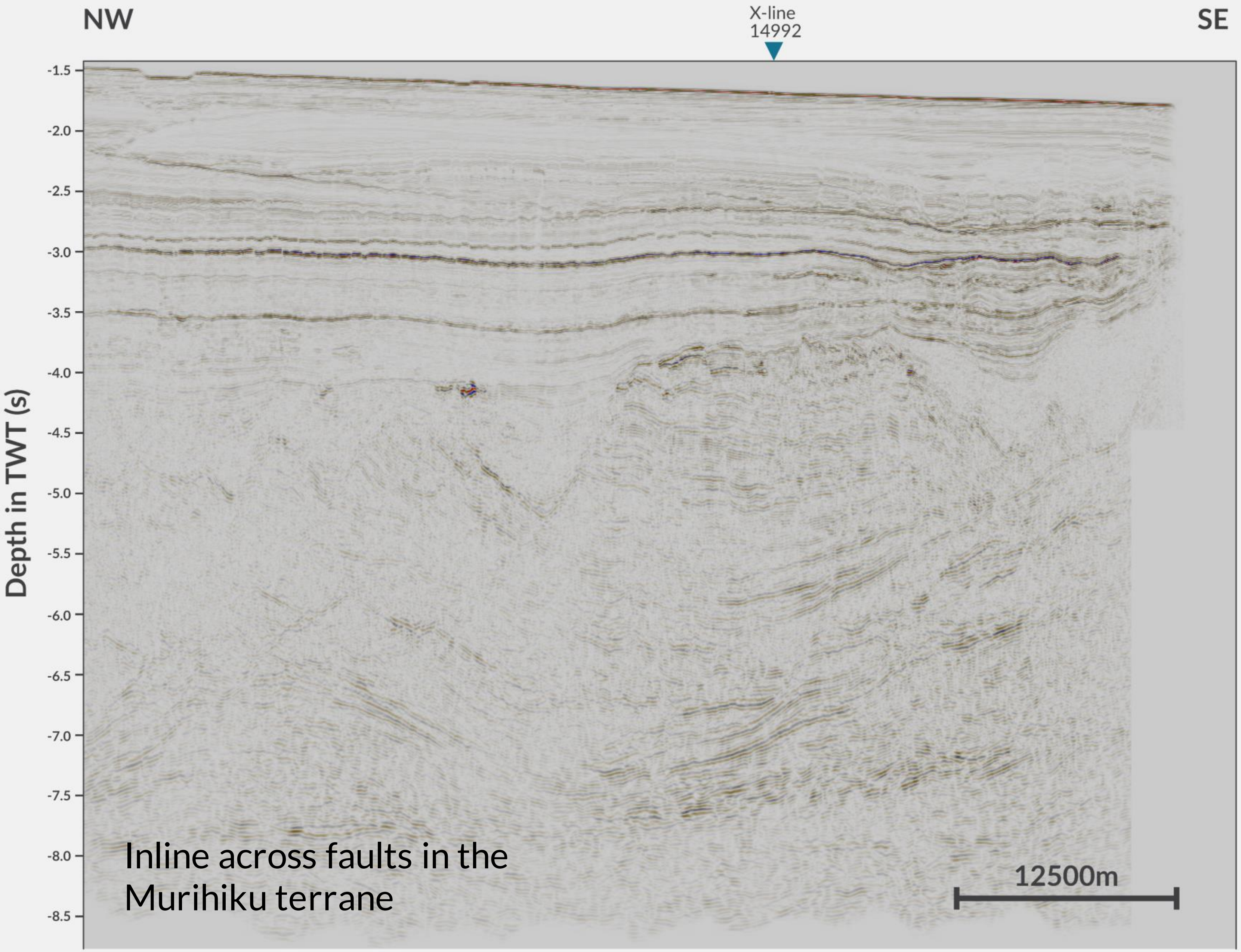
The 3D data covers two terrane boundaries – the Murihiku-DMM and DMM-Caples – which allows us to investigate their impact on rifting

Livingstone fault – separates DMM and Caples – up to 480m wide (onshore – Tarling et al. 2019) and possibly lithospheric in scale

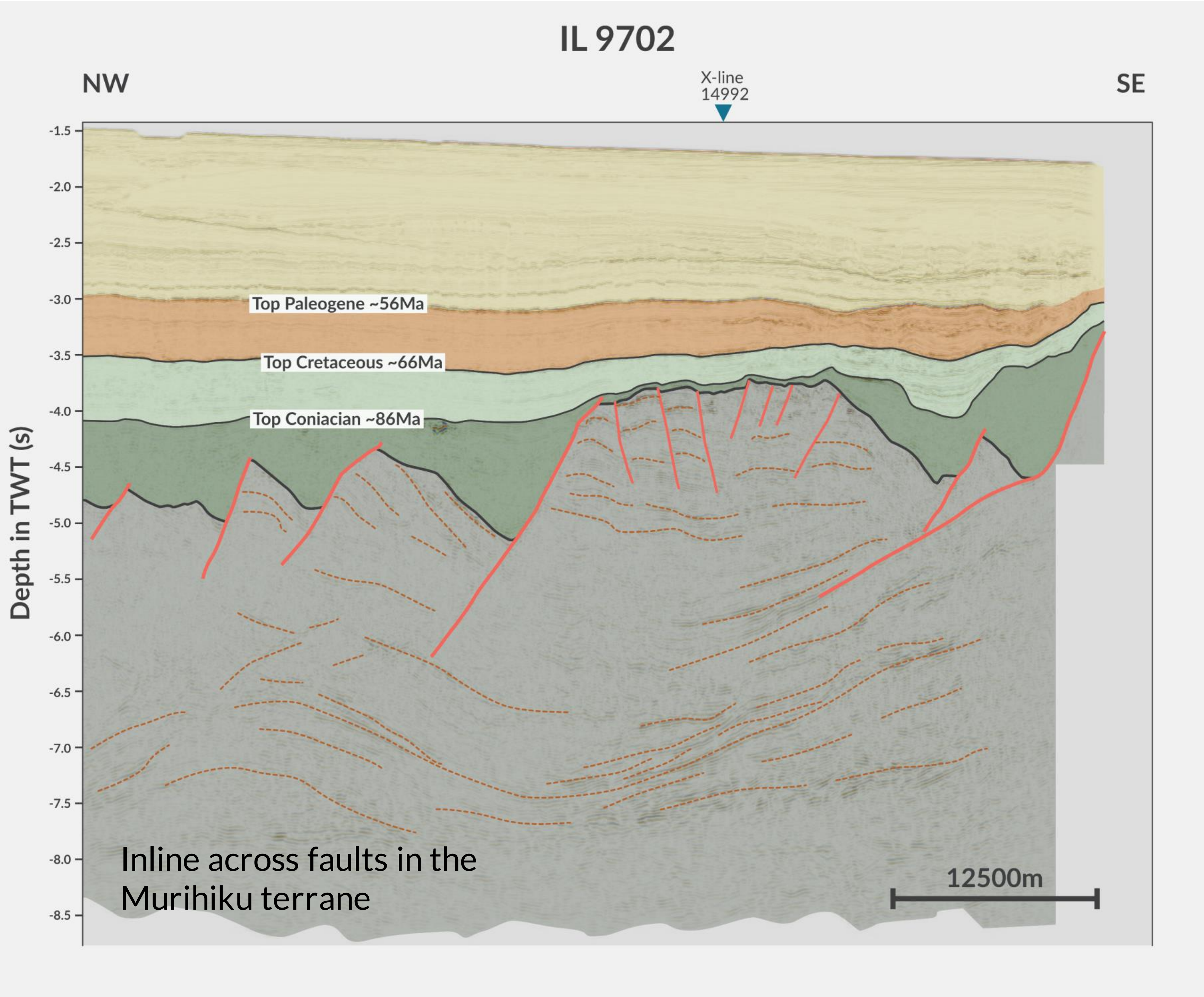
Late Permian to Late Jurassic volcaniclastic marine sandstones – Relict forearc basin

Early Permian Dun Mountain Ophiolite and adjacent metasediments

IL 9702



Inline across faults in the Murihiku terrane



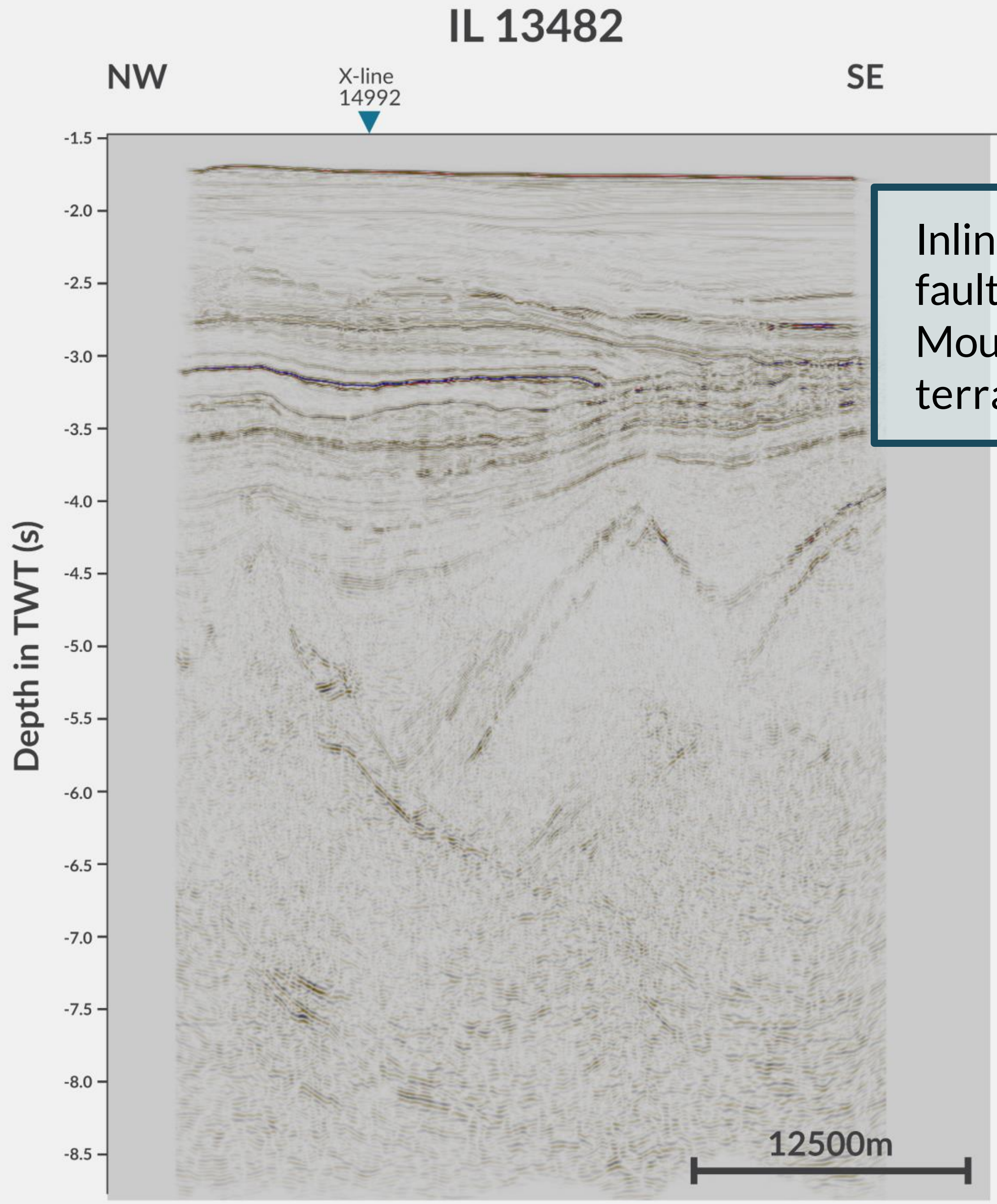
Inline across faults in the Murihiku terrane

Faults in the SE detach into the basement reflectivity

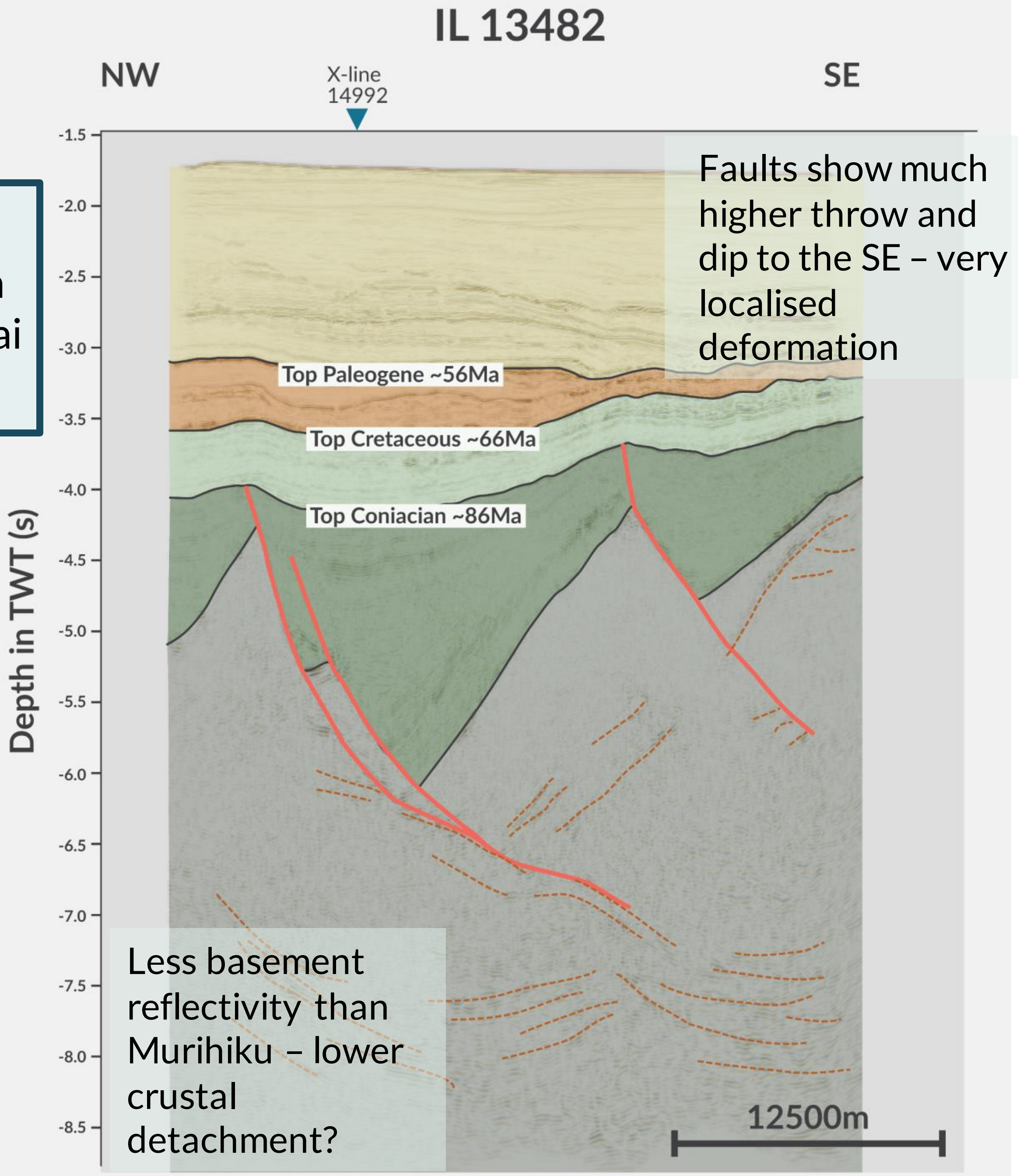
Most faults dip to the NW

Less intensely faulted basement high

Abundant intrabasement reflectivity – typical for Murihiku basement

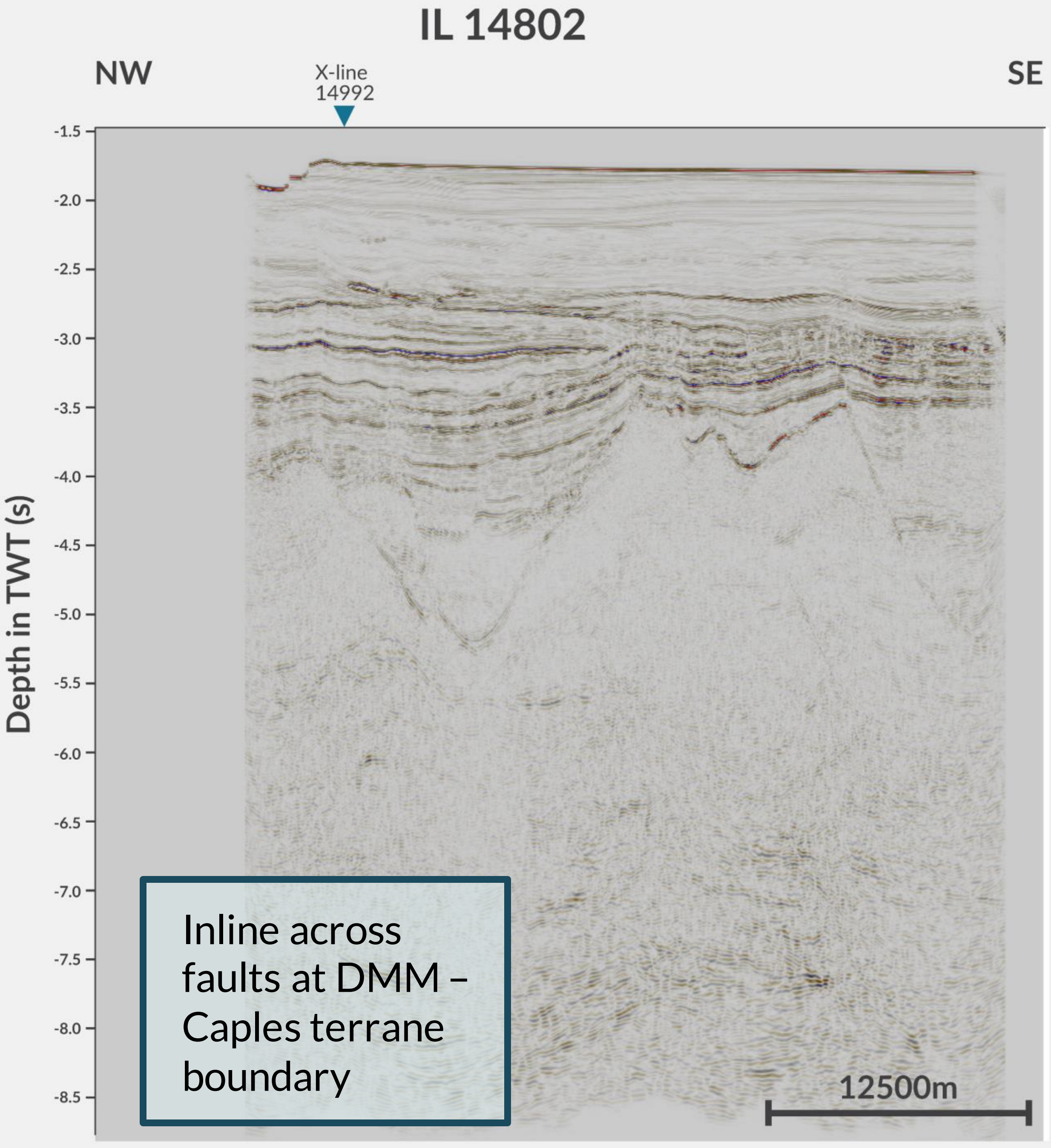


Inline across faults in the Dun Mountain - Matai terrane

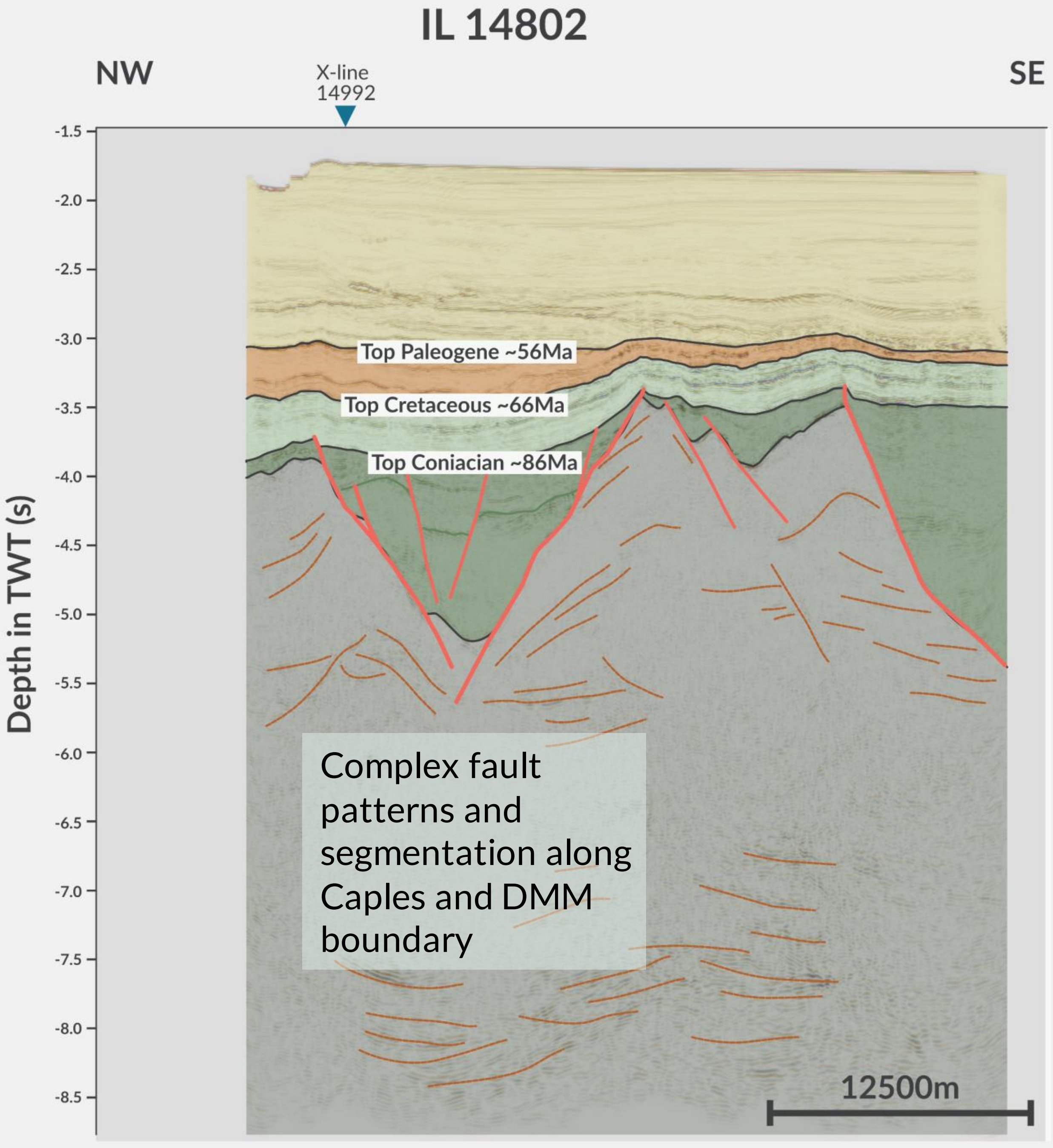


Faults show much higher throw and dip to the SE – very localised deformation

Less basement reflectivity than Murihiku – lower crustal detachment?

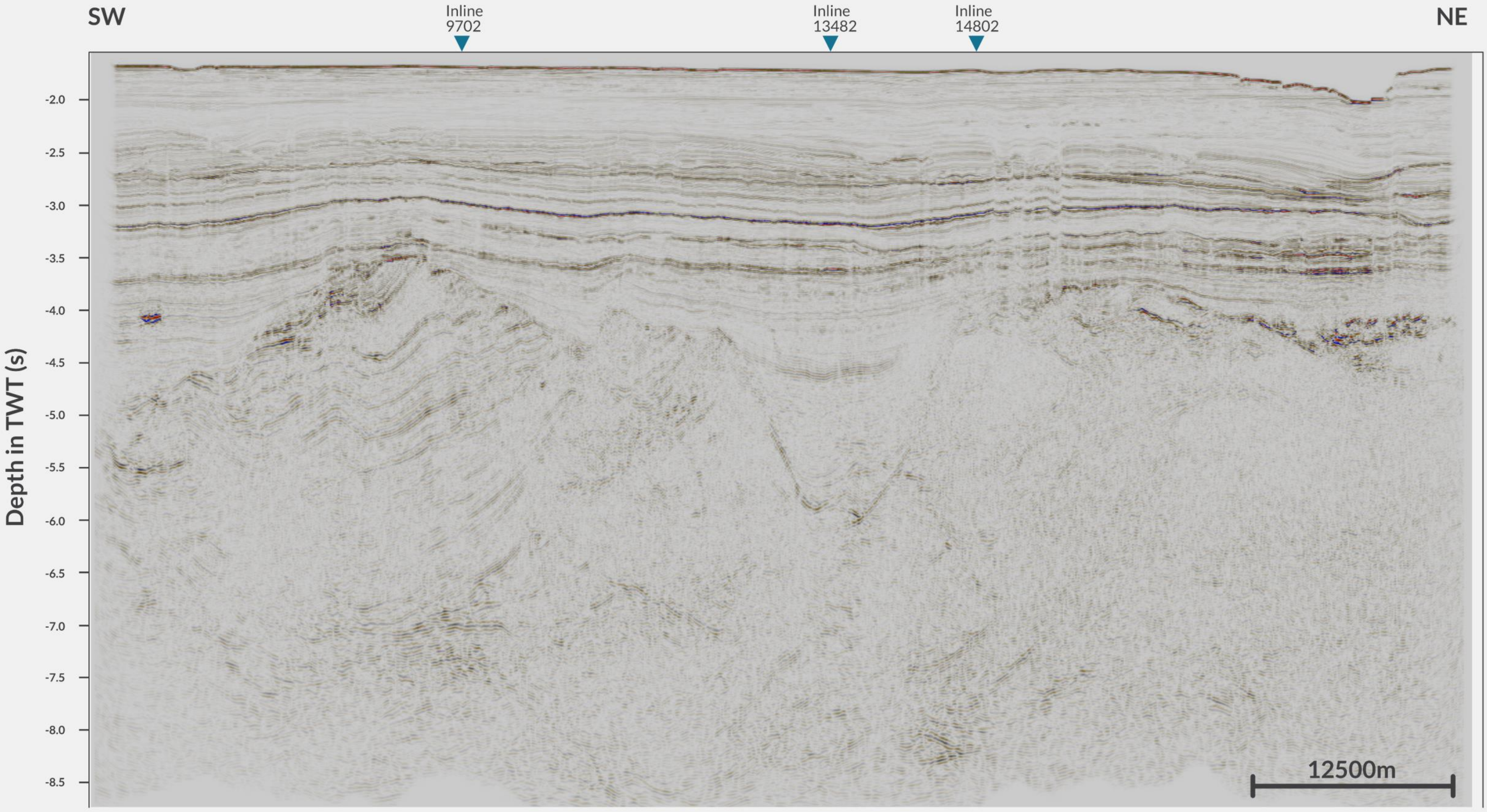


Inline across faults at DMM – Caples terrane boundary

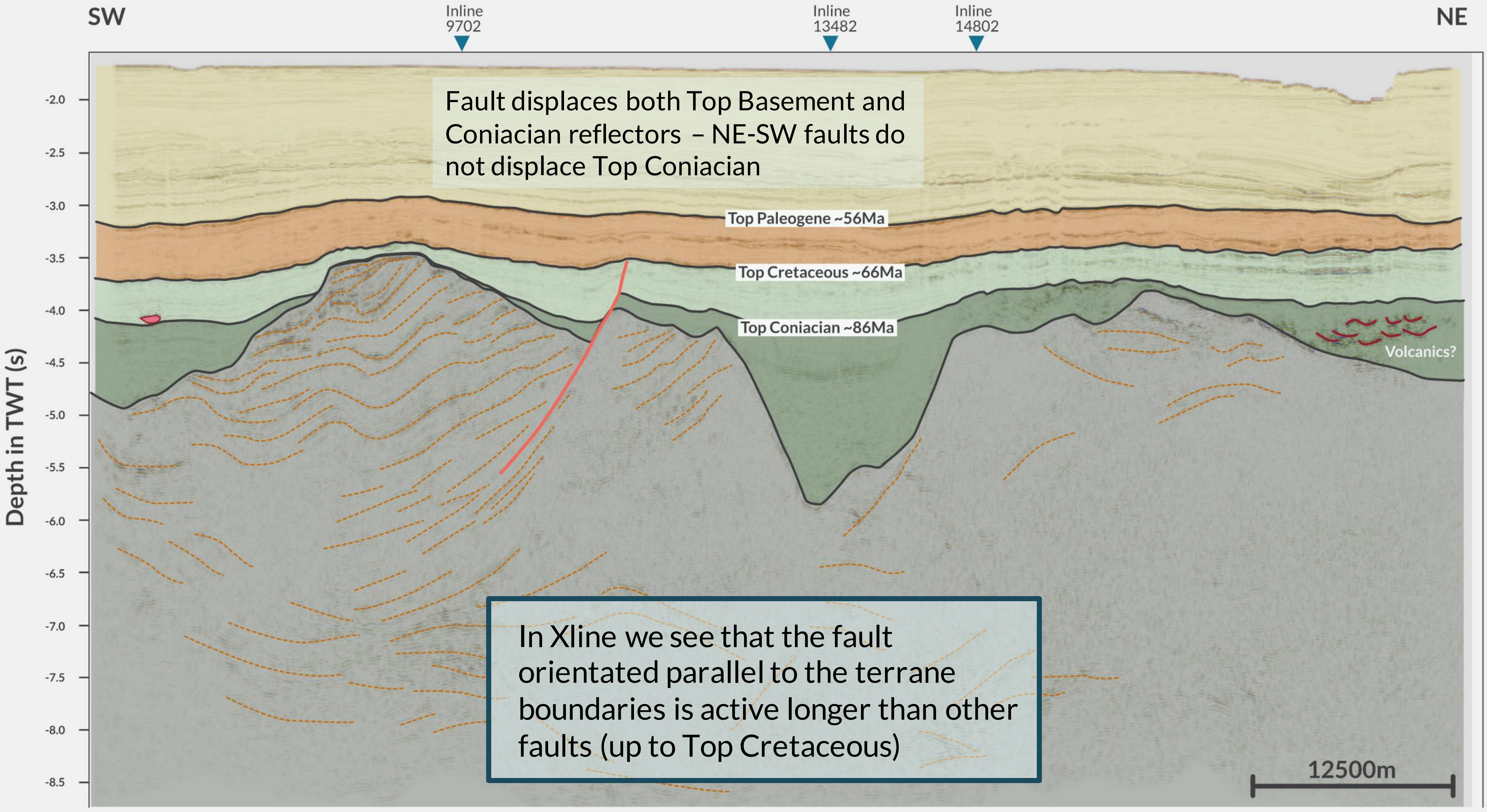


Complex fault patterns and segmentation along Caples and DMM boundary

XL 14992

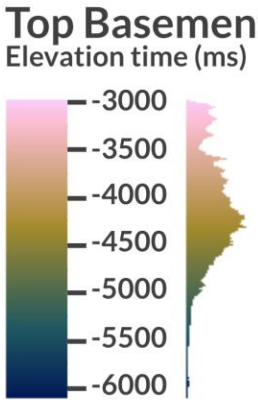

SW
Inline 9702
Inline 13482
Inline 14802
NE
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0
-5.5
-6.0
-6.5
-7.0
-7.5
-8.0
-8.5
Depth in TWT (s)
12500m

XL 14992

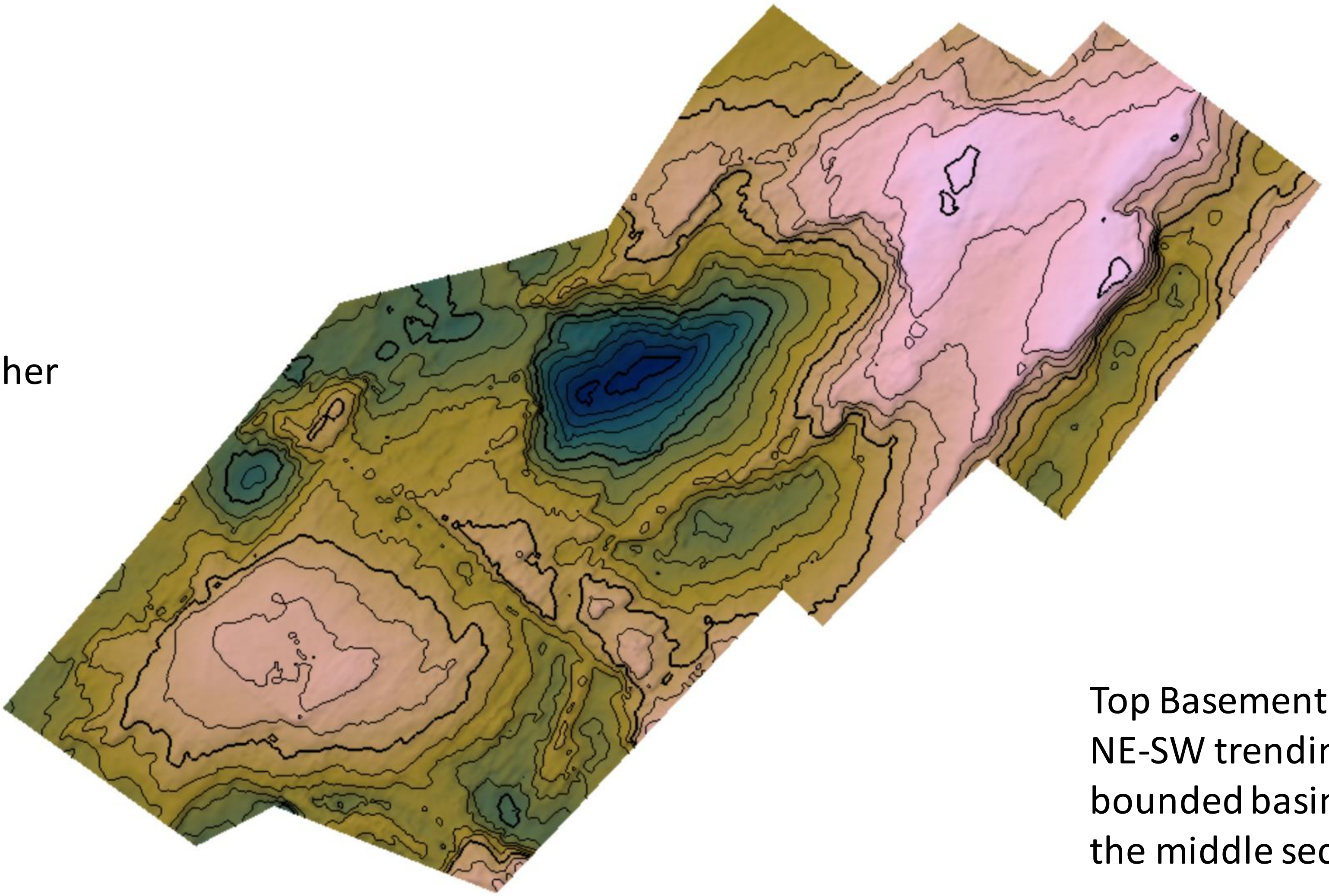


Fault displaces both Top Basement and Coniacian reflectors – NE-SW faults do not displace Top Coniacian

In Xline we see that the fault orientated parallel to the terrane boundaries is active longer than other faults (up to Top Cretaceous)



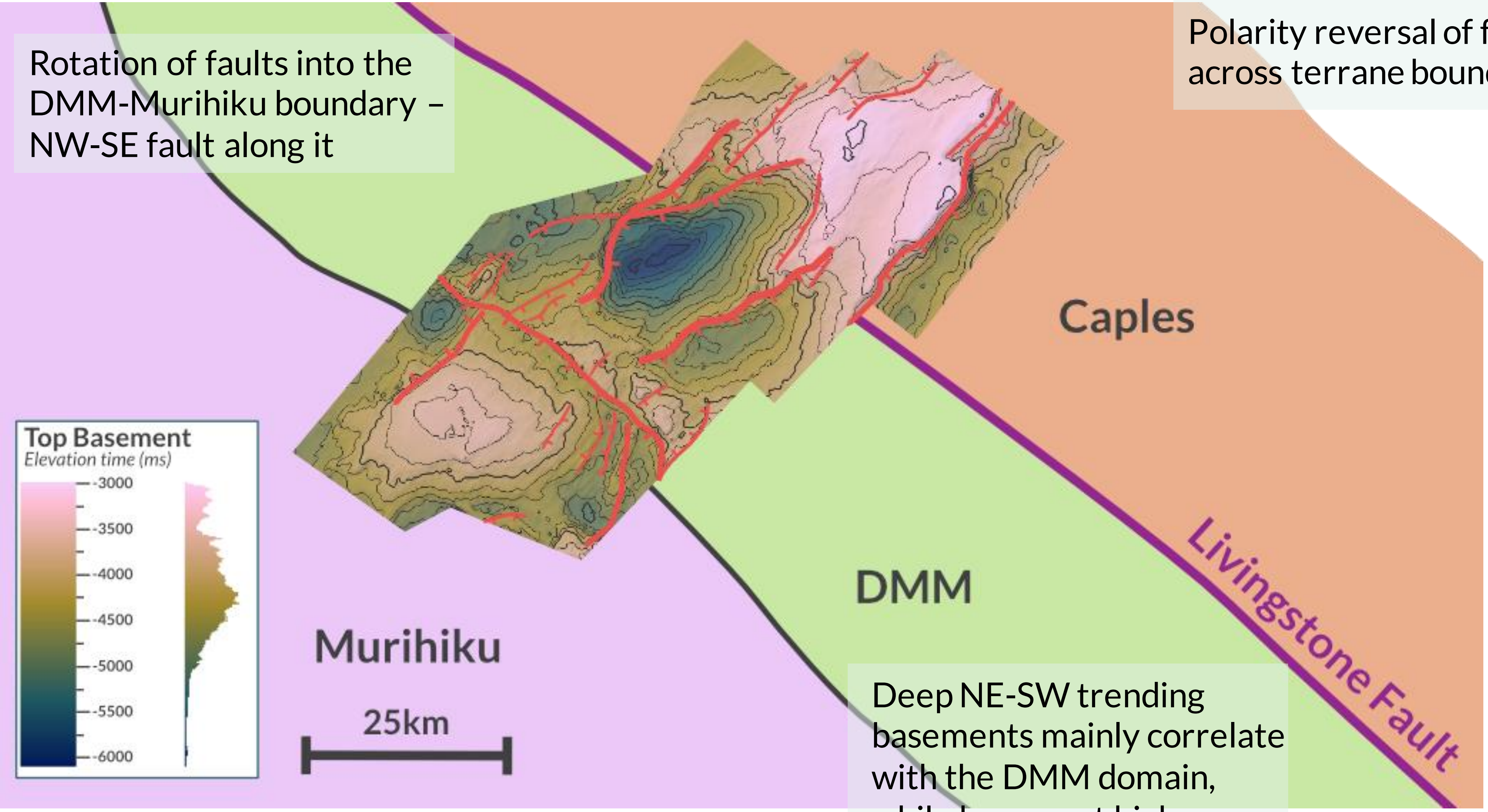
Two basement highs on either side – NE and SW



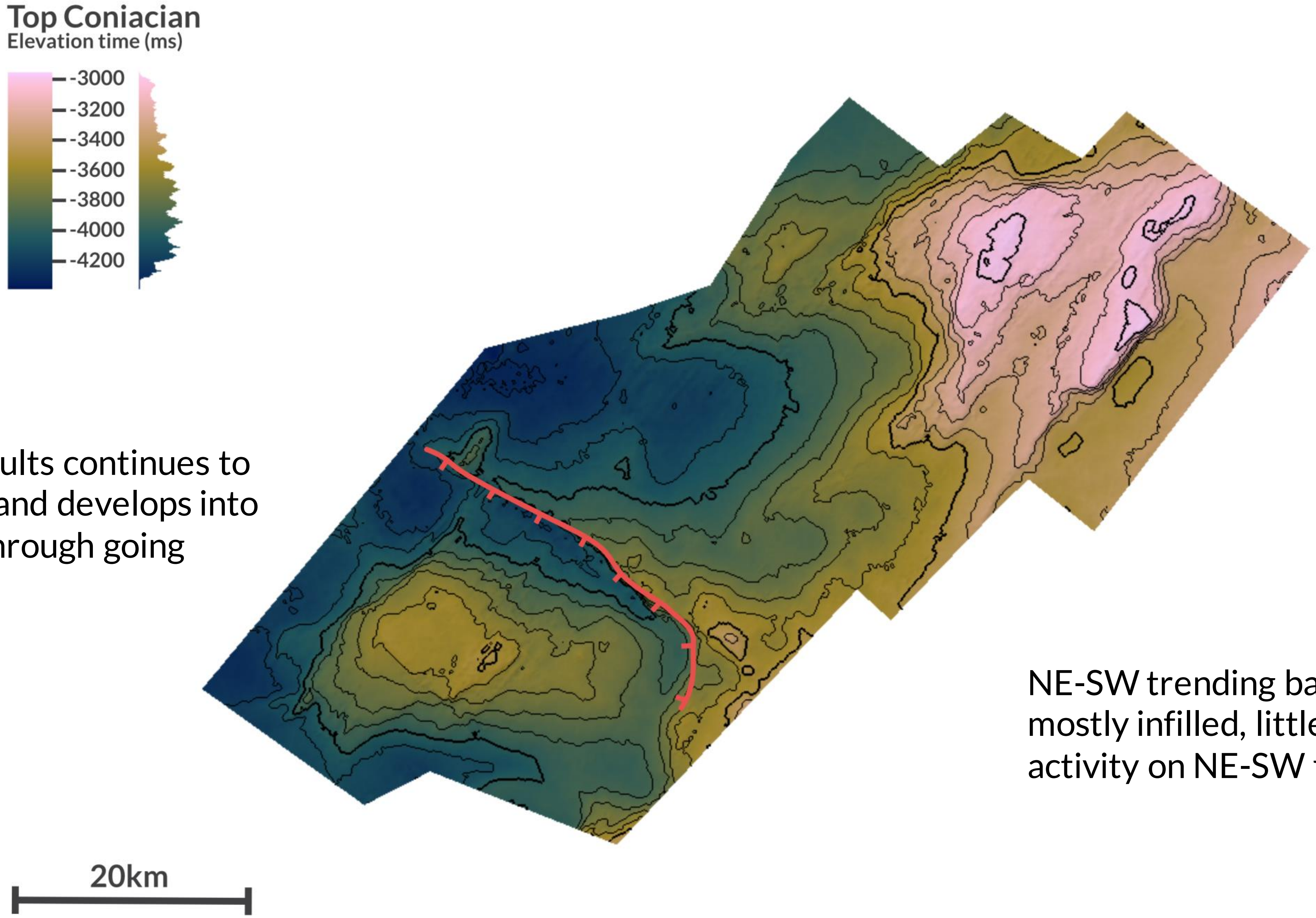
Top Basement shows largely NE-SW trending fault bounded basins, especially in the middle section

Rotation of faults into the DMM-Murihiku boundary – NW-SE fault along it

Polarity reversal of faults across terrane boundaries

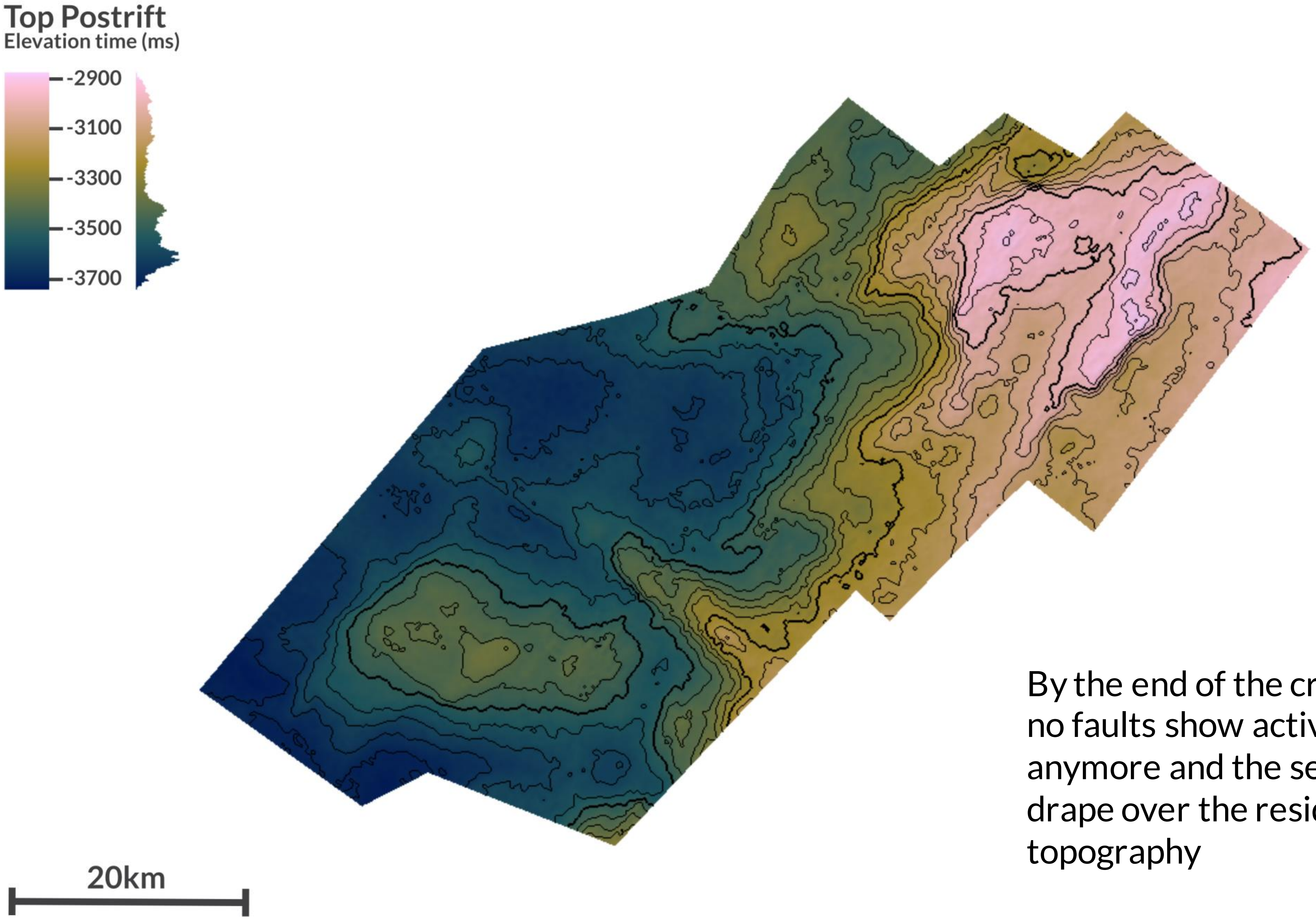


Deep NE-SW trending basements mainly correlate with the DMM domain, while basement highs occur in the Caples and Murihiku

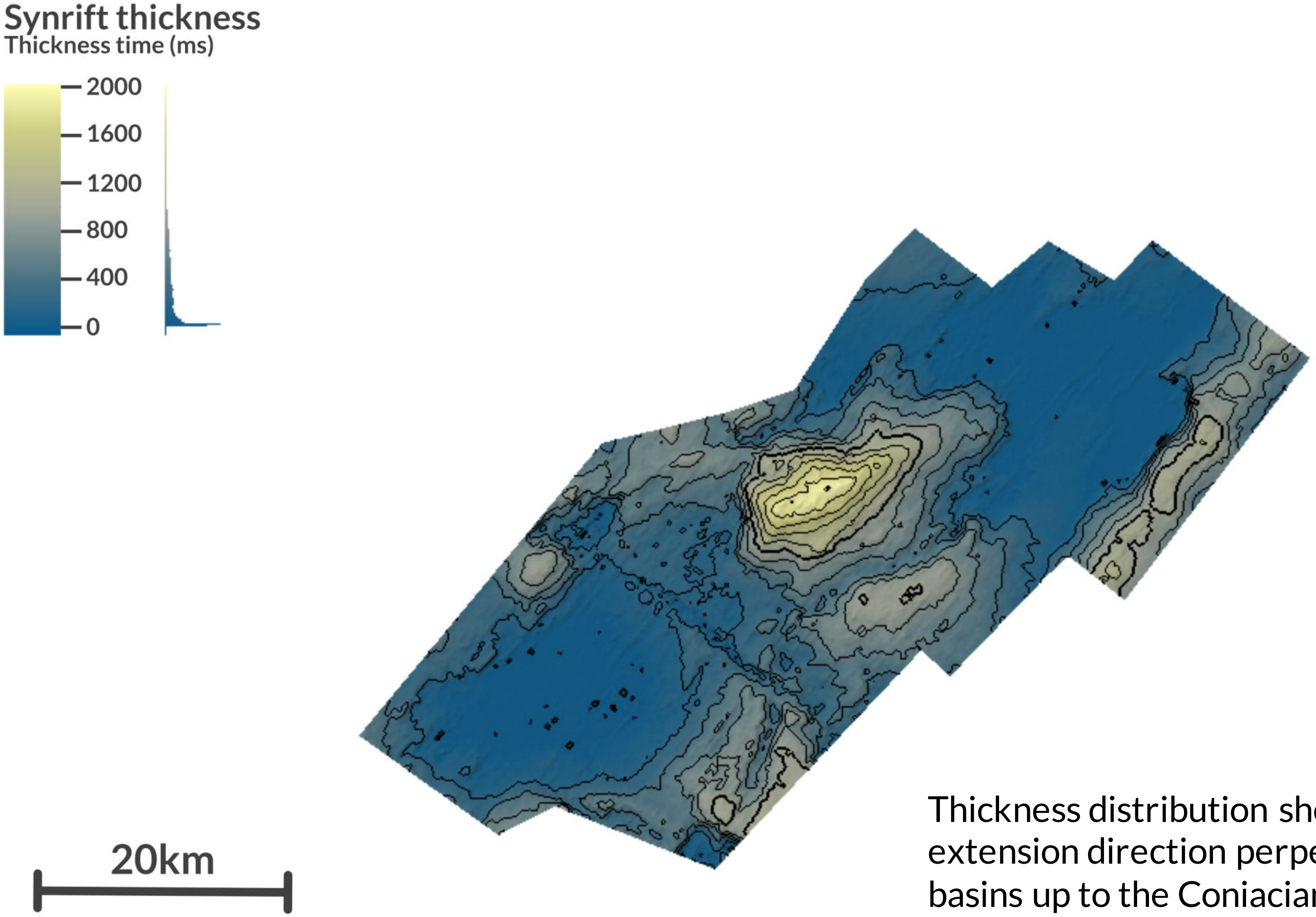


NW-SE faults continues to be active and develops into a linked through going structure

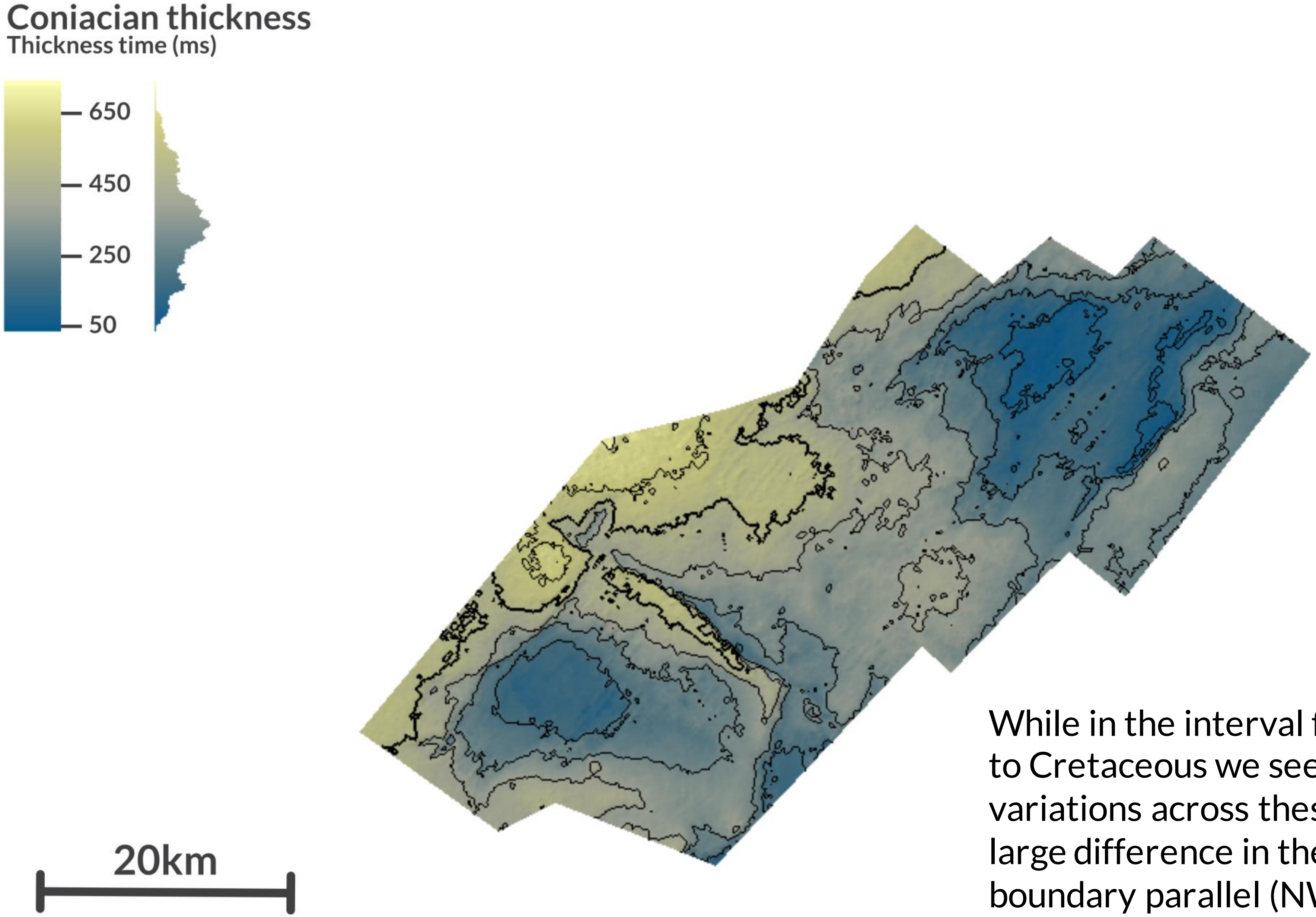
NE-SW trending basins now mostly infilled, little fault activity on NE-SW faults



By the end of the cretaceous no faults show activity anymore and the sediments drape over the residual topography

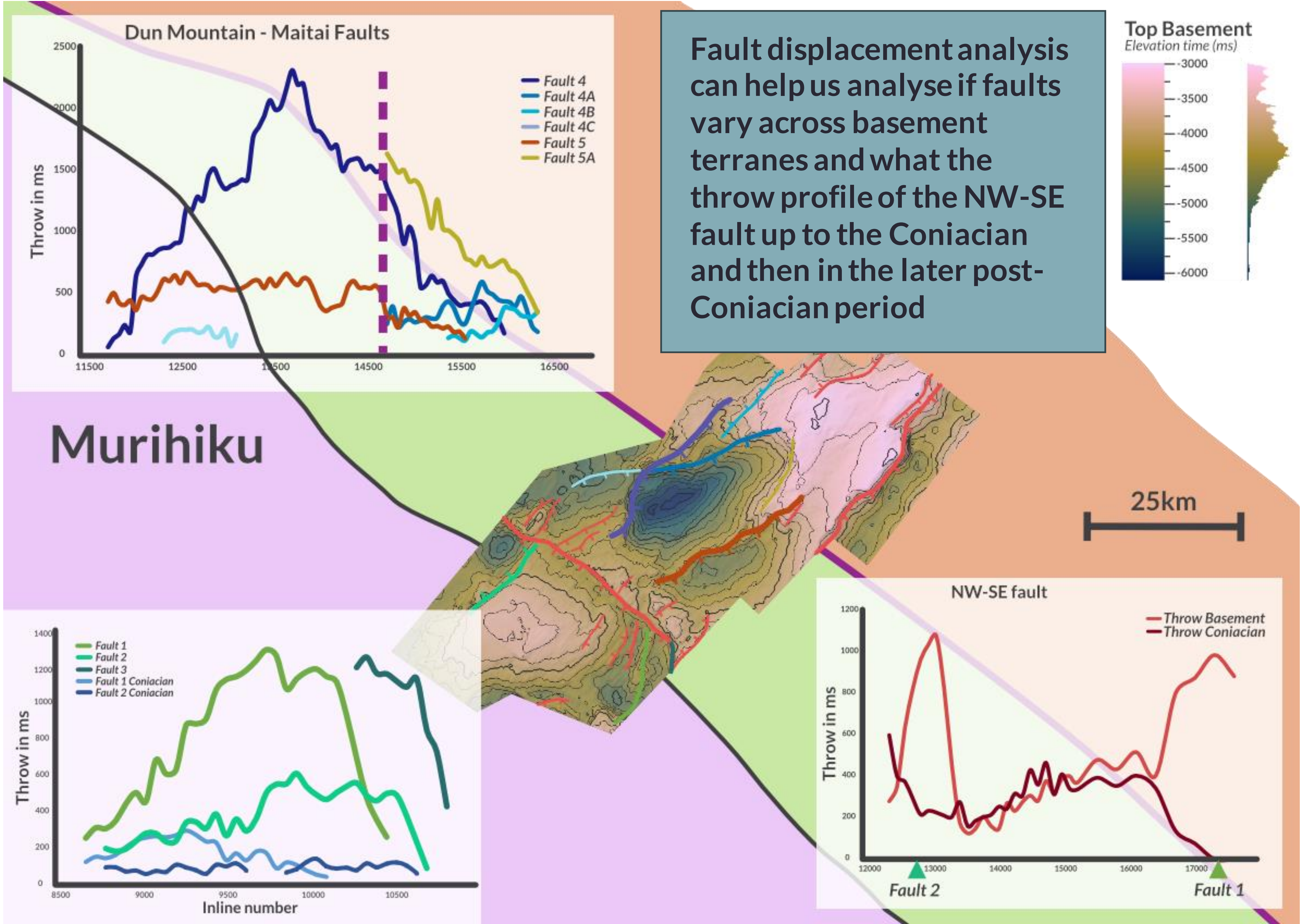


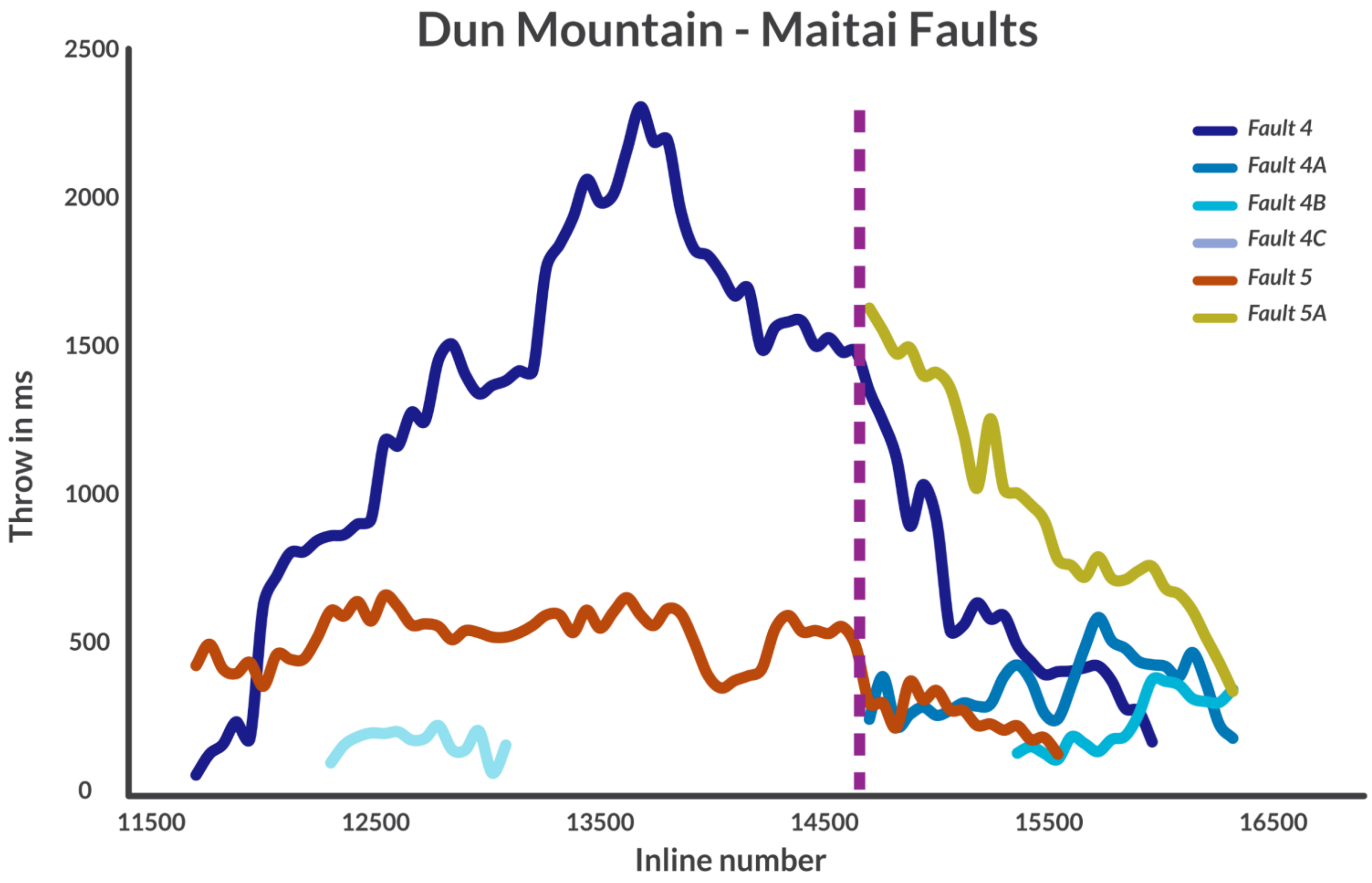
Thickness distribution shows large extension direction perpendicular basins up to the Coniacian



While in the interval from Coniacian to Cretaceous we see little thickness variations across these faults but a large difference in the terrane boundary parallel (NW-SE) one

Fault displacement analysis can help us analyse if faults vary across basement terranes and what the throw profile of the NW-SE fault up to the Coniacian and then in the later post-Coniacian period



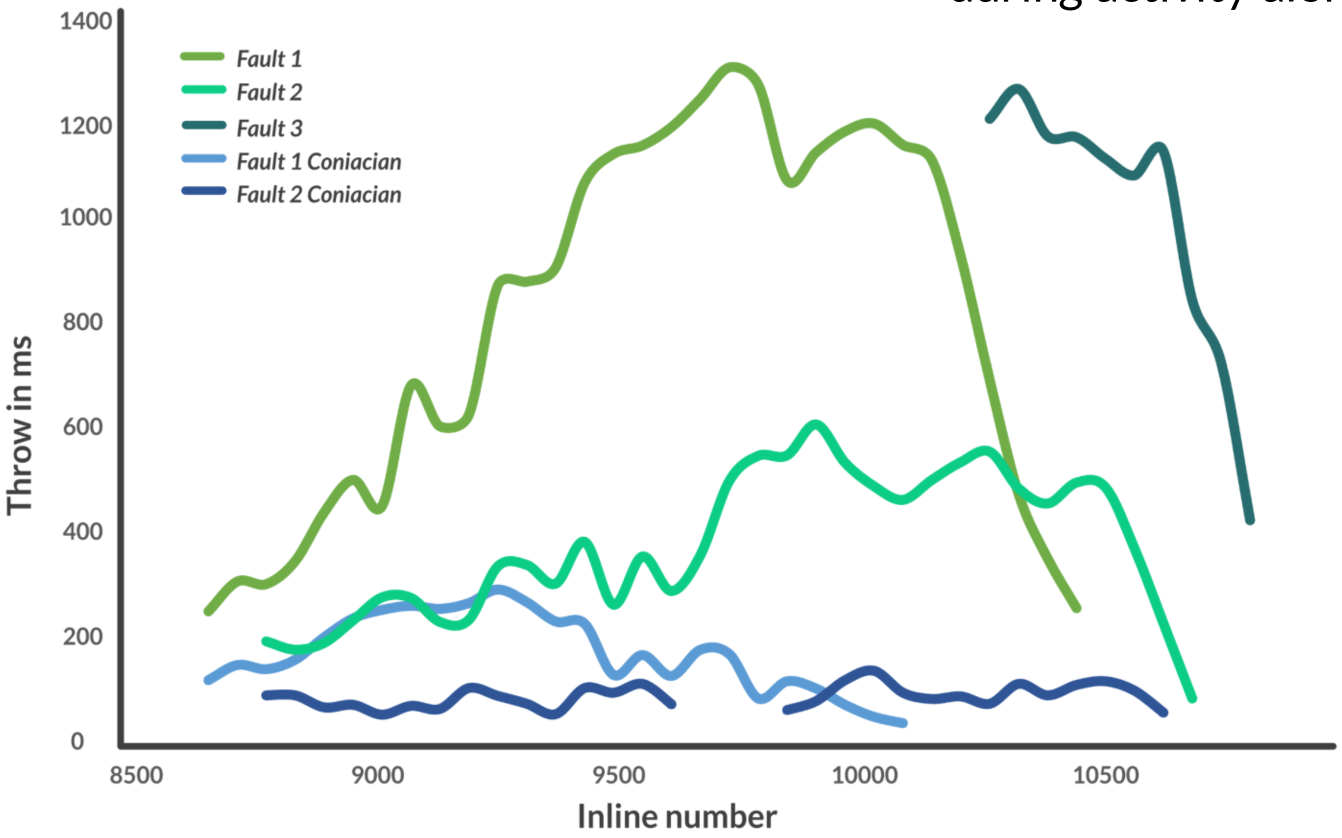


Both Fault 4 and 5 show largely symmetrical throw profiles with up to 2500ms of throw

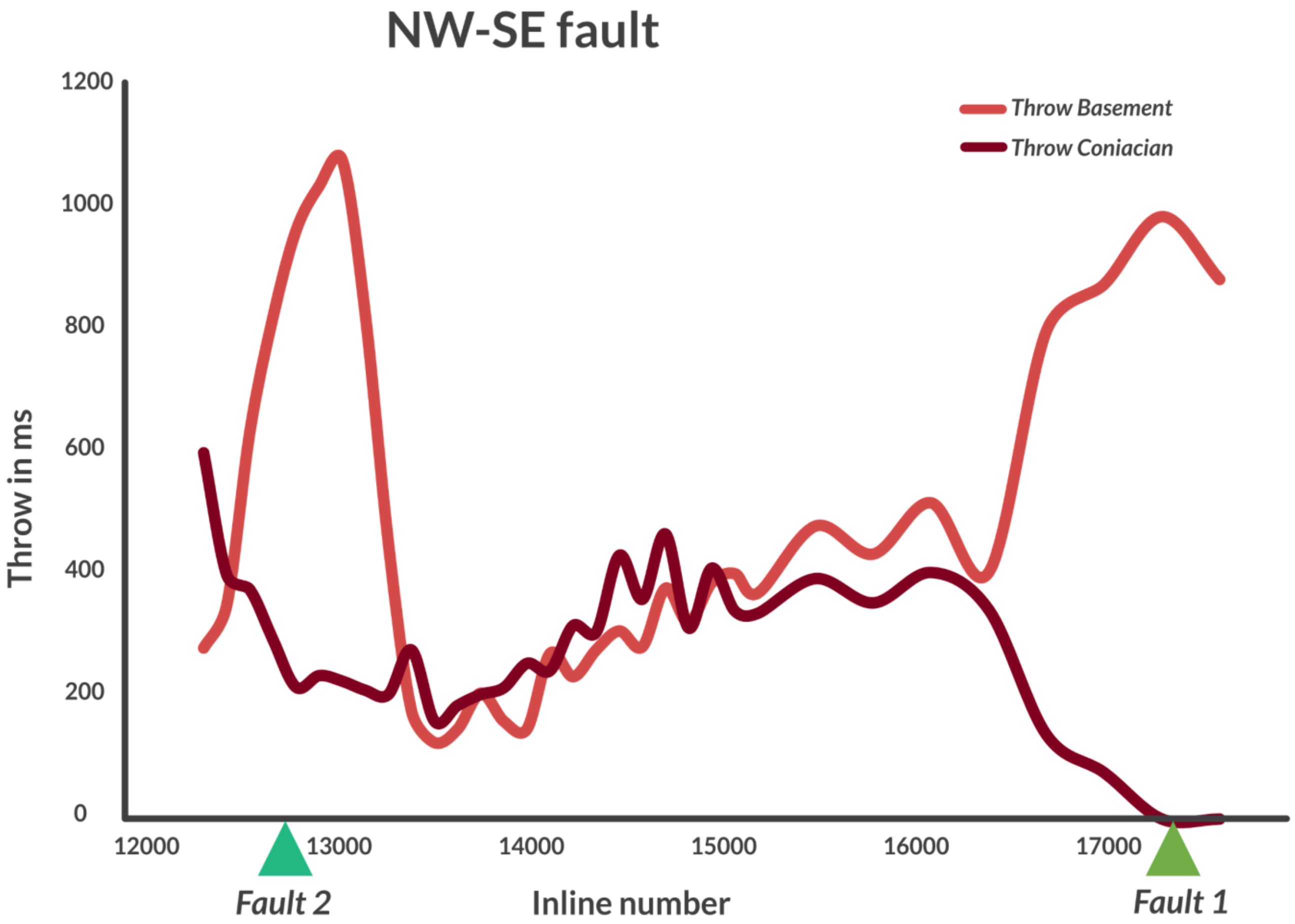
Both show segmentation along the 14500 Inline which is broadly coincident with the Livingstone Fault

Fault 1 and 2 show small amount of Coniacian throw which might be because the NE-SW segments show small amounts of reactivation during activity along the NW-SE structure

Murihiku Faults



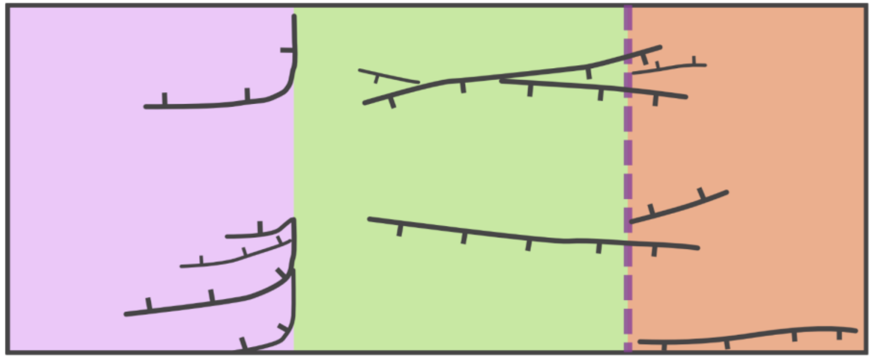
All faults in the Murihiku domain shows asymmetrical throw profiles with the largest throw close to the boundary with the DMM terrane



Throw profiles for the NW-SE fault are different in the two rift periods. Throw of the basement reflector is highest at the intersection with the NE-SW trending faults of the Murihiku domain

While the later rifting (Top Coniacian) shows the highest throw inbetween and almost no displacement at the fault intersections

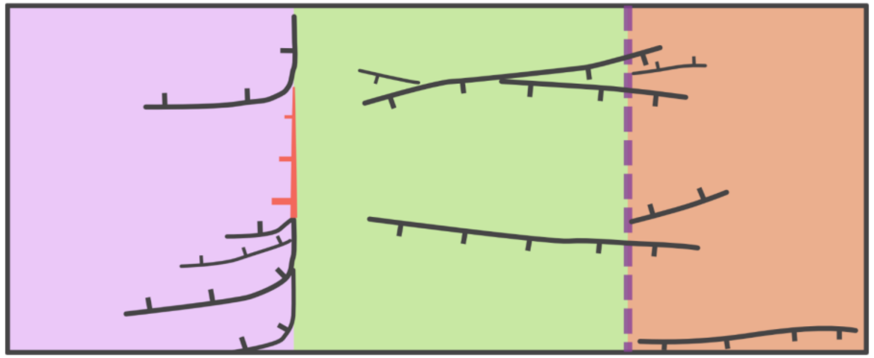
Coniacian ~86Ma



Frictionally weak crustal structures cause the rotation of the local strain field and create curved normal faults along the terrane boundary

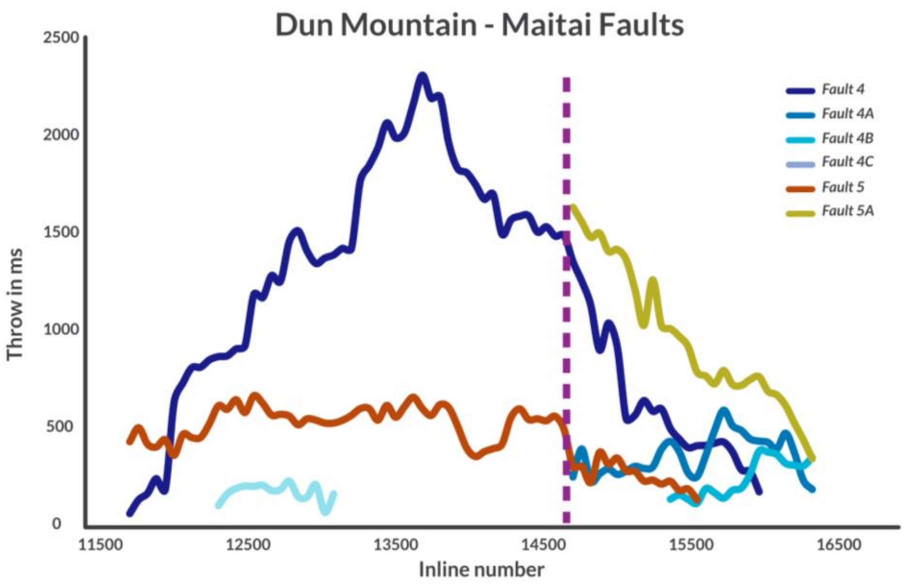
Lithospheric structures like the Livingstone Fault influence the location of splaying and formation of accomodation zones

Cretaceous ~66Ma

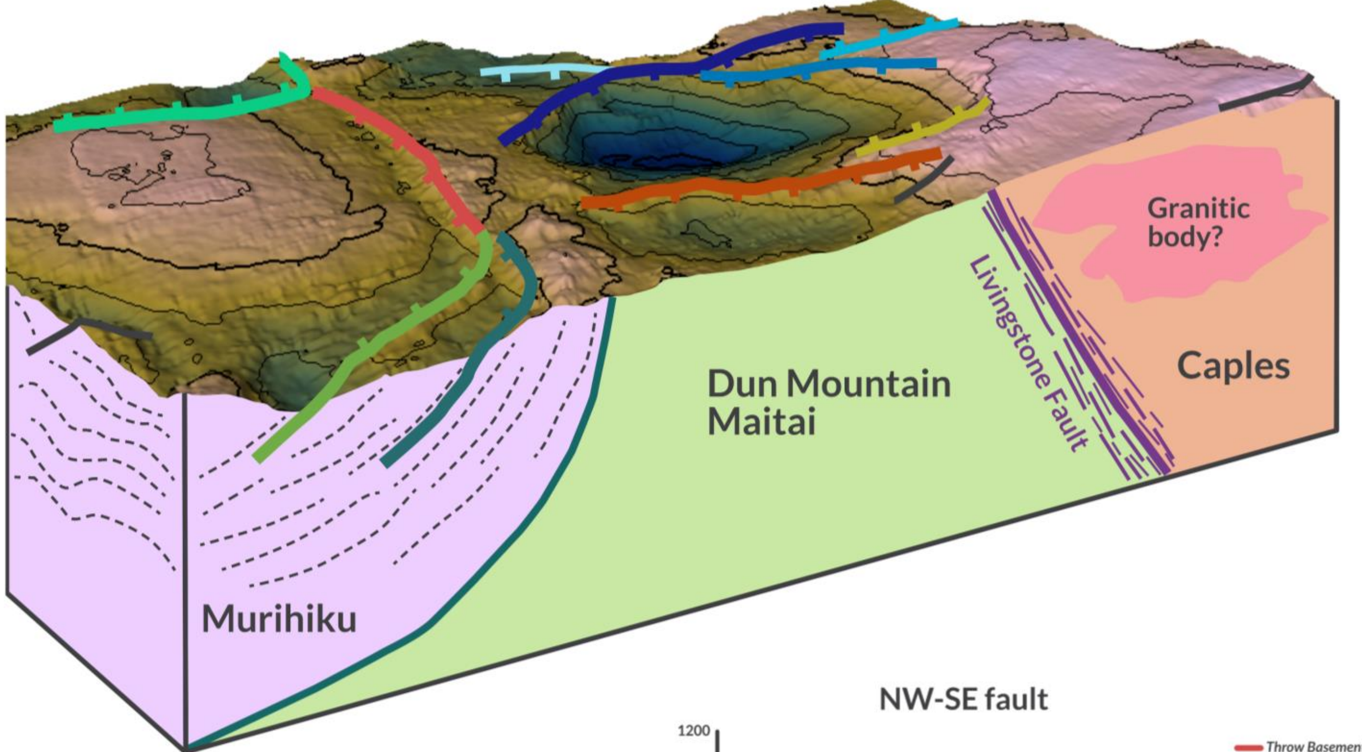


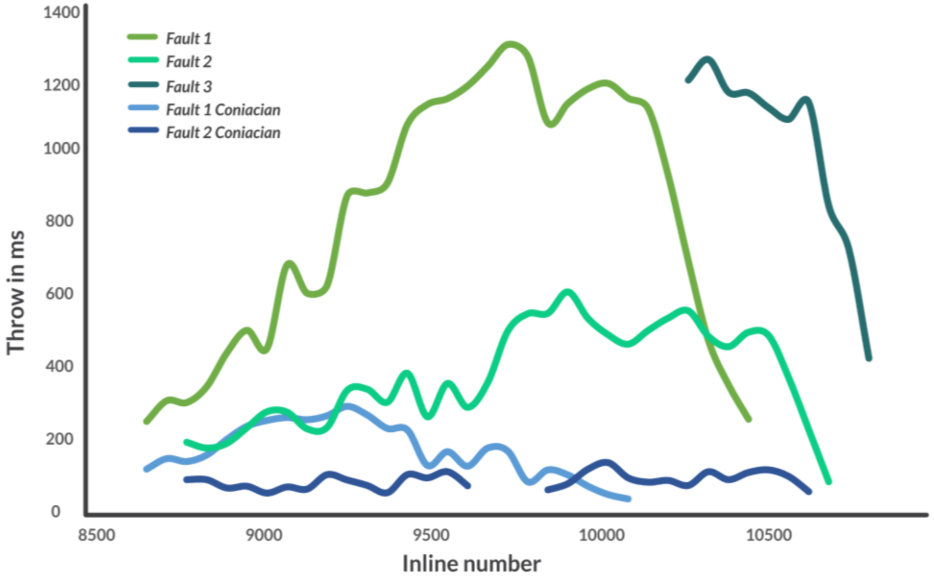
Frictionally weak crustal structures guide the linkage of the early formed curved basins and can be active for longer after other rift faults have become inactive

Both terrane boundaries have significant impact on rift architecture and evolution:



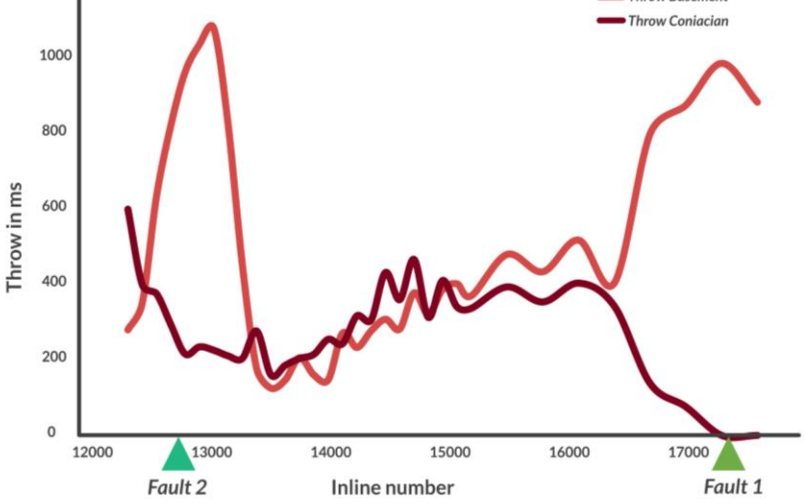
The Livingstone fault segments the rift in the early evolution and causes faults to splay





The weak slip planes of the DMM-Murihiku boundary causes faults to detach into them and rotate them along a NW-SE trend along it. These faults are active for longer – past the Coniacian up to the late Cretaceous

NW-SE fault



Selected References

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