Mapping the continent-ocean transition in the Eastern Black Sea Basin

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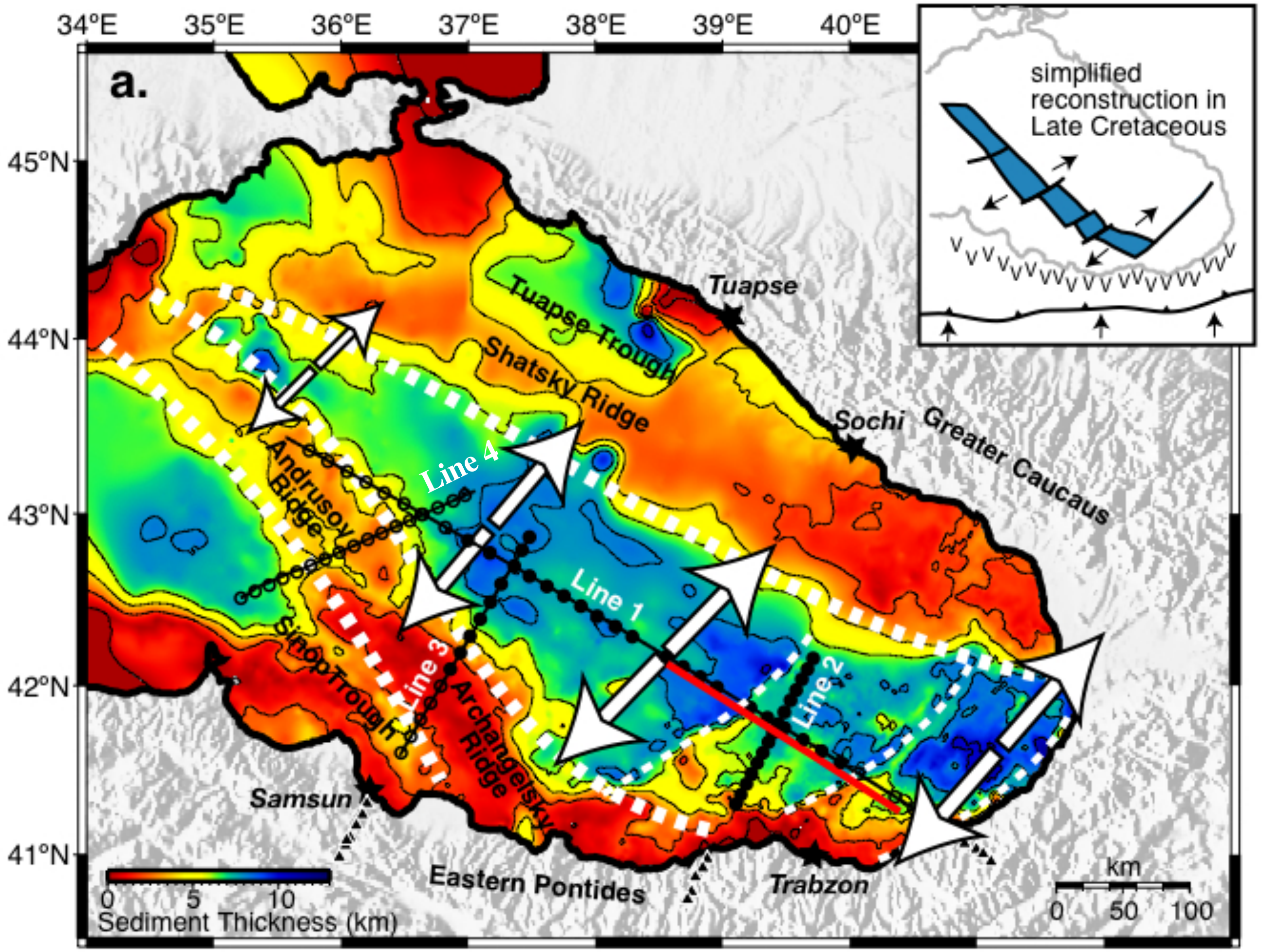
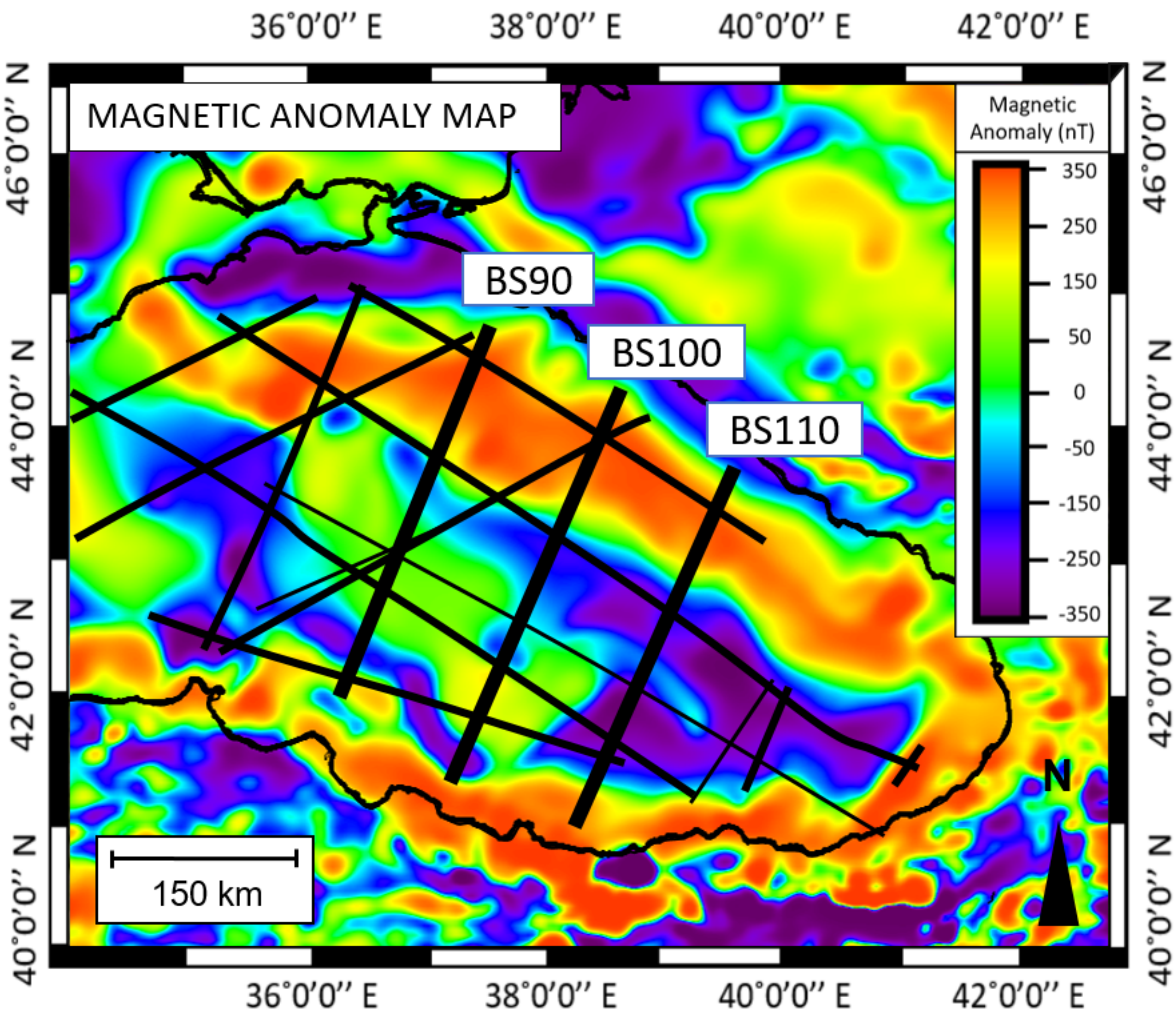
Opening of the Eastern Black Sea Basin

Late Cretaceous/early Cenozoic opening by clockwise rotation of the Mid Black Sea High (Andrusov and Archangelsky Ridges) relative to Shatsky Ridge. Black symbols mark 2005 ocean bottom seismometer deployments and black lines mark shooting profiles.



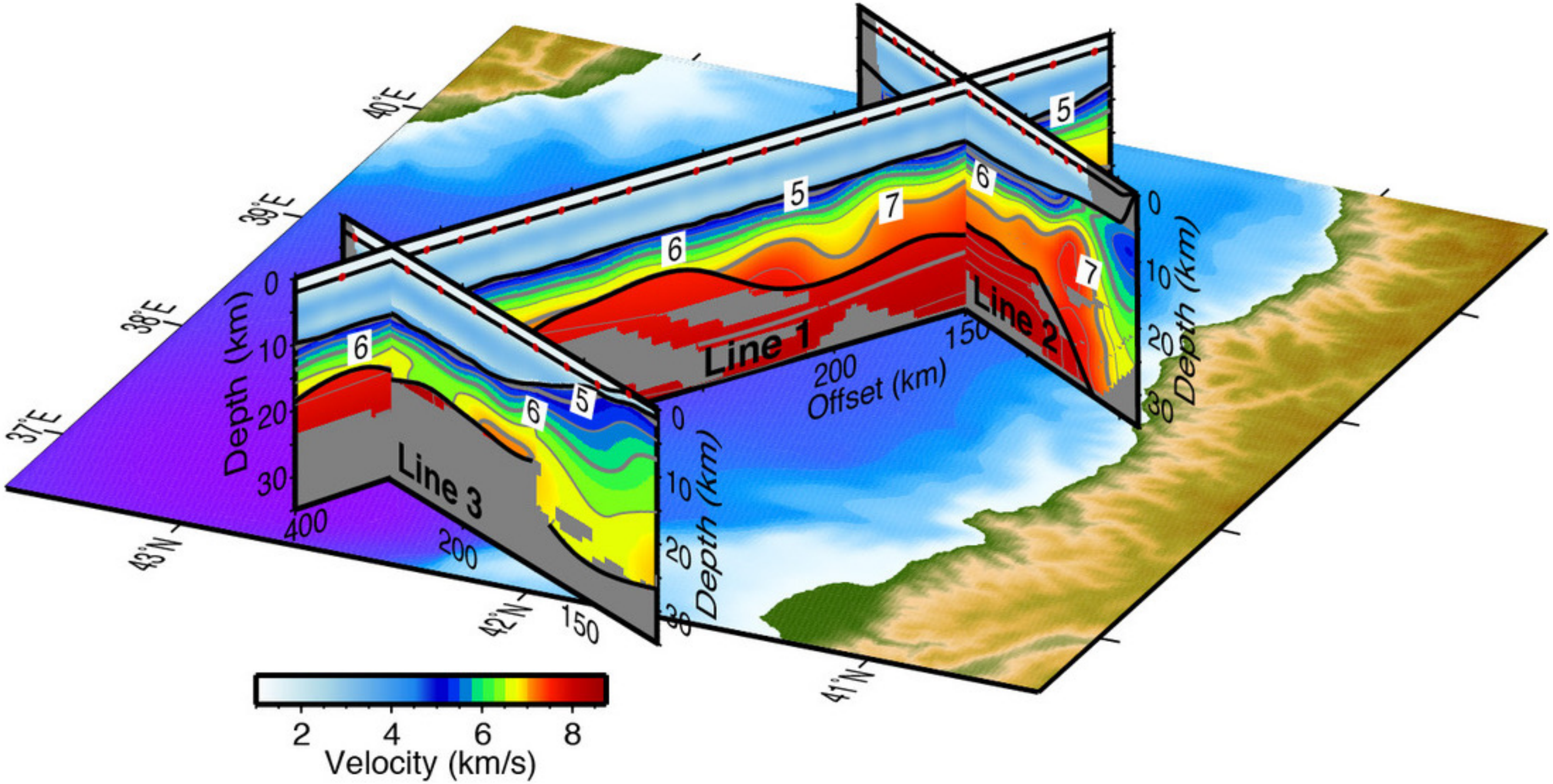
Shillington et al., 2009; https://doi.org/10.1130/G25302A.1



Shatsky Ridge and the Mid-Black Sea High both marked by positive magnetic anomalies. Negative anomaly in basin centre with small linear positive. Black lines mark 10-km streamer data acquired by Ion-GXT and Geology Without Limits in 2011, which image synrift sediments and top basement in unprecedented detail, and a few older profiles that we have also used.

Original interpretation based on wide-angle seismic profiles

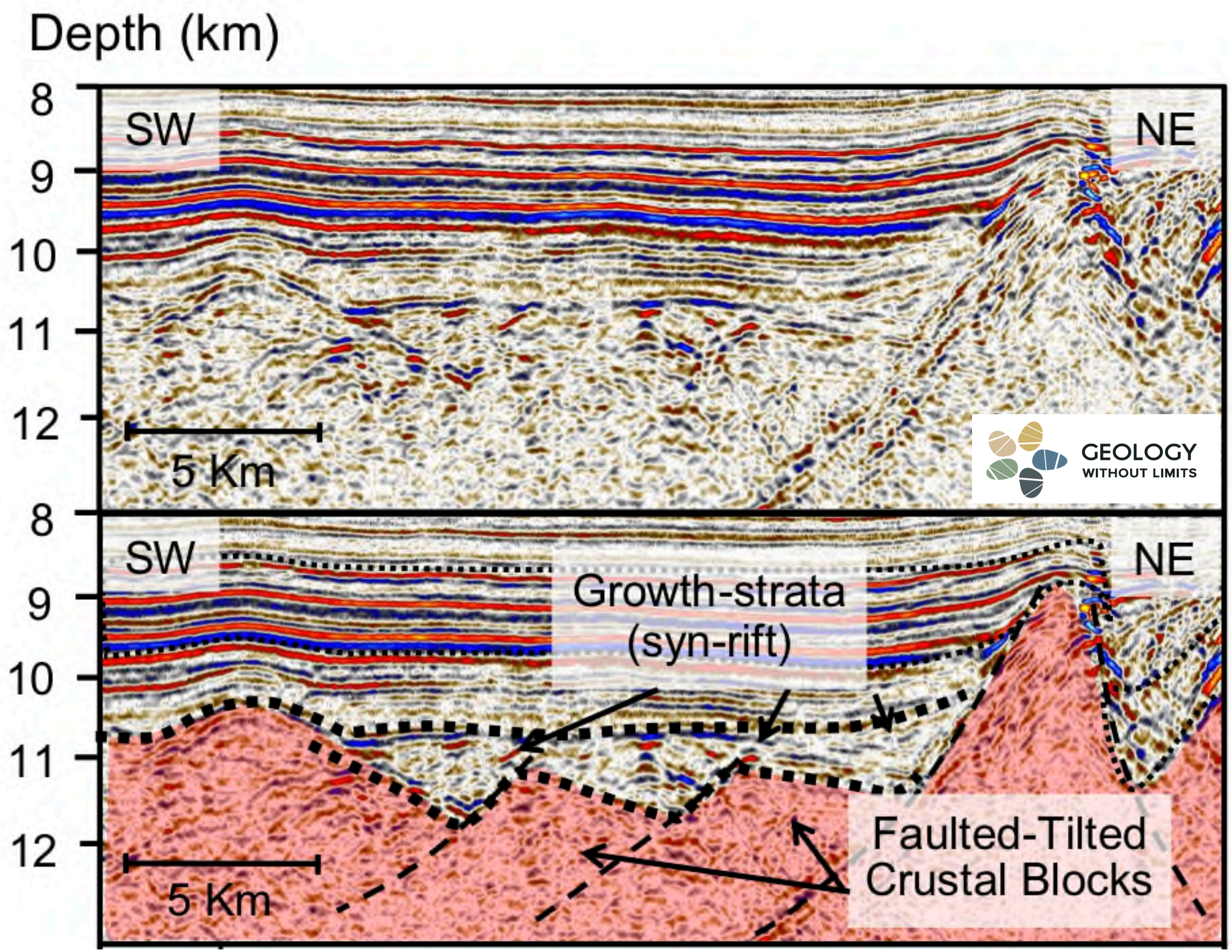
Line 3: thin crust with low velocities -> stretched continental crust
Line 2: thick crust with high velocities -> thickened oceanic crust
Line 1: transition between crustal types at c. 250 km offset



Shillington et al., 2009

Basement domains from reflection data

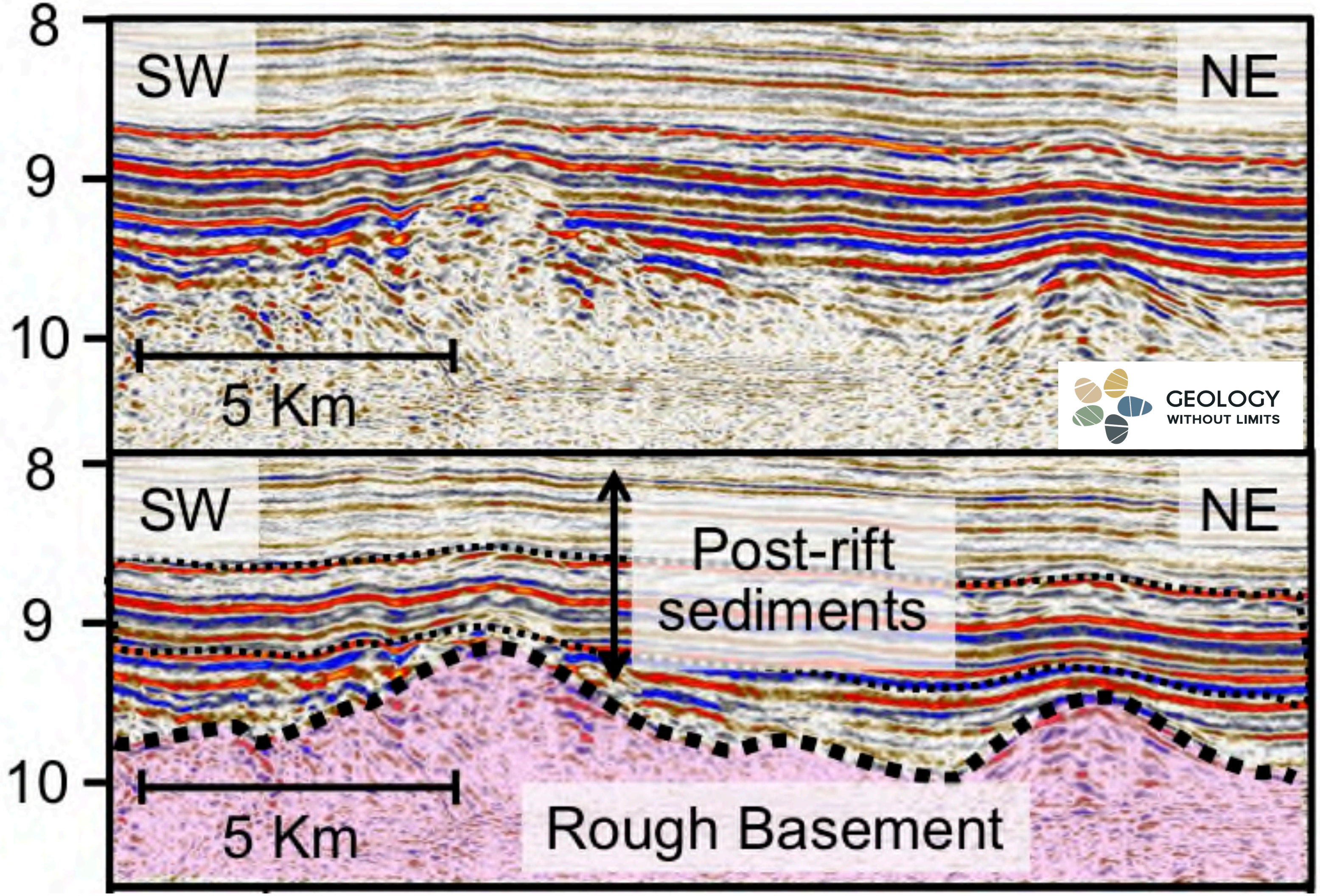
Domain I: faulted basement with sediment wedges on hanging walls



Monteleone et al., 2020; https://doi.org/10.1130/G47056.1

Basement domains from reflection data

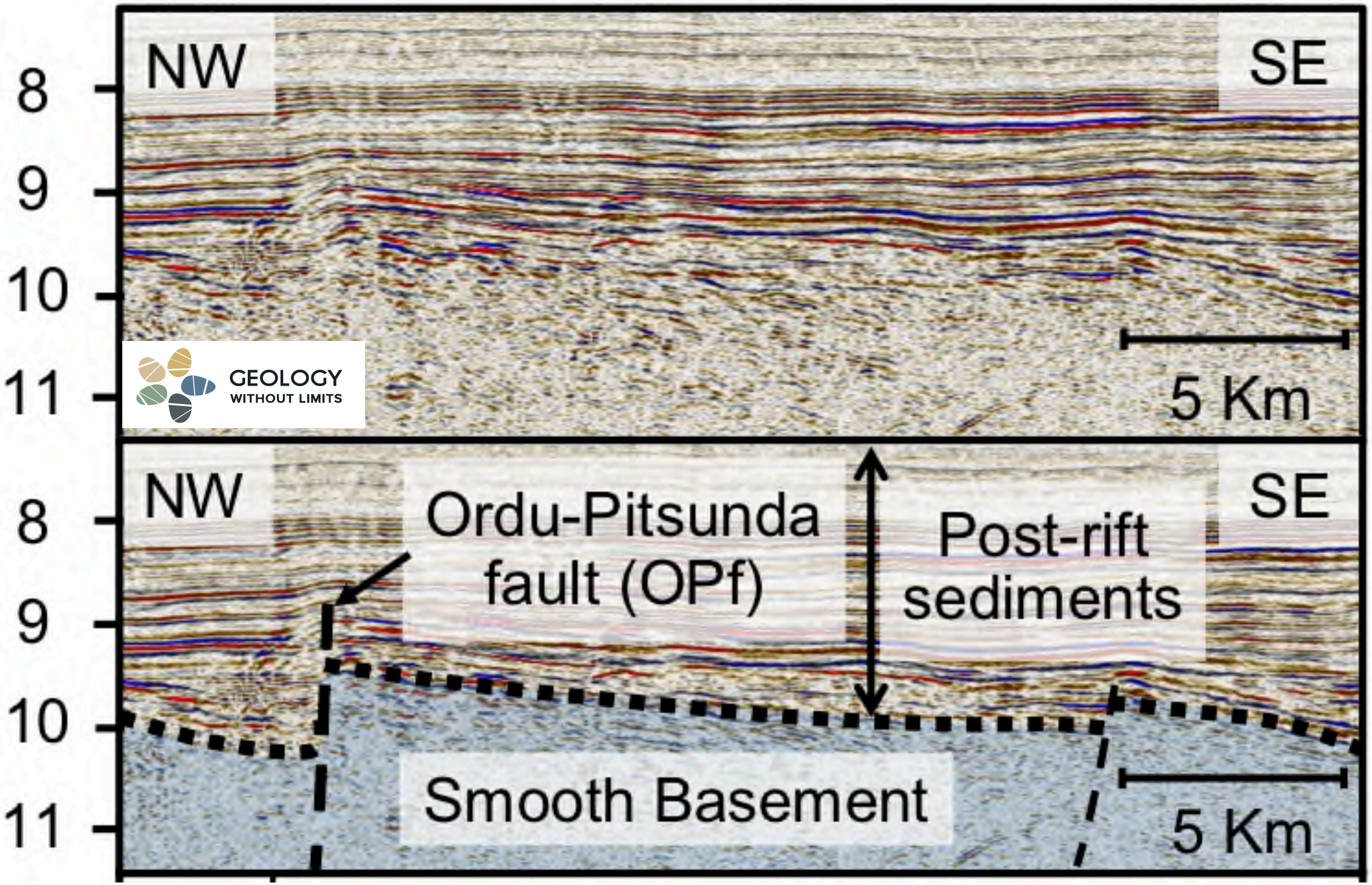
Domain II: faults less evident; no sediment wedges



Monteleone et al., 2020

Basement domains from reflection data

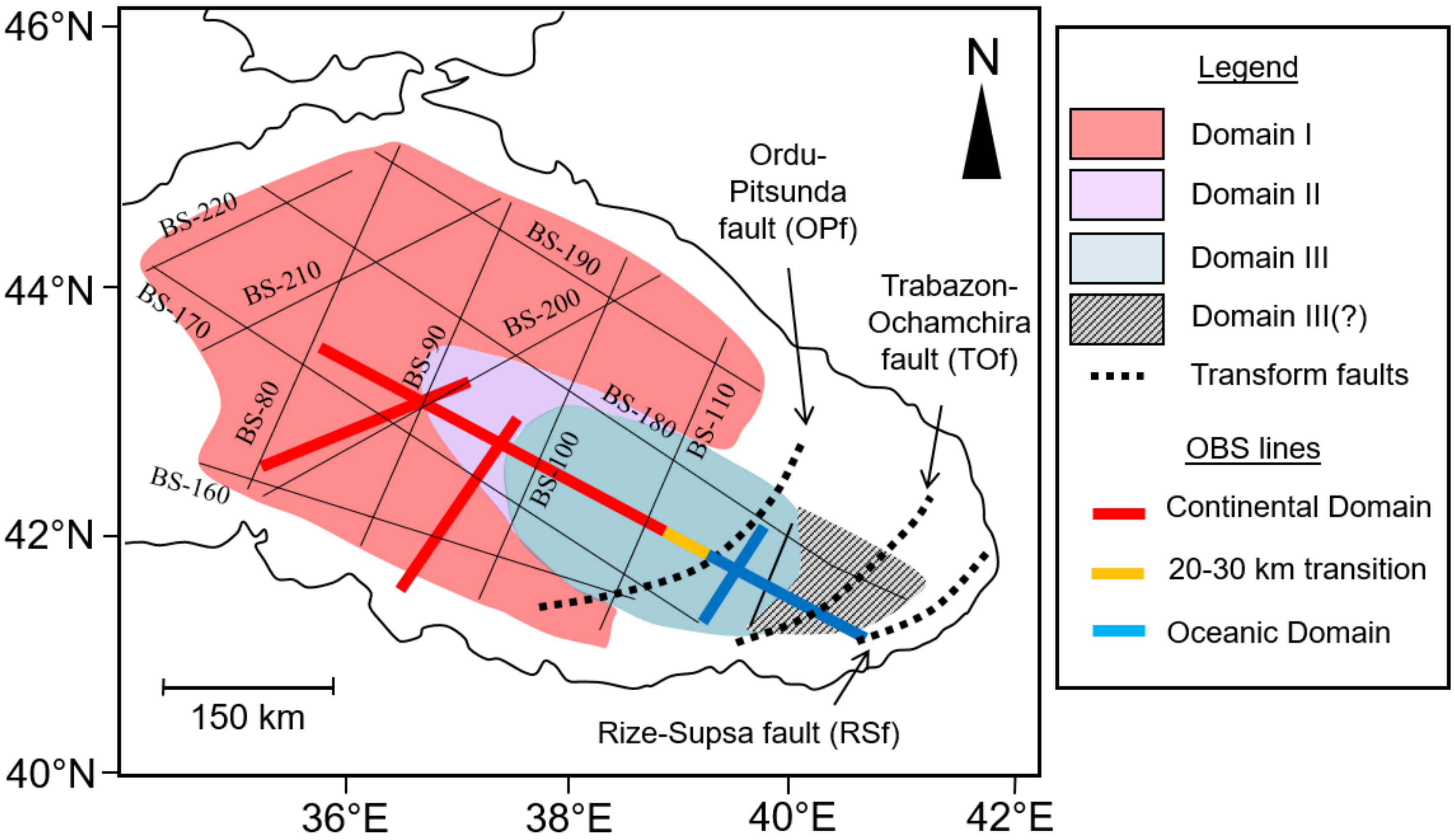
Domain III: smooth basement with occasional sub-vertical offsets



Monteleone et al., 2020

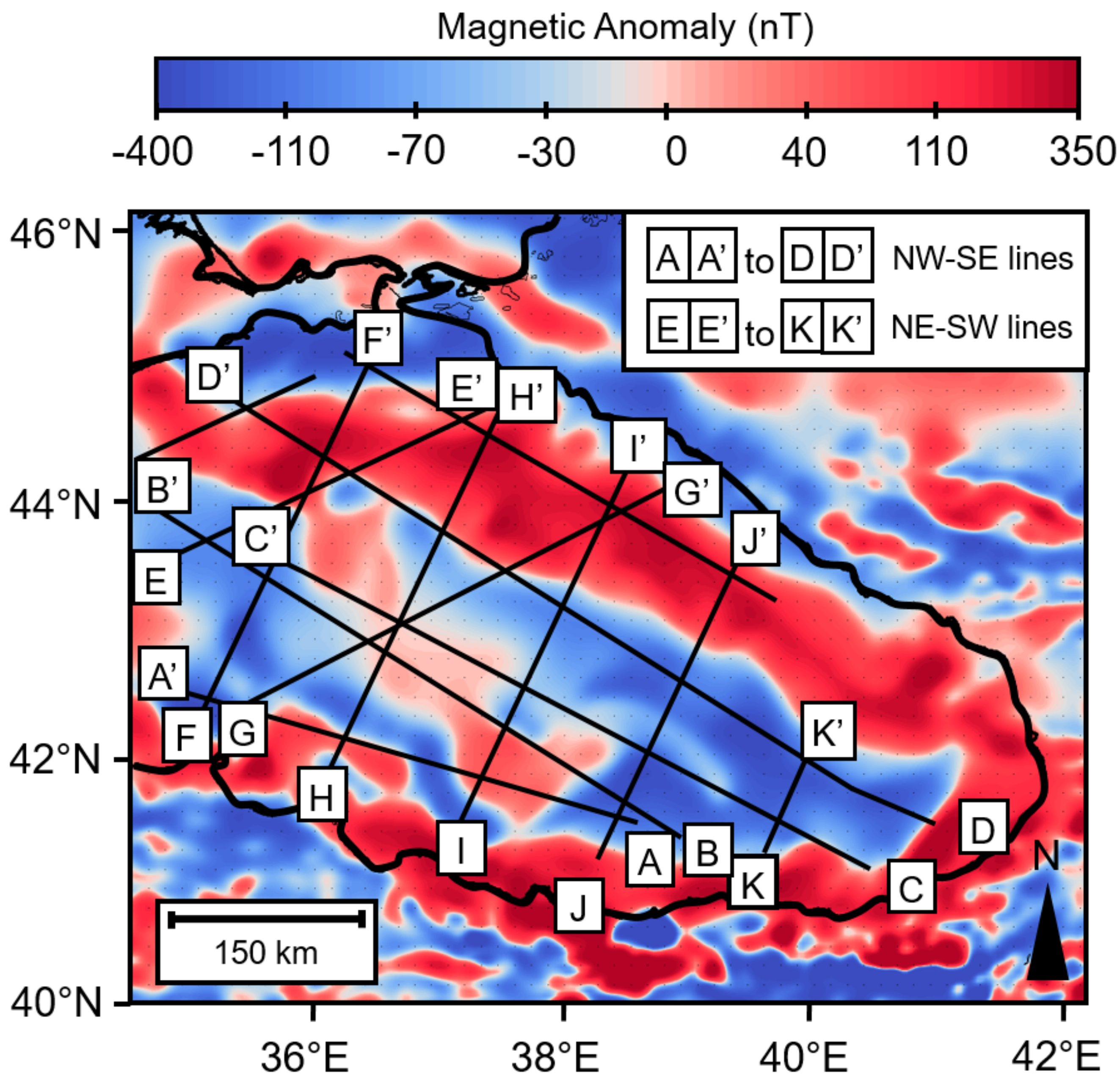
Domain map with wide-angle seismic constraints

Issue: domain boundaries do not appear to align with changes in crustal seismic velocity structure (though no conflict in domain I)

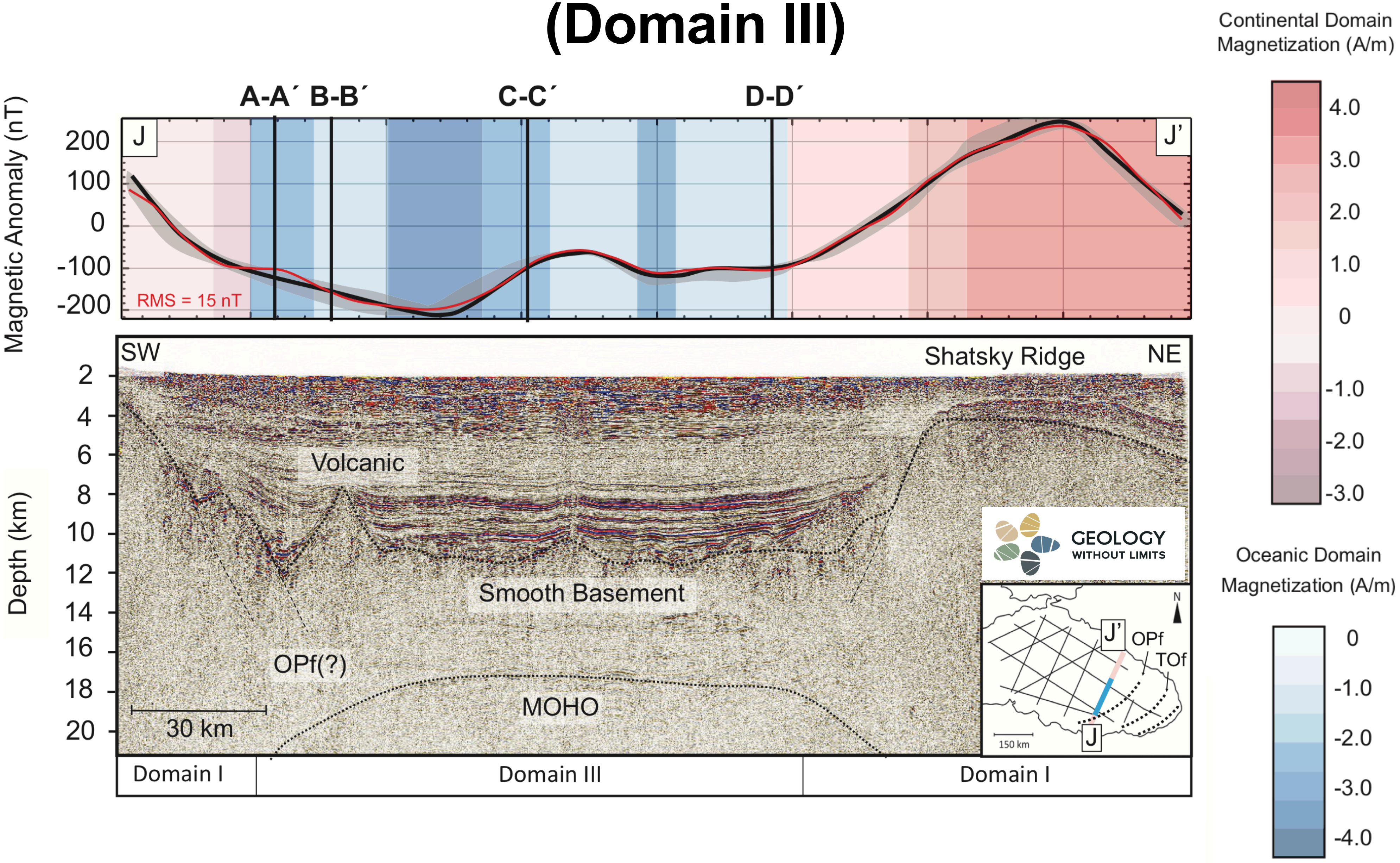


Monteleone et al., 2020

Profiles used for magnetic anomaly modelling

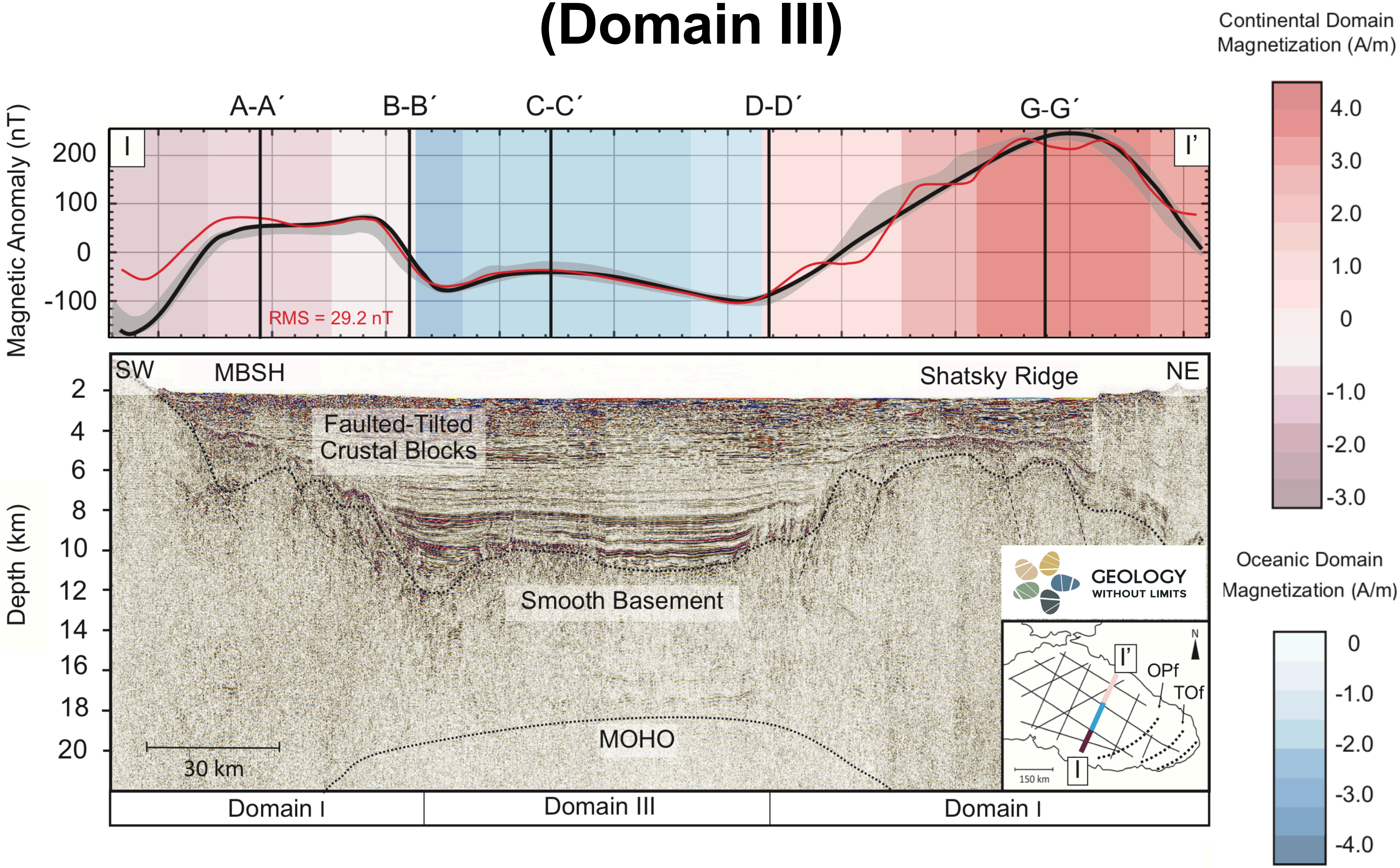


Profile with strong oceanic signature (Domain III)



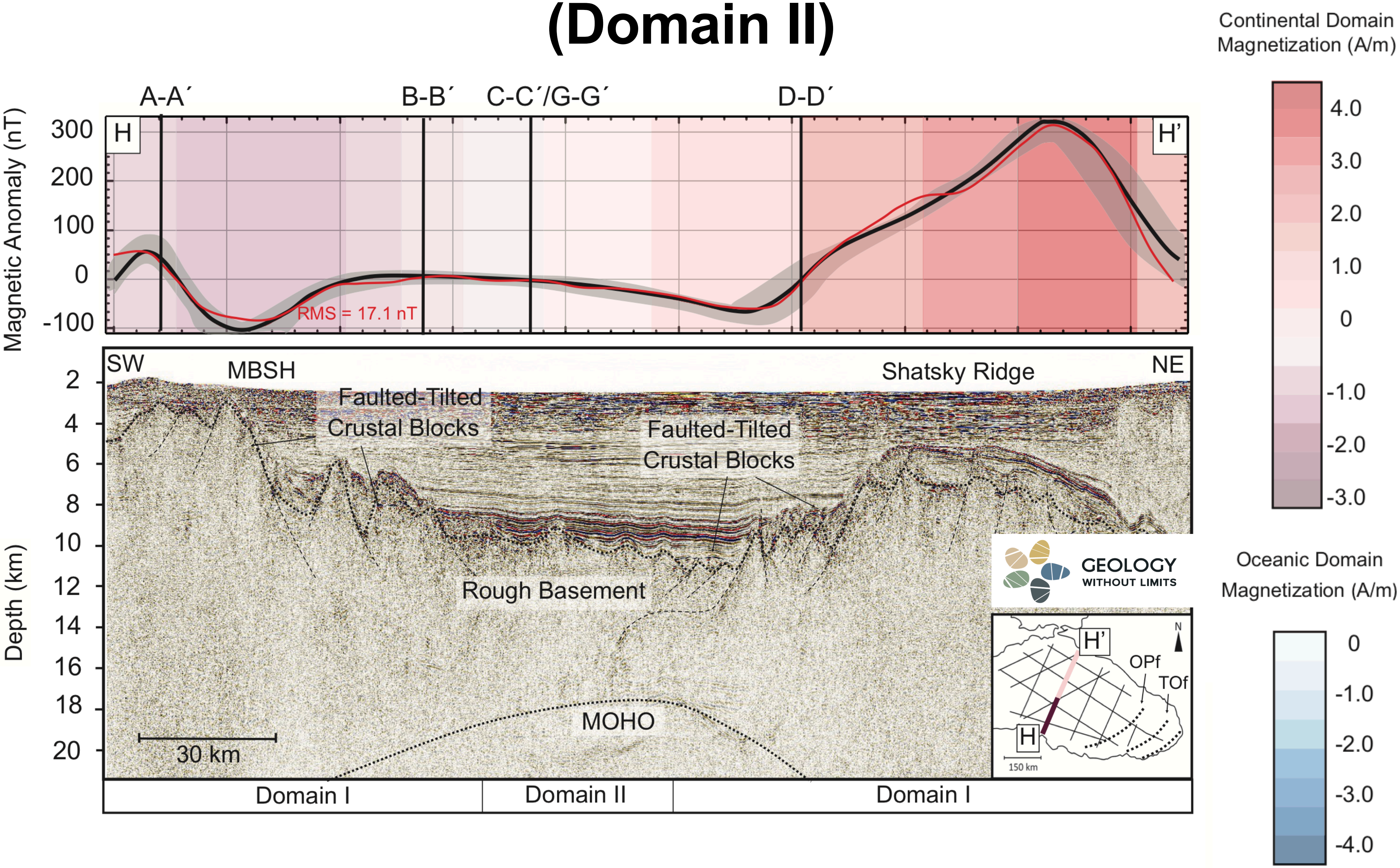
Monteleone et al., 2020

Profile with weaker oceanic signature (Domain III)



Monteleone et al., 2020

Profile without oceanic signature (Domain II)



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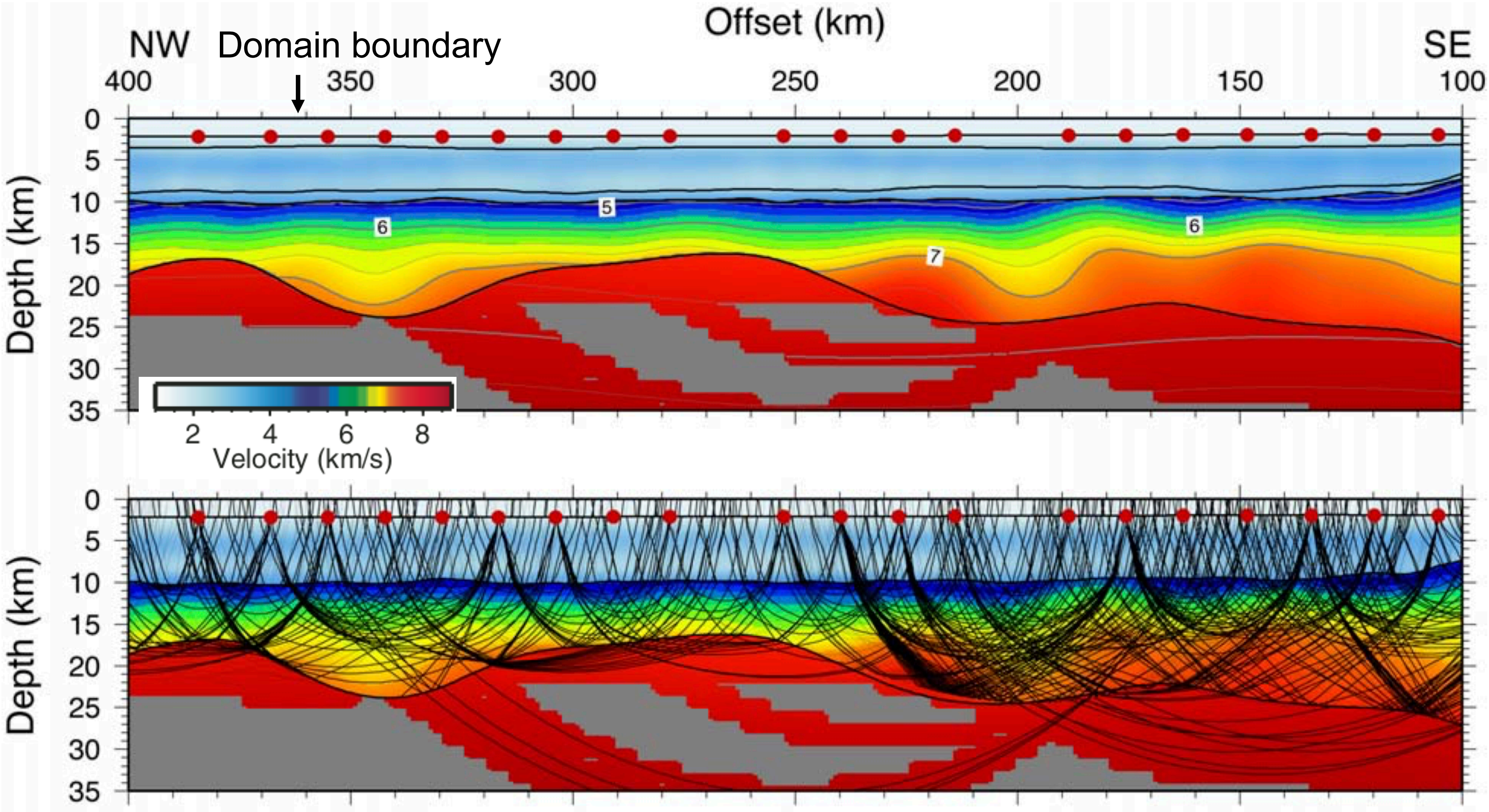
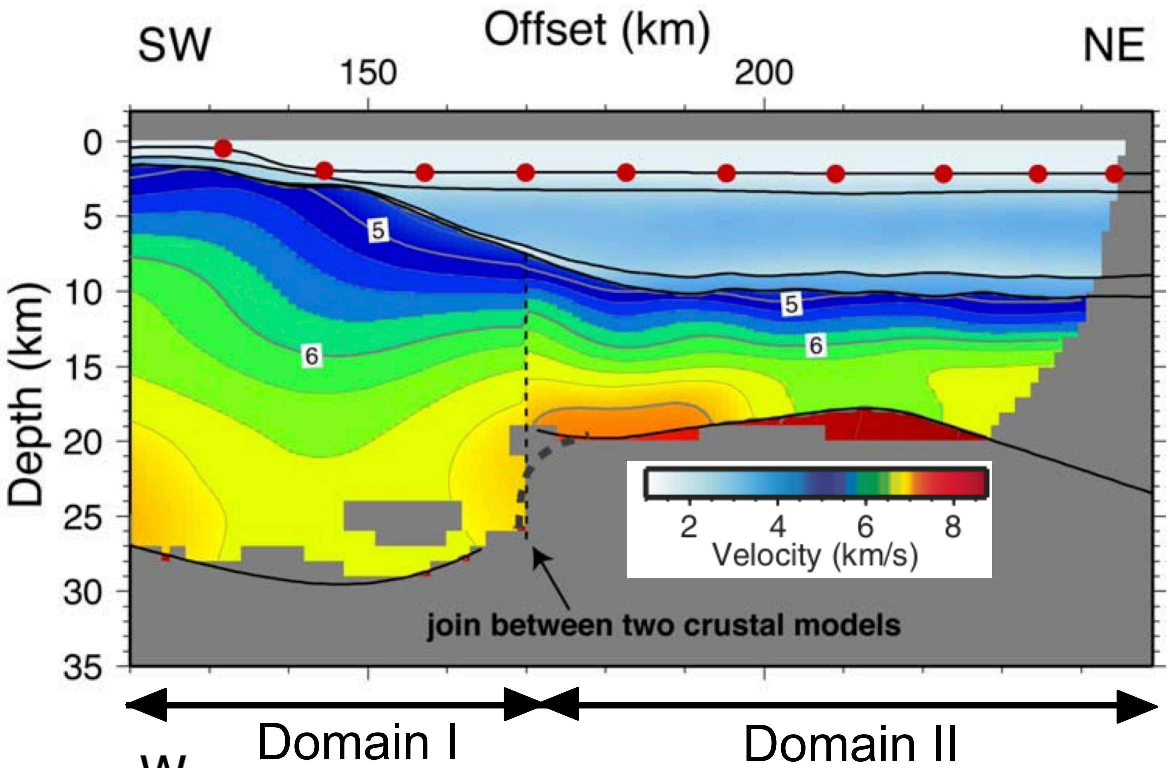
How do we reconcile with velocity model?

Boundary between domain II and domain III is at c. 360 km, while previously interpreted continent-ocean transition was at 240-260 km.
Thicker, higher-velocity crust present around 350 km. Thinner crust at c. 240-310 km is oceanic but with reduced melting near rift tip and thinner layer 3.

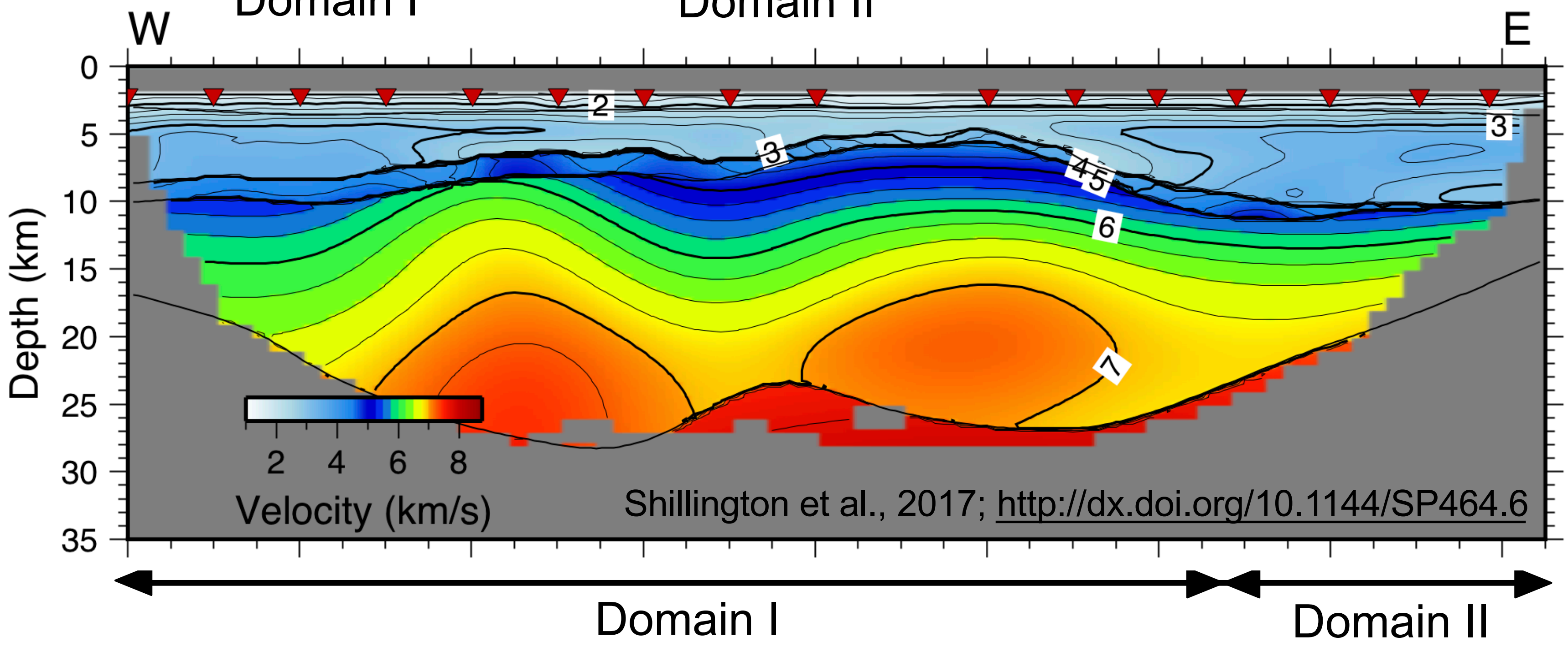


Shillington et al., 2009



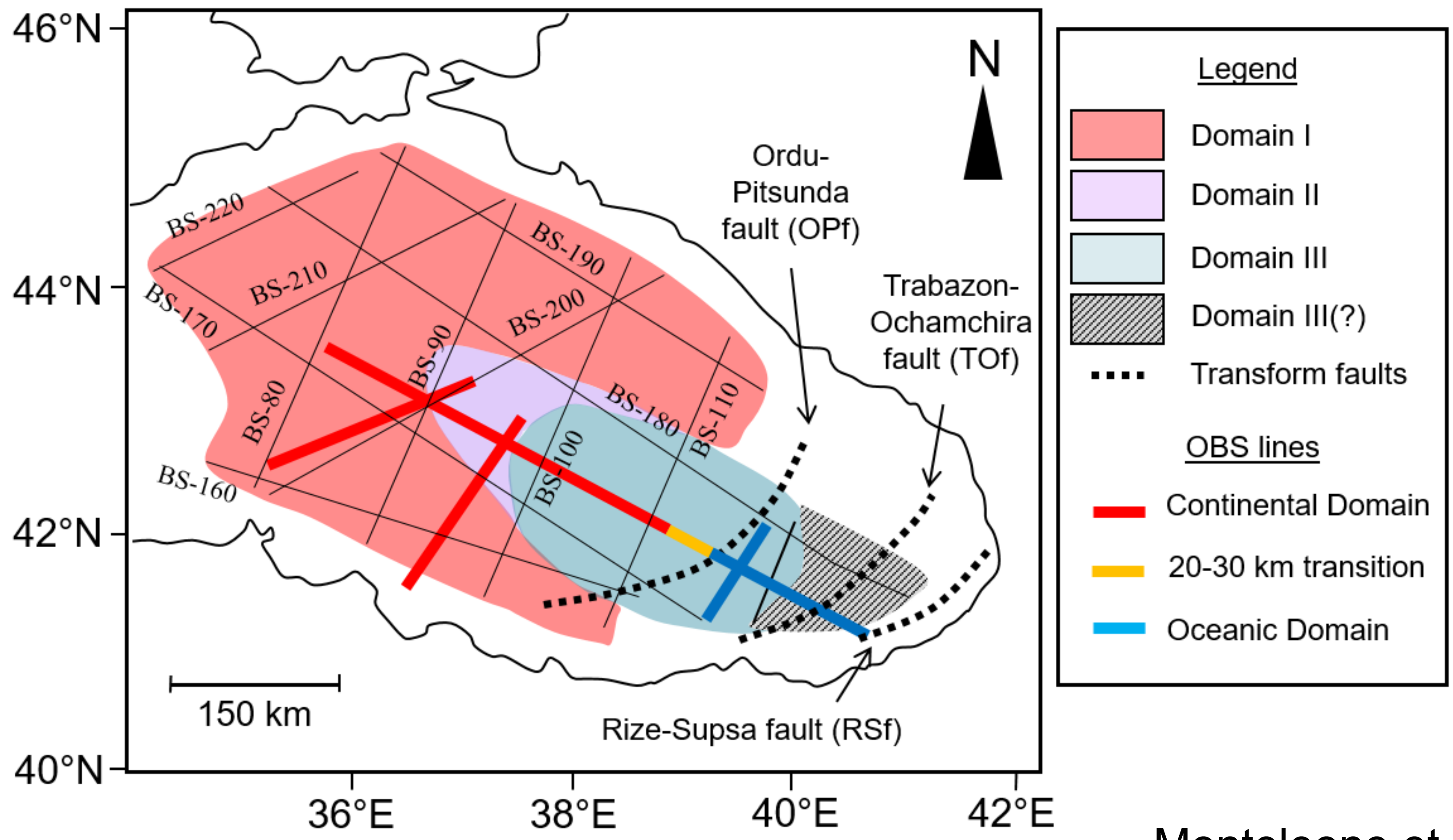
Crossing wide-angle profiles confirm that domain II has continental velocities.

Shillington et al., 2009



Lessons for the Eastern Black Sea Basin

Domain I has tilted blocks with syn-rift sediment, so is continental.
Domain III has smooth basement and no syn-rift, so is oceanic, possibly with fast extension.
Domain II has thin crust but continental velocities, a distinct basement morphology and a magnetic character different to that of domain III

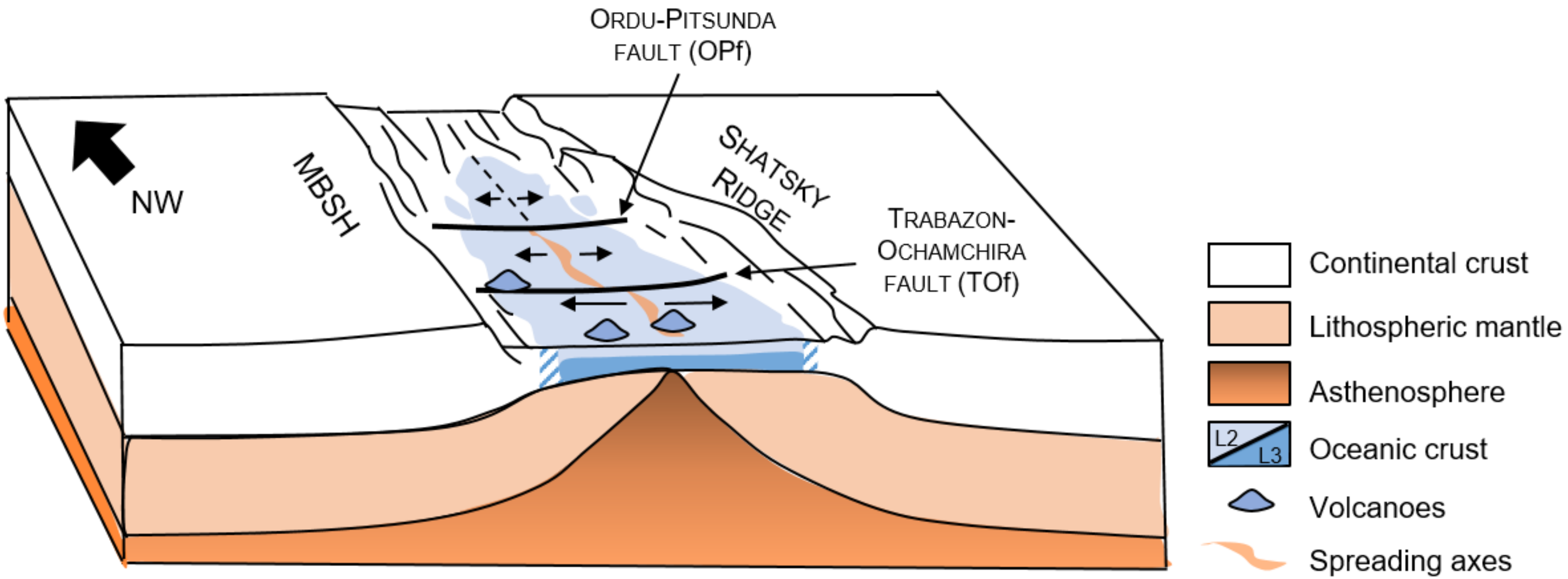


Monteleone et al., 2020

Lessons for the Eastern Black Sea Basin

Abrupt change in crustal thickness is within the oceanic domain and does not mark the continent-ocean transition.

Reduced mantle melting towards rift tip, abruptly changing at a fracture zone.



Monteleone et al., 2020

Broader Conclusions

- Different types of geophysical data tell us different things about the continent-ocean transition, so a fuller understanding comes from combining them.
- Rift propagation during breakup results in complex structures.