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Western Tethys subduction history constrained through upper and lower mantle structure coupled to kinematic reconstruction

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BACKGROUND

Deep-time plate reconstructions of now subducted ocean basins are challenging and often result in competing tectonic models, particularly when the upper plate was oceanic and is only preserved as ophiolitic relics. Correlations between paleogeography and tomographically imaged slab remnants has unlocked Earth's modern mantle structure as an archive for the analysis of such deep-time geological processes.

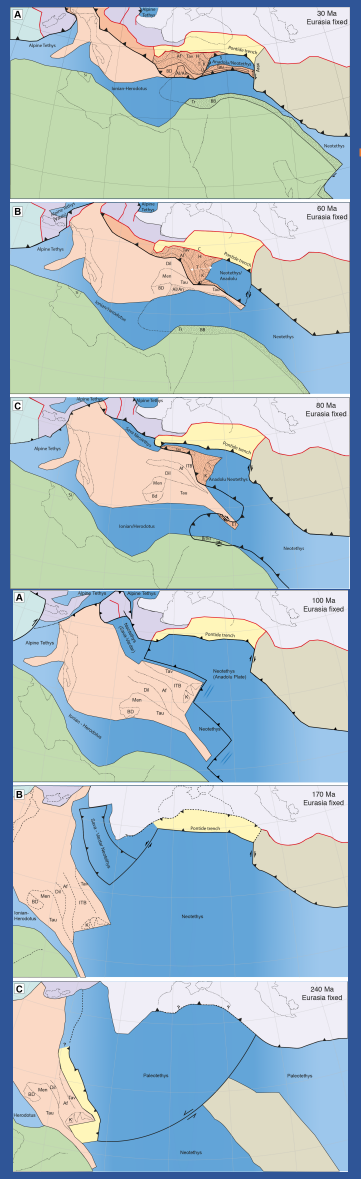
The geology of the western Tethyan realm from Greece to Oman holds records of the subsequent closure of the Paleo- and Neotethyan oceanic realms and of plates and microcontinents therein due to subduction since the Permian. Previous tomography-geology studies have interpreted the upper and lower mantle structure in terms of subduction history for the Aegean and Arabian segments, but particularly lower mantle structure of the **Anatolian segment has not been resolved in detail before**.

METHODS

Kinematic restorations have suggested that at least four subduction zones were responsible for the consumption of oceanic lithosphere, two consuming the Paleotethys, and two consuming the Neotethys. For the Neotethys system, slab segmentation may have led to more than two slab segments in the final mantle architecture.

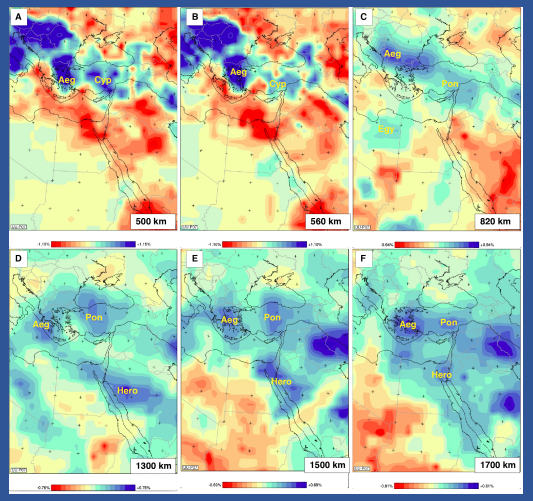
KINEMATIC RECONSTRUCTION

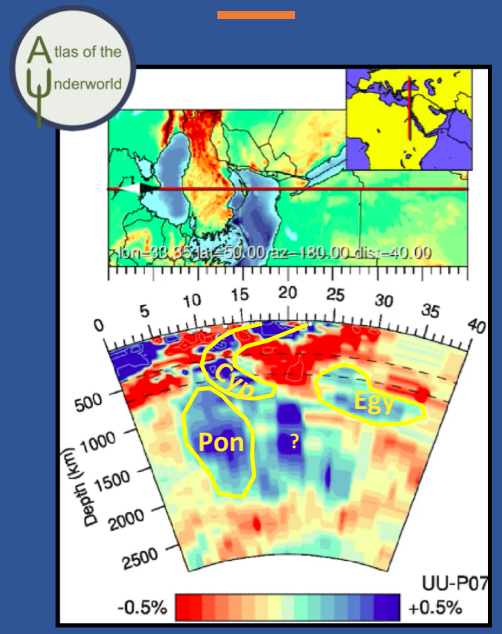
Gürer, 2017, van Hinsbergen et al., 2020



MANTLE STRUCTURE

van der Meer et al., 2018





We here interpret the upper, and for the first-time, the lower **mantle structure** associated with the Anatolian segment, thereby unraveling western Tethys oceanic lithosphere lost to subduction since the Early Triassic, and link this to mantle structure and subduction evolution of the Aegean and Arabian segments. The modern mantle structure as imaged in the tomographic P-wave speed model UU-P07, tested against multi-model vote maps (Shephard et al., 2017), provides means to find the relics of the complex subduction history and to discern between existing tectonic models.

RESULTS

Our analysis **reveals ten major positive wave speed anomalies** interpreted as slab remnants partly in the upper, but mostly in the lower mantle. We compare the dimensions, locations, and orientations of these slabs with the kinematically-restored subducted area of the Neotethys, and identify the previously identified Aegean, Algerian, Antalya, Egypt (which is part of the Arabian slabs), Cyprus, Mesopotamia, and Zagros slabs.

In the lower mantle we newly identify the Pontide and Herodotus anomalies along with the previously imaged anomalies (Emporios and Al Jawf). We identify the deepest lower mantle anomalies as remnants of Paleotethys subduction.

- The combination of kinematic reconstructions of surface geology and deep mantle structure allows to make **deep-time reconstructions of ocean basins lost to subduction.**
- The mantle structure of the Western Tethys holds record of both the **Neotethys and the Paleotethys**.
- Next: map slabs in 3D, calculate volumes and float them back to the surface.

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