Transpressional deformation in the mantle below the North Anatolian fault system, Turkey

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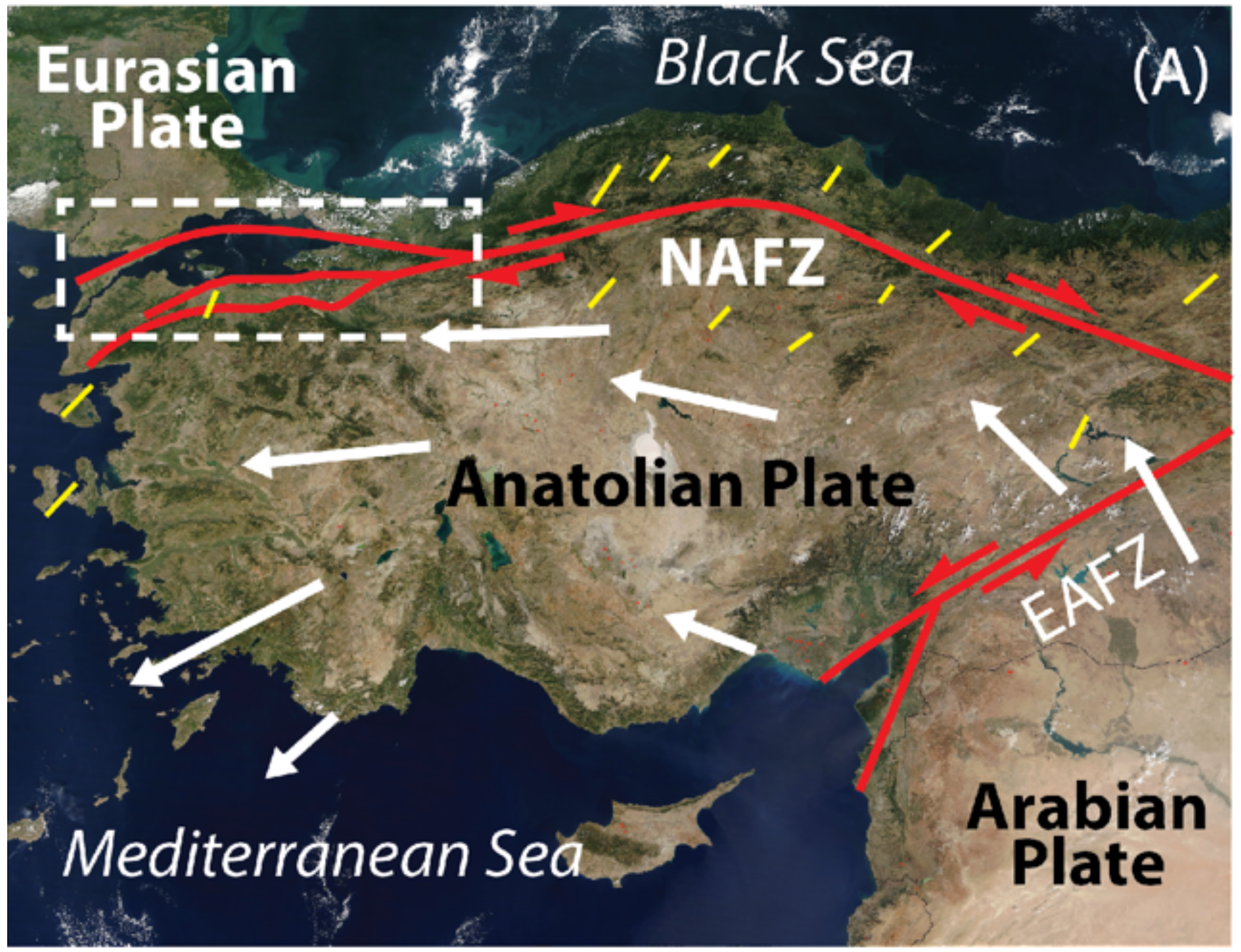
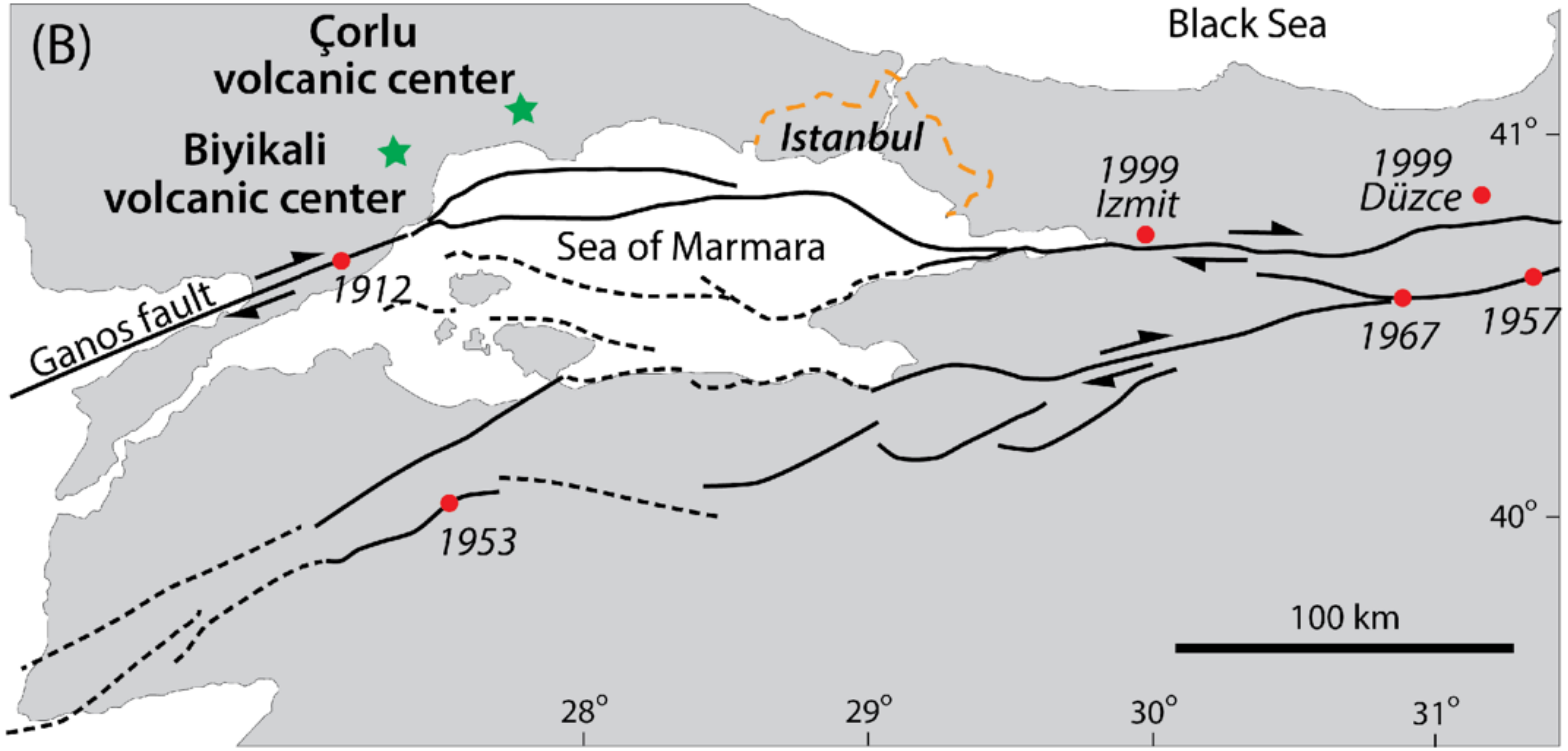
The North Anatolian Fault Zone, western Turkey



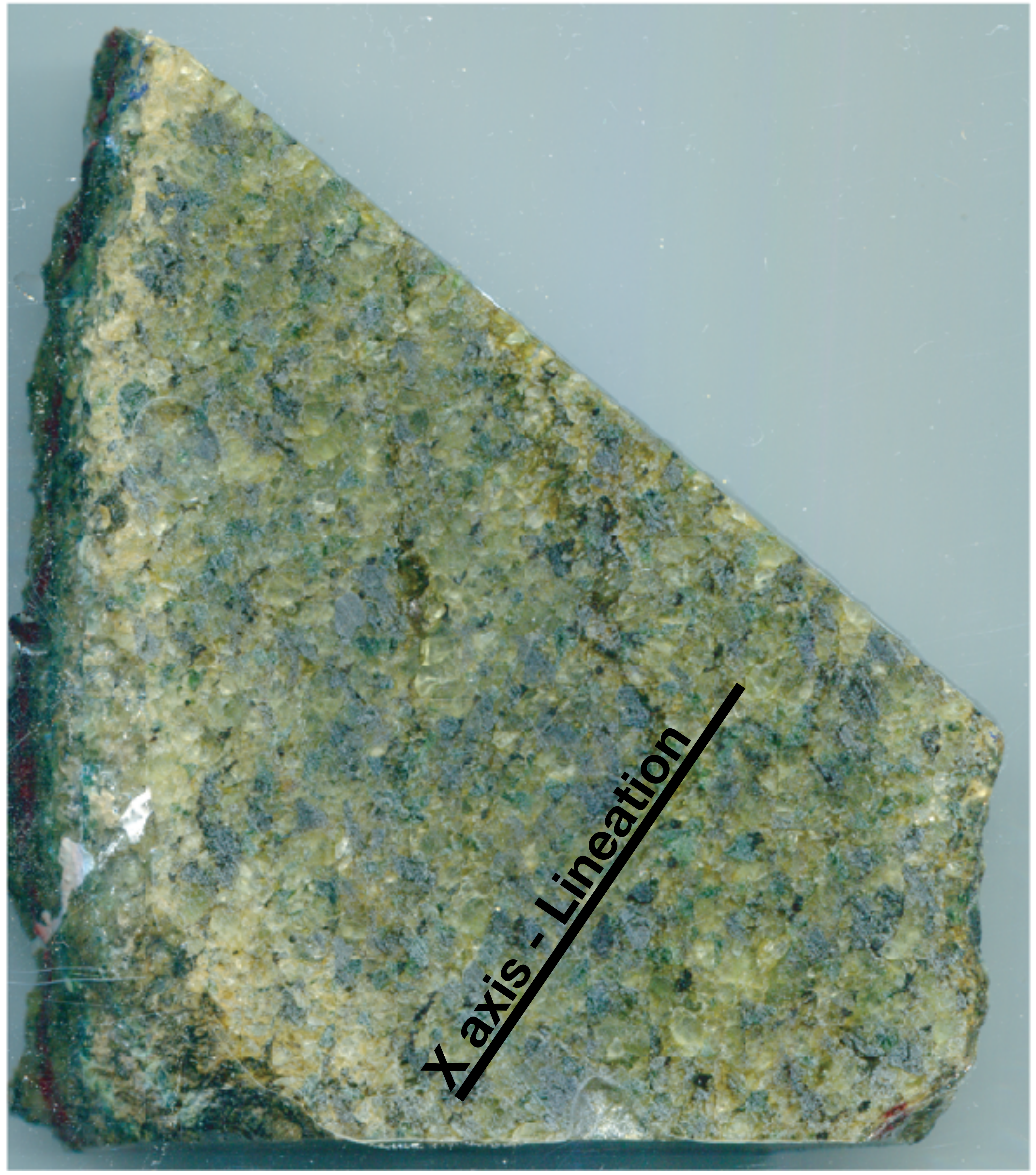


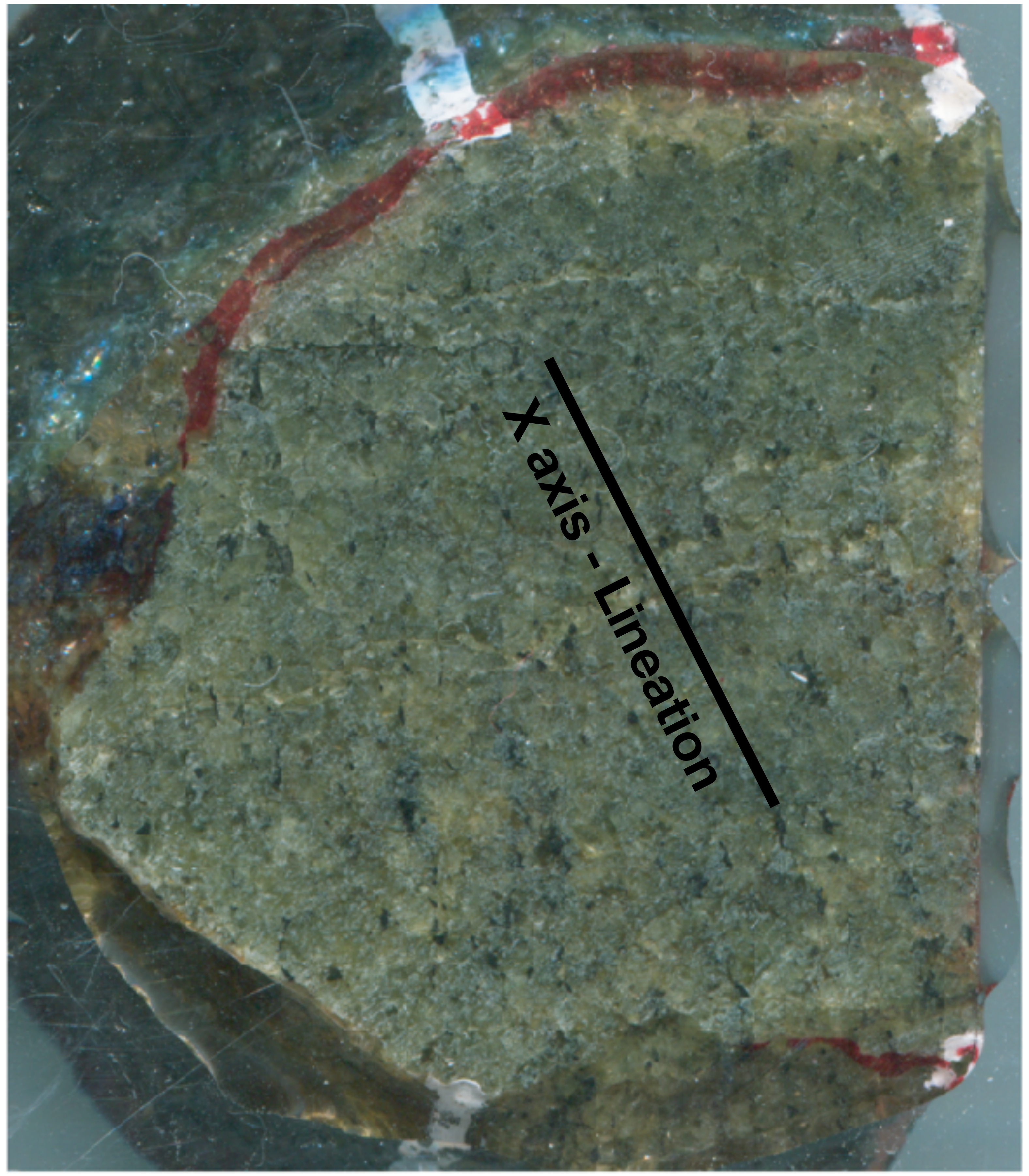
★ Volcanic centers from which xenoliths have been sampled for this study

A) Simplified tectonic map of Turkey. Red lines indicate major faults, white arrows correspond to plate motions, and yellow bars show shear wave splitting orientation.

B) Map of northwest Anatolia, around the Sea of Marmara area (location of map is shown in A). Green stars show the locations of the two volcanic centers from which the upper mantle xenoliths were sampled. The xenoliths were entrained in in late Miocene (11.68 ±0.25 to 6.47 ±0.47 Ma) alkali basalts and basanites (Aldanmaz et al., 2005). Red dots show epicenters of recent earthquakes.

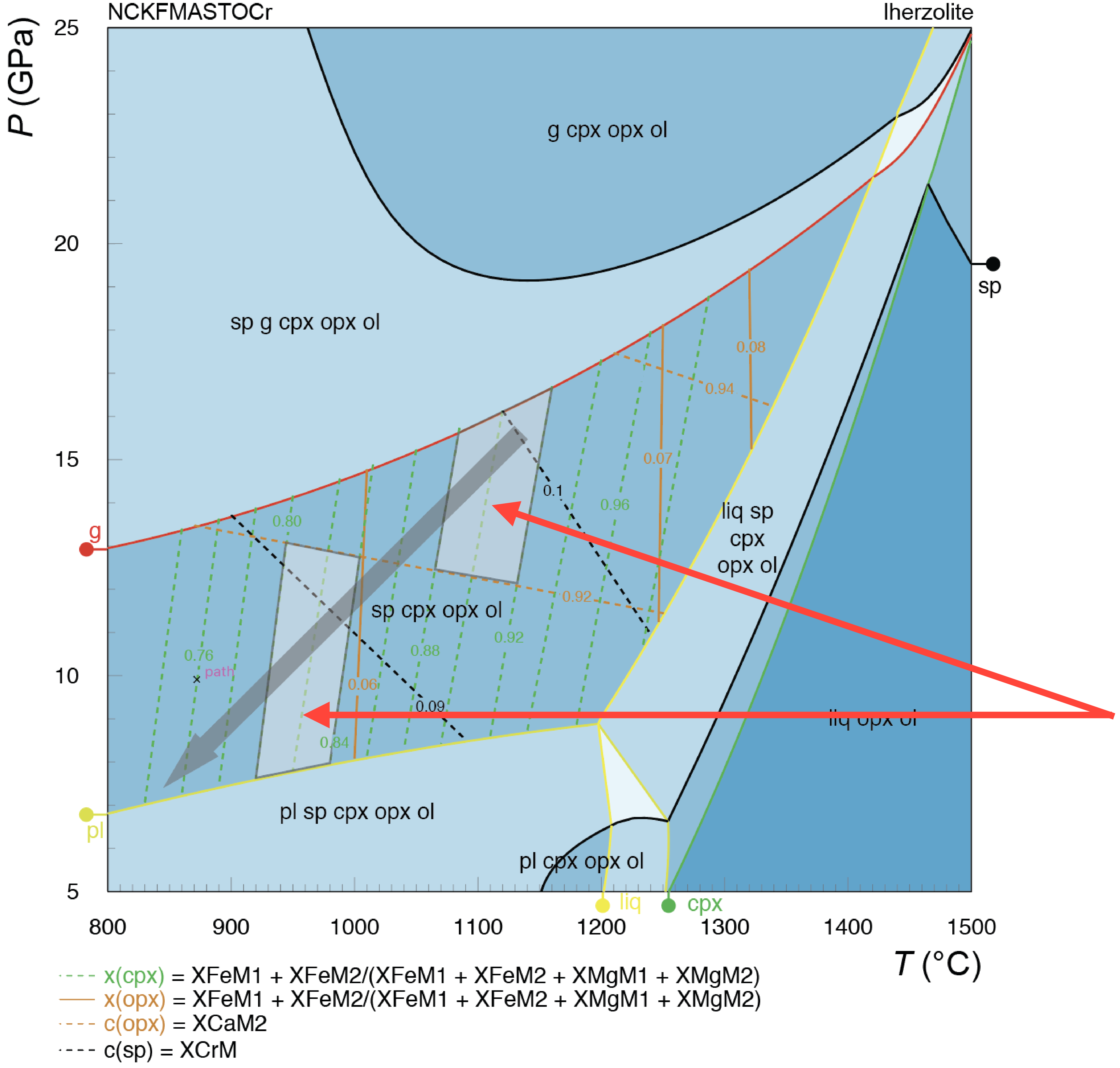
Upper mantle xenoliths from the Çorlu and Biyikali volanic centers





Examples of studied mantle xenoliths. The xenoliths are predominantly lherzolites. The slabs are cut parallel to the XZ plane (i.e. normal to the foliation and parallel to the lineation) of the spinel fabric ellipsoid. The elongation of spinel grains on the XZ plane define the X axis (black line) of the spinel fabric ellipsoid (mineral lineation).

Xenolith equilibration temperatures and pressures

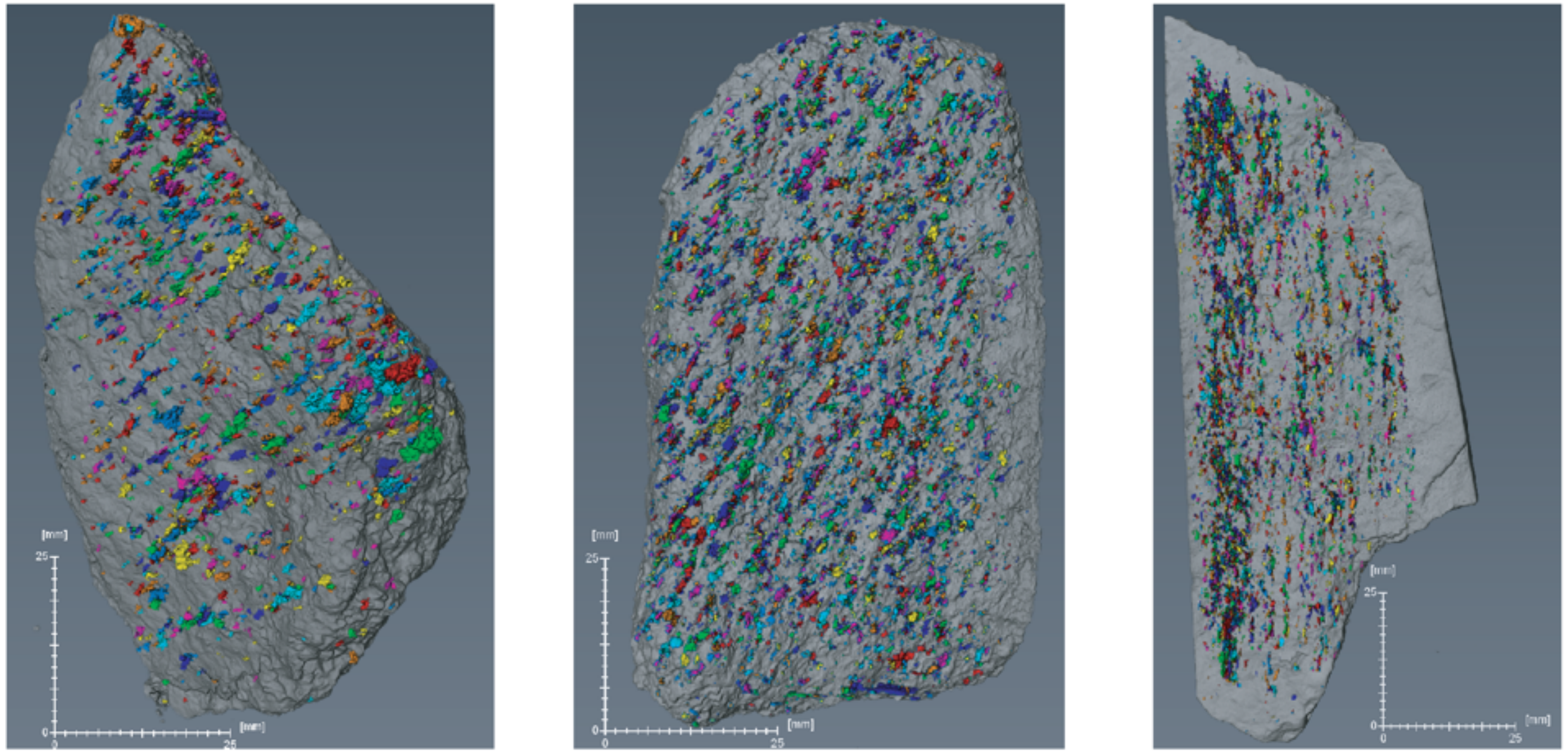


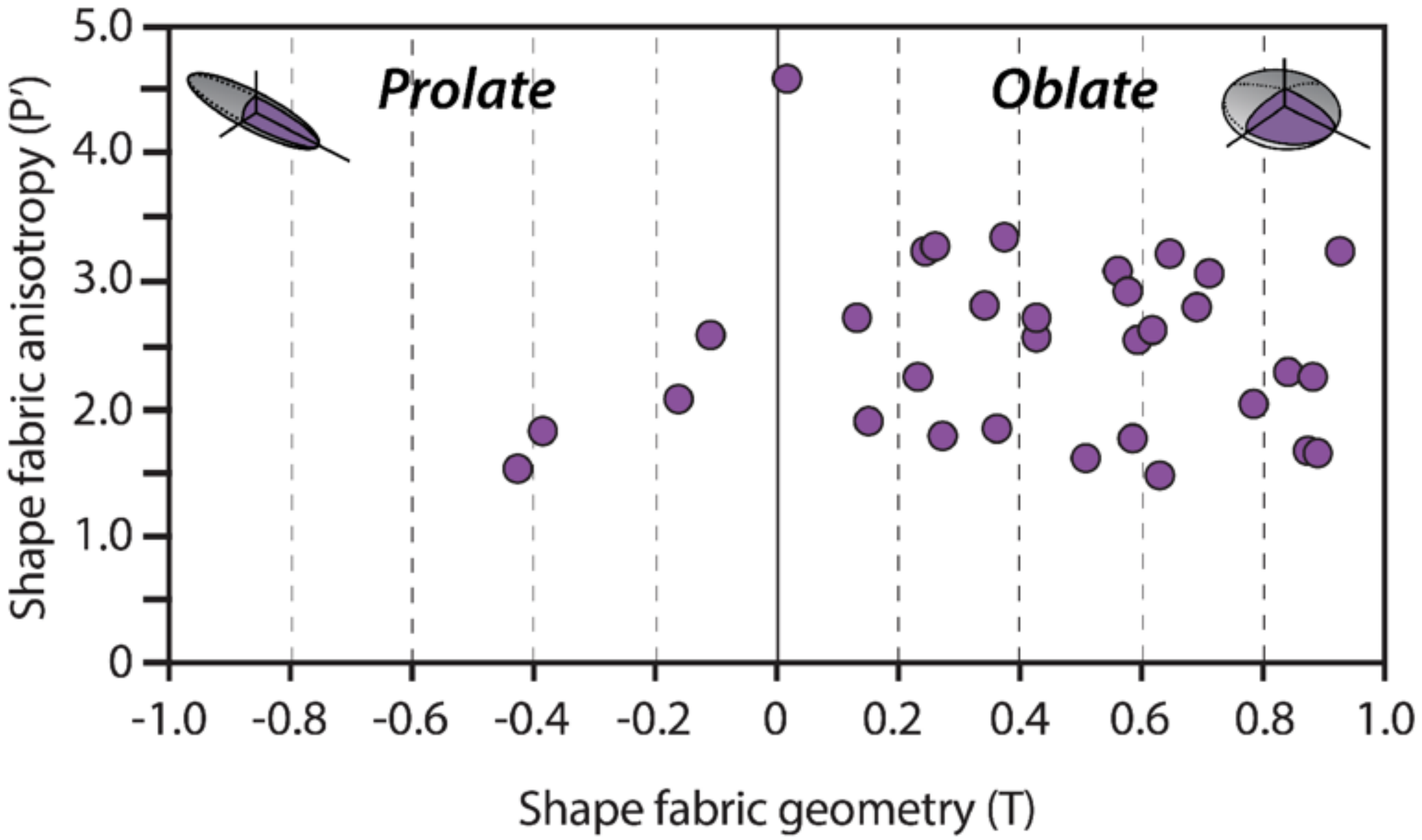
Equilibration temperatures estimated from two-pyroxene geothermometers range from 775 to 1020 °C.

Pressures estimated from the Cr in clinopyroxene geobarometer range from 120 to 220 MPa

Pseudosection PT constraints based on mineral major element map collected with an electron microprobe on a lherzolite seem to match the thermobarometry estimates.

3D spinel shape preferred orientation using X-ray computed tomography

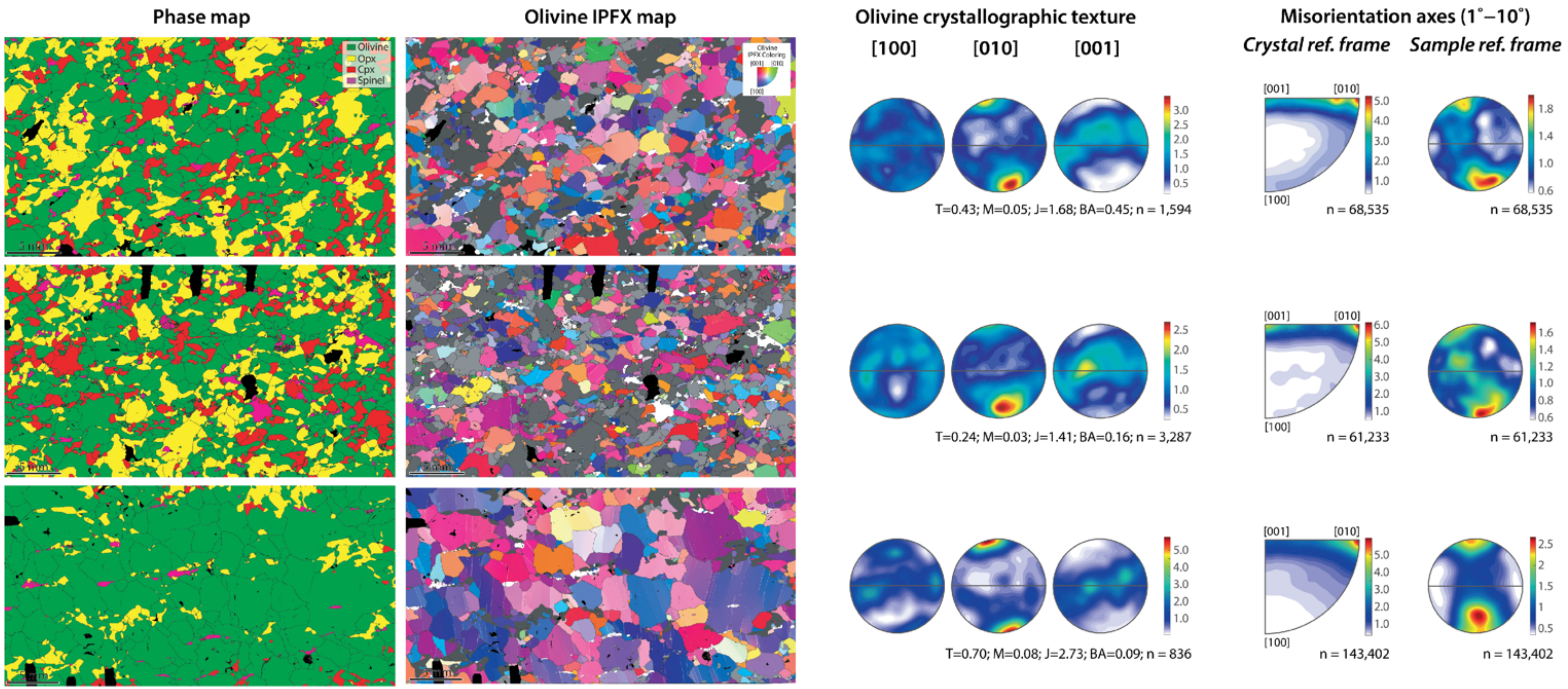




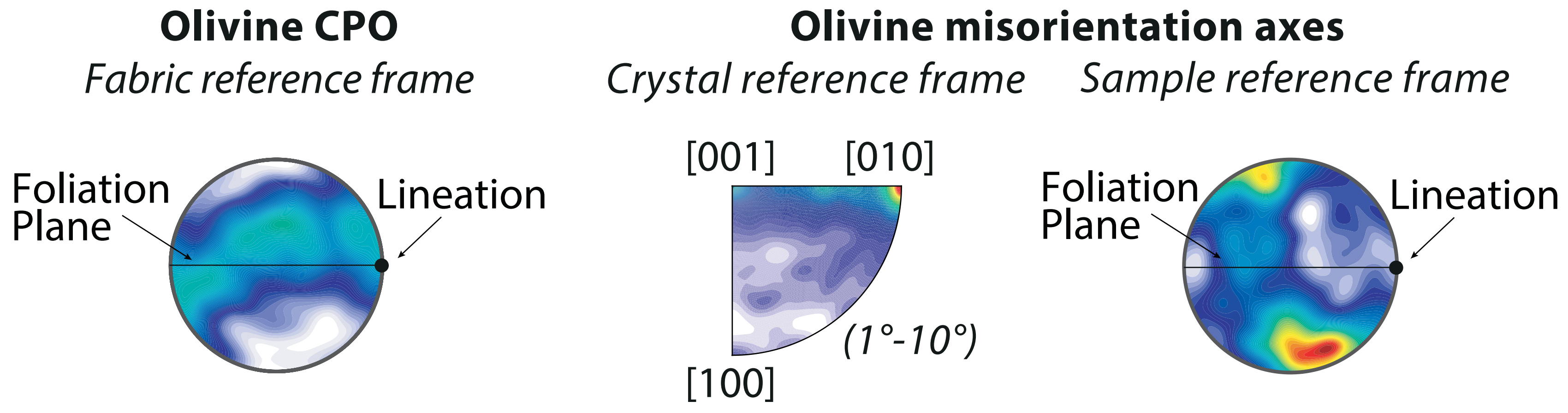
- We used high-resolution X- ray computed tomography to quantify the xenolith fabric defined by the 3D shape preferred orientation of spinel grains.

- Spinel displays dominantly oblate fabric ellipsoids, consistent with flattening strain.

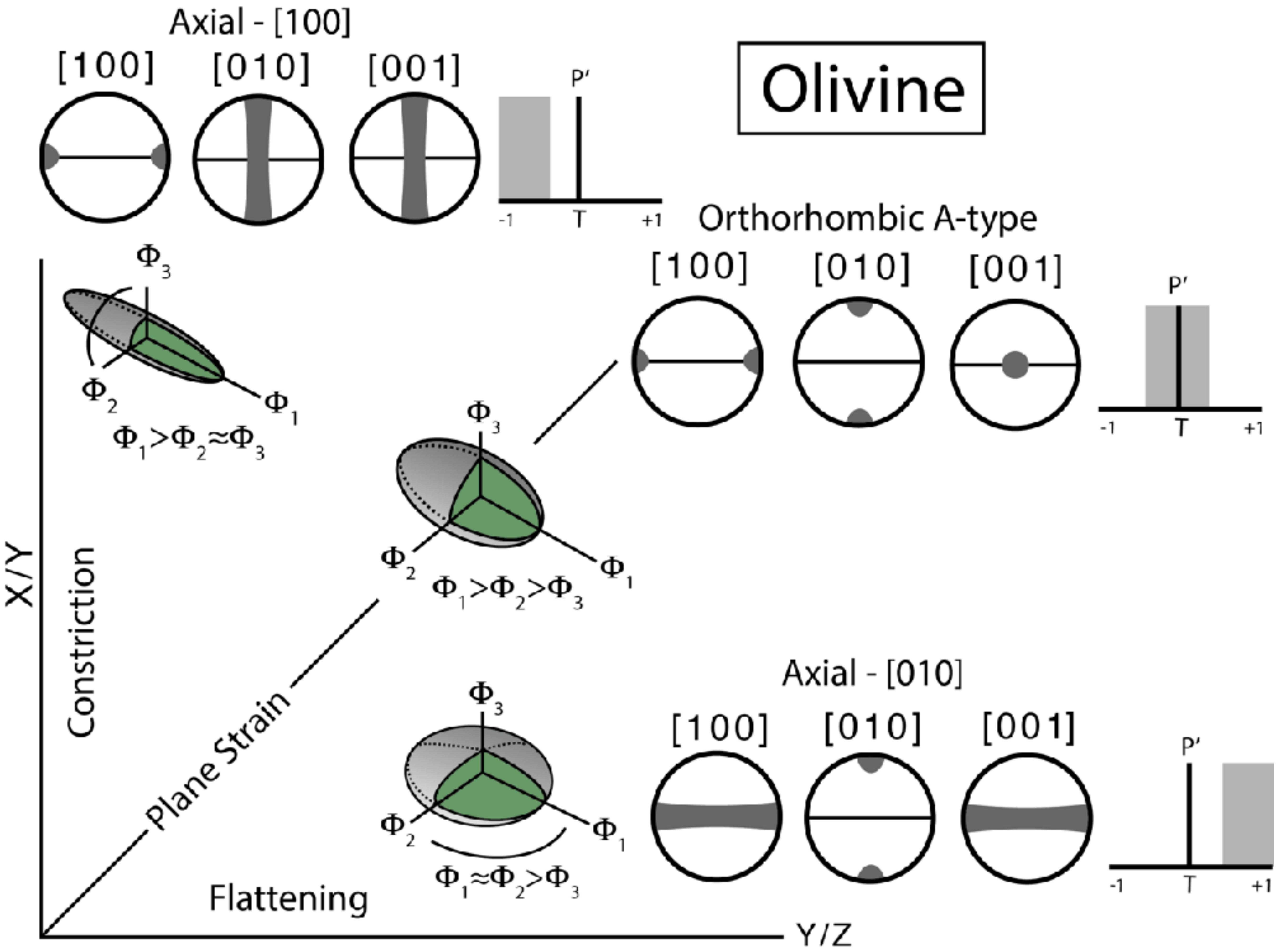
Olivine microstructures, CPOs, and misorientation axes using EBSD



- The xenoliths are characterized by axial-[010] olivine crystallographic preferred orientations.
- The misorientation axes in olivine show maxima subparallel to the [010] olivine crystallographic axes, i.e. at high angle to the spinel-defined foliation plane and lineation.
- The CPO show asymmetry, indicating a component of simple shear.



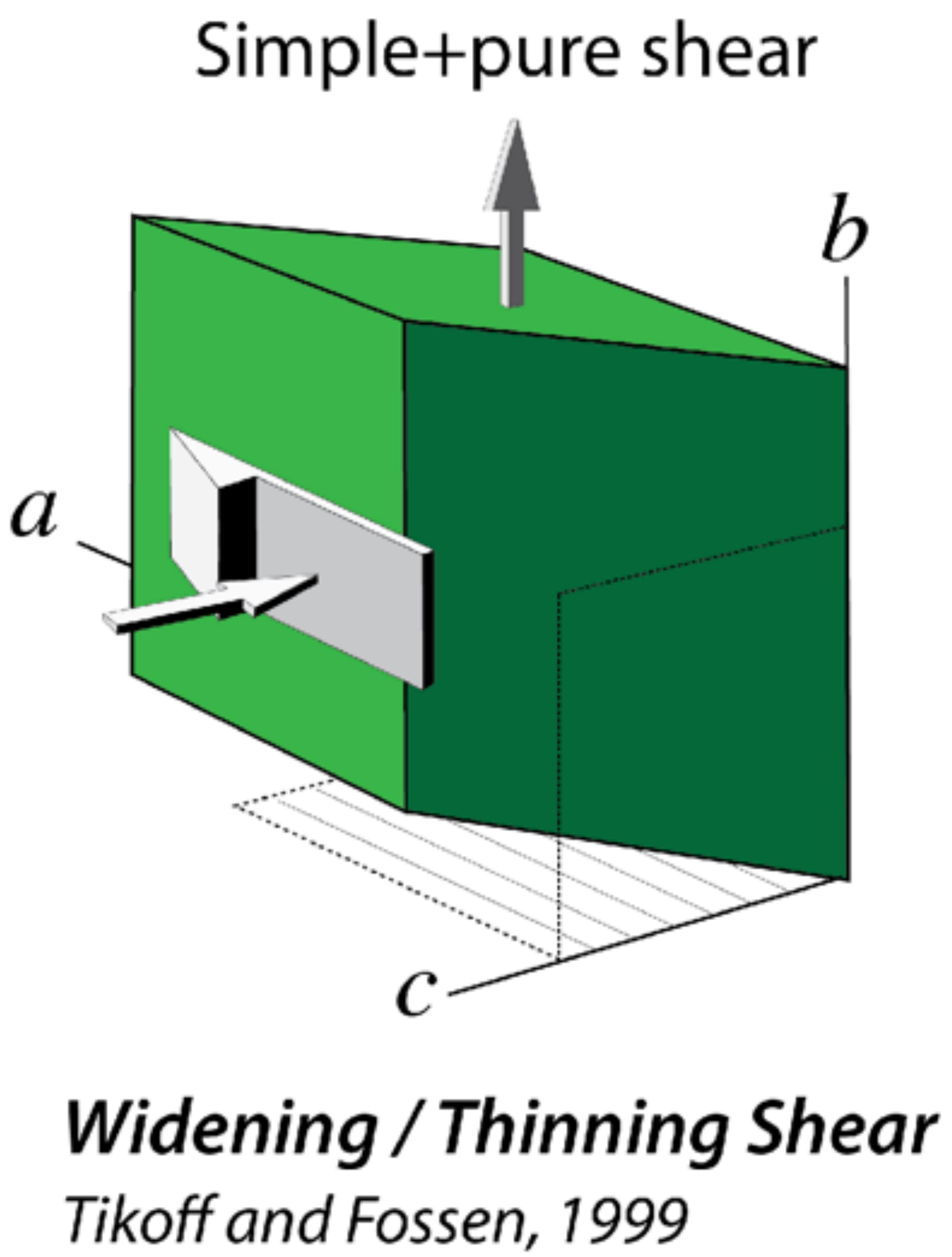
Relationship between shape fabric geometry and olivine CPO symmetry

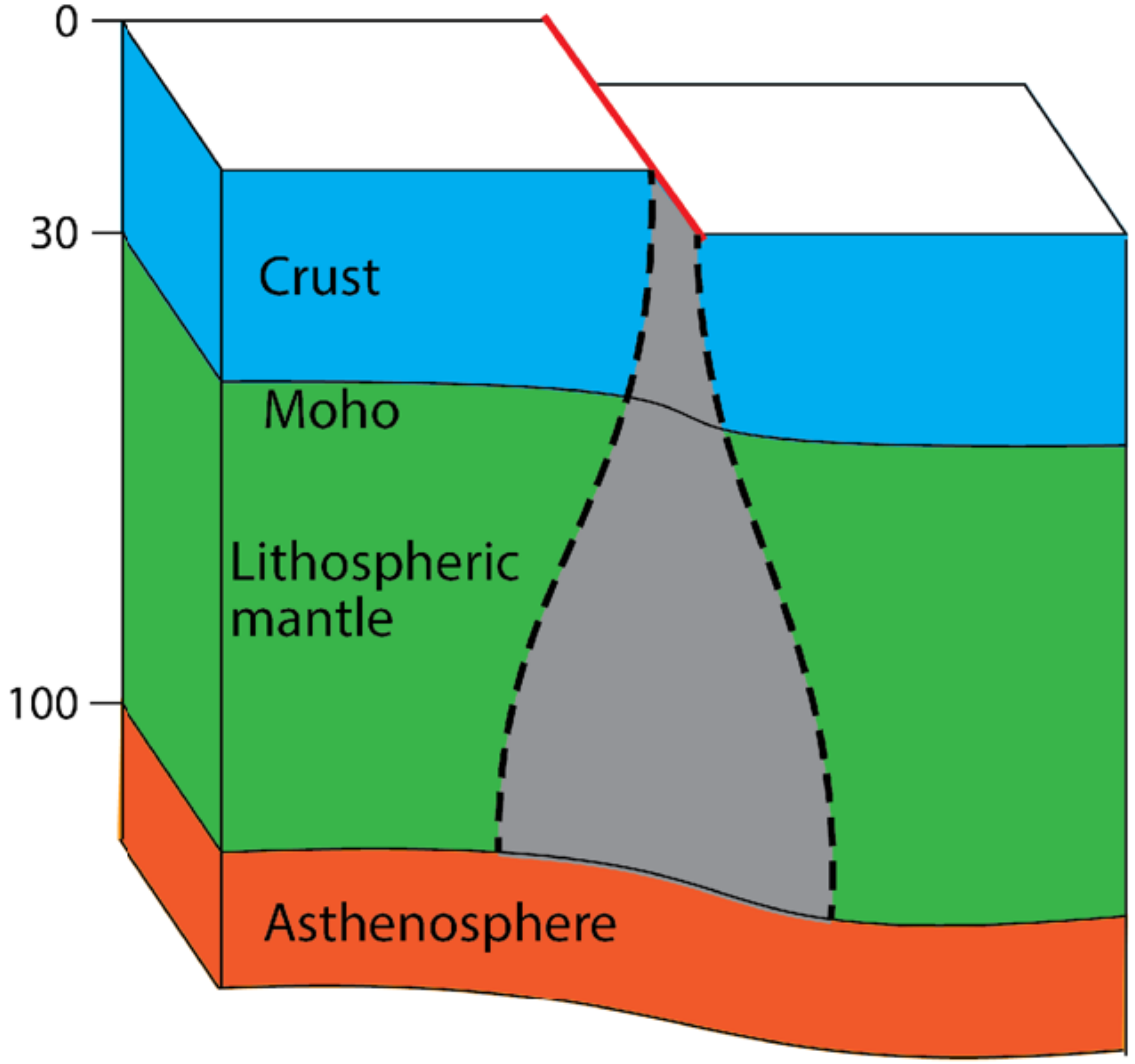


Chatzaras et al. (2016), JGR - Solid Earth

Our results support that the development of axial-type olivine CPOs may be controlled by finite strain geometry. Specifically, the axial-[010] olivine CPO is suggested to form in relation to oblate fabric ellipsoids.

Three-dimensional deformation in the upper mantle beneath the NAFZ





- The three-dimensional deformation in the upper mantle beneath the NAF may involve a simultaneous combination of a three-dimensional coaxial component (flattening) and an orthogonal simple shear component.
- The three-dimensional deformation may involve either widening / thinning shear or lengthening-widening shear.