

Tomographic studies of the upper mantle from data of passive seismic experiments

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Passive seismic experiments

- Regional or local **permanent networks densified with temporary stations**.
- Collecting high-quality data for investigation of **deep structure of the Earth**.
- Temporary stations of the **MOBNET** pool (IG CAS) have participated in many international experiments taking place in tectonically diverse regions.

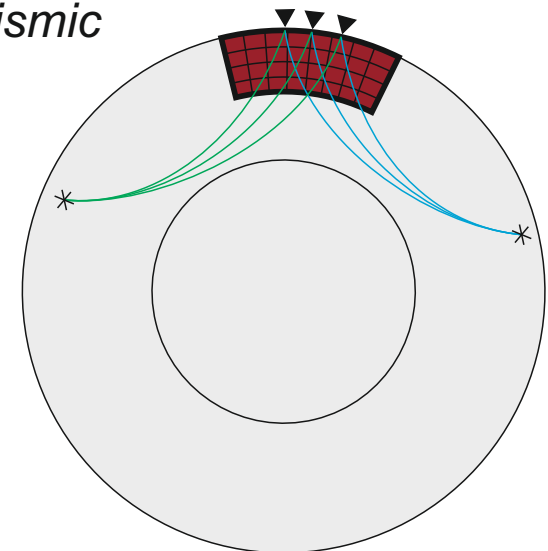
Examples of seismic-velocity tomography of the upper mantle:

- *Isotropic tomography:*
 - **BOHEMA I** – western part of the Bohemian Massif
 - **BOHEMA III** – southern part of the Bohemian Massif
 - **PASSEQ** – Trans-European Suture Zone
- *Anisotropic tomography:*
 - **LAPNET** – northern Fennoscandia

Isotropic teleseismic tomography of the upper mantle

- **Telinv** - code for isotropic tomography (*originally developed by J. Taylor, E. Kissling, U. Achauer, C. M. Weiland, L. Steck*)
- Inversion of relative **travel-time residuals** of teleseismic **body waves**.
- **3D model of isotropic-velocity perturbations of the upper mantle beneath the array of stations.**

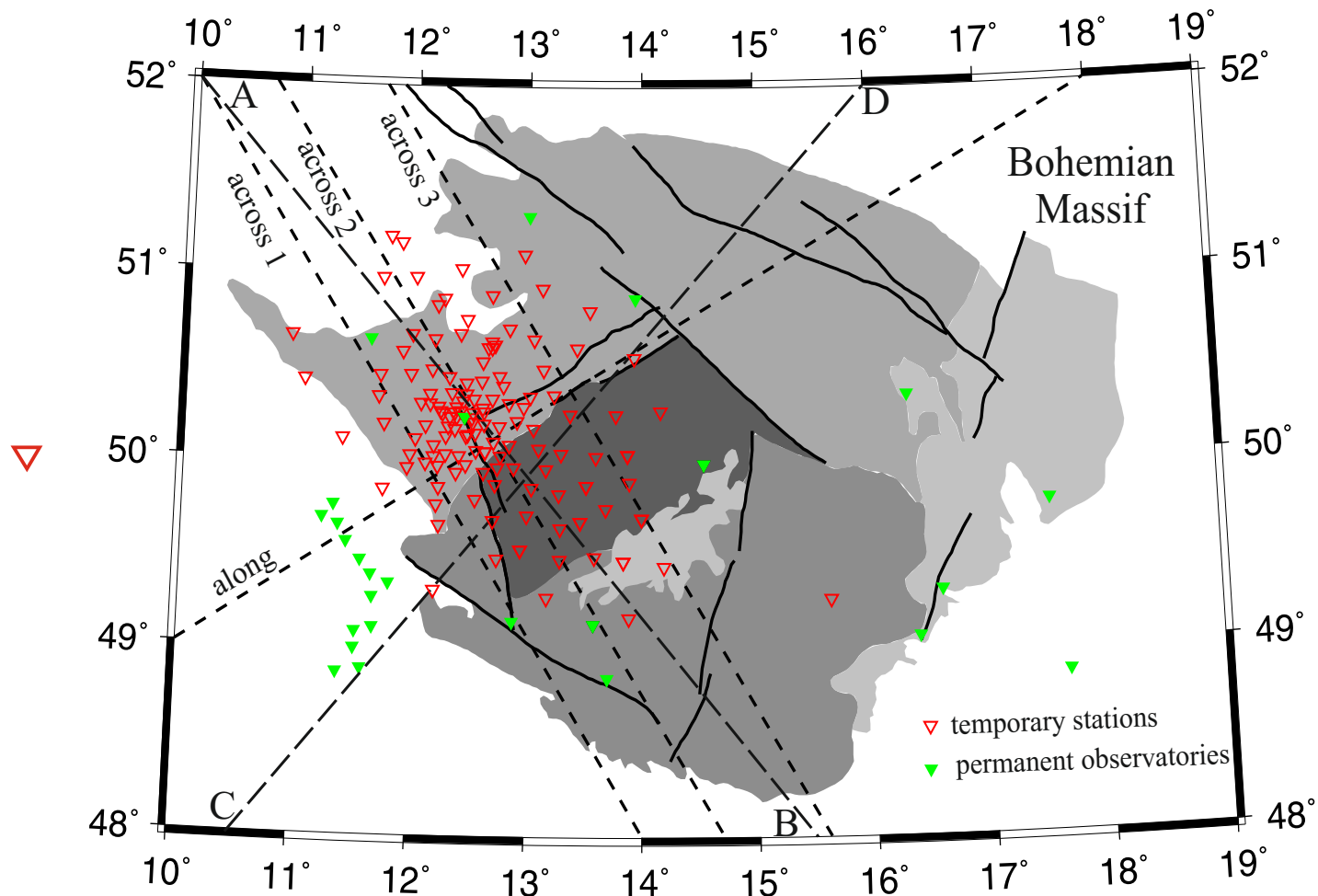
Regional teleseismic tomography



Passive seismic experiment **BOHEMA I**

Integrated network of seismic stations:

- **Permanent stations** (~ 60) from national observatories of:
 - Czech Republic,
 - Germany.
- Complemented with **temporary stations** (~ 90) from:
 - Czech Republic (**MOBNET**),
 - Germany,
 - France.
- 2001 - 2003
- **Structure of the crust and upper mantle of the western Bohemian Massif.**
 - Source of Cenozoic volcanism - „Baby-plume” concept (*Granet et al., 1995*) or asthenosphere upwelling?

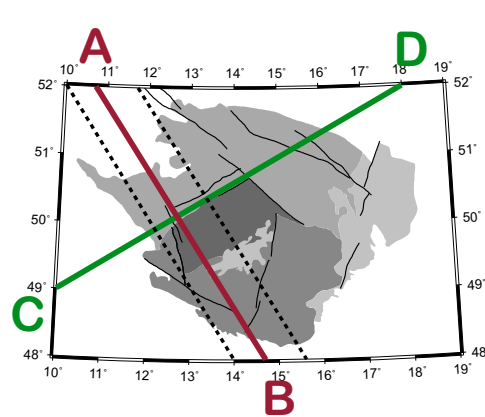
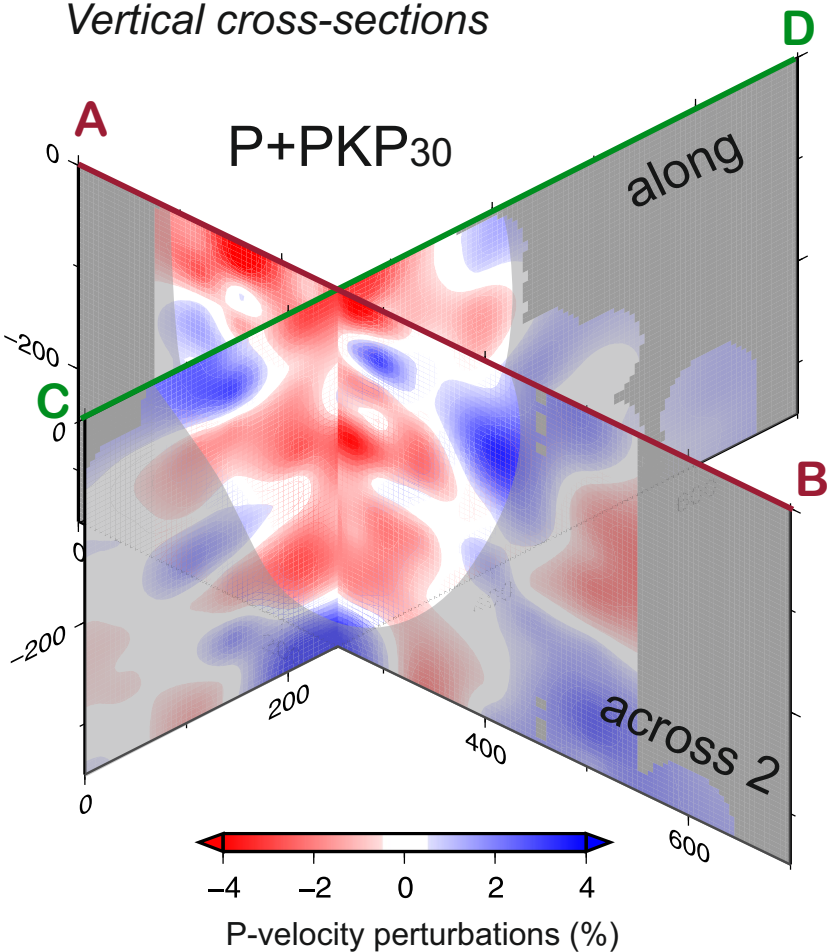


Plomerová et al. (Geochem. Geophys. Geosys., 2016)

BOHEMA I - Tomography of the western Bohemian Massif

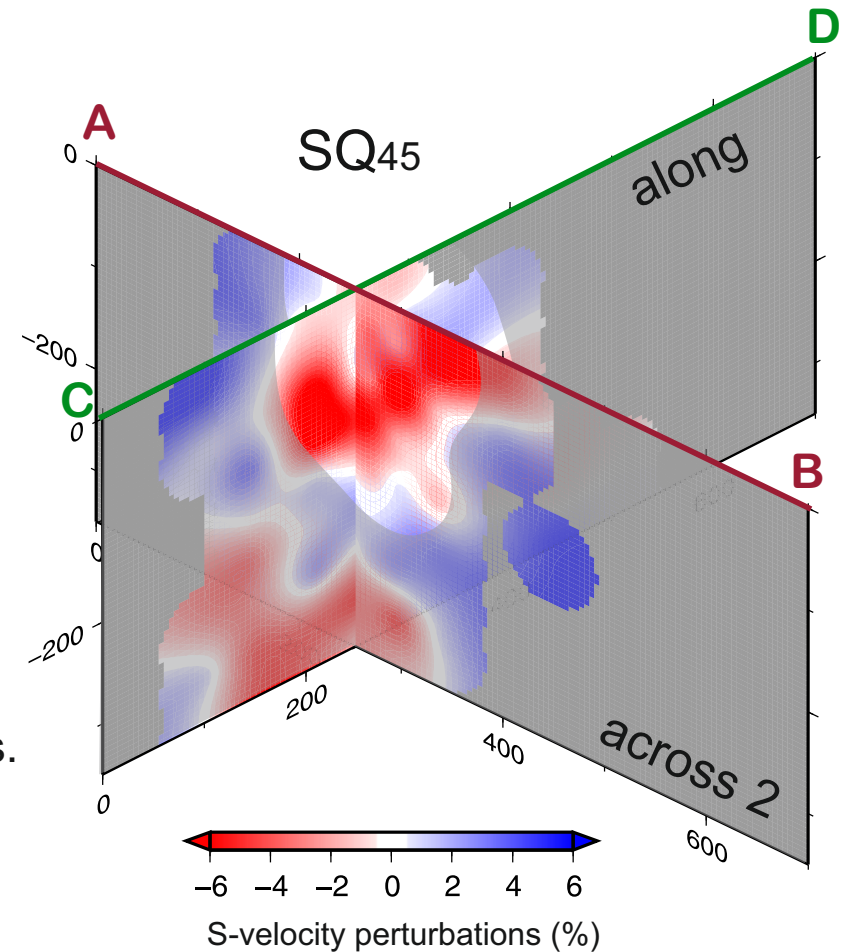
3D model of perturbations of isotropic P- and S-wave velocities

Vertical cross-sections



A 200 km wide zone of low-velocity perturbations in both the P- and S-wave tomogr. images.





No or a very weak connection with deeper parts of the mantle.

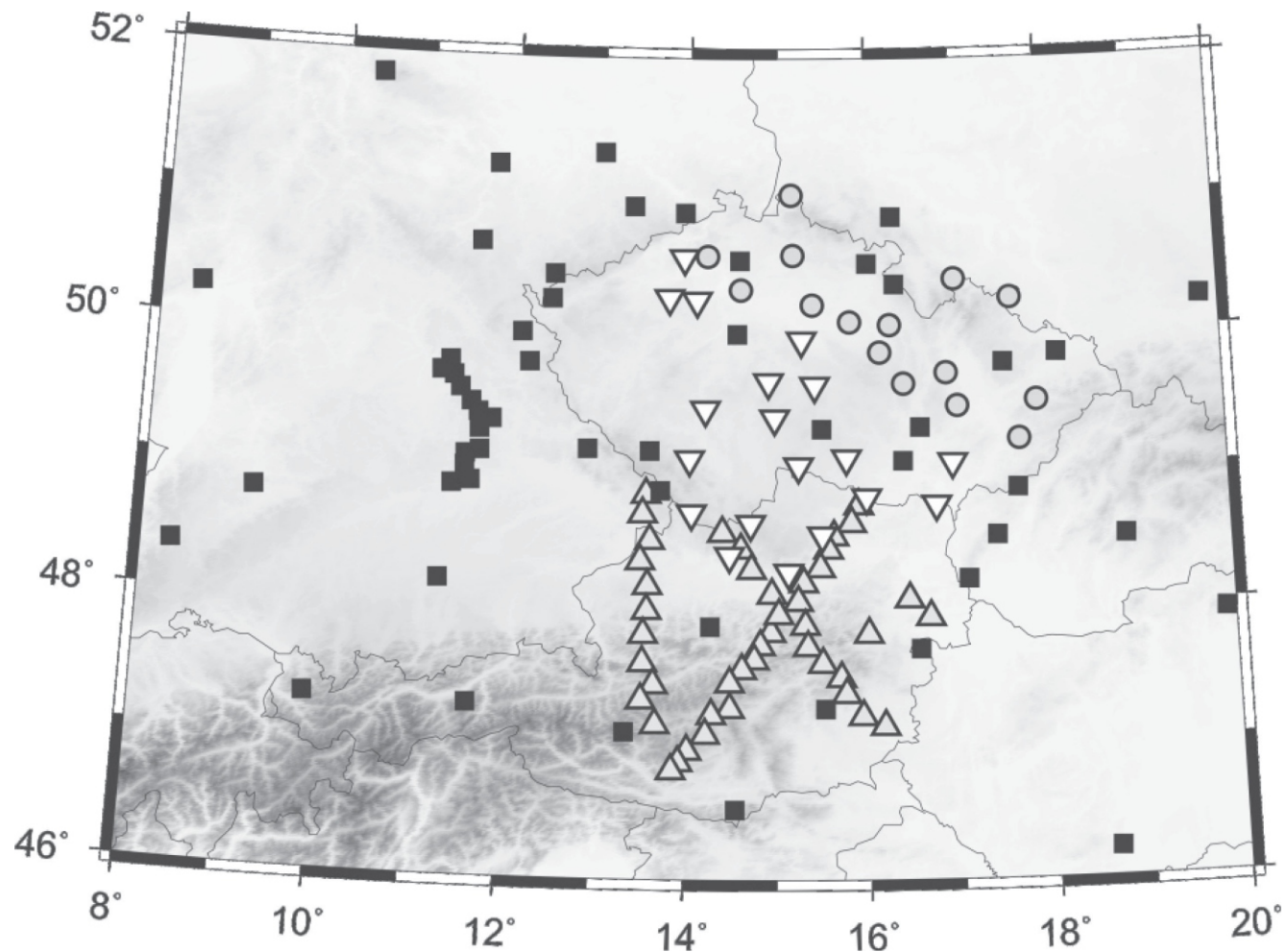


Interpreted as **asthenosphere upwelling** along the Eger Rift.

Passive seismic experiment **BOHEMA III**

Integrated network of seismic stations:

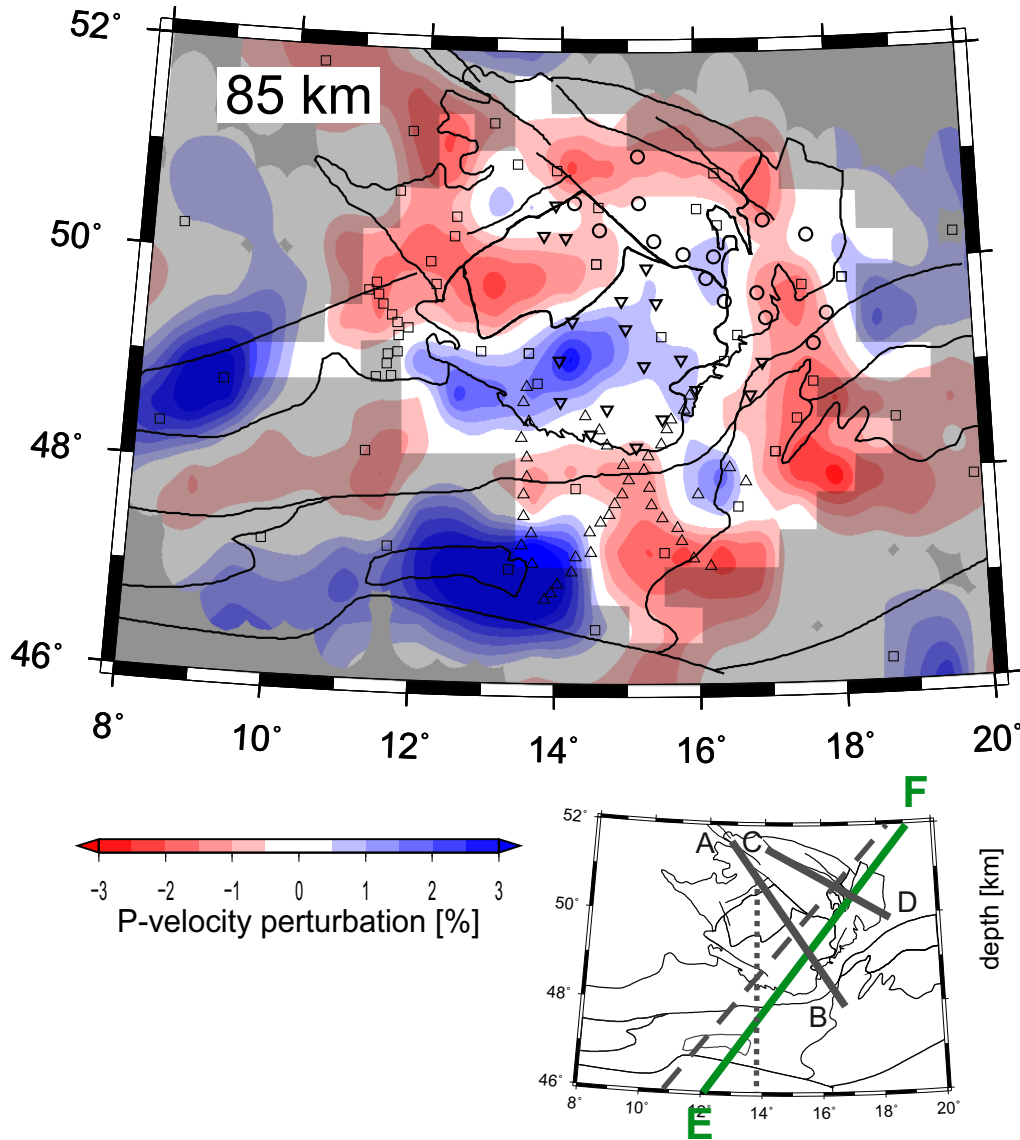
- **Permanent stations** (57) from national observatories of:
 - Czech Republic, 
 - Germany,
 - Austria,
 - Poland,
 - Slovakia,
 - Hungary.
- Complemented with **temporary stations** (65):
 - BOHEMA III (**MOBNET**) 
 - part of ALPASS 
 - part of BOHEMA II (**MOBNET**) 
- 2005 - 2006
- **Structure of the crust and upper mantle of the southern BM and its surroundings.**



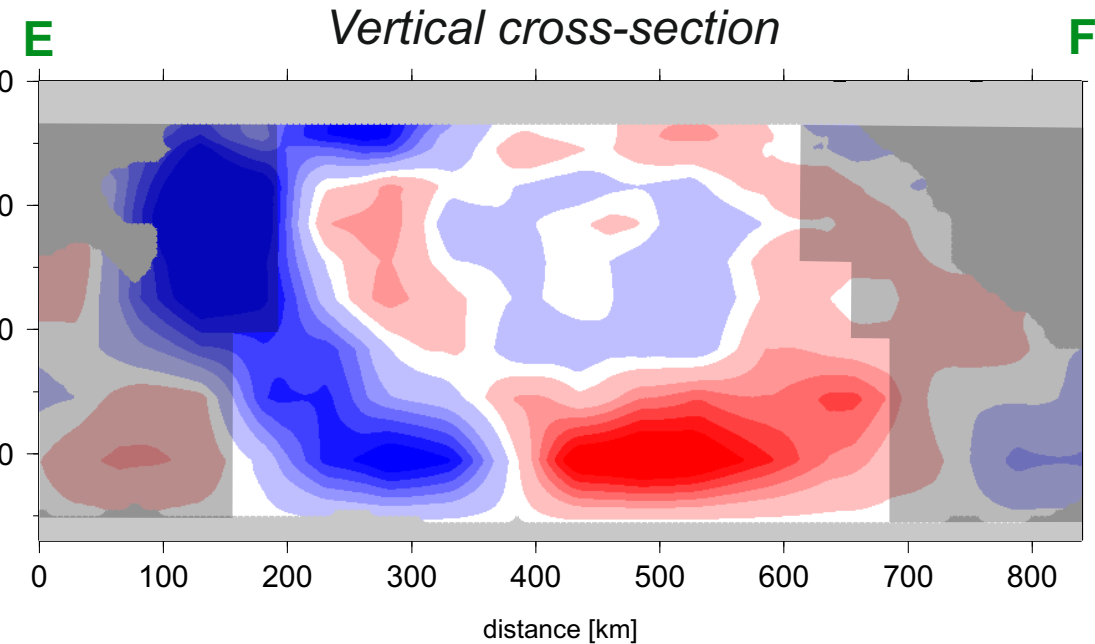
Karousová et al. (GJI, 2013)

BOHEMA III - Tomography of the Bohemian Massif

3D model of perturbations of isotropic P-wave velocities



- **Low-velocity heterogeneity** along the Eger Rift - lithosphere thinning.
- **High-velocity heterogeneity** beneath the **Moldanubian unit** - **thicker lithosphere**.
- **Strong high-velocity heterogeneity** in the south of the model:
 - **Eastern Alpine lithospheric root.**
 - **Northward dip** of this subduction.

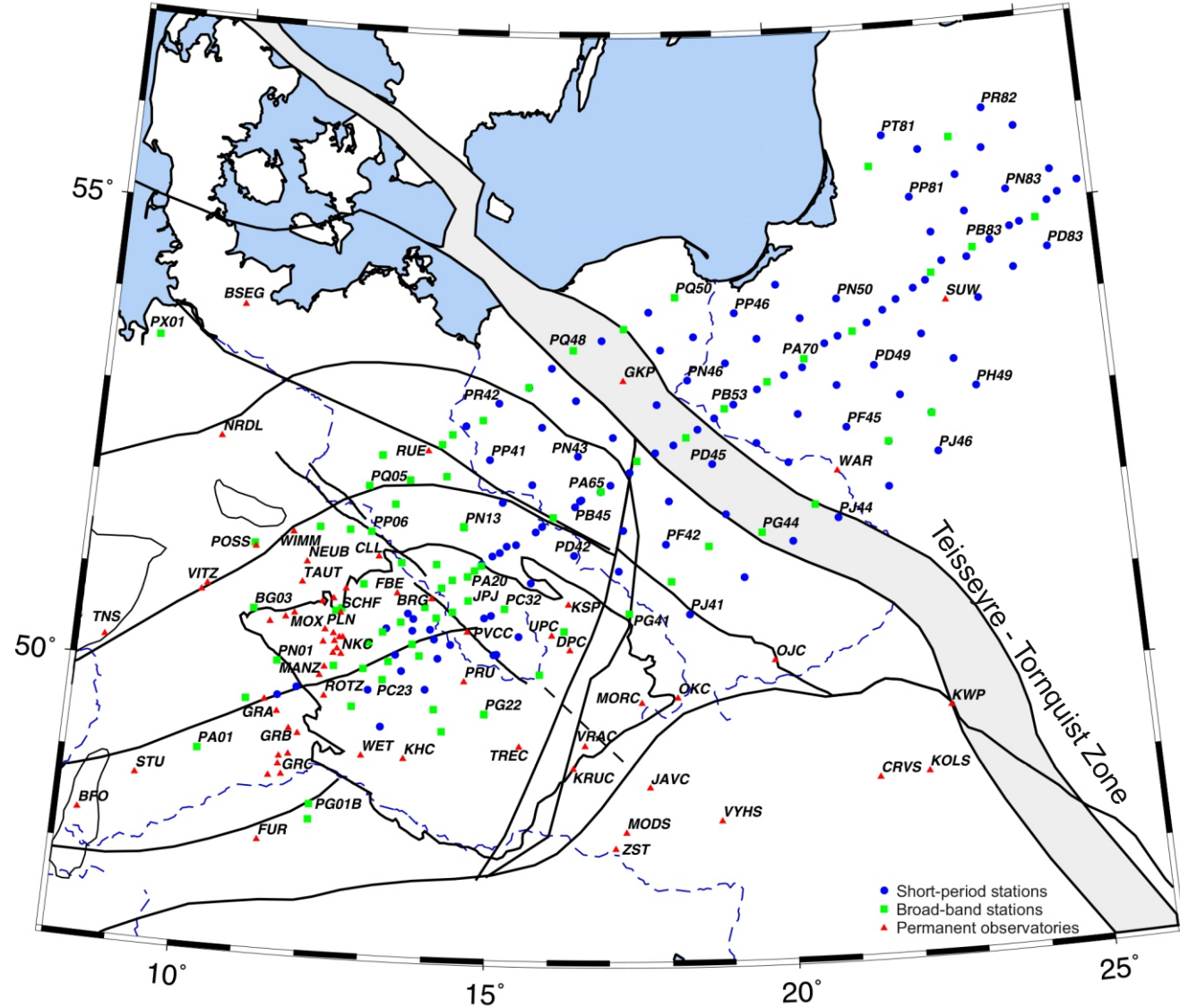


Karousová et al. (GJI, 2013)

Passive seismic experiment PASSEQ

Integrated network of seismic stations:

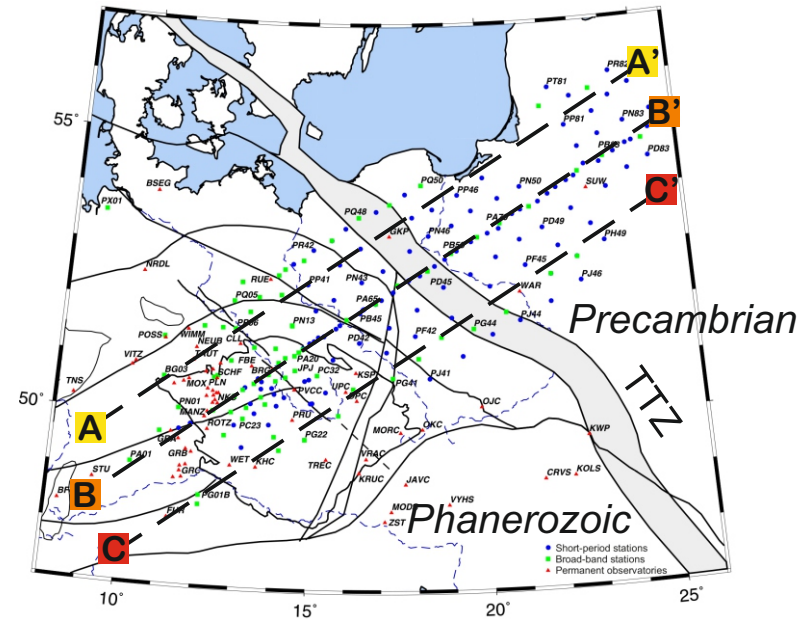
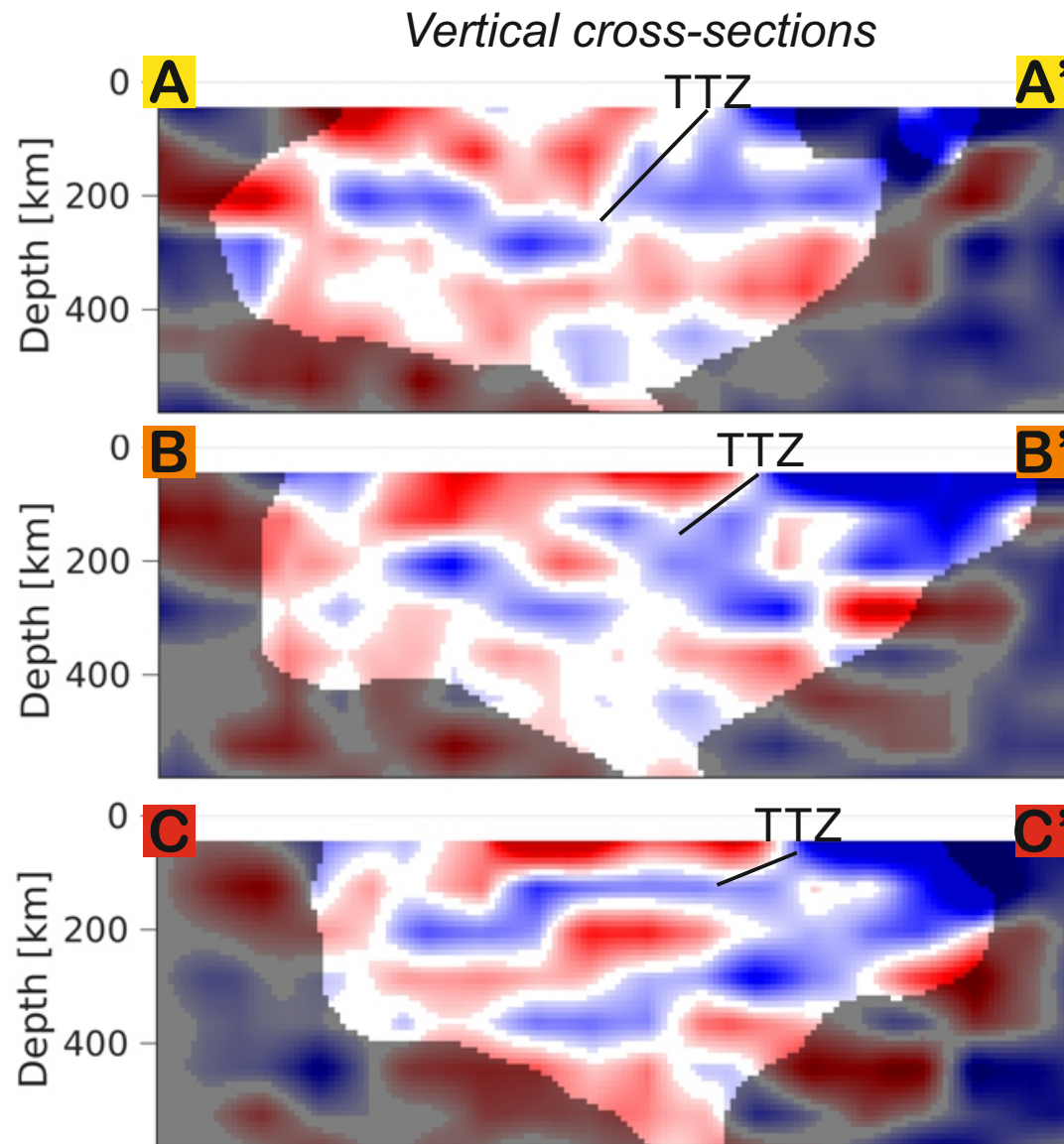
- **Permanent stations** (73) from national observatories of:
 - Czech Republic,
 - Poland,
 - Germany,
 - Slovakia.
- Complemented with **temporary stations** from various mobile pools, including MOBNET.
 - BB stations (81)
 - SP stations (119)
- 2006 - 2008
- **Structure of the crust and upper mantle of the TESZ and its surroundings.**



Vecsey et al. (Solid Earth, 2014)

PASSEQ - Tomography of the upper mantle around TESZ

3D model of perturbations of isotropic P-wave velocities

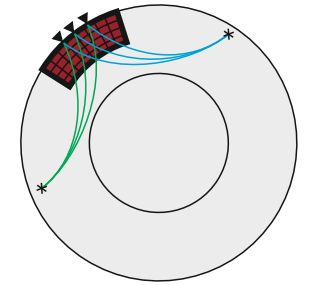


- Significant change of P-wave velocity perturbations across the TTZ.
 - Relatively lower velocity in younger Phanerozoic lithosphere.
 - Relatively higher velocity in older Precambrian lithosphere of East European Craton (EEC).
- Phanerozoic part of Europe thrusts over the Precambrian EEC.

Anisotropic teleseismic tomography of the upper mantle

Recent development:

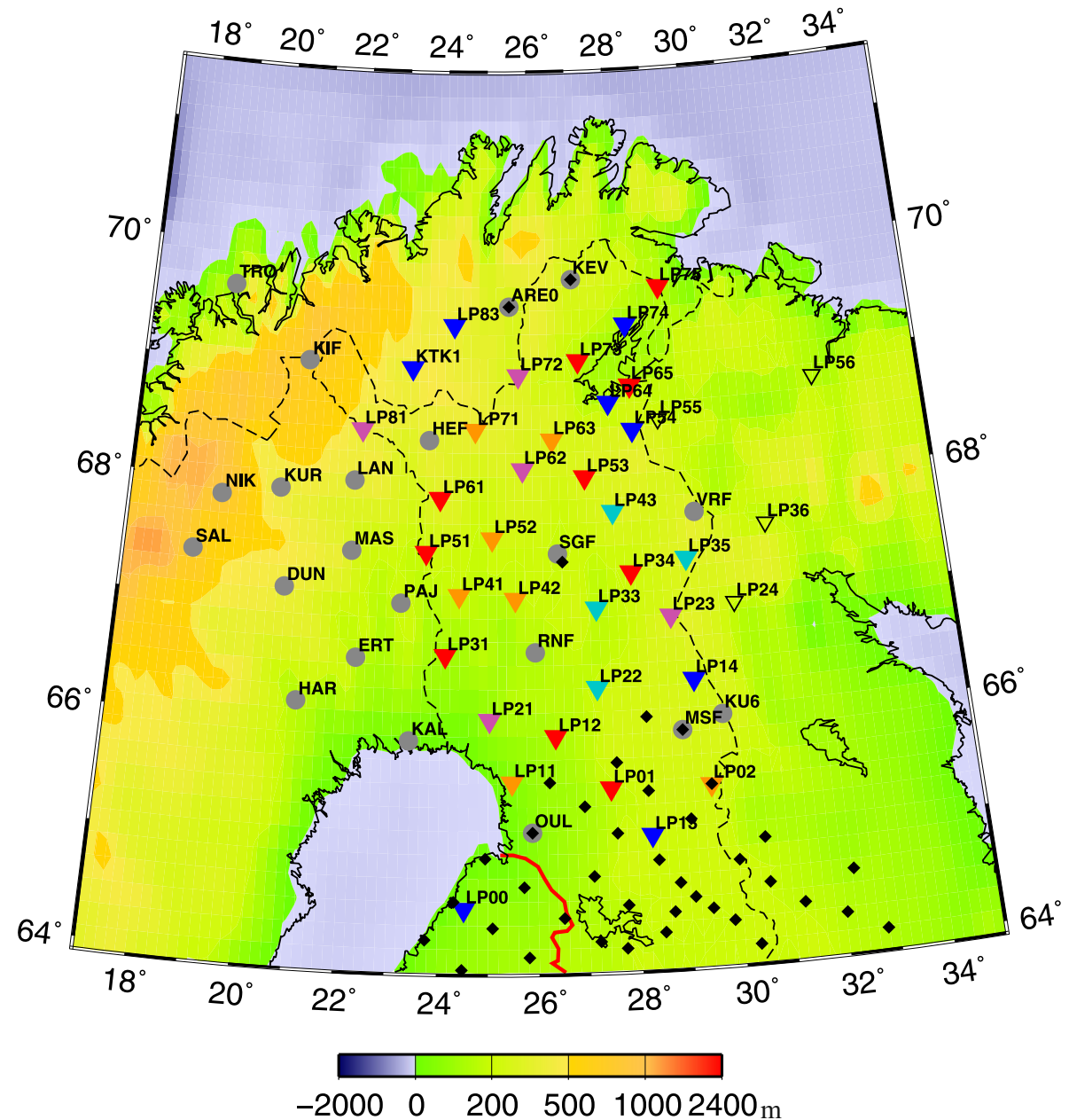
- **Modification of Telinv to invert for anisotropic velocities.**
- **AniTomo** - code for anisotropic tomography
- Inversion of relative **travel-time residuals** of teleseismic **P waves**.
- **3D model of anisotropic P-wave velocities of the upper mantle beneath the station array.**
 - **Weak anisotropy** with **hexagonal symmetry** and general orientation of **the axis in 3D**.
- Extensive **testing** of the new code with synthetic structures and data.
- **First application** to data from passive seismic **experiment LAPNET** is in preparation.



Passive seismic experiment **LAPNET**

Integrated network of seismic stations (59):

- **Permanent stations** from national observatories of:
 - Finland, ●
 - Sweden, ●
 - Norway, ●
- Complemented with **broad-band temporary stations** from:
 - Grenoble, ▼
 - Strasbourg, ▼
 - Prague (**MOBNET**), ▼
 - Oulu, ▼
 - Vienna, ▼
 - Moscow/Apatiti, ▼
- 2007 - 2009
- Experiment SVEKALAPKO (1998 - 1999) toward south. ◆
- **Structure of the crust and upper mantle of the northern Fennoscandia (archean).**



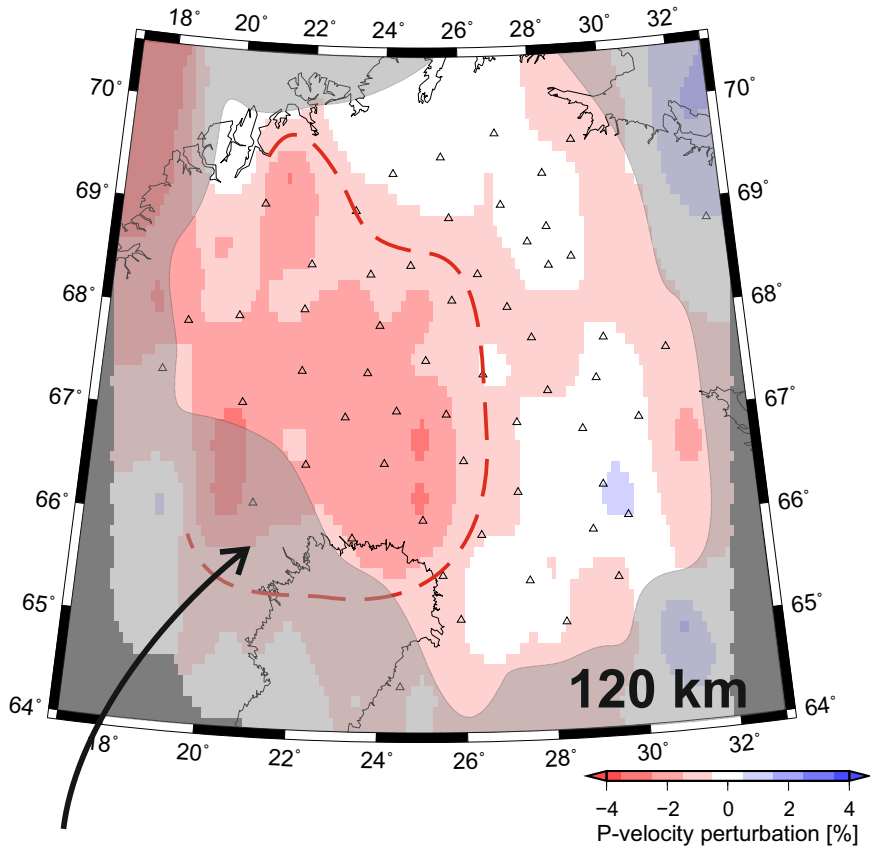
Plomerová et al. (Solid Earth, 2011)

LAPNET - Tomography of the northern Fennoscandia

3D model of P-wave velocities

120 km depth

Isotropic component

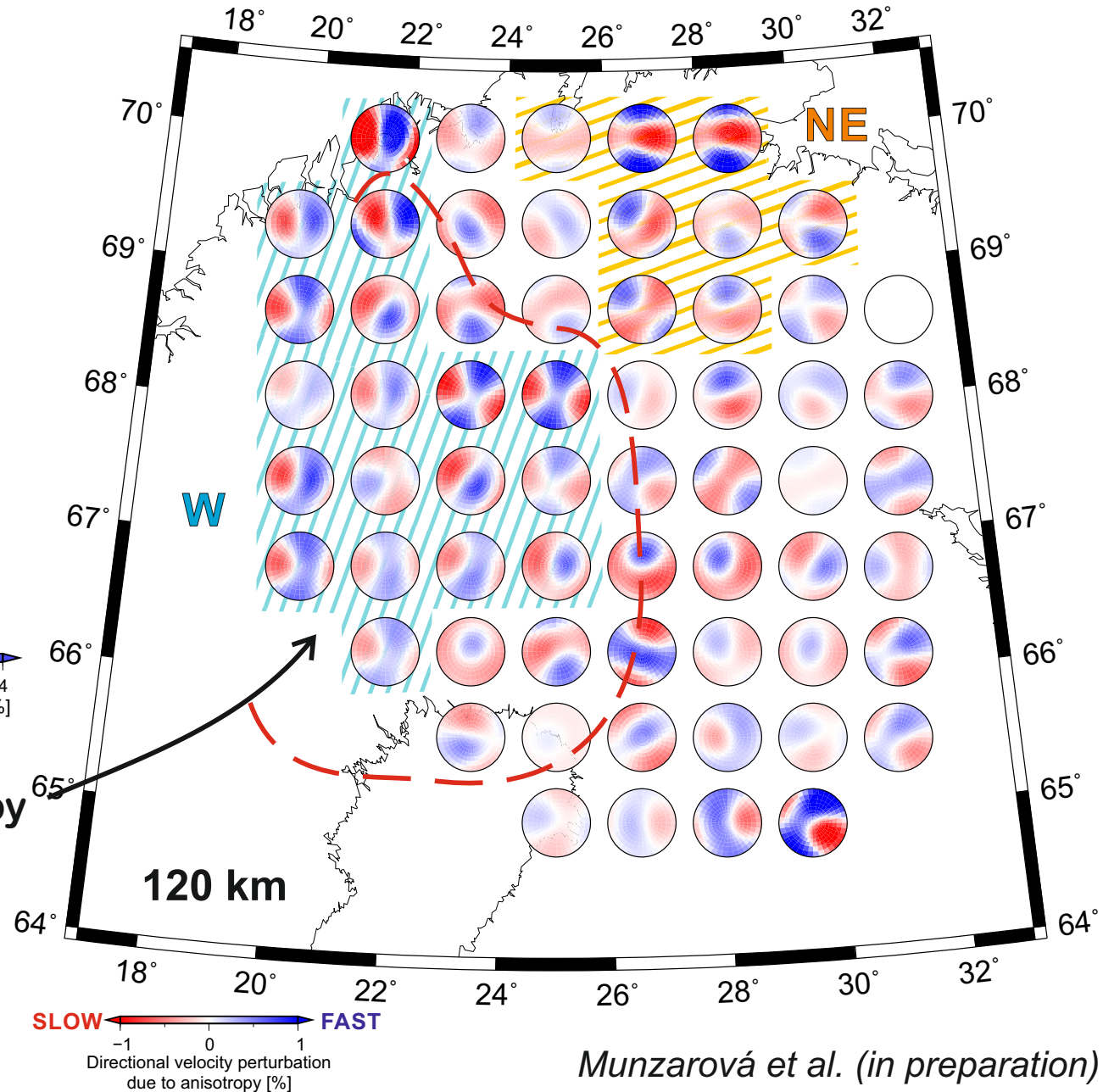


Low-velocity perturbations

Distinct and consistent anisotropy

- A uniform structure of the lithosphere in the west
- Consistent anisotropy also in the northeast

Anisotropic component



Munzarová et al. (in preparation)

Conclusions

- Recordings from **the MOBNET stations** deployed during temporary passive seismic experiments **densify** data from **the permanent stations**.
- High-quality data collected during temporary experiments enable to investigate not only **isotropic** but also **anisotropic structure of the Earth's upper mantle**.