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


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

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.

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

Chyba et al. (PEPI 2017, in press)
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.

*Munzarová et al. (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


- **Structure of the crust and upper mantle of the northern Fennoscandia (archean).**

*Plomerová et al. (Solid Earth, 2011)*
Low-velocity perturbations
Distinct and consistent anisotropy
• A uniform structure of the lithosphere in the west
• Consistent anisotropy also in the northeast

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.