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MOBNET pool of transportable seismic stations in European passive experiments

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Abstract

MOBNET pool of seismic stations of the Institute of Geophysics of the Czech Academy of Sciences has been created since nineties of the 20th century. It grew from a nucleus of 6 broad-band units (seismometer and data acqusition system) up to the current 80 portable stations for temporary installations. The need of having a dense network of transportable seismic stations to be installed temporarily in regions with different tectonics and to record data for detailed modelling of 3D anisotropic structure of the upper mantle, triggered formation of this pool. Since then, the pool equipment has been involved in several passive seismic experiments, both small- and international large-scale ones, which were in operation for only few months at the beginning up to several years nowadays. Data recorded during the experiments has contributed to different significant findings about the Earth, including those which revealed that the mantle lithosphere is formed by individual domains with their own tilted anisotropic fabrics. Changes of the fabric orientations mark boundaries of the domains amalgamated to cores of continental plates. Data from the passive experiments are essential for detailed research of the Earth structure and inferences about processes of plate formation.

Keywords: Passive seismic experiments; MOBNET pool; Portable stations; Continental lithosphere structure; Seismic anisotropy in 3D

1. Introduction

Any geophysical experiment is a targeted design of measurements of natural physical parameters realized either in a laboratory or in a field aiming at unraveling details of physical processes in the Earth. Dimensions of the features studied in the Earth are usually of a large extent, which leads to organizing large-scale experiments in the field. Propagation of seismic waves, especially their travel times or attenuation, represents one of the fundamental parameters that allow us to study the Earth's interior. Active and passive seismic experiments are distinguished according to the type of sources that generate seismic waves. Active sources of waves (so called controlled source seismics) are used prevailingly for the illumination of the crust and of the uppermost mantle. On the other hand, seismic waves from natural sources (earthquakes), or recently also broadly exploited ambient noise, are crucial for the passive experiments and related research of the Earth's structure. Data recorded by dense networks of temporarily deployed seismic stations during the passive experiments are often complemented by e.g., gravimetric, geodetic or magnetotelluric measurements and processed by multimethod and multidisciplinary approaches in a broad cooperation of scientists of different professions. Achieved results improve essentially our understanding of the Earth's structure, history of its evolution and contribute to estimates of seismic hazard.

The continents are the most complex and diverse parts of the Earth, which contain the oldest rocks and records of the early formation and evolution of the planet. To determine how the features seen at the Earth's surface correlate with structural and compositional differences in the deep parts of the planet, seismologists need recordings of different types of seismic waves that densely sample the Earth. Resulting snap-shots of its current physical stage serve as fundamentals for inferring processes of the Earth's formation back in time.

Probing the deep Earth with the use of data from passive seismic experiments became widespread in the last two decades of the 20th century. The temporary networks composed from lower tens of broad-band (BB) digital instruments were installed at that time in different tectonic regions all over the world, e.g., in Tibet (Owens et al., 1993; Yuan et al., 1997) or in Cameroon (Dorbath et al., 1986). The passive experiment in the French Massif Central (Granet et al., 1995) belongs among the pioneering cooperative passive seismic experiments in Europe. The technical development of seismometers, data acquisition systems, digital data transmission to seismological centers as well as computational facilities of data processing and research itself, made building large-aperture arrays covering vast territories to collect data for thorough view into the deep Earth possible. The US Transportable array (https://doi.10.7914/sn/ta) (IRIS Transportabel Array, 2003) is the best example of such passive experiments providing data for systematic research of the Earth.

While the deployment and operation of the US Transportable array, as well as its data collection, are strictly separated from the scientific research, organizing passive experiments in Europe depends prevailingly on supports of national grant agencies. The scientists have to cover all the steps of the experiments from instrument purchase, installation and running the network, up to the research itself and publishing the results. Therefore, coordination of both the availability of the stations from different pools and simultaneous financing of individual scientific groups is the most difficult task for experiments in Europe. Despite these challenges, large-scale array experiments have been realized in a frame of multidisciplinary international research programs as, e.g., the TOPO-Europe (Cloetingh and Ziegler, 2009), mainly in the Iberian peninsula and northwestern Africa (IberArray, Diaz et al., 2009, 2010; TopoIberia, Diaz et al., 2015), or EUROPROBE (Gee and Zayen,1996), including the TOR and SVEKALAPKO arrays in northern Europe (Pedersen et al., 1999; Hjelt et al., 1996), recently followed by the large-scale AlpArray (Hetényi et al., 2018a) and AdriaArray (Kolínský et al., 2025a) experiments. The instrumentation of these experiments was composed of equipments of individual European institutions.

The aim of this paper is to give an overview of the MOBNET pool of temporary stations of the Institute of Geophysics of the Czech Academy of Sciences (IG CAS) and to highlight some of the new discoveries of the Earth's structure achieved thanks to data from several passive experiments, in which the MOBNET stations were involved. The domain-like anisotropic structure of the continental mantle lithosphere with tilted symmetry axes (Babuška and Plomerová, 2021, 2022 for review) belongs among them primarily. We are far from presenting a complete overview of new inferences from the passive experiments in Europe, but we will give several examples to document the importance and irreplaceability of the passive experiments for gaining new and essential outcomes about the Earth's structure and scenarios of the Earth's evolution. By this overview of the step-by-step building the MOBNET pool and temporary deployment of its components we wish to document the feasibility of creating temporary networks from different national pools, funded by different national agencies providing grants in different periods. We also wish to acknowledge the cooperation with participants of various projects, who were active either in the fieldwork of the experiments or in the research.

2. Pioneering passive experiments in Europe

During the last decade of the 20th century, the technical development of seismological instruments, predominantly digital data acquisition systems (DAS) including their recording capacity and data transmission, enabled to gain data from large international collaborative campaigns of field measurements. Passive seismic experiments in the French Massive Central (MC) within a French-German collaborative project (Granet et al., 1995), in the Varmland (Sweden) with the Czech-French-Sweden-Slovak cooperation (Plomerová et al., 1996) or the experiment in south-east Germany (Plomerová et al., 1998) realized in early 90th, belong among the pioneering temporary arrays of seismic stations which collected data for detail regional studies of the upper mantle. Densely spaced rays from teleseismic earthquakes sampled the upper mantle with high density and enabled calculations of upper mantle tomography images with the unprecedented high resolution. The two small-sized experiments in the Varmland (1991) and in south-eastern Germany (1992) concentrated on the feasibility of mapping lateral changes of anisotropic structure of the rigid mantle lithosphere, as well as the lithosphere-asthenosphere boundary (LAB) relief. Results obtained by applying a novel method of directional variations of teleseismic P-wave travel time residuals and shear-wave splitting, and in particular by joint inversion/interpretation of anisotropic parameters retrieved from body waves (e.g., Babuška et al., 1984a, 1984b, 1993, Babuška and Plomerová, 1992; Šílený and Plomerová, 1996), clearly demonstrated that anisotropic structure of the mantle lithosphere and changes of its orientation in 3D, can be successfully detected and modelled from seismic recordings of the temporary arrays (Plomerová et al., 1993, 1998, 2001). Reprocessing the MC network data, targeted on extraction of seismic anisotropy, was successful and clearly revealed the opposite orientations of anisotropic fabrics in the western and eastern parts of the MC, with a shift of boundaries of the mantle domains with respect to the traces at surface of margins of the tectonic units in the crust (Babuška et al., 2002).

After testing the ability of our method (e.g., Babuška et al., 1993) to resolve the 3D lithosphere structure with the high resolution, including short-wavelength variations of the large-scale anisotropy strength and orientation in the two small-sized experiments in Sweden and south Germany, the anisotropy studies of the mantle lithosphere were also included in the two large-scale passive experiments in Europe – TOR and SVEKALAPKO, realized in the second half of 90^{th}. Besides tomography images of the Earth's crust and upper mantle or modelling the Earth's discontinuities (e.g., Arlitt et al., 1999; Cotte et al., 2002; Shomali et al., 2002; Alignaghi et al., 2003; Sandoval et al., 2003, 2004; Bruneton et al., 2004; Pedersen et al., 2006; Kozlovskaya et al., 2008), viability of studying lateral changes of the mantle lithosphere fabrics and the LAB depth from the experimental data appeared to be promising. Results obtained from the anisotropic studies based on data recorded during these experiments identified changes in fabrics of the mantle lithosphere domains, separated by the dominant sutures, namely by the Thor and Sorgenfrei-Tornquist Sutures in the Denmark-southern Sweden region (Plomerová et al., 2002; Babuška and Plomerová, 2004), or by the Proterozoic/Archean suture in south-central Finland (Plomerová et al., 2006, 2008; Vecsey et al., 2007; Kozlovskaya et al., 2007). Mapping the structure of the mantle lithosphere domains with tilted anisotropy, generally in 3D, and imaging the domain boundaries through anisotropy changes would have been hardly possible without the arrays of densely spaced temporary stations.

3. Building the MOBNET pool and achievements from relevant experiments e

Promising results achieved by application of the new method of joint analysis of anisotropic signals in P and S body waves recorded in the passive experiments in Varmland (SW Baltic Shield), and across the Saxothuringian-Moldanubian suture in south Germany, TOR and SVEKALAPKO, triggered our effort to form a core of the MOBNET pool of transportable seismic stations of IG CAS for temporary installations in the field. We can split the creation of the MOBNET pool into three main phases (Table 1). A nucleus of the pool has been created in the first phase, for which a new digital data acquisition system (DAS) VISTEC/Jupiter has been developed by the VISTEC company (Fig. 1). The DAS was built on a basis of an industrial PC with LINUX operation system and AD converters per each of 3 channels, with dynamics of 24 bits for 100Hz sampling of the 10-250 Hz sampling frequency range and S/N of 130db. Three VISTEC/Jupiter off-line recording systems in combination with the Guralp seismometers CMG were tested in the Bohemian Massif. Expenses to get the equipments were covered prevailingly from the supports of the national grant agencies (the Grant Agency of the Czech Repulic (GACR) and the Grant Agency of the Academy of Sciences (GAAV)) and so called "large investments" funds of the Czech Academy of Sciences (see Table 1). Only six portable stations contributed to field measurements in the first three years.

In the second phase, considered as the real birth of the pool, 30 pieces of DAS of the new advanced type of VISTEC data acquisition system, called GAIA, were paired with 15 short-period (SP; Le-3D) and 15 broad-band (BB; STS 2) seismometers (Table 1). A specific micro-computer was designed for the GAIA station to meet the low-consumption demand. Several parameters of the new station, e.g., dynamic range, sampling up to 1000 Hz, or number of channels (6) have been improved with respect to the previous version. The first generation of the GAIA operated off-line, but sent daily SMS text message reports (SMS) of its state-of-health (SOH) status to the IG CAS center (setting of the frequency of the reports was optional). Among others, the SMS reports included also number of one-hour long files stored on the SD cards per day or pendulum deflections. The new GAIA replaced the old VISTEC/Jupiter DAS.

Table 1. History of MOBNET pool building.

	Year	DAS	N	Seismometer	N	Financial source
Phase 1	1998	Vistec/Jupiter	3	–	–	GACR 205/98/K004
	1998	–	–	CMG-40T	1	GAAV A3012908
	1998	–	–	CMG-3T	2	CAS ‘large investment’
	1999	VISTEC III	2	–	–	GAAV A3012908
	2000	–	–	CMG-ESP	3	GAAV A3012908
	2001	VISTEC IV	1	–	–	GACR 205/04/04
						6 complete portable units
Phase 2	2003	GAIA 1	26	–	–	CAS ‘large investment’
	2003	Accessories		–	–	Ministry of Environment (ME) of the Czech Rep.
	2003	GAIA 1	1	–	–	GACR 205/02/0381
	2003	–	–	STS 2	15	CAS ‘large investment’
	2003	–	–	Le-3D	15	CAS ‘large investment’
	2004	GAIA 1	3	–		GAAV A3012404
						+30 complete portable units
	2004	GAIA 2	17	–		CAS ‘large investment’
	2005	–	–	Le-3D	17	CAS ‘large investment’ (for CSS experiments)
	2007	GAIA 3	8	–		CAS ‘large investment’ (substitution of 6 old VISTEC)
						+17 complete portable units **+2 extra DAS**
Phase 3	2016	GAIA 5	10			CAS ‘large investment’
	2016			CMG-3ESP	10	CAS ‘large investment’
						+10 complete portable units
	2018	GAIA 5+	15			OP RDE of MEYS of the Czech Rep., CzechGeo/EPOS-Sci CZ.02.1.01/0.0/0.0/16_013/0001800
	2019			CMG-3ESPC	11	
						+11 complete portable units **+4 extra DAS**
Total: **80 GAIA** 41 BB seismometers Ts > 60 s, CMG-40T (Ts = 30 s) and 32 Le-3D SP = **74 seismometers**						

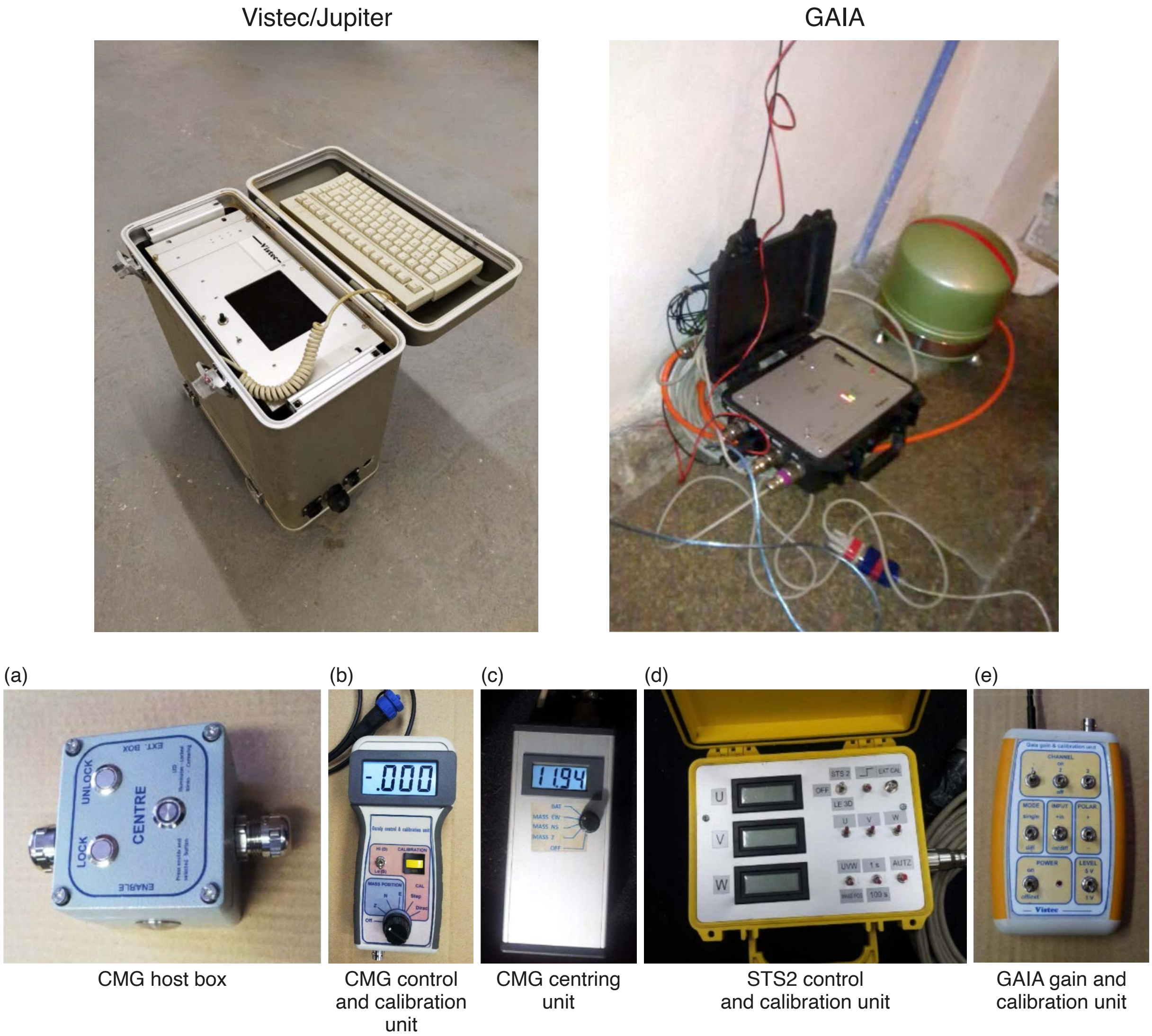

Figure 1. Data acquisition systems Vistec/Jupiter and GAIA (upper part) of the MOBNET pool and control calibration units (lower part: a-e) developed for the broadband seismometers and the GAIA to make easier their remote controls and to guarantee the high-quality of data.

In the second phase, the MOBNET pool consisted of 36 complete units (sets of the BB seimometers and DAS) available for deployment in passive seismic experiments requiring continuous recording of digital data for a long time. Besides that, 17 pairs of LE-3D seismometers and DAS of new type GAIA 2, designed especially for active seismic experiments (Control Source Seismology-CSS), were incorporated into the pool. The GAIA 2 works both in the continuous and trigger mode, and allows a very high sampling rate (e.g. 500 Hz), especially if running in the second mode.

The GAIA data acquisition systems were step-by-step upgraded during the long time of their operation. The system changed from the off-line operated stations reporting their SOH by SMS to the center as it worked at the early stage of the pool to the on-line stations transmitting actual data directly to the national centre and further to the European Integrated Data Archive (EIDA) nodes (http://www.orfeus-eu.org/data/eida/). In case of transmission failures or any recoverable station failures, data recorded on SD cards are checked and used to complement/substitute data in EIDA nodes (Kolínský et al., 2025b). Several station improvements (Fig. 1) relate to the remote control of both the DAS as well as the seismometers (Vecsey et al., 2017).

Enlargement of the pool by a set of 21 new transportable BB units (seismometers and DAS) and four additional spare GAIA 5+ DAS represent the third phase of the MOBNET pool building to its present size of 80 complete units. The GAIAs are paired with 41 broad-band seismometers of the STS2 and CMG types with corner periods Ts > 60 s, one CMG-40T (Ts = 30 s) and 32 Le-3D SP seismometers with Ts = 1 s. During more than 20 years of continuous operation in different experiments, only few of the instruments have been damaged by lightning, floods, vandalism, thefts, or have required major repairs.

3.1 MOBNET in experiments covering the Bohemian Massif

The Bohemian Massif (BM) is the largest one from the Variscan massifs in Europe. The crust consists of several tectonic units of different origin and history. Deciphering fabrics of the mantle parts of individual lithosphere domains was a challenge leading to a better understanding processes of the continental lithosphere formation, in general. With the exception of the central station PRU of the Czech Regional Seismic Network (CRSN), all other permanent stations were historically located around the rim of the BM. To capture different signals reflecting structures of the mantle lithosphere domains related to individual tectonic units, we installed 8 temporary stations (6BB+2SP) within a pilot project MOSAIC (Barrande program, Project No. 98087-2) operated in the Czech-French (EOST STRASBOURG) cooperation (Fig. 2). Though the network collected data for only 9 months, the results of joint interpretation of P-wave travel time deviations and shear-wave splitting, identified anisotropy within the mantle lithosphere of the BM with different orientation and inclination in its individual units (Plomerová et al., 2000). These findings were in accord with those retrieved for the MC lithosphere domains (Babuška et al., 2002) or for the Armorican Massif (Plomerová et al., 2000; Judenherc et al., 2002). The encouraging results called for an investigation of the BM in greater detail. The nucleus of the MOBNET pool, consisted of six seismometer-DAS pairs, was further included in the Czech-French-German experiment BOHEMA (2001-2003), formed by 61 permanent and 92 temporary stations all together (Plomerová et al., 2003). The network covered a territory approximately 270 km long and 150 km wide in the western BM with inter-station spacing of 10-30 km (Fig. 3). The experiment focused primarily on proving the existence or non-existence of a baby plume beneath the Eger Rift in the western part of the BM, suggested there in analogy with that in the MC (Granet et al., 1995). The existence of the baby plume was not proved (Plomerová et al., 2007, 2016). However, the enormous amount of collected new information about the anisotropic structure of the mantle lithosphere in the western BM represented a great benefit of the experiment.

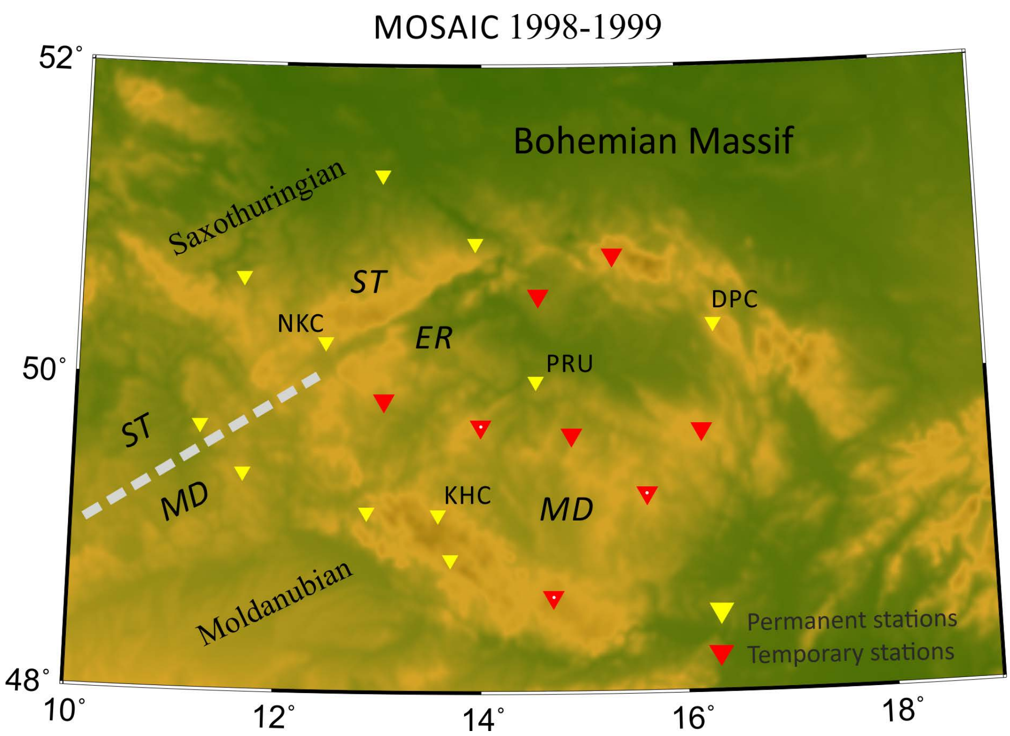

Figure 2. Distribution of stations within the BM during the MOSAIC passive seismic experiment (1998-1999). Three of eight temporary stations, red triangles with white dots, mark the MOBNET stations. Light grey dashed line along with Eger Rift (ER) follow the Saxothuringian (ST) and Moldanubian (MD) unit boundary (for all tectonic units of the BM see Fig. 3).

To create a 3D self-consistent model of the entire BM and to decipher its growth (e.g., Babuška and Plomerová, 2013), a necessity of having a transportable array of several tens of seismic stations became evident. This led to the enlargement of the MOBNET pool nucleus to the size which allowed a step-by-step coverage of the BM in consequent passive experiments BOHEMA II (2004-2005), Bohema III (2005-2006) (Babuška et al., 2005), EgerRift (2007-2014) and BOHEMA IV (2012-2014) (Babuška et al., 2013, Bianchi et al., 2015) (Fig. 3). High-quality data for the structural studies of the BM have been recorded also during the PASSEQ experiment 2006-2008 (Wilde-Piorko et al., 2008), covering central Europe by the SW-NE trending band of stations, and by the ALPASS (Mitterbauer et al., 2011), the array touching the southern part of the BM. Processing the high-quality data collected from densely spaced stations of these experiments resulted in a detailed 3D self-consistent model of the BM lithosphere (e.g., Babuška et al., 2008, 2010; Plomerová et al., 2007, 2012; Geissler et al., 2012; Karousová et al., 2012a,b, 2013). The mantle part of the lithosphere consists of individual domains of different thickness and fossil anisotropic fabrics with clearly defined boundaries. These boundaries can be steep, such as in case of the Saxothuringian-Teplá Barrandian contact (ST/TB), or inclined, such as in case of the Teplá Barrandian-Moldanubian contact (TB/MD) (Fig. 3). The boundaries of the mantle domains are often shifted relative to the surface traces of the corresponding crustal units by up to tens of km. We interpreted the boundaries as channels for transportation of the upper mantle rocks and fluids to the surface (Babuška and Plomerová, 2013, 2017; Kvapil et al., 2021; Faryad et al., 2024; Plomerová, 2024).

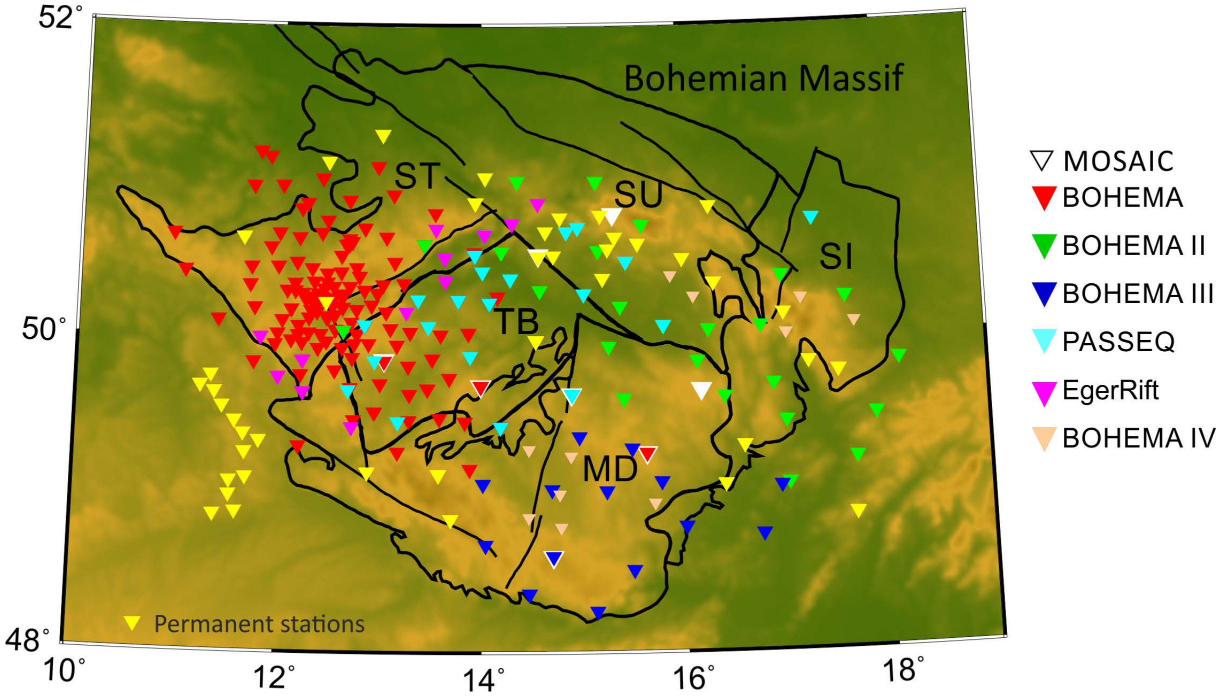

Figure 3. Distribution of MOBNET stations in regional passive seismic experiments (see also Table 2) that covered the BM and contours of tectonic units in the crust: ST-Saxothuringian, MD-Moldanubian, TB-Teplá-Barrandian, SU-Sudetes, SI-Silesian. Stations in margins of individual experiments, areas of which overlap, were involved in both experiments.

3.2 MOBNET in experiments in European regions with different tectonics

In addition to exploration of the BM lithosphere and the upper mantle beneath it, the stations of the MOBNET pool participated in several large-scale international passive experiments far in Europe (Table 2). Ten stations (STS2-GAIA) formed the back-bone of the Retreating-trench, extension, and accretion tectonics (RETREAT) experiment (2003-2006) in the Northern Apennines (Italy; Margheriti et al., 2006) (Fig. 4a). This multidisciplinary study of the Northern Apennines (earth.geology.yale.edu/RETREAT/) was funded by the United States National Science Foundation (NSF) in collaboration with the Italian Istituto Nazionale di Geofisica e Vulcanologia (INGV) and supported by the Grant Agency of the Czech Academy of Sciences (GAAV). The main goal of the RETREAT experiment was to develop a self-consistent dynamic model of syn-convergent extension using the Northern Apennines as a natural laboratory. A complex mantle flow as well as the 3D oriented fossil anisotropy in the mantle lithosphere (e.g., Plomerová et al., 2006; Salimbeni et al., 2008; Munzarová et al., 2013) along with standard travel-time tomography (Benoit et al., 2011) and other results (e.g., Agostinetti et al., 2008; Bianchi et al., 2010; Margheriti, 2014; Park and Levin, 2016) argued for segmentation of the Northern Apennine slab and a slab window in central Italy.

Table 2. MOBNET involvement in passive seismic experiments.

Experiment	Years	Seimometers	FDSN code	doi	Region	Reference
MOSAIC	1998-1999	3 BB	not assigned	not registered	Bohemian Massif (BM)	Plomerova et al., 2000, 2005
BOHEMA	2001-2003	5 BB	ZV(2001-2005)*	not registered	Western BM	Plomerová et al., 2003
RETREAT	2003-2006	10 BB	YI(2003-2006)	10.7914/SN/YI_2003	Northern Apennines	Margheriti et al., 2006
BOHEMA II	2004-2005	11 BB, 12 SP	ZV(2001-2005)*	not registered	Northern BM	Babuška et al., 2005
BOHEMA III	2005-2006	11 BB, 11 SP	not assigned	not registered	Southern BM	Karousová et al., 2013
PASSEQ	2006-2008	11 BB, 13 SP	7E(20006-2008)*	10.14470/2R383989	Central Europe	Wilde-Piorko et al., 2008
BOHEMA IV	2012-2014	10 BB	not assigned	not registered	Eastern BM	Babuška and Plomerová, 2013
EgerRift	2007-2014	21 BB, 15 SP	not assigned	not registered	Eger Rift	Babuška and Plomerová, 2013
LAPNET	2007-2009	5 BB	XK(2007-2009)	not registered	Northern Fennoscandia	Kozlovskaya et al., 2006
AlpArray-EASI	2014-2015	20 BB	XT(2014-2017)	10.12686/alparray/xt_2014	Eastern Alpine transect	Hetényi et al., 2018b
AlpArray-AASN	2016-2019	20 BB	Z3 (2015-2022)	10.12686/ALPARRAY/Z3_2015	Alps and surroundings	Hetényi et al., 2018a
AlpArray-IVREA	2017-2019	10 BB	XK (2017-2019)	10.5281/zenodo.1038209	Ivrea-Verbano Zone (N. Italy)	Hetényi et al., 2017; Scarponi et al., 2021
AlpArray-PACASE	2019-2022	41 BB	ZJ (1019-2014)	10.7914/SN/ZJ_2019	Carpathians-Pannonian-E. Alps	Schlömer et al., 2024
			Z3 (2015-2022)	10.12686/ALPARRAY/Z3_2015	Eastern Alps and BM	Schlömer et al., 2024
AdriaArray	2022-2025	50 BB	Z6 (2022-2026)	10.7914/2cat-tq59	Central Europe	Kolínský et al., 2025a
			Y8 (2022-2026)	10.7914/b1sc-0n71	South-eastern Europe	Kolínský et al., 2025a
* incomplete information						

Two large-scale experiments were organized in the first decade of the 21st century in central and northern Europe, in which MOBNET stations had been incorporated and we participated in the research. The PASSEQ experiment, 2006-2008 (Wilde-Piorko et al., 2008), extended from Bavaria (SE Germany), through the BM across the Trans-European Suture Zone (TESZ) and the Teisseyre-Tornquist Zone (TTZ, Poland) to Lithuania (Fig. 4b). Altogether 196 temporary BB (49) and SP (147) stations, including the MOBNET stations (Table 2) were equally mixed together and deployed in a band of ~400 km wide and 1500 long. The network was centered along the POLONAISE'97 profile P4 (Guterch et al., 1997) with the well-studied crust and the uppermost mantle in the TESZ (Guterch and Grad, 2006).

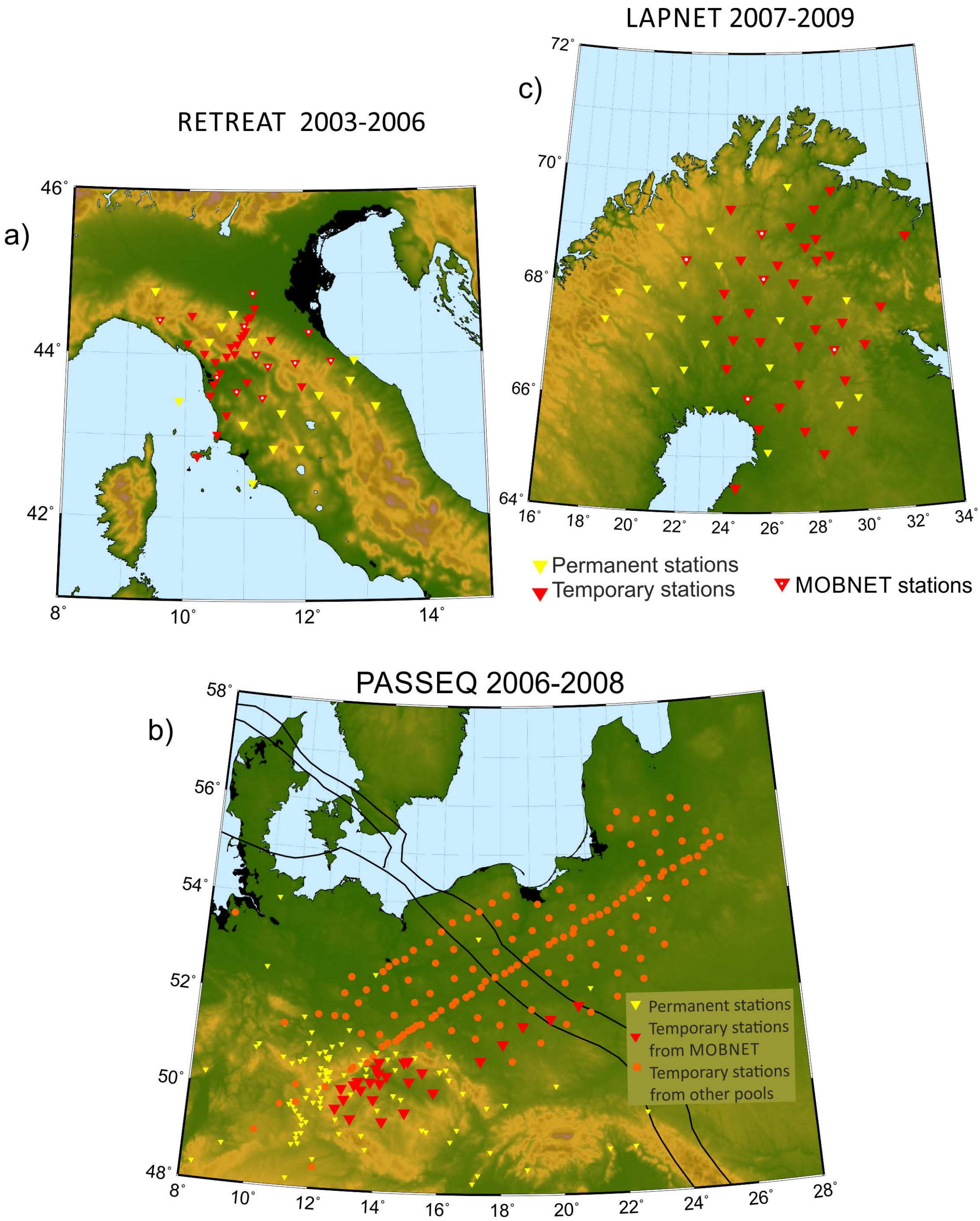

Figure 4. Distribution of stations (a) in the Northern Apennines (Italy) during the RETREAT experiment (2003-2006), (b) in central Europe during the PASSEQ experiment (2006-2008) and (c) in the northern Baltic Shield during the LAPNET experiment (2007-2009).

Data from the MOBNET stations contributed to recovering the high-resolution images of the upper mantle retrieved from body and surface wave tomography (e.g., Janutyte et al., 2015, Chyba et al., 2017; Meier et al., 2016), mapping the LAB, mid-lithospheric discontinuity (MLD) and other discontinuities in the mantle (e.g., Kind, 2017; Knapmeyer et al., 2013, 2017). Surprisingly, both the P and S wave anisotropy study did not record significant anisotropy changes in the mantle across the TT zone, separating the edge of the East European Craton and the Phanerozoic Europe in the crust. Instead, the characteristic anisotropic signal for the southern Baltica mantle lithosphere continues in the images across the TESZ up to the north of the BM (Vecsey et al., 2014; Plomerová, 2020). We interpreted these findings as an over-thrusting of the Phanerozoic Europe above the Precambrian lithosphere (Babuška and Plomerová, 2013, 2020, 2022; Plomerová, 2024). The south-westward penetration of the craton in depth is supported by the high-velocity heterogeneity in the mantle in the body-wave tomography (Kouba et al., 2017) or by cratonic LAB identification in the Sp receiver functions (Kind, 2017).

The LAPNET array (2007-2009, http://www.oulu.fi/sgo-oty/lapnet) of the POLENET/LAPNET sub-project of the POLENET-IPY consortium was related to seismic and geodetic studies in the Arctic region during the International Polar Year (Kozlovskaya et al., 2006). The array consisted of about 60 broadband seismic stations located on the territory of northern Finland and adjacent parts of Sweden, Norway and Russia. About half of them were temporarily installed stations, 5 of which (STS2-GAIA, operated in the off-line regime) belonged to MOBNET. The equipment from individual national pools was equally mixed together to avoid a potential failure in a sub-region due to severe weather conditions during the winter time (Fig. 4c). Data from the MOBNET stations included in the LAPNET array contributed to the 3D P- and S-velocity models of the crust and upper mantle down to 670 km (e.g., Pedersen et al., 2013; Silvennoinen et al., 2016) or modelling major lateral boundaries in the crust and the upper mantle (e.g., Vinnik et al., 2016). Studies of strength and orientation of upper mantle seismic anisotropy resulted in the modelling the extent of individual domains of the mantle lithosphere and shapes of their boundaries, particularly beneath the Archean domain of Fennoscandia (Plomerová et al., 2011). The coupled anisotropic-isotropic tomography code AniTomo (Munzarová et al., 2018a) was for the first time successfully applied on the P-wave travel time residuals beneath the LAPNET region to retrieve simultaneously the isotropic and anisotropic component of P velocities (Munzarová et al., 2018b). The velocity model of the upper mantle in the volume with horizontal grid spacing of 70 km × 70 km down to 370 km agrees well with the path-integrated 3D self-consistent models of anisotropic domains of the mantle lithosphere (Plomerová et al., 2011) and shows only very weak anisotropy in the sub-lithospheric upper mantle.

3.3 MOBNET in recent experiment AlpArray and its complementary constituents EASI, IVREA and PACASE

The AlpAarray passive seismic experiment (AA) is the largest one finished up to now in Europe (Hetényi et al., 2018a; https://alparray.ethz.ch) (Fig. 5). The AA project and its complementary experiments aimed at collecting new data for shading more light on orogeny, in general, and its relationship to mantle dynamics, plate reorganizations, surface processes and seismic hazard in the Alps-Apennines-Carpathians-Dinarides orogenic system. A specific task of the project was related to the contact of the European and the Adriatic plates. We participated with 20 BB stations of the MOBNET pool in the backbone of the AlpArray Seismic Network (AASN). The MOBNET stations were deployed in the southern half of the BM, on the territory of the Czech Republic. A series of complementary experiments, of the AlpArray project, either preceeded the AASN installation, operated in parallel with it, or followed the main AA phase (Hetényi et al., 2018a). We deployed the MOBNET stations in three of the complementary experiments: –20 stations in the AlpArray-EASI (2014-2015), a transect crossing the western part of the BM and the Eastern Alps (Hetényi et al., 2018b; Vecsey et al., 2017), and 10 stations in the AlpArray-IVREA (2017-2019) experiment in Val Sesia (Piedmont, N. Italy) (Hetényi et al., 2017; Scarponi et al., 2021). After 27 months of registration within the AlpArray-IVREA experiment, the ten stations were dismounted and along with 11 new CMG-3ESPC seismometers have been deployed in the eastern part of Slovakia as a part of the Pannonian-Carpathian-Alpine Seismic Experiment (PACASE) (Schlömer et al., 2024). Up to now, data from the MOBNET stations contributed to the research published in more than 100 scientific papers (http://www.alparray.ethz.ch/en/outreach/publications/), which present various results from the AlpArray data related to the Alpine orogeny and Earth's structure in a broader region of the Alps.

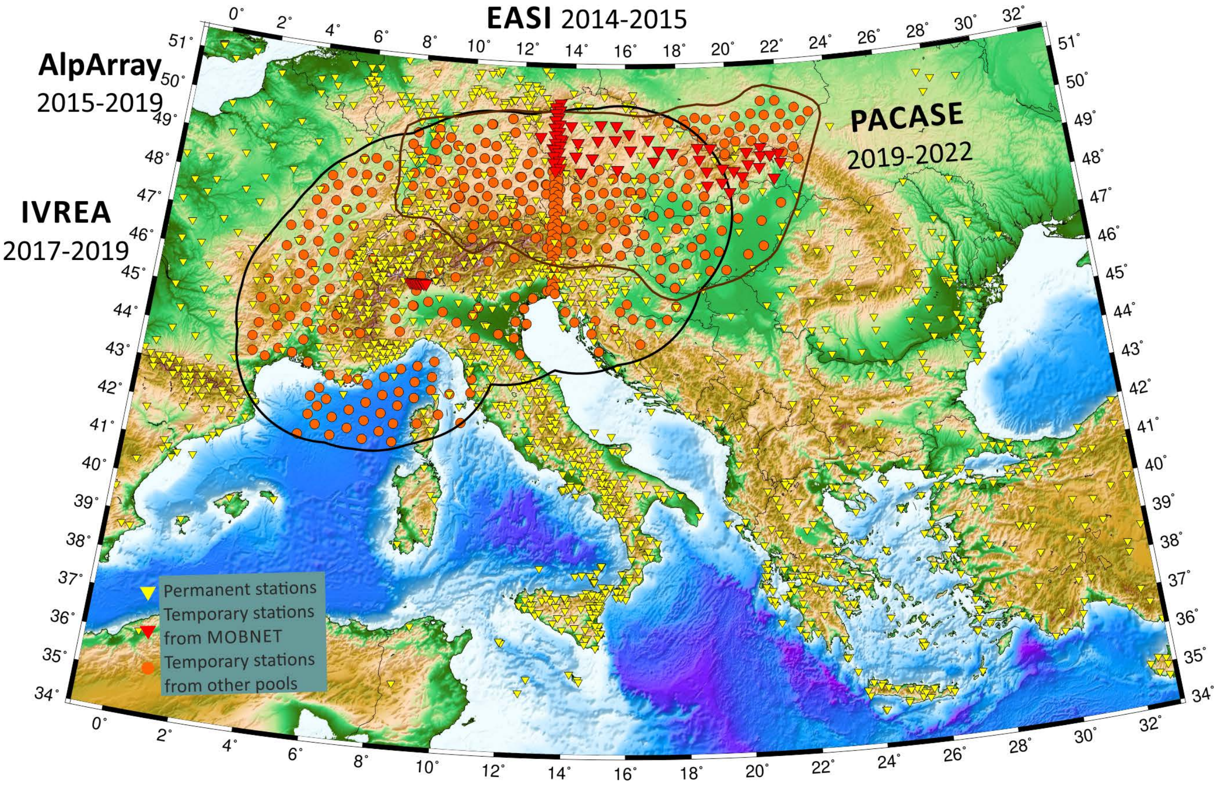

Figure 5. MOBNET pool in recent large-scale pan-European passive seismic experiment AlpArray and in three of its complementary components: the EASI experiment (the N-S profile from the Bohemian Massif to the Adriatic Sea), the PACASE experiment (from the Black Forest to the Western Carpathians) and the IVREA experiment (Ivrea-Verbano region, N. Italy).

The EASI experiment focused on the crustal structure of the Eastern Alps and adjacent tectonic units with the use of various methodologies based on teleseismic P-to-S converted phases (Hetényi et al., 2018b). Both the European and the Adriatic Moho deepen towards the Alpine orogen. The disruption of the deepening of the Moho beneath the BM is related to first order lithospheric block boundaries inherited from the Variscan orogeny, often expressed as faults on the surface. These clear Moho steps speak for a block structure of the BM lithosphere (e.g., Babuška and Plomerová, 2013). The best misfit between the synthetic receiver functions and waveform stacts of RF functions from inversions for shear-velocity-depth dependence (Hetényi et al., 2018b) reveals a broad, up to 20 km thick zone of low velocity-gradient identified as a contact of the European and Adriatic crusts at depth, located south and beneath the central part of the Tauern Window (Eastern Alps). This zone coincides with the Moho gap previously suggested from active seismic imaging (Spada et al., 2013) and the steeply northward dipping lithospheric slab in the upper mantle tomography (Babuška et al., 1990, Lippitsch et al., 2003, Kissling et al., 2006; Karousová et al., 2013; Plomerová et al., 2022), which is connected to the Adria plate entering the collision zone from the south. Ambient noise study (Kvapil et al., 2021) exploited the AlpArray network data, along with data from the complementary experiments and previous regional experiments covering the BM, and created a detailed 3D shear-velocity model of the BM crust (cf. with Valentová et al., 2017). The modelling captured, for the first time, a velocity drop interface (VDI) in the lower crust, interrupted at the boundaries of the crustal units, where movement along the sutures might locally modify, overprint, or erase the sub-horizontal fabric of the BM lower crust (approximated by vertical transverse isotropy model-VTI-with slow-velocity axis).

Controversial results occurred in the standard travel-time body-wave tomography of the upper mantle, aimed at illuminating the subduction zone resulting from the Eastern Alpine and Adriatic plate collision. While the "EASI+" targeted tomography clearly image the northward dipping high-velocity heterogeneity attached to the Adriatic plate (Plomerová et al., 2022) in accordance with previous results (Babuška et al., 1990; Lippitsch et al., 2003; see also Kissling et al., 2024), the large-scale tomography by Paffrath et al. (2021) imaged a detached high-velocity heterogeneity (interpreted as of European plate origin) at greater depth. Different potential sources causing the discrepancy have been analyzed, e.g., effects of crustal models, ray coverage and geometry, way of processing, as well as seismic anisotropy, but without getting a clear answer up to now.

The AlpAray-IVREA (2017-2019; https://alparray.ethz.ch/de/research/complementary-experiments/ivreaArray/; Hetényi et al., 2017) experiment focused on imaging the Ivrea Geophysical Body (IGB) with the use of joint receiver functions and gravity modelling, and ambient noise study (Scarponi et al., 2020, 2021, 2024). About 5 km spacing of the stations in the IvreaArray allowed us to model the IGB in much greater details and complex view with respect to the iconic and long-time referred to as the 'Bird's head' (Berckhemer, 1968). The shear-wave velocity anomaly of 3.6 km/s close to the surface, associated with the IGB in the new 3D vS model of the Ivrea-Verbano Zone (IVZ) crust, is in remarkable agreement with the location of the exposed lower-to-middle crustal and mantle outcrops. The fast IGB structure reaches 4 km/s velocity at 20-25 km depth, at the boundary between the European and Adriatic tectonic plates, and in correspondence with the earlier identified Moho jump in the same area (Spada et al., 2013; Diehl, 2009). A broad seismic survey is under way in the Ivrea region which exploits also the IvreaArray data, among others, for the DIVE (Drilling the Ivrea-Verbano zonE) project (e.g., Greenwood et al., 2024; Confal et al., 2025).

The seismic network of the Pannonian-Carpathian-Alpine Seismic Experiment (PACASE: https://doi.org/10.7914/SN/ZJ-2019) comprised of 214 temporary stations all together and covered the Eastern Alpine and Western Carpathian Mountain ranges, the southern part of the BM, and the sedimentary Molasse and Pannonian Basins (Schlömer et al., 2024). The network configuration was designed to get more data for modelling the "problematic" Eastern Alpine root and for structural studies of the Western Carpathians and Pannonian Basin. Moreover, the data provide a link between the AlpArray (Hetényi et al., 2018a) and the ongoing new experiment AdriaArray (Kolínský et al., 2025a), into which the PACASE array was integrated with only a tiny reconfiguration of the stations. The first scientific outcomes that incorporate also the PACASE experiment data include a homogeneously processed map of the Moho depths beneath the European Alps and western Carpathian obtained from the P-to-S receiver functions (Michailos et al., 2023). Benefitting from the continuation of the station operation, we are processing the P-to-S receiver functions (Vecsey et al., 2025) to improve resolution in the eastern part of the model of the Moho relief by Michailos et al. (2023). Similarly, the shear-wave recordings of the PACASE network broaden the portfolio of data suitable for anisotropy study of the upper mantle (Vecsey et al., 2025).

Processing the S-to-P converted phases resulted in the LAB depth estimates and information on the lithospheric structure of the broader Pannonian Basin region and the surrounding orogens (Kalmar et al., 2023). The high-resolution images confirm the LAB relief derived long time ago from P-wave travel time deviations recorded at permanent stations (Pajdušák et al., 1989; Babuška and Plomerová, 1992) and show the shallowest LAB under the central part of the Pannonian Basin, where the heat flow is the highest, and deepens at the periphery of the basin towards the Carpathians, the Dinarides and the Eastern Alps.

3.4 MOBNET in ongoing pan-European experiment AdriaArray

The AdriaArray (AdA) experiment collects data for a deep study of the Adria micro-plate in central Mediterranean and covers a large portion of south-eastern Europe. The dissolving Adriatic micro-plate, surrounded by subductions of both the continental and oceanic lithospheres is strongly deformed and affects dynamics of the surrounding regions as well as their seismicity and volcanism (Faccenna et al., 2014; Handy et al., 2015; Kissling, 2024-for a brief review of currently available constrains on the Adria micro-plate and reference therein). Deployment of the MOBNET stations within the AdriaArray experiment (https://orfeus.readthedocs.io/en/latest/adria_array_main.html) started in 2022 with one year delay due to the COVID-19. Fifty two (52) temporary BB stations of the MOBNET pool have been integrated in the AdA, which represents significant portion of all temporary stations involved in the experiment (~440). The stations are deployed in the eastern part of the Bohemian Massif (15), Slovakia (19), Romania (8) and Bulgaria (10) (Vescey et al., 2025; Borleanu et al., 2025; Kampfová et al., 2025) (Fig. 6). Spacing of the stations involved in AdA is a bit sparser (40 km on average) than that in the AA and related complementary experiments, but the AdA network is of much larger extent. The MOBNET stations are supposed to record until the summer of 2026 at least in some sub-regions. The realization of the AdA experiment triggered supplying data from many permanent stations in the Balkan region into the EIDA and thus made them available for a broad scientific community. For detailed description of the whole AdA we refer to Kolínský et al. (2025a).

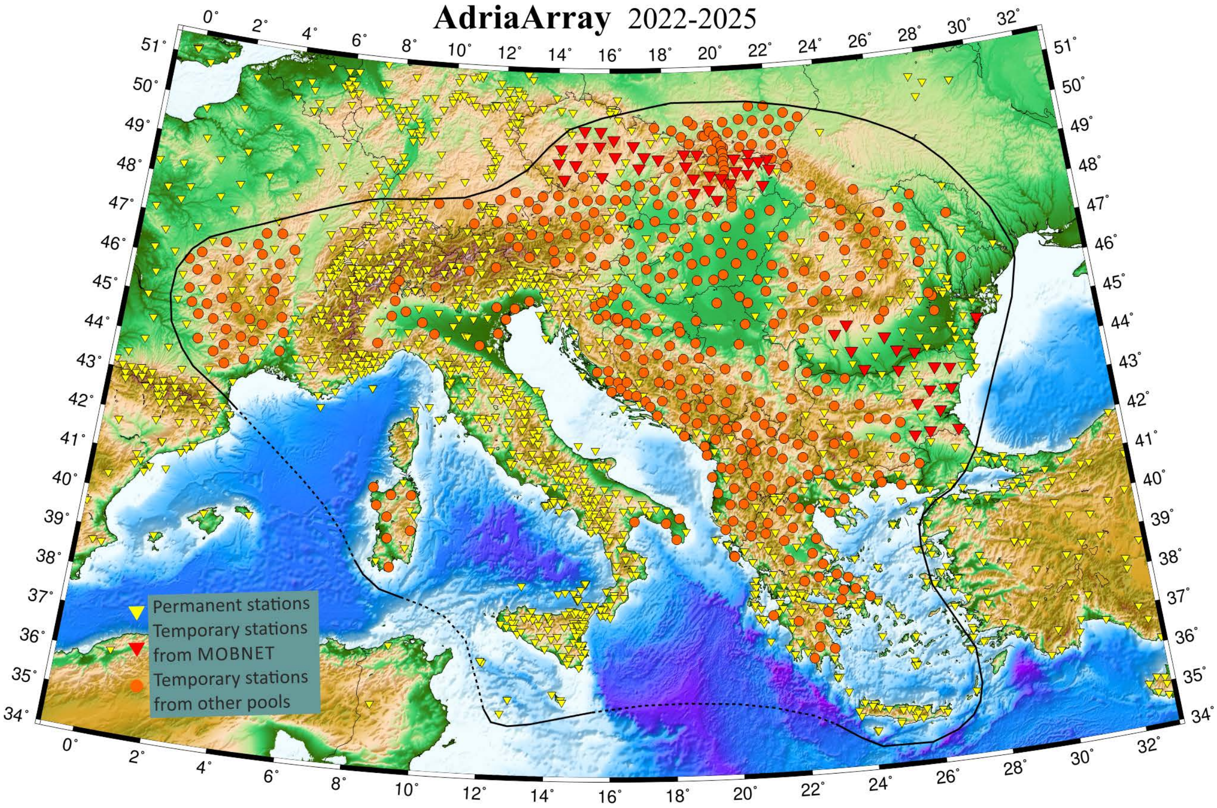

Figure 6. Distribution of stations in south-eastern Europe during the ongoing large-scale pan-European passive seismic experiment AdriaArray (2022-2025).

4. Concluding remarks

Almost 30 years of endeavor and experience with building the MOBNET pool of mobile stations, installing and running the temporary arrays, collecting, processing and archiving data, as well as a search for financial sources for the instruments, motivated us to summarize our findings about the seismic temporary array needs and benefits for scientific research. Seven sites, where stations were deployed temporarily in different passive experiments, have been transformed into permanent stations (HSKC, PVCC, ZVC, PRIC, TREC, KRLC, MAUC; https://www.ig.cas.cz/en/observatories/czech-regional-seismic-network/) with appropriate equipment and included into the Czech Regional Seismic Network (CRSN), which, among others, improved monitoring seismicity of the BM and surrounding regions.

By this overview of the temporary deployments of seismic stations of the MOBNET pool and examples of results achieved thanks to the realized field measurements, we wish to document the feasibility of the step by step building of national pools of instrument. Recent large-scale pan-European experiment AlpArray or just the ongoing one AdriaArray, clearly demonstrate that creating functional large-scale temporary networks from independent national pools, funded by different national agencies providing grants in different periods is viable, though it requires increased effort in organizing, planning and realizing the experiments. The diversity of seismometer-recorder units imposes additional requirements on operator teams to assure providing reliable high-quality data. Profound cooperation in the research among teams, intensified communication, know-how transfer and outreach, in general, are important positive aspects of this type of multimethod and multidisciplinary research related to large-scale temporary arrays. They will be applicable in other experiments organized in Europe in the future.

Data availability statement. Data can be downloaded at: http:// www.orfeus-eu.org/data/eida/nodes/.

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References

Alinaghi, A., G. Bock, R. Kind, W. Hanka et al. (2003). Receiver function analysis of the crust and upper mantle from the North German Basin to the Archean Baltic Shield, Geophys. J. Int.,155, 2, 641-652, doi:10.1046/j.1365-246X.2003.02075.x.

Arlitt, R. (1999). Teleseismic body wave tomography across the Trans-European Suture Zone between Sweden and Denmark, Ph.D. Thesis, ETH Zurich No., 13501, 110, doi:10.3929/ethz-a-003866526.

Arlitt, R., E. Kissling, J. Ansorge and TOR Working Group (1999). Three-dimensional crustal structure beneath the TOR array and effects on teleseismic wavefronts, Tectonophysics, 314, 1-3, 309-319, doi:10.1016/S0040-1951(99)00250-4.

Babuška, V., J. Plomerová and J. Šílený (1984a). Spatial variations of P residuals and deep structure of the European lithosphere, Geophys. J. R. Astr. Soc., 79, 1, 363-383, doi:10.1111/j.1365-246X.1984.tb02863.x.

Babuška, V., J. Plomerová and J. Šílený (1984b). Large-scale oriented structures in the subcrustal lithosphere of central Europe, Ann. Geophys., Italy, 2, 649-662, 1593-5213, 2037-416X.

Babuška, V., J. Plomerová and M. Granet (1990). The deep lithosphere in the Alps: a model inferred from P residuals, Tectonophysics, 176, 1-2, 137-165, doi:10.1016/0040-1951(90)90263-8.

Babuška, V. and J. Plomerová (1992). The lithosphere in central Europe-seismological and petrological aspects, Tectonophysics, 207, 1-2, 141-163, doi:10.1016/0040-1951(92)90475-L.

Babuška, V., J. Plomerová and J. Šílený (1993). Models of seismic anisotropy in the deep continental lithosphere, Phys. Earth Planet. Inter., 78, 2, 167-191, doi:10.1016/0031-9201(93)90154-2.

Babuška, V., J. Plomerová, L. Vecsey, M. Granet et al. (2002). Seismic anisotropy of the French Massif Central and predisposition of Cenozoic rifting and volcanism by Variscan suture hidden in the mantle lithosphere, Tectonics, 21, 4, 11-1-20, doi:10.1029/2001TC901035.

Babuška, V. and J. Plomerová, (2004). Sorgenfrei-Tornquist Zone as the mantle edge of Baltica lithosphere: new evidence from three-dimensional seismic anisotropy, Terra Nova, 16, 5, 243-249, doi:10.1111/j.1365-3121.2004.00558.x.

Babuška, V., J. Plomerová, L. Vecsey, P. Jedlička et al. (2005). Ongoing passive seismic experiments unravel deep lithosphere structure of the Bohemian Massif, Stud. Geophys. Geod., 49, 423-430, doi:10.1007/s11200-005-0018-0.

Babuška, V., J. Plomerová and L. Vecsey (2008). Mantle fabric of western Bohemian Massif (central Europe) constrained by 3D seismic P and S anisotropy, Tectonophysics, 462, 1-4, 149-163, doi:10.1016/j.tecto.2008.01.020.

Babuška, V. and J. Plomerová (2010). Mantle lithosphere control of crustal tectonics and magmatism of the western Ohře (Eger) Rift, J. Geosci., 55, 3, 171-186, doi:10.3190/jgeosci.070.

Babuška, V. and J. Plomerová (2013). Boundaries of mantle-lithosphere domains in the Bohemian Massif as extinct exhumation channels for high-pressure rocks, Gondwana Res., 23, 3, 973-87, doi:10.1016/j.gr.2012.07.005.

Babuška, V. and J. Plomerová (2017). Lateral displacement of crustal units relative to underlying mantle-lithosphere: example from the Bohemian Massif Massif as extinct exhumation channels for high-pressure rocks, Gondwana Res., 52, 125-138, doi:10.1016/j.gr.2017.08.008.

Babuška, V. and J. Plomerová (2020). Growth of primordial continents by cycles of oceanic lithosphere subductions: Evidence from tilted seismic anisotropy supported by geochemical and petrological findings, Solid Earth Sci., 5, 1, 50-68, doi:10.1016/j.sesci.2019.12.003.

Babuška, V. and J. Plomerová (2022). Corrigendum to ‘Growth of primordial continents by cycles of oceanic lithosphere subductions: Evidence from tilted seismic anisotropy supported by geochemical and petrological findings’ (Solid Earth Sciences 5 (2020) 50-68/SESCI-D-19-00022), Solid Earth Sci., Elsevier, Paesi Bassi, 7, 296-299, doi:10.1016/j.sesci.2022.09.002.

Benoit, M. H., M. Torpey, K. Liszewski, V. Levin et al. (2011). P and S wave upper mantle seismic velocity structure beneath the northern Apennines: New evidence for the end of subduction, Geochem. Geophys. Geosyst., 12, 6, Q06004, doi:10.1029/2010GC003428.

Berckhemer, H. (1968). Topographie des “Ivrea-K orpers” abgeleitet aus seismischen und gravimetrischen daten, Symposium Zore Ivrea-Verbano, Schweiz. Mineral. Petrogr. Mitt., 48, 1, 235-246, doi:10.5169/seals-37767.

Bianchi, I., J. Park, N. Piana Agostinetti and V. Levin (2010). Mapping seismic anisotropy using harmonic decomposition of receiver functions: An application to Northern Apennines, Italy, J. Geophys. Res., 115, B12, 317, doi:10.1029/2009JB007061.

Borleanu, F., L. Petrescu, C. Neagoe, H. Kampfová Exnerová et al. (2025). The Adria Array temporary broadband network in Romania: Enhancing seismic monitoring and data quality, Ann. Geophys.

Bruneton, M., H. A. Pedersen, P. Vacher., I. T. Kukkonen et al. (2004). Layered lithospheric mantle in the central Baltic Shield from surface waves and xenolith analysis, Earth Planet. Sci. Lett., 226, 1-2, 41-52, doi:10.1016/j.epsl.2004.07.034.

Chyba, J., J. Plomerová, L. Vecsey and H. Munzarová (2017). Tomography study of the upper mantle around the TESZ based on PASSEQ experiment data, Phys. Earth Planet Int., 266, 29-38, doi:10.1016/j.pepi.2017.01.002.

Cloetingh, S. A. P. L. and P. A. Ziegler (2009). TOPO-EUROPE: Coupled Deep Earth-Surface Processes in Europe, Eur. Rev., 17, 3-4, 517-540, doi:10.1017/S1062798709000933.

Confal, J. M., S. Salimbeni, A. Cavaliere, S. Danesi et al. (2025). A local seismographic network monitoring the lower continental crust drillings for the ICDP-DIVE project, Ann. Geophys., 68, in this Issue.

Cotte, N., H. A. Pedersen and TOR Working Group (2002). Sharp contrast in lithospheric structure across the Sorgenfrei-Tornquist Zone as inferred by Rayleigh wave analysis of TOR1 project data, Tectonophysics, 360, 1-4, 75-88, doi:10.1016/S0040-1951(02)00348-7.

Díaz, J., A. Villaseñor, J. Gallart, J. Morales et al. (2009). The IBERARRAY broadband seismic network: A new tool to investigate the deep structure beneath Iberia, ORFEUS Newsletter, 8, 2, 1-6.

Díaz, J., A. Villaseñor, J. Morales, A. Pazos, et al. (2010). Background noise characteristics at the IberArray broadband seismic network, Bull. Seismol. Soc. Am., 12, 2, 618-628, doi:10.1785/0120090085.

Díaz, J., J. Gallart, I. Morais, G. Silveira et al. (2015). From the Bay of Biscay to the High Atlas: Completing the anisotropic characterization of the upper mantle beneath the westernmost Mediterranean region, Tectonophysics, 663, 192-202, doi:10.1016/j.tecto.2015.03.007.

Diehl, T., S. Husen, E. Kissling and N. Deichmann (2009). High-resolution 3-DP-wave model of the Alpine crust, Geophys. J. Int., 179, 2, 1133-1147.

Dorbath, C., L. Dorbath, J. D. Fairhead and G. W. Stuart (1986). A teleseismic delay time study across the Central African Shear Zone in the Adamawa region of Cameroon, West Africa, Geophys. J. R. astr. Soc., 86, 751-766.

Faccenna, C., T. W. Becker and L. Auer et al. (2014). Mantle dynamics in the Mediterranean, Rev. Geophys., 52, 3, 283-332, doi:10.1002/2013RG000444.

Faryad, S. W., S. Mazur and J. Plomerová (2024). Location and polarity of Variscan sutures based on petrological and seismological data from the Bohemian Massif and the implications for the European Variscides, J. Geodyn. 159, 102020, doi:10.1016/j.jog.2024.102020.

Gee, D. G. and H. J. Zeyen (1996). Lithosphere Dynamics, Origin and Evolution of Continents, EUROPROBE Secretariat, Uppsala University, 138, 2903148910, 9782903148911.

Geissler, W. H., H. Kämpf, Z. Skácelová, J. Plomerová et al. (2012). Lithosphere structure of the NE Bohemian Massif (Sudetes) – A teleseismic receiver function study, Tectonophysics, 564-565, 5, 12-37, doi:10.1016/j.tecto.2012.05.005.

Granet, M., G. Stall, J. Dorel, U. Achauer et al. (1995). Massif Central (France): New constraints on the geodynamical evolution from teleseismic tomography, Geophys. J. Int., 121, 1, 33-48, doi:10.1111/j.1365-246X.1995.tb03509.x.

Greenwood, A., G. Hetényi, L. Baron, A. Zanetti et al. (2024). Active seismic surveys for drilling target characterization in Ossola Valley: International Continental Scientific Drilling Program (ICDP) project Drilling the Ivrea-Verbano zoneE (DIVE) phase I, Sci. Drill., 33, 2, 219-236, doi:10.5194/sd-33-219-2024.

Gregersen, S., L. B. Pedersen, R. G. Roberts, H. Shomali et al. (1999). Important findings expected from Europe's largest seismic array, EOS, 80, 1-12, doi:10.1029/99EO00001.

Gregersen, S., P. Voss and TOR Working Group, 2002. Summary of project TOR: delineation of a stepwise, sharp, deep lithosphere transition across Germany-Denmark-Sweden, Tectonophysics 360, 1-4, 61-73, doi:10.1016/S0040-1951(02)00347-5.

Guterch, A. and M. Grad (2006). Lithospheric structure of the TESZ in Poland based on modern seismic experiments, Geol. Q., 50, 1, 23-32.

Guterch, A., M. Grad, H. Thybo and G. Keller (1997). POLONAISE '97-an international seismic experiment between Precambrian and Variscan Europe in Poland, Tectonophysics, 314, 1-3, 101-121, doi:10.1016/S0040-1951(99)00239-5.

Handy, M. R., K. Ustaszewski and E. Kissling (2015). Reconstructing the Alps-Carpathians-Dinarides as a key to understanding switches in subduction polarity, slab gaps and surface motion, Int. J. Earth Sci., 104, 1-26, doi:10.1007/s00531-014-1060-3.

Hetényi, G., J. Plomerová, S. Solarino, M. Scarponi et al. (2017). IvreaArray-an AlpArray complementary experiment, Zenodo, doi:10.5281/zenodo.1038209.

Hetényi, G., I. Molinari, J. Clinton, G. Bokelmann et al. (2018a). The AlpArray Seismic Network: a large-scale European experiment to image the Alpine orogeny (AlpArray Seismic Network Team, AlpArray OBS Cruise Crew, AlpArrayWorking Group), Surv. Geophys., 1-25, doi:10.1007/s10712-018-9472-4.

Hetényi, G., J. Plomerová, I. Bianchi, H. Kampfová Exnerová et al. (2018b). From mountain summits to roots: Crustal structure of the Eastern Alps and Bohemian Massif along longitude 13.3°E, Tectonophysics, 744, 2, 239-255, doi:10.1016/j.tecto.2018.07.001.

Hetényi, G., J. Plomerová, M. Bielik, G. Bokelmann et al. (2019). Pannonian-Carpathian-Alpine Seismic Experiment (Data set), International Federation of Digital Seismograph Networks, doi:10.7914/SN/ZJ_2019.

Hjelt, S. E., S. Daly and SVEKAKALAPKO colleagues (1996). SVEKALAPKO – evolution of Palaeoproterozoic and Archean lithosphere, EUROPROBE 1996 – Lithosphere Dynamics, Origin and Evolution of Continents, (Gee, D. G., H. J. Zeyen (Eds.), EUROPROBE Secretariat, Uppsala University, 57-67.

IRIS Transportable Array (2003) USArray transportable array (Data set). International Federation of Digital Seismograph Networks, Other-Seismic Network, doi:10.7914/SN/TA.

Judenherc, S., M. Granet, J. P. Brun, G. Poupinet et al. (2002). Images of lithospheric heterogeneities in the Armorican segment of the Hercynian Range in France. Tectonophysics, 358, 1-4, 121-134, doi:10.1016/S0040-1951(02)00420-1.

Janutyte, I., M. Majdanski, P. H. Voss, E. Kozlovskaya and PASSEQ working group (2015). Upper mantle structure around the Trans-European Suture Zone obtained by teleseismic tomography, Solid Earth, 6, 1, 73-91, doi:10.5194/se-6-73-2015.

Kalmár, D., L. Petrescu, J. Stipčević, A. Balázs et al. (2023). Lithospheric Structure of the Circum-Pannonian Region Imaged by S-to-P Receiver Functions, Geochem., Geophys., Geosyst., 24, 9, e2023GC010937, doi:10.1029/2023GC010937.

Kampfová Exnerová, H., L. Dimitrova, T. Nagel, L. Dimova et al. (2025). AdriaArray experiment on the territory of Bulgaria, Ann. Geophys., 68, in this Issue.

Karousová, H., J. Plomerová and V. Babuška (2012a). Three-dimensional velocity model of the crust of the Bohemian Massif and its effects on seismic tomography of the upper mantle, Stud. Geophys. Geod., 56, 249-267, doi:10.1007/s11200-010-0065-z.

Karousová, H., J. Plomerová and L. Vecsey (2012b). Seismic tomography of the upper mantle velocity structure beneath the north-eastern Bohemian Massif (central Europe), Tectonophysics, 564-565, 5, 1-11, doi:10.1016/j.tecto.2012.06.031.

Karousová, H., J. Plomerová and V. Babuška (2013). Upper-mantle structure beneath the southern Bohemian Massif and its surroundings imaged by high-resolution tomography, Geophys. J. Int., 194, 2, 1203-1215, doi:10.1093/gji/ggt159.

Kind, R., M. R. Handy, X. Yuan, T. Meier et al. (2017). Detection of a new sub-lithospheric discontinuity in Central Europe with S-receiver functions, Tectonophysics, 700-701, 19-31, doi:10.1016/j.tecto.2017.02.002.

Kissling, E., S. M. Schmid, R. Lippitsch, J. Ansorge et al. (2006). Lithosphere structure and tectonic evolution of the Alpine arc: New evidence from high-resolution teleseismic tomography, Eurpean Lithosphere Dynamics, Gee D. G. and R. A. Stephenson, Editors, Geol. Soc., London, Memoirs, 32, 129-145, Geol. Soc., London, Memoirs, 32, 129-145, doi:10.1144/GSL.MEM.2006.032.01.08.

Kissling, E. (2024). Adria microplate: A puzzling key stone in west-central Mediterranean geodynamics, Ann. Geophys., 67, 4, S431, doi:10.4401/ag-9160.

Knapmeyer-Endrun, B., F. Krüger, C. P. Legendre, W. H. Geissler et al. (2013). Tracing the influence of the Trans-European Suture Zone into the mantle transition zone, Earth Planet. Sci. Lett., 363, 73-87, doi:10.1016/j.epsl.2012.12.028.

Knapmeyer-Endrun, B., F. Krüger, W. H. Geissler and PASSEQ Working Group (2017). Upper mantle structure across the Trans-European Suture Zone imaged by S-receiver functions. Earth Planet. Sci. Lett., 458, 429-44, doi:10.1016/j.epsl.2016.11.011.

Kolínský, P., T. Meier, M. Agius, A. Bijedić et al. (2025a). AdriaArray – a Passive Seismic Experiment to Study Structure, Geodynamics and Geohazards of the Adriatic Plate, Ann. Geophys., 68, in this Issue.

Kolínský, P., J. Stampa, L. Vecsey, F. Eckel et al. (2025b). Methods for data and metadata quality tests of large dense seismic networks – focus on AdriaArray, Ann. Geophys., 68, in this Issue.

Kozlovskaya, E., M. Poutanen and Polenet Working Group (2006). POLENET/LAPNET-a multidisciplinary geophysical experiment in northern Fennoscandia during IPY 2007-2008, Geophys. Res., 8, 07049.

Kozlovskaya, E., L. Vecsey, J. Plomerová and T. Raita (2007). Joint inversion of multiple data types with the use of multiobjective optimization: problem formulation and application to the seismic anisotropy investigation, Geophys. J. Int., 171, 2, 761-779, doi:10.1111/j.1365-246X.2007.03540.x.

Kozlovskaya, E, G. Kosarev, I. Aleshin, O. Riznichenko et al. (2008). Structure and composition of the crust and upper mantle of the Archean-Proterozoic boundary in the Fennoscandian shield obtained by joint inversion of receiver function and surface wave phase velocity of recording of the SVEKALAPKO array. Geophys. J. Int. 175, 1, 135-152, doi:0.1111/j.1365-246X.2008.03876.x.

Kvapil, J., J. Plomerová, H. Kampfová Exnerová, V. Babuška et al. (2021). Transversely isotropic lower crust of Variscan central Europe imaged by ambient noise tomography of the Bohemian Massif, Solid Earth, 12, 5, 1051-1074, doi:10.5194/se-12-1051-2021.

Margheriti, L., S. Pondrelli, D. Piccinini, N. Piana Agostinetti et al. (2006). The subduction structure of the Northern Apennines: results from the RETREAT seismic deployment, Ann. Geophys, 49,4-5, 1119-1131.

Margheriti, L., F. P. Lucente, J. Park, S. Pondrelli et al. (2014). Large-scale coherent anisotropy of upper mantle beneath the Italian peninsula comparing quasi-love waves and SKS splitting, J. Geodyn., 82, 26-38, doi:10.1016/j.jog.2014.07.007.

Michailos, K., G. Hetényi, M. Scarponi, J. Stipčević et al. (2023). Moho depths beneath the European Alps: A homogeneously processed map and receiver functions database, Earth Syst. Sci. Data, 15, 5, 2117-2038, doi:10.5194/essd-15-2117-2023.

Mitterbauer, U., M. Behm, E. Brückl, R. Lippitsch et al. (2011). Shape and origin of the East-Alpine slab constrained by the ALPASS teleseismic model, Tectonophysics, 510, 1-2, 195-206, doi:10.1016/j.tecto.2011.07.001.

Meier, T., R. A. Soomro, L. Viereck, S. Lebedev et al. (2016). Mesozoic and Cenozoic evolution of the Central European lithosphere, Tectonophysics, 692, 5, 58-73, doi:10.1016/j.tecto.2016.09.016.

Munzarová, H., J. Plomerová, V. Babuška and L. Vecsey (2013). Upper-mantle fabrics beneath the Northern Apennines revealed by seismic anisotropy, Geochem. Geophys. Geosyst., 14, 4, 1156-1181, doi:10.1002/ggge.20092.

Munzarová, H., J. Plomerová and E. Kissling (2018a). Novel anisotropic teleseismic body-wave tomography code AniTomo to illuminate heterogeneous anisotropic upper mantle. Part I – Theory and inversion tuning with realistic synthetic data, Geophys. J. Int., 215, 524-545, doi:10.1093/gji/ggy296.

Munzarová, H., J. Plomerová, E. Kissling, L. Vecsey et al. (2018b). Novel anisotropic teleseismic body-wave tomography code AniTomo to illuminate heterogeneous anisotropic upper mantle: Part II Application to data of passive seismic experiment LAPNET in northern Fennoscandia, Geophys, J. Int., 215, 2, 1388-1409, doi:10.1093/gji/ggy327.

Owens, T. J., G. E. Randall, F. T. Wu and Z. Rongsheng (1993). PASSCAL instrument performance during the Tibetan plateau passive seismic experiment, Bull. Seismol. Soc. Am., 83, 6, 1959-1970, doi:10.1785/BSSA0830061959.

Pajdušák, P., J. Plomerová and V. Babuška (1989). A model of the lithosphere thickness in the region of the Carpathians, Stud. Geophys. Geod., 33, 11-21.

Paffrath, M., W. Friederich, S. M. Schmid, M. R. Handy et al. (2021). Imaging structure and geometry of slabs in the greater Alpine area-A P-wave traveltime tomography using AlpArray Seismic Network data, Solid Earth, 12, 11, 2671-2702, doi:10.5194/se-12-2671-2021.

Park, J. and V. Levin (2016). Anisotropic shear zones revealed by backazimuthal harmonics of teleseismic receiver functions, Geophys. I. Int., 207, 2, 1216-1243, doi:10.1093/gji/ggw323.

Pedersen, T., S. Gregersen, U. Achauer, J. Ansorge et al. (1999). Project Tor: Deep lithospheric variation across the Sorgenfrei-Tornquist Zone, southern Scandinavia, Bull. Geol. Soc. Den., 1, 46, 13-24, doi:10.37570/bgsd-1999-46-02.

Pedersen, H. A., M. Bruneton, V. Maupin and SVEKALAPKO STWG (2006). Lithospheric and sublithospheric anisotropy beneath the Baltic Shield from surface wave array analysis, Earth Planet. Sci. Lett., 244, 3-4, 590-605, doi:10.1016/j.epsl.2006.02.009.

Pedersen, H. A., E. Debayle, V. Maupin and POLENET/LAPNET Working Group (2013). Strong lateral variations of lithospheric mantle beneath cratons-example from the Baltic Shield, Earth Planet. Sci. Lett., 383, 164-172, doi:10.1016/j.epsl.2013.09.024.

Piana Agostinetti, N., V. Levin and J. Park (2008). Crustal structure above a retreating trench: Receiver function study of the northern Apennines orogen, Earth Planet. Sci. Lett., 275, 3-4, 211-220, doi:10.1016/j.epsl.2008.06.022.

Plomerová, J., J. Šílený and V. Babuška (1996). Joint interpretation of upper-mantle anisotropy based on teleseismic P-travel time delays and inversion of shear-wave splitting parameters, Phys. Earth Planet. Inter., 95, 3-4, 293-309, doi:10.1016/0031-9201(95)03122-7.

Plomerová, J., V. Babuška, J. Šílený and J. Horálek (1998). Seismic anisotropy and velocity variations in the mantle beneath the Saxothuringicum-Moldanubicum contact in central Europe, Pure Appl. Geophys., 151, 365-394.

Plomerová, J., R. Arvidsson, V. Babuška, M. Granet et al. (2001). An array study of lithospheric structure across the Protogine zone, Varmland, south-central Sweden – signs of a paleocontinental collision, Tectonophysics, 332, 1-21, doi:10.1016/S0040-1951(00)00247-X.

Plomerová, J., V. Babuška, L. Vecsey, D. Kouba et al. (2002). Seismic anisotropy of the lithosphere around the Trans-European Suture Zone (TESZ) based on teleseismic body-wave data of the TOR experiment, Tectonophysics, 360, 1-4, 89-114, doi:10.1016/S0040-1951(02)00349-9.

Plomerová, J., V. Babuška, L. Vecsey, E. Kozlovskaya et al. (2006). Proterozoic-Archean boundary in the upper mantle of eastern Fennoscandia as seen by seismic anisotropy, J. Geodyn., 41, 4, 400-410, doi:10.1016/j.jog.2005.10.008.

Plomerová, J., L. Margheriti, J. Park, V. Babuška et al. (2006). Seismic anisotropy beneath the Northern Apennines (Italy) – mantle flow and/or lithosphere fabric? Earth Planet. Sci. Lett., 247, 1-2, 157-170, doi:10.1016/j.epsl.2006.04.023.

Plomerová, J., U. Achauer, V. Babuška, L. Vecsey et al. (2007). Upper mantle beneath the Eger Rift (central Europe): plume or asthenosphere upwelling? Geophys. J. Int., 169, 2, 675-682, doi:10.1111/j.1365-246X.2007.03361.x.

Plomerová, J., L. Vecsey, V. Babuška and LAPNET Working Group (2011). Domains of Archean mantle lithosphere deciphered by seismic anisotropy-inferences from the LAPNET array in northern Fennoscandia, Solid Earth, 2, 303-313, doi:10.5194/se-2-303-2011.

Plomerová, J., L. Vecsey and V. Babuška, (2012). Mapping seismic anisotropy of the lithospheric mantle beneath the northern and eastern Bohemian Massif (central Europe). Tectonophysics, 564-565, 38-53, doi:10.1016/j.tecto.2011.08.011.

Plomerová, J., H. Munzarová, L. Vecsey, E. Kissling et al. (2016). Cenozoic volcanism in the Bohemian Massif in the context of P-and S-velocity high-resolution teleseismic tomography of the upper mantle, Geochem. Geophys. Geosyst. 17, 3326-3349, doi:10.1002/2016GC006318.

Plomerová, J, H. Žlebčíková, G. Hetényi, L. Vecsey et al. (2022). Two subduction-related heterogeneities beneath the Eastern Alps and the Bohemian Massif imaged by high-resolution P-wave tomography, Solid Earth, 13, 251-270, doi:10.5194/se-13-251-2022.

Plomerová, J. (2024). Patchwork structure of continental lithosphere captured in 3D body wave images of its anisotropic fabrics, J. Geodyn., 161, 102041, doi:10.1016/j.jog.2024.102041.

Ritter, J. R. R., U. Achauer, U. R. Christensen and the Eifel Plume Team (2000). The teleseismic tomography experiment in the Eifel region, Central Europe: design and first results, Seism. Res. Lett. 71, 437-443, doi:10.1785/gssrl.71.4.437.

Ritter, J. R. R., M. Jordan, U. R. Christensen and U. Achauer (2001). A mantle plume below the Eifel volcanic fields, Germany, Earth Planet. Sci. Lett., 186, 7-14, doi:10.1016/S0012-821X(01)00226-6.

Salimbeni, S., S. Pondrelli, L. Margheriti, J. Park and V. Levin (2008). SKS splitting measurements beneath Northern Apennines region: A case of oblique trench-retreat, Tectonophysics, 462, 68-82, doi:10.1016/j.tecto.2007.11.075.

Sandoval, S., E. Kissling, J. Ansorge and SVEKALAPKO Seismic Tomography Working Group (2003). High-resolution body wave tomography beneath the SVEKALAPKO array: I. A priori three-dimensional crustal model and associated traveltime effects on teleseismic wave fronts, Geophys. J. Int., 153, 75-87, doi:10.1046/j.1365-246X.2003.01888.x.

Sandoval, S., E. Kissling and J. Ansorge (2004). High-resolution body wave tomography beneath the SVEKALAPKO array: II. Anomalous upper mantle structure beneath the central Baltic Shield, Geophys. J. Int., 157, 200-214, doi:10.1111/j.1365-246X.2004.02131.x.

Scarponi, M., G. Hetényi, T. Berthet, L. Baron et al. (2020). New gravity data and 3-D density model constraints on the Ivrea Geophysical Body (Western Alps), Geophys. J. Int., 222, 3, 1977-1991, doi:10.1093/gji/ggaa263.

Scarponi, M., G. Hetényi, J. Plomerová, S. Solarino et al. (2021). Joint seismic and gravity data inversion to image intra-crustal structures: the Ivrea Geophysical Body along the Val Sesia profile (Piedmont, Italy), Front. Earth Sci., doi:10.3389/feart.2021.671412.

Scarponi, M., J. Kvapil, J. Plomerová, S. Solarino et al. (2024). New constraints on the shear wave velocity structure of the Ivrea geophysical body from seismic ambient noise tomography (Ivrea-Verbano Zone, Alps), Geophys. J. Int., 236, 1089-1105, doi:10.1093/gji/ggad470.

Schlömer, A., G. Hetényi, J. Plomerová, L. Vecsey et al. (2024). The Pannonian-Carpathian-Alpine seismic experiment (PACASE): network description and implementation, Acta Geod. Geophys., 59, 249-270, doi:10.1007/s40328-024-00439-w.

Shomali, Z. H. and R. G. Roberts (2002). Non-linear body wave teleseismic tomography along the TOR array, Geophys. J. Int., 148, 562-574, doi:10.1046/j.1365-246x.2002.01592.x.

Silvennoinen, H., E. Kozlovskaya and E. Kissling (2016). POLENET/LAPNET teleseismic P wave travel time tomography model of the upper mantle beneath northern Fennoscandia, Solid Earth, 7, 425-439, 2016, doi:10.5194/se-7-425-2016.

Spada, M., I. Bianchi, E. Kissling, N. Piana et al. (2013). Combining controlled-source seismology and receiver function information to derive 3-D Moho topography for Italy, Geophys. J. Int., 194, 2, 1050-1068, doi:10.1093/gji/ggt148.

Valentová, L., F. Galovic and P. Maierová (2017). Three-dimensional S-wave velocity model of the Bohemian Massif from Bayesian ambient noise tomography, Tectonophysics, 717, 484-498, doi:10.1016/j.tecto.2017.08.033.

Vecsey, L., J. Plomerová and V. Babuška (2014). Mantle lithosphere transition from the east European craton to the Variscan Bohemian Massif imaged by shear-wave splitting, Solid Earth, 5, 2, 779-792, doi:10.5194/se-5-779-2014.

Vecsey, L., J. Plomerová, P. Jedlička, H. Munzarová et al. (2017). Data quality control and tools in passive seismic experiments exemplified on the Czech broadband seismic pool MOBNET in the AlpArray collaborative project, Geosci. Instrum. Methods Data Syst., 6, 2, 505-521, doi:10.5194/gi-6-505-2017.

Vecsey, L., P. Środa, J. Plomerová, G. Bokelmann et al. (2025). Northern Promontory of AdriaArray: Network Design and Realization, Ann. Geophys. , 68, in this Issue.

Vinnik, L, E. Kozlovskaya, S. Oreshin, G. Kosarev et al. (2016). The lithosphere, LAB, LVZ and Lehmann discontinuity under central Fennoscandia from receiver functions, Tectonophysics, 667, 23, 189-198, doi:10.1016/j.tecto.2015.11.024.

Wilde-Piórko, M., W. Geissler, J. Plomerová, M. Grad et al. (2008). PASSEQ 2006-2008: passive seismic experiment in Trans-European Suture Zone, Stud. Geophys. Geod. 52, 23, 439-448, doi:10.1007/s11200-008-0030-2.

Yuan, X., J. Ni, R. Kind, J. Mechie et al. (1997). Lithospheric and upper mantle structure of southern Tibet from a seismological passive source experiment, J. Geophys. Res., 102, B12, 27491-27500, doi:10.1029/97JB02379.

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