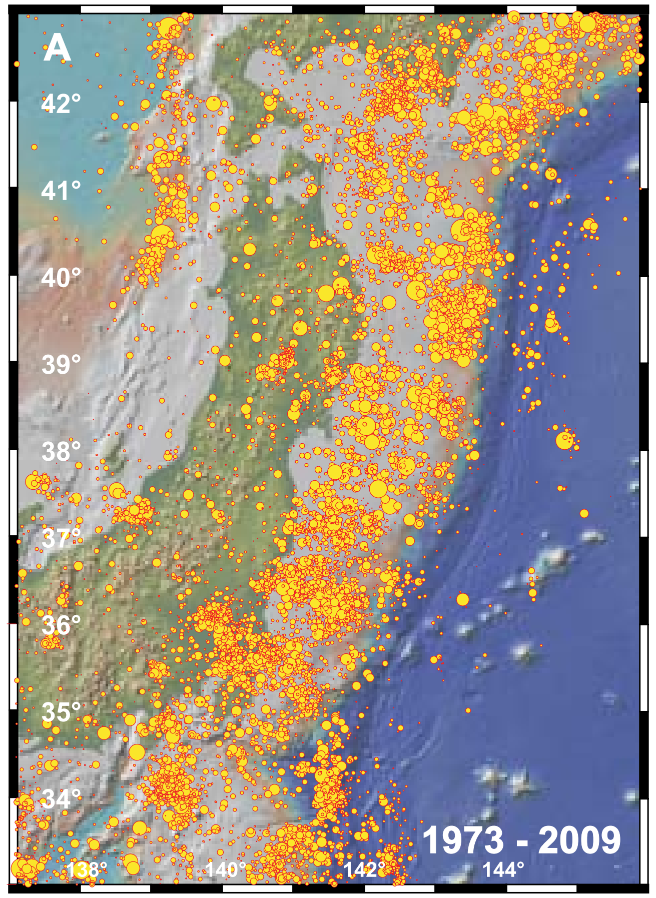
Academy of Sciences of the Czech Republic

Institute of Geophysics

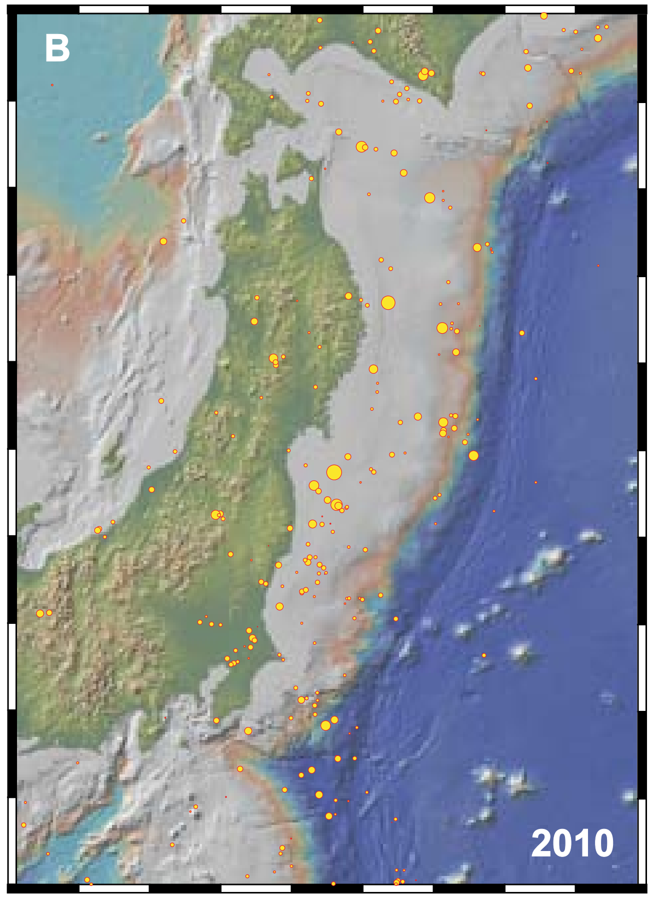
Report 2010–2011

Epicentral map of the broader surroundings of the March 11, 2011 Mw 9.0 Tohoku earthquake in several time intervals showing the contrast between regular earthquake occurrence and anomalous activity following the Tohoku earthquake (epicentral determinations of the USGS/NEIC – PDE catalogue):

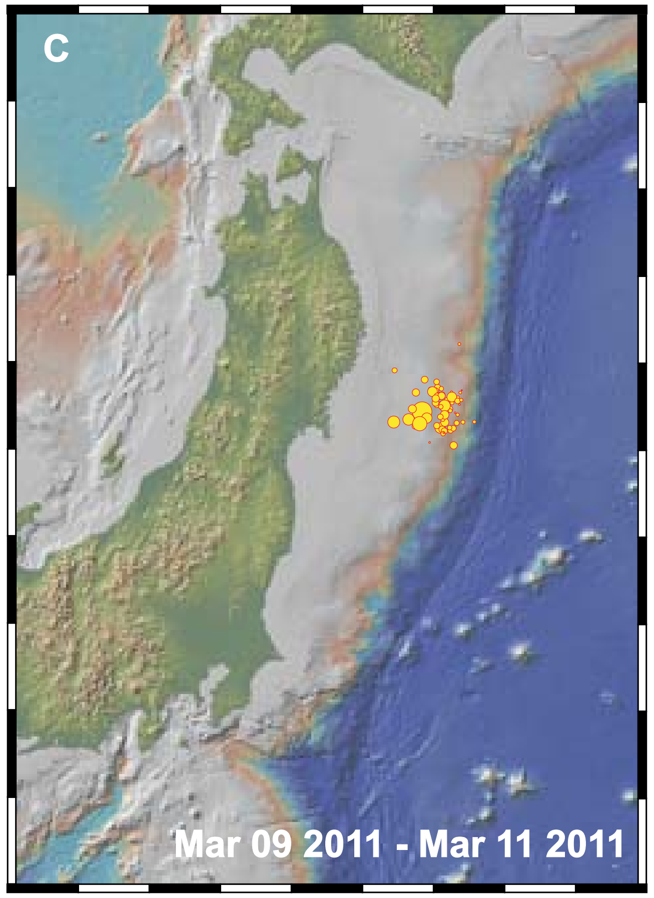
For details see pp. 10-11.



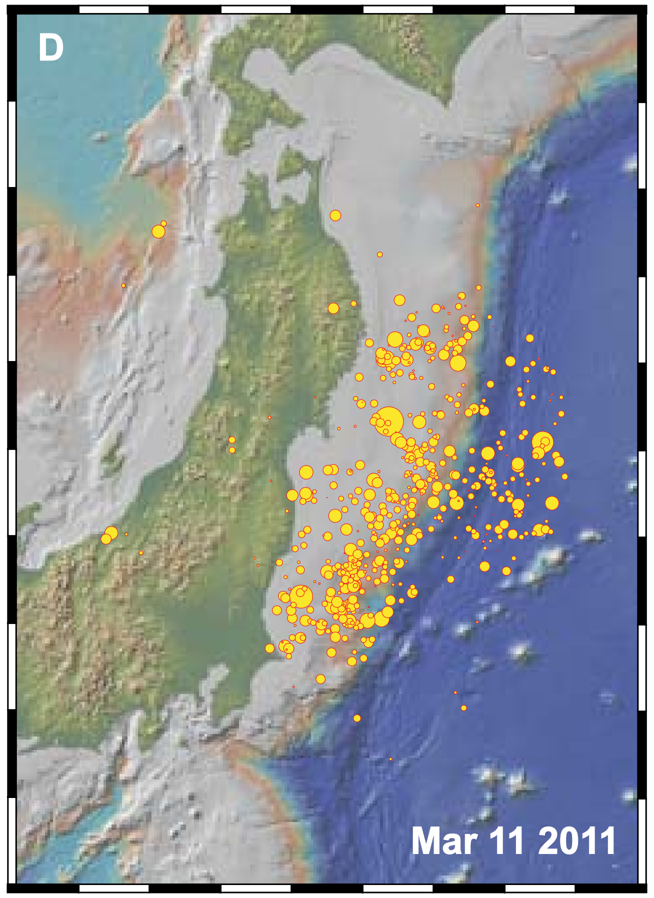
A – 37 years (1973–2009)



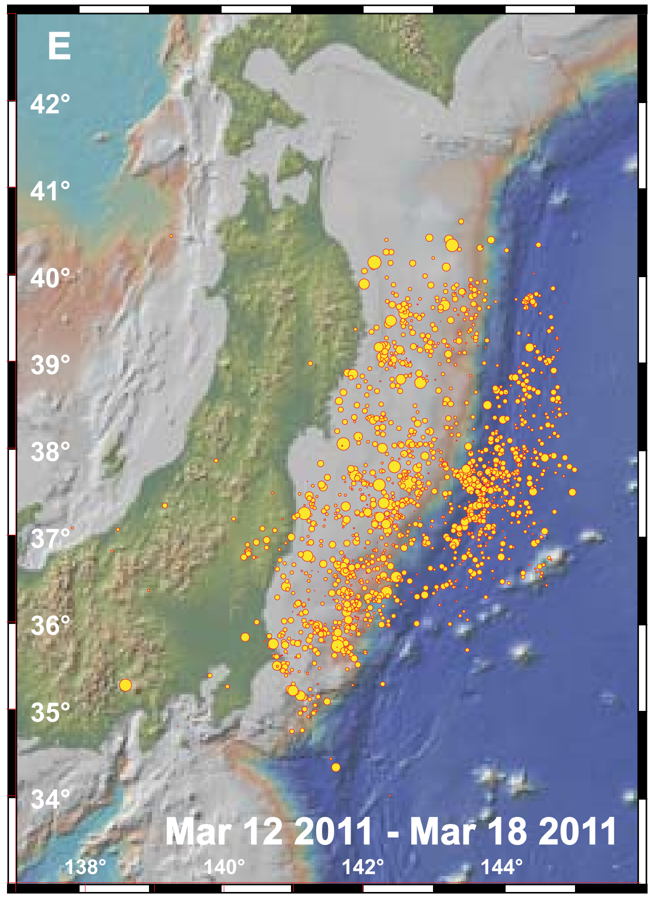
B – 1 calendar year (2010) before the Tohoku earthquake



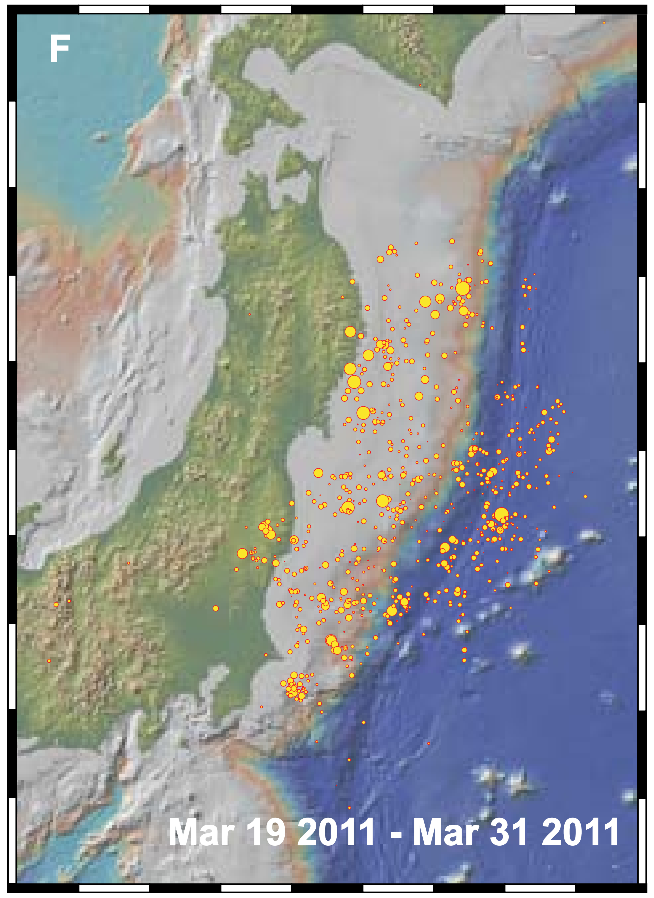
C – 2 days of foreshock activity before the mainshock (March 9–10, 2011)



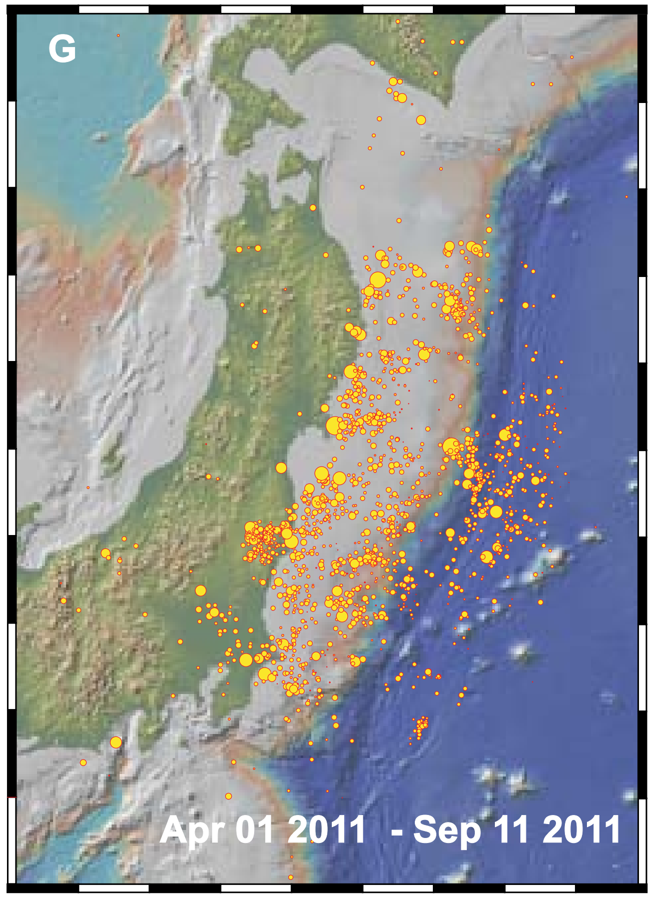
D – 1 day of the mainshock/aftershock sequence (March 11, 2011)



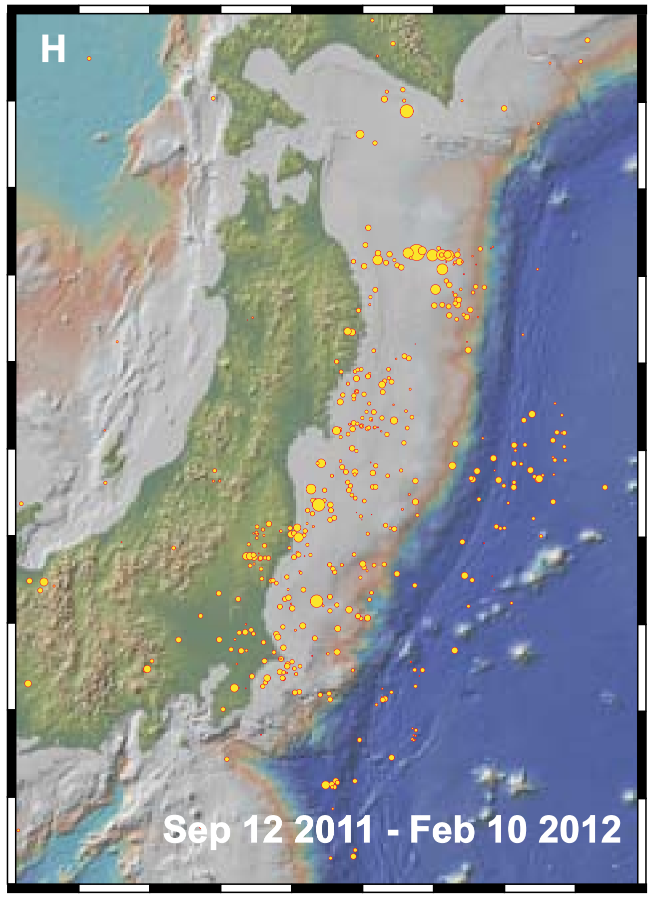
E – 6 days of the aftershock sequence (March 12–18, 2011)



F – 13 days of the aftershock sequence by the end of March 2011 (March 19–31, 2011)



G – six months of the aftershock sequence, by September 2011 (April 1–September 31, 2011)



H – another 5 months of the aftershock sequence (September 12, 2011–February 15, 2012)

Academy of Sciences of the Czech Republic

Institute of Geophysics

Report 2010–2011

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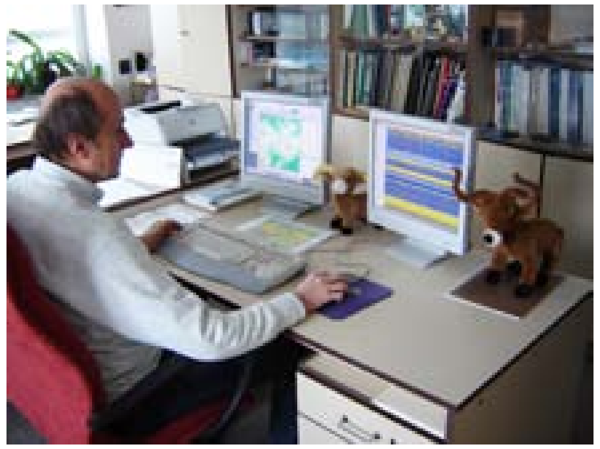
Institute of Geophysics of the Academy of Sciences of the Czech Republic

The Institute of Geophysics of the Academy of Sciences of the Czech Republic is a public research institution. The mission of the Institute is to conduct

fundamental research in physics of the solid Earth and its immediate space environment, in order to increase the level of general scientific knowledge as well as to contribute to practical application of the results of scientific research.

Geophysical interpretations include studies of the lithosphere and sub-lithosphere structure, crustal studies, geodynamics of the seismoactive regions, climatic changes, solar-terrestrial relations, environmental geomagnetism and many others. Theoretical modelling and numerical simulations of geophysical fields are an integral parts of the research programme of the Institute. The activities of the Geophysical Institute comprise regular observatory monitoring of Earth's physical fields as well as a broad collaboration with world-wide network services and data centres. A significant part of the Institute's activity is focused on higher education: many researchers lead and co-lead university courses and supervise research students, especially at the doctoral level, at universities both in the Czech Republic and abroad. Because a significant part of the mission of a research institution is exchange and dissemination of knowledge, the Institute organizes scientific meetings and seminars at both national and international levels, and publishes a scientific journal Studia Geophysica et Geodaetica (IF of 2010 is 1.123).

The Institute as well as its individual researchers are regularly involved in various public outreach activities. In 2010, a new initiative launched by the Institute of Geophysics in collaboration with the Centre of Administration and Operations of the ASCR, was the annual Earth Day celebration, with a series of public lectures and meetings aimed at elevating the public awareness about the Earth Sciences.



The Institute employs approximately 70 researchers organized in five research departments: seismology, geothermics, geomagnetism, geoelectricity, and tectonics and geodynamics. The research activities are supported by 5 technicians at the research departments and about 30 staff members of the operating division (IT center, library, administrative and technical services). In 2010-11, twelve of the research staff members were PhD students.

A direct successor to the State Institute of Geophysics founded in 1920, the Institute of Geophysics was incorporated into the Czechoslovak Academy of Sciences in 1953. Currently it is one of 53 public scientific institutes of the Academy of Sciences of the Czech Republic. (Detailed information about the structure of the ASCR and other institutes can be found at: www.cas.cz).

The Academy of Sciences of the Czech Republic regularly conducts evaluation of its scientific institutes according to the rules, customs and methodology applied in the scientifically advanced countries. The last round of evaluation, focused on the activity from 2005 to 2009, took place with the broad participation of international reviewers. The Institute of Geophysics was ranked among 10 best rated institutes of the Academy. This positive outcome helps to overcome the consequences of recent economical recession and, together with large research projects presented in this volume (e.g., CzechGeo/EPOS or AIM), gives good prospects for the forthcoming years.

Management of the Institute

(listed are board members in 2010-11 as well as those elected in December 2011 to serve in 2012-2016)

Director: RNDr. Pavel Hejda, CSc.
Deputy director: RNDr. Bohuslav Růžek, CSc.
Head of the Economy Department: RNDr. Marta Tučková
Scientific secretary: RNDr. Josef Pek, CSc.

Board of the Institute

Chairman: RNDr. Jan Šafanda, CSc. *(re-elected 2011)*

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RNDr. Josef Horálek, CSc *(2007-2011, re-elected 2011)*
RNDr. Josef Pek, CSc. *(2007-2011)*
RNDr. Eduard Petrovský, CSc. *(2007-2011, re-elected 2011, Vice-chairman)*
RNDr. Jaroslava Plomerová, CSc. *(elected 2011)*
RNDr. Aleš Špičák, CSc. *(2007-2011, re-elected 2011)*
RNDr. David Uličný, CSc. *(elected 2011)*
RNDr. Václav Vavryčuk, DrSc. *(Vice-chairman, 2007-2011)*

External members:
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RNDr. Jan Laštovička, DrSc. *(2007-2011, re-elected 2011; Institute of Atmospheric Physics, Academy of Sciences*
Doc. RNDr. Oldřich Novotný, CSc. *(2007-2011; Faculty of Mathematics and Physics, Charles University)*
Prof. RNDr. Jiří Zahradník, DrSc. *(2007-2011, re-elected 2011; Faculty of Mathematics and Physics, Charles University)*
Doc. RNDr. Hana Čížková, Ph.D. *(elected 2011; Faculty of Mathematics and Physics, Charles University)*
RNDr. Jiří Málek, CSc. *(elected 2011; Institute of Rock Structure and Mechanics, Academy of Sciences)*

Illustration photos: above - field measurement of soil magnetism in Croatia. Facing page - field work in the Klamath Mountains, Caribou Mountain Pluton, USA; processing of seismic data of the Czech Regional Seismic Network.

Supervisory Board

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Vice-chair: Ing. Marcela Švamberková *(Institute of Geophysics)*
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RNDr. Vladimír Fiala, CSc. *(Institute of Atmospheric Physics, Academy of Sciences)*
Secretary:
PhDr.Hana Krejzlíková *(Institute of Geophysics)*

Research staff, 2011

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BOCHNÍČEK Josef	Ing. CSc	067	jboch
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BOUŠKOVÁ Alena	Mgr.	381	ab
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HORÁLEK Josef	Ing. CSc.	076	jhr
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MICHÁLEK Jan	Mgr.	360	michalek
MRLINA Jan	RNDr. Ph.D.	314	jan
NEJEDLÁ Jaroslava	Ing.	335	jn
NOVOTNÝ Miroslav	RNDr. CSc.	386	mn
PEK Josef	RNDr. CSc.	320	jpk
PETROVSKÝ Eduard	RNDr. CSc.	333	edp
PLOMEROVÁ Jaroslava	RNDr. DrSc.	391	jpl
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SKOPCOVÁ Monika	Mgr.	106	skopcova
STANĚK Martin	Mgr.	313	stanekm
STŘEŠTÍK Jaroslav	RNDr. CSc.	321	jstr
ŠAFANDA Jan	RNDr. CSc.	384, 350	jsa
ŠIMKANIN Jan	RNDr. Ph.D.	351	jano
ŠÍLENÝ Jan	RNDr. CSc.	016	jsi
ŠPAČEK Petr	Ph.D.	017	spacek
ŠPIČÁK Aleš	RNDr. CSc.	345	als
ŠPIČÁKOVÁ Lenka	RNDr. Ph.D.	343	spicka
TELECKÝ Josef	Ing.	316	jot
ULIČNÝ David	RNDr. CSc.	326	ulicny
ULRICH Stanislav	RNDr. Ph.D.	017	stano
VACKOVÁ Lenka	Mgr.	106	vackova
VANĚK Jiří	RNDr. DrSc.	346	
VAVRYČUK Václav	RNDr. DrSc.	020	vv
VECSEY Luděk	RNDr. Ph.D.	021	vecsey
VLK Michal	Ing.		vlk
ZÁVADA Prokop	Ph.D.	313	zavada
ZEDNÍK Jan	RNDr.	015	jzd

Research departments

Department of Geoelectricity
Head: RNDr. Josef Pek, CSc.

- investigations of the crustal and upper mantle electrical conductivity
- theoretical and methodological research of electromagnetic fields and their numerical modelling
- study of external geoelectromagnetic fields
- investigations of solar-terrestrial relationships

Department of Geomagnetism
Head: RNDr. Eduard Petrovský, CSc.

- observations of the Earth's magnetic field
- field measurements of secular variations of geomagnetic field
- geodynamo modelling
- space weather studies
- research in effects of solar and geomagnetic activities on climatic changes
- research in rock and environmental magnetism

Department of Geothermics
Head: RNDr. Jan Šafanda, CSc.

- experimental and theoretical investigations of the temperature field of the Earth's crust and upper mantle
- temperature logging in boreholes
- experimental studies of the thermo-physical properties of crustal rocks, thermal conductivity and diffusivity and radiogenic heat production
- instruments for geothermal research, portable thermometers for borehole logging and systems for a long-term temperature monitoring
- reconstruction of climatic changes from temperature-depth profiles in deep boreholes
- study of the air, ground and bedrock temperature coupling and of the thermal regime within the soil and the underlying bedrock.

Department of Seismology
Head: RNDr. Jan Šílený, CSc.

- operating a regional network of broadband seismological stations, compilation of earthquake catalogs and bulletins, data exchange with European and world data centers
- collecting macroseismic data related to seismicity on the territory of Czech Republic
- monitoring and interpreting the seismicity and gas emanation in the geodynamically active region of West Bohemia
- study of deep geological structures down to the mantle lithosphere by active and passive seismological experiments
- theoretical research on seismic waves generation and propagation in complex structures
- theoretical modeling of fracturing the rock massif – investigation of foci of earthquakes and events induced by industrial activities

Department of Tectonics and Geodynamics
Head: RNDr. Aleš Špičák, CSc.

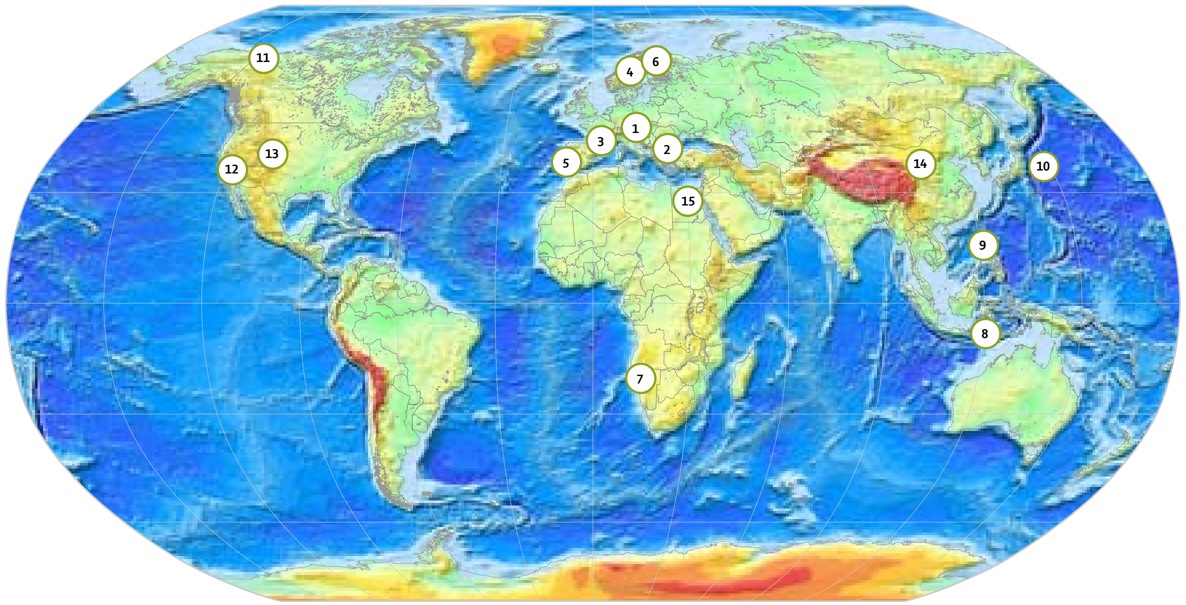
- study of processes at convergent plate margins, focused on tectonic interpretation of earthquake distribution and mechanisms
- study of orogenic processes and rheology of Earth's crust and mantle in ancient orogens
- study of volcanic processes on Earth and other planets, experimental and field study of magma ascent and diapirism
- research on evolution of sedimentary basin fills as sensitive records of the interaction between tectonic processes, sea-level fluctuations and climate changes
- study of recent crustal movements in tectonically active regions using gravity and geodetic methods
- monitoring and analysis of Earth tides, slope stability monitoring based on tilmeter and groundwater observations
- studies of oriented microporosity of rocks and its relation to elastic properties and permeability, e.g. for planning of radioactive waste repositories
- microgravity measurements in engineering geology and archaeology

Main research topics

The core of the yearbook is devoted to short communications summarizing the principal results achieved in various lines of research at the Institute during the years 2010 and 2011.

The topics studied and methods applied cover a very broad range, our researchers are commonly involved in multi-disciplinary teams and collaborate with colleagues from many institutions worldwide. Therefore the organization of the text does not strictly follow the administrative structure of the Institute's departments. After the first chapter devoted to the most significant geophysical event of 2011, the Tohoku earthquake in Japan, topics are arranged in several more or less loosely tied groups, following a direction from continental and regional – scale studies of lithosphere structure and tectonics, through studies focused on development of geophysical methods and on applications of geophysical approaches in various fields including the study of environmental changes, energy industry, or archaeology. Included are also theoretical studies and research on the outer Earth and Solar System processes.

The global focus of research undertaken at the Institute of Geophysics is illustrated by the map below.



World map constructed using the GMT software: Wessel, P. and Smith, W.H.F. (1998): New, improved version of the Generic Mapping Tools released. EOS Trans., AGU, 79, 579.

| 1 Studies of electromagnetic field across the Teisseyre-Tornquist Zone and surrounding regions in central and NE Europe
| 2 Study of magnetic properties of soils, Bulgaria
| 3 Microseismic experiments in the Soultz-sous-Forets geothermal facility, Alsace, France
| 4 Passive seimological experiment in northern Scandinavia
| 5 Study of magnetic properties of soils, coastal regions of Portugal
| 6 Geothermal study of the Outokumpu deep borehole, E Finland
| 7 The Kaoko Belt, Namibia: Field research of tectonic controls on repeated magmatic activity during formation of orogenic belts
| 8 Deep structure and tectonic evolution of the Banda Arc region, SE Asia
| 9 Geodynamics of the Izu-Bonin-Mariana arc-trench system, SE Asia
| 10 Study of seismic data related to the 9.0, 2011 Tohoku earthquake, Japan
| 11 Study of formation of gas hydrates in a warming arctic region, the Beaufort-McKenzie Basin, Canada
| 12 Study of pre- and post-collisional plutons penetrating the Klamath Mts. accretionary complex, California / Oregon, USA
| 13 Structural and geophysical study of volcanics emplacement in the Devils Tower National Monument, Wyoming, USA
| 14 Research on palaeomagnetic aspects of orientation of ancient tombs in central China
| 15 Geodetic and gravity monitoring of crustal dynamics in Aswan and Suez regions, Egypt.

The 9.0, 2011 Tohoku earthquake: Structural control of the extent of the mainshock rupture and aftershock distribution

The March 11, 2011 Tohoku earthquake with its M_w=9.0 was evaluated as the fourth largest earthquake in the instrumental era of seismology (i.e. approximately since 1900; http://earthquake.usgs.gov/earthquakes/world/10_largest_world.php). Estimates of the area of the rupture plane vary between 300 km x 150 km (Ammon et al., 2011) and 450 km x 200 km (Yoshida et al., 2011). The parameters of the fault plane derived from waveform modelling and focal mechanism agree: strike 200°, dip 10° and rake 90° (Shao et al., 2011; Global CMT Program). The foreshock-mainshock-aftershock sequence consists of 5.000 events (by February 15, 2012). In this contribution, we analyse spatial distribution of the events of the sequence as well as available focal mechanisms and compare the analysis with known tectonic features of the region and sea floor morphology. We have used hypocentral determinations of the National Earthquake Research Center (NEIC) of the US Geological Survey (PDE database – Preliminary Determination of Earthquakes; http://earthquake.usgs.gov/earthquakes/) and fault plane solutions of the GCMTS project (http://www.globalcmt.org/).

Epicenters of the 2011 Tohoku foreshock-mainshock-aftershock sequence are shown in Fig. 1 and the depth distribution of foci in two vertical sections perpendicular to the Japan Trench (azimuth 110°) (Fig. 2). These figures imply that aftershocks have been associated with three different structural units: (1) with the mainshock interplate rupture plane (events of reverse focal mechanism), (2) with the horizontally situated portion of the Pacific plate east of the Japan trench (with normal focal mechanism), and (3) with the lithospheric wedge above the subducting slab. In this contribution, we concentrate on the events associated with the interplate rupture plane. In the north, these aftershocks terminate at the latitude of a sharp deviation of the plate boundary, visualised by the Japan trench, from the azimuth of 180° (E of Honshu) to the azimuth of 240° (SE of Hokkaido). Such a sharp bent of the plate boundary probably acts as a robust geometrical barrier to the earthquake rupture propagation. In the south of the aftershock area, no change in the geometry of

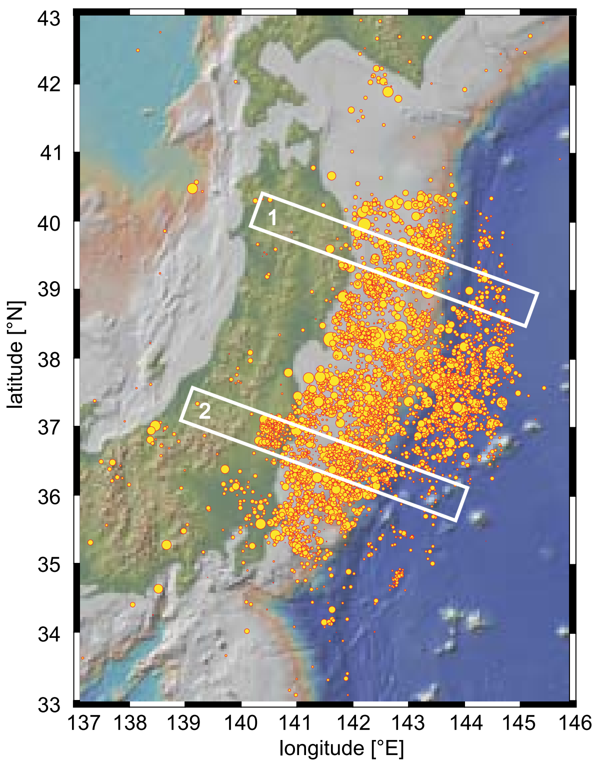


Fig.1. Epicentral map of the Mar 11, 2011 M_w 9.0 Tohoku foreshock-mainshock-aftershock sequence (Mar 09, 2011 – Feb 15, 2012). Five thousand earthquake epicenters with mb >4 from the NEIC/PDE database are shown. White rectangles denote swaths of two vertical sections shown in Fig.2.

the plate boundary is observed, but the sea floor morphology offers another structural explanation – a chain of seamounts on the Pacific ocean floor E of the Japan trench, between latitude 36°-38°N, aligned in the azimuth 220° and called the Kashima seamounts. The topography of the seafloor (Fig. 3) reveals that the chain is about 300 km long and

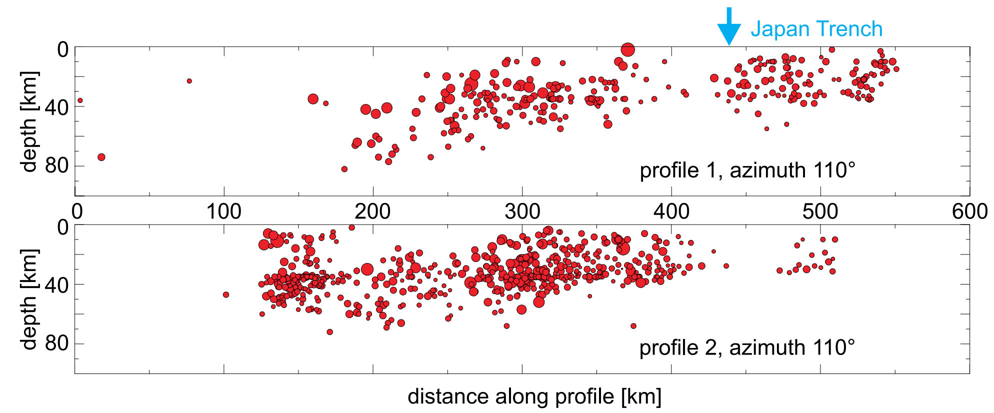


Fig.2. Vertical sections in the direction perpendicular to the plate boundary (azimuth 110°). Position of the Japan Trench is denoted by blue arrow. For position and width of the sections see Fig.1.

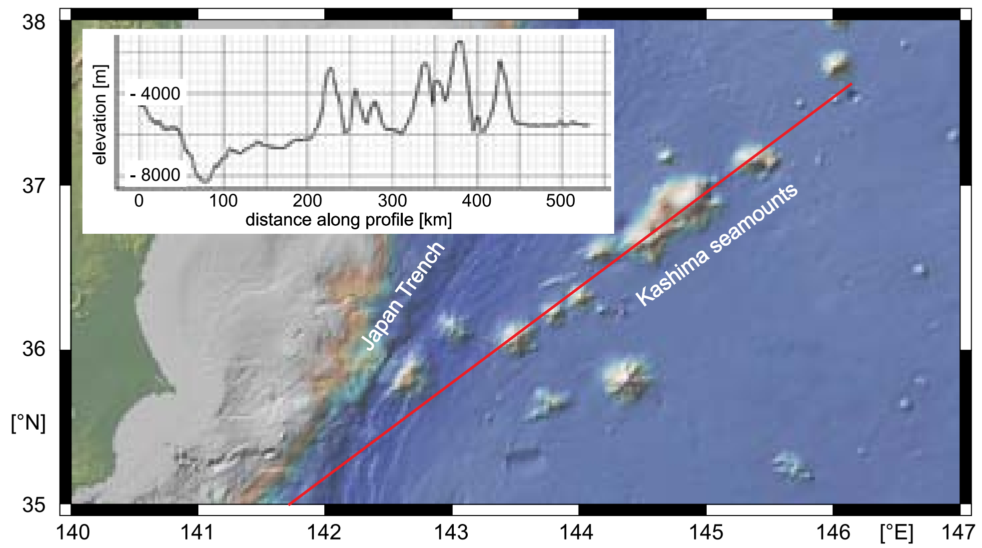


Fig.3. Sea floor morphology of the Kashima seamounts area with the elevation profile across the seamount chain.

consists of 6 seamounts with summit elevation 3000-4500 m above the sea floor. The existence of such a chain indicates a deep-seated fracture zone in the sea floor along which magmas forming the seamounts ascended to the surface. Such a distinct structural element in the approaching plate probably acted as a barrier to seismogenic fracture propagation. This effect could have been increased by subduction of the Kashima seamounts in the past.

IG research staff involved:

A. Špičák, J. Vaněk

Reference:

***Špičák, A. and Vaněk, J.: The Mw 9.0 Tohoku earthquake, Japan, March 11, 2011**. Studia geophysica et geodaetica, 55, no. 2 (2011), 389–395.*

Structure of continental mantle lithosphere

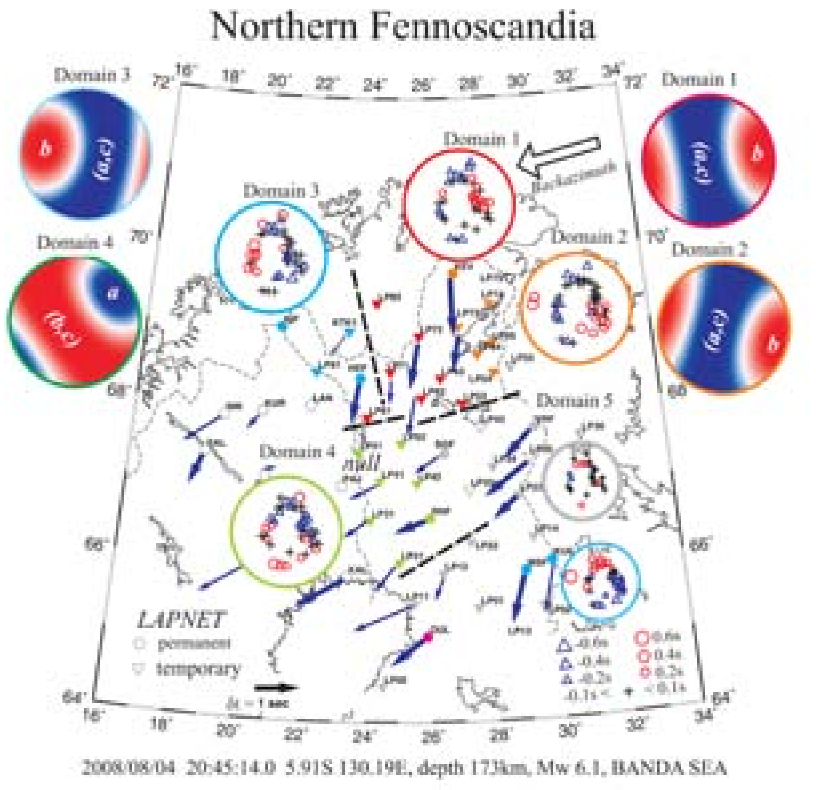


Fig.1. Stations clustered into domains according to similarity of distribution of early and delayed travel times relative to a directional mean at each station, calculated from relative residuals. The P spheres show smoothed azimuth-incidence angle dependent terms for representatives of each group and those calculated from all stations included in each group (marked by different colours). Geographical variations of fast shear-wave polarizations and split delay times for an event occurred on 2008/08/04 at 20:45:14.0 with epicentre in Banda Sea – 5.91S 130.19E are shown as well. Stations with similar fast S polarizations and split delay times form groups like those determined from P-spheres (station in the same colours as in Fig. 2). Anisotropic signal of shear wave decreases or disappears (null split) at stations close to boundaries (schematically marked by dashed lines). Good, firm and poor splitting measurements are marked by thick, thin and empty-head arrows, respectively. Anisotropic aggregates with divergently dipping high-velocity (a,c) foliations (the b-axis models) approximate the lithosphere fabric beneath the northern part of the LAPNET array, whereas in the central part a model with steeply dipping lineation a (the a-axis model) fit the observed shear-wave splitting and P-wave anisotropic parameters (in its western part).

Detailed body-wave analysis, based on evaluating P – and S-wave travel-time deviations and shear-wave splitting, aims at modelling mantle velocity structure, particularly structure of the mantle lithosphere in tectonically different provinces. Initial results (Fig. 1), obtained from data of the POLENET/LAPNET array (2007-2009) installed on the territory of northern Finland and adjacent parts of Sweden, Norway and Russia clearly demonstrate the Archean mantle lithosphere consists of domains with consistent fabrics reflecting fossil anisotropic structures (Plomerová et al., 2011a). Individual domains are delimited by boundaries (sutures), where the anisotropic parameters – polarizations of the fast shear-waves and the pattern of P-residual spheres – change. 3D self-consistent anisotropic models derived from peridotite aggregates with dipping lineation *a* or foliation *(a,c)*, accommodate the two independent sets of body-wave anisotropic observations. The results obtained from the LAPNET array fill a gap in structural studies of the upper mantle beneath northern Fennoscandia (Plomerová and Babuška, 2010; Eken et al., 2010; Jones et al., 2010).

Joint inversions of body-wave anisotropic parameters (Plomerová et al., 2011b) recorded during the BOHEMA II passive seismic experiment (2004-2005) resulted, for the first time, in delimitation of domains of the mantle lithosphere in the north-eastern part of the Bohemian Massif (BM). We inferred 3D self-consistent models of their fabrics (Fig. 2a), which in the northern and north-eastern parts of the BM are approximated best by peridotite aggregates with the *(a,c)* foliations dipping approximately to the N and NE, respectively, whereas a model with the westerly dipping *a* lineation fits best the fabric of the south-eastern domain. The Saxothuringian fabric, NW of

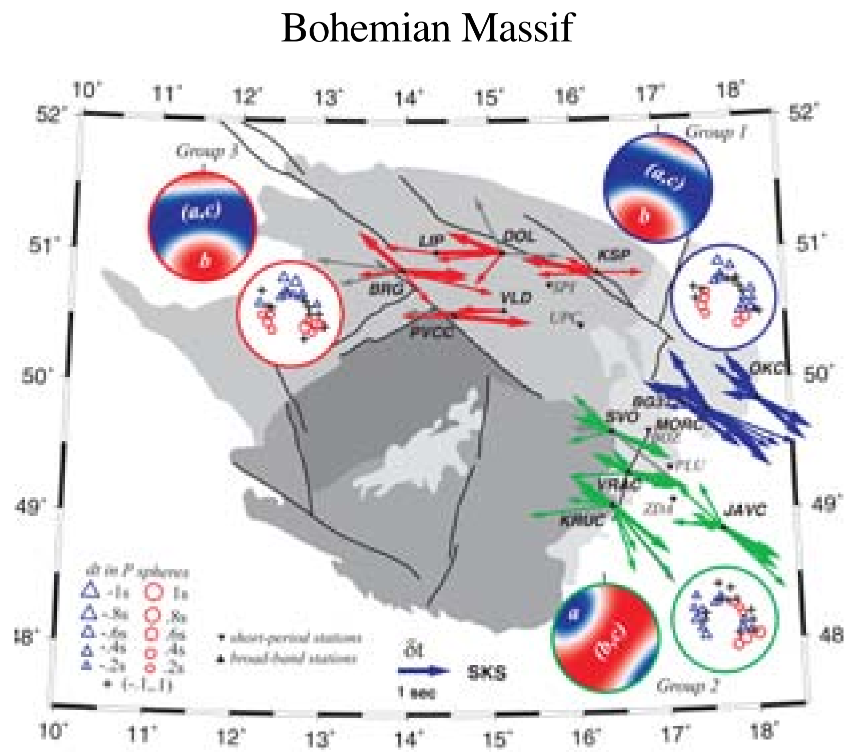


Fig. 2a. 3D self-consistent anisotropic models of the mantle lithosphere retrieved from data (shear-wave splitting and directional terms of relative P residuals) of three groups of stations of BOHEMA II array (Plomerová et al., 2011b). The P spheres show P-residual directional terms of all stations within each group smoothed at 20° (azimuth) and 5° ('incidence' angle) bins. Only stations with clear pattern were included into the joint inversion with shear-wave splitting parameters. Hexagonal models with high-velocity foliations (a,c) dipping to the N and NE fit data from stations in the northern (red) and north-eastern (blue) parts of the BM, respectively, while we retrieved hexagonal model with westerly dipping axis a from joint inversion of data in the south-eastern BM (green).

the Eger Rift, extends to the east across the Elbe Fault Zone and continues along this zone to the southeast beneath the Cretaceous Basin. The south-eastward continuation of the Elbe Fault Zone seems to be related to the boundary between two different fabrics of the northern and southern Brunovistulian domains below the Moravo-Silesian zone. This study shows an underthrusting of the Brunovistulian micro-plate beneath the eastern rim of the BM and indicates that its northern and southern fragments might have originally belonged to Baltica and to Gondwana, respectively. According to a zone of distinctly decreased anisotropic signals, the Brunovistulian micro-plate extends at least about 100 km westward beneath the Moldanubian. With these new findings we update the domain-like mantle structure of the BM and compare the results with inferences from the upper mantle velocity tomography (Karousová et al., 2011) and depth changes of the lithosphere-asthenosphere boundary (Fig. 2b) retrieved in a detailed model from relative residuals and from the receiver functions (Geissler et al., 2011). Inferences on anisotropic structure beneath the permanent observatories included in different experiments are stable and are validated by the BOHEMA II experiment. The decisive role of boundaries of the upper mantle domains on crustal tectonics is evident particularly in location of the Variscan magmatism and the Cenozoic volcanism in the western BM, as well as in the tectonic setting of the Eger Rift and the Cheb Basin (Babuška and Plomerová et al., 2010; Babuška et al., 2010a,b).

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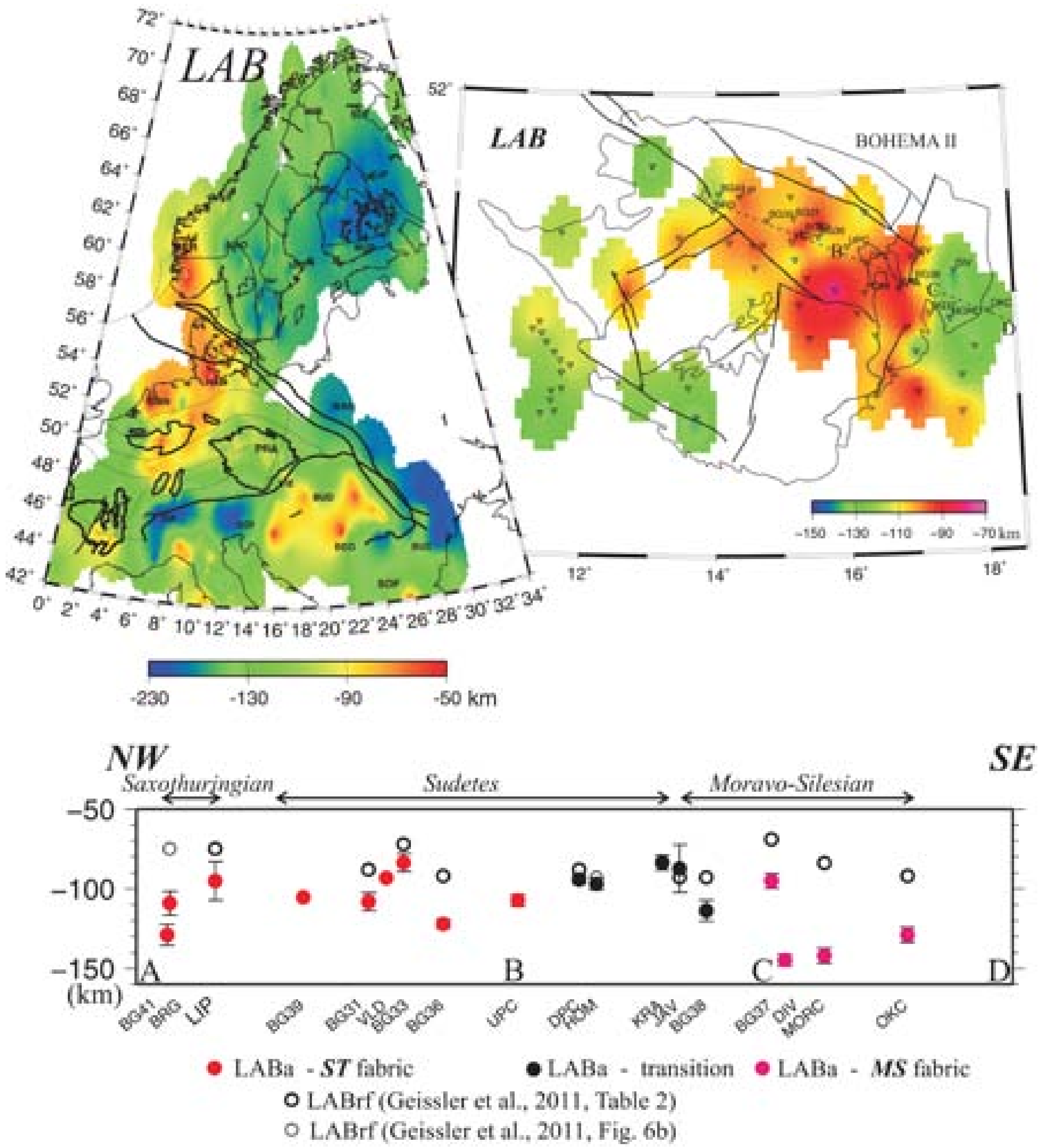

Fig. 2b. Estimates of depth variations of the lithosphere-asthenosphere boundary (LAB) in EUROPE (Plomerová and Babuška, 2010) and beneath stations involved in the BOHEMA II passive experiment (Plomerová et al., 2011b). The LAB shown on the top is calculated according to an empirical relation based on the static terms of relative residuals and is defined as a transition between a fossil anisotropy in the lithosphere and that part of anisotropy related to the present-day flow in the asthenosphere. A comparison of depths to this anisotropy considering LABa (full circles in the bottom figure, error bars recalculated from standard deviations of the static terms) with those of LABrf (blank circles in the bottom) determined from the Sp receiver functions along the AD profile (marked on the top) shows that the LABrf is mostly shallower than LABa.

References:

Plomerová J., Vecsey L, Babuška V., 2011b. *Mapping seismic anisotropy of the lithospheric mantle beneath the northern and eastern Bohemian Massif (central Europe). Tectonophysics, available online. doi:10.1016/j.tecto.2011.08.011.*

Karousová, H. Plomerová J., Vecsey L., in review. *Seismic tomography of the upper mantle velocity structure beneath the northeastern Bohemian Massif (central Europe). Tectonophysics, submitted 2011.*

Geissler W.H., Skácelová Z., Kämpf H., Plomerová J., Babuška V., Kind R., in review. *Lithosphere structure of the NE Bohemian Massif (Sudetes) – A teleseismic receiver function study, Tectonophysics, submitted 2011.*

Babuška V., Fiala J , Plomerová J., 2010a. *Bottom to top lithosphere structure and evolution of western Eger Rift (central Europe), Int J Earth Sci (Geol Rundsch), DOI 10.1007/s00531-009-0434-4*

Babuška V., Plomerová J., Vecsey L., 2010b. *Links between the structure of the mantle lithosphere and morphology of the Cheb Basin (Eger Rift, central Europe). Int. J. Earth Sci., (IJES) Special issue "Long-term rift evolution", 99:1535-1544, doi: 10.1007/s00531-010-0531-4.*

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

Eken; T.; Plomerová; J., Roberts; R., Vecsey, L., Babuška, V.; Shomali; H., Bodvarsson, R., 2010. *Seismic anisotropy of the mantle lithosphere beneath the Swedish National Seismological Network (SNSN), Tectonophysics 480, 241-258, doi 10.1016/j.tecto.2009.10.012*

Jones A.G., Plomerová J., Korja T., Sodoudi F., Spakman W., 2010. *Europe from the bottom up: A statistical examination of the central and northern European lithosphere – asthenosphere boundary from comparing seismological and electromagnetic observations. Lithos 120, 14-29, doi:10.1016/j.lithos.2010.07.013*

Plomerová, J., Babuška V., 2010. *Long memory of mantle lithosphere fabric – European LAB constrained from seismic anisotropy. Lithos, 120, 131-143, 10.1016/j.lithos.2010.01.008*

Plomerová J., Vecsey L, Babuška V. and LAPNET working group, 2011a. *Domains of Archean mantle lithosphere deciphered by seismic anisotropy – initial results from the LAPNET array in northern Fennoscandia, Solid Earth, doi:10.5194/sed-3-655-2011*

From Variscan to Alpine Orogeny: crustal structure of the Bohemian Massif and the Western Carpathians in the light of the SUDETES 2003 seismic data

—— Many aspects of the complex geological structures of the Variscan Bohemian Massif and the Western Carpathians, and especially their mutual contact, have been subject to ongoing research and debate. The Bohemian Massif is an excellent example of the Palaeozoic Variscan crust exposed on the surface, while the Carpathian crust records the crust-forming processes during Mesozoic to Cenozoic times. In an effort to investigate the crustal structure, the area was covered by a network of seismic refraction experiments (POLONAISE'97, CELEBRATION 2000, ALP 2002, and SUDETES 2003) as a result of a massive international cooperative effort. The refraction and wide-angle reflection profile S04 of SUDETES 2003 experiment extended in a NW – SE direction across all main tectonic units of the Bohemian Massif and continued through the Western Carpathian arc to the Pannonian Basin. It was in a favourable position for studying the superposition of individual tectonic units at depth. Contrasts in seismic properties together with the depth of the Moho discontinuity reflected compositional and structural variances resulting from crust-forming processes during Cadomian, Palaeozoic and Tertiary tectonic development.

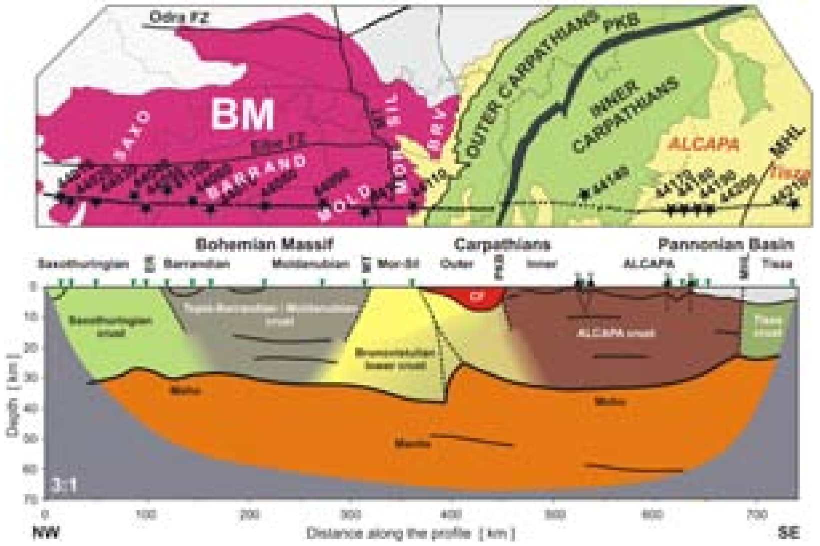

Fig.1. Schematic sketch indicating possible tectonic development along the S04 profile with surface geological map on the top. SAXO, Saxothuringian; BARRAND, Barrandian; MOLD, Moldanubian; MT, Moldanubian Thrust; Mor-Sil, Moravo-Silesian; ER, Eger Rift; PKB, Pieniny Klippen Belt; OCZ, Outer Carpathians Zone; MHL, Mid-Hungarian Line; CF, Carpathian Foredeep. Vertical exaggeration is 3:1.

—— The data acquired along the S04 profile were interpreted by 2-D trial-and-error forward modelling of P waves; additional constraints on crustal structure were provided by gravity modelling. The lower crust under the Saxothuringian of the Bohemian Massif exhibited a complicated structure ranging from a higher velocity lower crust, double Moho or the Moho with some lateral topography. The Moho under the major crystalline segment within the Bohemian Massif, the Moldanubian, was modelled as a first-order discontinuity with slightly shallower depth at its northern rim compared to its central part. The transition between the Bohemian Massif and the Western Carpathians was characterized by distinct lateral variations at the Moho depth ranging from 26 – 36 km. The abrupt change of the crustal thickness in this transition zone might be associated with the Pieniny Klippen Belt, a deep-seated boundary between the colliding Palaeozoic lithospheric plate to the north and the ALCAPA microplate to the south. In the upper crust of this transition, lower velocities extending to a depth of 6 km represented the sedimentary fill of the Carpathian Flysch and foredeep that thinned towards the foreland. This basin was also expressed as a pronounced gravity low. The crust in the Carpathians was characterized by missing orogenic root typical for the Eastern Alps and shallow Moho depth in the Pannonian Basin corresponded to the Pannonian gravity high.

—— IG research staff involved:

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—— References

Hrubcová, P., P. Środa, M. Grad, W.H. Geissler, A. Guterch, J. Vozár, E. Hegedűs, and Sudetes 2003 Working Group, 2010. *From the Variscan to the Alpine Orogeny: crustal structure of the Bohemian Massif and the Western Carpathians in the light of the SUDETES 2003 seismic data, Geophys. J. Int., doi: 10.111/j.1365-246X.2010.04766.x.*

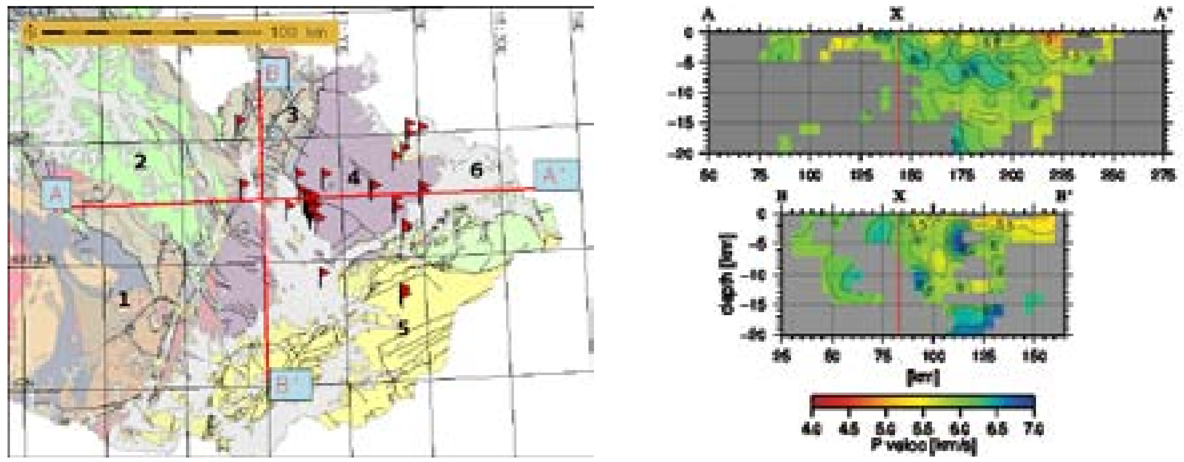
3D seismic tomography in the Moravo-Silesian Region

—— The Moravo-Silesian region belongs to weakly seismically active regions of the Bohemian Massif. Despite of that, however, it still represents an important subject of seismological monitoring. Besides episodic regional seismic events and seismic swarms of minor scale, also mining induced events from the Ostrava region and other seismic events are recorded. Investigation of the deep geological structure and seismotectonic regime is needed not only for mitigating the mining risk but also for answering questions regarding geologic and tectonic relations of the two major neighbouring geological units: the Variscan Bohemian Massif and outer zone of the West Carpathians. The basis for all relevant studies is a representative velocity model.

—— This study focused on construction of an indicative 3D seismic model based on seismic tomography, using all available and suitable data sets. We define our results as 'indicative' due to a limited resolution of the model, nevertheless the model can easily be improved in the future by adding new data, since all currently included data sets are published on internet for easy use.

—— The velocity model is achieved by jointly inverting Pg and Sg traveltimes / onset times from different types of seismic source: (i) traveltimes corresponding to CELEBRATION 2000 and SUDETES 2003 experiments, (ii) traveltimes from local quarry blasts, (iii) traveltimes from mining induced events occurring in Ostrava coal mines and, (iv) onset times from local tectonic events. Therefore our computations include localization of tectonic events, ray tracing and velocity model optimization.

—— The resulting P-wave velocity model is published on the internet for free use. An additional result of our study has been the localization of a set of 43 local tectonic events.



Left: A simplified geological map. 1: High-grade metamorphics and Variscan intrusions of the Moldanubian domain; 2: Mesozoic sedimentary rocks – sandstones, mudstones; 3: metamorphics of the Moravo-Silesian domain – schists, phyllites, micaschists to paragneises; 4: Palaeozoic sedimentary rocks; 5: Older Cenozoic rocks affected by Alpine folding; 6: Younger Cenozoic sedimentary cover. Red flags indicate epicentres of local tectonic events, bold red lines indicate positions of the cross-sections shown on the right.

Right: vertical cross-sections of the P-wave velocity model along the profiles A-A' and B-B'.

—— IG research staff involved:

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—— References

Růžek B., Holub K, and Rušajová J., 2011. *Three-dimensional Crustal model of the Moravo-Silesian region obtained by seismic tomography. Stud Geophys. Geod., 55, 87-107.*

Holub K., Růžek B. and Rušajová J., 2011. *A simple smoothed velocity model of the uppermost Earth's crust derived from joint inversion of Pg and Sg waves. Acta Geophysica DOI: 10.2478/s11600-011-0023-3.*

http://www.ig.cas.cz/en/personal-pages/bohuslav-ruzek/3d-tomography/

Crustal structures of the Altenberg–Teplice Caldera, České středohoří and Doupovské hory volcanic complexes by refraction tomography

Two refraction profiles of the SUDETES 2003 seismic experiment, S01 and S04, pass along and across the Eger Rift in West Bohemia. The S01 profile crosses two volcanic complexes of the Doupovské hory and the České středohoří Mts. Between them, the intersecting S04 profile crosses the Altenberg–Teplice Caldera (ATC) structures situated above the collision zone of the Saxothuringian and Teplá–Barrandian unit (Fig. 1). The depth-recursive tomography (DRTG), applied recently to the refraction data (Novotný et al. 2009, 2010; Skácelová et al. 2010), produced the velocity models that allowed reliable interpretation of the encountered structures down to the depths of 15–20 km.

Unlike the previous derivations of subsurface velocity distributions (Růžek et al. 2007; Grad et al. 2008; Hrubcová et al. 2010), the DRTG inversion involved just the first arrivals of refracted waves with minimum picking errors, in order to attain a superior lateral resolution in the velocity image. The inversion is based on a regular network of refraction grid rays providing data for a statistical assessment of the lateral resolution that is achieved in the single grid depth levels. Generally, the lateral sizes of the velocity anomalies to be resolved depend on their depths, velocity excesses and the required confidence level. Thus, for the 68% confidence and 5% excess, the velocity anomalies in the S04 and S01 patterns are resolved for the their minimum lateral sizes varying from 5 to 24 km in dependence on their depths of 0 – 20 km. This allowed a reliable 3-D interpretation near the profile intersection. Using velocity and gravity data, subsurface granitic and ultrabasic bodies were interpreted in the Saxothuringian and Teplá–Barrandian contact zone, together with possible magmatic centers for the Altenberg-Teplice Caldera (Fig. 3) , the Doupovské hory and the České středohoří volcanic complexes (DHVC and CSVC in Fig. 2).

A rather complex velocity image of the SXT–TBU collision zone in Figs. 2 and 3 results from several phases of magmatic activity and associated processes (tectonic disturbances, stoping, anatexis) affecting the host rocks and ascending melts during magmatic intrusions. The magmatic body discov-

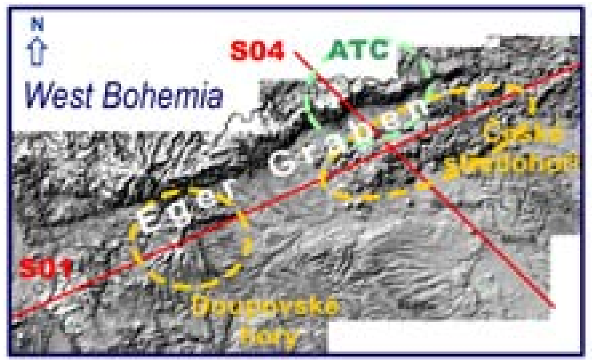

Fig.1. S01 and S04 refraction profiles crossing the Bohemian Massif at the Eger Graben and the Altenberg-Teplice Caldera (ATC)

ered close to the S04–S01 intersection (see Fig. 2) was interpreted as a shallower subvolcanic magmatic reservoir for the Altenberg–Teplice Caldera and the České středohoří Volcanic Complex. Confined by the 6050 m/s isovelocity, the body covers a subsurface area of 2000 km^2 at 9–5 km below the surface. The interpreted deeper reservoir demonstrated by a pronounced elevation on the 6500-6400 m/s isovelocity at the 15–13 km depth range is assumed to have fed a shallower reservoir interpreted in 9–5 km depths. Potential feeding channels are manifested in the S04 and S01 velocity images by the sequences of elevations in the P-wave velocity image whose maxima delineate the paths of ascending magma (see dashed arrows in the geological model – Fig. 3). The depth ranges of both reservoirs are in agreement with the two depth levels of magma storage predicted in by Müller et al. (2005) for Eastern Erzgebirge Volcano–Plutonic Complex.

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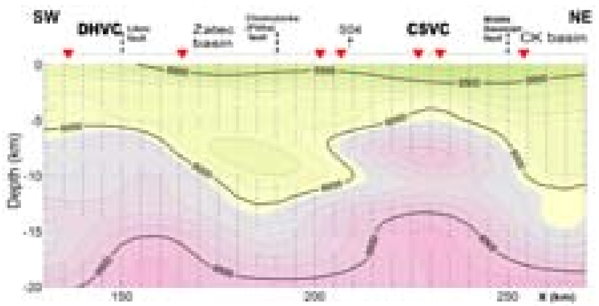

Fig.2. DRTG velocity section along the S01 profile crossing the Doupovské hory and České středohoří Volcanic Complexes (DHVC and CSVC). The dots denote the grid nodes verified by the refraction grid rays. CK Basin – Česká Kamenice Basin.

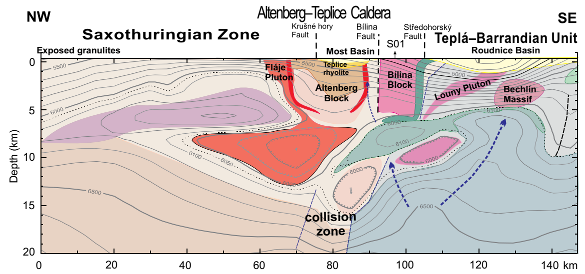

Fig.3. Geological model inferred from the S04 isovelocities (in km/s). The block boundaries are in conformity with the gravity modeling (Novotný et al. 2010).

References:

Grad M., Guterch A., Mazur S, Keller G.R., Špičák A., Hrubcová P., Geissler W.H., 2008. *Lithospheric structure of the Bohemian Massif and adjacent Variscan belt in central Europe based on profile S01 from the SUDETES 2003 experiment. J Geophys Res 113: B10304, DOI: 10.1029/2007JB005497.*

Hrubcová P. , Środa P., Grad M., Geissler W. H., Guterch A., Vozár J., Hegedüs E., Sudetes 2003 Working Group, 2010. *From the Variscan to the Alpine Orogeny: crustal structure of the Bohemian Massif and theWestern Carpathians in the light of the SUDETES 2003 seismic data, Geophysical Journal International, 183, 2, 611-633.*

Müller A., Breiter K., Seltmann R., Pécskay Z., 2005. *Quartz and feldspar zoning in the eastern Erzgebirge volcano–plutonic complex (Germany, Czech Republic): evidence of multiple magma mixing. Lithos 80: 201–227*

Novotný M., Skácelová Z., Mrlina J., Mlčoch B., Růžek B., 2009. *Depth – Recursive Tomography Along the Eger Rift Using the S01 Profile Refraction Data: Tested at the KTB Super Drilling Hole, Structural Interpretation Supported by Magnetic, Gravity and Petrophysical Data. Surv. Geophys 30, 561–600.*

Novotný M., Skácelová Z., Mlčoch B., 2010. *Crustal structures beneath the Saxonian Granulite Massif, the České středohoří and the Doupovské hory Mts. Based on the depth recursive tomography. Journal of Geosciences 55, 187-199.*

Růžek B., Hrubcová P., Novotný M., Špičák A., Karousová O., 2007. *Inversion of travel times obtained during active seismic refraction experiments CELEBRATION 2000, ALP 2002 and SUDETES 2003. Stud Geophys Geod 51: 141–164*

Skácelová Z., Mlčoch B., Novotný M., Mrlina J., 2010. *Upper crustal structure of northern part of the Bohemian Massif in relation to geological, potential field data and new deep seismic data (Eger/Ohre Rift, Central Europe). Z. geol. Wiss, Berlin 39,1-18*

Basic geoelectrical units at the eastern margin of the Bohemian Massif and its contact with the Carpathians imaged by magnetotelluric soundings

—— Crustal geological structures at the eastern termination of the Variscean Bohemian Massif and its transition to the Alpine West Carpathians show highly anomalous electrical features manifested by a joint effect of two regional-scale electromagnetic induction anomalies, one along the outer Carpathians Mts. arc, and the other, largely three-dimensional one, over the eastern slopes of the Bohemian Massif. So far these anomalies have been traced mainly by long-period geomagnetic induction data, and no detailed conductivity structure of the crust could be inferred from those measurements. Therefore, a new profile, about 200 km in length and roughly W-E oriented, was selected in the SE part of the Bohemian Massif and its transition to the West Carpathians for combined long-period and broad-band magnetotelluric measurements. The profile started in the Central Moldanubian Pluton in the west, crossed the Brunia block in southern Moravia and ended with a few sites in the Carpathian Foredeep in the east (Fig. 1). The profile was situated close to the seismic refraction profile CEL09, and its precise position was mainly dictated by cultural noise conditions. Magnetotelluric data, in the period range of 0.01 to about 5000 s, were collected at more than 50 sites along the profile, which allows us to obtain subsurface induction images down to depths of several tens of km.

—— Due to a largely 3-D character of the induction data acquired, a preliminary analysis of the dimensionality and near-surface distortions was of primary importance for the data analysis and modeling. Because of a complex and non-comprehensible pattern of directionality parameters of the deep structures in the area, we have developed a stochastic magnetotelluric decomposition procedure based on the Monte Carlo approach with Markov chains (MCMC). The approach allows us to better explore the decomposition parameter space in a probabilistic sense, and also to naturally perform decomposition hypotheses testing in a multi-frequency and multi-site regime (Červ et al., 2010). By applying this procedure to the magnetotelluric impedances from our profile, we could find two zones of different directionality patterns: NNW-SSE/WSW-ENE in the eastern Moldanubian and western Brunia blocks, and NE-SW/NW-SE in the eastern part of the profile (Fig. 2a). These directions do not fully conform with the regional geology, and are likely to be affected by 3-D regional conductors, as variations of the azimuths of long-period induction arrows along the profile may also indicate (Fig. 2b).

—— Two-dimensional magnetotelluric modeling along the profile, in a common N-S/E-W coordinate frame and with 21 good quality sites employed, has been carried out for long-period data, for periods greater than 20 s (Fig. 2c). Shallow structures, down to depths of several kilometers, will be refined after merging the long-period curves with broad-band data is finished. The model shows several distinct and stable features. First, east of a highly resistive Central Moldanubian Pluton we observe a conductive layer at a depth of about 10 km. This layer may be, in fact, shallower than that as it arises from highly split magnetotelluric curves, with E-W impedance phases even leaving their standard quadrant, which indicates a strong quasi E-W current channeling due to relatively near-surface conducting structures. As also lateral conductivity contrasts offset with respect to the profile may be the cause of the anomalous induction data in this region, the true causative structures for the crustal conductor are still not obvious. The Carpathian Foredeep is marked by another conductive layer extending from the depth of about 10 km down to 30 to 40 km below the eastern part of the profile. The conductor correlates spatially well with seismic reflections observed previously on the seismic profile 8HR crossing this area. A large-scale sub-crustal resistive body beneath the Brunia block is a stable feature of all modeling experiments, and is based mainly on generally decreased long-period impedance phases all over that area.

—— As 3-D effects are likely to affect the magnetotelluric data along the profile studied, additional examinations have been made, aiming especially at analyzing the consistency between general features of the magnetotelluric model and a large-scale conductivity distribution inferred from the spatial distribution of long-period induction arrows. Models of conductance distribution in a thin laterally non-uniform plate, approximating the Earth's crust in a long-period limit, have been generated by an MCMC-based inverse algorithm and compared with conductances calculated from the magnetotelluric model down to the 50 km depth limit (Fig. 2d). A qualitatively good coincidence of the two conductances may support, at least locally in the profile area, the laterally non-uniform conductance pattern suggested already earlier from geomagnetic induction data.

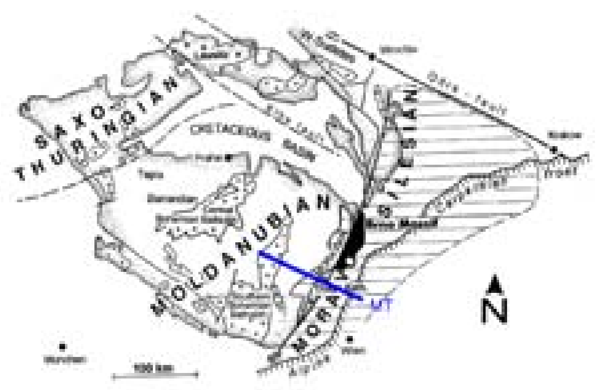

Fig 1. Major tectonic units of the Bohemian Massif (adopted from Finger et al., Int. J. Earth Sci., 89 (2000), 328-335) with the position of the magnetotelluric (MT) profile at the SE margin of the Bohemian Massif.

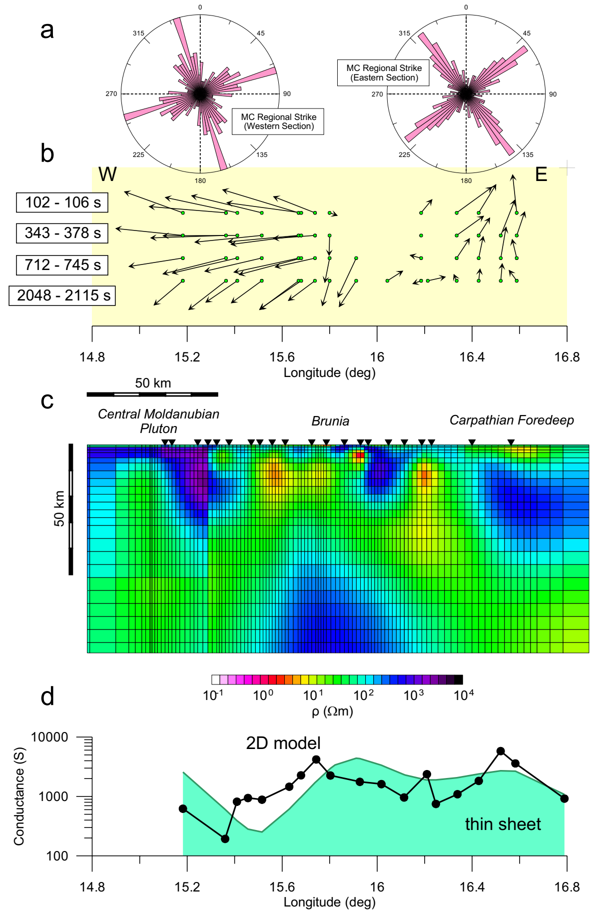

Fig 2. a) Estimates of the regional strike in the western and eastern parts of the MT profile based on the MCMC sampling from the magnetotelluric decomposition model. b) Real induction vectors along the MT profile in four different period ranges. c) 2-D inverse electrical model from long-period magnetotelluric data along the MT profile. d) Conductance along the MT profile derived from the 2-D inverse model and from a regional thin sheet inversion of long-period induction vectors interpolated from a rough mesh with spacing of 25 km.

—— IG research staff involved

V. Červ, J. Pek

—— Reference

Červ,.V., Pek, J., and Menvielle, M., 2010: *Bayesian Approach to Magnetotelluric Tensor Decomposition, Annals Geophys., 53 (2011); doi: 10.4401/ag-4681.*

Effects of external inhomogeneous sources on the electromagnetic field in Central and Northeast Europe

—— A long-term research effort, finalized in 2010, has been aimed primarily at eliminating effects of non-uniform external sources of the electromagnetic excitation on recorded data and at studying model distributions of the electrical conductivity in the Earth on an over-regional scale where source field non-uniformity may play a non-negligible role. Special attention in this respect is paid to the employment of various magnetovariational parameters, in particular those obtained by processing synchronous horizontal magnetic fields, which seem to be less sensitive to the geometry of the external sources than those derived from single-site magnetic records or from magnetotelluric data. Complex analysis of collected induction data and methods for separating external and internal magnetic fields across large areas of the Earth's surface have been employed in recovering horizontal magnetic fields from single-site induction vectors over regions with synchronous geomagnetic records missing.

—— The above formal procedures based on the potential nature of the geomagnetic induction field on the Earth's surface were further supplemented by true inverse solutions for the electrical conductivity in the Earth. As the study was based mainly on collections of geomagnetic induction data (induction vectors) over large areas, which is a typical experimental material in a number of regions of Central and Eastern Europe, the data modeling was built on the thin sheet approximation of laterally non-uniform conductivity structures. An Occam-type quasi-3D inversion procedure based on the thin sheet approximation has been developed. Effect of a frequently occurring superposition of near-surface inhomogeneities and those originating from a deeper crust was modeled by extending the thin sheet technique to account for another thin sheet, at a different depth, with a laterally inhomogeneous but fixed conductance obtained from data known a priori.

—— The thin sheet inverse procedure has been applied to geomagnetic induction data from two areas, specifically to the EMTESZ Pomerania array across the

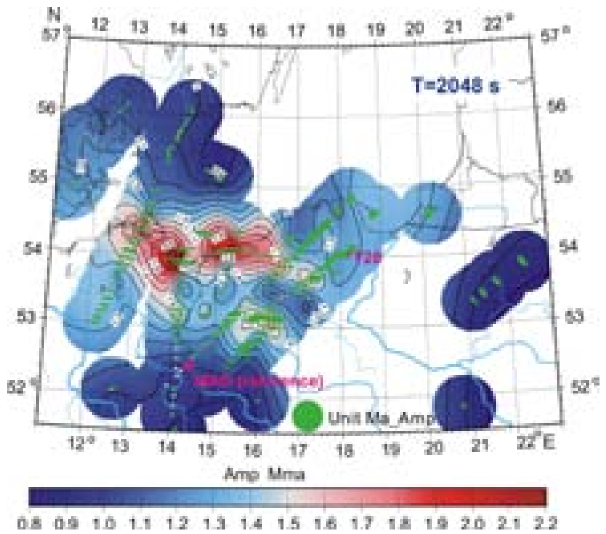

Fig.1. Area of the EMTESZ project in NW Poland/NE Germany: amplitudes and ellipses (green) of the horizontal magnetic tensor (M-responses) with the reference site MAD; period T=2049 s.

Trans-European Suture Zone in NW Poland and NE Germany, and to data from the region of the Kirovograd conductivity anomaly in Ukraine and its continuation in SW Russia (Gordienko et al., 2005, 2006). In the EMTESZ Pomerania experiment, the effect of the Polish and North-German sedimentary basins was considered by applying the inversion technique with two separate non-uniform sheets to the data, which made it possible to clearly focus and sharpen the crustal anomaly due to the Trans-European Suture Zone (Fig. 1, 2). In the study of the Kirovograd conductivity anomaly, the inverse procedure applied to the horizontal interstation magnetic responses (M-responses) allowed us to reliably separate the effect of the Dnepr-Donetsk sedimentary basin from that of the crustal Kirovograd anomaly (Fig. 3). In both case studies, the inverse models obtained from the M-responses seem less distorted by the influence of peripheral structures than models derived from the inversion of induction vectors alone, and they also provide better focused images of the crustal conductors.

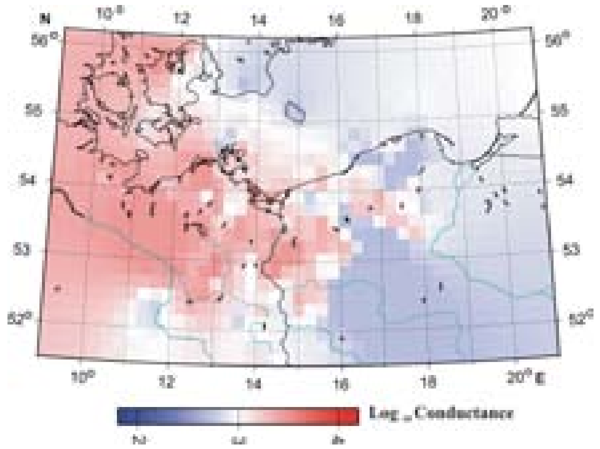

Fig.2. Results of a double-sheet inversion of geomagnetic induction data across the Kirovograd conductivity anomaly. Left: first, shallow sheet with a fixed a priori conductance at the depth of 2 km. Right: Model of the conductance distribution as a result of the thin sheet inversion for a second, crustal thin sheet at the depth of 10 km; period T=2049 s.

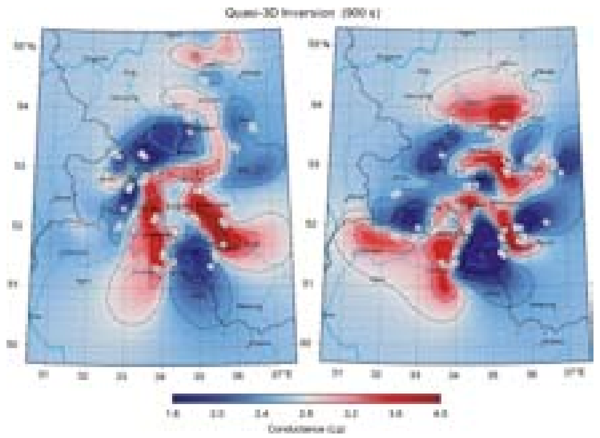

Fig. 3 Northern part of the Kirovograd anomaly – model of the conductance as a result of the thin sheet modelling for the thin sheet at the depth of 20 km; period T=900 s; left – inversion for the interstation horizontal transfer functions M, right – inversion for the vertical induction vectors Wz .

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—— References:

***Gordienko V. V., Gordienko I. V., Zavgorodnyaya O. V., Kováčiková S., Logvinov I. M., Pek J., Tarasov V. N., Usenko O. V., 2005.** „Ukrainian Shield (geophysics, deep processes)", monograph of the Ukrainian Academy of Sciences, Kiev. Korvin press. 210 pp.*

***Gordienko V. V., Gordienko I. V., Zavgorodnyaya O. V., Kováčiková S., Logvinov I. M., Pek J., Tarasov V. N., Usenko O. V., 2006,** „The Dnepr-Donetsk Basin (geophysics, deep processes)", monograph of the Ukrainian Academy of Sciences, Kiev : Korvin press. 143 pp.*

***Gordienko V.V., Gordienko I.V., Zavgorodnyaya O.V., Kovacikova S., Logvinov I.M., Tarasov V.N., Usenko O.V., in press.** "Volyno-Podolian Plate (Geophysics, deep processes)", monograph of the National Academy of Sciences of Ukraine, Kiev. NASU, Kiev.*

***Červ, V., Kováčiková, S., Menvielle, M., Pek, J. 2008.** Inversion of the geomagnetic induction data from EMTESZ experiments in NW Poland by stochastic MCMC and linearized thin sheet inversion. Protokoll über das Kolloquium Elektromagnetische Tiefenforschung. Potsdam : Deutsche Geophysikalische Gesellschaft, 2008 – (Ritter, O.; Brasse, H.) pp. 126-131. ISSN 0946-7467. [Kolloquium Elektromagnetische Tiefenforschung /22./. Děčín (CZ), 01.10.2007-05.10.2007]*

***Ernst, T., Brasse, H., Červ, V., Hoffmann, N., Jankowski, J., Jóźwiak, W., Kreutzmann, A., Neska, A., Palshin, N., Pedersen, L. B., Smirnov, M., Sokolova, E., Varentsov, I. M. and the EMTESZ-Pomerania Working Group, 2008.** Electromagnetic images of the deep structure of the Trans-European Suture Zone beneath Polish Pomerania. Geophysical Research Letters 35, N. 15.*

Deformation coupling between crustal units and their differential exhumation during Variscan crustal thickening

The crust-mantle interaction during orogenesis is a major issue in understanding deep-seated thermo–mechanical processes in large orogens, in particular the behavior of subcontinental mantle during continental collision. Despite a considerable effort in understanding rheology, petrogenesis and metamorphic conditions of these rocks from the Variscan orogenic root in the past, there has been a lack of detailed work and of a complex approach combining geochemistry, geochronology, structural geology, petrology and petrofabrics. The variety of relationships between peridotites, granulites surrounding them, migmatites and metabasites within the Gföhl Unit of the Bohemian Massif suggests that the thermal and mechanical behavior of orogenic lower crust and underlying mantle was complex and reflected multiple phases of the Variscan tectonic history. Various HP–HT (high pressure – high temperature) rocks from the Gföhl Unit in the Variscan Bohemian Massif have been studied in order to assess their origin, primary distribution in lithospheric profile and strain coupling.

The Mohelno peridotite is a garnet-spinel serpentinized harzburgite (Kusbach et al., in press) from the felsic Náměšť Granulite Massif. The Mohelno peridotite corresponds to a large slice of refertilized mantle with peak PT conditions of about 2.2 GPa and 1150 °C. The peridotite body forms a large fold with a steep hinge and a vertical axial plane. The surrounding felsic granulite shows mylonitic fabric S2 (rarely with preserved coarse-grained granulite fabric S1) revealing peak conditions of 1.8 GPa and 800 °C and heterogeneous D3 retrogression at about 0.7–1 GPa and 650 °C. The mylonitic granulite facies foliation S2, which is completely parallel with the shape of the peridotite folded sheet, was later affected by small-scale folding, shearing and melting during D3 retrogression. EBSD measurements demonstrated the presence of two different dry slip patterns. The inner margin of the fold reveals presence of an axial [010] LPO pattern, while the linear [100](0kl) LPO olivine pattern is dominant in the rest of the fold. Both slip systems are in good agreement with S2 fabric in the surrounding granulites. Our dataset shows good mechanical coupling between the peridotite sheet and the host felsic granulite, pointing to a relatively low rheological contrast between upper-mantle and lower-crustal rocks in the lower crustal conditions.

In the Blanský Les Massif (SW Bohemia), a combined microstructural and petrological analysis (Franěk et al., 2011) of preserved low strain domain of lower crustal felsic rocks was conducted in order to assess the physical conditions and possible mechanisms of deformation in granulite facies. In particular, the complex deformational behaviour of feldspar (the main constituent of the felsic granulites) was studied in order to evaluate the influence of solid solution mixing and variations in crystallographic structure during the cooling process. A complex evolution of alkali feldspar rheology during granulite formation and exhumation was observed. Changes in ductility are ascribed to chemically and deformationally driven recrystallization, variations in grain size as well as to changes in temperature and in the amount of interstitial melt.

The structure of the lithosphere formed by amalgamation of oceanic post-Cadomian crustal slices during the Variscan orogeny was investigated in the Letovice Complex in the eastern part of the Bohemian Massif (Soejono et al., 2010). The Letovice complex formed by metamorphism of enriched mid-ocean ridge basalts with trondhjemitic sheets, as well as of gabbroic and ultrabasic bodies. A polyphase tectonic evolution of the study area was connected with underthrusting and subsequent exhumation of the former oceanic crustal domain. New U–Pb dating of magmatic zircons from amphibolite and trondhjemite yielded statistically identical concordia ages of 530 ± 6 Ma and 529 ± 7 Ma (2σ), respectively, interpreted as the ages of intrusions of the protoliths of the studied rocks. The Letovice Complex is interpreted as a vestige of an incipient oceanic basin that developed on attenuated crust at the northern margin of Gondwana. It most likely reflects a post-Cadomian extensional regime that marked the onset of the break-up of the Gondwana supercontinent.

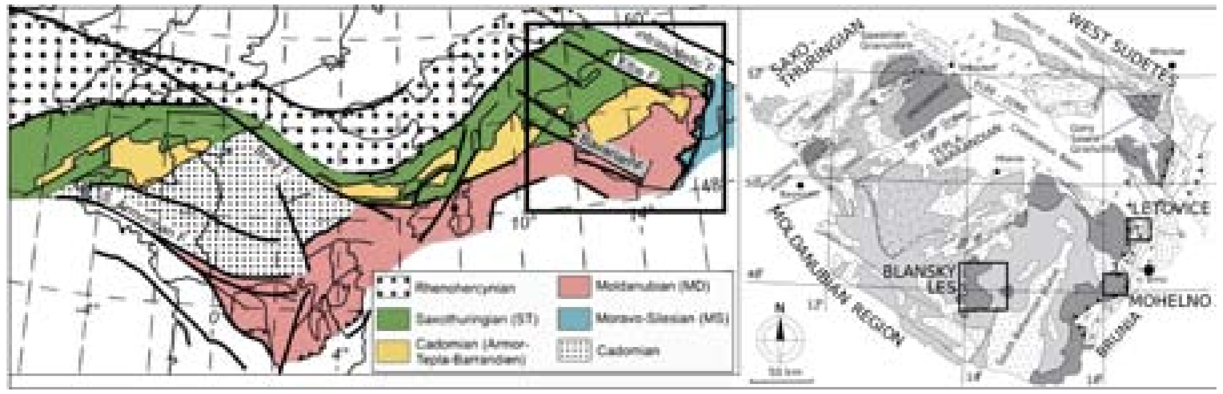

Fig. 1 Left: Map of Variscan Belt in Europe (modified after Franke, 2000). Bohemian Massif is the easternmost part of the European Variscides. Right: Simplified tectonic map of the Bohemian Massif showing the locations of the studied localities. (after Transeuropean Suture Zone project, http://www.geofys.uu.se/eprobe/Projects/tesz/TESZ.htm)

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References:

Franěk J., Schulmann K., Lexa O., Ulrich S., Štípská P., Haloda J. and Týcová P., 2011. *Origin of felsic granulite microstructure by heterogeneous decomposition of alkali feldspar and extreme weakening of orogenic lower crust during the Variscan orogeny, Journal Of Metamorphic Geology 29(1), 103–130.*

Franke, W., 2000. *The mid-European segment of the Variscides: tectonostratigraphic units, terrane boundaries and plate tectonic evolution, in: Franke, W., Haak, V., Oncken, O., D., T. (Eds.), Orogenic processes: quantification and modelling in the Variscan Belt. Geological Society, London, Special Publications 179, pp. 35-61.*

Kusbach,V., Ulrich, S., and Schulmann, K., 2012. *Ductile deformation and rheology of sub-continental mantle in a hot collisional orogeny: Example from the Bohemian Massif. Journal of Geodynamics 56-57, 108 - 123.*

Soejono I., Žáčková E., Janoušek V., Machek M., Košler J., 2010. *Vestige of an Early Cambrian incipient oceanic crust incorporated in the Variscan orogen: Letovice Complex, Bohemian Massif, Journal of the Geological Society, London, 167, 1113–1130. DOI: 10.1144/0016-76492009-180.*

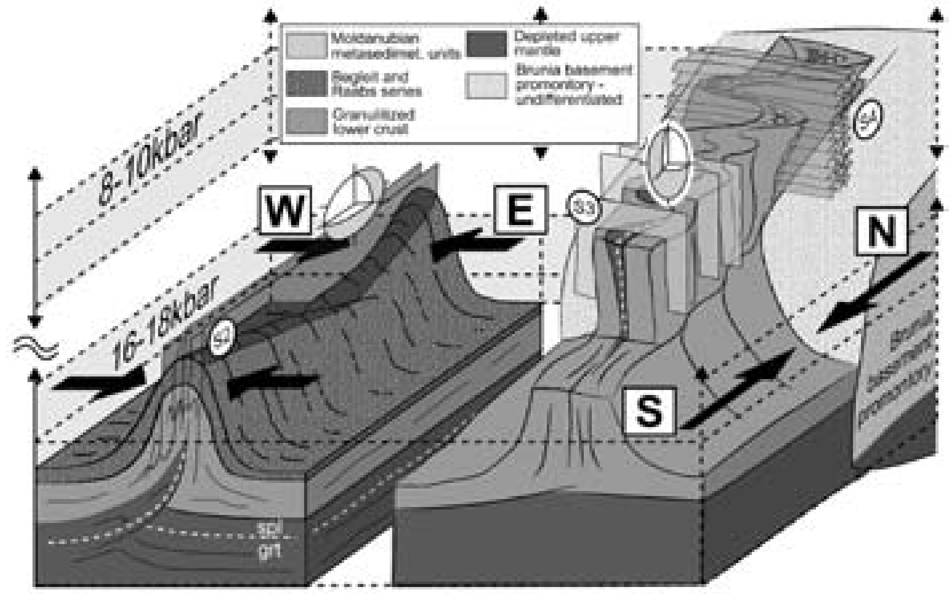

Fig.2. 3D model of imbrications of Mohelno lithospheric mantle and emplacement of the peridotite sheet into the folded lower crustal Náměšť Granulite Massif. Left: East-west shortening leads to emplacement of the mylonitized peridotite into the bottom of the thickened orogenic root and also triggers HT-HP mylonitization in surrounding granulites as well. Right: Later, in front of southward advancing Brunia continent, the mylonitic fabric both in peridotite and granulite is actively reworked during intensive folding and extrusion of the granulite-peridotite complex to mid-crustal conditions.

Transposition of structures in the Neoproterozoic Kaoko Belt (NW Namibia) and their absolute timing

The Neoproterozoic-Cambrian Kaoko Belt is a unique exposure of an orogen-scale (800×180 km), mid – to lower crustal transpressional system. It represents an important segment in understanding an amalgamation of West Gondwana. The Belt consists, from the east to the west and from the bottom to the top, of the following units: a) the Congo Craton with Neoproterozoic metasedimentary sequence, b) the strongly imbricated attenuated margin of the Congo Craton with inverted Barrovian metamorphic zoning (530-690ºC/0.85-0.9 GPa) developed between 585 and 550 Ma, c) the Congo Craton – derived migmatites of the Orogen Core metamorphosed in granulite facies (840ºC/0.8 GPa) at 550 Ma, d) the Boundary Igneous Complex of syn-collisional granitoids (580-550 Ma) dominated by continuous thick sheet of Amspoort granite (550 Ma) derived mainly from the Coastal Terrane Neoproterozoic metapsamites (Janoušek et al., 2011) and e) the metasedimentary Coastal Terrane with partial melting at the contact with the Boundary Igneous Complex dated to ~550 Ma. A unique presence of other migmatites developed at 650-620 Ma clearly distinguishes the Coastal Terrane from other tectonic units of the Kaoko belt (e.g. Goscombe and Gray, 2008; Konopásek et al., 2008). Structural profiles along Hoanib, Hoarusib, Khumib and Nadas rivers were constructed from the Coastal Terrane to the Orogen Core, in order to understand the temporal and spatial evolution of this "classical" transpressional orogen and to address the problems of kinematic partitioning as well as mechanism of rapid exhumation of granulite facies rocks.

We identified several generations of deformation fabrics. The oldest flat Si fabric occurs exclusively in the Coastal Terrane and is attributed to a pre-collisional tectono-metamorphic event (650-620 Ma). The first collisional deformation D1 either reactivated or folded the Si fabric in the Coastal Terrane and S1 fabric gently dips to the W. Distribution of F1 fold axes suggests a predominantly flattening regime during S1 development. S1 appears also as an early planar magmatic fabric in granitoids of the Boundary Igneous Complex, as well as a migmatitic fabric of the Orogen Core domain. A superimposed, subvertical S2 fabric corresponds to axial planar cleavage of upright closed to isoclinal folds developed during D2 deformation. Active migration of partial melt from S1 into progressively developed S2 fabric in the Orogen Core dates the onset of this deformation at ~550 Ma. The extent of S2 fabric increases to the N and its strike changes from the N-S in the Hoanib to the NW-SE in the Khumib profile. Finally, several large-scale S3 shear zones follow the S2 foliation and show mylonitic fabric with sinistral kinematics.

Distribution of F2 fold axes and L2 stretching lineations as well as solid-state reworking of both S1 and S2 planes suggest temporal evolution from E-W oriented and pure-shear dominated subhorizontal shortening, followed by sinistral transpression with strain partitioning into domains of oblique thrusting (reactivated S1) and transcurrent sinistral shearing (S2). The described succession of deformation structures suggests that major sub-vertical shear zones S3 in the Kaoko Belt, which are parallel to S2, do not correspond to early crustal discontinuities (e.g. Goscombe and Gray, 2008), but rather reflect late-phase strain localisation during cooling. Such spatial variation in the deformation record is attributed to the irregular shape of the Congo Craton indenter that is reflected by heterogeneous development of the S2 cleavage front in the Coastal Terrane and the Boundary Igneous Complex.

The switch from D1 to D2 deformation at 550 Ma is attributed to a drop in strength of the partially molten rocks within the S1 foliation in the Orogen Core. High viscosity contrast in partially molten, bilaminate rock decreased the critical buckling stress thus allowing significant shortening in flattening-dominated zones. Therefore vertical rock flow might be expected during buckling of low-viscosity rocks at the onset of transpression. Since the vertical heterogeneity (S2 fabric) was established, the deformation regime definitely changed to sinistral transpression and became more localized with progressive cooling. Ar-Ar dating of micas from the S3 shear zones suggest final termination of the transpression between 530-520 Ma.

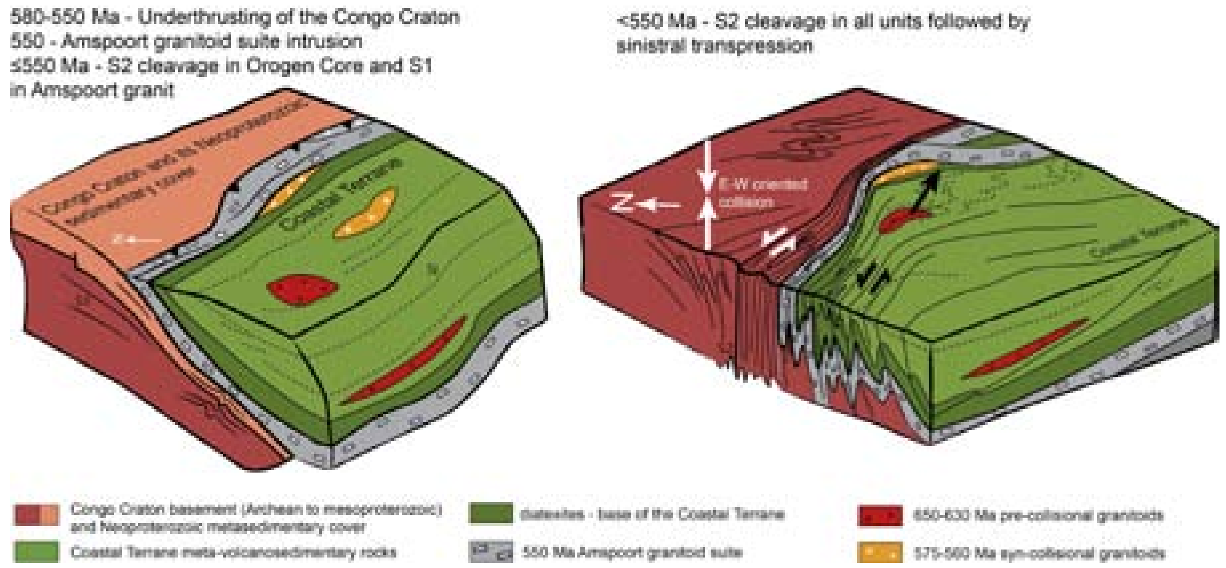

Fig.1. Schematic tectonic evolution of the Pan-African collision in the Kaoko belt. (a) Oblique underthrusting of the attenuated Congo margin below the Coastal Terrane, and development of S1 fabric and Barrovian metamorphic zones. At 550 Ma, a migmatization occurred in S1 foliation of the Orogen Core as well as at the base of the Coastal terrane, and intrusion of Amspoort granite suite along boundary of colliding crustal blocks. (b) Ongoing E-W shortening led to heterogeneous development of S2 cleavage front in the Coastal Terrane and the Boundary Igneous Complex as a result of irregular shape of the Congo Craton margin.

IG research staff involved:

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References:

Goscombe, B.D., Gray D.R., 2008. *Structure and strain variation at mid-crustal levels in a transpressional orogen: A review of Kaoko Belt structure and the character of West Gondwana amalgamation and dispersal. Gondwana Research, 13:45-85.*

Gray, D., Foster, D.A., Goscombe, B.D., Passchier, C. & Trouw, R., 2006. *40Ar/39Ar thermochronology of the Pan-African Damara Orogen, Namibia, with implications for tectonothermal and geodynamic evolution. Precambrian Research 150, 49-72.*

Janoušek, V., Konopásek, J., Ulrich, S., Erban, V., Tajčmanová, L., Jeřábek, P., 2010. *Geochemical character and petrogenesis of Pan-African Amspoort suite of the Boundary Igneous Complex in the Kaoko Belt (NW Namibia), Gondwana Research 18, 688-707.*

Konopásek, J., Košler, J., Tajčmanová, L., Ulrich, S., Kitt, S.L., 2008. *Neoproterozoic igneous complex emplaced along major tectonic boundary in the Kaoko Belt (NW Namibia): ion probe and LA-ICP-MS dating of magmatic and metamorphic zircons. J Geol Soc London 165:153-165.*

Processes of magma emplacement (Structural, microstructural, geophysical, analogue and numerical modelling studies)

—— The percolation of magma, its emplacement in the Earth's crust and eruption on the surface represent significant processes controling the Earth tectonics, rock deformation and rheology. Crucial information for the interpretation of magmatic processes associated with the viscous flow and deformation is recorded in internal fabrics of various magmatic bodies at different crustal levels (plutons, laccoliths, lava domes, lava flows). Internal fabric pattern within the magmatic rock bodies reflects the magmatic emplacement and ascent processes, regional deformation and their successions in time. Research of these processes requires use of a number of methods: field-oriented structural geology, anisotropy of magnetic susceptibility (AMS), paleomagnetic investigation, magnetic mineralogy, microstructural analysis and analogue modeling are combined with geophysical, petrological, geochemical, and numerical studies (Font et al., 2011; Kratinová et al., 2010; Kratinová et al., 2011; Závada et al., 2011; Žák et al. 2011). Below, selected results of research on these topics in the IG are presented.

—— Tectonics, emplacement mechanisms and shape of magmatic bodies

—— Tectonic aspects of magmatic intrusions, emplacement mechanisms and shape of magmatic bodies were studied in two plutonic regions of the Variscan orogenic belt (Bohemian Massif and Central Vosges massif, France) and on one phonolite body in the Tertiary Eger Rift system (Bohemian Massif). The structural and AMS analysis of a large anatectic crustal domain in the Central Vosges provides evidence for extensional tectonics of Late Carboniferous age, synchronous with the partial melting. The regional AMS fabric pattern reflects a complex evolution on regional scale, comprising vertical emplacement in transtensional regime followed by mid-crustal extensional flow and diapiric ascent of crustal granites (Kratinová et al., 2011).

—— An investigation of the Štěnovice and Čistá granodiorite–tonalite plutons (central Bohemian Massif) reveals their origin as the products of initial stage of voluminous Late Devonian plutonism. The calc-alkaline magma forming these plutons was generated in a continental margin arc setting, showing a shift of plutonic activity from the NW to the SE during Late Devonian to Early Carboniferous. This is compatible with the SE-directed subduction of the Saxothuringian Ocean beneath the Teplá–Barrandian upper plate as a principal cause of the arc-related plutonism (Žák et al., 2011).

—— Magmatic fabric superpositions and flow mechanisms

—— Correlation of internal fabric in magmatic bodies and analogue models provides important clues about the cause of magmatic fabric superpositions and nature of flow mechanisms. It has been documented that the finite shape of AMS fabric ellipsoid is highly sensitive to both strain regime and superpositions of successive orthogonal deformation events (Kratinová et al., 2011). The vertical movement of material in ascending intrusions is accommodated by various flow mechanisms operating simultaneously (Kratinová et al., 2010). The complex fabric patterns in such intrusions suggest that the rise of igneous material within them is associated with the transposition of the flow fabrics from vertical to horizontal, and development of vertical shear zones along the walls of the intrusions (Kratinová et al., 2010). Such behaviour documents the fact that the rheological properties play a key role in building the flow fabric in granites.

—— Combined techniques of structural analysis of fractures and magmatic fabrics on one particularly well exposed phonolite body (Bořeň, Eger rift, Bohemian Massif) together with analogue and thermal mathematical modeling revealed that the phonolite probably represents a remnant of an asymmetric extrusive dome emplaced into a phreatomagmatic maar-diatreme crater within estimated time period of 6–66 days and cooled down to a background temperature in 10,000 years (Závada et al., 2011). Analogue models corresponding to the Bořeň phonolite body revealed a domain of circumferential flow around highly anisotropic fabric associated with the upward plug-flow in the vertical stems underlying the extrusive domes (Závada et al., 2011). Mostly vertical microscopic cavities throughout the exposed body resulted from rapid lateral diffluence of the magma above the maar crater.

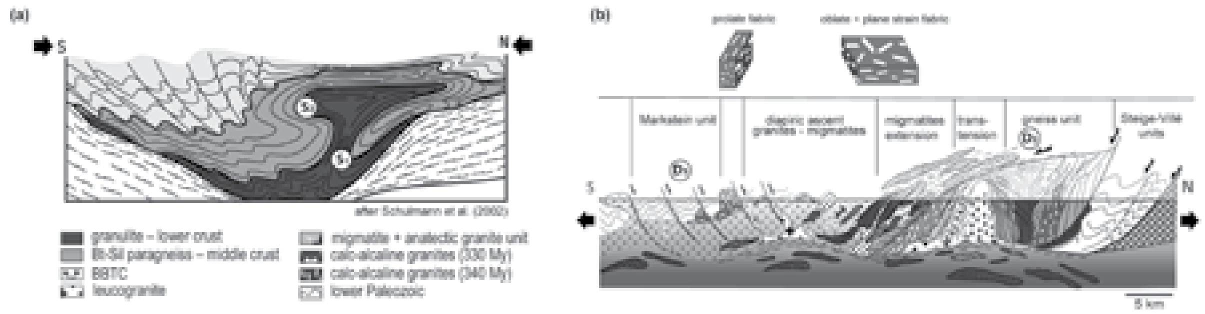

Fig.1. Schematic orogenic scale cross-sections showing the interpreted tectonic evolution of the Central Vosges. (a) Late convergent deformation is associated with the development of the steep foliation S1 due to the vertical extrusion of the lower crustal rocks. This is locally overprinted by flat foliations S2 related to the lateral spreading of partially molten rocks (b) The region is overprinted by the subsequent extensional deformation D3 structures.

—— IG research staff involved:

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—— References:

Font, E., Youbi, N., Fernandes, S., El Hachimi, H., Kratinová, Z., and Hamim Y., 2011. *Revisiting the magnetostratigraphy of the Central Atlantic Magmatic Province (CAMP) in Morocco. Earth and Planetary Science Letters, 309, (3-4), 302-317.*

Kratinová Z., Machek M., and Kusbach V., 2010. *Fabric transpositions in granite plutons - an insight from non-scaled analogue modelling,* Journal of the Geological Society of India, 75, 267-277.

Kratinová, Z., Schulmann.K., Edel, J.B., and Tabaud, A.S., 2012. *AMS record of brittle dilation, viscous stretching and gravity driven magma ascent in area of magma rich crustal extension (Vosges Mts., NE France). International Journal of Earth Sciences, 101, 705-714.*

Závada, P., Dědeček, P., Mach, K., Lexa, O. and Potužák, M., 2011. *Emplacement dynamics of phonolite magma into maar-diatreme structures — Correlation of field, thermal modeling and AMS analogue modeling data. Journal of Volcanology and Geothermal Research, 201 (1-4), 210-226.*

Žák J., Kratinová, Z., Trubač J., Janoušek V., Sláma J., and Mrlina J. , 2011. *Structure, emplacement, and tectonic setting of Late Devonian granitoid plutons in the Teplá-Barrandian unit, Bohemian Massif. International Journal of Earth Sciences, 100 (7), 1477-1495.*

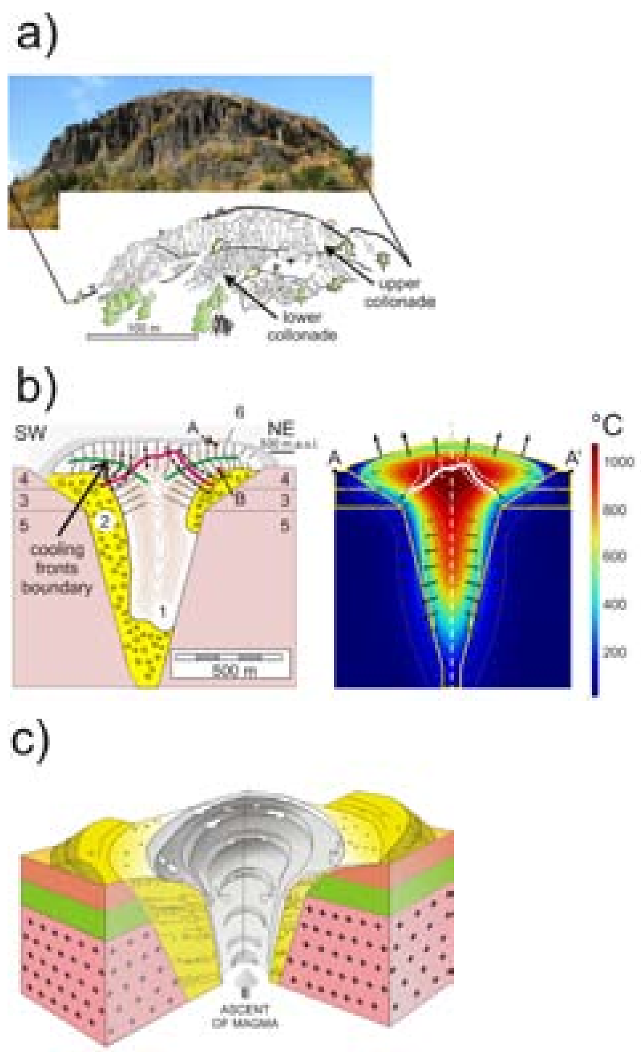


Fig.2. Double-tiered pattern of columnar jointing developed on Bořeň phonolite body (a) matches with the corresponding thermal model (b), which was constructed for an analogue modeling intrusion into a maar-diatreme crater. The internal flow pattern (c) interpretation within the maar-diatreme intrusions is based on the AMS (anisotropy of magnetic susceptibility) fabric in the models from dispersed magnetite powder.

Problems of AMS fabric acquisition in rocks

—— A fundamental technique to establish the internal rock structure is nowadays the anisotropy of magnetic susceptibility (AMS), because of the easy and fast measurement and high sensitivity. AMS has become an extensively used method in structural geology; it is frequently applied for systematic mapping of flow fabrics in magmatic rocks or deformation in metasediments. However, there is a lack of comprehensive information about the governing processes of AMS in rocks, origin of the magnetic fabric, its correlation with the bulk deformation and rock strain memory (e.g. Borradaile and Henry, 1997; Kratinová et al., 2010; Hrouda, 2010).

—— Ongoing research in the Department of Tectonics and Geodynamics at the IG aims at understanding of processes of AMS fabric formation, the evolution of AMS with progressive strain and its significance in specific rocks (magmatic, sedimentary). The research comprises field-oriented studies, comparative fabric studies, deformation experiments and analogue modeling.

—— The comparative studies contain detailed quantitative correlation between AMS and preferred orientation of other rock-forming minerals. The problems of AMS fabric interpretation in magmatic rocks were recently illustrated by a comparison between large feldspar phenocrysts representing a typical magmatic structural feature and AMS defined by biotite, exemplified by the Land's End granite (Kratinová et al., 2010). These two fabric types are correlated with respect to different scales of observation, location of samples, fabric intensity and dominant global tectonic trends. Tensor analysis of the K-feldspar fabric shows a complex pattern, characterized by meter-scale variations in orientation, symmetry, and intensity, mainly related to heterogeneous flow of the phenocryst-rich magma during emplacement. In contrast, the AMS fabric is predominantly homogeneous and stable at the pluton scale. Quantitative microstructural analysis suggests that the AMS fabric is controlled by deformation of the partially crystallized matrix, resulting from the combined effects of late internal adjustment within the pluton and regional deformation. A general model of fabric development associated with a vertical pure-shear overprint on a variable vertical fabric is evaluated by numerical modeling. The study demonstrates how the memory of different fabric elements may be dependent upon their grain size, crystallization sequence, and recorded previous strain. In general, a high sensitivity of AMS method to late overprints is demonstrated. In contrast, the feldspar fabric retains information about internal material transfer processes. Consequently, the AMS must be used in combination with other techniques of structural analysis to provide complete information about magma emplacement and transfer processes in local and crustal scales.

—— The research of AMS fabric acquisition in rocks continues in the frame of experimental study on deformed samples to analyze the initial formation of AMS compared with detailed microstructural analysis. The experimental results are compared with natural shear zones in marbles and salt rocks.

—— IG research staff involved:

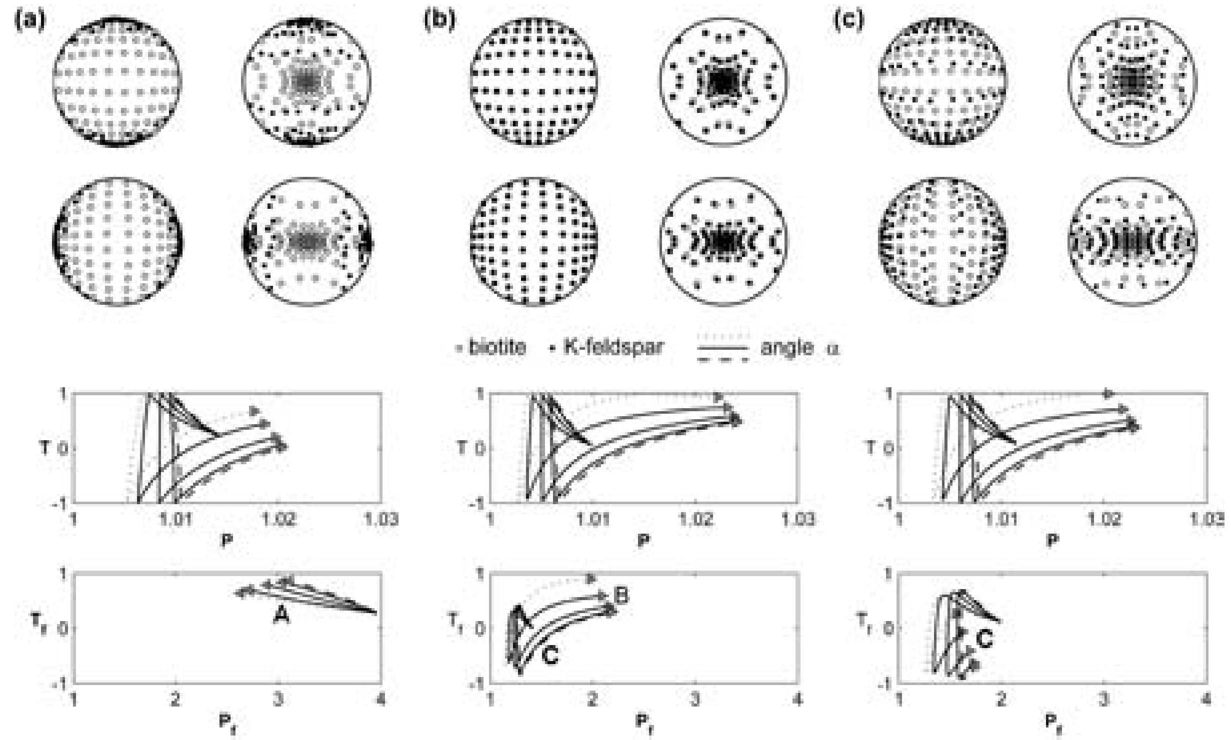
Z. Kratinová, M. Machek, P. Závada, V. Kusbach

—— References:

Borradaile, G. J., and Henry, B., 1997. *Tectonic applications of magnetic susceptibility and its anisotropy. Earth Sci Rev, 42, 49–93.*

Hrouda, F., 2010. *Modelling relationship between bulk susceptibility and AMS in rocks consisting of two magnetic fractions represented by ferromagnetic and paramagnetic minerals—Implications for understanding magnetic fabrics in deformed rocks. Journal of the Geological Society of India. 75(1). 254–266.*

Kratinová, Z., J. Ježek, K. Schulmann, F. Hrouda, R. K. Shail, and Lexa, O. 2010. *Noncoaxial K-feldspar and AMS subfabrics in the Land's End granite, Cornwall: Evidence of magmatic fabric decoupling during late deformation and matrix crystallization. J. Geophys. Res., 115, B09104, doi:10.1029/2009JB006714.*



Numerical models representing simplified scenarios of fabric development in the Land's End granite. The overall deformation overprint corresponds to a combination of vertical shortening and plane strain deformation with vertical shortening and horizontal elongation associated with NNW-SSE regional extension. The intensity versus shape of fabric ellipsoid is presented in the P-T plots for the AMS and Pf-Tf for the feldspar fabrics. (a) Scenario of initially strong vertical K-feldspar fabric reworked to the observed A type fabric (vertical feldspar foliation and horizontal biotite foliation). (b) Scenario of initially low intensity K-feldspar vertical fabrics resulting in the B type fabric (horizontal feldspar and AMS foliations). (c) Scenario of C type fabric developed due to late deformation superimposed on initially medium intensity K-feldspar fabric.

Plain-style volcanism in Tharsis on Mars

Mars displays a rich history of voluminous volcanic activity with a wide range of volcanic landforms. Even over 1000 Ma old volcanic landscapes are preserved on Mars due to the absence of plate tectonics, low erosion rates, and thin atmosphere. Main volcanic activity occurred in the Tharsis region, a volcanic plateau centered near the equator in the western hemisphere of Mars, with enormous shield volcanoes such as Olympus Mons. Many smaller old volcanoes and low shield volcanoes are often associated with extensive lava flows covering large areas of Tharsis. Their origin is connected with plain-style volcanism characteristic by widespread and relatively young effusive activity of low viscosity lavas The aim of our study was to interpret the age and rheological properties of selected lava flows in that area.

We presented absolute model age determinations of plains volcanism on Mars as derived from a previously developed model of impact crater size-frequency distributions. Our results suggested that extended areas in Tharsis have been resurfaced by volcanic activity in the last few tens of millions of years (see Fig. 1) by forming low shield volcanoes and associated lava flows. Morphometric analysis suggested that the yield strengths of selected lava flows are in the range of 100–300 Pa with viscosities between 10^2 and 10^3 Pa s, corresponding to basaltic compositions. The results of this study imply that, since Late Amazonian until the time determined in our study (last few tens of millions of years), and perhaps until recently, Mars has retained enough internal heat to produce wide-spread plain-style volcanism. No traces of recent endogenic activity have been found yet, although some studies point to very localized volcanism in the last few millions of years (e.g. Hartmann et al., 1999). Our current task is the investigation of an unnamed volcanic field north of the Biblis Patera shield volcano that displays a cluster of small volcanic edifices associated with heavily fractured crust, which most probably represent monogenetic pyroclastic cones (e.g. cinder cones).

IG research staff involved

P. Brož

References

***Hauber, E., P. Brož, F. Jagert, P. Jodłowski, and T. Platz, 2011**. Very recent and wide-spread basaltic volcanism on Mars, Geophys. Res. Lett., 38, L10201, doi:10.1029/2011GL047310.*

***Hartmann, W. K., M. Malin, A. McEwen, M. Carr, L. Soderblom, P. Thomas, E. Danielson, P. James, and J. Veverka, 1999.**, Evidence for recent volcanism on Mars from crater counts, Nature, 397, 586–589, doi:10.1038/17545.*

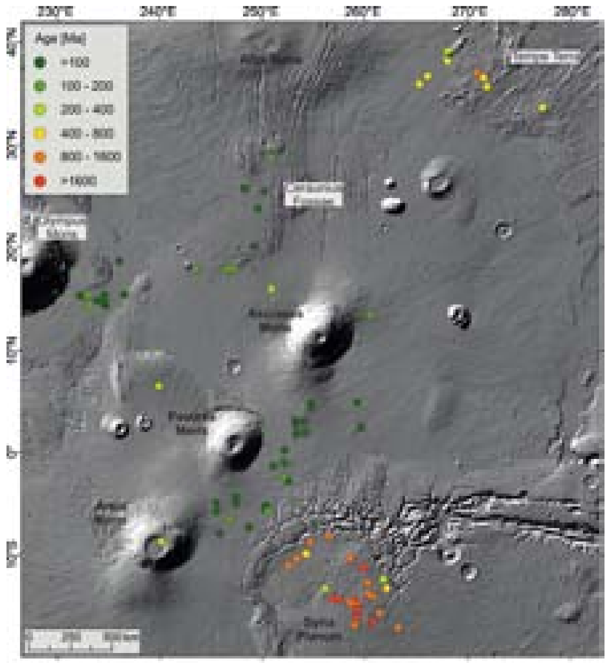


Figure 1. Ages of low shields in Tharsis on Mars. Background is MOLA shaded topography. Each colored dot represents one investigated low shield volcano. See legend for explanation of different colors.

Chinese tombs oriented by a compass: Evidence from paleomagnetic changes versus the age of tombs

A correspondence between an orientation of chinese imperial tombs („pyramids") along a modelled curve of declination (model CALS7K.2) for central China in the interval from 1000 BC. to 1420 AD. was found. It means for these objects of the dynasties Zhou, Han, Tang, Song and Ming. Chinese have used compass from time immemorial. They have used it for South-North orientation of objects in China in accordance with their spiritual principle feng shui. The study has been concentrated into the areas of historical capitals of Xi´an and Luoyang. An orientation of 32 pyramids has been studied. The magnetic pole continually moves, on the contrary to the nearly immobile rotating pole, and significantly deviate from it, up to 12o. Several chinese pyramids have a dimension similar to the greatest Egyptian pyramid, it means that their side is around 240 m. The study showed that the individual pyramids were oriented into direction to the position of the magnetic pole in the times of their constructions. The results of the study also enable an employing of the South-North orientations of further pyramids and also of greater chinese historical (architectural) objects such as city wals, spiritual paths, streets, palaces, canals, etc. as significant supplement for specification of computation of historical positions of magnetic pole. It is very suitable because data from considerable parts of Asia (including China) have not been so far included into computations of North pole positions because they are not so far available. This is the first worldwide study on this topic, not even China itself have not dealt with such research. The results of this study have already a great response in paleomagnetic or archeological research.

IG research staff involved

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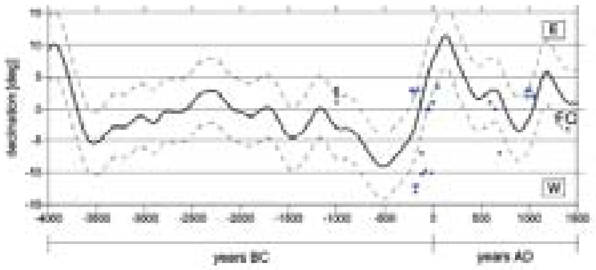
References

***Charvátová, I., Klokočník, J., Kolmaš, J. and Kostelecký, J., 2011.** Chinese Tombs Oriented by a compass: Evidence from Paleomagnetic Changes Versus the Age of Tombs, Studia Geophys. et Geod. 55, 159-174.*



Paleomagnetic declinations for the region of central China, according to the CALS7K.2 model for the time interval 4000 BC. till 1500 AD. The deviations of the declinations from the North geographic pole is plotted in degrees, positive values are to the East [E], negative values are to the West (W). A precision of the model has been estimated by the authors to be about 5o , it is indicated by the dashed lines around the paleodeclination curve.

Fig.1. The pyramid of the dynasty Western Han, Wudiling 140-87 BC, eye altitude 1.1 km, size 235x240 m (taken from Google Earth). Ling in chinese means imperial tomb.

Fig.2. The pyramid of the dynasty Western Han, Kan(g)ling 1 BC – 5 AD, eye altitude 1.1 km, size 225x235 m (taken from Google Earth). Ling in chinese means imperial tomb.

Deciphering the record on past sea-level changes and hydrodynamic conditions from stratigraphy and numerical modelling: examples from the Bohemian Cretaceous Basin

—— The Bohemian Cretaceous Basin represents an important archive of past climate and sea-level changes that took place during the mid-Cretaceous greenhouse time. Tectonic activity associated with reactivation of inherited fault zones of the Bohemian Massif during this time was the cause of formation of specific palaeogeographic setting of a strait surrounded by uplifted islands that connected the Boreal and Tethys marine realms, swept by vigorous currents of presumed tidal origin. The clastics shed from the uplifting islands formed deltaic and nearshore deposits that filled the marginal parts of the basin and interfingered with more distal, hemipelagic strata. Due to abundant borehole data the mutual relationships between the hemipelagic, strongly cyclically ordered strata dominated by carbonates, and nearshore clastics dominated by sandstone, can be studied in order to understand the role of sea-level change in the offshore cyclic successions.

—— Recent research has been focused on combination of the stratigraphic data obtained in the field and subsurface with numerical modelling. Two case studies are presented here, both using data from rocks of Turonian age: (i) a 2-D forward modelling study focusing on the record of sea-level fall in shallow-water hemipelagic strata, and (ii) an application of the Imperial College Ocean Model (ICOM), a fully hydrodynamic, unstructured mesh finite element model, to test the hypothesis of tidal circulation in the mid-Cretaceous shallow-marine strait.

—— Upper Turonian strata of the western part of Bohemian Cretaceous Basin record an interplay of relative sea-level oscillations, changes in hydrodynamic conditons and carbonate productivity in a shallow-water hemipelagic setting. A combination of outcrop data and well-log correlation with coeval siliciclastics makes it possible to examine in detail the lithological and geochemical expressions of the individual phases of sea-level cycle and corresponding changes in hydrodynamic regime (Laurin and Vodrážka 2010). These data suggest that lowstand systems tracts of ~400 k.y. sequences are marked by distinct (100 k.y.) phase lags between maxima in bottom shear stress (omission surfaces) and maxima in siliciclastic deposition (mudstone intercalations) in the shallowest zone of this hemipelagic setting. Importantly, sediment redistribution due to local differences in bathymetry induced up to 100 k.y. shifts in lithological markers, thus changing the hemipelagic expression of sea-level falls. The results, corroborated by numerical simulations (Fig. 1), underscore the fact that siliciclastic accumulation is a non-linear function of eustatic and relative sea-level changes. Hemipelagic records of climatic and orbital forcings can be markedly distorted in phases and magnitudes. It is demonstrated that two-dimensional numerical modeling can be instrumental in extracting unbiased signals.

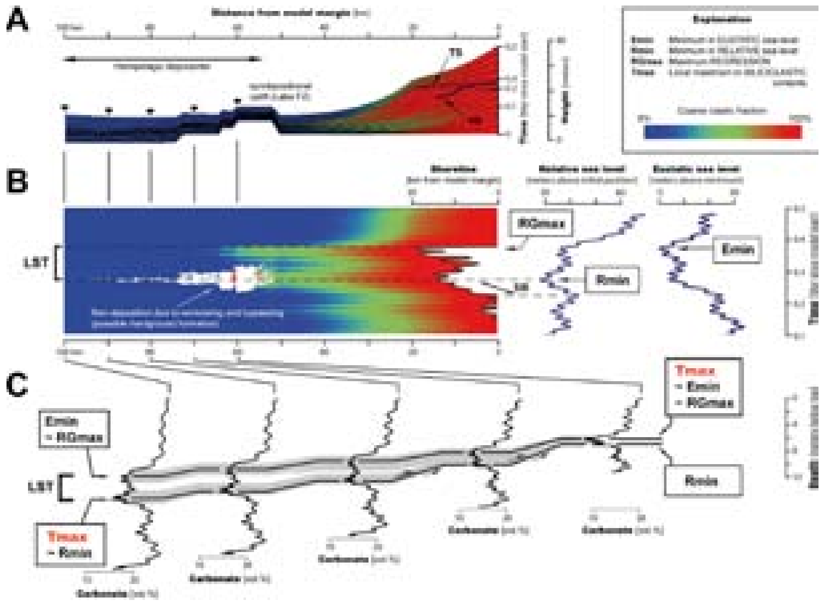


Figure 1. A Composite, 400 k.y. sequence simulated with SedTec2000 (Boylan et al. 2002). (A) Two-dimensional stratigraphic section (prior to burial compaction). SB = sequence boundary, TS = transgressive surface. (B) Chronostratigraphic section. Relative sea-level curve, eustatic sea-level curve and shoreline-movement curve shown for comparison. LST = lowstand systems tract. (C) Simulated boreholes. Lithology is represented by volumetric carbonate contents prior to burial. Note that the model generates a basinward change in the lithological expression of (1) minimum in relative sea-level (Rmin), (2) minimum in eustatic sea-level (Emin) and (3) maximum regression (RGmax).

—— For modelling of tidal current-induced bed shear stress and palaeocirculation in an epicontinental seaway, a case from Lower-Middle Turonian deposits of the Bohemian Cretaceous Basin was chosen that combines outcrop data on the depositional regime with subsurface data permitting the recosntrution of palaeogeography and basin-scale sandstone body geometry. In coarse-grained deltaic sandstones of Lower-Middle Turonian age, passing distally into fine-grained offshore sediments, dune-scale cross-beds superimposed on delta-front clinoforms indicate a vigorous basinal palaeocirculation capable of transporting coarse-grained sand across the entire depth range of the clinoforms (c. 35 m). Bi-directional, alongshore oriented, trough cross-set axes, silt drapes and reactivation surfaces indicate tidal activity. However, the Bohemian Cretaceous Basin at this time was over a thousand kilometres from the shelf break and separated from the open ocean by a series of small islands. The presence of tidally influenced deposits in a setting where co-oscillating tides are likely to have been damped down by sea-bed friction and blocked by emergent land-masses is problematic.

—— The Imperial College Ocean Model (ICOM), is used to test the hypothesis that tidal circulation in this isolated region was capable of generating the observed grain-size distributions, bedform types and palaeocurrent orientations. The model was first validated for the prediction of bed shear stress magnitudes and sediment transport pathways against the present day North European shelf seas that surround the British Isles. For the Bohemian Cretaceous Basin, the model predicts a micro – to mesotidal regime across a range of sensitivity tests with elevated tidal range in local straits and embayments. Funnelling associated with the straits increases tidal current velocities, with modelled bed-shear stresses capable of generating the sedimentary structures observed in the field. The model also predicts instantaneous bi-directional currents with orientations comparable to those measured in the field. Overall, ICOM predicts a vigorous tide-driven palaeocirculation within the Bohemian Cretaceous Basin that would have indisputably influenced sediment dispersal and facies distributions.

—— IG research staff involved

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—— References

Boylan, A.L., Waltham, D.A., Bosence, D.W.J., Badenas, B. and Aurell, M., 2002. *Digital rocks: linking forward modeling to carbonate facies. Basin Research, v. 14, p. 401-416.*

Laurin, J., and Vodrážka, R., 2010. *Record of sea-level fall in shallow-water hemipelagic strata: case study and numerical modeling. Terra Nova, v. 22, p. 103-109.*

Mitchell, A., Uličný, D., Hampson, G.J., Allison, P.A., Gorman, G.J., Piggott, M.D., Wells, M.R., Pain, C.C., 2010. *Modelling tidal current-induced bed shear stress and palaeocirculation in an epicontinental seaway: the Bohemian Cretaceous Basin, Central Europe. Sedimentology, 57, 359-388.*

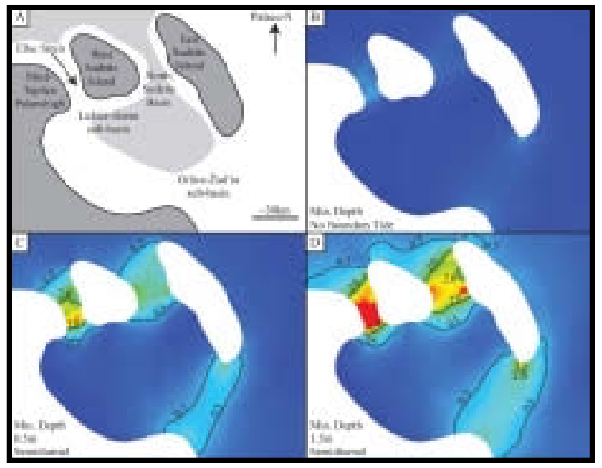


Figure 2. Comparison of modelled maximum bed shear stress patterns and magnitudes in the Bohemian Cretaceous Basin showing contours for significant values. The 0.5 Nm-2 contours show the approximate minimum bed shear stress required for the formation of dunes in coarse sand, whereas 1.0 N m-2 is the estimated minimum value required to form the interpreted 3D dunes in the Elbe Strait region. (A) Modelled palaeogeography of the Bohemian Cretaceous Basin and its constituent sub-basins; (B) The results for the scenario of purely astronomically forced tides and shallow regional paleobathymetry show bed shear stress values of <0.5 Nm^{-2} within the Elbe Strait, which are insufficient for the generation of 3D dunes. Results for (C) a 0.5 m semi-diurnal boundary tide regime and (D) a 1.5 m semi-diurnal boundary tide regime, both of which are set in the shallow regional palaeobathymetric domain, show that maximum bed shear stresses exceed the minimum threshold for the formation of dunes in coarse sand, with values in excess of 2.0 Nm^{-2} predicted in the Elbe Strait region. These results demonstrate that the magnitude of the maximum bed shear stress is strongly dependent on the amplitude of the co-oscillating boundary tide.

Gas hydrates stability and the dynamics of taliks in the Mackenzie Delta, Canada

—— Taliks are bodies of year-round unfrozen ground underneath shallow thermokarst lakes, which formed during Holocene in the last 10 000 years in regions of continuous permafrost. Thermal dynamics of taliks was explored by means of numerical modeling in the study area of the Beaufort Mackenzie Basin (Canada) permafrost and methane gas hydrate occurrences. The models and their analysis indicate that lithology and porosity play key roles in the control of talik formation or permafrost and gas hydrate persistence below lakes. When the underlying lithology is sandy the disappearance of permafrost and gas hydrate below a lake of any size is practically impossible, even if talik forms in the upper few tens of meters. The result is quite different for clayey lithologies. When the clayey lithologies are little compacted (48% porosity) neither permafrost nor gas hydrates disappear completely below the lake. However, when the clayey lithology is more compacted such that the porosity is 40% or less, both permafrost and gas hydrates disappear completely for a range of common lake bottom temperatures of 2 – 4 °C (Fig.1). The model results are in agreement with seismic and drilling interpretations and observations that show or infer talik forming under the centre of lakes. Conditions of sub-lacustrine permafrost and gas hydrate occurrences resemble generally settings where relict permafrost and gas hydrate persist under Holocene Beaufort Sea transgression, where gas hydrate preservation depends strongly on underlying lithological characteristics or low sea bottom temperatures. In both marine and lacustine settings permafrost degradation appears where porosities are <40% and water bottom temperatures reach 2-4 °C. However, a thin gas hydrate stability zone can persist where porosities are higher despite deep taliks formation.

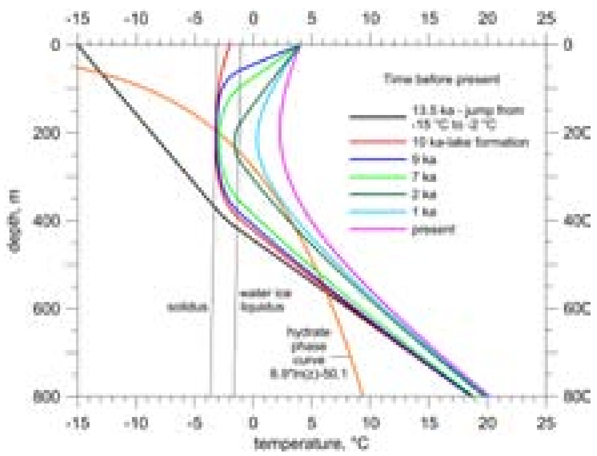


Fig.1. Transient temperature – depth profiles below the centre of a large lake (4 km across) simulated by solving numerically heat conduction equation in two dimensional geothermal model with clayey silt lithology of 35% porosity and the mean annual temperature of the lake bottom 4 °C. The simulation starts 13.5 ka ago by ground temperature rise from – 15 °C to – 2 °C. The lake formation 10 ka ago caused warming of the lake's bottom from – 2 °C to +4 °C and consequently gradual degradation of originally 400 m deep permafrost and shrinking of 500 m (60 m – 560 m) thick zone of gas hydrate stability. The last rests of permafrost disappear about 2 ka ago and the temperature rises everywhere above the gas hydrate stability zone 1 ka ago.

—— I.G. research staff involved:

J. Šafanda

—— References:

***Majorowicz, J., Šafanda, J., and Osadetz, K., 2011**. Gas hydrates stability and the dynamics of taliks in the Mackenzie Delta, Canada. Proceedings of the 7th International Conference on Gas Hydrates (ICGH 2011), Edinburgh, Scotland, United Kingdom, July 17-21, 2011. Paper number 684.00.*

Climate Warming in the Czech Republic: Evidence Stored in Shallow Subsurface

—— The long-term temperature monitoring in boreholes GFU-1 (150 m deep) and GFU-2 (40 m deep) on the campus of the Institute of Geophysics in Prague-Spořilov (50° 02′ 27″ N, 14° 28′ 39″ E, 274 m a.s.l.) and in the 40 m deep borehole Kocelovice (49° 28′ 02″ N, 13° 50′ 19″ E, 518 m a.s.l.) has shown that the surface air temperature (SAT) forcing represents the main cause for the ground surface temperature (GST) changes. This fact supports the use of the GST history as an indicator for the climate reconstructions. The shallow-depth temperature monitoring proved to be a useful tool to assess a certain measure proportional to the present-day warming rate. The 16-year (1994–2010) experiment at Prague-Spořilov clearly demonstrated a gradual warming (Fig.1). Its rate at the depth of 38 m varied within the range 0.025–0.040 K/year with a mean value of 0.0296 K/year. A shorter record from Kocelovice revealed lower warming rate, of 0.0168–0.0240 K/year at a similar depth. Both values are in good agreement with the observational results of local meteorological SAT series and with the GST histories extracted from the deeper holes, when the retardation effect of heat conduction is taken into account. The observed higher warming rate at Spořilov relative to Kocelovice together with the results of the SAT data from a number of local meteorological stations may confirm the assumption of regional character of the present-day (climate) warming and reflects an anthropogenic contribution to warming. The monitoring technique itself, if applied in an extensive area network of enough measuring sites, may suitably contribute to knowledge of regional aspects of the recent climate evolution.

—— IG staff involved:

V. Čermák, P. Dědeček, J. Šafanda, M. Krešl

—— References:

***Čermák, V., Dědeček, P., Šafanda, J., and Krešl, M., 2010.** Climate warming: evidence stored in shallow subsurface. In: Przybylak, R.; Majorowicz, J.; Brázdil, R.; Kejna, M. (Eds.) The Polish Climate in the European Context: An Historical Overview, 2010, DOI 978-90-481-3167-9_11, Springer Science+Business Media B.V.*

***Šafanda, J., and Majorowicz, J., 2010.** Geophysical Data. In: Przybylak, R.; Majorowicz, J.; Brázdil, R.; Kejna, M. (Eds.) The Polish Climate in the European Context: An Historical Overview, 2010, DOI 978-90-481-3167-9_8, Springer Science+Business Media B.V.*

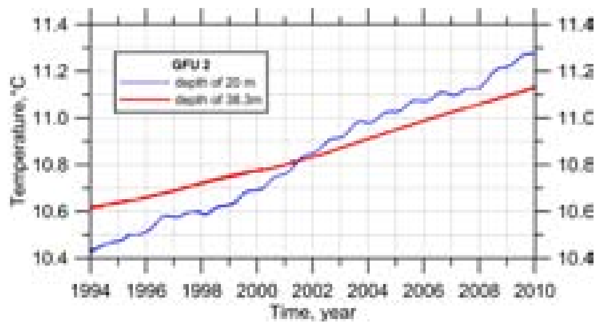


Fig.1. Sixteen year long time series of continuous temperature monitoring at two different depths (20 m and 38.3 m) of the borehole GFU-2 located on the campus of the Institute of Geophysics in Prague. In agreement with the theory, (i) amplitude of the warming propagating from the ground surface downward is larger at 20 m than at 38.3 m, (ii) the seasonal changes fade our between 20 m and 38.3 m.

Free convection of fluid in the borehole (results from the Outokumpu hole, Eastern Finland)

The Institute of Geophysics participated in high-resolution geothermal studies of the 2,516 m deep Outokumpu Deep Drill Hole in the Palaeoproterozoic complex in eastern Finland, drilled in 2004-2005. The geothermal results on temperature gradient, thermal conductivity and heat flow density yielded an exceptionally detailed data set and indicated a significant vertical variation in gradient and heat flow density. Heat flow density increases from about 28-32 mW m^{-2} in the uppermost 1000 m to 40-45 mW m^{-2} at depths exceeding 2000 m. The complete results appeared in Kukkonen et al. (2011a,b). Here we present an episode that occurred during our field work and helped in the understanding of the fluid convection mechanism in the hole.

When pulling-out the temperature probe from the hole, the cable got stuck at the depth of 1390 m and it took several days to save the probe. Due to this unfortunate incident, however, we obtained a high-resolution temperature-time monitoring record (Fig. 1), which clearly evidenced certain existing temperature "unrest" reflecting undoubted borehole fluid instability.

The inherence of time-dependent temperature variations with an apparent cyclic behavior presents an interesting phenomenon which deserves further explanation. External stress effects imposed by barometric fluctuations can have a significant impact on groundwater flow conditions, which may have their response in temperature variations. However, the observed high frequency character of temperature variations does not seem to correspond to at least one order lower frequency atmospheric pressure variations.

The water level in a hole tapping an aquifer responds to pressure head disturbances caused by dilatation of the aquifer, any harmonic component may be related to earth tides. In our case the water pressure (at 20 m depth) was monitored in the hole, as well as the heads in the shallow Quaternary aquifer were traced in a subsidiary hole at the distance of about 20 m from the main hole. The deep water table did not follow the shallow aquifer variations, instead it showed tidal variations. It is to be noted that these did not take place on time scales observed with the above temperature-time record. Nevertheless certain tidal modulation of the observed temperature variations cannot be excluded. Because tides influence the water movement and the saturation of the aquifer, the tidal hydrology may have a noticeable effect on the local conditions. On the other hand, highly heterogeneous structure and hydrogeological properties of the aquifer are difficult to characterize, and the modeling of the geothermal response to the tidal hydrology would be problematic.

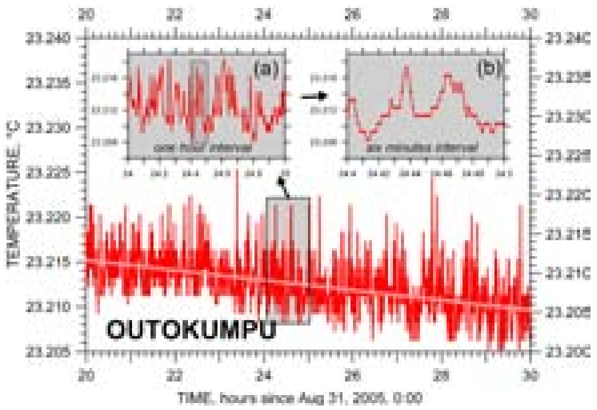


Fig.1. Temperature recorded at the 1390 m depth. Sampling interval 5 sec. Note the detailed oscillatory character of the temperature time variations in both inserted figures demonstrating the enlarged "1-hour" and/or "ten-minutes" time intervals. Slightly decreasing temperature corresponds to the unsettled probe temperature equilibration.

Based on our previous experience when we had detected similar temperature-time variations in other holes we attribute the observed temperature "unrest" to sluggish free convection of fluid in the Outokumpu hole. When a long fluid-filled column is subjected to thermal gradient, free thermal convection may occur in a hole filled with water as soon as the gradient exceeds a certain critical value. The increasing sensitivity of modern logging instruments recently opened new possibilities to analyze this phenomenon also in common boreholes.

The onset of free convection depends mainly on the borehole diameter and temperature gradient. The critical temperature gradient value, above which convection takes place, is about 0.15 mK/m in conditions of the Outokumpu hole (diameter 22 cm), which is about an order of magnitude smaller than the measured geothermal gradient values. Therefore, free convection is highly probable and the Outokumpu monitoring series well confirmed the complex stochastic structure of the microtemperature field. In analogy to the previous results based on theoretical considerations discussed in previous experiments, the height of convection cells is probably of the same order of size as the hole diameter; the characteristic period of the process amounts to 2.5-2.8 hours. The free convection creates only local temperature variations, which do not jeopardize the overall geothermal results. However, it generates a certain "noise" level which limits the temperature resolution that can be sought in studies of local temperature variations in a large diameter hole.

IG research staff involved:

V. Čermák, J. Šafanda

References:

Kukkonen, I.T., Rath, V., Kiveküs, L., Šafanda, J. and Čermák, V., 2011a. *Geothermal studies of the Outokumpu Deep Drill Hole. In: I.T.Kukkonen (Ed.), Outokumpu Deep Drilling Project 2003-2010. Geological Survey of Finland , Special paper 51, 181-197.*

Kukkonen, I.T., Rath, V., Kiveküs, L., Šafanda, J. and Čermák, V., 2011b. *Geothermal studies of the Outokumpu Deep Drill Hole, Finland: Vertical variation in heat flow and palaeoclimatic implications. Phys. Earth Planet. In., doi:10.1016/j.pepi.2011.06.002*

Moment tensor – a tool to assess the efficiency of hydraulic fracturing of geothermal reservoirs

—— The key question in creation of a well-permeable geothermal reservoir for facilities in geothermal industry is an effective fracturing of the rock mass between the boreholes of the Enhanced Geothermal System (EGS) that assures a sufficient connectivity of the boreholes for water circulation. The tool is the hydraulic fracturing – the industrial operation of pressurizing the borehole by pumping water in until the rock breaks. From the point of view of geomechanics, both the mode I and II, i.e., fracturing with the slip vector along the normal to the fault plane and tangential slip along the fault plane, are possible. It is obvious that just the former case is desirable, as a void space within the rock mass is created, where the water that exchanges heat can circulate effectively. During the hydro-fracturing, seismicity usually appears that can help to assess the properties of the crack system. The standard processing is the localization of the hypocentra of the microearthquakes, which answers the question where the rock massif has been fractured. On the next level of the data interpretation, the answer to the question "how the rock mass was fractured" can be gained by retrieving the mechanisms of the induced events.

—— The EGS at Soultz-sous-Forêts in Alsace, France (Fig.1), is one of the most important geothermal plants in Europe and a pioneering facility set up in the 1990s. It benefits from a high temperature gradient in the Rhine Graben that yields temperatures around 200 degrees in the depth of only 5 km (a sketch of the facility at an early stage is in Fig.2). We have processed several tens of sample events from the fluid injection in 2003 into GPK2 and GPK3 boreholes into the depth between 4400 and 5000 m, with the aim to determine the mechanism using the description by a complete moment tensor (MT). A possible presence of non-double-couple (non-DC) components of the complete moment tensor (which, in addition, have to be related by specific constraints) indicates an opening or closing of cracks due to fluid migration. The previous study by Cuénot et al. (2006) lined out mostly shear mechanisms but fairly large non-DC for few events close to the GKP3 borehole. We selected 45 largest events (all earthquakes above magnitude M_L1.8, and selected events between 1.6 < M_L < 1.8) with a high signal to noise ratio, which cover the entire duration of the experiment. We carefully picked peak P-wave amplitudes of the ground displacement recorded by the surface network of seismic stations deployed by the EOST, Strasbourg University, and inverted them as a standard linear

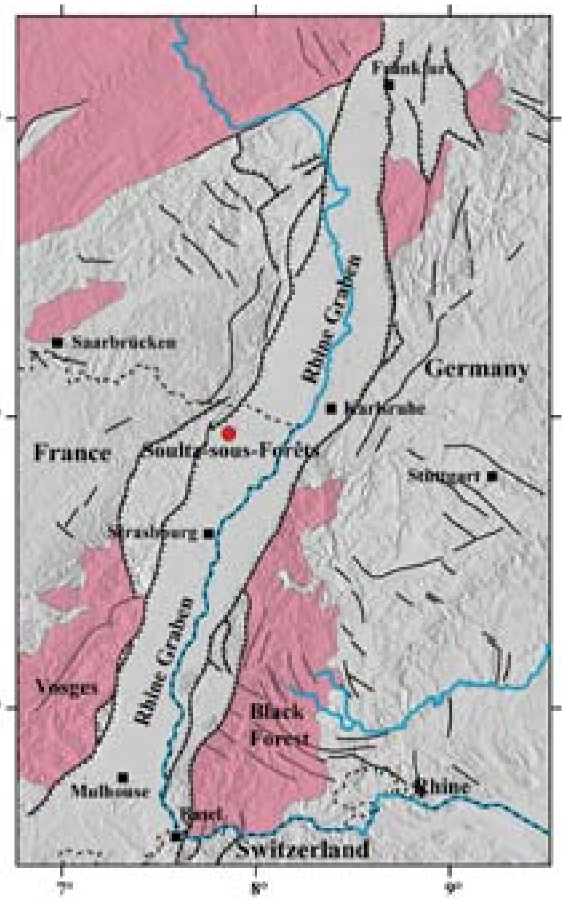


Fig.1. Location of the HDR site Soultz-sous-Forêts in the Rhine Graben (Cuénot et al., 2006).

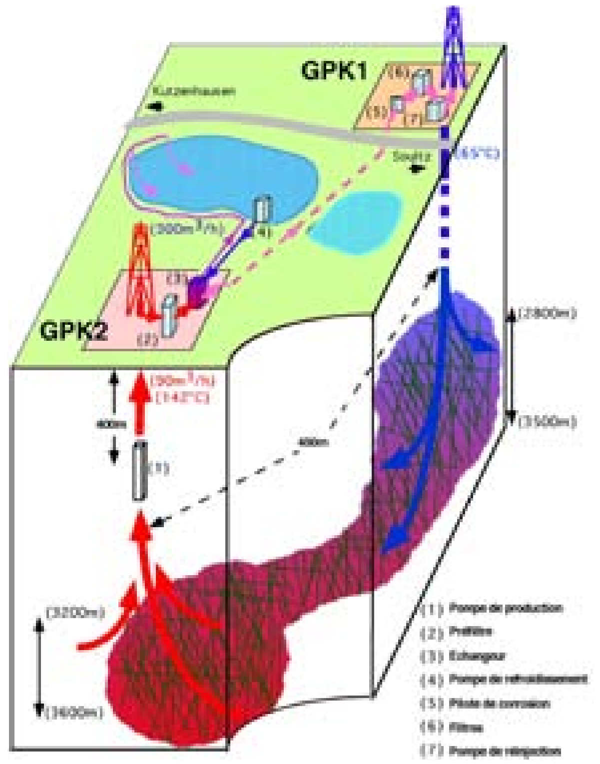


Fig.2: Sketch of the EGS facility Soultz-sous-Forêts at an early stage of its operation (Cuénot, 2010).

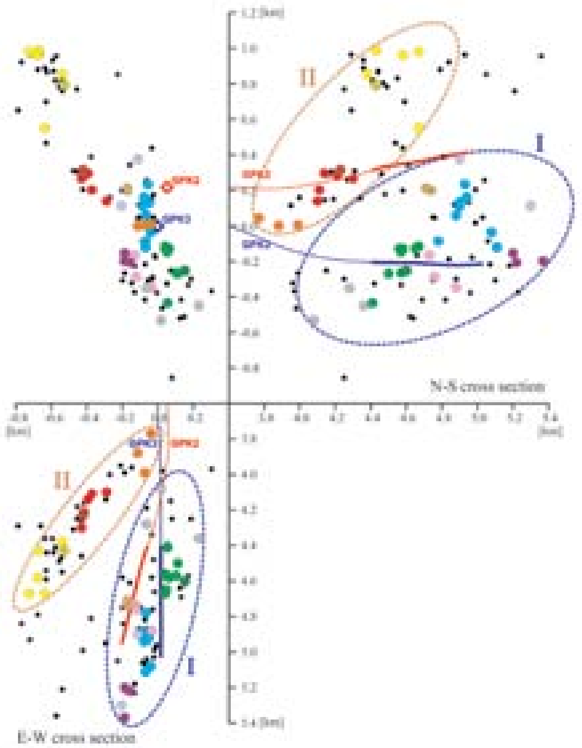


Fig.3: Spatial distribution of events investigated: upper left-hand side – map of epicentres; lower left-hand side – E–W cross-section and upper right-hand side – N–S cross-section. I, II – reservoir volumes where most of the seismicity occurred. Circles – events analyzed, colors correspond to the source mechanisms in Fig.4. Black dots – other events of magnitudes 1.4 ≤ M ≤ 1.6. Red and blue lines – trajectories of the GPK2 and GPK3 boreholes (thick lines denote the open-hole sections). Horálek et al., 2010.

inverse task by singular value decomposition (SVD). During the injection, two natural fault segments were activated (Fig.3). The source mechanism varies from a dip-slip pattern through an oblique normal (fault segment I) to a strike slip (segment II). No thrust component was found at all (Fig.4). This yields a subhorizontal clustering of T-axes and a rather large variation of P-axes from vertical to horizontal in the N-S direction, implying horizontal extension. An important feature was the absence of a significant non-DC component in the unconstrained MT: for all but one event, the non-DC remained below 10%, and in the jackknife testing it appeared to be insignificant. This means that despite the massive injection (total volume amounting 34 000 m^3) no large tensile cracks were originated and the injected fluid escaped into the natural fractures of the fault system. In other words, retrieval of the mechanism in description by unconstrained MTs suggests that the operation remained rather inefficient.

IG research staff involved:

J. Horálek, Z. Jechumtálová, J. Šílený

References:

Cuénot, N., 2010*. Induced microseismic activity at the Soultz-sous-Forêts EGS site: Main scientific results obtained in different experimental conditions. ECGS Workshop on Induced Seismicity – Luxembourg – November 15-17, 2010.*

Cuénot, N., Charléty, J., Dorbath, L. and Haessler, H., 2006*. Faulting mechanisms and stress regime at the European HDR site of Soultz-sous-Forêts, France, Geothermics, 35, 561–575.*

Horálek, J., Jechumtálová, Z., Dorbath, L. and Šílený, J., 2010*. Source mechanisms of micro-earthquakes induced in a fluid injection experiment at the HDR site Soultz-sous-Forets (Alsace) in 2003 and their temporal and spatial variations. Geophys. J. Int., 181, 1547-1565.*

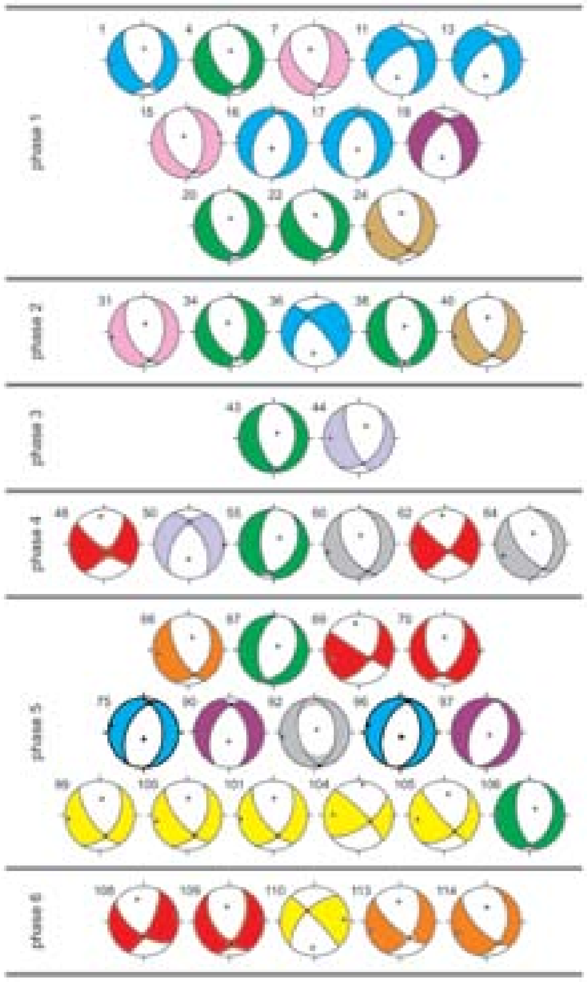


Fig.4: Source mechanisms of 45 micro-earthquakes that occurred during individual stages of the injection experiment (Horálek et al., 2010).

The geodynamo at a low Prandtl number

The geomagnetic field is generated by a hydromagnetic dynamo action in the Earth's core. Complicated processes occurring in the Earth's core constitute the driving mechanism of the geodynamo. Numerical simulations of the geomagnetic field have not been able to run in an Earth-like parameter regime because of the considerable spatial resolution that is required. The Prandtl number (the ratio of the kinematic viscosity to the thermal diffusivity), Pr, is the only parameter whose geophysical value can be directly used in dynamo models. In most numerical simulations researchers have used Pr=1, but for the outer Earth's core it is expected that the Prandtl number Pr=0.2 (Fearn, 2007). Hydromagnetic dynamos are strongly influenced by the Prandtl number and the magnetic Prandtl number (the ratio of the kinematic viscosity to the magnetic diffusivity), Pm.

In the case of low Prandtl numbers, dipolar dynamos are achieved for all values of Pm but Pm must be greater than some minimal value (Pm_{min}), which depends on the Ekman number (the ratio of the viscous force to the Coriolis force). The results show that Pm governs an influence of inertia for low Pr, i.e. an influence of inertia depends on how large the difference Pm – Pm_{min} is (see Fig. 1, the bottom row). For Pm close to Pm_{min} the magnetic field is convected out from polar region because inertia becomes important. There is much more activity in the polar regions at Pr=0.2 than at Pr=1 and as fluid motion becomes strong in the polar regions, the magnetic field is convected out (see Fig. 1, the top row and the right-hand panel). However, dynamos still remain dipolar and do not weaken. On the other hand, for Pm greater (much greater) than Pm_{min} magnetic field is not convected out from polar region (see Fig. 1, the top row and the left-hand panel). This case corresponds to the observed geomagnetic field (the magnetic field generated in the numerical modelling is in this case similar to the real geomagnetic field). Consequently, it is possible to conclude that the geodynamo operates in the mode Pm >> Pm_{min} (as Pr=0.2).

IG research staff involved:

P. Hejda, J. Šimkanin

References:

Fearn, D.R., 2007. *4.1. The Earth and its magnetic field, in Mathematical Aspects of Natural Dynamos, pp. 201-209, ed. Soward, A.M., Dormy, E., CRC Press, New York, USA.*

Šimkanin J., Hejda P., Saxonbergová-Jankovičová D., 2010. *Convection in rotating non-uniformly stratified spherical fluid shells in dependence on Ekman and Prandtl numbers, Phys. Earth Planet. Int., 178 (1-2), 39-47.*

Šimkanin J., Hejda P., and Saxonbergová D., 2011. *Hydromagnetic dynamos in rotating non-uniformly stratified spherical fluid shells in dependence on the Rayleigh number, Phys. Earth Planet. Int., 185, 100-106.*

Šimkanin J., Hejda P. , 2011. *Hydromagnetic dynamos in rotating spherical fluid shells in dependence on the Prandtl number and stratification, Geophys. J. Int., 185, 637-646.*

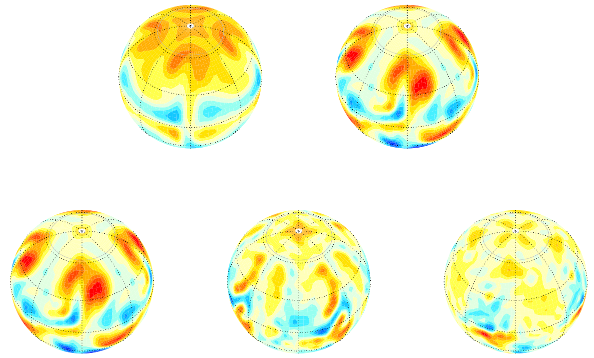


Fig.1. Space distributions of radial magnetic field components Br. Top row: cases modelled at Pm=3 and Pr=1 (left-hand panel) and Pm=3 and Pr=0.2 (right-hand panel). Bottom row: cases modelled at Pr=0.2 (all) and Pm=3, 15 and 35 (from left to right). Red and blue colours indicate positive and negative values, respectively.

Strongly magnetic soil developed on a non-magnetic rock basement: a case study from NW Bulgaria

Enhanced magnetic susceptibility (MS) of modern soils is supposed to be due to several causes, including, e.g., weathering of an iron-rich geological basement, natural fires, bacterial processes, and atmospheric deposition of anthropogenic particles. A specific case was studied (Grison et al., 2011) in which none of the above sources of magnetic enhancement is evident: a modern soil with high magnetic susceptibility over the entire soil profile, developed on non-magnetic limestones, in an area with no industrial activities. The spatial distribution of the MS of top-soils was measured over an area of about 1 km^2 using a Bartington MS2D field loop. Altogether 14 sites were measured and analysed by set of magnetic measurements. The surface MS varies from 60 to 110 x 10-5 SI, while that of the rock basement is nearly zero. The distribution of the MS along the vertical profiles did not show any specific zonation (Fig. 1). Significant frequency-dependent magnetic susceptibility, measured using different instruments at different frequencies, was observed along the entire vertical profiles (Fig. 2). In addition to this, we performed measurements of temperature dependence of MS, thermal demagnetization of 3D IRM. Hysteresis loops were measured at temperatures 300K, 100K and 5K, using a Quantum Design MPMS LX-5 instrument. Scanning Electron Microscopy with Wavelength Dispersive Spectrometry was carried out using CAMECA SX100 electron microscope. All the performed measurements suggest a dominant contribution of superparamagnetic magnetite/maghemite.

Mechanisms responsible for the increase of magnetic susceptibility may be connected with reduction-oxidation processes. It is known that an anoxic microenvironment favours efficient formation of Fe2+. Another possible mechanism of magnetic enhancement may be related to transformation of iron-(oxy)hydroxides and/or clay minerals migrating from the upper part of the profile and exposed to elevated temperatures. It is quite probable that the magnetic enhancement is caused by ooidal limestones, as in the case of soils in Wales and England (cf. Blundell et al., 2009). Limestones bearing Fe-ooids were found in basement rock in areas not far away from our study area. Although more analyses, such as Mössbauer spectroscopy, are needed in order to determine and characterize this magnetic phase, we believe that weathering the basement rock containing Fe-ooids is the most probable mechanism responsible for this magnetic enhancement of modern soil. Our findings are important for proper interpretation and site consideration in case of magnetic mapping of soils.

IG research staff involved:

H. Grison, E. Petrovský, N. Jordanova, A. Kapička

References:

Blundell A., Dearing J.A., Boyle J.F. and Hannam J.A., 2009. *Controlling factors for the special variability of soil magnetic susceptibility across England and Wales. Earth Sci. Rev., 95, 158–188.*

Grison H., Petrovský E., Jordanova N., Kapička A., 2011. *Strongly magnetic soils developed on non-magnetic rock basement: a case study from NW Bulgaria. Stud. Geophys. Geod., 55, 697-716.*

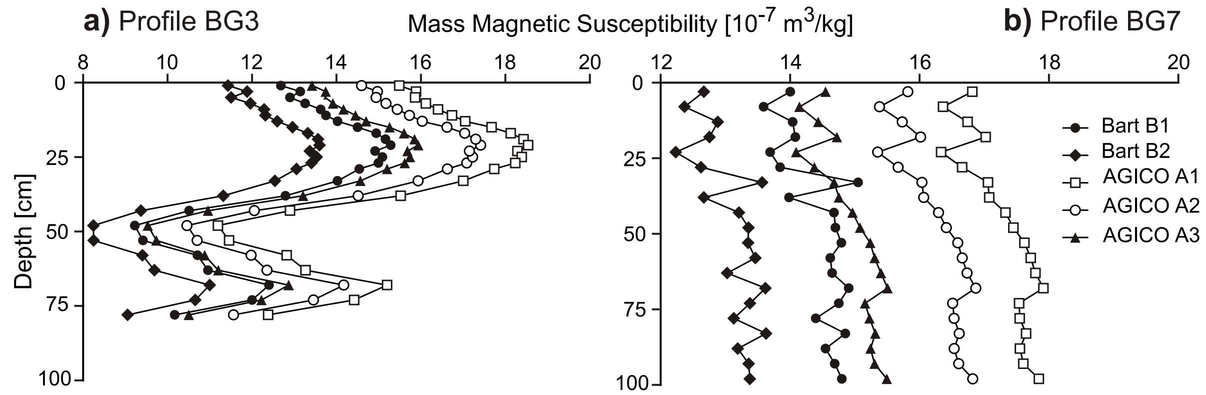


Fig. 1. Mass-specific MS of soil profile BG3 (a) and BG7 (b), measured using Bartington (frequencies B1 = 0.465 kHz, B2 = 4.65 kHz, amplitudes of magnetizing field 80 Am^{-1}) and AGICO instrument (frequencies A1 = 0.975 kHz, A2 = 3.904 kHz, A3 = 15.616 kHz, amplitudes of magnetizing field 200 Am^{-1}).

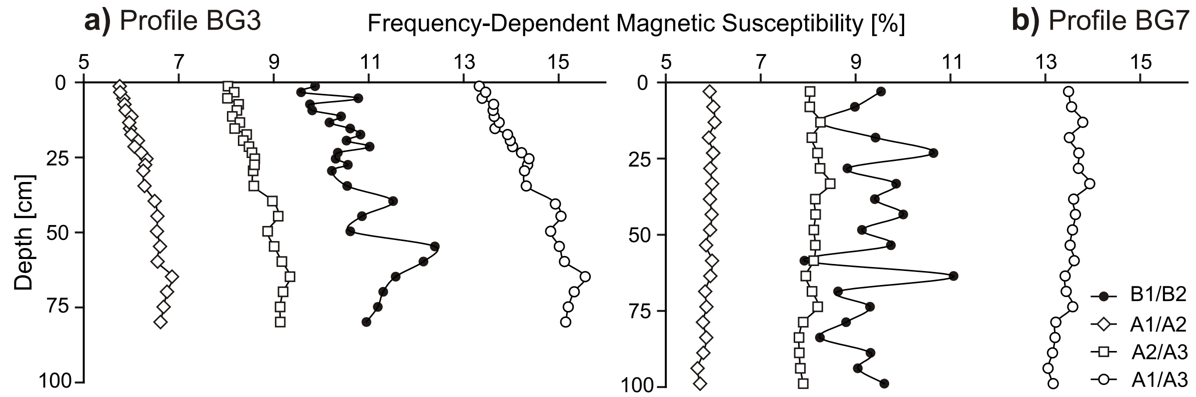


Fig.2. Frequency dependence (κFD%) of magnetic susceptibility along the BG3 (a) and BG7 (b) soil profile, measured using the Bartington and AGICO instruments.

Prediction of SEP events and the safety of spacecraft crews

Dynamic processes in the solar corona and interplanetary magnetized plasma accelerate particles, such as electrons, protons, heavy ions and neutrons up to high energies. Enhanced fluxes of such particles, especially protons with energies exceeding 10 MeV, are called solar energetic particle (SEP) events. The SEPs are able to penetrate through protective shielding of spacecrafts, endangering the health of humans on board and damaging sensitive technologies, and can have harmful effect also on aircraft crews and passengers or on communication systems.

Recent data indicate that SEP events are associated with fast and wide coronal mass ejections (CMEs). Full and partial halo CMEs were used in our study. Parameters considered were the position angle, width and linear speed. Additional information concerned solar flares. We were interested in the X-ray flares, which were observed near the centre of the solar disc and were accompanied with radio bursts of type II or IV. Our study was based on data from period 1998-2005. During these solar maximum years full or partial halo CME appeared frequently, approximately one event every 36 hours. The parameters of CMEs and X-ray flares were characterized by daily values. After the gaps from the data sequence were removed, a quasi-continuous sequence of 1978 patterns was at our disposal.

In order to understand the relationship between input parameters and SEP events, advanced statistical methods are required. Artificial neural networks (NNs) promised to be a good choice to accomplish this task. Three NN models were considered in our study: linear filter, neural network with hidden neurons and recurrent neural network. It is apparent that the way in which SEPs are accelerated by a CME depends not only on the parameters of the CME in question but also on the preceding CMEs or flares that occurred in the same region. This means that beside the data from the current day we also tried to use older data and the length of the history became an additional parameter to be estimated. Hundreds of neural networks were trained for each model. As a result, the model combining linear filter fed with CME and XRA information obtained during the previous 24 hours and the layer-recurrent neural network fed with the same information proved to be the best way to forecast severe SEP events. Figure 1 shows a small part of the test time series containing a severe SEP event. It seems that the linear filter gives better results than the recurrent neural network. However, the linear filter shows much more false alarms.

The question about the model accuracy can be addressed when a real practical use is simulated. Let us imagine a situation of how the model would be used if a spacecraft traveling outside the Earth's magnetosphere had to perform safety measures against SEP events, e.g. decide whether or not an astronaut could be sent into free space outside the protected spacecraft. We examined two different levels of safety measures. Recipe A is a simple instruction for performing safety measures if a critical level SEP forecast is exceeded during the following 24 hours. Recipe B issues in addition the alert also if the overload was forecast for the previous 24-hour interval or if the overloaded SEP flux was observed during the stated interval. For Recipe A, 20 SEP events were foreseen out of the 34 SEP events occurring during the test period of the length of 758 days. It was carried off at the toll of 63 false alarms. For Recipe B, 28 SEP events were foreseen at the toll of 116 false alarms. The higher number of false alarms is more than compensated by the decrease of missing alerts from 14 to 6.

IG research staff involved:

P. Hejda, J. Bochníček.

References:

***Valach, F., Revallo, M., Hejda, P. and Bochníček, J, 2011**. Prediction of SEP events by means of a linear filter and layer-recurrent neural network. Acta Astronautica, 69, 758-766. doi: 10.1016/j.actaastro.2011.06.003*

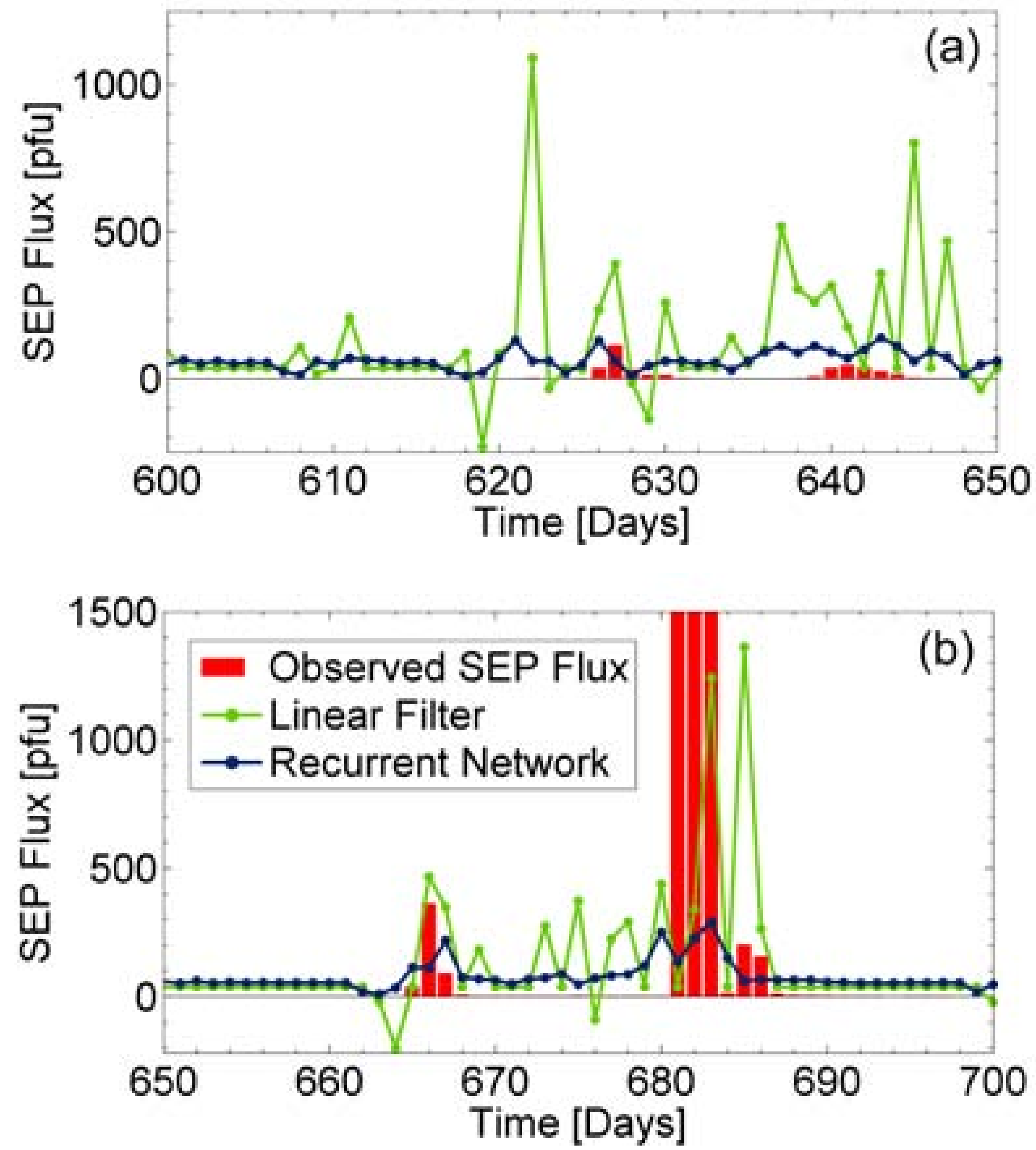


Fig.1. Detailed view of a part of the test time series with increased values of SEP flux > 10 MeV from August and September 2005, subplots (a) and (b), respectively.

Perturbation approaches in seismic-wave propagation studies

Seismic observations indicate that the Earth is weakly anisotropic and weakly attenuating in regions of special interest for geophysics. It concerns, for example, the uppermost crust, target of oil and mineral exploration. Despite their weakness, the effects of anisotropy and attenuation are observable, and can thus be used for gaining more details about structure of the medium. Study of wave propagation in heterogeneous weakly attenuating and/or weakly anisotropic media is impossible without use of perturbation approaches, in which weak anisotropy or attenuation is considered as a perturbation from isotropy or elasticity, respectively.

The coupling ray theory based on the perturbation approach (CRT, see Farra & Pšenčík, 2010a; Pšenčík et al., 2011; Bulant et al., 2011) makes it possible to study the shear wave propagation in perfectly elastic, but weakly anisotropic media. In such media, the shear waves propagate coupled and the standard ray theory (RT, see Červený & Pšenčík, 2011) is inapplicable. Figure 1 shows an example of shear-wave propagation in the vicinity of a conical singularity in an inhomogeneous, weakly orthorhombic medium, computed by three methods: RT, CRT and the Fourier pseudospectral method (FM), which is taken as an exact reference. In the upper plot, CRT synthetics (red) and in the bottom plot, RT synthetics (blue) are compared with the FM synthetics (black). The plots clearly indicate superiority of CRT over RT in the singular region. Applicability of the CRT is now extended to layered media, see Farra & Pšenčík (2010b). It can also be extended to the computation of Gaussian beams (Červený & Pšenčík 2010).

Another useful application of the perturbation formulae is in the inverse problems, specifically in the problem of the determination of local anisotropy from P-wave travel times and polarizations obtained at borehole receivers during a multiazimuth multiplesource VSP experiments (Barreto et al., 2011). Although only P-wave data are used, inverted parameters allow construction of the square of the phase velocity, from which orientation of the axis of symmetry of a transversely isotropic medium can be determined. This is illustrated in Fig.2.

Perturbation formulae play also an important role in the study of wave propagation in weakly attenuating media. They can, for example, be used for an approximate determination of the boundary attenuation angle γ^* (Červený & Pšenčík, 2011). Attenuation angle is an angle between the real and imaginary part of the complex-valued slowness vector. Its choice larger than γ^* leads to non-physical results, so-called forbidden directions, shown in Figure 3. This is why the role of γ^* is very important.

IG research staff involved:

I. Pšenčík

References:

***Farra, V. and Pšenčík, I., 2010a**. Coupled S waves in inhomogeneous weakly anisotropic media using first-order ray tracing. Geophys.J.Int., 180, 405–417.*

***Farra, V. and Pšenčík, I., 2010b**. First-order reflection/transmission coefficients for unconverted plane P waves in weakly anisotropic media. Geophys.J.Int., 183, 1443–1454.*

***Červený, V. and Pšenčík, I., 2010.** Gaussian beams in inhomogeneous anisotropic layered structures. Geophys.J.Int., 180, 798–812.*

***Červený, V. and Pšenčík, I., 2011.** Boundary attenuation angles for inhomogeneous plane waves in anisotropic dissipative media. Geophysics, 76, WA51-WA62.*

***Červený, V. and Pšenčík, I.,2011.** Seismic ray theory. Encyclopedia of Solid Earth Geophysics, Encyclopedia of Earth Sciences Series, Part 16, Seismic Ray Theory, 1244-1258.*

***Pšenčík, I., Farra, V. and Tessmer, E., 2011.** Comparison of the FORT approximation of the coupling ray theory with the Fourier pseudospectral method. Stud. Geophys. Geod., DOI: 10.1007/s11200-010-0086-7.*

***Barreto, A.C.R., Macambira, R.de N.A., Gomes, E.N.S. and Pšenčík, I., 2011.** Estimativa de anisotropia local de dados de onda P em experimentos de VSP multiazimutal. 12th International Meeting, SBGf, Expanded Abstracts, 2950.*

***Bulant, P., Pšenčík, I., Farra, V. and Tessmer, E., 2011.** Comparison of the anisotropic-common-ray approximation of the coupling ray theory for S waves with Fourier pseudospectral method in weakly anisotropic models. 12th International Meeting, SBGf, Expanded Abstracts, 2731.*

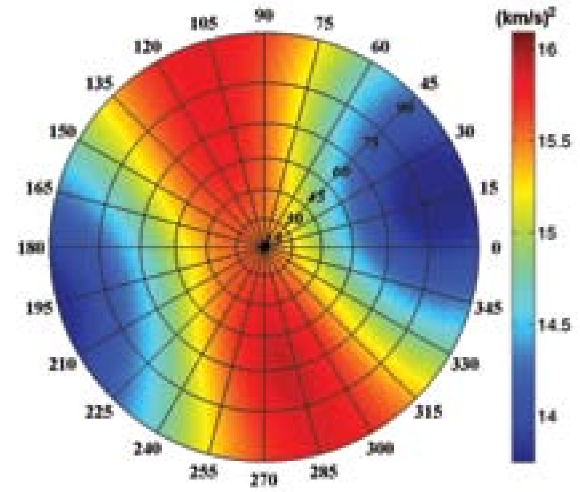


Fig.2. Stereographic projection of the square of the phase velocity calculated from values of the inverted anisotropy parameters. P-wave data are generated by sources situated along five profiles distributed regularly on the free surface and recorded in the borehole in a transversely isotropic medium with inclined axis of symmetry. The approximate position of the axis of symmetry (dark blue spot) is at an azimuth of 20° and inclination of 80°. Exact values are 25° and 80°).

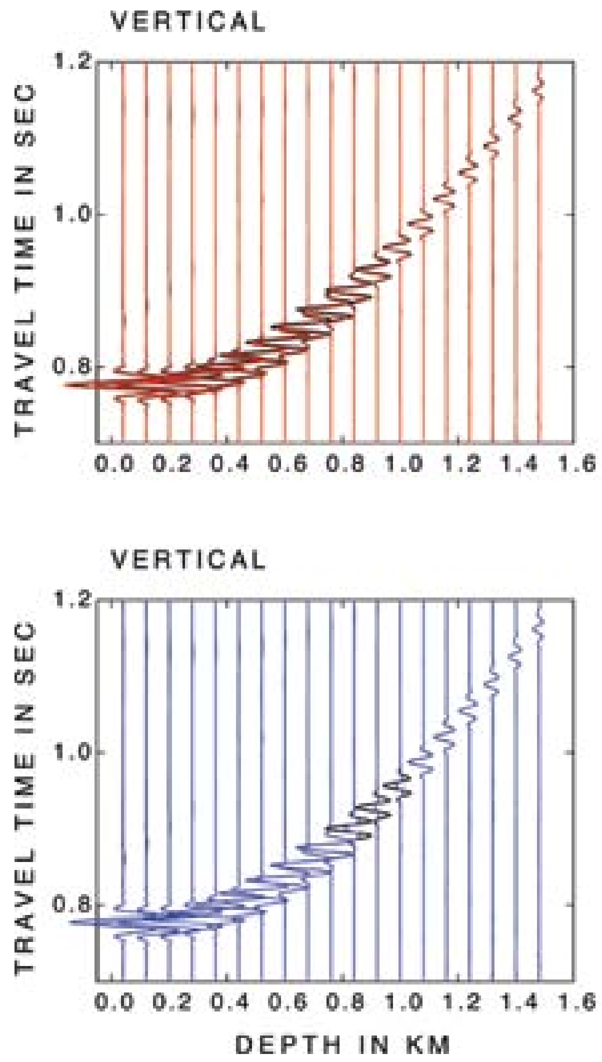


Fig.1. Comparison of seismograms of the vertical components of the displacement vector generated by the FM (black), CRT (red) and RT (blue) for the vertical single–force source in an inhomogeneous, weakly orthorhombic medium, in a vicinity of a conical singularity. Differences between RT and FM at intermediate receivers (depth between 0.8 and 1.2 km) are caused by ignored coupling effects and the failure of the two-point ray tracing.

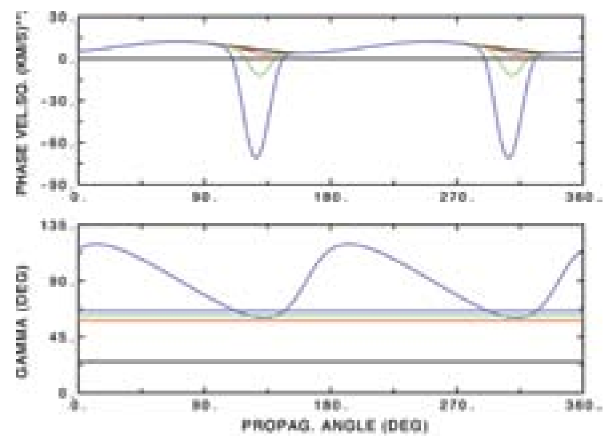


Fig.3. Variations with propagation angle i of the squares of the phase velocity C (top) of inhomogeneous SH plane waves in symmetry planes of a viscoelastic monoclinic medium. Individual curves are plotted for four values of the attenuation angle γ , γ = 25° – black, γ = 58° – red, γ = 62° – green and γ = 66° – blue. These angles are also shown in the bottom plot as horizontal lines. The oscillating blue curve in the bottom plot is the boundary attenuation angle γ^*. Note that green and blue C^2 curves intersect zero, defining thus forbidden directions, in which C^2 < 0. The forbidden directions in the top plot correspond to the regions where $\gamma > \gamma^*$ in the bottom plot.

Research student supervision and co-supervision

Every year, a number of PhD and MSc – level projects are supervised by the researchers of the Institute of Geophysics, and commonly also funded by research grants to the Insitute. Below, student research projects running or completed in 2010 and 2011 are listed, in alphabetical order of student's names and with the names of supervisors and co-supervisors from the Institute in bold letters.

PhD-level projects

Models of earthquake focus and their tectonic interpretations.

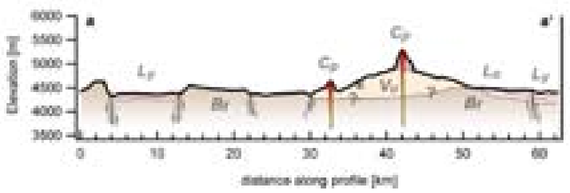
Student: **Petra Adamová**, Charles University, Prague, Faculty of Mathematics and Physics, Department of Geophysics
Supervisor: **Jan Šílený**
2006 - present

Pyroclastic cones on Mars: analogue experiments and comparison with terrestrial analogues

Student: **Petr Brož,** Charles University, Prague, Faculty of Science, Department of Structural Geology and Petrology
Supervisor: David Dolejš, co-supervisor: **Prokop Závada**
2011 – present

Publication:
Brož, P. and Hauber, E., 2012. *A unique volcanic field in Tharsis, Mars: Pyroclastic cones as evidence for explosive eruptions, Icarus, doi: 10.1016/j.icarus.2011.11.030.*

Research supported by the Ministry of Education Project KONTAKT no. ME0901, to A.Špičák.



Earthquake swarms in diverse tectonic environments (triggering mechanisms and driving forces)

Student: **Hana Čermáková**, Charles University, Prague, Faculty of Mathematics and Physics, Department of Geophysics
Supervisor: **Josef Horálek**
2009 - present

Research supported by the Grant Agency of the Academy of Sciences, grant No. IAA300120911 to J. Horálek and by the Grant Agency of the Charles University (GAUK), grant No. 171310, to Jan Michálek.

Factors determining temperature of soils and heat transfer from the ground surface to the rock basement

Student: **Petr Dědeček,** Charles University, Prague, Faculty of Science, Department of Engineering geology, Hydrogeology and Geophysics
Supervisor: **Jan Šafanda**
2002 – present

Publications:
Dědeček P., Šafanda J., Rajver D.,in press. *Detection and quantification of local anthropogenic and regional climatic transient signals in temperature logs from Czechia and Slovenia, Climatic Change, DOI 10.1007/s10584-011-0373-5 (online Dec. 2011)*
Čermák V., Dědeček P., Šafanda J., Krešl M., 2010. *Climate Warming in the Czech Republic: Evidence Stored in Shallow Subsurface, In: Przybylak R: The Polish Climate in the European Context: An Historical Overview, 3, 247-266, DOI: 10.1007/978-90-481-3167-9_11 Springer 2010*

Research supported by the Czech Science Foundation (GAČR) grant GAP210/11/0183 V. Čermák

Automated processing of seismic observational data from the local network WEBNET, with application on the West Bohemia earthquake swarm of 2011.

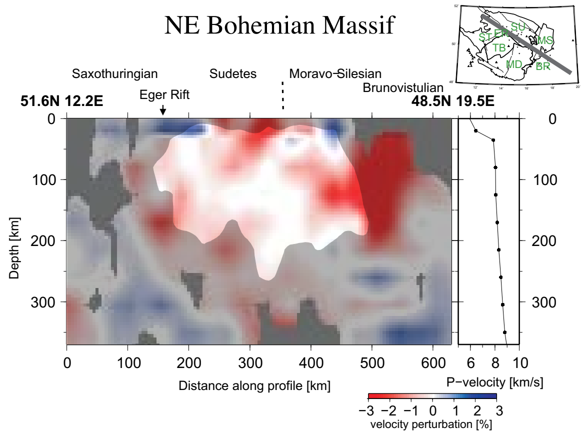
Student: **Jana Doubravová**, Charles University, Prague, Faculty of Mathematics and Physics, Department of Geophysics
Supervisor: **Josef Horálek**
2011 – present

Research supported by the Grant Agency of the Academy of Sciences, grant No. IAA300120911 to J. Horálek

Seismic tomography of the upper mantle beneath the Bohemian Massif

Student: **Hana Karousová,** Charles University, Prague, Faculty of Mathematics and Physics, Department of Geophysics
Supervisor: **Jaroslava Plomerová;** Co-supervisor: **Vladislav Babuška**
2008 – present

Passive seismic experiment BOHEMA II (May 2004 – June 2005) with 35 temporary stations complemented by recordings of the permanent observatories provided data for developing a 3D velocity model of the upper mantle beneath the northern and eastern parts of the Bohemian Massif (BM, Karousova et al., 2011b). To eliminate effects originated in the crust, the P-wave travel times were corrected for crustal structure of the BM according to the 3D model of the crust (Karousová et al., 2011a) developed for these purposes. The final tomographic model down to 350 km, with variance reduction of 84% after four iterations, is characterized by low-velocity perturbations, particularly beneath the Saxothuringian and Sudetic regions. Most of velocity perturbations in the model lie in a range of ±2.5%. At depths from 80 to 200 km, velocities increase towards the Moldanubian part of the BM, similar to findings from experiment BOHEMA I (2001-2003), which concentrated on the upper mantle structure of the western part of the BM. The high-resolution teleseismic tomography from data of passive experiment BOHEMA II does not indicate any distinct velocity variations in the upper mantle beneath the north-eastern BM.



Cross-section through the 3D velocity perturbation model retrieved by the tomographic inversion with the use of the damped LSQ method along the NW-SE profile in the north-eastern part of the Bohemian Massif. Regions with well resolved nodes are illuminated, fairly and poorly resolved areas are shaded in dependence on values of the diagonal elements of resolution matrix.

Research supported by the Grant Agency of the Academy of Sciences, grant No. IAA300120709 to J. Plomerová and Czech Science Foundation (GAČR) grant GA205/07/1088 to V. Babuška.

Publications:
Karousová, H. Plomerová J., Babuška V., 2011a. *A three-dimensional velocity model of the crust of the Bohemian Massif. Studia Geophys. Geodaet. 56, doi: 10.1007/s11200-010-0065-z.*
Karousová, H. Plomerová J., Vecsey L., submitted. *Seismic tomography of the upper mantle velocity structure beneath the north-eastern Bohemian Massif (central Europe). Tectonophysics.*

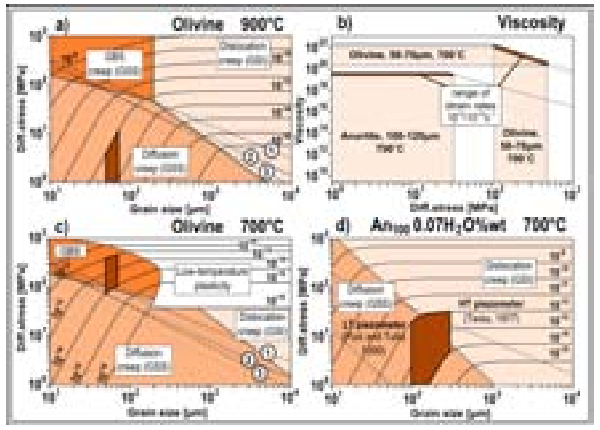
Strain coupling versus decoupling of mantle and crust during orogenesis

Student: **Vladimír Kusbach,** Charles University, Prague, Czech Republic, Faculty of Science, Department of Structural Geology and Petrology and Université de Strasbourg, Strasbourg, France, L'Ecole et Observatoire des Sciences de la Terre (Ph.D. "co-tutelle")
Supervisor: **Stanislav Ulrich** (Prague), Karel Schulmann (Strasbourg)
2007 – 2011

The crust-mantle interaction during orogenesis is a major issue in understanding deep seated thermo-mechanical processes in large orogens and behavior of subcontinental mantle during continental collision in particular. European Variscan belt offers an exceptional opportunity to study tectonic interactions between mantle and orogenic lower crust thanks to the presence of bodies of garnet – and spinel-bearing peridotites of variable size included in largest Ky–Kfs granulite massifs.

Research supported by Czech Science Foundation (GAČR) grant 205/09/0539 to Stanislav Ulrich (Internal strain fabric and rheology of orogenic peridotites and surrounding crustal rocks) and grant ANR-06-BLAN-0352-01 to Karel Schulmann.

Publication:
Kusbach, V., Ulrich, S., Schulmann, K., 2012. *Ductile deformation and rheology of sub-continental mantle in a hot collisional orogeny: Example from the Bohemian Massif. Journal of Geodynamics 56–57, 108 – 123.*



(A) Deformation mechanism map for olivine for measured grain size at constant temperature of 900°C indicate diffusion creep as the main mechanism. (B) Summarized graph of strength and viscosity for range of natural strain rates (10^{-14} – 10^{-12}). C,D) Deformation mechanism maps for olivine and plagioclase constructed at constant temperature of 700°C shows difference in strength between both lithologies for range of natural strain rates. Measured grain sizes of olivine and feldspars indicate dislocation creep assisted by GBS and diffusional creep as the dominant operating deformation mechanisms, respectively.

Evolution of microporosity and permeability of rocks with different microstructure and mineral composition

Student: **Matěj Machek,** Charles University, Prague, Faculty of Science, Department of Structural Geology and Petrology
Supervisor: **Stanislav Ulrich**
2003 – 2011

Research supported by SÚRAO/RAWRA (Radioactive Waste Repository Authority), Czech Republic, contract 60004319 2007/029/M, and Czech Science Foundation (GAČR) grant 205/08/0767 to L. Kalvoda (Czech Technical University – ČVUT, Prague), co-investigator M. Machek.

Publication:
Machek M., Špaček P., Ulrich S., and Heidelbach F., 2007. *Origin and orientation of microporosity in eclogites of different microstructure studied by ultrasound and microfabric analysis. Engineering Geology, 89, 266-277.*

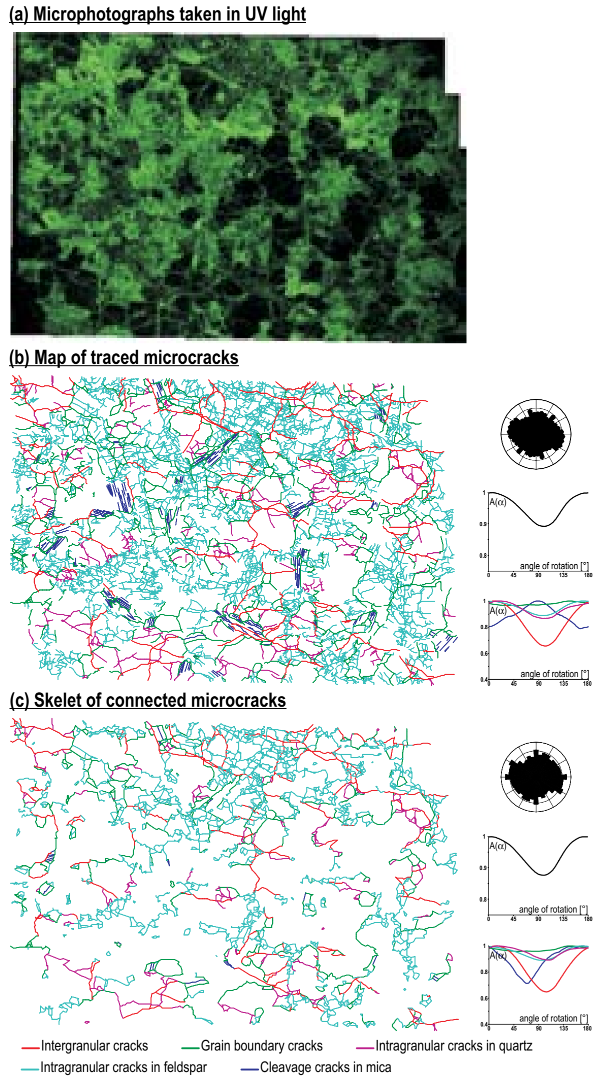


Illustration of microcrack analysis procedure: (a) Compiled set of microphotographs taken in UV light from thin sections of samples that were vacuum-saturated by fluorescent epoxy resin. (b) Map of microcracks classified into five microstructural types: intergranular cracks, grain boundary cracks, and intragranular cracks in quartz, feldspars and mica. (c) Skelet of connected microcracks - fracture network cleaned until no 1st degree node exists, withal keeping nodes on convex hull of the original network. Example of the rose diagrams of microcrack orientation and microcrack fabric of all cracks and of individual crack types. The curve A(α) represents the average crack projection (see SURFOR; Panozzo, 1984). A(α) is normalized: A(α) max = 1.00.

Interpretation of tectonic structure and evolution of plate margins by an analysis of earthquake foci distribution and mechanisms

Student: **Radka Matějková,** Charles University, Prague, Faculty of Mathematics and Physics, Department of Geophysics
Supervisors: **Aleš Špičák** and Jiří Zahradník (Charles University, Prague)
2008 (interrupted in 2011, maternity leave)
Research supported by the Ministry of Education Project KONTAKT no. ME0901, to A. Špičák

Exact automatic location and determination of source parameters of micro-earthquakes.

Student: **Jan Michálek,** Charles University, Prague, Faculty of Mathematics and Physics, Department of Geophysics
Supervisor: **Tomáš Fischer**
2006 – present

Research supported by the Grant Agency of the Academy of Sciences, grants No. IAA300120911 to J. Horálek and IAA300120905 to T. Fischer, and by the Grant Agency of the Charles University (GAUK), grant No. 171310, to Jan Michálek.

Publication:
Fischer, T., Horálek, J., Michálek, J., Boušková, A., 2010. *The 2008 West Bohemia earthquake swarm in the light of the WEBNET network. Journal of Seismology. Vol. 14, no. 4, p. 665-682.*

Microgravity survey and monitoring of subsurface inhomogeneities

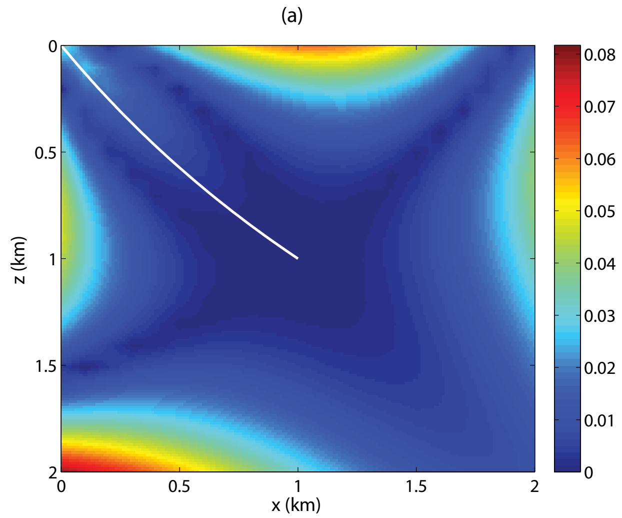
Student: **Marek Spěšný**, Faculty of Science, Charles University, Prague
Supervisor: **Jan Mrlina**
2010 – present

Structural and petrophysical characterisation of granites intended for nuclear waste repository site

Student: **Martin Staněk**
Supervisors: **Stanislav Ulrich** and Yves Geraud
Charles University, Prague, Faculty of Science, and Université Louis Pasteur Strasbourg
2008 – present
Research supported by SÚRAO/RAWRA (Radioactive Waste Repository Authority), Czech Republic.

Approximate traveltime computations in inhomogeneous anisotropic media

Student: **Umair bin Waheed**, King Abdulah University of Science and Technology (KAUST), Saudi Arabia
Supervisor: T.Alkhalifah, Co-supervisor: **Ivan Pšenčík**
2011 – present



Accuracy of approximate two-point traveltime formula. Approximate traveltimes are computed from quantities calculated along the reference ray (white curve). Plot shows a map of deviations of P-wave approximate traveltimes from exact ones in an isotropic model with constant vertical velocity gradient.

Leveling data processing in the West Bohemia local networks

Student: Alena Zavřelová (2011)
Faculty of Engineering, Czech Technical University, Prague. Leader: Ing. Michal Seidl, Ph.D.

2. MSc-level projects

Plains volcanism in Tharsis region on Mars: Ages and rheology of eruption product

Student: **Petr Brož**, Charles University, Prague, Faculty of Science, Department of Structural Geology and Petrology
2009 – 2010
Supervisor: **Prokop Závada**

Analysis of linearized R/T coefficients in TI and orthorhombic media.

Student: **Andrei Gomes de Oliveira**, UFPa, Belem, Para, Brazil
Supervisor: E.N.S.Gomes, external supervisor: **Ivan Pšenčík**
2008-2011

The record of sea-level changes, water circulation and sediment dispersal in Upper Turonian hemipelagic stata of the Bohemian Cretaceous Basin

Student: **Magdalena Hrnková,** Charles University, Prague, Faculty of Science, Institute of Geology and Palaeontology
Supervisor: **Jiří Laurin**
2011 – present

Reflection/transmission (R/T) coefficients in anisotropic media

Student: **Luís Fernando Katsuda Ito Cypriano,** State University of Campinas (Unicamp), SP, Brazil
Supervisor: Rodrigo Portugal (Unicamp), External supervisor: **Ivan Pšenčík**
2008 – 2011
Research supported by the State University of Campinas, Brazil

Heavy metals content and magnetic properties of soils in the Krušné Hory Mts. region

Student: **Pavel Křížek**, Czech University of Life Science Prague (CULS); Faculty of Environmental Science; Department of Ecology
2008 – 2011
Supervisor: Vilém Podrázský (CULS), co-supervisor: **Aleš Kapička**
Research supported by Czech Science Foundation (GAČR) grant 205/07/0941 to A. Kapička

Gaussian beam summation in heterogeneous anisotropic media

Student: **Yongxia Liu**, Colorado School of Mines, Golden, CO, USA,
Supervisor: I.Tsvankin, co-supervisor: **Ivan Pšenčík**
2009 – 2010

Magnetic mapping of anthropogenic soil pollution in the Krušné Hory Mts. region

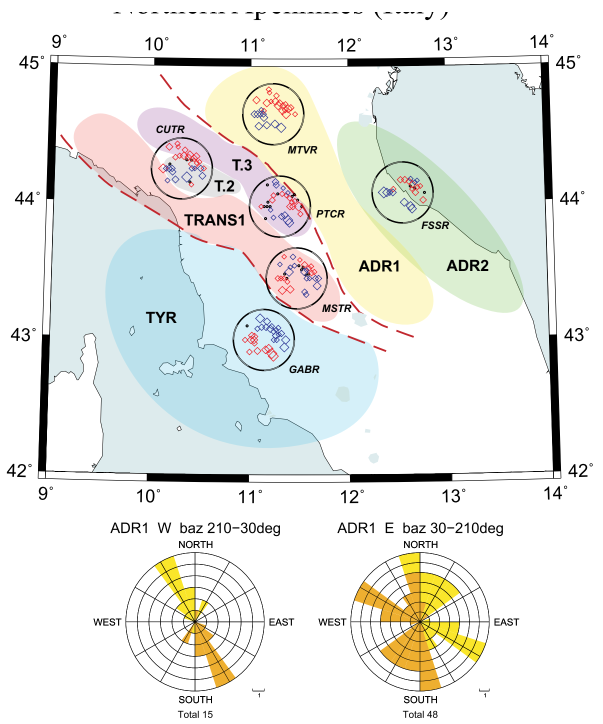
Student: **Veronika Lukešová,** Czech University of Life Science Prague; Faculty of Agrobiology, Food and Natural Resources; Department of Soil Science and Soil Protection
2009 – 2010
Supervisor: Radka Kodešová (CULS), co-supervisor: **Aleš Kapička**
Research supported by Czech Science Foundation (GAČR) grant 205/07/0941 to A. Kapička

Anisotropy of the upper mantle under the Northern Apennines based on data from the international experiment RETREAT (Italy)

Student: **Helena Munzarová,** Charles University, Prague, Faculty of Mathematics and Physics, Department of Geophysics
Supervisor: **Jaroslava Plomerová**
2009 – 2011

Based on analysis of directional terms of relative travel-time P-wave residuals and shear-wave splitting, evaluated from recordings of the passive seismic experiment RETREAT (2003 – 2006), we map anisotropic structure of the upper mantle beneath the Northern Apennines. We recognize several regions of different fabrics in the mantle lithosphere and also in the sub-lithospheric mantle. Joint analysis of the two different and independent data sets (P-wave travel-time residuals and shear wave splitting) allows us to infer anisotropic structures oriented generally in 3D with inclined symmetry axes.
Mantle lithosphere fabric in the Tyrrhenian plate, thinner in comparison with the Adriatic one, seems to be detected only in the anisotropic parameters of P waves, which indicate the easterly dipping high velocities there. In the wedge beneath the Tyrrhenian plate and above the subducting Adriatic plate, the shear-wave polarizations prefer a horizontal slab-parallel flow in the sub-lithospheric mantle to the slab perpendicular flow, which might be expected in the extension zone. Large-scale structure of both the lithospheric and sub-lithospheric mantle in the Adriatic region is complex. We detected laterally varying anisotropic signal which we associate with changes of fabrics of the lithospheric plate and based on that we delimited subregions of the thicker continental Adriatic plate. We also admit effects reflecting probable deviations (rotation?) in a slab-parallel corner flow in the asthenosphere.

Research supported by grant No. IAA300120709 (2007-2011) of the Grant Agency of the Academy of Sciences of the Czech Republic, and student grant of the Faculty of Mathematics and Physics, Charles University, No. SVV-2012-265308.



Location of the six domains, derived according to the similarity of the P-sphere pattern at individual stations, with a characteristic P sphere representing each domain. The boundaries between the Tyrrhenian region, transitional zone and the Adriatic region are marked with dashed brown lines. T.2 and T.3 stand for TRANS2 and TRANS3, respectively. Rose diagrams show differences in variations of shear-wave polarizations in two different back-azimuth segments. Two contributions to the anisotropy, i.e., from the continental Adriatic plate and from the sub-lithospheric mantle, are evident in the diagram from foci in 30°-210° backazimuths.

Depositional regime and genetic stratigraphy of Coniacian clastics in the Bohemian Cretaceous Basin: a response to changing tectonic regime during the Mesozoic

Student: **Roland Nádaskay**
Charles University, Prague, Faculty of Science, Institute of Geology and Palaeontology
Supervisor: **David Uličný**
2011 – present

Architecture and depositional regime of sandstone bodies of the Lower-Middle Turonian in the northwestern part of the Bohemian Cretaceous Basin.

Student: **Monika Skopcová,** Charles University, Prague, Faculty of Science, Institute of Geology and Palaeontology
Supervisor: **David Uličný**
2007 – 2011

Subaqueous deposits of coarse grained deltas of Lower and Middle Turonian in the northwestern part of the Bohemian Cretaceous Basin were affected by vigorous tidal currents that gave rise dominantnly to compound cross-bedding, resulting from asymmetric bi-directional currents. Reactivation surfaces, created by the subordinate current, are prominent in most exposures. The difference in strength of subordinate vs. dominant currents was medium to high. Couplets of mud drapes originating in slack water stages between flood and ebb are well preserved locally. Tidal bundles show lateral variation of thickness which could result from cyclic alternation of spring and neap tide. Analysis of the thickness and geometry of compound cross-strata across the depth range of the delta slope revealed distinct trends in distribution of bedform size and palaeoflow directions along the delta clinoform, interpreted as evidence that tidal currents affected the entire water mass in the tidal strait. This brings further support to the recently published numerical modelling that emphasized the role of the tectonic palaeotopography in inducing powerful tide-driven circulation in an otherwise microtidal Cretaceous epeiric sea of Central Europe.

Research supported by the Grant Agency of the Academy of Sciences IAA300120609 to D. Uličný, and the Ministry of Environment, project SP/2e1/153/07 (co-investigator D. Uličný).

Architecture and depositional regime of sandstone bodies of the Upper Turonian in the northwestern part of the Bohemian Cretaceous Basin

Student: **Lenka Vacková**
Charles University, Prague, Faculty of Science, Institute of Geology and Palaeontology
Supervisor: **David Uličný**
2007 – 2011

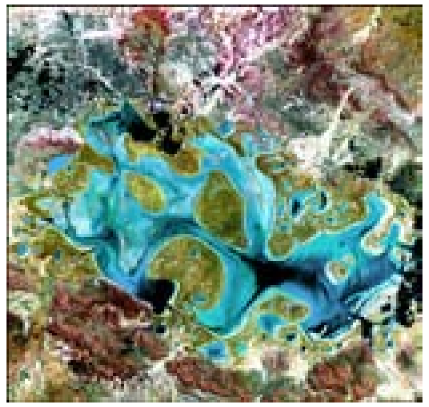
The opening and filling of the Bohemian Cretaceous Basin took place during a mid-Cretaceous reactivation of basement fault systems of the Bohemian Massif. The general tectonic regime during the basin lifetime, as well as its changes through time, can be interpreted from analysis of geometry of clastic sequences and, partly, of even minor changes in lithology. Previous studies in the Cretaceous of Central Europe have indicated changes in the tectonic regime known as the ´subhercynian´ tectonic phases, but their exact timing has not yet been determined in detail (cf. *Mortimore et al. 1998* and references therein). Results of the thesis confirm that the end of the Turonian (ca. between 90,4 and 88,9 Ma) was the time of a significant increase in subsidence rate in a narrowed depocentre of the NW part of the Bohemian Cretaceous Basin. Based on total thickness and estimated duration of sequences TUR 6 and 7, up to a fourfold increase in accommodation rate (largely represented by subsidence) occurred in the main depocentre during TUR 7 deposition. At the same time, strongly increased sediment input into the basin is indicated by a general increase in potassium, as shown by both outcrop gamma-ray spectra and macroscopic occurrence of feldspar grains. Another line of evidence for increased clastic input during TUR 7 time is the fact that this sequence, as an aggrading stack of prograding, shallow-water sandstones filled the entire accommodation space provided by the accelerated subsidence.

Research supported by the Grant Agency of the Academy of Sciences IAA300120609 to D. Uličný, and the Ministry of Environment, project **SP/2e1/153/07 (co-investigator D. Uličný).**

University – level courses taught by instructors from the Institute of Geophysics

—— Specialized as well as fundamental courses are taught by researchers from the Institute of Geophysics at a number of universities in the Czech Republic and abroad..

—— The list below shows courses taught in 2010-11, fully or partly, by instructors whose main employer was the Institute of Geophysics. The list follows an alphabetical order of names of instructors from the I.G., indicated by bold letters.

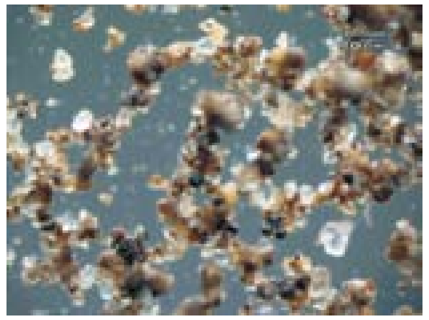


The sedimentary record of permanent and ephemeral lakes provides important information on the past climate. Shortwave infrared through red wavelength image of Lake Carnegie, Australia, courtesy NASA, Visible Earth (http://visibleearth.nasa.gov/).

Climatic changes in the Earth's history

Faculty of Science, Charles University, Prague
Course Code: MG421P4
MSc level, 2 hrs./week, winter semester
Instructor: **Jiří Laurin**

This course describes in detail the key components of Earth's climate system, and explains how these components evolved through the geological history, from the Precambrian to the Quaternary. Main focus is on the mechanisms of climate change at the time scales of thousands to millions of years. The origin of the three prominent climatic modes – greenhouse, icehouse and snowball – is discussed in detail. Certain methods of paleoclimate research, such as numerical modeling and time-series analysis, are demonstrated using both synthetic and real geological data.

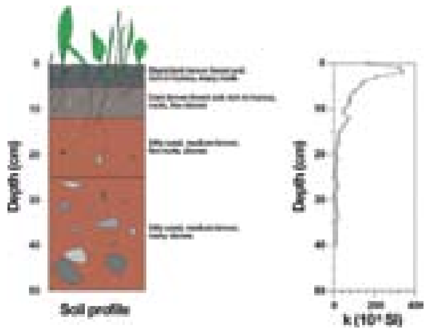


Magnetic extract of topsoil sample from the Ostrava region (N Moravia), with dark spherical magnetite of industrial origin.

Petrophysics

Faculty of Science, Charles University, Prague
Course Code: MG452P15
MSc programme, 3 hrs. /week, spring semester
Instructor: **Eduard Petrovský**

Rock as a physical environment. Mass property of rocks: density, porosity, permeability. Magnetic properties of rocks: anisotropy of magnetic susceptibility, paleomagnetic and archaeomagnetic research, magnetostratigraphy. Electrical properties of rocks: resistivity, permitivity, electrochemic activity, special electric properties. Radioactive properties of rocks. Thermal properties of rocks. Mechanical (engineering) properties of rocks. Inelastic and elastic constans of minerals and properties of rocks.



Typical vertical distribution of magnetic susceptibility in a soil profile, dominated by atmospheric deposition of dust particles.

Magnetomineralogy

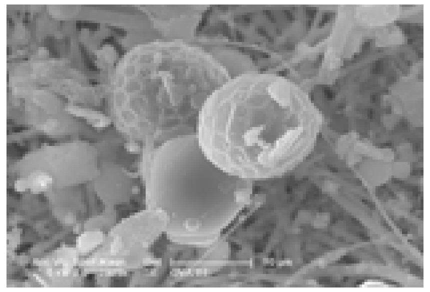
Faculty of Science, Charles University, Prague
Course Code: MG452P68
MSc programme, 2 hrs. /week, autumn semester
Instructors: **Eduard Petrovský, Aleš Kapička**

The course is aimed at a general introduction into magnetic minerals as carriers of record of environmental changes. Magnetic record in geomaterials (environmental magnetism) reflects changes in geological histor of the Earth (paleomagnetism), past climatic changes (magnetic paleoclimatology) as well as environmental impact of recent and present human activities, such as industrial pollution. Students will acquire basic knowledge of identification and characterization of magnetic minerals using magnetic methods and will learn to use this knowledge in environmental applications.

Analogous or closely related courses are also run at other universities under the following titles:

Magnetomineralogy (Applications to Environmental Problems)

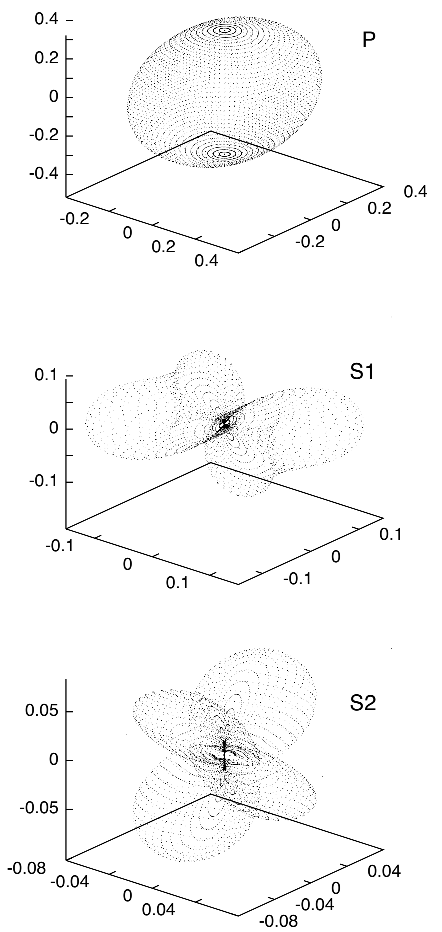
Faculty of Science, Masaryk University, Brno
Course Code: G9491
MSc programme, 2 hrs. /week, autumn semester
Instructors: **Eduard Petrovský, Aleš Kapička**



Spherules of industrial origin rich in magnetite ($FeOFe_2O_3$) as part of flight ash.

Environmental Magnetism

Faculty of Science, Helsinki University, Helsinki, Finland
Course Code: 535050
MSc programme, 20 hrs., spring semester, each even year
Instructor: **Eduard Petrovský**



Directivity functions (spreading-free amplitudes at a source) of P (top), S1 (middle) and S2 (bottom) waves generated by an explosive source in an orthorhombic medium. Note that S1 and S2 waves would not be generated if the medium is isotropic.

Seismic body waves in inhomogeneous anisotropic media

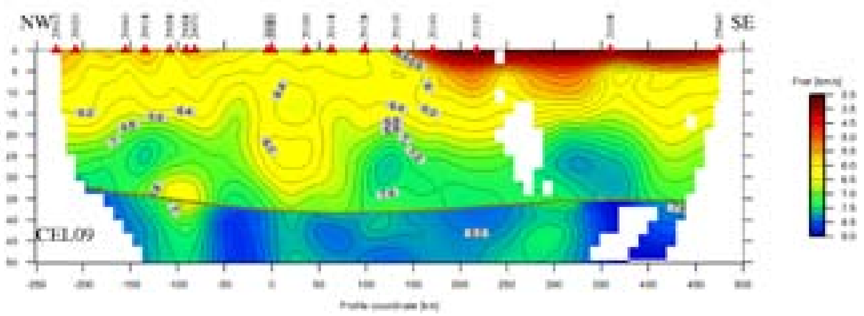
Faculty of Mathematics and Physics, Charles University, Prague
Course Code: NGE063
2hrs./week, winter semester
Instructor: **Ivan Pšenčík**

The goal of this advanced course is to introduce students to basics of the theory of seismic wave propagation in complex structures. The following topics are covered: basics of plane wave propagation in homogeneous isotropic or anisotropic media; effects of structural interfaces; differences in wave propagation in isotropic and anisotropic media; basics of the ray method for seismic body waves propagation in laterally inhomogeneous isotropic or anisotropic media with curved interfaces; wave propagation in layered, inhomogeneous, weakly anisotropic media using perturbation approaches; coupling ray theory for shear waves; wave propagation in isotropic or anisotropic, weakly dissipative media.

Selected chapters on inverse problems

Faculty of Mathematics and Physics, Charles University, Prague
Course Code: DGF019
2 hrs./week, summer semester
Instructors: **Oldřich Novotný** (IRSM ASCR / Faculty of Mathematics and Physics, Charles University) and **Bohuslav Růžek** (Institute of Geophysics, ASCR)

The course is dedicated to PhD students and researchers dealing with real data and geophysical inversions. Examples from real projects are presented in MATLAB environment. Course topics include: the notion of forward and inverse problems; historical development of inverse problems in geophysics; linear algebra, matrix operations; least squares method and minimum norm method; matrix regularisation; inverse matrix, generalised inversion; linear inverse problem; resolution matrix; methods of non-linear inversion and non-linear optimisation; examples of inverse problems in geophysics: seismic tomography and seismic kinematic inversion, inversion of waveforms, inversion of magneto-telluric data, inversion of surface-wave dispersion curves.
A similar course is also run at the Faculty of Science of the Charles University, Prague:



Seismic tomography introduces a classical inverse problem. A typical result looks like the depth-velocity cross-section along the profile CEL09. Careful processing has to take into account all aspects of non-uniqueness and potential instability.

Inverse problems in geophysics

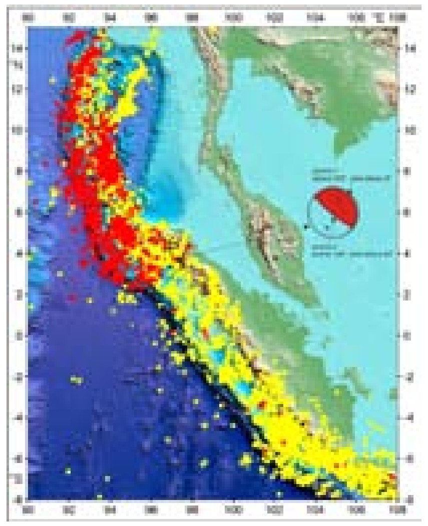
Faculty of Mathematics and Physics, Charles University, Prague
Course Code: MG452P73
3 hrs./week, winter semester
Instructor: **Bohuslav Růžek**

Dynamic recrystallization of garnetiferous peridotite shown in a thin section, polarized light

Deformation microstructures of rocks

Faculty of Science, Charles University, Prague
Course Code: MG440P26
BSc programme, 3 hrs. /week, winter semester
Instructor: **Stanislav Ulrich,** Petr Jeřábek (Charles University)

An introductory course into the study of deformation microstructures and crystal plasticity. The aim of this course is to clarify physical background of deformation and recrystallization processes occurring in most common rock forming minerals and rocks. In thin sections, students learns to carry out both qualitative (identification of deformation microstructures) and quantitative (Poly LX toolbox) microstructural analyses.

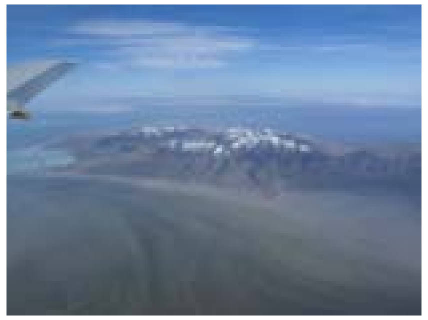


Map of epicentres (EHB data) of earthquakes in the Sumatra, Andaman and Nicobar Islands region. Yellow symbols – events from 1964 to Dec. 26, 2004; red symbols – from Dec. 26, 2004, to March 15, 2005. The GCMT focal mechanism of the main shock of Mw 9.1 is shown.

Fault tectonics and seismic activity

Faculty of Science, Charles University, Prague
Course Code: MG440P40
MSc programme, 2 hrs. /week, winter semester
Instructor: **Aleš Špičák**

The course concentrates on the causes of earthquake occurrence (tectonic stress concentration, brittle and inhomogeneous environment, movements of rock masses), explains earthquake distribution in the lithosphere and the phenomenon of deep earthquakes. Classifications of seismic events and seismic waves are discussed. Phenomena and processes accompanying tectonic stress concentration are analyzed from the viewpoint of earthquake prediction. The course gives a detailed view on the most seismically active regions on Earth, e.g. SE Asia, Andean South America, Central America, Tonga-Kermadec, East African Rift, Gulf of California, the Mediterranean, etc. Students analyse professional papers on related topics published recently in major scientific journals (e.g., EOS, Science, Nature).



The Basin and Range province of SW USA belongs to major continental domains of extensional tectonics

Geotectonics

Faculty of Science, Charles University, Prague
Course Code: MG440P15
BSc programme, 2 hrs. /week, winter semester
Instructor: Petr Jeřábek (Charles University), with guest instructors from the Institute of Geophysics: **Aleš Špičák, David Uličný**

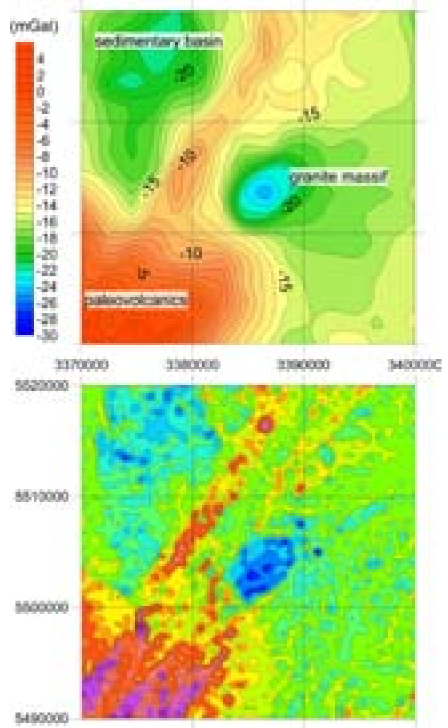
The course provides the basic review of the inner composition of the Earth, in particular its crust and mantle, and the physical processes behind the plate tectonics. An introductory part is devoted to a review of main geophysical methods. The main part of the course is focused on the plate boundaries, their tectono-metamorphic evolution, relationships to magmatism and sedimentary basin evolution.

Soft-sediment deformation in Miocene deltaic sediments interpreted as evidence for syndepositional seismic activity in the Most Basin, Czech Republic

Sedimentary record of geodynamic processes

Faculty of Science, Charles University, Prague
Course Code: MG440P76
primarily MSc level, but also available to BSc students; 2 hrs. /week, winter semester
Instructor: **David Uličný**

The course is focused on the tectono-stratigraphic evolution of sedimentary basins and on the sedimentary record of lithosphere evolution on time scales of basins as well as plate-tectonic cycles. Lectures are combined with exercises (including basics of geological interpretation of seismic reflection data) and reading seminars to provide the students with both theoretical and practical knowledge of the classical concepts as well as current issues in sedimentary basin research. Case studies for seminars and exercises are selected from extensional and foreland basins, passive margins, and other tectonic settings.

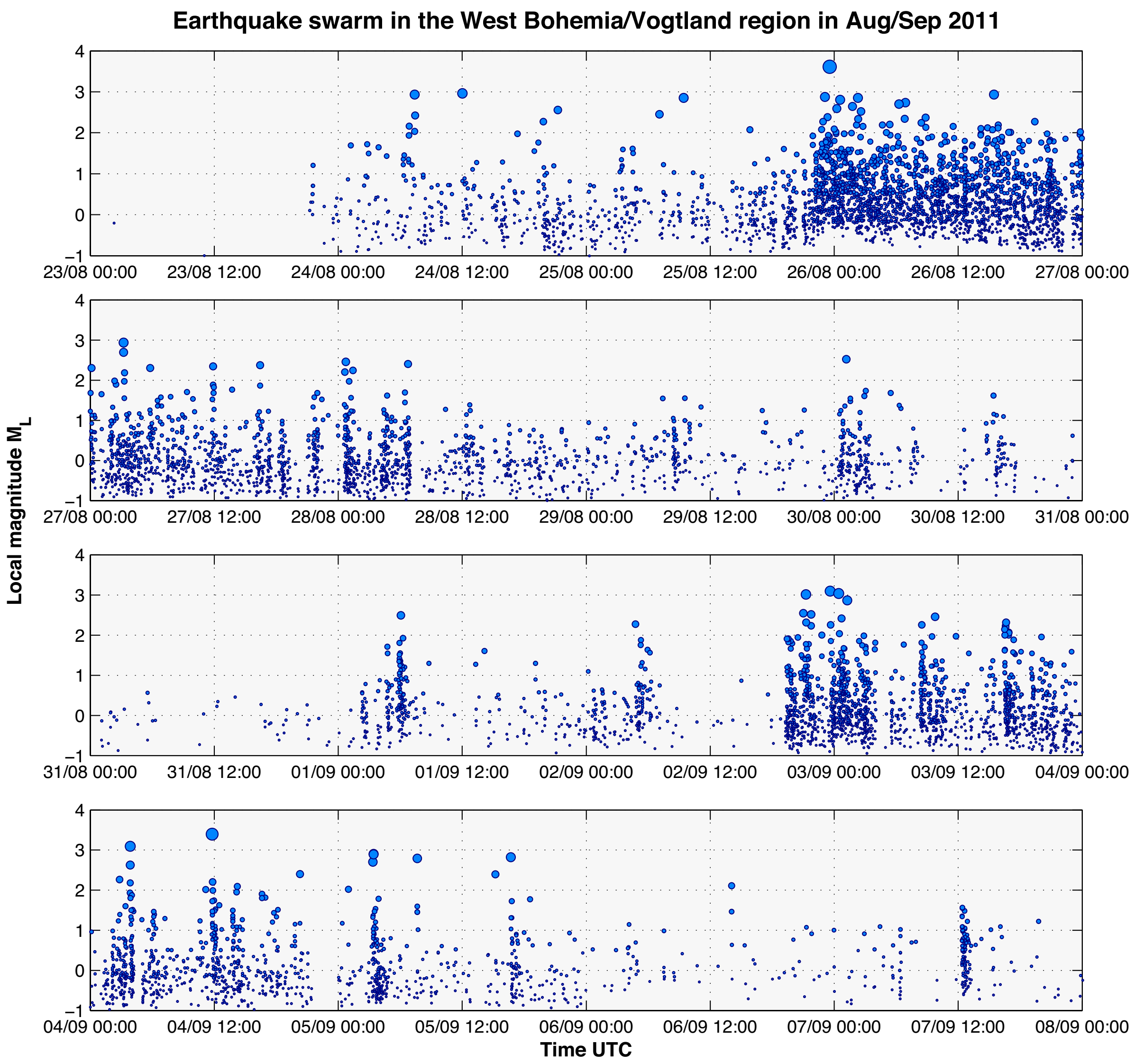


Among the course topics, the separation of the Bouguer gravity field (a) was discussed and the meaning of residual anomalies (b) explained. Maps show gravity expression of basic palaeovolcanic strips (red) and a negative anomaly (blue) of a granite intrusion in the Bohemian Massif Proterozoic Formation.

EAGE Distinguished Lecturer

Jan Mrlina, specialist in gravimetry, was selected by EAGE (European Association of Geoscientists and Engineers) as Distinguished Lecturer based on his previous lectures at various EAGE conferences, but mainly due to his presentation at the London 2007 EAGE Conference & Exhibition. His lecture "4D Gravity – fluids monitoring in reservoirs: chances and limitations" has been promoted by EAGE to the geoscience community.
In 2010-2011, he continued presenting this lecture, but other topics related to gravity investigations as well (e.g. "Gravity Survey, Microgravity and 4D Gravity: What is the difference ?") in the form of combined lectures and seminars. Following the previous lecturing in Saudi Arabia, Abu Dhabi, Qatar etc., he presented this set e.g. at Université de Pau, France, UAE University in Al Ain, SEG/SPE workshop Monitoring Giant Fields in Dubai, UAE, Qatar University, Doha Municipality Office in Qatar, Malaya University in Kuala Lumpur, Malaysia, etc.
The audience included students of geophysics, petrophysics, engineering geology and petroleum geology, BSc., MSc. and Ph.D., as well as faculty staff, other geosciences specialists, and also officials, e.g. from central municipality offices.

Lecturing to graduate and post-graduate students and academic staff at Malaya University, Kuala Lumpur, Malaysia.



Magnitude-time distribution of the earthquake swarm in the West Bohemia/Vogtland region recorded by the WEBNET network in Aug/Sep 2011. Short duration and high number of small earthquakes is the typical feature of the swarms in this area. This catalog is based on automatic detections and contains more than 8.000 earthquakes.

Observatories And Mobile Data Acquisition Systems

A significant part of the Institute's mission involves acquisition and sharing of primary geophysical data through a number of observatories and mobile measuring equipment. In 2010, a significant new step in these efforts was acomplished by joining the CzechGeo network of geophysical observations.

More information, including technical details and geographic coordinates of the Institute's observatories, can be found at http://www.ig.cas.cz/en/structure/observatories/.

CzechGeo/EPOS – Distributed System of Observatory and Field Measurements of Geophysical Fields in the Czech Republic

CzechGeo/EPOS is the distributed network of geoscience observations performed by research institutions and universities in the Czech Republic. The backbone of the project is formed by permanent stations (seismic, GPS, magnetic, gravimetric and geodynamic) involved in global networks which provide data mostly in real time. Permanent observatories are complemented by local stations in selected regions of interest. The third level of the observational system is formed by mobile stations which are deployed for repeated measurements or field experiments within various international projects. The project, initiated and managed by our Institute, involves activities of following geoscience institutions: Institute of Rock Structure and Mechanics of the AS CR, Prague, Institute of Geonics of the AS CR, Ostrava, Institute of Physics of the Earth, Masaryk University, Brno, Faculty of Mathematics and Physics, Charles University, Prague, Faculty of Science, Charles University, Prague and Research Institute of Geodesy, Topography and Cartography, Zdiby. Web pages of the project www.czechgeo.cz contain links to all institutions and research infrastructures. They will serve in the near future as a data portal of seismic, magnetic, GPS and other geoscience data for the research community and the public.

Project CzechGeo was recognized by the Czech government as an important national research infrastructure and together with the other eleven research infrastructures (e.g. CESNET – Czech Academic Internet Network, or PALS – Prague Asterix Laser System) included in the Czech National Roadmap. Ministry of Education, Youth and Sports allocated for the CzechGeo project the annual support of 20 million Czech crowns (about 800K Euro) for the period 2010 – 2015. This funding represents a substantial contribution to the operational and personnel costs as well as hardware investments of geophysical, GPS and geodynamic networks in the Czech Republic. The involved institutions formed the Consortium and signed the Consortium agreement.

The CzechGeo project could not be realized without close relation with the 7th FP project EPOS (European Plate Observing System) which was included into the European Roadmap of Research infrastructures of ESFRI (European Strategic Forum for Research Infrastructures) in 2008. In fact, the funding of the CzechGeo is largely conditioned by active involvement of the Czech representatives in the Preparatory Phase of EPOS.

Castle Třešť, owned by the Academy of Sciences, is not only the venue of numerous international conferences but also the site of one of the stations of the Czech Regional Seismic Network.

Czech Regional Seismic Network (CRSN)

The Institute of Geophysics operated nine stations of the CRSN in the period 2010-2011: Průhonice (PRU, since 1957), Kašperské Hory (KHC, since 1961), Dobruška/Polom (DPC, since 1992), Nový Kostel (NKC, since 1997), Úpice (UPC, since 1987), Panská Ves (PVCC, since 2003), Třešť (TREC, since 2005), Králíky (KRLC, since 2008), and Ostrava/Krásné Pole jointly with Technical University and Institute of Geonics, Ostrava (OKC, since 2000). Digital data were transferred continuously from all stations to the IG by Internet. Software packages Antelope and SeisComP were used for automated data acquisition, archiving and exchange European and global data centers and numberous neighbouring national data centers and observatories. Virtual network of the IG consisted of about seventy real-time seismological stations in central and southern Europe thanks to broad international cooperation established in the frame of EC projects Meredian (2000-2005) and

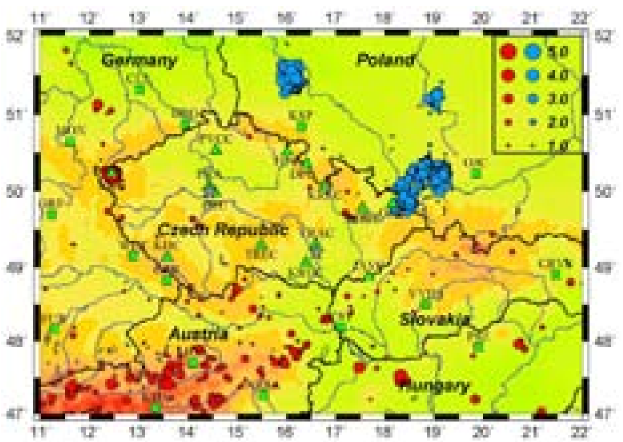
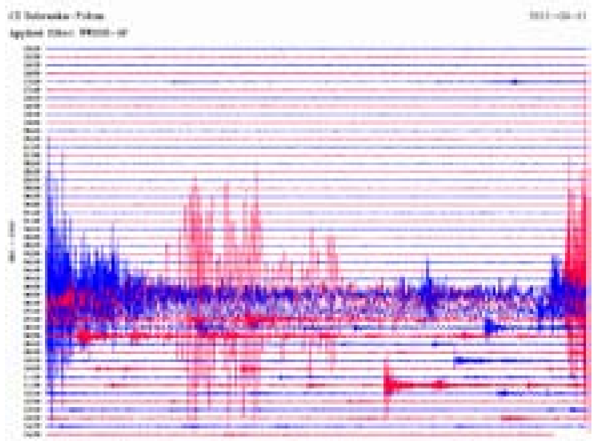


Fig.1. Stations of the Czech Regional Seismic Network (green triangles) and regional seismic events in central Europe in 2010-2011. Tectonic earthquakes are shown as red circles, mining-induced shocks as blue circles. The size of the circles is proportional to local magnitude.

Neries (2006-2010). Institute of Geophysics is one of twenty partner institutions from eighteen countries involved in the Preparatory phase of the research infrastructure project European Plate Observing System (EPOS) which started in November 2010 for the period of 4 years. The CzechGeo/EPOS project (described above) supported by the Ministry of Education, Youth and Sports for the period 2011-2015 is the national initiative of the EPOS project. More information about EPOS can be found on the web page http://www.epos-eu.org

Seismological Data Center of the Institute of Geophysics provides the following services:

- Automated near-real time data acquisition of continuous broadband and short-period seismic data by Antelope and SeedLink software packages and archiving on large raid systems.
- Global data exchange of both seismic phase readings and digital records with major international data centers (ISC, NEIC, IRIS, ORFEUS, EMSC) and a number of neighbouring national centers and observatories,
- Daily processing of digital seismograms by analysis program Seismic Handler.
- Compiling and publishing seismological catalogues and bulletins on the web, collection and evaluation of macroseismic reports about earthquakes felt on the territory of the Czech Republic.
- Providing automated locations of seismic events and live seismograms of the CRSN stations on the web pages of the IG.
- Informing the public through the media and web pages about strong and devastating earthquakes in Europe and worldwide.



"Live seismogram" of very-broadband seismological station Dobruska/Polom from March 11, 2011 shows the record of the great Tohoku earthquake Mw=9.0 and numerous aftershocks.

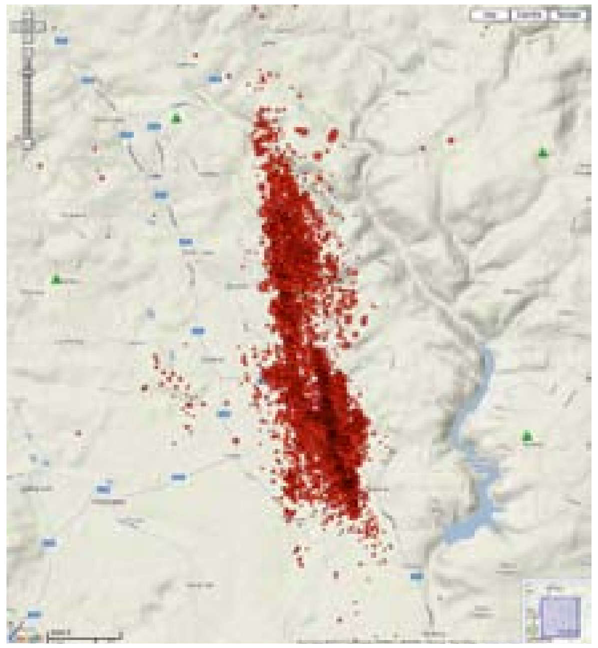
The WEBNET network

West Bohemia/Vogtland earthquake swarm region belongs to the most closely monitored seismically active areas in Europe. The WEBNET network, jointly operated by the Institute of Geophysics (IG) and the Institute of Rock Structure and Mechanics (IRSM) of the ASCR in Prague, is the primary source of seismic data from the whole region at present. It consists of 13 three-component stations and covers an area of about 1000 km^2. Further smaller local networks providing relevant, high quality data have been working in NE Bavaria and SE Saxony.

The individual stations are equipped by the SM-3 short-period seismometers and Janus-Trident/Nanometrics acquisition systems. In addition, central station Nový Kostel (NKC) and station ZHC (southern part of the seismogenic region) are equipped with the Güralp 40-T broadband sensors. Its configuration and the parameters of the seismograph systems guarantee high-quality recording of West Bohemia/Vogtland events of magnitudes $0.5 \le M_L \le 5.0$ in a frequency range of 0.5 to 80 Hz with a sampling frequency of 250 Hz. Thus, Webnet makes it posible to record high-frequency waves generated by local events, short-period body waves of regional and distant earthquakes, and surface waves excited by quarry blasts fired in the neighbourhod of the region under study. Data, both continuous and triggered, from all the stations are transmitted via Internet to IG, Prague. WEBNET is interconnected with the CRSN via station NKC (see paragraph Czech Regional Seismic Network).

To provide the best possible area and azimuth coverage with respect to the individual focal zones, ten seismic vaults consisting of a container with a concrete pillar c. 2m below the surface were built in West Bohemia for deployment of mobile stations in case of stronger seismic activity.

The catalogues and seismograms of all tectonic events (about 70,000) recorded by the WEBNET since 1992 and by the temporal stations since 2006 are archived in a joint digital database. Particularly, observations of the 2008 and 2011 swarms (recorded by 13 to 23 stations) represent a unique data set. Data from other networks operating in NE Bavaria and SE Saxony are available on request. The WEBNET data represent a major database for diverse seismic-source and upper-crust-structure investigations performed in the IG



Locations of epicentres of earthquakes between October 2010 and January 2012, in the West Bohemia/Vogtland region, as recorded by the WEBNET stations (green triangles).

ASCR. In addition, they are broadly used by cooperated scientists from all over the world.

Geodynamic and Earth Tide Observatories

Tidal observatories have been recording tidal data since 1952. At present, we operate three of them. SKALNA was included into the ICET (Int. Centre for Earth Tides) world network within the frame of the Global Geodynamic Project.

PŘÍBRAM, *Central Bohemia [49.6861N, 13.9972E]*

This observatory is located on top of an abandoned deep mine (depth 1300 m). Here, all istruments are maintained and undergo long-term tests in the mine gallery (tiltmeters, gravimeter, barographs, etc.). The data from all other sites are transmitted to this centre for control and processing. Moreover, based on the support of the CzechGeo Project, we decided to establish a complex observation system here at the second floor of the mine, with broadband seismograph (will be included into the Czech National Seismological Network), a couple of tiltmeters and semi-permanent gravity recording.

JEZEŘÍ, *North Bohemia [50.5553N; 13.5052E]*

The observatory was established in 1982 when a complex investigation of the Krušné hory slopes began with the aim of controlling the stability of the slopes of an open-pit coal mine. The observatory is composed of two sites in a horizontal gallery located under the Jezeří castle, equiped with the Ostrovsky's and ASNS tiltmeters with permanent recording of tilts. The target is to record the stability of the marginal block of the basement massif suspected of rotation or sliding into the open-pit mine. This observatory is a part of the monitoring system of the mining company, focused on the mine risk mitigation. We observed striking tilt signal before, during and after a significant landslide that occurred in January 2011. Such events represent hazard for the mine, as well as for the castle located nearby uphill.

January 2011 landslides on the edge of open-pit coal mine in the immediate vicinity of the Krušné Hory fault scarp, with the Jezeří castle on the horizon.

SKALNÁ, *West Bohemia [50.1688N, 12.3606E]*

This complex geodynamic observatory is located in the West Bohemia seismoactive region in an underground gallery inside a granite block in Skalná. The observatory contributes to the monitoring of the ongoing geodynamic processes in the region. It is furnished with a seismograph, a couple of tiltmeters, a barometer and a strainmeter. Occasionally, continuous measurements of gravity are performed to test local changes of the gravity field. Significant gravity signal was recorded during the Sumatra earthquake 2004. In 2008, tilt records were strongly affected by the October earthquake swarm taking place at about 7 km distant focal area.

Geomagnetic observatory

The long tradition of geomagnetic observations in Prague dates back to 1839. Due to the increasing influence of urban magnetic noise since the beginning of the 20th century, the Prague observatory was closed down in 1926, and was replaced in 1946 by the Průhonice observatory near Prague. Rapid expansion of the city and construction of DC – powered railways resulted in a deterioration of this location. In 1967, the observatory was moved to Budkov near Prachatice in south Bohemia, a sparsely populated area. Currently the observatory is equipped with two digital systems. CANMOS, installed in 1992 in co-operation with the Geomagnetic Observatory of the Geological Survey of Canada consists of a triaxial Narod S-100 ring-core magnetometer, an ELSEC 820 PPM magnetometer, and a control unit based on MS-DOS operating system. The main parts of GDAS system are DMI suspended fluxgate magnetometer, Overhauser proton magnetometer and Pentium-type embedded PC with QNX4 operating system and SDAS data acquisition software developed by British Geological Survey. Absolute measurements are carried out by DI magnetometer (fluxgate sensor mounted on non-magnetic theodolite Zeiss 010B).

New building of the Budkov geomagnetic observatory, open in 2010.

New main building – open in 2010 – created better working conditions for the staff taking care of the observatory. The observatory was linked by optical cable to the Czech Academic Network (CESNET). The former data transmission via switched telephone network was thus replaced by state-of-the-art communication tools.

The Department of Geomagnetism has been issuing daily forecasts of geomagnetic activity for Central Europe since 1994, weekly forecasts since 1995. Since 1998 the short term forecasts have been regularly sent to Czech TV, where they are presented as part of the Weather Forecast. At present, the forecasts, as well as reports of the actual state of the geomagnetic field in our region, are presented on the web pages of the Regional Warning Centre Prague (http://rwcprague.ufa.cas.cz/).

Geothermal climate-change observatories

The geothermal climate-change observatories on the campus of the Institute of Geophysics at Spořilov, at the meteorological station Kocelovice (operated by the Czech Hydrometeorological Institute) and near Potůčky (Krušné Hory Mountains) were established in the years 1993, 1998 and 2002, respectively. The observatories monitor air, soil and bedrock temperatures at a sampling rate of 30 minutes with the aim to provide data on the air-ground temperature coupling and on a propagation of seasonal, interannual and secular surface temperature changes into the bedrock. The monitoring is expected to continue into the future, to map the tracking of the air and ground mean annual temperatures on an interannual time scale. The tracking is crucial for the proper climatic interpretation of the ground surface temperature history reconstructed from borehole temperature profiles.

Air-ground temperature monitoring on the campus of the Institute of Geophysics.

The influence of vegetation cover on the soil temperatures is studied systematically using data from the fourth observatory located on the premises of the Institute of Geophysics in Prague – Spořilov. The monitoring system launched in 2002 provides data on the soil temperatures to the depth of 0.5 m under different surface conditions, namely under grass, barren soil, sand, and asphalt. The system was upgraded by installation of one pyranometer for monitoring the incoming short-wave radiation and four pyranometers for the short-wave radiation reflected by the individual surfaces. The monitoring provides data for a detailed study of the mean annual difference between air and soil temperatures, its long-term stability and dependence on the vegetation cover and provides useful data for an array of other disciplines like agronomy, forestry, ecological studies or alternative energy sources.

Geothermal observational site – Spořilov 3

The observed warming in most air-temperature meteorological records of the past 100-150 years provides an important piece of evidence that the present global climatic system is changing. The increase of air temperature is linked to the increase of the ground surface (soil) temperature and the change in the surface conditions penetrates downwards. The high-frequency component of this transient signal is progressively filtered out and fades out below the depth of about 20-30 m. The ground "smoothes" the temperature extremes and the magnitude of the present day climate warming can be obtained by temperature monitoring at shallow depths just below the penetration reach of the seasonal temperature variations.

An automatic system for monitoring ground temperatures in the Institute of Geophysics was developed in early 1990s and has been successfully running since then. The obtained record of the subsurface temperatures covering a 40 m depth interval is a unique document, which by far has exceeded the original expectations. It is understandable that after almost 18-year-service some of the thermistor sensors of the operational measuring chain need to be replaced and the whole system to be innovated. Another problem, which arose later, was the construction of a new building erected in the proximity of the observational site in the mid-1990s. The proper existence of the building and heating its basement may affect the pristine ground conditions. Even when this effect seems to be still negligible at present, for the future it signifies an unwanted disturbing effect on the observational results.

To continue the studies a new project P210/11/0183 "*Subsurface temperature monitoring – a useful tool to understand the contemporary climate change*" was granted for years 2011-15 and a new 50 m deep hole was drilled in May 2011 in the western promontory of the institutional campus (50°2′26″N, 14°28′27″E).

The principal outputs of the project include:

(a) To capture important features of the recent climate change on various time scales together with the studies of the inter-annual variability of soil temperatures and the difference between soil vs. air temperatures and their dependence on the surface type in relation to meteorological variables.

(b) To evaluate the observed present-day warming rate at the site location in Prague in relation to other experimental site located in south-central Bohemia (Kocelovice) and to estimate the potential "city heat island effect" of large agglomeration (Prague).

Drilling the borehole for the new geothermal observational site – Spořilov 3, in the Geopark of the Institute of Geophysics, May 2011.

(c) Together with the simultaneous analysis of the air-temperature records in several local meteorological station in various location of the country to assess the pre-observational surface air temperature conditions of the 19th and 20th century in the Czech Republic to improve the knowledge of the climate evolution on the century long scale.

Geopark Spořilov

—— The GEOPARK of the Geophysical Institute, open to the public, has been built on the premises of the Institute in several phases since 2003, with generous support from the Prague 4 municipal council and thanks to enthusiasm of companies that donated many rock specimens. The aim of the exhibition is to increase the awareness of the general public about processes operating in the Earth interior and on its surface, and about their products. Currently the Geopark features over 40 large specimens of igneous, sedimentary, and metamorphic rocks from the Bohemian Massif and a collection of magmatic rocks from Western Carpathians. Explanatory texts and accompanying posters about plate tectonics and the geological history of the Czech Republic are posted in the Geopark and on the Institute's website: http://www.ig.cas.cz/cz/o-nas/popularizace/geopark-sporilov/. The rock collection of the Geopark became a basis of the book „Geological processes marked in rocks" written by the staff of the Department of Tectonics and Geodynamics of the Institute. The book which introduces basic principles of plate tectonics, Earth's evolution and rock formation is available free to visitors of the Geopark. All visitors – locals, casual visitors, and, commonly, schools – thus have the opportunity not only to appreciate the beauty of the rocks on display, or read the posters and

the book, but they can also take part in a quiz-game named „The Alchemists' Stone", as an entertaining way to learn about minerals, rocks, and processes that create them. Public outreach activities, organized by the Institute, such as the Earth Day celebration, take place in the Geopark. Most recently, a new geothermal observational site, situated in a borehole, was set up in the Geopark in 2011 (see p. 69)

Public outreach activities

—— The Institute takes part in the annual "Science and Technology Weeks" organized by the Academy of Sciences. This is the main outreach activity of the Academy, aimed at informing the general public about the impact of science on daily life and its benefits (details can be found at http://press.avcr.cz/tyden-vedy-a-techniky/). In 2010 and 2011, researchers of the Institute of Geophysics contributed to public lectures given by researchers from all branches of science represented in the Academy of Sciences (http://videoserver.cesnet.cz/videoarchiv.php). In addition, the Institute organizes its Open Days which take place each year in November. In 2011, for example, the Open Days were visited by 110 visitors (mostly students) who could learn about earthquakes, scientific drilling at the continents and ocean bottom, the use of geothermal energy, take a guided tour through the Institute's Geopark, or watch sandbox experiments simulating volcanic eruptions or building of a mountain range.

—— In 2010, researchers from the Institute of Geophysics, in collaboration with the Centre of Administration and Operations of the ASCR, launched a new public outreach activity, a celebration of the Earth Day (April 22) with the Academy of Sciences, aimed specifically at increasing the public awarness about all branches of Earth Sciences. Between April 19 and 22,

2010, a series of public lectures took place in the headquarters of the Academy, given by researchers from the Institute of geophysics as well as by guest speakers from other geoscience institutions. Diverse topics ranged from the plate tectonic processes and their role in the formation of the landscape of the Czech Republic, volcanism, earthquakes, to climate and sea level change. A photograph exhibition focused on interna-

tional activities of Czech geologists, also at the Academy headquarters in central Prague, was a successful supplement to the lectures. A day full of interactive

outdoor activities, with demonstrations of simple geological experiments, was organized for schoolchildren in the Institute's Geopark. In 2011, the successful programme was supplemented by a seminar on selected topics in Earth Sciences for teachers of physics and geography in primary and secondary schools, and an photograph exhibition of rock materials under the microscope, again at the Academy's headquarters. The public lectures and other activities in 2011 were attended by more than 700 visitors. The details on our public outreach activities, including videos of experiments or archiove videos of lectures, are available, in Czech, on the web pages: http://www.ig.cas.cz/cz/o-nas/popularizace/.

—— A video presentation, in English, from the Earth Day 2010 is featured on the web pages of the Institute of Geophysics: http://www.ig.cas.cz/userdata/files/popular/Den_zeme2010_EN.flv

—— Researchers from the Institute of Geophysics are frequently featured in the media, in particular in TV and radio broadcasts related mostly to earthquakes, volcanism and other geological hazards, but also to the Earth evolution and other topics of general interest. In 2010 and 2011, our colleagues made 62 TV and radio appearances, explaining to the public the scientific background of important events such as devastating earthquake in Haiti, 2010, and the catastrophic Tohoku earthquake and tsunami in Japan, 2011.

—— Other outreach activities involved, for example, collaboration on the Otevřená Věda (Open Science) project: http://www.otevrena-veda.cz/ov/index.php?site=gfu. Individual researchers presented talks at high schools, museums, and other public institutions, or led field trips to secondary schools students. Various parts of the famous Jan Kozák collection of historical artworks related to geological catastrophes and natural history was featured in several exhibitions and presentations around the country.

List of supported research projects running in 2010–2011

Compiled from the data of CEP database (Central Register of Projects, see http://aplikace.isvav.cvut.cz/). This list includes only the projects with the Principal Investigator employed at the Institute of Geophysics.

Funding bodies:

GAASCR = Grant Agency of the ASCR, GACR = Czech Science Foundation, MEYS = Ministry of Education Youth and Sports, MEnv = Ministry of Environment, ASCR = The Academy of Sciences of the Czech Republic

Project ID	Project Title	Funding Source	Responsible Investigator at the IG	Duration
GAP210/11/0183	Subsurface temperature monitoring – a useful tool to understand the contemporary climate change	GACR	Vladimír Čermák	2011-2015
GAP210/11/0117	Seismic wave propagation in complex media – perturbation approaches II	GACR	Ivan Pšenčík	2011-2014
LM2010008	CzechGeo/EPOS – A Distributed System of Observatory and Field Measurements of Geophysical Fields in the Czech Republice	MEYS	Pavel Hejda	2010-2015
GAP210/10/1991	A new European reference section to study mid-Cretaceous sea-level change, palaeoceanography and palaeoclimate: drilling the Bohemian Cretaceous Basin	GACR	David Uličný	2010-2013
GAP210/10/0554	Magnetic specification of the atmospheric particles PM1, PM2.5 a PM10 from localities with different air quality	GACR	Eduard Petrovský	2010-2013
FP7-230669-AIM	Advanced Industrial Microseismic Monitoring (AIM)	EU	Václav Vavryčuk	2009-2013
GAP210/10/1728	Non-double-couple mechanisms: through induced seismicity to fluid-driven earthquakes	GACR	Zuzana Jechumtálová	2010-2013
ME09011	Subduction Factory: Earthquake Production and Magma Emplacement	MEYS	Aleš Špičák	2009-2012
ILA09015	Activities within IAGA (International Association of Geomagnetism and Aeronomy)	MEYS	Eduard Petrovský	2009-2012
ME10008	Rotational seismometers: design, construction, calibration and field testing	MEYS	Jan Kozák	2010-2012
IAA300120911	Common characteristics of the West Bohemia/Vogtland earthquake swarms and swarm-like seismicity triggered by fluid-injection into the HDR boreholes at Soultz-sous-Forets in Alsace	GAASCR	Josef Horálek	2009-2012
GAP210/10/2227	Regional and global distribution of geoelectrical conductance in the Earth's mantle using terrestrial and satellite measurements	GACR	Josef Pek	2010-2012
OC09070	Space weather variability and short-term forecasts of geomagnetic activity	MEYS	Pavel Hejda	2009-2012
GAP210/10/2063	Structure of the Earth's Crust in seismically active region in Western Bohemia	GACR	Pavla Hrubcová	2010-2012
GA205/09/1170	Upper mantle beneath the neovolcanic zone of the Bohemian Massif: xenoliths and their host basalts	GACR	Petr Špaček	2009-2012
GAP210/10/0296	Modelling the earthquake foci using second-order moment tensors	GACR	Petra Adamová	2010-2012
GA205/09/0539	Internal strain fabric and rheology of orogenic peridotites and surrounding crustal rocks	GACR	Stanislav Ulrich	2009-2012
IAA300120905	Dynamics of crustal fluids in the western part of the Bohemian Massif as a probe of the stress changes	GAASCR	Tomáš Fischer	2009-2012
IAA300120801	Seismic waves and seismic sources in anisotropic media II.	GAASCR	Václav Vavryčuk	2008-2012
GA205/09/0724	Non-double-couple mechanisms - a tool for monitoring the mode of fracturing	GACR	Jan Šílený	2009-2011
IAA300120704	Numerical models of the hydromagnetic processes and geodynamo in the Earth's core	GAASCR	Ján Šimkanin	2007-2011
IAA300120709	Mantle lithosphere of north-central Europe – mosaic of micro-continents	GAASCR	Jaroslava Plomerová	2007-2011
IAA300420805	Extraterrestrial factors influencing atmospheric circulation in medium and high altitudes	GAASCR	Josef Bochníček	2008-2011
GA205/07/1088	Eger Rift - deep lithosphere structure, its origin and geodynamic development	GACR	Vladislav Babuška	2007-2011
IAA300120701	Long-term monitoring and analysis of dynamics of atmospherically deposited magnetic particles in soils	GAASCR	Aleš Kapička	2007-2010
205/08/0332	Propagation of seismic waves in complex media - perturbation approaches	GACR	Ivan Pšenčík	2008-2010
IAA300120603	Long term measurement and analysis of soil temperature below different surfaces	GAASCR	Jan Šafanda	2006-2010
IAA300460602	Model of the upper crust in the Eger Rift and surroundings	GAASCR	Miroslav Novotný	2006-2010
IAA300120608	Short term and long term variations of the geomagnetic field: data analyses and forecasts	GAASCR	Pavel Hejda	2006-2010
IAA300120805	Finite seismic source of West Bohemia seismic events inferred from stopping phases	GAASCR	Petr Kolář	2008-2010
IAA300120703	Effects of external inhomogeneous sources on the electromagnetic field of the Earth within the Central and Northeast Europe	GAASCR	Světlana Kováčiková	2007-2010
GA205/07/0292	Basic geoelectrical units at the eastern margin of Bohemian Massif and its contact with Carpathians by means of magnetoteluric sounding	GACR	Václav Červ	2007-2010

International Publications

The following list contains original scientific publications authored or co-authored by employees of the Institute of Geophysics (underlined in the reference heading), only in journals with the ISI Impact Factor. Publications from years 2010 and 2011 are listed separately, in alphabetic order of names of the authors employed by the Institute of Geophysics.

A complete list of all publications is available at http://www.ig.cas.cz/en/research-&-teaching/publications/, and on the homepages of individual researchers.

2010

Adamová, P. – Šílený, J.
Non-double-couple earthquake mechanism as an artifact of the point-source approach applied to a finite-extent focus.
Bulletin of the Seismological Society of America. Vol. 100, no. 2 (2010), p. 447-457.
DOI: 10.1785/0120090097

Babuška, V. – Fiala, J. – Plomerová, J.
Bottom to top lithosphere structure and evolution of western Eger Rift (Central Europe).
International Journal of Earth Sciences. Vol. 99, no. 4 (2010), p. 891-907. DOI: 10.1007/s00531-009-0434-4

Babuška, V. – Plomerová, J. – Vecsey, L.
Links between the structure of the mantle lithosphere and morphology of the Cheb Basin (Eger Rift, central Europe).
International Journal of Earth Sciences. Vol. 99, no. 7 (2010), p. 1535-1544. DOI: 10.1007/s00531-010-0531-4

Babuška, V. – Plomerová, J.
Mantle lithosphere control of crustal tectonics and magmatism of the western Ohře (Eger) Rift.
Journal of Geosciences. Vol. 55, no. 3 (2010), p. 171-186. DOI: 10.3190/jgeosci.070

Čermák, V. – Šafanda, J. – Bodri, L.
Thermal instability of the fluid column in a borehole: application to the Yaxcopoil hole (Mexico).
International Journal of Earth Sciences. Vol. 99, no. 6 (2010), p. 1437-1451. DOI: 10.1007/s00531-009-0472-y

Červ, V. – Pek, J. – Menvielle, M.
Bayesian approach to magnetotelluric tensor decomposition.
Annals of Geophysics. Vol. 53, no. 2 (2010), p. 21-32. DOI: 10.4401/ag-4681

Anufriev, A. P. – Hejda, P.
Earth's core convection: Boussinesq approximation or incompressible approach?.
Geophysical and Astrophysical Fluid Dynamics. Vol. 104, no. 1 (2010), p. 65-83. DOI: 10.1080/03091920903517863

Hejda, P. – Reshetnyak, M.
Nonlinearity in a dynamo.
Geophysical and Astrophysical Fluid Dynamics. Vol. 104, no. 5-6 (2010), p. 491-504. DOI: 10.1080/03091929.*2010*.496365

Horálek, J. – Fischer, T.
Intraplate earthquake swarms in West Bohemia/Vogtland (Central Europe).
Jokull. Vol. 60, no. 1 (2010), p. 67-87.

Horálek, J. – Jechumtálová, Z. – Dorbath, L. – Šílený, J.
Source mechanisms of micro-earthquakes induced in a fluid injection experiment at the HDR site Soultz-sous-Forêts (Alsace) in 2003 and their temporal and spatial variations.
Geophysical Journal International. Vol. 181, no. 3 (2010), p. 1547-1565. DOI: 10.1111/j.1365-246X.*2010*.04506.x

Fischer, T. – Horálek, J. – Michálek, J. – Boušková, A.
The 2008 West Bohemia earthquake swarm in the light of the WEBNET network.
Journal of Seismology. Vol. 14, no. 4 (2010), p. 665-682. DOI: 10.1007/s10950-010-9189-4

Hrubcová, . – Środa, P. – Grad, M. – Geissler, W.H. – Guterch, A. – Vozár, J. – Hegedüs, E.
From the Variscan to the Alpine Orogeny: crustal structure of the Bohemian Massif and the Western Carpathians in the light of the SUDETES 2003 seismic data.
Geophysical Journal International. Vol. 183, no. 2 (2010), p. 611-633. DOI: 10.1111/j.1365-246X.*2010*.04766.x

Kozák, J. – Prachař, I.
First macroseismic map in transalpine Europe (1810 Mór earthquake in the Pannonian Basin).
Studia geophysica et geodaetica. Vol. 54, no. 2 (2010), p. 339-341.

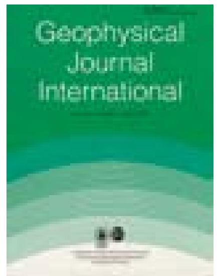
Kratinová, Z. – Machek, M. – Kusbach, V.
Fabric transpositions in granite plutons – an insight from non-scaled analogue modelling.
Journal of the Geological Society of India. Vol. 75, no. 1 (2010), p. 267-277. DOI: 10.1007/s12594-010-0014-z

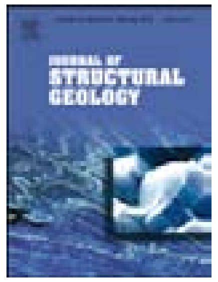
Kratinová, Z. – Ježek, J. – Schulmann, K. – Hrouda, F. – Shail, R. K. – Lexa, O.
Noncoaxial K-feldspar and AMS subfabrics in the Land's End granite, Cornwall: Evidence of magmatic fabric decoupling during late deformation and matrix crystallization.
Journal of Geophysical Research. Vol. 115, no. B9 (2010), p. B09104/1-B09104/21. DOI: 10.1029/2009JB006714

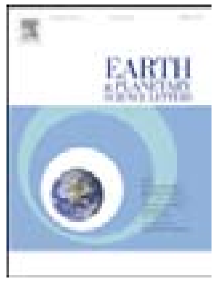
Laštovička, J. – Baše, J. – Hruška, F. – Chum, J. – Šindelářová, T. – Horálek, J. – Zedník, J. – Krasnov, V.
Simultaneous infrasonic, seismic, magnetic and ionospheric observations in an earthquake epicentre.
Journal of Atmospheric and Solar-Terrestrial Physics. Vol. 72, no. 16 (2010), p. 1231-1240. DOI: 10.1016/j.jastp.*2010*.08.005

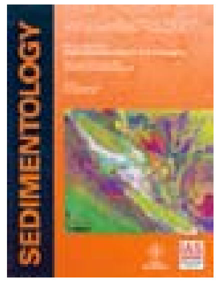
Jones, A. G. – Plomerová, J. – Korja, T. – Sodoudi, F. – Spakman, W.
Europe from the bottom up: A statistical examination of the central and northern European lithosphere–asthenosphere boundary from comparing seismological and electromagnetic observations.
Lithos. Vol. 120, no. 1-2 (2010), p. 14-29. DOI: 10.1016/j.lithos.*2010*.07.013

Plomerová, J. – Babuška, V.
Long memory of mantle lithosphere fabric — European LAB constrained from seismic anisotropy.
Lithos. Vol. 120, no. 1-2 (2010), p. 131-143. DOI: 10.1016/j.lithos.*2010*.01.008







Laurin, J. – Vodrážka, R.
Record of sea-level fall in shallow-water hemipelagic strata: case study and numerical modelling.
Terra Nova. Vol. 22, no. 2 (2010), p. 103-109. DOI: 10.1111/j.1365-3121.2009.00922.x

Soejono, I. – Žáčková, E. – Janoušek, V. – Machek, M. – Košler, J.
Vestige of an Early Cambrian incipient oceanic crust incorporated in the Variscan orogen: Letovice Complex, Bohemian Massif.
Journal of the Geological Society. Vol. 167, no. 6 (2010), p. 1113-1130. DOI: 10.1144/0016-76492009-180

Novotný, M. – Skácelová, Z. – Mlčoch, B.
Crustal structures beneath the Saxonian Granulite Massif, the České středohoří and the Doupovské hory Mts. based on the depth-recursive tomography.
Journal of Geosciences. Vol. 55, no. 3 (2010), p. 187-199. DOI: 10.3190/jgeosci.070

Rijal, M. L. – Appel, E. – Petrovský, E. – Blaha, U.
Change of magnetic properties due to fluctuations of hydrocarbon contaminated groundwater in unconsolidated sediments.
Environmental Pollution. Vol. 158, no. 5 (2010), p. 1756-1762. DOI: 10.1016/j.envpol.2009.11.012

Zahradník, J. – Plešinger, A.
Toward understanding subtle instrumentation effects associated with weak seismic events in the near field.
Bulletin of the Seismological Society of America. Vol. 100, no. 1 (2010), p. 59-73. DOI: 10.1785/0120090087

Eken, T. – Plomerová, J. – Roberts, R. – Vecsey, L. – Babuška, V. – Shomali, H. – Bodvarsson, R.
Seismic anisotropy of the mantle lithosphere beneath the Swedish National Seismological Network (SNSN).
Tectonophysics. Vol. 480, no. 1-4 (2010), p. 241-258. DOI: 10.1016/j.tecto.2009.10.012

Prikner, K. – Feygin, F. Z. – Raita, T.
A comparative Pc1 case study applying two modes of ionospheric Alfvén resonator modeling.
Studia geophysica et geodaetica. Vol. 54, no. 3 (2010), p. 495-511.

Farra, V. – Pšenčík, I.
Coupled S waves in inhomogeneous weakly anisotropic media using first-ordes ray tracing.
Geophysical Journal International. Vol. 180, no. 1 (2010), p. 405-417. DOI: 10.1111/j.1365-246X.2009.04423.x

Farra, V. – Pšenčík, I.
First-order reflection/transmission coefficients for unconverted plane P waves in weakly anisotropic media.
Geophysical Journal International. Vol. 183, no. 3 (2010), p. 1443-1454. DOI: 10.1111/j.1365-246X.*2010*.04794.x

Červený, V. – Pšenčík, I.
Gaussian beams in inhomogeneous anisotropic layered structures.
Geophysical Journal International. Vol. 180, no. 2 (2010), p. 798-812. DOI: 10.1111/j.1365-246X.2009.04442.x

Barlow, P. W. – Mikulecký, M. – Střeštík, J.
Tree-stem diameter fluctuates with the lunar tides and perhaps with geomagnetic activity.
Protoplasma. Vol. 247, no. 1-2 (2010), p. 25-43. DOI: 10.1007/s00709-010-0136-6

Lojka, R. – Sýkorová, I. – Laurin, J. – Matysová, P. – Matys Grygar, T.
Lacustrine couplet-lamination: evidence for Late Pennsylvanian seasonality in central equatorial Pangaea (Stephanian B, Mšec Member, Central and Western Bohemian basins).
Bulletin of Geosciences. Vol. 85, no. 4 (2010), p. 709-734. DOI: 10.3140/bull.geosci.1210

Šimkanin, J. – Hejda, P. – Saxonbergová-Jankovičová, D.
Convection in rotating non-uniformly stratified spherical fluid shells in dependence on Ekman and Prandtl numbers.
Physics of the Earth and Planetary Interiors. Vol. 178, no. 3-4 (2010), p. 39-47. DOI: 10.1016/j.pepi.2009.10.010

Šimkanin, J. – Hejda, P. – Jankovičová, D.
Inertial waves in spherical shells at low Ekman numbers.
Studia geophysica et geodaetica. Vol. 54, no. 2 (2010), p. 291-298.

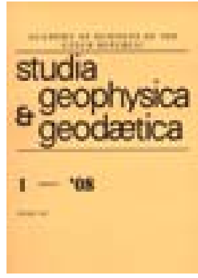
Fojtíková, L. – Vavryčuk, V. – Cipciar, A. – Madarás, J.
Focal mechanisms of micro-earthquakes in the Dobrá Voda seismoactive area in the Malé Karpaty Mts. (Little Carpathians), Slovakia.
Tectonophysics. Vol. 492, no. 1-4 (2010), p. 213-229. DOI: 10.1016/j.tecto.*2010*.06.007

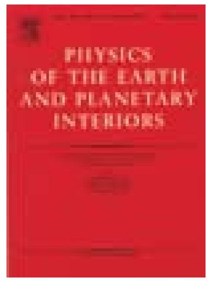
Desbois, G. – Závada, P. – Schléder, Z. – Urai, J. L.
Deformation and recrystallization mechanisms in actively extruding salt fountain: Microstructural evidence for a switch in deformation mechanisms with increased availability of meteoric water and decreased grain size (Qum Kuh, central Iran).
Journal of Structural Geology. Vol. 32, no. 4 (2010), p. 580-594. DOI: 10.1016/j.jsg.*2010*.03.005

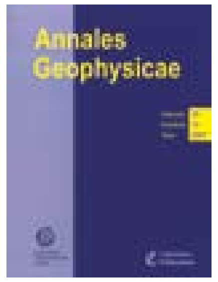
Zedník, J. – Pazdírková, J.
Seismic activity in the Czech Republic in 2008.
Studia geophysica et geodaetica. Vol. 54, no. 2 (2010), p. 333-338.

2011

Hauber, E. – Brož, P. – Jagert, F. – Jodlowski, P. – Platz, T.
Very recent and wide-spread basaltic volcanism on Mars.
Geophysical Research Letters. Vol. 38, no. 10 (2011), p. L10201/1-L10201/5. DOI: 10.1029/*2011*GL047310







Mitchell, A. J. – Uličný, D. – Hampson, G. J. – Allison, P. A. – Gorman, G. J. – Piggott, M. D. – Wells, M. R. – Pain, C. C.
Modelling tidal current-induced bed shear stress and palaeocirculation in an epicontinental seaway: the Bohemian Cretaceous Basin, Central Europe.
Sedimentology. Vol. 57, no. 2 (2010), p. 359-388. DOI: 10.1111/j.1365-3091.2009.01082.x

Janoušek, V. – Konopásek, J. – Ulrich, S. – Erban, V. – Tajčmanová, L. – Jeřábek, P.
Geochemical character and petrogenesis of Pan-African Amspoort suite of the Boundary Igneous Complex in the Kaoko Belt (NW Namibia).
Gondwana Research. Vol. 18, no. 4 (2010), p. 688-707. DOI: 10.1016/j.gr.*2010*.02.014

Vavryčuk, Václav
Behaviour of rays at interfaces in anisotropic viscoelastic media.
Geophysical Journal International. Vol. 181, no. 3 (2010), p. 1665-1677. DOI: 10.1111j.1365-246X.*2010*.04583.x

Kyselý, J. – Plavcová, E. – Davídkovová, H. – Kynčl, J.
Comparison of hot and cold spell effects on cardiovascular mortality in individual population groups in the Czech Republic.
Climate Research. Vol. 49, no. 2 (2011), p. 113-129. DOI: 10.3354/cr01014

Jiráková, H. – Procházka, M. – Dědeček, P. – Kobr, M. – Hrkal, Z. – Huneau, F. – Le Coustumer, P.
Geothermal assessment of the deep aquifers of the northwestern part of the Bohemian Cretaceous basin, Czech Republic.
Geothermics. Vol. 40, no. 2 (2011), p. 112-124. DOI: 10.1016/j.geothermics.*2011*.02.002

Grison, H. – Petrovský, E. – Jordanova, N. – Kapička, A.
Strongly magnetic soil developed on a non-magnetic rock basement: A case study from NW Bulgaria.
Studia geophysica et geodaetica. Vol. 55, no. 4 (2011), p. 697-716. DOI: 10.1007/s11200-009-0489-5

Valach, F. – Revallo, M. – Hejda, P. – Bochníček, J.
Predictions of SEP events by means of a linear filter and layer-recurrent neural network.
Acta Astronautica. Vol. 69, no. 9-10 (2011), p. 758-766. DOI: 10.1016/j.actaastro.*2011*.06.003

Charvátová, I. – Klokočník, J. – Kolmaš, J. – Kostelecký, J.
Chinese tombs oriented by a compass: evidence from paleomagnetic changes versus the age of tombs.
Studia geophysica et geodaetica. Vol. 55, no. 1 (2011), p. 159-174. DOI: 10.1007/s11200-011-0009-2

Kapička, A. – Kodešová, R. – Petrovský, E. – Hůlka, Z. – Grison, H. – Kaška, M.
Experimental study of fly-ash migration by using magnetic method.
Studia geophysica et geodaetica. Vol. 55, no. 4 (2011), p. 683-696. DOI: 10.1007/s11200-010-0078-7

Kodešová, R. – Kapička, A. – Lebeda, J. – Grison, H. – Kočárek, M. – Petrovský, E.
Numerical simulation of fly-ash transport in three sands of different particle-size distributions using HYDRUS-1D.
Journal of Hydrology and Hydromechanics. Vol. 59, no. 3 (2011), p. 206-216. DOI: 10.2478/v10098-011-0017-5

Kolář, P. – Růžek, B. – Boušková, A. – Horálek, J.
Visualization of the fault slip connected with the West Bohemia earthquake swarms.
Acta geodynamica et geomaterialia. Vol. 8, no. 2 (2011), p. 169-187.

Grigelis, A. – Wójcik, Z. – Narebski, W. – Gelumbauskaité, L. Ž. – Kozák, J.
Stanisław Staszic: An Early Surveyor of the Geology of Central and Eastern Europe.
Annals of Science. Vol. 68, no. 2 (2011), p. 199-228. DOI: 10.1080/00033790.2010.511263

Font, E. – Youbi, N. – Fernandes, p. – El Hachimi, H. – Kratinová, Z. – Hamim, Y.
Revisiting the magnetostratigraphy of the Central Atlantic Magmatic Province (CAMP) in Morocco.
Earth and Planetary Science Letters. Vol. 309, no. 3-4 (2011), p. 302-317. DOI: 10.1016/j.epsl.*2011*.07.007

Žák, J. – Kratinová, Z. – Trubač, J. – Janoušek, V. – Sláma, J. – Mrlina, J.
Structure, emplacement, and tectonic setting of Late Devonian granitoid plutons in the Teplá–Barrandian unit, Bohemian Massif.
International Journal of Earth Sciences. Vol. 100, no. 7 (2011), p. 1477-1495. DOI: 10.1007/s00531-010-0565-7

Košťák, B. – Mrlina, J. – Stemberk, J. – Chán, B.
Tectonic movements monitored in the Bohemian Massif.
Journal of Geodynamics. Vol. 52, no. 1 (2011), p. 34-44. DOI: 10.1016/j.jog.2010.11.007

Novotný, M.
Depth-recursive tomography of the Bohemian Massif at the CEL09 transect—Part A: Resolution estimates and deblurring aspects.
Surveys in Geophysics. Vol. 32, no. 6 (2011), p. 827-855. DOI: 10.1007/s10712-011-9143-1

Bućko, M. S. – Magiera, T. – Johanson, B. – Petrovský, E. – Pesonen, L. J.
Identification of magnetic particulates in road dust accumulated on roadside snow using magnetic, geochemical and micro-morphological analyses.
Environmental Pollution. Vol. 159, no. 5 (2011), p. 1266-1276. DOI: 10.1016/j.envpol.*2011*.01.030

Šálek, P. – Korecká, L. – Horák, D. – Petrovský, E. – Kovářová, J. – Metelka, R. – Čadková, M. – Bílková, Z.
Immunomagnetic sulfonated hypercrosslinked polystyrene microspheres for electrochemical detection of proteins.
Journal of Materials Chemistry. Vol. 21, no. 38 (2011), p. 14783-14792. DOI: 10.1039/C1JM12475G

Praus, O. – Pěčová, J. – Červ, V. – Kováčiková, S. – Pek, J. – Velímský, J.
Electrical conductivity at mid-mantle depths estimated from the data of Sq and long period geomagnetic variations.
Studia geophysica et geodaetica. Vol. 55, no. 2 (2011), p. 241-264. DOI: 10.1007/s11200-011-0014-5

Červený, V. – Pšenčík, I.
Boundary attenuation angles for inhomogeneous plane waves in anisotropic dissipative media.
Geophysics. Vol. 76, no. 3 (2011), p. WA51-WA62. DOI: 10.1190/1.3555174

Růžek, B. – Holub, K. – Rušajová, J.
Three-dimensional crustal model of the Moravo-Silesian region obtained by seismic tomography.
Studia geophysica et geodaetica. Vol. 55, no. 1 (2011), p. 87-107. DOI: 10.1007/s11200-011-0006-5

Holub, K. – Růžek, B. – Rušajová, J.
A simple smoothed velocity model of the uppermost Earth's crust derived from joint inversion of Pg and Sg waves.
Acta Geophysica. Vol. 59, – (2011), p. 1-11. DOI: 10.2478/s11600-011-0023-3

Kukkonen, I. T. – Rath, V. – Kivekäs, L. – Šafanda, J. – Čermák, V.
Geothermal studies of the Outokumpu Deep Drill Hole, Finland: Vertical variation in heat flow and palaeoclimatic implications.
Physics of the Earth and Planetary Interiors. Vol. 188, no. 1-2 (2011), p. 9-25. DOI: 10.1016/j.pepi.*2011*.06.002

Šimkanin, J. – Hejda, P. – Saxonbergová, D.
Hydromagnetic dynamos in rotating non-uniformly stratified spherical fluid shells in dependence on the Rayleigh number.
Physics of the Earth and Planetary Interiors. Vol. 185, no. 3-4 (2011), p. 100-106. DOI: 10.1016/j.pepi.*2011*.02.002

Šimkanin, J. – Hejda, P.
Hydromagnetic dynamos in rotating spherical fluid shells in dependence on the Prandtl number and stratification.
Geophysical Journal International. Vol. 185, no. 2 (2011), p. 637-646.
DOI: 10.1111/j.1365-246X.*2011*.04980.x

Ulrych, J. – Dostal, J. – Adamovič, J. – Jelínek, E. – Špaček, P. – Hegner, E. – Balogh, K.
Recurrent Cenozoic volcanic activity in the Bohemian Massif (Czech Republic).
Lithos. Vol. 123, 1/4 (2011), p. 133-144. DOI: 10.1016/j.lithos.2010.12.008

Špičák, A. – Vaněk, J. – Hanuš, V.
Recent plumbing system of the Krakatau volcano revealed by teleseismic earthquake distribution.
International Journal of Earth Sciences. Vol. 100, no. 6 (2011), p. 1375-1381. DOI: 10.1007/s00531-010-0543-0

Špičák, A. – Vaněk, J.
The M(W) 9.0 Tohoku Earthquake, Japan, March 11, 2011.
Studia geophysica et geodaetica. Vol. 55, no. 2 (2011), p. 389-395.
DOI: 10.1007/s11200-011-0022-5

Franěk, J.– Schulmann, K. – Lexa, O. – Ulrich, S. – Štípská, P. – Haloda, J. – Týcová, P.
Origin of felsic granulite microstructure by heterogeneous decomposition of alkali feldspar and extreme weakening of orogenic lower crust during the Variscan orogeny.
Journal of Metamorphic Geology. Vol. 29, no. 1 (2011), p. 103-130.
DOI: 10.1111/j.1525-1314.2010.00911.x

Ulrich, S. – Konopásek, J. – Jeřábek, P. – Tajčmanová, L.
Transposition of structures in the Neoproterozoic Kaoko Belt (NW Namibia) and their absolute timing.
International Journal of Earth Sciences. Vol. 100, no. 2-3 (2011), p. 415-429. DOI: 10.1007/s00531-010-0573-7

Vavryčuk, V.
Detection of high-frequency tensile vibrations of a fault during shear rupturing: observations from the 2008 West Bohemia swarm.
Geophysical Journal International. Vol. 186, no. 3 (2011), p. 1404-1414. DOI: 10.1111/j.1365-246X.*2011*.05122.x

Vavryčuk, V.
Principal earthquakes: Theory and observations from the 2008 West Bohemia swarm.
Earth and Planetary Science Letters. Vol. 305, no. 3-4 (2011), p. 290-296. DOI: 10.1016/j.epsl.*2011*.03.002

Vavryčuk, V.
Tensile earthquakes: Theory, modeling and inversion.
Journal of Geophysical Research. Vol. 116, no. B12 (2011), p. B12320/1-B12320/14. DOI: 10.1029/*2011*JB008770

Závada, P. – Dědeček, P. – Mach, K. – Lexa, O. – Potužák, M.
Emplacement dynamics of phonolite magma into maar-diatreme structures – Correlation of field, thermal modeling and AMS analogue modeling data.
Journal of Volcanology and Geothermal Research. Vol. 201, no. 1-4 (2011), p. 210-226. DOI: 10.1016/j.jvolgeores.2010.07.012

Professional Events

Research groups at the Institute of Geophysics organize or take part in organizing a number of professional meetings each year. A complete overview, with supplementary materials for each event, is posted on http://www.ig.cas.cz/en/about-us/conferences/.

The main events with the Institute's leadership or participation in 2010 and 2011 are listed below:

12th "Castle Meeting" on Paleo, Rock and Environmental Magnetism
Nové Hrady, Czech Republic; 29 August – 4 September, 2010 / Organized by the Institute of Geophysics, ASCR, and the Geophysical Institute of the Slovak Academy of Sciences, under the auspices of IAGA. For more information, see a report published in The IRM Quarterly, Vol.20, No.3 (http://www.irm.umn.edu/quarterly/irmq20-3.pdf)

Seismic waves in laterally inhomogeneous media VII
Teplá Monastery, Czech Republic, June 21–26, 2010 / International workshop meeting, organized by the Institute of Geophysics, Academy of Sciences of the Czech Republic, Prague, and the Consortium "Seismic Waves in Complex 3-D Structures", Department of Geophysics, Faculty of Mathematics and Physics, Charles University, Prague.
http://www.ig.cas.cz/cz/o-nas/konference/swlim-vii/

9th Meeting of the Central European Tectonic Groups, CETEG 2011
Hotel Skalský Dvůr, Lísek / Bystřice pod Pernštejnem, Czech Republic, 13.–17. April 2011 / Organized by the Institute of Geophysics, Academy of Sciences of the Czech Republic, together with Institute of Petrology and Structural Geology, Faculty of Natural Sciences, Charles University in Prague

AIM, Advanced Industrial Microseismic Monitoring
European Union Research Project, First annual meeting: Bratislava, Slovakia, 29–30.9.2010; Second annual meeting: Prague, 29–30.9.2011

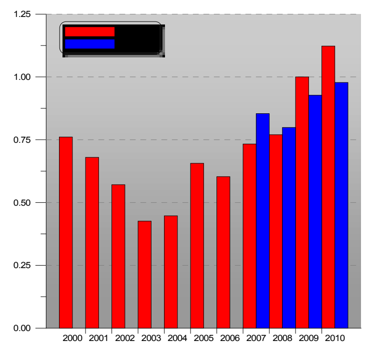
European-Mediterranean Quanterra & Antelope Users Group Meeting
Institute of Geophysics, Prague, March 22–24, 2010
http://www.ig.cas.cz/en/about-us/conferences/qug_aug-meeting/

Studia Geophysica et Geodaetica

Studia Geophysica et Geodaetica (SGEG), published by the Institute of Geophysics since 1956, is an international scientific journal covering all aspects of geophysics, geodesy, meteorology and climatology. In 2010 and 2011, the Editorial Board consisted of 24 experts from 13 countries (see list below). Electronic and printed versions of the journal are distributed by Springer.

At present, between 40 and 50 original reviewed papers are published per year. The mean submission to acceptance time is about 6 months. Rejection rate in the last two years was 33.3%. Special issues are published on various occasions, commonly as proceedings from scientific meetings. In the years 2010 and 2011, three special issues were compiled and published. Issue 1/2010 was devoted to the "11th Castle Meeting on Paleo, Rock and Environmental Magnetism", held in Bojnice, Slovakia, June 22-28, 2008. Issue 4/2010, and partially following issues, contained papers presented at the "1st LATINMAG Meeting", held at Isla Margarita, Venezuela, September 28–October 4, 2009. Issue 3/2011 was devoted to the session G14 on "Recent Developments in Geodetic Theory", held at the general assembly of the European Geosciences Union in Vienna in 2010. The special issues were guest edited by invited experts in the respective fields.

The Impact Factor for the period 2000-2010 is shown in Fig.1, see also the ISI Journal Citations Report (www.jcrweb.com). According to IF in 2010, the journal is ranking as 8th among the total of 32 journals with Impact Factor published in the Czech Republic. The journal is abstracted or indexed in Current Contents: Physical, Chemical and Earth Sciences; ISI Alerting Services; Meteorol. and Geoastrophys. Abstracts and Elsevier/Geo Abstracts. Since 2009, the journal uses the ScholarOne Manuscripts™ for automatic manuscript submission and reviewing (http://mc.manuscriptcentral.com/sgeg).



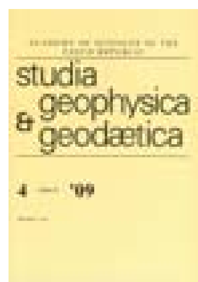


Fig.1. Impact factor of Studia Geophysica et Geodaetica between 2000 and 2010.

All the articles published in SGEG since 1956 can be found on the web page:
http://springerlink.metapress.com/content/109194/

The most cited paper since 2000:

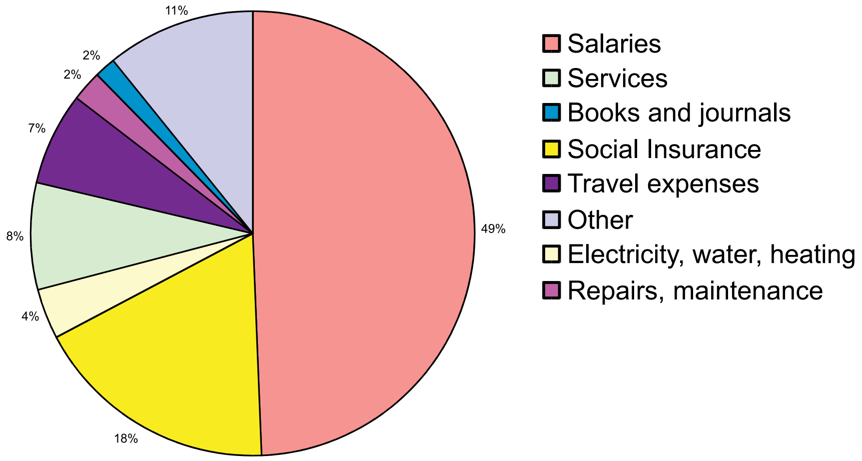
Horálek J., Fischer T., Boušková A. and Jedlička P., 2000. *The Western Bohemia/Vogtland region in the light of the WEBNET network. Stud. Geophys. Geod.,* ***44****, 107-125 (48 citations by September 2011, Web Of Knowledge).*

The h-index of the journal is 24 (as of September 2011, Web Of Knowledge).

The budget of the Institute of Geophysics

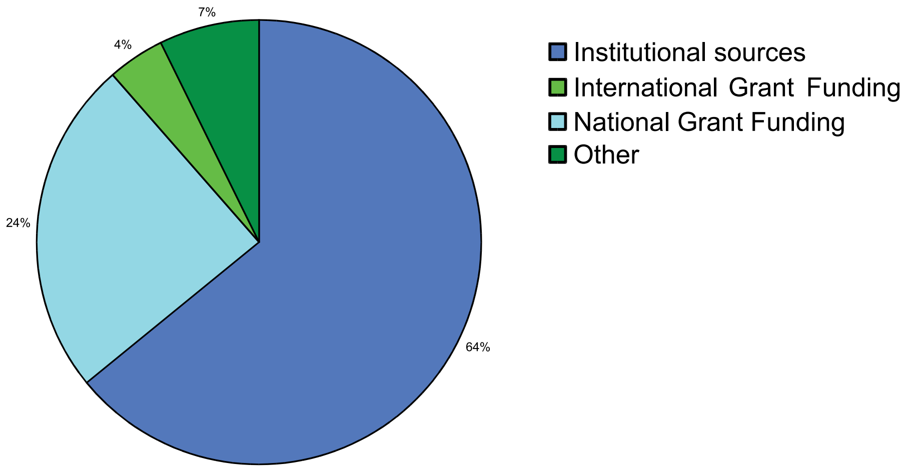
Institute of Geophysics, Total Spending in 2011

CZK 81 777,78



Institute of Geophysics, Total Income in 2011

CZK 81 800,29



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Art exhibitions

—— In 2010 and 2011, the Institute of Geophysics has continued the tradition of art exhibitions in the Lecture Hall of the Institute. A series of art exhibitions was launched in 2002 in cooperation with ARTARCHIV (the Archive of Fine Arts, http://www.artarchiv.cz/). The exhibition series was entitled "ENCOUNTERS" ("Setkávání" in Czech), in order to emphasize the specific viewpoint of these exhibitions: researchers meet with artists whose works apply procedures commonly used in science, such as forethought concept, analogy, variation, similarity etc. By now, exhibitions of 32 artists have taken place at the Institute: Marie Blabolilová, Jiří Hůla, Pavel Rudolf, Josef Procházka, Inge Kosková, Eva Prokopcová, Jana Budíková, Miroslav Koval, Karel Adamaus, Pavla Francová, Václav Vokolek, Ryosuke Cohen, Pavel Wojnar, Pavel Mühlbauer, Jindřich Růžička, Vladimír Gebauer, Pavla Aubrechtová, Ladislav Daněk, Jiří Lindovský, Lubomír Přibyl, Vladimír Havlík, Petr Veselý, Jaromír Zoul, Marie Molová, Pavel Hayek, **Zuzana Nováčková, Petr Kvíčala, Jan Kubíček, Asan Fryč, Milan Maur, Daniela Mikulášková and Aleš Svoboda**; the last seven exhibitions took place in 2010-2011. Two other exhibitions of the series were topical – Computer Graphics and Visual Poetry (more on the artists and exhibitions at http://www.artarchiv.cz and http://www.ig.cas.cz/cz/o-nas/spolecenske-aktivity). To commemorate the rounded number of 30 exhibitions at the Institute of Geophysics, a group exhibition **"Parallels and Intersections"** took place in the National Technical Library, a masterpiece of contemporary architecture in Prague, in November 2010. All artists of the "ENCOUNTERS" exhibition series were represented by their works, enabling the visitors to follow the joint idea of the series.

—— Parallel to the exhibition cycle, the Gallery of the Institute of Geophysics was founded to collect works of all artists who exhibited at the institute. The Gallery is placed in corridors and seminar rooms of the Institute and is thus accessible to the visitors of the institute.

—— In addition to the Encounters series, exhibitions of artwork by local artists of the the Spořilov area, named Spořilovský salon V and VI took place in 2010 and 2011.

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