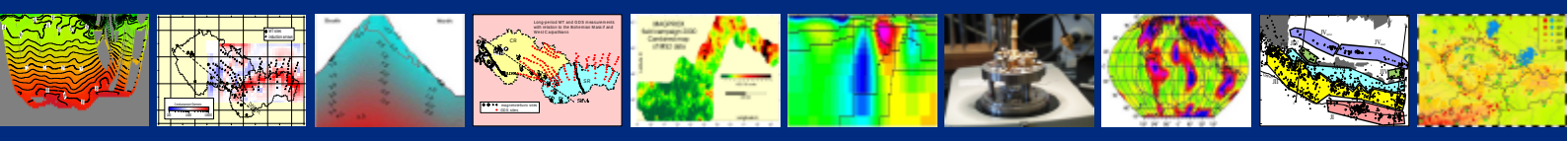
Academy of Sciences of the Czech Republic

Geophysical Institute



report 2000/2001

ACADEMY OF SCIENCES OF THE CZECH REPUBLIC

Geophysical Institute Prague

Report 2000 - 2001


AKADEMIE
VĚD

Academy of Sciences of the Czech Republic (http://www.cas.cz)

The Academy of Sciences of the Czech Republic was established in 1992 as the Czech successor of the former Czechoslovak Academy of Sciences. It is structured as a network of 59 research institutes and five supporting institutions, and staffed by 6500 employees, approximately one-half of whom are university-trained scientists and Ph.D. researchers.

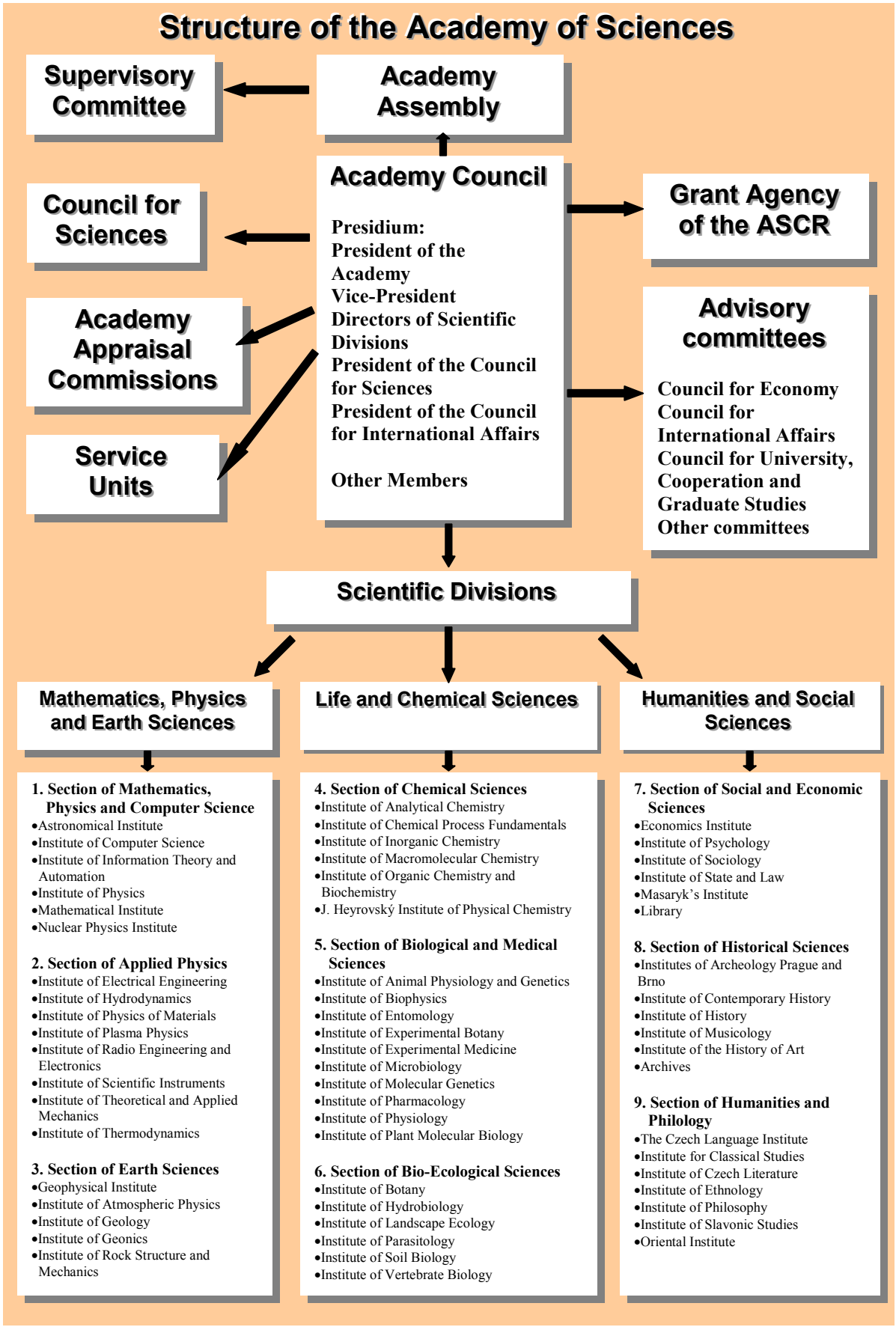
The chief objective of the Academy is to carry out fundamental and strategic applied research in natural, technical, and social sciences as well as in the humanities. This research is distinguished by adherence to high scientific standards whether it is interdisciplinary in nature or highly specialised. The Academy's institutes are involved in education by supervising Ph.D. theses, by providing post-graduate courses to young researchers and by lecturing at universities. The Academy promotes contacts with both the applied research and industrial sectors in order to foster technology transfer and exploitation of scientific knowledge.

The Academy of Sciences is financed primarily from the state budget. Further sources of income include funds acquired from grant agencies in competitions of scientific projects. The Academy has also its own grant agency to support smaller-scale projects.

The present-day Academy of Sciences of the Czech Republic builds upon the tradition of the former Czechoslovak Academy of Sciences as well as upon its predecessors. The first society that brought together scientists in the Czech lands was Societas Incognitas, active between 1746 and 1751. The oldest, truly long-existing (1773-1952) learned society was the Bohemian Learned Society, which encompassed the natural sciences and humanities. Its founders included mineralogist, geologist and natural scientist Ignác Born (1742-1791), Czech philologist Josef Dobrovský (1753-1829), the historian Gelasius Dobner (1719-1790) and the mathematician and founder of the Prague University observatory Joseph Stepling (1716-1778). In later years, Czech historian František Palacký led the Society. As early as in 1861, the famous biologist Jan Evangelista Purkyně (1787-1869) proposed in his work 'Academia' that a self-governing, non-university research institution be formed which would incorporate scientific institutes representing the main branches of science of that time. This vision of an institution devoted to interdisciplinary research was very close to the concept and structure of today's Academy of Sciences.

All research Academy's institutes are grouped according to the objective of their research into nine sections. Each section contains from 5 to 10 institutes. The Section of Earth Sciences consisting of five institutes includes the Geophysical Institute. The Section of Earth Sciences has a total of 470 employees, of which 260 are graduate research workers.

Structure of the Academy of Sciences



Geophysical Institute (http://www.ig.cas.cz)

The Geophysical Institute of the Academy of Sciences of the Czech Republic has followed a considerably long tradition connected with the interest in natural sciences. Abrupt increase in demanding more scientific knowledge in natural sciences was caused by an extensive exploitation of metals, metal ores and other minerals during the Middle-Ages. There is well-documented historical mining activity in Bohemia in areas of Kutná Hora, Jihlava and Příbram, among others. It follows that great scientific progress has been done in geology and mineralogy. As far as the Charles University in Prague (founded in 1348 by the emperor Charles IV.) was the education centre within the former Central Europe, natural sciences were lectured there since 1622. In 1760 the first mining Academy in Europe was established in Banská Bystrica (in Slovakia, former Czechoslovakia) where all the fundamental mining and geo-physical disciplines, including forestry, were lectured and practiced. Ten years later, in 1770, Private Society for Sciences (forerunner of today's Academy of Sciences) was established in Prague, being promoted and finally accomplished by Ignác Born, a top mid-European mineralogist and geologist of the time. Starting with the year 1771, the systematic daily measurements of the surface air temperature have been made in the Jesuit Academy in the Clementinum College in Prague. Also the sequence of regular precipitation measurements began in 1804 as one of the eldest ones in Central Europe. Geomagnetic measurements were started here in 1839, when Carl Kreil put into operation one of the eldest geomagnetic observatories at the German University in Prague. The first relative pendulum measurements of gravity were carried out in the mines of Příbram in 1882 by R.Sterneck-Doudlebský and were conducted with pendulum of his own original construction. In the mine area of Příbram, the seismological experiments made by H.Bendorf took place in 1903/5 (two Wiechert seismographs installed). In 1908, the seismological station, led by G. Irgang, began to operate permanently in Cheb in order to provide for instrumental records of earthquake swarms occurring in the region of Vogtland.

After the declaration of the Czechoslovak Republic in 1918, the State Institute of Geophysics was created in 1920. The first director was Václav Láska, and main research activities consisted in regular field measurements and interpretation of results for gravitational, seismic, geomagnetic, geoelectric, geothermic and radioactive geophysical fields. Systematic geophysical mapping of the state territory was performed. In 1924, a 1000 kg Wiechert horizontal seismograph was installed in the seismic station of Charles University in Prague. During the Second World War, the State Institute of Geophysics was dissolved, and the geophysical

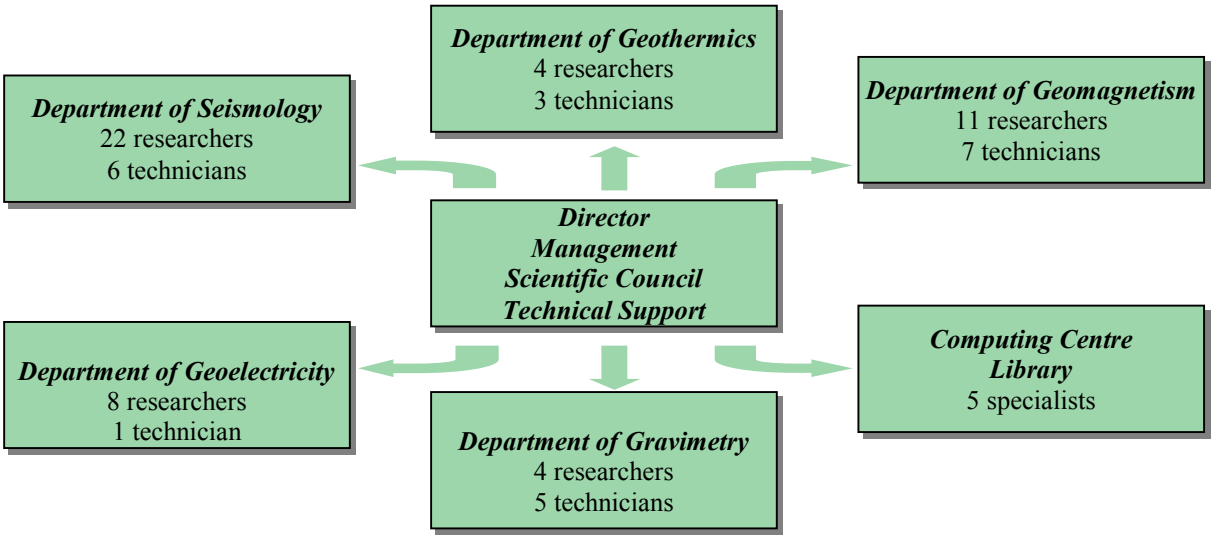
Czech Geophysical Milestones

- 1760 - Mine Academy in Banská Bystrica established
- 1770 – Private Society for Sciences founded in Prague, in 1773 renamed as the Royal Czech Learned Society
- 1771 – beginning of the surface air temperature daily measurements in Clementinum
- 1804 – beginning of the precipitation measurements in Clementinum
- 1839 – geomagnetic measurements in the German University in Prague
- 1882 – establishment of the Czech Academy of Sciences and Arts
- 1882 – first gravity measurements using pendulum in Příbram
- 1903 – two Wiechert seismographs installed in Příbram
- 1908 – seismic station Cheb (Belar-Zlatorog seismograph)
- 1920 – establishment of the State Institute of Geophysics in Prague
- 1924 – seismic station Prague (Wiechert seismograph)
- 1945 – re-establishment of the State Institute of Geophysics
- 1952 – foundation of the Czechoslovak Academy of Sciences, including the Geophysical Institute
- 1952 permanent geomagnetic measurements in Průhonice
- 1960-1970 –foundation of permanent observatories of the Geophysical Institute
- 1986 – beginning of systematic geophysical explorations in seismically active Western Bohemia/Vogtland region
- 1993 – establishment of the Academy of Sciences of the Czech Republic

activities were partly carried out in the Institute for Geophysics of the Prague German University, partly they declined. In the post-war period it was namely Alois Zátopek who formulated new program of Czechoslovak geophysical research and organised lecturing of geophysical disciplines at the Charles University. The state Geophysical Institute, re-established and reconstructed after 1945, was implemented in 1950 into the new state institution of fundamental research – the Czechoslovak Academy of Sciences. New permanent geophysical observatories were founded there during the 60-th and 70-th, e.g. geomagnetic, seismological and telluric observatory in Průhonice, electromagnetic and telluric observatory in Budkov, a tidal station in the mines of Příbram and the seismic station in Kašperské Hory. In this period, Vít Kárník, whose Mid-European, Balcan and All-European seismic catalogues have served as a basic tool for European seismicity studies, reached fundamental achievements in the field of seismicity. His macroseismic intensity scale (Medveděv-Sponheuer-Kárník, MSK 1964) is up to now used for earthquake intensity assessments.

In the last four decades numerous works (papers, monographs, research projects) performed and stimulated by Jiří Vaněk, a doyen of Czech seismological fundamental research of the second half of the 20-th century, raised considerably scientific reputation of the Geophysical Institute. Many other researchers significantly contributed to the progress in geophysics as well, e.g. Václav Bucha in geomagnetism, Miloš Pick in gravimetry, Oldřich Praus in geoelectricity, Ivan Pšenčík in theoretical seismology, Vladimír Čermák in geothermics, Václav Fiala and Pavel Tříska in ionospheric research. The latter two researchers moved to the Institute of Atmospheric Physics in 1994. In 1973, very broadband recording equipment, developed by A. Plešinger, was put into operation at seismic station Kašperské Hory as one of the first very broad-band seismic stations operated in the world.

The Geophysical Institute represents today a fairly compact body subdivided into five scientific departments covering major geophysical disciplines: seismology, gravity, heat-flow and radiometry, geomagnetism and geoelectricity. The activities of the Geophysical Institute include, above all, observatory and field measurements for the purpose of continuous monitoring of various geophysical fields on the territory of the Czech Republic connected with adjacent areas within central Europe. It also covers co-operation with world-wide data network services and data centres, geophysical studies of the lithosphere structure, laboratory investigations of physical properties of rocks, crustal studies, theoretical and numerical modelling of geophysical fields, interpretation of geophysical data, climatic changes in connection with solar activity and solar motion.



Torso of Carl Kreil's pendulum (seismoscope) constructed in Prague German University around 1849. Now kept in the National Technical Museum, Prague.

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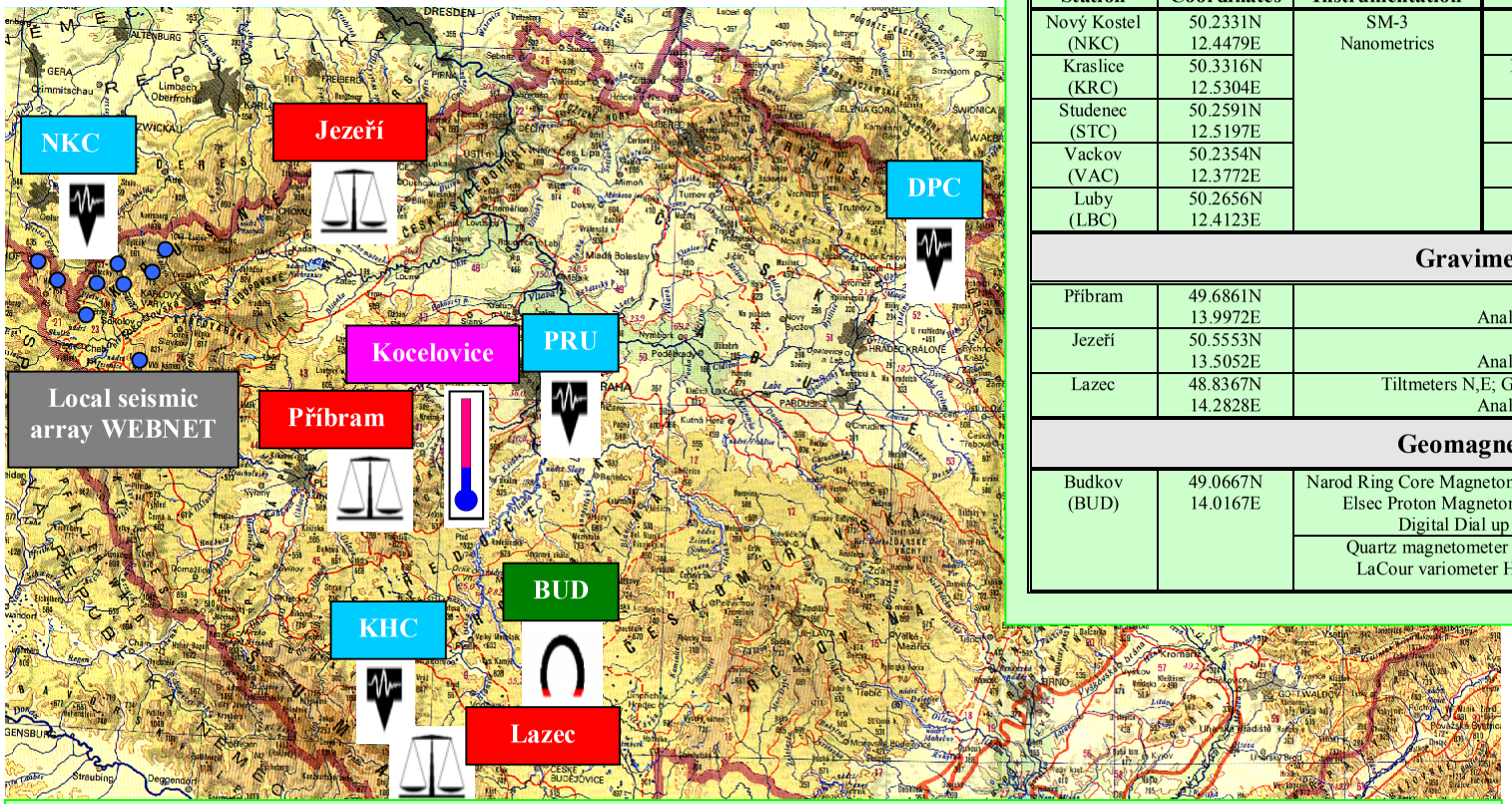
Observatories of the Geophysical Institute



Local seismic network WEBNET -Western Bohemia Network
Operated jointly with the Institute of Rock Structure and Mechanics AS CR Prague
All stations are 3-component short period, recording in trigger mode at 250 Hz

Station	Coordinates	Instrumentation	Station	Coordinates	Instrumentation
Nový Kostel (NKC)	50.2331N 12.4479E	SM-3 Nanometrics	Skalná (SKC)	50.1698N 12.3611E	Le-3D Nanometrics
Kraslice (KRC)	50.3316N 12.5304E		Kopaniny (KOC)	50.2652N 12.2336E	SM-3 Lennartz 5800
Studenec (STC)	50.2591N 12.5197E		Lazy (LAC)	50.0508N 12.6250E	
Vackov (VAC)	50.2354N 12.3772E		Trojmezí (TRC)	50.3032N 12.1448E	Le-3D Lennartz M88
Luby (LBC)	50.2656N 12.4123E				

Gravimetry

Příbram	49.6861N 13.9972E	Tiltmeters N,E Analogue autonomous line recorders
Jezeří	50.5553N 13.5052E	Tiltmeters N,E Analogue autonomous line recorders
Lazec	48.8367N 14.2828E	Tiltmeters N,E; Gravimeter Z; Quartz-tube extenzometers N,E Analogue autonomous line recorders

Geomagnetism

Budkov (BUD)	49.0667N 14.0167E	Narod Ring Core Magnetometer X,Y,Z Elsec Proton Magnetometer F Digital Dial up	Hard Disk digital data storage
		Quartz magnetometer H,D,Z LaCour variometer H,D,Z	Analogue drum recording

Stations of the Czech National Seismological Network - CNSN

Station	Coordinates	Sensors	Data acquisition	Station	Coordinates	Sensors	Data acquisition
Kašperské Hory (KHC)	49.1308N 13.5792E	Short-Period Z Broad-Band Z,N,E	Digital 130 dB PC Data Acquisition	Nový Kostel (NKC)	50°13'59''N 12°26'53''E	Broad-Band Z,N,E	Digital 130 dB PC Data Acquisition
Průhonice (PRU)	49.98833 14.54167	Short-Period Z,N,E Broad-Band Z,N,E	Digital 120 dB 5800 Lennartz VHF telemetry	Dobruška-Polom (DPC)	50°21'03''N 16°19'34''E	Very-Broad-Band Z,N,E	Digital 140 dB Quanterra Dial up

Geothermics

Kocelovice	49.4672N 13.8386E	borehole temperature monitoring

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Geophysical Institute October 2001

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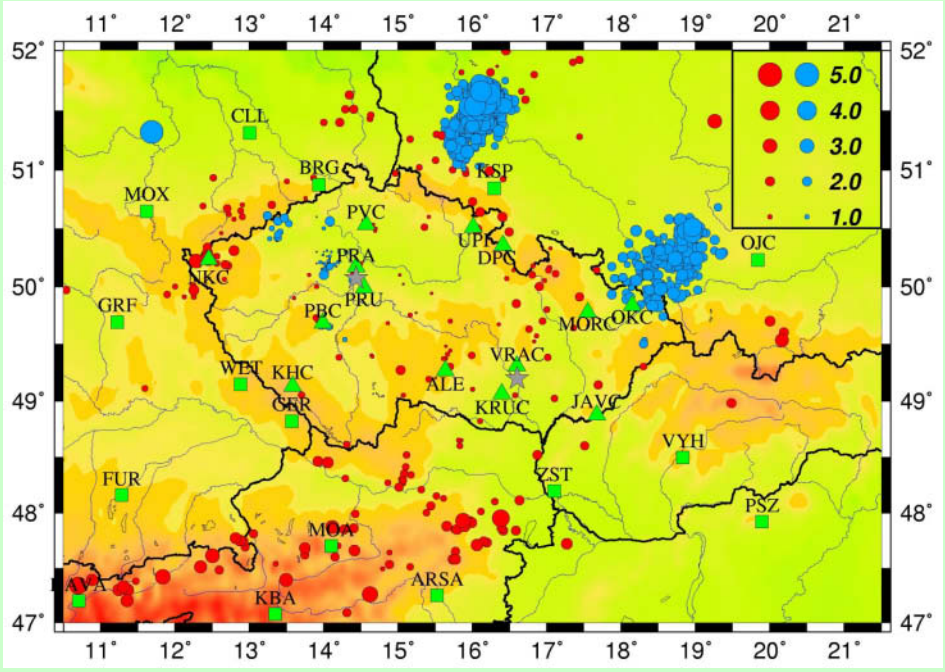
Department of Seismology

Seismic networks

Seismological observations on the territory of the Czech Republic have a tradition of nearly 100 years. The first seismic stations were established in Příbram in 1903 and later in Cheb in 1908. Since that time, seismic observations have been carried out permanently. The seismic data serve as an input information for reports, reviews, and bulletins required for building industry, mines, dams, power plants, radio-telecommunications, and the media. The researchers of the Department of Seismology are responsible for the operation of four permanent seismological observatories of the Czech National Seismological Network, and of the Local Seismic Network in Western Bohemia (WEBNET). Seismological bulletins and catalogues are published, and macroseismic reports about earthquakes felt on the territory of the Czech Republic are collected and evaluated.

Four permanent seismological stations of the Czech National Seismological Network are operated: Průhonice (PRU, since 1957), Kašperské Hory (KHC, since 1961), Dobruška/Polom (DPC, since 1992) and Nový Kostel (NKC, since 1997). The PRU, KHC, DPC and NKC stations are involved in the global seismological data exchange. Station KHC is known for the operation of the very broadband system installed in 1973. Station DPC, operated jointly with the Military Topography Institute Dobruška, is one of global seismological stations of the Federation of Digital Seismograph Networks.

The Geophysical Institute in co-operation with the Institute of Rock Structure and Mechanics of the Academy of Sciences of the Czech Republic has been operating local Seismic Network WEBNET since 1993. Six WEBNET stations were upgraded by purchasing new Nanometrics Callisto digitizers providing continuous digital seismic data of high quality in real time to the data centre during the year 2001. A new telemetric network based on the Orinoco Wavelan system was built to enable high capacity and reliable connection to the upgraded seismic stations. Four new stations were built in the



Permanent seismological stations operational in Czech Republic and surrounding countries and epicenters of seismic events in 1995-1999 (green triangles - Czech stations; green squares - neighbouring stations; stars - GI and IPE data centers; red circles - epicenters of regional tectonic events in 1995-1999, blue circles - epicenters of induced events in 1995-1999).

west and southeast margin of the main epicentral area to provide the best possible areal and azimuthal coverage of the studied region. Hence, at the end of 2001, WEBNET consists of 11 digital seismic stations. Four of them, Nový Kostel (NKC), Kraslice (KRC), Kopaniny (KOC) and Lazy (LAC) are located in individual epicentral areas of North-West Bohemia, recording reliably even very weak micro-earthquakes (events with magnitudes $M_L \geq -0.5$). The remaining seven stations, Luby (LBC), Vackov (VAC), Skalná (SKC), Studenec (STC), Květná (KVC), Kaceřov (KAC), and Trojmezí (TRC) are located in-between the epicentral areas to ensure suitable station geometry.

Seismological Laboratory

Seismological Laboratory provides the following services:

- Automated data acquisition of continuous broadband and short-period seismic data of permanent seismic stations PRU, KHC, DPC and NKC, semi-permanent station Panská Ves, and short-period station Úpice in near-real time (typical delay of 1 hour) into the data server of the Department of Seismology in Prague.
- Daily analysis of seismograms, location and magnitude estimation of local and regional seismic events, analysis of distant earthquakes.
- Publishing seismological catalogues and bulletins, collection and evaluation of macroseismic reports about earthquakes felt on the territory of the Czech Republic. Results of the interpretation of earthquakes world-wide are summarised in seismological bulletins which are accessible on the WWW pages of the Geophysical Institute for other geophysical institutions, universities, and the public.
- Global data exchange of both seismogram readings and digital records with international seismological centres (International Seismological Centre; European-Mediterranean Seismological Centre; N.E.I.C.; ORFEUS Data Center; the Incorporated Research Institutions in Seismology Data Management Center) and with neighbouring data centres and observatories. Digital seismograms of stations PRU, KHC, DPC and NKC are available on request by E-mail or ftp in near-real time through the AutoDRM service (autodrm@seis.ig.cas.cz).
- Archiving of digital records on CD-ROMs. Broadband records of selected strong earthquakes are provided to the ORFEUS Data Center, and the I.R.I.S. Data Management Center for archiving on CD-ROMs.

Laboratory of theoretical and experimental seismology

The laboratory focuses theoretical research into generation and propagation of seismic waves in complex structures and experimental research into anisotropic structures of the Earth's crust and mantle by analysis of seismograms.

The research into propagation of seismic waves includes development of algorithms and programs for computing seismic wavefields propagating in laterally varying, possibly absorbing, layered anisotropic structures using the ray method, study of wave propagation in weakly anisotropic media using the first-order perturbation theory, calculation of reflection/transmission coefficients for weak-contrast interfaces separating weakly anisotropic media and analytic calculations of higher-order ray approximations of seismic wavefields.

Within theoretical modelling of seismic source we study methods of high-frequency waveform inversion for retrieval of the source mechanism and its time function (development of the indirect parameterisation algorithm and upgrade of the relative moment tensor determination). Particular attention is given to assessment of errors imposed on the reconstructed source parameters by noise in the data, and especially by mismodeling of the medium and mislocation of the hypocentre. Resulting methods are applied to local and regional earthquakes, volcanic tremors and induced seismic events at various scales.

The anisotropic structure of the Earth's crust and upper mantle is studied using both body and surface waves, including P-wave residua and polarization of the SKS waves. The research is focused on the contact zone of Saxothuringicum and Moldanubicum in Central Europe, a prominent structure between two Variscan units (in co-operation with IPGP Paris, France).

Laboratory of tectonics and geodynamics

The research activities of the laboratory are based mainly on the analysis of distribution of earthquake hypocentres and on earthquake source studies. This approach enables to delimitate individual tectonic structures, determine the nature of their mutual displacement and the state of the stress in them, and also correlate seismicity with other manifestations of geodynamic activity as volcanism/magmatism, geochemical parameters of groundwaters, recent crustal movement etc. Geographically, the activities of the Laboratory cover the western part of the Bohemian Massif (West Bohemia/Vogtland earthquake swarm region) and two active convergent plate margins – Indonesian island arc and Andean South America.

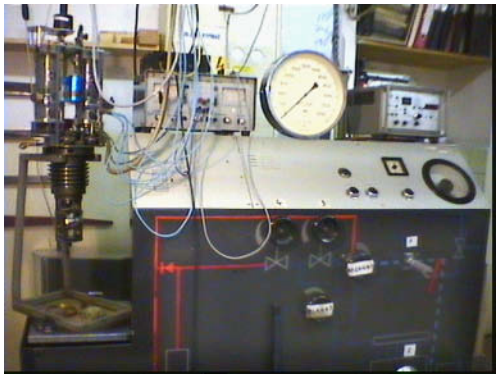
In the West Bohemia/Vogtland earthquake swarm region, seismic activity is monitored by the WEBNET network. After procedures of seismogram processing, location of events and source mechanism determination, uncommon pattern of seismic energy release has been analysed and correlated with some other geophysical parameters (see the paragraphs on gravimetric research). The research is performed in co-operation with the Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic; Institute of the Physics of the Earth, Masaryk University, Brno; and with German geophysical institutions (GeoForschungszentrum Potsdam; Technical University Bergakademie Freiberg; University of Munich; Seismological Central Observatory Erlangen).

The analysis of seismicity at convergent plate margins is based on the hypocentral determinations of the International Seismological Centre (ISC) and recently on relocated ISC and NEIC earthquake data for the period 1964-1999. Fault plane solutions from the list of Harvard centroid moment tensor solutions have been used. The research integrates seismological analysis with accumulated geological knowledge in co-operation with partner institutions (South-East Asia Research Group of the University of London, UK; University Göttingen, Germany; University of Colima, Mexico).

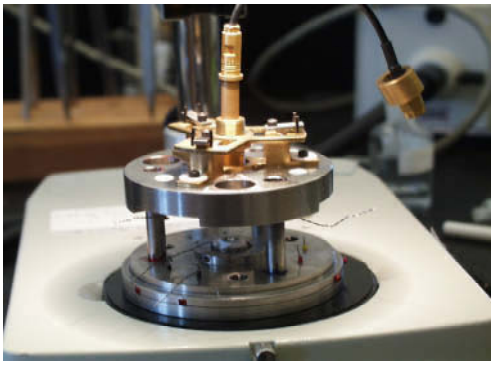
Laboratory of Global Tectonics and Metallogeny, European Centre Prague, the common project of the Academy of Sciences of the Czech Republic and the American University, Washington D.C., is included in the framework of the laboratory.

High – pressure laboratory

The laboratory specialises in GHz ultrasonic interferometry and acoustic sounding on mineral and rock samples. The equipment enables to make measurements under the pressure up to 400 MPa/20°C, or up to 6 GPa/800°C.



For an acoustic sounding under hydrostatic pressure up to 400 MPa there are used spherical rock samples 5 cm in diameter to reveal their elastic anisotropy. To study relation between elastic anisotropy and rock fabric and its components, the acoustic sounding is combined with texture measurement using neutron diffraction in GKSS Geesthacht, Germany, and mapping of crystal orientations in rock samples using EBSD technique in Université Montpellier, France. Measurement of the elastic anisotropy of mantle rocks from the Bohemian Massif is being prepared.



To obtain a single crystal elasticity data at simultaneous high pressure and temperature, a technique of GHz ultrasonic interferometry in a diamond anvil cell is applied. Using such ultrasonically measured travel times for crystals, seismic velocities can be calculated. A project for determination of cross pressure and temperature derivative terms of elastic moduli for spinel is prepared to fix temperature and pressure correction to the measured velocities.

Sedimentary basin research group

This group, established at the Geophysical Institute in 2001, focuses on geological and geophysical study of sedimentary basins. The history of filling and deformation of sedimentary basins provides detailed data elucidating the evolution of the lithosphere in varying plate-tectonic situations and the interactions between processes in the lithosphere, earth surface, oceans and atmosphere, at a wide range of temporal and spatial scales. Main research areas include stratigraphic analysis of sedimentary basins of various tectonic regimes, physical sedimentology of clastic depositional systems, study of relationships between sea-level fluctuations, paleoclimate and paleoceanography. Group members currently carry out research in the strike-slip – dominated Bohemian Cretaceous Basin (Czech Republic), the Western Interior foreland basin system of North America, the Eger Graben extensional basin system (Czech Republic) and in the post-orogenic, Late Palaeozoic extensional/transtensional basins of the Sudetes area at the border between the Czech Republic and Poland.

Department of Geomagnetism

The Department of Geomagnetism deals with traditional and modern geomagnetic research.

The research includes

- recording of the geomagnetic field at the observatory
- geomagnetic field network mapping
- theoretical modelling of geomagnetic field generation
- environmental magnetism and rock magnetism
- study of geomagnetic activity in connection with weather and climate
- laboratory experiments with very weak magnetic fields.

Geomagnetic observatories and geomagnetic mapping

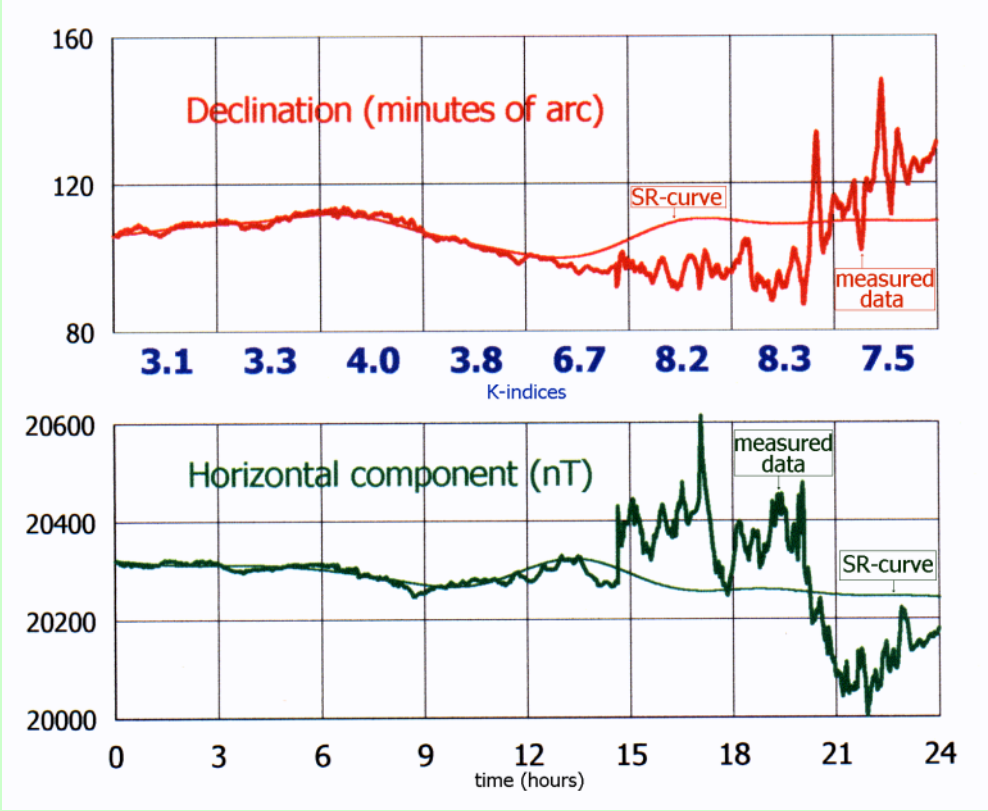
Observatory measurements. Observatory measurements provide information about short-period variations of the geomagnetic field, as well as a possibility for calculating secular variation, westward drift and local geomagnetic anomalies from the field measurements. The geomagnetic observatory at Průhonice was operated by the department in the past (1951-1966); the observatory at Budkov was established in 1967. Budkov is the national geomagnetic observatory listed in the Catalogue of World Geomagnetic Observatories and provides digitised data since 1988 and direct digital data since 1993. The observatory is a member of the INTERMAGNET network and the data are published on the INTERMAGNET CD-ROM.

The observatory operates two basic systems: a set of BOBROV analogue variometers (3 components D, H, Z), the data of which are manually digitised, and a triaxial NAROD ring-core 'Fluxgate' magnetometer with an ELSEC proton magnetometer (PPM), which gives digital data directly.

K-indices, hourly mean values, are displayed regularly on the WWW pages and published regularly in the Bulletin and submitted to WDC Boulder and 22 co-operating European observatories. Digital data are sent daily to GIN in Edinburgh. An advanced algorithm (Sucksdorff's algorithm) is used to calculate K-indices and real-time data from the observatory enable geomagnetic activity to be forecast.

Network mapping. After geomagnetic mapping campaigns carried out on the territory of the Czech Republic in 1858, 1894, 1950 and 1978, the fifth geomagnetic mapping was completed in 1996 at 199 geomagnetic sites. For the first time, the measurements were made with D&I Flux magnetometer Bartington MAG-01 mounted on a ZEISS 010B theodolite and with a Proton magnetometer GEM GSM-19G Overhauser. The calculation, filtering and comparison with observatory measurements have been completed and the results were published during 1999 together with maps of geomagnetic components. The measurements correspond with International Geomagnetic Reference Field (IGRF) over the territory of the Czech Republic.

Measurements at six secular points every two years enable updating of maps of magnetic components each year during more than last 10 years. In the period when the actual measurements at the secular points are not available, an advanced method of forecasting the secular variation for 2 - 4 years is used. The estimation of the eleven-year period of the secular variation plays a crucial role in the prediction; prediction maps can be constructed, which usually agree with later measurements at secular points up to ±5 nT.



Magnetic storm observed at the Budkov observatory on 15th July, 2000. K-indices are based on the regular daily variation (SR) curve, which represents non-K variation as solar and lunar daily variation, the influence of post storm-perturbation and solar effects.

Geomagnetic Research

Geomagnetic field generation. The generation of the geomagnetic field is studied in accordance with the so-called "Dynamo Theory". This theory comprises sophisticated numerical modelling performed by the research group of the Department. This group attempts to solve fully three-dimensional models considering small viscosity.

Environmental magnetism and rock magnetism. Many areas of the Czech Republic are exposed to industrial activity, and thus quantification of environmental pollution is required. For this purpose, pollution magnetometry has been applied. Compared to chemical analyses, magnetic methods are much faster, less expensive and enable acquisition of large data sets. Pollution magnetometry is applied to mapping the distribution of power-plant fly ashes in soils, contamination of fluvisols and stream sediments. The research is performed in co-operation with research institutions in Poland, Germany and France.

Geomagnetic activity, weather and climate. 'Sun-weather' research is a traditional branch studied in the Department. Correlation maps indicate that geomagnetic activity affects temperature and pressure fields at least as far as solar activity is concerned particularly in the Northern Hemisphere during the winter. The Department also provides forecasts of geomagnetic activity. The forecast is based on real-time data from Budkov observatory and on daily observations of the Sun carried out by the Astronomical Institute at the observatory Ondřejov. This information is complemented by solar activity data, coronal hole data and geomagnetic indices from WDC Boulder, which are supplied via INTERNET. YOHKOH satellite soft X-ray images have been used since 1995 to improve the quality of the forecast.

Very weak magnetic fields. A system for measurement of very weak magnetic fields was developed under the co-operation with the RS DYNAMICS company. This system offers the computer control of the temperature with an accuracy of hundredths of centigrade and it is based on a system of orthogonal

Helmholtz multicoils. This arrangement enables a measurement of relatively large samples (up to 50×50×50 cm) in a magnetic vacuum within the environment of precisely stabilised and controlled temperature. The system was developed for research in environmental magnetism and rock magnetism; however, it has been also used for medical research.

The system of orthogonal Helmholtz coils hold by wooden frames (N-S system is created by 4 Helmholt's coils, vertical one by 3 coils and E-W system by two coils). The whole set was optimized with respect to the smallest possible 3-D magnetic field gradient in large central volume. The achieved results offer very flat gradient characteristics featuring large inner room of 80 x 60 x 40 cm with deviation from homogeneity not higher then 2 nT. The stability of the output field is better then 0.1 nT.

Department of Geothermics

The Department of Geothermics focuses on research into the temperature field of the Earth's crust and upper mantle. The temperature distribution has been studied both experimentally by temperature logging in boreholes and theoretically by extrapolation of the borehole temperature data to a greater depth. The extrapolation is based on solving the heat transfer equation in the geothermal model of the studied part of the Earth's interior. In order to compile the model, information about distribution of heat sources, thermal conductivity and diffusivity is necessary together with knowledge of boundary conditions (temperature and its gradient) and the initial temperature field. The instrumental equipment necessary for carrying out this research consists of a portable thermometer for borehole logging to a depth of 1 km, rock thermal conductivity and diffusivity meters and the gamma-ray spectrometer for determination of the radiogenic heat production of the rocks.

The main effort has been concentrated on the regional geothermal studies, which resulted in an updated map of the terrestrial heat flow of the former Czechoslovakia. The map provides information on the geothermal activity of individual geological units of the Bohemian Massif and its surroundings, which have been used to assess deep crustal and lithospheric temperatures.

The most recent activities of the Department have covered a few topics, which are shortly described below.

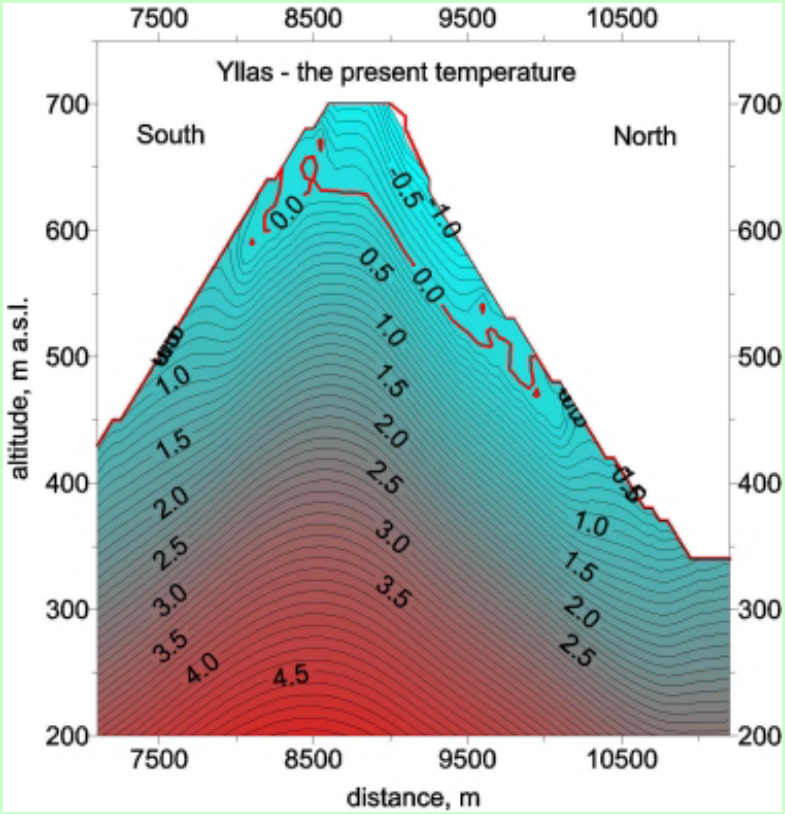
The temperature field of the Bohemian Massif. Special attention has been paid to the redistribution of heat flow contribution from deeper parts of the crust by the forced convection of groundwater in permeable layers of the Bohemian Cretaceous Basin sediments. The subsurface temperature was measured in the northern part of the basin in a group of 8 boreholes drilled in a hydrogeologically active area with a pronounced relief (400 m within 2 km from the borehole sites). The subsurface temperatures have been also studied on a set of 46 borehole logs measured in the vicinity of uranium deposits in the Bohemian Cretaceous Basin. An interpretation of borehole temperature profiles in terms of e.g. groundwater movement or subsurface climate change signal also requires better understanding of the effect of topography on the subsurface temperature field. A relationship between the mean annual ground surface temperature (GST) and the attitude of the surface was studied on the data set from seven temperature-depth profiles measured in boreholes located in a forest in the Krušné Hory Mountains. The extrapolated GSTs were related to the elevation and the slope attitude (angle and orientation) of the surface.

Thermal history of the sedimentary basins. The first results of paleogeothermal studies in the Lower Palaeozoic Barrandian Basin have suggested that the Lower Palaeozoic sediments experienced complex temperature history with at least two sudden thermal pulses. They could have been related to Silurian synsedimentary volcanism or to the emplacement of the Variscan Central Bohemian Pluton. The effect of the pluton formation on the adjacent rocks was assessed by simulation of the intrusion cooling. It turned out that the distance between the basin and the pluton, 15 km and more, is too large for the direct influence of the sediments by the intrusion heat.

The same methodology was used in assessing the thermal conditions of the contact metamorphism of Silurian black shales by basaltic, 4 m thick sill observed in the Kosov quarry in the Barrandian Basin. The zone of heating by more than 120°C, which was the background temperature experienced by the sediments during their subsequent burial, is limited for the intrusion temperature 800°C to a few metres around the sill.

Climate and borehole. The measured temperature-depth profiles were inverted and used to reconstruct the past climate changes expressed as the ground surface temperature history. Altogether 98 boreholes were analysed and climatic episodes over the past two millennia were identified, including warmer period around 400 A.D., colder times between 700–1000 A.D., the Little Climatic Optimum with its culmination around 1250±50 A.D., and the Little Ice Age with temperature minimum at 1650±30 A.D. Special attention was paid to the most recent warming during the last 35 years (1960–1995). This warming has been particularly intense around Prague and in its vicinity and decreased to the south and southwest. Another area of significant recent warming rate corresponds to the industrial regions of Sudety and Ostrava coal basins. The lowest warming rates were found in southwestern and southern parts of the Bohemian Massif, areas generally wooded. Urban growth and industrialisation, similarly as deforestation and consequent land development and/or change in vegetation cover, may contribute to warming and produce smaller or larger regional anomalies.

The formerly drilled experimental borehole located on the institute campus for monitoring ground temperature field changes and soil/air temperature coupling was completed with a new similar experimental hole in southern Bohemia (Kocelovice-hole). A complex set of a number of air/soil thermometers was installed and completed with monitoring of precipitation, snow cover, clouds and wind velocity.



Numerical simulation of the transient temperature field in the subsurface of Yllas Mountain in the northern Finland. The asymmetry of the permafrost region on the top caused by the north-south orientation of the hill.

Department of Geoelectricity

The Department of Geoelectricity traditionally concentrates on two basic research topics:

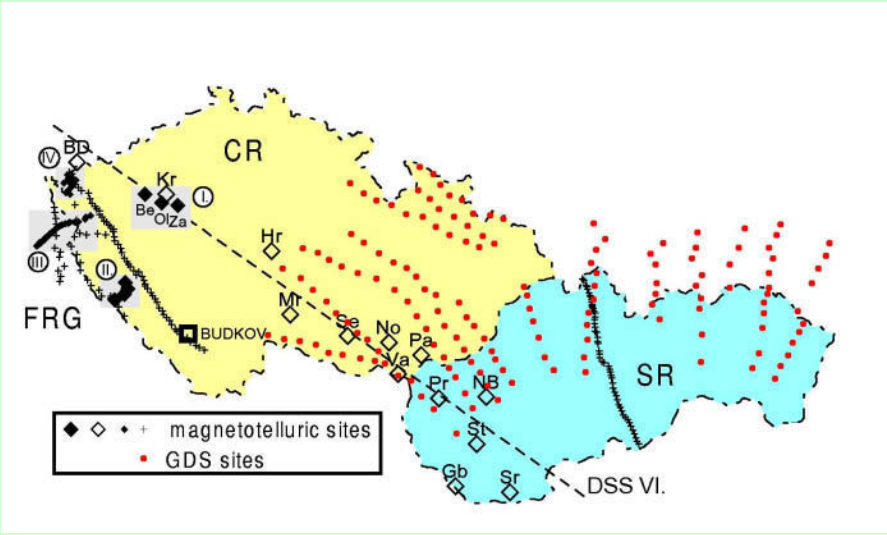
- geoelectrical studies of the solid Earth,
- external geoelectromagnetic fields and solar-terrestrial phenomena.

Regional studies of the electrical manifestation of large-scale tectonic features of the Bohemian Massif and surrounding geological units are one of the primary interests of the Department researchers. A large amount of regional geoelectrical data has been collected during many years of systematic experiments across the whole territory of the Czech Republic and Slovakia, particularly in areas of large-scale tectonic contacts and transition zones. A high electrical conductivity is known to be a sensitive indicator of anomalous thermodynamical conditions, fractured zones, fluid saturation, or accumulations of interconnected electronic conductors within the Earth, and thus the regional geoelectrical interpretations have substantially assisted in developing present ideas on the geophysical conditions in the deeper parts of the Earth's crust and in the upper mantle across the principal geological units of Central Europe.

Geoelectrical research in the Bohemian Massif. Recently, concentrated geoscientific research in the western part of the Bohemian Massif, motivated mainly by the KTB deep borehole project in Germany, has largely influenced the regional targets of the geoelectrical investigations. Geoelectrical data indicate a close similarity of the principal geoelectrical features across the whole Oberpfalz block, delineated by the Franconian Line in the west and the West Bohemian fault zone in the east. A three-level model of the electrical structure applies to the upper crust in this area, consisting of an E-W striking crustal conductor at the depth of about 10 km, overlaid by a highly anisotropic crustal layer, with preferred conductivity in the NNW-SSE direction, and a near-surface distorting layer. Recent co-operative German-Czech broadband magnetotelluric measurements along a specially designed SW-NE profile from the KTB area to the Mariánské Lázně ultrabasite complex have proved that the above structural pattern represents a stable and continuous feature across the entire Oberpfalz block. At present, the relation of the principal geoelectrical characteristics of the western part of the Bohemian Massif to the regional tectonic setting is being investigated.

Geoelectrical studies in the West Bohemia/Vogtland seismoactive region. Deep geoelectrical studies assist in detecting and delineating tectonically and seismically significant structural features within the crust. A series of sixteen audiomagnetotelluric measurements was carried out in the region. Despite the excessive industrial complete noise all across the target area, first model interpretation attempts have been completed. The data show the presence of rather extensive conductive structures at relatively shallow depths, within the range of 0.5 km to about 3 km, probably connected with the buried granitic massif beneath the area.

Detection of the first-order tectonic boundaries. Large-scale induction studies often provide reliable, physically substantiated information on the first-order tectonic boundaries within regional geological complexes. Recently, a large collection of previously acquired geomagnetic induction data from the eastern margin of the Bohemian Massif and its transition to the Western Carpathians has been revisited. Originally qualitative, morphological analysis of a set of more than 150 long-period induction arrows across the target area has been extended by the numerical simulation of causative currents for the induction data. The simulations clearly showed that different physical mechanisms are at play for the two prominent induction anomalies observed at the eastern termination of the Bohemian Massif. While the well-known Carpathian conductivity anomaly originates from a clearly defined structure of increased conductivity along the Carpathian Mts. arc, the induction anomaly at the western margin of the Brunovistullicum unit is essentially of a distortion nature, with generating induction processes taking part in conductive structures possibly remote with respect to the area of the anomaly manifestation. A step towards understanding of the system and interactions of the conductivity anomalies on the continental scale has been taken by merging the above regional data set with a large collection of the geomagnetic transfer functions available across the whole Europe.



Long-period MT and GDS measurements with relation to the Bohemian Massif and West Carpathians.

Solar-terrestrial relations. Studies of solar-terrestrial relations represent one of the research directions that has been developing for many years with breathtaking dynamics, mainly due to their presumable immediate and/or long-term impact on man's living conditions in a very general sense. In this direction, one of the most outstanding research topics has developed in the department in the last years, based on the idea that subtle patterns in the dynamical behaviour of the solar system, determined by a joint effect of the Sun and its planets, may play a primary role within the causal chain of solar-terrestrial relations, as well as in the long-term climatic variations on its terrestrial output. The developed theory aims to provide a prediction tool based on a fully deterministic input signal derived from the dynamics of the solar system. Statistical processing of solar, geomagnetic, volcanic and climatic data has already given a solid support to the underlying theory.

Theoretical research into the electromagnetic wave propagation. A method for numerical modelling of electromagnetic fields in heterogeneous, generally anisotropic media was developed and applied to the interpretation of magnetotelluric data from the western margin of the Bohemian Massif. Recently, anisotropy studies have been extended to other geoelectrical methods, specifically to direct current soundings. A systematic study of various versions of a magnetotelluric inverse algorithm based on the global minimisation controlled random search procedure has been initiated as part of the inverse technique comparison.

Theoretical research into the electromagnetic wave propagation in the Earth's magnetosphere and ionosphere can considerably assist in understanding the physical mechanisms of extra-terrestrial processes. In this respect, significant progress has been achieved recently in elucidating the generation mechanism of the IPDP pulsation. The Earth's ionosphere was studied as an Alfvén resonator, which is able to generate Pc1-type pulsation on its fundamental frequency at subauroral latitudes. During non-stationary substorm conditions in the ionospheric plasma, the Pc1 can smoothly convert into the IPDP-type pulsation, with periods decreasing with time. The theoretical conclusions could be proved by a numerical full-wave simulation of the process with the Scandinavian EISCAT data.

Periodicity of the geomagnetic activity. Within the external studies, a statistical analysis with long continuous records of geomagnetic, solar activity and radon activity data has been performed. A detailed investigation of the periodicity of the geomagnetic activity (Ap-indices) within the period range of 5 - 60 days and their correlation with the daily sunspot numbers, based on 1932 - 1991 records, was carried out. The highest peaks were found at periods of about 27 days (solar rotation) and 13.5 days (solar wind speed), with a series of subsidiary peaks distributed symmetrically with respect to the main periods. Less significant peaks were found at periods of about 9 days (origin unknown) and 7 days (connected with the interplanetary magnetic field). No significant response to the synodic month was detected.

Department of Gravimetry

The Department of Gravimetry concentrates on the following fields:

- different kinds of gravimetric measurements, data processing, analysis and interpretation,
- investigation of tidal effects.

Gravity/Earth Tides observatories

The department operates the following observatories:

- PŘÍBRAM – observatory for instrumentation tests and data processing. The 'tidal team' consists of electronic engineers and specialised researchers. Except analyses of the data from observatories, they also carried out an investigation of the influence of the tides on the groundwater level. Based on complex sequential analysis including barometric pressure, indications of the beginning of the 'autumn 2000' earthquake swarm were identified from the groundwater oscillation. The study of the relation between earth tides amplitudes and earthquakes was initiated.
- LAZEC – research tidal observatory equipped with two tiltmeters, two pure quartz pipe extensometers and one gravimeter. At this site the study of tidal effects should provide representative tidal parameters (amplitude characteristics and phase delays). Such data will serve as a basis for the investigation of crustal deformation by the means of spectral analysis of residual values. In this way the knowledge of deformation in the relatively stable crustal block may contribute to world-wide determination of tidal influence on the Earth crust. The tiltmeter data have been already sent to the world Earth tides data bank in Belgium.
- JEZEŘÍ – applied research observatory in the horizontal gallery inside the marginal block of the crystalline complex of the Krušné hory at the edge of the open-pit coal mine. The tilmeters data are used as an indicator of slope stability and the instrumentation is a part of a complex monitoring system of the mine required by the mine administration. The conditions at this observatory are favourable for the study of the influence of various phenomena on the observed tilts (meteorological conditions – air-pressure and temperature, quarry blasts, natural earthquakes, etc.). To increase the effectiveness of the monitoring there has been established second station close to the entrance of the gallery at the most active part of the crystalline blocks.

Gravimetric research

One of the main tasks is the investigation of temporal variations of gravity in the seismoactive West Bohemia/Vogtland region. Repeated measurements of gravity at selected points have been performed twice a year since 1993 on both sides of the main tectonic feature in the region - the Mariánské Lázně Fault. The data were analysed with respect to the temporal and spatial occurrence of earthquake swarms, mutual position of the foci and indications of the gravity changes, and number of seismic events compared with the amplitudes of the gravity variations. After 7 years of observation, correlation between the changes of gravity and the number of seismic events was determined in the Nový Kostel area, but there is not enough statistical evidence for this phenomenon yet. Further measurements of a long-term character are necessary to prove our assumptions. All disturbing effects were studied and their possible influence on gravity evaluated in order to avoid misleading interpretations (blocks displacements, groundwater, ground moisture, temperature and air-pressure, etc.).

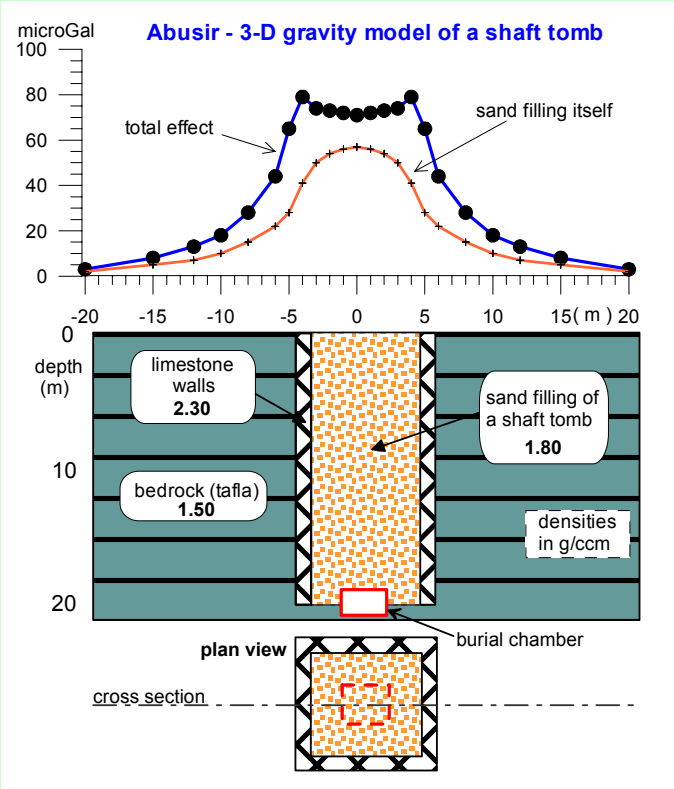
This investigation is a part of a complex geodynamic research comprising also the GPS measurements within local and regional networks and precise levelling within a special network at the centre of the most active area near Nový Kostel. While the GPS data do not show any significant regular horizontal displacements, some of the levelling points exhibit vertical movement up to 10 mm, which is far over the level of confidence. Such information confirms the existence of certain movements of crustal blocks. During the study period interesting indications were derived from groundwater level in the well P1A in the Cheb basin before one of the most significant seismic events in autumn 2000.

Similar gravity measurements for the investigation of crustal dynamics continued also in different conditions in the Gulf of Corinth, Greece (in co-operation with the National Observatory of Athens), and in the Aswan Lake region, Egypt (in co-operation with the National Research Institute of

Astronomy and Geophysics, Helwan). In Greece, the GPS data (IPG Paris) define the block's displacements, but there is no control on stress field regime. From this reason the repeated measurement of gravity were introduced along the southern coast of the Gulf (northern Pelloponnesus) with a connection to few stations at the northern coast by ferry-boat. Significant difference in gravity was determined in the eastern part around Nemea and Argo Korintos between 1994 and 1997 campaigns, but more important indications of extension were observed in the western part around Aigion between 1997 and 2000.

In 1997 the first campaign of gravity measurements was performed in the Kalabsha region around the north-western bank of the Aswan Lake in Upper Egypt. In this region the seismic activity is affected by the water level in the lake, which depends on annual variations and total amount of water coming from the source regions. The comparison with the second campaign in 2000 demonstrated two effects affecting the crustal blocks – water loading from the lake and strain changes. However, further measurements of gravity, GPS and precise levelling are the condition of complex analysis of the induced crustal dynamics.

Applied research is being performed in microgravimetry with the aim to solve problems of engineering geology, civil engineering, environment and archaeology for both state and private institutions. In order to improve data accuracy of microgravimetric measurements, new software was used for the gravimeter drift determination. In most cases the detection and location of buried voids was the target (natural cavities, caverns or breakdowns around sawage systems, historical cellars or tombs, etc.). For example, old mining works in the area of the Chomutov coal basin were indicated at a new railway tunnel construction site. The results of the measurements were confirmed by drilling of many shallow holes with the aim of void saturation and breakdown risk elimination. Microgravimetric investigations performed in Luxor, Egypt, in very complicated conditions of the Valleys of the Kings and Queens, were evaluated with the aim to justify microgravimetry as a suitable tool for discovering buried tombs or galleries. In the Czech archaeological concession in Abusir, Egypt, theoretical 3-D gravity modelling proved high chance to locate an unknown deep shaft tomb filled by sand.

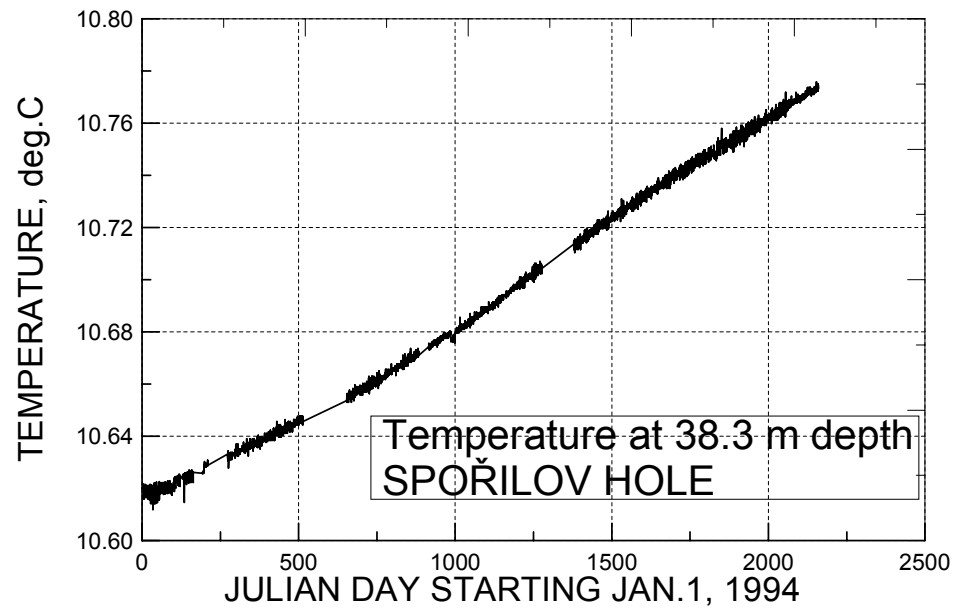


Gravimetric investigation at the archaeological site of Abusir, Egypt – theoretical modelling.

Key Areas of Research in 2000-2001

Geothermal studies

Most activities were focussed on various aspects of heat transport in the shallow subsurface. By a series of forward model analysis the behaviour of paleoclimatically induced temperature perturbation due to ground surface changes was analysed corresponding to a wide time span from Pleistocene Ice-Age to most recent climate warming. Special attention was paid to understand the propagation of the surface temperature variations into the rock basement and the soil/air temperature coupling. Theoretical calculations were completed with the analysis of the instrumental data obtained by a long-term temperature monitoring in three sites: (1) at the campus of the Geophysical Institute in Prague, location affected by the large urban agglomeration, (2) at Kocelovice, the generally farming area about 70 km out of Prague, and (3) at Svojšice, sparsely populated area in southern Bohemia. It was proved that the detected warming rate at the depth of about 40 m, i.e. below the coverage of seasonal temperature variations, might provide a valuable information of the magnitude of the present-day climate warming.
References : [7, 11, 12, 13, 14]



Six-year (1994-1999) temperature monitoring at 38.3 m depth in Spořilov-hole showing a direct record of recent climate warming of 0.0264 K/yr.

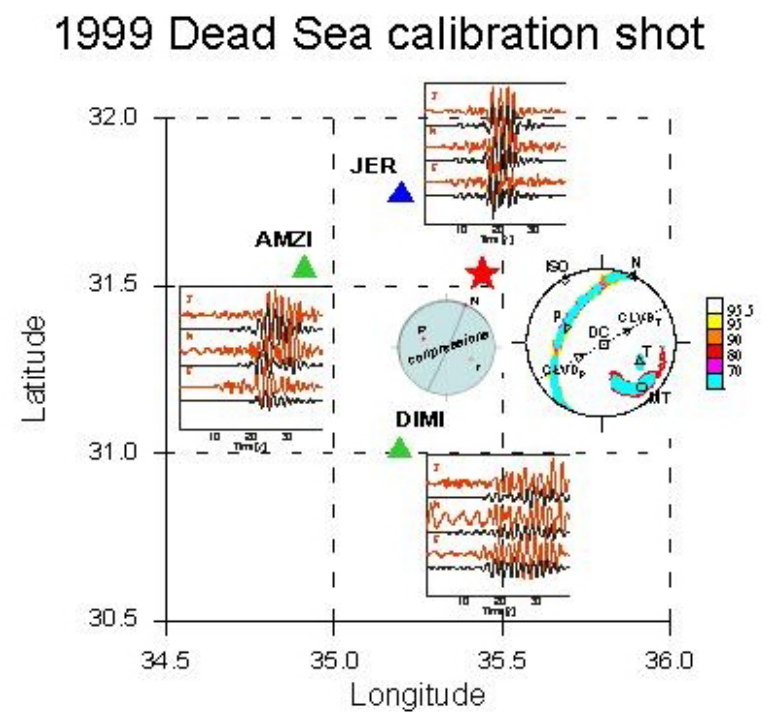
Theoretical and numerical studies of generation and propagation of seismic waves

Problems of generation and propagation of seismic waves at various scales were tackled from both theoretical (a-d) and practical (a,c-e) viewpoints including forward (a,b) and inverse (c-e) modelling.

(a) A modification of the ray-tracing algorithm for anisotropic media with singularities was proposed and tested. The algorithm is numerically stable and yields correct results in all kinds of singularities and their vicinities.
(b) Higher-order ray theory has been applied to derive the exact elastodynamic and elastostatic Green's functions for simple types of anisotropy. It was shown that the higher-order ray theory is capable to describe correctly the near-field waves as well as the S-wave coupling near singularities.

(c) Properties of seismic waves generated by tensile earthquake sources were studied. The results were applied to non-double-couple microearthquakes observed in the West Bohemia region.
(d) An algorithm for local determination of anisotropy parameters at receivers situated in a borehole from VSP measurements of slowness and polarisation vectors of qP waves has been developed and tested on synthetic and real data.
(e) The 1999 Dead Sea calibration blast was used to study a chance to retrieve correctly the information about seismic source from regional waveforms. The results suggest that the information can be retrieved confidently even for a rather uncertain model of the medium if the stations close to the epicentre and essential high-frequency filtering are used.

References : [17, 30, 33, 39, 65, 66,80, 81, 87, 90, 91, 92, 93, 94, 99]



Controlled-source test of significance of moment tensor retrieval from regional short period records in case of inexact modelling of the crust. Even with 5 % uncertainty of the 1-D model parameters the explosive mechanism was properly detected.

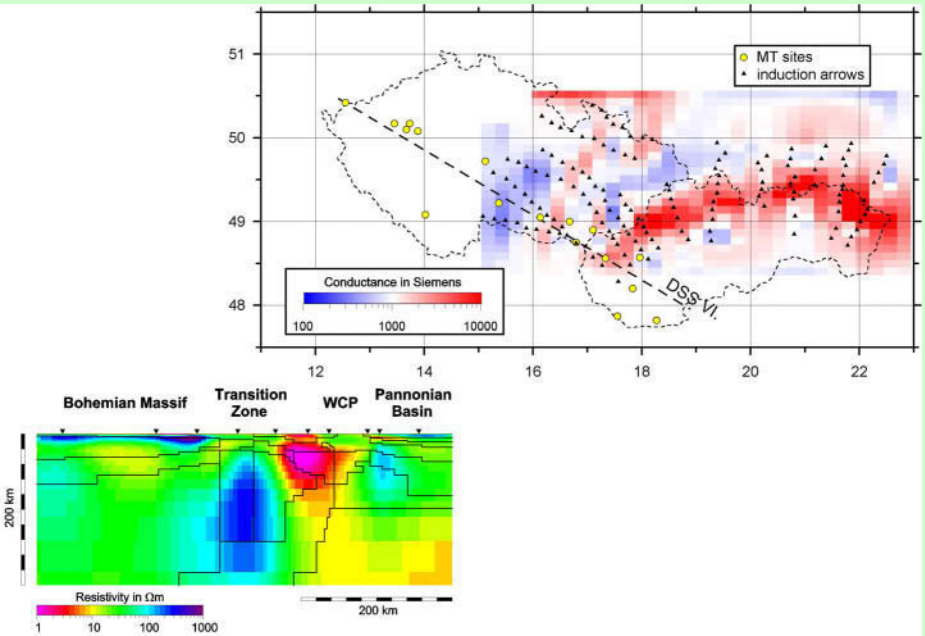
Local and regional geoelectric induction studies

An improved model of the regional distribution of the electrical conductivity to crustal and upper mantle depths beneath the Bohemian Massif and its transition to the West Carpathians has been suggested, based on a joint interpretation of long-period magnetotelluric data and induction arrows across the area.

First broad-band magnetotelluric measurements have been carried out across the margins of the Teysseire-Tornquist zone in Poland within the Europrobe-TESZ program. Structural differences of the upper crust between the NE and SW borders of the TTZ have been confirmed by inductive imaging.

A complete theory of magnetotelluric soundings in laterally homogeneous anisotropic media has been developed, based on the Riccati equation approach.

References : [15, 29]



Model map of the integrated crustal conductivity across the eastern margin of the Bohemian Massif and the Western Carpathians from long-period geomagnetic induction studies (top). Distribution of the electrical conductivity of the Earth's crust and uppermost mantle beneath the DSS profile No.VI across the Czech and Slovak territories from long-peri

Hydromagnetic dynamo models

Computer simulation of the three dimensional hydromagnetic dynamo within the Earth's core is recently developed in the frame of the international fellowship. A free rotating inner core is included in the model and also the viscous core-mantle coupling is taken into account. The new grid-spectral numerical method is applied in which a simplification in azimuthal direction is used (only several harmonics of the Fourier expansion are included). This simplification allows solving the task in the less powerful computers. The resultant dynamo model is characterised by the slow eastward rotation of the inner core relative to the mantle if the inertia of the inner core is taken into account, while ignoring the inertia of the inner core a westward rotation is obtained. The model is also applicable to the planet Neptun, which magnetic axis is very tilted from its rotation axis and thus it is rather more close to the equatorial plane.

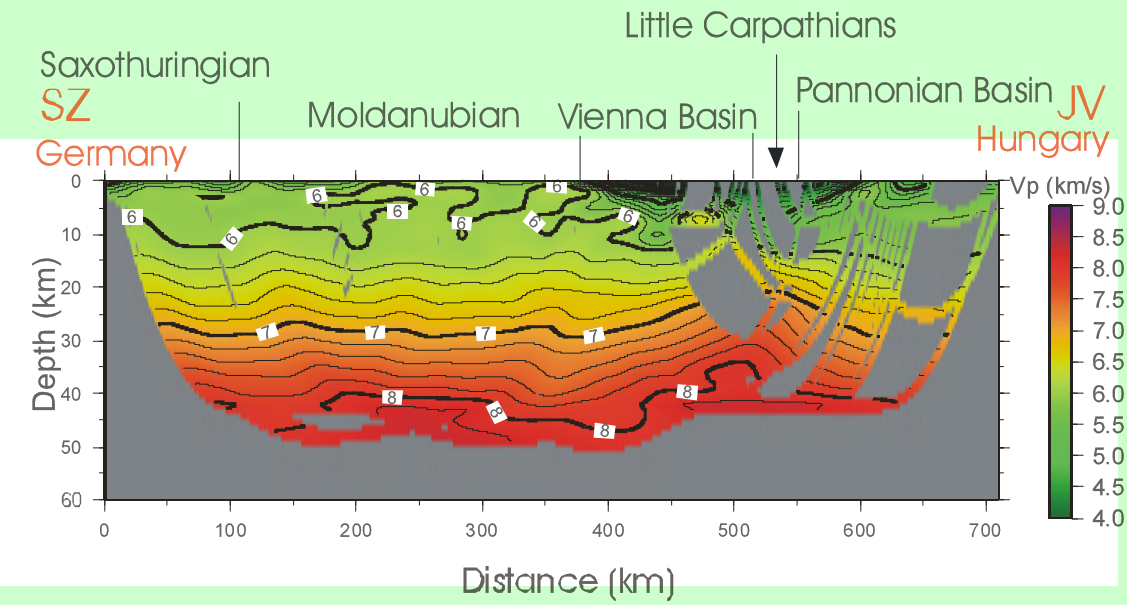
References : [1, 26, 27]

Project CELEBRATION 2000

Celebration 2000 (Central Europe Lithospheric Experiment Based on Refraction, June 2000) is an international seismic refraction experiment concentrating on investigation of crustal and uppermost mantle structure of Central Europe. The field work for this project was performed in June 2000 by geophysicists from Poland, the Czech Republic, the Slovak Republic, Hungary, Austria, Denmark, Canada, and the USA with important contributions from Germany, Finland, Belarus and Russia.

The layout of the experiment was a network of interlocking recording profiles with total length of about 8900 km and the station spacing along the profiles 2.8 or 5.6 km. Shots (147 in all, 24 in the Czech Republic, spacing 30km) were fired along most of the recording profiles and concluded in about 160,000 seismic records.

The tomographic inversion routine of Hole based on Vidale's finite difference algorithm was applied to determine seismic P-wave velocity distribution along profiles using first arrivals. P-wave velocity models for the Bohemian Massif show high gradient P-wave velocity zone between the surface and the depth of 7-10 km with velocity ranging from 5.1 to 5.9 km/s followed by small gradient and laterally homogeneous P-wave velocity in the lower crust.

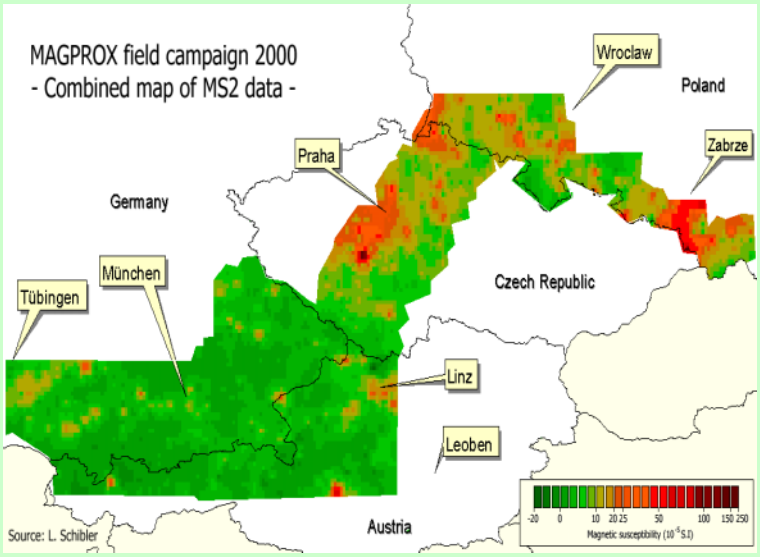


P-wave velocity model for profile CEL 09 (line Aš - Slavonice).

Environmental Rock-Magnetism

Research was focused on mapping of soil magnetic susceptibility on local as well as cross-boundary scales. In cooperation with foreign partners, a map of soil magnetic susceptibility was compiled, covering large areas of Germany, Austria, Czech Republic and Poland, including areas with different levels of pollution load. Map features are interpreted in terms of geological and anthropogenic contributions, the latter mainly due to atmospheric deposition of industrial fly ashes. Further laboratory studies of collected material are carried out with the aim of detailed characterisation of industrially derived magnetic minerals and their discrimination from the natural ones. Magnetic mapping can be thus used as a method of „proxy“ mapping of pollution extent and targeting the areas for detailed geochemical examinations.

References : [37, 38, 55, 56]



Map of magnetic susceptibility.

Gravity and Earth tides

The investigation of temporal variations of gravity in the seismoactive region of West Bohemia confirmed that stress and strain evolution during energy accumulation and release has a reflection in the gravity field. The character of changes within the gravity-geodetic network during the period of the "Autumn 2000" earthquake swarm was similar to that one indicated in 1994 and 1997. At the same time, vertical displacements in the main focal area around Nový Kostel proved correlation to seismicity.

The analysis of groundwater level and earth tides effects brought remarkable indication of the initial events of the earthquake swarm in West Bohemia in autumn 2000. The direct relation between earthquake events and earth tides maximum amplitudes seems to exist just as well and becomes a subject to further study.

Microgravity investigations, both theoretical modelling and field surveys, were applied in the field of archaeology and geoengineering. 3-D models of shaft tombs, as known in the Czech archaeological concession in Abusir, Egypt, demonstrated the effectiveness of microgravimetry for archaeological research. Microgravity survey in the Chomutov basin indicated voids related to historical mining, most of which were confirmed by drilling at a railway tunnel construction site, where the voids are the most risky engineering factor.

References : [50, 57]

Solar-Terrestrial research

Central point of solar-terrestrial research at the Geophysical Institute was the analysis of the influence of solar processes on space, magnetosphere and lower atmosphere at the various time-scales.

(a) The long-term changes of solar processes in which scope solar inertial motion was studied, showed prominent periods of 12.8, 10 and 7.8 years. Corresponding periods were detected in 10 various central European series of surface air temperature reaching back to the 18th century.

(b) Investigation of short-term changes in solar activity was aimed to find better knowledge about the dependence between the regular as well as irregular solar events and the level of solar wind inhomogeneity and so improve the quality of the geomagnetic activity forecasts. The daily and weekly forecasts are one of the outputs of Prague's Regional Warning Center (RWC), one of eleven RWC centres in the world regularly issuing forecasts of geomagnetic activity.

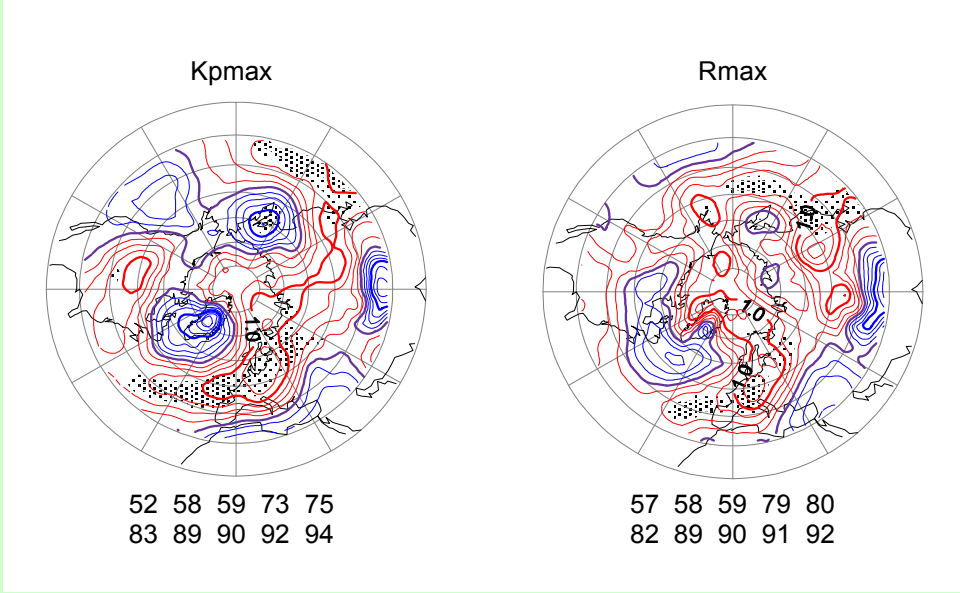
(c) Solar wind inhomogeneities cause magnetospheric disturbances, which manifest themselves, apart from other things, as geomagnetic field fluctuation of wide range of frequencies. Propagation of their short-term period component (0.1 – 10 Hz), from outer magnetosphere through the ionosphere to the ground at subauroral latitudes was studied in the project applying a new approach to interpretation of formation mechanism of Pc1 and IDPD pulsation signals in the ionosphere and on the ground. The new interpretation method, enabling to overcome difficulties of the previous one, was based on properties of the ionospheric Alfven resonator.

(d) Within the framework of short-term changes, the influence of the total solar eclipse (August 11, 1999) on the geomagnetic field was investigated at 14 observatories, covering the whole European eclipse trajectory. The most significant change was a temporary increase of about 10 nT in Y component, starting about 1 hour before the eclipse and lasting till 1 hour after it.

(e) Solar processes influence not only the dynamics of the magnetosphere and ionosphere, but under certain conditions, also the dynamics of the neutral atmosphere. The changes of pressure and temperature fields in winter lower troposphere observed in association with changes in solar/or geomagnetic activity were investigated. Significant increase of winter temperatures during high solar or geomagnetic activities over North American and European continent was found (see figure)

(f) Relations between geomagnetic activity, global mean surface temperature, The North Atlantic Oscillation and El Nino events were studied and possible causes leading to general year to year variability and to the global warming during the past 100 years were suggested.

References : [8, 9, 20, 31, 51, 52, 63, 64, 73, 74, 75, 76]



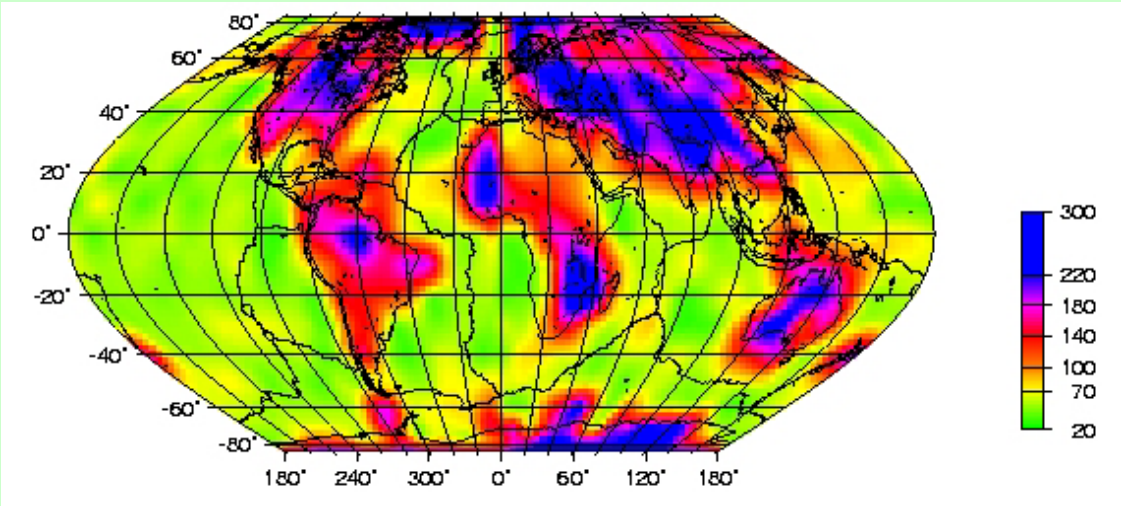
Composite anomaly patterns of 700 mb temperature (long-term average 1952-99) over the NH in Jan+Feb at high levels of geomagnetic (Kpmax) and solar (Rmax) activity. The figures below each pattern indicate the years of selected periods. Positive anomalies - red, negative - blue lines. Countour interval 0.25 C. Light and dark shades indicate areas where the *t* test is significant at 90 % and 95 %, resp.

Seismic anisotropy of the Upper Mantle

Research of seismic anisotropy of the mantle lithosphere, especially of lateral variations of its 3D orientation, resulted in formulating a new concept of anisotropic domains of the continental lithosphere. 3D self-consistent anisotropic models of the uppermost mantle, which are compatible for various types of seismic waves, were developed in parts of Variscan massifs, as well as around the Trans-European Suture Zone (TESZ). Modelling the seismic anisotropy around the TESZ delimited three lithospheric domains: (1) north of the TESZ, the high velocities of the anisotropic structures dip to the NE in the thick lithosphere of the Fennoscandia; (2) the sharply bounded fragment of a thinner lithosphere between the northern and southern branch of the TESZ, in which anisotropic structures dip to the WNW; (3) south of the TESZ, a domain belonging to a very thin lithosphere of Avalonia exhibits the high velocities dipping to the SW-W. Contrary to studies of the surface which assign the region between the two branches of the TESZ to the Baltica, the anisotropic study showed that the mantle fabric of this lithospheric domain is substantially different and is sharply separated from the Baltica. Deciphering anisotropic structure of the mantle lithosphere contributes to identification of lithospheric micro-plates comprising the continents. Monitoring the lateral changes of anisotropic structure allows us to understand better their geodynamic development.

The alignment of olivine crystals is the dominant source of seismic anisotropy in the sub-crustal lithosphere and asthenosphere. Different components of large-scale anisotropy can be traced in depth distributions of the radial and azimuthal anisotropy of surface waves. We proposed a global model of the lithosphere-asthenosphere boundary (LAB) as a transition between a frozen-in anisotropy in the lithosphere to anisotropy in the sub-lithospheric mantle related to the present-day flow.

References : [3, 4, 59, 60, 61, 62]



Litosphere thicknesss in kilometers.

Deep structure and seismotectonics of convergent plate margins

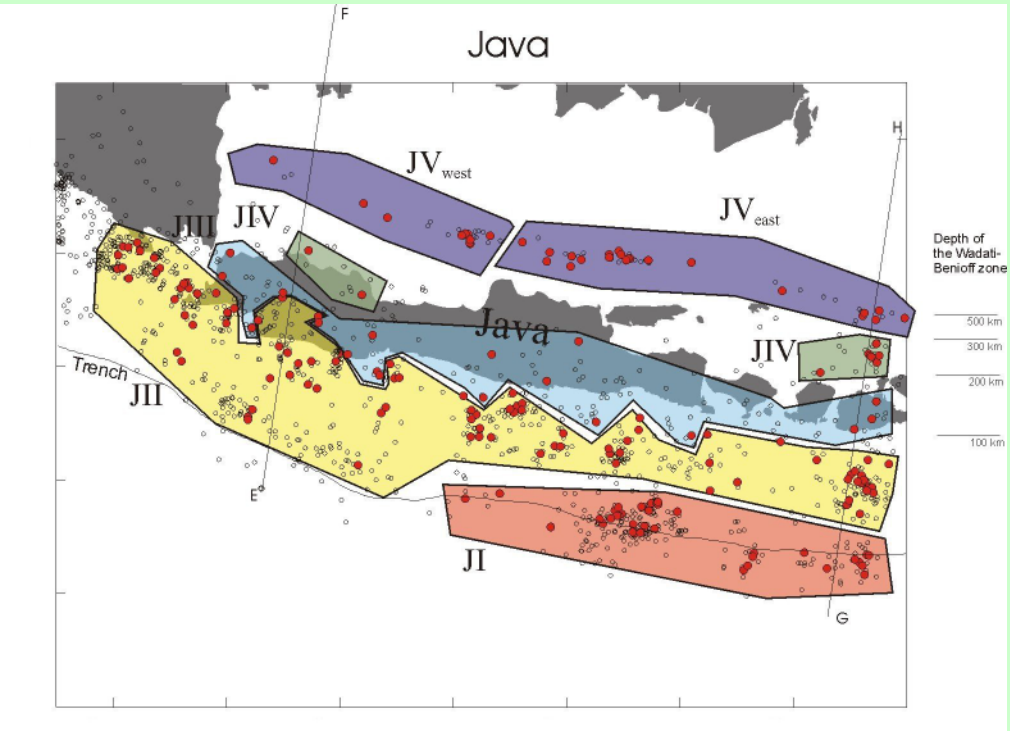
Major interest was focused on the variability of stress conditions in convergent plate margins of Andean South America and of Indonesian island arc (a), on geodynamic interpretation of the position of the disastrous 1999 Puebla earthquake in Mexico (b), and on metallogenic consequences of seismically active fracture zones in Sumatra and Java (c).

(a) The determination of the detailed variation of stress in the descending Nazca and Indo-Australian plates was based on the distribution of seismic activity and the orientation of P- and T-axes of fault plane solutions. International Seismological Centre (ISC) data and Harvard Centroid Moment Tensor (HCMT) solutions were used. Applying the Gephard-Forsyth method, 16 different domains with uniform state of stress in the Andean Wadati-Benioff zone and 8 such domains in the regions of Sumatra and Java were delineated.

(b) The position of the 1999 Puebla earthquake in Mexico was interpreted in terms of the seismotectonic pattern of the Middle American continental wedge. It was proved that this catastrophic earthquake did not occur in the subducted oceanic lithosphere, but in one of the seismically active fracture zones induced in the continental lithosphere by the process of subduction.

(c) Spatial correlation of the occurrences of hypogene mineral accumulations in the regions of Sumatra and Java with the position and orientation of the seismically active fracture zones in the continental lithosphere of the Euro-Asian plate has shown that the majority of polymetallic deposits are situated in the outcrops of these active fracture zones. It is supposed that these fracture zones effectuated channeling of ore-bearing solutions liberated from the oceanic lithosphere during the process of subduction.

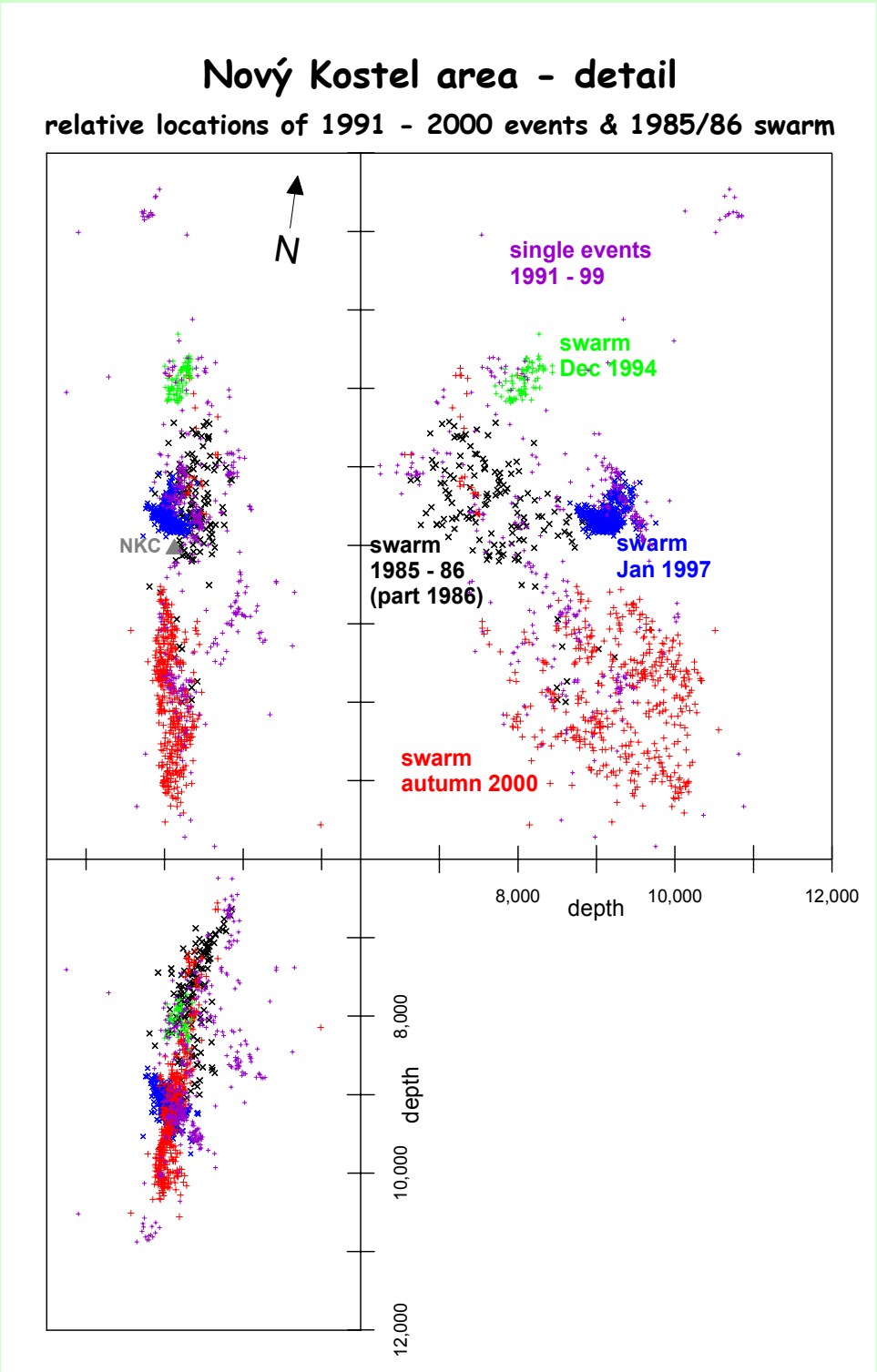
References : [25, 71, 72, 89]



Domains with uniform state of stress in the Wadati-Benioff zone beneath Java (JI-JV) and the distribution of epicentres of earthquakes located in the Wadati-Benioff zone; full circles indicate events with available focal mechanisms.

Western Bohemia Earthquake swarm 2000

From August 28 to December 26, 2000, high swarm-like seismic activity consisting of a total of nine swarm phases occurred in the NW-Bohemia in the area of Nový Kostel. This swarm belonged to the longest and strongest swarms of the 20th century. In the course of the swarm more than 10 000 earthquakes and microearthquakes were recorded by local seismic stations WEBNET, ten of them with magnitude ML $\geq$ 3.0. The largest event (November 6, 22:07:17 UTC) reached magnitude ML 3.4 and its macroseismic effects were felt in an area of up to 50 km in diameter. Although most of the NW-Bohemia/Vogtland swarms are typical in an erratic character of earthquake activity, the 2000 earthquake swarm was unique with respect to the number of swarm phases. Each of them lasted only a few days, and had a well pronounced character. The swarm took place in a very narrow volume. The foci formed a cluster of about 3500 x 3500 m, well approximated by a plane, at depths between 7.0 and 11.5 km. Numerous events occurred as multiplets (i.e. events located at nearly the same position and having very similar source mechanisms) which is a characteristic phenomenon for geothermal or volcanic regions. Preliminary studies indicate a total of seven types of focal mechanisms. The amount of observations of the 2000 swarm, in terms of the data volume, exceeds the number of all observations of local earthquakes in the West Bohemia/Vogtland region over a period of ten years.



Planar view (top left) and two cross-sections (top right: North-South, bottom right: West-East) of the Nový Kostel focal area. Individual swarms are distinguished by colours.

LIST OF GRANT PROJECTS SOLVED DURING 2000-2001

Title	Responsible Investigator	Grant Agency	Duration
Determination of earthquake source parameters in geologically complex media	I.Pšenčík	Project INCO-COPERNICUS	1997-2000
Thermal history of the sedimentary basins of the Czech Republic and its relation to tectonic processes	J.Šafanda	GA AV ČR	1997-2001
Velocity distribution in the Bohemian Massif and fast localisation of regional earthquakes from broadband seismological observations	J.Zedník	GA ČR	1998-2000
Seismotectonics and geodynamic evolution of the northern part of Andean South America	V.Hanuš	GA AV ČR	1998-2000
Extraterrestrial influences on the winter tropospheric circulation	J.Pýcha	GA AV ČR	1998-2001
Geodynamics of the West Bohemia seismic region	J.Mrlina	GA AV ČR	1998-2002
Orogenic roots-processes, manifestation and implication for evolution of continental litosphere	J.Plomerová	GA ČR	1998-2002
Geophysical investigation in the regions with different degree of tectonic activity in Central Europe and Japan	V.Červ	Project NJ-23 program KONTAKT	1998-2002
Changes in the microstructure of the geomagnetic field during the total solar eclipse on August 11, 1999	J.Střeštík	GA ČR	1999-2000
Recent geodynamics of West Bohemia in relation to the crustal structure (unique natural laboratory)	J.Horálek	GA ČR	1999-2001
Electrical anisotropy within the Earth's crust - modelling and tectonic relations	J.Pek	GA ČR	1999-2001
Earthquake source retrieval with inexact model of the structure	J.Šílený	GA AV ČR	1999-2001
Magnetic mapping and analysis of contaminated recent soil sediments	A.Kapička	GA AV ČR	1999-2002
Possibilities of geothermal sources exploitation for energy supply	J.Šafanda	MŽP	1999-2002
Elastic anisotropy of mantle rocks from the Bohemian Massif	A.Tomášková	GA ČR	1999-2003
World-wide scanning of seismic anisotropy of the litosphere	J.Plomerová	GA AV ČR	1999-2003
Updating of the tilt monitoring system in the hazardous environment of the ČSA mine, Most.	B.Chán	GA AV ČR	2000-2002
Detailed magnetic characteristics of power-plant fly ashes	E.Petrovský	GA ČR	2000-2002
Metodics of microgravity measurements and their applications to environmental geology	J.Mrlina	GA ČR	2000-2002
Model of a 3-D distribution of the electrical conductivity across Europe from long-period geomagnetic variations	O.Praus	GA ČR	2000-2002
Celebration 2000	A.Špičák	MŽP	2000-2002
Seismic waves in anisotropic media: applications	V.Vavryčuk	GA ČR	2000-2002

Title	Responsible researcher	Grant Agency	Duration
Deep structure, seismotectonics and state of stress in southeast Asia	A.Špičák	GA AV ČR	2000-2003
Screening and monitoring of anthropogenic pollution over central Europe by using MAGnetic PROXies	E.Petrovský	EU	2000-2003
Boussinesq's approximation of the hydrodynamic geodynamo	I.Cupal	GA AV ČR	2000-2003
Recent climate changes and its contingent anthropogenic component revealed by inversion of present temperature data measured in boreholes	V.Čermák	GA AV ČR	2000-2004
Controls on basin-fill architecture in intracontinental extensional and strike-slip basins: examples from the Cretaceous and Neogene, Bohemian Massif	D.Uličný	GA ČR	2001-2003
Seismic tomography of the litosphere of western part of the Ohře rift	V.Babuška	MŽP	2001-2003
Seismic anisotropy of the subcrustal litosphere of the Bohemian Massif	V.Babuška	GAČR	2001-2003
Collocated magnetotelluric and seismic reflection experiment across the Trans-European Suture Zone	V.Červ	GA ČR	2001-2003
Structural aspects of the evolution of volcanic centers: the České středohoří Mts. as an example	J.Mrlina	GA AV ČR	2001-2004
Impact of geomagnetic storm on ionosphere-atmosphere system	P.Hejda	GA AV ČR	2001-2004
Study of temporal variations of the geomagnetic field based on the observatory and repeat station measurements	P.Hejda	GA AV ČR	2001-2004

Events

Fifth International Meeting Heat Flow and the Structure of the Lithosphere

The Fifth International Conference on Heat Flow and the Lithosphere Structure at Kostelec n/Č.Lesy, June 10-16, 2001 was held under the auspices of the International Heat Flow Commission (IHFC) of the IASPEI and co-sponsored by the UNESCO Project No.428 of the International Geological Correlation Programme. The scope of the meeting followed successful tradition of four previous meetings held at Liblice (1982), Bechyně (1987 and 1991) and Třešť (1996). The scientific programme of the meeting was subdivided in six topical sessions covering all major problems of the contemporary geothermics including also the problems of the „borehole and climate“ studies. 65 colleagues from 20 countries who attended the meeting represented a sizeable part of the present-day geothermal community. Extremely positive was the active participation of a number of young post-graduates from several countries. Selected papers will be published as a special issue of Tectonophysics and also in Global and Planetary Change. Next similar meeting is planned for year 2005. For more detailed information, list of presentations and the general relevance and also for many photographs visit the www pages of the Geophysical Institute.

Celebration 2000 Workshop

One of numerous regular workshops devoted to processing and interpretation of the Celebration 2000 data took place at the Geophysical Institute in June 26-28, 2001. The first part of the program was oriented on presentations of the most recent results achieved in the area of the Bohemian Massif. The second part consisted of computer sessions followed by comparison and discussions of results reached by different methodology applied by different teams. 25 scientists attended the Celebration 2000 workshop from the Czech Republic, Poland, Hungary, Austria, Germany, Finland and the United States. These meetings are organised ad hoc in accordance with the current needs.

Czech-Slovak Seismological Days

Second Czech-Slovak Seismological Days took place in Smolenice Castle near Bratislava, Slovak Republic, on June 13-15, 2001. The meeting was organised jointly by the Geophysical Institute ASCR, Prague, and by the Geophysical Institute of the Slovak Academy of Sciences, Bratislava. The meeting served as a working session for the exchange of knowledge and experience between Czech and Slovak seismologists. Around 50 scientists participated in the event, including several researchers and students from the Charles University, Prague. Twenty seven oral contributions were presented, covering nine research areas: seismic monitoring, seismic risk, laboratory seismology, seismic source, propagation of seismic waves and Celebration 2000 project, mathematical modelling of seismic motion, signal analysis, structure and anisotropy of litosphere and astenosphere, seismicity in the Western Bohemia. The next meeting is scheduled for 2003.

Seismic Waves in Laterally Inhomogeneous Media V

The international workshop Seismic waves in laterally inhomogeneous media V was held at the Castle of Zahrádky, Czech Republic, June 5-9, 2000. The workshop was organised by the Geophysical Institute, Acad. Sci. and the Faculty of Mathematics and Physics, Charles University. As in the

previous workshops held under the same name in the Liblice Castle in 1978, 1983 and 1988 and in the Třešť Castle in 1995, this one was also oriented mainly on theoretical and computational aspects of seismic wave propagation in complex structures, and with applications involving these aspects in seismic exploration and Earth's crust studies. The main topics of the workshop were forward and inverse modelling of seismic wave fields in laterally inhomogeneous, isotropic and anisotropic structures. The workshop was attended by about 60 seismologists from 16 countries. The next workshop of this kind is planned for 2005.

25 contributions presented at the workshop have been accepted for publication in the topical issue of PAGEOPH, Vol.159, which will appear in July 2002.

Fifth Meeting of the Czech Tectonic Studies Group

The 5th Meeting of the Czech Tectonic Studies Group was held in the skiing and tourist resort Bublava in the westernmost edge of the Krušné hory Mts., Western Bohemia, on April 12-15, 2000. More than 100 participants from the majority of geological and geophysical institutions of the Czech Republic attended the Meeting. Their contributions were devoted to all aspects of tectonic processes and their consequences, with the emphasis on the Bohemian Massif. MSc and PhD students of Czech universities broadly attended the Meeting. 15 participants from the Slovak Republic and Poland reported on their work in neighbouring tectonic environment (mainly in Western Carpathians). Two one-day field trips framed the Meeting – the first devoted to the sediments of the Bílina Delta (Neogene of the Eger Graben) and the second to tectonic and metamorphic evolution of the central part of the Krušné hory Mts.

Summer schools

Two summer schools for graduate and postgraduate students of geology and geophysics were co-organised jointly by the Institute of Petrology and Structural Geology, Faculty of Science, Charles University, Prague and by the Geophysical Institute. These meetings took place at the Roztěž Castle. The first one, entitled “Geophysical Imagery of Orogenic Belts”, and dedicated to modern geophysical methods used in the interpretation and geological synthesis of ancient and active orogenic belts, was organised on July 2-10, 2000. The summer school on July 9-15, 2001 was entitled “Length and Time Scales of Mechanical Events in the Lithosphere”. Each teaching day of the summer schools consisted of two full-scale invited lectures given by leading experts in a respective field. Around 50 participants from 10 European countries attended each summer school.

IAS short course „Computer Modelling of Stratigraphy and Sedimentary Processes"

This course, organised in co-operation with the IAS (International Association of Sedimentologists) between October 24-27, 2000 at the Geophysical Institute, provided an introduction to the principles and applications of 2D and 3D forward modelling techniques to sedimentology and stratigraphy. The course leaders were Dave Waltham, Dan Bosence, Gary Nichols (Royal Holloway, University of London) and David Uličný. Three days of the course were devoted to the classroom work; one day was spent in the field. The course focused on (1) spreadsheet-based exercises used in forward modelling of sedimentation and (2) use of a 2-D forward modelling package 'SedTec' developed at the Royal Holloway. The examples studied came both from clastic and carbonate depositional systems and were supplemented by introductory lectures and a number of case histories with field and subsurface documentation. In addition, demonstrations of a newly developed 3-D modelling program for turbidity currents and other sedimentological phenomena were incorporated into the course. The field trip focused on stratigraphic architectures and sedimentological features of a coarse-grained delta system in the Bohemian Cretaceous basin. Eight PhD students and 14 professionals attended the course from research institutions from 7 countries of Eastern and Central Europe (Bulgaria, Croatia, Czech Republic, Lithuania, Poland, Slovakia, Turkey).

Workshop on Phase Picking

An international Workshop on Phase Picking was organised in the Geophysical Institute during September 20-26, 2000 (convened by J. Plomerová). Eleven members of the SVEKALAPKO Seismic Tomography Group from Finland, Switzerland, France, Russia and the Czech Republic, were trained in processing and evaluating seismograms recorded during the international passive seismological experiment in central Finland 1998/99, and listened to five lectures presented by seismologists of the Geophysical Institute.

Workshop on Seismological Imaging the Continental Lithosphere

An international Workshop on Seismological Imaging the Continental Lithosphere was held in the Geophysical Institute in November 27-29, 2000 under the auspices of the Czech-French research programme BARRANDE (convened by J. Plomerová and M. Granet, IPG Strasbourg, France). The scientific scope of this workshop was to examine the seismological structure of the continental lithosphere and mantle using various seismological tools and techniques, with a special focus on seismic anisotropy and on Variscan massifs in Europe. A preparatory meeting of the Czech-French-German project BOHEMA took place during the workshop.

Lectures and Exhibitions on Historical Seismicity

Further to the international Czech/US project No.96018 "Special Seismic Data Basis (1997-2000)", its principal investigator, Jan Kozák, prepared a series of eight lectures on testing and interpreting historical macroseismic data from pictorial materials. These lectures were presented at the Academy of Sciences of the Czech Republic in February 2001, at the Geophysical Institute AS CR, Prague, in October 2000 and in March 2001, in the Regional Museum in Rychnov nad Kněžnou in April 2001, in the Regional Museum in Česká Lípa in April and in May 2001, and in the Ventura (California, USA) in September 2001 – 2 lectures.

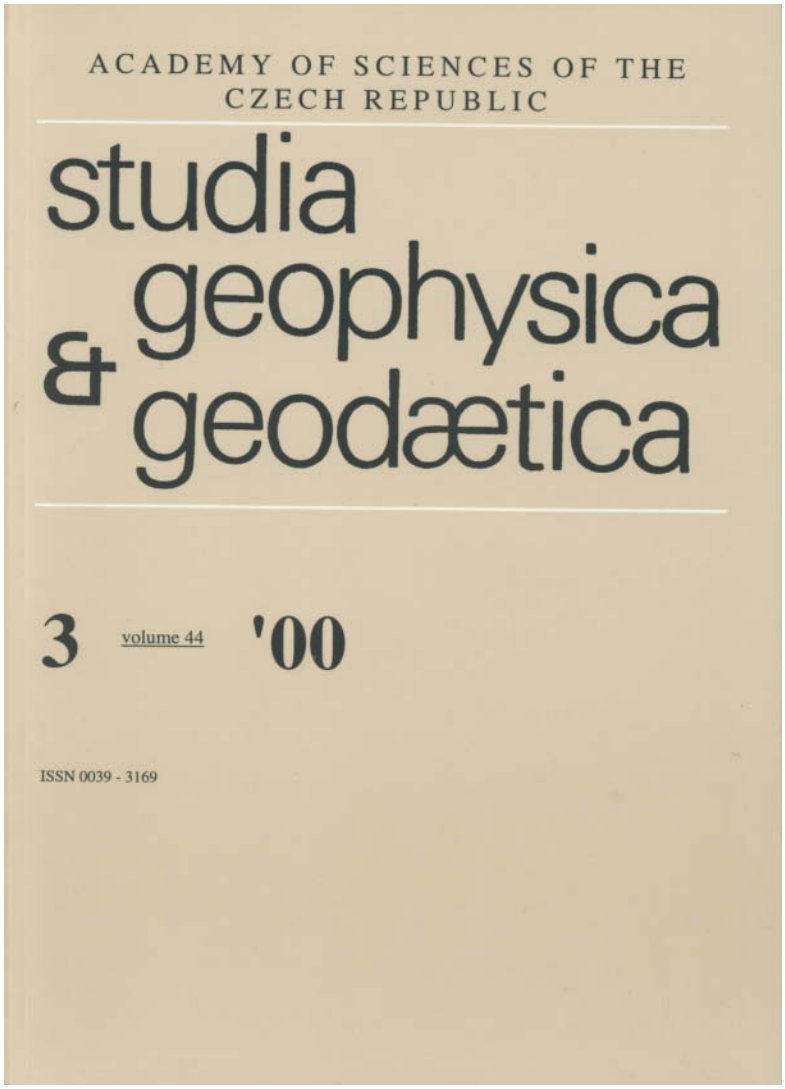
In the Ventura Country Museum for History and Arts the exhibit of historical images (selection of 'Collection Kozák', see www.eerc.berkeley.edu/kozak) was opened on Sep.14, 2001. (Photo Pavla Mraz, Dana Point, CA, USA)

Studia Geophysica et Geodaetica

Studia Geophysica et Geodaetica is an international scientific journal covering geophysics, geodesy, meteorology and climatology. It has a long tradition, being published quarterly since 1956. The journal is distributed to many geophysical and geodetical libraries all over the world and is cited and abstracted in, e.g., Current Contents, Meteorological and Geoastrophysical Abstracts and Elsevier/GeoAbstracts. In 2000, both editorial board and reviewing system have been changed and the journal has now 15 editors and 9 advisory editors from all around the world.

Recently, the journal was awarded by the Institute of Scientific Information with an impact factor of 0.761 in the year 2000, as published in the latest Journal Citations Report (www.jcrweb.com). This figure is given by 21 cites in 2000 to 31 articles published in 1998 and 46 cites in 2000 to 57 articles published in 1999. Since January 2002 it will be included to the list of Scientific Citation Index (SCI).

Another positive feature of the journal is fast publication. In 2001, the average time span between the date the manuscript was submitted and the date the paper was accepted reduced to 180 days.



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[7] Bodri L., Čermák V. and Kukkonen I.T., 2001. Climate change of the last 2000 years inferred from borehole temperatures: data from Finland. *Global and planetary change*, **29** (3-4), 189-200.

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[10] Burilichev D.E., Ivankina T.I., Klíma K., Lokajíček T., Nikitin A.N. and Pros Z., 2000. Investigation of rock samples by neutron diffraction and ultrasonic sounding. *Physica B*, **276/278**, 837-838.

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[16] Červ V., Pek J. and Praus O., 2001. Long period magnetotelluric studies in the western part of the Bohemian Massif. *Seismology and geology*, **23** (2), 166-177.

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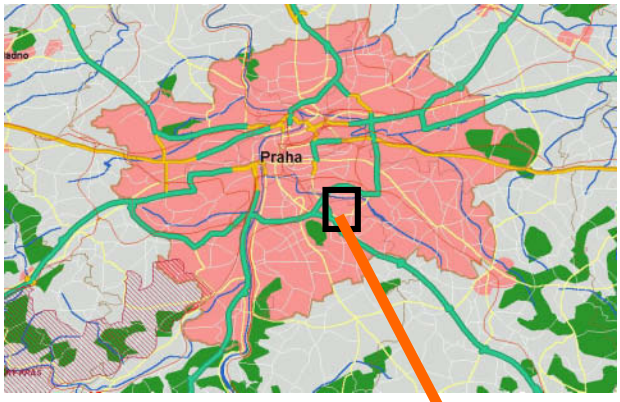

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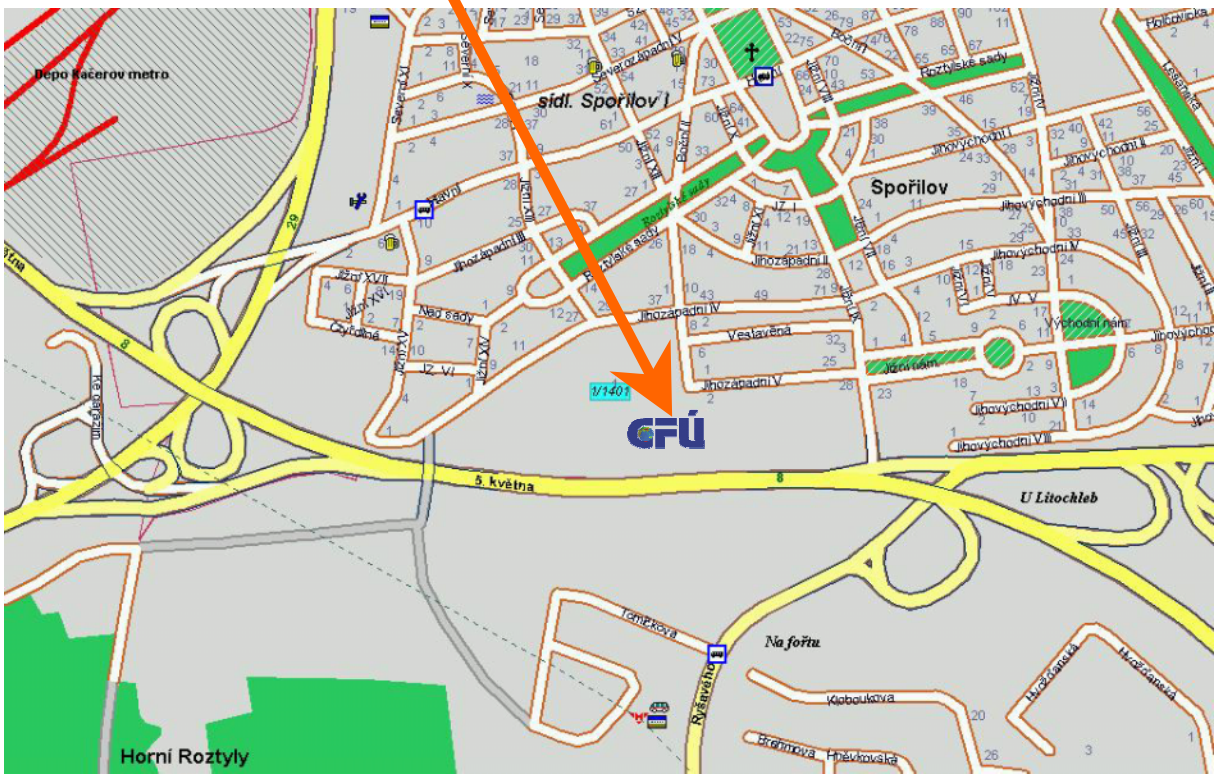

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Courtesy R.Gutdeutsch, Vienna, Austria

Komarno, Slovakia, June 25, 1763. Effects of one of strongest earthquakes on the Slovakian territory. Detail of original painting (1766) showing damage to the Jesuit Church (right) and the Jesuit College (left). The painting is kept in the Franciscan church at Frauenkirchen-Burgenland, Austria, see Collection Kozák KZ156B.

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