MINISTRY OF EDUCATION, YOUTH AND SPORTS

Progress Report on the Implementation of the Project of Large Research, Experimental Development and Innovation Infrastructure CzechGeo/EPOS in 2012

Full name of the project: CzechGeo/EPOS – Distributed System of Permanent Observatory Measurements and Temporary Monitoring of Geophysical Fields in the Czech Republic – Development and Operation of the National Node of the Pan-European EPOS Project

Project code: LM2010008

Beneficiary: Institute of Geophysics of the AS CR, v.v.i., Boční II./1401, 141 31 Praha 4, Id. No. 67985530

Principal investigator of the project: RNDr. Pavel Hejda, CSc.

Resolution of the Government of the day, number: 15 March 2010, number 207

Start of project financing: 7 October 2010

The main mission of the infrastructure (max. 500 characters): Permanent observatories and temporary monitoring networks of geophysical fields in the Czech Republic are carried out by several universities and public research institutes. Integration of these infrastructures on the national level and in the frame of the ESFRI Roadmap European Plate Observing System (EPOS) project is aimed at conceptual development, stable operation and improved data services for user community.

A. Scientific and Technological Excellence

(max. 6 000 characters)

Rating:1-5

Weight: 1

1. Scientific results

Indicate the main scientific results achieved on the basis of the infrastructure's use.

Indicator: *Number of publications in academic journals published on the basis of data created or stored on the infrastructure.*

Indicator: *Use of the infrastructure's capacity (describe the percentage use according to the type of the infrastructure and scientific focus, or approaches, the volume generated, stored or provided data, including percentage representation of users – universities, research institutions, industry). In case of construction of the infrastructure describe the current status or data from performed tests or limited service, etc.*

The permanent observatory data are in nearly real-time regime sent to international data centres and are free to use for non-commercial purpose. Although the users are obliged to

acknowledge data providers in published papers and inform them that their data were used in publications, this occurs rarely. That is why we can bellow report only about results obtained by researchers from institutions participating in CzechGeo and by their close collaborators (29 papers).

Selected most important scientific results:

- New method for improving the seismic model of Earth crust, in particular for identification of important speed discontinuities, was developed and new model of the crust and MOHO topography in West Bohemia was created. The analysis was based on data of microearthquakes registered by the seismic network WEBNET in West Bohemia and Vogtland.
- Long-term monitoring of relation between air and soil temperature carried out in cooperation with Geological Survey of Slovenia in 100 m deep borehole showed the increase of yearly mean air and soil temperature of 0,5 K.
- Detailed regional tomography of the speed of seismic waves confirmed lowered speeds in the mantle beneath Bohemian Massive (against the standard reference model of the Earth). It is in agreement with the results of global tomography.
- Long-term GPS measurements in West Bohemia in period 2007 – 2009 were used for modelling the changes of surface motions, deformations and strains that occurred during the seismic swarms in October 2008.
- Indicators of periods of enhanced geodynamic activity were analysed in in TecNet network. Anomalous motions were observed repeatedly before the large earthquake near Modena in May 2012.
- Relations between changes of the level of water in boreholes and the seismicity in the region of Hronov-Poříčí fault were studied. Connection between the ground water level and tidal forces in the periods of enhanced seismic activity was found.
- Deformations of the Earth crust on profiles Sevastopol - Příbram and Marsaly (Sicily) – Nachod were studied.
- Anomalous deformations were correlated with anomalous strains on Kamchatka, with ElMag anomalies in USA, with gravity anomalies on Taiwan and thermal anomalies all around the world (NASA).
- On the base of observed microseismic activity in the region of “Hornomoravsky uval”, Analysis of selected faults from the point of view of history of their motions in late Quaternary was started.
- Harmonic analysis of the monitoring of the outlet of underground CO2 has shown that periodicity of this process is mainly caused by daily temperature variations which shield weaker influence of Earth tides.

The backbone of the infrastructure consists of permanent observatories that work in non-stop regime. The use of infrastructure is thus 100 per cent. Data are on-line sent to data centres and are free available for non-commercial use. We suppose that the general distribution of users is Universities 40%, Research Institutes 50%, Industry 10%.

2. Cooperation with Other Research Institutions, Industry or Other Entities that Using Results of the Infrastructure

Indicate newly established or running cooperation in the Czech Republic and abroad with research institutions, industry and other entities that using results of the infrastructure.

Indicator: *Number of new/running cooperation.*

There exists wide cooperation with tens of institutions in the frame of worldwide observatory networks. The list in Appendix 3 gives the closest partners. There are 6 domestic research and educational institutions and 13 industrial companies or institutions belonging to public administration. New cooperation was started with Diamo, state enterprise.

The list of foreign partners has 85 items, among them 6 new partners: NAGRA, Grimsel, Switzerland, Geophysical Institute, Lima, Peru, Universidad de Las Pakmas de Cran Canaria, Las Palmas, Spain, IGME Canaria Islands, Spain, Japan Aerospace Exploration Agency, Japan, National Observatory of Athens, Greece. Cooperation with some of them is multidisciplinary (EPOS partners), with other specialized (e.g. in the frame of Seismological Software Centre).

3. Cooperation with Other Infrastructures in the Field

Indicate newly established or running cooperation with other infrastructures in the field.

Indicator: *Number of new/running cooperation.*

CzechGeo/EPOS cooperates with prestigious European and worldwide infrastructure that collect, analyse and distribute geoscience data: EMSC (European-Mediterranean Seismological Centre), GEOFON Global Seismic Network, ORFEUS, HUSN (Hellenic Unified Seismic Network), EUREF Permanent Network, International GNSS Service, The EUMETNET GPS Water Vapour Programme, Global Geodynamics Project, International Centre for Earth's Tides, BGI – Bureau Gravimetrigue International, International Service for Earth's Rotation and Reference Systems, BKG (Bundesamt für Geodäsie und Kartographie) GNSS data Center, CZEPOS - Network of Permanent GNSS Stations in the Czech Republic, TopNet, INTERMAGNET, EPOS (European Plate Observing System). This list of 17 infrastructures was enlarged by 2 new partners: NOANET and MGMNet.

4. Service to Science Community

Indicate the number of users of the infrastructure from the Czech Republic and abroad. Indicate the number of conferences and seminars organized by the infrastructure, including the number of participants from the Czech Republic and abroad. Indicate the number of meetings with users and the feedback results thus obtained. Indicate the number of agreements with other institutions (e.g. contracts, memoranda).

Indicator: *Number of users of the infrastructure/ foreign from total. Number of organizations with which the infrastructure has agreements. Number of countries with which the infrastructure has agreements. Number of conferences and seminars organized by the infrastructure.*

The basic service for research community consists in continuous observations and publication of data via international networks. The number of users cannot be plausibly estimated. For example, number of accesses of portal www.tecnet.cz exceeded 2000 of unique users, data of Geomagnetic Observatory Budkov have been download from www.intermagnet.org server by about 80 unique users per year. However, most data portals do not have such statistics.
Cooperation is usually not formalized. There is legal relevant agreement with 19 organizations from 18 countries.

Conferences and seminars:
The First Regional EPOS Preparatory Phase Conference, March 2012, 70 participants / 56 from abroad
EPOS PP Integration Meeting: Preparing for Construction, September 2012, 102 participants / 93 from abroad
Czech-Slovak seismology days, June 2012, 56 participants / 8 from abroad
The department of Geophysics of the Charles University organizes weekly seismic and geodynamic seminars, where colleagues from universities and research institutes are invited.
The infrastructure is presented among High school students during The Open Door Days, Days of the Earth and One Day with Physics as well as among participants of the Third Age University.

5. Internationalization

Indicate the number of international research grants, their names, a brief description and financial volume.

Indicator: *Number of international grants (e.g. FPs, including the type of grant).*

- EC FP7-INFRASTRUCTURES-2010-2014, European Plate Observing System (Grant agreement No. 262229) – Preparatory phase of large European research infrastructure aimed at preparing scientific, technical, legal and financial conditions for the operational phase with special attention paid to e-infrastructure as a basic tool for data integration – 4 500 000 € total, 102 750 € for IG ASCR.
- EC FP7 SP3 People, AIM – Advanced industrial microseismic monitoring (Grant agreement No. 230669) – Project coordinated by Institute of Geophysics - Support for

training and career development of researchers – Industry-Academia partnership – financial support 867 197 €

- DFG, Maar Mytina - Železná hůrka and active magmatic degassing zone CO2 Milhostov – Hartoušov in western Ohre Rift, 2011 – 2013, 22 000 €.
- Polish National Science Centre, project 2789/B/T02/2011/40 „Integration of permanent and epoch GNSS measurements for needs of local and regional investigation on the Czech-Polish network SUDETEN“
- National Geographic Society/Waitts Grants Program grant n. W244-12: Mega-landslides: imminent hazard or sleeping giants? Monitoring the landslide hazard related to ongoing volcanic activity around El Hierro, Canary Islands, Spain. (2012-2013)
- Scientific Co-operation Agreement GZ 4150/15-23a/92, partner: Central Institute for Meteorology and Geodynamics, Department of Geophysics, Hohe Warte 38, A-1190 Vienna, Austria, 1,2 mio. CZK yearly
- Evaluation of tectonic movements along the faults, project LH12078 (Kontakt II)- 2012-2015, collaboration with University of San Diego, CA, 3 mio CZK
- Using space geodesy to investigate the mechanics of earthquake ruptures, Ident. code 7AMB12GR006, project MOBILITY, MŠMT, 2012 – 2013, 140 000 CZK. Cooperation with geodetic group of Dr. A. Ganase from National Observatory of Athens.

6. Multidisciplinarity

Indicator: *Number and titles of scientific disciplines that use the infrastructure's services.*

11 – geodesy, geodynamics, geology, geomagnetism, geothermics, gravimetry, hydrogeology, climatology, magnetotellurics, meteorology, seismology

7. Strategic Management of the Scientific Development of the Infrastructure

Indicate the main features of the scientific strategy of the infrastructure, including plan for update of the technology used.

Strategic management of CzechGeo will be coordinated with the EPOS PP, which the CzechGeo project team takes active part in. It should be noted that EPOS covers all aspects of the infrastructure development and operation: legal, financial, strategic, technical.

CzechGeo is distributed infrastructure consisting of several hundreds of components. The upgrade of technology is a continuous process. New technologies are taken into consideration by installation of all new equipment.

The project is aimed at long-term stability in order to get time series as long as possible. Priorities are: continuous upgrade of observatory systems aimed at data quality enhancement, integration of data and continuous maintenance in order to ensure high reliability.

B. Stable and Efficient Management

(max. 5 000 characters)

Rating: 1-5

Weight: 1

1. The Efficiency of the Use of Funds

Indicate verbally or by table the use of the provided grant for the period, primarily describe the personal costs (e.g. number of jobs), overheads and investments. Indicate how the allocated funds are used in the context of the overall budget of the infrastructure. Indicate the percentage of the budget of the infrastructure that has been obtained from external international grants and in collaboration with industry or other entities using the infrastructure's services.

The operation and maintenance of observatories and mobile systems is carried out by about 40 (mostly graduated) technicians. Eighteen persons are financed by CzechGeo budget, the other by institutional or project money of corresponding institute or faculty. Separate components are managed by research workers. They should guarantee that the infrastructure will be developed in accordance with the needs of scientific community and other users. Their wages are not paid from CzechGeo grant.

The investments were concentrated on improving the quality of instrumental basis, strengthening of computing capacity for storage, processing and accessing data (including the web application for GzechGeo portal) and on high quality internet access for observatories. Investments are listed in the Financial sheets.

Large items in the running costs are electrical energy, telecommunications, repairs and maintenance of instruments. Travel costs were mostly spent on trips to observatory and stations spread out over the whole territory of the Czech Republic.

The allocated money was entirely spent in agreement with the project. In personal expenditures, as well as in the running costs and investments the allocated money had to be completed by mostly institutional money. The grant covers about 50% of all costs, institutional means 40%, other grants 8% and contracts 2%. Related international and national grants are aimed at utilizing the data. They are important from conceptual and methodological points of view, but they do not directly support the infrastructure operation.

2. Stable Management

Describe your plan for human resources development. Describe your strategy for transparent allocation of the infrastructure's capacity. Provide an organizational chart of the project, changes in staffing the project. Indicate the composition and any changes in the external advisory bodies (scientific and management focus). Describe new ways in addressing the challenges that have been implemented in the area of the infrastructure's management in the period.

Geophysical observation systems are often unique apparatuses that cannot be simply maintained and repaired by commercial companies doing service of common electronic or laboratory devices. Purpose-trained experienced technicians are crucial for the system run. In the frame of CzechGeo/EPOS we therefore aim at long-term stabilization of these working

posts. The workers responsible for infrastructure must continuously follow new trends in measuring data acquisition and processing techniques. Long-term participation in the project plays a key role. Possibility of a broader international cooperation in the frame of EPOS project can be beneficial.

Regarding the transparent allocation of the infrastructure capacity it must be noted that the observatory infrastructure is not designed for visiting researchers. The broader science community uses the data by means of data centres or directly by providers.

CzechGeo/EPOS integrates observations and mobile systems of seven geoscience institutions. The coordination is directed by the Agreement on collaboration by the performance of the project of large research infrastructure. The agreement is every year amended in order to reflect necessary changes. The Project is coordinated by the Council consisting of representatives of the parties as well as of the Czech representative in the EPOS project. The Council is chaired by the Principal Investigator. Joint meeting of the Council and The national EPOS group was held on December 11, 2012. Invited were also all research workers responsible for individual infrastructures. In 2012 the responsible investigator of the Research Institute of Geodesy, Topography and Cartography, prof. Ing. Pavel Novák, PhD. was changed by Ing. Jakub Kostelecký, PhD.

The definitive proposal of legal structure will be worked out in coordination with the preparatory phase of project EPOS, Work Package 2 – Legal Work.

The members of CzechGeo team take active part in the Preparatory Phase of EPOS. Jan Zedník is vice-chair of the Inter-activity Preparatory Council (the top EPOS body), Pavel Hejda is chair of the Working Group WG9 Geomagnetic Observations and Jan Douša active member of WG4 Geodetic Data.

3. Progress towards Objectives and Compliance with the Timetable of the Realization of the Project

Indicate the comparison with the original plan of the realization of the project stated in the project proposal approved by the Government; describe the progress in meeting project objectives and the compliance with the timetable of the realization of the project. Indicate all changes (financial, personnel, etc.) in the realization of the project and their explanation.

The performance of the project is in agreement with the purpose declared in the application (securing long-term stable operation with emphasis on the high quality of data; on-going modernization of existing facilities with the aim of sustaining high technical standards of facilities; development of methods of processing and distributing data; support of joining significant international structures – at present particularly the project ESFRI/EPOS). Following actions were carried out in 2012

- New seismic station Bílá Voda was established. Stations Ostaš a Chvaleč were equipped with better connections and were included into the Czech regional seismic network.
- The gravity measurements at observatory Skalná was completed with measurements of atmospheric conditions (temperature, pressure) for computation of compensations.
- EUTecNet network has been on selected points completed with monitoring of the level of underground water and Rn. Automatic TecNet data acquisition and data analysis system is

under development.

- Data from 20 permanent GNSS and GEONAS stations are continuously sampled in 1 sec or 5 sec rate in Rinex format. Data are available on request and will be soon displayed on CzechGeo portal.
- Long-term stability of GEONAS network was evaluated for the purpose of geodynamic research, including the stability of four regional networks.
- Detection and localization of earthquakes in the Hronov-Poříč fault region has been improved.
- New device for measurements of rotation components of seismic waves Rotaphone was tested on the WEBNET stations Nový Kostel and Lazy.
- GNSS network Hornsund on Svalbard was established in cooperation with Wroclaw University and Polish Polar Station Hornsund and first (zero) measurements were carried out. The network is aimed at monitoring of geodynamic motions.
- Analysis of repeated absolute measurements of gravity field in Czech Republic, Slovakia and Hungary was performed.
- Seismological Software Centre established in the frame of CzechGeo project contains more than 100 source computer codes independent on the computer platform. The codes are completed with hypertext documentation and sample data.

C. Socio-economic Impacts of the Infrastructure

(max. 4 000 characters)

Rating: 1-5

Weight: 1

1. Impact on the Economy

Indicator: *Number of jobs in the infrastructure (researchers/research staff/other).*

Indicator: *Number and volume of contracts with industry concluded in the framework of public procurement to maintenance and renewal of the infrastructure.*

Eighteen full time jobs (4/14/0) were created in the frame of the infrastructure.
The institutions closed 16 investments contracts (instruments, installation of data networks) in the amount of 3,3 mio. CZK. 9 contracts (1,5 mio CZK) were closed with domestic companies. About 30 contracts in the amount of 2,5 mio CZK was closed for the supply of energy, telecommunications, repair of instruments or buildings.

2*. Impact on the Society*

Indicator: *Number of new textbooks, lecture notes and other practical outputs carried out on the basis of the infrastructure's operation.*

Although the observatory activities belongs to the scope of basic research, they find many applications in the environment protection and mitigation of the natural disaster risks (the commercial activities are not supported by the grant money):

- Seismic networks are used for the safety assessment of the underground gas reservoir Příbram-Háje.
- Measurement results of EUTecNet are used by the Radioactive Waste Repository Authority for assessment of potential localities for long-term deposit of radioactive waste.
- Tilt and hydrological measurements in a horizontal gallery located under the Jezeří castle the stability of the Krušné hory Mts slopes above the open-pit coal mine – contract with Litvínovská uhelná a.s.
- Monitoring of seismic risk of water reservoirs Horka, Skalka and Jesenice located in epicentral region of West Bohemian earthquake swarms – contract with VODNÍ DÍLA-TBD, a.s.
- Observation activities of the Institute of Geonics are aimed at documenting the natural seismic activity of the most northern part of Moravia, identifying technical quakes (quarry blasts) and mine induced seismicity of Karvina region and adjacent Polish mining districts. Database of blasts carried out on the territory of Northern Moravia and Silesia has been created and continuously updated for the purpose of better discrimination of seismic events registered on the seismic station OKC. Data of all seismic stations operated by the Institute are primary interpreted and the database is available on the web.
- Observation activities involves also measurements of the manifestations of mine induced seismicity, experimental measurements of the rotational components of these vibrations was made by the sensor S-5-SR of own construction.
- Uncommon sequence of earthquakes from the region of Hrubý Jeseník Mountains was registered by the seismic network MONET. The strongest event with magnitude 2,3 was noticed by the residents. Operators of the pumped storage hydro plant Dlouhé Stráně and nuclear power plant Dukovany were informed.

3. Impact on Innovation

Indicator: *Number of spin - off companies established on the basis of infrastructure's operation.*

Indicator: *Number of pilot plants, utility models, demonstrators made in connection with the operation of the infrastructure, number of patents recognized in connection with the operation of the infrastructure.*

Prototype of the GNSS station measuring the signals of Galileo system was developed.
Spin-offs are not supposed for this infrastructure.

D. Appendices

1. Required:

- *Table of the real financial costs of the project in 2012*
- *Table of indicators for monitoring of the implementation of the project*

2. Optional:

- *Appendix 3 – List of publications and cooperating institutions*