

**Progress Report on the Implementation  
of the Large Research, Experimental Development and  
Innovation Infrastructure (LI)  
CzechGeo/EPOS in 2014**

*Full name of the LI:* 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

*LI's code:* LM2010008

*Recipient:* Institute of Geophysics of the AS CR, v.v.i., Boční II./1401, 141 31 Praha 4, Id. No. 67985530 (IG ASCR)

*Another participant/s of the LI:*

Institute of Rock Structure and Mechanics of the ASCR, v.v.i., Praha (IRSM ASCR)

Institute of Geonics of the ASCR, v.v.i., Ostrava (IGN ASCR)

Institute of Physics of the Earth, Faculty of Sciences, Masaryk University in Brno (IPE MU)

Department of Geophysics, Faculty of the Mathematics and Physics, Charles University in Prague (FMP CU)

Institute of Hydrogeology, Engineering Geology and Applied Geophysics, Faculty of Science, Charles University in Prague (FS CU)

Research Institute of Geodesy, Topography and Cartography, v.v.i., Zdíby (RIGTC)

*Principal investigator of the LI:* RNDr. Pavel Hejda, CSc.

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

*Start of the LI's financing:* 7 October 2010

*The main mission of the LI (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

#### 1. Research Team

*List the members of research team (all persons that are paid via personnel costs), append brief job descriptions and classifications including their full-time equivalent (lowest, highest and average) and overall budget; distinguish as well between permanent and temporary staff.*

The project money does not cover personal costs of all persons engaged in the development

and operation of observatory infrastructures. The budget had to be completed by institutional money. Forty-one persons (17,3 FTE) are paid via project personnel costs. The average load is 0,42 FTE. Short term labour contracts are mostly made with local people who help with operation of observatories. The complete list is in Appendix 3.

## **2. Scientific results**

*I. Indicate the main scientific results achieved on the basis of the infrastructure's use during last period of time. Present single results according to valid methodology of CRDI (Council for Research, Development and Innovation), if possible J type results supplement with impact factor according to WoK or Scopus. Among these results specify 10 most important ones.*

*II. Indicate the main scientific results (not more than 10) achieved on the basis of the LI's use (its Czech branch in case of distributed research infrastructure) by its users, if possible to attest. Present single results according to valid methodology of CRDI (Council for Research, Development and Innovation), if possible J type results supplement with impact factor according to WoK or Scopus.*

### **Ad I. Main scientific results achieved by internal workers**

#### **Papers in journals with IF**

- [1] Briestenský M., Stemberk J. (2014): The use of damaged speleothems and in situ fault displacement monitoring to characterise active tectonic structures: an example from Západní Cave, Czech Republic. *Acta Carsologica*, 43, 129-138. IF = 0.542
- [2] Briestensky M., Thinova L., Praksova R., Stemberk J., Rowberry M.D. and Knejflova Z. (2014): Radon, carbon dioxide and fault displacement in Central Europe related to the Tohoku earthquake. *Radiation Protection Dosimetry*, pp. 1–5 doi:10.1093/rpd/ncu090. IF=0.861
- [3] Čermák, V., L.Bodri, J.Šafanda, M.Krešl, P.Dědeček (2014). Ground-air temperature tracking and multi-year cycles in the subsurface temperature time series at geothermal climate-change observatory, *Studia geoph. et geod.*, 58, 406-424. DOI: 10.1007/s11200-013-0356-2. IF=0.752
- [4] Dahm, T., Fischer, T. (2014). Velocity ratio variations in the source region of earthquake swarms in NW Bohemia obtained from arrival time double-differences. *Geophysical Journal International*, 196, 957-970. IF=2.724
- [5] Fischer, T., Bachura, M., 2014. Detection capability of seismic network based on noise analysis and magnitude of completeness, *Journal of Seismology* 18, 137-150, doi: 10.1007/s10950-013-9407-y. IF=1.388
- [6] Fischer, T., Horálek, J., Hrubcová, P., Vavryčuk, V., Bräuer, K., Kämpf, H. (2014). Intra-continental earthquake swarms in West-Bohemia and Vogtland: A review. *Tectonophysics*. 1-27. IF=2.866
- [7] Flechsig, Ch., Heinicke, J., Mrlina, J., Kämpf, H., Nickschick, T., Schmidt, A., Bayer, T., Günther, T., Rücker, C., Seidel, E. and Seidl, M. (in print, 2015): Integrated geophysical and geological methods to investigate the inner and outer structures of the Quaternary Mýtina maar (W-Bohemia, Czech Republic). – *Int J Earth Sci (Geol Rundsch)*, DOI 10.1007/s00531-014-1136-0. IF = 2.084

- [8] Kalenda, P., Borovička, J., Spurný, P. (2014): The localization of fireball trajectories with a help of seismic networks. *Studia Geophysica and Geodaetica*, Vol. 58 (2014), 84-99.
- [9] Kaplon, J., Kontny, B., Grzempowski, P., Schenk, V., Schenková, Z., Balek, J., Holešovský, J. (2014): GEOSUD/SUDETEN network GPS data reprocessing and site velocity estimations. *Acta Geodynamica et Geomaterialia*, Vol. 11, No. 1(173): 65 – 75. DOI: 10.13168/AGG.2013.0058. IF=0.667
- [10] Lyubushin, A.A., Kaláb, Z., Lednická, M.: Statistical properties of seismic noise measured in underground spaces during seismic swarm. *Acta Geod Geophys.* 2014, Vol. 49, Issue 2, s. 209-224. DOI 10.1007/s40328-014-0051-y. IF=0.394
- [11] Mrlina J., Fischer T., Horálek J. and Seidl M., 2014. Comment on “Crustal deformations in the epicentral area of the West Bohemia 2008 earthquake swarm in Central Europe” by Schenk et al., *J. Geophys. Res.*, 119, 7865–7869, doi:10.1002/2013JB010918, IF = 3.44
- [12] Plicka, V., and J. Zahradník (2014). Inverting full waveforms into 1D seismic velocity model of the upper crust by neighborhood algorithm - Corinth Gulf, Greece. *Stud. Geophys. Geod.* 58, 388-402, doi: 10.1007/s11200-013-0371-3. IF = 0.752
- [13] Raška P., Hartvich F., Cajz V., Adamovi (in print): Structural setting of the Čertova landslide (Ústí nad Labem, Czech Republic) analyse by morphostructural analysis and electrical resistivity tomography. – *Geological Quaterly* 2014. IF = 0.672
- [14] Špaček P., Bábek O., Štěpančíková P., Švancara J., Pazdírková J., Sedláček J. (2014): The Nysa-Morava Zone: an active tectonic domain with Late Cenozoic sedimentary grabens in the Western Carpathians' foreland (NE Bohemian Massif). *International Journal of Earth Sciences*, doi: 10.1007/s00531-014-1121-7. IF=2.084
- [15] Valenta, J., Rappich V., Stárková, M., Skácelová, Z., Fojtíková, L., Staněk, S., Balek, J. (2014): Problems and challenges in detection of pre-Mesozoic maar volcanoes: example from the Principálek Volcano in the Permian Krkonoše Piedmont Basin, *Journal of Geosciences*, vol. 59 (2014), no. 3, 169 – 181. IF=0.744
- [16] Zahradník, J., J. Janský, and V. Plicka (2015). Analysis of the source scanning algorithm with a new P-wave picker. *J. of Seismology*, accepted. IF = 1.386
- [17] Zedník, Pazdírková, J., 2014. Seismic Activity in the Czech Republic in 2012. *Studia geophys. et geod.*, 58, 342-348. IF=0.752

#### Papers in other journals

- [18] Bucha, V. (2014): Kirchhoff prestack depth migration in orthorhombic velocity models with differently rotated tensors of elastic moduli. *Seismic Waves in Complex 3-D Structures*, 24, 59-75.
- [19] Bucha, V. (2014): Kirchhoff prestack depth migration in triclinic velocity models with differently rotated tensors of elastic moduli. *Seismic Waves in Complex 3-D Structures*, 24, 77-93.
- [20] Bulant, P. & Klimes, L. (2014): Anisotropic-ray-theory geodesic deviation and two-point ray tracing through a split intersection singularity. *Seismic Waves in Complex 3-D Structures*, 24, 179-187.
- [21] Klimes, L. & Bulant, P. (2014): Prevailing-frequency approximation of the coupling ray theory for S waves along the SH and SV reference rays in a transversely isotropic medium. *Seismic Waves in Complex 3-D Structures*, 24, 165-177.
- [22] Klimes, L. & Bulant, P. (2014): Anisotropic-ray-theory rays in velocity model SC1\_II with a

split intersection singularity. *Seismic Waves in Complex 3-D Structures*, 24, 189-205.

- [23] Kostelecký J., Bezděk A., Klokočník J.: Variace geoidu detekované z družicové mise GRACE (Variations of geoid detected by satellite mission GRACE). In: *Sborník referátů: Družicové metody v geodézii a katastru. Seminář s mezinárodní účastí, Brno, 6.3.2014*, p. 32-38. Vydal: ECON publishing, s.r.o., Pod nemocnicí 13, 625 00 Brno, 118 stran, 2014, ISBN 978-80-86433-58-5.
- [24] Vojkůvka M., Bureš J.: Analýza meteorologických dat permanentní GNSS stanice TUBO (Analysis of meteorological data of permanent GNSS station TUBO). In: *Sborník z konference JUNIORSTAV 2013, sekce 6.1 Geodézie, Brno, 2013*
- [25] Fischer T. (2014). Další překvapení z hlubin (Further surprise from depths). *Vesmír*, on-line rubrika Stručně, 6.6.2014.
- [26] Hejda P. (2014). Historie geomagnetických pozorování - 175 let od zahájení magnetických pozorování v Klementinu (History of geomagnetic observations – 175<sup>th</sup> anniversary of magnetic observations in Klementinum). *Vesmír* 93, 551-555.
- [27] Hoppe A., Košťák B., Kuhn G., Lehné R., Simons U., Stemberk J. (in print): *Rezente Bewegungen an den Haupttrandverwerfungen im Nördlichen Oberrheingraben. - Geologisches Jahrbuch Hessen (Wiesbaden)*

## II. Scientific results achieved on the basis of the infrastructure's use by external workers

### Papers in journals with IF

- [28] Ahmed F., Václavovic P., Teferle F.N., Dousa J., Bingley R., Laurichesse D.: Comparative analysis of real-time precise point positioning zenith total delay estimates, *GPS Solutions*, First Online doi:10.1007/s10291-014-0427-z. IF=2.202
- [29] Alexandrakis, C., Calò, M., Bouchaala, F., Vavryčuk, V. (2014). Velocity structure and the role of fluids in the West Bohemia Seismic Zone. *Solid Earth*, 5, 863-872. IF=2.155
- [30] Bezák, V., Pek, J., Vozár, J., Bielik, M., Vozár, J. (2014). Geoelectrical and geological structure of the crust in Western Slovakia. *Studia geophys et geodaet.*, 58, 473-488. IF=0.752
- [31] Douša, J, Václavovic, P, (2014): Real-time zenith tropospheric delay in support of numerical weather prediction applications. *Advances in Space Research* (2014), Vol 53, No 9, pp. 1347-1358, doi:10.1016/j.asr.2014.02.021. IF=1.238
- [32] Kolář, P. (2014). 5 years of measurement of electromagnetic emission in West Bohemian seismoactive region. *Acta geodynamica et geomaterialia*, 11, 133-142. IF=0.667.
- [33] Vačkář, J., J. Zahradník, E. Sokos (2014). Strong fast long-period waves in the Efpalio 2010 earthquake records: explanation in terms of leaking modes. *J Seismol*, 18, 81–91, doi: 10.1007/s10950-013-9402-3.
- [34] Vecsey, L., Plomerová, J., Babuška, V. and PASSEQ Working Group, 2014. Mantle lithosphere transition from the East European Craton to the Variscan Bohemian Massif imaged by shear-wave splitting. *Solid Earth Journal*, doi:10.5194/sed-6-229-2014

### Papers in other journals

- [35] Plomerová, J. (2014). Pasivní seismické experimenty – sonda do hlubin Země (Passive seismic experiments – probe to the Earth depth). *Vesmír*, 93, 411.

### **3. Utilisation of the LI**

*Describe utilisation of the LI's capacity (according to the type and scientific field of the LI describe the percentage utilisation, eventually number of accesses, volume of produced, stored or provided data, distribution of users by their affiliation – universities, public research institutions, industry). In case of construction of the LI describe the current status or data from performed tests or limited service providing, etc.*

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 and public authorities 10%. In addition, most observatory data are displayed on the web of the project and on the web of host institutions

Almost all the WEBNET data which have been recorded since the deployment of the network in 1992 have been utilised in the domestic as well as European geoscience institutes, mostly in Germany. Data from the WEBNET network served as a resource for more than 10 doctoral and master theses here and in Germany. At present the data are used by 4 PhD students in Czech Republic (2 PhD student of the Faculty of Mathematics and Physics and 2 of the Faculty of Science, Charles University), and 4 PhD students in Germany (Potsdam University, Leipzig University and Freiberg University).

Similarly to 2013, also within 2014 the pool of mobile stations constituting the seismic network MOBNET has been in nearly permanent use, all the stations have been deployed in the field for most of the year excepting few which demanded for a repair or calibration. There are two dominant users of the MOBNET in the Institute of Geophysics: (1) the team investigating the lithosphere, and (2) the group studying geodynamics of areas exhibiting earthquake swarms, i.e. active zones within the Earth's crust, which are characterized by swarm-like tectonic energy release.

The group investigating the lithosphere by seismic waves from distant earthquakes does the monitoring in a frame of broad international experiments. During summer 2014, a temporary seismic monitoring network called AlpArray-EASI has been deployed in cooperation of Czech Republic, Switzerland and Austria, which is situated around the 13.5 E meridian from Ore Mountains (HSK) across the Alps to as far as Trieste in N. Italy. Twenty stations have been deployed from the MOBNET pool there. The monitoring network will be in use for about a year and it is a part of a large European project AlpArray (see the Chapter 6 "Internationalisation"). The aim of the EASI is the study of the lithosphere of East Alps and of the contact of the Alps and Bohemian Massif. In the study, also the data from permanent seismic stations will be used.

The group investigating the geodynamics of earthquake swarm areas deals prevalingly with monitoring of the active zone of West Bohemia, a part of the MOBNET pool supports the WEBNET stations on the long-term basis. In 2013, the project REYKJANET was initiated, consisting of 15 stations from the MOBNET pool which monitors the active zone Reykjanes in South Iceland, with the observation period estimated to 3 years.

Institute of the Physics of the Earth operates 4 broadband stations and local seismic network MONET consisting of 6 short-period stations. By the network of broadband and short-period stations, an unusual earthquake from 1 June 2014 with epicentre near Hostěradice, 14 km SE

from Nuclear Power Plant Dukovany, was interpreted. This earthquake with local magnitude 2.0 was perceived by local population. Information was immediately sent to ČEZ, a.s., the entrepreneur of the NPP Dukovany, mayors of neighbouring villages and police.

Due to the occurrence of a strong earthquake M4.4 near Nový Kostel on 31 May, 2014, we exceptionally performed two epochs of the precise levelling observations with the aim of evaluating vertical displacements before and after this event

CO2 flow data from the CarbonNet network were subject to enhanced interest of German colleagues due to possible anomalies related to the occurrence of several stronger earthquakes at spring/summer 2014.

Industrial partner Severočeská energetická, a.s., Most, first time included a brief document on our results in monitoring the hazardous slopes of the Krušné hory Mts in the vicinity of the kastle Jezeří overlooking the mine ČSA into their yearly summary report for the Mining Office of the Czech Republic. It can be considered as higher appreciation of the importance of our observatory data.

GREVOLCAN - Partner from Kapodistrian University of Athens requested to start working on a common summarizing publication evaluating the dynamics of the Nisyros volcano in Greece.

Infrastructure devices of PSLNET work in a continual mode and deliver the data to the data centre of the Patras University, from where the data are further distributed to partner organizations, especially to universities, research institutions and international data centres. In year 2014, the infrastructure provided 175 GB of data. Most of the data are used by the research community. The representation of the universities and research institutions is roughly equal.

According to the monitoring, the Seismological software centre provided 134 717 files with total extent of 54 GB of data in year 2014.

The GNSS network VESOG was extended by one new station Pruhonice; it consist 8 stations now. The stations work in permanent regime and the data are distributed to International GNSS service's data centre (IGS - 3 stations), to EUREF Permanent Network (EPN – 3 stations) and to Czech Network of permanent stations for positioning – CZEPOS (3 stations). The data are also available after request (for example from Faculty of Electrical Engineering of Czech Technical University in Prague) and the data are also used in processing and further analysis in the Research Institute of Geodesy, Topography and Cartography.

In the cooperation of the Department of geophysics of Faculty of Mathematics and Physics of Charles University, the Research Institute of Geodesy, Topography and Cartography and the Seismological Laboratory of University of Patras (Greece) the erection of PPGNet – network of GNSS stations in Greece – was finished. The network consists of 6 stations. Beside the VALY station at middle-west part of Pelopones peninsula other stations are located at the north from Patras Gulf on the west of Greece. The data are – beside of using for monitoring of geodynamic movements related with earthquake – transferred to National Observatory of Athens and they are available for use in the Corinth Rift Laboratory.

The gravimetric laboratory at the Geodetic Observatory Pecny performs daily campaign with absolute gravimeter FG5 No. 215 on month basis and continuous observations with

superconducting gravimeter OSG-050. The data are distributed to the Global Geodynamic Project and they also processed at the Research Institute of Geodesy, Topography and Cartography.

The network TECNET operates recently 158 stations monitoring fault active displacement. The frequency of recording in Automated stations is between 10 minutes and 1 hour (EU: CZ: gallery Bedřichov, cave Šeptouchov, cave Na Pomezí, cave 13C; Germany: tunnel Wattkopf; Swiss: Deep underground rock laboratory Grimsel; Slovenia: cave Postojna; Austria: cave Eisenstein Hohle, cave Emmeberg Hohle, cave Obir Hohle, cave Pottstein Hohle, cave Zede Hohle; Italy: underground space Norcia, Mattinata; Canary Islands: gallery Tijrote on El Hierru; Slovakia: Čachtická cave; Svalbard: Hornsund 2; out of EU: USA: Imler, Anza (CA); Peru: gallery Nana by Lima). Other stations (EU: CZ, Poland, Germany, Slovenia, Italy, Bulgaria, Greece, Canary Islands, Svalbard; out of EU: Peru, Kyrgyzstan) are operated with a manual reading with frequency 14 to 30 days. The data are centrally processed and archived in the IRSM.

GNSS measurements on GEONAS network are carried out on 19 stations in continuous mode (30 s). The data transfer to IRSM is also continuous. The data are there archived and further processed.

#### **4. Cooperation**

*I. Indicate newly established or running cooperation within the Czech Republic and abroad with research institutions, industry and other entities using results of the LI.*

*II. Indicate newly established or running cooperation with other research infrastructures in the field, both Czech and foreign ones.*

Only newly established cooperation is described in this section The list of all cooperation is in Appendix 4. There are 6 home research institutions and universities, 13 private companies and institutions of public administration, 111 foreign partners and 23 cooperating infrastructures.

Ad I.

Memorandum of Understanding was signed between The National Observatory of Athens, Institute of Geodynamics (NOA), The Research Institute of Geodesy, Topography and Cartography, Geodetic Observatory Pecny (RIGTC) and The Charles University in Prague, Faculty of Mathematics and Physics, Department of Geophysics (FMP CU). The representatives of the three institutions affirm their common interest for cooperation and research on the Geodynamics, Active Tectonics, Satellite Geodesy and Mechanics of Earthquakes in the area of Greece and surroundings.

A new collaboration with GFZ German Research Centre for Geosciences, Potsdam, has been initiated with the aim of developing optimal way of CO2 monitoring in boreholes.

In the frame of preparation of EPOS Implementation Phase Project close cooperation was started with Finnish Meteorological Institute (the network of auroral magnetic stations IMAGE), University Oulu (European magnetotelluric network), Université de Strasbourg, Observatory Ebro (indices of geomagnetic activity) and British Geological Survey (database of observatory

data).

Database CZET was introduced to the new potential partner – Instituto de Geociencias, Madrid, Spain – we plan the data exchange with the Lanzarote geodynamic observatory.

Deutsche Bahn, D – access to real-time GNSS data from the GOPE station for more accurate positioning – for systems of train control support.

U.S. Naval Observatory, USA – development of a unique database system (GOP-TropDB) for intra-/inter-space-geodesy-technique comparisons of tropospheric and meteorological parameters in support of research and applications in space geodesy, meteorology and climatology.

Instituto Geográfico Nacional, Santa Cruz de Tenerife, Tenerife, Spain (Dr. María José Blanco) – cooperation by interpretation of fault displacement on island El Hierro in the frame of TecNet.

Department of geomatics, Faculty of Civil Engineering, Czech technical University: utilization of GNSS data for the training of students.

COST Action ES1206 „Advanced Global Navigation Satellite Systems tropospheric products for monitoring severe weather events and climate – „GNSS4SWEC“ (Dr. Michal Kačmárik, Dr. Jonathan Jones) – exploitation of GNSS data

Università degli Studi di Bari, Italy – vertical pendulum measurements in a cave near Bari

Società Adriatica di Speleologia, Italy – a framework agreement on the support of monitoring in Italian caves.

Memorandum on cooperation and data exchange in the field of geodynamic processes, active tectonics and monitoring was signed between IRSM and The Council for Geoscience of South Africa in the frame of TecNet in 2014.

Ad II.

Multi-GNSS Asia (MGA) – association of institutions performing observations, processing, research and exploitation of GNSS systems in area of east Asia and Australia – the Geodetic observatory Pecný operates the GOP7 station of Japan Aerospace Agency for observations of QZSS system – Japan system for augmentation of GPS NAVSTAR. Due this reason, the observatory is a member of MGA association.

### **5. Service to Science Community**

*Indicate the number of users (eventually number of accesses) of the LI from the Czech Republic and abroad. Indicate the number of conferences and seminars organized by the LI, 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).*

The basic service for research community consists in continuous observations of geophysical fields 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](http://www.tecnet.cz) was 24 104



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. Fifty-one new users of Seismologic software centre were registered.

Users of the infrastructure are, of course, all cooperating institutions. Stays of foreign workers on observatories are quite exceptional, sometimes for comparison measurements or training.

Selected users from commerce or public administration:

- Broadband seismic station VRAC is a part of international monitoring system CTBTO - Comprehensive Nuclear-Test-Ban Treaty Organization
- SÚRAO (agency managing repositories of nuclear waste) subscribes to reports on the seismicity of Czech Republic and Central Europe quarterly.
- RWE (gas distribution company) subscribes to annual reports on the seismicity on the territory of Czech Republic, and to alerts of increased earthquake activity.
- The company VODNÍ DÍLA-TBD subscribes to the WEBNET data monitoring the West Bohemia earthquake swarms. We deliver annual reports on seismic activity and alerts in case of increased activity resulting in earthquakes above magnitude 3, the alerts contain data on the ground displacement and ground acceleration amplitude. In 2014, the reports were used for an updated assessment of the earthquake hazard related to the water storage Horka, which is situated just in the epicentre area Nový Kostel.
- Communal offices within the districts Cheb and Sokolov subscribe to the alerts of increased earthquake activity.
- New users of GNSS data are Institute of Atmospheric Physics of the ASCR, Deutsche Bahn, DE a U.S. a Naval Observatory, USA (USA-CR bilateral project)
- Tide and hydrological measurements in gallery Jezeří are monitoring the stability of the open-pit coal mine - for Severní energetická, a.s. Interest in the data expressed recently also the Brown Coal Research Institute.

#### Conferences, Workshops

- Integration Conference of the EPOS Preparatory Phase was held in Prague in February 2014, 106 participants (98 from abroad).
- At the joint Assembly of European Association of Earthquake Engineers (EAEE) and European Seismological Commission (ESC) in Istanbul, Turkey, the session took place on "Earthquake swarms and associated phenomena", which was convened by J. Horálek, T. Fischer a T. Dahm. Contributions based on the WEBNET data formed the prevailing part of the session. From the participants of the Assembly, 55 participants.
- During the annual assembly of European Geophysical Union (EGU) at Vienna in 2014, a symposium was organized on modeling of upper mantle, which was convened by J. Plomerová and U. Achauer (EOST Strasbourg). About 100 persons participated in the event.
- J. Plomerová and U. Achauer (EOST Strasbourg) were conveners of the workshop on the lithosphere-asthenosphere boundary (LAB), taking place in Hainburg an der Donau, Austria.
- Information about CzechGeo was presented on regional conference in Ostrava (New knowledge and measurements in SL, EG and GT), about 50 participants.
- 15th Czech-Polish Workshop „On recent geodynamics of the Sudeten and the adjacent areas“, Karlov pod Pradědem 5.-8.11.2014 organized by IRSM, many contributions used data from GEONAS and TecNet, about 100 participants from Czech Republic, Slovakia, Poland and Austria.

## **6. Internationalisation**

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

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.

Evaluation of tectonic movements along the faults, project LH12078 (Kontakt II), 2012-2015, cooperation with the University of San Diego, CA, 3 mil. CZK

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 mil. CZK yearly.

Active tectonics and recent dynamics of micro-displacements along major fault systems of the Eastern Alps registered in caves (SPELEOTECT) – 2013-2016. Main investigator Naturhistorische Museum Wien, monitoring of 3-D movements in selected cave systems in Austria, 5.000 EUR in 2014.

ESA project ITT 7076 Assessment Techniques of Tropospheric Effects for Local Augmentation Systems, 2012-2014 – techniques for tropospheric effects introduction in GNSS localisation with augmentation info from surface stations - about 2,2 mil. CZK.

ESA project ITT AO/2-1610/14/NL/CVG DARTMA – Development and Assessment of Regional Tropospheric Model for Augmented GNSS Position and Navigation, 2014-2015 – improvement of GNSS localisation based on augmentation info from surface stations with introduction of tropospheric effects from regional model - about 2 mil. CZK.

COST Action ES1206 „Advanced Global Navigation Satellite Systems tropospheric products for monitoring severe weather events and climate – „GNSS4SWEC“ (Dr. Michal Kačmárik, Dr. Jonathan Jones)

LASMO (Large Scale Monitoring Project) 2014 – 2018 – monitoring of fault displacement in deep underground rock laboratory Grimsel (Swiss) – cca 0,5 mil. CZK per year (total 2,8 mil. CZK)

Proposal of the project of crustal drilling (ICDP) for the purpose of study the dynamics of subsurface fluids, seismicity and geobiology in active region of West Bohemia and Vogtland was prepared in 2014. The broad international consortium includes GeoForschungsZentrum, University Edinburgh, USGS and CzechGeo partners FS CU, IG ASCR, IRSM ASCR. The proposal “Drilling the Eger Rift: An observatory for study of crustal fluid flow, non-volcanic, mid-crustal earthquake swarms and the deep biosphere “, submitted on 15 January 2015 is based mostly on WEBNET data.

On the basis of ESFRI very high evaluation of EPOS, the consortium was invited to prepare EPOS Implementation Project to the Call H2020-INFRADEV-1-2015-1. The proposal was submitted on 15 January 2015. IG ASCR (departments of geomagnetism and of seismology) and RIGTC

(Geodetic Observatory Pecný) participated on the proposal preparation.

During 2014, a series of projects on national basis has been concluded, which were designed to initialize the major European project AlpArray, supported to start in the mid of 2015. More than 400 broad-band seismic stations will cover the Alps and their broader vicinity. Within this large passive seismological experiment, seismic data will be recorded with the aim to study the lithosphere at the contact of European and African plate and the Earth mantle down to about 600 km. The spacing of the stations is supposed to remain below 40 km, and also permanent seismological observatories will be included, i.e. the stations of the CNRS as well.

### **7. Multidisciplinarity**

*Indicate the number and titles of scientific disciplines that use the LI's services. Append particular results.*

14 scientific disciplines. Numbers in brackets refers to results in the part A.1.

astronomy [8], geodesy [9, 23], geodynamics [11], geology [7], geomagnetism [on-line data transfer to Geomagnetic Information Node of INTERMAGNET], geomorphology [13], geotechnics [10], geothermics [3], gravimetry [34], karstology [1], meteorology and climatology [30], seismology [16], tectonics [6], volcanology [7].

### **8. Strategic Management of the Scientific Development of the Infrastructure**

*Indicate the main features of the scientific strategy of the LI, including plan for update of the technology used and plan of possible decommissioning.*

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 and 100% time coverage. On-line connecting of stations wherever technically possible and financially bearable belongs to permanent tasks. Cooperation with the infrastructure CESNET is developing successfully.

Upgrade will concentrate on improvement of reliability of measuring equipment, enhancement of their resolution and on improvement of data connection.

Managerial staff is in close contacts with the scientific community in corresponding branches and can thus guarantee that observatories and mobile systems will be on sufficiently high level that is necessary for achievement of scientific goals.

We have submitted proposal to the new call related to the upgrade of the Czech roadmap of large research infrastructures for the period 2016-2022. The consortium was completed by the Czech Geological Survey, because geological and geophysical data in databases managed by CGS are inevitable for complex interpretations. According to the letter of MEYS Deputy Minister, it will not be possible to support the CzechGeo since 2016. It would lead to substantial damping of activities and also closing of some infrastructures.

Strategic management of CzechGeo is coordinated with the EPOS PP, which the CzechGeo project team takes active part in. EPOS PP was crowned by the preparation of preparatory documents for establishment of European legal body EPOS ERIC. EPOS was in May 2014

classified by the EU Council as one of three priority projects. It was recommended to submit proposal for support of the implementation phase in the frame of Horizon 2020. IG ASCR and RIGTC took active part in preparation of this project.

## B. Stable and Efficient Management

### 1. The Efficiency of the Use of Funds

*Describe and document by table the use of the provided grant for past period; primarily describe the personnel costs (e.g. number of jobs), overheads and investments. Describe the mechanism of calculation of overhead costs approved by the host institution. Indicate how the allocated funds are used in the context of the overall budget of the LI. Indicate the percentage of the budget of the LI that has been obtained from external international grants, in collaboration with industry or other entities using the LI's services.*

The operation and maintenance of observatories and mobile systems is carried out by 41 (mostly graduated) technicians (17,22 FTE) financed by CzechGeo budget and 38 employees (20,5 FTE) paid 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 personnel costs are not paid from CzechGeo grant.

Labour capacities according to institutions (list of participating institutes and their acronyms is in Appendix 3.

	paid by CzechGeo		paid from other sources	
	employees	FTE	employees	FTE
IG ASCR	6	5,8	11	8,4
IRSM ASCR	16	5,8	10	7,0
IGN ASCR	4	0,9	2	0,3
IPE MU	4	1,5	6	3,0
FMP CU	2	1,75	2	0,2
FS CU	2	0,15	1	0,1
RIGTC	7	1,4	6	1,5
Total	41	17,3	38	20,5

Beneficiaries do not have an analytical accounting system to fully identify their indirect costs. The overheads of projects are transferred to a common account that is used for covering costs of energy, maintenance, cleaning, cost of administrative staff, etc. The overhead costs are less than 7% of the project budget and do not cover indirect costs related to the project.

The investments were concentrated on improving the quality of instrumental basis, strengthening of computing capacity for storage, processing and accessing data and on high quality internet access for observatories. Investments are listed in the Financial sheets and justified in part B.3.

Large items in the running costs are electrical energy (power supply of instruments and heating of observatory huts), telecommunications (data transfer from many remote localities), repairs and maintenance of instruments. Travel costs were mostly spent on trips to observatories and stations or for field survey.

The project money was entirely used in benefit of the observatory infrastructure and in accordance with the project targets. The funding had to be completed by additional, mostly institutional sources. These costs are estimated in the bellow table/

Financing of the observatory infrastructure. Funding by CzechGeo and other public sources (institutional money, grants) in thousands of CZK.

	IG ASCR	IRSM ASCR	IGN ASCR	IPE MU	FMP CU	FS CU	RIGTC	Total
CzechGeo	7 061	7 101	504	1 575	1 175	458	1 575	19 989
other	9 800	5 500	35	2 800	65	100	1 400	19 700

## 2. Stable Management

*Describe your plan for human resources development. Describe your strategy for allocation of the LI's capacity. Provide an organizational chart of the LI, changes in staffing of the LI. 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 LI'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 number of students of master and PhD level, who are working with observatory data, give a good prospects for the future. 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.

Personal changes: New director of this Institute of the Physics of the Earth, Masaryk University in Brno, RNDr. Petr Špaček, Ph.D. was appointed investigator responsible for the participation of IPE MU. Mgr. Petr Kolínský, Ph.D discontinued his activities in IRSM team and was replaced by Mgr. Jan Valenta, Ph.D.

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 data 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.

The meeting of the council held on 14 July was devoted to the preparation of the proposal to the call for upgrade of the Czech Roadmap. The following cooperation on proposal preparation continued via e-mails.

The annual joint meeting of the Council and The national EPOS group was held on January 12, 2015. Invited were also all research workers responsible for individual infrastructures. The usual

points on agenda were information on the activity of research team in 2014, information about project EPOS and preparation of Progress report.

The Council further concerned with the conclusions of evaluation notified by the Deputy Minister in letter from 18 December, according them CzechGeo could not be financial supported from 2016 until the budget for the support of research infrastructures administered by MEYS is enhanced in a substantial way. The Council believes that the danger of the loss of financial support still could be averted, entrusts the Chair of the Council with further negotiations and asks him to inform the Council about the results.

During the discussion several consequences of the suspension of support were mentioned: Substantial damping of our up to now very active inclusion into the European EPOS program, damage or waste of conceptual development of experimental geoscience networks and instrumental pools as well as data services that have been develop in the frame of CzechGeo in the last 5 years, threat of continuity and high-quality standards of data services that are included in our international cooperation, Potential risk of loss of high-quality specialists in the field of instrumental support of geoscience experiments a data services.

Most institutions are going to continue, even if in a limited extend, in observation activities with the support of institutional budget, because termination of these activities would paralyze the geoscience research in the Czech Republic and damage also external users. The members of the Council decided that the coordination in the frame of CzechGeo/EPOS will continue.

However, some partners (RIGTC in the first place) do not have any institutional financial sources for support of the observatory infrastructure and termination of the recent support will terminate their very successful activities.

Based on the recommendation in evaluation report the Council decide to establish the International Scientific Board instead of External Advisory Board suggested a year ago. The main role of the Board will be to evaluate the infrastructure activities and propose its development with respect to recent and anticipated task in accordance with the recent initiative Earth science in Europe (ESE).

The members of CzechGeo team take active part in the proposal of EPOS Implementation Phase Project. Pavel Hejda is a coordinator of the Work package WP13 *Magnetic Observations*, Jan Douša coordinates Task *GNSS data Dissemination* in WP10 *GNSS Data and Products* and Jan Šílený leads the Czech team in WP14 *Antropogenic Hazard*.

### **3. Progress towards Objectives and Compliance with the Timetable of the Realization of the LI**

*Indicate the comparison with the original plan of the realization of the LI stated in the LI's proposal approved by the Government; describe the progress in meeting LI's objectives and the compliance with the timetable of the realization of the LI. Indicate all changes (financial, personnel, etc.) in the realization of the LI 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 2014:

- Instrumentation of WEBNET was significantly improved by 14 broadband seismic sensors Guralp CMG-3ESPC a 12 data acquisition units Centaur – Nanometrics that replaced the obsolete seismometers SM-3 apparatuses PCM 5800 Lennartz. The price was beyond the capability of CzechGeo. We succeeded in getting financial support from the central budget of the Academy of Sciences.
- Gyrocompass Quadrans / IXBlue for orientation of seismometers of permanent stations or regional and local networks as well as of mobile stations engaged in international research projects (e.g. AlpArray) was purchased. The gyrocompass enables more precise orientation of seismometers and will contribute to a substantial enhancement of data quality.
- The faulty sensors on stations Nový Kostel (NKC) a Providia were replaced by broadband sensors Guralp CMG40-T. The station Lazy (LAC) was also upgraded including the group station and the antenna mast for wireless transmission to station (KAC) was increased.
- The Quanterra 330S seismic data acquisition system and the Sercel L4C seismometer were purchased for improvement of reliability and quality of seismic data from station Lošov. The station was registered in the international register with the code LOSC and made accessible to other users via CzechGeo web portal.
- Three GSM routers WR44-EDGE were installed for on-line data transfer to data centre in Brno.
- The network of GNSS stations VESOG was expanded by one station (PRUH – Pruhonice) and the network of GNSS stations in Greece – PPGNet – was completed by installation of last 2 stations (Lepenou and Rigani) from total sum of 6 stations. From Kato Retsina station which was installed in 2013 year the data transfer to internet was established.
- Reconstruction of the equipment for monitoring of the natural carbon dioxide at station Hartoušov (CarbonNet) is going on.
- Since 2014 a new methodology and apparatus for measurement of undiluted gas flow in underground water in borehole is being developed. During the next year functionality will be verified in the field conditions.
- Development of communication software at the Geomagnetic observatory budkov enabled to start on-line transmission of one-second data to the Geomagnetic Information Node of INTERMAGNET, instead of recent one-minute data. It is important in particular for the analysis and processing of geomagnetic data of satellite mission SWARM.
- Automation of data acquisition from 3-D dilatometers TM71 of TecNet has been in progress.

## C. Socio-economic Impacts of the Infrastructure

### 1. Impact on the Economy

*I. Indicate the number of jobs in the LI (researchers/research staff/other).*

*II. Indicate the number and volume of contracts with industry concluded in the framework of public procurement to maintenance and renewal of the LI.*

Ad I.

The support by MEYS was used for salaries of 17,3 FTE: researchers 3,35, research staff 8,22, other 5,73. For details see Appendix 3.

Ad II.

Investment costs were used for the purchase of specialized instruments of domestic or foreign provenience (c.f. the Table of Real; Financial Costs). Other running costs – material, small equipment, services, travel costs – are carried out by companies acting on the Czech territory.

Big suppliers:

Czech Telecommunication Office, licences for radiofrequencies, 121 000,- CZK

GeoNetPro s.r.o., geodetic levelling, 140 000 CZK

GESTRA CZ, production of 3-D dilatometers TM71 (3pc), 120.879,- CZK

SMM, ing. Plch, production of sensors for the measurement of Rn concentration(3pc), 221.067,- CZK

Geodézie Sever s.r.o., purchase of GNSS sensor, 90.000,- CZK

Oresta s.r.o., construction of calibration unit for 3-D dilatometer TM71, 105.572,- CZK

Rocknet s.r.o., development of 4 boreholes for HPV minitoring, 223.245,- CZK

Telemetry Services s.r.o., 102.329,- CZK

### 2. Impact on the Society

*I. Indicate the number of master and doctorate students using the LI.*

*II. Indicate the number of new textbooks, lecture notes and other practical outputs carried out in connection with the LI's operation, number and names of curricula whose students are using the LI.*

PhD students (20):

IG ASCR: J. Michálek, H. Čermáková, H. Munzarová, J. Doubravová, K. Freyerová, B. Pechačová,

IRSM ASCR: J. Balek, J. Holešovský, Jakub Stemberk, F. Staněk

FMP CU: M. Halló, D. Křížová, J. Vackář, L. Valentová, E. Zábranová

FS CU: J. Vlček, M. Bachura, P. Tábořík

RIGTC: Miloš Vaľko

Faculty of Electrical Engineering, Czech Technical University: M. Vlk

Master students (9):

FMP CU: F. Čejka, M. Dostalík, M. Káňová, F. Kostka

FS CU: O. Vaško



FS MU: V. Ambrož, M. Urban, J. Šváb  
Faculty of Electrical Engineering, Czech Technical University: P. Kubašta

Bachelor students (8):  
IG ASCR: J. Chyba, K. Pantůčková, R. Klanica, M. Labuta  
FS CU: D. Hanák, L. Valdiviezo  
FS MU: D. Hibler, K. Hrnčářová

The infrastructure is presented to students of secondary schools and to general public during every-year Days of open doors, One day with physics, the Day of the Earth (IG ASCR 609 participants, IRSM ASCR 50, IGN ASCR 70, FMP CU 168) and to the participants of the University of the Third Age.

The outreach impact of papers in the journal Vesmír (items 25, 26, 26 in A.2) should be also considered.

### **3. Impact on Innovation**

*I. Indicate the number of spin - off companies established on the basis of LI's operation.*

*II. Indicate the number of pilot plants, utility models, demonstrators made in connection with the operation of the LI, number of patents (including their names) recognized in connection with the operation of the LI.*

Ad I. Spin-off establishment is not assumed in this infrastructure.

Ad II.: 1 functional sample – GNSS station for measurement of satellite navigation signals from GPS NAVSTAR, GLONASS, Galileo, Beidou and meteorological data

## **D. Appendices**

### **1. Required:**

- 1) *Table of the real financial costs of the LI in 2014*
- 2) *Table of monitoring indicators of the LI's implementation*

### **2. Optional:**

- 3) *CzechGeo/Epos Research Team*
- 4) *Cooperation with research institutions, industry and other entities using results of the infrastructure.*

In Prague

*Date:* 31 January 2015

*Signature of investigator:*