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 2013

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

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 or 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 (17,22 FTE) are paid via project personnel costs. The average load is 0,44 FTE. Some other workers engaged in operation and management of the infrastructure were awarded by small financial bonus. Short term labour contracts are mostly made with local people who help with operation of observatories. The complete list is in Appendix 3.

Participating institutions and their acronyms:

IG ASCR – Institute of Geophysics of the ASCR, v.v.i., Praha

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

IGN ASCR – Institute of Geonics of the ASCR, v.v.i., Ostrava
IFE MU – Institute of Physics of the Earth, Faculty of Sciences, Masaryk University in Brno
FMP CU – Department of Geophysics, Faculty of the Mathematics and Physics, Charles University
FS CU – Faculty of Sciences, Charles University
RIGTC – Research Institute of Geodesy, Topography and Cartography, v.v.i., Zdiby

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 main scientific results (not more than 10) achieved on the basis of the infrastructure's use (or perhaps its Czech branch) by external workers, 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

The local network WEBNET is monitoring the seismic activity in seismogenic region of the West Bohemia and boundary region of Saxonia and Bavaria (so-called Vogtland). This region is characterized with frequent occurrence of intra-tectonic seismic swarms. The network WEBNET consists of 13 stations linked to internet and 10 autonomous stations. Data from on-line stations are transferred in real-time to the Institute of geophysics. Data from autonomous stations are downloaded once per month. WEBNET belongs to the top local networks in Europe. The network is a source of unique data used by a broad geophysical community worldwide. Catalogues or bulletins (parametric data) are available free on web, continuous data on request.

[1] Růžek, B. and Horálek, J., 2013. Three-dimensional seismic velocity model of the West Bohemia/Vogtland seismoactive region. Geophys. J. Int., 195, 1251–1266, doi: 0.1093/gji/ggt295. IF=2,853

[2] Hartvich F., Valenta J. (2013): Tracing an intra-montane fault: an interdisciplinary approach. Surveys in Geophysics, 34, 317-347. IF = 4,125

[3] Burda J., Hartvich F., Valenta J., Smítka V., Rybář J. (2013): Climate-induced landslide reactivation at the edge of the Most Basin (Czech republic) – progress towards better landslide prediction. Natural hazards and Earth System Science, 13, 361-374. IF = 1,751

[4] Briestenský M., Stemberk J., Rowberry M. D. (in print): 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 2014. IF = 0,542

[5] Vavryčuk, V., Bouchaala, F., Fischer, T., 2013. High-resolution fault image from accurate

locations and focal mechanisms of the 2008 swarm earthquakes in West Bohemia, Czech Republic, *Tectonophysics*, 590, 189-195. doi: 10.1016/j.tecto.2013.01.025. IF=2.684

[6] 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

Study of relations between meteorological parameters and microseism was realized.

[7] Holub K., Kalenda P. and Rušajová J. (2013): Mutual coupling between meteorological parameters and secondary microseisms. TERR ATMOS OCEANIC SCI (TAO), Vol. 24, No. 6, 933-949. IF=0,705

Vibration effect due Kraslice earthquakes measured in near medieval Jeronym Mine (National Cultural Heritage) was evaluated.

[8] Lednická, M., Kaláb, Z. (2013): Vibration effect of the earthquakes in abandoned medieval mine. Acta Geod Geophys., Vol. 48, Issue 3, s. 221-234. DOI 10.1007/s40328-013-0018-4. ISSN 2213-5812. IF=0,347

[9] 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

[10] Bouchaala, F., Vavryčuk, V., Fischer, T., 2013. Accuracy of the master-event and double-difference locations: Synthetic tests and application to seismicity in West Bohemia, Czech Republic, *J. Seismology*, 17, No. 3, 841-859, doi: 10.1007/s10950-013-9357-4. IF=1.388

[11] J. Janský, V. Plicka and L. Eisner (2013): Feasibility of jointly locating microseismic events with data from surface and downhole receivers. First Break, **31**, No: 7, 59-65. IF=0.444

[12] Kalenda, P., Neumann, L. and Šebela, S. (2013): Early results of micro-deformation measurements in Magdalena jama (Slovenia) by a vertical static pendulum. Acta Carsologica, 42, 1, 143−154. IF = 0,542

[13] Dědeček, P, Rajver, D., Čermák, V., Šafanda, J., Krešl, M.: Six years of ground–air temperature tracking at Malence (Slovenia): thermal diffusivity from subsurface temperature data. Journal of Geophysics and Engineering. 10, (2013), 025012/1-025012/9. IF = 0,721

<u>Papers cited in SCOPUS</u>

[14] Kaplon, J., Kontny, B., Grzempowski, P., Schenk, V., Schenková, Z., Balek, J., Holešovský, J. (in print): GEOSUD/SUDETEN network GPS data reprocessing and site velocity estimations. Acta Geodynamica et Geomaterialia, DOI: 10.13168/AGG.2013.0058

Application of GNSS in seismo-kinematic analyses. Analysis of the variation of gravity field from satellite and ground data.

[15] Kostelecký J., Bezděk A., Klokočník J.: Global and regional seasonal variations of the geoid detected by GRACE, Acta Geodyn. Geomater., Vol. 10, No. 3 (171), 285-291, 2013, DOI: 10.13168/AGG.2013.0028

<u>Papers in Proceedings</u>

The analysis of the gravity monitoring measurements data aimed at monitoring fluids in hydrocarbon and water reservoirs was performed and gravity monitoring at two Greek volcanic islands was resumed. The results proved in both cases the possibility of monitoring fluids movement in permeable geological formations. That is significant for the control of exploitation of such fluids, as well as for the assessment of increased volcanic hazard.

[16] Mrlina, J. (2013): Feasibility of 4D gravity reservoir monitoring. – Proc. 75th EAGE Conference & Exhibition, 10 - 13 June, 2013, London, Th-10-16, p.1-5.

[17] Kostelecký J., Kostelecký J. (jun.): Application of GNSS in seismics. In: Proceedings: Satellite methods in geodesy, Workshop with international participation, Brno, 31.1.2013, p. 31-36. Publisher: ECON publishing, s.r.o., Pod nemocnicí 13, 625 00 Brno, ISBN 978-80-86433-57-8 (in Czech).

[18] Špaček P., 2013: Active tectonics in the West Carpathian Foreland: Nysa-Morava Zone and Upper Morava Basin System (Czech Republic). PATA Days - Seismic Hazard, Critical Facilities and Slow Active Faults (C. Gruetzner, A. Rudersdorf, R. Peréz-Lopéz, K. Reicherter, eds.) 4th International INQUA Meeting on Paleoseismology, Active tectonics and Archeoseismology, Aachen, Germany, 255-257. ISBN: 978-3-00-045796-1

[19] Havíř J., 2013: Záznamy severokorejských jaderných explozí na seismické stanici VRAC (Registrations of the North Korean nuclear explosions on the seismic station VRAC). Geol. Výzk. Mor. Slez., 182-184, Brno.

[20] Pazdírková J., Zedník J., Špaček P., Pecina V., Sýkorová Z., Krumlová H., 2013: Zemětřesení v Hrubém Jeseníku 14.6.2012 (Earthquake in the Hrubý Jeseník Mts. on 14.6.2012). Geol. Výzk. Mor. Slez., 203-206, Brno.

Other

Czech regional seismic network is permanently monitoring the seismic activity in the Czech republic as well as in the Central Europe. Continuous data are exchanged with other data centres, parametric data are published in seismic bulletins and catalogues and displayed on the web of GzechGeo.

[21] Zedník, J., Pazdírková, J., 2013. Seismic Activity in the Czech Republic in 2010. Studia geophys. et geod., 57, 332-337.

[22] Zedník, J., Boušková, A., Pazdírková, J., 2013. Seismic Activity in the Czech Republic in 2011. Studia geophys. et geod., 57, 535-542.

[23] Stemberk J. (2013): Současné tektonické pohyby měřené ve Zbrašovských aragonitových jeskyních.(Recent tectonic movements in Zbrašov aragonite caves) – Acta speleologica, 4, 73 – 77.

[24] Frydrýšek, K., Wandrol, I. and Kalenda, P. (2012): Application of SBRA Method in Mechanics of Continental Plates. International Journal of Mechanics, 6, 4, 230-237. ISSN: 1998-4448

[25] Holub, K., Kalenda, P. and Rušajová, J. (2013): Mutual coupling between meteorological parameters and secondary microseisms. Terr. Atmos. Ocean. Sci., 24, 6, 933-949. doi: 10.3319/TAO.2013.07.04.01(T).

[26] Kalenda P., Holub K., Rušajová J.and Neumann L.(2013): Microseisms and spreading of stress waves around the globe. J. New Concepts in Global Tectonics (NCGT), Vol. 1, No.1, 38-57.

[27] Bucha, V.: Kirchhoff prestack depth migration in velocity models with and without vertical gradients: Comparison of triclinic anisotropy with simpler anisotropies, Seismic waves in complex 3-D structures (Report 23), Praha, Charles University, 45-59, 2013.

[28] Bucha, V.: Kirchhoff prestack depth migration in velocity models with and without rotation of the tensor of elastic moduli: Poorly displayed part of migrated interface in correct model with triclinic anisotropy, Seismic waves in complex 3-D structures (Report 23), Praha, Charles University, 61-69, 2013.

[29] Bucha, V.: Kirchhoff prestack depth migration in velocity models with and without rotation of the tensor of elastic moduli: Orthorhombic and triclinic anisotropy, Seismic waves in complex 3-D structures (Report 23), Praha, Charles University, 71-80, 2013.

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

As the permanent observatory data are in nearly real-time regime sent to international data centres and are free to use for non-commercial purpose, the infrastructure use can be documented only partially.

In seismic tomography (Karousová et al., 2013), low-velocity perturbations in upper mantle below the Bohemian Massif dominate, which are separated from high velocities below East Alps. A high resolution allows to identify also small heterogeneities with high velocities below the central part of Moldanubium, interpreted as a consequence of the collision of Brunovistulicum an East part of the Massif. The paper is a part of the PhD thesis completed in September 2013.

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

A detailed study of mantle anisotropy below North Appenines (Munzarová et al.; 2013) confirmed the existence of domains with differently oriented structure, contributed to a more accurate estimate of the thickness, shape and the depth of the subducting Adriatic slab, and distrusted a simple model of the mantle mass flow in the vicinity of this hypothetically retreating slab.

[31]Munzarová, H., Plomerová, J., Babuška, V., Vecsey, L. Upper-mantle fabrics beneath the Northern Apennines revealed by seismic anisotropy. Geochem. Geophys. Geosyst. (G3), 14, 1156-1181, doi:10.1002/ggge.20092.

The study of the lithosphere-mantle boundary (Babuška V., Plomerová J., 2013) relates the appearance of high-pressure – ultra-high-pressure rocks within the Bohemian Massif (BM) to boundaries of the domains of the mantle lithosphere, which can be interpreted as weak zones in the lithosphere along which the mantle material is transported towards the Earth surface. The results prefer a bivergent tectonic development of the BM dominated by collision/subduction of micro-plates of Saxothuringian-Teplá-Barrandien-Moldanubian

[32] Babuška V., Plomerová J., 2013. Boundaries of mantle-lithosphere domains in the

Bohemian Massif as extinct exhumation channels for high-pressure rocks. Gondwana Res. 23, 973–987, doi: dx.doi.org/10.1016/j.gr.2012.07.005.

Data from regional seismic network PSLNET (seismic stations LTK) were used in the research of isotropic component of regional seismic moments (Křížová, et al., 2013), which studied two moderate earthquakes near the island of Santorini. The paper Vackar et al. (2013) used the data of five network's stations to research the PL waves observed at Efpalio earthquake (Mw5.3). The data from the station SERG was used in the work Sokos & Zahradnik (2013) devoted to estimate uncertainties moment tensor using ISOLA software.

[33] Křížová, D., J. Zahradnik, and A. Kiratzi (2013). Resolvability of isotropic component in regional seismic moment tensor inversion. Bull. Seism. Soc. Am.,. 103, 2460–2473, doi: 10.1785/0120120097.

[34] E. Sokos and J. Zahradník (2013). Evaluating Centroid-Moment-Tensor Uncertainty in the New Version of ISOLA Software. *Seismol. Res. Letters*, 84, 656-665, doi: 10.1785/0220130002.

[35] J. Vačkář, 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.

[36] Novotný, M., Špičák, A., Weinlich, F. H. (2013): Structural preconditions of West Bohemia earthquake swarms. Surveys in Geophysics, 34, 491-519. IF = 4.125

3. Utilisation of research infrastructure

Describe utilisation of research infrastructure capacity (according to the type of research infrastructure describe proportionally utilisation, number of accesses, volume of produced, stored or provided data, distribution of users by their affiliation – university, public research institutions, industry). In case of construction of infrastructure 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 10%. In addition, most observatory data are displayed on the web of the project and on the web of host institutions

Nearly all data from the WEBNET registered since 1992 have been used by Czech as well as European geosciences institutions. More than 10 PhD and diploma thesis in Czech Republic and Germany were based on WEBNET data. The data are recently used by 5 PhD students in the Czech Republic (Faculty of mathematics and physics 3, Faculty of Sciences 2) and by 4 PhD students in Germany (Uni Potsdam, Uni Leipzig and Uni Freiberg).

The pool of mobile seismic stations constituting the network MOBNET was exploited almost to 100% during 2013. Most of the year, stations have been in the field apart from few exceptions

due to necessary repairs or calibrations. In the Department of Seismology of the Institute of Geophysics, Mobnet has two dominant users: (1) the team investigating the lithosphere and (2) the team investigating the geodynamics of earthquake swarm areas, i.e. active zones in the Earth crust characterized by swarm like release of the accumulated tectonic energy.

The group investigating the lithosphere in specific areas of interest by exploiting seismic waves originated by distant earthquakes typically cooperates in the frame of widely designed international observational experiments, where our stations are deployed at sites of our prior interest. The seismological experiments usually span several years, we mention PASSEQ, LAPNET, ATTOC to name some of them at least. A special position is gathered by AlpArray, which is in a preparatory stage now and will proceed into the active phase soon. The group investigating the lithosphere has several long-term cooperations with similar teams in several institutes abroad, the most important are the following: EOST Strasbourg, Univ. Oulu, ETH Zurich, Univ. Varšava, GFZ German Research Centre for Geosciences, POTSDAM a Uni Vienna.

The group investigating the geodynamics of earthquake swarm areas performs monitoring of the active part of West Bohemia first of all. A subset of the Mobnet pool serves as a long-term support for the Webnet network. Among the cooperating partners interested in similar topics a particular role is played by Iceland University, Iceland Meteorological Institute (IMO) a Iceland GeoSurvey (ÍSOR). The topic of the cooperation is seismoactivity of South Iceland,where we participate in monitoring the seismicity by using our instruments deployed in the site within a long-term expedition.

Infrastructure devices of PSLNET network 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. The infrastructure provided 160 GB of data in year 2013. Most of the data are used by the research community.

The seismology software centre provided in 2013 94124 files of total size of 39GB.

Broadband stations operated by IPE MU situated in southern Moravia were used for the processing of the most significant earthquakes related to the increased seismic activity in the Ebreichsdorf epicentral area (Austria, S of Vienna) in September and October 2013. The network of broadband stations was used for the processing of an unusual earthquake of 14.10.2013 west of Domažlice which was felt by people in broad vicinity of the epicentre in the Czech Republic as well as in Germany.

Monitoring and assessment of the stability of the medieval mine Jeronym (National cultural heritage) is carried out in cooperation with VSB – Technical University Ostrava and Muzeum Sokolov. Vibration effects due Kraslice earthquakes (epicentral distance about 25 km) have been also analyzed. Dertailed knowledge of these processes is essential, because the mine is about to be open for public.

The network of 7 GNSS stations VESOG operates in continuous mode and the data are supplied

to the data centers of the International GNSS Service (IGS - 3 stations), the EUREF Permanent Network (EPN - 3 stations) and to the Czech network of permanent stations for positioning - CZEPOS (3 stations). Data are also available on request (e.g. from the Faculty of Electrical Engineering of the Czech Technical University in Prague) and are also used for processing and further analysis at the Research Institute of Geodesy, Topography and Cartography.

The gravimetric laboratory at the Geodetic Observatory Pecný operates the absolute gravimeter FG5 No. 215, which carries out daily measurements at monthly intervals, and the superconducting gravimeter OSG-050, which is operated continuously. Data are supplied to the Global Geodynamic Project and are also processed at the Research Institute of Geodesy, Topography and Cartography.

Renovation of the monitoring system on the station Soos (a part of the CarbonNet network for monitoring of the natural CO2 discharge) was started and the acquired data have been provided for the collaborating German institutions.

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 infrastructure.*

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

Only new cooperation are 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, 100 foreign partners and 21 cooperating infrastructures.

Ad I.

New cooperation with University Iceland, Island meteorological institute (IMO) and Iceland GeoSurvey (ÍSOR) is aimed at a research of the seismic activity of South Iceland, where we participate in monitoring the seismicity by using our instruments deployed in the site within a long-term expedition.

Cooperation was established with Kapodistrian University of Athens, where the Institute of Geophysics carries out a monitoring of two volcanic regions and an active rift with aim to monitor eventual changes of dynamic state of the volcano interior and of the active rift structures. The partner carries out the monitoring of the surface movement and Institute of geophysics the changes of gravity field connected with the volcanic activity.

Institute of the Physics of the Earth RAS, Moscow – cooperation in observations of Earth tides including improvement of instruments and in comparison of our data with data from Russia and Armenia. The research will concentrate on the impact of large geodynamic events (earthquakes,

tsunami, volcanic eruptions aimed at better understanding of the response of the Earth crust in these regions.

IRSM established cooperation with Naturhistorische Museum Wien in the frame of project SPELEOTECT and with the Department of geomatics of the Czech technical University

Preparation of the agreement on cooperation in the frame of Corinth Rift Laboratory (CRL) that includes Greece, France and Czech Republic.

Seismologic software centre established cooperation with Total E&P Research and Technology USA, Houston

In the frame of network CarbonNet cooperation was established with Bayreuth University for geochemical research of mobility of arsenic by enhanced CO2 concentration.

Ad II.
A cooperation was established with large infrastructure CzechPolar (doc. Elstner, University of South Bohemia, České Budějovice)

5. 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).

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

Users of the infrastructure data are all cooperating institutions. Visits of workers from other institutions at observatories are rare (comparison measurements or training of new workers).

Users from public or commercial sphere:
VODNÍ DĹA-TBD a.s., seismic risk of dam reservoirs Horka, Skalka, Jesenice situated in epicentral region West Bohemian seismic swarms. Daily contact in the case of enhanced activity, otherwise yearly reports.
Conctract with SÚRAO (Radioactive Waste Repository Authority) – quarterly reports on seismicity in the Czech Republic and Central Europe
Data on movements are used by SÚRAO for a long-term assessment of stability of rock massives.

Conctract with RWE (Electricity and gas company) – quick localization and annual reports about earthquakes on the Czech territory.
Municipal offices in Cheb and Sokolov region during the seismic swarms.
Tide and hydrological measurements in gallery Jezeří are monitoring the stability of the open-pit coal mine - for Severní energeticka, a.s.
Data from GEONAS and TecNet networks are used by Czech Technical University and Charles University in their MSc. and PhD. programs.
Agreement on GPS data exchange with Geodis s.r.o. company.
Slovmag Bubeník a.s. uses data obtained by vertical pendulums.
National Taurida V.Vernadsky University a National Academy of Sciences of Ukraine, Lvov use data obtained by vertical pendulums for correlation with other geophysical measurements in their underground lab on Krym
Karst Research Institute uses data on movements from network TecNet.

Workshops
6. MagNetE Workshop and EPOS WG 9 Magnetic Observations, June 2013, 28 participants (23 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.
http://karel.troja.mff.cuni.cz/seminarSeis.htm
http://karel.troja.mff.cuni.cz/seminarGeod.htm

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.

Software centre organized two meetings with users: Intensive training of program ISOLA in Brazil and meeting with users of SW3D in Prague.

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.

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 €.

"Mega-landslides: imminent hazard or sleeping giants? Monitoring the landslide hazard related

to ongoing volcanic activity around El Hierro, Canary Islands, Spain." NGS/Waitt Grants Program n. W244-12, 2012-2013, 15 000 EUR.

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.

Active tectonics and recent dynamics of micro-displacements along major fault systems of the Eastern Alps registered in caves (SPELEOTECT) – 2013-2016. Main investigater Naturhistorische Museum Wien, monitoring of 3-D movements in selected cave systems in Austria was started, : 3.000 EUR in year 2013.

7. Multidisciplinarity

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

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

geodesy [17], geodynamics [8], geology [6], geomagnetism [Hejda, P. et al. (2012):Secular variation on the territory of the Czech Republic and reduction of the magnetic survey to the epoch 2010.5, Annals of Geophysics. 55, 1095-1099], geomorfology [2], geotechnics[3], geothermics [13], gravimetry [16], hydrogeochemistry [16],karstology [4], rock mechanics[3], meteorology and climatology [3], seismology [1], tectonics [32], volcanology [16].

8. 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 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. Innovations will also involve interconnection of various methods of monitoring (e.g. spatial dilatometers and vertical pendulums) into a compact on-line monitoring complex. Upgrade of instruments is a permanent task, most urgent in the branch of fast developing GNSS technologies.
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.

Strategic management of CzechGeo is 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. The main effort in the frame of EPOS is now concentrated to the proposal and architecture of Thematic Core Services – TCS and Integrated Core Services . These services will in the future contribute to enhanced data utility by virtue of better diagnostics, interconnection of data from various disciplines and more user-friendly environment.

B. Stable and Efficient Management

1. The Efficiency of the Use of Funds

Indicate verbally and 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 infrastructure. Indicate the percentage of the budget of the infrastructure that has been obtained from external international grants, 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 (17,22 FTE) financed by CzechGeo budget and 37 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 wages 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	employeess	FTE
IG ASCR	6	5,8	11	8,4
IRSM ASCR	16	5,6	10	7,0
IGN ASCR	4	0,9	2	0,3
IFE MU	4	1,5	4	2,5
FMP CU	2	1,75	3	0,5
FS CU	2	0,32	1	0,1
RIGTC	7	1,35	7	1,8
Celkem	41	17,22	38	20,6

Beneficiaries do not have an analytical accounting system to fully identify their indirect costs. The overhead costs are less than 7% of the project budget.

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 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 for many remote localities), 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 as well as abroad.
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	IFE MU	FMP CU	FS CU	RIGTC
CzechGeo	7 061	7 101	504	1 575	1 175	458	1 575
other	4 900	4 500	100	2 400	252	100	1 400

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 of 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. Recent situation on the job market is favourable for recruiting capable graduates of technical universities. 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, 2013. Invited were also all research workers responsible for individual infrastructures. The usual points on agenda were information on the activity of research team in 2013, information about project EPOS and preparation of Progress report.

The National EPOS Group further approved a proposal for co-optation of Czech Geological Survey. The proposal is based on concept of EPOS as an integrated infrastructure in the solid Earth science and on the EPOS strategy of inclusion of geological data into the integrated geoscience data system and on close cooperation between EPOS and European branch of OneGeology.
The Council also approved proposal of establishment of External Advisory Board of CzechGeo. The Board should consist of five members with expertise in geophysics, advanced measurement technology, telecommunications and application of geophysical data.
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 member of the Legal working group 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 2013:

- Faulty seismometer at Kraliky station of the Czech National Seismic Network was replaced by modern broadband seismometer Guralp CMG-3ESPC.
- Seismic station Mutkov (network MONET) was upgraded. The station is now equipped with Seismologic registration system Quanterra 330S, Kinemetrics Inc., USA a 3D passive seismometer Sercel L4C.
- Obsolete seismic systems PCM 5800 Lennartz on WEBNET stations Kopaniny, Lazy a Trojmezí were replaced by data loggers Centaur Nanometrics. Data formats of all WEBNET stations become compatible and all stations will provide continuous seismograms.
- Establishing of a new station Chlum sv. Maří is of great importance because of its suitable location in the region concerned. It is expected that data from this station will help substantially to solve a moot point of existence of tensile forces on some tectonic faults which could trigger the West Bohemia earthquake swarms.
- Detection ability of the Czech Regional Seismic Network in South Bohemia was improved by installation of new seismic station in Český Krumlov. The data are also used by the Institute of the Physics of the Earth, Masaryk University, Brno for improved

detection of events registered by the local seismic network Temelín.

- Seismological network PSLNET included in year 2013 eight broadband seismographs (BB) and ten accelerographs (SM). Three new permanent GPS stations were installed at the end of 2013 in the Patras Gulf area. The GPS instruments were tested during 2012, and 2013 years on geodetical observatory Pecny before instalation. Data from two GPS stations (Katochi, Paravola) are online transfered to the data center GOP (Geodetic observatory Pecný) and re-distributed to the greece partner (National Observatory of Athens) and reciprocally from him receive data from its network of 18 permanent GPS stations (NOANET). The third station is working in stand-alone regime at this moment. The online data connection will be ready at the begining of the 2014 year.
- Gravimetry observatory Příbram was equipped with 2-D tiltmeter developed in the Institute of the Physics of the Earth RAS, Moscow.
- Optical network was installed at the Budkov geomagnetic observatory. The network wires up registration huts and absolute house with the central building. Power lines were reconstructed at the same time.
- Upgrade of the data unit on geothermal station Caravelinha in Portugal was accomplished in spring. The new unit is equipped with modem for automatic data transfer via mobile network to internet and further to data centre of company Fiedler-Mágr in Česke Budějovice www.fiedler-magr.cz. Station Malence in Slovenia was upgraded in similar way in autumn.
- Planetarium J. Palisy in Ostrava that hosts the seismic station Ostrava-Krásné Pole (OKC) went through general reconstruction.
- Automation of 3-D dilatometers TM-71 within TecNet monitoring net continues. Recently full automatic devices are in operation in Italy (Norcia, Mattinata), Switzerland (Grimsel Test Site), Germany (Wattkopftunnel close to Karlsruhe), Canarian Islands (Hiero), Slovenia (Postojna Cave), Slovakia (Driny Cave), Czech Republic (Bedřichov gallery, 13C Cave), Austria (4 caves in southern part of Vienna basin)
- 3-D monitoring of movements on faults in cave Fík (Šumava) was started

C. Socio-economic Impacts of the Infrastructure

1. Impact on the Economy

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

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

Ad I.
researchers 12 (FTE 3,44), research staff 15 (8,87), other 14 (4,91)

Ad II.:
IG ASCR
Installation of optical network at geomagnetic observatory Budkov – 398 th. CZK
Installation of gas heating at observatory Budkov – 221 th. CZK
Nivellation in the region Nový Kostel – 69 th. CZK
Fee for radiofrequencies ČTÚ – 254 th. CZK

Telecommunications – 63 th. CZK
IRSM ASCR)
Production of spatial dilatometers – 489 th. CZK
Production of optical parts of spatial dilatometers – 62 th. CZK
Automation of spatial dilatometers – 218 th. CZK
Data transfer, telecommunication – 50 th. CZK
ÚFZ PřF MU (Institute of the Physics of the Earth, Masaryk University, Brno)
Terrain works at the seismologic station Mutkov – 64 th. CZK
RIGTC
Telecommunications – 53 th. CZK
Memory media, ICT components, supplies for GNSSstations – 32 th. CZK
Calibration of the standard of meteorological quantities in Czech metrological institute – 16 th. CZK
Repair of the radiometer of water vapour – 195 th. CZK
Repair of ion pump of absolute gravimeter – 49 th. CZK

2. Impact on the Society

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

II. *Indicate number of new textbooks, lecture notes and other practical outputs carried out on the basis of the infrastructure's operation, number and names of curricula using the infrastructure.*

I.
PhD students (22):
IG ASCR: J. Michálek, H. Čermáková, H. Munzarová, J. Doubravová, K. Freyerová, B. Pechačová, H. Kampfová-Exnerová
IRSM ASCR: J. Balek, J. Holešovský, L. Nováková, Jakub Stemberk, F. Staněk, M. Richter, I. Wandrol
FMP CU: D. Křížová, J. Vackář, Ľ. Valentová, E. Zábranová
FS CU: J. Vlček, M. Bachura
RIGTC: Miloš Vaľko
FEL Czech Technical University: M. Vlk

master students (11):
IG ASCR: L. Čápová, M. Mytyska
FMP CU: F. Čejka, M. Dlask, M. Káňová, F. Kostka, J. Michálek, K. Sládková, P. Svoboda, H. Šustková
FEL Czech Technical University: P. Kubašta

bachelor students (3):
IG ASCR: J. Chyba, K. Pantůčková, R. Klanica

FMP CU: The infrastructure is presented to high school students during yearly Open Door Days and One Day with Physics and to participants of the University of the third age.
II.

lecture notes:
T. Kopf: Earts cylinder
J. Horálek: Observatory seismology; Appendix of the text book Observatorní seismologie; příloha vysokoškolské učebnice B. Vybíral: Oscillation and waving, University Hradec Králové, Faculty of science, 2013

Curricula:
FMP CU: Geophysics
FS CU: Applied geophysics
Faculty of Electrotechnics, Czech Technical University: Open informatics – computer engineering
Faculty of Civil Engineering, Czech Technical University: Geodesy and cartography

3. Impact on Innovation

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

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

Ad I. Spin-off establishment is not assumed in this infrastructure.
Ad II.: functional sample – GNSS stations measuring navigation signals of QZSS

D. Appendices

1. Required:

- *Table of the real financial costs of the large RDI infrastructure project in 2013*
- *Table of indicators for monitoring of the implementation of the project*

2. Optional:

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

In Prague
Date: 30.1.2014

Signature of investigator: