

Questionnaire

Summary of the main activities of a research institute of the Slovak Academy of Sciences

Period: January 1, 2012 - December 31, 2015

1. Basic information on the institute:

1.1. Legal name and address

Earth Science Institute of the Slovak Academy of Sciences
(Geophysical Institute of the Slovak Academy of Sciences until 30.06.2015)
Dúbravská cesta 9, P.O.Box 106, 840 05 Bratislava

1.2. URL of the institute web site

<http://www.geo.sav.sk/en/>

1.3. Executive body of the institute and its composition

Directoriat	Name	Age	Years in the position
Director	RNDr. Ladislav Brimich, CSc.	66	2005 - 2015
Director	RNDr. Igor Broska, DrSc.	61	2015 -
Deputy director	Mgr. Miriam Kristeková, PhD.	46	2009 - 2015
Deputy director	RNDr. Ladislav Brimich, CSc.	66	2015 -
Scientific secretary	RNDr. Dušan Majcin, CSc.	61	2009 - 2015
Scientific secretary	Mgr. Adam Tomašových, PhD.	38	2015 -

1.4. Head of the Scientific Board

2009 - 2015 RNDr. Peter Vajda, CSc.
2015 - RNDr. Marian Janák, DrSc.

1.5. Basic information on the research personnel

1.5.1. Number of employees with university degrees (PhD students included) engaged in research projects, their full time equivalent work capacity (FTE) in 2012, 2013, 2014, 2015, and average number of employees in the assessment period

	2012		2013		2014		2015		total		
	number	FTE	number	FTE	number	FTE	number	FTE	number	averaged number per year	averaged FTE
Number of employees with university degrees	42.0	31.880	40.0	31.120	42.0	30.780	41.0	30.480	165.0	41.3	31.065
Number of PhD students	2.0	0.800	2.0	1.000	4.0	2.000	4.0	1.800	12.0	3.0	1.400
Total number	44.0	32.680	42.0	32.120	46.0	32.780	45.0	32.280	177.0	44.3	32.465

2015 - Only Division of Geophysics of the Earth Science Institute of SAS

1.5.2. Institute units/departments and their FTE employees with university degrees engaged in research and development

Research staff	2012		2013		2014		2015		average	
	No.	FTE	No.	FTE	No.	FTE	No.	FTE	No.	FTE
Institute in whole	42.0	31.880	40.0	31.120	42.0	30.780	41.0	30.480	41.3	31.065
Department of Atmospheric Physics	4.0	2.550	3.0	2.300	3.0	2.300	5.0	2.100	3.8	2.313
Department of Geomagnetism	14.0	10.850	14.0	9.460	13.0	10.010	12.0	10.300	13.3	10.155
Department of Gravimetry and Geodynamics	12.0	11.000	12.0	11.000	14.0	11.080	13.0	10.800	12.8	10.970
Department of Seismology	12.0	7.480	11.0	7.360	12.0	7.390	11.0	7.280	11.5	7.378

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1.6. Basic information on the funding of the institute Institutional salary budget and others salary budget

Salary budget	2012	2013	2014	2015	average
Institutional Salary budget <i>[thousands of EUR]</i>	518.392	519.439	504.801	496.177	509.702
Other Salary budget <i>[thousands of EUR]</i>	20.190	27.543	29.699	15.471	23.226

2015 - Only Division of Geophysics of the Earth Science Institute of SAS

1.7. Mission Statement of the Institute as presented in the Foundation Charter

The Institute carries out research in the Earth and the Environmental Sciences. It focuses on basic research in geophysical fields and the solid Earth with particular focus on the Western Carpathians, on the development of interpretation methods, on investigation of energy balance and radiation processes in the atmosphere, as well as atmospheric pollution.

Original theoretical work regarding the properties of geophysical fields in inhomogeneous environments, and mathematical modelling of meteorological processes in rugged terrain are part of the research activities.

The Institute is the only worksite in Slovakia, which systematically observes and continuously analyses seismic phenomena, spatial and temporal changes of the geomagnetic field, and slow deformations of earth's crust. It performs also various non-standard meteorological investigations. Data from observatories are processed and assessed. They serve as databases for research tasks and expert opinions on the Slovak territory. The data are also provided to international data centres, where they meet the needs of global research.

The Institute is in charge of PhD studies, too, in accordance with general statutes.

1.8. Summary of R&D activity pursued by the institute during the assessment period in both national and international contexts, (recommended 5 pages, max. 10 pages)

The research activities of the Geophysical Institute of the Slovak Academy of Sciences have been aimed at the fields of (1) seismology (2) gravimetry and geodynamics (3) geomagnetism and (4) atmospheric physics. Most of the Institute's projects have international dimension and are carried out in collaboration with foreign colleagues mainly from countries of the European Union, Norway, Ukraine, Russia, USA and China. The most of research outputs is published in high ranked journals, including Science.

1. Seismology

Numerical modelling of seismic motion and seismic wave propagation

A new discrete representation of a discontinuous material heterogeneity based on orthorhombic averaging was developed. The new representation is more accurate than the one we developed earlier (*Moczo et al. 2002*). The new representation is important especially when strong surface waves propagate along horizontal large-contrast interface. The representation is one of key ingredients of accuracy-and-computational-efficiency of our finite-difference modelling.

A procedure of waveform inversion for improving structural model of local surface sedimentary basins based on the adjoint method utilizing recorded earthquake ground motion and numerical modelling was developed. Extensive numerical tests led us to procedure which is capable to improve the initial model and reduce the initial waveform misfit. The developed adjoint-method procedure provides a solid basis for elaborating procedures specific to other types of local surface sedimentary structures.

The monograph "The Finite-Difference Modelling of Earthquake Motions: Waves and Ruptures" published by Cambridge University Press (*Moczo et al. 2014*) is the first monograph of its kind. The monograph presents the complete theory and computational algorithm of the method developed by the team (partial results published originally in journals), new results on optimization of the finite-difference schemes, discrete representation of material heterogeneity, initiation of rupture propagation, and filtration of a slip rate. The monograph also includes original textbook chapters on the mathematical-physical model of seismic motion, rheological models of continuum for implementation of realistic attenuation and hysteretic stress-strain relation, and introduction to the finite-difference method.

Seismic hazard analysis of the Slovak territory

A new probabilistic seismic hazard analysis (PSHA) of the Slovak territory was performed in 2010-2012 due to new seismological, geological and geophysical data, and methodological progress in PSHA. The classical Cornell – McGuire procedure was followed. The earthquake catalogue for the Slovak territory and adjacent area was homogenized for the moment magnitude and declustered by the space-time windows. The time completeness of the catalogue based on different magnitude classes was analysed.

As a part of the PSHA procedure, a new zonation for the Slovak territory and adjacent area has been developed. Due to lack of data for the considerable part of the computational area outside the Slovak territory, the zonation developed in the SESAME Project was used. Due to absence of strong-motion accelerometric data for the Slovak territory, six ground motion prediction equations (GMPEs) from other regions in the world based on similarity of the macroseismic

attenuation curves were chosen. A logic-tree approach was adopted to model the epistemic uncertainty. The final logic-tree consists of 570 end branches with expertly assessed weights.

The new seismic hazard map in terms of peak ground acceleration (PGA), compatible with Eurocode 8, has been accepted by the Slovak Standards Institute as the official map in the Slovak National Annex to Eurocode 8.

Seismic hazard analysis of Jaslovske Bohunice site

A new PSHA of the Jaslovske Bohunice site was performed in 2011-2013 in relation to the New Nuclear Power Plant Project. A new seismotectonic model for the Region and Near Region was prepared based on the newly compiled seismological database and geological database for the Region and Near Region.

The 16, 50, 84 percentile and the mean PGA and pseudospectral acceleration (PSA) for the return periods of 475 years and 10 000 years were determined. The GMPEs were set to obtain the so-called rock site conditions defined by the average S-wave speed of 800 m/s in the top 30 metres. By the deaggregation of the probabilistic computation for the period of 0.2s and for the return period of 10000 years the magnitude and the distance of the controlling earthquake were determined. The average horizontal response spectrum was scaled to the value of the mean response spectrum for the period of 0.2s to determine the review level earthquake (RLE). The vertical RLE spectrum was determined using available H/V ratios.

In the Western Carpathians, so far no strong ground motions have been recorded. Therefore, for RLE we selected 13 three-component accelerograms from the PEER Ground Motion Database.

Analysis of earthquakes and explosions

A new strategy for weak events in sparse networks based on the first-motion polarity solutions constrained by single-station waveform inversion was developed. (*Fojtiková and Zahradník 2014*). The strategy is called 'cyclic scanning of the polarity solutions' (CSPS) and overcomes problems in determinations of focal mechanisms of small earthquakes (Mw 2-3): Their signal-to-noise ratio is good only at frequencies above that of the microseismic noise peak (~ 0.2 Hz) and, at the same time, waveforms can be modelled only up to ~1-2 Hz at relatively near stations (up to a few kilometres). More distant stations might provide enough first-motion polarities, but the polarity solution is often highly non-unique. The CSPS method has a great application potential in sparse networks where weak events are recorded in many stations, thus providing polarities, but only few of the stations are situated near epicentre to allow full waveform modelling. The method has been validated on a previously studied event in the Corinth Gulf, Greece and applied on weak earthquakes in Slovak territory.

The CSPS method has been later extended (*Zahradnik et al. 2015*) by adding a new feature of repeated inversions using multiple first-motion polarity sets and was applied to the Mara Rosa earthquake (Brazil).

An extension of the local seismic network in order to improve seismic monitoring of the Little Carpathians source zone was suggested. This epicentral area is very important from the point of seismic hazard with respect to its seismic activity and vicinity of the nuclear power plant. Usefulness of suggested network extension was demonstrated using combination of several methods (including the recent and newly developed ones). The results clearly show and quantify how and where the suggested network extension remarkably decreases the uncertainties of the location and moment tensor solutions (*Fojtikova et al., Online First 2015*). The methods presented and developed within the paper together with freely available computer codes provide practical tools helping to evaluate pros and cons when considering possible extension of given seismic network configuration, either existing or planned.

2. Gravimetry and geodynamics

Geophysical investigation of the earth crust/lithosphere

Research is carried out devoted to the structure, physical parameters, and tectonic evolution of the Earth crust and lithosphere, with special emphasis on the Carpatho-Pannonian region and the Central Europe. Both direct inversion and forward modelling of geophysical data are applied as

the methods of investigation. 2D and 3D forward density modelling as well as integrated modelling is applied to construct improved structural models of the crust and the lithosphere. The stripping approach is incorporated, too. The lithosphere-asthenosphere boundary (LAB) is part of the solutions. Geothermic modeling is integrated with these structural studies. Rheological properties of the lithosphere are part of the investigations. The modeling results are viewed in the context of the tectonic evolution of the region.

It was found out that the thickness of the lithosphere decreases from the older and colder platforms towards the younger and hotter Pannonian Basin with a maximum thickness under the Eastern and Southern Carpathians. The thickness of the Carpathian arc lithosphere varies between 150 km in the North (the Western Carpathians) and about 300 km in the Vrancea zone (the Eastern and Southern Carpathian junction). In the Platform areas it is between 120 and 150 km and in the Pannonian Basin it is about 70 km. Brand new results were obtained for the Southern Carpathians and the Moesian Platform. The models showed that the Moesian Platform is overthrust from the North by the Southern Carpathians and from the South by the Balkanides and characterised by bending of this platform.

Geothermics

Geothermic modeling is utilized to study the thermal state of the lithosphere in the region of the Western Carpathians and the surrounding units. Our modeling approaches incorporate both the steady state and the transient thermal regimes appropriate to structure and tectonic development of the studied area. Refraction effects on upper crust structures with significant conductivity contrasts were identified and evaluated to be included in the methodology of the geothermic progressive stripping of local phenomena influencing the thermal field of uppermost parts of the crust. The solution methods of the direct and inverse problems and constructed software packages were applied in last 4 years mainly to the interpretation of local and regional heat flow density and temperature field distribution anomalies in regions of the eastern part of the Carpathian Outer Flysch, in the Transcarpathian depression and in the Little Danube Basin. As for applied research, the thermal conditions were determined for the exploitation of hot dry rock energy sources in the region of Slovakia. The results were applied in identification of the most perspective areas mainly for utilization in energetics (at least by the binary cycle technologies) and their classification by thermal, lithological, technical and economic criteria.

Gravimetric methodology

We have developed a new and innovative inversion method at our institute referred to as the Harmonic inversion method. Testing this inversion approach in structural and geodynamic studies revealed its benefits and potential contributions to the field of inverse problems. We have applied the inversion methodology developed by Prutkin to structural studies in the Carpatho-Pannonian region and for the first time to volcano-gravimetric studies. These pilot and test applications of the two inversion approaches demonstrated their benefits and contributions to the gravimetric inverse problem solutions. We have executed several studies of the structure and physical properties of the lithosphere based on global computations of topographic or crust-component stripping corrections in spectral form. Research was conducted in precise computation of topographic corrections, prediction of in-situ vertical gradients of gravity, and reverse reconstruction of gravity from Bouguer anomalies for geodetic purposes.

Geodynamics

Valuable contribution to understanding the volcanic unrest of 2004/5 on Tenerife, Canary Islands resulted from the application of the Prutkin inversion approach to the gravity changes of the unrest. This new approach revealed the deeper magmatic source of the unrest allowing for the specification of the unrest as hybrid with a failed eruption. We have revisited also the deformation-induced topographic effects on temporal gravity changes, by conducting synthetic studies (numerical simulations), as well as numerical predictions of the in situ vertical gradients of gravity in volcanic areas, identifying the cases when Free-Air and Bouguer approximations appear insufficient or inadequate. Aperiodic local tectonic component and core-mantle effects have been

observed and interpreted in the continuous extensometric records from our tidal station in Vyhne, Central Slovakia.

Near surface applied geophysics

Microgravimetric prospecting applications were improved by making the evaluation of the terrain correction and correction for anthropogenic objects more accurate and more precise, making use of special 3D photogrammetric approaches or laser scanning. Such microgravimetric prospecting, integrated with GPR observations, serve for archeological exploration of our cultural heritage, as well as for detection of possible geohazards in geotechnical studies, such as potential sinkholes over active or abandoned mines.

3. Geomagnetism

Studying the deep Earth's interior

We have studied the complex transport phenomena that occur during the solidification of multicomponent alloys in mushy regions. We have analysed how the effects of the disparity in both the rates of mass diffusion and the rates of solute segregation affect the complex dynamical interactions between heat transfer, convection and solidification. The implications on the structure of the inner-outer core boundary has been discussed.

A solution for vertical magnetic field variations was found analytically. 3 different processes modified the field: its advection by large-scale horizontal flows, upwellings and downwellings making it to weaken or intensify, and resistive processes in a boundary layer causing its alternation with the vertical. We proposed this phenomenon as a possible explanation for the reversed flux patches which are a part of the geomagnetic secular variation.

The influence of anisotropy of thermal diffusivity and viscosity on the rotating magnetoconvection in the horizontal plane layer was investigated. A comparison of two models with different orientations of the rotation axis was done. We also investigated the dynamo in a simultaneous dependence on the nonuniform stratification, electrical conductivity of the inner core and the Prandtl number.

Magnetotelluric and paleomagnetic research, and monitoring of ^{222}Rn :

Main research activities in the years 2012-2015 were focused on problems how the tectonic structures of the Western Carpathians are projected in geophysical data. For this reason the magnetotelluric profiles MT-15 and 2T were geologically interpreted with use of gravimetric, magnetic and seismic data. Second group of problems is interpretation of deep seated magnetic and gravimetric anomalies in the Western Carpathians (newly modelled magnetic anomalies in the flysch belt of NE Slovakia interpreted as neovolcanic intrusive bodies, carbonate complexes below flysch sediments, newly interpreted deep seated Kolárovo gravimetric and magnetic anomaly in southern Slovakia). Third group is the problem of geothermal energy assessment and thermal state of lithosphere. In the cooperation with geology we are focused to the paleotectonic reconstructions mainly of Hercynian crystalline basement and evolution of Hercynian granitoids.

Paleomagnetic research and structural geology were focused on in the frame of the project APVV-0212-12 named Tectonic and sedimentary mass transfer within the prograding Western Carpathian orogenic wedge. The activities in were aimed at geological and paleomagnetic research of the Western Carpathians and the adjacent areas. The geological research, aimed mostly at heavy mineral analysis, resulted in several papers, some of them in distinguished journals. The paleomagnetic results have not been published yet, because of unexpected death of Dr. Túnyi.

The continual radon monitoring in the Važecká cave started and is still being carried out. The influence of meteorological parameters on radon variations is investigated. Indoor radon was measured in selected houses and radon in air and thermal water of four spas was monitored over a period of one year. The effective dose for employees and patients was assessed. Now radon monitoring in kindergartens is performed.

Observations of the geomagnetic field and studying the geomagnetic activity:

The Hurbanovo Geomagnetic Observatory ESI SAS continued the registration of the geomagnetic field. The base-lines of the magnetograms have been determined twice a week with the absolute measurements. The processed data have been sent to the INTERMAGNET data centers on the daily basis.

Two magnetic repeat station surveys were carried out and their results were reduced to the epochs 2012.5 and 2014.5, respectively. As a member of the MagNetE group, we contributed to the European chart of magnetic declination.

We have proposed short-term prediction model for geomagnetic storms based on the method of artificial neural networks, using the solar wind parameters as an input and providing the Dst geomagnetic index as an output. The model that we have studied could be potentially useful to predict not only major geomagnetic disturbances due to CMEs but also to contribute to assess the disturbances due to moderate or weak solar energetic events (CIRs).

We also proposed another neural network-based model, which provides forecasts of potentially dangerous high geomagnetic activity a few days in advance. Here the input quantities were information about X-ray flares, type II and IV radio bursts as well as information about coronal mass ejections (CME).

4. Atmospheric physics

Atmospheric deposition and air quality in High Tatra Mts.

Both dry deposition of ground-level ozone (O₃) and wet deposition of acidifying components (S, N, H⁺) as well as O₃ interactions with terrestrial biota were investigated. Tropospheric O₃ as strong oxidative reagent can evoke various damage of living cells while increased level of O₃ may result to phytotoxic injury of vegetation due to oxidative stress. Evaluation of O₃ data (EMEP project) for different landform areas over the period 2000-2009 shows larger O₃ burden for highlands where the most of emissions from road transport and industry are produced. This induces that highland sites are more vulnerable to health and environmental risk associated with the long-term ozone exposure (Bičárová et al., 2013). High phytotoxic potential is related to stomatal O₃ flux. The deposition models such as DO₃SE is an appropriate tool for the assessment of critical O₃ level and risk of secondary air pollution for the mountain forest ecosystems. High potential risk of ozone damage for spruce forest was found. Preliminary results of POD₁ (Phytotoxic Ozone Dose above a flux threshold of 1 nmol m⁻² s⁻¹) for PLA (projected leaf area) calculated for five experimental sites in elevation profile from 810 to 1,778 m a.s.l. in the High Tatra Mts. show exceedance of flux-based critical level of ozone (CL_{ef}) both in 2014 and 2015. Further research priorities related to O₃ effect on forest vegetation in the High Tatra Mts. are focused on biomonitoring of conifer pine species, particularly at ozone sensitive species such as *Pinus cembra* and *Pinus mugo*.

Serious problem of mountainous regions is also caused by long-range transport of secondary air pollution, especially wet deposition. The modelled precipitation chemistry exhibited a high degree of temporal coherence with the lake water chemistry. The ionic composition of lake water reflected progress in their acidification until the late 1980s, and then a rapid recovery. The response of lake water chemistry to changes in precipitation chemistry differed for individual ions, nutrients, and among lakes, predominantly reflecting the proportions of soil in their catchments (Kopáček et al., 2015).

Climate change impacts

ESI became part of the COST Action ES1106, AGRIWAT in June 2015; the Action came to end in April 2016. The main objective of AGRIWAT was to deliver integrated methodologies and databases for the European wide assessment of water use and trade associated to key food and energy crops at different spatial scales under current and future climatic conditions.

The Action worked with the water footprint concept of different crops which is defined as the ratio between the evapotranspiration and crop yield, computed over the cropping period.

Further to the interim report of the Action giving the methods of calculation of water footprint in agriculture, the estimation of the water footprint calculation of the main crops in 30 participating

countries including Slovakia was done in the series of the case studies. The studies showed the potential of water footprint concept for the evaluation of water needs and water use in European agriculture.

Climate services

In 2015 ESI cooperated together with the Czech Globe, CZ and Slovak Hydrometeorological Institute on the completion of drought monitoring system in Slovakia. The system called InterSucho is an operative system monitoring the drought in one week time step giving various drought characteristics in the soil layer 0-1m. The operational run is based on daily meteorological data and the system respects different type of soils. Further to the drought intensity and relative soil saturation the system calculates also impacts on vegetation. Intersucho system produces maps at country and county levels. The products of InterSucho are freely available on the web (www.Intersucho.sk). Further to the Slovak and Czech territory the system is run also on a part of Austria. Thus, this initiative represents a joint international effort in operative climate related services.

2. Partial indicators of main activities:

2.1. Research output

2.1.1. Principal types of research output of the institute: basic research/applied research, international/regional (ratios in percentage)

The estimation of the ratio of basic to applied research output of the institute: 80/20 percent.

The estimation of the ratio of international to regional research output of the institute: 95/5 percent.

2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications listed for the assessment period should not exceed the average number of employees with university degrees engaged in research projects. The principal research outputs (max. 5, including Digital Object Identifier - DOI) should be underlined

01. MOCZO, Peter - KRISTEK, Jozef - GÁLIS, Martin. *The finite-difference modelling of earthquake motions: waves and ruptures.* Cambridge : Cambridge University Press, 2014. 365 p. ISBN 978-1-107-02881-4.

02. GRINČ, Michal - ZEYEN, Hermann - BIELIK, Miroslav - PLAŠIENKA, Dušan. *Lithospheric structure in Central Europe: Integrated geophysical modelling.* In *Journal of Geodynamics*, 2013, vol. 66, no. 1, p. 13-24. (2.967 - IF2012). doi: 10.1016/j.jog.2012.12.007

03. PRUTKIN, Ilya - VAJDA, Peter - GOTTSMANN, Jo. *The gravimetric picture of magmatic and hydrothermal sources driving hybrid unrest on Tenerife in 2004/5.* In *Journal of Volcanology and Geothermal Research*, 2014, vol. 282, p. 9-18. (2.515 - IF2013). doi: 10.1016/j.jvolgeores.2014.06.003

04. KOPÁČEK, Jiří - BIČÁROVÁ, Svetlana - HEJZLAR, Josef - HYNŠTOVÁ, Marie - KAŇA, Jiří - MITUŠINKOVÁ, Marta - PORCAL, Petr - STUHLÍK, E. - TUREK, Jan. *Catchment biochemistry modifies long-term effects of acidic deposition on chemistry of mountain lakes.* In *Biochemistry*, 2015, vol. 125, no. 3, p. 315-335. (3.015 - IF2014). doi: 10.1007/s10533-015-0127-y

05. REVALLO, Miloš - VALACH, Fridrich - HEJDA, Pavel - BOCHNÍČEK, Josef. A neural network Dst index model driven by input time histories of the solar wind-magnetosphere

interaction. In *Journal of Atmospheric and Solar-Terrestrial Physics*, 2014, vol. 110-111, no. 1, p. 9-14. (1.751 - IF2013). doi: 10.1016/j.jastp.2014.01.011

06. AUBRECHT, Roman - LÁNCZOS, Tomáš - GREGOR, Mikuláš - SCHLÖGL, Ján - ŠMÍDA, Branislav - LIŠČÁK, Pavel - BREWER-CARÍAS, Charles - VLČEK, Lukáš. Reply to the Comment on "Sandstone caves on Venezuelan tepuis: Return to pseudokarst? In *Geomorphology*, 2013, vol. 197, no. 1, p. 197-203. (2.552 - IF2012). doi: 10.1016/j.geomorph.2012.11.017

07. BEDNÁRIK, Martin - KOHÚT, Igor. Three-dimensional colour functions for stress state visualisation. In *Computers and Geosciences*, 2012, vol. 48, p. 117-125. (1.429 - IF2011). doi:10.1016/j.cageo.2012.05.010

08. BROSKA, Igor - PETRÍK, Igor - SHLEVIN, Yaron Beerli - MAJKA, Jarosław - BEZÁK, Vladimír. Devonian/Mississippian I-type granitoids in the Western Carpathians: A subduction-related hybrid magmatism. In *Lithos*, 2013, vol. 162-163, no. 1, p. 27-36. (3.779 - IF2012). doi: 10.1016/j.lithos.2012.12.014

09. BEZÁK, Vladimír - PEK, Josef - VOZÁR, Ján - BIELIK, Miroslav - VOZÁR, Jozef. Geoelectrical and geological structure of the crust in Western Slovakia. In *Studia Geophysica et Geodaetica*, 2014, vol. 58, p. 473-488. (0.818 - IF2015) doi: 10.1007/s11200-013-0491-9

10. KUCHARIČ, Ľudovít - BEZÁK, Vladimír - KUBEŠ, Peter - KONEČNÝ, Vlastimil - VOZÁR, Ján. New magnetic anomalies of the Outer Carpathians in NE Slovakia and their relationship to the Carpathian Conductivity Zone. In *Geological Quarterly*, 2013, vol. 57, no. 1, p. 123-134. (0.761 - IF2012). doi: 10.7306/gq.1079

11. MATENCO, Liviu Ciprian - ANDRIESEN, Paul - ANDRIESEN, P. A.M. - AVRAM, Corina - BADA, Gábor - BEEKMAN, Fred - BIELIK, Miroslav - KOVÁČ, Michal - KRÁLIKOVÁ, Silvia - MINÁR, Jozef - PLAŠIENKA, Dušan - STANKOVIANSKY, Miloš - THE SCIENTIFIC NETWORK. Quantifying the mass transfer from mountain ranges to deposition in sedimentary basins: Source to sink studies in the Danube basin-black sea system. In *Global and planetary change*, 2013, vol. 103, no. 1, p. 1-18. (3.155 - IF2012). doi: 10.1016/j.gloplacha.2013.01.003

12. BIELIK, Miroslav - KRAJŇÁK, Martin - MAKARENKO, Irina - LEGOSTAEVA, Ola - STAROSTENKO, Vitaly I. - BOŠANSKÝ, Marián - GRINČ, Michal - HÓK, Jozef. 3D gravity interpretation of the pre-Tertiary basement in the intramontane depressions of the Western Carpathians: a case study from the Turiec Basin. In *Geologica Carpathica*, 2013, vol. 64, no. 5, p. 399-408. (1.143 - IF2012). doi: 10.2478/geoca-2013-0027

13. FOJTÍKOVÁ, Lucia - ZAHRADNÍK, Jiří. A new strategy for weak events in sparse networks: the first-motion polarity solution constrained by single-station waveform inversion. In *Seismological Research Letters*, 2014, vol. 85, no. 6, p. 1265-1274. (2.268 - IF2013). doi: 10.1785/0220140072

14. ZAHRADNÍK, Jiří - FOJTÍKOVÁ, Lucia - CARVALHO, Joao - BARROS, Luca, Vieira - JANSKÝ, Jiří. Compromising polarity and waveform constraints in focal-mechanism solutions; the Mara Rosa 2010 Mw 4 central Brazil earthquake revisited. In *Journal of South American Earth Sciences*, 2015, vol. 63, p. 323-333. (1.367 - IF2014). doi: 10.1016/j.jsames.2015.08.011

15. SEMENOV, Vladimír Yu. - HVOŽDARA, Milan - VOZÁR, Ján. Modeling of deep magnetovariation soundings on the rotating earth. In *Acta Geophysica*, 2013, vol. 61, no. 2, p. 264-280. (0.910 - IF2012). doi: 10.2478/s11600-012-0086-9

16. PAŠTEKA, Roman - KARCOL, Roland - KUŠNIRÁK, Dávid - MOJZEŠ, Andrej. REGCONT: A Matlab based program for stable downward continuation of geophysical potential fields using Tikhonov regularization. In *Computers and Geosciences*, 2012, vol. 49, p. 278-289. (1.429 - IF2011). doi: 10.1016/j.cageo.2012.06.010

17. KOCIFAJ, Miroslav - KÓMAR, Ladislav - KOHÚT, Igor. Modeling the aerosol effects on the light field below a tubular-pipe: A case of clear sky conditions. In *Solar Energy*, 2014, vol. 107, p. 122-134. (3.541 - IF2013). doi: 10.1016/j.solener.2014.05.024
18. KLAČKA, Jozef - KOCIFAJ, Miroslav - KUNDRACIK, F. - VIDEEN, Gorden - KOHÚT, Igor. Generalization of electromagnetic scattering by charged grains through incorporation of interband and intraband effects. In *Optics Letters*, 2015, vol. 40, no. 21, p. 5070-5073. (3.292 - IF2014). doi: 10.1364/OL.40.005070
19. KOCIFAJ, Miroslav - KLAČKA, Jozef - VIDEEN, Gorden - KOHÚT, Igor. Optical properties of a polydispersion of small charged cosmic dust particles. In *Journal of Quantitative Spectroscopy & Radiative Transfer*, 2012, vol. 113, p. 2561-2566. (3.193 - IF2011). doi: 10.1016/j.jqsrt.2012.05.014
20. GÁLIS, Martin - PELTIES, Christian - KRISTEK, Jozef - MOCZO, Peter - AMPUERO, Jean Paul - MAI, Martin P. On the initiation of sustained slip-weakening ruptures localized stresses. In *Geophysical Journal International*, 2015, vol. 200, p. 888-907. (2.560 - IF2014). doi: 10.1093/gji/ggu436
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32. TENZER, Robert - GLADKIKH, Vladislav - NOVÁK, Pavel - VAJDA, Peter. Spatial and spectral analysis of refined gravity data for modelling the crust-mantle interface and mantle-lithosphere structure. In *Surveys in Geophysics*, 2012, vol. 33, no. 5, p. 817-839. (3.093 - IF2011). doi: 10.1007/s10712-012-9173-3
33. PRUTKIN, Ilya - VAJDA, Peter - GOTTSMANN, Jo. The gravimetric picture of magmatic and hydrothermal sources driving hybrid unrest on Tenerife in 2004/5. In *Journal of Volcanology and Geothermal Research*, 2014, vol. 282, p. 9-18. (2.515 - IF2013). doi: 10.1016/j.jvolgeores.2014.06.003
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35. TENZER, Robert - HAMAYUN - NOVÁK, Pavel - GLADKIKH, Vladislav - VAJDA, Peter. Global crust-mantle density contrast estimated from EGM2008, DTM2008, CRUST2.0, and ICE-5G. In *Pure and Applied Geophysics*, 2012, vol. 169, no. 9, p. 1663-1678. (1.787 - IF2011). doi: 10.1007/s00024-011-0410-3
36. TENZER, Robert - NOVÁK, Pavel - VAJDA, Peter - GLADKIKH, Vladislav - HAMAYUN. Spectral harmonic analysis and synthesis of Earth's crust gravity field. In *Computational Geosciences*, 2012, vol. 16, no. 1, p. 193-207. (1.348 - IF2011). doi: 10.1007/s10596-011-9264-0
37. PRUTKIN, Ilya - VAJDA, Peter - BIELIK, Miroslav - BEZÁK, Vladimír - TENZER, Robert. Joint interpretation of gravity and magnetic data in the Kolárovo anomaly region by separation of sources and the inversion methods of local corrections. In *Geologica Carpathica*, 2014, vol. 65, no. 2, p. 163-174. (0.835 - IF2013). doi: 10.2478/geoca-2014-0011
38. SAIZ, Elena - CERRATO, Yolanda - CID, Consuelo - DOBRICA, Verena - HEJDA, Pavel - NENOVSKI, Petko - STAUNING, Peter - BOCHNÍČEK, Josef - DANOV, Dimitar - DEMETRESCU, Crisan - GONZALES, Walter Demetrio - MARIS, Georgeta - TEODOSIEV, Dimitar - VALACH, Fridrich. Geomagnetic response to solar and interplanetary disturbances. In *Journal of Space Weather and Space Climate*, 2013, vol. 3, p. A26. (2.846 - IF2015) doi: 10.1051/swsc/2013048
39. VALACH, Fridrich - BOCHNÍČEK, Josef - HEJDA, Pavel - REVALLO, Miloš. Strong geomagnetic activity forecast by neural networks under dominant southern orientation of the

interplanetary magnetic field. In *Advances in Space Research*, 2014, vol. 53, p. 589-598. (1.238 - IF2013). doi: 10.1016/j.asr.2013.12.005

40. ZAHOREC, Pavol - MIKUŠKA, Ján - PAPČO, Juraj - MARUŠIAK, Ivan - KARCOL, Roland - PAŠTEKA, Roman. Towards the measurement of zero vertical gradient of gravity on the Earth's surface. In *Studia Geophysica et Geodaetica*, 2015, vol. 59, no. 4, p. 524-537. (0.818 - IF2015) doi: 10.1007/s11200-015-0837-6

2.1.3 List of monographs/books published abroad

MOCZO, Peter - KRISTEK, Jozef - GÁLIS, Martin. *The finite-difference modelling of earthquake motions: waves and ruptures*. Cambridge : Cambridge University Press, 2014. 365 p. ISBN 978-1-107-02881-4.

2.1.4. List of monographs/books published in Slovakia

AUBRECHT, Roman - BARRIO-AMORÓS, César Luis - BREURE, Abraham - BREWER-CARÍAS, Charles - DERKA, Tomáš - FUENTES-RAMOS, Oswaldo A. - GREGOR, Miloš - KODADA, Ján - KOVÁČIK, Ľubomír - LÁNCZOS, Tomáš - LEE, Natuschka M. - LIŠČÁK, Pavel - SCHLÖGL, Ján - ŠMÍDA, Branislav - VLČEK, Lukáš. *Venezuelan Tepuis - their caves and biota*. Acta Geologica Slovaca AGEOS - Monograph. Bratislava : Comenius University, 2012. p. 168. ISBN 978-80-223-3349-8.

VOZÁR, Jozef - EBNER, F. - VOZÁROVÁ, Anna - HAAS, János - KOVÁCS, S. - SUDAR, Milan - BIELIK, Miroslav - PÉRO, Csaba. *Variscan and Alpine terranes of the Circum-Pannonian region*. Second Edition (Available only as DVD version). Bratislava : Geological Institute of SAS Bratislava : Comenius University, Faculty of Natural Sciences, Bratislava, 2014.

2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items

- Regular (twice a year) reports about seismic activity of the Slovak territory within the project of Ministry of Environment of the Slovak Republic: Partial Monitoring System (PMS) – Geological Factors, Subsystem: Tectonic and seismic activity of the territory. PMS is a part of Monitoring system of the environment of the Slovak Republic,
- Kristek, Kysel, Moczo, Kristeková, et al. 2013. Assessment of the Seismicity and Geological Conditions for the new NPP EBO Project – Part: Probabilistic Seismic Hazard Assessment (Final Report). EQUIS s.r.o.
- Map of Seismic Hazard of Slovakia in the Slovak Technical Standard EN 1998-1/NA by Peter Franek, Róbert Kysel, Peter Moczo, Jozef Kristek in 2012.
- Magnetic declination for military aviation purposes: The measurements of the magnetic declination for the navigational purposes (compass swing bases) have been carried out on a yearly basis for Ministry of Defence of the Slovak Republic.
- Magnetic declination for civil aviation purposes: The technical expertise was written for civil aviation purposes (for Air Navigation Services Provider) in which the global models for the geomagnetic field distribution were assessed.
- The Slovak Office of Standards, Metrology and Testing approved the Hurbanovo Geomagnetic Observatory ESI SAS to be the Slovak reference centre for magnetic declination.

2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad, incl. revenues

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2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia, incl. revenues

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2.1.8. Table of research outputs (as in annual reports).

Papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately.

Scientific publications	2012			2013			2014			2015			total			
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	averaged number per year	av. No. / FTE	av. No. / salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad (AAA, ABA)	0.0	0.000	0.000	0.0	0.000	0.000	1.0	0.031	0.002	0.0	0.000	0.000	1.0	0.3	0.008	0.000
Scientific monographs and monographic studies in journals and proceedings published in Slovakia (AAB, ABB)	1.0	0.031	0.002	0.0	0.000	0.000	1.0	0.031	0.002	0.0	0.000	0.000	2.0	0.5	0.015	0.001
Chapters in scientific monographs published abroad (ABC)	2.0	0.061	0.004	2.0	0.062	0.004	1.0	0.031	0.002	0.0	0.000	0.000	5.0	1.3	0.039	0.002
Chapters in scientific monographs published in Slovakia (ABD)	0.0	0.000	0.000	1.0	0.031	0.002	0.0	0.000	0.000	0.0	0.000	0.000	1.0	0.3	0.008	0.000
Scientific papers published in journals registered in Current Contents Connect (ADCA, ADCB, ADDA, ADEB)	11.0	0.337	0.021	13.0	0.405	0.025	10.0	0.305	0.020	9.0	0.279	0.018	43.0	10.8	0.331	0.021
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS (ADMA, ADMB, ADNA, ADN B)	11.0	0.337	0.021	6.0	0.187	0.012	8.0	0.244	0.016	12.0	0.372	0.024	37.0	9.3	0.285	0.018
Scientific papers published in other foreign journals (not listed above) (ADEA, ADEB)	2.0	0.061	0.004	1.0	0.031	0.002	1.0	0.031	0.002	3.0	0.093	0.006	7.0	1.8	0.054	0.003
Scientific papers published in other domestic journals (not listed above) (ADFA, ADFB)	4.0	0.122	0.008	4.0	0.125	0.008	2.0	0.061	0.004	0.0	0.000	0.000	10.0	2.5	0.077	0.005
Scientific papers published in foreign peer-reviewed proceedings (AEC, AECA)	0.0	0.000	0.000	4.0	0.125	0.008	3.0	0.092	0.006	0.0	0.000	0.000	7.0	1.8	0.054	0.003
Scientific papers published in domestic peer-reviewed proceedings (AED, AEDA)	8.0	0.245	0.015	5.0	0.156	0.010	4.0	0.122	0.008	0.0	0.000	0.000	17.0	4.3	0.131	0.008
Published papers (full text) from foreign and international scientific conferences (AFA, AFC, AFBA, AFDA)	1.0	0.031	0.002	7.0	0.218	0.013	7.0	0.214	0.014	7.0	0.217	0.014	22.0	5.5	0.169	0.011
Published papers (full text) from domestic scientific conferences (AFB, AFD, AFBB, AFDB)	7.0	0.214	0.014	2.0	0.062	0.004	3.0	0.092	0.006	12.0	0.372	0.024	24.0	6.0	0.185	0.012

- **Supplementary information and/or comments on the scientific outputs of the institute.**

The journal Contributions to Geophysics and Geodesy, which is published by the institute, is integrated to the database SCOPUS, Versita (MetaPress) and indexed also in GeoRef information services (American Geological Institute).

Our journal is published quarterly in electronic version as Open Access in DE GRUYTER. <http://www.degruyter.com/view/j/congeo>

Journal parameters: SCImago Journal Rank (SJR) 2015: 0.241; Source Normalized Impact per Paper (SNIP) 2015: 0.462; Impact per Publication (IPP) 2015: 0.407

2.2. Responses to the research outputs (citations, etc.)

2.2.1. Table with citations per annum.

Citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately.

Citations, reviews	2011		2012		2013		2014		total		
	number	No. / FTE	number	averaged number per year	av. No. / FTE						
Citations in Web of Science Core Collection (1.1, 2.1)	187.0	5.722	251.0	7.814	228.0	6.955	268.0	8.302	934.0	233.5	7.192
Citations in SCOPUS (1.2, 2.2) if not listed above	79.0	2.417	24.0	0.747	39.0	1.190	34.0	1.053	176.0	44.0	1.355
Citations in other citation indexes and databases (not listed above) (3.2,4.2,9,10)	10.0	0.306	10.0	0.311	1.0	0.031	6.0	0.186	27.0	6.8	0.208
Other citations (not listed above) (3, 4, 3.1, 4.1)	18.0	0.551	12.0	0.374	9.0	0.275	14.0	0.434	53.0	13.3	0.408
Reviews (5,6)	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.0	0.000

2.2.2. List of 10 most-cited publications, with number of citations, in the assessment period (2011 – 2014).

1. MOCZO, Peter - KRISTEK, Jozef - VAVRYČUK, Václav - ARCHULETA, Ralph J. - HALADA, Ladislav. 3D heterogeneous staggered-grid finite-difference modeling of seismic motion with volume harmonic and arithmetic averaging of elastic moduli and densities. In *Bulletin of the Seismological Society of Amerika*, 2002, vol. 92, no. 8, s. 3042-3066. ISSN 0037-1106.
88 citations in the assessment period
2. BONNEFOY, Claude - CORNOU, Cecile - BARD, Pierre Yves - COTTON, F.A - MOCZO, Peter - KRISTEK, Jozef. H/V ratio: A tool for site effects evaluation. Results from 1-D noise simulations. In *Geophysical Journal International*, 2006, vol. 67, no. 2, p. 827-837. ISSN 0956-540X.
64 citations in the assessment period
3. MOCZO, Peter - KRISTEK, Jozef - HALADA, Ladislav. 3D fourth-order staggered-grid finite-difference schemes: Stability and grid dispersion. In *Bulletin of the Seismological Society of America*, 2000, vol. 90, no. 3, p. 587-603. (2000 - Current Contents).
50 citations in the assessment period
4. MOCZO, Peter - KRISTEK, Jozef - GÁLIS, Martin - PAŽÁK, Peter. The finite-difference and finite-element modeling of seismic wave propagation and earthquake motion. In *Acta Physica Slovaca : journal for experimental and theoretical physics*, 2007, vol. 57, issue 2, p. 177-406. (0.647 - IF2006). (2007 - SCOPUS). ISSN 0323-0465.
37 citations in the assessment period
5. MOCZO, Peter - BYSTRICKÝ, Erik - KRISTEK, Jozef - CARCIONE, Joś M. - BOUCHON, Michel. Hybrid modeling of P-SV seismic motion at inhomogeneous viscoelastic topographic structures. In *Bulletin of the Seismological Society of America*, 1997, vol. 87, no. 5, p. 1305-1323. (1997 - Current Contents). ISSN 0037-1106.
36 citations in the assessment period
6. KRISTEK, Jozef - MOCZO, Peter - ARCHULETA, Ralph J. Efficient methods to simulate planar free surface in the 3D 4th-order staggered-grid finite-difference schemes. In *Studia Geophysica et Geodaetica*, 2002, vol. 46, no. 2, p. 355-381. (0.680 - IF2001). (2002 - Current Contents). ISSN 0039-3169.
26 citations in the assessment period
7. KRISTEK, Jozef - MOCZO, Peter. Seismic-wave propagation in viscoelastic media with material discontinuities - a 3D 4th- order staggered-grid finite-difference modeling. In *Bulletin of the Seismological Society of America*, 2003, vol. 93, no. 5, p. 2273-2280. (1.256 - IF2002). (2003 - Current Contents). ISSN 0037-1106.
24 citations in the assessment period
8. ZAHRADNÍK, Jiří - MOCZO, Peter - HRON, F. Testing four elastic finite-difference schemes for behavior at discontinuities. In *Bulletin of the Seismological Society of America*, 1993, vol. 83, no. 1, p. 107-129. ISSN 0037-1106.
22 citations in the assessment period
9. KRISTEKOVÁ, Miriam - KRISTEK, Jozef - MOCZO, Peter - DAY, Steven M. Misfit criteria for quantitative comparison of seismograms. In *Bulletin of the Seismological Society of America*, 2006, vol. 32, no. 1, p. 1836-1850. (1.772 - IF2005). (2006 - Current Contents). ISSN 0037-1106.
22 citations in the assessment period
10. CHALJUB, Emmanuel - MOCZO, Peter - TSUNO, Seiji - BARD, Pierre Yves - KRISTEK, Jozef - KÄSER, Martin - STUPAZZINI, Marco - KRISTEKOVÁ, Miriam. Quantitative comparison of four numerical predictions of 3D ground motion in the Grenoble Valley, France. In *Bulletin of the*

Seismological Society of America, 2010, vol. 100, no. 4, p. 1427-1455. (1.860 - IF2009). (2010 - Current Contents). ISSN 0037-1106.

22 citations in the assessment period

2.2.3. List of most-cited authors from the Institute (at most 10 % of the research employees with university degree engaged in research projects) and their number of citations in the assessment period (2011– 2014).

1. Kristek Jozef	498 citations in the assessment period
2. Moczo Peter	455
3. Bielik Miroslav	91
4. Kristeková Miriam	81

- **Supplementary information and/or comments on responses to the scientific output of the institute.**

The Institute contributes to the world databases of seismic, geomagnetic and meteorological data, which are not quoted.

M. Galis worked in the Geophysical institute of SAS in the year 2012 and has 99 citations in the assesment period.

2.3. Research status of the institute in international and national contexts

The research at the Geophysical Institute of the Slovak Academy of Sciences is of international character. It follows from the results published in a number of papers in highly ranked international journals. The renowned position of our research is a basis for calls and invitations of our researchers to review papers in high impact journals, international projects, organising committees of international conferences. The international editorial board of our journal Contributions to Geophysics and Geodesy consisting of experts from European countries is also the result of a good position of our institution within Europe.

- **International/European position of the institute**

2.3.1. List of the most important research activities demonstrating the international relevance of the research performed by the institute, incl. major projects (details of projects should be supplied under Indicator 2.4). Max. 10 items.

1. Development and improvement of forward numerical methods for simulation of earthquake motion and their combination with the adjoint waveform inversion in order to refine structural models. (APVV-0271-11 MygdonEMotion, FP7 EU Quest)

2. Monitoring and analysis of seismic recordings from National Network of Seismic Stations as a part of the international data exchange (GPI SAS as the National Data Centre of CTBTO, associated partner in EPOS - European Research Infrastructure on Solid Earth, AlpArray)

3. Methodological development of seismic data analysis with main focus on the improvement of moment tensor estimation of local earthquakes (FP7 EU AIM, APVV-0271-11 MygdonEMotion)

4. The study of the geophysical and geological structure and tectonics of the lithosphere in the Carpathian orogen in tectonic position with the surrounding tectonic units as the Eastern European

platform, Pannonian Basin System, Bohemian Massif and Eastern Alps.(Bilateral academic projects with Czech republic and Ukraine, APVV-0724-11, APVV-0099-11, VEGA 2/0088/12).

5. The Hurbanovo geomagnetic observatory, as a member of the Group for European Repeat Station Surveys, MagNetE, participated in producing a European Declination Chart for the epoch 2006.0. This chart was based on the numerous magnetic repeat station measurements performed in more than 20 countries in Europe, including Slovakia.

6. The Hurbanovo Geomagnetic Observatory ESI SAS monitors the Earth's magnetic field in the frame of the global network of observatories. (The INTERMAGNET Programme)

7. Space weather forecasting and the identification of dominant geoeffective processes in the 24th solar cycle, particularly using methods of artificial neural networks. We have found that forecasting results improve when gathering certain parameters, such as X-ray solar flares, Type II and/or Type IV radio emission and solar energetic particles enhancements as inputs for the algorithm. (APVV-0662-12, VEGA 2/0030/14, VEGA 2/0022/11)

8. A common measurement protocol of the Visegrád countries for measuring indoor radon concentration using track detectors was elaborated and selected houses in each country were monitored during one year. Water from sources used in spas was collected for radon determination. The effective dose for employees, patients and visitors of spas was assessed. Radon monitoring in selected kindergartens is performed. (Visegrad Fund nos. 21120293, 21320324 and 21510153)

9. The cooperation of 30 European countries has brought the unified view on the water footprint calculation and related regional studies in member countries (COST ES1106)

10. Development of a fluid-dynamic model for solidification of multicomponent alloys with the application to the Earth's inner-outer core boundary. This research has been a joint collaboration with the George Mason University (Fairfax, VA, USA) and the National Institute of Standards and Technology (Gaithersburg, MD, USA), and carried out under the APVV-14-0657-11 and VEGA-2-0115-16 projects.

2.3.2. List of international conferences (co)organised by the institute.

- 3rd QUEST Workshop, Tatranská Lomnica, Slovakia, 20.05.-26.05.2012
- 13th Castle Meeting on Paleo, Rock and Environmental Magnetism, Zvolen, Slovakia, 16.06.-23.06.2012
- 3rd Annual meeting of the EU 7FP project AIM, Smolenice Slovakia, 10.10.-13.10.2012
- Environmental changes and adaptation strategies, Skalica, Slovakia, 09.09.-11.09.2013
- Ecological potential of the Issyk Kul lake and monitoring of transborder rivers in Kyrgyzstan, Astana, Kazachstan. 15.05.-16.05.2014
- 9th ESSEWECA Conference Environmental, Sedimentary & Structural Evolution of the Western Carpathians, Smolenice, Slovakia, 05.11.-07.11.2014
- Numerical Modeling of Earthquake Motions: Waves and Ruptures, Smolenice, Slovakia, 05.06.-09.06.2015
- Towards climatic services, Nitra, Slovakia, 16.09.-18.09.2015

2.3.3. List of edited proceedings from international scientific conferences.

- Environmental, Sedimentary & Structural Evolution of the Western Carpathians : 9th ESSEWECA Conference, November 5-7, 2014, Smolenice, Slovakia : Abstract Book. Editor Jana Bučová, Ľubica Puškelová. Bratislava : Geophysical Institute, Slovak Academy of Sciences : Geological Institute, Slovak Academy of Sciences, 2014. 74 s. ISBN 978-80-85754-31-5 (ESSEWECA conference).
- Numerical Modeling of Earthquake Motions : Waves and Ruptures - NMEM 2015, July 5-9, 2015 : proceedings of the workshop - abstract book. Eds. Ralph J. Archuleta, Peter Moczo, Jozef Kristek, Martin Galis. Bratislava : Faculty of Mathematics, Physics and Informatics, 2015. 79 p. ISBN ISBN: 978-80-8147-030-1 (NMEM 2015).
- Towards climatic services: international scientific conference, conference proceeding, abstracts : Nitra, 15th-18th September 2015, Nitra, Slovakia. Eds. Bernard Šiška, Pavol Nejedlík, Mariana Eliašová. Nitra : Slovak University of Agriculture, 2015. 80 p. ISBN 978-80-552-1390-3 (Towards Climatic Services : International Conference).

2.3.4. List of journals edited/published by the institute:

2.3.4.1. WOS (IF of journals in each year of the assessment period)

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2.3.4.2. SCOPUS

Contributions to Geophysics and Geodesy, (<http://www.degruyter.com/view/j/congeo>)

2.3.4.3. other databases

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2.3.4.4. not included in databases

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• National position of the institute

The national position of the institute is highlighted by the National Network of Seismic Stations (NNSS), which is the most important Slovak infrastructure for monitoring of seismic activity. The seismic database comprises data on earthquakes with epicentres on the territory of Slovakia as well as earthquakes epicentres outside Slovakia having macroseismic effect on the territory of Slovakia. The Geomagnetic observatory at Hurbanovo is one of the oldest observatories in Europe that has observed the data of the geomagnetic field at the same place since 1900.

2.3.5. List of selected projects of national importance

- VEGA project 2/0188/15

The tectonic situation in the Malé Karpaty (Little Carpathians Mts.) area is complex and this source zone belongs to the most active parts of the Slovak territory. The main purpose of this project is an improvement of the knowledge of seismic regime of investigated area. Data obtained within the project are very important for seismic hazard studies. Necessity of the complex seismic hazard evaluation of this area is increased by presence of close nuclear power plant Jaslovské Bohunice. This is follow-up project of the FP7 EU project AIM.

- FP7 EU project AIM (2009-2013)

One working group was focused on the Little Carpathians source zone in the vicinity of the NPP Jaslovske Bohunice. One of the outcomes of the project was an improvement of seismic monitoring by extension of the existing local network by 3 new seismic stations and by other temporary 3-station miniarray in Dobrá Voda area.

- International project AlpArray (infrastructure building started in 2015)

Seismic monitoring of Little Carpathians source zone and also of the SW part of Slovakia will be significantly improved by addition of 9 new high quality broad-band seismic stations, built in the close cooperation with the University of Vienna).

- Contract with SUTN (2010-2012)

Development of a Map of Seismic Hazard of Slovakia compliant with the Eurocode 8 standard for the Slovak Technical Standard EN 1998-1/NA.

- Contract with EQUIS s.r.o (2011-2013)

Assessment of the Seismicity and Geological Conditions for the new NPP EBO Project – Part: Probabilistic Seismic Hazard Assessment.

- Partial Monitoring System (PMS) – Geological Factors, Subsystem.

Tectonic and seismic activity of the territory. Project of Ministry of Environment of the Slovak Republic. PMS is a part of Monitoring system of the environment of the Slovak Republic, that is based on the international agreements and requirements resulting from integration of Slovak Republic into the international system of protection of the environment.

- VEGA 1/0141/15, VEGA 2/0091/15 (2015–2018)

Improved structural and tectonic model of the lithosphere on the territory of the Slovak Republic.

- APVV-0724-11 (2012–2015)

Structure and thermal state of the lithosphere under the territory of Slovakia with social and economic benefits in the area of renewable energy resources.

- APVV-0194-10 (2011–2014)

A new cleaned and improved database of Bouguer anomalies compiled based on the highest gravimetric standards and the state-of-art methodology. All possible gravimetric applications based on the new database.

- VEGA 1/0095/12 (2012–2014)

Improved structural models of selected parts of the earth crust on the territory of Slovakia by the interpretation of the geophysical field anomalous sources.

- COST Action ES1106 (Assessment of European Agriculture water Use and Trade under Climate Change - AGRIWAT).

The Action summarized the methods of water footprint calculation including the remote sensing techniques and the assessment of water use of key food and energy crops in participating European countries was done.

- APVV-0212-12 (2013–2017)

The partial research topic of the project is to gather new paleomagnetic data from the Central Western Carpathian nappe stack, for instance from the Ipolica Group of the Hronic nappe system, which has no equivalent in Alps and its occurrences are limited only to the territory of Slovakia.

- VEGA 2/0015/11 (2011–2013)

Spatial distributions of the elements of the geomagnetic field on the territory of Slovakia were determined for the epoch 2012.5. In practical terms, the most important element is magnetic declination, which is needful for navigational purposes.

- VEGA 2/0030/14 (2014–2016)

Spatial distributions of the elements of the geomagnetic field on the territory of Slovakia are determined for the epochs 2014.5 and 2016.5.

2.3.6. Projects of the Slovak Research and Development Agency (APVV)

- Meteorology for the public. LPP-0247-09. 2009-2012. Project leader A.Pribullová.
- Bouguer anomalies of new generation and gravimetric model of Western Carpathians. APVV-0194-10. 2011-2014. Work package leader P.Vajda.
- Structure and thermal state of the West Carpathian lithosphere: hot dry rock energy sources potential of Slovakia. APVV-0724-11. 2012-2015. Project leader P.Vajda.
- Forward Modeling and Waveform Inversion Applied to Earthquake Ground Motion in the Mygdonian Basin. APVV-0271-11. 2012-2015. Work package leader M.Kristeková.
- Development of the Danube Basin depositional systems. APVV-0099-11. 2012-2015. Work package leader D.Majcin.
- Mapping of phytotoxic ozone doses in the forest environment of the High Tatras. APVV-0429-12. 2013-2017. Work package leader S.Bičárová.
- Tectonic and sedimentary mass transfer within the prograding Western Carpathian orogenic wedge. APVV-0212-12. 2013-2017. Work package leader I.Túnyi / J.Bučová.
- Signatures of the solar activity in the time-spatial variations of the geomagnetic field. APVV-0662-12. 2013-2017. Work package leader F.Valach.

2.3.7. Projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA)

- Jurassic migration of the Carpathian blocks towards Africa - a paleomagnetic evidence. 2/0195/12. Project leader R. Aubrecht. 2012 – 2014.
- Interpretation of tectonic structures in the region of Central Slovakia based on magnetotelluric and other geophysical data. 2/0088/12. Project leader V. Bezák. 2012 – 2014.
- Interactions between climate factors and mountain environment. 2/0079/11. Project leader S. Bičárová. 2011 - 2013.

- Geoevidence of karst forms and explanation of genesis of sinkholes in selected karst plateaus in Little Carpathians. 1/00747/11. Work package leader M. Bielik. 2011 – 2013.
- Optical characterization of non-spherical atmospheric particles and retrieval of their microphysical properties. 2/0002/12. Work package leader I. Kohút. 2012 – 2015.
- Modelling of processes in the near-Earth space and prediction models for space weather. 2/0022/11. Project leader M. Revallo. 2011 - 2013.
- Temporal and spatial variations of radon activity concentration in cave atmosphere. 2/0135/12. Project leader I. Smetanová. 2012 – 2014.
- Geodynamic evolution of westcarpathians shear corridor in Cenozoic.1/0712/11. Work package leader I. Túnyi. 2011 – 2013.
- Integration of geothermal modeling into the gravimetric inverse problem solving. 2/0067/12. Project leader P. Vajda. 2012 – 2014.
- Interpretation of the geophysical field anomalous sources with the aim to improve the knowledge on the structure and dynamics of the Carpathian orogen. 1/0095/12. Work package leader P. Vajda. 2012 – 2014.
- Time series of the geomagnetic field elements registered by Hurbanovo observatory since the 19th century – the continuity to the 21st century and the analysis of anthropogenic disturbances in the geomagnetic field. 2/0015/11. Project leader F. Valach. 2011 – 2013.
- Magnetoconvection in rotating planar layer; in an inclined layer and in a layer with anisotropic diffusive coefficients. 1/0523/13. Work package leader T. Šoltis. 2013 – 2015.
- Atmospheric processes and tropospheric ozone in the mountain environment. 2/0053/14. Project leader S. Bičárová. 2014 – 2017.
- Flow deposition of acidifying components and ozone in the selected submountain and mountain areas of Slovakia. 2/0089/14. Work package leader S. Bičárová. 2014 – 2017.
- Transient and secular variations of the geomagnetic field on the territory of Slovakia. 2/0030/14. Project leader F. Valach. 2014 – 2016.
- Crustal tectonic structures in Eastern Slovakia – interpretation based on magnetotelluric and others geophysical data. 2/0091/15. Project leader V. Bezák. 2015 – 2018.
- Seismic regime in the Malé Karpaty focal zone. 2/0188/15. Project leader L. Fojtíková. 2015 – 2018.
- Statistical analysis of long-term radon time series from Slovakia. 2/0083/15. Project leader I. Smetanová. 2015 – 2017.
- Geophysical model of the lithosphere of the Western Carpathians. 1/0141/15. Work package leader P. Vajda. 2015 – 2018.
- Implementation of recent innovations in potential field interpretation methodology. 2/0042/15. Project leader P. Vajda. 2015 – 2018.

2.3.8. Projects of SAS Centres of Excellence

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2.3.9. National projects supported by EU Structural Funds

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2.3.10. List of journals (published only in the Slovak language) edited/published by the institute:

2.3.10.1. WOS (IF of journals in each year of the assessment period)

2.3.10.2. SCOPUS

2.3.10.3. Other databases

2.3.10.4. Not included in databases

- **Position of individual researchers in an international context**

Our researcher J. Kristek obtained from Editorial Board of the Geophysical Journal International appreciation Outstanding reviewer of the year 2014. We are members of the editorial boards of 7 foreign (European) scientific journals. Scientists from the seismological department gained the award for the greatest contribution in bilateral Slovak- French scientific and technical collaboration.

Our researcher D. Podhorský became Honorable academic of Euroasian International Academy of Science of Ecology and Life safety of UN in Astana, KZ.

2.3.11. List of invited/keynote presentations at international conferences, as documented by programme or invitation letter

Bezák, V., 2012. Geology and prospection of W-Au mineralization in the Nizke Tatry Mts. (Central Slovakia). International Conference of Euromines. 30-31. 10. 2012, Limasol, Cyprus.

Bičárová, S.: Wet and dry periods (1961-2011) and occurrence of heavy rainfall events in the High Tatras region. Conference „Hydrologic risks- floods and droughts“ under the auspices of Hungary Slovakia Cross border Cooperation and European Union programme 2007-2013 project HUSK/1001/2.1.2: May 6 - 7, 2013, Košice

Brimich, L.: Surface deformations and gravity changes due to underground heat source. 15th Annual Conference of the International Association of Mathematical Geosciences. 4.9. 2013. Madrid, Spain.

Vajda, P.: Reinterpretation of Teide 2004-2005 gravity changes by 3D line segments approximation. 15th Annual Conference of the International Association of Mathematical Geosciences. 4.9. 2013. Madrid, Spain.

Gribovszki, K., Mónus P., Kovács K., Bokelmann G., Konecny P., Lednicka M., Brimich L., Bednárík M.: Estimation the upper limit of prehistoric peak ground acceleration using the parameters of intact stalagmite in Plavecka Priepast cave, in the Little Carpathians, Slovakia Seismic Hazard of Vienna and Bratislava. Preliminary results.
Conference name: „Get to know the secrets of science“ Institute of Geonics, Ostrava, Czech Republic, 10th-12th November, 2014

Kristek J., Moczó P., Chaljub, De Martin, Kristekova M.: A new discrete representation of a heterogeneous medium for the finite-difference modelling of seismic wave propagation.
1st ASCETE Sudelfeld Summit - Workshop on advanced numerical methods for earthquake and tsunami simulation on modern HPC systems, Bayrischzell – Oberbayern, Nemecko, 20.-23.5.2014.

Kristek J., Moczo P., Chaljub, De Martin, Kristekova M.: A new discrete representation of a heterogeneous medium for the finite-difference modelling of seismic wave propagation. PRENOLIN Meeting, Nice, Francúzsko, 15.-17.12.2014.

Moczo P., Kristek J., Gális M. : An Introduction To Numerical Modelling in Seismology. Developer School for HPC applications in Earth Sciences, The Abdus Salam International Centre for Theoretical Physics, Trieste, Taliansko, 10.-12.11.2014.

Fojtikova L.: Focal mechanisms of weak events from polarities and waveforms inversion – new approaches demonstrated on a rare Mw 4.3 event in Brazil, Brazília, 7. december 2015

2.3.12. List of researchers who served as members of the organising and/or programme committees

3rd QUEST Workshop, 2012:

Prog&Org: P. Moczo; Org: J. Kristek, M. Kristeková, L. Fojtková, A. Cipciar, K. Csicsay, R. Kysel

13th Castle Meeting on Paleo, Rock and Environmental Magnetism, 2012:

Prog&Org I. Túnyi, L. Brimich; Prog: T. Šoltis

3rd Annual meeting of the EU 7FP project AIM, 2012:

Prog&Org: M. Kristeková; Prog: P. Moczo; Org: L. Fojtková, A. Cipciar, K. Csicsay, R. Kysel

Environmental changes and adaptation strategies, 2013:

Org: S. Bičárová

Ecological potential of Issyk Kul lake and the monitoring of transborder rivers in Kyrgyzstan, 2014:

Prog&Org: D. Podhorský

9th ESSEWECA Conference Environmental, Sedimentary & Structural Evolution of the Western Carpathians, 2014:

Prog: I. Túnyi, V. Bezák; Org: J. Bučová, L. Kubišová

Numerical Modeling of Earthquake Motions: Waves and Ruptures, 2015:

Prog&Org: P. Moczo; Prog: J. Kristek, Org: M. Kristeková, L. Fojtková, A. Cipciar, K. Csicsay, M. Gális, R. Kysel, Z. Margočová, M. Srbecký, E. Bystrický

Towards climatic services, 2015:

Org: P. Nejedlík

- **Position of individual researchers in a national context**

The renowned position of our key senior researcher is a basis for calls and invitations of our researchers to review PhD.-habilitation and professor theses, national projects as well as to work in scientific boards at two universities (Faculty of Natural Sciences, Comenius University, Faculty of Civil Engineering, Slovak Technical University).

2.3.13. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter

Brimich, L.: History and present time of the Geophysical institute of SAS. X. Slovak geophysical conference. Smolenice. 19.8.2013

Moczo, P.: Seismology. X. Slovak geophysical conference. Smolenice. 19.8.2013

Bielik, M.: Actual trends in Slovak gravimetry. X. Slovak geophysical conference. Smolenice. 19.8.2013

Valach, V. Geomagnetism. X. Slovak geophysical conference. Smolenice. 19.8.2013

Moczo, P.: The position of Geophysical institute of SAS in geophysical research in the Slovakia. X. Slovak geophysical conference. Smolenice. 19.8.2013

2.3.14. List of researchers who served as members of organising and programme committees of national conferences

Soil-Vegetation-Atmosphere Modeling, 2015:

Org: S. Bičárová

Monitoring and modeling of surface ozone – interactions in forest ecosystems, 2015:

Org: S. Bičárová

X. Slovak geophysical conference, 2013:

Prog&Org: L. Brimich, P. Moczo, M. Bielik; Prog: J. Dérerová, I. Kohút, A. Cipciar, T. Šoltis, J. Pánisová

XI. Slovak geophysical conference, 2015:

Prog: L. Brimich, M. Bielik, P. Moczo, P. Guba, J. Kristek, J. Kristeková, P. Vajda, D. Majcin, F. Valach

• Supplementary information and/or comments documenting the international and national status of the Institute

We have non-financed international cooperation in terms of joint research tasks or joint publications with the following organizations:

- Departement des Sciences de la Terre Universite de Paris-Sud, France
- Institute of Geophysics NAS of Ukraine
- National Research Institute of Astronomy and Geophysics in Cairo, Egypt
- Institute of Meteorology and Geophysics, University of Vienna, Vienna, Austria
- Department of Geodesy and Geomatics Engineering, University of New Brunswick, Fredericton, N.B., Canada
- Research Institute of Geodesy, Topography and Cartography, Ondřejov, Czech Republic
- Institute of Rock Structure and Mechanics of the ASCR, v. v. i., Czech Republic
- Faculty of Aerospace Engineering, Physical and Space Geodesy, DUT, Delft, Netherlands
- School of Civil Engineering and Geosciences, Newcastle University, Newcastle upon

- Tyne, United Kingdom
- Institute for Geosciences, FSU Jena, Jena, Germany
- Institute for Physical Geodesy, TU Darmstadt, Darmstadt, Germany
- Instituto de Astronomia y Geodesia, Universidad Complutense de Madrid (CSIC- UCM), Madrid, Spain
- Observatoire Royal de Belgique, Bruxelles, Belgium
- Institute of the Physics of the Earth, Russian Academy of Sciences, Moscow, Russia
- Geophysical Institute of the Academy of Sciences of the Czech Republic, Praha, Czech Republic
- Geodetical and Geophysical Research Institute of Hungarian Academy of Sciences, Sopron, Hungary
- Geophysical Institute of the Polish Academy of Sciences, Warszawa, Poland
- Polar Institute, Tokyo, Japan
- University of Bristol, Bristol, UK
- West Bohemian University, Plzen, Czech Rep.
- National School of Surveying, University of Otago, New Zealand
- School of Geodesy and Geomatics, The Key Laboratory of GeoSpace Environment and Geodesy, Wuhan, China

Members of editorial board of the international journals in assessment period:

R. Aubrecht - Bulletin of Geosciences; Kwartalnik Akademii Gorniczo-Hutniczej - „Geologia“; Tomy Jurajskie.

M. Bielik - Acta Geodaetica et Geophysica Hungarica; Geologica Carpathica; Geophysical Journal.

D. Majcin - Geoinformatika.

P. Moczo - Studia Geophysica et Geodaetica.

P. Nejedlík - Italian Journal for Agrometeorology.

Members of editorial board of the national journals in assessment period:

V. Bezák - Mineralia Slovaca.

M. Bielik - AGEOS Acta Geologica Slovaca; Contributions to Geophysics and Geodesy, Mineralia Slovaca

L. Brimich - Contributions to Geophysics and Geodesy (Editor-in-Chief).

P. Guba - Contributions to Geophysics and Geodesy

I. Kohút - Contributions to Geophysics and Geodesy (Managing Editor).

D. Majcin - Contributions to Geophysics and Geodesy

P. Moczo - Contributions to Geophysics and Geodesy

P. Nejedlík - Meteorologický časopis

A. Pribullová - Kozmos

P. Vajda - Contributions to Geophysics and Geodesy

2.4. Tables of project structure, research grants and other funding resources

• International projects and funding

2.4.1. **Major projects within the European Research Area and other important project – Framework Programmes of the EU, ERA-NET, European Science Foundation, NATO, COST, INTAS, etc. (here and in items below please specify: type of project, title, grant number, duration, total funding and funding for the institute, responsible person in the institute and his/her status in the project, e.g. coordinator “C”, work package leader “W”, investigator “I”),**

	Project title	Typ / Project number	Duration in months	Funding for the Institute (EUR)	Role of the Institute / Responsible person
2012	Prevention of Landslide Dam Disasters in the Tien Shan, Kyrgyz Republic	NATO / ESP.EAP.SFPP 983289	01/2009 - 09/2012	16871	W / M.Kristeková
	Advanced Industrial Microseismic Monitoring	7RP / FP7-PEOPLE-IAPP-2009-230669	10/2009 - 09/2013	14527	W / Kristeková
2013					
2014					
2015	Assessment of European Agriculture Water Use and Trade under Climate Change	COST / EURO-AGRIWAT	03/2015 - 04/2016	11829	W / Nejedlík

2.4.2. Other international projects, incl. total funding and funding for the institute

-

2.4.3. Other important, international projects and collaborations without direct funding (max. 10 projects)

- Time Dependent Seismology; 2014-2018; COST ES1401 international project; work group leader Moczo
- A European network for a harmonized monitoring of snow for the benefit of climate change scenarios, hydrology and numerical weather prediction; 2014-2018; COST international project, HARMOSNOW, work group leader Nejedlík
- Harmonization of determining the radiation dose of the population originating from radon, in V4 countries; 2012-2012; International Visegrad Found (IVF) multilateral project, investigator Smetanova
- Structure and dynamics of the Carpathian lithosphere based on gravimetry and geothermics, 2011- 2013, bilateral project, Ukraine, coordinator Bielik
- Assessment of the peak ground horizontal acceleration generated by paleo-earthquakes from failure tensile stress of speleotherms. Study of seismicity of the remote past with the use of engineering seismology, 2011-2015, bilateral project, Hungary, coordinator Brimich
- Monitoring and analysis of earthquakes with respect to oherský rift in Czech Republic and area of Male Karpaty in Slovak Republic, 2012-2014, bilateral project, Czech Republic, coordinator Kristeková
- Investigation of the influence of the geological inhomogeneities on the microseismical measurements, bilateral project; Russia, 2009 - 2015, coordinator Brimich
- AlpArray; 2013-2015; multilateral project; work group leader Csicsay
- Integrated 3D geophysical interpretation of the lithosphere in the junction of the Carpathians and European platform; 2014-2016; bilateral project; Ukraine; coordinator Bielik

- Electrical conductivity and geological structure in the West Carpathians and its transition to the Bohemian Massif; 2015-2017; bilateral project; Czech Republic; coordinator Bezak

- **National projects and their funding**

2.4.4. Projects supported by the Slovak Research and Development Agency (APVV)

Role of the Institute e.g. coordinator "C", investigator "I".

	Project title	Typ / Project number	Duration in months	Funding for the Institute (EUR)	Role of the Institute / Responsible person
2012	Meteorology for the public	LPP-0247-09	09/2009 - 08/2012	50951	C / A.Pribullová
	Bouguer anomalies of new generation and gravimetrical model of Western Carpathians	APVV-0194-10	05/2011 - 10/2014	42456	I / P.Vajda
	Structure and thermal state of the West Carpathian lithosphere: hot dry rock energy sources potential of Slovakia	APVV-0724-11	07/2012 - 12/2015	177947	C / P.Vajda
	Forward Modeling and Waveform Inversion Applied to Earthquake Ground Motion in the Mygdonian Basin	APVV-0271-11	07/2012 - 12/2015	21154	I / M.Kristeková
	Development of the Danube Basin depositional systems	APVV-0099-11	07/2012 - 12/2015	18054	I / D.Majcin
2013	Mapping of phytotoxic ozone doses in the forest environment of the High Tatras	APVV-0429-12	10/2013 - 03/2017	68078	I / S.Bičárová
	Tectonic and sedimentary mass transfer within the prograding Western Carpathian orogenic wedge	APVV-0212-12	10/2013 - 09/2017	34965	I / I.Túnyi, J. Bučová
	Signatures of the solar activity in the time-spatial variations of the geomagnetic field	APVV-0662-12	10/2013 - 09/2017	55990	I / F.Valach
2014					
2015					

2.4.5. Projects supported by the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA) for each year, and their funding

VEGA	2012	2013	2014	2015
Number	12	13	11	10
Funding in the year (EUR)	46935	52726	46217	59160 ¹

¹ Excluding projects for the popularisation of science

- **Summary of funding from external resources**

- 2.4.6. **List of projects supported by EU Structural Funds**

Formulation and Confirmation of the Theory of Earth Origin by Accretion in Cooperation with Internationally Recognized Experts. 2012-2014; ITMS: 26140230006; Project coordinator I. Tunyi

- 2.4.7. **Summary of external resources of the EU Structural Funds (ERDF/ESF)**

Role of the Institute in the project, e.g. coordinator “C”, work package leader “W”, investigator “I”.

Year	Project title	Project number	Duration in months	Funding for the Institute (EUR)	Role of the Institute
2012	Formulation and Confirmation of the Theory of Earth Origin by Accretion in Cooperation with Internationally Recognized Experts	ITMS: 26140230006	01/2012 - 12/2014	382100	C
2013					
2014					
2015					

External resources	2012	2013	2014	2015	total	average
External resources (milions of EUR)	0.133	0.065	0.184	0.000	0.382	0.096
External resources transfered to cooperating research institute (milions of EUR)	0.000	0.000	0.000	0.000	0.000	0.000

- **Supplementary information and/or comments on research projects and funding sources**

Additional resources were gained also from commercial contracts and expertise activities.

2.5. PhD studies and educational activities

- 2.5.1. **List of accredited programmes of doctoral studies, period of validity**

4.1.30 aplikovaná geofyzika (applied geophysics)

- 2.5.2. **Summary table on doctoral studies (number of internal/external PhD students; number of foreign PhD students, number of students who successfully completed their theses, number of PhD students who quit the programme)**

PhD study	12/31/2012			12/31/2013			12/31/2014			12/31/2015		
Number of potential PhD supervisors	9			8			6			11		
PhD students	number	defended thesis	students quitted									
Internal	2.0	0.0	0.0	2.0	0.0	0.0	4.0	0.0	0.0	4.0	0.0	0.0
External	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0	1.0
Other supervised by the research employees of the institute	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2.5.3. Summary table on educational activities

Teaching	2012	2013	2014	2015
Lectures (hours/year) ²	126	160	144	220
Practicum courses (hours/year) ²	199	167	82	151
Supervised bachelor theses (in total)	1	2	9	4
Supervised diploma theses (in total)	0	2	3	8
Supervised PhD theses (in total)	3	6	5	14
Members in PhD committees (in total)	1	3	2	13
Members in DrSc. committees (in total)	1	0	0	0
Members in university/faculty councils (in total)	4	4	3	4
Members in habilitation/inauguration committees (in total)	1	0	0	18

²

2.5.4. List of published university textbooks

HVOŽDARA, Milan. *Naša Zem pevná i premenlivá* [Our Earth solid and variable]. 1. vyd. Bratislava : VEDA, Vydavateľstvo Slovenskej akadémie vied, 2012. 260 s. Svet vedy, Zväzok 22. ISBN 978-80-224-1263-6.

TÚNYI, Igor - AUBRECHT, Roman - GUBA, Peter - ŠOLTIS, Tomáš - BOČÍK, Andrej - MAJCIN, Dušan - BRIMICH, Ladislav - BILČÍK, Dušan. *Akrécia Zeme s podporou impulzných magnetických polí*. Bratislava : Geofyzikálny ústav SAV, 2014. 320 s. + elektronická príloha. ISBN 978-80-85754-32-2.

² Do not include time spent with bachelor, diploma or PhD students during their supervising

2.5.5. Number of published academic course books

The institute published one academic course book.

2.5.6. List of joint research laboratories/facilities with universities

Joint research laboratory with Faculty of Mathematics, Physics and Informatics, Comenius University).

Main common research:

- seismological station
- paleomagnetic and archeomagnetic laboratory
- station of the radon emanation

- **Supplementary information and/or comments on doctoral studies and educational activities**

2.6. Social impact

2.6.1. List of the most important results of applied research projects. Max. 10 items

1. InterSucho - an application of an original method of drought monitoring realized in Czech Republic, Slovakia and a part of Austria. The results of the monitoring which is done in one week step can be used in agriculture but also in other branches like water sector, energy sector etc.
2. Map of Seismic Hazard of Slovakia in the Slovak Technical Standard EN 1998-1/NA
3. Assessment of the Seismicity and Geological Conditions for the new NPP EBO Project – Part: Probabilistic Seismic Hazard Assessment
4. Macro seismic Intensity Assessments (expertize) for insurance companies after earthquakes macroseismically felt on the Slovak territory.
5. Determination of geothermal and geological conditions for geothermal energy sources in Slovakia usable for electricity production by EGS systems (APVV-0724-12).
6. Long term cooperation agreement between IES SAS (former GPI SAS) and Faculty of Mathematics Physics and Informatics (Comenius University Bratislava) with Microstep, s.r.o. (cooperation in development and testing of the equipment for seismic measurements).
7. Long term cooperation with Progseis, s.r.o. in monitoring around NPPs Jaslovské Bohunice and Mochovce (agreement about bilateral cooperation and data exchange, IES SAS is a scientific guarantor of monitoring).
8. Implementation of the state-of-the-art surveying techniques - laser scanning and digital close range photogrammetry in the microgravity method.
9. New, effective approach of microgravity data processing allowing to precisely calculate the gravitational effects of buildings in any near surface applications (archaeology, geotechnical, environmental or geohazard surveys in urban areas).
10. Verification of the new methodology on two archaeological sites in western Slovakia: i) the late Romanesque church of Virgin St. Mary's Birth near Nitra town – two medieval crypts were successfully detected; ii) the ruins of the St. Catherine's monastery complex located 20 km

northwest from Trnava – three aristocratic crypts were detected based on microgravity and GPR surveys, two of them have been verified by archaeological excavation in 2014.

2.6.2. List of the most important studies commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes

Magnetic declination measurements and analyse for Ministry of Defence of the Slovak Republic. The data applied for navigation purposes (compass swing bases).

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues

- Long term cooperation agreement between IES SAS (former GPI SAS) and Faculty of Mathematics Physics and Informatics (Comenius University Bratislava) with Microstep, s.r.o. (cooperation in development and testing of the equipment for seismic measurements)
- Long term cooperation with Progseis, s.r.o. in monitoring around NPPs Jaslovske Bohunice and Mochovce (agreement about bilateral cooperation and data exchange, IES SAS is a scientific guarantor of monitoring)
- Cooperation with Progseis Ltd. in seismic monitoring by National Network of Seismic Stations (agreements about installation, operation and data sharing for 2 stations)
- Microgravimetric prospecting of the site Taunusstein (Germany) in cooperation with G-Trend company.

2.6.4. List of licences sold abroad and in Slovakia, incl. revenues

2.6.5. List of most important social discourses under the leadership or with significant participation of the institute (max. 10 items)

2.6.6. Summary of relevant activities, max. 300 words

We are an exclusive Slovak workplace that analyzes seismic threat on the entire territory of Slovakia, elaborates seismic expert opinion reports at key national economic sites, and maps of seismic hazard for Slovakia.

The Geomagnetic observatory in Hurbanovo serves as the Reference Centre for magnetic declination on the territory of Slovakia.

The institute owns a „know how“ in gravimetric and microgravimetric methods that are applicable to construction works and operation of underground gas reservoirs, as well as near surface geophysics methods applicable in archeological prospecting.

All data monitored and collected by the institute are made available to the respective national and international institutions and databases.

2.7. Popularisation of Science (outreach activities)

2.7.1. List of the most important popularisation activities, max. 20 items

- In 2013 the Department of Seismology of the Geophysical Institute organized, jointly with the Faculty of Mathematics, Physics and Informatics of the Comenius University, press conference devoted to the 250-th anniversary of the most catastrophic documented earthquake on the territory of Slovakia – the earthquake of 28 June, 1763 near the Komárno town.
- Our institute has co-organized the exhibition “The Planet on which we live” that took part in 2012 in Martin. (P. Pažák, L. Fojtíková, M. Kristeková, A. Cipciar, E. Bystrický, V. Bezák)
- In 2012 a documentary film titled „Earthquakes hidden in numbers“ was produced and broadcasted in Slovak national TV within the series Spectrum of Science and Technology. It is available on DVD.
- Our institute, in cooperation with the Slovak Bioclimatological Society, and with support of the Committee for cooperation with scientific societies, published in August 2013 a brochure "Observatory of the Slovak Academy of Sciences Skalnaté Pleso – 70 years of meteorological observations". Editor: S. Bičárová.
- Popular scientific films “Planet Earth below our feet” and “Volcanoes threatening Europeans” were produced and distributed on DVDs as a follow up after several popular oral presentations and exhibitions for high school students and physics teachers (in charge: P. Vajda).
- Prof. Peter Moczo gave oral presentations at the Petržalka Super-School and at the Kids Comenius University titled „Earthquakes worldwide and at home“and „Why tides?“.
- L. Fojtíková and M. Kristeková co-organized activities associated with a three-day concluding scientific event for kids of the Petržalka Super-School. Over several years they prepared and conducted popular talks and displays for pupils of junior high schools.
- Series of 4 presentations of P. Nejedlík on "Climate change – what about it nature and what about it man?" for expert workers, pedagogical workers and students. Within the event: "Know the secret of science: Meteorology and climatology – what awaits us". Ostrava, Czech Republic, 2015.
- Presentation of P. Nejedlík on “Development of COST mechanism” within the event “COST info Day in Slovakia”, Bratislava, 2015.
- F. Valach – excursions at worksites of the Geomagnetic observatory in Hurbanovo.
- S. Bičárová et al. – excursions at the Meteorological observatory Skalnaté pleso.
- S. Bičárová et al. – excursions and popular talks at the Meteorological observatory in Stará Lesná.
- M. Kristeková, L. Fojtíková – prepared a kiosk of our institute at the popularizing event the Night of the Researchers.

2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2012	2013	2014	2015	total
Articles in press media/internet popularising results of science, in particular those achieved by the Institute	4	1	6	20	31
Appearances in telecommunication media popularising results of science, in particular those achieved by the Institute	1	3	3	12	19
Public popularisation lectures	95	44	26	16	181

- **Supplementary information and/or comments on popularisation activities, max. 300 words**

Year-round lectures and excursions at the observatories of the institute as well as the periodical lectures for the students of the high schools are organized. Every year institute participates the open day action during the week for science and technic. The scientific workers from the institute immediatly respond to actual course of events in the world as earthquakes, the changes in the rotation of the Earth etc.

2.8. Background and management. Human resources and implementation of recommendations from previous assessment

2.8.1. Summary table of personnel

Personnel	2012	2013	2014	2015
All personnel	61.0	61.0	61.0	61.0
Research employees from Tab. Research staff	42.0	40.0	42.0	41.0
FTE from Tab. Research staff	31.880	31.120	30.780	30.480
Average age of research employees with university degree	45.7	45.7	44.5	45.3

2.8.1.1. Professional qualification structure (as of 31.12. 2015) FEMALE

FEMALE	AGE									
	Number of	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	> 65
DrSc. / prof.	0	0	0	0	0	0	0	0	0	0
II.a / Assoc. prof.	0	0	1	0	1	0	0	0	0	0
Other researchers PhD./CSc.	1	1	4	0	1	1	0	0	0	0
doc. / Assoc. prof.	1	0	0	0	1	0	0	0	0	0

2.8.1.2. Professional qualification structure (as of 31.12. 2015) MALE

MALE	AGE									
	Number of	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	> 65
DrSc. / prof.	0	0	0	0	0	0	0	1	0	2
II.a / Assoc. prof.	0	0	0	1	3	0	1	1	1	1
Other researchers PhD./CSc.	1	4	1	4	2	0	0	1	1	1
doc. / Assoc. prof.	1	0	0	2	0	0	1	0	1	1

2.8.2. Postdoctoral and mobility scheme

2.8.2.1. Postdoctoral positions supported by national and international resources

2.8.2.2. Postdoctoral positions supported by external funding

2.8.2.3. SAS stipends and SASPRO stipends

2.8.2.4. Internal funding - the Slovak Academy of Sciences Supporting Fund of Stefan Schwarz

2.8.3. Important research infrastructure (max. 2 pages)

National Network of Seismic Stations (NNSS) is the most important Slovak infrastructure for monitoring of seismic activity. Its main goal is to monitor and localize earthquakes with macroseismic effects (effects on people, objects, buildings and nature) on the territory of Slovakia. Besides these earthquakes the seismic stations of NNSS record also weaker local earthquakes and other seismic events (e.g. quarry blasts) as well as regional and teleseismic earthquakes and nuclear explosions.

The results of seismic monitoring of the territory of Slovakia and following analyses of seismic records enter into the national seismic database for the territory of Slovakia that has been long-term created at the ESI SAS (former Geophysical Institute of Slovak Academy of Sciences).

The seismic database comprises data on the earthquakes with epicentre on the territory of Slovakia and the earthquakes with epicentre outside Slovakia but with macroseismic effect on the territory of Slovakia. The seismic database is an inevitable part of the seismic hazard assessment for the whole territory of Slovakia (e.g. for the building standards, civil protection activities, etc.) as well as for the economically important areas (e.g. nuclear power plants, water dams, dense populated areas, etc.).

National Network of Seismic Stations consists of **13 seismic stations** recording the ground motion velocity. All seismic stations are registered at the International Seismological Centre (ISC) in the Great Britain. Continuous digital records from the seismic stations are transmitted to the Data and Analysis Centre at ESI SAS in Bratislava in a real-time mode, where the data are analysed and archived. Only the oldest seismic station Hurbanovo is, due to historical reasons, equipped with analogue registration on a smoked paper.

Geomagnetic Observatory ESI SAS at Hurbanovo is one of the oldest observatories in Europe which has observed the data of the geomagnetic field (GMF) on the same place since the beginning of its operation. It continues carrying out systematic monitoring of the geomagnetic field. In 1998 the observatory was officially included into the INTERMAGNET, the International Real-Time Magnetic Observatory Network. It provides the so-called data Exchange, which means that

the data distribution is supplied within 72 hours via electronic media to the collection and distribution center Paris GIN, France. INTERMAGNET produces the yearly definitive data as INTERMAGNET DVD using data from the IMO (Intermagnet Magnetic Observatory network), on which we give the measured and processed data from Hurbanovo Observatory, too. The Observatory is now equipped with the absolute and variational devices that have to conform to the INTERMAGNET. As a standard instrument for the absolute measurements we use fluxgate theodolite LEMI-203 and for the measuring of the field variations (elements X, Y and Z of the GMF) the torsion photoelectric magnetometer (TPM) employing Bobrov-type quartz variometer is utilised. Since the year 1997 we have measured one-minute values of the geomagnetic field. The Hurbanovo Geomagnetic Observatory ESI SAS belongs to those observatories that have not even a minute of outage at the minute registration since the very beginning of their operation in the frame of the INTERMAGNET. In addition to the one-minute data we also measure one-second values of the elements of GMP which are available on request for scientific purposes since 2000. Every day we issue a forecast of the geomagnetic activity and monthly we evaluate local K-index and rapid variations, which are available on the website of the Observatory:
<http://www.geo.sav.sk/en/structure-of-the-institute/laboratories/geomagnetic-observatory/>

Meteorological observatory Skalnaté Pleso is dedicated to monitor and to support the research of alpine climate. It is run by ESI in cooperation with Slovak Hydrometeorological Institute (SHMU). It is positioned in alpine area at south slope of High Tatra Mountains (1778 a.s.l.) and represents the alpine climate over the timberline. The observatory is equipped with standard climate station with some supplementary measurements of solar radiation and ozone.

The station is a part of the observing network of SHMU. Automated measurements are supplemented by manual observations in order to keep the time series fully homogenous.

Parameters monitored by the climate station:

- air temperature, air humidity, air pressure
- precipitation, snow cover height
- wind direction and wind speed
- solar radiation components (global radiation, diffuse radiation, reflected radiation, UVB)
- radiation balance
- soil temperature
- present weather
- state of ground

Ground level ozone concentration is also measured.

Climate station at Skalnaté Pleso belongs to the most important mountain stations in Slovakia. It works from 1941 and the data supply Partial Monitoring System – Meteorology and Climatology which is a part of Monitoring system of Slovak Republic. These data are important for climate studies in Tatra region such as for Climate Atlas of SK, for Atlas of the Tatra Mountains – abiotic nature. The highest wind speed ever recorded in Slovakia (248 km/h) occurred at Skalnaté Pleso.

2.8.4. Description of how the results and suggestions of the previous assessment were taken into account

Main suggestions of the previous assessment were summarized as follows:

1. The upgrade of the quality of the scientific activity to approach to the mean world institutions.
2. To define the bearing problematics in which the institute will achieve good results in term of the international standards.
3. To create the stimulative milieu for the young scientists.
4. To upgrade the processes of the management to increase the scientific output.

Response to the suggestions of the previous assessment:

The executive body initiated the new financial terms stimulating the efficiency of the scientific staff regarding publication of their results in internationally recognized scientific journals. In comparison with the previous period our research outputs increased.

The strategic vision of the development of the institute and the research activities considering the structure of the research teams, their scientific efficiency and the significance of the scientific outputs was elaborated.

At the verge of 2011/2012 we commenced the preparation of PhD students in the newly accredited specialization 4.1.30 Applied Geophysics. By active approach we have gradually increased the number of internal students to 4 during the evaluation period. All the students were involved in research work not only in terms of their dissertation work, but also on research projects of the institute.

- **Supplementary information and/or comments on management, research infrastructure, and trends in personnel development**

On July 1st 2015 Geophysical Institute of the SAS merged with Geological Institute of SAS and established Earth Science Institute of the Slovak Academy of Sciences.

The modernisation of the observatory instrumentation made possible the reduction of the technical staff of the institute.

3. Research strategy and future development of the institute for the next five years (2016-2020) (Recommended 3 pages, max. 5 pages)

The research strategy and future development concerns the Earth Science Institute of the Slovak Academy of Science newly established on 1st July 2015. Therefore, this part of the assessment is common for both the former institutes, the Geological Institute of the Slovak Academy of Sciences and the Geophysical Institute of the Slovak Academy of Sciences.

The Presidium of the Slovak Academy of Sciences issued the order no. 557 on March 12, 2015 that approved the merger of the two institutes – the Geological Institute and the Geophysical Institute. The Geophysical Institute of the Slovak Academy of Sciences ceased the existence as a organization without liquidation on July 1, 2015. Its legal successor was represented by the Geological Institute of the Slovak Academy of Sciences that continued as the contributory organization. By order of the Presidium of the Slovak Academy of Sciences no. 591 issued on April 9, 2015, the Geological Institute of the Slovak Academy of Sciences was renamed to the Earth-Science Institute of the Slovak Academy of Sciences, with the effective date starting on July 1, 2015.

The early period of existence of the new joined Institution was characterised by general administrative re-organisation: unification of the Economy department, establishing of new management, new property evidence, preparation of new identification document, new agreements with the supplying firms, as well as instructions for financial operation at the institution. The election of common Scientific Board completed this process.

3.1. Present state of the art in both the national and the international contexts

The current research in the Geological division generated a significant progress in several fields, including petrology, stratigraphy and palaeobiology. One of the most prominent examples is represented by investigations of ultrahigh pressure metamorphism and by reconstructions of marine ecosystems and depositional environments during the Mesozoic and Cenozoic. The outcomes of this research were mostly published in journals that belong to the first quartile in their research categories. Moreover Hurai et al. published in Elsevier the monograph for the first time devoted to geofluids. Improvements in research, in quality and in educational outreach at national

and international level were connected with improvement of infrastructure and development of laboratories with new analytical instruments. The discovery of diamonds was honoured by one of the highest Slovak awards for scientists - "Crystal Wing" for the year 2013, and Prize of the Slovak Academy of Sciences for the year 2015.

The core research at the Geophysical division is in international cooperation in seismology, gravimetry, geothermics, geomagnetic activity, and analyses of atmospheric data in high mountains. The most prominent research at the top international level is the development and application of numerical methods for seismic wave propagation and dynamic rupture modelling. The monograph published by the Cambridge University Press together with identification of the team as one of the Excellent Research Teams of the Slovak Academy of Sciences, and Prize in the category "Science and technology team of the year" also illustrate the strong position of the team in the international and national contexts. The outcomes from analysis of seismic data for the use of civil protection in Slovakia, seismic hazard analysis for economically important sites (e.g., nuclear power plants), and the use of geomagnetic measurements by Slovak military airports underlines the national importance of the Institute.

3.2. Research strategy of the institute in the national and the international contexts, objectives and methods

Project proposals submitted to 7RP or H2020	2012	2013	2014	2015
Institute as coordinator				
Institute as participant				1

The research strategies and methods that will be applied at our institution reflect the merging of two former institutes and documents clear compatibility of the main topics. The research can be divided into six major research orientations with detailed plans for the next five years:

1. investigation of the physical processes and the dynamics of the Earth's continental lithosphere:

- a. research of the composition, history and dynamics of the lithosphere: lithologies, thermodynamic, density, seismic, magnetic, palaeomagnetic, geothermal and magnetotelluric modelling;
- b. validation of the 3D seismic model using the seismic noise analysis and improvement of the model using full waveform inversion;
- c. transformation of continental crust and upper mantle during deep subduction;
- d. preservation of ultrahigh-pressure minerals and their transformation during exhumation back to the Earth's surface;
- e. reconstruction of metamorphic P-T-t paths of crustal and mantle rocks, especially eclogites, garnet peridotites and diamond-bearing gneisses;
- f. fluid-rock interaction at upper mantle/lower crustal levels;
- g. partial melting and formation of granitoid magma, with particular emphasis on the role of water and oxidation/reduction conditions and evolution of I-, S- and A-type granite magmatism;
- h. volcanism in connection with metallogenesis;
- i. accessory minerals in relation to magmatic, metamorphic and melt/fluid reactions;
- j. Isotope study in minerals and geochronology of mineral evolutionary stages.

2. analysis and interpretation of important phenomena and characteristics of the physical fields of the Earth

- a. analysis of seismic recordings from the National Network of Seismic Stations as well as from the European AlpArray temporary seismic network as a part of the international data exchange;
- b. collection and analysis of macroseismic data after earthquakes observed in the territory of Slovakia;
- c. implementation of state-of-the-art methods for increasing precision of earthquake hypocentre locations, improving focal mechanism solutions of weak local earthquakes;
- d. research focused on space weather and developing the prediction models of geomagnetic activity due to various solar energetic events;
- e. research focused on testing and application of new Prutkin method to understand the gravity changes especially in volcanic area.

3. reconstructing climate, ecosystem, and environmental changes across major global and regional environmental events

The major goal is the integration of stratigraphic patterns generated by past climatic, tectonic and biological events during the Mesozoic and Cenozoic and to infer the dynamics of these events on the basis of geochemical, palaeobiological, sedimentological, taphonomic and geochronological approaches. We will target the following questions:

- a. tracing and quantifying the effects of climatic changes, extinctions, and ecosystem disturbances on the composition and diversity of benthic and planktonic communities preserved in the stratigraphic record of marine shelves and oceanic basins during the Mesozoic in the Western Carpathians, Alps, and other Tethyan regions (end-Triassic mass extinction, early Toarcian anoxic event, Jurassic/Cretaceous boundary, and Cretaceous anoxic events);
- b. inferring the sequence stratigraphy and depositional mechanisms of Palaeogene synorogenic turbidite basins in the Carpathians;
- c. detecting the Palaeocene-Eocene thermal maximum, the Mid-Eocene climatic optimum, and middle Miocene climatic optimum in the stratigraphic successions of the Carpathians, Mediterranean, and Atlantic, using planktonic foraminifers, calcareous nanoplankton, and benthic communities;
- d. reconstructing the environmental history of Late Miocene-Pliocene lake systems in the Pannonian Basin;
- e. reconstructing palaeoclimatic conditions during the Pleistocene and Holocene preserved in cave sediments and speleothems with geochronological and geochemical methods;
- f. modelling time averaging, stratigraphic mixing and fossilization dynamics of benthic skeletal assemblages on modern continental shelves since the last glacial maximum, and
- g. detecting human disturbances in the sedimentary record of continental shelves over the last centuries (Adriatic, California). We also intend to nominate several sections in the Western Carpathians as reference stratotype sections to calibrate the geological timescale and sedimentary archives of global and regional events. Multidisciplinary integration will be a major agenda of advanced stratigraphic, sedimentological and palaeobiological research because independent climatic and biotic proxies of environmental events significantly improve and constrain our inferences.

4. development and improvement of the analytical and numerical methods, especially of the integrated modelling with the specific emphasis on the numerical modelling of seismic wave propagation and seismic motion at sites of interest

- a. identification and characterization of a potential for anomalously large earthquake ground motion (site effects) in a local surface structure using robust numerical modelling of earthquake ground motion and statistical analysis;
- b. development and improvement of forward numerical methods for simulation of earthquake motion with the main focus on optimization and computational efficiency;
- c. increasing precision of methods for earthquake hypocentre location and improvement of focal mechanism solutions of weak local earthquakes;
- d. improvement of seismic noise analysis methods suitable for validation of seismic model;

- e. development and improvement of full waveform inversion methods for improvement of seismic model.

5. investigation of the origin and evolution of raw material

- a. genesis and origin of mineral deposits based on the study of geofluid, mineral, rock and melt compositions. Special care will be devoted to the stable isotope research and thermodynamic modelling of mineral- and rock-forming processes.
- b. perlite genesis to support exploitation strategy and utilization of this important environment-friendly industrial mineral;
- c. genesis of an unusual caldera-hosted epithermal Au deposit in the central zone of the Štiavnica stratovolcano (Western Carpathians) with the aim of supporting further exploration for this type of Au-rich mineralization;
- a. hydrocarbon potential of sedimentary basins, application-oriented basic research for developing various types of geological reservoirs
- b. maintaining, developing and extending the non-destructive micro-beam analytical basis needed also for research on historical artefacts, biominerals, and industrial stones;
- c. part of the existing analytical techniques and human capacity will be devoted to the public service and educational outreach, e.g. determination of rocks, minerals and meteorites, expert advice and consultation.

6. analysis of the geo-hazards, the effects of climate change and the factors menacing the environment

- a. seismic hazard assessment of the territory of Slovakia compliant with the Eurocode 8 standard: microzonation of the territory of Slovakia and estimation of suitable response spectra;
- b. continuous recordings of the climate parameters, air substances composition, and phenology at high-mountain localities;
- c. harmonization of monitoring methods of cryosphere;
- d. climate change impact at regional scale with a focus on mountain areas and impacts of climate change on biosphere in high mountains of the North-West Carpathians;
- e. multi-hazard assessment of the territory of Slovakia and enhancement of early warning systems;
- f. analysis of radon risk in the Slovak tourist caves.

The working areas include mainly the Western Carpathians, Eastern Carpathians, Eastern Alps, Rhodopes, Pontides, Scandinavian Caledonides, Brazilian Highlands, Central volcanic Carpathians complex, Volcanics of Tenerife, Mygdonian basin in Greece.

Future of the Earth Science Institute of Slovak Academy of Sciences

The Earth Science Institute of the Slovak Academy of Sciences was established on July 1, 2015 by merging the *Geological Institute of the Slovak Academy of Sciences* with the *Geophysical Institute of the Slovak Academy of Sciences*. The former institutes were founded in 1953 therefore and it is also an official date of origin of the whole Earth Science Institute. Presently, the institute is situated at four locations – Bratislava, Banská Bystrica, Hurbanovo, Stará Lesná. The diverse locations of the Earth Science Institute are an advantage for its orientation, and the further development of all locations should be in focus. The integration of the employees in Bratislava into a single building will be crucial for the future development of the institution.

(1) Infrastructure

Institute operates and maintains the Slovak National Network of Seismic Stations which was extended and modernized in 2003. Since that time there were very low investments to hardware, the network must be modernized in the next years. We will continue in our effort to include this infrastructure into Slovak ESFRI roadmap which will enable our full membership in EPOS-ERIC (European Plate Observing System - European Research Infrastructure Consortium).

Institute uses very modern laboratories and unique equipments in Banská Bystrica workplace, including e.g. mass spectrometry, electron microprobe, Raman spectroscopy, stable isotope laboratory. In the future these laboratories will be utilised not only for the basic research but also for service purposes. The laboratories are used not only by our researchers and workers from Comenius and Matej Bel universities, but also internationally by researchers and students from the Czech Republic, Hungary, Poland, Ukraine, Russia, and Romania. We will continue in the policy of the high accessibility of our infrastructure to other researchers. The modern laboratories with sensitive devices will be further developed at the workplace in Banská Bystrica as institutional core facilities for research and for service applications or purposes.

The core infrastructure and instruments must be modernized in the next years also in Bratislava work place of Geological division, mainly its separation and optical laboratory as well as some modernisation of the former analytical facilities. These laboratories will require care and next investments for sustainable future development.

A renovation of paleomagnetic laboratory and modernization of meteorological observation point are necessity in near future. Plan of modernisation will be progressively realised within years 2017-2020.

(2) Human resources

The backbone of research at our institution is formed by a team of highly qualified experts supported by active young scientists, students and technicians. The differentiated financial funding of the best experts will be widely applied. The organization will need to enhance its research capacity by improving salary conditions for the key scientists and by increasing the number of research positions, including the number of graduate students and postdoctoral scholars. A stronger effort to obtain international projects will be required from the core scientists. The core infrastructure needs high qualified, skilled researchers for it permanent and effective use, too.

A potential enlargement of the Institute by incorporating and creating a new branch oriented towards geomorphology and hydrology, is desirable if projects oriented towards water resources and management will be implemented at the institution.

Maintaining the high quality level of the international journal *Geologica Carpathica* and developing the quality of the journal *Contribution to Geophysics and Geodesy* will be an important agenda leading to integration of edition offices.

(3) Basic and applied research

The research realized in future must be basic and mostly international. It will be realized according to the above mentioned research directions mainly in the teams. The Institute will apply for projects towards wide international collaboration, for example, in the framework of the raw material strategy of the European Union, especially by cooperation with the Montana University at Leoben.

The majority of researchers are now also partly involved in applied research, mainly in collaboration with the Slovak oil company (Nafta a.s.) that can provide us access to unique borehole material. The target of such research in future will be the investigation of the structure, physical properties and tectonic evolution of the crust and lithosphere in the Carpathian-Pannonian region and quantitatively to improve the existing geophysical and geological models. The research aimed at the underground storage of hydrogen in Earth's gas reservoirs will probably form an important part of the institute's applied research activities. In addition to the research of high energy underground storage, we will also investigate low-capacity hydrocarbons reservoirs.

Another applied research activity with outcomes for basic research will be seismic hazard assessment and microzonation of sites with facilities critically important for operation of the nuclear power plant Jaslovské Bohunice. This study will be in cooperation with the Nuclear Regulatory Authority of the Slovak Republic.

The institute will only do the kind of applied research that will be open for publication of the obtained data. In this manner we will attempt to integrate applied and basic research.

One of the latest important activities of the institute is preparing a joint multidisciplinary research project based on complex modelling of cycles between Geology - Environment - Water and relations with forecasting the sustainable development of society.

4. Other information relevant for the assessment

The Earth Science Institute of the Slovak Academy of Sciences was formed by merging two institutes financed in different ways: the former Geological Institute was a contributory organization; the Geophysical Institute was a budgetary organization. The economic and administration department was unified as a first step of the institutional merger, allowing us to reduce the administration department by half.

Compared to the past we are extending our activities to get financial support for researchers via external funding sources, and this effort is visible already in this year. Through the Slovak Academic Information Agency, we obtained a short-term research scholarship of Jakub Bazarnik from Poland (Warszaw) and Liubomyr Gavryliv from the National Taras Shevchenko University of Kyiv (Ukraine). Moreover, we are more intensively involved to the training courses of foreign students which offer further new research data. During this summer, our institute organized mapping course for four students from the University of Texas at Austin (USA) accompanied by Prof. L. Catlos and prof. R.Kyle. During this course, we advised them on sampling of granites from the Western Carpathians for new datings, and these activities can lead to future collaborative papers. Fourty students from the AGH University of Science and technology (Krakow, Poland) will take part at a course of laboratory techniques at our laboratories. Our Institute employs Dr. Jan Vozar, who worked for six years at the Trinity University in Dublin, now he is co-funded by the European Union (SASPRO project). We started to participate within international KIC or EIT Raw Material scheme headed by the Montana Universität in Leoben (e.g. project bauxite deposits and provenance of the residue from the Balkans). Further coming activity will be the participation in the project WATERS in Central Europe via the Joint Research Centre of the European Commission.

The Earth Science Institute at the beginning of new existence needs the stability and consolidation of personel according to rules accepted by our Scientific council. It means a distinct motivation of core researchers and more significant mobility of the rest of researchers. The contribution to the existence of Earth Science Institute from the Presidium of the SAS is able to cover most of the personnel costs but only partly operation capacity (mainly heating). The running cost - administration, maintance of buildings and infrastructure, insurance, modernization etc. - is covered mainly from the projects and external contracts. Therefore, further development of institution strongly depends on quality of well-funded projects and contracts.