Evaluation of the Research and Professional Activity of the Institutes of the Czech Academy of Sciences (CAS) for the period 2010–2014

Final Report on the Evaluation of the Institute

Name of the Institute: Institute of Geophysics of the CAS, v. v. i.

Fields, in which the Institute registered its teams:

Earth and related environmental sciences

Observer representing the Academy Council of the CAS: Josef Lazar
Observer representing the Institute: Bohuslav Růžek

Commission No. 5: Earth and related environmental sciences
Chair: Prof. Dr. Franz Fiedler

Date(s) of the visit of the Institute: November 4, 2015
Programme of the visit of the Institute: see attached Minutes from the visit

Evaluated research teams:
No. 1 - Department of Geomagnetism; No. 2 - Department of Geothermics; No. 3 - Department of Tectonics and Geodynamics; No. 4 - Department of Seismology

A. Evaluation of the Institute as a whole

Report on the Geophysical Institute of the CAS

Foreword

The Institute consists of four departments (Department of Seismology, Department of Geomagnetism, Department of Tectonics and Geodynamics and Department of Geothermics), all of which have been evaluated by Commission 5. The Institute has not seen major organisation changes in the past five years; only the Geoelectric Department has been integrated into the Geomagnetic Department.

1. General impression of the institute (Main research activities)
The Institute does mostly primary research focused on physical and partly geological study of the solid Earth. It is in charge of monitoring the seismic activity in the Czech Republic and also performs permanent measurements of the magnetic field and other physical quantities. In the past, it has been involved in large Central European projects on the crust and mantle. Some of the research areas (studies on earthquakes in West Bohemia, environmental magnetism, etc.) and periodic information by the Institute's staff on seismic activity on the territory of the Czech Republic and abroad have an immediate impact on society's quality of life. Three of the four departments are purely geophysical and apply sophisticated methods connecting physical theory and experiment, and involving sophisticated mathematical modelling procedures. The fourth, youngest Department of Tectonophysics and Geodynamics integrated experts in gravimetry and seismotectonics, and currently mostly focuses on geological research of a nature similar to that of the Institute of Geology. This department is successful in acquiring young talented researchers who are open to cooperation with their geophysical colleagues, which opens future space for potentially interesting interdisciplinary research. The chief problem of the other departments, perhaps except the Geomagnetic Department, is a lack of staff in the age group of 30-40 years with good education in mathematics and physics who could progressively replace the strong older generation, which is still very powerful in the scientific realm. This problem is largely related to the political development in the Czech Republic in the 1990s and the low level of interest in studying mathematics and physics among the young generation today. The problem is further enhanced by the fact that the Institute is located far from university facilities and its staff are thus not in everyday contact with students. Given the low number of students of Geophysics at the Charles University Faculty of Mathematics and Physics, the Institute staff do not teach at this faculty, focusing instead on the CU Faculty of Science and other university facilities.
The SWOT analysis presented by the Institute correlates relatively well with the impression that Commission 5 acquired during the visit of the Institute. The ageing problem concerns primarily the departments of Seismology and Geothermics; the latter, noticeably smaller department also currently suffers from the fact that its head is fully occupied by his office of Vice President of the Czech Academy of Sciences. The chief problem of the Geomagnetic Department is the uneven quality of its scientific work. The department is highly thematically heterogeneous and associates dynamically developing and highly productive teams on the one hand and teams whose research production is stagnating or even decreasing in the long term on the other hand. This problem is the consequence of restructuring to which the department has been subjected in recent years and which has not been completed yet. The Department of Seismotectonics and Geodynamics, with geological rather than geophysical focus, was historically largely isolated from the rest of the Institute; it seems, however, to be successfully overcoming this handicap at present, largely thanks to the young staff who are open to interdisciplinary research. A strength of the institution as a whole is good scientific production, efficient connection of theory and experiment, and extensive collaboration with

institutions domestically and abroad. Some of the Institute's researchers belong among the top ones in the discipline. The institution publishes the international journal "Studia geophysica et geodaetica" (SSG)**,** an international peer-reviewed journal with IF= 0.806 (2014), currently classified in quartile 3. The journal serves for publication of papers not only in geophysics, but also in geodesy, where the publishing options are limited. According to a communication from the Chairman of the Board of the Institute, the peer-review procedure for the journal is comparable in terms of difficulty with periodicals such as the Journal of Geophysical Research, and the journal is suitable for doctoral students and young researchers who are only learning to publish. There is the question, however, of whether doctoral students should write papers directly for top-class journals which, unlike the SSG, have a much larger impact on the international scientific community.

2. Structure of the Institute

The structure of the Institute, divided into four departments, appears to be effective at present and matches the structure of the research done. The measurement of geophysical quantities at stations run by the Institute is well-organised and stable in the long run. The Institute library belongs among the largest of its type in the Czech Republic. The Institute is also successful at performing its societal function, consisting in provision of information and analyses related to seismic and geomagnetic activity. The Geopark near the Institute is a popular place for walks among the local inhabitants and for school excursions.

3. Role of the Board

The Board of the Institute has 11 members, of which 7 are internal (including the Director) and 4 are external. All the departments are represented in the Board. The Chairman of the Board is a charismatic personality, respected among the scientists, who strives for continuous development of the institution and promotes positive changes. The composition of the external section of the Board matches the geophysical focus: two members are from the Department of Geophysics of the CU Faculty of Mathematics and Physics, one is a seismologist from the Institute of Rock Structure and Mechanics of the Czech Academy of Sciences, and one is a physicist from the Institute of Atmospheric Physics of the CAS. The Board works efficiently; its influence on the Institute functioning is substantial and clearly positive.

4. Role of the Director

The Director appears to be a man of consensus, succeeding in maintaining good working relationships among the departments. His agenda is of a technical nature to some extent, and involves primarily the material functioning of the Institute, including acquisition of funds for the financially intensive operation of the seismic network and geophysical observatories.

5. Recommendations

The Institute's scientific work has maintained a high quality in the long run, but there is a risk of the research quality decreasing in the coming years in connection with the retirement of some first-class researchers who are now of retirement age or nearing it. Since a noticeable middle generation is absent from the Institute, it is necessary to pay great attention to raising young researchers and to the acquisition of talented scientists from outside. For post-doctoral researchers, the Institute should support long-term fellowships with first-class institutions abroad, and it should consider carefully which young researchers are promising to it. With long-term researchers, continuous attention must be paid to their scientific

performance and their benefits to the Institute ought to be gauged if they show poor results in the long run. The Institute should dedicate more resources to making itself visible in society and to promoting its work at faculties from which its future employees may be recruited.

B. Evaluation of the individual teams

Evaluation of the Team No. 1: Department of Geomagnetism

Report on the Research Team of Geomagnetism, Geophysical Institute of the CAS

1. **Introduction**. The team members deal with the research related to the Earth's magnetic field. The scope of the department activities includes numerical magneto-hydrodynamic modelling, electromagnetic induction research of crust and mantle conductivity, magnetotellurics, environmental magnetism and space weather.

2. **Strengths and Opportunities**. The team members have a good education in mathematics and physics and are experts in their field. The scientific activities of the team include both field and station measurements as well as the interpretation of data; an important part of the research is mathematical modelling. The scientific activity of a number of team members is internationally competitive, and some team members belong among the leaders in their field. The department is successful in obtaining talented young people and involving them in cutting-edge research. The team leader is a charismatic and internationally recognised person.

3. **Weaknesses and Threats**. The range of the team activities is wide and the quality of the research is quite heterogeneous. The productivity of individual groups varies considerably and in some cases has stagnated, which is in contrast with the performance of team members who successfully develop new directions of research. It appears that individual groups operate more or less independently and interactions within the department are rather rare.

4. **Recommendations**:

    - The evaluation panel recommends a critical reflection on the quality of the research of each group of the team. The research directions which are currently not as successful, but have a potential for further improvement, have to be encouraged to greater scientific productivity. Where research stagnates or its performance is declining, internal reorganisation should be considered, or eventually the unproductive line of research should be suppressed.

    - When hiring new team members, emphasis should be placed on quality education in mathematics and physics. Young people should be sent to long-term fellowships abroad and integrated into the team later.

    - The panel suggests that space weather research should be carried out jointly with members on the Institute of Atmospheric Physics who have similar research interests and experience.

5. **Detailed evaluations**.

a) The department as a whole produces good-quality output. Of the 24 evaluated articles, 4 articles are in Category 1 and 10 in Category 2. 40% of bibliographic outputs were published in journals with a high impact factor (the first decile to the second quartile), but an even higher percentage of articles has been published in journals in the third and

fourth quartiles. A more detailed analysis of the output confirms that the productivity of the team is quite heterogeneous.

b) The team members are actively involved in teaching at universities in the Czech Republic and abroad, and the supervision of student work at different levels.

c) Although the department primarily deals with basic research, some of its outputs, particularly in the area of environmental magnetism, have an immediate impact on the quality of life of society.

d) In the Czech Republic, the department has a dominant position in environmental magnetism, electromagnetic induction, magnetotellurics and numerical modelling of the geodynamo. Some of these fields are also successful in the international context. The department belongs among the best workplaces in the world in the area of environmental magnetism.

e) The team has a good age structure in the range between 25 and 55 years. However, a relatively high proportion (30%) of employees is in the age group over 65 years. It is worth considering whether the experience of all these workers is really important for the future development of the department.

f) The plan of the team is specific and quite detailed. However, it is only limited to the list of planned activities of each group, some of which are just continuing the previous work. It lacks a unifying strategic vision. When reading the plan, the reader has the impression that there are several independent divisions which have almost nothing in common. The plan does not address the concept of the department as a whole, neither does it deal with how to improve the quality of work of certain groups.

Evaluation of the Team No. 2: Department of Geothermics

Report on the Research Team of Geothermics, Geophysical Institute of the CAS

1. **Introduction**. The research team of the Department of Geothermics deals with the measurements of temperature and heat flux in boreholes. This kind of research has a long tradition in the Czech Republic and its history goes back to the 1960s. At present the research mainly focuses on studies of temperature variations in the past and due to climate change.

2. **Strengths and Opportunities**. The team has extensive experience with temperature measurement in boreholes and interpretation of the results of these measurements. In the past, it gained international notoriety when mapping heat flux and it currently participates in measurements which are important for the understanding of climate changes in the past. Jan Šafanda and Vladimír Čermák are internationally recognized personalities who belong among the leaders in their field.

3. **Weaknesses and Threats**. The team is not very large and its main weakness is the strong dependence on its leader who is very busy with his function of CAS vice-President. He is the only employee in the working age able to formulate a research strategy.

4. **Recommendations**.

- The team should be strengthened by young prominent personalities who have a good physics education.
- The research conducted by the team is of great importance for the study of paleoclimate. Team members should consider closer cooperation with climatologists at other CAS institutions or abroad.

5. **Detailed evaluations**.

a) The department produces good-quality publication output. Six papers were submitted for the evaluation, of which two were classified as Category 1 and one as Category 2. Most of the work was published in journals in the first and second quartile, and a significant minority in journals of the first decile. The articles have a decent citation index.

b) The team members participate in a limited way in supervision of students at the Faculty of Science of Charles University. Students are involved in the research work of the department. However, students with better education in mathematics and physics should be attracted.

c) The study of climate changes in the past is very important because it provides a better understanding of climate changes in the present. From this perspective, the research carried out by the department has a significant societal impact.

d) The position of the team in the national context can be described as exclusive. The results of the team are competitive in the international context and are internationally recognised. Team members develop working links with institutions abroad.

e) The team performance strongly depends on personalities who are already at retirement age XXX or close to it XXX. It is uncertain whether it will be possible to find somebody among the young team members who could replace them in the future.

f) The plan is quite brief, and most of the planned activities of the team builds on current projects. The team lacks a bold vision for the future, which is largely due to the negative factors mentioned above. Only little attention is paid to the links of conducted research to the study of climate changes.

Evaluation of the Team No. 3: Department of Tectonics and Geodynamics

Report on the Research Team of the Department of Tectonics and Geodynamics in the Institute of Geophysics of the CAS

1. **Introduction**. This group has energy, good ideas, and an understanding of "what it takes" to be a professional, and taken seriously by colleagues inside and outside the Czech Republic. Far too often geophysicists have little or no knowledge of geologic terranes (geologic entities) that they are assessing. Conversely, geologists often work without supplementary geophysical data. The group integrates geology and geophysics very well. The department has several basic research areas:

   a) volcanism related to tectonic plate margins. It is impressive that this group is investigating subduction-related volcanism, intra-plate magma movements (and volcanism), planetary volcanism, and (rather interestingly) magma and/or salt diapirism as causes of crustal deformation.

   b) upper mantle and crust dynamics. This group is quite innovative. They have an interesting hypothesis for a volcanic neck in USA, as well as Boe, NW Czech Republic. Their modeling evaluation of these features is fascinating.

   c) sea-levels and their cyclicity, and paleoclimates. This work is an interesting part of the group's overall success. Work on widespread Cretaceous-age rocks has been multi-disciplinary, including sedimentology, biostratigraphy, carbon isotopes, and magnetic susceptibility. The goal is to characterize the mid-Cretaceous thermal event with the inclusion of sequence stratigraphy. Some interesting applied projects include GPS and gravity work in the Bilina open pit coal mine, tilting of Jezerí Castle as a result of coal mining, and volcanic risk Rinjani volcano, Indonesia.

2. **Strengths and opportunities**. There is a broad representation of age groups in the department. All members are very up to date in methods and applications, as well as literature review. Diversity of research topics is impressive, and overlap with other institutes and departments is minimal. Work with international colleagues is to the department's credit. The group has reviewed publications in influential international journals, such as Earth and Planetary Science Letters (EPSL), Tectonophysics, Journal of Geophysical Research (JGR), Palaeogeography Palaeoclimatology Palaeoecology (PPP), Bulletin of Petrology, and others. These publications are witnesses of the team's efforts at international recognition; such are enhanced by work with others outside of the Czech Republic. Given these strengths, there is no question that the group has the ability and intention to produce much more published results.

3. **Weaknesses and threats**. Two aspects apply. There needs to be more effort in securing international grant funding. Work with foreign nationals should continue and increase. A second concern is that the “geological“ work done by the department must be recognized as augmenting geophysical investigations. A perception might emerge - that the group is duplicated by the Geological Institute or even some members of other institutes. The new group‘s continued development will attract more students.

4. **Recommendations**. The group is developing its momentum and should proceed along the niche in the Czech science system that it has innovatively developed.

5. **Detailed evaluations**.

a) Publications are improving in quality and quantity. Albeit a fairly new group, the members are well aware of their need to have high profile publications. As shown above, there are several high-profile publications already completed by the group.

b) There has been a reasonable number of students at all levels graduated via the department‘s program. Four PhD projects are listed as current. Numbers of M.S. and Bachelor degrees are increasing. Team profile paperwork shows some exciting research being conducted by the PhD students.

c) This group has a respectable impact on society. Coal mine work, with a focus on ground collapse, groundwater resource mapping, and microfracture analysis of the Melechov pluton are admirable.

d) The group should continue to expand its visibility in international media and conferences.

e) Vitality of the group is refreshingly high. With their new equipment, frontier research appears to be likely.

f) The future looks stable for this group. There is a refreshing mix of applied and basic research productivity by the group. This meets and exceeds expectations.

Evaluation of the Team No. 4: Department of Seismology

Report on the Research Team of Seismology, Geophysical Institute of the CAS

1. **Introduction**. The research team of the Department of Seismology deals with physical investigation of earthquakes and related seismic phenomena. This research includes observation of seismic activity in the territory of the Czech Republic, development of theoretical tools for physical description of seismic source and wave propagation, and numerical modelling of the seismic structure of the Earth's crust and mantle. Seismology in the Czech Republic is traditionally strong and its history goes back to 1920s.

2. **Strengths and Opportunities**. Most of the senior team members are seismologists with an excellent background in mathematics, physics and computing. In some areas, the research is world leading and has a substantial international impact. The department has strong professional links to geophysical institutions all over the world and it participates in international seismic experiments and projects.

3. **Weaknesses and Threats**. The age structure of the department is far from optimal. Almost 60% of researchers are older than 50 years and some of the key researchers are in their 60s. Only less than 20% of the staff is in the age group 30-50 and, what is worse, there are only few personalities in this age group who could replace the experienced researcher approaching the age of retirement.

4. **Recommendations**.

   - The team leaders should continue to attract young and mid-aged researchers from abroad using suitable home and European grants (Czech Academy stipends, Marie-Curie fellowships, EC grants, etc.). This strategy has already been successful in the case of a Czech researcher who spent several years at ETH Zurich and will enter the department next year.

   - In cooperation with the institute management and the partners from the Charles University, the department should create an effective PR strategy which will raise awareness of its research activities.

   - The tenure track positions should only be offered to people with international experience and a sufficient knowledge of mathematics and physics.

5. **Detailed evaluations**.

   a) The publication record of the team is very good. Twenty five papers were submitted for evaluation; 6 were judged to be in category 1, 18 in category 2, and 1 in category 3. The research team of the Department of Seismology is one of the most productive teams in the field of solid Earth research in the Czech Republic and most of its research outputs are internationally competitive.

   b) Due to the lack of students of geophysics, the team members are not much involved in regular teaching activities at home university institutions. Nevertheless,

they supervise several PhD students in cooperation with the Charles University and participate in research seminars held at the Department of Geophysics of the Faculty of Mathematics and Physics.

c) The department's fundamental work lies in basic research and monitoring of seismic activity. Besides the basic research, the team members provide the public with information regarding the seismic activity in the Czech Republic and large earthquakes in the world, and, to a limited extent, they participate in projects of seismic hazard assessment.

d) The Department of Seismology plays the key role in organising both experimental and theoretical seismological research in the Czech Republic. Some of the members of the department have established a fruitful cooperation with foreign laboratories and institutions which is manifested by a large number of papers written by international teams.

e) The further development of the department is threatened by the lack of qualified young researchers who could effectively replace the old guard. The solution of the problem is complicated by the small number of students interested in theoretical geophysics and by low salaries in research in comparison with older EC countries. There is a danger that the department will attempt to improve its age structure by hiring young people without sufficient physical and mathematical education and/or it will discourage the young researchers from applying for post-doctoral fellowships abroad, fearing that they will not return. Such a personal strategy would eventually lead to a decrease of quality of the geophysical research at the department. The network of seismic stations run by the department is vulnerable to variations in governmental support of research infrastructures.

f) The strategy and future research plans are described in detail and they are good in all respects.

Date: December 28, 2015

Commission Chair: Prof. Dr. Franz Fiedler