

THE “SABBA S. ȘTEFĂNESCU” INSTITUTE OF GEODYNAMICS OF THE ROMANIAN ACADEMY AT ITS 25th ANNIVERSARY

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The “Sabba S. Ștefănescu” Institute of Geodynamics of the Romanian Academy was constituted in 1990 (Government decision HG no. 364/April 3, 1990), simultaneously with the revival of the Romanian Academy. At its constitution, the Institute was based on the Laboratory of Geodynamics and the Research Group for Natural Fields, which used to be, together with a Laboratory of Seismology and a research group for Rock Mechanics, parts of the Centre of Earth Physics and Seismology; the latter became in 1990 the National Institute for Earth Physics. The founding Director was Dr. eng. Dorel Zugrăvescu, corresponding member of the Romanian Academy since 1991, who led the Institute till his retirement from the position in 2006. On November 25, 2015, the Romanian Academy celebrated both the 25th Institute’s and the 85th Dorel Zugrăvescu’s anniversaries.

The Institute continues a tradition begun in the framework of the Geophysical Research Centre of the Romanian Academy when, on the occasion of the February 15, 1961 total solar eclipse, it may be considered that instrumental Geodynamics was introduced in our country. On the occasion of this eclipse, in a building belonging to the Căldărușani monastic complex, the first recordings of the variations in time of the gravitational field in our country were carried out, using as a sensor an Askania type gravimeter and recording systems of own construction. Also, recordings with a paraconical pendulum, devised by Maurice Allais (1980 – Nobel Prize in Economical sciences) and constructed by Dorel Zugrăvescu, have been simultaneously carried out at the time. At present, the Căldărușani Geodynamics Observatory is functioning in the building where these recordings were carried out. The co-operation established in 1961 between the *Căldărușani Monastery* and the

Căldărușani Geodynamics Observatory (the Geophysical Research Centre) was officially celebrated in 2001 (Fig. 1), on the occasion of the anniversary of four decades of existence of the first, and up to now the only co-operation established between one of the orthodox churches – the Romanian Orthodox Church and a scientific forum – the Romanian Academy.



Fig. 1 – The signatories of the collaboration between the Căldărușani Monastery and the Căldărușani Geodynamics Observatory, on the anniversary of four decades of cooperation (left – Dorel Zugrăvescu, right – Gherasim Cristea, former Abbot at the Căldărușani Monastery)

Since its foundation, the Institute of Geodynamics “Sabba S. Ștefănescu” of the Romanian Academy has focused its interest on fundamental research imposed by the tasks implied by the Priority Program of the Romanian Academy “Complex Geophysical Research in Geodynamically Active Areas Concerning Especially the Vrancea Seismogenic Area”, regarding particularly:

– the study of space-time variations of some parameters causally linked to the accumulation

of stresses responsible for earthquakes occurrence; measurements in observatories and networks regarding the gravity, geomagnetic and geoelectric Earth's fields, as well as crustal deformation and relative displacements of tectonic blocks;

- the electric tomography of the Vrancea seismogenic area;
- relationship between internal geodynamic processes and the seismicity of the Vrancea area;
- modelling of the thermo-mechanical evolution of lithosphere;
- main geomagnetic field and its secular variation;
- evolution of endogene processes and volcanism in correlation with geodynamic processes;
- evaluation of natural hazards;
- the study of the correlation between fluid dynamics and crustal stress;
- construction of equipment for geodynamic observatories and mobile laboratories;
- complex inter-disciplinary research on the environment in which the Earth is evolving: the solar-terrestrial interaction, the atmosphere – solid Earth coupling, the non-linear analysis of geodynamic systems.

The above research is carried out at present within the frame of seven departments, namely:

1. Electromagnetism and lithosphere dynamics (head: Dumitru Stănică)
2. Solid-Earth dynamics (head: Lucian Beşuţiu)
3. Endogene processes, natural hazards and risk (head: Mihai Tatu)

4. Natural fields of the Earth (head: Venera Dobrică)

5. Fluids role in lithosphere dynamics (head: Lidia-Maria Nuţu)

6. Geodynamics observatories / the UNESCO chair in Geodynamics (head: Dorel Zugrăvescu)

7. Complex analysis of geophysical data (head: Alina Marin).

The administration of the Institute is undertaken by other three offices (Accounting, Human Resources, Maintenance). At present the Institute is composed of 91 employees, out of which 47 research staff.

The research infrastructure of the Institute is composed of:

- network of observatories and observation points concentrated in three geodynamics polygons (the Caldăruşani – Tulnici Geodynamics Polygon, the Crăciuneşti – Deva, Sarmizegetusa Regia, Padeş – Gorj Geodynamics Polygon and the Danube Delta - Mangalia Geodynamics Polygon – see Fig. 2);
- network of repeated gravity and GPS measurements along main tectonic contacts (Tornquist-Teisseyre, Peceneaga – Camena, Trotuş faults);
- network of annually repeated geomagnetic measurements;
- mechanical/electronics shop for equipment construction;
- HPC (High Performance Computing Cluster).

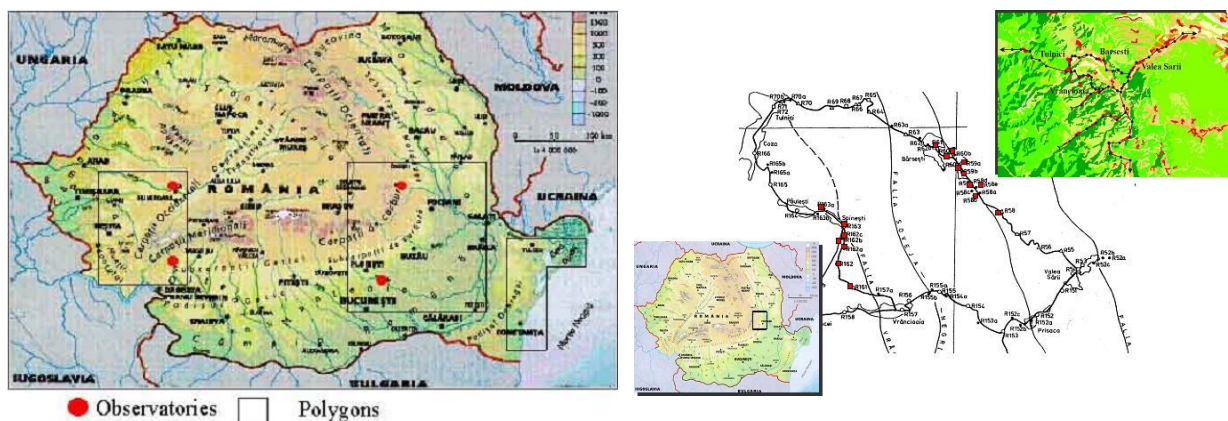


Fig. 2 – The geodynamics observatories and polygons (left) and a detail regarding the network of pillars for gravity and GPS measurements in Vrancea area

We underline here that the present configuration of polygons and the geodynamics observatories are a result of a long, sustained efforts of a small group of technicians led by Dorel Zugrăvescu to create conditions for accurate measurements of crustal deformation (Earth tides included) in Romania, as regards both the equipment and the environment, since the first measurements done in 1961 to the present, of course, within the time-changing organizational frame in which the instrumental geodynamics had to develop. It is important to stress that the dedicated sensors that are installed in observatories (horizontal quartz pendulums, water-tube tiltmeters, extensometers, etc. – see Fig. 3 for an example) had been built in the Institute’s mechanical/electronics shop. As well, the equipment was installed in old, mechanically stabilized mine galleries (Ursoiu Observatory – Fig. 4) or deep inside caves (Padeș – Gorj Observatory), in order to ensure a constant environment (temperature included) necessary for the correct functioning of the very sensitive geodynamics equipment. Where natural conditions were not found, proper ones were created, as was the case with the Căldărușani Observatory: even if the building were an old, very well stabilized, 70 cm thick-wall one,

provision was taken to implant the equipment pillars as deep as possible in the consolidated rock beneath the building, avoiding in the same time any contact to the building walls (see in Fig. 5 an axonometric presentation of the pillars); also, a proper thermal insulation was insured by creating a double-wall room to host the equipment.

Important results obtained by the Institute’s researchers to the first years of the 21st century are illustrated, as examples of syntheses resulted from reinterpretation of specific data, in Figs. 6 and 7: geodynamic compartments on the Romanian territory (Zugrăvescu *et al.*, 1997), recent vertical crustal movements (Zugrăvescu *et al.*, 1998), heat flow map of Romania (Demetrescu and Andreescu, 1994), thermal model of the lithosphere including the Vrancea seismogenic volume (Demetrescu *et al.*, 1998), electromagnetic tomography of the Vrancea area (Stănică *et al.*, 2004), a new concept on geomagnetic field constituents and geomagnetic jerks (Demetrescu and Dobrică, 2005, 2014), a new image on the crustal magnetic properties in Romania (Beșuțiu *et al.*, 2008). In 2005, a highly sensitive vertical pendulum of own design (mass – 25 kg, length – 17 m, oscillation period – 8 s) had been constructed. It was installed in the Underground Geodynamic Observatory Crăciunești – Deva.

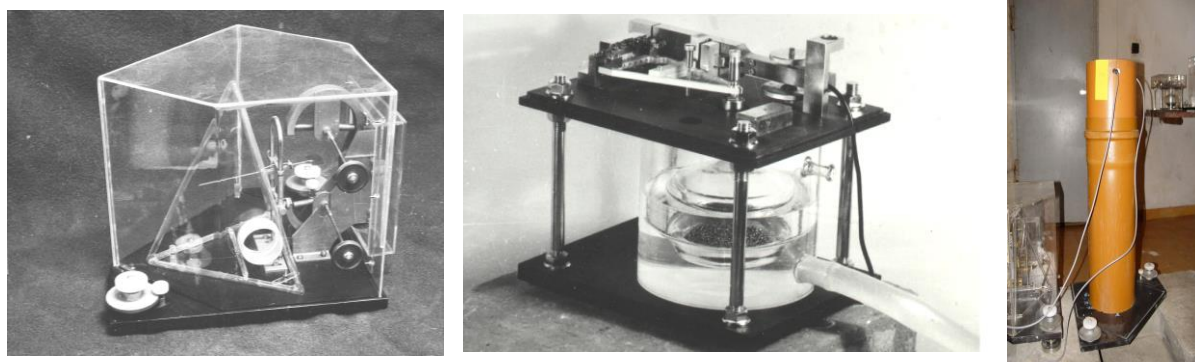


Fig. 3 – Examples of geodynamic sensors of own construction (left – horizontal quartz pendulum, middle – water-tube tiltmeter, right – vertical pendulum).



Fig. 4 – Ursoiu Observatory
(left – surface building; right – axonometric view of the underground observatory).

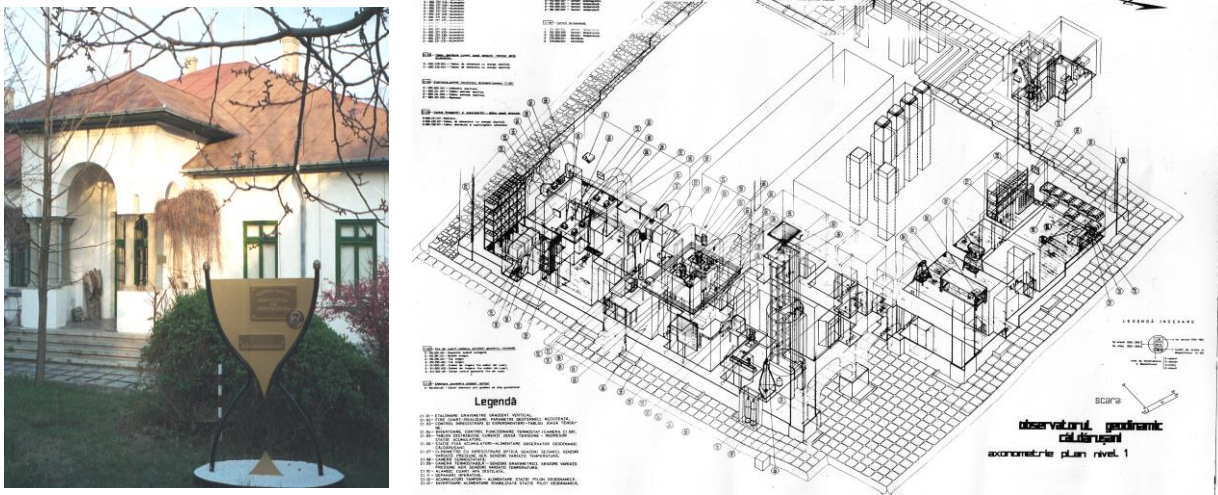


Fig. 5 – The Căldăruşani Observatory.
(left – observatory building; right – an axonometric presentation of the pillars).

In the last ten years the research palette has been diversified according to contemporary trends in this science branch, without giving up the directions already approached. We can mention in this respect research regarding the geomagnetic field at the core-mantle boundary, the solar-terrestrial relationship, based on study of the interaction between the solar wind and the terrestrial magnetosphere, research on electromagnetic precursors to Vrancea earthquakes, based on dedicated measurements in a new geodynamics observatory (Proviţa de Sus), monitoring by geodetical means horizontal displacements on the Peceneaga – Camena fault at the Başpunar geodynamics station, construction

of the HPCC facility (supercomputer CYBERDYN) to model the evolution of the lithosphere in the Vrancea area, as well as other geodynamic processes that take place in Romania.

The performance and the international visibility of the Institute of Geodynamics have constantly increased along years, as is attested by performance indices (see an example for the last three years in Fig. 8) and, respectively, by the cooperation of the Institute with foreign scientific organizations such as the Royal Belgian Observatory – Belgium, the Institute for Theoretical Geodesy of the University of Bonn – Germany, the Institute of Geophysics of the

University of Karlsruhe, Germany, the Walferdange Observatory – Grand-Duché de Luxemburg, the Institute of Earth Physics Paris – France, the Laboratory of Geophysics of Aarhus University, Denmark, the United Institute of Earth Physics – Moscow, Russia, the Institute of Geophysics and Geology – Kishinev, Republic of Moldova, the Institute of Geophysics – Bratislava, Slovak Republic, the Institute of Geodesy and Geophysics – Sopron, Hungary, the Institute of Nuclear Research –

Debrecen, Hungary, the Institute of Seismology and Volcanology of Hokkaido University, Japan, the United States Geological Survey, USA. Also, in 2001, the Institute of Geodynamics of the Romanian Academy founded, in cooperation with the United Institute of Earth Physics of the Russian Academy of Sciences, the *International Virtual Laboratory of Geodynamics (LIVG)*, supported by UNESCO – Paris. This is currently becoming an international network of specialists from institutes interested in geodynamics.

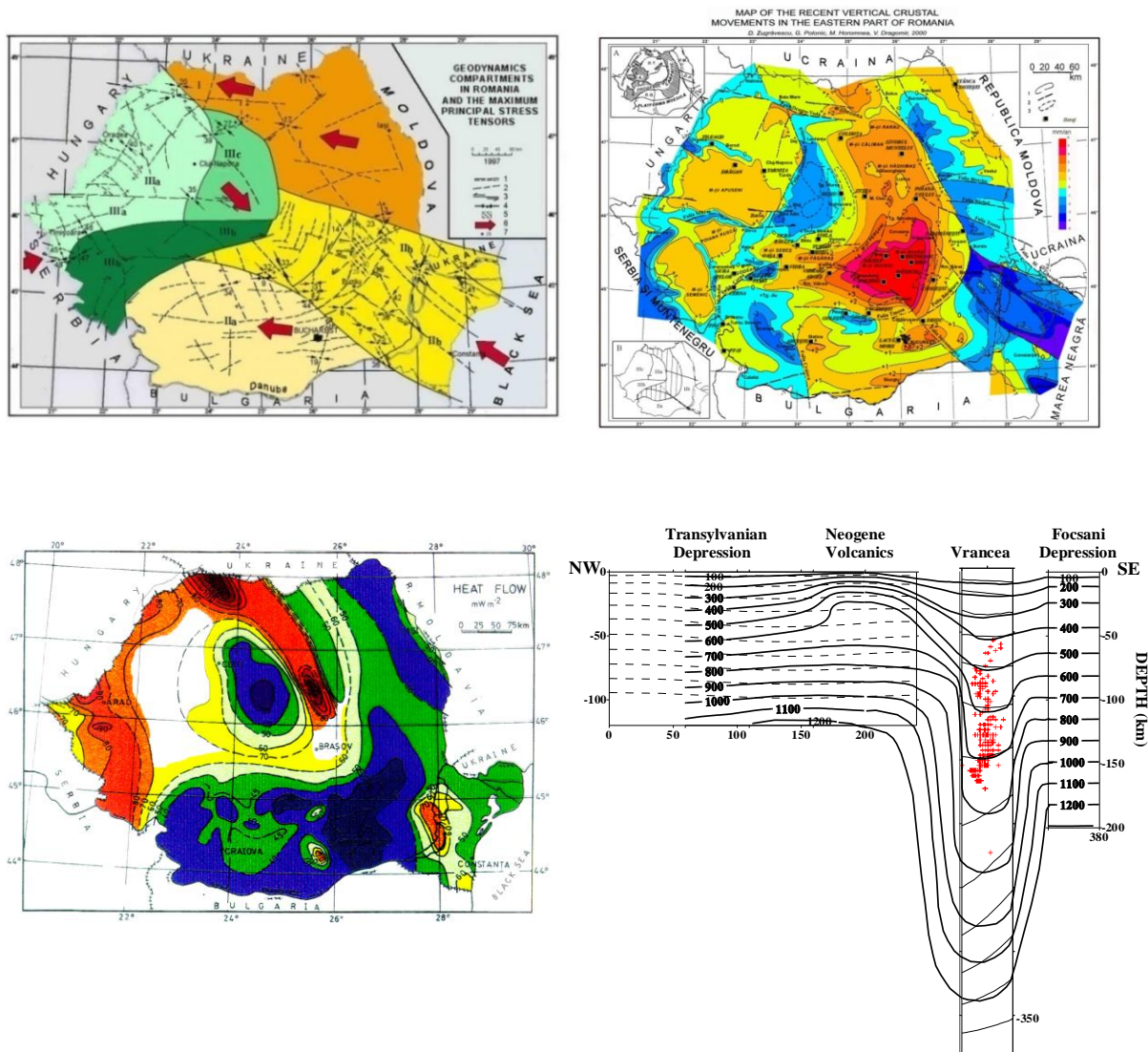


Fig. 6 – Geodynamic compartments on the Romanian territory (upper left); recent vertical crustal movements (upper right); heat flow map of Romania (lower left); thermal model of the lithosphere including the Vrancea seismogenic volume (lower right).

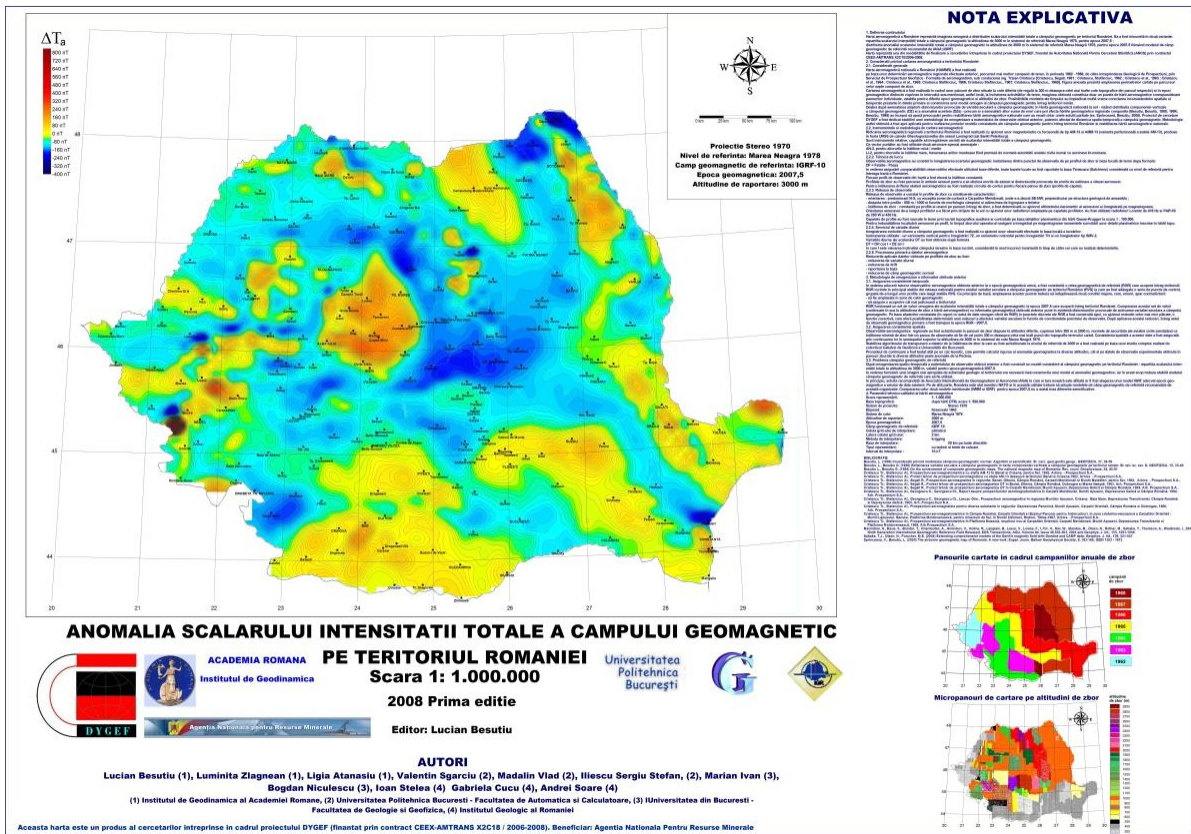
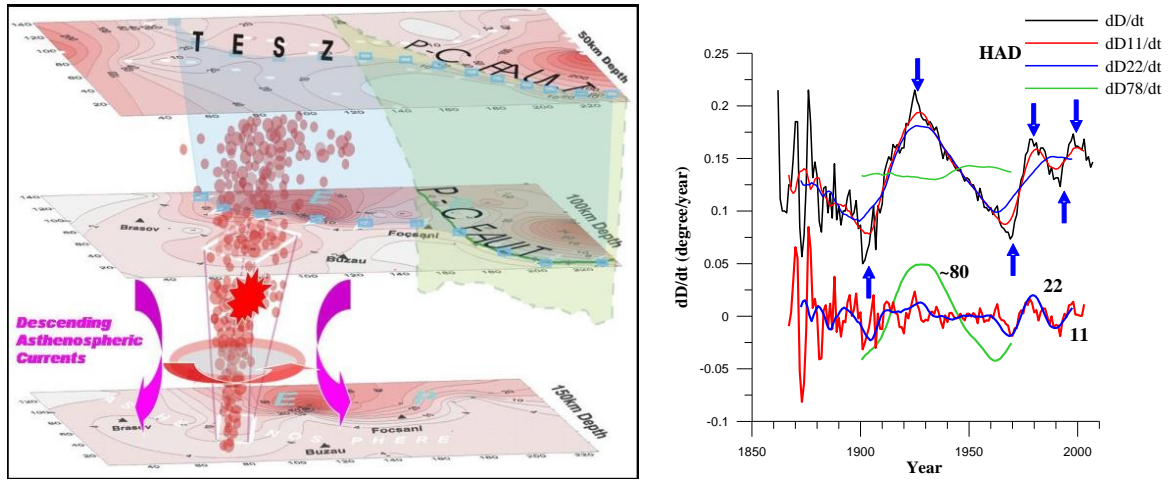


Fig. 7 – Electromagnetic tomography of the Vrancea area (upper left); a new concept on geomagnetic field constituents and geomagnetic jerks (upper right); a new image on the crustal magnetic properties in Romania (lower panel).

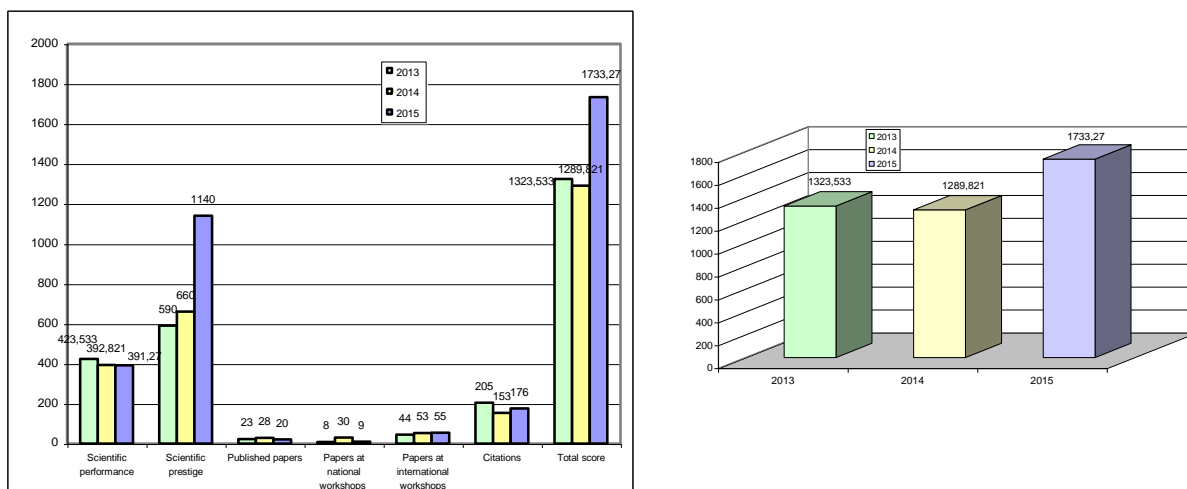


Fig. 8 – Performance score of the Institute of Geodynamics. Comparison for the last three years (left – evaluation items; right – total score).

In 2004 the first Romanian UNESCO Chair in Geodynamics was established, chairholder: Dr. eng. Dorel Zugrăvescu, corresponding member of the Romanian Academy. Several scientific sessions and field trips were organized under the auspices of this Chair, with researchers from the Royal Observatory of Belgium, Institute of Earth Physics Paris, France, Institute of Geophysics of the Academy of Sciences of Ukraine, Fribourg University, Switzerland, Saint Mary's University, Halifax, Canada.

The high performance of the Institute's researchers is also being proven by three European projects and over 40 projects, granted in the 25 years of activity, by the Romanian Academy and the Ministry of Education and Research (CNCIS/UEFISCDI, AEROSPATIAL, CERES, MENER, CEE, IDEI, TE).

Not in the least, the Institute of Geodynamics organizes, within the School of Advanced Studies of the Romanian Academy, Ph.D. programs in the domain of Earth Sciences – Geology. More than 20 members of the Institute have been involved in these programs in the 25 years that passed since the Institute came into existence.

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