

THE UNIVERSITY GEOPHYSICAL EDUCATION IN ROMANIA. LANDMARKS

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The paper is a detailed account of the university geophysical education in Romania, starting with the beginnings of applied geophysics in the framework of the Geological Institute of Romania (January 1st, 1925) and introducing geophysical classes in the Polytechnical School curricula between 1927 and 1948, continuing with dedicated departments in several higher education institutions, such as the Geological and Mining Technique Institute, Oil, Gas and Geology Institute, and finally Bucharest University.

Key words: education, geophysics, university, Romania.

The university education in Geophysics, on systematic bases, cannot be separated from the beginning and evolution of Geophysics application in Romania

A significant marker is represented by organizing, at January 1st, 1925 in the framework of the Geological Institute of Romania, by initiative of Ludovic Mrazec, the president of this institution, of the Geological and Mining Prospection Section, as a way of orienting the fundamental geological research of the Institute towards practical and economical applications. In a short time, this section became the Prospecting and Applied Geophysics Section, recognizing the role and development perspectives of the new geophysical methods for subsoil research, in close connection with the identification and evaluation of mineral resources for the Romanian economy.

The core of specialists with the role of organizing and introducing geophysical prospecting methods included Toma Petre Ghițulescu, Iulian Gavăț, Mircea Socolescu and Sabba S. Ștefănescu. All of them conducted the Prospecting and Applied Geophysics Section of the Geological Institute of Romania during 1926–1950, following Prof. David Roman (died 1927), the first head of Prospecting Section, who strongly supported the introduction and development of Applied Geophysics in its beginning phases.

In close connection with exploration drilling for hydrocarbons, the geophysical logging was

introduced in Romania in 1931, as a distinct branch of Applied Geophysics. In short time it became a compulsory geophysical technique, with significant informative potential and major economical implications.

The beginnings of Romanian geophysics extended over about 25 years, from 1925 to 1950, the year when some complex specialized companies were organized: the Prospecting and Laboratories Company (“Întreprinderea de Prospekțiuni și Laboratoare” – I.P.L.) in the framework of the Geological Committee of Romania, the Geological and Geophysical Prospecting Company for Hydrocarbons (“Întreprinderea de Prospekțiuni Geologice și Geofizice pentru Hidrocarburi” – I.P.G.G.H.) and the Well Logging and Perforating Company (“Întreprinderea de Carotaj și Perforare” – I.C.P.) – Ploiești.

The role and importance of geophysical methods in the higher education were presented, for the first time, by Prof. Toma Petre Ghițulescu in the framework of an Ore Deposits course, taught at Bucharest Polytechnic School during 1927–1935. An independent course of Geophysical Prospecting Methods was presented and published for the first time by Prof. Sabba S. Ștefănescu, at the same school, in 1936.

After 1948, the goals of the Romanian extractive industry development imposed the training of highly-qualified specialists for the field application of different geophysical methods and

techniques and, also, an efficient cooperation with geologists, engineering geologists and drilling and mining engineers, in order to extend the applicability domain of geophysical methods for practical and economical purposes.

The role and place of geophysical prospecting and geophysical well logging in the framework of complex geological research of subsoil being well defined after about 25 years of evolution, Geophysics was taught in the higher education process. Starting with 1949, at the Geology Faculty of Bucharest University, a *Geophysics* course was introduced and taught successively by Prof. Sabba S. Ștefănescu, Prof. Mircea Socolescu and Prof. Ștefan Airinei.

The higher education in Geophysics started in Romania in 1948, in the framework of the Geological and Mining Technique Institute (I.G.T.M.) – Bucharest.

During the 1950–1955 period, the Section of Geophysics existed with this name within the Geology Faculty, belonging in 1951–1952 to the Geological and Mining Technique Institute and from 1952 to the Bucharest Mining Institute.

The first series of geophysicists graduated in 1952. Before 1952, the specialists who worked in the field of Geophysics, particularly Applied Geophysics, originated from the graduates of Polytechnic Institutes, Faculty of Mining and Metallurgy, mainly from Bucharest and Timișoara, but also from other fields such as Physics.

At the Bucharest Mining Institute, within the Technical Geology Faculty, Geophysics was organized in a separate section of “Geophysical Prospecting”, started from the third academic year with a distinct Geophysics Chair conducted by Acad. Prof. Sabba S. Ștefănescu. For the development of engineering education in Geophysics, in the framework of the Geophysics Department (Section) and Geophysics Chair, a remarkable support was offered by Acad. Prof. Nicolae Petruțian, Rector of the Bucharest Mining Institute and, later, of the Bucharest Oil, Gas and Geology Institute.

In 1957, the Technical Geology Faculty from Bucharest Mining Institute was transferred to the Bucharest Oil, Gas and Geology Institute. In the framework of this institute, the engineering geophysics training was carried out under

different organizational systems, like the Geological and Geophysical Section, during 1970–1974.

Following the transfer of the Oil and Gas Institute to Ploiești, the higher engineering education in Geology and Geophysics of the Technical Geology Faculty moved to the Bucharest University, where, starting with the 1974–1975 academic year, a unique Engineering Geology and Geophysics Section was organized at the Geology and Geography Faculty. This structure was maintained until 1985, when the Faculty of Geology and Geography became the Faculty of Biology, Geography and Geology, by including the Biology Faculty of the Bucharest University. In this faculty, a distinct Section of Geological and Geophysical Engineering continued its activity.

The last change in the higher education in Geology and Geophysics took place in January 1990, when the Faculty of Geology and Geophysics was organized at the Bucharest University and the Geophysics Section became a distinct specialization. It is worth mentioning that higher education in Geophysics was structured and developed in close correlation with the higher education in Geological Engineering.

A key role in the organization and development of the higher education in Geophysics was played by the Geophysics Chair, where all the problems of various geophysical specialties have been discussed and solved by the contribution of teaching staff.

At the beginning, the Geophysics Chair benefited from the competent management of Prof. Sabba S. Ștefănescu (1950–1962), who was extremely active in organizing and developing the geophysical activity in Romania, with significant theoretical and practical contributions. It is worth mentioning that for a long time period (until 1967), Prof. Sabba S. Ștefănescu coordinated the Geophysics activity at the Geological Committee of Romania, being directly involved in the selection of areas for geophysical prospecting works and, also, in the monthly and yearly evaluation of the results. This activity was carried out in parallel with the complex teaching activity in the framework of the Geophysics Chair.

At the Geophysics Chair of Bucharest Mining Institute, the disciplines of Geophysics have

been covered by Prof. Sabba S. Ștefănescu, Prof. Liviu Constantinescu, Prof. Iulian Gavăt, Prof. Radu Botezatu, Assoc. Prof. Constantin Gheorghiu, Assoc. Prof. Aurel Iacovache and Assoc. Prof. Mircea Paucă. At the Bucharest Oil, Gas and Geology Institute, after 1957, and especially after 1960, the teaching staff in Geophysics increased by including new permanent members (Mihai Săsărman, Constantin Calotă, Aurelian Neguț, Adona Hagi, Paul Georgescu, Tudorel Orban, Gheorghe Stănescu, Adriana Pârjol, Dumitru Enescu, Dinu Ștefănescu, Matei Trâmbițașu) and, also, by including teaching staff from the Geodesy-Topography Laboratory of the Drilling and Exploitation Faculty (Prof. Gheorghe Constantinescu and, later, Lecturers Alexandru Fronescu and Eftimie Pănoiu). After 1974, the Geophysics Chair included also Prof. Ștefan Airinei, who covered three disciplines: *Geothermy* and *Marine Geophysics* (for geophysicists) and *Geophysical Research Methods and Techniques* (for geologists).

As Heads of the Geophysics Chair, Prof. Sabba S. Ștefănescu and later Prof. Liviu Constantinescu (1962–1973) and Prof. Radu Botezatu (after 1974) were permanently concerned for professional training and orientation of young teaching staff in the main fields of interest of the Geophysics Chair and, also, in maintaining and developing the scientific debate spirit regarding these fields. Such tasks were accomplished via periodical presentation of large scientific reports on theoretical and practical aspects concerning the application of geophysical methods or compulsory participation at the bi-monthly Seminars of Geophysics, organized by the Geophysics Chair.

For the same purpose of improving the professional training of the teaching staff, the Chair of Geophysics supported and covered the participation at specialization programs abroad for four young teaching staff members at that time: Aurelian Neguț, Constantin Calotă (Fulbright scholarships, U.S.A.) and Paul Georgescu and Gheorghe Stănescu (scholarships in the Federal Republic of Germany), during 1968–1973, with obvious benefits for their

teaching and scientific activity in the fields of Geophysics in which they were involved.

For a high-quality professional and scientific training of the students in Geophysics, during time, in close correlation with the established academic programs, the Geophysics Chair cooperated with several specialists – geophysicists from industry and scientific research fields, covering various domains of Geophysics, on variable time periods. For this category, we mention: Misac Nabighian (*Theory of Electromagnetic Field and Electrical Prospecting*), Mircea Rădulescu (*Theory of Electromagnetic Field*), Dumitru Paicu (*Seismic Prospecting*), Petre Tănăsescu (*Gravity Prospecting, Electrical Prospecting, Geological Data Base for Romanian Hydrocarbon Wells*), Vladimir Șteflea (*Magnetic Prospecting*), Andrei Soare (*Geomagnetism*), Dorel Zugrăvescu (*Geodynamics*), Vasile Vâjdea (*Remote Sensing*), Marius Visarion (*Geological Interpretation of Geophysical Data*), Dragomir Romanescu (*Magnetic Prospecting, Petrophysics*), Șerban Veliciu (*Geothermy*), Nicolae Heredea (*Radiometry, Environmental Protection*), Dumitru Ioane (*Gravity and Magnetic Prospecting, Geological Interpretation of Geophysical Data*), Vlad Roșca (*Gravity Prospecting*), Virgil Bardan (*Processing of Seismic Signal*).

Ever since its beginning, the Geophysics Chair worked as a homogeneous and coherent team, covering a variety of Applied Geophysics fields. All the teaching staff members, particularly the young ones, gained from their predecessors (Prof. Sabba S. Ștefănescu, Prof. Iulian Gavăt, Prof. Liviu Constantinescu and Prof. Radu Botezatu) an extremely important body of knowledge regarding not only the professional accomplishment, but also the personal development: necessity of continuous and solid work, responsibility, exigency and correctness, punctuality, scientific rigor and optimism.

A special mention to Prof. Iulian Gavăt for his decisive role in the complex activity of Geophysics, within the first nucleus organized at the Geological Institute of Romania in 1925,

focused mostly on gravity and seismic prospecting for hydrocarbons. In addition, Prof. Iulian Gavăt had a long teaching activity in our faculty, in the higher education of geologists and geophysicists belonging to the Engineering Sections. Two main disciplines were illustrated by Prof. Iulian Gavăt: *Geology of Oil and Gas Deposits* and *Geological Interpretation of Geophysical Data*. The *Geological Interpretation of Geophysical Data*, a unique discipline, which was maintained and continuously kept up to date in our faculty, offered to the geophysicists-engineers an essential advantage in their professional activity: the capacity to interpret, in an integrated manner, in geological terms, the complex geophysical results for a defined area of interest. At the present time, this course is also offered in the Geological Engineering program of our faculty.

The permanent members of the current Department of Geophysics are: Prof. Dumitru Ioane, Prof. Marian Ivan, Prof. Victor Mocanu, Prof. Cornel Păunescu, Assoc. Prof. Bogdan Mihai Niculescu, Assoc. Prof. Ionelia Panea, Lecturer Florina Chitea-Tuluca, Assist. Prof. Gina Andrei, Assist. Prof. Gabriela Militaru and Teaching Assist. Matei Mezincescu.

Currently, Geophysics is a distinct domain of Geosciences and a profession in continuous development and diversification. The Geophysics specialization, in the framework of the Faculty of Geology and Geophysics, covers the fundamental training of specialists for specific domains:

- Planning, organizing and managing the geophysical prospecting and borehole geophysics activities for fluids (hydrocarbons, ground waters) and solids (ore deposits, coals, mineral salts, raw minerals) by application of gravity, magnetic, electrical, seismic, radiometric and geothermic methods and complex well logging, in various geological and technical conditions (environments);
- Elaboration of geophysical maps, cross sections and interpretation models (national, regional or detailed);
- Fundamental and applied research specific to the Earth's Physics (Seismology, Geomagnetism and Geodynamics);

- Solving specific problems of Hydrogeology, Engineering Geology and Environmental Protection;
- Marine Geophysics and Remote Sensing.

The particular training in the field of General and Applied Geophysics is continuously improved and adapted to the national and international technical-scientific evolution and, also, includes a fundamental training (Mathematics, Physics, Geology, etc.), in order to allow the graduates an easy adaptation to the current technologies and their rapid changes in the future. The Geophysics specialization is highly requested by industry and scientific research institutions in Romania and worldwide.

Presently, the geological and geophysical engineering education is organized according to the Bologna System, with 4 years of studies (240 credits). In the 1st and 2nd years the academic training is common for all engineering programs; the specialization for the domain of Geophysics is carried out in the 3rd and 4th years.

The academic disciplines, under the coordination of the Department of Geophysics, correspond to the following geophysical fields:

1. **Applied Geophysics** (Seismic, Gravity, Magnetic, Electrical, Electromagnetic, Radiometric and Geothermal prospecting methods, Borehole Geophysics and Geological Interpretation of Geophysical Data);
2. **Planetary Geophysics** (Earth's Physics, Seismology);
3. **Environmental Geophysics.**

The Licence studies are finalized with the title of *Engineer*. Geological background training has a significant weight in the geophysicists' education, along the academic years. In addition to the theoretical and practical training, field applications are offered to the students in the 2nd and 3rd years of studies, continued with a documentation practice for the Licence thesis during the 4th year.

The Licence (Diploma) thesis, elaborated by every student in Geophysics, represents the beginning of a specialization in a distinct domain of Geophysics for:

- Identification, delineation and evaluation of mineral resources (hydrocarbons, coals, ore deposits) or ground waters by geophysical methods (ground and airborne geophysical surveys, measurements in boreholes, remote sensing);
- Deciphering the structure of the Earth's deep interior, continental and oceanic crust and, also, the tectonic/geodynamic processes at a regional, continental or global scale;
- Studies of the geological hazards by geophysical methods, the evaluation of seismicity and seismic risk being the most important topics;
- Delineation and monitoring of soil, subsoil and ground waters pollution using geophysical methods.

The specialization in Geophysics is continued by a part of the graduates in Geophysics in the framework of Master studies (2 years program) organized by the Faculty of Geology and Geophysics for the domain of Geological Engineering, in Romanian language ("Master in Geophysics") or in English language ("Master in Applied Geophysics"). The Master in Geophysics program started in the 2009–2010 academic year and may continue, depending upon the number of applicants, either in Romanian language, in English language or in parallel.

The programs of Master in Geophysics complement two other Master studies domains for Geological Engineering:

- Evaluation of Sedimentary Basins and Mineral Resources (EBSRM);
- Engineering Geology and Environmental Geotechnics (IGGA).

The graduates in Geophysics may chose to continue their Master studies in the two domains above mentioned.

During more than 50 years of higher education in Geophysics organized in Romania, more than 1500 geophysicists-engineers have graduated, 170 of them being foreign students.

In the framework of the Geophysics Chair (currently, the Department of Geophysics) and Geophysics specialization, the Doctor Degree

(Ph.D.) studies have been organized exclusively in Bucharest, at the present Faculty of Geology and Geophysics. During the 1960–2010 time period, 111 geophysicists obtained the Ph.D. scientific title in the main domain – Geology and different branches of Geophysics specialization; 25 of them were foreign students from 12 countries. A number of 8 scientific titles of Doctor (Ph.D.) were obtained by Romanian geophysicists at foreign universities.

Currently, at the Faculty of Geology and Geophysics – Bucharest University, the Doctor Degree programs are organized in the form of Doctor Degree School, the candidates usually originating from graduates of Master programs. The Doctor Degree studies cover an extended area of theoretical and practical problems of Engineering Geology and Geophysics.

In the present organizational and development form of engineering higher education in Geology and Geophysics, the Geophysics specialization, unique in Romania at the Faculty of Geology and Geophysics – Bucharest University, must remain a distinct specialization due to the particular role and place of Geophysics in the framework of Geosciences, with multiple scientific, practical and economic implications.

As in the past, Geophysics is omnipresent in all fields of exploration and exploitation of mineral resources. New challenges will arise for geophysicists in the future, such as:

- Re-evaluation of mature hydrocarbon reservoirs by applying modern techniques and technologies in order to increase the final recovery factor;
- Exploration for gas hydrates;
- Identification and evaluation of gas reservoirs in compact formations ("Tight Gas Shales");
- Definition of the geological conditions for underground CO₂ storage;
- Multiple applications in environmental geology: evaluation, protection, remediation;
- Increasing the number of underground gas storage facilities;
- Re-evaluation of alternate energy sources (*e.g.*, the geothermal energy in Romania).

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Received: October 29, 2014

Accepted for publication: January 11, 2015