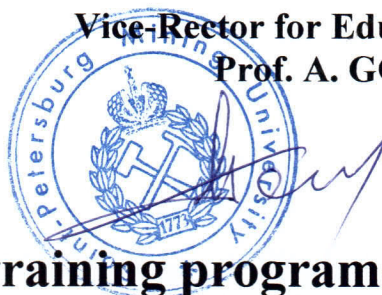


THE FIRST HIGHER TECHNICAL UNIVERSITY IN RUSSIA



MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
Federal State Budgetary Educational Institution of Higher Education
“Saint-Petersburg Mining University”



Approved by
Vice-Rector for Educational Activity
Prof. A. GOSPODARIKOV

18/12/2017

Professional training program

«PHYSICS OF THE EARTH»

Training Areas: 130101 ‘Applied geology’, 130102 ‘Geological exploration technology’, 120401 ‘Applied geodesy’, 130400 ‘Mining’

Mode of Study: full time

Course Leader

Head of Geophysical and
Geochemical Methods of
the Mineral Deposits
Prospecting Department,
Prof. A.S. Egorov

Course Developer:

A.S. Egorov, Head of
Geophysical and
Geochemical Methods of
the Mineral Deposits
Prospecting Department,
Dr.Sc. in Geology,
Professor

SAINT PETERSBURG
2017

General Provisions

Course objectives

Acquiring knowledge of the internal structure of the Earth, its energy sources and physical fields; systematization of the knowledge gained earlier from studying mathematics, natural sciences and the general professional disciplines; transition to the study of specific professional disciplines such as 'Applied geology', 'Geological exploration technology', 'Applied geodesy' and 'Mining'. The aim of the course is to provide students with knowledge about the physical fields of the Earth, the structure of the Earth and the conditioning parameters of the Earth by geological processes of the previous geological epochs. The students should get an idea about the main directions and methods of scientific research of our planet, its energy sources and resources.

Competences to be formed following the training results

The main professional competences to be formed following results of training are given in the Table below.

№ comp etenc e	Target groups	Description of professional competences gained /availability for occupational activities as part of the occupational performance types.
1	Managers and specialists - geologists, geophysicists and mining engineers of different specializations	Ability to process geological and geophysical data, analyze and interpret them based on existing international experience, Ability to present investigation results, draw and justify conclusions at a high scientific, technical and professional levels
2	Managers and specialists - geologists, geophysicists and mining engineers of different specializations	Ability to carry out high-tech research in the field of geological exploration, geodesy and mining industry of new technologies, including the modeling of systems and processes, automation of scientific investigations
3	Managers and specialists - geologists, geophysicists and mining engineers of different specializations	Ability to take and justify decisions in the fields of geological exploration, geodesy and mining enterprises
4	Managers and specialists - geologists, geophysics and mining engineers of different specializations	Ability to raise awareness in the problems of the Earth's interior exploitation for mineral resources complex
5	Managers and specialists - geologists, geophysicists and mining engineers of different specializations	Ability to establish natural origin of problem arising in the process of professional activity, to attract physical and mathematical technologies for its solving
6	Managers and specialists - geologists, geophysicists and mining engineers of different specializations	Ability to apply knowledge of modern methods of geological and geophysical investigations
7	Managers and specialists - geologists, geophysicists and mining engineers of different specializations	Ability to plan and carry out geological and geophysical research (investigations), to evaluate the results

8	Managers and specialists - geologists, geophysicists and mining engineers of different specializations	Understanding of the physical nature of the phenomena recorded in the geophysical fields, the ability to define and solve the problem of getting geological information from analysis of the geophysical fields
9	Managers and specialists - geologists, geophysicists and mining engineers of different specializations	Ability to solve primal and inverse geophysical problems, to achieve a high educational level

Practical experience of:

- development and justification of physical and geological model of the study area, selection optimal methods and techniques of geological exploration and adequate interpretation of geological and geophysical data.

Skills to:

- apply the knowledge of the laws of the Earth's development, the processes taking place in its interior space and regularities of natural physical fields and correlation of their characteristic features with different types of structural-composition units of the Earth's crust and patterns of localization of mineral deposits.

Knowledge of:

- the origin, regularity of development and present condition of the Universe and the Solar system;
- characteristics of deep interior structure, composition and evolution of the Earth according to the plate tectonics theoretical ideas;
- types of natural physical fields and their dependence on the parameters of the structure and composition of the Earth's crust and processes occurring in its interior;
- international and national programs of studying the Earth's deep interior using regional geophysical methods and technologies of deep and ultra-deep drilling;
- energy resources of the Earth.

Course description

Type of educational work	Total, hours
Total	72
Lectures	34
Laboratory and practical works	34
Individual work including preparations for the final test	2
Final test	2

Course structure

№	Module	Total hours	Including		Competencies list (see Table above)
			Lectures	Laboratory and practical works	
1.	Module 1. Cosmology, the origin and the general structure of the Earth	8	4	4	1, 8
2.	Module 2. Deep structure and evolution of the Earth based on	14	10	6	1, 2, 3, 8, 9

	the of the plate tectonics theory.				
3	Module 3. Geodynamic setting and forms of geographical relief.	2	2	-	
4.	Module 4. International and national research programs of the deep structure of the Earth's crust and upper mantle.	4	4	-	1, 2, 3
5.	Module 5. Physical fields of the Earth and their informative value in studies of the deep structure and composition of our planet.	24	16	8	5, 6, 7, 8, 9
6.	Module 6. The energy sources of the Earth.	4	4	0	1, 2, 3
	TOTAL:	68	40	18	

Final form of examination

The final form of examination is an individual test.

Certificates

After training program has been successfully accomplished, the listeners obtain certificates of advanced training in OSH.

Training process staffing

№	Full name	Education, qualification, Institution graduated	Position, academic degree, academic rank, work experience (years)	The total number of publications
Course Leader				
1	Alexey Egorov	Higher, mining engineer geophysicist, Leningrad mining institute	Head of geophysical and geophysical methods of mineral deposits exploration department, Professor, Dr. Sc. Geology, 44 years	More than 100 publications
Lecturers				
2	Igor Movcan	Higher, engineer, Leningrad state university	PhD, associate professor, 20 years	More than 60 publications

Course program

Training modules	Content of training material, laboratory works and practical classes, self-studies	Hours
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Module 1. Cosmology, the origin and the general structure of the Earth		
Topic 1.1 Cosmology.	The first ideas about the structure of the Universe. Geocentric and Heliocentric model of the Universe. Modern ideas about the formation of the Universe. The Big Bang theory. The shape of galaxies. The birth of stars. The energy source of stars. The material of the Universe.	2
Topic 1.2. The composition of the Solar system	Formation of the Solar system. Proto-planetary disks. Planetesimal, proto-planet. The structure, composition and physical characteristics of the Sun. The principal processes in the shells of the Sun. The Terrestrial planets (Mercury, Venus, Earth, Mars). The principal features of the Earth's structure. The Moon formation. Planets of the Jupiter group. Pluto's status. Asteroids and comets.	2
Module 2. Deep structure and evolution of the Earth based on the of the plate tectonics theory.		
Topic 2.1. Characteristic features of the Earth's deep structure within the continents and oceans.	The principal layers of the Earth. Parameters of the continental and oceanic lithospheres.	2
Topic 2.2. Formation and principal statements of the plate tectonics theory.	The idea of continental drift. Alfred Wegener's arguments. Disadvantages of the continental drift idea. Spreading and subduction. The principal statements of the plate tectonics theory. Energy sources of lithospheric plates migration. Age of present-day oceanic lithosphere. Migration of continents in the geological past.	2
Topic 2.3. Geodynamic settings and geophysical features of their manifestation.	Intraplate geodynamic settings: hot spots and mantle plumes; intracontinental rifts; intraplate basins; passive continental margins.	2
	Geodynamic settings of <i>divergent</i> (inter-continental and oceanic rifts) and <i>convergent</i> (island arcs and active continental margins) lithospheric plate boundaries.	2
	Geodynamic settings of collisional orogen, transform faults and zones of regional strike-slips.	2
Module 3. Geodynamic settings and forms of geographical relief		
Topic 3.1. Geodynamic settings and forms of geographical relief.	Forms of geographical relief created by geodynamical processes at the lithospheric plates' boundaries. The processes of the mass movement on the surface of the Earth. Mud-rock flood. Rock-falls, debris flows and rock avalanches. Snow avalanches. Submarine mass movements.	2

Module 4. International and national research programs of the deep structure of the Earth's crust and upper mantle		
Topic 4.1. National program of investigations of the Earth's crust and upper mantle deep structure along reference geophysical profiles (geo-traverses) and by ultra-deep drilling.	Aims and objectives of the deep structure of the lithosphere investigations. Data base.	2
	<p>The deep seismic sounding (DSS) seismic surveys. A typical model of radial layering of the crust according to DSS data. Principal scientific results of the regional DSS investigations.</p> <p>Regional CDP seismic method. Features of the CDP technique in the process of regional investigations. Sources of elastic waves activation. Infrastructure of seismic reflectors in deep section of the crust. Examples of CDP investigations. Principal scientific results of the regional CDP investigations.</p> <p>Deep structure and tectonic zoning of the Russian Federation territory. Characteristic features of the Northern Eurasia continental lithosphere continental shelf of Arctic and the Far East.</p>	2
Topic 4.2 "Study of the Earth's interior by ultra-deep drilling" in the framework of national scientific and technical program.	Basic scientific drilling projects in the Russian Federation. Kola, Uralian, Tyumen superdeep boreholes and others. The principal results of the scientific drilling.	2
Module 5. Physical fields of the Earth and their informative value in the studies of deep structure and composition of our planet		
Topic 5.1. The Gravity field of the Earth.	Theoretical foundations of the Earth's gravity field. Units of the gravity field. Newtonian gravity force. Centrifugal force. The shape of the Earth. The concept of isostasy. Isostatic models of Airy and Pratt. Isostatic recovery and viscosity of the lithosphere.	2
Topic 5.2. The Earth's magnetic field.	Theoretical foundations of geomagnetism. Magnetic declination and inclination. Normal geomagnetic field of the Earth. Anomalous magnetic field. Variations of Earth's magnetism. Plasmasphere and solar wind. The magnetization and magnetic susceptibility of rocks and ores. Curie point. Paleomagnetic stratigraphy. Strip magnetic anomalies.	2

Topic 5.3. The natural radioactivity of the Earth.	Principal application of radioactive decay properties in geophysics. The types of radiation. Gamma method. Spectrometer and radiometer. The penetrating ability of gamma rays. Ground and aerial surveys. Radiometric methods in prospecting for mineral deposits and in geological mapping. Age of rocks and radiometric dating. Schematic diagram of the radiometric dating. Uranium-lead dating. Principal assumptions while the radiometric dating. Potassium-argon and other dating methods. The oldest Earth's rocks. Material and age of meteorites. The age of the Earth.	2
Topic 5.4. Seismology and seismicity of the Earth.	Global seismology and seismic waves. Wavelength, amplitude and frequency. Seismic velocity. The wave front and rays. Measuring of seismic waves. Seismographs and geophones. Determination of seismic ray traces. P and S waves. Diving waves. The seismic model of the Earth. Ray traces in the Earth. Seismic tomography. What is an earthquake? Areas of earthquakes localization. Geodynamic settings of earthquake formation. Mechanisms of earthquakes. Calculation of the position of the earthquake source. Hypocenter and epicenter of an earthquake. Measurements of an earthquake magnitude. Seismically active zones of the world.	2

Topic 5.5. Electric and thermal fields of the Earth:	<p><i>Natural electric fields of the Earth.</i> Electromagnetic fields. The Earth's magnetosphere. Plasmosphere and ionosphere. Magneto-telluric fields. Natural variable fields of atmospheric nature. Electrochemical natural fields. Natural field of electro-kinetic nature. Magneto-telluric methods. Geo-electrochemical methods. Method of natural field measurements.</p> <p><i>Thermal fields of the Earth.</i> The history of geothermal investigations. The basic ideas of geothermics. Forms of the heat flow movements. Convection and conduction flows within the Earth. Heat flow and temperature. Thermal conductivity. The continental lithosphere and radioactivity. Heat generation. Parameters of the structure and composition of the lithosphere according to geothermal data. Geothermal energy and geothermal resources. Forms of practical application of geothermal energy: natural water vapor; hot water; hot dry rocks; heat pumps. Thermal radiation. Thermal surveys.</p>	2
Module 6. The energy sources of the Earth.		
Topic 6.1 The energy sources of the Earth.	<p><i>The energy sources of the Earth.</i> Energy sources in the history of mankind. Forms of hydrocarbons in nature. The origin of the hydrocarbons. Where are oil and gas deposits formed? Reserves and production of oil and gas in the World. Methods of extraction of hydrocarbon deposits. Coal deposits. The origin of coal. Classification of coals. The prospecting of coal deposits. Coal mines. Peat. Atomic Energy. Nuclear power plants. Hydroelectric power plants. The energy of the ocean waves. Geothermal energy. Wind and solar energy. Biofuels. Fuel cells. Recovery of hydrogen from industrial waste, using electrolysis process.</p>	4
Topic 6.2. Исследования континентального шельфа.	Types of drill ships and platforms. Analysis of international experience of oil and gas prospecting on the shelf. Features of geophysical investigations which are being carried out on the shelf.	2

Course venue – premises of The Saint-Petersburg Mining University.

Informational support of the program

The list of recommended textbooks, online resources for further reading.

a) main sources:

Egorov AS. Physics of the Earth: the textbook. St. Petersburg, 2015, National University of the mineral resources "Mining", the registration certificate number 43546, number of state registration of legal deposit of electronic publications - 03211600201

Егоров А.С., Глазунов В.В., Сысоев А.П. Геофизические методы поисков и разведки месторождений: учебное пособие. Санкт-Петербург, 2016» National University of the mineral resources "Mining. State registration number of legal deposit of electronic publications - 0321602335

b) additional sources:

- Labor Code of the Russian Federation dated from 30.12.2001 No. 197-FZ (with amendments).
- Federal Law dated from 28.12.2013 No. 426-FZ 'On Special Assessment of Working Conditions'.
- Federal Law dated from 28.12.2013 No. 421-FZ. 'On Amending into Individual Legal Acts of the Russian Federation in Connection with Passage of the Federal Law 'On Special Assessment of Working Conditions'.
- Federal Law dated from 24.07.1998 No. 125-FZ 'On Compulsory Social Insurance against Industrial Accidents and Occupational Diseases' (with amendments).
- Federal Law dated from 21.07.1997 No. 116-FZ 'On Industrial Safety at Hazardous Production Sites' (with amendments).
- Federal Law dated from 17.12.2001 No. 173-FZ 'On Labor Pensions in the Russian Federation' (with amendments).
- Ordinance issued by the Russian Ministry for Labor from 24.01.2014 No. 33n 'On Approval of the Methodology of Special Assessment of Working Conditions, the Classifier of Harmful and (or) Dangerous Occupational Factors, Forms of Reporting on Special Assessment of Working Conditions and Instruction on its Filling Out'.
- Ordinance issued by the Russian Ministry for Labor No. 549n from August, 12, 2014 'On Approval of the Procedure of State Assessment of Working Conditions'.
- Ordinance issued by the Russian Ministry for Labor No. 524n from August, 14, 2014 'On Approval of the Professional Standard 'Occupational Safety and Health Specialist'.
- Ordinance issued by the Russian Ministry for Labor from June, 24, 2014 No. 412n 'On Approval of the Standard Regulation on the Committee (Commission) for Occupational Safety and Health'.
- GOST 12.0.003-74*. System of Occupational Safety and Health Standards. Harmful and Dangerous Production Factors. Classification.
- GOST 12.0.230-2007. System of Occupational Safety and Health Standards. Systems of Occupational Safety and Health Management. General Requirements. ILO-OSH 2001. Guidelines on occupational safety and health management systems (IDT).
- GOST P 54934 – 2012/ OHSAS 18001:2007. Occupational health and safety management systems. Requirements.
- Resolution of the Independent Trade Unions Federation of Russia dated from 26.09.2007 No. 4-6 On Methodological Recommendations on Overseeing (Control) over the Status of the Occupational Safety and Health and Conditions at Work Places by Representatives of Trade Unions'.