Geology and Geoenvironment
MSc Programme
STUDENT HANDBOOK

Applied Environmental Geology, Stratigraphy-
Paleontology, Geography and Environment, Dynamic
Geology and Tectonics/ Hydrogeology, Geophysics-
Seismology

2013-14
TABLE OF CONTENTS

1. Geology and Geoenvironment MSc Programme 3
2. Specialization in Applied Environmental Geology 3
3. Specialization in Stratigraphy and Palaeontology 5
4. Specialization in Geography and the Environment 8
5. Specialization in Dynamic, Tectonic and Applied Geology 11
6. Specialization in Geophysics and Seismology 14

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1. Geology and Geoenvironment MSc Programme

The Faculty of Geology and Geoenvironment, University of Athens offers a taught postgraduate programme leading to MSc degree in the following specializations (majors):
- Applied Environmental Geology
- Stratigraphy- Palaeontology
- Geography and Environment
- Dynamic Geology and Tectonics/ Hydrogeology
- Geophysics- Seismology

The duration of study is 2 years (4 semesters) and includes a series of lectures, practical and field exercises in the first year followed by a student dissertation project in the second year. All courses are delivered in the Greek language. Some details on each specialization of the programme are given in the following paragraphs.

2. Specialization in Applied Environmental Geology


This program aims on providing students with skills appropriate to find solutions to geo-environmental problems, within the frame of sustainable development. The objectives of the course are:
- To provide the scientific understanding of the environmental risk and the assessment of contamination in soil, water and atmosphere due to natural processes and/or human activities.
- To provide skills needed for the management of energy resources, primary raw materials and wastes, surface and groundwater resources.
- To provide training in modern field and laboratory environmental methods for environmental assessment, protection and remediation.
- To provide knowledge on the National and European environmental legislation enacted for pollution prevention and remediation.

The content of the courses is described below.

1st Semester - Mandatory courses

1. Environmental Geology (10 ECTS-credits): General overview of environmental problems, geodynamic significance for evolution of the natural environment, environmental mineralogy and bio-mineralogy. Fieldwork and Laboratory practice

2. Environmental Geochemistry (10 ECTS-credits): Geochemical pollution of soil, water and atmosphere, kinetics of geochemical processes, the role of isotopes in geochemical processes, water chemistry, environmental implications of geochemical anomalies of elements, biogeochemistry, acid mine drainage and remediation technologies. Fieldwork and Laboratory practice.


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1 European Credit Transfer and Accumulation System
1st semester - Optional courses (two required)

1. **Technical works and environment** (5 ECTS-credits): Seismic activity and technical works planning, planning of technical works, foundation of technical works, dams, slope stabilization.

2. **Environmental Economics and Environmental law** (5 ECTS-credits): The course aims on providing an introduction to the theory of environmental economics, applications and case studies, and Environmental law - environmental authorizations. European Directive on Environmental liability in relation to the prevention and remediation of environmental damage.


2nd Semester - Mandatory courses

1. **Management of primary raw materials** (10 ECTS-credits): Geology of mineral deposits and geoenvironmental models, wastes from mining activity, pilot plants and metallurgical processes, remediation techniques,


2nd Semester - Optional courses (two required)

1. **Waste management** (5 ECTS-credits): Landfill selection criteria for the waste management, modern technologies, recycling.

2. **Conservation and restoration of monuments and archeological sites** (5 ECTS-credits): Identification of building stones-location of ancient quarries used for the exploitation of the building materials in order to use them for the monuments restoration. Conservation techniques

3. **Aquatic and terrestrial ecosystems** (5 ECTS-credits): Ecosystems, inshore and sea ecosystems. Pollution and remediation techniques

4. **Urban and emergency planning-Environmental impact studies** (5 ECTS-credits): The role of civil protection, civil protection authorities at national, regional and local level. Organization and promotion of volunteer organizations. Elaboration of the available scientific information for the mobilization of resources in case of emergencies.

3rd Semester

**Mapping in areas with environmental interest** (10 ECTS-credits): Application of Remote Sensing and GIS techniques. Seminars and Invited talks

4th Semester: **Dissertation (30 ECTS-credits)**: Preparation, presentation and examination.
3. Specialization in Stratigraphy and Palaeontology

This postgraduate specialization targets the most important issues in Stratigraphy, Sedimentology and Palaeontology. State or the art methodologies are taught and applied, such as high-resolution stratigraphic logging, chemostratigraphy, seismic stratigraphy, cyclostratigraphy and sequence stratigraphy. Sedimentary basin analysis is used in a multidisciplinary approach to the study of basin evolution and extent of mineral resources such as hydrocarbons. Fossils, apart from biostratigraphic indicators, are used to reconstruct the palaeoenvironment, palaeoclimate and palaeogeography, through palaeobiogeography and palaeoecology. Mass extinctions and their causes are examined as well as species’ evolution through geologic time (http://geopal.geol.uoa.gr/pms_%20ma8imata_en.html).

1st Semester - Mandatory courses


2. Sedimentological methods and depositional models (10 ECTS-credits): Outcrop and drill core description, depositional processes, sedimentary facies analysis and interpretation, lithostratigraphic units and sequences, sequence stratigraphy and correlation, 3D depositional models.

3. Informatics applications in geosciences (10 ECTS-credits): Introduction to Geographic Information Systems and geodatabase management.
2nd Semester - Mandatory courses

1. **Sedimentary basin analysis** (10 ECTS-credits): Sedimentary basin origination, filling and evolution. Stratigraphic, sedimentologic, tectonic, geometric and geochemical characteristics of the different basin types. Analysis methods: sequence stratigraphy, seismic stratigraphy, magnetostratigraphy, cyclostratigraphy, chronostratigraphy. Important past and present sedimentary basins of Greece: passive and active continental margin basins, foreland basins and back-arc basins. Flysch and molasse. Case studies and applications (e.g. in hydrocarbon research).

2. **Palaeogeographical methods** (10 ECTS-credits): Reconstruction of the palaeoenvironment and its evolution through geologic time. Calcareous and clastic formations interpretation, microfacies analysis, sequence stratigraphy, cyclostratigraphy, isotopic data incorporation, palaeoecologic analysis, palaeoclimate reconstruction. 2nd Semester - Optional courses (two courses are required)


3. **Macrofauna evolution in geologic time and space** (5 ECTS-credits): Fossil biocommunities’s structure and evolution in geologic time. Inter-population interactions. Biotic and abiotic conditions, environmental limitations (climate, substratum etc), internal dynamic parameters – biotic interactions, distribution limitations (geographic parameters analysis, mobility).

4. **Plant evolution in geologic time and space** (5 ECTS-credits): Plant evolution record, representations and chronology. The first plant forms and primal environments, the first woods, mass extinctions, biogeographic distribution and plant distribution through geologic time.

3rd Semester - Mandatory courses

1. **Stratigraphical – Palaeontological – Sedimentological applications in the field** (10 ECTS-credits): Field work methodologies in connection with the optional courses and the master’s thesis. This may include: Formation recognition and description, geologic mapping, facies lateral transitions and transformation, stratigraphic sequences field identification, tectonic phenomena field identification based on stratigraphic data, fossiliferous horizons, palaeontologic excavations, macroscopic description of the lithostratigraphic and sedimentologic formation characteristics, study and sampling methodologies in modern and palaeo- environments. On site facies identification and dating.

3rd Semester - Optional courses (four courses are required)

1. **Marine Ecosystems** (5 ECTS-credits): The role of microorganisms in the lithosphere – atmosphere – hydrosphere interactions. Biogeochemical indicators and microfossils. Primary productivity and the global carbon cycle, stable isotopes and palaeoceanographic applications. Marine protists (Coccolithophores, Foraminifera, Dinoflagellates etc) and the benthic meiofauna as environmental health indicators. Applications in the Greek marine modern and palaeo- environments.

2. **Terrestrial ecosystems** (5 ECTS-credits): Classification, protection and management. Sustainable use and development or terrestrial biotopes. Mediterranean ecosystems.
Stable and migrating terrestrial faunas. Terrestrial biodiversity analysis. Trophic chain model creation and energy flow in terrestrial ecosystems, using fossil remains of fish, amphibians, reptiles, mammals, bivalves, gastropods, insects, ostracods, and plants. Reconstruction of ancient terrestrial environments and ecosystems.


4. **Geological monuments and geotopes** (5 ECTS-credits): Natural monuments and Geological Heritage, monuments classification, geotopes and geological parks, recording, preservation, protection, conservation and presentation of geological monuments, important Greek geological monuments, Museum and Exhibitions.

5. **Alpine formations Stratigraphy** (5 ECTS-credits): The main formations of the alpine system in their palaeogeographic framework: Triassic evaporites, platform formations, condensed facies, pelagic formations (Ammonitico Rosso, Posidonia beds, Radiolarites, Maiolica-type limestones), Flysch, Molasse, Oceanic Anoxic Events and important chronostratigraphic boundaries in alpine formations.


4**th** **Semester: Dissertation (30 ECTS-credits):** Preparation, presentation and examination.

Students working during a paleontological excavation at Pikermi site, Attica.
4. Specialization in Geography and the Environment

During the academic year 2002-03 the Department of Geography and Climatology initiated the postgraduate specialization programme entitled “Geography and Environment” (http://www.geol.uoa.gr/engindex.htm). This M.Sc course aims to provide postgraduate students with skills appropriate in finding solutions to problems related to environmental geography and geology.

Objectives of the course:

• The scientific understanding of extreme weather events, natural hazards and climate change (e.g. floods, droughts, inundation, erosion, slides).
• The investigation of the various human impacts upon the natural environment, such as forest fires, soil erosion, dam construction, coastal works, changes in land use etc.
• To provide training in the modern field and laboratory methods for environmental assessment, protection and mitigation (e.g. digital mapping, remote sensing, GIS applications).
• To provide knowledge on aspects of the National and European Environmental Law in relation to environmental sustainability.

1st Semester - Mandatory courses

1. Mathematical Geography and Geographical Information (6 ECTS-credits): Geographic information systems for physical geographers and environmentalists, statistical methods in geosciences, spatial analysis, advanced geostatistics (regional variables and kriging), simulations and environmental applications

2. Geomorphological Techniques and methods of research (6 ECTS-credits): It includes geomorphological applications related to human constructions and land uses, a series of morphometric methods, geomorphological survey, photographs, sampling, mapping, regional palaeogeographic analysis, laboratory analyses with respect to physical and mechanical properties of rocks and soil.

1st Semester - Optional courses (two courses are required)

1. Fluvial Geomorphology (4 ECTS-credits): It covers the hydrologic cycle, fluvial geomorphologic cycle, fluvial erosion and deposition, analysis of drainage morphometric characteristics, human intervention, time-related evolution of river networks.

2. Principles of General Meteorology and Environmental Analysis (4 ECTS-credits): Vertical profile of the atmosphere, Stability/Instability conditions in the atmosphere, Meteorological elements (air temperature, precipitation, relative humidity, atmospheric pressure, wind), Time series analysis, Homogeneity tests.

3. Management of Aquatic and Terrestrial Ecosystems (4 ECTS-credits): Aspects related to terrestrial and coastal aquatic environments (e.g. coastal lakes, lagoons, dunes), draining systems, ecosystem sustainability, mitigation of pollution and remediation schemes.

4. Applied and Urban Geomorphology (4 ECTS-credits): It deals with issues related to human intervention in the natural environment such as managing of surface water resources, urban development, urban and industrial wastes management, environmental impact of man-made constructions (e.g. marinas, dams, motorways etc), problems related to changes in land use.

2nd Semester - Mandatory courses

1. Environmental Oceanography and Management of the Coastal Zone (10 ECTS-credits). It includes various environmental aspects concerning the marine environment (physical and dynamic characteristics of sea water, basic marine biology, sea level changes,
marine sediment) coast classification and aspects related to coastal zone management related to human activities and natural processes (e.g. tsunamis).

2. **Theoretical and Applied Climatology** (10 ECTS-credits): Climatic systems and related factors, earth energy balance, greenhouse effect, water (floods, droughts), general circulation of the atmosphere, climatic classifications, climatic change, air-sea interaction (El Nino), past climates, introduction to climatic models, methods on climatic data processing (e.g. Factor/Discriminant/ Cluster/ Time/Spectrum Analysis)

2nd Semester - Optional courses (two courses are required)

1. **Geospeleology** (4 ECTS-credits): The course is focused primarily on geological, physicogeographical and hydrological aspects, on types and geographical distribution (national and international) of caves and on methods of their exploration, management and protection.

2. **Natural Hazards** (4 ECTS-credits): Prognostic methods for extreme weather events (droughts, floods), impacts on natural environment / geomorphologic consequences (earthquakes, volcanic eruptions, landslides, tsunamis, coastal floods and inundation, erosion) and human intervention (forest fires, changes in land use, deforestation, man-made constructions). Spatial and time dependent analysis of selected natural hazards occurring in Greece (e.g. floods, fires, desertification, soil erosion).

3. **Environmental Changes during Quaternary – Archaeo-geomorphology** (4 ECTS-credits): Climate and sea level changes related to sedimentary sequences and relief evolution. Contribution of the geomorphological analysis in the understanding of relief evolution of the broader area of archaeological sites for identification of environmental and morphological changes within late Quaternary, aspects of prospecting, excavation and protection “exploitation” of archaeological sites.

4. **Energy sources, pollution and protection of the atmospheric environment** (4 ECTS-credits): Energy raw materials, Exploitation techniques of fly ash, sequestration of CO2 emissions from the lignite-fired power plants, geothermal and hydroelectric works and their environmental impact, aeolian and solar energy, energy policy, issues of atmospheric pollution.

3rd Semester - Mandatory courses

1. **Geomorphological Mapping** (6 ECTS-credits): Types of geomorphological maps, landform mapping (spatial scales, use of symbols). The combined use, extrapolation and incorporation of information derived from topographic maps, aerial photographs and satellite images. Landform morphogenetic analysis, geomorphological mapping contributing to the solution of environmental problems.

2. **Environmental Geomorphology** (6 ECTS-credits): It deals with environmental issues related to human activities (man as geomorphological agent), vulnerability related to geomorphological risk, geomorphological hazards (e.g. soil erosion, landslides, river floods, seismicity, active volcanism) and issues of geomorphologic impact assessment.

3rd Semester - Optional courses (two courses are required)

1. **Morphotectonics** (4 ECTS-credits): Large scale landforms as products of plate tectonics, landforms related to normal, reverse and strike-slip faults. The influence of active tectonics (faulting, folding) on drainage systems and coastal environments. Volcanic landforms, effects of tectonism on human activities.


3. **Applied Oceanography** (4 ECTS-credits): It focuses primarily upon aspects of beach (shore) zone formation and evolution (including human intervention), coastal erosion and mitigation techniques, sediment quality, marine resources, water pollution, modern sea level fluctuations, Law of the Sea.


**4th Semester:**
1. **Dissertation** (30 ECTS-credits): Preparation, presentation and examination.
2. Seminars and Invited talks

![Sea notches signifying sea level change at East Korinthiakos Gulf.](image)
5. Specialization in Dynamic, Tectonic and Applied Geology

This specialization includes two courses, alternating every other year. The first course gives emphasis to Structural Geology and Tectonics and the second course to Hydrogeology (http://dtag.geol.uoa.gr/courses.php?lang=en&category=2&type=1).

1st Semester - Mandatory courses
1. **Structural Geology** (10 ECTS-credits). Study of the orientation, deformation and relationships of primary and secondary foliations, which may have been faulted, folded or given a new foliation by some tectonic event. Cross sections and three dimensional block models of tectonic fabric.

2nd Semester - Mandatory courses
2. **Geological mapping** (10 ECTS-credits). Geological mapping of areas with emphasis on basic research and structural analysis or applications to hydrogeology.

3rd Semester Mandatory courses
1. **Techniques for long-term monitoring and recording of field parameters and field data sets** (10 ECTS-credits). Introduction and exercise to modern techniques that focus on long term recording of geological parameters and field measurements.

4th Semester - Mandatory
1. **Dissertation** (30 ECTS-credits): Preparation, presentation and examination.

Optional courses (three courses per semester are required in the first and second semesters)
1. **Tectonics of Greece** (7 ECTS-credits). Study of deformation structures and structural evolution in relation to regional structures. Examples from the geotectonic units of Greece.
2. **Neotectonics** (7 ECTS-credits). Study of the geologically recent deformation and motions of the Earth's crust, particularly those produced by earthquakes, with the goals of understanding the physics of earthquake recurrence, the growth of mountains, and the seismic hazard embodied in these processes. Neotectonics of Greece. Estimation of deformation rates and impact from seismic activation of faults.
4. **Seismotectonics** (7 ECTS-credits). Relationship between earthquakes, active tectonics and individual faults of a region. Understanding which faults are responsible for seismic activity in an area by analyzing regional tectonics, recent instrumentally recorded events, accounts of historical earthquakes and geomorphological evidence.
5. **Microtectonics – Metamorphism** (7 ECTS-credits). Deformation structures and mechanisms in the microscopic scale and linkage with metamorphic facies and events. Determination of sequence of events and relative or absolute age methods and techniques.

6. **Physics of deformation – Experimental tectonics** (7 ECTS-credits). Study of the physical processes that underlie deformation. Quantization of deformation. Spatial patterns of stress, strain, and differing rheologies in the lithosphere and asthenosphere of the Earth. Relationships between these patterns and the observed patterns of deformation. Laboratory techniques and methods for the modeling of rock deformation.


18. **Applied geophysics** (7 ECTS-credits). Study and application of geophysical techniques to hydrogeological problems. Introduction to basic principles and methodology of geophysical techniques. Presentation of selected cases and appropriate methods.


21. **Rock and Soil Mechanics** (7 ECTS-credits). Study of the mechanical behavior of rock and rock masses and soils. Principles of rock and soil mechanics. Response of rock and rock masses and soils to the force fields of the physical environment. Analysis of deformation and flow of fluids within natural and man-made structures that are supported on or made of rock or soil, or structures that are either buried in soils or built in or of rock. Examples applications: building and bridge foundations, retaining walls, dams, and buried pipeline systems, tunnels, mining shafts, underground excavations, open pit mines, oil and gas wells, road cuts, waste repositories, and other structures.


![Landslide aftermath in a village built on flysch rocks at Ioannina NE Greece.](image-url)
6. Specialization in Geophysics and Seismology


1st Semester - Mandatory courses


1st Semester - Optional courses (one course is required)


2nd Semester - Mandatory courses

1. Advanced Seismology II (10 ECTS-credits): Seismometry, Signal processing, Filtering, earthquake kinematics and dynamics, source spectrum, magnitude scales, body wave modeling, seismic arrays.


2nd Semester - Optional courses (two courses are required)


2. Exploration of the Deep Earth’s interior (5 ECTS-credits): Identification of seismic phases, traveltime curves, triplications phases, seismic profiles, crustal, mantle and core structure determination, local and regional earthquake tomography, surface wave tomography, SKS and surface wave anisotropy, teleseismic receiver functions.

3. Geophysical Applications in Archaeometry – Archaeoseismology (5 ECTS-credits): Engineering geophysical applications in the detection and mapping of archaeological targets; introduction to the principles and applications of Archaeoseismology.

3rd Semester - Mandatory courses
1. **Space-borne Applications in Geophysics and Seismology** (10 ECTS-credits): State-of-the-art methodologies of Space-borne applications in the Earth Sciences (e.g. GPS and SAR Interferometry)

3rd Semester - Optional courses (one course is required)

1. **Seismic Source Parameters and their Physical Properties** (5 ECTS-credits): Seismic sources and slip models, equivalent body forces, elastostatics, elastodynamics, seismic moment tensor, determination of faulting parameters, macroseismic parameters and their calibration.


3. **Environmental and Engineering Geophysics** (5 ECTS-credits): Application of near-surface, high-resolution geophysical exploration methods and techniques in environmental and geotechnical engineering problems.

4th Semester: **Dissertation** (30 ECTS-credits): Preparation, presentation and examination.