

## EARTH SCIENCE FOR FOREIGN STUDENTS

A one-year course of study will be offered in the year 2009-2010 for earth science students in the Faculty of Earth Sciences, covering topics in geology, geography, and geophysics. Emphasis will be put on aspects of Icelandic geology like volcanic and geothermal activity, glaciers and plate tectonics, as well as physical and human geography. The course should be suitable for Erasmus exchange students from the EU and others who want to spend a year in Iceland as a part of their university education. A minimum background of one year of undergraduate study in earth science is assumed. All teaching will be in English. Course descriptions are given below.

### Why study Earth Science in Iceland?

Owing to Iceland's geographical position in the North Atlantic, and its geotectonic position over a mantle plume and astride the Mid-Atlantic Ridge, geological and tectonic processes are extraordinarily rapid and easily observed in Iceland. On the constructive side, some 20 to 30 volcanic eruptions occur every century on average, producing lava in the order of  $45 \text{ km}^3/1000 \text{ years}$ . This production is counterbalanced by equally rapid destructive processes: thermal contraction, erosion by the North Atlantic waves, and by glaciers, wind, and rain. Chemical erosion, too, is surprisingly rapid owing to the highly reactive nature of the volcanic glass created in the Pleistocene subglacial eruptions.

In Iceland, some 400 km are exposed of the Mid-Atlantic ridge, allowing the student to observe and investigate the tectonic processes of crustal accretion, the central rift, fracture zones, submarine/subglacial volcanism and associated features and processes. The volcanics, too, are surprisingly varied both compositionally and in terms of appearance - from picrite to rhyolite, from glass to plutonic rock. Associated with the volcanoes are numerous geothermal systems, ranging from fresh-water to saline, and from warm to super-critical temperatures. Over 40% of Iceland's total energy consumption is geothermal, being an example of environment-friendly exploitation of nature.

Glaciers, large and small, cover about 10% of the country. This permits the hands-on study of periglacial environments similar to those that existed in Europe and N-America 10,000 years ago. The glaciers feed large glacial rivers in which subglacial volcanic eruptions and geothermal areas occasionally cause large floods (jökulhlaup). Nowhere on Earth are glaciers and large ice caps more easily accessible for study than in Iceland.

So, why study Earth Science in Iceland - under the guidance of University Professors having long research experience and who are active in the international arena in their respective



fields of study? Modern geology is process-oriented, and Iceland is exceptionally well suited for the study of various geological processes. Here the raw elements that have shaped the Earth throughout most of its 4.5 billion years' history are creating and molding the surface and lithosphere faster than in most other places. Therefore, geophysicists and physical geographers alike, geochemists, petrologists, and human geographers, will all benefit a great deal from studying in Iceland - how the forces of nature created the Earth we know, and how they shape the people living in Iceland.

<b>Fall semester, 15 weeks</b> <b>August – December</b>	<b>Spring semester, 15 weeks</b> <b>January - May</b>
<p><b>Introduction to the geology and geography of Iceland</b>  <b>10 ECTS</b>  <b>JAR106G</b></p> <p>a) 1 week study tour  b) 3 weeks 12 lectures/week  c) 1 week report and quiz</p>	<p><b>Glaciology</b>  8 ECTS  JAR609G</p> <hr/> <p><b>Quaternary Environments</b>  8 ECTS  JAR208G</p>
<p><b>Introduction to geophysics</b>  <b>6 ECTS, 10 weeks</b>  <b>JED104G</b></p>	<p><b>Volcanology</b>  8 ECTS  JAR610G</p>
<p><b>Current crustal movements</b>  <b>6 ECTS, 10 weeks</b>  <b>JED106G</b></p>	<p><b>Environmental geochemistry</b>  8 ECTS  JAR611G</p>
<p><b>Igneous petrology</b>  <b>6 ECTS, 10 weeks</b>  <b>JAR108G</b></p>	<p><b>Resources and regional development</b>  8 ECTS  LAN204G</p>
<p><b>Soils and vegetation</b>  <b>6 ECTS, 10 weeks</b>  <b>LAN106G</b></p>	<p><b>Nature-based tourism</b>  8 ECTS  FER206G</p>

## FALL SEMESTER

**JAR106G Introduction to the Geology and Geography of Iceland** - 10 ECTS - Module: H - 1-week excursion (August 26-30) followed by 12 lectures per week in September  
Supervision: Ármann Höskuldsson, Research Volcanologist

a) 1 week excursion at the end of August

A one-week study tour in South Iceland, with focus on both constructive and destructive geological processes, as well as human activities in the region. The tour is integrated with the course "Introduction to the Geology and Geography of Iceland". Students will observe active volcanoes (albeit probably not erupting), geothermal activity, glaciers and glacial rivers, weathering and erosional processes and flora and fauna. The settlement and economy of the region are studied, including visits to a geothermal greenhouse, industrial plant, and fish factory. The students will keep a field diary as well as working on specified themes, according to their interests and the courses they plan to take later in the program. Lodgings will be at Youth Hostels or farms, and food will be provided. The last week of September will be devoted to writing a report and preparing for a quiz on the entire course.



b) 12 lectures/week through September

The course, which is coupled with the S-Iceland Study Tour at the end of August, aims to provide an overview of Icelandic geology and geography, with emphasis on themes that are of special interest to Iceland, so as to provide a common foundation for the courses that follow from October onwards. Lectures cover the tectonic setting and tectonics of Iceland, general geology, geomorphology and weathering, climate and climatic history, petrology, volcanology, glaciology and glacial geology, cold and hot water geochemistry and hydraulics. The human geography of Iceland is described: Settlement and population, economic structure and regional differences.

Text: Einarsson, Geology of Iceland.

**JED104G Introduction to Geophysics** - 6 ECTS -  
Module: H  
Supervision: Magnús Tumi Guðmundsson, Professor

An introduction to the physics of the Earth. The course should be suitable as a first course for those majoring in geophysics and for geology students wanting to become familiar with the subject. Gravity, shape and rotation of the Earth, gravity anomalies. The geomagnetic field, magnetic anomalies, palaeomagnetism. Earthquakes and seismic waves. Layered structure of the Earth, heat



transport and the internal heat of the Earth. Origin and age of the Earth. Dating with radioactive elements. Geophysics of Iceland, introduction to geophysical research in Iceland. Text: Fowler, The Solid Earth; journal articles.

### **JED106G Current Crustal Movements** - 6 ECTS - Module: H

Supervision: Páll Einarsson, Professor

The subject of the course is active tectonic movements with emphasis on processes currently active in Iceland. Elastic and ductile behaviour of rocks in the crust and mantle. Brittle fracturing. Isostasy, vertical crustal movements and sea level. Plate velocity models, both relative and absolute. Plate boundary deformation. Rifts and rifting structures. Transcurrent faulting and associated structures. Post-rifting and post-seismic movements. Volcano inflation and deflation, dyking and intrusions. Measuring crustal movements, GPS-geodesy, levelling, SAR-interferometry, sea-level measurements, tilt- and strainmeters. A field project will be carried out.

Texts: Journal articles and chapters from various textbooks.

### **JAR108G Igneous Petrology** - 6ECTS - Module: H

Supervision: Sigurður Steinþórsson, Professor

Classification of igneous rocks and their relationship to tectonic environment. Evolution of igneous rocks in the light of phase diagrams, trace elements, and isotopes. Petrological lessons from intrusions, the oceanic rifts, oceanic islands, and continental regions. Petrology of Iceland: volcanic systems, magma series and their relationship to volcano-tectonics; palagonite and palagonitisation. Laboratory exercises with the petrological microscope, interpretation of chemical data, and one-day petrological excursions.

Text: Wilson, Igneous Petrogenesis; journal articles.

### **LAN106G Soils and Vegetation** - 6ECTS - Module: H

Supervision: Guðrún Gísladóttir, Associate Professor

Soil formation processes. Physical and chemical properties of soils. Soil classification and global distribution. The role of soil in the ecosystem. Soil nutrients and interactions between soil, vegetation and the atmosphere. Soil erosion and land degradation. Icelandic soils and their properties. The geography of Icelandic vegetation. Human impact on soils and vegetation.

## **SPRING SEMESTER**

### **JAR609G Glaciology** - 8 ECTS - Module: V

Supervision: Helgi Björnsson, Research Professor

The distribution of ice on Earth, snow, glaciers, sea ice, permafrost. The formation and mass balance of glaciers. Transformation of snow to ice. The heat budget and climatology of a glacier. Distribution of temperature in glaciers. Glacier hydrology. Glacier bursts (jökulhlaup). Deformation of ice, glacier sliding, deformation of subglacial till. Flow of



glaciers. Surface profiles of ice sheets. Dating of glacier ice based on flow models. Glacier response to mass balance. Glacier surges. Geothermal activity in glaciers in Iceland. Structures in glaciers. Glacier measurement techniques. Radio echo sounding. Ice core studies. Isotope ratios in ice and climatological studies. Glacial erosion and sediment transfer. Sea ice studies. A field project will be carried out.  
Text: Paterson, The Physics of Glaciers; journal articles.

**JAR208G Quaternary Environments** - 8 ECTS - Module: V  
Supervision: Áslaug Geirsdóttir, Professor

The aim of the course is to give a comprehensive summary of the environmental change that occurred during the Quaternary period with special reference to Iceland. Contents: The characteristics of the Quaternary and geological evidence for global climatic change. The history of ice on Earth. How do glaciers work? Glacial debris transport and glacial sedimentation on land and in water. Climate records from polar ice sheets. The glacial and deglacial history of Iceland and the North Atlantic Ocean.

Text: Lowe & Walker, Reconstructing Quaternary Environments; journal articles.

**JAR610G Volcanology** - 8 ECTS - Module: V  
Supervision: Sigurður Steinþórsson, Professor, and Páll Einarsson, Professor

History of volcanology. Volcanic processes and products. Magma, origin and evolution. Eruptive systems. Kinds of volcanoes, volcanic eruptions and their products, lava, tephra, gases. Tephrochronology. Volcanism in different tectonic settings. Magma chambers and associated crustal deformation.

Volcano forecasting and monitoring. Effects of volcanism on land use. Volcanic hazards and mitigation. Extraterrestrial volcanism. Geology and hydrology of geothermal systems, thermal gradient, hydrothermal alteration, geothermal fluid compositions, drillings. Environmental aspects of geothermal utilisation. Field excursion.

Text: Francis, Volcanoes; journal articles.



**JAR611G Environmental Geochemistry** - 8 ECTS - Module: V  
Supervision: Stefán Arnórsson, Professor

Scope of environmental geochemistry. Origin and distribution of the chemical elements. Isotopes. Exploitation of mineral resources. Composition of the atmosphere. Sources to substances in the atmosphere and the urban atmosphere. The structure of minerals and weathering processes. Solid products of weathering. Chemistry of continental waters, contamination, nutrients. Water quality standards. Estuarine processes. Chemistry of sea water and chemical cycling. Global change, geochemical cycles.

Text: Berner & Berner, The Global Water Cycle: Geochemistry and the Environment.

**LAN204G Resources and Regional Development** - 8 ECTS - Module: V  
Supervision: Karl Benediktsson, Associate Professor

Analysis of the potentials and problems in regional development based on natural resources.

Economic base in a service/knowledge economy. Fishing and energy sectors of Iceland: The resource base, history of resource use, management methods and planning, interest and value conflicts. Economic, social and environmental considerations. Impacts of globalization on local development.

### **FER206G Nature-based Tourism - 8 ECTS -**

Module: V

Supervision: Anna Dóra Sæþórsdóttir, Assistant Professor

Nature as a resource in tourism. Types of tourists, their expectations and requirements, and environmental impacts. Iceland as a tourism destination: Images and realities. Ideas of wilderness and 'the unspoiled land'. Conflicts between tourism and other use of land. Ideologies of sustainable development and ecotourism. Rural tourism. Nature conservation, national parks and reserves as tourist destinations.



## **APPLICATIONS**

Those who want to apply for the course should contact the Office of International Education:

Office of International Education  
Neshaga 16  
107 Reykjavík  
Iceland

Tel: +354 525 4311

E-mail: [ask@hi.is](mailto:ask@hi.is)

Website: [www.ask.hi.is](http://www.ask.hi.is)

The Office provides various information of specific and general nature. Two useful booklets are:

# Information booklet for foreign students at the University of Iceland

# Guide and English course catalogue for incoming exchange students

both available from the Office of International Education.

The School of Engineering and Earth Sciences, University of Iceland, reserves the right to restrict admission to the Earth Science program to students having an adequate background of at least one-year study in geology, geophysics, or physical geography. A basic knowledge of mathematics and physics is assumed in Introduction to Geophysics, Current Crustal Movements, Volcanology and Glaciology, while some chemical background is required for Environmental Geochemistry.

Projects beyond the course program are in general not offered. However, a 10 credit hours project (equivalent to 5 weeks of work) may be an option for students in geophysics and geology, subject to instructor availability.

## **EARTH SCIENCE IN ICELAND - USEFUL WEBSITES**

Useful information on the University of Iceland and Earth science research in Iceland can be obtained from the following websites:

<a href="http://www.hi.is">http://www.hi.is</a>	University of Iceland
<a href="http://www.earthice.hi.is">http://www.earthice.hi.is</a>	Institute of Earth Sciences, University of Iceland
<a href="http://www.norvol.hi.is">http://www.norvol.hi.is</a>	Nordic Volcanological Centre - Volcanoes
<a href="http://www.vedur.is">http://www.vedur.is</a>	Icelandic Meteorological Office - Earthquakes
<a href="http://www.os.is">http://www.os.is</a>	National Energy Authority - Various applied research
<a href="http://www.jfi.is">http://www.jfi.is</a>	Geoscience Society of Iceland
<a href="http://www.ni.is">http://www.ni.is</a>	Icelandic Institute of Natural History
<a href="http://www.hi.is/~palmi/deild/09/foreign.html">http://www.hi.is/~palmi/deild/09/foreign.html</a>	University information for students