Geological Risks concentration

Coordinateurs : Costanza Bonadonna

Geological processes such as landslides, earthquakes and volcanic eruptions are fascinating but complex phenomena with potentially significant impacts on society. These impacts may occur at different levels, local, regional and global.

The geological hazards concentration focuses on the dynamic challenges facing societies worldwide when developing risk reduction measures. This concentration forms on the deep and surface processes that generate geological hazards and on assessment methods of exposure and vulnerability of people and the built environment. Hazard and vulnerability assessments are then combined to conduct the analysis of impacts and associated risks. Through this concentration, students have access to teachers at the forefront of research, to acquisition tools of specific data, as well as to different approaches for modeling and risk analysis. Field works enable to integrate various aspects of risk management. This multidisciplinary concentration offers students the opportunity to acquire skills that make them employable in geological and geotechnical consulting firms, international and nongovernmental organizations, and federal offices.

PART A3 mandatory: 24 ECTS credits

The mandatory part A4 includes four modules:

- Petrological processes in geodynamic environments
- Fundamentals of numerical modelling and data analysis
- Spatial analysis applied to geology and risk
- Geophysics across scales for geologists

Module Petrological processes in geodynamic environments

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrological processes in geodynamic environments</td>
<td>U. Schaltegger, O. Müntener</td>
<td>Fall</td>
<td>70h C PW E S</td>
<td>Seminars</td>
<td>9</td>
</tr>
<tr>
<td>Processus pétrologiques dans les environnements géodynamiques</td>
<td>S. Pilet, L. Caricchi</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>L. Baumgartner, S. Schmalholz</td>
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<tr>
<td></td>
<td>L. Fontboté</td>
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</tbody>
</table>

One ECTS credits corresponds to 25-30 hours of actual work


This module must be followed during the first semester of the Master and then validated during the following exam session. Il est validé et les 9 crédits ECTS attribués si la note de l'évaluation est de 4 au moins. It is validated and the 9 ECTS credits earned if the grade is at least 4.

Module Fundamentals of numerical modelling and data analysis

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamentals of numerical modelling and data analysis</td>
<td>Y. Podladchikov</td>
<td>Fall</td>
<td>Practical (Report)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Les fondamentaux de la modélisation numérique et l'analyse de données</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction to data analysis with MATLAB (Introduction à l'analyse de données avec Matlab)</td>
<td>G. Simpson</td>
<td>Fall 3d CE</td>
<td>Practical (Report)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>MATLAB as a language of scientific computing (Matlab comme langage de calcul scientifique)</td>
<td>Y. Podladchikov</td>
<td>Fall 42h CE</td>
<td>Practical (Report)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Physics as a basis for modeling (La physique comme base de modélisation)</td>
<td>Y. Podladchikov</td>
<td>Fall 28h CE</td>
<td>Practical (Report)</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

The courses of this module are validated and the 9 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.
Module Spatial analysis applied to geology and risk

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial analysis applied to geology and risk</td>
<td>M. Sartori</td>
<td>Spring</td>
<td>Practical</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Cartographic data management and landslide susceptibility assessment</td>
<td>M. Sartori, C. Frischknecht</td>
<td>Spring</td>
<td>CE</td>
<td>Practical</td>
<td>3</td>
</tr>
<tr>
<td>Spatial risk assessment</td>
<td>C. Frischknecht, P. Peduzzi, B. Chatenoux</td>
<td>Spring</td>
<td>CE</td>
<td>Practical</td>
<td>3</td>
</tr>
</tbody>
</table>

The courses of this module are validated and the 9 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

Module Geophysics across scales for geologists

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geophysics across scales for geologists</td>
<td>György Hetényi, B. Quintal, M. Lupi, D. Do Couto</td>
<td>Fall</td>
<td>C PW</td>
<td>Written exam</td>
<td>3</td>
</tr>
</tbody>
</table>

The part A3 is validated if each of the four modules is validated.

PART B3 : a choice of 24 ECTS credits

The student must select four modules among those proposed in this part:
- Advanced petrology and volcanology
- Earth surface processes and tectonic geomorphology (bisannuel)
- Fluid and granular dynamics in geosciences
- Risk Management
- Volcanic and seismic risk
- Hazards and risks of slope movements
- Advanced risks
- Géologie environnementale
- Practical seismic reflection
- Borehole logging and rock physics
- Introduction to fluid flow for geologists

Module Advanced petrology and volcanology

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced petrology and volcanology</td>
<td>L. Caricchi, L. Pioli, C. Bonadonna, S. Pilet</td>
<td>Fall / Spring</td>
<td>Séminaires</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Volcanic rocks</td>
<td>L. Pioli, C. Bonadonna</td>
<td>Fall</td>
<td>Seminar</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Module Earth surface processes and tectonic geomorphology (bisannuel)

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth surface processes and tectonic geomorphology (bisannuel)</td>
<td>F. Herman, S. Castelltort</td>
<td>Every even semester</td>
<td>Spring</td>
<td>Continuous assessment</td>
<td>6</td>
</tr>
</tbody>
</table>

Module Fluid and granular dynamics in geosciences (biennial)

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid and granular dynamics in geosciences (biennial)</td>
<td>L. Pioli, C. Bonadonna</td>
<td>Every even semester</td>
<td>Spring</td>
<td>Practical (Report)</td>
<td>6</td>
</tr>
</tbody>
</table>

Module Risk Management

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Management</td>
<td>S. Menoni, C. Gregg, F. Romerio and teachers of the CERG-C</td>
<td>Fall</td>
<td>84h C</td>
<td>Written exam</td>
<td>6</td>
</tr>
</tbody>
</table>

In this module, courses are in English.

Module Volcanic and seismic risk

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volcanic and seismic risk</td>
<td>C. Bonadonna</td>
<td>Spring</td>
<td>Written exam</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Volcanic risk (Risque volcanique)</td>
<td>C. Bonadonna et enseignants du CERG-C</td>
<td>Spring</td>
<td>Written exam</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Seismic Risk (Risque sismique)</td>
<td>D. Fäh, B. Duvernay</td>
<td>Spring</td>
<td>Written exam</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

In this module, courses are in English.

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

Module Hazards and risks of slope movements

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazards and risks of slope movements</td>
<td>M. Jaboyedoff</td>
<td>Spring</td>
<td>Written exam</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.
Module Advanced risks

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced risks (Risques avancés)</td>
<td>M. Jaboyedoff</td>
<td>Fall</td>
<td></td>
<td>Written exam, Continuous assessment</td>
<td>6</td>
</tr>
<tr>
<td>Advanced quantitative risk and vulnerability (Risques avancés quantitatifs et la vulnérabilité)</td>
<td>M. Jaboyedoff</td>
<td>Fall</td>
<td>28h C 14h E</td>
<td>Written exam, Continuous assessment</td>
<td>3</td>
</tr>
<tr>
<td>Communication on environmental risks (Communication sur les risques environnementaux)</td>
<td>M. Jaboyedoff, K. Süddecker-Rieux, S. Rondic</td>
<td>Fall</td>
<td>16h C 16h E</td>
<td>Practical (Report)</td>
<td>3</td>
</tr>
</tbody>
</table>

Prerequisite: Environmental hazards (BSc) or equivalent

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained. 3 supplementary credits can be obtained in the student’s elective part by taking the course «Hazards and risks of slope mass movements: field camp II ».

Module Géologie environnementale

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Géologie environnementale (in French)</td>
<td>S. Girardclos</td>
<td>Spring</td>
<td>Practical</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Environmental geology</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Sites contaminés (Contaminated sites)</td>
<td>S. Girardclos, J. Poté</td>
<td>Spring</td>
<td>5d C PW</td>
<td>Practical</td>
<td>3</td>
</tr>
<tr>
<td>Gestion, traitement et entreposage des déchets (Management, processing and storage of waste)</td>
<td>J. Poté, S. Girardclos, J. Faessler, G. Giuliani</td>
<td>Spring</td>
<td>5d C PW</td>
<td>Practical</td>
<td>3</td>
</tr>
</tbody>
</table>

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained. The optional course « Ore dressing, geometallurgy and environmental geochemistry of mine waste » (3 days, 1 ECTS credit) of the part C2 of the GATO concentration can meaningfully complement the module of Environmental geology.

Module Practical seismic reflection

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical seismic reflection</td>
<td>A. Moscariello, D. Ariztegui</td>
<td>Fall/ Spring</td>
<td>Practical</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Sismique réflexion - pratique (Courses of this module cannot be taken separately)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>2D and 3D interpretation (Petrel and Kingdom) (Interprétation 2D et 3D - Petrel et Kingdom)</td>
<td>A. Moscariello</td>
<td>Fall/ Spring</td>
<td>Practical</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Marine seismic acquisition, interpretation and data integration (Acquisition, interprétation et intégration de données sismiques marines)</td>
<td>D. Ariztegui</td>
<td>Spring 8d F</td>
<td>Practical</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.
### Module Borehole logging and rock physics

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borehole logging and rock physics</td>
<td>B. Quintal, A. Moscariello</td>
<td>Fall</td>
<td>42h C E + personal work</td>
<td>Practical</td>
<td>6</td>
</tr>
<tr>
<td>Borehole logging and rock physics Diagraphie de puits et physique des roches</td>
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<td></td>
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</tr>
</tbody>
</table>

### Module Introduction to fluid flow for geologists

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher in charge / Speaker(s)</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to fluid flow for geologists</td>
<td>M. Lupi, L. Pioli and colleagues</td>
<td>Spring</td>
<td>5d C 5d F</td>
<td>Practical (report)</td>
<td>6</td>
</tr>
<tr>
<td>Introduction pour géologue aux écoulements des fluides</td>
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</tbody>
</table>

### PART C3 : 12 student’s elective ECTS credits

The student completes his curriculum by selecting courses among those proposed in the Master in geology or in other Master’s programs (for example: Master in Environmental science, UNIGE; Master in Environmental geosciences, UNIL; Master in biogeo-sciences, UNIL/UNINE).

The list of courses can contain courses of the Bachelor-level, for a maximum of 5 ECTS credits.

An internship in an enterprise can be validated in this part, as provided by the rules and regulations (art. 12, al. 5).

The student must draw up a list of courses selected in agreement with his Master’s thesis supervisor. Here are some suggestions:

<table>
<thead>
<tr>
<th>Course</th>
<th>Teacher</th>
<th>Semester</th>
<th>Modality</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomineralization (Bimoinéralisation)</td>
<td>A. Meibom</td>
<td>Fall</td>
<td>42h C TP</td>
<td>Report Oral presentation</td>
<td>4</td>
</tr>
<tr>
<td>Hazards and risks of slope mass movements, field camp II (part I of the field of the module «Hazards and risks of slope movements» mandatory)</td>
<td>M. H. Derron, M. Jaboyedoff</td>
<td>Spring</td>
<td>5d F</td>
<td>Practical (report)</td>
<td>3</td>
</tr>
<tr>
<td>Intership in an enterprise (validated by the Master’s thesis supervisor)</td>
<td></td>
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<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Modules or courses of the curriculum of the Master in geology*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Courses proposed by the MUSE (UNIGE), Environment MSc (UNIL), Biogeosciences MSc (UNIL-UNINE)*</td>
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<td></td>
</tr>
<tr>
<td>Courses proposed by another academic institution*</td>
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<tr>
<td>Courses of the Bachelor-level*</td>
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<td>5 ECTS credits, at most</td>
</tr>
</tbody>
</table>

Total of the credits to validate: 12 ECTS credits

*: for these courses, the evaluation and the number of attributed ECTS credits are those contained in the curriculum from which they are taken.

In the part C3, courses are individually validated if their grade is equal of at least 4.0/6 or if the validation is obtained.
Part Master’s thesis in geology - 60 ECTS credits

This Master’s thesis is an individual research work under the responsibility of an ELSTE teacher.

By the end of the first semester of Master’s studies at the latest, the student must have chosen the subject of his Master’s thesis. Before the beginning of the second year of the program, the student must draft and present his Master’s thesis project. The ECTS credits of the Master’s thesis project are obtained when its grade is equal of at least 4.

Theses are evaluated based on the submitted manuscript and the quality of the oral defense. This evaluation, weighted according to stipulations in the internal directive on theses, takes the form of a single grade. ECTS credits for the thesis are earned when that grade is 4 or higher.

<table>
<thead>
<tr>
<th>Master’s thesis</th>
<th>Semester</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Evaluation</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master’s thesis project</td>
<td>Spring</td>
<td>•</td>
<td></td>
<td>Report and oral examination</td>
<td>10</td>
</tr>
<tr>
<td>Master’s thesis</td>
<td>Spring</td>
<td>•</td>
<td></td>
<td>Manuscript and oral defense</td>
<td>50</td>
</tr>
</tbody>
</table>