

19 Thinking the future of geoscience education in Switzerland to meet the challenges of sustainable development and exploration for resources and energy

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Swiss Association of Geologists, CHGEOL
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19.1

Joint Master in Applied Geophysics: a unique international study programme to educate tomorrow's geoscientists to solve global challenges for a sustainable future

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Applied Geophysics involves the advancement and application of exploration and monitoring techniques for investigating the Earth's subsurface, from a few meters to several kilometres depth. This depth range is crucial for various issues that are highly relevant to our society. Applied Geophysics entails developing and applying tools to image the subsurface for geosciences and natural resources to address the energy transition, to characterise the subsurface for engineering and archaeological investigations, to monitor geohazards and the impact of climate change on the environment as well as to manage the underground.

To meet the rising demand for highly qualified Earth scientists, three leading European technical universities – ETH Zurich (Switzerland), TU Delft (The Netherlands), and RWTH Aachen University (Germany) – collaboratively established the *Joint Master in Applied Geophysics* in 2006 (Green et al., 2007; IDEA League, 2023). Our mission is to educate students in geophysical methodologies for exploring and monitoring the subsurface of the Earth to solve global challenges for a sustainable future.

A cohort of typically 20 students moves as a class from Delft to Zurich and finally to Aachen to follow courses for one semester at each university. During the fourth semester, students undertake their thesis work at one of the partner universities within the program, an approved external university, research centre, or company.

The Joint Masters programme offers a unique international and multifaceted education leading to an outstanding qualification in Applied Geophysics for career paths in industry and academia. The international programme provides the students an exceptional experience to study in cross-cultural teams and to live and learn in three European cities. The curriculum covers methodological aspects in the physical, mathematical, computational as well as data analysis and signal processing foundations of Applied Geophysics. Theoretical and methodological aspects are translated into practice in hands-on exercises and field work. The Joint Masters Programme is run in close collaboration with industry. Companies support the programme by providing grants for scholarships and opportunities for research projects. Experts from industry and governmental agencies deliver special lectures and are involved in the co-supervision of master thesis projects.

As of today, 350+ students and alumni are studying or have completed the programme. Around 50% of our current students are female. After completing the Master's, about 40% pursue PhDs, 27% work in the engineering/energy sector, and about 29% in other sectors. The program attracts students from Europe (80%), the Americas (10%), Asia (6%), and Africa (4%).

Like many other Earth science study programs, student enrolment has experienced a decline over recent years. The figures have dropped from a peak of 39 students (cohort beginning in 2014) to 19 students (cohort beginning in 2022). In order to maintain the attractiveness of our program to future generations of students, we consistently review, modify, and reconsider both our curriculum and promotional approaches. Regular exciting feedback from our alumni underscores the comprehensive education of our programme that integrates theory and practice, along with a unique international atmosphere.

REFERENCES

- Green, A. G., Maurer, H., Slob, E., Wapenaar, K., Clauser, C., & Littke, R. 2007: Joint MSc programme in applied geophysics: a new concept in geophysics education, *First Break*, 25(4), <https://doi.org/10.3997/1365-2397.25.1106.27417>
 IDEA League 2023: Joint Master in Applied Geophysics, <https://idealeague.org/geophysics/>



Figure 1. Students and teaching staff at the graduation ceremony in Delft in August 2022.

19.2 Adventure Geology

Christa Feucht, Thomas Buckingham

The association “Adventure Geology” (www.erlebnis-geologie.ch) promotes general public awareness of the importance of geosciences and geodiversity for our society.

It is only thanks to knowledge of the underground that drinking water can be obtained, geothermal energy can be used, buildings can be constructed or warning and protection systems against landslides and floods can be developed. The main activity of “Adventure Geology” is the operation of the interactive trilingual website www.erlebnis-geologie.ch (DE, FR, IT), where geo-offers and geo-events of Switzerland are currently linked: Whether excursions, guided tours, visits to mines, hikes, exhibitions, geological trails, lectures - (almost) everything is available on the website.

Our goal for the future is not only to reach out to the general public, but also to guides and rangers of the growing number of Swiss geoparks as well as to teachers. Geology is mostly forgotten, as covered under the biosphere. However, it is the base of all life and it is important to educate not only about biodiversity but also geodiversity.

Our supporting members and partners are:

- Swiss Association of Geologists (CHGEOL)
- Swiss Academy of Natural Sciences (SCNAT)
- Federal Office of Topography (swisstopo)
- Swiss Geological Society (SGG)



19.3

Why do students choose Earth Sciences?

How do graduates view our study programme in retrospect?

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Continuous curriculum revision is a fundamental process in higher education institutions. An important input is feedback from students frequently gathered through surveys.

For the past 10 years, prospective students in the Earth and Climate Sciences programme at ETH Zurich have completed a questionnaire about the sources of information used for their study selection and their reasons for studying Earth Sciences. Classic information sources such as the department's website and the study guide are of great importance. Also the ETH study information days for prospective students and geography teachers are often stated. The incoming students frequently mentioned the broad study programme and the excursions/field courses as decisive for choosing Earth Sciences.

An ongoing survey among graduates of the study programme will provide valuable feedback on our Master's programme. Questions regarding aspects that were either insufficiently covered or overly detailed during their studies will aid in improving our MSc Earth Sciences curriculum.

19.4 Enhancing Fundamental Geological Education for Optimal Mineral Resource Utilization in a Context of Climate Change and Global Environmental Concern.

Arnaud Le Bec

Head of Competence Center Geology, OMYA International AG. Switzerland.

Geology, a branch of the natural sciences centered on observation, plays a pivotal role in modern society. It is instrumental in addressing two key challenges: the acquisition of new mineral resources and the understanding of climate change impacts. Geologists are tasked with discovering essential resources while optimizing extraction methods to mitigate ecological consequences. Simultaneously, they analyze rock records to glean insights into past climatic shifts. Utilizing tools such as hammers, magnifying glasses, and data from geophysics, geochemistry, mineralogy, and geomorphology, geologists survey outcrops to decipher Earth's history and dynamics. This interdisciplinary approach combines foundational scientific principles with advanced technology, facilitating precise interpretations of Earth's processes. The practice of geological interpretation thrives on meticulous attention to detail, encompassing both micro and macro perspectives. Geologists also play a critical role in education, imparting fundamental geoscience principles and technological advancements. A tangible illustration of these responsibilities is evident in the mineral industry, exemplified by OMYA, where geologists contribute their expertise to resource management and technological innovation.

19.5

Geoscientists, guarantors of sustainable management of subsoil resources

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When we look around us, and throughout our day, geologists are everywhere! From the mineral materials that make up our homes to the metals that transport us whether we're cycling or driving a car, from the plastic bags we use to the computer components we surf on, from the waterproof coat we wear in the rain to the sunglasses we wear when the weather's fine, in our light bulbs or candles, whether we light up with electricity or the glow of a small flame, in our rechargeable batteries or our internal combustion engines - everything is geology! Indeed, in most of the objects that surround us, mineral resources have been used and have therefore had to be the subject of preliminary work to locate and characterize them, before they can be exploited and made available. Geoscientists are among the most essential professions in the supply of raw materials required by our societies. Despite this fundamental role, fewer people are interested in geoscience training today than a few decades ago. And yet, never more than today are the skills of those trained in the Earth sciences required to find solutions to today's climatic, environmental, meteorological, energy and even geopolitical challenges. Knowledge of the mechanisms that drive our planet and of the resources available to us is of the utmost importance, and all the more so if we are to meet the imperatives of sustainable, coordinated resource management.

Subsoil as a substrate for ecological transition

The ecological transition will need the subsoil and its local resources to take place. The current paradigm of transporting all the resources required to satisfy any need anywhere in the world, in infinite quantities, is untenable. In the space of a few centuries, we have gone from a situation where development was only possible if resources (notably water, wood and rock) were available directly on the territory concerned, to a situation where cities are built in deserts and all the resources required are imported. In the future, local and regional resources will be given priority, in short, virtuous circuits where they can be recycled. We can no longer be satisfied with a situation where our knowledge of the subsoil is poor, because in any case the required resources will be imported, or those that are exploited locally can be exploited ad infinitum without concern for their sustainability. We need to re-anchor ourselves, and to do this we need to know which resources are available locally and which ones we'll have to dispose of, or else assume the risks of dependence on third parties.

Regional geology is set to regain its credentials as an answer to these questions, and universities in particular need to step up their teaching on this topic and on local issues related to the subsoil. In the future, geologists will no longer be mainly mercenaries sent around the world on successive missions to go from one finished deposit to another, but rather the guarantors of sustainable management and exploitation of the underground world, in a given territory. The Deep-City concept developed some fifteen years ago (Parriaux, A. et al. 2010) proposed a simplified methodology for integrating the subsoil and its resources into land-use planning. The Canton of Geneva drew on these principles to draw up its new law on subsoil resources and to create a new tool called the "subsoil resource management plan - PGR" (Etat de Genève 2022), which aims to protect and ensure the sustainable management of resources while creating a framework conducive to their efficient exploitation.

Job trends for geoscientists

In addition to the renewed role that geoscientists will play in our more sustainable societies, the number of geoscientists in countries with no mining, gas or oil traditions will increase. This dynamic was already set in motion some twenty years ago with the introduction of legislation on the identification of polluted sites and the remediation of contaminated sites. Indeed, alongside the historical themes of mining, oil and gas, geotechnics, natural hazards, hydrogeology, quarries and gravel pits, other environmental themes such as polluted sites and landfills, remediation work and management of polluted materials, recycling of mineral materials, renaturation of watercourses, environmental impact studies and, of course, geothermal energy issues have already gained considerable ground. Universities and other research institutes are training professionals in the specifics of geothermal energy, providing the market with people who have the skills required to carry out projects (Meyer 2021). As far as research is concerned, there is of course a need to develop innovative technologies for future generations, but there is also a need for research projects to enable know-how that exists elsewhere to be transferred to Switzerland. As a result, academia not only has a fundamental research role to play, but must also provide the foresight and feedback on which public and industrial strategies can be built. The academic world must regain the legitimacy to carry out research on very concrete and local elements, such as improving knowledge of regional geology, to encourage the recognition and implementation of best practices. This means not only continuing to develop training programs, but also carrying out communication initiatives to show that geoscience professions can be a way of getting directly and concretely involved in solving the current climate crisis. To reinforce this local anchoring and the potentially highly applied side of geology studies, links between universities and local professional players (industries, authorities, design offices, companies) should be strengthened and student involvement in local projects sought.

REFERENCES

- Etat de Genève 2020 : Plan de gestion des ressources du sous-sol. <https://www.ge.ch/dossier/gestion-durable-ressources-du-sous-sol/gerer-protger-ressources-du-sous-sol/plan-gestion-ressources-du-sous-sol>
- Meyer, M. 2021 : Collaboration entre l'industrie, l'académie et la politique :L'expérience genevoise. Swiss Bull. angew. Geol. Vol. 26/1, 43-46.
- Parriaux, A., Blunier, P., Maire, P., Dekkil, G.& Tacher, L. 2010 : Projet Deep City. Ressources du sous-sol et développement durable des espaces urbains. Lausanne, 100p.

P 19.6

Results from two surveys with employers of geologists and individual professional geologists in Switzerland – Suggestions to make the job we're passionate about more attractive for everybody.

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CHGEOL represents around 400 professional geologists and 30 companies employing geologists in Switzerland. This year we have conducted two surveys. The first survey addressed our member companies regarding the job market and particular needs with respect to the training of geologist at Swiss universities. The second survey addressed our individual members with questions also regarding the job market and employee satisfaction in general.

Hence, we feel competent to raise the voice for those employing young professionals leaving Swiss universities with a degree in Earth sciences or geology, but also for those who work as geologists in Switzerland. We will present findings from these surveys and will draw conclusions for employers but also for institutions training geologists.

Switzerland is a small job market for geologists, but still there is a considerable thematic breadth in potential jobs. This is a challenge with respect to adequate training. The cohort of international students at Swiss universities not intending to work in Switzerland has increased. Some university programs have deviated from the specific needs of the Swiss geological consulting companies. In addition, some expertise needed to address future challenges faced in Switzerland, is not taught at Swiss universities. Some geologists quit their employment in geological jobs to move elsewhere, why? With our presentation we hope to shed light on these issues with the intent it may be useful for decision makers at company, university, or government level.

P 19.7**Geoscience Education in Switzerland – is there Potential for Improvement?**

Martin Wyss

No Abstract submitted...