Links to Sustainable Development

Geology

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GEOLOGY AT THE UNIVERSITY OF BERN

Geological sciences include the study of the processes that shape the Earth, from its formation to the present. Topics investigated range from high-temperature processes deep below the Earth's surface to interactions between water, life, and minerals on its surface. Many of the urgent social, economic, and environmental challenges we face today require input from the geological sciences, derived from our understanding of how minerals, rocks, and mountains form and interact with the Earth's hydrosphere and atmosphere. These challenges include climate change, natural hazards, and the sustainable supply of water, energy, and raw materials. Researchers at the University of Bern's Institute of Geological Sciences conduct fundamental and applied research on a variety of topics, from the origin and evolution of the Earth to past climate and environmental change – and from natural hazards or mineral resources to the geological disposal of waste. The study programmes combine lectures and fieldwork, as well as hands-on research through Bachelor's and Master's theses. It also offers specialization in different areas of Earth sciences that share the same fundamental geological principles.

How is geology linked to sustainable development, and how has this influenced practice?

Geological sciences and sustainable development are inextricably linked: geological knowledge informs predictions about the Earth's future state and enables the development of resources as well as remediation and storage of wastes. A central tenet of the geosciences is that the present holds the key to the past: processes we can observe today have probably operated in similar ways throughout the history of the Earth. This means we can look to the past to help us predict the state of the Earth in the future. Using lithological, chemical, and isotopic evidence from the Earth's archives – such as sediments and continental ice sheets – geoscientists can reconstruct climatic changes and some of their impacts on the planet over geological timescales. Past changes in the Earth's climate and in atmospheric CO_2 concentrations provide an idea of the Earth's future climate amid currently rising CO_2 concentrations. Similarly, knowledge of the Earth's history and the history of the various environments found on Earth provides concrete narratives of past extremes [1] and informs decisions on sustainable development and the future of the planet. Our understanding of rock–water interactions inspires strategies for remediation of pollutants, renewable energy generation, and removal of greenhouse gases.

The use of geological resources provides both challenges and opportunities for sustainable development. On the one hand, extraction and use of geological resources has major environmental and social consequences; on the other, solid Earth resources are needed to support green technologies. Moreover, the Earth's subsurface, which geoscientists study using geophysical, geochemical, and petrological techniques, can be a source of renewable geothermal energy and a secure place to store greenhouse gases and wastes from nuclear energy generation. In the geological sciences, the life cycle of resources such as base and critical metals, fossil fuels, water, and hydrogen are studied from genesis to exploitation to environmental impact. Geological knowledge has been critical to exploiting fossil fuel energy, but it is also critical for finding and responsibly developing the resources needed to supply the green energy transition. These resources include rare-earth elements, nickel, and lithium, which are used in green technologies such as wind turbines and electric vehicle batteries.

Geoscientists are increasingly studying the impacts of human activities on Earth systems and the ways in which geoscience knowledge should support sustainable development. At the University of Bern, this translates into research and teaching that includes tracking plastic pollution in aquatic systems, developing geothermal energy, studying CO_2 removal and storage, understanding past climate changes, and more.

Example: Using geological knowledge to support the green energy transition

The green energy transition requires large volumes of solid Earth resources – such as metals used in batteries and solar panels, or iron and aggregate for construction – that are ultimately sourced from mining activities [2]. There is no doubt that a shift from fossil fuel energy systems towards sustainable energy sources is required to achieve the goals of the Paris climate agreement and avoid the worst outcomes of climate change [3]. However, a sustainable energy transition requires careful management of the social and environmental impacts of mining activities. Geological knowledge is used to find the mineral resources used in green technologies – and it can also support sustainable use of these resources (**SDG 7**). For example, knowledge of fluid–mineral interactions can be applied to repurpose, reprocess, and safely store waste products from mining operations and reduce the impacts of mining on surrounding communities (**SDGs 3** and **9**) [4,5]. Certain mine wastes might even be used to capture and store CO_2 [6], and mineral resources could be obtained from municipal wastes (**SDG 12**) [7]. And alongside reductions in CO_2 emissions, storing CO_2 captured from the air in the subsurface – where it can be securely stored over long timescales – could contribute to the stabilization of the Earth's temperature at <2°C above pre-industrial levels (**SDG 13**) [3,8].

Sustainable Development Goals (SDGs) of particular relevance to the Geology.

How does the University of Bern's Institute of Geological Sciences incorporate sustainability into research and teaching?

At the Bachelor's and Master's levels, the Institute of Geological Sciences directly incorporates the topic of sustainable development into teaching, through courses on the interlinked nature of the Earth's systems and climate history, on waste materials and the circular economy, on CO_2 storage, and on other contemporary and cross-cutting environmental issues. In one field course, for example, students examine climate change and its impacts on the environment. From Bachelor's to Doctoral level, students have the opportunity to conduct research on topics such as nuclear waste storage, reuse and disposal of municipal solid wastes, CO_2 removal and storage, natural H_2 exploration, microplastic pollution, and paleoclimate. The next generation of Earth scientists is thus supported to better incorporate sustainability considerations into their future careers.

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