

# Annual Report 2019

Georesources Switzerland Group  
Fachgruppe Georessourcen Schweiz (FGS)

February 2020

## Acknowledgements

This annual report was reviewed by the FGS steering committee, consisting of Prof. Dr. Maria Schönbächler (D-ERDW professor who is in charge of FGS), Dr. Andreas Möri (swisstopo representative) and Dr. Stefan Heuberger (FGS group head).

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# 1 The Georesources Switzerland Group

The Georesources Switzerland Group (Fachgruppe Georessourcen Schweiz, FGS) processes information and conducts applied research on Swiss mineral resources and their industrial application on behalf of the federal government or in collaboration with industry partners. It was founded in July 2018 at ETH Zürich and succeeds the office of the Swiss Geotechnical Commission (SGTK). The group forms an associated group in the Department of Earth Sciences with the staff (7 employees) and the premises (NO F 35) being equivalent to ones of the former SGTK office. The group is >90% third-party funded (excl. SNF) and raises an average annual budget of about 700-800 kCHF.

The close collaboration with the Swiss Geological Survey (Federal Office of Topography swisstopo) and the Federal Office of Energy (BFE) provide a solid financial basis for the longterm focus of our applied research. We focus on collecting and compiling fundamental geological data and data related to the use of the geological resources in Switzerland. Focus areas are the mineral resources of Switzerland (i.e. gravel, sand, clay, limestone, salt, natural building stones), energy resources from the deep underground (geothermal energy and hydrocarbons) as well as geological questions related to the use of georesources and the underground in general. The group maintains a long-lasting sample and literature archive and makes those data accessible to the public by web services and through swisstopo's web portal [map.geo.admin.ch](http://map.geo.admin.ch).

Our group has a unique position in this field of applied research in Switzerland - and this field will remain essential in the future. Extraction of raw materials is becoming increasingly complicated because of the scarcity of materials (e.g. sand), land use conflicts and several types of emissions. Moreover, since Switzerland has neither a hydrocarbon nor a substantial mining industry, fundamental geological data on the deeper underground are still scarce. Switzerland possesses abundant mineral resources but the country does not have the uniform mineral royalty laws that most other European countries do. Thus, the mineral resources sector suffers from a lack of systematic production and resources data. This hampers the generation of reliable predictions of the national resources supply situation. In this field, our group conducts essential applied research. We process basic geological data to consolidate our knowledge on the Swiss geological underground and to improve the corresponding geodatabases, cartographic tools and 3D models.

[georessourcen.ethz.ch/en](http://georessourcen.ethz.ch/en)

[erdw.ethz.ch/en/research/associated-groups/fgs.html](http://erdw.ethz.ch/en/research/associated-groups/fgs.html)

## 2 Projects

### 2.1 Key projects

#### 2.1.1 Geological evaluation of "Hartstein" units of Switzerland

The construction and maintenance of the Swiss railway and road infrastructure requires more than 2 million tons of fractured bedrock of highest physical strength and durability, commonly referred to as Hartstein. In the past decades, Switzerland has seen a dramatic decrease of extraction sites, mostly due to conflicting interests. Swiss quarry operators are therefore struggling to cover the present and future domestic demand of Hartstein products.

In this swisstopo-funded study, which is a part of the superordinate long-term project "Assessment of mineral resources of Switzerland" we evaluate the spatial distribution and quality (grade) of potential Hartstein units. During the first months after project initiation in spring 2019, we have established an overview of existing data and a quantitative, standardised evaluation procedure for Hartstein occurrences. We are currently collecting new data describing the volumetry of potential occurrences (i) from published geological cross-sections and (ii) by Matlab-based automated extraction of orientation and layer thickness information from geological maps. Additionally, we analyse stratigraphic profiles to estimate values for the extractable thickness within a mapped stratigraphic unit.

Products of this early project phase, due in 2020, will include (i) a list and an internal report about stratigraphic units in Switzerland with Hartstein potential, (ii) an updated occurrence map which will be based on our new results regarding the thickness and grade, and (iii) a peer-reviewed publication in which the automated extraction of orientation and thickness information from geological maps will be presented and compared to field-based thickness estimates at selected localities in the Helvetic nappes.

The long-term project results (after 2020) will include an occurrence and a resource map publicly available on [map.geo.admin.ch](http://map.geo.admin.ch).

Project leader: [Lukas Nibourel](#)

#### 2.1.2 New heat flow map of the Swiss Molasse Basin

The most recent heat flow map of the Swiss Molasse Basin dates back to 1995. Since then, several new temperature measurements in boreholes were conducted and, more importantly, geothermal energy became much more important in order to achieve Switzerland's desired energy transition. Temperature data with a corresponding heat flow map are an important basis for geothermal exploration.

Mandated by swisstopo and the Swiss Federal Office of Energy, we launched this project in January 2019. Since then, we mainly compiled and analysed temperature data from deep boreholes in the Swiss Molasse Basin area. This analysis provided good constraints on the temperature distribution down to 2 km. These intermediate results will be published in a peer-reviewed article in 2020, in close collaboration with Prof. E. Kissling. This paper will provide a strong basis for the next project stage aiming at establishing an interpolation procedure for the calculation of the steady-state conductive heat flow of the Swiss Molasse Basin and finally a new heat flow map of the Swiss Molasse Basin.

In parallel, we collaborate with the Geothermal Energy and Geofluids Group (Prof. M. Saar) and their swisstopo-funded pilot study on the heat flow in the greater Aargau region.

Project leader: [Loïc Pierdona](#)

### 2.1.3 Assessment of Switzerland's gravel and sand occurrences

Quaternary deposits in Switzerland are fairly well known and mapped at the 1:25'000 scale. Dozens of regional and local companies extract more than 30 million tons of gravel and sand per year. Volume estimations of Swiss mineral resources were so far based on compilations of regional data from the cantons and the local producing industry. The absence of a country-wide, systematic resource assessment hampers reliable predictions of the national resources supply situation.

The objective of our project is to derive a methodology to systematically assess the gravel and sand occurrences of Switzerland. We aim at providing GIS-based tools that operate at a level of detail such that the methodology can be run over the entire country, and produce results in a timely manner.

In 2019 we tested different approaches in a pilot study area covering the Lower Reuss and Lower Aare catchments. We have extracted areas with gravel occurrences from the published and vectorised GeoCover 1 and 2 datasets. In our tests, we evaluated different GeoCover 2 attributes of the unconsolidated deposits layer. We have used vector data of the groundwater tables (acquired from different Cantonal authorities) to calculate a continuous raster of groundwater level for the main aquifers. These raster data can be used to estimate extractable volumes of unconsolidated sediments above the groundwater table which provides a first approximation of the spatial distribution of larger gravel bodies at depth.

In 2020 we attempt to combine these two approaches, develop an automated GIS-routine and verify our method by comparing the output with punctual data from extraction sites and boreholes.

Project leader: [Regina Reber](#)

### 2.1.4 Machine learning algorithms to assess geoscientific datasets

In the framework of the long-term project "Automated analysis of geothermal exploration data of Switzerland" (see chapt. **Error! Reference source not found.**), we focus, in a first subproject, on the automated categorisation and extraction of geoscientific data from swisstopo inventories. In this process, geological reports archived as pdfs are first categorised using Natural Language Processing (NLP) and subsequently subjected to a Computer Vision algorithm. The latter identifies and passages figures such as complete borehole profiles and relevant tables into a database. This, together with new exploration data available as from beginning of 2020, will allow for a detailed analysis of the geothermal potential in Switzerland. In doing so, we are putting forward the deployment of the Swiss energy strategy 2050.

In 2019 we started categorising geological reports employing a K-Means clustering algorithm, which already produced promising results. In early 2020, we will refine the Clustering algorithm and wish to timely complete this step. The main focus, however, is the Computer Vision part, which we initiated together with ETH juniors.

We also began to work on a Data Management Plan (DMP) to coordinate data transfer between swisstopo and geothermal prospection and exploration agents. The intent here is to establish a standardised protocol to minimize data loss and to ease quality control — all in all, a necessary step to facilitate data-driven analysis and prediction.

Project leader: [G rard Perren](#)

### 2.1.5 Resources Information System (RIS)

FGS runs a continuously updated and freely accessible web portal ([map.georessourcen.ethz.ch](http://map.georessourcen.ethz.ch)) providing detailed information on occurrences and extraction sites of mineral resources in Switzerland. This includes data on cement raw materials, brickyard raw materials, crushed stones, natural building

stones, gypsum and salt, all of which currently being extracted in Switzerland. Furthermore, the RIS also contains data on currently not produced mineral resources like energy resources, metals and metallic ores. The RIS thus represents the only platform that aggregates comprehensive information on mineral resources at a national scale. Thanks to its regular synchronisation with the web portal of the Federal Office of Topography [swisstopo map.geo.admin.ch](http://swisstopo.map.geo.admin.ch) our data are accessible for a large user group.

In 2019 we updated the RIS topic layers "Naturwerksteine an Bauwerken" (natural building stones) and "Ziegeleirohstoffe" (brickyard raw materials) and established the integration into swisstopo's web portal [map.geo.admin.ch](http://map.geo.admin.ch).

In order to make more unpublished but valuable raw materials databases publicly accessible we submitted a grant application to the Sophie und Karl Binding Foundation (see chapt. **Error! Reference source not found.**). In that 2-year project we aim at creating an inventory of historical extraction sites of natural building stones in Switzerland, based on a comprehensive compilation of data already available at FGS. The final product will be publicly available on the RIS and [map.geo.admin.ch](http://map.geo.admin.ch) platforms; a dataset of great use for curators of monuments and architects.

Project leader: [Donat Fulda](#)

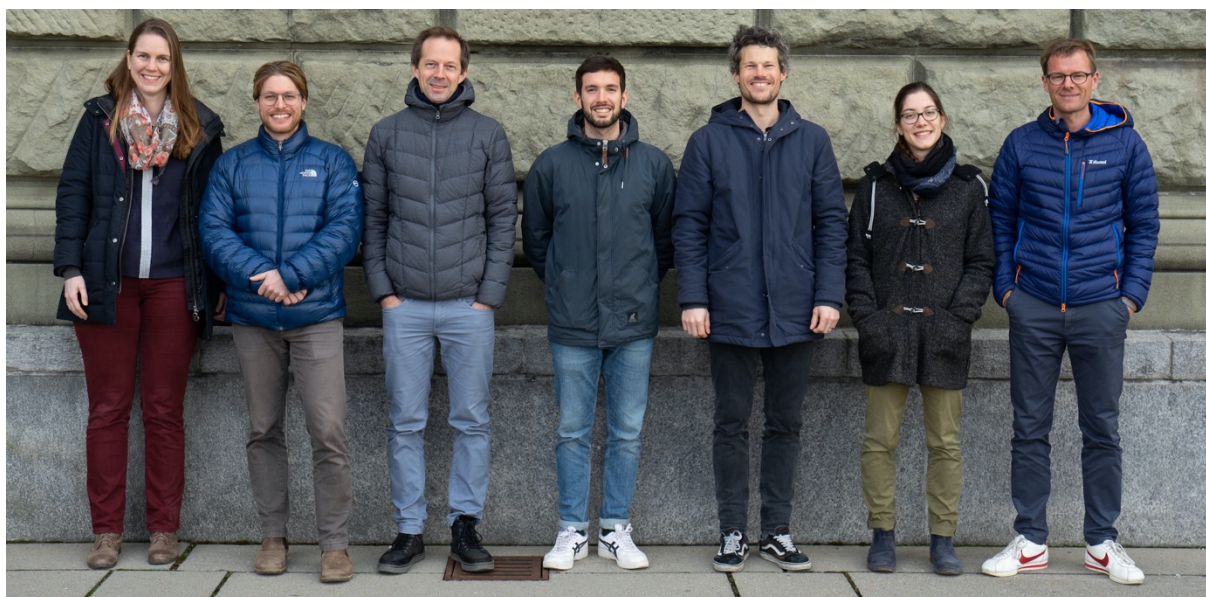
#### 2.1.6 Geological Atlas (1:25'000) Map Sheet "Val Bregaglia"

In November 2018 we started this 3-year mapping project mandated by the Swiss Geological Survey. We are producing the new geological map sheet "Val Bregaglia" (Geologischer Atlas der Schweiz 1:25'000, sheet 1276) including the corresponding explanatory notes. The field area is located in the Central Alps in southeastern Switzerland (Bergell area).

A main part of this project is to compile existing unpublished maps of the area. In early 2019, more than 30 existing draft geological maps were scanned, processed, georeferenced and merged into a GIS project. Based on these maps we developed a generalised legend of the more than 140 bedrock units. During summer, field work was carried out at selected locations to quality check the existing mapping results. Based on these results, the compilation and digitisation work in the ToolMap software was initiated in fall 2019.

Project leader: [Donat Fulda](#)

### 3 Personnel 2019



*From left to right: Regina Reber, Gérard Perren, Donat Fulda, Loïc Pierdona, Lukas Nibourel, Sandra Grazioli, Stefan Heuberger. Not on the picture: Isabel Schumacher. Picture taken on 8.1.2020.*

Employee	Function	max. contract/funding until	Pensum
Dr. Stefan Heuberger	Group Head, Wiss. MA II	03/2023	90%
Donat Fulda	Technical Specialist II	permanent	80%
Dr. Regina Reber	Scientific Assistant II	08/2021	60%
Loïc Pierdona	Scientific Assistant I	06/2021	80%
Dr. Lukas Nibourel	Scientific Assistant II	03/2031 *	80%
Dr. Gérard Perren	Scientific Assistant II	06/2031 *	80%
Sandra Grazioli	Hilfsassistentin	12/2020	20%
<b>Total FTE</b>			<b>4.9</b>

Contractor	Function	contract & funding until	Pensum
Peter Nievergelt	third-party collaborator	10/2021	fixed rate

\* project duration and funding is longer than the possible maximum contract duration for scientific personnel at ETH.



## 4 Teaching and public outreach

### 4.1 Teaching at D-ERDW and other departments or universities

#### Stefan Heuberger

Course title	Level	ECTS	Comments
Integrierte Erdsysteme III	BSc	5	main responsibility
Erdwissenschaftliche Exkursionen I	BSc	1	main responsibility f. Glarus-Exkursion
Feldkurs II Sedimente, Gemmipass	BSc	3	lead: V. Picotti
Field course IV, non-alpine field course, Morocco	MSc	3	lead: V. Picotti
Integrierte Exkursionen I	BSc	1	lead: A. Rudow (D-USYS)
Co-supervision of BSc thesis of D. Schwendener (2019)	BSc	12	lead: S. Willett, V. Picotti

#### Donat Fulda

Course title	Level	ECTS	Comments
Swiss Alpine Archaeology Summer School	MSc	3	run by Uni Bern & Uni Zürich
Natural building stones in Switzerland "Vom Naturwerkstein zur Geologie"			Further education 2-days course by NVS (Natural Building Stones Association Switzerland)

#### Lukas Nibourel

Course title	Level	ECTS	Comments
Erdwissenschaftliche Exkursionen I	BSc	1	Glarus-Exkursion

#### Sandra Grazioli

Course title	Level	Comments
Geological city excursion in Zürich	public	by focusTerra

## 5 Publications

### Papers

**Heuberger, S.** (2019). Report on SASEG's 86<sup>th</sup> Annual Convention, 22-24 June 2019, Geneva. Swiss Bulletin of Applied Geology, 25, 87-98.

### Papers *(in preparation)*

**Nibourel, L.**, Berger, A., Egli, D., **Heuberger, S.** and Herwegh, M. (*in prep.*). Structural and thermal evolution of the eastern Aar Massif: insights from structural field work and Raman thermometry. *To be submitted to Swiss Journal of Geosciences.*

**Nibourel, L.**, Rahn, M., Dunkl, I., Berger, A., Herman, F., Diehl, T., **Heuberger, S.** and Herwegh, M. (*in prep.*). Orogen-parallel migration of exhumation in the eastern Aar Massif revealed by low-T thermochronology. *To be submitted to Tectonics.*

### Abstracts (Talks/Posters)

**Nibourel, L.**, **Heuberger, S.**, & Galfetti, T. (2019). Automated extraction of layer orientation and thickness information from geological maps to support the characterisation of siliceous limestone deposits. Abstract 17<sup>th</sup> Swiss Geoscience Meeting, Fribourg, 2019.

**Reber, R.**, **Heuberger, S.**, **Nibourel, L.** & Galfetti, T. (2019). The challenge of compiling a Swiss gravel and sand occurrence map. Abstract 17<sup>th</sup> Swiss Geoscience Meeting, Fribourg, 2019.

**Nibourel, L.**, Rahn, M., Dunkl, I., Herman, F., Berger, A., Diehl, T. & Herwegh, M. (2019). Orogen-parallel migration of exhumation in the eastern Aar Massif revealed by low-T thermochronology. Abstract 14<sup>th</sup> Alpine Workshop, Sion, 2019

Diehl, T., Kissling, E., **Nibourel, L.**, Herwegh, M., Brockmann, E. & Schmid, S. (2019). Structure and Deformation of the Central-Eastern Aar Massif. Abstract 14<sup>th</sup> Alpine Workshop, Sion, 2019

### Interviews

**Heuberger, S.** (2019). SalzTalk "Wie lässt sich der Rohstoffabbau in der Schweiz minimieren?", Sel-SalzSale, Ausgabe 4.0. Published [online](#) on 19.12.2019.

**Heuberger, S.** in: Die Suche nach einem Atomendlager – Ein steiniger Weg. Lars Badertscher (2019). High school diploma thesis. Kantonsschule Rychenberg, Winterthur, 52 pp.

## 6 Network

### 6.1 Active committee memberships

Organisation	FGS member	Function	Since
NEROS (Network for Mineral Resources in Switzerland)	S. Heuberger	member of the steering committee	2019
SASEG (Swiss Association of Energy Geoscientists)	S. Heuberger	member of the steering committee	2019
SFOE (Swiss Federal Office of Energy), expert panel for reviewing funding applications of geothermal exploration projects	S. Heuberger	member of expert panel	2018
SGPK (Swiss Geophysical Commission)	S. Heuberger	visiting guest	2017
NVS (Natural Building Stones Association Switzerland)	D. Fulda	member of the quarry commission	2018

### 6.2 Review committees for the Swiss Federation

Organisation	FGS member	Function	Since
SFOE (Swiss Federal Office of Energy) expert panel for reviewing funding applications of geothermal exploration projects	S. Heuberger	member of expert panel	2018

**FGS** Fachgruppe  
Georessourcen  
Schweiz

ETH Zurich  
Department of Earth Sciences  
Georesources Switzerland Group  
Sonneggstrasse 5, NO F 35  
8092 Zurich

[georessourcen.ethz.ch/en](http://georessourcen.ethz.ch/en)

[erdw.ethz.ch/en/research/associated-groups/fgs.html](http://erdw.ethz.ch/en/research/associated-groups/fgs.html)

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