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21. Geoscience and Geoinformation – From data acquisition to modelling and visualisation

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21. Geoscience and Geoinformation – From data acquisition to modelling and visualisation

Nils Oesterling, Adrian Wiget, Massimiliano Cannata, Michael Sinreich

Georesources Switzerland Group,
Swiss Geodetic Commission,
Swiss Geophysical Commission,
Swiss Hydrogeological Society

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21.3
The Resource Information System (RIS) – the digital memory of mineral resource occurrences in Switzerland

Donat Fulda [1], Arsin Grünig [1], Stefan Heuberger [1]

[1] *Georesources Switzerland Group, Department of Earth Sciences, ETH Zürich, Sonneggstrasse 5, 8092 Zürich (donat.fulda@erdw.ethz.ch)*

In the late 19th century, the importance of systematical investigations of distribution, occurrence and application of mineral resources in Switzerland was recognized. A huge amount of georesources data were collected by different organisations and compiled by the Swiss Geotechnical Commission (SGTK) during the last 120 years (Heuberger *this volume*). Today, the Georesources Switzerland Group maintains and extends this outstanding data archive.

Only parts of the data are digitized and available to the public at the moment. Furthermore, the datasets are heterogeneous in terms of structure, documentation, quality and data format. Therefore, assessing, analysing or evaluating the data is not straightforward. There is increasing need to 1) structure, harmonize and verify these data, 2) migrate them to a uniform, data model-based platform and 3) make them all available to the public.
These needs are addressed with the development of a comprehensive, web-based management system containing these mineral resource occurences, the so-called Resource Information System (RIS). It succeeds and builds on SGTK's innovative digital databases like the "Rohstoffinventar" (Vogler 1995) and the "Geotechnischer Umwelt-Atlas (GUA)" (Baumeler et al. 2005). But in contrast to these former inventories, the RIS is built upon data models, i.e. the Georesources Switzerland Group's raw materials data model as well as swisstopo's «Geology» data model (swisstopo 2017a). Using data models leads to higher data quality and reduces data errors. Furthermore, modelled data can be accessed, compared and analysed more easily. However, data models increase the complexity of a system. Therefore, migration and integration of data remains a time-consuming task. Although some data can be imported automatically, lots of datasets still need manual editing or research (Grünig & Fulda *this volume*).

Since the RIS data management platform was put into operation in 2015, nearly 2000 datasets on ores, energy resources and industrial minerals were harmonized and migrated from the "Rohstoffinventar" to the RIS. Today, datasets of most resource groups currently mined in Switzerland are processed and migrated into the system and updated on a yearly basis. However, the huge amount of already digitized data on historical mining sites and products (produced before 1980) containing more than 20'000 datasets, is still waiting to be harmonized and integrated into the platform. The RIS represents an important data basis for the future implementation of the measures defined in swisstopo's report on mineral resources in Switzerland (swisstopo 2017b). Mainly measure A1 "Acquisition and characterisation of geological raw material occurences" is heavily depending on such data.

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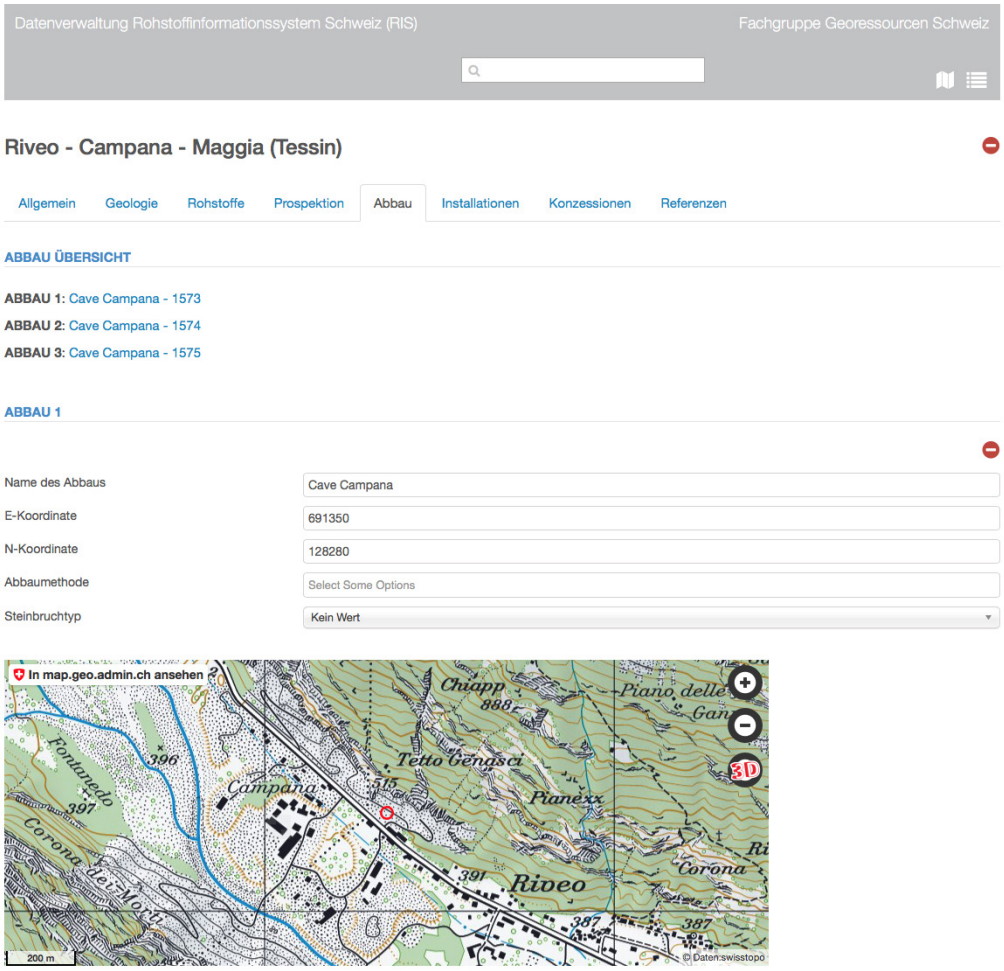

Figure 1: data management platform of the RIS showing exploitation data of a dimension stone quarry in the Canton of Ticino.

21.6
Harmonizing and aggregating datasets of different periods of time – the process explained by means of Swiss quarries

Arsin Grünig [1], Donat Fulda [1]

[1] *Georesources Switzerland Group, Department of Earth Sciences, ETH Zürich, Sonneggstrasse 5, 8092 Zürich (arsin.gruenig@erdw.ethz.ch)*

The Resource Information System (RIS) of the Georesources Switzerland Group (Heuberger *this volume*) contains operational and geological data of mineral resources in Switzerland (Fulda et al. *this volume*, Fulda & Grünig *this volume*). One major mineral resource group of the RIS covers quarries. The data has been collected over a long period of time and ranges from the Roman Empire to this day. Our dataset contains a separate geodatabase for each acquisition period (Roman Empire to 1910, 1915, 1935, 1965, 1980, 1995, and 2015). The type and amount of data in each geodatabase varies highly. For example, the 1915 dataset consists of many historical sites but only with sparse details for each entry (3564 data entries with 9 attributes). In contrast, the data entries for 2015 are more detailed but far less numerous because the dataset contains only the active sites and many quarries are not in operation anymore (141 data entries with 17 attributes).

One task of the Georesources Switzerland Group's RIS project was the harmonization and aggregation of the datasets for the years 1980, 1995, and 2015 into one single combined dataset. Due to economical restrictions, the datasets from 1965 and before were not included in the aggregation; if necessary, these datasets can be processed at a later date. The advantages of such an aggregation are 1) quarries can be viewed on a single layer instead of multiple layers (one for each period of time), 2) data is stored in a central database, 3) data can be managed continuously instead of periodically, and 4) geological terms such as lithology and stratigraphy are updated to today's terminology. The main challenges of the aggregation are that 1) some quarries can occur in one, two or all three periods of time, 2) a quarry can consist of one or multiple exploitation sites which all should be represented by a single object, and 3) some source data is inconsistent, which makes manual research inevitable and thus is time consuming.

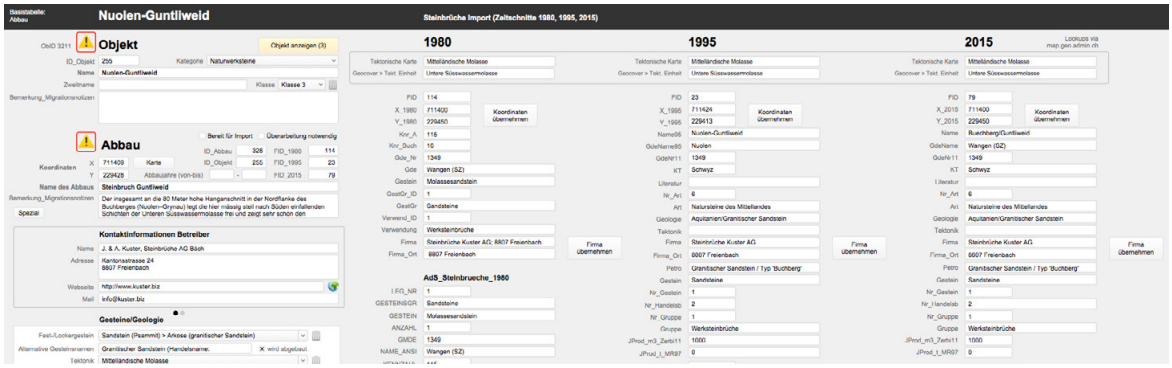

Figure 1. Screenshot of FileMaker application for harmonizing and aggregating data. Aggregated data on the left, data of different points in time (1980, 1995, and 2015) on the right.

In order to support the harmonization and aggregation of the datasets, a utility FileMaker database solution has been developed. The solution allows to import the source data and establish relations for quarries and its exploitation sites between datasets. Subsequently, all the data for a single quarry is arranged on a single screen (cf. Figure 1). This kind of arrangement allows the editor to decide for each data attribute whether to transfer it from one of the datasets into the aggregated data record, or to enter it manually.

The aggregated data from the utility database was migrated into the relational data structure of the RIS by means of a technique called Selector Connector (Young 2015). This FileMaker technique allows to connect different data sources and transfer data easily between them. Source tables and destination tables are connected by a central transistor table which is then used for script-controlled copying of the field data, one by one. The data from the seven source tables of the utility database were successfully migrated and distributed into 15 PostgreSQL tables of the RIS, cf. Figure 2.

The migrated data has been published at map.georessourcen.ethz.ch and map.geo.admin.ch (layers «Natural stone: mining» and «Broken rock: mining»).

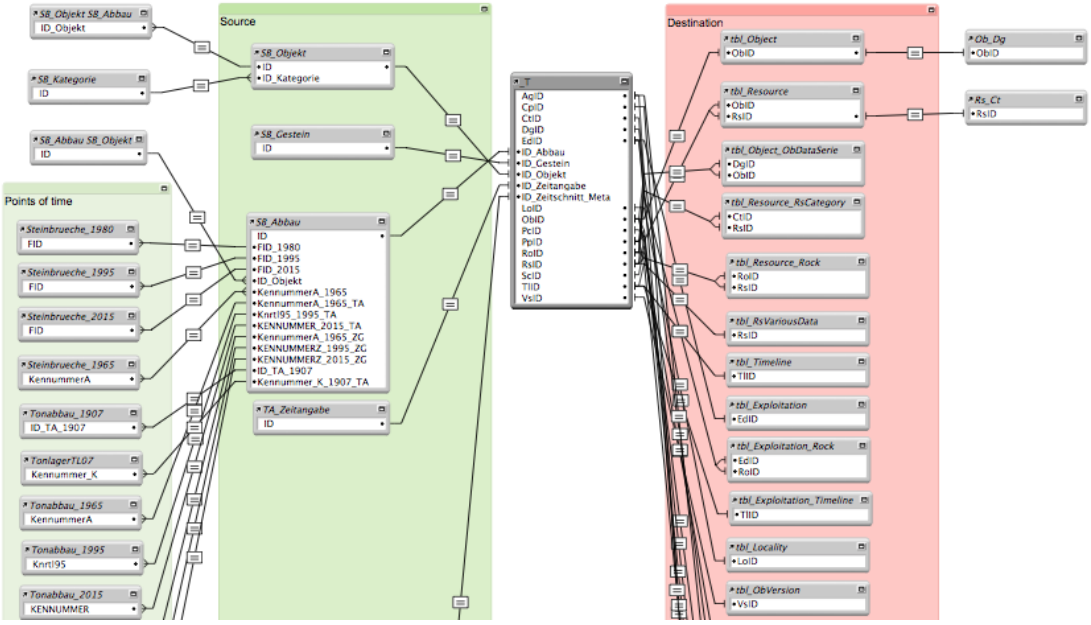

Figure 2. Data schema of the utility FileMaker database with the Selector Connector technique for transfering data. Harmonized and aggregated data of quarries in green on the left (source tables), PostgreSQL tables of RIS in red on the right (destination tables), connecting transistor table with ID fields in the centre.

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21.7
120 years of institutional research on Swiss georesources

Stefan Heuberger [1]

[1] *Georesources Switzerland Group, Department of Earth Sciences, ETH Zürich, Sonneggstrasse 5, 8092 Zürich (stefan.heuberger@erdw.ethz.ch)*

The Georesources Switzerland Group (Fachgruppe Georessourcen Schweiz) was founded in July 2018 at ETH Zürich and succeeds the office of the Swiss Geotechnical Commission (SGTK). It forms an associated group in the Department of Earth Sciences. The staff and the premises are equivalent to ones of the former SGTK office which already was located at ETH Zürich. The group conducts applied research in close collaboration with the Swiss Geological Survey (Federal Office of Topography swisstopo) as well as with different partners from industry and administration. This includes collecting and compiling fundamental geological data and data related to the use of the geological resources of Switzerland. Focus areas are the mineral resources of Switzerland, energy resources from the deep underground (geothermal energy and hydrocarbons), secondary raw materials as well as geological questions related to the use of georesources and the underground in general.

This presentation will take you through the history of evaluation and documentation of Switzerland's geological resources from the late 19th century until today. Swiss georesources were firstly documented as becoming a major national issue during the national exhibitions (Landesausstellungen) 1883 in Zürich and 1896 in Geneva. In the mid 19th century, many European countries founded geological surveys in order to provide base data for the exploitation of geological resources. Research and data compilations were coordinated by the Swiss Geological Commission (SGC), founded in 1860 by the Schweizerische Naturforschende Gesellschaft (e.g. Nabholz & Spicher 1973), today the Swiss Academy of Sciences (SCNAT). In the framework of the exhibitions, a mineral resources map of Switzerland (Weber & Brosi 1883, Fig. 1), a comprehensive monograph on construction material (Meister et al. 1884) and several other fundamental datasets on Swiss geology and georesources were published. These activities, among others, led to the establishment of several organisations looking after georesources. Swiss industrialists founded the Swiss Coal Drilling Society in 1874. This private organisation was succeeded by the Swiss Coal Commission in 1892 as subcommission of the SGC. This subcommission was then replaced by the SGTK in 1899, which was turned into a self-contained commission in 1909 (e.g. Grubenmann 1915). Since then, the commission's president was always a professor of an earth science institute of ETH Zürich. SGTK's office was located first at EMPA Dübendorf until 1927 when it was moved to ETH Zürich.
From 1899 to 2012, SGTK published more than 100 technical reports of Swiss georesources in the series "Beiträge zur Geologie der Schweiz – Geotechnische Serie". Until 1925, main research focus was on hydrocarbons, 1925 it switched to mainly metallic raw materials with a short interlude of hydrocarbon studies during and after world war II. Around 1975, the study focus significantly diversified also including construction materials (aggregates, clay), unconsolidated rocks and Nagra's deep drilling program. Today, the Georesources Switzerland Group continues this institutional, applied research and maintains the different archives and online data portals (e.g. Fulda et al. *this volume*, Fig. 1, Grünig & Fulda *this volume*) in close collaboration with the Swiss Geological Survey.
This compilation of SGTK's history thus nicely illustrates how the demands for georesources in Switzerland have changed through time.

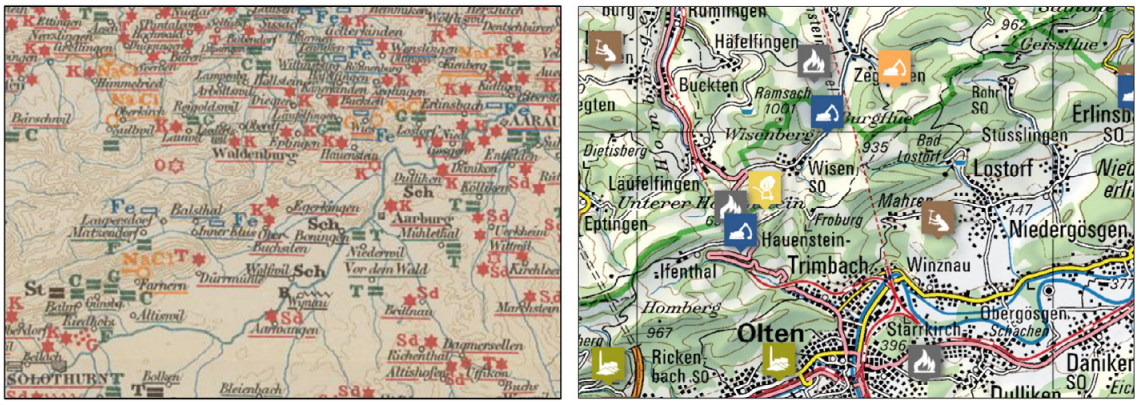

Figure 1. Left: exemplary extract of the georesources map by Weber & Brosi (1883). Right: Extract of today's online portal map. georessourcen.ethz.ch.

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P 21.3
The Resource Information System (RIS): A web application for mineral resource data of Switzerland

Donat Fulda [1], Arsin Grünig [1]

[1] *Georesources Switzerland Group, Department of Earth Sciences, ETH Zürich, Sonneggstrasse 5, 8092 Zürich (donat.fulda@erdw.ethz.ch)*

The Resource Information System (RIS) is a freely accessible web-based information system providing data on occurrences and extraction sites of mineral resources in Switzerland (Fulda et al. *this volume*). It includes data on gravel, sand, cement raw materials, brickyard raw materials, crushed rocks, natural stone, gypsum and salt, all of which are currently extracted in Switzerland. Furthermore, the RIS also contains data on currently not produced mineral resources like energy resources, industrial minerals (except salt and gypsum) and metals (cf. Fig. 1).

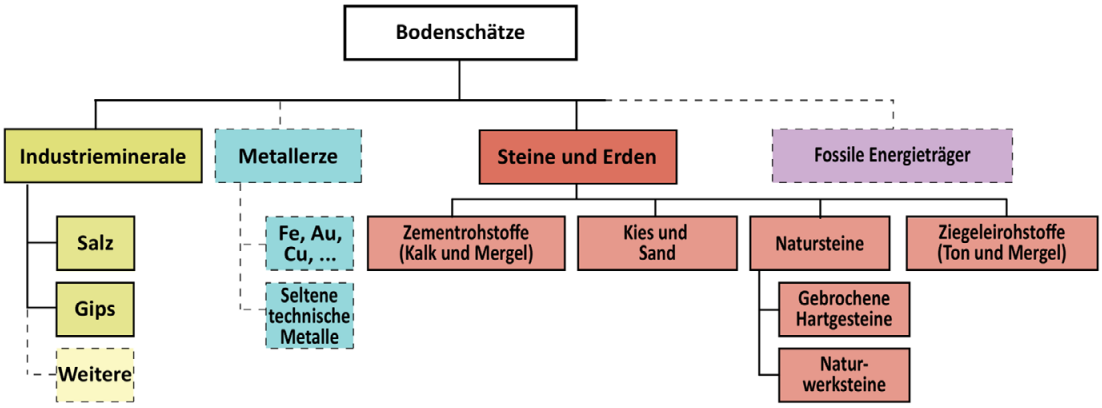

Figure 1. The RIS includes data on all mineral resource groups while the main focus is on raw materials which are currently extracted in Switzerland (boxes with solid lines). Figure by swisstopo (swisstopo 2017a).

Map viewer application

The data of the RIS is published on two platforms. Firstly, on the RIS map viewer application (map.georessourcen.ethz.ch), where all available data can be accessed, and secondly – for overview purposes – as a condensed version on the federal geodata portal map.geo.admin.ch (cf. Fulda et al. *this volume*). The objects on the two platforms are two-way linked, i. e. the object information of a quarry on map.geo.admin.ch links to the same object on map.georessourcen.ethz.ch, and vice versa. Complementary to map.geo.admin.ch, the RIS map viewer provides the following functionalities: 1) by clicking on a point of interest a data window is shown which contains data on the exploited resources, geology, operational information and literature references as well as photos of sites and rock samples (cf. screenshot in Fig. 2), and 2) advanced filtering, i. e. objects can be shown/hidden depending on the exploitation status (both, current and past periods of time), the importance of sites, or the material (rock group, lithology, minerals and elements).

Data management

The data of RIS is managed with a custom web application that has been developed by the Georesources Switzerland Group. Besides functionality for searching and editing data entries, the application features a simple method for tracking changes.

Technical architecture and interfaces

The RIS is based on a model-view-controller pattern, a commonly used architecture to build web applications. This architecture separates the data layer (data storage and retrieval) from the presentation layer (e. g. user interface for back- and frontend) and the application logic, a controller that processes in- and outputs. The data structure is based on the data model for raw materials developed by our group and the data model «Geology» published by swisstopo (swisstopo 2017b). The controller serves data to both, a backend view where editors can manage the data and to a frontend view where mineral resource data is published on a map interface (map.georessources.ethz.ch). A JSON module pushes the data to map.geo.admin.ch and other web applications for synchronization. Front- and backend views of the RIS are built upon different open source web services and libraries (e.g. the swisstopo GeoAdmin API, Leaflet, and Bootstrap). The business logic is written in PHP; the data is stored in a PostgreSQL database with the PostGIS extension for storage of spatial data. QGIS applications can directly be connected to the PostgreSQL database with read/write access.

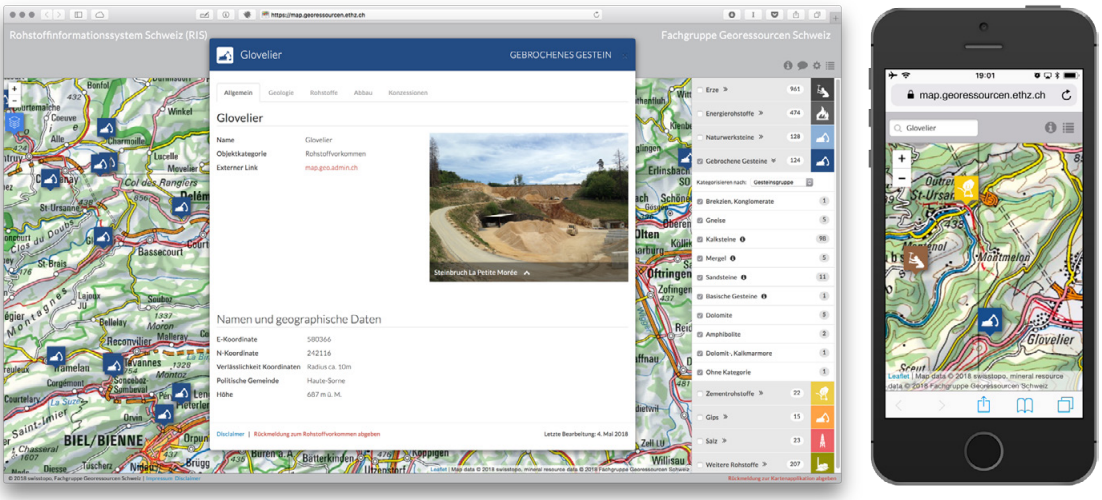

Figure 2. Desktop and mobile version of map.georessourcen.ethz.ch. Here in focus: Glovelier, an active quarry for crushed rocks in the canton of Jura.

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