The Swiss Geotechnical Environmental Atlas
– a new multimedia tool

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1. Major goals and potential users

One of the major goals of the Swiss Geotechnical Commission is the development of a new concept of a «Geotechnical Environmental Atlas» within the frame of the Swiss Atlas Information System [1]. This new geotechnical atlas system can be characterized as an interactive multimedia tool for geotechnical, hydrogeological and environmental analysis and cartographic visualization in a geo-spatial multimedia environment.

The previous two editions of the «Geotechnische Karte der Schweiz 1:200’000» (Swiss Geotechnical Commission 1934–1937 and 1963–1968) are highly complex maps. These maps were produced by a classical print technique using a coloured geological-geotechnical base map in combination with several layers of point data information as well as some pattern fills for specific technical usage of rocks and minerals. The maps are overloaded with information and are mainly graphical with limited functionality. Although the maps were published several years ago, the public demand is still lively. Unfortunately some of them are out of print by now. Therefore there has been a need to find new ways to republish the already existing map sheets but updated with an actualized geotechnical content. They should be produced in a user-friendly manner, be much more flexible in usage than a common (static) map and be adaptable to the needs of future users. The following criteria had to taken into consideration:

– widespread availability for the interested public
– digital data management
– dynamic visualization of the geotechnical database on a geographic reference
– links to extended digital information in geotechnic domains
– dynamic upgrade of the information content with respect to future applications and further developments.

Using conventional cartographic techniques, these conditions could not be achieved. As a solution, we are in the process of developing an Atlas Information System (AIS) with a similar functionality as the interactive «Atlas of Switzerland» (2000).

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The «Geotechnical Environmental Atlas» will comprise a GIS-based data set which will be integrated within a graphic and numeric visualization process and will allow the user to create a variety of geotechnical maps from a common basic data system. Useful interaction of geotechnical, hydrogeological and environmental parameters with spatial information on different levels will be achieved by a concept of «intelligent maps». This means that a multimedia AIS can be generated out of a primary data system. This AIS will allow the use of incorporated geotechnical information of many different types (maps, tables, charts, text explanations, graphics databases) without specified expert GIS knowledge. Visualization will be controlled by several multimedia functionalities (modules) with the aim of providing a tool for complex queries to a broad public in a simple way. Thus GIS specific functions, so far only accessible to a limited user group, have to be incorporated within the AIS – a new technique which has been demonstrated recently by the work of other researchers (Schneider 2001). The GIS-techniques and on-line capabilities for the internet increase the flexibility and the use of the AIS. Thus, the «Geotechnical Environmental Atlas» system has the full potential to serve as a basic cartographic layout for further designs, reaching far beyond the classic way of interpretation in geotechnics. This is of particular interest in the perspective of sustainable development with respect to the geotechnical behaviour of the underground, hydrological processes, natural hazard assessment and mineral resources. This AIS will be produced not only for geoscientists, potential users could...

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Figure 1: Database system of the «Geotechnical Environmental Atlas». Data input sources and the three main inquiry levels «internal», «external» and «www».
as well be engineering and environmental organizations, public and governmental offices in charge of water supply, sewage systems, solid and waste disposal as well as environmental, industrial, energy, urban and transportation planning.

The project is subdivided into three major parts: an expert domain based on a GIS-system, a multimedia domain for visualization purpose and a web domain with the capability of internet queries.

For most users the prefabricated multimedia atlas will be sufficient. However experts can work directly with the principle GIS-based data records (see Figure 1). The «Geotechnical Environmental Atlas» has to be seen as a subsystem within a larger multimedia project, which includes the integration, archiving and updating of many different geotechnical data sets.

A team of the Swiss Geotechnical Commission will gather and update the geotechnical base data records in an information system, which in its content reaches far beyond a classical GIS concept. Later, the same data set will serve as a basis for updates or for the periodic publication of more detailed or spatially localized atlases. A schematic overview is displayed in Figure 1. In principal, the «Geotechnical Environmental Atlas» represents an electronic information system, in which geographical data sets as well as text, diagrams, illustrations and data bases are linked in a rather complex way. The core of this «Geotechnical Environmental Atlas» consists of an overall data base providing the necessary data sets for different inquiries. Three main inquiry levels are differentiated (Figure 1):

- Classical GIS system for handling and maintenance of the data bases as well as for the use as a so-called expert area. Advantages: overall data access, expert functions, possibility of a wide range of areal integration. Disadvantages: limited group of potential users, expert knowledge required, rather complex handling, limited guidance, variable computing time depending on the task.

- Atlas Information System (AIS) with additional GIS functionalities for the semi professional use. Advantages: large group of potential users, simple handling, predefined user interaction, flexibility in the representation of geotechnical parameters, avoidance of senseless data combination and false applications. Disadvantages: predefined data sets, predetermined area selection (national/regional), output and visualization predominantly on screen.

- WWW information system. Advantages: large group of possible users, publicity, free of charge, future development potential, very fast. Disadvantages: restricted functionality, no direct influence on the data sets (for safety reasons).

2. Development and Structure of the Swiss «Geotechnical Environmental Atlas» system

The development and the production of the «Geotechnical Environmental Atlas» system can be subdivided into two main parts: an overall geotechnical section as a
master data system (GIS and data base areas) and a multimedia based visualization and production part. The software used as well as the need for data integration, data maintainance, data security and multimedia tools are different in the two parts. Within the geotechnical environment data records, existing printed and digitally produced geotechnical maps and related geoscientific maps are processed and displayed by means of GIS (ArcInfo, ArcView) (Figure 1, central part). In this domain the acquisition of other GIS data or the integration of external geotechnical data material is performed. Based on existing maps controlling, handling and integration of geotechnical data takes place continuously at the same time. Master data bases are developed, linked and connected with data sets from relevant geotechnical publications. Most of the geotechnical input data is thereby taken out of the scientific monographs and publications released during the last 100 years by the Swiss Geotechnical Commission. The data administration is coordinated in such a way that within individual applications (GIS domain: Arc/Info; data base domains: MS-Access; graphic domains: EPS, TIFF, PDF, etc.), the relevant data standards remain ensured in each case. The aim of this procedure is a transformation of very heterogeneous raw material (e.g. maps, diagrams, graphics, tables, pictures) into a system where these raw data can be used equivalently in a multimedia environment. Data connections (GIS-DB, DB-dia-

![Geotechnical Environmental Atlas](image)

Figure 2: «Geotechnical Environmental Atlas», schematic view of the multimedia visualization and production part.
grams, DB-text/pictures etc.) have to be flexible and unequivocal with respect to handling, corrections and updates. Redundancies must be avoided.

The multimedia visualization and production part (Figure 2) represents a concentrated data set generated from the master data system at a certain time. Thereby much importance has been placed on the simple guidance for the user. Different parts of the main data bases together with descriptive textblocks and illustrations are arranged within an AIS on a CD ROM. In addition to the basic data records, the user should also be able to manage his own data sets. Furthermore, the integration of updates and/or additional geotechnical data acquired during the course of a project must be possible. Within the multimedia part of the atlas information system, different cartographic modules developed by the Federal Institute of Cartography (ETH-Zurich) should be applicable in addition to standard multimedia programs (e.g. Macromedia Director). All these plug-ins will be modularly structured and can be combined in different ways. Regarding the structure of the data system, the multimedia information is based on a universal multimedia-format (Bär and Sieber 1999) which permits the user to integrate certain GIS functionalities within the AIS. The data should be stored in such a way that reclassifications, as they are now possible in an AIS, or thematic queries by the user can not lead to a falsification of the existing data. Thus, the original data status remains equivalently available and obligatory for different users at any time (Schneider 2000). Therefore it has to be defined which attributes can be reclassified and which values can be modified.

3. Multimedia concept and example of the «Swiss Geotechnical Environmental Atlas» information system

The «Geotechnical Environmental Atlas» is structured into three major data groups: primary cartographic and point input data as well as numeric input data, and secondary output data. The graphic input data on the scale of 1:100’000 comprise soil and rock formations in terms of their petrographic lithologies, geological structures, hydrographic and hydrogeological data.

Within the numerical data set, geotechnical and hydrological parameters are given: grain-size, density, porosity, permeability, chemical composition, conductivity, temperature, etc. Quarries, mines, boreholes, wells, springs and mineralizations appear as point data. Additional geotechnical information such as the newly edited book «Die mineralischen Rohstoffe der Schweiz» (Kuendig et al. 1997) can be added in various proportions using HTML-techniques as well as platform-independent PDF-formats.

With different pilot projects it could be demonstrated so far that the aims of this project are realistic, and that even different visualization techniques exist in order to manage areas of completely different information contents (scale factors) within the same AIS (Schirmer 1998). The interactive multimedia environment contains the following features: functionality groups (general functions, thematic navigation, spatial
navigation and orientation, visualization functions and GIS-functions). The structure of a geotechnical atlas information system on a more detailed scale is represented in Figure 3. On the basis of a GIS data record of a digital geological map, the attribute table was completed with special geotechnical parameters. The whole data record was linked with further information levels according to the structure shown in Figure 1.

The main potential of this system lies in the integration of visualization techniques, multimedia and adopted GIS-functionality. The term multimedia implies not only the multisensorical component and a non-sequential access to the Atlas, but especially the criteria of interactivity. In this way and in a certain reliability range of the geotechnical parameters, different output levels can be generated from the same basic input data, depending upon the preferences of the user.

Using such a «Geotechnical Environmental Atlas» information system, it will then be possible to compare different data sets from different disciplines for the specific purpose of environmental engineering and planning, hydrological and hydrogeological processes (e.g. underground flow modelling) and assessment of natural hazards (e.g. landslides, rock falls, earthquake activity etc.). The ease of the graphical user interface will enable people who would have been unable to correlate different phenomena and parameters to do so electronically.

Figure 3: Information content and structure of a geotechnical atlas information system on a detailed scale.
The ability to develop a tailored, user-friendly AIS has recently been successfully proven by developing the multimedia part of the «Atlas of Switzerland» [1]. In its next version (2003) a first geotechnical atlas information system will be integrated. Geographically it will be based on a map scale factor of 1:500'000. But in its geotechnical content it will be linked to a more detailed information input which corresponds approximately to a classical map scale factor of 1:200'000. Later on, geotechnical atlas information systems with an even more detailed information content will be created.

The new approach also promises a level of insight into the deeper underground including major aquifers and into the structure of hazard assessment. The ease and versatility in manipulating a large number of overlays and 3D-reliefs with a large quantifying analytical potential and customising it to one’s own requirements will set a new standard.

References: