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Geological Information System Switzerland -
Supplying geoscientific geoinformation to the NSDI

by

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Preface & Acknowledgements

Preface

The present master thesis was worked out in the framework of the UNIGIS course of studies *Geographical Information Science & Systems* at the University of Salzburg, Austria. The topic of the thesis is related to my work at the Swiss Geological Survey (SGS). The SGS is beside other tasks responsible for the coordination of the geological, geotechnical and geophysical survey in Switzerland. This task is difficult to perform, because the Swiss geo-community is diverse and heterogeneously structured. A corporate geological survey like in other countries does not exist. Because of this reason a tool for the coordination of the national geo-community and the access and exchange of geo-scientific data and information is need.

The *vision* for such an envisioned information system is:

Create an interactive tool for the players of the Swiss geo-community to improve existing work-flows. Using such a system, the nowadays dispersed and heterogeneously organised Swiss geo-community gets a tool for the coordination of their tasks and the efficient and easy exchange of data and information. The more efficient access to geological information facilitates the activities in the geo-community and enhances the awareness of geology in the society, politics and economy.

The present master thesis is a preliminary study for the development of a national geological information system. It gives an overview of existing information system of geological purposes in Switzerland and on the international level. Furthermore the needs and requirements of the geo-community are evaluated and a basic concept is designed. This concept can be used as a basis for future considerations and the development of the final system.

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First of all I would like to thank Andreas Kühni (Head of the Geological Survey Coordination and Management division of the Swiss Geological Survey (SGS)) for the supervision of this thesis. I am very grateful for his continuous technical support and the many fruitfull discussions. I am also gratefull to the SGS which founded my participation in the UNIGIS course of study.

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Last but no least I would like to thank Josef Strobl and the entire UNIGIS-Team in Salzburg who did a great job during the entire almost three years of my study. Keep it up!

Declaration

I confirm that this master thesis was written without the help of others and without using any sources other than the ones cited and that this thesis has not been submitted in its present form or a similar form to another examination board. All passages in this thesis that are quoted from other sources are marked accordingly.

Gümligen, October 2009

Nils Oesterling

Abstract

Geological information is of great importance for many products and activities of our every day life. For instance, the creation of roads, buildings and other constructions or the supply of fossil energy resources like oil and gas is impossible without geological data, information and knowledge.

In Switzerland the accessibility of geological and geology related information, referred to as geo-thematic data in this thesis, is limited. This situation is caused amongst others by the heterogeneous structure of the Swiss geo-community. Unlike other countries, Switzerland does not have a corporate geological survey organisation. All geology related tasks are shared by the geo-community which is composed of federal and cantonal offices, universities, private consultants etc. As a consequence, of this non-uniform structure and the related non-coordinated activities of the individual organisations the geo-community has a restricted public awareness. Furthermore, the support by politics and economy is limited.

In order to enhance the accessibility of geo-thematic data and to contribute to the solution of the aforementioned problems, the Swiss Geological Survey (SGS) is developing the *Geological Information System Switzerland (Geolo-GIS-CH)*. This internet based information system is intended to be the future gateway to all available geo-thematic data in Switzerland. It constitutes a tool for the Swiss geo-community which facilitates the communication among its particular members and improves their accessibility for external clients.

The present master thesis represents a preliminary study for the development of the Geolo-GIS-CH. It analyses the present situation regarding the geo-thematic data and its provision in Switzerland. Especially the existing geological information systems on the international and national level are identified and their components are reviewed. Moreover, the requirements of potential users of the Geolo-GIS-CH are determined by a poll. This poll reveals that the international as well as the national geo-community consider the same components of the system as most important. Comparing these core-components to those supplied by existing geological information systems, it turns out that the major part of the required components are already in use. However, they are independent from each other, thus a central gateway is lacking.

Based on the analysis mentioned above a basic concept for the development of the Geolo-GIS-CH is proposed. Apart from the definition of the objectives of the system and its target groups, the general design and the abstract architecture of the Geolo-GIS-CH is discussed. One entry point to the system is the *Geology Portal*. This web portal contains three thematic sectors which which provides access to geo-thematic data, information on the members of the Swiss geo-community and to easy understandable geological knowledge. The second way to access the geo-thematic data in the core of the Geolo-GIS-CH are web-services. These services can consumed by GIS and other applications.

A roadmap illustrates the relative timing of particular tasks and reveals its dependencies. This roadmap shows one possible way for the future realisation of the project.

The Swiss geo-community is a community around thematic data in the framework of the National Spatial Data Infrastructure (NSDI). The Geolo-GIS-CH is the gateway to the data, information and knowledge of this community and represents by this one of the different thematic pillars of the Swiss NSDI.

Kurzfassung

Geologische Informationen sind für eine Vielzahl von Produkten und Aktivitäten des täglichen Lebens von entscheidender Wichtigkeit. So ist beispielsweise der Bau von Strassen, Gebäuden und anderen Bauwerken oder die Versorgung mit fossilen Energieträgern, wie Erdöl und Erdgas ohne geologische Daten, Informationen und Wissen unmöglich.

In der Schweiz ist der Zugang zu geologischen und geologierelevanten Informationen, allgemein als geo-thematische Daten in dieser Arbeit bezeichnet, stark eingeschränkt. Dieser Umstand wird unter anderem durch die heterogene Struktur der Schweizer Geo-Szene begründet. So existiert, nicht wie in anderen Ländern, in der Schweiz kein einheitlicher Geologischer Dienst. Sämtliche geologiebezogene Aufgaben sind auf die nationale Geo-Szene aufgeteilt, die sich aus Bundesämter, kantonale Fachstellen, Universitäten, Private Beratungsfirmen etc. zusammensetzt.

Folgen dieser uneinheitlichen organisatorischen Struktur und der damit verbundenen unkoordinierten Aktivitäten der Mitglieder ist die geringe öffentliche Wahrnehmung der Geo-Szene und die eingeschränkte Unterstützung durch Politik und Wirtschaft.

Um den Zugang zu geo-thematischen Daten zu verbessern und damit die zu einer Lösung der vor genannten Probleme beizutragen, arbeitet die Landesgeologie an der Entwicklung des *Geologischen Informationssystems Schweiz (Geolo-GIS-CH).* Dieses internet-basierte Informationssystem soll zukünftig den zentralen Zugang zu sämtlichen geo-thematischen Daten in der Schweiz darstellen und ein ein Werkzeug für die Schweizer Geo-Szene bilden. Mittels dieses Werkzeugs wird sowohl die Kommunikation zwischen der Mitgliedern der Geo-Szene vereinfacht, also auch die Sichtbarkeit und der Zugang zu den einzelnen Mitgliedsorganisationen verbessert.

Die vorliegende Arbeit stellt eine Voranalyse für die Entwicklung des Geolo-GIS-CH dar. Sie analysiert zum einen den aktuellen Zustand im Bezug auf geo-thematische Daten bzw. Geoinformation (GI) und der Bereitstellung in der Schweiz. Insbesondere werden bestehende *geologische Informationssysteme* auf nationaler und internationaler Ebene identifiziert und deren Komponenten analysiert. Zum anderen werden die Anforderungen von potentiellen Kunden des Geolo-GIS-CH mittels einer Umfrage bestimmt. Sowohl auf nationaler als auch auf internationaler Ebene werden ähnliche Komponenten des Systems verlangt. Der Vergleich dieser *Kern-Komponenten* mit den bestehenden geologischen Informationssystemen zeigt, dass der Grossteil der verlangten Komponenten bereits zur Nutzung zur Verfügung steht.

Basierend auf diesen Analysen wird ein Grobkonzept für die Entwicklung des Geolo-GIS-CH vorgeschlagen. Neben der Definition der Ziele und Zielgruppen wird darin der generelle Aufbau und die abstrakte Lösungsarchitektur des Systems diskutiert. Der Zugang zu Geolo-GIS-CH wird durch ein *Geologie Portal* gewährleistet. Dieses Web-Portal beinhaltet drei thematische Sektoren, über die auf sämtliche geo-thematischen Daten zugegriffen werden kann, Informationen über die Mitglieder der Schweizer Geo-Szene verfügbar sind und geologisches Wissen in laien-

verständlicher Weise angeboten wird. Neben dem Zugang über das Geologie Portal, können die geo-thematischen Daten, auf denen das gesamte Geolo-GIS-CH basiert, über Web-Services direkt in GIS und anderen Anwendungen integriert werden.

Eine Roadmap für die Durchführung des gesamten Projektes beschreibt die zeitliche Abfolge von Arbeitsschritten und deren gegenseitige Abhängigkeiten. Diese Roadmap bildet die Planungsgrundlage für die konkrete Umsetzung des Geolo-GIS-CH.

Die Schweizer Geo-Szene ist eine Fachinformationsgemeinschaft im Rahmen der Nationalen Geodaten Infrastruktur (NGDI). Das Geolo-GIS-CH bildet den Zugang zu den Daten, Informationen und Wissen dieser Gemeinschaft und stellt damit einen thematischen Pfeiler der Schweizer NGDI dar.

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Abbreviations

APAT	Italian Agency for Environmental Protection and Technical Services: Geological Survey of Italy
API	Application Programming Interface: Interface that allows the interaction with a particular software on the program code level
BGR	Federal Institute for Geosciences and Natural Resources: Geological Survey of Germany
BGS	British Geological Survey
BRGM	Bureau de recherches géologiques et minières: Geological Survey of France
CHGEOL	Swiss Association of Geologists
CGI	Commission for the Management and Application of Geoscience Information: Commission of the IUGS
COGIS	Coordination, Geo-Information and Services division of swisstopo
CSW	Catalogue Service for Web: OGC standardised service for the publication of information on geo-applications, spatial services and geodata
DBMS	Database Management System
DEM	Digital Elevation Model : Aquatic research institute within the ETH-Domain.
e-geo.ch	Project on the federal level for the development of the Swiss NSDI and FSDI
EGK	Swiss Federal Geological Commission
EGKV	Federal Ordonnance of the Swiss Federal Geological Commission: Related to the GeoIG
EGS	EuroGeoSurveys: Association of the European GSOs
ESDI	European Spatial Data Infrastructure
EU	European Union
FOEN	Swiss Federal Office for Environment
FSDI	Federal Spatial Data Infrastructure
FSO	Swiss Federal Statistical Office
GA25	Geological Atlas of Switzerland 1:25'000: Detailed scale geological map series of Switzerland and major product of the SGS
GBA	Geologische Bundesanstalt Österreich: Geological Survey of Austria
GeoIG	Federal Act on Geoinformation
GeoIV	Federal Ordonnance on Geoinformation: Related to the GeoIG
Geolo-GIS-CH	Geological Information System Switzerland: Information system for geological purposes as described in the present thesis
GeoRSS	RSS for geographic content
GeoSciML	Geoscience Markup Language: GML-application schema for geological features
GI	Geoinformation: Information with a spatial reference
GIC	Geoscience Information Consortium: Assembly of the GI-responsibles of the international GSOs
GIS	Geographic Information System
GML	Geographic Markup Language: XML-based language for the description and transfer of geographic data
GSDI	Global Spatial Data Infrastructure
GSC	Geological Survey of Canada
GSO	Geological Survey Organisation: Organisation responsible for the geological survey and related issues on the national or state level
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technology

IUGS	International Union of Geosciences
INSPIRE	Infrastructure for Spatial Information in Europe: Legal basis and driving force for the built-up of the ESDI
INTERLIS	Modelling language and exchange format for GI. INTERLIS stands between (INTER) land information systems (LIS)
IYPE	International Year of Planet Earth
KML	Keyhole Markup Language
LGeolV	Federal Ordonnance of the Swiss Geological Survey: Related to the GeoIG
NAGRA	National Cooperative for the Disposal of Radioactive Waste: National organisation in charge of the search for suitable disposal sites for radioactive waste in Switzerland
NSDI	National Spatial Data Infrastructure
OGC	Open Geospatial Consortium
OGM	OpenGeoMap: Interactive Web2.0-application for capturing geo-thematic VGI. Component proposed for the envisioned Geolo-GIS-CH
OneGeology	International Project of the GSOs in the framework of the IYPE
OSI	Open Systems Interconnection Reference Model
RSS	Really Simple Syndication: Web-service for updating frequently changing web contents
sc|nat	Platform Geosciences: Platform of the Swiss Academy of Natural Sciences responsible for geo-scientific issues
SDI	Spatial Data Infrastructure
SFOE	Swiss Federal Office of Energy
SGPK	Swiss Geophysical Commission
SGS	Swiss Geological Survey: Specialist department for geology of the Swiss confederation and division of swisstopo
SOGI	Swiss Organisation for Geographic Information
SQL	Standardised Querying Language
swisstopo	Swiss Federal Office of Topography
VGI	Volunteered Geographic Information
W3C	World Wide Web Consortium: Standardisation body for web related technologies
WMS	Web Map Service: OGC standardised service for the delivery of map data in raster format (i.e. images) via the internet
WFS	Web Feature Service: OGC standardised service for the querying and retrieval of geographical objects in vector format via the internet
WFS-T	Transactional Web Feature Service: While a *normal* WFS is restricted to querying and retrieval of geographic objects, a WFS-T allows to create, delete and update geographic features
WPS	Web Processing Service: OGC standardised service GIS-processing, e.g. spatial analysis available via the internet
WWW	World Wide Web
XML	Extensible Markup Language
XMML	Exploration and Mining Markup Language

1 Introduction

1.1 Background of thesis

Geo-thematic data, information and knowledge, i.e. those from the field of geology and related specialisations (for definition cf. Section 2.2), are of great importance for a large number of products and activities of our everyday life (Fig. 1.1). Traffic constructions like roads, railway lines, supply with fossil and geothermal energy, groundwater resources and protection from natural hazards are only some of the most prominent topics for which geo-thematic knowledge is crucial. All of these disciplines require such knowledge as an important basis for decision-making processes. For instance, information on the stability of bedrock and superficial deposits and its contamination with pollutants is essential for choosing specific building sites for houses, tunnels etc. Questions concerning the search for radioactive waste disposal sites can only be answered with the help of geo-thematic data and information. Furthermore geo-thematic data supply basic information for the preparation of natural hazard maps, a topic, which is becoming increasingly important in recent years (e.g. extreme flooding of Swiss rivers in the summer of 2005[1] and a rock fall directly striking a car on the Gotthard Highway in 2006[2]) and will be in the future.

Increasing and accelerating mobility of human population and the related demand for functional and secure traffic infrastructure require the construction of further roads, railway lines etc. The growth of our cities and municipalities by the construction of above ground and subsurface buildings like houses, traffic lines, tunnels, car parks, service pipes etc. causes an increasing shortage of space, not only above ground, but also below the earth surface. Thus, conflicts of beneficial use are occurring in a growing number of instances (Beer and Schenker, 2006, Parriaux *et al.*, 2006). These conflicts can only be solved, i.e. prevented, by a sustainable three-dimensional city and regional planning. Such a so-called *Tiefenplanung* (Beer and Schenker, 2006) which extends the conventional two-dimensional planning of the earth surface to a spatial planning of the upper part of the earth crust, is without geo-thematic data impossible.

The availability of geo-thematic data, information and knowledge in Switzerland is limited. This situation is at least partly rooted in the heterogeneous structure of the Swiss geo-community. Unlike other countries, like France (Bureau de recherches géologiques et minières (BRGM)) or Great Britain (British Geological Survey (BGS)), Switzerland does not have a corporate Geological Survey Organisation (GSO). All geology related tasks are distributed to a multitude of organisations from administration, academia and the private sector. Those organisations are integrated in the above mentioned geo-community (for definition cf. Section 2.1). Loosely defined responsibilities of the particular organisations and lacking coordination cause amongst others

[1] http://www.news.admin.ch/message/index.html?lang=de&msg-id=12493, Last checked: 23.8.2009
[2] http://www.spiegel.de/reise/aktuell/0,1518,418970,00.html, Last checked: 23.8.2009

Fig. 1.1: What is geology and where is it relevant for society? Geological and other geo-thematic knowledge is relevant to many products and activities of our every-day life. Geology is about: 1) basic research, 2) environmental protection, 3) energy supply, 4) traffic and constructions, 5) natural hazard protection, 6) natural resources, 7) education and understanding our planet, 8) health and many other tasks and challenges of the modern society.

the aforementioned limitation in availability of geo-thematic data, information and knowledge. Moreover, unequally directed activities of the members of the geo-community lead to a low awareness of the importance of geology and other geo-scientific fields in society. This limited awareness, in turn, leads to poor political and economical support.

1.2 Motivation

One of the main tasks and the major challenge of the Swiss Geological Survey (SGS), the specialist department for geology of the Swiss Confederation and one of the major players of the national geo-community, is to coordinate and thereby concentrate the geology related activities in Switzerland. Concerning this challenge, the overall aim of the SGS is therefore, to strengthen the impact of the geo-communities activities in society.

In order to meet this challenge and to efficiently achieve the aim described above, a tool is required. Therefore, the SGS decided to develop such a tool in the form of a *geological information system* and provide it to the Swiss geo-community. The *vision* of this Geological Information System Switzerland (Geolo-GIS-CH) is as follows:

Create an interactive system for the players of the Swiss geo-community to improve existing workflows. Using such a system, the nowadays dispersed and heterogeneously organised Swiss geo-community gets a tool for the coordination of their tasks and the efficient and easy exchange of data and information. The more efficient access to geo-thematic information facilitates the activities in the geo-community and enhances the awareness of geology in society, politics and economy.

1.3 Aim of thesis

The development and implementation of the Geolo-GIS-CH requires a conceptual planning. Such a planning includes the development of a concept which implies besides design and architecture related considerations, also the analysis of the present state of relevant issues with respect to geo-thematic GI and the requirements of potential users of the Geolo-GIS-CH. This thesis addresses the aforementioned issues, thus its following aims are defined:

1. Give an overview of the present state of relevant issues related to geo-thematic data, information and knowledge, with special focus on the situation in Switzerland
2. Give an overview of the requirements of potential users of the Geolo-GIS-CH, with special focus on those of the Swiss geo-community
3. Develop a basic concept for the Geolo-GIS-CH, based on the present state in Switzerland and the requirements of the Swiss geo-community
4. Identify relevant issues and open questions to be considered for the development and implementation of the Geolo-GIS-CH

This thesis is a preliminary study for the development of a detailed concept for the Geolo-GIS-CH. Because of the size and complexity of the system the individual issues can be discussed only on a high level of abstraction. Detailed analyses are required in subsequent future projects.

1.4 Approach & structure of thesis

In order to achieve the aims of this thesis, the following approach has been taken:

- Perform a present state analysis regarding the handling and distribution of geo-thematic data, information and knowledge on the international level and particularly in Switzerland
- Identify the central problem on the basis of the present state analysis
- Analyse the requirements of the international geo-community and those of the members of the Swiss geo-community, concerning a geological information system
- Develop a basic concept for a geological information system in Switzerland, based on the analysis performed in the steps before

For the purpose of applying the above mentioned approach the thesis has been structured as follows:

Terminology (Chapter 2)

Important and frequently used terms in this thesis are described and definitions are given. These definitions are intended to constitute a common basis of understanding. Questions like *How is the Swiss geo-community defined? What is a geological information system?*, *What are geo-thematic data, information etc.?*, *How is a SDI defined and on which levels does it exist?* etc. are addressed.

Methods (Chapter 3)

The methodology applied in this thesis are described. In particular the present state analysis and the analysis of the requirements of potential users are reported. In the framework of the latter analysis a number of components conceivable for the envisioned Geolo-GIS-CH are introduced.

Results (Chapter 4)

The results of the present state analyses on the international and national level are reported. Furthermore, the requirements of the different geo-communities concerning the envisioned information system are described. Based on theses results the core-components of the Geolo-GIS-CH and advancements and improvements of existing components are identified.

Discussion - A basic concept (Chapter 5)

On the basis of the results of the present state analysis and the analysis of requirements, i.e. the identified core-components, a basic concept is developed. In particular, the aims and target groups of the Geolo-GIS-CH are identified and its overall system design and abstract system architecture and further issues related to the development of the Geolo-GIS-CH are discussed. Furthermore, a roadmap for the project are proposed and qualitative costs and benefits of the information system for the Swiss geo-community and potential risks of the project are considered.

Summary, Conclusions & Outlook (Chapter 6)

The addressed problems, applied approach and the results of the thesis are summarised and important conclusions are drawn. Based on the performed work and its results various tasks to be performed parallel or after the implementation of the Geolo-GIS-CH are identified and listed in the outlook section of this chapter.

2 Terminology

Unambiguous terminology is an important precondition for avoiding misunderstandings. In order to built a common basis of understanding, this chapter defines important and frequently used terms.

2.1 Geo-community

The term *geo-community* in general, describes a group of organisations, institutions and individuals which are dealing with geology in a broad sense. A definition of what is mean by *broad sense* is given in Section 2.4. An international and national geo-community can be distinguished.

For this thesis, the international geo-community comprises the international GSOs only. In particular, the GSOs of the neighbouring countries of Switzerland, on the federal and state level, are addressed. Further organisations like administrative bodies, academia or private consultants have been excluded, because those organisations participate in the Swiss geo-community only very little. In contrast, Switzerland's national geo-community comprises a large variety of organisations. It contains governmental offices, agencies and societies on the federal and cantonal level, commissions and associations, universities and other research institutes, private consultants, major projects (e.g. AlpTransit Gotthard[1]), multipliers of geo-thematic information like teachers, museum educators, tourism specialists and technology writers as well as laymen from the broad public (cf. Tab. 2.1).

Regarding the involvement of the individual members of the Swiss geo-community an inner and outer circle can be defined. The members of the inner circle are closely involved in the activities of the Swiss geo-community. They directly work in the field of geology, e.g. perform geological surveys and consultancy, contribute to the completion of geo-thematic data coverage and map production or work in the field of legislation, standardisation etc. The members of the outer circle, in contrast, are users of geo-thematic data and are involved in the activities of the geo-community only peripherally. Fig. 2.1 illustrates the distribution of the particular organisations to both circles. Depending on the tasks of the respective organisation, i.e. of its divisions, respectively, it may appear in the inner as well as in the outer circle.

The national geo-community can furthermore be interpreted as *Fachinformationsgemeinschaften* in the sense described by e-geo.ch (2008). Accordingly, a *Fachinformationsgemeinschaft* is a community which is dealing with the same type of thematic data. This definition corresponds to the one given by Maguire and Longley (2005). They would call such a community a *community around data categories*. Such a community are responsible for data quality and its

[1]http://www.alptransit.ch/, Last checked: 23.8.2009

up-to-dateness. It maintains and supports the utilisation of a particular information system, i.e. a geoportal, respectively.

In Switzerland the national geo-community is of special importance, because a corporate GSO, like those of other countries, does not exist. All tasks and responsibilities concerning the geological, geotechnical and geophysical survey etc. are shared among the members of the geo-community.

Tab. 2.1: Major members, i.e. players of the Swiss geo-community. For each organisation, its organisational category, operational level and its affiliation to the respective geo-communities circle (cf. text and Fig. 2.1) is indicated. The international geo-community is represent by the *International* GSOs, only.

Player	**Organisation**	**Level**	**Circle**
International GSOs	Administration	international	(inner)
Swiss Geological Survey (SGS)	Federal administration	(inter-)national	inner
Hydrogeology specialist department (Section of Swiss Federal Office for Environment (FOEN))	Federal administration	(inter-)national	inner
Natural hazards specialist department (Section of FOEN)	Federal administration	(inter-)national	outer
Disposal of radioactive waste (Section of Swiss Federal Office of Energy (SFOE))	Federal administration	(inter-)national	outer
National Cooperative for the Disposal of Radioactive Waste (NAGRA)	Private agency	national	inner
Cantonal offices	Cantonal administration	national	inner/outer
Federal commissions	Academia	national	inner
Universities & research institutes	Academia	national	inner
National associations and societies	Private organisations	national	inner
Private consultants	Private companies	national	inner
Major projects	Private companies	(inter-)national	(inner)
Teachers & Museums & Tourism & technology writers (Multipliers of geo-thematic information)	Governmental organisations, academia, private companies, individuals	national	outer
Laymen	Public organisations & individuals	(inter-)national	outer

2.2 (Geo-thematic-)data, information and knowledge

A large variety of terms are used to describe what we know about a certain things, circumstances etc. *Data*, *information* and *knowledge* is only a selection form this variety descriptions. There is no general agreement about the definitions of these three terms. For this thesis the propositions of Longley *et al.* (2005) (their chapter 1.2) are applied which are as follows:

- *Data* is referred to pure text, numbers, symbols which are almost free of context. Examples may by temperatures at a specific time and location.
- *Information* can be defined in two ways. First as a synonym for data, as defined above and second, as data which serve a specific purpose. In the latter sense, information implies, in contrast to data, a certain degree of selection, organisation and interpretation. An example may be a geological map which reflects the geological interpretation of data captured in the field.

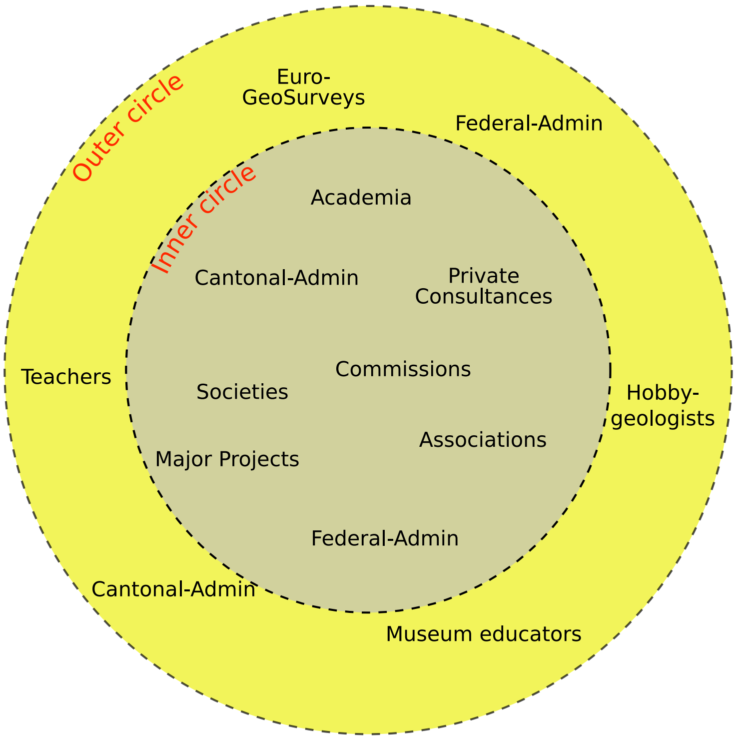

Fig. 2.1: Sketch of the Swiss geo-community. Two circles can be distinguished. Organisation within the inner circle are closely involved in the activities of the national geo-community. Those within the outer circle contribute only partly or peripherally the geo-community's activities. Entries of the same organisation in both circles indicate that different parts, i.e. divisions of that organisation are involved to a different degrees in the geo-community.

- *Knowledge* is not easy to obtain or share. It is information with some added value. The added value is based on the interpretation of the information and depends on the particular context, purpose, experience, expertise and needs of the respective interpreter.

A specification of *data*, made for this thesis, is *geo-thematic data*. This kind of data comprise datasets from various fields, all relevant for geology in a *broad sense* (cf. Section 2.4). Examples are geological maps and cross section, geotechnical maps, geophysical datasets, Digital Elevation Models (DEMs), geomorphological maps, hazards maps, hydrological and hydrogeological data etc. A more complete overview of such data is given by the BGS (cf. Britain beneath your feet[2]) (BGS, 2004) for the UK and by the Geologische Bundesanstalt Österreich (GBA) (cf. Geoaltas[3]) (Geologische Bundesanstalt Österreich, 2007) for Austria. A comparable overview of the geo-thematic data available for Switzerland is in preparation by the SGS, its current status is show in Appendix A.

Geo-thematic data has almost always a spatial reference, which is why it can be regarded as spatial data i.e. Geoinformation (GI). Moreover, this data contains generally a substantial amount of interpretation, thus, it may be regarded as *geo-thematic information*, i.e. *geo-thematic* GI. Because of this reason, the terms *data* and *information* are used synonymously for the remainder of the present thesis.

[2]http://www.bgs.ac.uk/britainbeneath, Last checked: 27.10.2009
[3]http://www.geologie.ac.at/, Last checked: 27.10.2009

2.3 Portal & geoportal

A *portal*, i.e. *web portal* represents an entry point to other locations on the World Wide Web (WWW) (Tait, 2005). As stated by Maguire and Longley (2005), portals serve as a door or gateway to information resources like datasets, services, news, collections of links etc. Therefore, a portal can be regarded as a web environment which acts as a platform for aggregating and sharing content from an organisation or a community of information users and providers.

Various types of portals with different aims, such as personal portal, regional and governmental portals, corporate portals, domain specific portals etc. can be distinguished (Wikipedia, 2009c). Besides these thematic variants of portals which may be general, specific or niche portals, Maguire and Longley (2005) separates furthermore, portals with non-spatial content from those providing content with a clear spatial reference (Fig. 2.2). The latter type is called *geoportal* which can be furthermore sub-divided into catalogue-portals and application portals. Catalogue portals give access to GI via its metadata, while application portals provide datasets and various spatial web-services, such as mapping, routing.

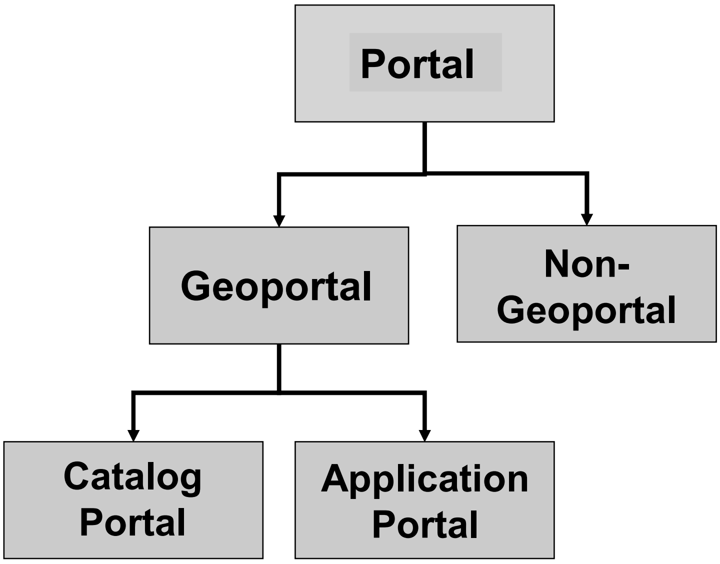

Fig. 2.2: Classification of portals after (Maguire and Longley, 2005).

Tait (2005) defines the term *geoportal* more specifically: *A web site that presents an entry point to geographic content on the web or, more simply, a web site where geographic content can be discovered. [...] a geographic portal is a web site where the discovery of geographic content is a primary focus.*

In the present study the aforementioned definitions of geoportal will be basically followed. However, catalogue and application portals will not be strictly separated. Therefore, a *geoportal* is referred to as a web site combining an application portal with a map-window and a couple of tools for zooming, panning etc. and a catalogue portal providing access to datasets and services. It represents, furthermore, an entry point to an information system. An example for a geoportal closely approaching the above definition is the *Geological Dataviewer*[4] provided by the SGS.

More recently theories like the *semantic web*[5] (Berners-Lee *et al.*, 2001, Wikipedia, 2009b) and *ontologies*[6] Wikipedia (2009a) start to influence the development of geoportals and information systems. Such approaches aim to deal with the growing volume of data, information and knowledge (Reitsma *et al.*, 2009). As the volume increases steadily, it is getting essential to filter and extract information suitable for the respective question from this volume (Athanasis *et al.*, 2009). Buccella and Cechich (2007) describes the development of an entire information systems for managing different types of geographic information (hydrology and road maintenance) which are based on ontologies.

Although these theories provide important mechanisms for the retrieval of particular information from the hugh volume information they are not discussed in thesis in greater details. However, it should be considered during the design and developing phase of the Geolo-GIS-CH.

2.4 Geological Information System

When defining the term *geological information system*, two parts should be separated. First, *geological* and second, *information system*. In this thesis the term *geological* is defined in a broad sense. This means that it comprises all disciplines which are related to geology in a narrow sense[7]. Such disciplines comprise hydrogeology, geomorphology, natural hazards, geography, geophysics, geodesy, geotechnics, civil engineering, geo-botanic, land-use planing, energy supply etc.

Other terms which might have been used instead are *geoscience* or *earth science*. Both terms are rather loosely defined. Overlaps between the both terms exist and sometimes they are used as synonyms. Because of this reason the term *geological* is preferred, it describes best the scope of the envisioned information system.

The second term to be defined is *information system*. It is used in this study to describe a system which provides data, information and knowledge from a specific thematic field. In this case the thematic field is geology in the sense described above.

Such an information system may be divided into an internal and an external part. The internal one can be regarded as an intranet providing information, for instance on the production status or on sensitive data and metadata of the respective organisation (e.g. personal information of staff, responsibilities etc.). Unlike the internal part, the external one provides data, metadata, information and knowledge specifically designed for public users. Referring to the Swiss geo-community and its heterogeneous organisational structure, an information system should provide geo-thematic data and information (e.g. mainly map data), information on the structure of the geo-community and its members (e.g. tasks, contact information etc.) as well as, geo-thematic knowledge for laymen from the broad public (e.g. easy understandable information on geology). It should be intended to represent the tool for the geo-community to enhance data availability, improve workflows, ameliorate networking among the players and to external partners and enhance public awareness of geology. Interaction of the user with the system in the

[4]http://www.geologieviewer.ch/, Last checked: 23.8.2009
[5]http://en.wikipedia.org/wiki/Semantic_Web, Last checked: 23.8.2009
[6]http://en.wikipedia.org/wiki/Ontology, Last checked: 23.8.2009
[7]http://en.wikipedia.org/wiki/Geology > Field or related disciplines, Last checked: 23.8.2009

sense of Web2.0 philosophy (cf. Section 2.7), e.g. by providing user generated content, may be possible but is not mandatory. Maguire and Longley (2005) would call such a system *enterprise information system* which is characterised by a large number of users from various locations, large databases, various application etc.

This thesis focuses on the external part of such an *information system*. The internal one copies the organisation's internal processes. Its examination is not the aim of this study and would exceed its scope.

Since the majority of geo-thematic data has a spatial reference, the information system discussed in this this thesis implicitly deals with spatial data. Therefore, The Geolo-GIS-CH is to a large extent a Geographic Information System (GIS) as defined by Longley *et al.* (2005) (their Chapter 1.4). After their definition GISs represent *simply containers for digital maps, tools for solving geographic problems, spatial decision support systems, mechanised inventories of geographically distributed features and facilities, tools for revealing what is otherwise invisible in geographic information and tools for performing operations on geographic data.*

2.5 Web-Services

The term *web-services* in general is defined rather imprecisely. The World Wide Web Consortium (W3C) defines it as follows:
The World Wide Web is more and more used for application to application communication. The programmatic interfaces made available are referred to as Web services.[8] [9].

In this thesis two specifications are distinguished: First, spatial web-services for handling geospatial datasets (e.g. Web Map Service (WMS), Really Simple Syndication (RSS) for geographic content (GeoRSS)[10] etc.) and second, non-spatial web-services for providing thematic applications, e.g. on-line shops, address-databases, image-databases, calculation services, RSS[11] etc. The latter type is not discussed in greater detail, because it is only of minor relevance for this thesis.

In contrast to non-spatial services which are standardised by the W3C, spatial web-services are passed by the Open Geospatial Consortium (OGC). The most common OGC-web-services are WMS, Web Feature Service (WFS) and Catalogue Service for Web (CSW). Apart from spatial web-services, OGC pass also other standards like SimpleFeatures for the specification of geographical objects, Geographic Markup Language (GML) for the exchange of geographical objects etc. An overview of the entire palette of standards of OGC can be found on the OGC's web site[12].

[8] http://www.w3.org/2002/ws/, Last checked: 23.8.2009
[9] http://de.wikipedia.org/wiki/Webservice, Last checked: 23.8.2009
[10] http://en.wikipedia.org/wiki/GeoRSS, Last checked: 29.9.2009
[11] http://en.wikipedia.org/wiki/RSS, Last checked: 29.9.2009
[12] http://www.opengeospatial.org/standards, Last checked: 23.8.2009

2.6 Spatial data infrastructure

Spatial data and information are the basis for a wide range of products, services and decisions in government, economy, security and society in general (Frick *et al.*, 2003, Frick and Finger, 2008). About 80% of the decisions in politics, economy and the private sector are based on GI (COGIS, 2003). Detailed analyses of the geoinformation market in Switzerland performed by Frick *et al.* (2003) and (Frick and Finger, 2008) clearly show the economical potential of GI. This is the reason why the ease of access to spatial data and information is crucial for decision making processes and developments in government, economy and society. Therefore, governments started in recent years to built-up IT- and internet-infrastructures for the access and interchange of GI. These infrastructures are called Spatial Data Infrastructures (SDIs). SDIs are not only restricted to the technical level. They also deal with organisational issues, standards, networking, politics, policies, education, etc. (Maguire and Longley, 2005). Furthermore, SDIs exist on different regional or administrative levels, i.e scales. The particular levels are nested into each other as shown in Fig. 2.3. Table 2.2 give a brief overview of some SDIs at different levels. A more complete overview of SDIs can be found on the web site of the Global Spatial Data Infrastructure (GSDI)[13].

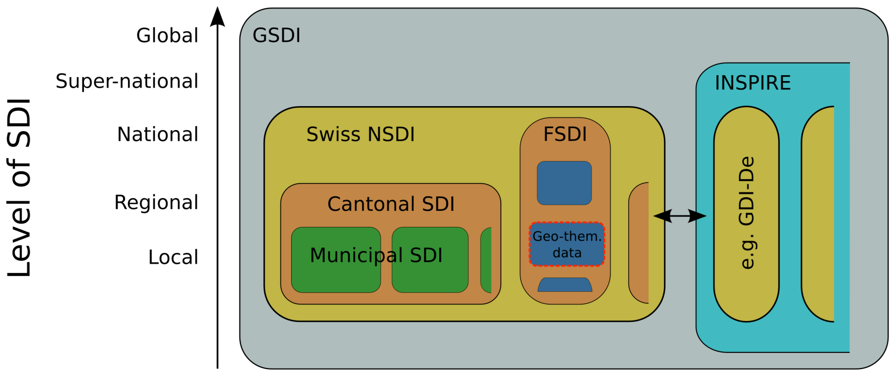

Fig. 2.3: Levels of SDIs, modified after Huber and Fischer (2008). The indicated SDIs resemble the situation in Switzerland and its relation to other national an super-national SDIs. GDI-DE referred to the NSDI of Germany. Examples of the different levels of SDI are listed in Tab. 2.2. The location of geo-thematic data as provided by the Geolo-GIS-CH are indicated by the box bounded by red dots.

2.7 Web2.0 and volunteered geographic information

The term *Web2.0* was coined by O'Reilly (2005). It stands for the second generation of the WWW. Wikipedia[14], one of the most popular Web2.0 sites, defines the term *Web2.0* as follows: *"Web 2.0" refers to the second generation of web development and web design. It is characterized as facilitating communication, information sharing, interoperability, user-centred design and collaboration on the World Wide Web. It has led to the development and evolution of web-based communities, hosted services, and web applications. Examples include social-networking sites,*

[13] http://www.gsdi.org/SDILinks.php, Last checked: 23.8.2009
[14] www.wikipedia.org/, Last checked: 23.8.2009

Tab. 2.2: Examples of different levels of SDIs as illustrated in Fig. 2.3

Level of SDI	Example and Point of entry
Global	Global Spatial Data Infrastructure (GSDI): http://www.gsdi.org/SDILinks.php, Last checked: 23.8.2009
Super-national	European Spatial Data Infrastructure (ESDI), i.e. INSPIRE: http://www.inspire-geoportal.eu/index.cfm, Last checked: 2.10.2009
National	NSDI-Switzerland: (No central point of entry. However, geoportal is under construction (Giger and Loidold, 2009))
Federal	Federal Spatial Data Infrastructure (FSDI)-Switzerland: (No central point of entry. Separated geoportal available at http://www.swisstopo.admin.ch/internet/swisstopo/de/home/products/services/web_services/webGIS/webGIStab.html, Last checked: 2.10.2009
State	Solothurn-GIS (SOGIS) for the canton of Solothurn: http://www.so.ch/departemente/bau-und-justiz/sogis.html,Lastchecked:2.10.2009 and the geoportal of the Swiss Conference of State Centres for Geodata Coordination and GIS (KKGEO) for an inter-cantonal SDI: http://www.kkgeo.ch/go/, Last checked: 2.10.2009.
Municipal	SDI-Zurich: Point of entry described by Gees (2006)

video-sharing sites, wikis, blogs, mashups and folksonomies.[15]

The basic differences between Web1.0 and Web2.0 are summarised by O'Reilly (2005) and important characteristics of the Web2.0 are shown in Fig. 2.4. Cormode and Krishnamurthy (2008) investigate these characteristics on the basis of popular Web2.0 sites. It becomes obvious that in the Web2.0 philosophy the internet serves as a platform which allows the internet user to actively participate in shaping the WWW. Therefore, the Web2.0 is called *participatory web*[16]. Web sites like Wikipedia, YouTube, Flickr, facebook etc., for instance, can be used not only to consume information (in the style of the Web1.0) but also to generate new content and to comment or modify existing content. Such user-generated content[17] are named in multiple ways. Popular terms which are generally used as synonyms are *user-created content* and *crowd sourcing*[18].

Liang (2008) detects in the change over form Web1.0 to Web2.0 a paradigm shift from the information age towards the recommendation age. Since a huge volumes of information is available easily, recommendations serve as shortcuts through the thicket of information. For instance, the online bookstore *amazon*[19] not only enables the client to simply buy books. It also provides revisions and comments from other clients which have purchased the respective product. Furthermore, amazon shows products which have been purchased together with the respective product by other clients.

Apart from the general characteristics of the Web2.0 mentioned above, it influences also the usage of GI. Applications like GoogleMaps[20] enables the users to apply the entire functional range by the help of its Application Programming Interface (API). Thus, Mash-ups with interactive maps can be developed and integrated in the user's web sites (e.g. Rinner *et al.*

[15]http://en.wikipedia.org/wiki/Web_2.0, Last checked: 23.8.2009
[16]http://en.wikipedia.org/wiki/Web_2.0, Last checked: 23.8.2009
[17]http://en.wikipedia.org/wiki/User-generated_content, Last checked: 5.9.2009
[18]http://en.wikipedia.org/wiki/Crowdsourcing, Last checked: 5.9.2009
[19]http://www.amazon.com/, Last checked: 29.9.2009
[20]http://maps.google.ch/, Last checked: 29.9.2009

Fig. 2.4: Weighted tag cloud of terms related to the Web2.0. The figure is extracted from http://en.wikipedia.org/wiki/Web_2.0, Last checked: 23.8.2009

(2008), *Cadastre geologique* of the Canton Vaud[21]). Furthermore, OpenStreetmap[22], OpenAddresses[23], Wikimapia[24], Globe Swiss[25] etc. can be used to generate geographic content. Such user-generated geographic content, i.e. the process of its generation, is termed in multiple ways. Frequently terms are *collaborative mapping*, *neogepgraphy*, *user-generated spatial content* and *Volunteered Geographic Information* (VGI). In this thesis the latter term will be applied which has been introduced by Goodchild (2007, 2008).

[21]http://www.vd.ch/fr/themes/territoire/geologie/cadastre-geologique/consulter-des-donnees/carte-des-sondages-geologiques/, Last checked: 29.9.2009
[22]http://www.openstreetmap.org/, Last checked: 29.9.2009
[23]http://www.openaddresses.ch/de/, Last checked: 29.9.2009
[24]www.wikimapia.org, Last checked: 29.9.2009
[25]http://map.globe.admin.ch/, Last checked: 29.9.2009

3 Methods

In the following sections the methods are described which have been applied in the framework of the present thesis. Furthermore, the proposed components of the Geolo-GIS-CH which have been evaluated by the potential user are briefly introduced.

3.1 Web- and literature research

The present state analysis performed in this study, investigates the present situation concerning the handling and distribution of geo-thematic information and GI in Switzerland. In order to give an overview of the present situation the following aspects have been analysed in a web-research:

- General technical status of Information and Communication Technology (ICT) and GIS
- Availability and accessibility of geo-thematic data in Switzerland
- Data quality issues
- Standards relevant for geo-thematic GI
- Switzerland's NSDI and the ESDI
- Legal basis for handling of geo-thematic data in Switzerland
- Existing geological information systems

Since the present state analysis focusses on the situation in Switzerland the web presences of the major members of the Swiss geo-community and those of the GSOs of Switzerland's neighbouring countries (Italian Agency for Environmental Protection and Technical Services (APAT) for Italy, the Federal Institute for Geosciences and Natural Resources (BGR) for Germany, the BRGM for France and the GBA for Austria) have been investigated. Additionally, the web presence of the BGS, representing a major GSO in the European Union (EU) and the the Geological Survey of Canada (GSC) for America. Since in Germany geological survey is in the responsibility of the states, the web portals of the geological state survey of Bavaria and Baden-Wuertemberg have been analysed (cf. Tab. 3.1).

The web portal of each organisation was analysed according to the presence of 18 different features. Each feature can be assigned to one of five categories. Features and categories are listed in Tab. 3.2.

In addition to the aforementioned analysis of the respective web portals, the relevant literature has been examined. Such literature can be found in international scientific journals, organisations strategy papers, federal acts of law and associated ordinances, subject-specific guidelines and recommendations, project reports, etc.

Tab. 3.1: Organisations whose web presences have been examined. Its name, abbreviation, country and kind of geo-community are indicated. In order to take the french speaking part of Switzerland into account the web presence of the canton of Vaud (VD) has been analysed in addition to the one of the german speaking canton Solothurn (SO). For analysing the private sector, four greater geological consultants have been selected at random. Note that SGS and FOEN are acting nationally as well as internationally.

Organisation	**Abbreviation**	**Country**	**geo-community**
Geological Survey of Italy	APAT	Italy	international
Federal Institute for Geosciences and Natural Resources	BGR	Germany	international
Bureau de recherches géologiques et minières	BRGM	France	international
Geological Survey of Austria	GBA	Austria	international
British Geological Survey	BGS	United Kingdom	international
Geological Survey of Canada	GSC	Canada	international
Geological State Survey of Baden-Wuertemburg	LGBR	Germany	national
Geological State Survey of Bavaria	LfU	Germany	national
Swiss Geological Survey	SGS	Switzerland	(inter-)national
Federal office for environment	FOEN	Switzerland	(inter-)national
Cantonal Administration (cantons Solothurn and Vaud)	SO, VD	Switzerland	national
Platform Geosciences, Swiss academy of science	sc|nat	Switzerland	national
Swiss Geotechnical Commission	SGTK	Switzerland	national
Swiss Geophysical Commission	SGPK	Switzerland	national
Universities (e.g. ETHZ)	ETHZ	Switzerland	national
Swiss Association of Geologists	CHGeol	Switzerland	national
Private geo-consultants	CSD, Geotest, Geo7, von Moos	Switzerland	national

3.2 Poll on requirements

In order to get a better understanding of the requirements of the users of the planned information system, a poll has been performed. It was sent to the members of the international and national geo-community, separately. The national version was launched in the framework of an overall project of the SGS and consists of an introductory paper, a questionnaire and an appendix with additional information. All these documents are attached in Appendix B to this thesis.

The entire poll, accompanied by an official cover letter, was sent to the recipients by mail. Since Switzerland is a multi-lingual country, the poll was performed in German and French, depending on the origin of the respective recipient. Recipients from the Italian speaking part of Switzerland were addressed in German or French. Additionally to mailing, all documents were made accessible via the SGS's web site.

Unlike the national poll, the international version was sent by e-mail in English language only. Moreover, its content is restricted to a questionnaire. Additional information on the background of the entire project was given directly in the e-mail. However, the structure of the questionnaire is basically the same as the one of the national poll (cf. Section 3.2.1). Some further questions concerning the functionality of the information systems of the respective recipients (if a system is operated) have ben added. Such questions address topics like: integration of Web2.0-functionality, data delivery using spatial web-services, treatment of metadata, trends in

Tab. 3.2: Features and categories investigated in selected organisations' web sites. The investigated web sites have been analysed according to the presence of various features. Each feature can be assigned to one of five categories.

Category of feature	Feature and description
Integration of spatial data	Dataviewer, geo-thematic data, spatial web-services (e.g. WMS, WFS, RSS for geographic content (GeoRSS) etc.)
Supply of non-spatial web-services	Information (e.g. RSS), transformations and calculations, guide lines and quality assurance, GeoReports, image database, job-portal, event calendar
User interaction	User account, shop for purchasing products and services interactively, discussion forum, user-generated content, i.e. VGI
Geology for laymen	Glossary with definitions of geological terms, easy understandable descriptions of geological facts and key-sites of geology. Educational material.
Swiss specifics	Components especially required by the Swiss geo-community: Overview and description of the members of the Swiss geo-community, address database

geoinformation science with respect to geology foreseen for the future. However, the answers have not been into account for the analyses performed in this thesis.

3.2.1 Structure of questionnaire

The questionnaire is composed of two parts. The first one refers to the requirements of potential of the Geolo-GIS-CH. It queries the usefulness and priority of implementation of a number of proposed components (Section 3.2.2). Besides the results of the web-research, this part of the questionnaire constitutes the major data basis of the development of the basic concept of the Geolo-GIS-CH (cf. Chapter 5).

The second part of the questionnaire is related to the use and priority of production of various geo-thematic datasets, which are planned to be produced by the SGS. Although this part gives important information on the user requirements for geo-thematic datasets, it exceeds the scope of this thesis and will not be discussed in greater detail. For the rest of the thesis the term *questionnaire* is referring to the first part only.

3.2.2 Proposed components

The questionnaire is structured in twelve blocks, each of which regarding a specific proposed component of the envisioned information system. Each particular component, its intention and target group as well as examples of existing similar applications are briefly described below.

1. Dataviewer

Description: A dataviewer, i.e. a geoportal in the sense described in Section 2 is the on-screen gateway to spatial data and GI. Maps, in this case geo-thematic maps (cf. *Geo-thematic data* below) can be visualised, queried and selected to be ordered in an online shop. Simple zoom, pan and query functionalities are provided. Depending on the type, i.e. format of the respective dataset, simple spatial (coordinate-search, postal-codes, Swissnames[1] etc.) and semantic queries

[1] http://www.swisstopo.admin.ch/internet/swisstopo/de/home/products/landscape/toponymy.html, Last checked: 29.9.2009

are performable.
Target groups: The target-group of this component is rather broad, it comprises every internet user interested in geo-thematic data.
Examples: An example of such a dataviewer and its basic functionality is the *Geological Dataviewer*[2] provided by the SGS.

2. Geo-thematic data
Description: Geo-thematic data (cf. Section 2.2 for definition) is the core of the planned information system. Each component is based on it. A large number of geo-thematic data is already existing in the Swiss geo-community, will be generated and completed in the near future or are planned to be produced.
Target groups: Similar to the dataviewer (cf. above), the target-group of this component data comprises every user of the internet. However, professional geologists and other specialists are mainly addressed.
Examples: Overview of existing geological maps and status of production; metadata on geological reports and well-data; geological, geotechnical and geophysical maps, data on natural hazards, etc. Like the BGS (Britain beneath your feet) and the GBA (Geoaltas), the SGS is compiling an overview of the existing geo-thematic data in Switzerland.

3. Web-Services
Description: Web-Services, as defined in Section 2.5 comprise any spatial- and non-spatial services distributed via the internet. The questionnaire focuses basically on the spatial services like OGC-WMS and OGC-WFS.
Target groups: The target-group for the above described web-services are mainly professionals.
Examples: An example for a spatial web-service is the WMS of the Geological and Tectonic map of Switzerland 1:500'000 (swisstopo, 2005a,b) which is provided by the SGS for the OneGeology project. Furthermore, non-spatial web-services like coordinate transformations between different coordinate systems, stratigraphic lexicon, discussion forum, glossary, address database, job exchange, event calender etc. does exist on various web presences of the members of the Swiss geo-community. Since the latter five components are believed to be of special importance for the Swiss geo-community, they are treated in separate blocks below (cf. No. 4, 7, 8, 9 and 10).

4. Geo-Glossary
Description: A glossary gives easy understandable definitions of important geological and geo-scientific terms and facts. Such a glossary may be administered by a single body or may be designed in *Wiki*-style, where a user-community creates and administers its content.
Target groups: Primary target-groups are semi-professionals and laymen.
Examples: None

5. Key-sites of Swiss geology
Description: In addition to the glossary, this component gives easy understandable descriptions

[2]http://www.geologieviewer.ch/, Last checked: 23.8.2009

of key-features, particularities and peculiarities of Switzerland's geology. An example such a key-site may be the *Glarner Hauptüberschiebung* which is one of the major tectonic structures in Switzerland and a crucial feature for understanding the evolution of the Alps.
Target groups: Semi-professionals and laymen are mainly addressed by this component.
Examples: None

6. Overview of geo-community
Description: As described in the Chapters 1.1 and 2.1 , Switzerland does not have a corporate GSO like other countries. Instead, a diverse geo-community exists. In order to introduce the members of the national geo-community, present their tasks and responsibilities and to illustrate their integration, this component gives an overview. The integration of the particular organisations may be represented in a graphical way to better illustrate common interfaces, relationships and dependencies.
Target groups: The main target-group are professional geologists. However, the component is open to everybody who need to get in contact to or are interested in the national geo-community.
Examples: None

7. Address database
Description: Closely related to the described overview of the geo-community is a comprehensive address database. It contains all addresses of the members of the geo-community and provides tools to easy query and locate them on a map. Systems with such functionalities already exist, mainly for common directories, like the Swiss search engine *Local.ch*[3].
Target groups: This component is designed for professionals, however, it is freely available on-line to everybody.
Examples: For the Swiss geo-community the Platform Geosciences (sc|nat) provide a comprehensive address database[4]. This tool gives access to a large number of addresses and contact-information to individuals, institutions, organisations, research projects and research programs. The database provides address information only, a spatial extension for the visualisation of search results in map-view is not implemented yet. The existing database may be incorporated into the envisioned one, i.e. may be extended by a spatial extension.

8. Discussion-forum on geological topics
Description: On the internet discussion forums are available for many different topics. They provide a basis for discussions between the members of specific communities. For geology such an discussion-form does not exist. Threats like general geology; geoinformation and geology; help with your master thesis; different threats on specific methods (geological mapping, applied geology, microscopy etc.) are conceivable.
Target groups: Every geologists with an affinity to the internet may be the primary target-group. Students of any specialisation may use such a forum for support on their studies.

[3]http://www.local.ch, Last checked: 23.8.2009
[4]http://geosciences.scnat.ch/index.php?nav1=3&nav2=34, Last checked: 23.8.2009

Examples: An example from the geoinformation area is the Swiss GeoWebForum[5]. This forum provides in various thematic threats a platform for discussing different topics related to geoinformation science in Switzerland.

9. Job portal

Description: Compared to other specialisations like informatics, live-sciences, etc. the geo-community is rather small. Open positions, i.e. job offers can therefore be found only rarely in common print media and job portals. Because of this reason, a job portal specialised on geo-scientific positions would provide access to only job offers relevant to geologist and other geo-scientists.
Target groups: The target group of this component comprises everybody who searches an open position in the geo-scientific area.
Examples: Examples for web sites supplying such job offers do already exist in Switzerland (e.g. the Swiss Association of Geologists (CHGEOL) job portal[6] and the sc|nat-Job portal[7]). However, these portals are not synchronised, thus, for getting every offer, always each portal have to be checked separately. Because of this reason, the envisioned job portal should integrate all existing ones, thus, a central gateway to geo-scientific job offers in Switzerland as well on the international level can be provided.

10. Event calendar

Description: Colloquia, fairs, conferences, exhibitions, lectures, public events (e.g. *Erlebnis Geologie*[8] and *Basecamp09*[9]) are activities which shape the geo-community and support the internal and external communication and knowledge transfer.
Target groups: As target-groups professionals, semi-professionals and laymen can be identified.
Examples: Similar to the job portal, several event calendars do exist for the Swiss geo-community. Those of the CHGEOL[10] and the sc|nat[11] are the most prominent ones. The content, however, is not synchronised, thus, it is hard get an overall overview of upcoming events. Therefore, the envisioned application should collect all event announcements by integrating the existing calendars.

11. OpenGeoMap

Description: Inspired by the OpenStreetMap-project[12] and other participatory-GIS[13] projects (e.g. WikiMapia[14] and Globe Switzerland[15] etc.) an interactive Web2.0-tool for collecting and publishing user-generated geo-thematic data is proposed. Basically two types of functionalities which have an implication on the complexity of the component are conceivable. First, a *revision*

[5] http://www.geowebforum.ch, Last checked: 23.8.2009
[6] http://www.chgeol.org/d/2/jobs.asp, Last checked: 23.8.2009
[7] http://www.geosciences.scnat.ch/index.php?nav1=2&nav2=166, Last checked: 23.8.2009
[8] http://www.erlebnis-geologie.ch, Last checked: 23.8.2009
[9] http://www.basecamp09.ch, Last checked: 23.8.2009
[10] http://www.chgeol.org/d/2/agenda.asp, Last checked: 23.8.2009
[11] http://geosciences.scnat.ch/index.php?nav1=3&nav2=33, Last checked: 23.8.2009
[12] http://www.openstreetmap.org, Last checked:23.8.2009
[13] http://en.wikipedia.org/wiki/Participatory_GIS, Last checked: 29.9.2009
[14] http://www.wikimapia.org, Last checked: 23.8.2009
[15] http://map.globe.admin.ch, Last checked:23.8.2009

client similar to the one provided by swisstopo[16] which allows the user to comment on existing geo-thematic datasets such as geological pixel-maps to communicate errors in the geometry of geological bodies or its interpretation. The respective entries are stored in the information system and can be used for the updating the existing maps. Second, platform for capturing personal geological discoveries. Registered users may digitise geo-thematic objects and store them directly on a server provided by the information system. In combination with a *Wiki*-site, the geometry, geological interpretation etc. may be discussed by the community. As a vision, all geologically uncovered areas in Switzerland are mapped and verified by the geo-community itself.
Target groups: Both varieties may be used by a broad geo-scientifically interested community.
Examples: An example of an application similar to the one described above is provided by Globe Switzerland[17], a division of the international Globe project[18] which provides an interactive platform for students, teachers and scientists for capturing data on various topics.

12. Further required or desired components and general comments
Description: The proposition of the above described components is based on considerations of the SGS. In order to give the recipients the possibility to indicate further desired components and features as well as to comment on the entire system, this block has been inserted into to the questionnaire.

The proposition of the above listed components is based mainly on the analysis of the existing web sites of the members of the Swiss geo-community. Furthermore, the existence of a geo-community covering the tasks of a single corporate geological survey, like in Switzerland, makes components like *Overview of geo-community* and *Address data base* necessary.

3.2.3 Scale of evaluation

For each block, i.e group of components, respectively, its usefulness and priority of implementation have been queried. Participants of the poll could have assigned grades according to the following 5-point scale:

$$1 = \text{very low},\ 2 = \text{low},\ 3 = \text{medium},\ 4 = \text{high},\ 5 = \text{very high}$$

Additionally to the evaluation of each block, specific comments on each component and further desired components could have been added. For adding general remarks on the entire information system, block No. 12 (cf. above) could have been used.

3.2.4 Recipients

The aim of the poll was to get an overview of the requirements of potential users of the envisioned information system. Because of this reason, recipients from various fields of specification and

[16]http://www.swisstopogeodata.ch/swisstopo_apps/tlm/index.php?lang=en, Last checked: 23.8.2009
[17]http://www.globe-swiss.ch, Last checked: 23.8.2009
[18]http://www.globe.gov/, Last checked: 23.8.2009

various organisations have been addressed. All major players of the national and international geo-community, as defined in Section 2.1, and related organisations have been incorporated. A detailed list of all recipients is presented in Appendix B.1.1 and B.2.1.

In order to broaden the audience, the addressed recipients were encouraged to forward the poll to further interested persons and organisations.

The number of recipients varies between the international and national poll. On the international level a total of 46 questionnaires have been send out. All recipients are coming from international GSOs and are member of the Geoscience Information Consortium (GIC). The GIC is the assembly of the GI-responsibles of the international geological survey organisations and its aim is to enhance the knowledge transfer between the respective GSOs.

On the national level all documents of the poll have been send to 92 recipients coming from varies types of organisations in the Swiss geo-community. Each organisation can be assigned to one of the categories listed in Tab. 3.3.

Tab. 3.3: Categories of organisations addressed in the national poll. Each organisation can be assigned to one of four categories. For each category its abbreviation (Abrv.) and members are listed. The individual recipients are shown in Appendix B.2.1

No	Category	Abrv.	Members
1	Federal Administration	FedAdmin	Federal offices and specialist departments
2	Cantonal Administration	CantAdmin	Cantonal offices and specialist departments
3	Academia	Academia	Universities, research institutes, commissions, museums, societies, teachers
4	Private Sector	Private	Private companies, associations, insurances

The distribution of the recipients with respect to their affiliation to a category of organisation are illustrated in Fig. 3.1; the respective send-return-statistic is given in Tab. 4.7 in Chapter 4.

All Recipients were asked to fill-in and return the poll within one month time. By own experiences, answering polls is not a very welcome task. Because of this reason, the number of responses is usually limited. In order to enhance the return-rate, a reminder was send to the recipients 10 days prior to the expiration of the deadline of return.

3.2.5 Data analysis

In order to analyse the results of the poll described above, the returned questionnaires have been processed. For each question i.e. each thematic block mean and standard deviation of its rating have been calculated. The mean of the rating is a measure for the importance of the respective component. The standard deviation reflects the homogeneity of the answers. A standard deviation of close to zero indicates that the majority of the participants evaluated the respective component similarly. In contrast, a high standard deviation indicates a dispersion of the individuals ratings.

Apart from anonymous answers all returned questionnaires were included in the calculation. Occasionally, the components were rated not uniformly, e.g. a rating of 4-5 were given instead of 4 or 5. In such cases the lower rating has been used for the calculation.

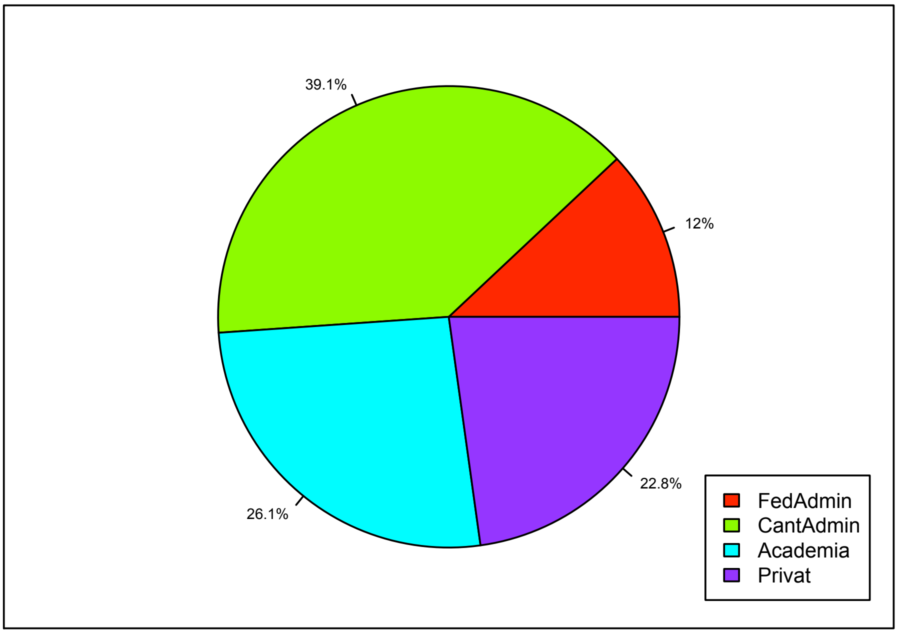

Fig. 3.1: Distribution of recipients addressed in the national poll according to the category of its organisation. Recipients from the cantonal administration (CantAdmin) constitute the largest fraction (39.1%). Academia (26.1%) and the private sector (22.8%) are in the mid-range and the federal administration (FedAdmin) (12%) constitute the smallest fraction. Related data is provided in Tab. 4.7 in Chapter 4.

In the questionnaire the component *geo-thematic data* in general, could not been evaluated individually. Instead, several example datasets (e.g. geological maps, geotechnical maps, geophysical maps etc.) have been asked to be evaluated (cf. Appendix B.2). In order to obtain a rating for usefulness and priority of implementation of geo-thematic data as a whole, the mean and standard deviation of the rating of all example datasets has been calculated. Furthermore, various examples for web-services could have been evaluated besides the usefulness and priority of implementation of web-services in general. The rating of the examples have been excluded from the analysis, because they represent a different level compared to the other components.

On the international level, the results for all participants of the poll have been used. No further classification and specification according to the affiliation of the particular participants has been performed. In contrast, on the national level, the results for the particular components have been segmented according to the categories of the respective organisations (cf. Tab. 3.3). Thus, the requirements of the federal administration, the cantonal administration, academia and the private sector can be compared to each other.

Apart from the rating of the individual proposed components, the participants of the poll could have indicated comments and propositions regarding each component which in turned could have been rated. These comments, propositions etc. were collected and segmented subjectively by the author of the thesis into various categories. The individual categories (cf. Tab. 4.10), in turn have been grouped into five topics (Additional datasets, improvements for dataviewer, additions to dataviewer, web-services and additional features). In order to analyse the importance of the individual categories its number of reference has been multiplied by the rating for its usefulness and priority of implementation, respectively.

4 Results

In order to accomplish a basis for the development and implementation of the Geolo-GIS-CH, the following analyses have been performed in the framework of this thesis:

- Present state analysis of relevant issues concerning geo-thematic data, it's handling and distribution with special focus to the situation in Switzerland.
- Analysis of the requirements of potential users of the Geolo-GIS-CH by means of pre-defined components. In doing so, the requirements of the Swiss geo-community are in the centre of interest.

4.1 Present state analysis

The present state analysis examines different aspects with respect to geo-thematic GI such as data availability and quality, existing SDIs and geological information systems, standards and legal bases on the international and national level.

4.1.1 General technical progress

In recent years ICT advanced constantly. Apart from more powerful hardware and user-optimised software, high-performance local and wide area networks are established in many countries. Using these networks, the fast and failure-free communication among internet users and among computers as well as the exchange of large datasets is facilitated.

These advancements also influenced the GI- and GIS-sector. In general, the utilisation and the integration of GI in standard operating procedures and standard applications is getting increasingly common and self-evident. Thus, the vision that *GIS is established when nobody needs to interpret this acronym* (Strobel, 1999) is becoming reality. Applications like GoogleEarth[1], NASA World Wind[2] and other virtual globes familiarise the general public with the value and the handling of GI (Butler, 2006). Especially the internet supports the utilisation of GI. For instance, many web sites contain interactive maps which show e.g. the location of stores or events. Such features which are based on Application Programming Interfaces (APIs) are continuously replacing the conventional static graphics of the position plan. One of the most popular APIs is the GoogleMaps-API which allows the user to apply the entire functional range of GoogleMaps. But also other APIs like the JavaScript-based OpenLayers[3] and the related MapFish-framework[4] provide similar functionalities.

[1] http://earth.google.com/, Last checked: 29.9.2009
[2] http://worldwind.arc.nasa.gov/, Last checked: 29.9.2009
[3] http://openlayers.org/, Last checked: 29.9.2009
[4] http://trac.mapfish.org/trac/mapfish, Last checked: 29.9.2009

Data transfer and exchange is increasingly achieved by the use of spatial web-services. Thus, storage and maintenance of the particular GI can be performed locally by the data producer, i.e. owner, respectively. In doing so the permanent supply of up to date GI can be guaranteed. Apart from the provision of raster, i.e. picture data (e.g. scanned maps) using WMS, the supply of vector data by the use of WFS is getting increasingly important. Furthermore, the development of transactional web services like Transactional Web Feature Service (WFS-T) and Web Processing Service (WPS) (Huber, 2008) are being advanced. Transactional services can be applied for the bi-directional transfer of VGI and facilitates thereby the participation of the internet user in the process of data generation. WPSs permit spatial analyses and processing of GI via the internet, a functionality which is provided usually by desktop-GIS only.

In order to be able to provide the aforementioned services a large variety of applications can be applied. The most popular one is the opensource *MapServer*[5] which allows to distribute WMS as well as WFS. For the supply of WFS-T other products like the opensource *GeoServer*[6] or commercial applications like *ESRI ArcGIS Server*[7] are required.

4.1.2 Data availability & accessibility

As described in Chapters 1 and 2, a corporate GSO does not exist in Switzerland. Instead, all tasks which are related to geology are carried out by the national geo-community. Apart from various other activities, such as geological consultancy, development of guidelines and standards, geo-scientific education etc., the members of the geo-community, in particular those of the inner circle (cf. Section 2.1) act as producers and providers of the majority of the geo-thematic data of Switzerland. An overview of the variety of existing geo-thematic data in Switzerland is given in Appendix A. Despite of this variety, the availability and accessibility of particular datasets is restricted. This limitation is caused by the following three reasons:

1) Each data producer, i.e. owner is providing their datasets via a separate channels, usually the producers web site. A central gateway to all existing datasets does not exist. Even the corresponding metadata are not uniformly and entirely captured. Thus, they are not properly retrievable via metadata catalogues like geocat.ch[8] or geometa.info[9]. Clients have to search, detect and verify such information by themselves, a situation which clearly restricts data accessibility.

2) The coverage of Switzerland with various of the datasets listed in Appendix A is not completed. For instance, the Geological Atlas of Switzerland 1:25'000 (GA25) (cf. No. 6, 7 and 8 in Appendix A), a map series which was initiated about 80 year ago, is still being assembled. As shown in Fig. 4.1, about 50% of the 254 map sheets of the GA25 have not been mapped yet and are, therefore, still not available.

Furthermore, the GA25 is primarily published as paper maps, a format which still is of great

[5]http://mapserver.org/, Last checked: 29.9.2009
[6]http://geoserver.org/display/GEOS/Welcome, Last checked: 29.9.2009
[7]http://www.esri.com/software/arcgis/arcgisserver/index.html, Last checked: 29.9.2009
[8]http://www.geocat.ch/, Last checked: 29.9.2009
[9]http://geometa.info/, Last checked: 29.9.2009

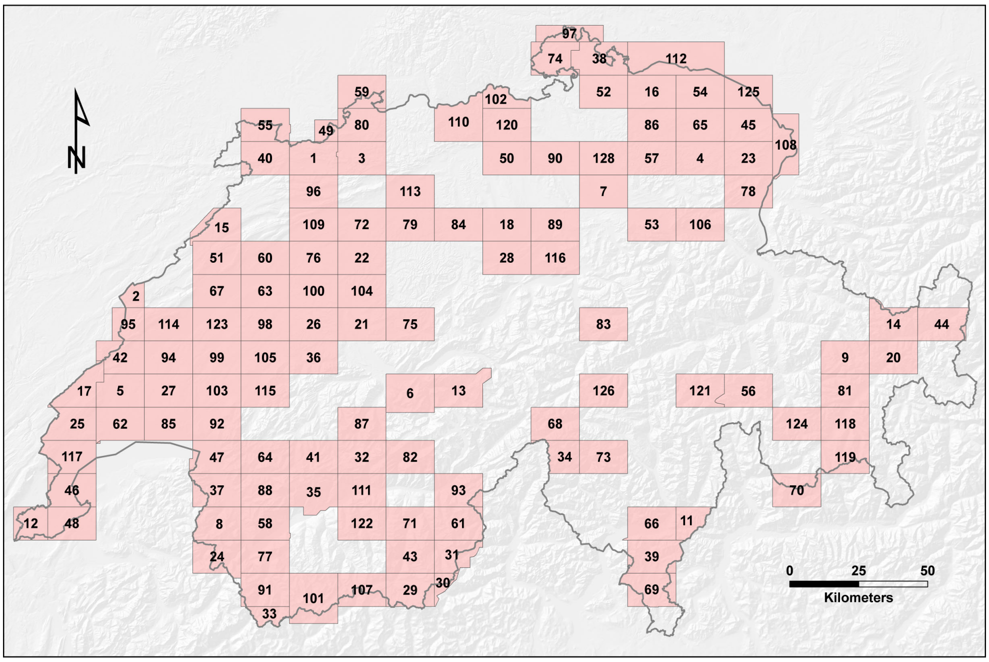

Fig. 4.1: Present (2009) production status of the Geological Atlas of Switzerland 1:25'000 (GA25). Switzerland is not entirely covered with detailed maps, limiting the access to geological information. Indicated numbers represent the sequential numbers of the individual map sheets.

importance for various applications, e.g. for getting a general impression of an overall geological setting without restrictions by the computer's screen size, for outdoor usage independent from power supply etc. However, the increasing usage of ICT leads to an increasing demand for digitally processable data. Because of this reason existing map sheets of the GA25 have been digitised, i.e. scanned. An on-going project performed by the SGS aims to vectorise these pixel maps. At present day about 60 map sheets (about a quarter of the entire area) of the GA25 have already been vectorised. Various other datasets listed Appendix A do not even exist in raster format, a situation which reflects the limited availability of digital and digitally processable geo-thematic data in Switzerland.

3) The process of data purchase is frequently complicated and time consuming. Tab. 4.1 shows a typical generalised ordering and despatching process for a digital geological map from the SGS. Following the presented estimation the purchase of one pixel map of the GA25 requires 12 days, i.e. about two working weeks. The most time consuming steps in the entire process are the handling of the license contract (6 days) and the manual preparation of the data and its despatch by mail (5 days). For comparison, direct download of the same dataset (~250Mb) would take a much shorter time (in the scale of minutes). In daily business, the time constraints are usually narrow which is why data availability and access is crucial for the working progress. With the current delivery system, described above, short time data supply cannot be guaranteed and time consuming manual work has to be performed.

Apart from the geo-thematic data described above (cf. Appendix A), there is a lot of data and information that is not related directly to geology but is supporting the operation of the

Tab. 4.1: Generalised procedure for ordering digital geological data. Indicated time spans (days) are estimated. The contact to the data provider is usually established by phone or e-mail. Licensing issues are following and taking a substantial amount of time. Data preparation and delivery are performed manually. Automated workflows for the aforementioned steps are absent. As a consequence clients receive purchased data after approximately twelve days.

No	Step	Who	Medium	Time [d]
1	Get in contact with data provider	client	mail, tel, fax, email	1
2	Prepare licence contract	data provider	IT	3
3	Despatch of contract	data provider	mail	1
4	Complete and sign contract	client	IT	1
5	Send contract back to provider	client	mail	1
6	Preparation of data and media (CD,DVD)	data provider	IT	3
7	Despatch data	data provider	mail, email	2
			total	12

Swiss geo-community (cf. Section 2.1 for definition). Such data include e.g. the addresses of the members of the geo-community, announcements of events, job offers etc. Each of the aforementioned dataset contains a concealed spatial reference. However, usually this spatial reference is not used for the presentation or retrieval of particular datasets.

4.1.3 Data quality issues

Different aspects influence the quality of the available geo-thematic data. Again, as a representative for the other geo-thematic datasets, these aspects are presented by the example of the GA25.

Since the GA25 is a map series primarily published in paper format, it is based on a sheet line system. Each existing map sheet with a sheet specific geological legend has been published only once. Subsequent editions, i.e. updated versions, respectively, are not intended to be produced until completion of the entire map series. This situation has a direct effect on the quality of the particular map sheets as part of an entire nationwide dataset, because of two reasons:

1) Changes in the geological outcrop situation caused e.g. by landslides, constructions, boreholes etc. and revised geological interpretations, cannot be incorporated in the existing dataset. As a consequence, since such natural and artificial modifications of the earth surface are unavoidable, the changed portion of the respective geological map is not up-to-date and do not reflect the current situation in reality.

2) As mentioned above the GA25 is being produced since about 80 years. During this period of time geological concepts and mapping styles changed several times. For example, in the beginning of the production of the GA25 (1930s) quaternary sediments have been mapped only poorly. This mapping style changed completely in recent year, since it became obvious that quaternary sediments are essential for the understanding and determination

of ground stability for example during earthquakes (Bundesamt für Wasser und Geologie, 2004). Changes like those mentioned above, influence the homogeneity of the geological objects distinguished and listed in the particular geological map's legend. As a consequence, adjacent map sheets showing a similar geological setting, not necessarily have a consistent legend.

Another issue influencing data quality and data consistency is joined to the latter point. In order to harmonise and standardise the existing geological map legends a corporate datamodel is needed. At present day such a datamodel is under construction BY the SGS. Without a corporate datamodel and standardise semantics, the compilation of a seamless vector dataset is impossible and nationwide analyses are hampered.

On the federal level the development of datamodels is mandatory for basic GI (Frick and Kettiger, 2006, Swiss Confederation, 2008a). Since geological, geotechnical and geophysical data are basic GI the present day absent datamodels have to be developed until the end of 2011. COGIS strongly supports and guides the process of model developments.

4.1.4 Standards

For the modelling and the transfer of geo-spatial data, i.e. GI a number of standards have been developed. As described in Section 2.5, those are passed by OGC. A complete list of OGC standards can be found on the OGC's web site[10]. In the remainder of this section important standards and related projects with respect to the transfer of geo-thematic GI are described.

GML

GML (OGC, 2007) is one of the most important standard for the GI-sector. It is based on XML and can be used for extensive modelling of GI. Web-services like WFS, for instance, use the GML syntax for the transfer of geographic features.

GeoSciML

Although GML has an extensive specification of more than 400 pages (OGC, 2007) which defines a large number of so-called primitives (e.g. features, geometries, coordinate systems, time etc.)[11], thus, only basic properties of geographic features can be represented. For a more detailed modelling of thematic objects, like , e.g. geological units, wells etc., so-called *application schemas*[12] have to be developed. For geo-scientific, i.e. geological applications, respectively, the Geoscience Markup Language (GeoSciML) application schema has been developed by the Commission for the Management and Application of Geoscience Information (CGI) of the International Union of Geosciences (IUGS) in recent years. Using GeoSciML, geological features, can be modelled and transferred via the internet. GeoSciML replaces the Exploration and Mining Markup Language (XMML) with was developed for modelling and exchanging data and information from the mining and natural resources sector.

[10]http://www.opengeospatial.org/standards, Last checked: 23.8.2009
[11]http://de.wikipedia.org/wiki/Geography_Markup_Language, Last checked: 29.9.2009
[12]http://en.wikipedia.org/wiki/GML_Application_Schemas

One difficulty in the application of GeoSciML is, that the standard WFS specification does not support GeoSciML by implication. Because of this reason, when serving WFSs with GeoSciML a mediation between standard GML and GeoSciML is required (Fig. 4.2). This mediation is established by the mapping of the *private* GML schema of the service provider and the GeoSciML schema of the service request. In the framework of the OneGeology project (cf. below) Apache *tomcat*[13] and the *cocoon framework*[14] is used as mediator between the two schemas. More detailed information on this mediator and its installation is given in OneGeology WFS cookbooks (CGI, 2009a,b) and on the Seegrid-web site[15])

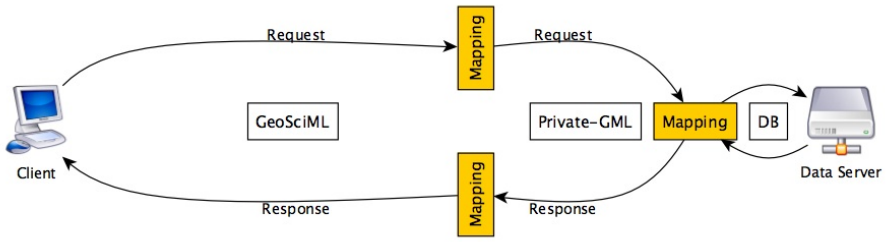

Fig. 4.2: Abstract system architecture of a WFS using GeoSciML, modified after the WFS cookbook of the OneGeology project (CGI, 2009b))

OneGeology

The development and testing of GeoSciML is closely related to the OneGeology project[16]. OneGeology aims to collect and collectively visualise every available geological map data worldwide in a common portal[17] using WMS and WFS. The main objective and mission of OneGeology is therefore:

*Make web-accessible the best available geological map data worldwide at a scale of about 1:1 million, as a geological survey contribution to the International Year of Planet Earth (*IYPE).

In addition to the aforementioned goal, the transfer of know-how related to GI-sciences and -services from advanced GSOs to those who need knowledge, is a central aim of the project.

Currently (August 2009), more than 100 countries are participating in the project by providing their geological GI as standard WMS. The progress of the project, which started in 2007, can be followed on its web site[18]. In the extended, EU-founded *OneGeology-Europe* project, the development of GeoSciML and application of WFS for geo-scientific GI is supported.

[13]http://tomcat.apache.org/, Last checked: 29.9.2009
[14]http://cocoon.apache.org/, Last checked: 29.9.2009
[15]https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/CocoonTB3Implementation#GIN_mediator_architecture, Last checked:9.9.2009
[16]http://www.onegeology.org, Last checked: 23.8.2009
[17]http://portal.onegeology.org
[18]http://www.onegeology.org, Last checked: 23.8.2009

KML

Apart for GML in recent year the Keyhole Markup Language (KML) becomes more and more popular. KML is, like GML, based on Extensible Markup Language (XML) and is being developed by Google. It primarily serves for the visualisation of GI in applications like GoogleEarth[19]. In 2008 KML Version 2.2 (OGC, 2007) has been passed officially as OGC-standard. The specification of KML with detailed information is available at the OGC's web site[20].

INTERLIS

In Switzerland INTERLIS[21] (COGIS, 2006) plays, apart from the above mentioned formats, an important role for the entire GI-sector. INTERLIS is an exchange mechanism which consists of a conceptual modelling language and a XML-based transfer format. It was developed out of the requirements of the Swiss official survey, but can be used for a wide range of applications from other fields of specialisations. INTERLIS is a Swiss standard (SN 612030 and SN 612031)[22] and is fully compatible with the ISO 19100 series. Its importance is strengthened by the Swiss Federal Act on Geoinformation (GeoIG) (Swiss Confederation, 2008a) (cf. below). The GeoIG legally stipulates that for basic GI, as defined in appendix 1 of the Federal Ordonnance on Geoinformation (GeoIV) (Swiss Confederation, 2008e,b), a datamodel in INTERLIS-format has to be defined.

4.1.5 Spatial data infrastructures

As described in Section 2.6 SDIs exist on different level. In the present state analysis the national level of Switzerland NSDI and FSDI have been considered. Furthermore, the european level has been briefly reviewed.

Switzerland's NSDI

Like other countries and regions (Bruggemann *et al.*, 2004, Annoni and Craglia, 2005) also Switzerland is developing a NSDI. It comprises various levels, thus cities (e.g. city of Zurich (Gees, 2006)), communes and cantons (Hösli and Ilfejika, 2006) as well as entire regions (Lippuner, 2006) are participating and supplying their data. On the federal level the FSDI is being built-up. It contains the available GI of public interest which is owned by the confederation (swisstopo, 2009). Additionally, spatial data from public organisations and private companies accessible to the broad public is incorporated. The major goal of the NSDI is to enhance accessibility of GI and hence to create greater national economic benefits (COGIS, 2003).

The driving force of the NSDI and FSDI is the e-geo.ch-project which is coordinated by COGIS the coordination centre for GI of the Swiss confederation. The e-geo.ch-project started in 2003 and focuses on several fields of activities[23] (Fig. 4.3). These fields are dealing with the

[19] http://earth.google.com/, Last checked: 29.9.2009
[20] http://www.opengeospatial.org/standards/kml, Last checked: 29.9.2009
[21] http://www.interlis.ch/, Last checked: 29.9.2009
[22] http://www.interlis.ch/general/faq_d.php, Last checked: 29.9.2009
[23] http://www.swisstopo.admin.ch/internet/swisstopo/de/home/topics/geodata_inf/bgdi.html, Last checked: 1.10.2009

built-up of the technical infrastructure and issues related to GI like standards, metadata, web-services but also with the legal basis, education, distribution and pricing strategies[24]. Moreover, the foundation and advancement of a network of stakeholder, supporting the FSDI have been identified as one of the most important tasks (cf. centre of Fig. 4.3).

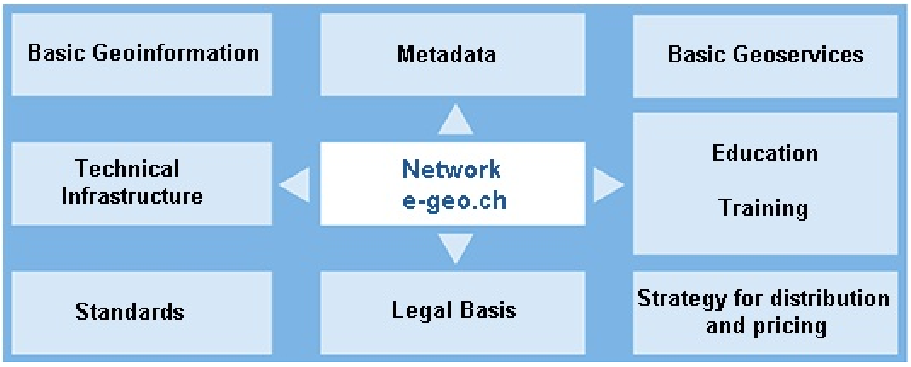

Fig. 4.3: Fields of activities of e-geo.ch for the built-up of the FSDI and NSDI (COGIS, 2003, Gubler, 2003)

Apart from COGIS, also the Swiss Organisation for Geographic Information (SOGI)[25] supports the implementation of the NSDI. SOGI hosts several working groups[26] which are addressing important issues related to the NSDI, such as standardisation, technology etc.

Since the beginning of e-geo.ch several projects addressing the built-up of the NSDI have been performed. Projects which are relevant for the development of the Geolo-GIS-CH are listed in Tab. 4.2. Additionally to a brief description the current status of the particular project is indicated.

Maguire and Longley (2005) mention that SDIs are or should be part of e-government-programs. In Switzerland a complete integration in the national e-government program[27] is not achieved yet. However, the *access to geobasis data and interactive map applications with the help of geobasis services (WEB-GIS) (A1.14)* (egovernment Schweiz, 2009a,b) is prioritised and will be finalised in 2010. In general, the relationship between e-geo.ch, the national e-government program and eCH (the Switzerland's organisation for e-government standards) is not obvious. For example, *NSDI* and topics related to the NSDI like spatial web-services (e.g. WMS) are not mentioned on the eCH-web site.

European SDI and INSPIRE

Since Switzerland is located in the heart of Europe, surrounded by countries of the EU, the ESDI is the most important external SDI for Switzerland. The driving force for the implementation of the ESDI and its legal basis is the INSPIRE directive. INSPIRE stands for *Infrastructure for Spatial Information in Europe.*

[24]http://www.swisstopo.admin.ch/internet/swisstopo/de/home/topics/geodata_inf/bgdi.html, Last checked: 1.10.2009
[25]http://www.sogi.ch/, Last checked: 30.9.2009
[26]http://www.sogi.ch/index.php?id=9, Last checked: 30.9.2009
[27]http://www.egovernment.ch, Last checked: 30.9.2009

Tab. 4.2: Projects in the framework of e-geo.ch which are relevant for the development of the Geolo-GIS-CH. The indicated numbers correspond to the original project numbers in the framework of e-geo.ch. the current status of the particular projects are indicated

No.	Project	Description & relevance for Geolo-GIS-CH	Status
06-03	Specification of spatial web-services	Advancement of integration of GI in the framework of the NSDI by the development of a common specification of spatial web-services. *Relevance for Geolo-GIS-CH:* This specification constitutes the basis for the development of web-services for geo-thematic data.	finished
06-04	Usefulness of GIS for instructions	Poll on the usefulness of GIS in instructions at Swiss secondary schools. *Relevance for Geolo-GIS-CH:* This poll provides basic information on the status regarding GIS in general at secondary school level. It can be used as a basis for a future poll concerning the requirements on geo-thematic GI of teachers.	finished
06-09	Inventory for the advancement of communities around thematic GI	Creation of an overview of the existing communities around thematic GI. Specification of appropriate affirmatives. *Relevance for Geolo-GIS-CH:* The Swiss geo-community is a community around thematic GI. This inventory identifies other communities, thus, synergies with the Swiss geo-community can be established.	finished
08-03	Concept of national geoportal	Development of a concept for a national geoportal which serves as the gateway to the Swiss NSDI. *Relevance for Geolo-GIS-CH:* The Geolo-GIS-CH is intended to be the gateway to geosciences in Switzerland. It is essential to integrate this gateway in or link it to a national geoportal.	finished
06-17	Creation and implementation of the GeoIG and related ordinances	Guarantee easy access to up-to-date GI for federal, cantonal institutions and municipalities, economy, society and academia. *Relevance for Geolo-GIS-CH:* The GeoIG and it ordinances constitute the legal basis for the Geolo-GIS-CH.	on-going
07-01	Catalogue of spatial web-services	Many spatial web-services already exist. Its existence, however, is only poorly known. *Relevance for Geolo-GIS-CH:* It is essential for the usage of geo-thematic data that it is easy available. Therefore, such a catalogue enhances the accessibility of services and data.	on-going

INSPIRE[28] intends to remove basically five obstacles which are holding back the development of the EU (Bernard *et al.* (2005), Annoni *et al.* (2004) in Maguire and Longley (2005)). These obstacles are: *1) gaps in spatial data (missing and incomplete data); 2) lack of metadata, limiting the reuse of data; 3) incompatibility of spatial data, limiting interoperability; 4) incompatible GIS and 5) obstacles to share and reuse spatial data.* Therefore, the goals of INSPIRE which are basically the same as the those of the Swiss NSDI are related to *the harmonisation of metadata, the development of interoperable web-services for delivering spatial data and information and the development of harmonised specifications of geodata (i.e. datamodels).*

Although INSPIRE originally focussed on environmental data only (Kettiger, 2007), at the present state also other geo-scientific data are incorporated in its data basis. Geological data are mentioned in annex II of the INSPIRE directive. The directive have to be achieved by 2013.

For geological data the implementation of the INSPIRE directive is coordinated by the EuroGeoSurveys (EGS), i.e by the participating GSOs. Furthermore, the technical implementation is strongly supported by OneGeology which is described in Section 4.1.4.

[28]http://inspire.jrc.ec.europa.eu/, Last checked: 23.8.2009

The INSPIRE directive is not legally binding for Switzerland, but the GeoIG builds the INSPIRE-conform legal basis for Switzerland. It is clearly pointed out by COGIS that the activities related to INSPIRE are also useful for Switzerland (swisstopo, 2007). Because of this reason and to prevent problems related to the integration of national data into an ESDI (cf. below), the Swiss INSPIRE contact point (swisstopo, 2007) was initiated, which coordinates the INSPIRE related activities in Switzerland. Such problems when integrating national data into a SDI are:

- Conflicting understanding of what a SDI is (Bruggemann *et al.*, 2004)
- Incompatible technical solutions (Bruggemann *et al.*, 2004)
- Diverging organisational structures and legislation
- Differences in spatial reference systems
- Languages
- Missing data harmonisation (e.g. borders, semantics)
- Interoperability, for instance interoperability of metadata (COGIS, 2005), i.e. compatible with standards like ISO19115

4.1.6 Legal basis

The implementation of the Swiss NSDI and the handling of GI is regulated by the Federal Act on Geoinformation (GeoIG) (Swiss Confederation, 2008a) and its associated ordonnances[29]. In 2008 the GeoIG was passed by the Swiss Parliament and Swiss Federal Council and thus, became operative. The same applies to the majority of the associated ordonnances.

The GeoIG is basically restricted to the so-called basic GI which are defined in appendix 1 of the Federal Ordonnance on Geoinformation (GeoIV) (Swiss Confederation, 2008e). A large number of geo-thematic data and information are part of the catalogue of basic GI, as mentioned in Section 4.1.3. In particular the geological, geophysical and geotechnical data and information as well as basic data of the SGS are listed (cf. ID 46, 47, 48 and 50 of appendix 1 of the GeoIV). Therefore, also for geo-thematic data the regulations of the GeoIG, such as the development of datamodels, capture of metadata, fees etc. have to be applied.

In the framework of the GeoIG the Federal Ordonnance of the Swiss Geological Survey (LGeolV) (Swiss Confederation, 2008d) and the Federal Ordonnance of the Swiss Federal Geological Commission (EGKV) (Swiss Confederation, 2008c) are of special importance for the Swiss geo-community. The latter ordonnance regulates the composition, tasks and duties of the Swiss Federal Geological Commission (EGK) which is the advisory board of the Swiss Federal Council regarding geology related affairs.

The LGeolV defines the tasks and duties of the SGS. A basis of the LGeolVrepresent the reports of Spinatsch and Hofer (2004a,b, 2003) which identify the main tasks of the SGS and its importance for political economics. These tasks are:

[29] http://www.admin.ch/ch/d/sr/51.html#510.6, Last checked: 30.9.2009

- Compile geological maps and reports
- Archive geological information (mainly reports and borehole data)
- Coordinate the geological, geotechnical and geophysical survey in Switzerland

The LGeolV constitutes the first strong legal basis for the SGS in its more than 100 years of history.

4.1.7 Geological information systems

As described above (cf. Section 4.1.1), in recent years ICT and GIS-technologies are getting increasingly evolved, fast, widely used and familiar even to the broad public. Because of this reason also the international geo-community is applying these technologies for presenting and communicating their products, i.e. their geo-thematic data, respectively. Almost every GSO (at least in the developed countries) runs its own web portal which can be regarded as an entry point to the *geological information system* of the particular GSO. In such portals geo-thematic GI is increasingly incorporated. This integration is generally achieved by a geoportal, i.e. an application portal as described by Maguire and Longley (2005) which makes geo-thematic GI available in map view. Additional information like geological map's legends and metadata are provided together with the respective dataset, so that the user can obtain the same information like from printed products.

The international level

The BGS addresses in its 2009-2014 strategy (BGS, 2009) the improvement of the communication of geo-scientific knowledge as one of its priority challenges. In order to face this challenge the internet is identified as the most important tool of communication. Thus, numerous examples for applications of their geological information, its respective importance and how data and services can be presented and distributed via the internet[30] [31] are available at the BGS's web site. The accessibility of these geo-thematic information and services is easy and in many cases free of charge. Their relevance and importance is easy understandable for professionals and laymen.

Like the BGS, also other GSOs have discovered the enormous potential of the internet for the distribution and the exchange of information. In order to get an overview of which portals do exist and what content is presented on the international level, the web presences of the GSOs, listed in Tab. 3.1 have been analysed.

Each investigated web portal has been analysed with respect to the occurrence of the features listed in Tab. 3.2. A major part of the investigated components (cf. numbers in brackets in Tab. 4.3) correspond to those described and evaluated in the poll on requirements described in Section 3.2.2.

The results of this analysis are shown in Tab. 4.3. On the right side of the table (three right most columns) the summary of the occurrences of each particular component are shown. For comparison, the summary of the evaluation performed by the Swiss geo-community (cf. Tab.

[30] http://www.bgs.ac.uk/britainbeneath, Last checked: 23.8.2009
[31] http://www.bgs.ac.uk/services/home.html, Last checked: 23.8.2009

4.4) are indicated to the left of the international results. The occurrences are color coded. If a component exists on the respective web site, it has been indicated as *yes* in green color, if a component does not exist a *no* has been indicated in red. Some component on the analysed web sites do not exactly copy the particular specification, these components have been indicated as *(yes)* in yellow color. The urls of the particular web sites are given in Appendix C.1 for reference.

In general, each web portal gives numerous information on the tasks and activities of the respective organisation, its products and services as well as its national and international integration. Additionally, various *non-spatial* web-services, like geological reports (GeoReports[32]), shops, image databases, job portals etc. are provided.

Besides these non-spatial web-services, each portal gives access to geo-scientific GI. This is achieved by the use of either geoportals or spatial web-services. A geoportal is provided by each organisation. It is separated from the main web site and is mainly composed of a stand-alone application portal, as defined in Section 2.3. The applied technologies are coming from the entire product spectrum from commercial, e.g. ESRI ArcIMS[33] to open source, e.g. mapbender[34]. The complete integration of the visualisation of GI in the main web site, by using map-APIs, like OpenLayers[35] or GoogleMaps-API[36], is not established yet.

Spatial web-services, mainly OGC-WMS, OGC-CSW or other non standardised services are provided by each portal. The supply of OGC-WFS, however, is at the present status not existing.

The possibility for internet users to generate and provide user generated content and VGI, in terms of Web2.0-philosophy, does not exist at present day. Thus, wiki-sites and transactional services (e.g. WFS-T) are not provided. Some organisations offer a user-account, however, this is basically used for purchase processes in on-line shops. The BGS is the only organisation which supports social-networking applications such as facebook[37], twitter[38], YouTube[39], etc. Furthermore, GeoRSS feeds on recent worldwide and UK-based earthquakes can be subscribed or included in the user's web sites.

In contrast to the rather little activities in the area of Web2.0, almost every analysed portal provides geological information, products and services, especially prepared for non-professionals and laymen. Many of these services are available free of charge. Examples for such products are:

- The multimedia section[40] of the web portal of the BRGM. This section provides for instance many laymen understandable block diagrams which illustrate various geology related processes.

- The BGS application *Make-a-Map*[41] allows the user to manipulate a geological map interactively in map view. The different geological formations can be switched on and off, thus,

[32]http://shop.bgs.ac.uk/GeoReports/, Last checked: 25.10.2009
[33]http://www.esri.com/software/arcgis/arcims/index.html, Last checked: 30.9.2009
[34]http://www.mapbender.org/Main_Page, Last checked: 30.9.2009
[35]http://openlayers.org/, Last checked: 29.9.2009
[36]http://code.google.com/apis/maps/, Last checked: 30.9.2009
[37]http://de-de.facebook.com/, Last checked: 30.9.2009
[38]http://twitter.com/, Last checked: 30.9.2009
[39]http://www.youtube.com/, Last checked: 30.9.2009
[40]http://www.brgm.fr/multimedia.jsp, Last checked: 1.10.2009
[41]http://www.bgs.ac.uk/education/makeamap/home.html, Last checked: 1.10.2009

Tab. 4.3: Analysed web sites of the international geo-community. The components and groups for which the web sites have been analysed are indicated on the left hand side. Numbers in brackets indicate correspondent components proposed in the poll (cf. Section 3.2.2). The urls of individual analysed web sites are listed in Appendix C.1, Tab. C.2. Existent components marked as *yes* in green, not existing ones as *no* in red and those which only partly copy the specification as *(yes) in yellow*. The summary of the occurrences are given in the three right-most columns. For comparison, the summary of the evaluation of the national evaluation (cf. Tab.4.4) are listed on the left side.

		Switzerland	Neigbourling countries				Europe	America	German state surveys				
Group	**Component**	**Swiss geo-community**	**APAT**	**BGR**	**BRGM**	**GBA**	**BGS**	**GSC**	**Baden-Würtemberg**	**Bavaria**	**Yes**	**(Yes)**	**No**
Interation and supply of GI	Dataviewer (1)	Yes	Yes	Yes	Yes	Yes	Yes, multiple	Yes, multiple	Yes	Yes	9	0	0
	Geo-thematic data (2)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	0	0
	Spatial web-services (3)	WMS	WMS	WMS	WMS	No	WMS	WMS	WMS	WMS	8	0	1
Supply of non-spatial web-services	Informations guidance and calculations (3)	Yes	Yes	No	No	Yes	Yes	Yes	No	No	5	0	4
	Guidelines and quality assurance (3)	Yes	Yes	No	No	No	Yes	No	No	No	3	0	6
	GeoReports	No	No	No	Yes	No	Yes	No	No	No	2	0	7
	Stratigraphic lexicon (3)	Yes	No	No	No	No	(Yes)	Yes	No	No	2	1	6
	Image database	No	No	No	Yes	No	Yes	No	No	No	2	0	7
	Job portal (9)	Yes	No	No	(Yes)	No	No	No	No	No	1	1	7
	Event calender (10)	Yes	No	Yes	No	No	(Yes)	No	No	No	2	1	6
User interaction	User Account	Yes, for shop	No	Yes	Yes	No	No	No	No	No	3	0	6
	Shop	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	6	0	3
	Discussion forum (8)	No	No	No	No	No	(Yes)	No	No	No	0	1	8
	User-generated content (11)	No	No	No	No	No	(Yes)	No	No	No	0	1	8
Geology for laymen	Glossary (4)	(Yes)	No	No	No	Yes	(Yes)	Yes	No	No	2	2	5
	Description of geological facts and sites (5)	Yes, very little	Yes	No	Yes	Yes	Yes	Yes	Yes	(Yes)	7	1	1
Swiss specifics	Overview of geo-community (6)	No	No	No	No	No	No	No	No	No	0	0	9
	Address database (7)	Yes	No	No	No	No	No	No	No	No	1	0	8

the user can get an inside in the structure of a geological map and the geological setting in Great Britain.

- The web site *Geologie-ist...*[42] of the GBA provides short, laymen oriented descriptions of the manifold fields of geology.

- The Swiss Geological Survey (SGS)[43] provides simplified geological, tectonic and hydrogeological maps in postcard format.

The national level

In order to analyse the present situation in Switzerland, the web portals of the major players of the Swiss geo-community have been analysed. The investigation was performed similar to the one performed on the international level (cf. *The international level* above). Table 4.4 summarises the results of the analysis of the national web portals.

In general it turns out, that a substantial number of data and information on geosciences and geo-scientific organisations in Switzerland do exist on the web sites of the members of the Swiss geo-community. About two-thirds of the analysed components can be found on one or the other web site of a member of the Swiss geo-community.

Apart from geological, geotechnical and geophysical maps and cross-sections etc. a large number of non scientific data and information which is required for the activities and organisation of the Swiss geo-community is provided. Examples of such data are:

- Addresses and contact information of the members of the Swiss geo-community

- Offers for geo-scientific jobs

- Announcements of events like conferences, speeches etc.

Although this data and information are not obviously GI, it contains a clear spatial reference. This spatial reference is not used is the particular web portal,s neither for visualisation nor for search and filter functionalities. Thus, for instance, addresses (cf. address data base of the sc|nat[44]) can be retrieved only via textual search queries. Search results are presented only as text and not in map view.

Each of the analysed web site can be regarded as a geological information system on its own, i.e. as a part for an overall geological information system, respectively. However, data and information provided, mainly reflect the tasks and responsibilities of the respective organisation. It serves mainly the individual organisation's requirements. An overall information system, combining and integrating the content of all of these web presences is lacking.

A proposition of the integration of the content of the existing web portals, relevant for the Swiss geo-community and the design of a overall geological information system for Switzerland was given by Oesterling *et al.* (2008b). These first ideas are extended in Chapter 5 of the present thesis.

[42] http://www.geologie-ist-alles.at/index.html, Last checked: 1.10.2009

[43] http://www.swisstopo.admin.ch/internet/swisstopo/de/home/products/accessories/postcards.html, Last checked: 1.10.2009

[44] http://geosciences.scnat.ch/index.php?nav1=3&nav2=34, Last checked: 23.8.2009

Tab. 4.4: Analysed web sites of the national geo-community. The components and groups for which the web sites have been analysed are indicated on the left hand side. Numbers in brackets indicate correspondent components proposed in the poll (cf. Section 3.2.2). The urls of individual analysed web sites are listed in Appendix C, Tab. C.2. Existent components marked as *yes* in green, not existing ones as *no* in red and those which only partly copy the specification as *(yes) in yellow*. The summary of the occurrences are given in the three right-most columns.

		FedAdmin		CantAdmin		Academia				Private				
Group	**Component**	**SGS**	**FOEN**	**Solothurn**	**Vaud**	**sc|nat**	**SGTK**	**SGPK**	**Unis (ETHZ)**	**CHGEOL**	**Private consultants**	**Yes**	**(Yes)**	**No**
Interation and supply of GI	Dataviewer (1)	Yes	Yes, multiple	Yes	Yes	No	No	No	No	No	No	4	0	6
	Geo-thematic data (2)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	8	0	2
	Spatial web-services (3)	WMS	WMS	Yes	No	No	No	No	No	No	No	3	0	7
Supply of non-spatial web-services	Informations and calculations (3)	(Yes)	Yes	No	No	No	No	Yes	Yes	No	No	3	1	6
	Guidelines and quality assurance (3)	No	No	No	No	No	No	Yes	No	No	No	1	0	9
	GeoReports	No	No	No	No	No	No	No	No	No	Not as web-service	0	0	10
	Stratigraphic lexicon (3)	No	No	No	No	Yes	No	No	No	No	No	1	0	9
	Image database	No	No	No	No	No	No	No	No	No	No	0	0	10
	Job portal (9)	No	No	No	No	Yes	No	No	No	Yes	No	2	0	8
	Event calender (10)	No	No	No	No	Yes	No	No	No	Yes	No	2	0	8
User interaction	User Account	Yes, for shop	No	No	No	Yes, member login	Yes, member login	No	Yes, member login	Yes, member login	No	5	0	5
	Shop	Yes	No	No	No	No	Yes	No	Yes	No	No	3	0	7
	Discussion forum (8)	No	No	No	No	No	No	No	No	No	No	0	0	10
	User-generated content (11)	No	No	No	No	No	No	No	No	No	No	0	0	10
Geology for laymen	Glossary (4)	No	No	No	(Yes)	No	No	No	No	No	No	0	1	9
	Description of geological facts and sites (5)	Yes, very little	No	Yes	No	Yes	No	No	Yes	Yes, very little	No	5	0	5
Swiss specifics	Overview of geo-community (6)	No	No	No	No	No	No	No	No	No	No	0	0	10
	Address database (7)	No	No	No	No	Yes	No	No	No	No	No	1	0	9

Geological information systems in literature

In literature *Geological Information Systems* as corporate applications are described rather rarely. For instance Chang and Park (2004) describes a *Geological Information System* especially designed for the management of borehole and other geo-thematic data. It is restricted to a map viewer and its backbone is the datamodel of the individual datasets and the IT-architecture. The integration of other data or information (spatial and non-spatial) as well as issues related to a geo-community are not taken into account.

A recent study by Howard *et al.* (2009) presents a corporate system of the BGS which focuses on the one hand on geological surveying and data production and on the other hand on capturing and saving geological knowledge of the individual staff members. This tacit knowledge is neither stored in analogue nor digital form but only as individual knowledge of the staff members. Their system is called *Knowledge Management System* and focuses on guarding these unpublished explicit geological knowledge.

The study by Fanger (2005) describes a web-based system for delivery and exchange of geological data in Switzerland. However, the presented system covers the requirements of geological consultants and excludes requirements of other members of the Swiss geo-community.

4.2 Requirements of potential users

The requirements of the international and national geo-community on a geological information system and its components were derived from the returned questionnaires described Section 3.2.1. In the questionnaire the usefulness and priority of implementation of 11 proposed components of the envisioned Geolo-GIS-CH have been queried. Each of those components is described in Section 3.2.2 in detail. Table 4.5 briefly lists the name and abbreviation of each component. The indicated abbreviations are used in the subsequent figures and tables.

Tab. 4.5: Names and abbreviations of the proposed components of the planned Geolo-GIS-CH. Name and abbreviation of each component is listed. Abbreviations are used in subsequent figures and tables.

No	Name	Abbreviation
1	Dataviewer	GDView
2	Geo-thematic data	GDat
3	Web-services	GWebS
4	Geo-glossary	GGlos
5	Key-sites of Swiss geology	GKeyS
6	Overview of geo-community	GCom
7	Address database	GADB
8	Discussion-forum on geological topics	GForum
9	Job portal	GJobs
10	Event calender	GEvent
11	OpenGeoMap	OGM

According to the applied method of analysis the components with the highest rating can be regard as the most required ones.

For each geo-community the requirements have been analysed separately. On the national level the poll generates a substantial databases for the analysis of the requirements of the Swiss geo-community. In contrast, the analysis of the international requirements is based only on a small number of samples which is why the significance of the poll is strongly restricted. However, as will be described later-on (cf. Section 4.2.3), the general pattern of both polls is similar to each-other.

In the following sections the evaluations of the international and national geo-community are described and the most important components, i.e. the core-components of the geological information system are derived.

4.2.1 International geo-community

The mean usefulness of the individual proposed components is plotting asymmetrically around the medium line (ranking 3.0) (cf. Fig. 4.4 and Tab. 4.6). Although most components have been rated between 2.0 and 3.0, the highest possible rating (5.0) was reached twice and ratings below 2.0 (second lowest possible rating) only occurs once. This indicates a general shift of the distribution towards higher values, i.e. more positive ratings.

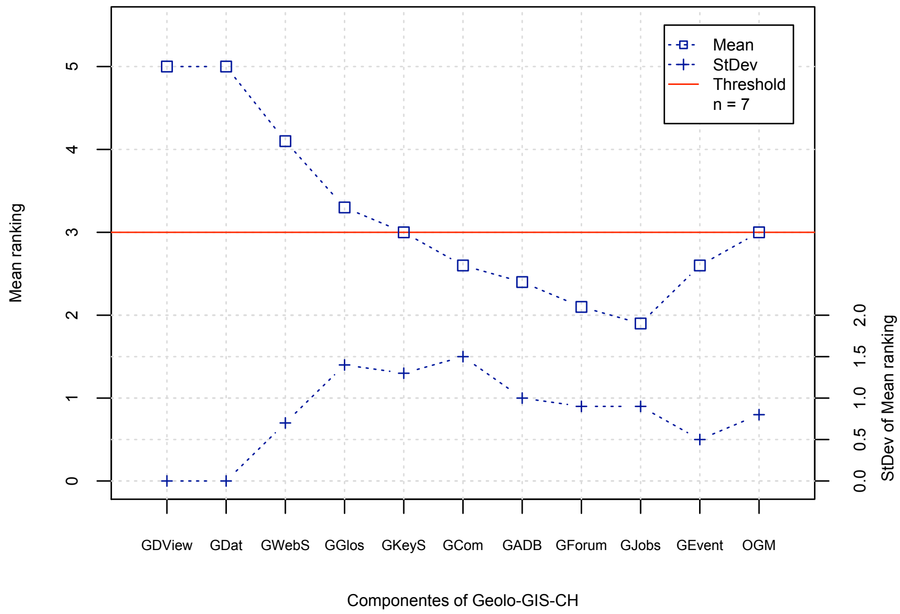

Fig. 4.4: Requirements of the international geo-community. Usefulness (open squares) and respective standard deviation (crosses) for the proposed components of the geological information system are shown. The horizontal red line (Threshold) indicates the medium-line of the ranking scale (cf. Section 3.2.3). The full name of the individual components can be found in Tab. 4.5, a detailed description of the components is given in Section 3.2. The scale on the left side represents the mean ranking, the one on the right side the standard deviation. Note that the number of samples in restricted to 7 which limits the significance of the dataset.

Three groups may be distinguished. The first one contains the following four components: *dataviewer, geo-thematic data, web-services* and *geo-glossary*. All these components have been rated higher than the medium line. All participants of the poll rated the *dataviewer* and the *geo-thematic datasets* with 5.0. *Web-services* are plotting slightly above 4.0 and the *geo-glossary* was evaluated slightly higher than 3.0.

The second group is the largest one and contains the *overview of geo-community, address*

Tab. 4.6: Mean (Mean) and standard deviation (StDev) of the raking of the usefulness of each proposed component from the international poll. The distribution can be divided into three parts which are indicated in the column *Group*. The full name of each component is given in Tab. 4.5 and a detailed description of it is given in Section 3.2.2.

Component	Mean useful	StDev useful	Group
GDView	5.0	0.0	1
GDat	5.0	0.0	1
GWebS	4.1	0.7	1
GGlos	3.3	1.4	1
GKeyS	3.0	1.3	3
GCom	2.6	1.5	2
GADB	2.4	1.0	2
GForum	2.1	0.9	2
GJobs	1.9	0.9	2
GEvent	2.6	0.5	2
OGM	3.0	0.8	3

database, discussion forum, job portal and *event calender.* Apart form the *job portal* (rating 1.9) all components have been rated between 2.0 and 3.0 with a mean of 2.3.

The last group contains the *key-sites of Swiss geology* and the *OpenGeoMap* component. Both components have been rated with 3.0, directly plotting on the medium line. For the latter component a similar rating was achieved on the national level and was proposed as an additional, desired component (cf. Fig. 4.11 d). This is notable and will be discussed later-on in Chapter 4.2.2.

The standard deviation gives an idea about the homogeneity of the rating per component. For the international poll it is dispersed between 0.0 and 1.5. The minimum value of 0.0 indicates that all participants have evaluated the *dataviewer* and the *geo-thematic data* with 5.0. However, it should be noted that for the *geo-thematic data* one participant did not evaluated this component, reducing the number of samples by one.

The remaining components are plotting between a standard deviation of 0.5 and 1.5, with a mean of 1.0. For these components a normal distribution of the ranking can be assumed.

As already mentioned above, the significance of the results of the international poll is strongly restricted, because the number of independent samples is low. Only 7 members of the international geo-community have participated in the poll which corresponds to about 15% of the send questionnaires. However, the results give a first idea of the requirements on the international level. In order to draw more detailed conclusions further investigations would be needed.

4.2.2 Swiss geo-community

In contrast to the return-rate on the international level (cf. above), 54 participants, corresponding to about 60% have returned their questionnaires. This percentage includes six additional answers (two from the cantonal administration and four from the private sector) from participants which have not been addressed officially. These participants received the forwarded documents from other participants. The answers have been included into the analysis. In contrast, two answers were returned anonymously which have been excluded from further analysis.

The majority of all answered questionnaires (42.6%) have been received from the cantonal administration (Fig. 4.5). It is followed by the private sector (27.8%) and academia (20.4%). Only 9.3% of all answers were returned by the federal administration. The contrast between the percentage of the latter category and the three first might by interpreted as a lack of interest in the poll by the federal administration. However, when considering the initial number of recipients per category, another pattern becomes visible. Fig. 4.6 illustrates the distribution of the returned questionnaires per category of organisation, taking into account the initial number of recipients. Two groups may be distinguished. The first one with a return-rate of more than 60% indicates that 71.4% of the addressed members of the private sector and 63.9% of the cantonal administration returned their questionnaires. The second group with a return-rate of about 45% indicates that about the half of the academic recipients (45.8%) and also about the half of the addressed federal administration (45.5%) answered the poll. The entire databases for the send-return-statistics (i.e. absolute numbers and percentages) is shown in Tab. 4.7.

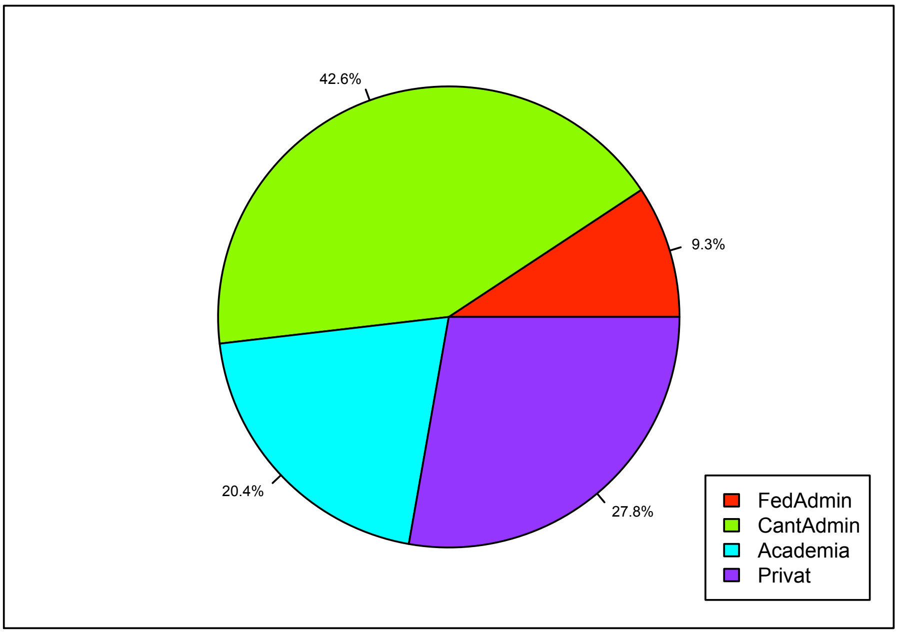

Fig. 4.5: Return rate of the national poll per category of organisation. 42.6% of all 54 returned questionnaires have been received from the cantonal administration (CantAdmin). The private sector (Privat) participated with 27.8% and academia (Academia) with 20.4%. The federal administration (FedAdmin) contributes only with 9.3% to the answers of the poll. It should be noted that absolute numbers of addressed participants are not taken into account (cf. Fig. 4.6). Two anonymously returned answers have been excluded from this analysis. The percentages illustrated in this figure correspond to those given in column *%-return* in Tab. 4.7

In the questionnaire the proposed components (No. 1 to 11 in Section 3.2.2) have been evaluated by the participants. Additionally general advancements and further desired components and datasets could have been indicated. In the following sections the results for the proposed components are discussed first, those of the additional features subsequently.

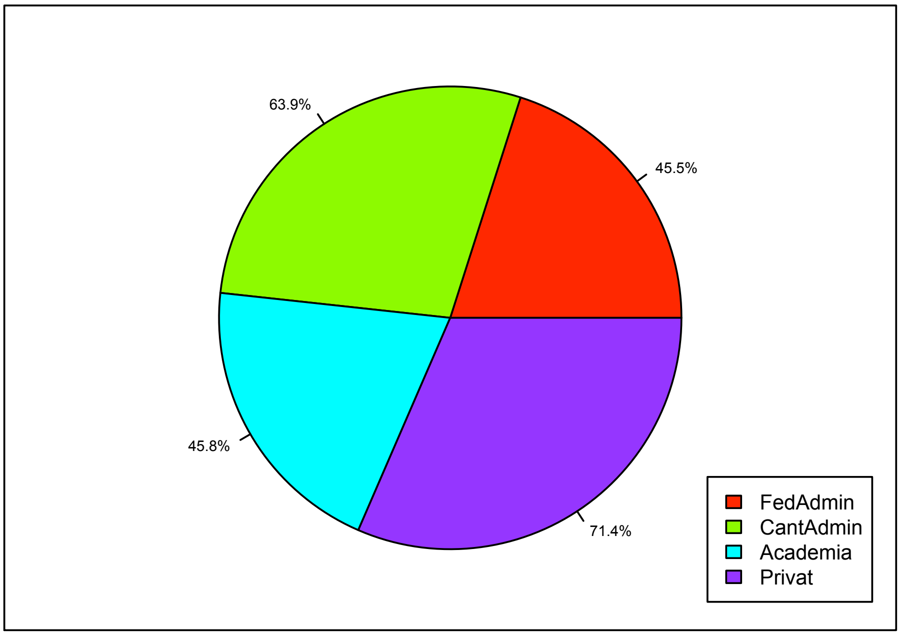

Fig. 4.6: Return rate of the national poll per category or organisation taking into account initial number of recipients. Two groups (greater than 60% and about 45%) may be distinguished. The first group contains the privat sector (Privat) with 71.4% and the cantonal administration (CantAdmin) with 63.9%. The second group comprises academia (Academia) with 45.8% and the federal administration (FedAdmin) with 45.5%. The percentages illustrated in this figure correspond to those given in column *%-back* in Tab. 4.7.

Results for proposed components

Similarly to the rating of the international geo-community also on the national level the mean usefulness of the proposed components is distributed asymmetrically with respect to the medium line (cf. Fig. 4.7 and Tab. 4.8). Four components are located below (rating 2.6 - 3.0) and six components above (rating 3.1 - 4.3) the medium line of 3.0. Only one component is plotting directly on the medium line. Since no component have been rated below 2.5 and the highest possible rating of 5.0 is closely approached, a clear tendency towards higher ratings, i.e. positive ratings becomes obvious.

Four groups may be distinguished. The first one contains the "top-level"-components *dataviewer, geo-thematic data* and *web-services* with ratings of 4.0 and higher. All these components are also contained in group one of the international results (cf. Tab. 4.6). Only the *geo-glossary*-component is lacking in this group of the national results.

The second group contains the *address database, job portal* and *event calender*. Each of these components are plotting slightly above the medium line with ratings of 3.1 and 3.4, indicating a slightly reduced importance compared to the components of group 1.

The third group contains only the OGM-component which, compared to the international results, also plots directly on the medium line. This result indicates that OGM is not thought to be a priority component of high importance, but that a certain interest in such a component is present. It might be getting more important in the future.

Tab. 4.7: Send-return-statistics of the national poll. Absolute numbers of send (#-send), added (#-add), not-returned (#-no-return) and returned (#-return) questionnaires. Additionally the respective percentage for send- (%-send) and returned (%-return) questionnaires are indicated. The percentage of returned polls per category, taking into account the initial number of recipients are given in column *%-back*.

Cat	**#-send**	**#-add**	**#-no-return**	**#-return**	**%-send**	**%-return**	**%-back**
FedAdmin	11	0	6	5	12.0	9.3	45.5
CantAdmin	36	2	13	23	39.1	42.6	63.9
Academia	24	0	13	11	26.1	20.4	45.8
Private	21	4	6	15	22.8	27.8	71.4
Total	92	6	38	54	100.0	100.0	58.7

Tab. 4.8: Mean (Mean) and standard deviation (StDev) of the rating for usefulness (useful) and priority of implementation (prio) form the national poll. The distribution can be divided into four groups which are indicated in the the column *Group*. The full name of each component is given in Tab. 4.5 and a detailed description of it is given in Section 3.2.

Component	**Mean useful**	**StDev useful**	**Mean prio**	**StDev prio**	**Group**
GDView	4.3	0.7	4.0	0.8	1
GDat	4.1	0.8	3.6	1.0	1
GWebS	4.0	0.9	3.3	1.0	1
GGlos	2.8	1.2	2.1	1.0	4
GKeyS	2.7	1.1	2.2	1.1	4
GCom	2.9	1.1	2.5	1.0	4
GADB	3.4	1.0	3.0	1.1	2
GForum	2.6	1.1	2.0	0.8	4
GJobs	3.4	1.	2.7	1.2	2
GEvent	3.1	1.2	2.6	1.2	2
OGM	3.0	1.3	2.3	1.1	3

The rest of the components (*geo-glossary, key-sites of Swiss geology, overview of geo-community* and *discussion-forum*) are summarised in the last group. They are plotting below the medium line, indicating a lower importance.

Each component have been evaluated homogeneously by the participants. This is supported by the respect standard deviation. For all ratings its standard deviation is close to 1, indicating a normal distribution. The lowest value is reached by the *dataviewer* with 0.7, indicating a high agreement of the participants concerning the rating of this component. In contrast the highest value is reach by the *job portal* with 1.4, where a certain discordance with respect to the importance of this component is notable.

Apart from the latter component, the following trend is visible. The higher the usefulness of a component have been rated, the higher is the agreement about this rating, i.e. the lower is the standard deviation. This trend additionally supports the importance of the derived top-level-components.

Unlike the international poll the priority of implementation have been evaluated from the participants of the national poll. It follows the distribution of the usefulness of each component, plotting slight at lower values. The maximum of 4.0 is reached by the dataviewer and the discussion-forum is evaluated with 2.0 as least priority. Also the standard deviation basically

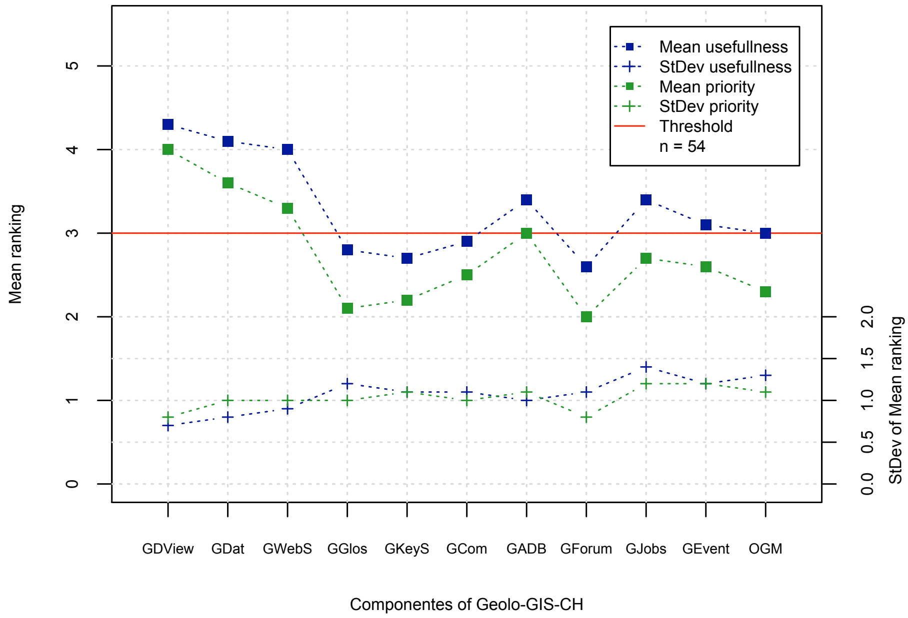

Fig. 4.7: Requirements of the national geo-community. Usefulness (filled blue squares), priority of implementation (filled green squares) and the respective standard deviations (blue and green crosses) of the ratings for the proposed components of the geological information system. The horizontal red line (Threshold) indicates the medium-line of the ranking scale (cf. Section 3.2.3). The full name of the individual components can be found in Tab. 4.5, a detailed description of the components is given in Section 3.2. The scale on the left side represents the mean ranking, the one on the right side the standard deviation. A total of 54 independent samples are included in the analysis.

follows the one of the usefulness. Because of these similarities the priority of implementation is not further considered for analysis.

In order to get a better understanding of the requirements of the individual categories of organisations, the ratings of group-1-, group-2- and group-3-components have been analysed in detail (cf. Fig. 4.8 and Tab. 4.9).

For the components of group 1 (Fig. 4.8a and Tab. 4.9a) each category of organisation has evaluated similarly. The *dataviewer* has been rated always as most important (3.8 - 4.5), followed in descending order by *geo-thematic data* (3.7 - 4.3) and *web-services* (3.4 - 4.0). The differences in absolute values is increasing from federal to cantonal administration and further to academia and the private sector. Comparing all categories academia rated each component best.

The overall high rating of the components of this group, is supported by the server-statistics of the Geological Dataviewer[45] and the WMS of the Geological and Tectonic Map of Switzerland 1:500'000 served to the OneGeology project by the SGS. Regarding the Geological Dataviewer (red line in Fig. 4.9) an above-average usage for the period of December 2007 to February 2009 can be detected. Almost constantly more than 20'000 map requests per month, since the go-live of the viewer in December 2007, have been recorded. Compared to the other dataviewers (grey lines in Fig. 4.9) the Geological Dataviewer is the eight-most frequented viewer.

The aforementioned WMS (blue line in Fig. 4.9) plots one order of magnitude lower than

[45] http://www.geologieviewer.ch, Last checked: 23.8.2009

the Geological Dataviewer, however, still reflecting a traffic of 1000 to 10'000 map requests per month.

Group two components can be divided into two sub-groups, showing particular distributions. The first one, as reflected by the *address database* and the *event calendar*, resemble the general trend the of group one components. However, a slight shift towards lower values is visible. Thus, the federal and cantonal administration and the private sector rated the two components below the medium line or directly on it. The second sub-group comprises the *job portal* only. The federal administration rated it lowest and the cantonal administration highest. Academia and the private sector rated the job portal similarly slightly above the medium line.

Group three contains only the OGM-component. The rating of the four different categories of organisations is dispersed. Its minimum is at 1.6, rated by the federal administration. In contrast the maximum is located at 3.5 as rated by academia. The remaining categories rated OGM with 2.8 (private sector) and 3.0 (cantonal administration).

Tab. 4.9: Ratings per category of organisation for the individual components. Four groups can be distinguished. a) *Top-level*-components (group 1) with the highest ratings. b) Slightly lower rated components (group 2), but still above the medium line. c) OGM (group 3) is the only component directly plotting on the medium line. d) Components (group 4) with ratings below the medium line, indicating a lesser importance. The full names of the components are given in Tab. 4.5.

a) Group 1

Cat	GDView	GDat	GWebS
FedAdmin	3.8	3.7	3.8
CantAdmin	4.0	3.9	3.7
Academia	4.5	4.3	4.0
Privat	4.1	3.8	3.4

b) Group 2

Cat	GADB	GJobs	GEvent
FedAdmin	3.0	1.6	2.0
CantAdmin	3.4	3.7	3.0
Academia	3.4	3.2	3.5
Privat	3.1	3.3	2.7

c) Group 3

Cat	OGM
FedAdmin	1.6
CantAdmin	3.0
Academia	3.5
Privat	2.8

d) Group 4

Cat	GGlos	GKeyS	GCom	GForum
FedAdmin	1.4	1.4	2.2	2.2
CantAdmin	3.1	2.7	2.7	2.5
Academia	3.3	3.7	3.0	2.5
Privat	1.9	2.4	3.0	2.5

Results for additional desired features

Additionally to the components quoted in the questionnaire the recipients of the poll were asked to indicate further components which cover their needs. In 68% of the returned questionnaires

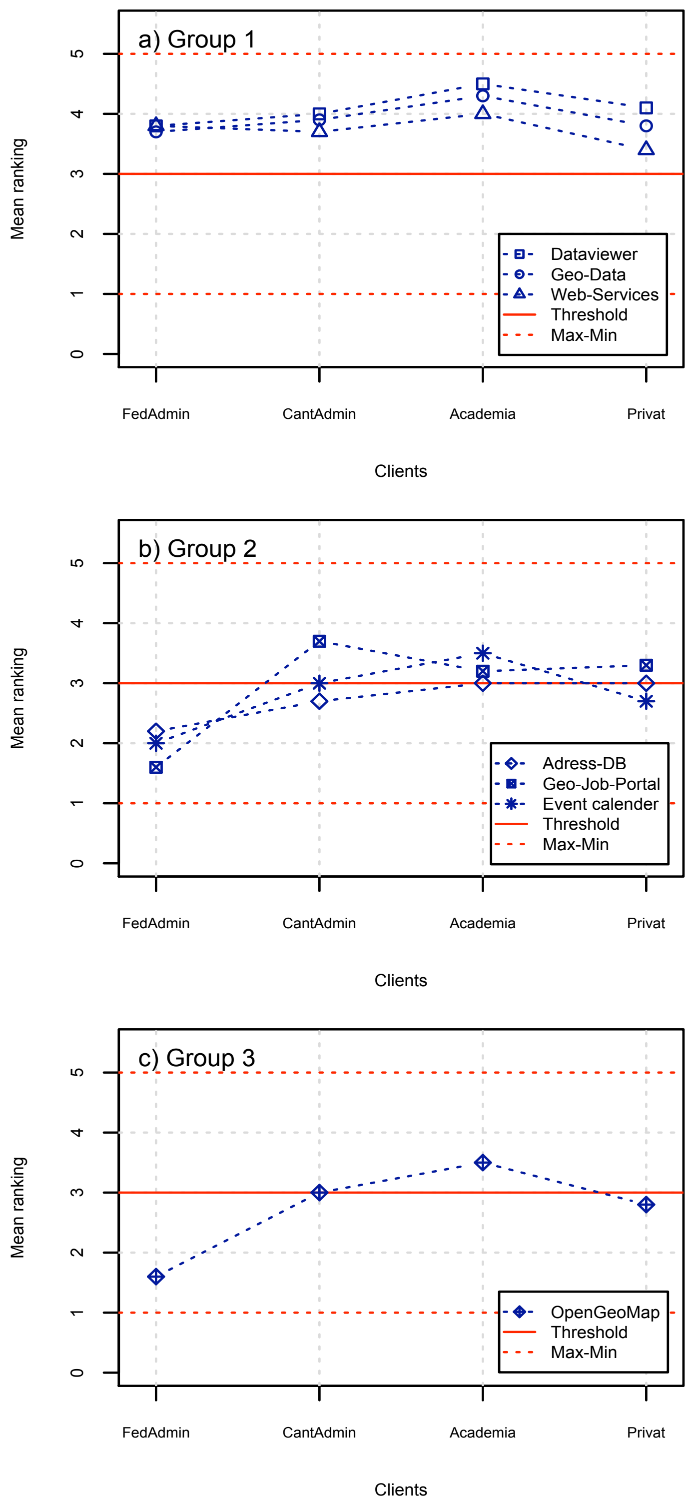

Fig. 4.8: Group-1-, group-2- and group-3-components analysed per category of organisation. a) Group 1: *Dataviewer, geo-thematic data and web-service.* b) Group 2: *Address database, job portal and event calender* c) Group 3: *OpenGeoMap.* The medium line (Threshold) of the evaluation scale is indicated. Full names of indicated clients are given in Tab. 4.5.

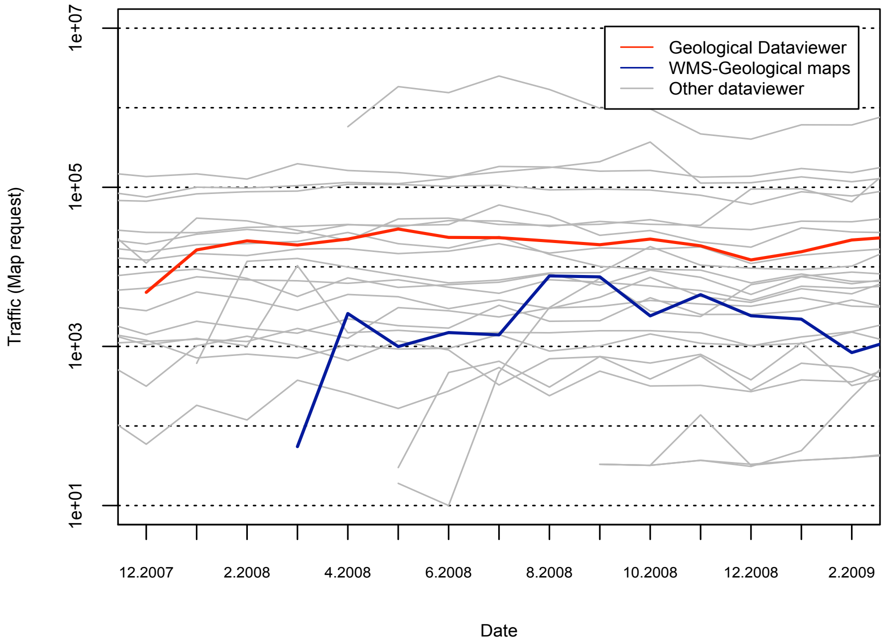

Fig. 4.9: Server statistics of the Geological Dataviewer and WMS served to OneGeology. The statistics of the Geological Dataviewer (red line) in comparison to other dataviewers (grey lines) hosted by swisstopo is shown. The blue line indicates the statistics of the WMS of the Geological and Tectonic Map of Switzerland 1:500'000 served to the OneGeology project.

such "wishes" were indicated. This high participation illustrates the importance of the intended system and the interest of the geo-community in such a system.

The additional components and features have been categorised into the following groups: *Additional datasets; improvements for the dataviewer, additions to the dataviewer; web-services and additional features for the information system in general.* The results of each particular group are shown in Figs. 4.10 and 4.11 and are described below. The underlying databases is given in Tab. 4.10.

Additional datasets

Apart from the already incorporated datasets in the Geological Dataviewer, 16 further datasets were indicated by the participants of the poll. The number of indications per type of dataset is ranging between 1 and 7. Usefulness and priority of implementation is plotting generally above 4.3 and 3.3, respectively. Similarly to the evaluation of the proposed components (Fig. 4.7), priority closely resembles the trend of the usefulness, with slightly lower values.

Three components (K8, K11, K14 in Fig. 4.10) have been indicated with a partial ranking, or without any ranking.

In order to extract the most important datasets the number of indications (count in Figs. 4.10 and 4.11 and Tab. 4.10) have been multiplied by the particular ranking of usefulness and priority of implementation. Components with a "normalised" ranking of equal to 10.0 or higher are regarded as the most important ones and should be considered to be implemented in the dataviewer. These components are in descending order: *hydrological and hydrogeological data*

Tab. 4.10: Additional desired features for the geological information system. The number of indication of each particular feature (Count) and its individual ranking for usefulness and priority of implementation (Use, Prio) are listed. For each feature the normalised usefulness (Use norm) and priority (Prio norm) have been calculated (for details cf. text). Note, that some feature have been indicated by the participants of the poll, however, have not been evaluated. Indicated IDs correspond to those given in Figs. 4.10 and 4.11.

ID	Feature	Count	Use	Prio	Use norm	Prio norm
K1	Soil maps	2	4.5	4.5	9.0	9.0
K2	Well data and reports	3	4.7	4.7	14.0	14.0
K3	Depth of top bedrock	2	4.5	4.5	9.0	9.0
K4	Geo-thermic maps	2	4.5	3.5	9.0	7.0
K5	Geo-touristic maps	1	5.0	5.0	5.0	5.0
K6	Hydrological and hydrogeological data	7	4.6	4.3	32.0	30.0
K7	Cantonal data	1	4.0	5.0	4.0	5.0
K8	Status of map updates	1	5.0	—	5.0	—
K9	Natural hazard data	3	4.7	4.0	14.0	12.0
K10	Cross sections	1	5.0	5.0	5.0	5.0
K11	Distribution of radon	1	—	—	—	—
K12	Geological special maps	3	4.3	3.3	13.0	10.0
K13	Tectonic data	1	5.0	5.0	5.0	5.0
K14	Topographic data	2	5.0	—	10.0	—
K15	Vector data	2	4.5	4.0	9.0	8.0
K16	Further datasets	5	4.8	4.4	24.0	22.0
A1	Extent attribute table	1	5.0	5.0	5.0	5.0
A2	Usability, user guidance	5	4.2	3.8	21.0	19.0
A3	Optimisation for browser	1	4.0	5.0	4.0	5.0
A4	Print quality	9	4.2	4.1	38.0	37.0
A5	Integration of different dataviewers	2	4.5	4.5	9.0	9.0
A6	Size of map window	4	4.5	4.0	18.0	16.0
A7	Accessibility of legends	15	4.9	4.5	73.0	67.0
B1	3D-Visualisation	1	3.0	4.0	3.0	4.0
B2	Download for Data	3	4.3	3.3	13.0	10.0
B3	Display of topographic height	1	4.0	3.0	4.0	3.0
B4	Access to map specific literature	4	5.0	4.0	20.0	16.0
C1	Generate summary sections	1	5.0	4.0	5.0	4.0
C2	Geological Dictionary	1	—	—	—	—
C3	Coordinate transformation	1	5.0	5.0	5.0	5.0
C4	WFS for well data and reports	3	4.3	3.3	13.0	10.0
C5	WMS various datasets	3	4.7	4.0	14.0	12.0
C6	Up- and download for data	1	5.0	5.0	5.0	5.0
C7	Additional information on geological maps	1	5.0	5.0	5.0	5.0
D1	Harmonisation of maps and legends	1	5.0	5.0	5.0	5.0
D2	Platform for general information on geology and the geo-community	1	5.0	5.0	5.0	5.0
D3	OpenGeoMap	2	4.5	4.5	9.0	9.0
D4	Platform for accessing geo-scientific literature	1	4.0	2.0	4.0	2.0

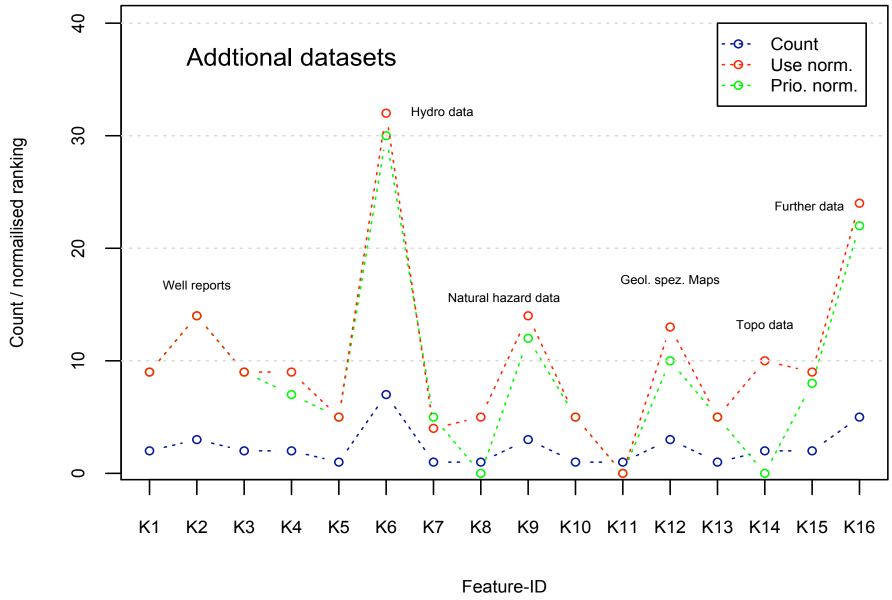

Fig. 4.10: Additional datasets desired for the Geological Dataviewer. The individual datasets are indexed along the horizontal axis, the respective datasets are listed in Tab. 4.10. Vertical scale corresponds to the number of indications (Count) of the particular features, i.e. the normalised usefulness (Use norm.) and normalised priority of implementation (Prio norm.). For details cf. text. The dataset K16 (Further dataset) refers to non-specified suggestions.

(32.0), *well reports and its location (14.0)*, *natural hazard data (14.0)*, *geological special maps (13.0)* and *topographic data (10.0)*.

Additionally to these datasets five participants indicated the need for *further datasets* without any specification. These datasets have been rated with 24.0 constituting the second highest result. However, because no specification exists they have not been taken into account for analysis.

Improvements for dataviewer

Concerning the existing Geological Dataviewer seven improvements have been proposed. Again, features with a normalised ranking of a usefulness of 10.0 and higher have to be considered as important. In descending order these features are: *Accessibility of geological legends (73.0)*, *printing quality (38.0)*, *usability and user guidance (21.0)* and *size of map window (18.0)*.

Legend accessibility have been ranked as the most important improvement. This is an important result, because the legends of the geological maps are already present in the present version of the Geological Dataviewer. Immediate improvement is therefore needed.

Additions to dataviewer

Apart from the improvements of the existing features of the Geological Dataviewer four additional new features have been indicated. Two of those (*access to map specific literature (20.0)* and *download of data (13.0)*)are plotting higher than a normalised rating of 10.0.

Web-services

In the questionnaire spatial and non-spatial web-services have been quoted. Also for the

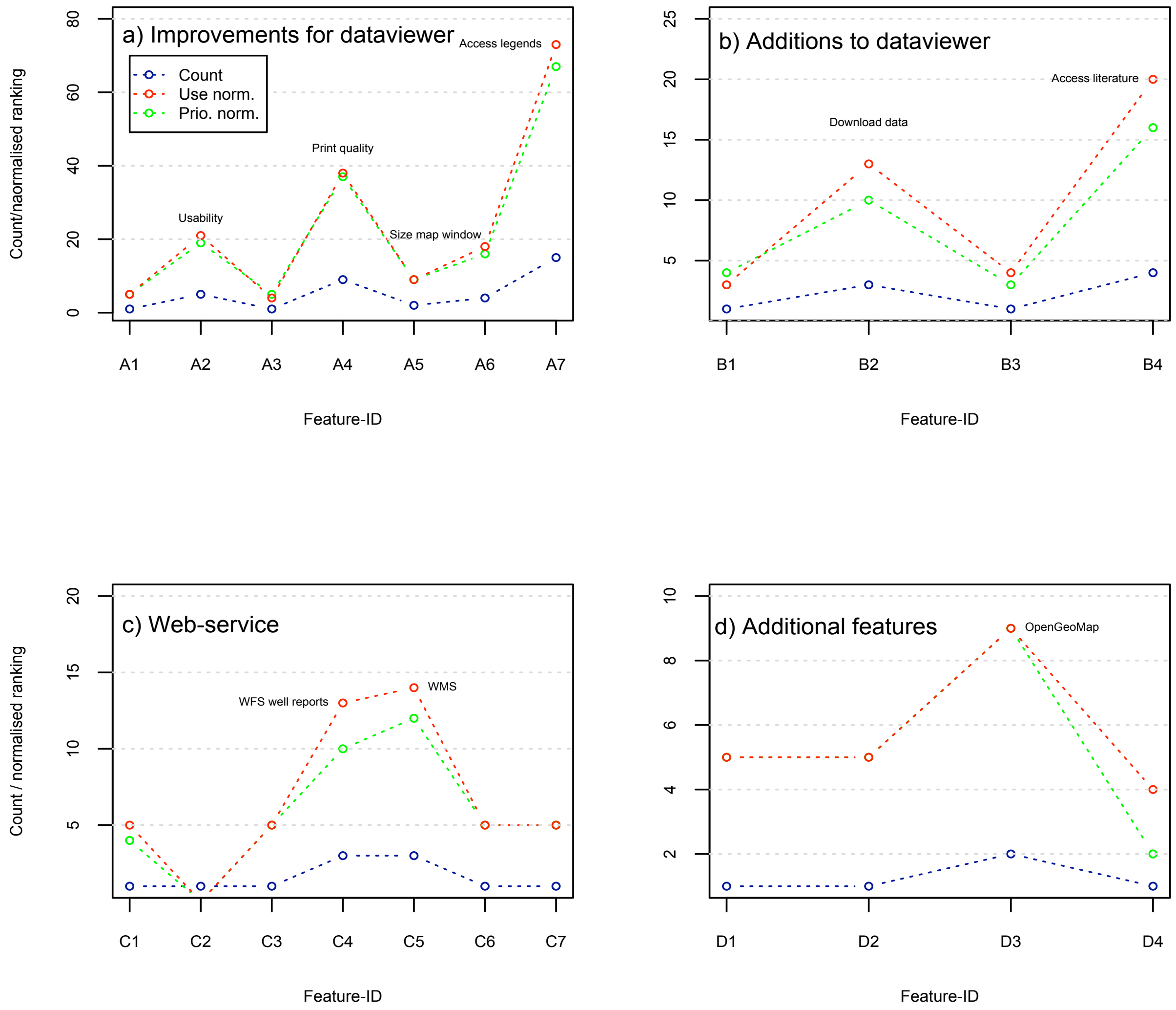

Fig. 4.11: Further suggestions for the Geological Dataviewer. The indexes at the horizontal axis show feature indicated by the participants of the poll. The respective dataset is listed in Tab. 4.10. Vertical scale corresponds to the number of indications (Count) of the particular features, i.e. the normalised usefulness (Use norm.) and normalised priority of implementation (Prio norm.). For details cf. text a) Desired improvements of the existing Geological Dataviewer. b) Additional components for the Dataviewer. c) Desired web-services. d) General additional features for the geological information system.

additional services example of these two types have been indicated. The spatial web-services (*WMS (14.0)* and *WFS (13.0)*) of the seven proposed additions have clearly been ranked highest. This pattern indicates a higher importance of spatial web-services compared to the non-spatial ones. However, when combining the ranking of the *data download* feature (B2) with the *Up- and download-service* (C6) the ranking of this non-spatial web-service is exceeding (usefulness 18.0 and priority 15.0) the values of the spatial web-services.

General additional features

Four additional features to the entire system have been proposed. Apart from the OGM (rating 9.0) all other feature have been rated with 4.0 and 5.0. The rating of OGM on its own may not be notable, however, regarding the rating of this component in the questionnaire supports its importance i.e the interest of the geo-community in this type of component.

4.2.3 Core-components derived from requirements

In the two last sections the requirements of the international and national geo-community have been described. Comparing the results of both polls a largely consistent pattern evolve (Fig. 4.12). Both geo-communities evaluated the *dataviewer*, *geo-thematic data* and *web-services* as the top-level components with the highest importance. The high importance is supported by the rating of the additional features and datasets proposed for the Geological Dataviewer (cf. 4.10 and 4.11 and Tab. 4.10).

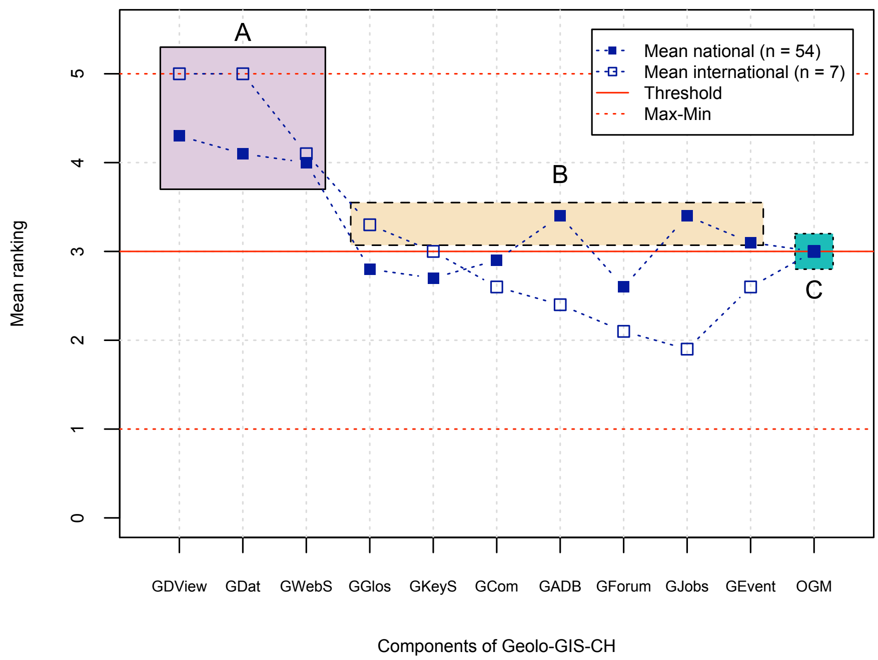

Fig. 4.12: Core-components of the Geolo-GIS-CH. Comparison of international and national results. According to their importance, three groups of components can be separated. A = Most important (purple box with solid border); B = Important (Light orange box with dashed border); C = Less important (two green box with dotted border). The remaining components are of minor importance for the international and national geo-community. The full names of the components (horizontal axis) are given in Tab. 4.5.

In the mid-range consistency between international and national level is not given. A *geo-glossary* is indicated as required by the international geo-community. This component seems to be not important for the Swiss geo-community. In contrast, on the national level an *address database*, a *job portal* and an *event calender* are required. All these component are unimportant for the international geo-community.

Special emphasis should be given to the OGM-component. Both geo-communities rated it consistently with 3.0. Although the rating is not high, the consistency is notable. The result of the additional features (Fig. 4.11 d) support the special position of this component.

The rest of the components are plotting below the medium line (rating of 3.0), indicating a minor importance.

Summarising the above results the following core-components for the Geological Information System Switzerland can be derived. According to its importance they can be grouped into three sequences of implementation and improvement:

A. Most important for the international and national geo-community. Immediate improvement and implementation is required.
Components: *Dataviewer, Geo-thematic data, Web-services*

B. Important for the Swiss geo-community. Implementation should be envisioned for the mid-term
Components: *Address database, job portal, event calendar. Geo-glossary* only important for the international geo-community

C. Less important, however, interesting for the international and national geo-community. New technology (Web2.0) which might become important in the future. Keep up-dated and develop prototype on the long-term.
Components: *Open-Geo-Map*

5 Discussion - A basic concept

In order to initialise the development and implementation of the Geolo-GIS-CH, a basic concept has been elaborated. This concept is presented in the following sections.

5.1 Present state and focal problem

The present state analysis performed in Section 4.1 reveals several aspects which influence the availability, accessibility and handling of geo-thematic GI and the awareness of geology in Switzerland. Positive and negative aspects can be distinguished. In the following sections these aspects are separately summarised and its interrelation is briefly discussed.

5.1.1 Positive aspects

The following aspects supporting the usage of geo-thematic GI can be detected.

- The general state of the technology in terms of ICT, GIS and internet is rather advanced. Thus, the handling, provision and processing even of large datasets is easily feasible. Therefore, technical barriers for the development of the Geolo-GIS-CH can be neglected.
- In Switzerland technical infrastructures for the hosting the Geolo-GIS-CH and for supplying geo-thematic data to the NSDI are operated by different members of the Swiss geo-community. Therefore, an important basis for the implementation and operation of the Geolo-GIS-CH is already existing.
- The members of the Swiss geo-community produce and provide a large variety of geo-thematic data and information. Furthermore, many components of the envisioned Geolo-GIS-CH are available via their web portals. Even in comparison to the international level the major part of the components provided by the international GSOs are supplied by either one or the other organisation of the Swiss geo-community (cf. Tab. 4.4). Therefore, the technical know-how with respect to such components does exit in the Swiss geo-community. However, it must be concentrated in a single point only.
- The awareness of the usefulness of geo-thematic GI and its applications is increasing steadily in Switzerland. This situation is endorsed by the large number of events performed in Switzerland or internationally which address or apply GI for geo-scientific purposes. Examples for Switzerland are: Swiss Geoscience Meeting[1]; Géoperspective[2]; SIT/GIS[3]; base-

[1]http://geoscience-meeting.scnatweb.ch/sgm2008/, Last checked: 1.10.2009
[2]http://lasig2.epfl.ch/projets/cantons/programme/Geoperspectives09.pdf, Last checked: 1.10.2009
[3]http://www.congrex.ch/gis_sit2008/, Last checked: 1.10.2009

camp2009[4]; Erlebnis-Geologie[5] etc. On the international level projects like OneGeology[6], OneGeology-Europe[7] and conferences like the International Geological Congress[8] and EUREGEO[9] strongly support the application of GI, the conceptual and technical progress and the enhanced accessibility of GI.

5.1.2 Negative aspects

Apart from the above listed positive aspects, a number of negative aspects does exist. The cause and effect relationship of these aspects can be illustrated in a problem-tree as shown in Fig. 5.1. In such a problem tree, aspects shown in the lower part, i.e. in the roots of the tree, cause those which are above them. Thus, the aspects in the upper part, i.e. the top of the tree, represent the effects of those in the lower part. The focal problem can be imagined as the trunk of the tree. The problem tree should be read from bottom to top. The following negative aspects can be discovered.

- At the bottom of the problem tree a number of factors which cannot be influenced and changed are the basis for the present situation. Such factors are the historical evolution of the Swiss geo-community, i.e. the nonexistence of a corporate national GSO and the distribution of tasks to several organisations; the ambition of these particular organisations to act independently and the fact that geology is a subsidiary field of study for many other disciplines. Furthermore, a fact which cannot be influenced is that Switzerland does not have large amounts of economically important natural resources such as hydrocarbon (e.g. oil, gas etc) resources or ore-deposits (e.g. copper, gold etc).

- Based on the aforementioned aspects, a heterogeneously structured and dispersed geo-community evolved. Lacking coordination and poor interaction among the particular members of the Swiss geo-community lead to separated activities and a non uniform appearance of the geo-community. Therefore, for clients, especially from outside the geo-community it is difficult no get in contact with the desired organisation or to obtain the desired information.

- These aspects cause different problems. For instance, separated activities and a non-uniform appearance leads to a low public visibility of the geo-community and, thus, a poor awareness of the relevance of geology for society (cf. Section 1.1). Furthermore, separated and un-coordinated activities result in an inefficient use of money, because similar tasks are performed by several organisations simultaneously. This aspect is directly strengthened by the fact that geology is a subsidiary field of study for many disciplines (cf. above).

- Caused by separated strategies for data capture and map production of the particular organisations, the coverage of Switzerland with different map series, i.e. geo-thematic

[4]http://www.basecamp09.ch/, Last checked: 1.10.2009
[5]http://www.erlebnis-geologie.ch, Last checked: 1.10.2009
[6]http://www.onegeology.org/, Last checked: 1.10.2009
[7]http://www.onegeology-europe.org/, Last checked: 1.10.2009
[8]http://www.33igc.org/coco/LayoutPage.aspx, Last checked: 1.10.2009
[9]http://www.lfu.bayern.de/veranstaltungen/euregeo2009/, Last checked: 1.10.2009

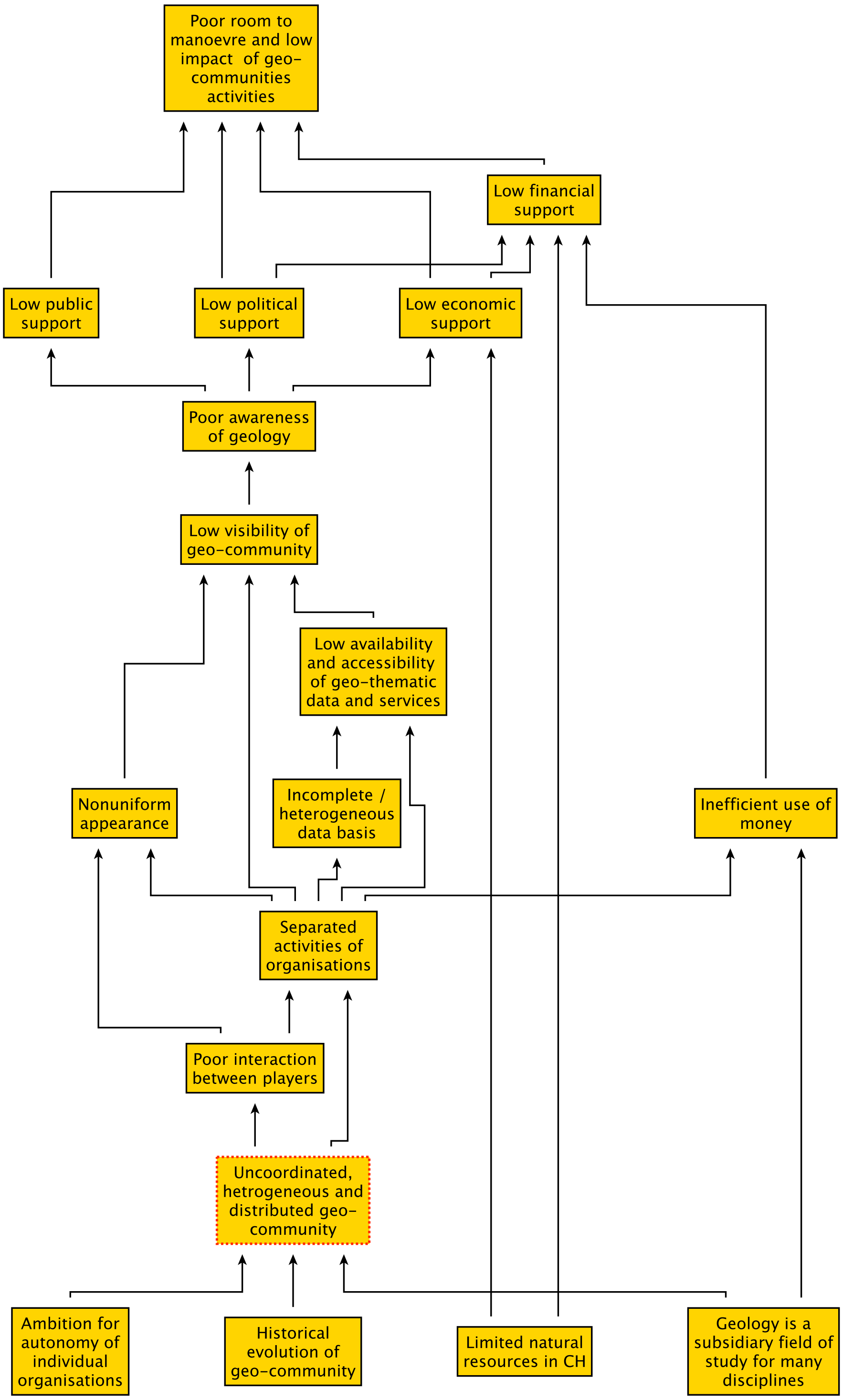

Fig. 5.1: Problem tree illustrating the focal problem (red dotted box) and subsequent problems and their cause-effect relationship of the present situation of the Swiss geo-community . As focal problem the heterogeneous structure of the geo-community can be identified. The overall effect of this situation is poor room to manoeuvre and poor impact of the activities of the Swiss geo-community.

datasets is incomplete. Thus, the availability of the existing datasets is strongly limited. Furthermore, each organisation provides their data and services individually. A single point of contact does not exist. Therefore, the accessibility of the existing data and services are strongly restricted.

- Apart for the restricted availability particular datasets are frequently incompatible to each other, because of their heterogeneous structure. Frequently datamodel are poorly documented, non uniform or even absent.
- Restricted availability of geo-thematic data also influences the awareness of geology and geosciences. A low awareness, in turn, lowers the public, political and economical support which reduces the financial resources of the Swiss geo-community. The low financial support of the economical sector, however, is also caused by the fact that Switzerland is not rich in economically exploitable natural resources.
- The overall effect of the aspects mentioned above is that the room to manoeuvre of the Swiss geo-community is rather small. With poor financial resources and limited public and political support the impact of the activities of the geo-community is poor.

5.1.3 Focal problem

The analysis of the aforementioned aspects reveals the focal problem of the Swiss geo-community and the usage of the geo-thematic GI. Thus, the trunk of the problem tree, i.e. the focal problem is the *uncoordinated, heterogeneously structured Swiss geo-community* itself (cf. red dotted box in Fig. 5.1). Therefore, for changing the present situation, this focal problem has to be tackled.

5.2 Target situation

The network of problems illustrated in Fig. 5.1 can be converted into the future, desired situation. This target situation can be illustrated as objective tree (Fig. 5.2). The objective tree focuses on the means and end relation of the particular activities which are required for solving the focal problem. Thus, the strategy for solving the focal problem can be derived. In the case of the present study it becomes apparent, that the key for solving this problem is closely related to the development of a *tool for the coordination of the geo-community and for the communication among its members* (cf. red-dotted box in Fig. 5.2).

5.3 Solution

In order to meet the challenges of the SGS (cf. Section 1.2) and to solve the problems described above (cf. Section 5.1.2), the development of the Geological Information System Switzerland (Geolo-GIS-CH) is intended. As part of the National Spatial Data Infrastructure (NSDI) of Switzerland the Geolo-GIS-CH is thought to be the gateway to geosciences in general and to geological sciences in particular. Thus, for instance, a geological consultant who needs information on the geological setting of a particular location can quickly get it (cf. Fig. 5.3). When searching

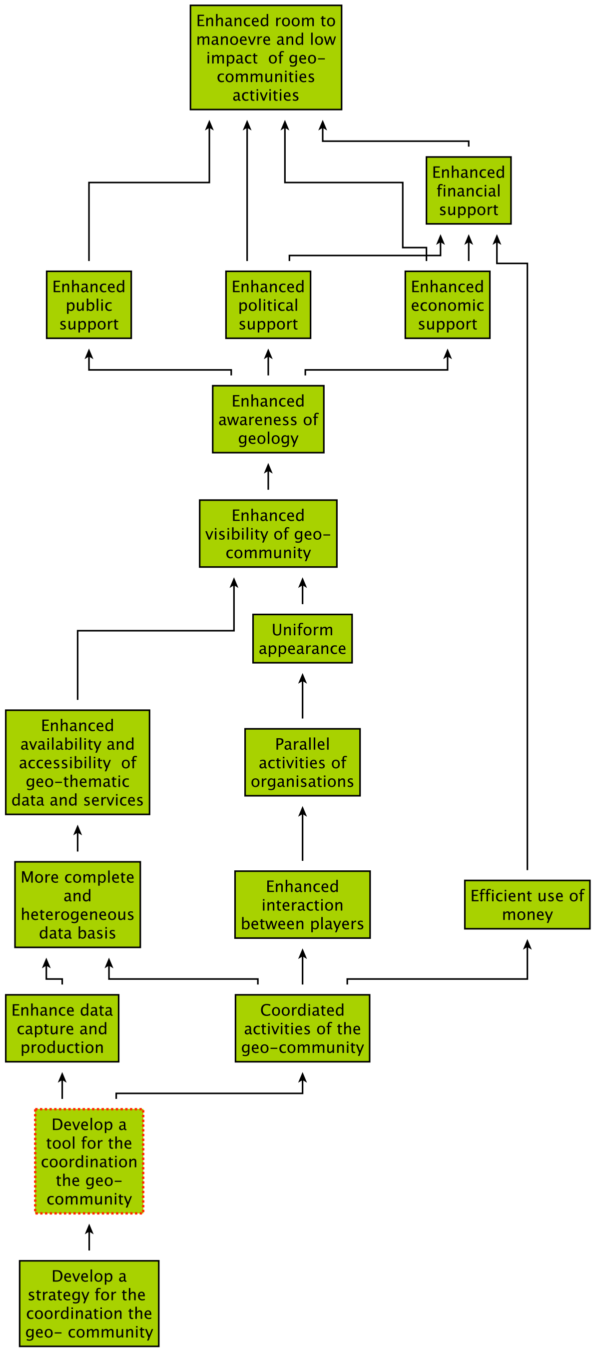

Fig. 5.2: Objective tree illustrating the desired situation concerning the Swiss geo-community and the handling of geo-thematic GI in the future. The key-position of the central web-based tool, i.e. the Geological Information System Switzerland (Geolo-GIS-CH) becomes apparent (red dotted box). It is identified as the key for achieving the desired situation.

the Geolo-GIS-CH the consultant immediately discovers which organisation has to be contacted in order to get the required information (straight yellow arrows in Fig. 5.3). The information itself is then provided by conventional manners or can be consumed by web-services (bent yellow arrows in Fig. 5.3).

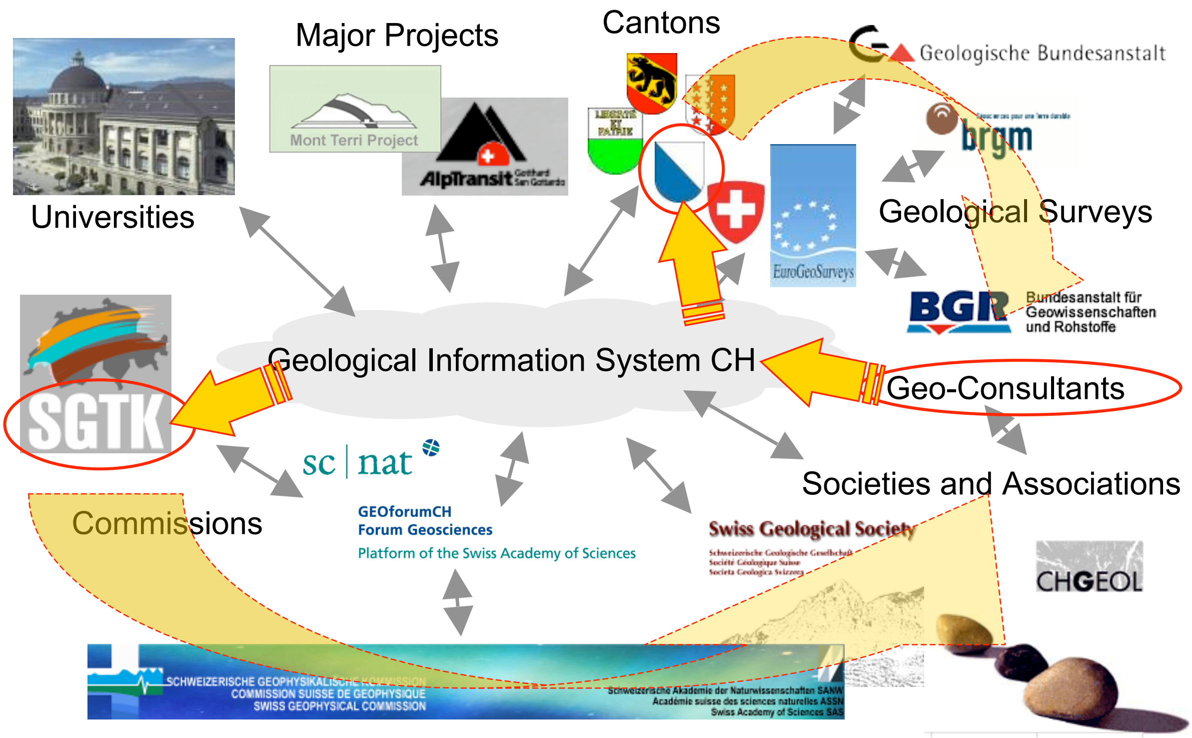

Fig. 5.3: The Geolo-GIS-CH is intended to be the central platform for the national geo-community. It enhances the communication between the members of the geo-community and externals, it facilitates workflows such as data purchase and delivery etc. Straight yellow arrows: Information request by a geological consultant. Bent yellow arrows: Information provision by the respective data providers.

Since, nowadays high performance internet access is guaranteed, almost entirely in Switzerland (Fig. 5.4), the Geolo-GIS-CH should be web-based.

5.4 Aims

Based on the desired target situation described in the objective tree shown in Fig. 5.2 the following strategic and operative objectives of the Geolo-GIS-CH can be defined:

Strategic objectives

1. Enhance the accessibility of existing geo-thematic data and services to improve existing workflows of the members of the Swiss geo-community
2. Enlarge the room to manoeuvre of the Swiss geo-community and enhance the impact of its activities
3. Improve the awareness of the Swiss geo-community in society

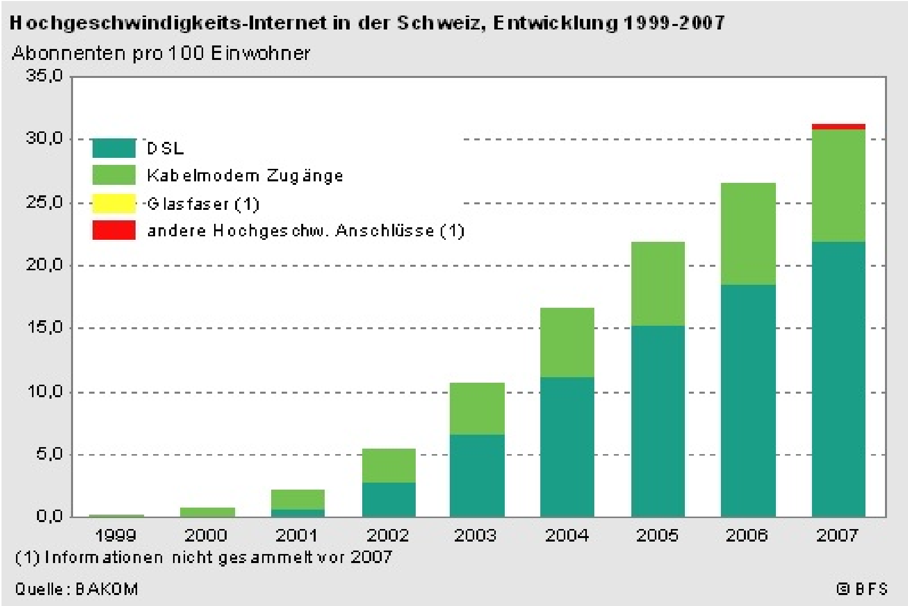

Fig. 5.4: Trend of the access to high-speed internet connections in Switzerland. Graphic created by the Swiss Federal Statistical Office (FSO) (http://www.bfs.admin.ch/bfs/portal/de/index/themen/16/03/key/ind16.indicator.30107.160101.html, Last checked: 23.8.2009). A clear upward trend between 1999 - 2007 is visible. More than 30% of Switzerland's households have access to high-speed internet connection. It is likely that this trend continued during the last two year and will continue in future.

Operative objectives

In order to achieve the overall strategic objectives the following operative goals have to be reached.

1. Make existing geological data in its best quality available and web-accessible
2. Visualise the organisation of the Swiss geo-community
3. Strengthen the public awareness of geology and geosciences in Switzerland

5.5 Target groups

The overall target group of the Geolo-GIS-CH is the entire national and international geo-community. Three sub-groups can be distinguished which have different focuses:

1. *Professionals* from governmental bodies, academia and the private sector (mainly members of the inner circle of the Swiss geo-community, cf. Fig. 2.1) do need geo-thematic information for their daily business, such as creating reports, performing investigations etc. Furthermore, politicians and other decision makers need to make decision on the basis of geo-thematic data. However, they do have a limited understanding of the importance and the use of geo-thematic data. Professionals from the sectors mentioned above have the opportunity to communicate the importance and usefulness of geo-thematic data to those decision-makers.

2. *Multipliers* of geo-thematic information such as teachers, museum educators, tourism specialists, technology writers etc. All of those require geo-thematic information in order to educate geological sciences or to communicate geological facts to the broad public.

3. *Laymen*, e.g. Hobby-geologists and other people interested in geosciences from a broad public. Laymen need geological information for private issues and spare time activities.

Reaching the two latter target groups is especially important for strengthening the awareness of geology in society. Teachers and museum educators need easy understandable geo-thematic information in order to teach geology and to captivate their students. Tourism specialists need information about geo-touristic sites for their recommendations to tourists. And technology writers serve, just as the groups mentioned above, as multipliers for geo-scientific and geological knowledge. Last but not least laymen demand access to easy understandable geological information for their spare-time activities.

5.6 Supporting organisations

In order to achieve the most possible acceptance for the Geolo-GIS-CH, the members of the Swiss geo-community should be actively involved in the process of its development. However, related to the involvement of the organisations and its tasks the following questions arise:

- Whom to involve? – Involve only the interested members or all players of the Swiss geo-community?
- How many players to be involved? – The more involved, the more input – versus – The more involved, the more different options and opinions, the slower the progress.
- How should the project be accomplished? – Realisation by the members of the geo-community, or realisation with the help of external partners and contractors?
- Where will the system, i.e. the technical infrastructure be hosted? – Inside geo-community or at external contractors?
- Which organisation(s) is/are in charge of the realisation of the Geolo-GIS-CH? Who is providing the project manager(s)? – Single organisation – versus – steering committee
- Who is in charge of the administration of the final system? – Members of the Swiss geo-community – versus – external contractor

These questions cannot be answered in the framework of this thesis. However, it should be addressed prior to the development of the system during the elaboration of a detailed concept.

5.7 Overall system design

As a basis for the development of the Geolo-GIS-CH, the overall design and structure of the system have been outlined. A sketch of this proposition is shown in Fig. 5.5. This sketch illustrates the major parts of the information system and acts as an overview for future discussions, activities and developments. The particular parts of this proposition are described in the subsequent sections.

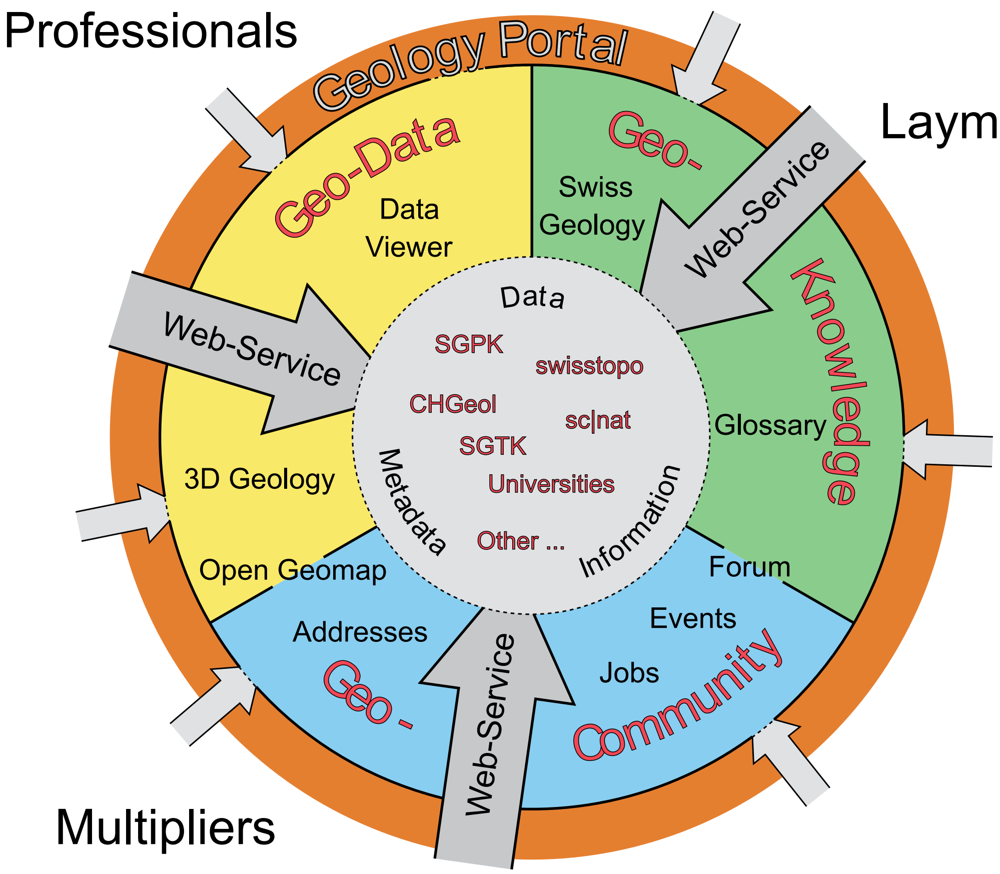

Fig. 5.5: Sketch of the Geolo-GIS-CH. The core of the proposed system is composed of the geo-thematic data and its metadata available in Switzerland. The particular data providers are indicated in red in the centre of the diagram. All data are accessible either via a web portal (Geology Portal, orange ring) or directly via web-services (large grey arrows). The system is divided into three sector (geo-data, geo-community and geo-knowledge) corresponding to the three strategic and operative objectives of the Geolo-GIS-CH (cf. Section 5.4). Each sector contains several components which are described in Section 3.2.2. The system is intended to meet the requirements of professional geologists or other specialists, multipliers of geo-thematic information (e.g. teachers, museum-educators etc.) and laymen.

5.7.1 Sectors

According to the strategic and operative aims of the Geolo-GIS-CH (cf. Section 5.4) three thematic sectors are defined. Each sector contains several components which correspond to those proposed in the questionnaire described in Section 3.2. The sectors are not strictly bounded, thus components may overlap its boundaries. Examples for such overlapping components are the Discussion-Forum and OpenGeoMap (OGM), both described in Section 3.2.2. The following three sectors are proposed:

1. **Geo-Data**

   This sector covers issues related to geo-thematic data, i.e. especially geo-thematic GI.

The most important component of this sector (and probably of the entire system) is a dataviewer, i.e. a geoportal in the sense described in Section 2.3. Such a geoportal gives access to spatial geo-thematic data, information and its metadata. The same data and information are provided by spatial web-services, thus, it can be directly used in the GIS of the clients. Each component mentioned above has been evaluated by the international and national geo-community as most important for the Geolo-GIS-CH (cf. *Most important* in Section 4.2.3). However, further components like e.g. a visualisation tool for geological 3D-models, comprehensive search functionalities and a catalogue of available services are conceivable.

2. **Geo-Community**
   The Geo-community sector contains components relevant for the presentation of the structure of the Swiss geo-community and the national and international integration of its members. It gives access to contact information of the members of the geo-community, describes their tasks and responsibilities and announces news, events and open positions etc. Therefore, an address database, an event calendar and a job portal are the major components of this sector. Each of the aforementioned components have been evaluated as important for the Geolo-GIS-CH in the poll of requirements (cf. *Important* in Section 4.2.3).

3. **Geo-Knowledge**
   The Geo-Knowledge sector provides geological facts and communicates it to the broad public. It serves as gateway to easy understandable information about geology and related specifications. Definitions of terms in glossary-style and descriptions of geological sites in Switzerland are in the centre of the scope of this sector. It is intended to mainly enhance the awareness of geology and geosciences in the broad public. Regarding the evaluation of the potential users of the Geolo-GIS-CH, the above mentioned components are of minor importance (cf. d) group 4 in Tab. 4.9)

5.7.2 Core

The core of the system, like for every GIS is data, i.e. GI. This data, as illustrated in Fig. 5.5, is provided by the members of the Swiss geo-community which are its producers and owners. Apart from geo-thematic data, in the sense defined in Section 2.2, the system's core comprises also data on the organisational structure of the geo-community, for instance, addresses, job and events announcements etc.

5.7.3 Points of entry

The data in the system's core can be accessed in two different ways. First, via a web portal and second, via spatial and non-spatial web-services.

Geology Portal

The web portal is the representation of the Geolo-GIS-CH in the internet and its central entry point. In Fig. 5.5 this portal is indicated as *Geology Portal* by the outer orange ring enclosing the entire system. The Geology Portal should be discoverable by search engines like Google[10] and should be returned as first hit from search request on terms like *Geology Switzerland* in the three official languages of Switzerland (German, French and Italian) as well as in English.

Internally the Geology Portal pictures the overall structure of the Geolo-GIS-CH. Thus, after entering the portal, its content is sub-divided into the three thematic sectors described above (cf. Section 5.7.1). Via each sector the components proposed in Section 3.2.2 are accessible.

Furthermore, the ease of accessing particular content of the Geolo-GIS-CH is crucial for the degree of its utilisation. Therefore, a comprehensive search functionality should be placed prominently on the main page of the Geology Portal. Search results should be displayed in map and table view in order to benefit from the added value of GI.

A basic concept for such a Geology Portal was designed by Oesterling *et al.* (2008a). This concept is based on the analysis of several web portals of European and North-American GSOs and gives propositions for the functionality, usability and design of a web portal for the Swiss geo-community. Furthermore, the question on appropriate domain names for the portal and on different models of realisation are discussed.

An example of an existing web portal from another field of specification, covering the aforementioned requirements, is *Search.ch*[11] (Fig. 5.6). This portal provides the possibility to search various topics, such as phone numbers and addresses, locations and routes, real estate, weather conditions, events etc. The search results are displayed in map view, as text or in combination of both. Extended attribute querying possibilities complete the functionality of the portal. Furthermore, detailed information on objects displayed in map view are retrievable by mouse-over functionality. All of these features should be available in the envisioned Geology Portal as well. Thus, geo-thematic data and other datasets can be searched, displayed and combined easily.

Another example for a thematic web portal, is the portal of the cadastral surveying in Switzerland[12]. It is a portal of a *community around a data category* (Maguire and Longley, 2005) or of a *Fachinformationsgemeinschaft* (e-geo.ch, 2008) which closely resembles the requirements of the one envisioned for the Swiss geo-community. It provides, as illustrated in Fig. 5.7, recent news on cadastral surveying, addresses of the members of the cadastral surveying community, relevant topics in relation to cadastral surveying, products, documents like legal texts etc. Components like those are required for the Geology Portal as well.

Although the basic concept for a geology web portal proposed by Oesterling *et al.* (2008a) addresses a substantial number of issues related to the development of the Geology Portal, some questions stay open. Such questions which are similar to those listed in Section 5.6 comprise issues like:

- Who is developing and implementing the Geology Portal? – One organisation – versus – all members.

[10]http://www.google.ch, Last checked: 30.9.2009
[11]http://www.search.ch, last checked: 23.8.2009
[12]http://www.cadastre.ch/, last checked: 23.8.2009

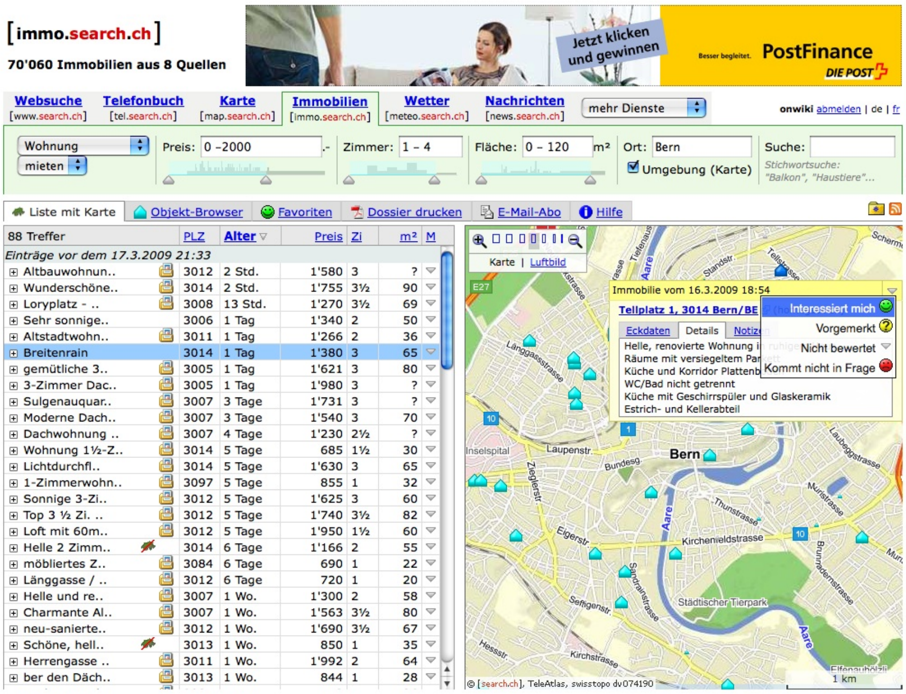

Fig. 5.6: Example for the integration of table and map view in a web portal. *Immo.search.ch* (http://www.immo.search.ch, last checked: 23.8.2009) is part of search.ch and integrates attribute based and spatial-search functionalities. Search results are displayed in map and table view or as a combination of both. Attribute information of objects displayed in map view can be retrieved via mouse-over functionality.

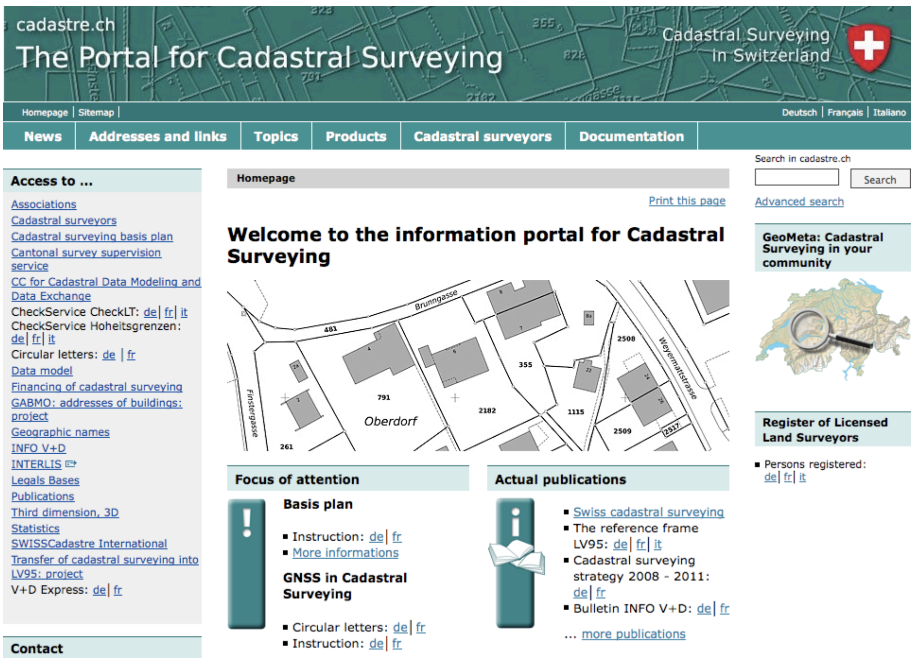

Fig. 5.7: Example of a web portal of a *Fachinformationsgemeinschaft*. The portal of the cadastral surveying of Switzerland resembles closely the requirements of the Swiss geo-community.

- Where is the Geology Portal to be hosted? – inside geo-community – versus – external contractor.
- How is the portal financed? Is it, for instance, permitted to include advertisements (e.g. for geological consultants or other companies) for funding the portal and its maintenance?
- How does the layout of the Geology Portal look like? Do corporate design guidelines have to be followed?
- How is the geoportal integrated in the Geology Portal? Make the geoportal the Geology Portal's main page, because most geo-thematic data and information are spatially referenced – versus – Geoportal in separated web site.
- How to administrate the system and its users? – Members of the Swiss geo-community – versus – external contractor.

Web-Services

The second way to access the data in the core of the system is the use of spatial and non-spatial web-services. These services are provided by the respective data owners and can be consumed by the clients of the Geolo-GIS-CH and be embedded in the client's GIS.

Available services are provided via the Geology Portal or can by retrieved via metadata catalogues like geocat.ch[13]. Mainly spatial web-services are provided, because of the spatial nature of geo-thematic data. In order to support the interoperability of such services, standardised services like WMS, WFS, WFS-T, CSW etc. should be supported.

Moreover, the use of web-services in general, should be favoured against the implementation of independent components. For instance, the above mentioned provision of metadata via the Geology Portal, should be performed by using the geocat.ch-service instead of implementing an independent metadata-catalogue.
Questions concerning the implementation of web-services are:

- Which type of services (WMS, WFS, CSW etc.) should or have to be served?
- Which are the strategic objectives of serving geo-thematic data via web-services? What is the pricing strategy for web-services?
- Which transfer format, e.g. INTERLIS, GeoSciML, KML etc. should be provided and have to be used?

5.8 Abstract system architecture

In Section 5.7 the overall design of the Geolo-GIS-CH has been outlined. For the technical implementation of the system the specification of it's architecture is required. In this section a system architecture on a high level of abstraction is proposed. It is illustrated in Fig. 5.8 and is described below.

[13]http://www.geocat.ch, Last checked: 30.9.2009

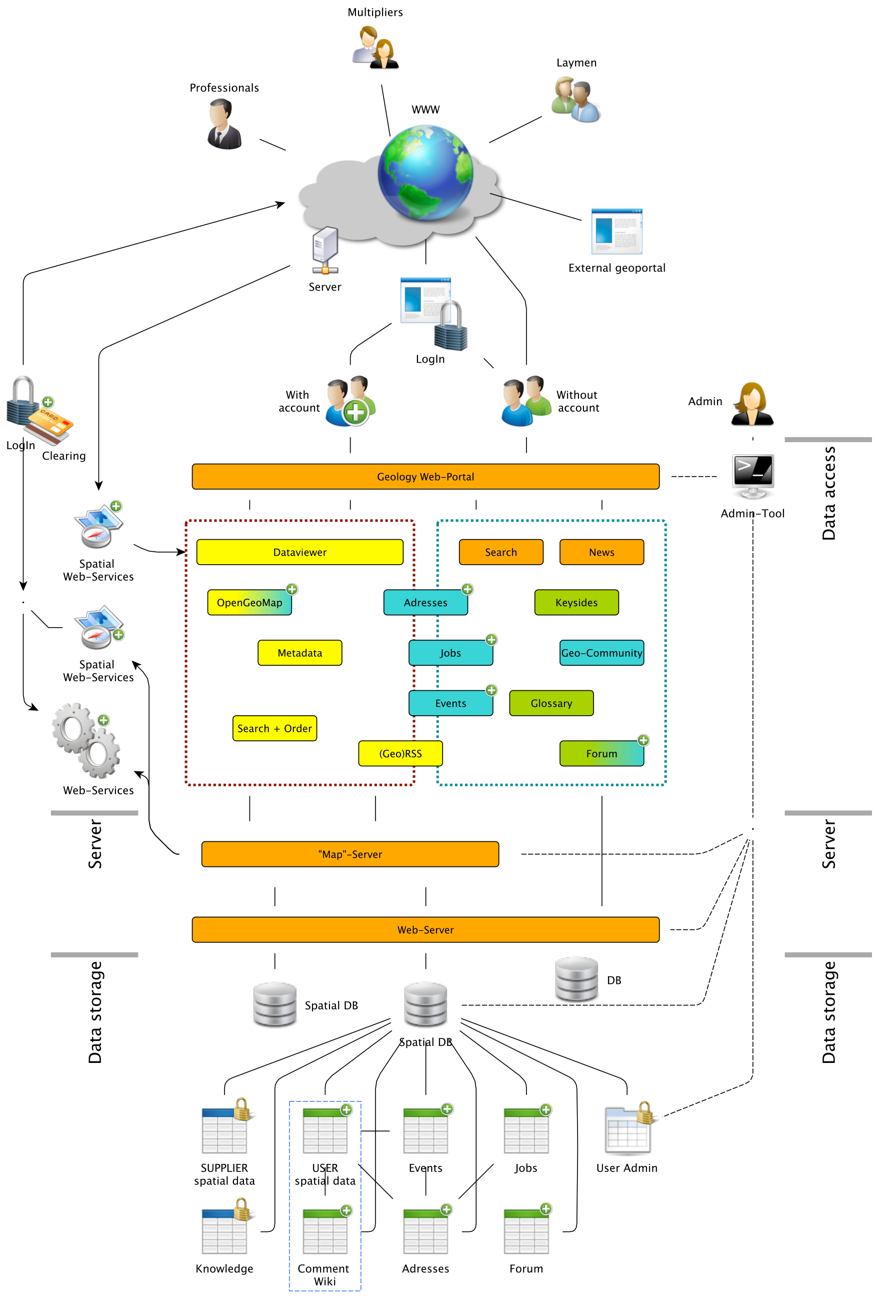

Fig. 5.8: Abstract system architecture of the Geolo-GIS-CH. Three tiers can be distinguished (data storage, server and data access) which are indicated along the sides of the figure. The different coloured boxes resemble components contained by the sectors of the Geolo-GIS-CH (cf. Fig. 5.5): orange = overall system components; yellow = Geo-Data; blue = Geo-Community; green = Geo-Knowledge; mixed colours = sector crossing components. The red-dotted box represent the *geoportal* as described by Tait (2005). The blue-dotted box, instead resemble a *normal* web portal. Components crossing the limit between both types of portals contain information of spatial and non-spatial character. The blue-dashed box at the bottom of the figure embraces the database table required for the OpenGeoMap-tool, provided by the geoportal. Boxes with an *plus-symbol* provide extended functionalities, if users have an user-account. For instance, users may add job offers or save content to the system's server. Database tables with a locker-symbol cannot be modified by the system's users.

5.8.1 Tiers

The proposed architecture is characterised by three tiers which corresponds to the classical three-tier-system architecture[14] (back end, middle tier, front-end). The three tiers described here comprise, a data storage tier, a server tier and a data access tier. Each particular tier is described in the following sections.

Data storage

Similar to the overall design of the Geolo-GIS-CH (Fig. 5.5), its architecture is based on the comprised data. Thus, the bottom tier covers the data storage. Data storage is realised by one or multiple databases and Database Management Systems (DBMSs). Spatial data is stored in databases with a spatial extension, non-spatial data in other relational databases. Querying and information retrieval is performed on the basis of Standardised Querying Language (SQL).

Web- and map-server

On top of the DBMS a web-server is processing the data and serving them to the web portal. If spatial data have to be served, a *map-server* supplies maps in raster format or geographic features in vector format.

This tier is not only responsible for the supply of information to the web portal. It also provides spatial and non-spatial web-services which can be consumed without visiting the web portal. Data transfer is performed by HTTP-OSI reference model[15] and OGC web-services.

Data access

As described in Section 5.7.3 the data can be accessed either via a web portal, i.e. the *Geology Portal* or via web-services. The *Geology Portal* can be subdivided into a common web portal which supplies non spatial content (cf. blue dotted box in Fig. 5.8) and a geoportal serving spatial content (cf. red dotted box in Fig. 5.8). Depending on the kind of data supplied, the web-server or the map-server is contacted.

In order to permit the user to actively interact with the system a user account and a authentication mechanism, e.g. triple-A-system[16] with a login and password, is required. Such a user account extends the range of functionality of the respective components. Thus, users which have signed in are permitted to add or modify the content of particular components, i.e. database tables. For instance, events may be announced, jobs may be offered, or VGI may be captured in the OGM-component. In Fig. 5.8 components or tables which can be accessed in the way described above, are indicated with a *plus*-symbol.

5.8.2 Administration

The entire system and its users need to be administered. Therefore, an administration interface is proposed in the system's architecture (cf. Fig. 5.8). Using this interface, each tier of the

[14] http://de.wikipedia.org/wiki/Schichtenarchitektur, Last checked: 23.8.2009
[15] http://de.wikipedia.org/wiki/OSI-Modell
[16] http://de.wikipedia.org/wiki/Triple-A-System

information system, i.e. the respective databases, the servers, the Geology Portal and the user accounts can be managed.

In order to better control the permissions of different user groups, a set of user-roles (Ferraiolo and Kuhn, 1992) may be defined. Depending on the particular role different types of permission may be allocated. In Tab. 5.1 are a number of such roles proposed for the administration of the users of the Geology Portal, i.e. of the Geolo-GIS-CH.

Tab. 5.1: Proposed user-roles of the Geology Portal

No.	Role name	Description
1	Administrator	Read and Write access to all components and tables
2	Normal (internet) user	Read access to defined domain of components and tables
3	Signed-in user	Read and Write access to a defined domain of components and tables
4	Super user	Read and Write access to an extended domain of components and tables

5.9 Third-party systems

Infrastructures for providing geo-thematic data and information are operated by the major players of the Swiss geo-community. Those infrastructures follow individual aims which are related to the tasks of the particular hosting organisations. They are all operated individually and not connected to each other. Therefore, they have to be considered as third-party systems which influence the development of the Geolo-GIS-CH and its future operation. These third-party systems may be involved into the hosting the Geolo-GIS-CH or parts of it. Thus, the Geolo-GIS-CH becomes a distributed data infrastructure provided by the major players of the Swiss geo-community in the the sense of the NSDI.

5.10 Timing / Roadmap

In order to develop, implement and operate the Geolo-GIS-CH various tasks have to be performed. Such tasks are related to:

- Data production
- Development of standards
- Built-up of a technical infrastructure
- Analysis of requirements of potential user
- Development of concepts
- Sensitisation of target-groups and the built-up and consolidation of the geo-community

- Finding of partners and supporting organisations
- Technical development of new components and advancement of existing components
- Implementation of the entire system
- Promotion of the system

The relative timing for performing these tasks are illustrated as *roadmap* in Fig. 5.9. It corresponds to a large extend to stage 1 of the model proposed by Longley *et al.* (2005) (their fig. 17.4). This roadmap shows the dependencies of the particular tasks and can be used as central planning tool for the development of the Geolo-GIS-CH. For the planning the following aspects can be retrieved from the roadmap:

- The data production is independent from the development and implementation of the Geolo-GIS-CH.
- At the current status (blue dotted line in Fig. 5.9) the definition of a datamodel is independent from the development and implementation of the Geolo-GIS-CH. However,at later stages it becomes essential for the development of databases which are storing the respective vector datasets.
- At the current status the requirements of potential users have been analysed (cf. sections 3.2 and 4.2) and a basic concept for the development of the Geolo-GIS-CH (cf. this section) have been elaborated (bold bordered squares in Fig. 5.9). The completion of the basic concept is the most important tasks, because almost all subsequent tasks are dependent on it.
- The tasks in Fig. 5.9 which are located between *poll of user requirements* to the elaboration of a *detailed concept* have to be performed largely in a sequential chain.
- After completion of the detailed concept two branches of further tasks have to be considered. First, the built-up of a server and database infrastructure and second, the technical development of the components of the Geolo-GIS-CH. Both branches are in parallel, however, the technical infrastructure have to be built-up prior the implementation of the respective components.

The development of the Geology Portal has to be regarded as the most extensive task. It includes several subordinate tasks, like the creation of web sites, the development of components, the generation of web-services etc. In order to prioritise the particular sub-tasks the following questions have to be addressed:

- Which tasks are important for reaching strategic and operative objectives of the respective organisation (in this case of the SGS)? – Those tasks should be prioritised.
- Which tasks are required in order to provide the core-components of the Geolo-GIS-CH (cf. Section 4.2.3)? Following the results of the poll of requirements, the core-components have been identified as most useful for the geo-community. – Those tasks should be prioritised.

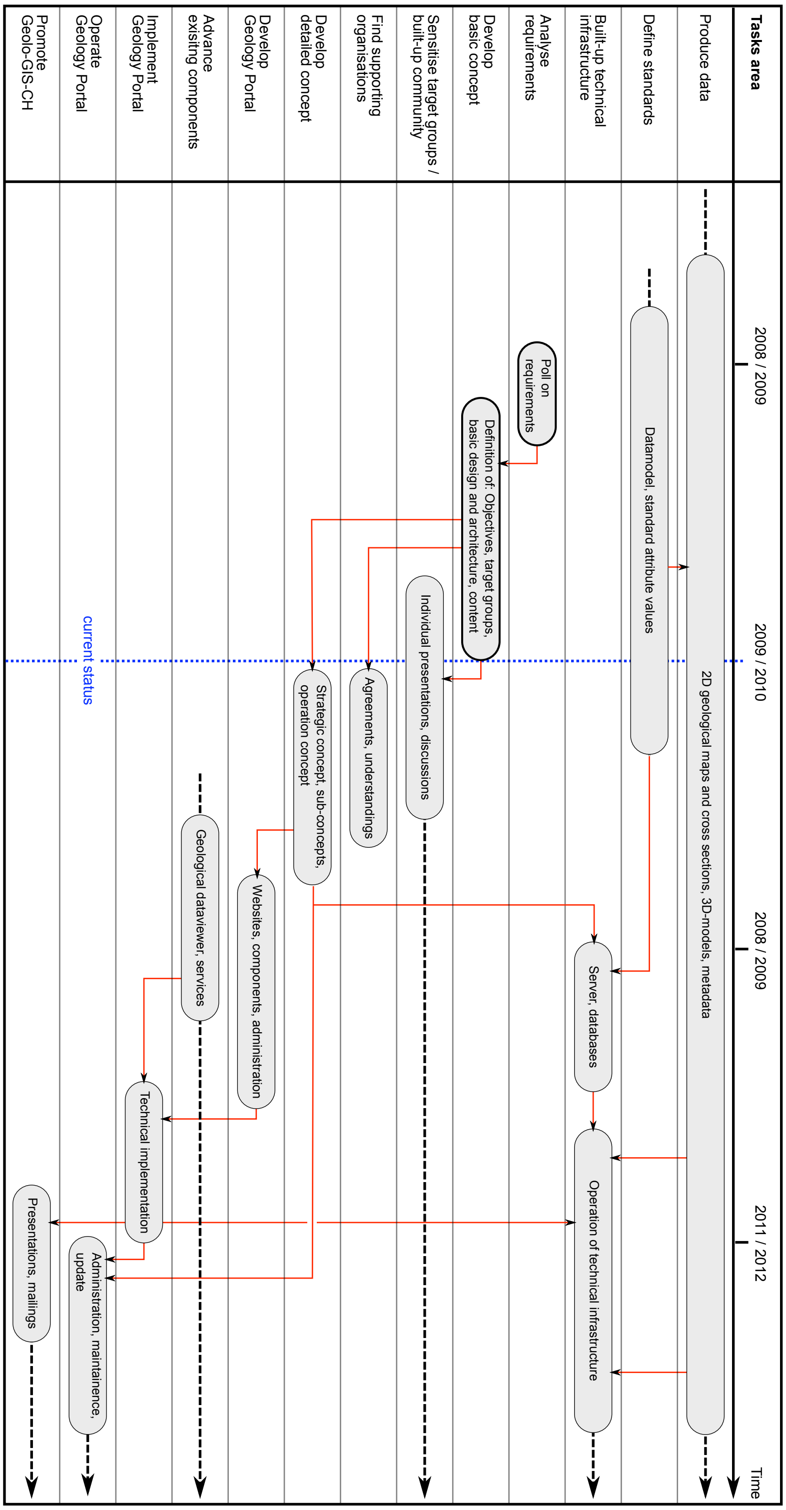

Fig. 5.9: Proposed roadmap for the development of the Geolo-GIS-CH. The different tasks to be performed during development and implementation of the Geolo-GIS-CH (left side of figure) and the current status (blue dashed line) of the project are indicated. Black dashed lines represent the duration of tasks. The red lines illustrate interrelationships of particular tasks. The tasks covered by this thesis are shown as bold bounded boxes.

- Which tasks are required in order to provide additional features to existing components or to advance existing components? (cf. Section 4.2.2). – Those tasks should be prioritised.
- Which tasks are depended on each other? – Basic tasks should be prioritised.
- Which tasks of minor importance can be implemented with low effort? Is it worth implementing those tasks? – If yes, those tasks should be prioritised.

5.11 Costs & benefits

The built-up of the Geolo-GIS-CH generate costs as well as benefits for the Swiss geo-community. In this section the qualitative cost and benefits are briefly listed. These listings are intended to provide general aspects which have to be considered in detail in a future detailed concept.

Costs

- The implementation and operation of the Geolo-GIS-CH requires a system administration (systems content and user accounts). Therefore, at least one 100%-position is required for this function. The required skills (IT, geosciences) of this position need to be defined.
- A technical infrastructure (servers, databases etc.) for the Geolo-GIS-CH have to be provided. The volume of the infrastructure depends on the degree of participation of the members of the Swiss geo-community, i.e. the participation of the various third-party systems.
- The development of the Geolo-GIS-CH requires financial and human resources. These resources have to be supplied by the members of the Swiss geo-community. Expenses for the technical development of the system, working groups, project management have to be taken into account.

Benefits

- The improved awareness within the geo-community for the tasks and activities of other members supports the development of efficient workflows.
- The improved collaboration among the members of the Swiss geo-community discovers synergies and the establishment of partnerships.
- The enhanced accessibility causes an greater benefit of the individual geo-thematic datasets, because they are used more frequently by more users.
- All members of the Swiss geo-community are accessible by a central gateway. As a consequence communication among the members and the access for customers to particular organisations is facilitated.
- The public awareness of geosciences and geology is enhanced, because the access to geoscientific topics is more prominent in the internet.

- The impact of the activities of the members of the Swiss geo-community is greater, because decision makers can have better access to easy understandable geo-scientific data.

5.12 Risks

For the built-up of the Geolo-GIS-CH a number of risks which may hamper the projects progress can be identified. These risks are listed, together with its priority, probability and avoiding actions in Tab. 5.2:

Tab. 5.2: Risk analysis for the development and implementation of the Geolo-GIS-CH. Each risk is briefly described and its impact on the project, its likelihood of occurrence (probability) and avoiding actions are indicated.

No.	Description	Impact on project	Probability	Avoiding action
1	**Refused participation of the Swiss geo-community:** Is it possible to sensitise the members of the national geo-community, so that they participate in the built-up of the information system?	high	medium	Intensify sensitisation of target groups and search for supporting organisations
2	**Lack of resources:** Is the supply with financial and human resources assured?	high	high	Search for supporting organisations and sponsors
3	**Damaged reputation of the Swiss geo-community** as a consequence of the non-realisation of the project – A damaged reputation of the involved organisations, resulting in less public awareness and political and economic support	medium	medium	Intensify sensitisation
4	**Technical know-how for the development and implementation of the** Geolo-GIS-CH does not exit	small	none	Capacity building, research, training
5	**Target groups do not use the system**	small	small	Intensify sensitisation
6	**Data are not supplied by owners**	small	small	Intensify sensitisation

6 Conclusions & Outlook

6.1 Conclusions

On the basis of the analyses and considerations performed in this thesis the following conclusion can be drawn:

- The majority of the content of the envisioned information system is already existing on the web sites of the members of the Swiss geo-community. Many on-going projects are covering relevant tasks and open questions, e.g. creation of datamodels for harmonised of geo-thematic datasets.
- Some of the system's core-components (job portal, event calendar) are provided by different members simultaneously. Its content, however, is not harmonised. The centralisation of such components and its supply with the help of web-services would enhance its efficiency.
- Many data has a concealed spatial reference. For instance addresses, jobs and events can all be spatially referenced. The benefit of the spatial component, e.g. spatial querying, representation on maps etc. should be exploited.
- On the international level the major components (dataviewer, data, services) are ranked equally as on the national level. However, components which are specific for the structure of the Swiss geo-community, e.g. an address database are less important for the international community.
- Based on the results of the poll on requirements the development and implementation of particular components have to be prioritised. The identified core-components should be implemented first. Advancements of existing components should be performed with high priority, as well.
- The built-up of the NSDI is a chance for the Swiss geo-community to better communicate the usefulness of geo-thematic data. In doing so more users can be attracted and thus, the public and political awareness of geology can be enhanced.

6.2 Outlook

This thesis is a preliminary study and contains a basic concept for the development and implementation of the Geolo-GIS-CH. It provides a basis for decisions during the planning of the realisation of the project. During the realisation a number of tasks have to be performed which are introduced in the roadmap of Section 5.10. Performing these tasks are the next future steps.

Apart from these tasks a number of issues should be considered for the handling of geo-thematic data and the further advancement of the Geolo-GIS-CH. These issues are:

- Improve the availability of geo-thematic data by speeding up its production cycle. The application of GIS during data capture and map production should be pushed.
- The Web2.0 philosophy and the possibility for users to participate in the generation of information becomes increasingly important. Therefore, the potential of VGI for the production of geo-thematic data should be examined.
- Information on the subsurface is scarce. The creation of digital geological 3D-models can bridge this gap. Therefore, geological 3D-modelling techniques should be applied and advanced.
- The volume of information is increasing steadily. Thus, it becomes more and more difficult to extract relevant information from this volume. Therefore, theories like ontologies and the semantic web should be applied to be able to filter geo-thematic information more efficiently.

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A Overview of geo-thematic data in Switzerland

Tab. A.1: Overview of geo-thematic data in Switzerland. The data are derived form a current study of the SGS. For fullnames of data owner, if not indicated, cf. section Abbreviations.

No.	Dataset	Category	Data owner
1	Höhenstufen	Basics	swisstopo
2	Bathymetrie	Basics	Federal research institutes
3	Einzugsgebiete der Ströme	Basics	FSO
4	Physiografische Einheiten	Basics	FSO
5	Häufigste Bodentyp	Basics	FSO
6	Geologie	Basics	SGS
7	Gesteinsentstehung	Basics	SGS
8	Alter der Gesteine	Basics	SGS
9	Tektonik	Basics	SGS
10	Höhenänderungen	Basics	swisstopo
11	Das Geoid der Schweiz	Basics	swisstopo
12	Magnetische Totalintensität	Basics	SGPK
13	Magnetische Deklination	Basics	SGPK
14	Magnetische Inklination	Basics	SGPK
15	Aeromagnetische Karte	Basics	SGPK
16	Schwerefeld Isostatische Anomalien	Basics	SGPK
17	Schwerefeld Bouguer-Anomalie	Basics	SGPK
18	Erdbeschleunigung	Basics	swisstopo
19	Gletscherausdehnung (seit Eiszeit)	Basics	SWA
20	Quartärmächtigkeit	Basics	SGPK
21	Felshöhe	Basics	NAGRA
22	Schweiz 3D – Molassebecken	Basics	SGPK
23	SAPHYR/Tiefenplanung	Construction & Rescources	SGPK
24	Geothermie	Construction & Rescources	SGPK
25	Geothermische Leistung	Construction & Rescources	SGPK
26	Erdwärmesonden	Construction & Rescources	Cantonal offices
27	Grundwasservorkommen	Construction & Rescources	FOEN
28	Grundwasservulnerabilität	Construction & Rescources	FOEN
29	Hydrologischer Abfluss	Construction & Rescources	FOEN
30	Jährliche Niederschlagsmenge	Construction & Rescources	Universities
31	Bodenbedeckung/Durchlässigkeit	Construction & Rescources	FSO
32	Baugrundklassen	Construction & Rescources	FOEN
33	Lithologie	Construction & Rescources	SGTK
34	Industrieminerale	Construction & Rescources	SGTK
35	Vererzungen	Construction & Rescources	SGTK
36	Vorkommen von Kohlen, Erdöl	Construction & Rescources	SGTK
37	Abbau Festgesteine	Construction & Rescources	SGTK
38	Abbau Tongesteine	Construction & Rescources	SGTK
39	Geomorphologie	Natural hazards	Universities
40	Permafrost	Natural hazards	FOEN

Continued on next page

Tab. A.1 – continued from previous page

No.	Dataset	Category	Data owner
41	Gefahrenhinweiskarte/Gefahrenkarte	Natural hazards	FOEN
42	Erdbebengefährdung	Natural hazards	SGPK
43	Erdbebenereignisse/Seismotektonik	Natural hazards	SGPK
44	Terrestrische Dosisleistung	Natural hazards	Federal office
45	Radonrisiko	Natural hazards	Federal office
46	Bodenbelastung	Natural hazards	Federal research institutes
47	Bodenbelastung Schwermetalle	Natural hazards	Federal research institutes
48	Grundwasserbelastung	Natural hazards	FOEN
49	Historische geologische Karten	Geotourism	Private organisation
50	Stein & Wein	Geotourism	SGTK
51	Nationale Schutzgebiete	Geotourism	FOEN
52	Geotope	Geotourism	sc|nat
53	Schauhöhlen	Geotourism	Private organisation
54	Geologischer Führer/Via Geoalpina	Geotourism	sc|nat

B Questionnaires

B.1 International geo-community

B.1.1 Recipients

Tab. B.1: Recipients list of the international poll. The GSO of the listed countries have been asked to participate in the poll of requirements.

No.	Country
1	Australia
2	Austria
3	Canada
4	Czech Republic
5	Denmark
6	Finland
7	France
8	Germany
9	Hungary
10	Ireland
11	Italy
12	Japan
13	Litauen
14	Namibia
15	Netherlands
16	Norway
17	Poland
18	Slovakia
19	South Africa
20	Sweden
21	UK
22	USA

B.1.2 Questionnaire to the international geo-community

Subject: Poll on definition and requirements of a geological information system

Dear GIC-colleagues,

I am contacting you to ask for your input (informations, comments, suggestions, ...) to one of our major projects starting this year.

"The Build up of the Geological Information System Switzerland (Geol-GIS-CH)".

Since a system for geological information management and distribution, data visualisation and delivery is lacking at the Swiss Geological Survey (SGS), we are building up a web-based information system for geological purposes. Target groups are professional geologist, teachers as well as laymen from the broad public.

One challenge of the build-up is related to the structure of the Swiss "geo-community". In Switzerland a corporate geological survey like in other countries does not exist, which is why geological tasks and responsibilities are distributed to a number of committees, commissions and other organisations. The organisational structure of this community is not always transparent, especially for people from outside the community. Clarification is therefore needed.

The overall aims of the Geol-GIS-CH are:
1) Make geological (geo-)data and information easy available to professionals, but also to the broad public
2) Present the organisational structure of the Swiss Geo-Community transparently
3) Enhance public awareness of geology. Attract people to get in touch with geology

Questionnaire:
In order to get an idea what are the ideas, suggestions and requirements of the international geological surveys, I like to ask you to answer the following questions and fill in your feedback.

----
1) Is your organisation solely responsible for geological issues in your country or are their other players, maybe on other levels (state, province, commune, ...)?

----
2) How would you define a geological information system?

----
3) What are the core-components of such a system?

----
4) How would you evaluate the benefit and priority of implementation (1 = very low; 2 = low; 3 = medium; 4 = high; 5 = very high) of the following components, which we are thinking to be necessary for the Geol-GIS-CH?

4a) Dataviewer:

4b) Geological and geo-thematic data:

4c) Web-services (e.g. WMS, WFS, but also Geo-RSS and non geospatial services):

4d) Geology-Glossary (geological terms explained easy understandable) or Geology "Wiki"-site:

4e) Easy understandable description of "key-sites" of the Swiss Geology (e.g. Glaner Hauptüberschiebung, UNESCO world heritage):

4f) Graphical presentation of the Swiss geo-community and description of tasks and responsibilities of its members:

4g) Adress-database of the members of the geo-community:

4h) Geology discussion-forum:

4i) Job exchange:

4j) Calender of events:

4k) Web-application for user-generated geological content. Users can comment on existing geological maps or create their own geological maps:

- Do your organisation run a geological information system?

If yes:

- Please specify URL (if it is accessible via the internet)

- Which components does your system contain?

- Do the users can contribute their own data to your system via the internet? ("Web2.0-functionality": Transactional WFS-T, forum, wiki-sites, RSS, etc.)

- Do you distribute your data via geo-web-services (WMS, WFS)?

- How do you handle metadata? Are you running your own metadata catalogue or are you using an external one?

- Do you visualise your data in 3D?

- How do you handle multiple languages (in your system and in your data)?

Thank you very much in advance for giving your input. It is very valuable for the further steps of the build-up of the Geological Information System Switzerland.

Best regards

Nils Oesterling

B.2 National geo-community

B.2.1 Recipients

Tab. B.2: Recipients of the national poll on requirements

No.	Organisation	Category
1	Bundesamt für Energie (BFE)	FedAdmin
2	Bundesamt für Gesundheit (BAG)	FedAdmin
3	Bundesamt für Raumentwicklung (ARE)	FedAdmin
4	Bundesamt für Strassen (ASTRA)	FedAdmin
5	Bundesamt für Umwelt (BAFU) - Gefahrenprävention	FedAdmin
6	Bundesamt für Umwelt (BAFU) – Hydrogeologie	FedAdmin
7	Bundesamt für Verkehr (BAV)	FedAdmin
8	Forschungsanstalt Agroscope Reckenholz-Tänikon (ART)	FedAdmin
9	Staatssekretariat für Wirtschaft (SECO)	FedAdmin
10	Bundesamt für Privatversicherungen (BPV)	FedAdmin
11	Interkantonaler Rückversicherungsverband	Private
12	Swiss RE	Private
13	Akademie der Naturwissenschaften (SCNAT) – Platform Geosciences	Academia
14	Centre de recherche sur l'environnemant alpin (CREALP)	Private
15	Eidgenössische Geologische Kommission (EGK)	FedAdmin
16	Fachverband der Schweizer Kies- und Betonindustrie (FSKB)	Private
17	Schweiz Tourismus	Private
18	Schweizer Geologenverband (CHGEOL)	Private
19	Schweizerische Akademische Gesellschaft für Umweltforschung und Ökologie (SAGUF)	Academia
20	Schweizerische Fachgruppe der Ingenieurgeologen (SFIG)	Private
21	Schweizerische Geologische Kommission (SGK)	Academia
22	Schweizerische Geophysikalische Kommission (SGPK)	Academia
23	Schweizerische Geotechnische Kommission (SGTK)	Academia
24	Schweizerische Gesellschaft für Hydrogeologie (SGH)	Academia
25	Schweizerische Vereinigung der Petrolium-Geologen und –Ingenieuren (VSP)	Private
26	Schweizerische Vereinigung der Strahler, Mineralien- und Fossiliensammler (SVSMF)	Academia
27	Schweizerische Vereinigung für Geothermie (SVG)	Private
28	Schweizerischer Verband der Umweltfachleute	Private
29	Schweizerisches Institut für Speläologie und Karstforschung (SISKA)	Academia
30	WWF Schweiz	Private
31	Aargau (AG) – Dep. Bau, Verkehr und Umwelt	CantAdmin
32	Appenzell Ausserrhoden (AR)- Amt für Umwelt	CantAdmin
33	Appenzell Innerrhoden (AI) – Amt für Umweltschutz	CantAdmin
34	Basel-Landschaft (BL)	CantAdmin
35	Basel-Stadt (BS) – Amt für Umwelt und Energie	CantAdmin
36	Basel-Stadt (BS) – Uni Basel	CantAdmin
37	Bern (BE) – Amt für Umwelt	CantAdmin
38	Bern (BE) – Wasser- und Energiewirtschaftsamt	CantAdmin
39	Freiburg (FR) – Service de l'environnement	CantAdmin
40	Freiburg (FR) – Service des constructions et de l'aménagement	CantAdmin
41	Freiburg (FR) – SIT	CantAdmin
42	Genf (GE) – Service de géologie, sols et déchets	CantAdmin
43	Glarus (GL) – Departement Bau und Umwelt	CantAdmin
44	Graubünden (GR) – Amt für Natur und Umwelt	CantAdmin
45	Graubünden (GR) - Tiefbauamt	CantAdmin
46	Jura (JU) – Office de l'environnement	CantAdmin
47	Luzern (LU) – Umwelt und Energie	CantAdmin

Continued on next page

Tab. B.2 – continued from previous page

No.	Organisation	category
48	Neuenburg (NE) – Département de la gestion du territoire	CantAdmin
49	Nidwalden (NW) – Amt für Umwelt	CantAdmin
50	Obwalden (OW) – Amt für Landwirtschaft und Umwelt	CantAdmin
51	Schaffhausen (SH) - Tiefbauamt	CantAdmin
52	Schwyz – Amt für Umwelt	CantAdmin
53	Schwyz (SZ) - Volkswirtschaftsdepartement	CantAdmin
54	Solothurn (SO) – Amt für Umwelt	CantAdmin
55	St. Gallen (SG) – Amt für Umwelt und Energie	CantAdmin
56	Tessin (TI) – Ufficio tecnico	CantAdmin
57	Thurgau (TG) – Amt für Umwelt	CantAdmin
58	Uri (UR) – Amt für Umweltschutz	CantAdmin
59	Waadt (VD) – Dépt. de la sécurité et de l'environnement	CantAdmin
60	Waadt (VD) – Dépt. des infrastructures	CantAdmin
61	Waadt (VD) – Service des eaux, sols et assainissement	CantAdmin
62	Wallis (VS) - Département des transports, de l'équipement et de l'environnement	CantAdmin
63	Wallis (VS) – Département des transports, de l'équipement et de l'environnement	CantAdmin
64	Zug (ZG) – Amt für Umweltschutz	CantAdmin
65	Zürich (ZH) – Amt für Abfall, Wasser, Energie und Luft	CantAdmin
66	Zürich (ZH) – Amt für Abfall, Wasser, Energie und Luft	CantAdmin
67	EPFL, Laboratoire de géologie de l'ingénieur et de l'environnement	Academia
68	ETH Zürich, Geologisches Institut	Academia
69	ETH Zürich, Ingenieurgeologie	Academia
70	Scuola Universitaria Professionale della Svizzera Italiana	Academia
71	Uni Basel, Geologisch-Paläontologisches Institut	Academia
72	Uni Bern, Institut für Geologie	Academia
73	Uni Bern, Phil.-Naturwissenschaftl. Fakultät	Academia
74	Uni Freiburg, Département des Géosciences	Academia
75	Uni Genf, Dp. Géologie & Paleontologie	Academia
76	Uni Genf, Institute F.-A. Forel	Academia
77	Uni Lausanne, Institut de géomatique et de l'analyse du risque	Academia
78	Uni Zürich, Geologisches Institut	Academia
79	Böhringer AG Ingenieure Planer	Private
80	CSD-Bern	Private
81	Dr. Heinrich Jäckli AG	Private
82	Dr. von Moos AG	Private
83	Geotechnisches Institut	Private
84	Geotest AG	Private
85	Holcim Schweiz AG	Private
86	Kellerhals und Haefeli AG	Private
87	Matousek, Baumann & Niggli AG	Private
88	Schenker Korner & Partner	Private
89	Naturama Aargau	Academia
90	Naturhistorisches Museum Basel	Academia
91	Naturhistorisches Museum Neuenburg	Academia
92	Uni Bern, Geographisches Institut	Academia

B.2.2 Introduction to national poll

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement für Verteidigung, Bevölkerungsschutz und Sport VBS
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22.01.2009

Umfrage Anforderungen an das Geologische Informationssystem Schweiz und Geothematische Karten

Einleitung und Hintergrund der Umfrage

Geologische Informationen und Daten bilden eine wichtige Grundlage für eine Vielzahl von Produkten des täglichen Lebens. So sind Strassen- und Tunnelbau, Energie- und Trinkwasserversorgung, Umweltschutz, Prävention von Naturgefahren, usw. ohne geologischen Input undenkbar.

Seit einigen Jahren verzeichnet die Landesgeologie einen deutlichen Anstieg der Nachfrage nach digitalen geologischen Informationen. Dieser Anstieg ist einerseits durch die starke Verbreitung von Computern und die aktuellen Entwicklungen im Bereich IT, Internet und GIS bedingt. Andererseits steigern Faktoren, wie zum Beispiel die zunehmende Einbindung der Geologie in die Raumplanung (z.B. im Bereich Naturgefahren) oder die vermehrte Nutzung der Geothermie die Nachfrage. Die zielorientierte und schnelle Umsetzung solcher Projekte ist nur mit Hilfe digitaler geologischer Daten möglich. Trotz der erhöhten Nachfrage nach digitalen Daten behalten gedruckte geologische Karten ihre Wichtigkeit. Besonders für den Einsatz im Feld oder die schnelle Analyse der geologischen Situation sind gedruckte Karten entscheidend.

Um die gestiegene Nachfrage zu befriedigen, den Zugang zu sämtlichen geologischen Daten und Informationen zu erleichtern und kundenorientierte Produkte und Dienstleistungen verfügbar zu machen, sind bei der Landesgeologie unter anderem die folgenden Projekte in Bearbeitung:

- Konzeption eines Internet-basierten geologischen Informationssystems
- Machbarkeitsstudie zur Erstellung geothematischer Karten im Bereich der angewandten Geologie

Nachfolgend werden die beiden zuvor genannten Projekte kurz beschrieben. Im Anschluss an den Fragebogen werden im Anhang weitere bereits umgesetzte bzw. geplante Vorhaben vorgestellt.

Geologisches Informationssystem Schweiz (Geol-GIS-CH)

Über das geplante geologische Informationssystem können Informationen zur Verfügbarkeit von geologischen Daten abgerufen, die Daten selber visualisiert und bereitgestellt werden, Informationen zu den verschiedenen Organisationen der „Geo-Szene" der Schweiz (z.B. Kommissionen der scnat, Universitäten, CHGeol, kantonale und nationale Fachstellen, private Büros, etc.) dargestellt und verschiedene weitere Dienstleistungen angeboten und bezogen werden. Hauptziel des Geologischen Informationssystems Schweiz ist die Schaffung einer zentralen Plattform für die Geo-Szene Schweiz, mit der die folgenden Teilziele erreicht werden sollen:

A. Vereinfachung und Zentralisierung des Zugangs zu „geologischen" Daten, Informationen und Diensten
B. Verbesserter Überblick über die Geo-Szene Schweiz und deren nationale und internationale Vernetzung
C. Verbesserung der öffentlichen Wahrnehmung des Fachgebiets Geologie und verwandter Fachbereiche

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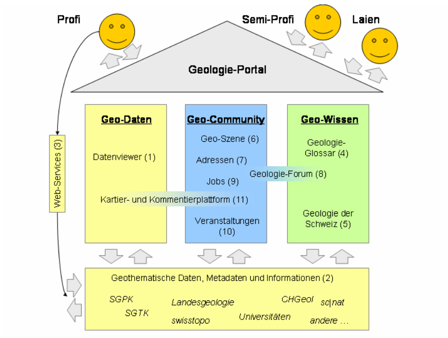
Der Aufbau eines solchen Informationssystems, das über ein Internetportal (Geologie-Portal) zugänglich sein wird, ist in der untenstehenden Abbildung schematisch dargestellt.



Übersicht über den Aufbau und die Komponenten des geplanten Geologischen Informationssystems Schweiz. Die Farben grenzen verschiedene thematische Bereiche (Geo-Wissen, Geo-Daten und Geo-Community) von einander ab. Die Nummern, die auch im nachfolgenden Fragebogen und Bericht vermerkt sind , kennzeichnen die unterschiedlichen Komponenten des Informationssystems. Kern des Informationssystems sind die enthaltenen Daten. Diese sind über das Geologie-Portal oder direkt über Web-Services zugänglich.

Viele der oben dargestellten Komponenten bestehen bereits in den Web-Auftritten der Organisationen der Schweizer Geo-Szene. An dieser Stelle soll ausdrücklich festgehalten werden, dass das geplante geologische Informationssystem in keiner Weise die Webauftritte und –dienste der Organisationen und Institutionen der Schweizer Geo-Szene konkurrenzieren oder diese gar ersetzen soll. Vielmehr wird, wie oben bereits erwähnt, die Schaffung einer zentralen Informationsplattform für die Schweizer Geo-Szene angestrebt.

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Geothematische Karten

Die Basis eines jeden Informationssystems stellen die enthaltenen Daten und Informationen dar. Bereits heute ist ein breites Angebot an geologischen Daten vorhanden. Unter anderem können Pixelkarten des Geologischen Atlas der Schweiz 1:25'000 (GA25) im Geologischen Datenviewer der Landesgeologie oder die Adressdatenbank der Platform Geosciences der Schweizerischen Akademie der Wissenschaften online abgerufen werden.

Um die Wertschöpfung des GA25 zu erhöhen und die Bedürfnisse einer erweiterten Kundschaft zu befriedigen, sollen nun auch aus dem GA25 abgeleitete geothematische Karten in digitaler und/oder analoger Form erstellt werden. Basierend auf einer Ideensammlung wurden dazu in einer Machbarkeitsstudie 46 mögliche Themen im Hinblick auf ihren Nutzen evaluiert und entsprechende Datengrundlagen geprüft.

Als Basis dieser Vorhaben dient die digitale Rückerfassung des GA25, die zurzeit erfolgt. Parallel dazu sind folgende Projekte bereits in Realisierung:

- Digitalisierung des Archivs der Geologischen Informationsstelle
- Geologischer Datenviewer
- Radonrisikokarte
- Atlas geothematischer Karten

Zudem werden derzeit die mögliche Konzeption und die Machbarkeit folgender geothematischer Karten und Datensammlungen geprüft:

- Schweiz 3D (dreidimensionale geologische Datenbank, z.B. mit Hilfe von seismischen Daten)
- Geotechnische Karte der Schweiz
- Geochemische Übersichtskarte geogener Hintergrundgehalte
- Digitale Bibliothek als Grundlage für die Tiefenplanung
- Touristische geologische Karten (z.B. Wanderkarten, Höhlenkarte)

Nähere Angaben und Beschreibungen dieser Projekte finden sich im Anhang.

Vor dem Aufbau des Geologischen Informationssystems Schweiz und der Produktion geothematischer Karten soll mit dem nachfolgenden Fragebogen abgeklärt werden, welche Anforderungen und Wünsche seitens der Schweizer Geo-Szene an diese Projekte bestehen.

Aufgrund der grossen Bedeutung dieser Thematik ist der Fragebogen sehr umfangreich ausgefallen. Gerade deshalb wissen wir Ihre Bemühungen und Ihren Beitrag sehr zu schätzen.

Herzlichen Dank!

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B.2.3 Questionnaire to the national geo-community

Schweizerische Eidgenossenschaft
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armasuisse
Bundesamt für Landestopografie swisstopo

22.01.2009

Fragebogen

Der Fragebogen ist in zwei Teile gegliedert. Im ersten Teil kann der Nutzen und die Priorität der geplanten Komponenten des Geologischen Informationssystems Schweiz bewertet werden. Der zweite Teil ist auf die Bewertung der geplanten geothematischen Karten ausgerichtet. Pro Projekt kann der Nutzen und die Priorität bewertet werden.

Teil 1: Anforderungen an das Geologische Informationssystem Schweiz

Nachfolgend sind die Komponenten des geplanten Geologischen Informationssystems Schweiz aufgeführt. Der Fokus liegt auf neuen Komponenten, Funktionen und Datensätzen. Die bestehende Funktionen, wie z.B. das Anzeigen und Selektieren von Daten im Geologischen Datenviewer können nicht bewertet werden.

Die Liste der aufgeführten Komponenten ist nicht abgeschlossen. Ergänzungen sind sehr willkommen und können an den vermerkten Stellen eingefügt werden.

Bewertung

Bitte bewerten Sie durch eintragen der unten angegebenen Ziffern den Nutzen der aufgeführten Komponenten für Ihre Arbeit und die Priorität der Umsetzung anhand des folgenden Systems:

1 = sehr gering; 2 = gering; 3 = mittel; 4 = hoch; 5 = sehr hoch

1. Geologischer Datenviewer (vgl. 1.2 im Anhang)		
Beschreibung	Applikation zur Visualisierung von Daten im Internet. Nachfolgend sind geplante Funktionen des bestehenden Geologischen Datenviewers aufgeführt.	
Stand	Erste Version besteht (http://prod.swisstopogeodata.ch/kogis_apps/ga/ga.php) und wird ergänzt	
	Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität dieser Komponente ein?		
Bitte tragen Sie nachfolgend wünschenswerte Funktionen des Datenviewers ein und bewerten Sie ihren Nutzen und ihre Priorität.		
	Nutzen	**Priorität**

2. Geothematische Daten, Metadaten und Informationen (s. auch Teil 2 des Fragenbogens)		
Beschreibung	Die Daten (geologische und geothematische Karten, Informationen, etc.) bilden den Kern des Geologischen Informationssystems. Eine Vielzahl von Datensätzen besteht bereits und eine grosse Anzahl weiterer Datensätze ist denkbar. Geplante geothematische Karten können im Teil 2 des vorliegenden Fragebogens bewertet werden.	
Stand	Bestehend	
Wie schätzen Sie den Nutzen und die Priorität der folgenden Daten ein?		
	Nutzen	**Priorität**
Übersichten über die verfügbaren geothematischen Datensätze (Geologisches Kartenverzeichnis)		
Übersicht über Bohrdaten, Geologische Berichte, etc. (GISGeol) http://prod.swisstopogeodata.ch/kogis_apps/webgeol/webgeol.php?		
Geologische Karten		
Geotechnische Karten und Rohstoffkarten		
Naturgefahren, z.B. Historische Erdbeben, Baugrund, Mikrozonierung, Permafrost		
Bitte tragen Sie nachfolgend weitere wünschenswerte Datensätze ein und bewerten Sie ihren Nutzen und ihre Priorität.		
	Nutzen	**Priorität**

3. Web-Services (Dienste)		
Beschreibung	Über Web-Services können Dienstleitungen über das Internet angeboten oder Datensätze verteilt werden. Insbesondere bieten die Standards des OpenGIS-Consortium (OGC) die Möglichkeit, Karten als Bilder (WebMapService, WMS) oder als vektorisierte Datensätze (WebFeatureService, WFS) über das Internet bereitzustellen und in einem Desktop-GIS zu visualisieren und zu nutzen.	
Stand	In Planung, zum Teil bestehend	
	Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität dieser Komponente ein?		
Wie schätzen Sie den Nutzen und die Priorität der folgenden Dienste ein?		
	Nutzen	**Priorität**
Bereitstellung als Pixelkarten (WMS) (geplant)		
Bereitstellung von Vektordaten (Web Feature Service, WFS) (geplant)		
Einfügen und Editieren von Daten auf dem Server des Geologischen Informationssystems (geplant)		
Qualitätssicherung in der angewandte Geophysik (besteht bei der Schweizerischen Geophysikalischen Kommission, http://www.gr.sgpk.ethz.ch/)		
Stratigraphisches Lexikon (besteht bei der Plattform Geosciences http://www.geosciences.scnat.ch/index.php?lang=fr&nav1=5&nav2=55&nav3=77)		
Rechendienst zur Transformation von Koordinatensystemen (besteht bei swisstopo Geodäsie, http://www.swisstopo.admin.ch/internet/swisstopo/de/home/apps/calc/reframe.html)		
Bitte tragen Sie nachfolgend weitere wünschenswerte Dienste ein und bewerten Sie ihren Nutzen und ihre Priorität.		
	Nutzen	**Priorität**

4. Geologie-Glossar		
Beschreibung	Kurze, laienverständliche Beschreibung wichtiger geologischer oder geo-wissenschaftlicher Begriffe und Sachverhalte. Eventuell ähnlich wie in www.wikipedia.org, bei dem die Nutzer den Inhalt selber erstellen.	
Stand	Geplant	
	Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität der Komponente ein?		

5. Geologie der Schweiz; Die Schlüsselstellen der Schweizer Geologie		
Beschreibung	Schlüsselstellen der Schweizer Geologie, wie z.B. die Glarner Hauptüberschiebung werden laienverständlich beschrieben und in den generellen geologischen Bau der Schweiz eingebunden. Interaktive 3D-Darstellungen unterstützen die Verständlichkeit.	
Stand	Geplant	
	Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität der Komponente ein?		

6. Grafische Übersicht über die Organisation der Geo-Szene Schweiz		
Beschreibung	Darstellung der Vernetzung und der Aufgaben der Organisationen der Schweizer Geo-Szene.	
Stand	geplant	
	Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität der Komponente ein?		

7. Adressdatenbank und -suche		
Beschreibung	Applikation zur Suche nach Adressen von Organisationen und Personen der Schweizer Geo-Szene.	
Stand	Besteht bei der Platform Geosciences: „Geoscience-Switzerland"-online: http://www.geosciences.scnat.ch/	
	Nutzen	**Priorität**
Wie schätzen Die den Nutzen und die Priorität der Komponente ein?		

8. Geologie-Forum	
Beschreibung	Diskussionsforum für geologische Fragen. Professionelle Geologen können untereinander Probleme diskutieren oder sich mit Laien austauschen.
Stand	Denkbar, ähnlich wie http://www.geowebforum.ch/

	Nutzen	Priorität
Wie schätzen Sie den Nutzen und die Priorität der Komponente ein?		

9. Jobbörse			
Beschreibung	Stellenangebote und -gesuche können auf einer Website platziert werden		
Stand	Besteht via CHGeol-Webseite: http://www.chgeol.ch/d/2/jobs.asp		
		Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität der Komponente ein?			

10. Veranstaltungskalender (Konferenzen, Versammlungen, Sitzungen, Events, ...)			
Beschreibung	Übersicht über aktuelle Veranstaltungen in Zusammenhang mit Geologie. Denkbar wäre eine Darstellung im Datenviewer bei der die Orte der Veranstaltungen angezeigt werden und weitere Informationen abrufbar sind.		
Stand	Besteht bei der Plattform Geosciences: http://geosciences.scnat.ch/index.php?nav1=3&nav2=33		
		Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität der Komponente ein?			

11. Geologische Kartier- und Kommentierplattform			
Beschreibung	Geologische Entdeckungen und Kartierungen können in einem interaktiven Datenviewer und –editor im Internet erfasst, dargestellt und diskutiert werden. Bestehende geologische Karten können z.B. bei Fehlern oder veränderter geologischer Situation kommentiert werden.		
Stand	denkbar		
		Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität der Komponente ein?			

Weitere Komponenten		
Bitte tragen Sie nachfolgend weitere wünschenswerte Komponenten mit einer kurzen Beschreibung ein und bewerten Sie ihren Nutzen und ihre Priorität.		
	Nutzen	**Priorität**

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Teil 2: Geothematische Karten

Nachfolgend sind die künftigen Projekte zu geothematischen Karten aufgelistet. Erläuterungen zu den jeweiligen Projekten sind im Anhang (Kapitel 3) zu finden.

Die Inhalte sind nicht abgeschlossen; Ergänzungen sind sehr willkommen und können für jedes Projekt und am Ende dieses Teils eingefügt werden. Bitte bewerten Sie durch einfügen der unten angegebenen Ziffern den Nutzen und die Priorität der Projekte

Bewertung

Bitte bewerten Sie durch eintragen der unten angegebenen Ziffern den Nutzen der aufgeführten Komponenten für Ihre Arbeit und die Priorität der Umsetzung anhand des folgenden Systems:

1 = sehr gering; 2 = gering; 3 = mittel; 4 = hoch; 5 = sehr hoch

Schweiz 3D (s. 2.1)			
Beschreibung	dreidimensionales geologisches Modell der Schweiz, basiert auf der drei-dimensionalen Erfassung geologischer Daten (z.B. Tunnelprofile und Seismiken)		
Stand	Machbarkeit mittels des derzeit in Entstehung begriffenen, seismischen Atlas des Molassebeckens (s. Marillier et al. 2007) nachgewiesen; entsprechendes Modell müsste aber auf ganze Schweiz ausgedehnt werden.		
		Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität des Projekts ein?			
Wie schätzen Sie den Nutzen und die Priorität der folgenden Inhalte ein?			
		Nutzen	**Priorität**
Untiefe Bohrungen (< 100 m)			
Tiefe Bohrungen (> 100 m)			
Tunnelaufnahmen			
Bitte tragen Sie nachfolgend weitere wünschenswerte Inhalte ein und bewerten Sie ihren Nutzen und ihre Priorität.			
		Nutzen	**Priorität**

6/10

Geotechnische Karte der Schweiz (s. 2.2)			
Beschreibung	Flächendeckende, moderne geotechnische Karte mit Angaben zu Lithologie, Grundwasserspiegel, Grundwasserstauer, Felsoberfläche und Sondierlokalitäten.		
Stand	Projekt in Evaluation, technische Machbarkeit nachgewiesen		
		Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität des Projekts ein?			
Bitte tragen Sie nachfolgend weitere Inhalte ein, welche Sie sich ausser den im Projektbeschrieb genannten Inhalten (Lithologie, Grundwasserisohypsen, Isolinien von Grundwasserstauer und Felsoberfläche sowie bekannte Sondierlokalitäten) wünschen würden (vgl. 2.2 in Anhang) und bewerten Sie ihren Nutzen und ihre Priorität.			
		Nutzen	**Priorität**

Übersichtskarte Geogener Hintergrundgehalte (s. 2.3)			
Beschreibung	Flächendeckende Karte der geogenen Hintergrundsgehalte der wichtigsten bzw. problematischsten Schwermetalle im C-Horizont. Diese Karte ermöglicht es die Herkunft von Bodenbelastungen abzuschätzen und z.B. Gebiete mit erhöhtem Risiko von Schwermetallbelastungen auszuscheiden.		
Stand	Projekt in Evaluation, technische Machbarkeit nachgewiesen		
		Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität des Projekts ein?			
Bitte tragen Sie nachfolgend weitere Inhalte ein, welche Sie sich ausser den im Projektbeschrieb genannten Inhalten wünschen würden (vgl. 2.3 in Anhang) und bewerten Sie ihren Nutzen und ihre Priorität.			
		Nutzen	**Priorität**

7/10

Tiefenplanung (s. 2.4)			
Beschreibung	Elektronische Bibliothek der Grundlagen der Tiefenplanung; umfasst u.a. Daten der bisherigen Richtplanungen, geotechnische Karten und Schweiz 3D		
Stand	Projekt in Evaluation		
		Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität des Projekts ein?			
Bitte tragen Sie nachfolgend weitere Inhalte ein, welche Sie sich ausser den im Projektbeschrieb genannten Inhalten wünschen würden (vgl. 2.4 in Anhang) und bewerten Sie ihren Nutzen und ihre Priorität.			
		Nutzen	**Priorität**

Geologische Wanderkarten (s. 2.5)			
Beschreibung	Geologische Wanderkarte für einzelne ausgewählte Gebiete, Highlights werden z.B. in separatem Führer oder auf Kartenrückseite in Bild und Wort erläutert.		
Stand	Projekt in Evaluation, technische Machbarkeit durch analoge Projekte im Ausland nachgewiesen (z.B. geologische Wanderkarte Sextener Dolomiten)		
		Nutzen	**Priorität**
Wie schätzen Sie den Nutzen und die Priorität des Projekts ein?			
Bitte tragen Sie nachfolgend wünschenswerte Inhalte einer geologischen Wanderkarte ein.			
		Nutzen	**Priorität**

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Höhlenkarte (s. 2.5)		Nutzen	Priorität
Beschreibung	Flächendeckende Karte der bekannten Höhlen und Bergwerke im Massstab 1:200'000, analog z.B. zu Burgenkarte gestaltet.		
Stand	Projekt in Evaluation		
Wie schätzen Sie den Nutzen und die Priorität des Projekts ein?			
Bitte tragen Sie nachfolgend wünschenswerte Inhalte einer Höhlenkarte ein.			
		Nutzen	**Priorität**

Bemerkungen

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Kontaktinformationen:

Name .... Vorname ....

Firma/Organisation ....

Typ der Organisation Privat Forschung Verwaltung sonstige

Telefon / e-mail ....

Alle Ihre Angaben werden vertraulich behandelt. Selbstverständlich nehmen wir auch gerne Fragebogen ohne persönliche Angaben entgegen. Damit wir Ihre Antworten besser den Bedürfnissen unserer verschiedenen Kundengruppen zuordnen können, wären wir Ihnen aber sehr dankbar, wenn Sie zumindest die Angaben zum Typ Ihrer Organisation einfüllen würden.

Herzlichen Dank für Ihre Mitwirkung und Ihre Unterstützung!

Bitte senden Sie Ihre Antworten mit beiliegendem Rückantwortecouvert bis am **28. Februar 2009** an die nachfolgende Adresse. Die Teilnehmer werden innerhalb von drei Monaten nach dem zuvor genannten Datum über die Ergebnisse der Umfrage informiert.

Bundesamt für Landestopografie swisstopo
Landesgeologie
Koordination und Administration geol. Landesuntersuchung
Dr. Milan Beres
Seftigenstrasse 264
3084 Wabern

oder per e-mail an:

milan.beres@swisstopo.ch

Die vorliegenden Dokumente stehen unter www.swisstopo.ch/Geol-Q oder www.swisstopo.ch > Themen > Geologie > Umfrage und Fragebogen zum Download zur Verfügung.

Für weitere Informationen stehen Ihnen folgende Personen zur Verfügung

Geologisches Informationssystem:

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Bundesamt für Landestopografie, 3084 Wabern
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Geothematische Karten:

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B.2.4 Appendix to questionnaire

Schweizerische Eidgenossenschaft
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armasuisse
Bundesamt für Landestopografie swisstopo

22.01.2009

Anhang

Geothematische Karten

1 Projekte in Realisierung

Um den Zugang zu den bestehenden geologischen Daten zu verbessern und die Bedürfnisse der Kunden zu decken, wurden in den letzten Jahren verschiedene Projekte in Angriff genommen. Diese aktuell laufenden Projekte werden nachfolgend kurz vorgestellt.

1.1 Digitale Rückerfassung bestehender geologischer Karten

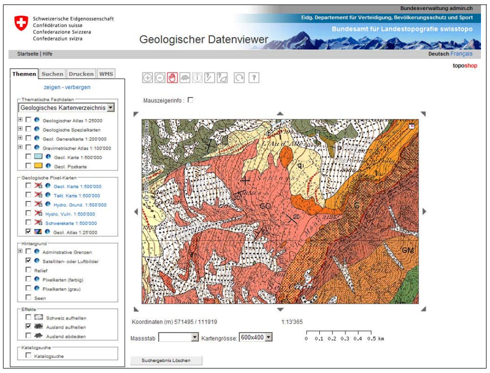
In Zusammenarbeit mit verschiedenen kantonalen Fachstellen und der Universität Lausanne werden die bestehenden geologischen Kartenblätter, insbesondere die des GA25 systematisch vektorisiert. Für die Erfassung stehen eine spezielle Vorgehensmethode und ein Datenmodell zur Verfügung. Die Legenden der einzelnen Kartenblätter liegen separat vor und sind nicht aufeinander abgestimmt. Die durch die Digitale Rückerfassung erzeugten geologischen Vektordaten bilden die Basis für einen schweizweiten, blattschnittlosen geologischen Datensatz. Die Harmonisierung der einzelnen Kartenlegenden wird zur Zeit in separaten Gebieten vorangetrieben.

Weitere Informationen:

Swisstopo (2007): Swisstopo Kolloquium vom 19. Januar 2007, Geologisches Informationssystem Schweiz.- Öffentliche Kolloquien des Bundesamtes für Landestopografie. (http://www.swisstopo.admin.ch/internet/swisstopo/de/home/docu/colloquia/coll_06_07.html)

1.2 Geologischer Datenviewer

Zur Visualisierung der geologischen und fachverwandten Datensätze wurde Ende 2007 ein Datenviewer in die Internetseite der Landesgeologie integriert und aufgeschaltet. Dieser ermöglicht es dem Nutzer die publizierten geologischen Karten als Pixelkarten und diverse andere Datensätze in Pixel- und Vektorformat darstellen. Des Weiteren lässt sich auch das geologische Kartenverzeichnis einblenden und der Stand der Verfügbarkeit der jeweiligen Datensätze abrufen.



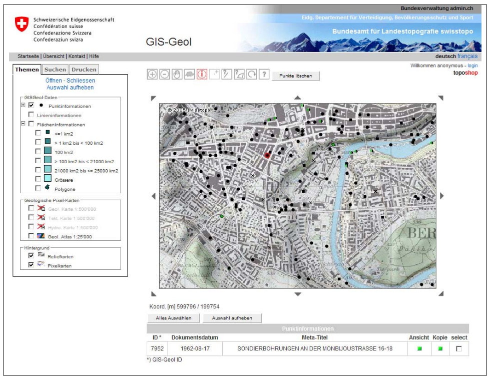
Weitere Informationen:

Swisstopo (2007): Swisstopo Kolloquium vom 19. Januar 2007, Geologisches Informationssystem Schweiz.- Öffentliche Kolloquien des Bundesamtes für Landestopografie. (http://www.swisstopo.admin.ch/internet/swisstopo/de/home/docu/colloquia/coll_06_07.html)

Swisstopo (2007): Geologischer Datenviewer unter: http://prod.swisstopogeodata.ch/kogis_apps/ga/ga.php

1.3 Digitalisierung des Archivs der Geologischen Informationsstelle

Die Digitalisierung des Archivs der Geologischen Informationsstelle hat im vergangenen Jahr begonnen. Sämtliche Informationen werden bereits in einer neukonzipierten Datenbank verwaltet. Seit kurzem können die verfügbaren Dokumente über die Internetapplikation GISGeol online abgefragt und bestellt werden. Ein Link zu GISGeol ist auch im Geologischen Datenviewer integriert. Um den Zugang zu digitalen oder digitalisierten Dokumenten zu erleichtern wird derzeit geprüft, ob im Rahmen der Regelungen des Zugangsschutzes diese Dokumente auch im Internet zum Download angeboten werden können.

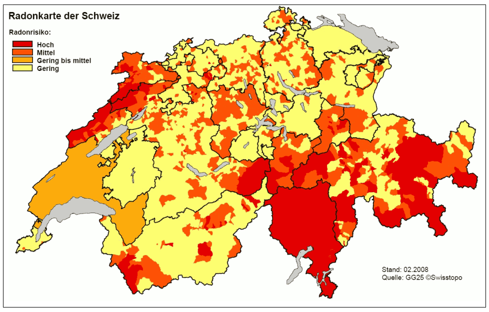


Weitere Informationen:

Swisstopo (2008): GISGeol.- Internetapplikation unter http://prod.swisstopogeodata.ch/kogis_apps/webgeol/webgeol.php

1.4 Radonrisikokarte

Eine bereits bestehende geothematische Karte stellt die vom Bundesamt für Gesundheit (BAG) erstellte Radonrisikokarte der Schweiz (Radonrisikokarte: s. http://www.bag.admin.ch/themen/strahlung/00046/index.html) dar. Diese soll in absehbarer Zeit über den Geologischen Datenviewer zugänglich gemacht werden. Im Gegenzug unterstützt die Landesgeologie das BAG bei der kartographischen Darstellung der Karte im Internet und der geologischen Auswertung der beobachteten Phänomene.

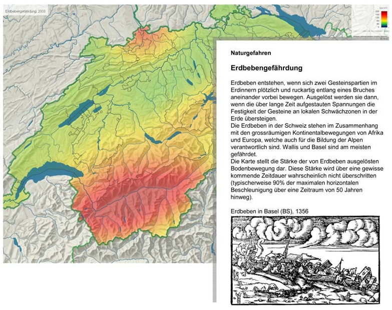


Weitere Informationen:

Bundesamt für Gesundheit (2008): Radonrisiko.- Homepage unter http://www.bag.admin.ch/themen/strahlung/00046/index.html

1.5 Atlas geothematischer Karten

Im Hinblick auf eine effizientere Anwendung geothematischer Daten wird derzeit ein Verzeichnis der bereits vorhandenen geothematischen Karten erarbeitet. Dieser sogenannte Atlas der geothematischen Karten wird ähnlich aufgebaut sein, wie das entsprechende Verzeichnis des British Geological Survey und der Österreichischen Geologischen Bundesanstalt. Er listet alle in der Schweiz verfügbaren geologischen und geothematischen Karten auf, und soll die Verwendung geologischer und geothematischer Karten insbesondere erdwissenschaftlichen Laien näher bringen. Damit soll das Potential und der Nutzen der Geologie breiteren Kreisen erschlossen werden.



Weitere Informationen:

British Geological Survey (2005): Britain beneath our feet.- Homepage unter http://www.bgs.ac.uk/britainbeneath/guide.html

Österreichische Geologische Bundesanstalt (2007): Geo-Atlas Österreich.- Böhlau Verlag, Wien, 112 pp. (s. http://www.boehlau.at/main/book.jsp?bookID=3-205-77726-3)

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2 Künftige Projekte zu geothematischen Karten

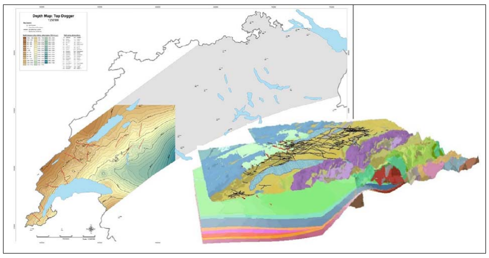
Neben den im vorherigen Abschnitt vorgestellten Projekten sind eine Reihe weiterer Projekte bei der Landesgeologie in der Planungs- oder Konzeptphase. Diese Projekte, die verschiedene Bereiche der Geologie abdecken, bilden die Basis für die geplanten geothematischen Karten, die in der einleitend erwähnten Machbarkeitsstudie evaluiert wurden.

2.1 Schweiz 3D

Der derzeit in Entstehung begriffene Seismischen Atlas des Molassebeckens (s. Marillier et al. 2007) zeigt das Potential einer flächendendeckenden 3-dimensionalen Erfassung geologischer Daten. Der 3-dimensionale Abgleich von Daten aus verschiedenen Quellen erlaubt weit schärfere Interpretationen als diese z.B. in 2 Dimensionen möglich sind.

Das daraus abgeleitete Schichtmodell kann zudem z.B. für seismische, hydrogeologische, und geothermale Modellierungen verwendet werden. Dies wiederum ermöglicht z.B. eine gezielte geothermale Prospektion. Erste Abschätzungen zeigen, dass der potentielle längerfristige Nutzen den Aufwand bei weitem überwiegen dürfte.

Konkret ist geplant, mittelfristig auf der Basis des Seismischen Atlas des Molassebeckens z.B. Oberflächengeologie, tiefe Bohrungen, seismischen Linien und Tunnelbauten mit grosser Überdeckung zu erfassen. Daraus soll ein laufend nachgeführtes geologisches 3-dimensionales Modell erstellt werden.



Weitere Informationen:

Marillier, F, Eichenberger, U. & Sommaruga, A. (2007): Seismic Synthesis of the Swiss Molasse Basin, Report for 2007.- Swiss Geophysical Commission, 11 pp. (s. http://www.sgpk.ethz.ch/jahresbericht/2007/marillier-2007.pdf)

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2.2 Geotechnische Karte 1:25'000

Die letzte geotechnische Karte, welche die gesamte Schweiz abdeckt datiert aus den Jahren 1963 – 1967. Da diese Karte im Massstab 1:200'000 erstellt wurde, gibt sie zudem die geotechnischen Verhältnisse nur übersichtsmässig wieder. In einzelnen urbanen Gebieten sind zwar aktuelle und detailliertere geotechnische Karten vorhanden. In weiten Teilen der Schweiz fehlt jedoch eine den heutigen Ansprüchen genügende geotechnische Karte.

Mittelfristig ist geplant, die im Geologischen Atlas 1:25'000 beschriebenen geologischen Einheiten so zu attributieren, dass z.B. auch Lithologien separat ausgewertet werden können. Dies soll in Kombination mit weiteren Daten, wie z.B. den Grundwasserisohypsen aus kantonalen und/oder eidgenössischen Kartenwerken, die Basis für die geplante geotechnische Karte im Massstab 1:25'000 legen.

Konkret soll diese Karte gemäss aktuellem Planungsstand folgende Elemente enthalten:

- Lithologie der Deckschicht
  Darstellung mit Übersignaturen sofern Deckschicht Mächtiger als 1 m
- Lithologie der obersten Schicht unter Deckschicht
- Grundwasserisohypsen
  sofern vorhanden werden mittlerer und höchster Grundwasserstand dargestellt
- Isolinie des Grundwasserstauers
  sofern genügend genau bekannt
- Isolinie der Felsoberfläche
  sofern genügend genau bekannt
- Lokalität der bei der Landesgeologie erfassten Sondierungen

In der Internetversion der Karte ist vorgesehen auch eine Abfragemöglichkeit einzubauen, mit welcher über die Sondierlokalitäten auch die entsprechenden Berichte ermittelt und bestellt werden können.

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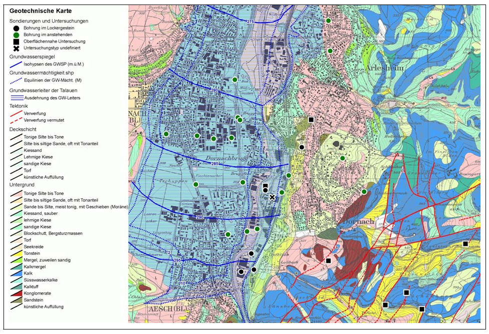

Weitere Informationen:

de Quervain, F. et al. (1963 - 1967): Geotechnische Karte der Schweiz, 1:200'000.- Schweizerische Geotechnische Kommission, Karte im Massstab 1:200'000 in vier Blättern. (s. http://www.sgtk.ch/main.asp?content=inhalt/produkte/baugrund_geotechnische_karten.htm&nav=23)

2.3 Übersichtskarte geogener Hintergrundgehalte

Die Erfahrungen im Rahmen der Umsetzung der Umweltgesetzgebung zeigen, dass lokal geogene Hintergrundgehalte im Bereich der Richt-, Grenz- und Sanierungswerten der Verordnung über Belastungen des Bodens (VBBo) vorliegen. Beispielsweise wurden in unbelasteten Böden des Juras Cadmium-Gehalte von bis zu 10.4 mg/kg (entsprechender Prüfwert der VBBo: 2 mg/kg) gemessen. Dies ist auf die deutlich erhöhten Cadmium-Gehalte der unterliegenden Karbonate des Bajocians und des Oxfordians zurückzuführen (s. Rambeau, 2006).

Für die korrekte Interpretation von Schwermetallgehalten in Böden und im Untergrund ist daher die ungefähre Kenntnis der geogenen Hintergrundsgehalte zentral. Zudem könnte die Kenntnis der geogenen Hintergrundgehalte auch für Fruchtfolge- und Düngeplanung in gewissen Gebieten von Bedeutung sein.

Dementsprechend ist vorgesehen mit Hilfe der bisher erhobenen geochemischen Parameter eine Karte zu generieren, welche auf mögliche Überschreitungen der Prüf-, Richt und Sanierungswerte bei den Schwermetallen Cr, Cd, Zn, Pb, Ni, Hg und Sb hinweisen.

Wie die Publikationen von Tuchschmid (1995), Keller & Desaules (2001) sowie Rehbein & Keller (2007a, b) zeigen, sind bereits mit Übersichtsdaten diesbezügliche Abschätzungen möglich.

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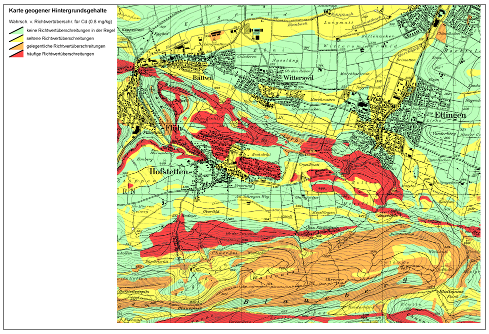
Literaturrecherchen, wie sie z.B. auch im Rahmen der Redaktion der Erläuterungen von Kartenblättern vorgenommen werden und gezielte geochemische Analysen von Proben der im Bereich eines Kartenblatts vorkommenden lithostratigraphischen Einheiten sollten mit angemessenem Aufwand eine weitere Detaillierung erlauben.

Allerdings erlaubt die natürliche Variabilität des Geochemismus in der Regel nur die Angabe der Grössenordnung der Gehalte. Trotzdem können anhand solcher Informationen sinnvolle Probeentnahmestellen bestimmt werden und damit eine deutlich effizientere Bearbeitung erzielt werden.



Weitere Informationen:

Keller, Th. & Desaules, A. (2001): Kartiergrundlagen zur Bestimmung der Bodenempfindlichkeit gegenüber anorganischen Schadstoffeinträgen in der Schweiz.- Eidg. Forschungsanstalt für Agrarökologie und Landbau, Zürich-Reckenholz, 81 pp.

Rambeau, C. (2006): Cadmium anomalies in Jurassic carbonates (Bajocian, Oxfordian) in western and southern Europe.- Thèse en géologie et hydrogéologie, Faculté des sciences, Université de Neuchâtel, Thèse n. 1858. (s. http://doc.rero.ch/search.py?recid=5693&ln=fr)

Rehbein, K. & Keller, A. (2007) Grossräumige Schwermetallgehalte in den Böden des Kantons Thurgau.- Nationale Bodenbeobachtung NABO, Bibliographie 156.

Rehbein, K. & Keller, A. (2007) Räumliche Interpolation von Zinkgehalten in den Böden des Kantons Thurgau.- Nationale Bodenbeobachtung NABO, Bibliographie 155.

Tuchschmid, M.P. (1995): Quantifizierung und Regionalisierung von Schwermetall- und Fluorgehalten bodenbildender Gesteine der Schweiz.- Bundesamt für Umwelt BAFU, Umwelt-Materialien 32.

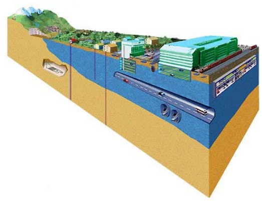
2.4 Tiefenplanung

Zunehmende Ansprüche der Gesellschaft an Fläche und Raum führen zu einer erhöhten Nutzung des Untergrundes. Immer mehr Verkehrsstränge (Bahnlinien, Autobahnen) werden in Tunnels verlegt. Auch Energie- und Wasserleitungen werden in Zukunft vermehrt unterirdisch verlaufen (Beispiel Transitgas).

Dem stehen immer intensivere, zum Teil konkurrierende Nutzungen gegenüber. Einerseits steigen der Wasserbedarf und die Grundwassernutzung stetig an. Andererseits sind wir zudem z.B. für die Bauwirtschaft auch zwingend auf die Nutzung von mineralischen Rohstoffen (Kies, Hartgestein) angewiesen. Im Zuge der aktuellen Entwicklung ist zudem auch die Bedeutung des Untergrunds für die Energiegewinnung (z.B. für Geothermie und Erdgasprospektion) stark angestiegen. Es ist absehbar, dass zumindest der geothermischen Nutzung strategische Bedeutung zukommen wird. Daher zeichnet sich ein dringender Planungsbedarf für die Nutzung und Bebauung des Untergrunds ab (s. Beer & Schenker, 2006 sowie http://www.chgeol.org/d/1/tiefenplanung.asp).

Dementsprechend sollen mittelfristig von der Landesgeologie die entsprechenden Planungsgrundlagen bereitgestellt werden. Zwei wesentliche Bausteine dazu sind die Projekte Schweiz 3D (vgl. 2.1) und Geotechnische Karte 1:25'000 (2.2). Zusätzlich werden zu diesen Daten die bislang bestehenden Richtplanungen zentral z.B. auf einem GIS-Server zusammengetragen. In urbanen Gebieten oder potentiellen Konfliktgebieten soll zudem wenn möglich auch die Ortsplanung zentral abgelegt werden.

Diese Daten wiederum erlauben es zusammen mit den bestehenden Umweltdaten, welche z.B. vom BAFU erhoben werden, potentielle Konflikte frühzeitig zu erkennen und gemeinsam mit allen betroffenen Stellen auszuräumen.



Weitere Informationen:

Beer, C. & Schenker, F. (2006): Tiefenplanung: Eine Umsetzungsskizze für die Schweiz und die Bedeutung der Geologie.- 4th Swiss Geoscience Meeting, Bern 2006, Abstracts, http://geoscience-meeting.scnatweb.ch/sgm2006/SGM06_abstracts/18_Geology_Urban/Beer_Christoph_Talk.pdf

CHGEOL, Projektgruppe Tiefenplanung (2008): Vorstellung der Projektgruppe.- http://www.chgeol.org/d/1/tiefenplanung.asp.

2.5 Touristische Karten

Die Geologie ist eines der wesentlichsten Gestaltungselemente unserer Natur. Gerade die Alpen, aber auch der Jura und das Mittelland wurden stark durch geologische Prozesse geprägt. Das geologische Erbe wir allerdings nur wenig von der Öffentlichkeit wahrgenommen und der nachhaltige Umgang mit ihm nur selten berücksichtigt (z.B. bei Bauvorhaben).

Die Landesgeologie möchte daher breitere Bevölkerungsschichten für die Geologie sensibilisieren und begeistern. Konkret stehen dabei folgende Projekte im Vordergrund

Geologische Wanderkarten

Für einige ausgewählte Gebiete (z.B. Geoparks), in welchen die Geologie „greifbar" ist, sollen geologische Wanderkarten herausgegeben werden. Wie z.B. eine geologische Wanderkarte aus den Sextener Dolomiten zeigt, finden derartige Karten bei einem breiteren Publikum durchaus Anklang (s. z.B. http://www.cipra.org/de/alpmedia/publikationen/1404) Basis der Karten im Massstab 1:25'000 ist der entsprechende Ausschnitt aus dem Geologischen Atlas der Schweiz.

In einer solchen geologischen Wanderkarte sollen auf ausgewählten Routen möglichst attraktive Aufschlüsse und Aussichtspunkte die Geologie des Gebiets dem Wanderer näherbringen. Jeder dieser Punkte wird mittels Bild und Text auf der Kartenrückseite oder in einem separaten Führer erläutert. Um den Erlebniswert sicherzustellen, sollen wenn möglich auch Bergwerke, Höhlen und andere geologische Sehenswürdigkeiten in die Routen miteingeschlossen werden.

Höhlenkarte

Höhlen und Bergwerke üben seit jeher eine grosse Faszination aus. Daher wird geprüft, ob analog zur Burgenkarte mittelfristig auch eine Höhlenkarte im Massstab 1:200'000 herausgegeben werden soll. Die Signaturen auf der Höhlenkarte geben Auskunft über die Art des Objekts (z.B. Höhle, Bergwerk, Schacht) und dessen Zugänglichkeit (z.B. Schauhöhle, mit Führer begehbare Höhle oder Speleologen vorbehaltene Höhle). Auf der Rückseite der Karten sollen, analog zu den Skitourenkarten, Kontaktadressen, Warnhinweise und Notfallnummern aufgedruckt werden.

Weitere Informationen:

Autonome Provinz Bozen-Südtirol (2004): Geologische Wanderkarte Naturpark Sextner Dolomiten, Massstab 1:25'000.- Casa Editrice Tabacco, Karte im Massstab 1:25'000; s. http://www.cipra.org/de/alpmedia/publikationen/1404

Geologischer Dienst Nordrhein-Westfalen (1994): Geologische Wanderkarte 1:50000 Naturpark Rothaargebirge.- Publikation des geologischen Dienstes Nordrhein-Westfalen, Karte im Massstab 1:50'000 in zwei Blättern; s. http://www.gd.nrw.de/g_detail.php?wg=16

C Analysed web sites

C.1 International geo-community

Tab. C.1: Analysed web sites of the international geo-community. The indicated components correspond to those shown in Tab. 4.3. All urls have been last checked August 22nd, 2009. If no specific url can be indicated, all individual steps necessary to access the site are given separated by ">".

Organisation	Component	URL
Swiss Geological Survey (SGS)	homepage	http://www.swisstopo.admin.ch/internet/swisstopo/en/home/swisstopo/org/geology.html
SGS	Dataviewer	http://www.geologieviewer.ch/
SGS	Spatial web-services	cf. http://portal.onegeology.org/
SGS (i.e. swisstopo geodesy division)	Non-spatial web-services	http://www.swisstopo.admin.ch/internet/swisstopo/de/home/apps/calc.html
SGS	Shop	http://www.toposhop.admin.ch/de/shop/index
SGS	Geology for laymen	http://www.swisstopo.admin.ch/internet/swisstopo/de/home/topics/geology.html
Geological Survey of Italy (APAT)	homepage	http://www.apat.gov.it/site/en-GB/
APAT	Dataviewer	http://serviziogeologico.apat.it/Portal/
APAT	Spatial web-services	cf. http://portal.onegeology.org/
APAT	Non-spatial web-services	http://www.apat.gov.it/site/en-GB/Environmental_Services/Environmental_services_list/
APAT	Geology for laymen	http://www.museo.isprambiente.it/home.page
Federal Institute for Geosciences and Natural Resources (BGR)	homepage	http://www.bgr.bund.de
BGR	Dataviewer	http://geoviewer.bgr.de
BGR	Spatial web-services	http://www.bgr.bund.de/cln_092/nn_1002738/DE/Themen/Geoinformationen/Webdienste/webdienste__node.html?__nnn=true
BGR	Event calendar	http://www.bgr.bund.de/cln_101/nn_334532/DE/Gemeinsames/Nachrichten/Veranstaltungen/veranstaltungen__node.html?__nnn=true
BGR	Shop	http://www.geoshop-hannover.de
Bureau de recherches géologiques et minières (BRGM)	homepage	http://www.brgm.fr/index.jsp
BRGM	Dataviewer	http://infoterre.brgm.fr/
BRGM	Spatial web-services	cf. http://portal.onegeology.org/
BRGM	GeoReports web.service	http://www.brgm.fr/georapport.jsp

Continued on next page

Tab. C.1 – continued from previous page

Organisation	Component	URL
BRGM	Image database service	http://www.brgm.fr/image.jsp
BRGM	Job portal	http://www.brgm.fr/brgm/Emploi/default.htm
BRGM	Geology for laymen	http://www.brgm.fr/multimedia.jsp
Geological Survey of Austria (GBA)	homepage	http://www.geologie.ac.at/
GBA	Dataviewer	http://www.geologie.ac.at/ > GBA-online
GBA	Web-services	http://www.geologie.ac.at/ > GBA-online
GBA	Glossary	http://www.geologie.ac.at/ > GBA-online > RockyAustria
British Geological Survey (BGS)	homepage	http://www.bgs.ac.uk/home.html
BGS	Dataviewer	http://www.bgs.ac.uk/geoindex/beta.html
BGS	Spatial web-services	cf. http://portal.onegeology.org/
BGS	Non-spatial web-services	http://www.bgs.ac.uk/services/home.html
BGS	GeoReports	http://www.bgs.ac.uk/services/services_for_you/home.html
BGS	Stratigraphic lexicon	http://www.bgs.ac.uk/education/britstrat/home.html
BGS	Image database	http://www.bgs.ac.uk/photoarchive/home.cfm
BGS	event calendar	http://www.bgs.ac.uk/news/diary.html
BGS	Shop	http://shop.bgs.ac.uk/
BGS	Discussion forum	http://www.bgs.ac.uk/education/ask_about_geology/question.html
BGS	Geology for laymen	http://www.bgs.ac.uk/education/home.html
Geological Survey of Canada (GSC)	homepage	http://gsc.nrcan.gc.ca/index_e.php
GSC	Dataviewer	http://gdr.ess.nrcan.gc.ca/english/explorer.jsp
GSC	Spatial web-services	http://gdr.nrcan.gc.ca/access_e.php
GSC	Non-spatial web-services	http://gdr.nrcan.gc.ca/index_e.php
GSC	Stratigraphic lexicon	http://cgkn1.cgkn.net/weblex/weblex_e.pl
GSC	Glossary	http://gdr.nrcan.gc.ca/gloss_e.php
GSC	Geology for laymen	http://gsc.nrcan.gc.ca/education_e.php
Geological state survey of Baden-Würtemberg (LGRB)	hompage	http://www.lgrb.uni-freiburg.de/lgrb/home/index_html
LGRB	Dataviewer	http://www.lgrb.uni-freiburg.de/lgrb/lgrb_mapserver
LGRB	Spatial web-services	http://www.lgrb.uni-freiburg.de/lgrb/lgrb_mapserver/wms-layer
LGRB	Shop	http://www.lgrb.uni-freiburg.de/lgrb/Produkte
LGRB	Geology for laymen	http://www.lgrb.uni-freiburg.de/lgrb/Fachbereiche/geotourismus
Geological State Survey of Bavaria (LfU)	homepage	http://www.lfu.bayern.de/geologie/
LfU	Dataviewer	http://www.bis.bayern.de/bis/initParams.do?role=bis

Continued on next page

Tab. C.1 – continued from previous page

Organisation	Component	URL
LfU	Spatial web-services	http: //www.gdi.bayern.de/Geowebdienste/geowebdienste.htm#GK500
LfU	Shop	http://www.bestellen.bayern.de/
LfU	Geology for laymen	http://www.lfu.bayern.de/geologie/fachinformationen/geoforum/ geologische_grundlageninformationen/index.htm

C.2 National geo-community

Tab. C.2: Analysed web sites of the national geo-community. The indicated components correspond to those shown in Tab. 4.4. All urls have been last checked August 22nd, 2009. If no specific url can be indicated, all individual steps necessary to access the site are given separated by ">".

Organisation	Component	URL
Swiss Federal Office for Environment (FOEN)	homepage	http://www.bafu.admin.ch/?lang=en
FOEN	Dataviewer	http://umweltzustand.admin.ch/
FOEN	Non-spatial web-services	http://www.hydrodaten.admin.ch/d/index.htm?lang=de
Canton Solothurn (SO)	homepage geology	http://www.so.ch/departemente/bau-und-justiz/amt-fuer-umwelt/ fachbereiche/steine-erden-geologie/geologie.html?0=
SO	Dataviewer	http://www.sogis1.so.ch/sogis/internet/pmapper/map.phtml?
SO	Spatial web-services	http://www.so.ch/departemente/bau-und-justiz/sogis/ web-map-services-wms.html
SO	Geology for laymen	http://www.so.ch/departemente/bau-und-justiz/ geologische-sehenswuerdigkeiten/durchblicke-in-die-urzeit.html
Canton Vaud (VD)	homepage geology	http://www.vd.ch/fr/themes/territoire/geologie/
VD	Dataviewer	http: //www.vd.ch/fr/themes/territoire/geologie/cadastre-geologique/ consulter-des-donnees/carte-des-sondages-geologiques/
VD	Glossary	http://www.vd.ch/fr/themes/territoire/dangers-naturels/ informations/lexique/
Platform Geosciences (sc|nat)	home	http://www.geosciences.scnat.ch/
sc|nat	Stratigraphic lexicon	http://www.stratigraphie.ch/
sc|nat	Job portal	http://www.geosciences.scnat.ch/index.php?nav1=2&nav2=166
sc|nat	Event calendar	http://geosciences.scnat.ch/index.php?nav1=3&nav2=33
sc|nat	Geology for laymen	http://geosciences.scnat.ch/index.php?nav1=1&nav2=120
sc|nat	Address database	http://geosciences.scnat.ch/index.php?nav1=3&nav2=34
Swiss Geotechnical Commission (SGTK)	2	http://www.sgtk.ch/main.asp?content=inhalt/start.htm&nav=10
SGTK	Shop	http://www.sgtk.ch/inhalt/shop/candypress/Scripts/default.asp
Swiss Geophysical Commission (SGPK)	homepage	http://www.sgpk.ethz.ch/

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Tab. C.2 – continued from previous page

Organisation	**Component**	**URL**
SGTK	Non-spatial web-services	http://www-geol.unine.ch/GEOMAGNETISME/difcalc.htm and http://www.sgpk.ethz.ch/ > Quality guidelines for geophysical methods
Department of Earth Sciences Swiss Federal Institute of Technology Zurich (ETHZ)	homepage	http://www.erdw.ethz.ch/
ETHZ	Non-spatial web-services	http://www.seismo.ethz.ch/
ETHZ	Shop	https://www.shops.ethz.ch/dienste/anwendungen/benutzerdb/scripts/main.php
ETHZ	Geology for laymen	http://www.focusterra.ethz.ch/
Swiss Association of Geologists (CHGEOL)	homepage	http://www.chgeol.org/
CHGEOL	Job portal	http://www.chgeol.ch/d/2/jobs.asp
CHGEOL	Event calendar	http://www.chgeol.ch/d/2/agenda.asp
CHGEOL	Geology for laymen	http://www.erlebnis-geologie.ch/d/index.php