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International Consortium
of Geological Surveys

Seminar on

Application of geoscience mapping and related geoscientific products in the 21st Century

Rio de Janeiro, August 15-16, 2000

31st International Geological Congress
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ABSTRACTS

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ICOGS (International Consortium of Geological Surveys):

Application of geoscience mapping and related geoscientific products in the 21st Century and Business Meeting
31st IGC, Rio de Janeiro, August 15-16, 2000
Room G-9

Conveners: Raimundo Umberto Costa (Brazil) and Gabor Gaál (Finland)

PROGRAM

Tuesday, August 15, 13:00-17:30, room G-9

13:00-13:10	Opening - Application of geoscience mapping and related geoscientific products in the 21st Century
13:10-13:40	*Keynote - GENERAL* *Asch, K. (Bundesanstalt für Geologie und Rohstofforschung, Germany): The Geological Map - Masterpiece or Anachronism*
13:40-14:00	Varet, J. (BRGM – French Geological Survey): Geology and society in the 21st century, a strategic view for geological surveys - Introduction
14:00-14:20	Shaikh, N. A. (Geological Survey of Sweden): Growing need for thematic geoscientific products
14:20-14:50	*Keynote - EUROPE* *Varet, J. (BRGM – French Geological Survey): Geoscience on the Web*
14:50-15:10	Ian Jackson (British Geological Survey): Staying relevant: Delivering geoscience knowledge in a digital era
15:10-15:30	Brezsnyánszky, K. et al. (Geological Institute of Hungary, Hungarian Geological Survey): Geoscientific information service in Hungary, past and future
15:30-16:00	*Keynote - AUSTRALIA* *Willams, N. and Lambert, I. B. (Australian Geological Survey Organization): Geoscience for the new millennium: A perspective from the Australian Geological Survey Organization*
16:00-16:20	Griffin T.I. (Geological Survey of Western Australia): Customized, high-quality geoscience maps from the one comprehensive database – your choice of content, scale, size and medium
16:20-16:40	Short presentations and possible late arrivals
16:40-17:30	General discussion

Wednesday, August 16, 13:00-17:30, room G-9

13:00-13:30	*Keynote – AMERICA* *Broome, J. (Geological Survey of Canada): New directions for delivery of geoscience knowledge at the Geological Survey of Canada*
13:30-14:00	*Keynote – ASIA* *Kodama, K. et al. (Geological Survey of Japan): Geoscientific Information and Geohazard Mapping in Eastern Asia*
14:00-14:20	Topchishvili, M. (Geological Institute, Georgia): Litho-paleogeographic map of Georgia in scale 1:500.000
14:20-14:50	*Keynote – AFRICA* *Frick, N. (Geoscience Council, South Africa): Geoscience products which require a low level of public understanding of science and technology to promote local economic development in Africa*
14:50-15:10	Kohonen, J. (Geological Survey of Finland): Application of high-tech IT in developing countries
15:10-16:00	General discussion
16:00-17:30	*ICOGS Business Meeting (for GS directors and associates)*

THE GEOLOGICAL MAP: MASTERPIECE OR ANACHRONISM

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For several centuries the geological map has been THE means for geologists, not only to disseminate their information and knowledge of rocks and unconsolidated deposits at the Earth's surface, but also to record and store that information. Geological maps have provided the basis for understanding earth processes and the distribution and incidence of natural resources and hazards. To the expert eye geological maps not only depict the surface distribution of rocks but also predict their disposition at depth. Geological maps, produced by the partnership of skilled cartographers and geologists, exemplify the art of presenting complex science in an aesthetically pleasing way. These skills were taken forward and refined in several countries and often in parallel (or example the maps of William Smith in England, Von Buch in Germany, W. Logan in Canada, J.E. Guettard in France). These maps often attempted to hold and display every detail and piece of knowledge the eminent scientists recorded. Further, in every geologist's mind, behind the map, is a developing (for it is never finished!) 3 and 4 dimensional model of the small piece of crust he is surveying.

With the advent of Information Technology however, the factors that constrained our predecessors no longer have to be. Modern computing systems (for example relational databases, GIS and Web tools) allow us to store, retrieve and present far more information and knowledge about an area than we could ever display on the surface of a 2 dimensional piece of paper. The key point is that we can now separate the storage and recording of information from the means of disseminating it; we are no longer forced to try and serve all purposes with the same "general purpose document". We can select the area, change the scale and topographic base, choose the theme, amend the colors and line styles. We can disseminate the knowledge in an infinitely variable number of ways, delivering it on paper, on CD, or across the Web and choose a variety of resolutions, qualities and levels of complexity. Increasingly geologists are now using modeling software to create 3 and 4 dimensional models, allowing users, through a variety of visualization methods, an insight into the originating scientist's interpretation of the rocks below our feet. Many more users in the next few years will see these models as virtual reality displays on their PC screens and in "Data Caves"!

So where do the revolutionary developments in Information Technology of the last 20 years leave the traditional geological map? Does it still have a role to play in the 21st century? Will the paper geological map survive the next century? Is our next challenge to exploit this new technology more effectively to better meet our user's needs? This presentation will raise some of these questions and discuss the issues.

GEOLOGY AND SOCIETY IN THE 21ST CENTURY, A STRATEGIC VIEW FOR GEOLOGICAL SURVEYS - INTRODUCTION

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This paper is an attempt to provide a prospective view on geological surveys major issues in the 21st Century based on an analysis of the evolution of society and of the key achievements and pending issues in the Earth Sciences. It is based on the data provided by the annual questionnaire issued and exploited by BRGM during the last 20 years. It focuses on the major strategic objectives that Geological Surveys must identify in order better to fulfil societal needs of the 21st Century.

This overview attempts to

(i) consider the major relevant past and future changes in society, '
(ii) examine the evolution of research in the Earth Sciences,
(iii) precise the major trends encountered by geological surveys in Europe in the past 20 years, and
(iv) infer from this comparison the challenges facing Geological Surveys. As the major aim of the Geological Survey is to serve societal needs by mobilizing geology effectively, it is hoped that this approach will provide relevant information to give advance warning of potential problems and lacunae.

In addition to challenges in scientific research and data management using New Technologies of Information and Communication (NTIC), networking will have to be developed in terms both of interdisciplinary (including the social sciences) and of integration of information at local and global levels. Here regional survey organizations have a major role to play in facilitating these challenges while respecting the subsidiary principle.

GROWING NEED FOR THEMATIC GEOSCIENTIFIC PRODUCTS

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In recent years government of many countries have restructured the Geological Survey organizations in a way that organizations have become more customer/user oriented. Products, which are produced, must be relevant to the problems with which the general public is concerned. The Geological Survey of Sweden (SGU) has undergone a rather drastic change. Government has given new and well-defined goals. This has led to that SGU being a production-oriented organization in the past has become a demand-oriented organization. The focal point is to synthesize the basic geoscientific information further into various kinds of thematic products, which directly meet the changing needs of the society.

Geological Surveys have extensive geological databases containing data and information both as conventional maps, files and databases. These databases are continuously updated. The needs of the community and customers must be given priority. Digital geoinformation increase considerably the application possibilities of the data in various fields. Many different kinds of thematic maps/products can be produced by modifying and reclassifying the geological data. It is a great challenge for geoscientists to develop the key components of the decision-making tools and methods to exploit geological data and facilitate its uses in the modern society. Decision-makers must be constantly made aware of the possibility and importance of the geoscientific data and how it can assist in the decision-making process. Geological Survey organizations must try hard to present their primary and synthesized information in such a way that potential user find it relevant and understandable in order to draw maximum advantage from it. Thematic maps which directly illustrate various possibilities and limitations will certainly provide sound basis for effective environmental management and regulatory control in exploitation of our natural resources.

Geological data has been used in regional planning only to limited extent but GIS applications present new possibilities in the utilization of this data. The proper consideration of sustainability, in regional planning demands more attention given to the geological factors.

In hard exploited densely populated centers around the world, there is an increasing need to place many functions serving the community like new traffic routes, parking, storage and sports facilities in the underground. By processing the combined data (geology, geophysics, rock mechanics) new classification and models can be prepared illustrating for decision makers the suitable places for cost effective construction and for safe disposal of certain waste/rest products.

GEOSCIENCE ON THE WEB

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One of the major task of Geological Surveys, if not the only one, is to provide geological data to the public, whether policy makers, enterprises, scientists, or the society in general. During the last 150 years, this was mainly achieved through publishing geological maps, generally quadrangles covering the whole (if possible) concerned country, as well as settling libraries, data banks and documentation centers.

The development of information technologies allowed for new approaches based on lexical systems and dictionaries. Geological Information Exchanges Systems could hence be developed at continental scale, allowing to make available to survey personnel, geologists world-wide, and the public in general, information on what is available (in term of maps, data banks, publications, etc...) in each geological survey. In Europe, GEIXS, developed in 1998-1999, was a major advance in this respect. Such systems are based on meta-data. They allow to know where the data are, and eventually how to obtain them, but do not offer a direct access to the data.

Another step can be achieved now, based on systems recently developed for e-commerce. This allows obtaining on line, not only the meta-data, but also the data themselves, whether maps, publications, analysis, lithographic sections, photographs of outcrops, samples or thin section. This is particularly pertinent for hydrogeology, polluted soils or natural hazards, as it allow to display quantitative as well as qualitative information. It also allows regulating the distribution of the information according to legal (ownership) or economic (pricing system). Such a system was developed by BRGM with the INFOTERRE site in France.

We are now facing a new challenge, due to the development of new information and communication technologies (NTIC), but also to globalization of the economy, as well as integration of Europe (as an economic cultural and political entity). This requires the surveys to be able to built jointly a new, coherent, unique, 3D information system, covering the whole European space with geological information of guaranteed quality. The system should not only provide the geological contours and structures, but also geophysical, geochemical, geotechnical, as well as hydrogeological, mineral resources, natural hazards and anthropic data (pollution, cavities, etc).

The aim of this paper is to provide a first description of this system, as a base for discussion among geological surveys.

STAYING RELEVANT: DELIVERING GEOSCIENCE KNOWLEDGE IN A DIGITAL ERA

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The Context

Like most other European geological surveys, the British Geological survey (BGS), is a public sector research organization with a mission to acquire, analyze, manage and disseminate geoscience information and knowledge, in order to contribute to the quality of life and economy of the UK. When BGS and many other surveys were founded in the mid-1800s, the factors driving geological surveys were scientific understanding and frontier exploration. These drivers have evolved over the years, through resource assessment and economic development to the present day concentration on environmental issues and societal benefit (Findlay, 1997). In response most national geological surveys have changed the focus of their activities, from initial primary mapping, through resurveys, to thematic mapping and several are now embracing client-driven research and the improved management and dissemination of their unique knowledge bases. In the last 20 years two other significant factors have appeared, declining budget allocations from governments and the IT revolution. This, then, is the context in which geological surveys now have to operate. The world at the beginning of the 21^{st} century presents both opportunity and threat, but one thing is certain – it would be foolish indeed for any geological survey to assume that their current *modus operandi* will continue unchanged.

Despite most surveys having over 100 years of public service and geological map production behind them, the relevance of geology to managing our environment (both resources and hazards) is still not as widely understood outside the geoscience profession as it should be. Regrettably, too many of today's decision-makers (and fund-holders) – the politicians and the businessmen - are often woefully unaware of the critical role geological factors can play in disaster mitigation and planning, environmental protection and sustainable resource development. Perhaps worse is the ignorance of the comprehensive and unique information and knowledge bases that exist, under-exploited, within each national survey.

So who is to blame for this lack of awareness? Those of us who claim to embrace the client-focus ethic must also be prepared to accept the dictum that "the customer is always right"! So we (the geological surveys) have to accept responsibility - on two counts. First, decision-makers don't know about *us* because *we* don't inform them effectively. Second, too often *we* fail to address the customer's real needs. There is little or no meaningful dialogue to establish their requirements and a tendency to offer what *we* think they should have, frequently coupled with an ongoing (arguably myopic) concentration on traditional "academic", geological map, output. The latter, while essential and comprehensible to fellow geoscientists, generally leaves the end-user impressed by the elegant color scheme but otherwise uninformed. To stay relevant surveys have to address these issues. This abstract describes recent BGS initiatives that are attempting to do this.

Meeting the Challenge

It is worth making clear that this paper is not challenging the absolute necessity of a strong foundation of high quality geoscience research and knowledge. But there is an urgent need to reassess the traditional focus on complex "academic" output. There is a need to build products and services that genuinely meet society's requirements. These products need to be expressed in a way that is meaningful to the largely non-geoscientific end-user and made available to them when they need it and in the format they require. In order to do this successfully we must understand more fully what the customer needs, a difficult task, requiring time-consuming dialogue *and listening*, perhaps in one-to-one interviews, or market sector forums. "Public Understanding of Science" programs might be better replaced by "Scientists Understanding the Public"! If we can tease out the requirement, we have never been better equipped to be able to meet it. The availability of inexpensive, powerful and sophisticated IT tools and especially Internet technology provides all surveys with the facility to deliver customized and flexible products based on their unique geoscience knowledge bases.

In November 1999 BGS launched a new corporate strategy. This confirmed that the emphasis of its programs would change from systematic survey, data collection and internally driven research to the management, dissemination and application of knowledge to meet the needs of its clients. To implement this strategy BGS is pursuing several major initiatives to deliver geoscience knowledge in the digital era.

Geoscience Integrated Database System (geo-IDS)

A program whose overall aim is to introduce a coherent approach to information policy and practice in BGS that will underpin knowledge delivery. Sub-projects within geo-IDS are defining and implementing corporate data management policy, a logical data model, metadatabase, data and application software standards, common geological and cultural datasets and GIS-enabled intranet access to the data for all BGS geoscientists.

DIGMAPGB

BGS completed vector, attributed (GIS) digital geological map cover of the UK at 1:250 000 scale in 1999. By the end of this year it will complete vector digitization and GIS attribution of all 534 1:50 000 scale sheets in Great Britain and complete more detailed 1:10 000 digital cover for all urban areas (2500 sheets) 12 months later. While this dataset is fundamental to many other "applied geoscience" initiatives, its achievement means that truly flexible, on-demand, site-centered geological mapping at high quality and resolution can be offered for anywhere in the country.

Digital Geological Spatial Model (DGSM)

In reality this is more than a program; it marks a whole new philosophy for BGS in terms of how it will acquire, organize and describe its data. Work has just concluded to define the program. It is seen as having two elements 1) DGSM-Framework, which will construct the 3/4 dimension architecture, standards, software applications and procedures; and 2) DGSM-UK, the population of the framework. The second element will not just use specific DGSM funds (an additional 4.5 million pounds over 5 years) but also incorporate all other BGS work in the UK, which will be expected to comply to the standards set; feed in data to the framework and thus gradually build up the model. Models, is probably more appropriate, as it is envisaged that the DGSM will comprise consistent structural models, geochemical models, hydrogeological models, etc.

Digital Report Generating System (DRGS)

While significant geological survey resources have gone into the digitization of maps and "structured" (tabular) data, it is a fact that much knowledge is locked in accompanying "unstructured" narrative text and reports. The objective of the DRGS project is to unlock this considerable knowledge source by creating a system that allows information to be retrieved flexibly and geoscientific reports to be generated semi-automatically to meet specific requirements. The system is based on Standard Generalized Mark-up Language, designed for structuring complex technical documents but also exploits GIS and web-based interactive technologies.

Site Specific Products

For several years BGS has been increasingly moving away from the geological map sheet paradigm, to the digital delivery of customer-specific information for particular sites or locations, e.g. a house or property (using, in the UK, a postcode). One very successful example is a system for assessing geological risk for the insurance industry. The cost to insurance companies of settling claims for damage caused or influenced by geological factors runs to millions of pounds every year in the UK. BGS has developed a commercial product, in collaboration with an insurance industry partner, (trade name, "Residata Subsidence") to assist the insurance sector in establishing more accurate and detailed buildings insurance ratings. It gives underwriters a better understanding of their exposure to risk of geological hazards and helps them diagnose the type of problem present in each claim. The system is based on 1:50 000 and 1:10 000 scale geological map data plus other BGS databases and the local knowledge of the geoscientist. It provides an assessment of shrink/swell clays, landslips, cambering, shallow mining, natural dissolution and compressible deposits for each UK postcode (about 13 houses in an urban area). The system delivers a quantitative assessment of susceptibility to each hazard for each postcode - *reducing geological knowledge to a single number* - to be used by insurance companies as one of a series of variables in their premium calculations! BGS has also recently introduced a GIS-based system for automatically generating reports on the radon risk at any specific location (which can be specified either by coordinates or address through the postcode).

The Internet

The major overarching element of the new BGS strategy is to accelerate the switch of focus and resources away from output based on conventional media, to Internet delivery of data, information and knowledge. BGS products will be available either for free, on its existing web-site, www.bgs.ac.uk, (particularly "internal" standards and dictionaries), or for a price, on its e-commerce site, www.british-geological-survey.co.uk, launched in April 2000. Site-specific report delivery, of the type detailed above and flexible digital map data provision, will rapidly follow the first stage of selling the conventional product range on-line.

In Summary

The future success of BGS and other national surveys is likely to depend as much on how effectively we manage and disseminate our current knowledge as on how we acquire more. Understanding user, i.e. society's need and exploiting IT to meet that need, will be critical factors.

GEOSCIENTIFIC INFORMATION SERVICE IN HUNGARY, PAST AND FUTURE

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Geoscientific information refers fundamentally to the makeup and evolution of the Earth's crust as well as the spatial distribution and temporal succession of geological events. They are traditionally displayed on maps. The information represented on maps is a true mirror of the state of development of geological knowledge. Due to its impact on the national, economic and cultural life creation, processing and publication of geological information of a county is essentially a national task. In Hungary the Geological Institute of Hungary is the responsible institute for performing this mission. Since its foundation in 1869 it is the only organization in our country completing systematic geological survey as well as publishing regional and national summarizing maps.

The systematic mapping launched in 1869 in the Geological Institute has always corresponded to the scientific level of the given era and satisfied increasingly growing thematic demands. Geological mapping proceeded in the last century on the scale of 1:144.000 but the strive for gaining more detailed knowledge progressively enhanced the scale and precision of the surveys. Modernization left an impact on applied methods reflected among others in using aerial images in the first half of the XXth century beside traditional mapping techniques. Prospecting raw materials got substantial impetus after World War II further increasing the need for detailed survey. The 1:200.000-scale geological map series of Hungary based on 1:25.000 survey was completed during this period.

The social-economic development, the recognition of the serious damage imposed by man on the environment and the technological advance revolutionized the way in which geological information is transferred and maps are prepared. Digital techniques gained the upper hand over traditional printing technologies pushing them to the background and allowing following fast changes. Nevertheless, practice shows that traditional methods are still needed for meeting special demands.

During this period previous mapping data were summarized in syntheses in Hungary. Simultaneously, digital mapping techniques were introduced and put in practice. 1:500.000 synthesis maps have still been prepared using traditional methods but new surveys were supported by GIS: instead of a single effort to prepare geological maps improvement of digital methods facilitated integrating them into a complex information system. A uniform mapping system for plains and hilly lands has been elaborated. Its significance was further improved by the fact that in contrast to traditional survey techniques used in mountain areas it put an emphasis on describing near-surface sediments. As a result Quaternary mapping, hydrogeological, agrogeological, engineering geological and environmental geological surveying, sampling and complex analyses gained substantial impetus. These programs on plains represented the first practical examples of building large databases and processing digital maps.

Using information technology the traditional map representing the cartographic „final product" of the map-based databank is detached from the database; fast production and reproduction techniques of large digital data volumes facilitate, however, their preparation. At the same time, transfer of large data volumes increases the need for uniform, standard methods, and changes in the means of data processing („data-mining") also increase the importance of computer-assisted operations.

In Hungary, geological data service and processing are supported by Intergraph MGE and Arc/Info GIS. They facilitate preparation and digital processing of the 1:100.000-scale geological map series of the country sheet by sheet. The digital geological and simultaneously processed well databases together with applied geological (agrogeological, engineering geological, etc.) maps promote detailed study of specific geographic, geological or political land units. In turn it supports to give professional answer to questions emerging through social-economic development but in different way in different regions. 1:500.000-scale maps of the generalized geological map series of Hungary were produced using archive-mapping data. Their digital processing is currently underway. They will be made available for national administration facilitating the survey of environmental vulnerability of regions to be just created.

The future of geological data service and geological mapping is determined by two principal factors.

One of them states that servicing geological information of high level remains the basic task of the Geological Institute. This task is financed from state budget. Improvement of geological data service is elaborated in many aspects, like:

- continuation of mapping using modern means,
- compilation of generalized, overview sketches on scale 1:250.000–1:500.000–1:1.000.000 based on the results of 1:100.000-scale mapping
- preparation of maps displaying the depth, thickness and geology of buried formations as attached to the 1:100.000-scale series
- preparation of 1:100.000-scale thematic map series (groundwater, environmental, soil-mechanical etc.)

The other factor is represented by the change from the current principally 2D processing to 3D interpretation and modeling supported by the development of information technology. Setting up the meta database of our databases, launching internet and intranet services can be expected in the following years. Joining the GEIXS international system was an important step in improving international access of our databases and preparing our entrance in the EU. Our institute has taken part in the creation and maintenance of METATÉR and KIKERES database systems attached to the national administration system and representing one of the bases of domestic meta database service.

GEOSCIENCE FOR THE NEW MILLENNIUM: A PERSPECTIVE FROM THE AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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The modern geoscientific framework established by the past generation of geoscientific mapping has resulted in a more comprehensive understanding of the geology of Australia and its mineral and petroleum resource potential. This framework is underpinned by structured databases for effective storage, management and manipulation of spatial data; digital cartography for rapid map output; and modern systems for the integration and analysis of multiple spatial datasets. All of this is leading to more efficient and effective exploration, and reduced exploration risk, thereby making Australia an attractive site for exploration investment in the face of increasing global competition.

The role of the Australian Geological Survey Organization (AGSO) is changing, premised on the view that a national geoscientific organization needs make fundamental contributions to meeting a range of societal needs – to achieve enhanced potential for the Australian community to obtain economic, social and environmental benefits through the application of first class geoscience research and information. Accordingly, while continuing activities that assist discovery of mineral and petroleum resources and enhance the global attractiveness of Australia for exploration investment, AGSO is developing important new activities in support of:

- improved resource management and resource policy decisions;
- environmental protection, land and marine use planning;
- targeted management of land and water degradation;
- mitigation of geological hazards, such as earthquakes, volcanic eruptions, and landslides; and
- enhanced use of Australia's geoscience capability to meet foreign and trade policy objectives.

To this end, AGSO is concentrating on:

- adding value to the existing knowledge base by a strategic approach to the science of survey work;
- targeting specialized areas and technologies where it can uniquely add value; and
- providing scientific and technical information and advice to an increasing range of clients.

This paper overviews AGSO's petroleum and marine program and its geohazards program, both of which have been growing rapidly. It then deals in more detail with the minerals program, which has developed new priorities in the face of budgetary constraints arising from the Federal Government's limited responsibilities for exploration and mining.

Petroleum and marine program

AGSO has dramatically increased its marine program since the mid-1980s, when it took a long-term charter for a research vessel to test and promote petroleum prospectivity of offshore basins. In particular, *Rig Seismic* was used to acquire high-quality seismic data, in conjunction with geochemical analyses of the seabed sediments and water column.

Although the *Rig Seismic* charter was terminated in 1997, roughly half of AGSO's budget is now committed to its program in Australia's marine zone. A range of vessels, technologies and databases is being used to provide geoscience information for:

- petroleum exploration in frontier basins;
- Australia's claim under Law of the Sea;
- developing marine zone management plans; and
- mitigating the impact of development on estuaries and the coastal zone.

AGSO applies the petroleum systems approach – identifying potential source rocks, migration pathways and traps. Several remote sensing and geochemical tools are used to detect leaking petroleum; multibeam-sonar systems for seabed mapping; and monitoring technologies to detect nutrient processing in estuarine and coastal sediments. These activities provide information that is also used in providing advice to governments at federal, state and local levels for resource planning and management purposes.

Geohazards program

This is a relatively new and exciting field for AGSO. It involves working with governments and communities in providing research-based geohazard and geomagnetic information and expertise for the safety and well being of communities. The key work areas are risk from natural hazards; earthquake monitoring; nuclear explosion detection and advice; geomagnetic monitoring and applications; and natural hazards in neighboring nations. Vulnerability mapping, disaster information networks and decision support tools are important elements of this multi-disciplinary work.

Minerals program

After a decade of collaboration with State/Northern Territory geological surveys in modern geoscientific mapping under the National Geoscience Mapping Accord, Australia is developing a new National Geoscience Agreement. Through the 1990s, AGSO acquired and interpreted high-resolution regional airborne magnetic and gamma ray spectrometric data, for rapid, cost-effective, systematic definition of structure and lithology in diverse geological provinces and terrains. Magnetic and gravity data proved crucial in determining basement geology and structure, and continuity of basement under cover.

Other important technologies and studies used extensively include multi-spectral imagery; GPS navigation; deep seismic reflection surveys to define crustal structure; precise geochronology to establish time relationships of key geological units and events; and multi-element geochemistry for lithological characterization and definition of background values and anomalous regions.

Moving into the new millennium, AGSO is building on this strong foundation, again in collaboration with the States and Northern Territory, shifting its focus to:

- tackling specific major problems – particularly in relation to exploration for buried ore deposits;
- using geoscientific information in a wide range of applications – involving an emphasis on information management, "on line" accessibility, filling information gaps and extending the client base.

Exploration for minerals in Australia is increasingly facing the tyranny of depth. One facet of this relates to locating mineralisation through regolith (weathering products and transported materials) and thin sequences of sedimentary strata that form extensive blankets across Australia – studies of regolith features, integrated with airborne geophysics, are assisting in this regard. A second facet relates to facilitating exploration at depths of greater than the hundred meters or so in major mining districts – seismic transects and detailed gravity data are increasing knowledge of geological features at depth.

To assist exploration for buried mineral deposits, AGSO continues to apply a multidisciplinary "mineral systems" approach, which employs high level conceptual thinking and effective integration and analysis of multi-dimensional spatial datasets. This extends beyond traditional mapping to identifying and mapping the essential elements of mineral systems for key commodities, to provide a larger target than the ore deposit. In addition, the mineral potential of geoprovinces across Australia is being evaluated.

AGSO is developing increasingly influential roles in facilitating decisions on contentious land use issues – for example, it has been involved in Government processes considering uranium mining proposals, sustainable management of forested lands, and suitable sites for a national radioactive waste repository. It is also working with other agencies on land and water degradation, particularly dryland salinity – an holistic geological systems approach is being used to increase understanding of the underlying causes of degradation, so that remedial actions can be better targeted. AGSO's important roles in such activities involve integrating and analyzing relevant geoscientific and other information in advanced GIS-based decision support systems.

CUSTOMIZED HIGH-QUALITY GEOSCIENCE MAPS FROM THE ONE COMPREHENSIVE DATABASE - YOUR CHOICE OF CONTENT, SCALE AND MEDIUM

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Thirty eight published 1:100 000-scale geological maps from the mineral-rich Eastern Goldfields Province of the Archaean Yilgarn Craton, Western Australia, have been combined to form two large datasets for use in a Geographic Information System. These maps were published from the early nineteen eighties to the present, and were mapped by a variety of authors. The southern portion of the dataset comprises twenty maps covering 55 000 km^2 between Norseman and Menzies and includes the Kambalda and Kalgoorlie regions. Considerable effort has been made to produce a seamless database of the 1:100 000-scale outcrop geology through the elimination of discrepancies along map sheet boundaries, and the adoption of standardized rock type codes and definitions.

The outcrop geology data has been stored in a spatial database as polygon, line, and point themes. Additional themes include interpreted Archaean geology at 1:250 000-scale, historical mine workings, locations of identified mineral resources, and mineral exploration and mining tenement information. Digital pseudo-color images of Landsat TM and aeromagnetic data are also provided.

Software, based on Arcview®, has been developed to create RoxMap, an interactive map-making tool to use with the seamless database. RoxMap allows the client to choose the data to be displayed, the degree of labeling, the scale at which the map is to be presented, and the size of the sheet of paper if a hard copy is required. The resulting map can be checked on screen prior to either printing as a multi-colored map sheet or copying to a digital file. The automatically generated map contains all the elements that one normally expects in the margins of a traditional hard copy map, including the scale, a map title, and the rock reference that is automatically tailored to the area selected for display. In addition, information is provided in the margins about the versions of data used in the map, together with a date stamp. The development of seamless databases allows for regular updating of the map information, irrespective of whether the changes are large or small.

This approach to map-making is seen by the Geological Survey of Western Australia as the future of map production. Progress is well advanced in setting up spatial databases into which geological map data are collated. The RoxMap software represents the first phase of software development that will ultimately see all maps produced directly from the spatial database by this process. The generation on-demand of customized, high-quality, geoscience maps will have a major impact on the way we carry out our business, particularly when this facility can be delivered on the World Wide Web.

NEW DIRECTIONS FOR DELIVERY OF GEOSCIENCE KNOWLEDGE AT THE GEOLOGICAL SURVEY OF CANADA

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Catalysts to Change

Dramatic advances in data management and communications technology have presented many new opportunities for government and business. In Canadian geoscience agencies, developments in digital field systems, GIS-based project data management, digital cartography, and the Internet have coalesced into systems in which geoscience data remain in the digital domain from field acquisition through to publication. This new methodology has resulted in more rapid release of products, the ability to publish map data in digital form, and the potential to deliver geoscience information to a broader range of users. The growing dominance of the Internet as the source for scientific knowledge has led to worldwide recognition of the value of developing network-based knowledge infrastructures at national and global levels. Within Canada, the GeoConnections Program (http://geoconnections.org) has been established to develop the Canadian Geospatial Data Infrastructure.

The Geological Survey of Canada is seeing a gradual shift in its mission from geoscience research, frontier exploration, and support for national resource exploration, to management of the national geoscience knowledge base to support sustainable economic growth, environmental management, and health and safety. With this change has come the realization that traditional geoscience products and delivery mechanisms do not meet the needs of non-traditional users. As a result, the Geological Survey of Canada is currently investing in initiatives to develop client-focussed Internet access to their knowledge assets and integrate them into national and international geospatial data infrastructures.

Developing the Canadian Geoscience Knowledge Network (CGKN)

Canadian government geoscience is conducted by 12 federal and provincial agencies with the National Geological Surveys Committee as the coordinating body. The Geological Survey of Canada is actively collaborating with provincial agencies in promotion of a common national approach to geoscience data management. In 1998, the National Geological Surveys Committee became actively involved in development of the Canadian Geoscience Knowledge Network (CGKN) (http://cgkn.net) which will provide a single Internet portal to distributed Canadian government geoscience data and become the geoscience node of the Canadian Geospatial Data infrastructure.

The first collaboration of geological surveys toward CGKN objectives is the Canadian Geoscience Publications Directory (http://ntserv.gis.nrcan.gc.ca/), which supports searches for geoscience publications from all agencies. The Canadian Geoscience Publications Directory web site supports interactive geographic and text-based searches for geoscience publications and displays search results on a geological map background. This Mapguide®-based web site was developed and continues to be maintained by the Geological Survey of Canada.

The first CGKN workshop involving representatives from all Canadian government geoscience agencies was held in December 1998. The objective was to refine the CGKN concept and investigate how federal, provincial, and territorial agencies could cooperate on its development. The CGKN concept received strong support from all participants. Key recommendations were that each survey participate in the CGKN at its own rate, fund its own activities, and maintain its own data locally; that the CGKN should adopt existing international standards, protocols, data models; and that the CGKN should be managed by the National Geological Surveys Committee. There is broad agreement that CGKN development must be an iterative process involving cycles of design, testing, and implementation. This approach will ensure that the architecture and standards evolve in a manner that meets the needs of stakeholders and take advantage of the anticipated rapid improvements in technology for management and delivery of diverse distributed data such as the OpenGIS initiative.

During 1999, CGKN agencies continued design and construction of data management and delivery systems that would ultimately be integrated into the CGKN. At the Geological Survey of Canada, the ResSources GSC Program (http://rgsc.nrcan.gc.ca/) continued work on a suite of projects that demonstrate innovative approaches to Internet delivery of diverse geoscience data. The ResSources GSC Program has achieved a dramatic increase in the volume of on-line Geological Survey of Canada data since 1998.

A Canadian Geoscience Data Model

Geoscientists have become increasingly aware that common standards for data management are essential for integration of maps and data across political and map boundaries. This awareness led to CGKN establishing the Canadian Geoscience Data Model Working Group to coordinate the implementation of national standards, data models, and thesauri for geoscience data. Canadians are active participants with United States Geological Survey and American State geological surveys in the design and testing of the North American Data Model.

A 2nd CGKN workshop was held in June 2000 to evaluate the results of a survey of geoscience data models currently in use at government geoscience agencies and determine if existing models can be adopted or modified to meet the needs of the Canadian geoscience community. This workshop built on the success of the first workshop by setting in place more detailed plans for development of CGKN and establishment of a Canadian Geoscience Data Model.

The Future: Challenges and Opportunities

The first CGKN priority is preparation of a catalogue of government geoscience data set that is searchable via the Internet. While this on-line catalogue will greatly aid discovery of data, there will also be a client expectation that newly discovered data can be obtained in consistent digital form. To meet this expectation, some surveys may have to increase their investment in digitization and management of their data. A more consistent corporate approach to knowledge management has been identified as a priority at the Geological Survey of Canada and steps are being taken to accelerate preparation of consistent digital data managed in conformity to CGKN standards.

Once the CGKN standards and infrastructure are in place and consistent geoscience data become available in digital form, the emphasis can shift to adding value to geoscience data through customization of delivery to support non-traditional uses and through integration with other types of data. If this goal is achieved, the value of geoscience should become more widely recognized by society, which will have a positive effect on future funding and investment in geoscience.

GEOSCIENTIFIC INFORMATION AND GEOHAZARD MAPPING IN EASTERN ASIA

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SANGIS (Southeast Asian Network for a Geological Information System)

This is a geological information management project aiming at developing a regional geosciences information network in Southeast Asia. UNESCO member states adopted a resolution in their General Conference instructing the UNESCO Secretariat to develop programs and actions aimed at increasing the use of scientific data, especially geological data in the political/social decision making process. The first workshop was held in Bangkok, July 1999 and five issues were recommended as follows:

1) CCOP (Co-ordinating Committee for Coastal and Offshore Geosciences Program), an intergovernmental organization whose members are consisted of Cambodia, China, Indonesia, Japan, Korea, Malaysia, Papua New Guinea, Philippines, Thailand and Vietnam as focal point,
2) Increase use of geologic data (application development support, language translation, data sharing-start with bibliography),
3) Modernize geoscience data handling (provide modern hardware and software, assistance to convert paper to digital data, assistance in database development)
4) Training (Application design and development, databases development)
5) Consultation with each country before implementing the project

DCGM (Digital Compilation of Geoscientific Maps)

This project was proposed by the GSJ (Geological Survey of Japan) as a CCOP project in 1991.

The main objective is

- to construct the digital interdisciplinary geoscientific maps of CCOP regions,
- to transfer the technology to analyze the multilayered data sets using GIS
- to develop a geoinformation service system for citizens.

The DCGN project is divided into three phases. In Phase 1, the project newly compiled a small-scale (1:2,000,000) geologic map of East and Southeast Asia. They were digitized by national compilers, some of which were trained by staff of the GSJ and CCOP. ARC/Info and TNTmips softwares were used. In Phase 2, the project treated the offshore sediments and mineral and industrial resources of the given region. MapInfo and TNTmips softwares were used. In Phase 3 (April, 1998-March, 2000), the main purpose is to apply the various techniques of GIS to a large-scale map than those of DCGM Phase 1 and 2. This project includes the technology transfer of data management and compilation using GIS.

The main targets of the DCGN Phase 3 are:

- to construct the digital interdic\sciplinary geoscientific maps of large Urban areas of CCOP regions for preliminary urban planning
- to transfer the technology to analyze the multi-layered data sets under GIS
- to develop the geoinformation service system for citizen

EANHMP (The Eastern Asia Natural Hazards Mapping Project).

This Project coordinated by the GSJ aims to compile 1:5,000,000 scale geo-hazards map of eastern Asia region and to develop relevant databases.

LITHO-PALEOGEOGRAPHIC MAPS OF GEORGIA IN SCALE 1:500 000

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Lithological and paleogeographic investigations of the territory of Georgia (Central and Western Caucasus) have been carried out in the Geological Institute for many years. The results of these researches have been presented in a series of paleogeographic maps compiled for various time spans and in special monographs and papers scrutinizing these problems.

Comprehensive geological and geophysical studies of the territory of Georgia and rich deep-bore-hole material obtained during the last decade have allowed starting working on the compilation of lithological-paleogeographic maps on a 1:500 000 scale. The main principles and legend of these maps are based on those used for the analogous atlas of Central Eurasia of the same scale.

The lithological-paleogeographic maps of Georgia will reflect systematic cartographic depiction of physical-geographic conditions and distribution of principal rock types, both sedimentary and volcanogenic, throughout the territory of Georgia for various geological periods, epochs and ages from Precambrian to Pliocene. The following maps are intended to be compiled: Precambrian - 1 map (R-V), Paleozoic - 2 maps (Cm-O-S, D-C), Mesozoic - 16 maps, including 9 Jurassic ones and 7 Cretaceous, Cenozoic - 7 maps, including 4 Paleogene and 3 Neogene. In all, the atlas will contain 26 maps.

The maps will show, in color, the following geographical environments: marine of different depths, lowlands and uplands, denudation and accumulation areas. Besides, the maps will reflect the total thickness of sedimentary and volcanogenic rocks shown by isopachite lines, location of volcanic centers, various paleotectonic regimes and conditions. In addition, there will be shown deep-seated faults and fault zones active during the given tectonic epoch as well as intrusive magmatic formations.

The maps will be accompanied by generalized historical-geological columns for individual systems and structural-facial zones. Each litho-paleogeographic map will be also accompanied by the explanatory note containing description of all the litho-stratigraphic units (together with faunal and floral index forms) shown on the maps.

GEOSCIENCE PRODUCTS WHICH REQUIRE A LOW LEVEL OF PUBLIC UNDERSTANDING OF SCIENCE AND TECHNOLOGY TO PROMOTE ECONOMIC DEVELOPMENT IN AFRICA

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Geological Surveys derive their origins from the British Geological Survey well over one and a half century ago, and hence all the Geological Surveys established since that time has, in one way or another emulated the research programs of the British Geological Survey of that time. Although the primary objective for the creation of the BGS was the cost-effective establishment of canals for transport in England during the Industrial Revolution, all Geological Surveys created subsequently have played important roles in the global industrialization process. Of particular note was the extent to which Geological Surveys had provided the basic knowledge on which exploration for mineral and energy resources have been based. This, not only contributed to the provision of the metal and energy resources needed for industrialization, but also contributed to the concomitant urbanization processes and to the establishment of the basic physical infrastructure both contributing to and resulting from industrialization.

A characteristic of the outputs of Geological Surveys over the past century has been that the outputs were specialized scientific knowledge products aimed at other geoscientists in the exploration, mining, industrial, engineering and academic sectors. The evolution in the levels of sophistication of the outputs has increasingly made the output products less comprehensible or useable to the non-geologist population of the world.

With the rapid establishment of a post-Industrial Society (Knowledge Society), particularly in the First and Second world countries, the primary concerns of society have also evolved to center, on environmental issues, safety and security, entrepreneurship development and the production of knowledge products and services. This trend has, over the last decade, accelerated and became a crucial factor in a globalized world economy, in which the individual, rather than a company, is fulfilling the role of creating wealth.

Internet, global communications and e-commerce have become the main vehicle to drive information and knowledge dissemination and the use of knowledge for the development of new economic undertakings which is a characteristic of the Knowledge Society. This shift in the evolution from a resource based economy to a knowledge based economy has increasingly presented Geological Surveys with a dilemma, of a shrinking clientele, and the inability to adapt their outputs to serve a Knowledge Society. Clearly, the challenge for Geological Surveys is to develop a new generation of output products, which the average citizen can understand and use to add value to his specific line of business.

In a country such as South Africa, with a duelist economy, consisting of a small first world economy as well as a larger developing economy, the challenge is greater because output products, adding value to the economic aspirations of both groups are dissimilar and have to be developed taking each target group's characteristics into consideration.

The fact that a very large section of the South African Society also has a very low public understanding of science and technology thus requires that Geoscience products, taking the needs of this part of society into consideration have to be developed and produced. In the presentation, examples of such Geoscience products recently produced by the CGS are discussed and their relevance to developing economies are evaluated, both with respect to the unlocking of economic opportunity as well as to enhancing the safety and security of citizens.

CUSTOMIZING MODERN IT IN DEVELOPING COUNTRIES – THE ART OF RECOGNIZING, TAILORING AND RE-ENGINEERING.

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An extensive information technology (IT) project is a big challenge to any organization: new tools, different work routines, new tasks, changing positions, endless chain of training courses. Interestingly, it seems that in real life the obstacles are mainly not technical but cultural in nature. Consequently, it is obvious that such an implementation process is especially difficult in a developing country with short 'high-tech tradition'.

The key fields of IT for most geological organizations are:

- Geographic Information Systems (GIS) and Digital Cartography
- Remote Sensing and Image Processing
- Databases and related 'database engines'
- Internet applications
- Local Area Networks (LAN)

The related applications and projects fall in three categories: (1) Collection and management of geological data, (2) Communication and (3) IT infrastructure.

Key factors and problems in developing countries

There are some features typical for most geological organizations in developing countries.

Financing framework of the organization. In many developing countries governmental institutions suffer from chronic scarcity of budget funding. In addition - and due to the development projects - there are strong fluctuations in funding level; there are project periods and periods of normal government funding. Consequently, it appears that there has been temptation to plan the project procurement lists according to the possible future needs instead of the current needs. Unfortunately, this is not cost efficient practice with the fast developing IT equipment.

Staff resources; both number and profile of staff. Regarding the staff one striking feature is the profile: the percentage of graduated professionals is typically much less than in developed countries. This is an important factor when considering the organization's capacity to assimilate new methods and technologies in the short time of project implementation. There is even a risk that the number of productive professionals decreases during the project with movement from basic geo-activities to IT-activity. Too complicated systems and applications may therefore even decrease the total capacity of an organization

Abundance and availability of data. The most important difference between developed and developing countries is the abundance and availability of data. Almost all the geological institutions in wealthy countries are currently busy arranging the data in uniform and comprehensive databases for efficient analysis and delivery, whereas most developing countries aim to improve the mapping and other basic data collection processes. Also the situation with other data (like base maps) is very variable. These both factors may substantially affect the applicability of systems developed for a different environment.

Status of general IT infrastructure and telecommunications. Status of telecommunications, frequency of power failures and other practical aspects must be considered before final setting of objectives and specifications. Similar factors are the local availability of technical support and spare parts. Proper Internet connections may be rather expensive or not in access at all.

Solutions

Clear objectives and proper planning. The most important part of an IT development program is the specification of the overall objectives. The top management of the host organization has the key role and the focus is ideally in the overall performance of the organization. Real participation and open discussions are the critical elements of the following planning stage. Realistic outputs and timetables with clear milestones form the framework for the project.

Support to the basic processes. Most often the real objective is actually not introduction of IT, but re-engineering of basic key processes and application of IT to those processes.

Simple is beautiful. Low need of system maintenance, proper safety features, utilization of common (off-shelf) software with a local dealer and practical user interfaces with minimum need of computer training are often the keys to productivity.

Evolution rather than revolution. Confusing the host organization is not the mission. Creative tailoring with combination of traditional working methods and high tech applications is the ideal way of implementation. What is technically possible, is not often (most often) functionally justified by real needs.

Follow-up. Proper system documentation is always needed but it can not replace the feeling of having the helping hand waiting... Frequently at the other end of e-mail connection.

GEOSCIENCE MAPPING IN SPAIN AND ITS APPLICATION TO OTHER COUNTRIES

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The I.T.G.E., Spanish Geological Survey, is the institution, which is in charge, since its foundation in 1849, of the Spanish Geological Map at various scales, as well as other geoscientific maps.

At present, the I.T.G.E. is about to finish the Geological Map of Spain (MAGNA) at 1:50.000 scale (or at of 1:25.000 in the insular territories); it constitutes the most emblematic cartographic series that it has elaborated in its long history. This series is made of 1.180 individual sheets, in which the geological map, a selected chronostratigraphic legend and 2 or 3 geological cross sections are represented. Each sheet is accompanied by a memoir containing chapters of: Stratigraphy, Geomorphology, Tectonics, Geological History, Geological Heritage and Economic Geology. Furthermore, each sheet is associated with a complementary documentation with a series of physical and documentary registers: samples map, detailed stratigraphic sections, thin sections, samples, photographic album and thematic reports. All this information is available at the ITGE Documentation Center for the Scientific Community, Public Administration, specialists and general public.

Among the geological maps at other scales and geoscientific maps that the ITGE elaborates the most relevant maps are:

Geomorphologic map: elaborated together with MAGNA since 1992 and published at 1:50.000 scale. It represents processes, landforms and recent deposits grouped together according to its genesis: fluvial, karstic, glacial, gravitational, antropogenic, etc, represented with different colors. The area covered is at present 21% of the country.

- Spanish Geological Map at 1:200.000 scale, similar to MAGNA. The area covered is 100% in its first series (1972) and 30% in the new series.
- Continental Shelf and Adjacent Areas Geological Map at 1:200.000 scale; at present covering a 35% of the total area.
- Iberian Peninsula, Balearics and Canaries Islands Geological Map, at 1:1.000.000 scale, with a strong chronostratigraphic component, periodically updated.

As thematic or geoscientific maps could be mentioned:

- Rocks and Industrial Minerals maps at 1:200.000 scale (100% of territorial coverage in first series -1974- and 25% in the new series).
- Metallogenic maps at 1:200.000 scale, providing metallotects information with a simplified geological base (100% of territorial coverage in first series -1974- and 15% in the new series).
- Hydrogeological maps at 1:200.000 scale, providing geological permeable units information and of quantitative data expressed in the map, as well as piezometry, flows and gauging (40% of territorial coverage).
- Geotechnic and Urban Areas Natural Hazards maps at 1:25.000 scale.
- Geoscientific, Environmental or Groundwaters Atlas of provinces and autonomous regions.

The I.T.G.E. also elaborates diverse thematic maps at 1:1.000.000 scale:

- Iberian Peninsula and Balearics Islands Tectonic Map.
- Spain Quaternary Map.
- Spain Mining Map.
- Karst National Map.
- Expansive Clays National Map.
- Pollution Vulnerability of Aquifers Map (orientated to solid waste dumping).
- Lineaments Map, derived from Landsat images.
- Spain Neotectonic Map.
- Spain Seismotectonic Map.
- Spain Geomorphologic Map.

The I.T.G.E. has assimilated new advances of information technology and in the last years has developed a digitized geological mapping program at different scales. The aim is to create a digital system for geological cartography in order to develop integrated and multidisciplinary projects with a GIS (Geographic Information System) technology; as well as the user service improvement at the Information Center. Some of this information is already available in Internet.

The I.T.G.E has recently initiated an international projection stage of its mapping activity, transferring the "MAGNA model" and making it suitable for the systematic geological mapping of some Latin American and other countries. For example, Argentina undertook geological maps at 1:100.000 and 1:250.000 scales. In Dominican Republic were planned and elaborated geological maps at 1:50.000 scale and geomorphological and mineral resources maps at 1:100.000 scale. In Morocco the ITGE is elaborating geological and geochemical maps at 1:50.000 scale.

GEOINFO-GEOLOGICAL DATA BANK OF MÉXICO

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The Council of Mineral Resources (CRM) (Mexican Geological Survey) researches data on the soil and subsoil of the Mexican territory through a national cartography program that consists in systematically covering the geological, geochemical and aeromagnetic information in 1:250,000 and 1:50,000 scale maps. Furthermore, the CRM develops new areas of geological knowledge on Mexico, through the assessment of geological risks, technological research and services to the mining industry.

This entire geological information obtained by the CRM is input in a large geological data bank (GEOINFO), that also contains information generated by all national governmental and educational institutions related to the study of geosciences, as well as of data generated by a large diversity of national and foreign mining companies that conduct exploration activities in Mexico.

GEOINFO: The National Geological Data Bank is a source that provides rapid, timely and reliable information to support planning and development activities for detailed exploration projects, as well as for all those research projects related to Earth Sciences.

GEOINFO is an Interactive Data Bank that presently consists of 7,000 geological-mining reports; 25,000 mining project maps; 3,000 geological charts inputs of different disciplines, representing a large volume of information estimated in over 70 million data.

The design of GEOINFO'S data base and space model was designed in ARC/INFO as a geographic information system and Oracle 8i Spatial, as data base manager.

The information system (GEOINFO) optimizes response times in diffusion areas, sharing the information in a globalized world, by offering geological products and services through Internet, thus saving time in the consultation and analysis thereof. Consulting GEOINFO benefits all users by providing data on environmental, education, research, mining exploration, natural resource, industrial project issues and Mexico's territorial ordering.

GEOINFO: In the fundamental tool for data and exploitation of natural resources in the Mexican territory.

STILL PRODUCING GEOSCIENCE MAPS

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Geological mapping in Romania has a long history, which started in 1892, when the first geological map of the country was printed. Since then, mapping was a permanent task of Geological Bureau (founded in 1882); followed latter by the Geological Institute (founded in 1906)

All kinds of geoscience maps at various scales do exist for Romania, starting with the basic maps 1:500,000 (Surveying193 1956, printed 1956-1968) 1:100,000 (15 sheets printed 1963), and 1:200,000 (51 sheets, printed 1964 -1968). A whole atlas with maps at the scale 1:1,000,000 is available since 1970, comprising geology, tectonics, hydrogeology, mineral resources, magnetic ΔZ and ΔT, soils geobotanic etc. The 1:50,000-survey program reached in 1999 a coverage percentage on about 80% of the mountainous areas (140 sheets). As many differences occurred in time between maps printed in 1970 and 1999, especially as it concerns the stratigraphic units, digitizing of maps already started in order to make easier the link between maps edited at different times. The new maps are produced now in digital form.

New kinds of maps such as geochemical (scales 1:3,000,000 and 1:1,000,000) different maps using remote sensing data (slope, slope orientation, land use etc), and geothermal maps are now also available in digital form. New editions of the 1:500,000 scale maps (geologic and mineral resources) are now complied.

Is it a real need of geoscience maps or mapping?

The question is important as this job is quite expensive and most of the necessary money is a budgetary one and the money used needs to be justified in a broadly social sense. Then,

Why we still produce geoscience maps?

- to create a basis for understanding of the global changes on the Earth
- to support GIS development on a country scale
- to contribute to a landscape-friendly use of mineral resources

How to produce maps?

- in a digital form
- to ensure a fast completion and enhancement of older maps
- to facilitate metadatabase on a continental scale
- in a hard-copy form:
- to help education in the geoscience fields
- to connect HITECH opportunities to all levels of understanding geosciences

What types of maps are likely to be most useful in the future?

All kinds and types, provided they belong to a GIS, which enables both large and small scale areas to be "anatomized" for different purposes, i.e. roads and rail roads development, underground waste disposal, water supply etc.

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