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VISION
Geology as a basis for sustainable growth and welfare.

MISSION
The Geological Survey of Finland (GTK) produces and disseminates geological information for use in promoting systematic, sustainable use of the national geological endowment. GTK studies and maps the Earth's crust, inventories mineral and ore resources, provides a national geological information service, performs contract services for external clients and participates actively in international projects.

GTK operates under Finland’s Ministry of Employment and the Economy. It was established in 1885.

VALUES
● Strong research emphasis
● Reliability
● Accountability
● Cooperation and partnership

STRATEGIC GOALS 2007–2015
● Mapping and data collection to meet specific needs
● Increasing the quality and accessibility of natural resource data
● Promoting new technology for sustainable development
● Supplying geodata in forms that can be combined with other datasets
● Making GTK databases and publications available online
● Focus on core functions and international networking
● Maintaining world-class expertise in select fields
● Providing a healthy, innovative working environment

THE YEAR IN FIGURES

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<thead>
<tr>
<th></th>
<th>2007</th>
<th>2006</th>
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<tbody>
<tr>
<td>Expenditures, € million</td>
<td>59.3</td>
<td>55.3</td>
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<tr>
<td>Revenues, € million</td>
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<td>Income from contract services, € million</td>
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<tr>
<td>Employees with academic degrees, %</td>
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A strategic shift to strengthen organizational performance

Under our new strategy, GTK emphasizes developing its role as a provider of geological expertise to many constituencies. Dividing our focus into two main areas, we aim first at establishing ourselves as an international leader in natural resource inventory and sustainable use, and second, at making GTK Finland’s geodata centre.

The significance of geological spatial data continues to increase at the national and European levels. The EU’s INSPIRE directive aims at harmonizing geodata collected in different countries to allow general comparison and interpretation. We are building up GTK’s information systems to be able to manage geological data collected in Finland, while assuring access by a wide body of users to our databases. The process includes the transfer of the massive exploration and survey archives accumulated over five decades by the former state mining companies Outokumpu and Rautaruukki. The transfer is now complete, and with the current mining boom GTK has encountered a strong demand for this material.

We also proudly announce the completion of our national programme of low-altitude airborne geophysical mapping. Finns now have access to the world’s best airborne geophysical data.

GTK also provides information on mineral resources, including available expertise, the quality and size of deposits and strategies to reduce environmental impact, for example, in protected areas. Sustainable development policies for mineral resources need to be based on objective information that allows decision-makers to weigh rationally the economic, social and environmental consequences of their decisions. The advisory bodies of sectoral research institutes have defined sustainable use of natural resources as a core objective of national structural reforms and decision-making. Indeed, every research institute in Finland should strive to provide our nation and its business community with relevant, unbiased information, particularly information concerning our forests and geological resources.

Final go-aheads for the mines in Kittilä and Sotkamo, as well as several other major mine projects in advanced stages of development, indicate that sustainable development strategies can be readily incorporated into mine planning. The significance of Finland’s natural resource endowment and mining activity continues to grow. When these new mines come on stream, the ore production levels will be more than double the heyday levels last seen in the late 1970s. GTK and the research laboratories in Otaniemi and Outokumpu are developing new mining and metal extraction methods that are environmentally friendly and energy efficient to meet the needs of modern industry.

GTK is actively involved in the government’s programme to increase public sector productivity. In 2007, as part of this programme, we spun off our chemical analysis services into an independent company. Even with the change, however, GTK faces further staffing cuts – and we still need to boost in-house expertise to meet our new goals. One challenge will be to increase the international experience and multinational make-up of our staff.

Our 2007 performance was the best in GTK’s history. In the midst of ongoing structural reforms in state administration, our personnel consistently managed to boost productivity. I extend my heart-felt gratitude to every GTK employee for their excellent contribution and dedication to improving their knowledge and skills. I also thank our departing board members for their work. This board has given substantial added-value to GTK’s role in Finnish society.

Elias Ekdahl
Director General
T he flurry of activity at GTK last year reflected a rising business cycle in the minerals and metals sector that is now entering its fifth year. High energy prices also encouraged our researchers to revisit domestic energy sources. An increased share of GTK environmental studies now relate to sustainable development.

During the financial year, major mining project investment continued at the Talvivaara nickel mine in Sotkamo and the Suurikuusikko gold mine in Kittilä. Other senior and junior mining companies were also busy with economic and technical feasibility plans concerning dozens of other deposits – most originally discovered by GTK geologists. The Kevitsa nickel-PGE deposit leads this group of advanced-stage projects. The current wave of investment in new mines already exceeds €1 billion.

The impact of these projects on Finnish society will be substantial both at the national and regional levels.

In the energy sector, mapping of national peat reserves continued. Research on exploiting geothermal heat was ramped up to determine if this form of heating and cooling might satisfy a substantial share of Finland’s energy needs for detached houses, as well as large apartment and commercial buildings. New low-carbon sources will be increasingly important in Finland’s energy future as it seeks to meet its commitments under international climate change agreements.

Our researchers also completed a number of long-term GTK projects during the year. The national airborne geophysical mapping programme, which began in 1972, was completed. A five-year project to transfer and digitize the ore exploration and mine data archives of Outokumpu Oyj into GTK databases was also finished.

The board continues to develop GTK’s internal operations in accordance with our goals. As part of the government’s productivity programme, GTK’s chemical analysis services were spun off to create Labtium Oy. This new business opened its doors on September 1, 2007. The preparation process for the launch of the new enterprise went smoothly. We owe our staff many thanks for their active participation in this process.

The board’s four-year term ended in February 2008. As chairman, I would like to thank all of our board members for their inspiring contributions and the diverse range of insights they brought to the table in guiding GTK through a period of organizational transformation. Despite extensive external and internal challenges, GTK’s capable management group and committed staff met or surpassed all set performance targets.

Tom O. Niemi
Chairman of the Board
Review of 2007 Activities

Performance targets consistently achieved

GTK operations during the financial year were highly productive; all core performance targets were met. There was record demand for GTK services and geo-data. This was evidenced both in strong revenues from contract services and a vast increase in website traffic.

GTK’s web-based operations model continued to gain acceptance, while project work and international cooperation activities remained brisk.

GTK responded well to growing demand for its publications and services. Development efforts targeted productivity in accordance with both the government’s public-sector productivity programme and GTK’s own strategic targets. Chemical analysis laboratory operations were spun off as an independent company. More people were dedicated to research into sustainable use of Finland’s geological resources.

Challenges in a changing operating environment

Implementation of the government’s productivity programme and development of sectoral research continued. As part of the productivity programme, the operations of GTK’s chemical analysis laboratory were spun off as an independent company on 1 September 2007. The new company, Labtium Oy, provides chemical laboratory, measurement and testing services, as well as consulting. The company is 100% state owned. The spin-off shifted about 90 GTK staff involved in geochemical analysis over to Labtium. GTK also participated actively in the Ministry of Trade and Industry’s service centre project, as well as a separate project to quantify public-sector productivity.

The basic policy line for reform of sectoral research was refined during the financial year. GTK was mostly concerned with allocation of research tasks under its sustainable development programme.

GTK published two major works on domestic gold deposits in 2007. The book *Gold in the Central Lapland Greenstone Belt* (GTK Special Paper 44), edited by research professor Juhani Ojala, features twelve articles on the history of Central Lapland’s geology, geological structures and overviews of the most-studied gold deposits. Special researcher Pasi Eilu compiled the highly informative *FINGOLD: Brief descriptions of all drilling-indicated gold occurrences in Finland – the 2007 data* (GTK Research Report 166). The study provides overviews of all drilling-indicated gold deposits in Finnish bedrock. Shown here is the Kittilä mine operated by Agnico-Eagle Mines Ltd.
Mining constitutes one of the major economic pillars of the Finnish economy. Mines benefit local economies directly and indirectly by increasing employment and the tax base. Finland is currently updating its mining law to secure the conditions for sustainable development in ore exploration and mining operations.

GTK plays a significant role in mapping and assessing Finland’s Precambrian bedrock and Neocene overburden. As part of its mission, GTK systematically maps Finland’s geological resources. Ore discoveries are reported to the Ministry of Employment and the Economy, which decides the terms on which the finds will be offered to competitive bidders.

Currently, over a dozen substantial mining projects are under way in Finland. Most involve ore deposits originally identified by GTK. A number of these deposits are significant by international standards.

The Suurikuusikko gold deposit, boasting proven economic gold content of about 120 tons, will eventually be Europe’s largest operating gold mine. The mine’s potential, however, based on initial assays, suggests the amount of commercially viable grades of ore may be far greater.

The Talvivaara nickel deposit is the largest in Western Europe. Based on proven reserves, the mine has the capacity to produce nearly three percent of the world’s nickel over its scheduled 25-year operating life. Probable reserves indicate the mine will ultimately operate many years longer. A second important nickel mining project is the Kevitsa mine near Sodankylä. The nickel-PGE ore body is nearly as extensive as that of Talvivaara. Production at the Kevitsa mine is slated to get under way in 2010.

The EU also faces growing concern over Europe’s available non-energy mineral reserves. This resulted in a call for increased research and exploration under the Commission Staff Working Document SEC(2007) 771.

Ore finds and innovative concentration methods will create a solid foundation for sustained mining investment. This will create jobs, promote entrepreneurship and help Finland gain new competences. Finland’s mining industry in the medium-term will provide a tremendous economic boost to regional economies by bringing large investment to remote areas traditionally lacking high-paying industrial jobs.

Mineral reserves support Finland’s economic future
Review of 2007 Activities

Sustainable use of natural resources

GTK produces extensive information about Finland’s bedrock and soil geology, as well as basic data on natural resource inventories to promote exploration for new deposits and sustainable use.

GTK provides basic information for the mining sector through online and physical publication of its broad databases on Fennoscandian ore deposits and studies of Finnish ore potential. Modelling and studies of the potential of Finnish gold deposits appeared in domestic and international publications. Client-commissioned studies to develop a flotation process for the complex Kevitsa nickel-platinum ore yielded excellent results. An extensive database on the chemical composition of Finnish bedrock for modelling and research appeared. Targeted studies were exceeded in peat reserve mapping and studies. Peat studies focused on production in key areas to assure industry with adequate peat supplies. A calculation of the bioenergy balance of the Suupohja resources in Central Finland was prepared as an appendix to a Metla report.

Mapping of geological structures in groundwater areas continued in joint projects with water supply officials and sustainable use of natural resources. These studies will help define the criteria for groundwater and other land use within the framework of the EU water directive. Ten studies were prepared during the year.

A mineral inventory system aimed at promoting sustainable use of minerals and securing society’s mineral supplies was introduced during 2007 on a trial basis for use by environmental and other permitting officials, as well as mineral producers. An online interface will be introduced in 2008 and later upgraded to include substitute materials. A study on use of waste rock from Southeast Finland quarries was completed and the results reported.

During the financial year, increases in manpower dedicated to scientific study of geothermal heating and sustainable use of natural resources were approved. A strategic development project for sustainable use of natural resources was also launched. The project’s next phase will review domestic and international activities in the field. A seminar on the topic of sustainable use of natural resources was arranged for interest groups. It was attended by nearly 100 experts from industry, official bodies and research institutes. Several geothermal heating studies were completed in collaboration with universities and technology firms. Studies currently focus on applying ground-based heating and cooling to structures such as malls and housing developments.
The sustainable use of geological resources requires good quality data on available resources and careful exploitation of those resources to assure that their benefits continue for future generations. Through providing objective data, GTK equips decision-makers with information that lets them take even remote environmental factors into their decisions. In addition, GTK has improved the conditions for companies that develop geological resources through increasing awareness about sustainable use strategies. This is fully compatible with EU policy, which seeks reduction of harmful environmental impacts, even as production levels and living standards continue to rise.

“The development of most industrialized countries has been based on access to geological natural resources,” says GTK special researcher Saku Vuori, who works with mineral material flows and related sustainable use strategies. “The rising global population and demands for higher living standards and consumption patterns matching those of industrialized countries puts a strain on our efforts to exploit mineral resources effectively.”

“Land use planning is a relatively concrete subject that brings together mineral resource development and decision-making. At GTK, the groundwork has been made for improving company operating conditions, as well as securing society’s essential access to mineral supplies by e.g. gathering information about mineral reserves in over 10,000 bedrock areas. This information is available to decision-makers and advisory groups for consideration in zoning decisions, optimizing mineral quarrying areas and infrastructure development projects.

GTK’s role in promoting sustainable use of natural resources is manifested quite concretely in its operations. Our work with inventory of mineral reserves includes finding and promoting beneficial uses for waste rock generated in quarrying and mining activities. Our work also involves quality issues related to minerals and the advancing ecological efficiency in land use and matters related to recycling, as well as material flows and lifecycle analyses.

GTK is especially interested in metal-bearing ores, industrial minerals, natural stone, rock and soil materials, peat and groundwater. The wide-scale adoption of a system for tracking the national geological inventory in the coming years will be joined with tracking byproducts of the mineral industry and suitable substitutes. We are expanding our assessment of peat reserves to include bioenergy balances.”

Much of the crushed rock generated from tunnelling activity under Helsinki is stored temporarily at the tip of the Hernesaari area on the city’s southern shore. From there, the crushed rock is loaded on barges and taken to construction sites.
Review of 2007 Activities

Providing independent data as a basis for policy decisions

GTK supports official decision-making processes through independent research, by providing expert advice to working groups, and through preparation of statements for official decisions.

In 2007, research activity focused on peat and carbon balances, climate change adaptation and studies of the Baltic sea bottom. The studies were made in cooperation with other research groups nationally and internationally. The results concern studies on Finland’s glacial ridges and moraines, as well as elemental concentrations present in farmland and land use risks associated with climate change. GTK researchers participated in a number of international congresses to discuss risks associated with climate change, including the UN panel on sustainable development held in New York.

GTK experts participated in a variety of working groups. They were involved with the Ministry of the Environment’s working groups on soil contamination and evaluation of remediation needs in formulating draft statute language and preparation of a guide to the statute. They also worked with Finland’s atomic safety council, which is preparing draft legislation on nuclear waste handling and disposal, and helped author the government’s statements on the proposed statutory reforms. During the year, GTK prepared several statements on the environmental impacts of the proposed gas pipeline from Russia to Central Europe, as well as plans to regulate waste-water releases into the sea in areas protected under the Natura 2000 programme.

GTK also continues to support decision-makers by strengthening its role as the national geodata centre. In establishing institute-level information policies, GTK created a basis for establishing principles for pricing and granting user rights. A big hit with GTK clients was our new online topological vector-form soil distribution maps. GTK responded to INSPIRE directive challenges by participating in drafting of a national spatial data law and digital imaging of GTK information records.

A project to inventory the diversity of Baltic marine life (VELMU) was expanded in 2007 to include the Gulf of Finland. Studies included sea bottom formations and sedimentation layers. As part of the project, GTK maps underwater geology with acoustic-seismic sounding and sample-taking. The project runs through 2012. Here, marine geologist Jyrki Hämäläinen examines sounding data on the bridge of the research vessel Geomari.
GTK special researcher Raimo Sutinen’s project “Forest soils and global change” considers the potential impacts of climate change on soil temperature and soil water content of Finland’s northern forests. The project, which runs through 2012, assembles a team that includes GTK researchers and scientists from the Finnish Forest Research Institute (Metla) and the Finnish Meteorological Institute. They have created a scenario that shows climatic conditions found in Southern Finland are moving northward, causing changes in soil conditions that affect forest growth, shift timberlines, modify logging and timber transport plans, and alter the composition of tree species. The exceptionally warm 2007–2008 winter provided insights into the unforeseen consequences of climate change. The timber industry found itself literally bogged down in unfrozen terrain that made it difficult to reach trees to be cut and even harder to skid cut timber to roadside pick-up points. With the spring thaw extended, roads were subject to unusually heavy frost damage.

The Scots pine timberline has shifted 35 km to the north since the 1930s into the Hetta granite area. At the same time, the birch timberline remains constrained by soil factors to the southern edge of the Lapland granulite band. Norway spruce is likely to remain foreign to Lapland’s fells. For example, wind blowing off snow cover on the burn area of the Great Tuntsa Forest Fire of 1960 explains the failure of the forest to regenerate nearly fifty years since the fire despite remaining tundra in the area. Tuntsa soil temperatures beneath the winter snow remain just slightly above or below freezing. Typically, natural organic matter can decompose under the snow blanket, but the lack of snow lowers soil temperatures, which depresses microbial activity and affects nutrient availability.

The data for the project, including modelling studies, are being generated by a network of 24 automated soil stations located across Lapland. Each station monitors the effect of snow on water and temperature conditions in the soil at sites above the boreal zone. The stations are sited in major rock type zones; the altitudes and types of soils where the stations are situated vary. Sensors measure soil moisture and snow water content dielectrically, while soil electrical conductivity is measured with resistor sensors. In addition, soil and air temperature, the thickness of the snowpack and precipitation are measured and stored with data-loggers. Telemetry allows data collection and monitoring of the network to take place at the regional office in Rovaniemi. Four stations in Lapland track the effects of intensive forestry practices on soil water and nutrient availability, as well as groundwater quality. GTK, in cooperation with Metla and the state forests administration Metsähallitus, are also studying the impacts of logging, skidding and bunching methods on forests. The shift in timberline is tracked in the Pallastunturi area and the mire degeneration in the Peera area of Kilpisjärvi.

Influence of soil types on extent and composition of future forests

During winter warm spells, snow melt permeates the frozen ground and collects as groundwater, regardless of the granularity of the soil. Winter wind also affects snow cover thickness as well as soil temperature, especially in Lapland’s fells. For example, wind blowing off snow cover on the burn area of the Great Tuntsa Forest Fire of 1960 explains the failure of the forest to regenerate nearly fifty years since the fire despite remaining tundra in the area. Tuntsa soil temperatures beneath the winter snow remain just slightly above or below freezing. Typically, natural organic matter can decompose under the snow blanket, but the lack of snow lowers soil temperatures, which depresses microbial activity and affects nutrient availability.

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Land use, construction and the environment

An extensive urban mapping of the growing suburbs around Tampere was launched during the financial year. The project involves five municipalities, the Finnish Road Administration, as well as the regional environmental centre. In the Helsinki region, GTK assisted planners of the western extension of the metro into the city of Espoo by compiling and interpreting geological information for the areas along the proposed metro route.

Development of a data management system for national drill core data proved to be more complicated than expected. The main actors in the field, however, see construction of the system as worthwhile in terms of both the economic and environmental benefits gained in urban planning. During the year, several discussions were held with actors in the field to establish a basis for implementation and funding.

A number of major EU projects came to a close in 2007, including the GTK-coordinated RAMAS, SUMANAS and ASTRA projects. The RAMAS project examines the occurrence and environmental risks of arsenic in Pirkanmaa. Results of studies with the national board of health indicate a statistical link between cancer rates and the prevalence of arsenic in Pirkanmaa. The SUMANAS project examined arsenic risks in Hungary. The ASTRA project looked at the costs of adapting to climate change in land use planning. The results raised wide international interest.

The BALANCE project for developing underwater topographic mapping was concluded. Maps of Baltic sea bottom were released and the results are already being applied in the evaluation of potential environmental impacts of a natural gas pipeline running under the Baltic Sea. The methods and data will be used in crafting future plans involving the Baltic sea bottom and protection of the marine environment. The project is associated with the wide-ranging interdisciplinary Finnish Inventory Programme for the Underwater Marine Environment (VELMU). VELMU joint studies focus on the Kvarken/Merenkurkku area in the Gulf of Bothnia and the Archipelago Sea.

Risks from metals in industrial and natural environments were studied in GTK-led projects conducted by the Environmental Risk Assessment Centre (ERAC) and FINMERAC. Funding was provided by the EU and Tekes. The projects involved development of methods for assessing ecotoxicological and health risks of certain metals for use by industry and environmental officials. An international seminar on the topic included representatives from the European Commission and the US. A joint national multiyear study with MTT Agrifood Research Finland on trace elements in farmland was completed.

The national airborne geophysical measurement programme was concluded in 2007.

ERAC focuses on risks to human health and the environment

Methods for environmental risk assessment apply to many areas of human health and environmental degradation. Assessment of environmental risk is an independent, multidisciplinary scientific process that can support official decision-making. GTK, the Finnish Environment Institute (SYKE), the National Public Health Institute (KTL) and the University of Kuopio established the Environmental Risk Assessment Centre (ERAC) in 2005 to engage in scientific research and implement development projects.

ERAC is involved in multidisciplinary networking that involves e.g. geochemistry, biogeochemistry, ecology, environmental sciences, toxicology, epidemiology, risk analysis and the social sciences. The centre seeks to develop integrated and universally applicable methods of risk assessment. ERAC information is available for use by industry and public officials.
As more people move to the Helsinki region, pressure mounts to move transportation underground. This allows rededication of space above ground for other purposes, while reducing traffic constraints. As main commuter flows are shifted underground, valuable space above ground is freed up for future generations. Ongoing urbanization and infilling will continue as the population grows in the Helsinki region. Metro construction is part of dealing with this change.

As a rule, Finnish bedrock is of such excellent quality that construction succeeds just about anywhere. GTK performed the general bedrock studies for the Helsinki metro project. These studies considered the bedrock structure and bedrock fracture. The studies were based on experiences with bedrock fracture in the Helsinki region. “We also expect to be involved in the next phase of the metro extension,” says special researcher Ossi Ikävalko.

Bedrock construction in the Helsinki area continues. State and private organizations systematically collect data about bedrock and develop new forecasting and data models about current bedrock behaviour. The improved understanding can yield saving at all phases of construction projects.

**Geological data for future generations**

**Stricter safety rules**

Bedrock construction is subject to ever-tightening safety rules. Increased safety demands compared to ten years ago partly explain the rising costs of metro construction. Fires, for example, can have horrific consequences in a tunnel, so Finland’s safety authorities demand better emergency egress routes. Today, two separate tunnels are used in metro construction. By having passages from one tunnel to the other, escape routes can be provided all along the route. Metro tunnels also have vertical shafts built at intervals that allow people to get to the surface in the event of an accident. Such solutions add to construction costs. Knowing the policy rules ahead of time can greatly benefit builders, because once the plan is decided it is difficult to alter (e.g. move station sites or routes).

GTK performs soil and bedrock studies as needed. Bedrock construction is still the most emphasized element in urban geology. “Our goal is to collect and store data that will have future uses. We are about to establish a national register of basic study data in order to preserve such of data and ease the work of architects and other construction planners,” notes Ossi Ikävalko.
International cooperation

As in recent years, GTK enjoyed brisk activity in international project work throughout 2007. This was seen in project activities and development of international contacts. GTK participated in 73 jointly funded projects in 2007, of which a fifth were international.

In addition to project work, GTK participated actively in various European cooperation organizations. From GTK’s standpoint, the most important cooperation organization is the EuroGeoSurveys (EGS) network. Working closely with industry, EGS last year produced the European Technology Platform on Sustainable Mineral Resources as part of the EU’s seventh R&D framework programme.

Publications

GTK published a total of 389 articles, abstracts, reports and maps in 2007. Of these, 55 papers were refereed for publication in major scientific journals.

Publication topics covered a wide swath from geological processes to resource inventories, from geophysics and geochemistry to environmental issues.

GTK publication series saw the release of three special papers. They dealt with geology of gold occurrences in Central Lapland, Quaternary research in the central part of glaciated terrain and Holocene sedimentary environment and sediment geochemistry of the eastern Gulf of Finland. Some 40 peer-reviewed articles appeared, of which 25 were prepared by GTK staff. Map publication activities included publication of the World Magnetic Anomaly Map, a project coordinated by GTK. The map has aroused broad international interest. Two members of GTK staff completed their doctoral theses in the field of isotope geology.

GTK’s development project activities enjoyed great success in 2007. The large multiyear mapping projects in Mozambique and Tanzania wrapped up, achieving all set goals. The project was funded by the World Bank and the Nordic Development Bank. New development projects are under planning for several African countries, and projects in Eastern Europe are under consideration.

GTK and the British Geological Survey (BGS) completed airborne geophysical mapping projects in Kosovo and Angola. The revenues from international projects in 2007 exceeded €5 million.
Meeting Tanzania’s challenge

GTK completed a mapping project in Western Tanzania in 2007. The goal of the four-year project was to establish a system that allows the Tanzanians to keep mapping their country, taking advantage of the latest methods. The project was funded by the Nordic Development Fund. The project’s long-term goal is to assure managed growth and steady investment in Tanzania’s mineral sector. Success in this effort will boost export revenues, create jobs and help reduce poverty. The project involves a range of agencies and brings the mapping methods used at the Geological Survey of Tanzania (GST) into line with current standards. The research methods include geological and geochemical mapping, as well as in situ and airborne geophysical measurement. All collected data are stored in digital formats, making them easy to access and manipulate. The quality of the products and array of services provided by the GST are truly diverse and high quality, benefiting geologists and companies seeking geodata.

Looking to Angola and beyond

The outlook for projects in Africa is quite promising. GTK has demonstrated in several of its completed projects the ability to transfer state-of-the-art skills to national geological surveys even under demanding and constrained circumstances.

GTK signed a cooperation agreement with the Swedish mining company IGE (International Gold Exploration) to provide airborne geophysical measurements in Angola. The initial mappings were completed in summer 2007. GTK produced the airborne geophysical measurement data to support IEG’s diamond prospecting efforts. Further orders are expected in the near future.

Valuable isotope information on groundwater recharging

GTK researcher Nina Kortelainen defended her doctoral thesis “Isotopic fingerprints in surficial waters: Stable isotope methods applied in hydrogeological studies,” before the Department of Mathematics and Natural Science at the University of Helsinki on 10 December 2007. Her thesis advisor was Professor Juha Karhu of the University of Helsinki and her opponent was Ramon Aravena, earth sciences research professor from the University of Waterloo, Canada. Ms. Kortelainen studied carbon isotope formation at an artificial groundwater recharge plant in Tuusula, as well as in Virttaankangas, where an artificial groundwater facility is planned. Reducing the concentration of dissolved organic carbon (DOC) in water is a primary challenge in the process of artificial groundwater recharge, because DOC reduces drinking water quality. Using isotopic analysis, Kortelainen showed that in Tuusula a significant part of the original organic carbon broke down through oxidation. The Virttaankangas aquifer was found to have an exceptionally high pH (9) for a shallow aquifer on glaciated crystalline bedrock.
Tourism is an important livelihood in Northern Finland. Outside the peak spring skiing season and summer hiking season, there are many quiet months for adventurers to experience Lapland. Geological maps can help promote tourism and raise tourist interest in year-round Lapland outings.

The typical purchaser of a geological excursion map is a person with keen interest in the natural world. Excursion maps and guidebooks from GTK are also popular with professionals, who use them to augment their knowledge of local geology. The new excursion maps for Ylläs–Levi and Pyhä–Luosto, released in 2007, augment earlier series maps for the Urho Kekkonen, Nuuksio, Koli and Pallas–Ylläs national parks, as well as the placer gold sites along the Ivalojoki and Lemmenjoki rivers.

Geotourism is expected to increase in Northern Finland, especially during the summer – the off season for popular skiing resorts. For the average tourist, there are plenty of marked trails close to roads that lead to interesting sites. Access to breathtaking sites such as the remote Lemmenjoki Gorges requires backpacking deep into the national park and camping overnight.

European Geopark at Pyhä–Luosto
Finland’s first geopark (geological national park), the Pyhä–Luosto national park and adjacent tourist resorts, is now part of the European geopark network. GTK and Metsähallitus were the prime proponents of this effort. The project helps create good jobs and economic diversity in an area that has been losing population.

“The next geological excursion map will cover the Iso-Syöte fell region,” says GTK area manager Peter Johansson. “Our goal is to increase the diversity of tourist activities available around Iso-Syöte. The proximity of this spectacular area to the Oulu region has made Iso-Syöte a popular day-hike destination. With a geological map and guidebook in hand, an adventurer can experience several spectacular sites on the same day. Visiting these impressive geological formations was even a treat for the mapmaker himself.”
Over 40,000 households in Finland now heat their homes by extracting heat from soil or bedrock. GTK, in cooperation with companies active in the ground-source heating business, as well as the state institutes VTT and TKK, are studying the technical possibilities for rolling out this renewable energy production strategy on a wide basis. Current studies show promising possibilities for application of geothermal heat exchange technologies in large buildings as well.

There are several ways of exploiting or storing heat energy in soil and bedrock. Surface soils, for example, acquire much of their heat energy through absorption of solar radiation. Such heat is collected by pumping water through a horizontal or spiral grid placed sufficiently below the frost line so it can operate year round. This is currently the most widely favoured approach for detached houses. Installation of ground-source heating systems can be easily incorporated into a standard house construction project.

While there is relatively little variation in the heat conductivity of Finnish rock generally, crystalline bedrock has very good heat conductivity. Overall, bedrock structure and groundwater conditions are determinative as to the type of ground-source heating system selected. Since water is an even better heat conductor than rock, one of the best heat sinks is formed by fractured bedrock permeated with water. The higher the energy needs, of course, the more critical the heat source becomes at the design stage, requiring a good knowledge of the local energy field and modelling capabilities. Local conditions such as the fracturing in the bedrock, heat conductivity and groundwater conditions always need to be assessed thoroughly.

Senior specialist Jarmo Kallio from GTK’s Western Finland Office reports that several bedrock energy studies are underway at the moment in Finland. GTK is participating in geothermal heat exchange studies for Espoo’s Nupurinkartano residential housing development and the Vaasa Housing Fair 2008.

The heating or cooling factor for bedrock is typically around three, i.e. the system can extract three times more heat energy than the amount of electricity consumed. In large structures such as malls, office buildings or hospitals, the required multiplier may be higher since these structures typically require both heating and cooling. Since both heating and cooling is performed by a vertical bedrock loop system, the ratio improves.
FUNDING STRUCTURE, REVENUES AND EXPENDITURES

In the financial year, GTK’s total available funding, including external funding and funds carried over from the previous year, amounted to €46.9 million. Of this, the share of money from the state budget in 2007 was €40.7 million, while an additional €3.3 million was carried over from 2006. GTK received some €0.9 million in external funding. The carry-over to 2008 from 2007 amounted to €4.0 million.

Income financing in GTK’s funding structure, as in 2006, was sufficient to cover 28% of budget spending. The share of external financing increased from 2006. External funding includes €0.2 million in government funding for the spin-off of GTK’s chemical analysis services and €0.1 million for investment in mineral processing technology at the Outokumpu unit as part of the Ministry for Trade and Industry’s programme to increase productivity.

Total income increased to €16.5 million, an €0.6 million increase from 2006. Revenues from contract services rose to €14.0 million (€12.4 million in 2006). Much of these revenues came from studies performed for the mining industry, international projects and airborne geophysical services. Revenues from jointly funded activities fell relative to the two previous years, due mainly to the completion of several major EU-funded programmes. In first eight months of the year, before the chemical analysis laboratory was spun off as a separate company, the unit generated revenues amounting to €2.2 million.

Total expenditures reached €59.3 million, €4.1 million more than in 2006. Some €58.6 million was booked to GTK’s budget account, while €0.7 million was funded from external sources. Spending on chemical laboratory operations, not counting the costs of spinning off the unit, amounted to €5.0 million. Wages and salaries accounted for €33.8 million, while other operating expenses were €23.0 million and investment €2.5 million. A small amount went to transition costs. Spending on wages and salaries was up €1.0 million from 2006, even if the number of person-years worked declined from the previous year. The salary and wages figure was boosted by a one-time compensation package paid for persons transferred out of GTK to work at the newly created Labtium Oy and accumulated holiday pay which was paid for Labtium Oy. Other operating expenses rose to €2.0 million. In addition, operating expenses were increased as GTK began to purchase chemical analysis services from Labtium Oy. Investments increased €1.1 million from the previous year. They went largely to acquisition of laboratory equipment and other research equipment.

PERSON-YEARS

GTK’s total work contribution amounted to 773 person-years, or 23 person-years fewer than in 2006. GTK’s original budget projection called for an input of 763 person-years, of which contract work was to be 98 person-years. External funding, mainly from state employment programmes, covered the costs of 10 person-years of work.
Performance indicators

Geological mapping 2007

<table>
<thead>
<tr>
<th>Bedrock mapping</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage under national programme, %</td>
<td>78</td>
<td>78</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quarternary deposit mapping</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic mapping (1:20,000 scale), km²</td>
<td>1,000</td>
<td>925</td>
</tr>
<tr>
<td>Coverage under national programme, version 1.0, %</td>
<td>75</td>
<td>80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marine geological mapping</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mapped surface area, km²</td>
<td>500</td>
<td>330</td>
</tr>
<tr>
<td>Soundings, line km</td>
<td>1,000</td>
<td>1,900</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Urban geological mapping</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents in mapped areas (in thousands)</td>
<td>750</td>
<td>830</td>
</tr>
<tr>
<td>Number of municipalities affected</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Airborne low-altitude geophysical mapping</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>National mapping programme coverage, %</td>
<td>97</td>
<td>100</td>
</tr>
</tbody>
</table>

Prospecting and inventories 2007

<table>
<thead>
<tr>
<th>Commercially viable deposits reported to the Ministry of Trade and Industry</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional inventories of natural rock resources, coverage %</td>
<td>61</td>
<td>61</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mapping of peat reserves</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mapped peatlands, km²</td>
<td>300</td>
<td>323</td>
</tr>
<tr>
<td>Reported volume of peat suitable for production, million m³</td>
<td>100</td>
<td>137</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Groundwater assessment in conjunction with construction studies</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14</td>
<td>10</td>
</tr>
</tbody>
</table>

Research and development 2007

<table>
<thead>
<tr>
<th>Publication activities</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internationally refereed scientific publications</td>
<td>60</td>
<td>55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Jointly financed activities (number of projects)</th>
<th>Planned</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>70</td>
<td>73</td>
</tr>
</tbody>
</table>

Income by client group 2006–2007 (€ thousand)

(Total €16.5 million in 2007)

<table>
<thead>
<tr>
<th>Private sector</th>
<th>8,174</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central government</td>
<td>5,405</td>
</tr>
<tr>
<td>International contracting</td>
<td>2,164</td>
</tr>
<tr>
<td>EU-funded research projects</td>
<td>1,131</td>
</tr>
<tr>
<td>Local administrations</td>
<td>983</td>
</tr>
<tr>
<td>Others</td>
<td>724</td>
</tr>
</tbody>
</table>

2007: [Colors and values for 2007]

2006: [Colors and values for 2006]
GTK’s mineral processing laboratory in Outokumpu offers its unique research resources for studies of sample lots of ores from around the world. Clients receive services ranging from mineralogical analysis to process design.

While the lion’s share of samples submitted to the laboratory come from Finland or other Nordic countries, GTK has received samples from five continents.

“Several years ago, when the local mining sector hit one of its lowest points in decades, we turned our sights outward and discovered a substantial international demand for our services,” reports Kauko Ingerttilä, laboratory head of GTK’s mineral processing laboratory.

“World metal prices, particularly those that are critical to quality of life, have risen dramatically, driven in part by the industrial revolutions in China and India.

At the moment, it makes sense to go after even low-grade or relatively intractable ores.”

According to Ingerttilä, the biggest demand at the moment is for nickel. There is a huge global shortage and the price has risen to sky-high levels. Nickel is used in making stainless steel. Recent research at the mineral processing laboratory has focused on nickel, gold, platinum and niobium related research. Other base metals such as copper, lead and zinc have also come back into fashion. Process studies are critical in determining the economical viability of a given mining operation and planning the concentration facility.

In 2007, the Commission for the Geological Map of the World (CGMW), under the auspices of UNESCO, published a map of the world’s magnetic anomalies. The map was prepared through the cooperation of five international scientific working groups before the final printed version was assembled at GTK, where the project was led by geophysicist Juha Korhonen.

Lithospheric structural details and major areas of geological interest can be readily recognized from the map. A general picture of the structure of the earth’s crust is needed to support instruction, research, mapping and prospecting. A second elaborated version of the map will be released in conjunction with the International Geology Congress in Oslo in August 2008.
GTK last year completed its programme of low-altitude airborne geophysical mapping of Finland. Systematic airborne measurement of the physical properties of the Earth’s crust in Finland (electrical conductivity, magnetic field variations and natural background radiation levels) began nearly 40 years ago. International demand for GTK’s airborne geophysical measurement services remains strong.

Airborne geophysical mapping provides valuable subsoil data. Many user groups such as prospectors, officials involved in zoning, construction and environmental permitting, and those seeking to identify groundwater areas rely on this data. GTK’s measurement package performs three types of geophysical measurement. Magnetic measurement gives information about bedrock fracture zones as well as the magnetic properties of various types of rock. Variations in electrical conductivity are detected with an electromagnetic method. Background radioactivity measurement provides clues of what lies beneath the ground. Measurement flights were made at 30 meters above the ground in long single-direction measurement lines, spaced 200 meters apart.

GTK’s flight team has measured around two million line kilometers and logged over 15,000 flight hours in Finland. The huge amount of measurement data collected has been stored in digital form. When the need for more detailed data arises, e.g. around gold deposits in Lapland, line spacing has been narrowed.

“Finland’s low-altitude aerial mapping began in 1972. At first the mapping focused on ore-critical areas, but soon our work was extended to cover all of Finland,” remarks geophysicist Maija Kurimo. The close-knit flight team has improved and developed equipment, followed trends in the field and maintained world-class expertise. “The job of using these measurement data falls to researchers in years to come,” she states.

As far as future prospects, Kurimo notes, “Our way of working is unique. Competition is positive for this business, as different measurement techniques are applied for different purposes. Our cooperation with BGS offered both parties beneficial solutions and increased the pool of resources to develop and keep the equipment up to date. We expect to keep our emphasis on quality, state-of-the-art approaches and international cooperation. I expect much of our coming work will involve areas in and around Europe.”

National aerial mapping comes to a close
Preserving GTK’s in-house expertise

The demographic shift of Finland’s aging population means that GTK will lose many of its top people in the coming decade even as competition for available talent increases. Our organization is expected to lose about 190 people by 2012. For an expert organization like GTK, most capital resources reside with the staff. This determines to a large extent the organization’s success in achieving its mission. Great attention has been focused on ensuring this hard-won expertise is successfully passed on to the next generation. The turnover of research staff at GTK has traditionally been quite low, which means that the typical retiring researcher has a long work history with GTK. In addition, GTK is preparing the coming wave of retirements and change in the job market with new personnel policies.

Transfer of knowledge and skill-sets needs to be evaluated on a case-by-case basis, taking into account future needs and research demands. Many of these measures can be achieved at low cost now as they represent opportunity costs. What is required, however, is planning. Among the techniques used to help track expertise, we use goal-setting and development talks, mentoring, redundant recruiting, career planning and departure interviews. The entire organization, not just mid-level management and directors, is responsible for transfer of skills.

Future needs and strategic goals are the basis for developing expertise and personnel planning. One vision is to transform GTK completely into an expert organization so that we preserve our core competences and remain competitive, while staying fully networked with Europe’s top experts. Another goal is to operate as national provider of geodata. With the managed reduction in overall staffing levels, we have had to narrow our recruiting efforts, focusing on reinforcing the organization’s core competences.

International networking, innovation and cooperation are stressed in strategic goals. Internationalization is essential and supported by e.g. researcher exchanges and recruiting. GTK also develops group skills through e.g. leadership and management training courses.

Breakdown by division, 2007 (in person-years)

<table>
<thead>
<tr>
<th>Division</th>
<th>Person-Years</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information management</td>
<td>101.7 p-y</td>
<td>13%</td>
</tr>
<tr>
<td>Geological mapping</td>
<td>135.9 p-y</td>
<td>17%</td>
</tr>
<tr>
<td>Research and development</td>
<td>208.3 p-y</td>
<td>27%</td>
</tr>
<tr>
<td>Bedrock geology and resources</td>
<td>338.1 p-y</td>
<td>43%</td>
</tr>
</tbody>
</table>

Breakdown by education, 2007

<table>
<thead>
<tr>
<th>Education</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>University degree</td>
<td>27%</td>
</tr>
<tr>
<td>Comprehensive school or equivalent</td>
<td>22%</td>
</tr>
<tr>
<td>Upper secondary school</td>
<td>21%</td>
</tr>
<tr>
<td>Other higher academic degree</td>
<td>15%</td>
</tr>
<tr>
<td>PhD</td>
<td>10%</td>
</tr>
<tr>
<td>Licentiate</td>
<td>5%</td>
</tr>
</tbody>
</table>
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Geology as a basis for sustainable growth and welfare.