IUGG Annual Report 2004
Geological Survey of Finland (GTK)
Compiled by Seppo Elo

Airborne geophysics
(Maija Kurimo)

GTK carried out National Aerogeophysical Mapping project, which covered 11.000 sq.km during 2004. The standard survey line spacing was 200 meters and flight altitude 30 meters. The survey, which started on 1972, will cover finally the whole country in 2008.

Moreover, GTK made specific airborne surveys for exploration in three areas using very-high-resolution concept: only 50 meters line spacing. These surveys covered 800 sq.km in Middle-Finland and northern Finland.

The British Geological Survey (BGS) and the GTK agreed to establish a Joint Airborne-geoscience Capability (JAC) based on GTK's existing facility. The primary purpose of the JAC is to provide both partners with a cost effective, state-of-the-art capability for acquiring high-resolution airborne geophysical data for their respective national strategic science programmes. The agreement was signed on September 2004.

Environmental geophysics
(Heikki Vanhala)

GTK developed and applied bore-hole, ground and airborne geophysical techniques to problems such as groundwater exploration and protection, mapping of contaminated soil and old industrial areas, land use, engineering geological and civil engineering applications. The methods employed included: Electromagnetics, Gravity, Ground penetrating radar (GPR), Magnetics, Resistivity (and /or Induced Polarization) and Seismic refraction (and /or near surface seismic reflection). A typical environmental geophysical project consists of, step-by-step, Data acquisition, Data processing, Visualization, Modelling, Interpretation (i.e. integration of all data and visualizations).

In 2004, two cases "Detailed geophysical study of glaciofluvial aquifer at Kempele, western Finland" and "Characterizing tailings impoundment at the closed Hammaslahti Cu-Zn mine, Finland" were presented in: Near surface 2004, 10th European Meeting of Environmental and Engineering Geophysics, Utrecht, The Netherlands, and one case " Integrated geophysical study of acid sulphate soil area near Seinäjoki, southern Finland" was presented in: Sharing the Earth, EAGE 66th Conference & Exhibition, Paris, France.

Development of geophysical methods
(Hannu Hongisto)

Through a sponsor agreement with AMIRA International GTK participates in testing of electromagnetic software developed by Australian CSIRO. The software includes thin-sheet, 3D-body, 2.5D-element and layer-inversion programs. GTK has a restricted right to use the software in its own research work.

Fixed-wing airborne electromagnetic measurements of GTK were modelled using numerical methods.

STROB Time-domain electromagnetic (TEM) instrument with single loop configuration was tested on sea ice, over conductive clay and on granitic bedrock

The group participated in test measurements of NuPulse (neutron pulse activation) method.

Finnish Reflection Experiment FIRE
(Ilmo Kukkonen)

The aim of the project **FIRE** (**Fi**nnish **R**eflection **E**xperiment) is to investigate the structure of the crust in Finland on several transects using reflection seismics during 2001-2005. The project is participated by the Geological Survey of Finland, and the universities of Helsinki and Oulu. The field work was carried out in 2001-2003 and it resulted in 2100 km of high-quality reflection lines. The transects crossed the major geotectonic units of the Precambrian in Finland, including several areas of metallogenic significance. The field operations were carried out by the Russian government-owned company Spetsgeofizika acting as a contractor. The funding of the contractor was based on the partial compensation of Russian debt to Finland. In 2004 the interpretation and reporting of the FIRE results was being done. Among the main results of the FIRE surveys are the strong reflectivity seen often throughout the crust, distinctly three-dimensional structures and diffuse reflection Moho, particularly under the anomalously thick crust beneath the Central Finland Granitoid Complex.

International geophysical map projects
(Juha Korhonen)

As the final result of multinational NW-European project 1996-2002 the Geological Map and Geophysical Maps of the Fennoscandian Shield 1:2 000 000 and corresponding summary of petrophysical properties of lithosphere were presented to the 32nd ICG and the General Assembly of CGMW 2004 in Florence by Juha V. Korhonen.

Planning of the World Digital Magnetic Anomaly Map (WDMAM) continued. Co-operation between IAGA under IUGG and CGMW under IUGS was established. Contacts were made to continental, oceanic and satellite magnetic data reduction groups, and the project was promoted in international geoscience meetings globally. Methods developing group was initiated in GFZ-Potsdam. A call of abstracts was made for "World Magnetic Anomaly Map; Anomaly Definition and Calculation" session to be held at IAGA Scientific Assembly in Toulouse 2005. Working group chairmen were Juha V. Korhonen (GTK, Finland) and Colin Reeves (ITC, The Netherlands).

Outokumpu Deep Drilling Project
(Ilmo Kukkonen)

The Geological Survey of Finland started a deep drilling project targeting at 2.5 km deep research borehole in Outokumpu, eastern Finland. The project aims at improved understanding of (1) the upper crustal structures of the Outokumpu ore belt by correlating drilling results with high resolution reflection seismic results and potential field data, (2) the petrology and genesis of the Outokumpu ophiolites and metasediments, (3) the hydrogeology and geochemistry of the saline fluids characteristic of the Outokumpu belt, and (4) the vertical variations of several geophysical, geological and petrophysical parameters, such as the geothermal heat flow, magnetic and electrical properties, density, porosity, etc.

The drilling commenced in April 2004 and was finished in January 2005 ahead of schedule. Among other results, the borehole has successfully revealed the geological character of the strong reflectors in the Outokumpu area (ophiolite-related rocks, serpentinites, skarn rock and black schist). Hydrogeological studies have revealed deep saline fluids with high concentrations of methane.

The borehole (with a diameter of 216 mm) will be left open after drilling and will be used as a geolaboratory for various long-term in situ experiments and follow-up measurements. The Outokumpu Deep Drilling Project is open for international and national partners to carry out specific research projects utilizing the open hole facility, drill cores and geophysical logging results. The hole is completely cored, and an extensive geophysical logging program was carried out. More details of the project can be found at
http://www.gsf.fi/projects/o_k_deepdrilling/lithologies.htm.

Paleomagnetic investigatons
(S. Mertanen)

The laboratory for Paleomagnetism at GTK carried out studies that are related to the investigations of the ancient plate movements and developed new applications for the usage of paleomagnetic method especially for dating purposes.

Paleomagnetic studies, combined with geochemical and isotopic age studies on Archean-Paleoproterozoic formations were continued in order to define timing for the rifting of an Archean supercontinent and to calculate plate movement of the Fennoscandian Shield. Studies on ca. 1.8-1.6 Ga lamprophyre and microtonalite dykes in Juankoski and Lake Ladoga area in Russia were continued in co-operation with the University of Turku and State Company Mineral (St. Petersburg).

Paleomagnetic method was applied in dating gold mineralisations in northern Finland and in dating late geological events in fault and shear zones of the ca. 1.9-1.8 Ga Sveco-fennian basement in southern Finland.

GTK had the main responsibility (together with the Geophysics Department of the University of Helsinki) in arranging the 5th Nordic Paleomagnetic Workshop that was held in Suitia at 25.-29.92004. The main study objects of the workshop were remagnetization, Vendian age paleomagnetism of the Fennoscandian Shield and geomagnetic modelling. The workshop was attended by all Nordic paleomagnetists and several other researches from the USA, the Netherlands, Poland, Estonia and Russia.

Petrophysical research
(Tapio Ruotoistenmäki)

Measurements of density, magnetic susceptibility and remanent magnetization were made at the petrophysical laboratory of altogether 1700 samples. Petrophysical data were used in establishing and interpreting relationships between the evolution and structure of bedrock and geophysical anomalies, in exploration of ores and industrial minerals, in studying sites for nuclear waste disposal, the GEOMEX joint venture and in urban geology. Summaries of petrophysical data were published in explanations of bedrock maps. The Geomex project covering the Outokumpu area, which was carried out in collaboration with Outokumpu Mining Oy, was concluded. It produced important new information and digitized models of the history of the bedrock in the Outokumpu area and the origin of ores. A paper dealing with “aerogeophysical approach to ductile and brittle structures in the densely developed urban Helsinki” is in preparation by Airo, M-L. et al.

Regional gravity measurements and modeling
(Seppo Elo)

Geological Survey of Finland (GTK) continued applying gravity measurements to bedrock research, to exploration of metallic ores and industrial mineral deposits, and environmental studies. In regional gravity surveys, the station interval was 400 to 500 m (4 to 6 stations per sq. km. Local measurements are either profiles with a station spacing of 20 m or regular grids usually of 20 m x 100 m or 20 m x 50 m. In addition, to our own measurements, the data of the Finnish Geodetic Institute and those compiled in international projects are utilized.

In 2004 the number of gravity stations measured by GTK was as follows:
1. Regional gravity measurements: 6592 stations
2. Local measurements: 18359 stations

In 2004 major targets were layered intrusions and bedrock structures in gold-prospecting areas. The gravity method maintained its position in estimating overburden thickness mostly in conjunction of assessing groundwater resources and mapping contaminated soils. Results of the GPS-gravity measurements at a waste treatment center to obtain estimates for the subsidence rate and density of landfills and the density of bio-waste in composting tunnels were presented at the EAGE 66th Conference & Exhibition in Paris.

New software for processing the results of gravity measurements was designed by V. Sipola and is currently in test use.

GTK cooperated with the University of Oulu in a project the aim of which was to construct an integrated 3-D geophysical model of the crust below the southern and central Finland by joint interpretation of seismic tomographic, gravity, aeromagnetic, petrophysical and geological data. In 2004, the principal scientist of the project, Dr. M. Pirttijärvi, developed software for three-dimensional modelling and interpretation of gravity and magnetic field data (GRABLOX and MAGBLOX programs), visualization and maintenance of the three-dimensional models (BLOXER program), and lithologically weighted interpolation of petrophysical data (PETROCK program). Results were presented in the EGU General Assembly 2004, Nice, France. The project ended in 2004.

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