THE GLOBAL GEOSCIENCE TRANSECTS PROJECT IN FINLAND

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An international Global Geoscience Transects (GGT) Project was initiated in 1985 with the primary goal of integrating surface geological data with subsurface geophysical data to enhance our understanding of crustal structure from a variety of active and ancient tectonic environments (Goetze & Monger 1992). The international GGT Project, which was completed at the end of 1998, has been a collaborative venture of the International Lithosphere Program (ILP) established by the International Union of Geological Sciences (IUGS) and the International Union of Geodesy and Geophysics (IUGG). Its goal was to construct lithospheric transects, mainly crustal cross sections through crucial geologic and tectonic features, such as mountain belts, grabens, sedimentary basins, and hazardous regions prone to the disastrous activities of earthquakes and volcanoes, in order to allow direct comparisons. All of the available data have been assembled at an equal scale of 1:1 million in order to enable global comparisons of similar structures as well as to display the nature and evolution of the Earth's lithosphere. Transects typically consist of strip maps that portray geological and geophysical data covering a region at least 100 km in width and variable in length. The subsurface crustal sections include geologic and tectonic interpretations with observed and calculated geophysical anomalies. Data such as geochemical, geodetic, borehole, earthquakes, electrical resistivity, heat flow, and seismic reflection or refraction are presented where available. The first transect compilations were published by the ILP and American Geophysical Union (AGU) in August, 1991. Since then the digitization guidelines were developed (Goetze & Williams 1993) and in 1995 ILP decided that future transects will be available only as digital products (see GGT homepage at http://quake.wr.usgs.gov/GGT).

The studies along the SVEKA profile form a Finnish contribution to the GGT Project (Korja & Korsman 1993). The GGT/SVEKA transect, which contains the most comprehensive geological, geochemical and geophysical data available for Finland, is located in the central part of the Fennoscandian Shield. It crosses the main tectonic units in southern and central Finland and covers an area 160 km wide and 840 km long extending from near the Finnish-Russian border in the northeast to the Finnish-Swedish border within the Åland archipelago in the southwest (Figs. 1 and 2). In the northeast, the transect traverses across

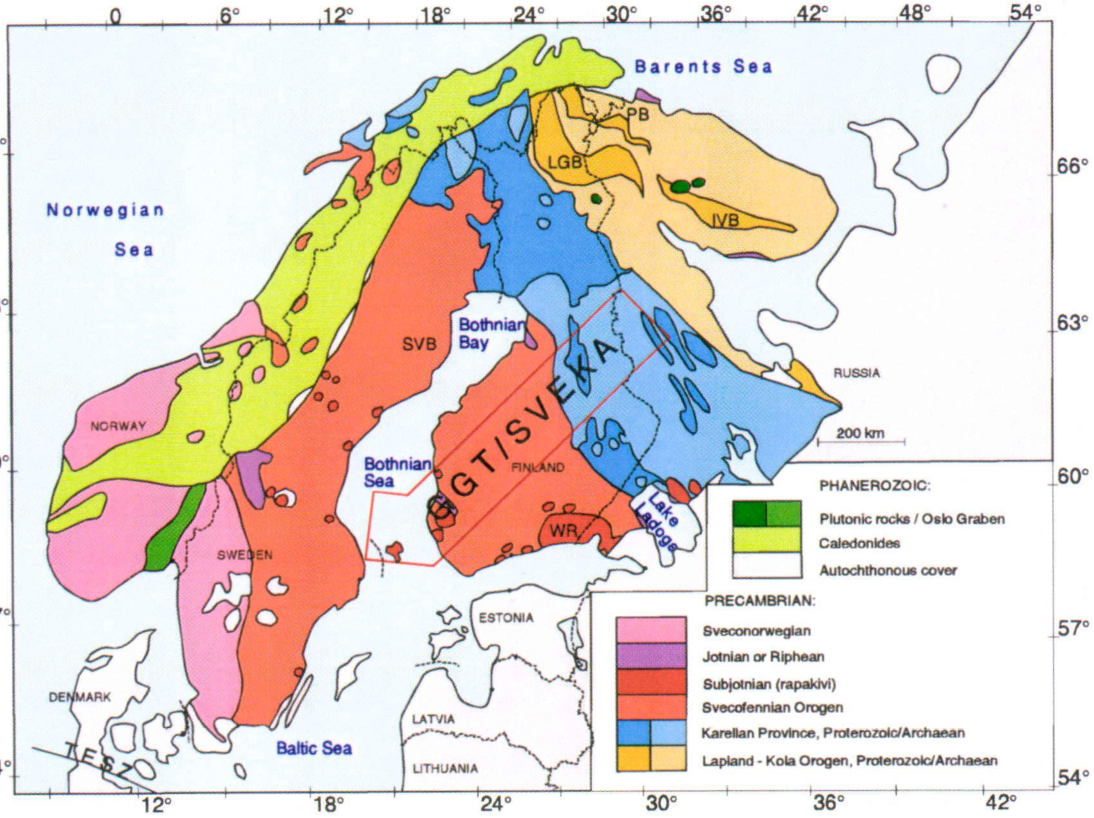

Fig. 1. Main geotectonic units in the Fennoscandian Shield. IVB – Imandra-Varzuga Belt, LGB – Lapland Granulite Belt, PB – Pechenga Belt, SVB – Skellefteå Volcanic Belt, TESZ – Trans-European Suture Zone, and WR – Wiborg Rapakivi. The GGT/SVEKA transect is outlined by a polygon.

the western part of the Karelian Province, which includes e.g. the Archaean Kuhmo Greenstone Belt and the Palaeoproterozoic Jormua Ophiolite Complex, and crosses the boundary zone between the Karelian Province and the Palaeoproterozoic Svecofennian Orogen. Further to the southwest, the transect traverses across the northern and central part of the Svecofennian Orogen including, from the northeast to the southwest, the Pyhäsalmi Primitive Island Arc, the Central Finland Continental Arc, and the Southern Finland Sedimentary-Volcanic Complex. The transect ends in an area of Mesoproterozoic rocks, which includes rapakivi granites, Subjotnian diabase dykes, and Jotnian sandstones. The geological evolution started 3.2 Ga ago in the eastern part of the transect and is rejuvenating gradually to the southwest, the youngest rocks being the 1.2 Ga old Subjotnian diabase dykes as well as the minor occurrences of Neoproterozoic sedimentary rocks. The transect is therefore ideally situated for studying the Svecofennian orogeny and its effects in the Archaean Karelian crust as well as the later, mainly Subjotnian, extension of the Svecofennian crust.

The GGT/SVEKA program, following the objectives of the international GGT program, has been aimed at constructing a tectono-evolutionary model of the crust along a transect with special emphasis on the crustal thickness variations, the high metamorphic temperatures associated with the Svecofennian orogeny, the significance of deep crustal conductors, and the effects of the Sve-

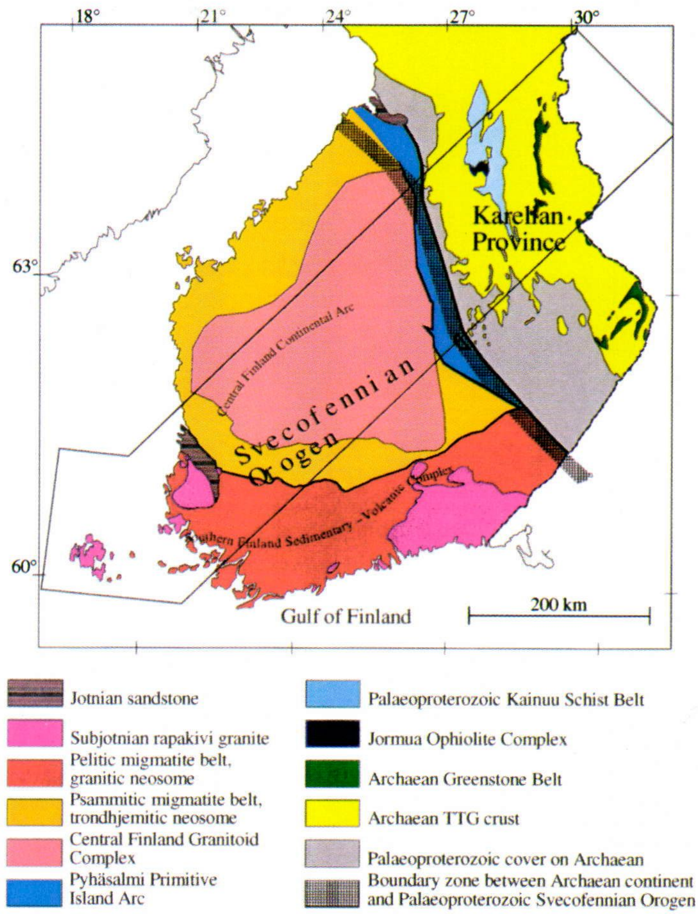

Fig. 2. Geotectonic units in southern and central Finland. The GGT/SVEKA transect is outlined by a polygon.

cofennian orogeny in the Archaean Karelian Province (Fig. 3). Much attention has been given to understand the temporal and causal relationships between deformation, metamorphism, and magmatism because this is a necessary step for understanding the evolution of a tectonically thickened crust metamorphosed under high-T/low-P conditions.

The Svecofennides have a complex evolution that varies in space and time in detail. Many coeval, overlapping and continuous processes have resulted in a unique crust rich in geophysical and geological details (see e.g. Korsman et al. 1999). The major findings of the GGT/SVEKA work, based on geophysical and geological observations, can be summarized by the following features characterizing the Svecofennian crust, its evolution, and its geophysical and geological properties:

1 – Seismic data indicate remarkable variations from 27 km to 65 km in the crustal thickness of the Precambrian crust in Fennoscandia but most of the variations in Moho depth can be explained by variations in the thickness of the high-velocity lower crust which ranges from 0 to 30 km.

2 – The crustal thickness variations, which have a bimodal distribution in Fennoscandia, are mostly compensated within the crust by density variations. Thinner crust (dominant crustal thickness in average 45 km) is found in regions that have experienced one or several anorogenic extensional events (e.g. the Archaean Karelian Province and the Subjotnian rapakivi areas), whereas large parts

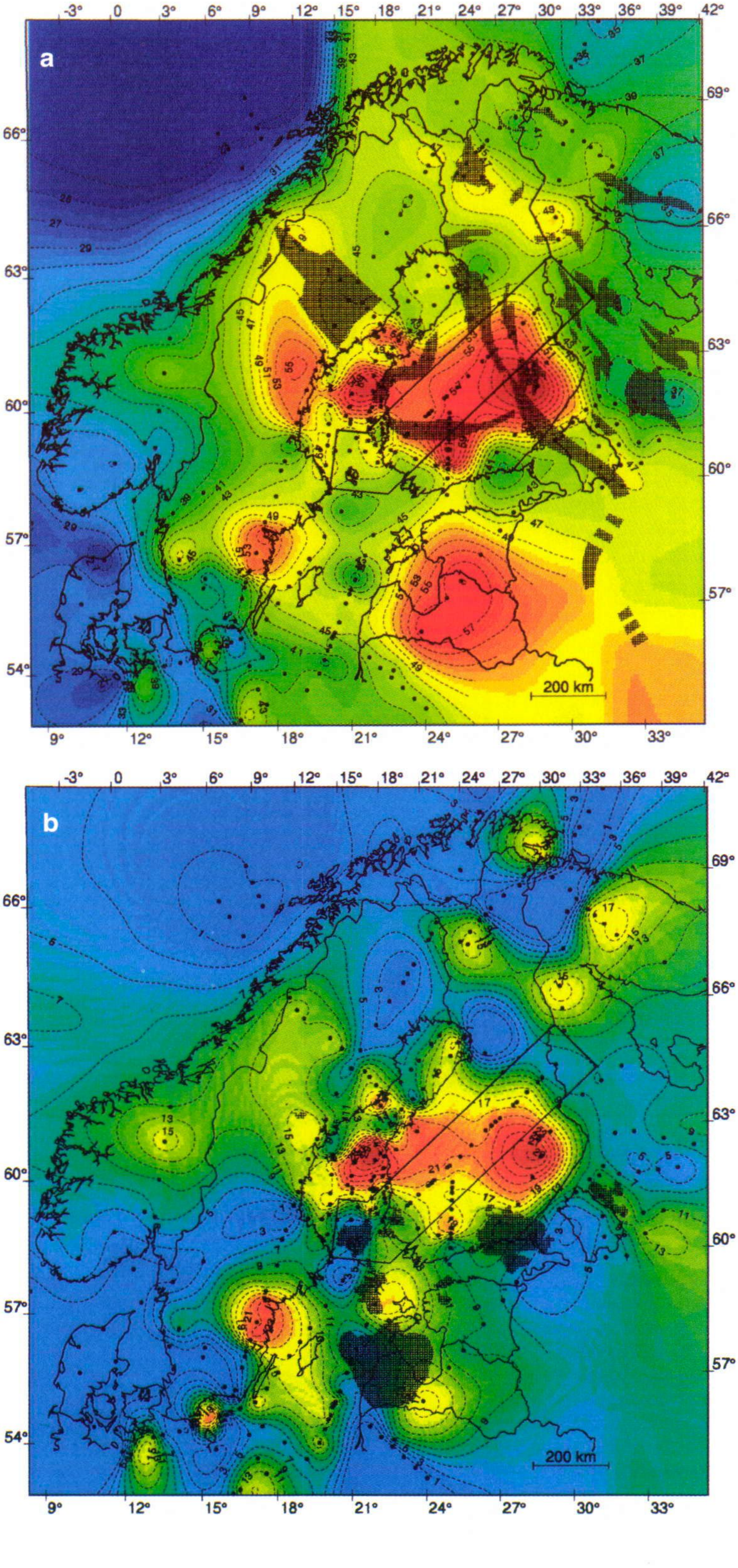

Fig. 3. (a) Crustal thickness and crustal conductors in Fennoscandia. Contours represent depths to Moho (km) obtained from refraction seismic studies. Moho depths are interpolated from 2D velocity models at sites shown as black dots. Dark brown areas indicate exposed parts of crustal conductors revealed by magnetometer and airborne electromagnetic data from the central and northeastern parts of the shield; no data are available from the southwestern part of the shield. The GGT/SVEKA transect is outlined as a polygon. (b) Thickness of the lowermost high-velocity crustal layer. Contours represent thickness (km) of the 7.0 – 7.7 km/s layer. Thickness values are interpolated from 2D velocity models at sites shown as black dots. Dark brown areas show rapakivi intrusions. The GGT/SVEKA transect is outlined by a polygon. Original references to the data used to compile the maps and to other details can be found in Korsman et al. (1999).

of the Svecofennian Orogen have notably greater thickness (dominant thickness in average 55 km) indicating that the crust does not always attain a "normal" thickness of ca. 40 km but may remain much thicker. Orogenic collapse, as a mechanism for producing normal (thinned) crust, was apparently inhibited in these areas and isostatic balance was achieved by density variations within the crust.

3 – Crust was thickened tectonically and by magmatic under- and intraplating. Tectonic thickening involved both under- and overthrusting. The presence of the thick high-velocity lower crustal layer indicates magmatic under- and intraplating.

4 – The thick Svecofennian crust has been preserved, because its density was increased by magmatic intra- and underplating. The entire Svecofennian crust equilibrated soon after magmatic underplating.

5 – Mafic high-velocity deep crustal layer was formed at several phases including the Palaeoproterozoic pre-Svecofennian extension of the Archaean crust, the formation of the Svecofennian island arc systems in subductions, the Svecofennian post-collisional underplating caused by mantle upwelling and melting of the lower crust, and the Subjotnian extension associated with the rapakivi magmatism.

6 – High metamorphic temperatures in the Svecofennian Orogen were caused by magmatic underplating between 1.885 and 1.800 Ga. Extension started soon after subduction and thickening of the crust. This extensional phase, however, did not thin the Svecofennian crust because a continuous push from southwest in ongoing accretionary processes prohibited a true collapse of the crust.

7 – In general, the large-scale architecture of the crust as imaged today have resulted from several tectonic processes that affected the whole crust. In the Svecofennides, the thickest crust was formed during the Palaeoproterozoic Svecofennian orogeny whereas the regions of thinner crust were formed during the Subjotnian extension. Similarly, the thinner parts of the Archaean Karelian Province represent Palaeoproterozoic pre- and post-Svecofennian extension, whereas the thickest parts, primarily along the craton margin, are Palaeoproterozoic Svecofennian. The latter implies that the current Moho boundary beneath the Archaean crust is likely Palaeoproterozoic in age in both regions.

Original results of the GGT/SVEKA work have been published in separate articles and in special volumes associated with the GGT/SVEKA Project (Appendix 1). This Bulletin, published by the Geological Society of Finland, is just one example of the special volumes. Major scientific results of the GGT/SVEKA work has been published by Korsman et al. (1999). Final maps and an explanatory text including a complete list of references to original work and data sources can be found in Korsman et al. (in print).

The GGT/SVEKA Project was participated by nearly all geoscientific organizations in Finland: Geological Survey of Finland, Espoo and Kuopio; Department of Geology at the University of Helsinki, Institute of Seismology at the University of Helsinki, Institute of Geology and Mineralogy at the University of Turku, Geological Department at Åbo Akademi, and the Institute of Geosciences at the University of Oulu. Many researchers outside from Finland have helped us in the course of the GGT/SVEKA work.

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Appendix 1: Articles related with the GGT/ SVEKA project.

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- Elo, S. Gravity data, 2 p.
- Kurimo, M. & Ruotoistenmäki, T. Magnetic data, 2 p.
- Luosto, U. Seismic data, 3 p.
- Kukkonen, I.T. Thermal data, 3 p.
- Korja, T. & Lerssi, J. Geoelectromagnetic data, 3 p.
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- Säävuori, H. Petrophysical data, 2 p.
- Korja, T. Major geophysical features along the GGT/ SVEKA transect, 19 p.
- Korsman, K. General geological features and tectonometamorphic evolution, 10 p.
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