Rock geochemistry research project (RGRP) in the Geological Survey of Finland

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Introduction

The Fennoscandian shield is divided into the Archean and Paleoproterozoic continental Karelian and orogenic Svecofennian domains. The bedrock lithology is relatively well known due to extensive bedrock mapping at scales of 1:400 000 and 1:100 000. The results of many detailed geochemical studies, especially concerning volcanics, are available but some large areas still remain poorly constrained. Only major elements and some trace elements are normally available. Analytical methods, sampling methods and strategies all vary, making comparisons between different studies somewhat difficult. A regional till mapping program covering the whole Finland is now at the final publishing stage. This data set includes a total of 80 000 till samples which form a valuable data bank for different studies. Interpretation of this data set requires an undestanding of compositional variations between different rock types and in different areas. The Rock Geochemistry Research Project (RGRP) was initiated by the Geological Survey of Finland (GSF) in 1991 to meet these requirements. This is an eight year regional research program covering the whole of Finland. A pilot study was conducted in the Tampere-Hämeenlinna area in southern Finland during 1989 to develop sampling strategies and methods, analytical methods and interpretation methods for the RGRP. The results of pilot project have been presented in five papers published as GSF bulletin (Salminen, in press). More thematic studies are presented as separate papers (e.g. Lahtinen, this volume).

Main objectives

The main objective of the RGRP is to acquire a data base including field, analytical and petrophysical data. Different bedrock types are classified into different tectono-magmatic and genetic groups with interpretations of their metallogenic significance. The evaluation of areal differences and correlations are critical to a better understanding of Finnish bedrock. Geochemical aspects of crustal evolution and the origin of rock types are also considered. The data are also applied to integrated interpretations of till and rock geochemical data and to indentify mineralization indications.

Material and methods

Samples are taken from outcrops and the sampling density varies from one sample per 30 km^2 to one sample per 120 km^2 depending on the degree of lithological variation. Eventually a total of 7000–8000 samples will be collected and analyzed. The sampling strategy is based on the available bedrock maps and all the major rock types are included. The sampling sites are distributed as evenly as possible and sampling is carried out by a portable mini-drill with a diamond bit. Each sample comprises five sub-samples all taken from the same lithological unit. In the case of heterogeneous or coarse-grained unit the amount of sub-samples is increased. Four sub-samples are used for analysis and the fifth is for petrophysical and petrographical studies. The sampling includes a detailed outcrop description with sample unit classification. The samples are analyzed in the GSF chemistry laboratory for over 50 elements including *REE*s, the main analytical methods being XRF, ICP-MS, ICP-AES and GAAS. As the sampling and analytical stages are critical an efficient quality control is used. Assessment of contamination during sampling and sample pretreatment are controlled by quartz samples. Systematic duplicate analysis has been introduced including field and laboratory duplicates and a batch of control samples from the first year samples analyzed repeatedly every year, in order to eliminate the effect of possible annual drift and to render the results comparable for the whole duration of the project.

Results and present situation

The results will be published as regional reports in the GSF report series. The field and analytical data including petrophysical data, are stored in the Alkemia-data base, enabling the simultaneous study of a large number of samples from a wide area and particularly, access to data from specific localities. The regional reports will include classification of single samples and definition of areal and geochemical groups. A comparison with available geological, geophysical, isotopical and age data is also made to evaluate similarities and differences. The integrated interpretation of till, rock geochemical and lithological data is used to approximate the bedrock lithology in areas covered by thick overburden. The background values of ore-related elements between different rock types are used to predict favourable rock types and to separate anomalous samples from non-anomalous samples. Thematic studies considering more detailed aspects of the data are presented as separate and joint papers.

The results of the Tampere-Hämeenlinna pilot project, consisting of 403 samples from an area of 9600 km^2 are available during the end of 1994. At present, about 5250 samples have been collected, covering approximately 70% of Finland. Sampling is expected to be completed in 1995 and final results are to be published during 1998. Analyses from 1600 samples will be available during 1994 and the first sub-regional reports will be published in 1995.

Discussion

This type of combined geochemical, geophysical and petrological data makes it possible to delineate regional differences and similarities in geochemistry, petrogenesis, metallogeny and areal distribution of different rocks types. The general geochemical differences e.g. between Archean and Paleoproterozoic evolution are revealed with special priority being given to any differences in the character of mafic and felsic magmatism, and sediment composition. The point-like nature of sampling does not address the problem of small scale variation within different formations and represents only a single sample from each outcrop. During the pilot study, in addition to duplicate field reference samples, a duplicate formation reference sample was taken from similar rock type about 200–700 m away from the sampling outcrop. The comparison between these reference samples show however, that in about 70% of cases, they give the same information and are regionally similar. If the geochemical affinity, instead of direct geochemical similarity, is considered we obtain an even greater amount of similarity between these samples (80–85%). Of course, many important rocks units are not sampled by this method and many critical geological boundaries are very thin or internally complex. Fortunately many detailed thematic geochemical studies associated with stratigraphical, metamorphical, structural, isotopical and age data are available or are in progress, thus providing a framework for comparison with this type regional study. The results of the pilot study made it possible to characterize schist belts and associated plutonic rocks according to different evolution stages with different geochemical fingerprints. The results clearly demonstrate the uselfulness of this type approach when studying the geochemical and geological evolution of the Fennoscandian shield. The ultimate goal will be a better undestanding of geochemical cycles and evolution of Archean and Paleoproterozoic crust and mantle.