The Falun supracrustal belt. Part 1: primary geochemical characteristics of proterozoic metavolcanics and granites

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Abstract

The main lithostratigraphic units of the felsic supracrustal sequence of the Falun area are described. The $> 100 \, km^2$, E–W trending synformal enclave is bordered to the N and S by co-magmatic Svecokarelian granites.

The 4.5 km thick sequence comprises lower units of rhyolitic tuffs with minor mafic intercalations, passing up through felsic volcanics to the sulphide-bearing ore horizon.

The primary geochemical characteristics of the felsic volcanics and the Svecokarelian granites are illustrated using multicationic classification diagrams. The results for 360 samples collected at $\pm 50 \, m$ intervals along 3 lithogeochemical traverses reveal primary lithogeochemical features which in the B–A classification of magmatic associations diagram (Debon & Le Fort, 1983) are considered to reflect a horizontal to positive aluminous trend for the Falun supracrustals. The Svecokarelian (early – to synorogenic) granites (urgranit) close to the supracrustal border also reveal a similar trend.

Introduction

The massive sulphide deposit at Falun has attracted several exploration companies to the region during the past centuries. As part of a detailed exploration programme carried out by LKAB Prospektering and BP Minerals International Ltd, geological mapping, airborne and ground geophysics, and till geochemistry have been supplemented by a major and trace element lithogeochemical study of the area. 360 samples of felsic metavolcanics, metasediments, amphibolites and granites, collected approximately every 50 metres along three N-S, across strike profiles have been chemically analysed.

This paper briefly describes the geology of the Falun area and presents an interpretation of primary geochemical features which can be deduced from the major element chemistry of the samples.

Geology

The felsic metavolcanic supracrustal belt of Falun, (Fig. 1) is an isoclinally folded, major synformal enclave, in excess of $100 \, km^2$ and extending both to the E and W of the Falu Copper mine. The general strike is E–W with a vertical to sub-vertical dip southwards.

Svecokarelian granites ('urgranit') occur both to the N and S of this belt, with intrusive contacts running sub-parallel to the strike direction of the felsic metavolcanics.
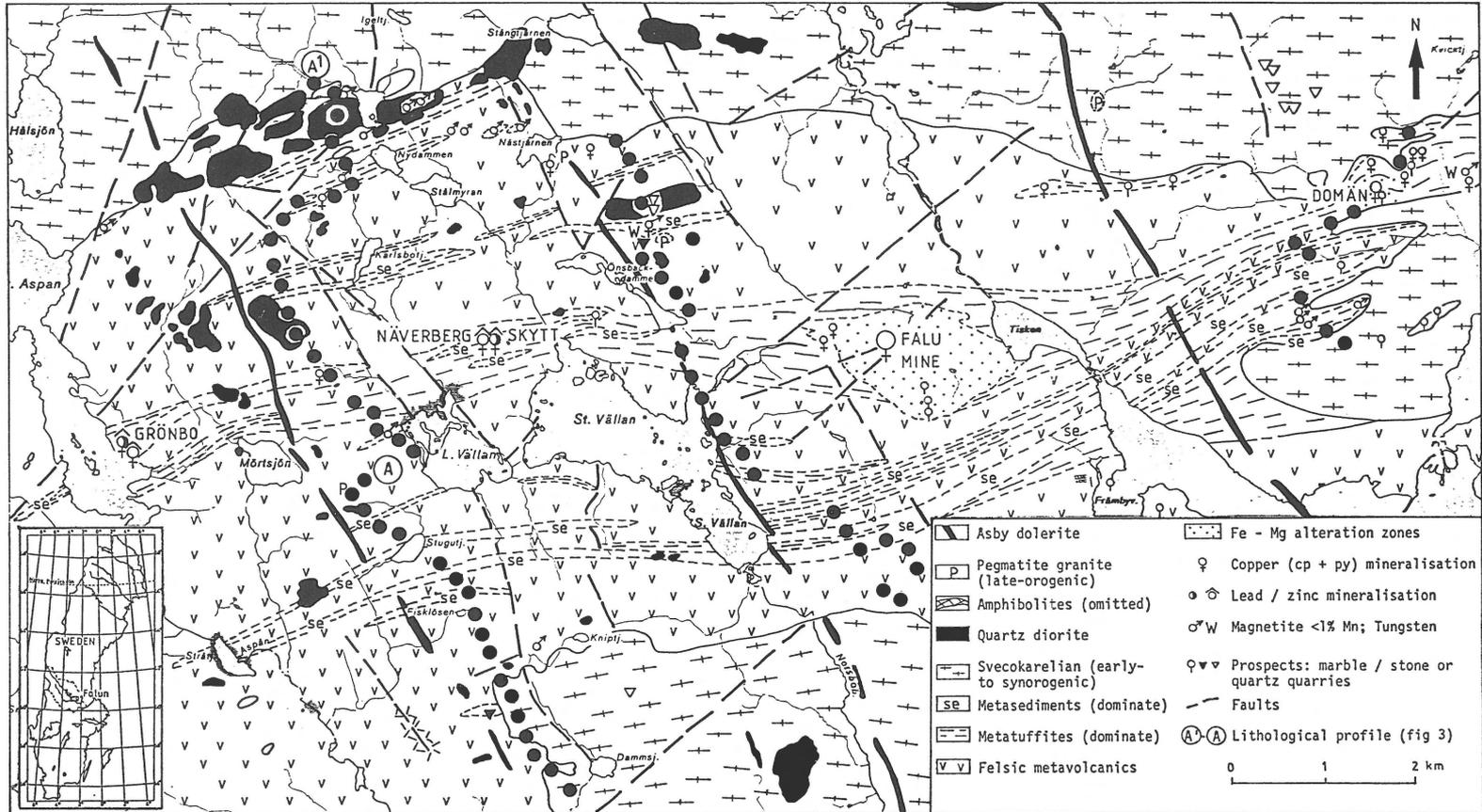
Fig. 1. Geological sketch map of the Falun area showing lithogeochemical sampling profiles (marked by dotted lines).

The metavolcanic rocks directly south of the Svecokarelian granites were considered by Geijer & Magnusson (1944) to be the oldest preserved parts of the supracrustal sequence within the area. They belong to the Lower Proterozoic Leptite Formation 1.9–1.8 Ma, (Åberg et al., 1984; Welin et al., 1980). The nearest dated sample (approximately 8 km NE of Falun) gives an age 1900 ± 19 Ma. (Åberg et al., 1984). In common with other parts of Bergslagen no basement rock has yet been identified. Previous descriptions of the geology of the Falu Copper mine, and the supracrustals in which it occurs, are given amongst others by Geijer (1917), Koark (1960, 1962), Koark et al. (1986) and Kresten (1986).

The supracrustals consist predominantly of metarhyolites-rhyodacites and to a lesser extent metatuffites, amphibolites, quartz and quartz-feldspathic gneisses, mica schists, calc-silicate rocks (skarns) and marbles.

The Svecokarelian granites (urgranit) in this area are considered to be early- to synorogenic biotite granites with a mainly granodioritic composition and an estimated age falling between 1845–1880 Ma. The closest dated synorogenic granite belonging to this suite (approximately 8 km NE of Falun) gives an age of 1873 ± $^{10}_{11}$ Ma (Åberg et al., 1984).

The general geological sequence of events is shown in the geochronological table (Fig. 2). A simplified description of the main lithostratigraphic units in the area is given below.

Summary lithostratigraphy of the Falun area

The stratigraphy of the Falun area is discussed in relation to the lithogeochemical sampling traverse A-A' (Fig. 1), corresponding to part of the western bedrock geochemical survey. It covers approximately 4.5 kms across strike from the Svecokarelian granite (urgranit) border to Lake Lilla Vällan.

Although the lithological profile (Fig. 3) assumes a general younging trend upwards, there may be repeated isoclinally folded sequences which could imply that the supracrustals do not entirely conform to a simple synformal enclave. Meta-rhyolites and meta-rhyodacites are interpreted as felsic to intermediate tuffs and lavas. They represent by far the commonest supracrustal rocks in the Falun area (Fig. 3). Generally they are light grey to pale red, and fine to medium grained. Regional metamorphism (amphibolite facies) has obscured most of the primary features. However, relict rounded, high temperature blue quartz phenocrysts can be observed. Both relict phenocrysts and porphyro-

Age, Ma	The Falun area
900–970	Trans-tensional faulting and fracturing permit emplacement of Falu Dolerite dykes along subvertical extensional faults striking 150°
~1370–1635	Lower greenschist facies veinlets in fractures (metamorphism during burial beneath Sub-Jotnian and Jotnian supra-crustals)
1675–1735	Retrogressive lower greenschist facies metamorphism (associated with emplacement of the postorogenic Dala granites to the west)
	Intrusion of basic dykes during post-orogenic relaxation; metamorphism continues.
>1726	Epidote-amphibolite facies metamorphism (during Svecokarelian deformation)
1750–1800	Emplacement of serorogenic granites and NNW-SSE compression causing subvertical tilting and extension and folding of the pre-existing rocks (Svecokarelian deformation)
1845–1870	Emplacement of the Svecokarelian granitoids and intrusion of basic dykes and sills, initiating Svecokarelian deformation
	Syndepositional hydrothermal metasomatism
	Rapid subsidence and burial
>1880	Deposition of the Leptite Formation

Fig. 2. Geochronology of the Falun area (after Welin et al., 1980, Åberg et al., 1984; Kresten, 1986).
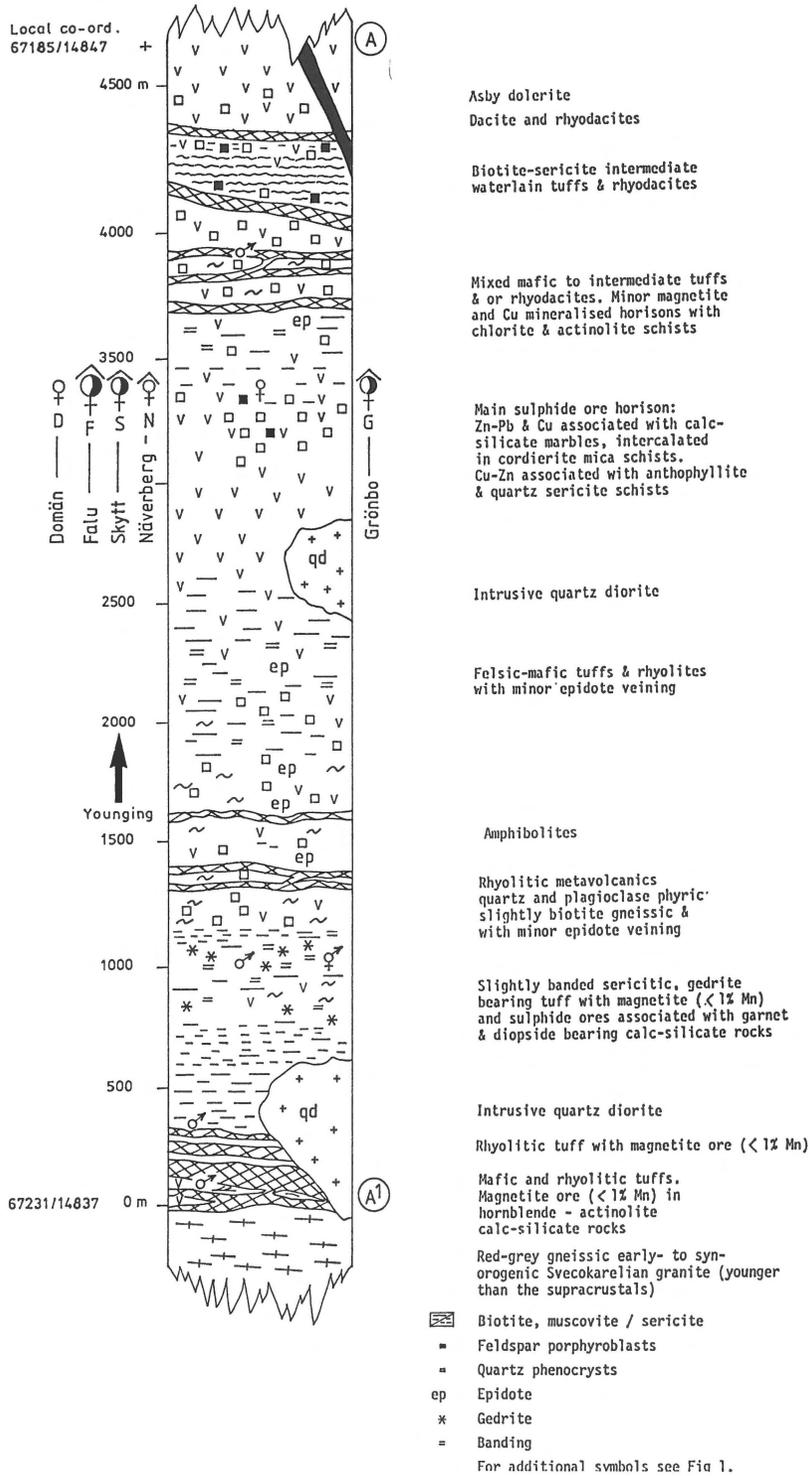
242

Local co-ord.
67185/14847

4500 m

Asby dolerite
Dacite and rhyodacites

Biotite-sericite intermediate
waterlain tuffs & rhyodacites

4000

Mixed mafic to intermediate tuffs
& or rhyodacites. Minor magnetite
and Cu mineralised horisons with
chlorite & actinolite schists

3500

Main sulphide ore horison:
Zn-Pb & Cu associated with calc-
silicate marbles, intercalated
in cordierite mica schists.
Cu-Zn associated with anthophyllite
& quartz sericite schists

Domän D
Falu F
Skytt S
Näverberg N
Grönbo G

Intrusive quartz diorite

2500

Felsic-mafic tuffs & rhyolites
with minor epidote veining

2000

Younging

1500

Amphibolites

Rhyolitic metavolcanics
quartz and plagioclase phyric
slightly biotite gneissic &
with minor epidote veining

1000

Slightly banded sericitic, gedrite
bearing tuff with magnetite ($< 1\%$ Mn)
and sulphide ores associated with garnet
& diopside bearing calc-silicate rocks

500

Intrusive quartz diorite

Rhyolitic tuff with magnetite ore ($< 1\%$ Mn)

Mafic and rhyolitic tuffs.
Magnetite ore ($< 1\%$ Mn) in
hornblende - actinolite
calc-silicate rocks

67231/14837   0 m

Red-grey gneissic early- to syn-
orogenic Svecokarelian granite (younger
than the supracrustals)

Biotite, muscovite / sericite

Feldspar porphyroblasts

Quartz phenocrysts

ep   Epidote

*   Gedrite

=   Banding

For additional symbols see Fig 1.

Fig. 3. Lithological profile A-A′ (see Fig. 1) showing distribution of felsic rock types, position of mafic rocks, sulphide-oxide ores and Svecokarelian granite.

blasts of plagioclase are recognised. Biotite and rare hornblende are minor constituents. Thin horizons of felsic metavolcanics revealing pyroclastic textures are observed at the Skytt deposit and also further northwards.

The intrusion of the Svecokarelian granites (urgranit) has had a varied influence along the contact with the metavolcanic rocks. The two types seem to merge progressively with the grain size of the metavolcanics increasing approaching the granites. This can be interpreted as an indication of palingenic origin or also the effect of felsic magma on felsic volcanic detritus.

Amphibolites of at least two generations have been recognised (Fig. 3). Concordant amphibolites in the felsic to intermediate tuffs and lavas are in some cases extrusive, but in other cases part of a suite of transgressive sills and dykes. Pyroclastic textures are visible in some of the extrusive amphibolites.

As can be seen in Fig. 3 the oldest supracrustal rocks in the metavolcanic sequence are meta-rhyolites and meta-rhyodacites. Continuing up through the sequence, thin zones of gedrite-bearing quartzo-feldspathic gneiss (altered metatuffite) are observed in the metavolcanics. These are overlain by thin layers of very fine grained, laminated felsic, and intermediate metatuffites. These are accompanied by a gradual increase in the frequency of the amphibolites. Mixed metasediments and metavolcanics appear further up in the sequence with small intercalated skarn-magnetite bands, associated with pyrite and pyrrhotite. The metasediments consist mainly of fine grained, micaceous quartzofeldspathic rocks, mica schists and calcium-magnesium marbles. This horizon hosts the main base metal ores of the Falu, Skytt, Näverberg, Grönbo, and Domän deposits (Fig. 1).

The sulphide deposits of the Falun area are situated with rather a regular spacing of between 4 to 5 kms in an ENE-WSW direction following the main sulphide mineralised horizon.

The sulphide ore bodies include both complex (massive) and disseminated ores and are contained in a single stratigraphic horizon at the top or close to the interface between the felsic volcanics and the mixed metavolcano-sediments. Thick phyllo-silicate zones often enclose the complex ores, whilst the disseminated ores are often associated with quartz-rich anthophyllite-cordierite schists.

Rock units above the ore-bearing strata consist of mixed mafic to intermediate tuffs and waterlain tuffs, (see Fig. 3) and are not further described in this paper.

Rock alteration and field observations

The fine grained felsic metavolcanic rocks are the most dominant in the Falun enclave. They consist mainly of quartz, microcline, plagioclase and biotite. Both the microcline and plagioclase (albite-oligoclase) crystals are often turbid with minute flakes of sericite. The slight biotite content tends to give a faint planar foliation fabric to this otherwise equigranular felsic rock. Quartz phenocrysts (quartz-eyes) often bluish in colour, and plagioclase porphyroblasts (in part phenocrysts) also occur. The quartz phenocrysts have retained their idiomorphic form though they have been subjected to magmatic corrosion and have a partially rounded shape. The plagioclase porphyroblasts show multiple albite, lamellar twinning with intergrowths of microcline, which are somewhat turbid owing to the growth of flakes of sericite.

Schistose, mica-rich felsic rocks also occur in the Falun supracrustal belt though their occurrence is rather limited. They are often observed as subcontinuous horizons in the vicinity of iron and sulphide mineralisations. They differ mainly from the previous rocks by the increase in sericite, biotite, quartz and the occasional trace of diopside, garnet and Mg-Fe amphibole. These rocks often merge into (muscovite, sericite, chlorite, biotite) mica schists bearing cordierite, anthophyllite and sometimes andalusite. Isolated porphyroblasts of plagioclase (albite-oligoclase) and relict 'quartz-eye' phenocrysts occur sporadically. Very pronounced micaceous knots, pseudomorphic after cordierite are observed, leaving the rock with a somewhat contorted, micaceous appearance. Large cordierite crystals are often replaced by a talc-sericite assemblage (Fahlunite). These rock types in Central Sweden are often found associated with medi-

um to coarse grained saccharoidal siliceous rocks containing disseminated sulphide mineralisation.

The siliceous rocks consist mainly of granular quartz with cordierite, biotite (in K-felsics), gedrite (in Na-felsics) and anthophyllite.

To a lesser extent andalusite, garnet (almandine), magnetite and cummingtonite may be present.

Sulphide mineralisation also occurs in calc-silicate (skarn) and marble horizons. The calc-silicate rocks contain different assemblages represented by diopside-garnet, hornblende-garnet and actinolite-tremolite.

The Ca-Mg marbles are often associated or pass laterally into impure calc-silicate marbles where humite group minerals are replaced and pseudomorphosed by serpentine. The resulting black porphyroblastic, white marble matrix host rock, or 'ophicalcite marble' is often spatially associated with base metal sulphide mineralisation.

Exploration

As part of a regional exploration programme the Falun supracrustal belt has been examined by a lithogeochemical survey sampled along 3 traverses across the strike of the supracrustal belt. Primary lithogeochemistry in other ore districts (Govett & Nichol, 1979) has been significant in defining prospective units within volcano-sedimentary sequences (Selinus, 1983 at Stollberg, LKAB/BP at Åmmeberg and Lovisa, personal communication, C. Carlon).

Lithogeochemical traverses across mineralised areas often indicate characteristic anomalous features. With volcanogenic massive sulphides, footwall rocks develop a characteristic element pattern while the ore horizon is often characterised by the addition of elements.

This is the case in the Falun area, where distinctly anomalous single or multi-element (Pb, Zn, Cu, Ba, Fe, Mn, Ca, Mg, Na and K) horizons can be followed a number of kilometers along strike, revealing a distinct but similar fingerprint which can be identified parallel to and often cross-cutting the lithostratigraphic formations. The aim of this lithogeochemical survey was

(a) to distinguish the primary geochemical features;
(b) to define the position of the known ore horizon extensions;
(c) to identify elemental bedrock patterns which could define new targets;

The methods used and the primary geochemical features noted with regard to the lithostratigraphic unit and mineralisation are discussed below.

Sampling procedure and analytical techniques

Macroscopic rock classification of the fine-grained felsic supracrustals is based on their mode of occurrence and where possible upon their non-obliterated pre-metamorphic textures. Field classification of the meta-volcanics and metasediments is based on their contents of quartz phenocrysts and quartz, feldspar, mica content and textures. It is also dependent upon characteristic associated minerals such as the presence or absence of aluminium silicates.

A total of 360 bedrock samples were collected in almost continuous profiles with approximately 50 m sample point spacing (Fig. 1). The size of the chip samples were rarely less than 2 kg. Less than 7% of these samples contained visible metallic mineral grains. Samples were crushed (< 4 mm) and split, 500–250 g of which was then ground to finer than 63 μm. From a 250 g homogenised sample 0.5 g was taken and digested in a solution of nitric + hydroflouric acid and allowed to evaporate. The precipitate was then redisolved in 1 g of tartaric acid plus 15 ml HCl and diluted to 100 ml.

These samples were then analysed by ICP-AES at the laboratory of LKAB Prospektering Stockholm for the following elements: Cu, Pb, Zn, Ag, W, Mo, Fe, Mn, Ba, Ca, Mg, Al, Ti, V, Co, Ni, Na, K, Li, B, P, Ce, Cd, La, Be, Sr, Y using an unpublished method developed by Patzauer.

Chemistry

Chemical data treatment and application
The major elements have been converted to oxides

as wt%. Since Si was not included in the ICP programme it has been calculated by assuming that the total oxide content is 100% and that $SiO_2 = 100 - (Na_2O + K_2O + Al_2O_3 + CaO + \ldots$ etc.). Since the felsic rocks contain only a minor amount of biotite the amount of volatiles contained in the samples is very low so that LOI is less than 1%. Also since the silica content is so high (generally > 70%) the relative error in this recalculation is very low. A similar range in SiO_2 values has been measured in felsic volcanics from the Hällefors area (Baker, unpublished data). Major element Box-Cox plot figures showing mean, mean error (mer), standard deviation (std), maximum (max), and minimum (min) values for the metavolcanics and Svecokarelian (older or 'urgranit') granites are presented in Fig. 4. The metavolcanic and granite data sets have been divided into three populations based on comparable or excess Na or K for granitic rocks, as an indicator of hydrothermal alteration. Values given as wt% oxides.

The metavolcanic and Svecokarelian granite (urgranit) samples discussed in this paper numbered 264 out of a total of 360 samples. The remaining samples make up minor groups of metatuffites, metasediments, quartz diorites, amphibolites and distinctly altered rocks close to mineralisation. For this reason these samples were omitted and are not discussed further.

The description of the geology given here and elsewhere show that the rocks of the Falun supracrustal Belt form a series of quartzo-feldspathic, dominantly felsic, granitic rock types. This raises immediate problems when looking for primary features in the geochemistry. The high and generally restricted SiO_2 content of these rocks means that using bivariate plots of Harker (1909) show only limited variations. It has also been demonstrated that AFM diagrams are totally unsuited for distinguishing granitic suites (MacGeehan, 1978; Batchelor & Bowden, 1985). The most effective approach to major element chemistry of granites is through multicationic parameters (de La Roche 1964, 1978; Debon & Le Fort, 1983).

Metavolcanics

It has previously been established that there is a division in the felsic volcanic pile into a lower Na-enriched unit and an upper K-enriched unit (Sundius, 1923; Geijer & Magnusson, 1944; Frietsch, 1982). This non-primary variation has been related by Baker (1985), Lagerblad & Gorbatschev (1985), to sub-seafloor alteration processes occurring post depositionally in the sequence. The Na and K divisions run sub-parallel to the stratigraphic layering and this has been related to temperature control on the hydrothermal process (Baker, 1985). In cross-cutting conduits, related to ore forming processes, zones of high Mg enrichment have also been developed (Baker & De Groot, 1983).

The suitability of the Hughes (1972) igneous spectrum for separating altered from unaltered felsic and mafic samples in central Sweden has been demonstrated by Frietsch (1982), Baker (1985), Lagerblad & Gorbatschev (1985), and Hellingwerf & Oen (1986).

The impractibility of petrographically examining 225 felsic metavolcanic samples meant that an arbitrary selection into definitely altered and least altered samples had to be made, using the Hughes igneous spectrum. Those samples falling in the igneous spectrum, and closest to the granite field, have been given a separate notation, though it is not certain that the samples are completely unaltered. Both altered and least altered samples are plotted in all the figures.

In the igneous spectrum diagram (Fig. 5) the sample pattern for the metavolcanics display an almost even distribution from sodic alteration, through least altered to potassic altered rocks. Samples falling between the lines have a so-called normal Na/K ratio and should represent the 'least altered' samples. The samples falling outside the spectrum have either excess Na or K for a given total alkali content. They are either albitized, Na-enriched or show potassic alteration, involving the secondary formation of potash feldspar with possible sericitization and/or biotite which may imply an increase in iron.

The P-Q diagram $P = K-(Na+K)$, and $Q = Si/3-(K+Na+2Ca/3)$ (Fig. 6), is a general multicationic classification and rock nomenclature diagram for common igneous rocks (modified after De La Roche 1964, 1966, 1972, 1978). Its parameters
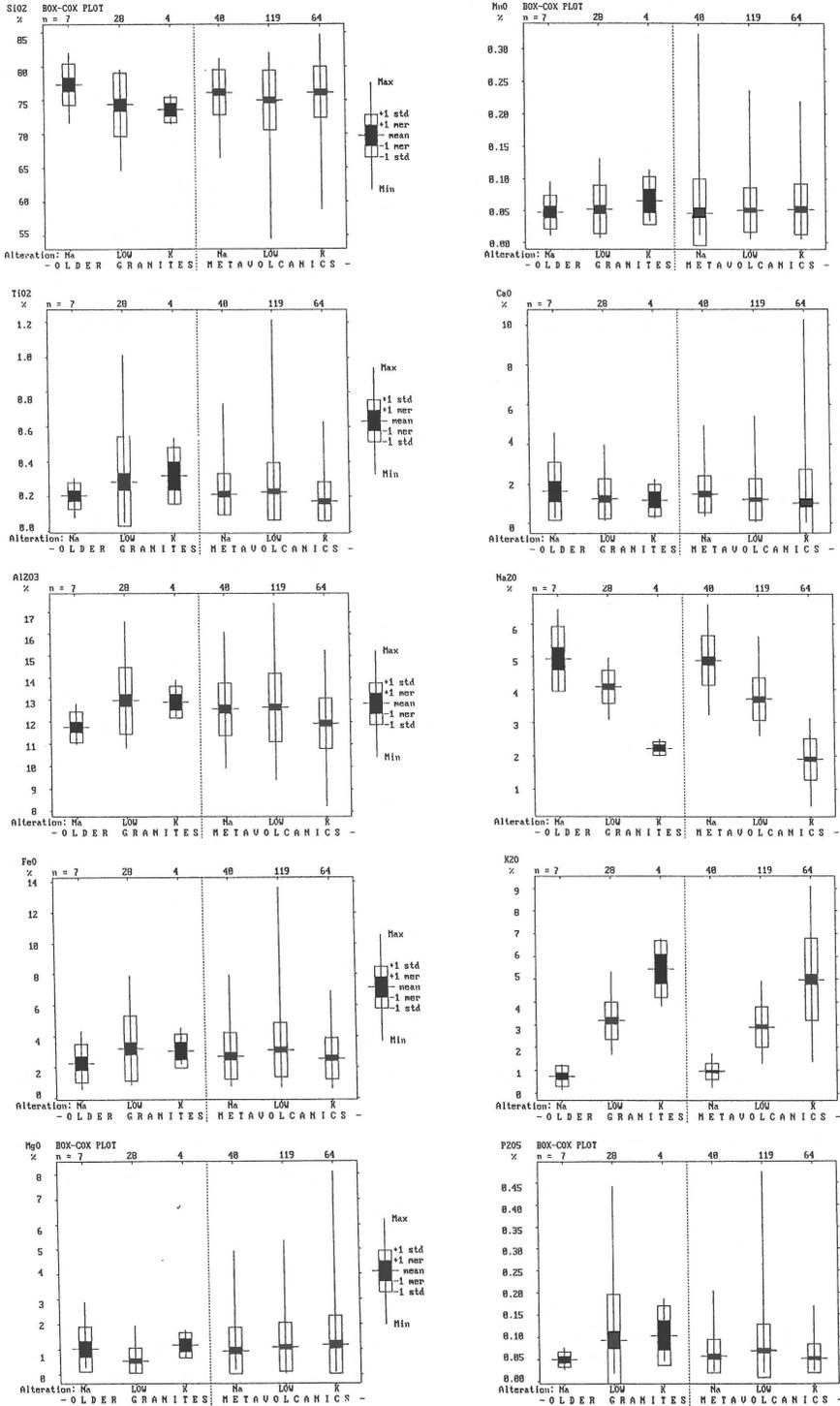
Fig. 4. Major element Box-Cox plot figures showing mean, mean error, standard deviation, maximum, and minimum values for the metavolcanics and Svecokarelian (older or 'urgranit') granites.

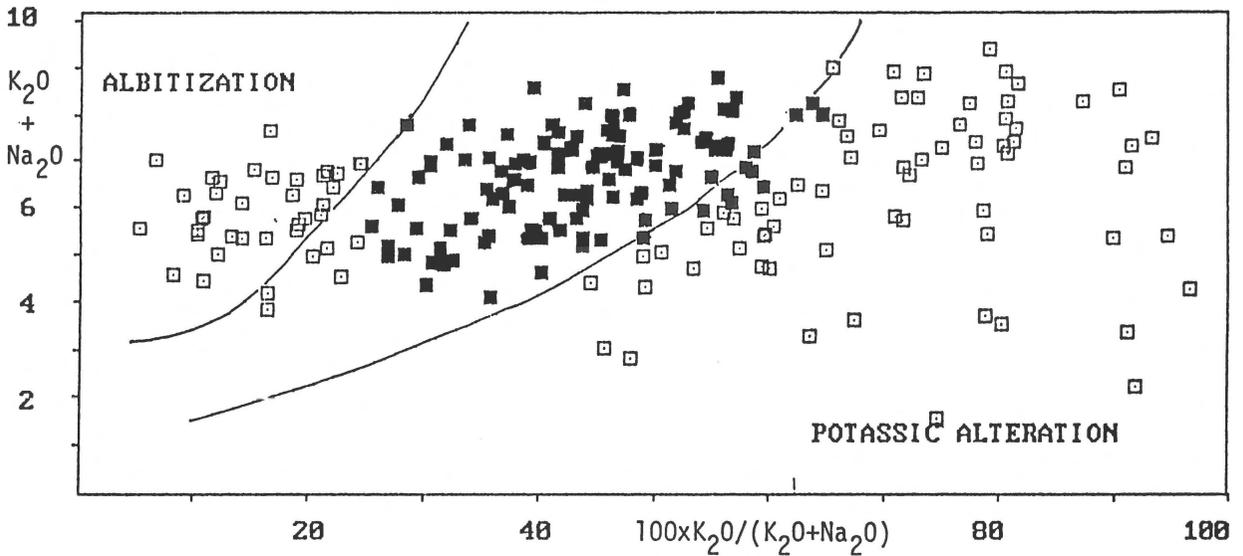Falun felsic volcanics (225 samples)

Fig. 5. Hughes igneous spectrum: Metavolcanic samples from the Falun area. Samples falling in the field of normal Na-K-compositions arbitrarily give a separate notation (filled square).

are expressed as gram atoms $\times 10^3$ of each element in 100 g of material (rock or single mineral). The diagram also accomodates the volcanic rocks giving a corresponding nomenclature.

In the P-Q diagram (Fig. 6) the least altered samples fall in the rhyolite-dellenite-rhyodacite fields, while clearly altered samples fall in the dacite or rhyolite fields. The wide spread in the P values reflects the alkali ion exchange discussed above. There is also a great variation in Q, with many samples straddling or lying above the upper line, with increased Q contents clearly reflecting secondary silicification. The least altered volcanics (black squares) are compositionally closest to rhyodacites and dellenites.

The B-A diagram of Debon & Le Fort (1983) where B = Fe+Mg+Ti, and A = Al−(K+Na+2Ca), its parameters expressed as gram atoms $\times 10^3$ of each 100 g of material, can be used as a 'characteristic minerals' diagram. It distinguishes sub-alkaline, anatectic and calc-alkaline trends. In the B–A diagram (Fig. 7) the bulk of the samples fall in the upper aluminous quartz – rich domain. The aluminium content appears to be associated with the primary alteration of the felsic

volcanics. The samples plot within a field occupied by greywackes, on both sides of the line dividing sectors II and III.

There is a scattering of points of the least altered and altered meta-volcanics in the peraluminous field, with the highest concentration of points close to the leucocratic field. From the origin the majority of the least altered samples (black squares) form a fan shaped cluster and define a positive, and thus non-calcalkaline, trend.

The B–A plot does not reflect the effects of alkali ion exchange (Na⇌K), since the parameter A = Al − (K+Na+2Ca) contains all the alkalies. The scattering of points outside the main field is probably due to contamination in the samples (such as epidote veining etc).

The R1–R2 multicationic diagram (De La Roche et al., 1980; Batchelor & Bowden, 1985) enables sub-division and classification of the rock types relating to their origin and relative age. The vectors plotted in the diagram are R1 = 4Si-11 (Na+K) −2(Fe+Ti) and R2 = 6Ca+2Mg+Al. The diagram (Fig. 8) shows that the altered and least altered volcanics form an elongated cluster occupying the same field close to the converging lines near the syn-post-orogenic sector.
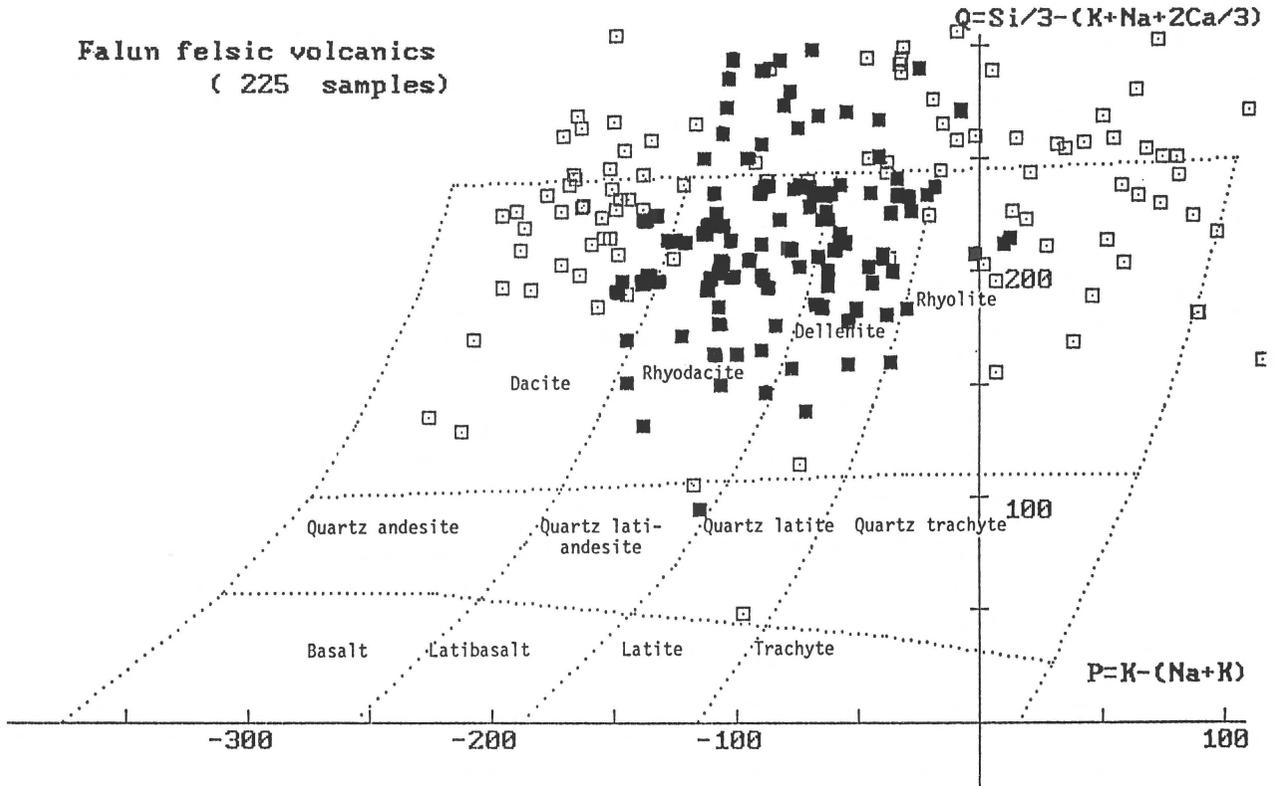
Fig. 6. P-Q multicationic classification plot for volcanic rocks modified after De La Roche (1960, 1966, 1972, 1978). Symbols for metavolcanics as in Fig. 5. Rock names refer to average composition rather than defining fields.
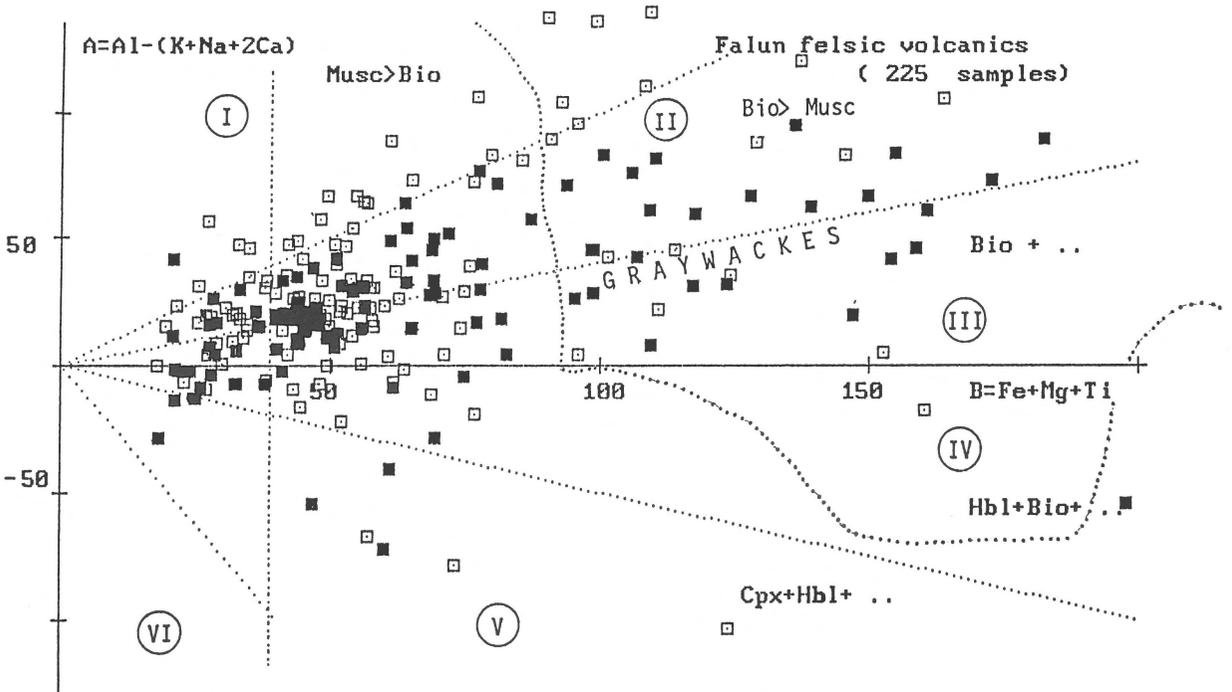

Fig. 7. B-A classification of magmatic associations diagram (Debon & Le Fort, 1983). Symbols for metavolcanics as in Fig. 5.
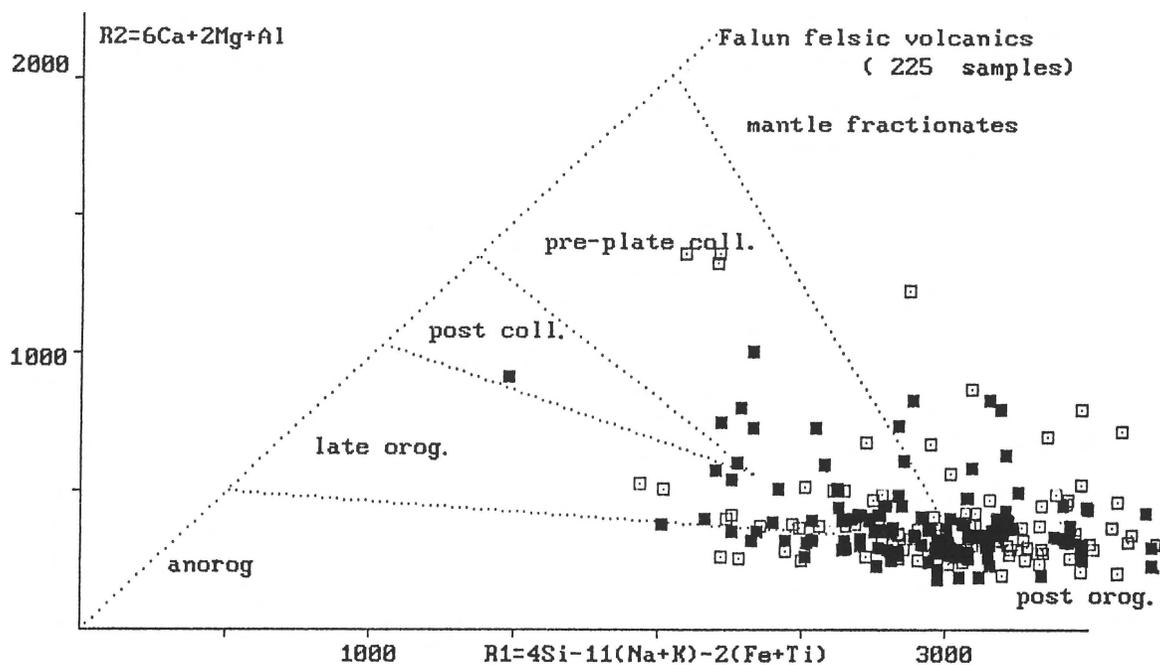
Fig. 8. R$_1$–R$_2$ plot (De La Roche et al., 1980) modified by Batchelor & Bowden (1985) to show fields occupied by different tectonic suites. Symbols for metavolcanics as in Fig. 5.

Svecokarelian granites (urgranit)

The granites were sampled on both sides of the metavolcanic enclave. To the north the Svecokarelian granite is a greyish, oligoclase and biotite-bearing, foliated intrusive; to the south it is more correctly termed a granitic gneiss which is entirely recrystallised and locally more felsic in composition. Both to the north and south the rock samples have been collected relatively close to the supracrustal boundary (see Fig. 1 for sample locations). This could imply hybridization effects which should be reflected in the following plots by a chemical scattering of the 39 samples; this, however, is not apparent.

The Hughes igneous spectrum (Fig. 9) shows that the majority of the samples fall between the two lines indicating that they have a normal Na/K ratio and are probably unaltered. Samples plotting in the albitized field are Na enriched and the K-enriched samples plot in the potassic field just outside the least altered 'normal' field.

In the P-Q nomenclature diagram (Fig. 10) the samples cover a range from granite-adamellite-granodiorite and tonalite. The majority of these samples fall in the granodiorite-adamellite fields; those samples which cluster in the upper left of the diagram maybe altered and should if this is the case, be termed pseudo-tonalites.

Using the B-A diagram (Fig. 11) almost all the samples altered and least-altered, show distinctly a horizontal to positive trend falling in the aluminous, quartz normal-quartz poor field, sector II and III. Samples plotting to the left of the line (at 38.8 along the B axis) are leuco-granitoids. In the R$_1$–R$_2$ diagram (Fig. 12) the samples cluster close to the converging tie lines near the post-orogenic field. No distinct trend is observable; possibly the samples could be divided into two main subparallel groups which may reflect the slightly different composition of the Svecokarelian granites occurring to the north and south of the supracrustals.

Since the Svecokarelian granites cluster near the post-orogenic field it appears that they have been partially remelted and display anatectic characteristics.
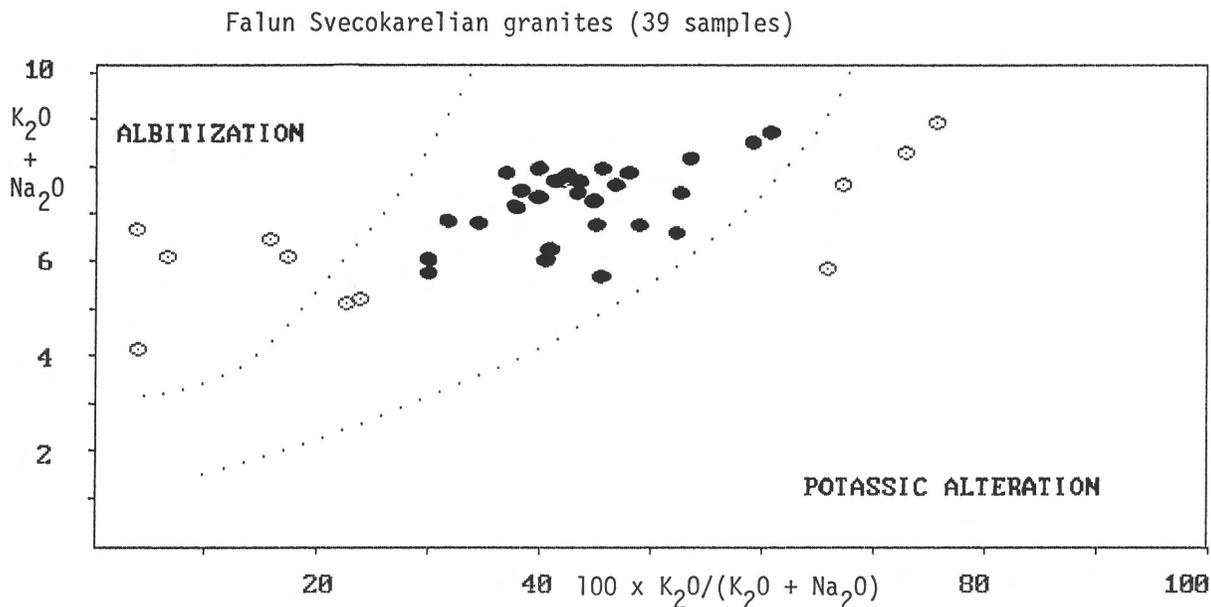
Falun Svecokarelian granites (39 samples)

Fig. 9. Hughes igneous spectrum: Svecokarelian granite samples from the Falun area. Samples falling in the field of normal Na-K-compositions arbitrarily give a separate notation (filled square).
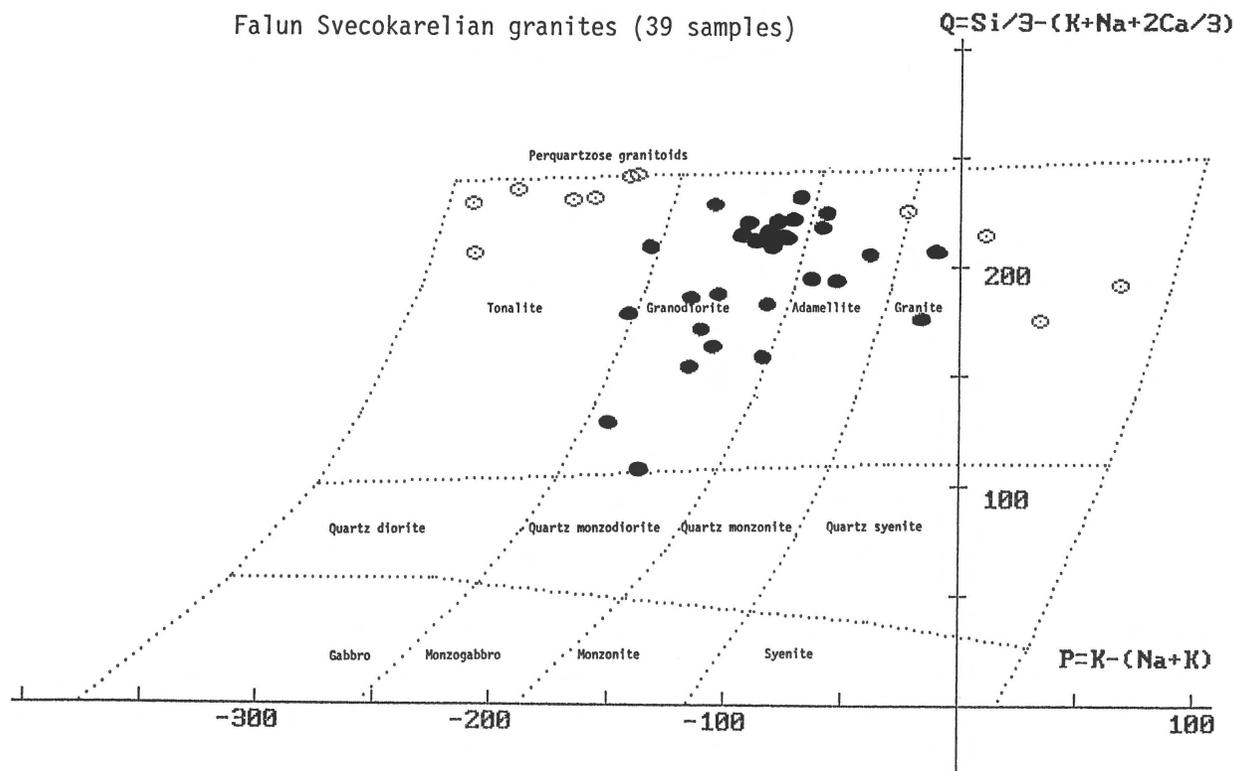
Falun Svecokarelian granites (39 samples)

Fig. 10. P-Q multicationic classification plot for common igneous rocks modified after De La Roche (1964, 1966, 1972, 1978). Symbols for Svecokarelian granites as in Fig. 9).
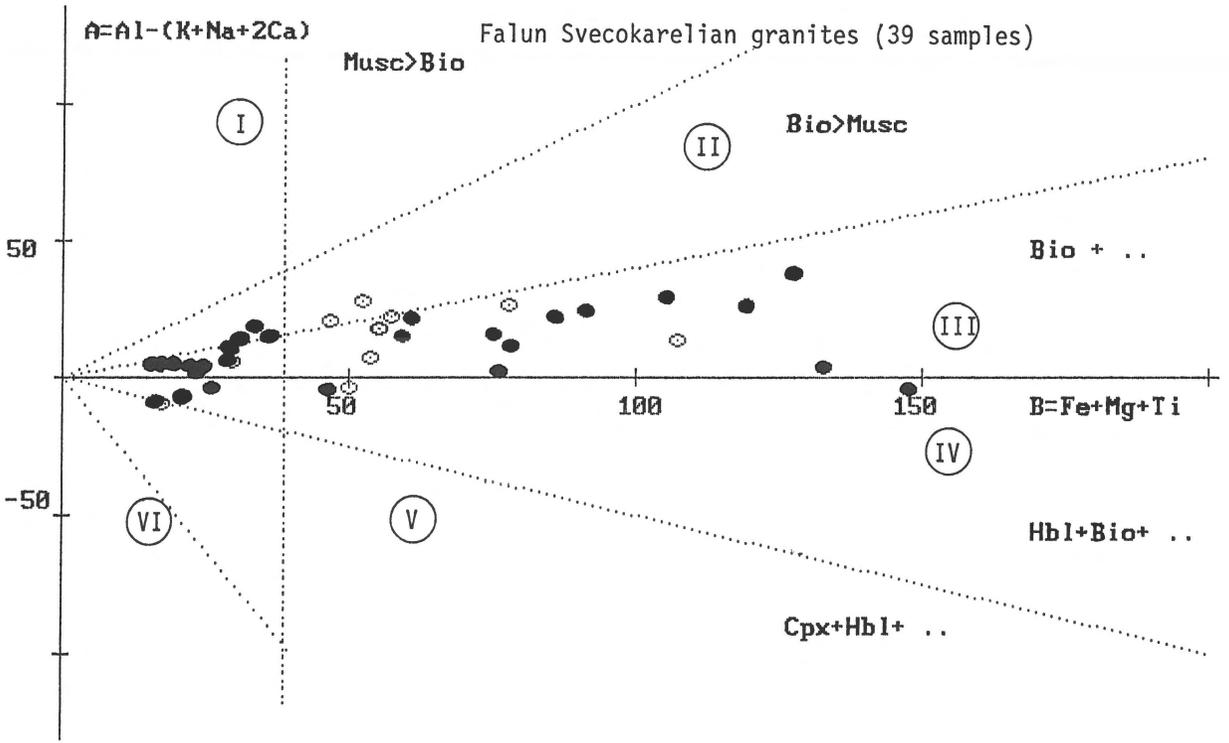
Fig. 11. B-A classification of magmatic associations diagram (Debon & Le Fort, 1983). Symbols for Svecokarelian granites as in Fig. 9.
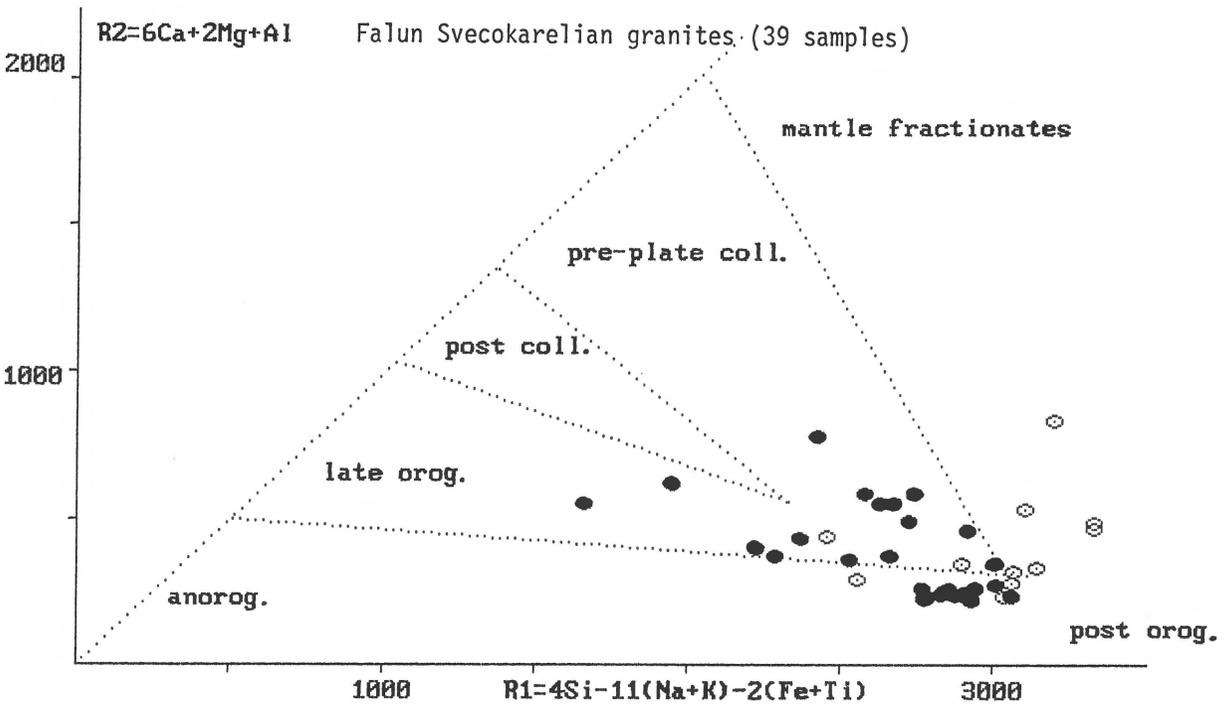

Fig. 12. R₁–R₂ plot (De La Roche et al., 1980) modified by Batchelor & Bowden (1985) to show fields occupied by different tectonic suites. Symbols for Svecokarelian granites as in Fig. 9.

Discussion of the chemical data and conclusions

The sub-seafloor hydrothermal alteration is reflected in an alkali ion exchange in the felsic metavolcanics of central Sweden (Frietsch, 1982; Baker, 1985; Lagerblad & Gorbatschev, 1985). This is also seen in the Falun area and is displayed in the Hughes igneous spectrum (Fig. 5) for the felsic metavolcanics.

The felsic metavolcanics and Svecokarelian granite (urgranit) samples in the B–A plot of Debon & Le Fort (1983) show that there is distinct aluminous associations in the rocks of the Falun area.

The De La Roche R_1–R_2 plot (Fig. 8) for the Falun felsic volcanics displays a distinct trend which does not seem to be attributed to a calc-alkalinity which would be located in the pre-plate collision field of Batchelor & Bowden (1985). Neither is this noted for the Falun Svecokarelian granites (urgranit).

These results contrast with previous investigations by Kresten (1986) in the Falun area, Vivallo & Rickard (1984) in the Garpenberg area, and to the regional investigation carried out by Lagerblad & Gorbatschev (1985), who suggest a calc-alkaline affinity. While the conclusions of Vivallo & Rickard (1984) seem valid for the Garpenberg area, the results of this study demonstrate that this is not applicable to the Falun enclave, which geochemically resembles the Filipstad–Nora–Kopparberg area (Baker, 1985).

From the Box-Cox plots (Fig. 4) it can be seen that the Svecokarelian granites chemically resemble the felsic volcanics, and could well be co-magmatic.

The number of samples analysed which form the background for this investigation give a statistically sound basis for this study; the least altered samples have been selected carefully in order to avoid erroneous results. It remains to be seen if other areas in the ore province of central Sweden have similar (aluminous) primary geochemical features.

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