Bergvesenet
Postboks 3021, 7002 Trondheim

Rapportarkivet

Bergvesenet rapport nr	Intern Journal nr	Internt arkiv nr	Rapport lokalisering	Gradering
BV 410			Oslo	**Fortrolig**
Kommer fra ..arkiv	Ekstern rapport nr	Oversendt fra	Fortrolig pga	Fortrolig fra dato:
Østlandske og USB	Aspro 1454		Utmål	

Tittel

Geological mapping in the Søve Area, Fen Carbonatite Compleks. south Norway.

Forfatter	Dato	Bedrift
Morten C Andersen	22.11 1983	Prospektering A/S

Kommune	Fylke	Bergdistrikt	1: 50 000 kartblad	1: 250 000 kartblad
Nome	Telemark	Østlandske	17134	Skien

Fagområde	Dokument type	Forekomster
Geologi	Rapport	Fensfeltet
Råstofftype	Emneord	
Malm/metall	Nb Ta Y P	

Sammendrag

Detailed geologic mapping (scale 1:1000) was carried out within a 0,4 km2 area in the northernmost part of the Fen Carbonatite Complex.

Structural analysis of faults and faultcontrolled søvite-intrusions could suggest:

1) Two generations of søvite-intrusion and

2) The presence of a high-level søvitic residual-magma. These considerations are however highly speculative and needs further testing in other parts of the complex.

No new mineralizations were found, but new exposures of lamprophyric rocks were located SSW of Torsnæs. Allthough this lamprophyre (in contrast to lamprophyres previously encountered in the Tuftehavna area) proved unmineralized, the presence of lamprophyric rocks in the northern part of the carbonatite complex points towards a more widespread occurence of this rock-type than previously realized.

Denne har vi 2 eksemplarer av.

USB Boks 39

ASPRO PROSPEKTERING A/S
GAMLE RINGERIKS VEI 14, POSTB 83 - 1321 STABEKK
HELEID AV AKTIESELSKABET SYDVARANGER

USB
Tlf. (02) 12 05 18
(02) 53 08 34
Telex 72 987 aspro n

INTERN RAPPORT

DATO: 22.11.83	RAPPORT NR: 1454	KARTBLAD 1713 IV	Antall sider —"— bilag 1

SAKSBEARBEIDER Morten C. Andersen, exploration geologist

RAPPORT VEDRØRENDE:

Geological mapping in the Søve-area, Fen Carbonatite Complex, South Norway.

RESYMÉ:

Detailed geologic mapping (scale 1:1000) was carried out within a 0.4 km² area in the northernmost part of the Fen Carbonatite Complex.

Structural analysis of faults and fault-controlled søvite-intrusions could suggest:

1) two generations of søvite-intrusion and

2) the presence of a high-level søvitic residual-magma. These considerations are however highly speculative and needs further testing in other parts of the complex.

No new mineralizations were found, but new exposures of lamprophyric rocks were located SSW of Torsnæs. Allthough this lamprophyre (in contrast to lamprophyres previously encountered in the Tuftehavna area) proved unmineralized, the presence of lamprophyric rocks in the northern part of the carbonatite complex points towards a more widespread occurence of this rock-type than previously realized.

FORDELING

OSLO:

1	Bergmesteren
1	I.D. Bergverkskontoret
1	U.S.B.

KIRKENES:

ANDRE:

2	Union Minerals
1	Fenco
1	Siv.ing. Cappelen
1	Elkem
1	Å.S.V.
4	ASS

KOMMENTAR:

INTRODUCTION

Geological mapping was carried out in the period Sept. 19. to Oct. 7 during which a total of 15 days were spent in field.

Field work was concentrated on the peripheral parts of the carbonatite complex, in the area between the Hydro Quarry and Torsnæs - see Fig. 01. The westernmost part of this area is previous mapped in detail by S.D. Olmore (Olmore, 1981), while the area from Søve to Torsnæs so far has been subjected to reconnaissance survey by S.D. Olmore, who recommended further detailed work.

All of the Fen area was mapped by E. Sæther in 1946, and the Søve Area was subjected to mining operations for Nb by A/S Norsk Bergverk in the period 1953-1965. Results of the geologic mapping and the prospecting and mining operations are presented in the works of Sæther (1957) and Bjørlykke & Svinndal (1960).

TABLE OF CONTENTS

MCA/rf

PETROGRAPHIC DESCRIPTIONS/FIELD RELATIONS

Fenitized rocks

Fenite:

In this report the term fenite covers all rock types which can macroscopically be recognized as metasomatic altered Precambrian gneiss.
The fenite is typically red or greenish gray, medium to coarse grained, and often exhibits mm-scala irregular ? aerigine-filled cracks and joints.

Fenite is often transected by numerous veins and dikelets of white søvite with mafic sillicate-rich margins, giving the rock a megascopic mosaic texture with angular cm-scale fragments of fenite in a matrix of white søvite - seefig. 02.

Fenite is characteristically composed of K-feldspar and aegirine +/- Na-amphibole as the dominating phases while calcite, apatite, quarz, titanite, zirkon and pyrite occurs as minor constituents (Sæther, 1957, Olmore, 1982).

Syenitic fenite/Nepheline syenite

Where the metasomatic alterationprocess is almost complete the rock typically consists of K-feldspar, albite, chlorite, aegirine and biotite (Olmore, 1982) and is termed syenitic fenite.

Pulaskitic fenite (Sæther, 1957) is a completely recrystallized medium to coarse grained nepheline syenite with up to 3 mm euhedral dark aegirine crystals in an equigranular matrix of fine to medium grained K-feldspar, nepheline, calcite and ? biotite.
Pulaskitic fenite is seen at a few scattered localities along the shore of Lake Norsjø.

Fenite breccias

Along the northwestern margin of the Hydro dike fenite is developed as a breccia with mm- to m- scale angular to rounded fragments of fenitized gneiss in a fine grained red matrix of syenitic fenite. Fenite breccia is also seen at scattered localities on the peninsular Torsnes.

Basic sillicate rock

In the area around Torsnæs peninsular basic sillicate rock is dominated by feldspar- biotite- calcite rocks, "which must be interpreted as altered fenites and shonkinites" (Sæther, 1957 p. 82).

Between the Hydro Dike and the Cappelen Quarry basic sillicate rock occurs as variable amounts of melteigite, ijolite, biotite-søvite and feldspar-biotite søvite intermingled with fenite.

At a few scattered localities SW of the Cappelen Quarry a hybrid phase between basic sillicate rock and fenite is developed. This hybrid phase occurs in the field as a dark, slightly reddish, medium grained, homogeneous rock.

Basic sillicate rocks in the Søve-Tufte and Søve-Torsnæs area are heavily altered and mixed up with fenite (locally with søvite), and any further sub-division of the map unit in this area is probably of little or no valve.

Søvite

At the type locality Søve (and elsewhere along the shore of Lake Norsjø) søvite occurs as veins and dikes sizing from mm- to 10 m-scale.

The most prominent localities in the area are the Hydro and Cappelen quarries, where søvite is seen as a white to slightly pink, massive, medium to coarse grained calcite-rock with variable amounts of magnetite and ? pyhrochlore.

Field evidence of two generations of søvite intrusion is seen in a road cut at the entry to the Cappelen Quarry. The first generation has developed a søvite- fenite- migmatite complex, where white to pinkish søvite intrudes fenite as numerous irregular dikes and veins in mm- to m-scale. This søvite often contains layers and lumps of mafic sillicates, dominantly biotite - see fig.03.

The second generation of søvite intrusion is clearly related to a conjugated fault system, where søvite is intruded in fault planes as cm- to m- scale dikes - see fig.04.

In the southwestern part of the Hydro Quarry, pegmatitic søvite is seen in a a fault zone. Similar coarse grained søvite is seen at one locality in the northern part of the Cappelen Quarry. The pegmatitic søvite is white to grayish with up to 5 cm large euhedral calcite crystals.

Lamprophyre

Lamprophyric rocks outcrops in the Torsnæs area as a steeply dipping NW-SE trending dike (overall orientation of dike: 123°/85° NE) with maximum thicknes 4 m and estimated length 50 m.

The rock is a dark gray biotite lamprophyre. Brownish-black euhedral biotite (? phlogopite)- phenochrysts reach 5 mm in size. Similar biotite-phenocrysts are locally set in a finegrained dark gray groundmass thus giving the rock a damtjernitic appearance. The transition zone between the two rock types is gradational (see fig.05) thus indicating a close genetical relationship.

Field evidence also points towards a close genetical relationship between biotite lamprophyre and basic sillicate rock/biotite- calcite fels. The contacts between the rock types are allways gradational within mm- to cm-scale, and there seem to be no significant change in $CaCO_3$ - content (as measured in the field by reaction with HCl) across the contacts between the different rock types.

The lamprophyric rocks are transsected by cm- to dm-scale discordant veins/dikes of rauhaugite type II.

Rauhaugite type II

The large rauhaugite "massif" in the centre of the Fen Complex is not considered in this report, but rauhaugite type II does outcrop at few other localities in the northern part of the complex.

In the eastern part of Cappelen Quarry and southwest of Torsnæs, rauhaugite type II outcrops as numerous mm- to dm-scale dikes (fig.06). Weathered rauaugite has a light brown rusty coating while it is yellowish-white or gray on fresh surfaces. The rock shows no or only weak HCl-activity, the dominating minerals being ankerite and dolomite with only minor amounts of calcite (Sæther, 1957 p. 99).

The rauhaugite type II dikes cut fenite, basic sillicate rock, both generations of søvite and the lamprophyric rocks.

Damtjernite/Damtjernite breccia

Damtjernitic rocks are exposed at four different localities, three of which show damtjernite breccia.

The damtjernite is a dark porphyrritic rock with mm- to cm-scale euhedral biotite phenocrysts in a dark gray fine grained groundmass. Biotite phenocrysts are often rounded along the edges, probably due to mechanical abrasion in the ascending magma. The damtjernite W of the entry to the Hydro Quarry shows a well exposed contact to the surrounding fenite, which clearly demonstrates that the damtjernite is younger than the fenite. The contact is developed as a metasomatic alteration-zone with the following characteristics:

Unaltered damtjernite

Metasomatic Alteration-zone:
- Increasing grainsize
- Increased contents of pink K-feldspar
- Decreased contents of biotite phenochrysts
- Decreased $CaCO_3$ -contents (measured by HCl-activity)

"Unaltered" fenite

From 0 to about 5 cm from the contact, the biotite phenocrysts in the damtjernite show a pronounced parallel orientation of crystallographic c-axes perpendicular to the contact, thus defining a rough flow-banding. This flow-banding is vertical, and could therefore support the idea of damtjernite intrusions as pipe- or dike-like bodies (Wiik, 1982 p. 11).

The damtjernitic rocks SE of the Hydro Quarry, S of the Cappelen Quarry and at Søve, are developed as breccias - see fig. 07. The matrix is like the previously described damtjernite, but in addition the rock contains numerous fragments of søvite, fenite and rauhaugite ranging in size from mm- to m-scale. In the damtjernite breccia S of the Cappelen Quarry the fragments/matrix-ratio exeeds 1 as seen in outcrops, and this is something to be considered in other parts of the Fen area as well, especially regarding interpretation of gravity measurements because the specific density of damtjernite is drastically reduced with increased contents of other rock fragments.

STRUCTURAL GEOLOGY

The dominating structural features within the area are dikes and faults, the Hydro Dike being the main single structural element. This dike is traced for about 350 m and reaches a thicknes of 30 m, where it disappears into Lake Norsjø whereas the thickness in the SW part of the map area is reduced to about 10 m. In the Hydro Quarry strike of the dike is 34° and dip 79° - 84° towards SE.

From W to E along the shore of Lake Norsjø there is a tendancy for major, early søvite dikes (including the Hydro Dike) to change direction of strike from NE-SW to E-W. This could reflect part of a ring-dike pattern around the centre of the whole Fen carbonatite complex, allthough the dip of the different dikes is somewhat variable, 80° N to 68° S. Other søvite-intrusions of this early phase occur as numerous irregular dikes and veins resulting in a migmatization of fenite/basic sillicate rock - see fig. 08.

Later søvite-intrusion is controlled by a conjugated fault-pattern, which is well developed/exposed in the area between Tuftestollen and Søve - see fig. 04. Measurements on different pairs of conjugated faults show a systematic change in direction of max. stress (∂_3) when going from the Cappelen Quarry in the E to Tuftestollen in the W - see plate 01. Allthough the number of measurements is limited (8 pairs) the variation is considered significant, and it is interesting to note that ∂_3 in all areas points "outwards" i.e. more or less away from the centre of the carbonatite complex. This could indicate that the conjugated faults and the associated late søvite dikes formed in response to a radiating stress directed away from the centre of the complex. This stress could be caused by a late-stage, high P residual søvite magma, the centre of which would be rather shallow (compared to present day errosional level) as the plunge of the ∂_3 -axes varies between 5° - 21°. These speculations, however, needs much more testing in the field before any further conclusions regarding an eventual late-stage, high level søvite residual magma can be given. In this context chemical analysis of different generations of søvite material could be of great help, as these might delineate an eventual differentiation trend towards a late-stage residual søvite magma.

Major faults in the area are steep, trending NE-SW to NW-SE. Although it is difficult/impossible in the field to establish the magnitude and direction of slip along these faults, the outcrop-pattern shows that displacement must be considerable in some cases.

Based on observations from diamond drilling, Bjørlykke & Svinndal (1960, p. 107) postulates a vertical displacement of 60 m along the major fault in the SE part of the Cappelen Quarry, the SE block being the downfaulted one.

Observations along the major fault-system at Søve are scarce because the area has been used as waste disposal area during mining operations. There are however few outcrops along the eastern margin of the system, which show a considerable drag, indicating a horizontal sinistral slip-component in the order of 40 m. In addition to this horizontal component, Sæther (1957, p. 128) considers a downfaulting of the eastern block likely.

MINERALIZATION

Except for the Cappelen and Hydro deposits, no mineralizations of potensial economic grade is seen within the mapped area.

One sample of biotite, lamprophyre (MCA 83.001) was submitted to IFE for analysis for Nb, Ta, Y and P, giving the following results:

Nb_2O_5	0,05%	(estimated 0,04%)
Ta_2O_5	0,05%	
Y_2O_3	0,05%	
P_2O_5	1,6%	

It is obious that this biotite-lamprophyre is unmineralized and in this respect far from comparable to biotite-apatite-lamprophyres encountered in the Tuftehavna area (Qvale, 1982), allthough the two rock types macroscopically show great similarities.

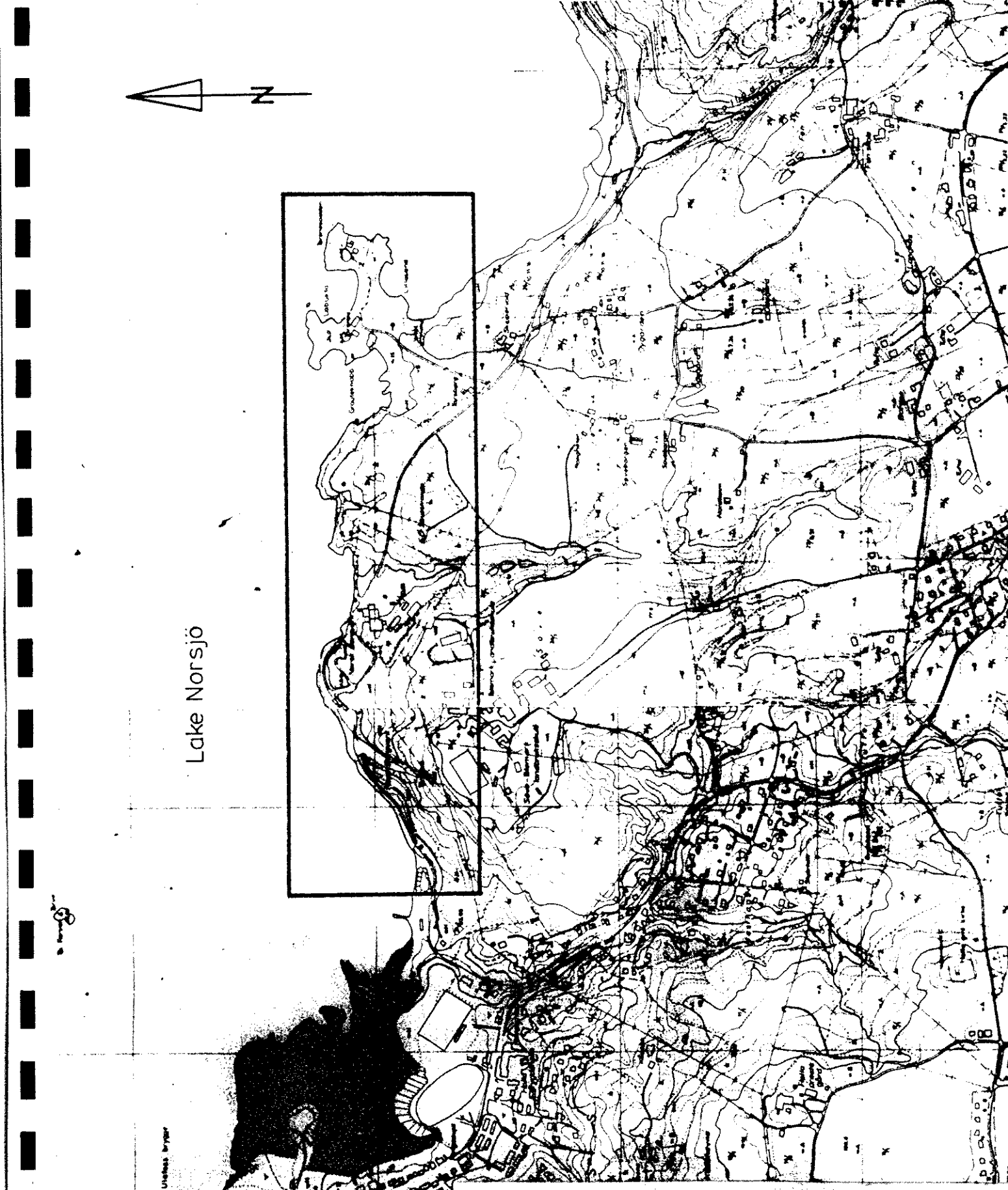
CONCLUSIONS

Allthough unmineralized, the occurence of biotite-lamprophyre at Torsnæs is interesting, because it demonstrates a more widespread occurence of lamprophyric rocks in the Fen area than hitherto known. As lamprophyres encountered in the Tuftehavna area are highly mineralized, this rock type should be looked for in other parts of the Fen Area (maybe as part of a ring-dike complex).

In the area considered in this report, attention should be paid to the part of the Tuftestollen, which represents the same geological setting (in relation to the centre of the complex) as the Tuftehavna area. Furthermore would it be desireable with a reexamination of material from earlier diamond drilling, aimed at locating eventual new occurences of lamprophyric rocks.

Oslo, November 22. 1983

Morten C. Andersen
Exploration geologist



Location of the map area.

M 1:10000

Målt:

Tegn:

Trace:

PROSPEKTERING A/S

Fig. 01

Fig. 02. Pink fenite with mm-scale light søvite veins. Note the mafic sillicate-rich margins of the søvitic veins, and the mosaic pattern of the veining.

Fig. 03. Flow-banding of mafic sillicate-rich layers in white to pinkish søvite.

Fig. 04. Conjugated faults and fault-controlled late søvitic dikes.

Fig. 05. Biotite-lamprophyre showing gradational contacts to surrounding damtjernite-like rock.

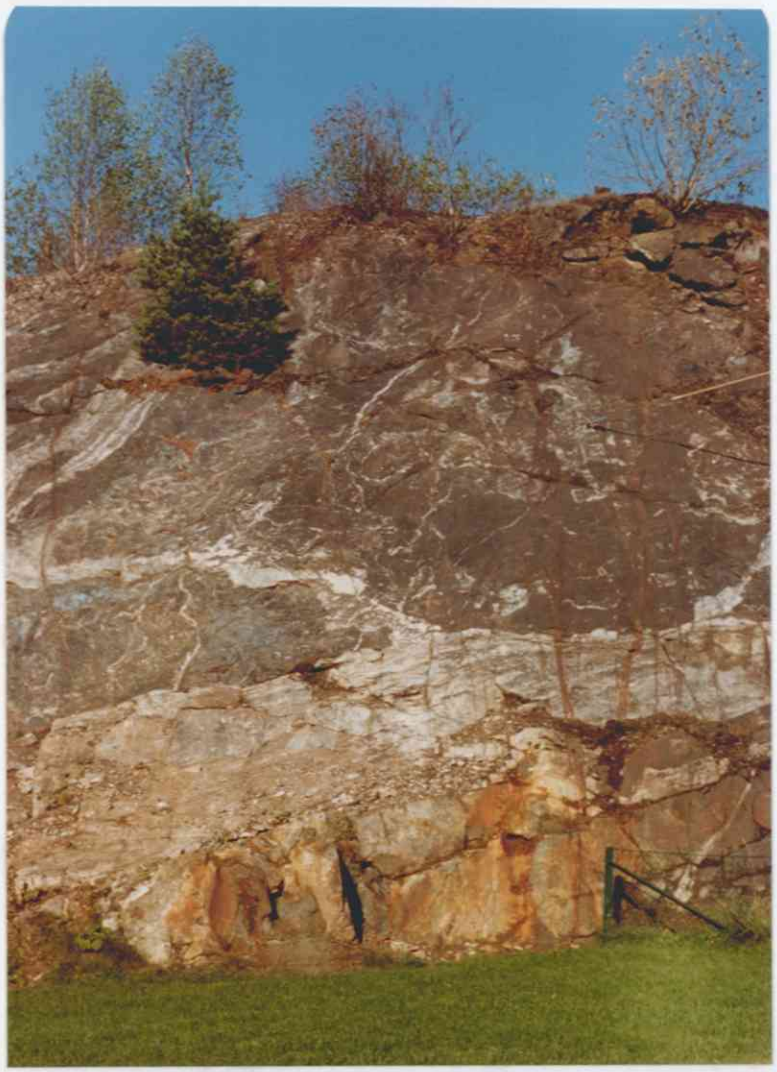


Fig. 06. Rusty weathering mm-cm-scale rauhaugite type II dikes transecting fenite and søvite. Cappelen Quarry.

Fig. 07. Damtjernite with numerous fragments of søvite, fenite and rauhaugite.

Fig. 08. Fenite/søvite migmatite transected by late-stage, fault controlled søvite dike.

REFERENCES

Bjørlykke, H. & Svinndal S. (1960) - The carbonatite and per-alkaline rocks of the Fen area - Mining and exploration work. NGU, 208 p. 105 - 110.

Olmore, S. (1982) - Fen Project - update on geological progress. UMN Fen report no. 03, 40 pp.

Qvale, H. (1982) - Tuftehavna, Fen Complex. South-Norway Geology, mineralogy and mineralizations. A/S Sydvaranger rapport 1354, 59 pp.

Sæther, E. (1957) - The alkaline rock province of the Fen Area in southern Norway. K.N.V. Skr. 1957, No 1, 150 pp.

Wiik, V.H. (1982) - The Fen Project. A geological survey of the Vipeto-Rullekoll Sub-area. Å.S.V. report, sept. 1982, 34 pp.

GEOLOGICAL MAP OF THE SÖVE-AREA FEN CARBONATITE COMPLEX, NORWAY.

by

Morten C. Andersen

Scale 1:1000