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Quality of talc from the Nakkan deposit,

Altermark, northern Norway

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Summary:

Drill hole samples from the Nakkan-deposit, Altermark, have been investigated with respect to mineralogy and chemistry. In addition a short description of whiteness analysed by Norwegian Talc Altermark is described. In general, the mineralogical investigation confirms earlier field description of the drill holes. The common composition of the talc-carbonate ore is about equal amounts of talc and breunnerite, and small amounts of chlorite and magnetite/chromite. Locally, and especially along the contact towards serpentinite, serpentine of the type antigorite is present, either in the matrix or as inclusions within breunnerite. Also locally, dolomite may be present. Amphibole of the type anthophyllite is present in parts of the talc-carbonate zone. Its occurrence is restricted to definable parts. In the investigated drill holes their occurrence is restricted to the drill holes NAK 9606 (most of the talc bearing unit) and NAK 9604 (small parts). The amphiboles are in many cases fibrous and may therefore represent a problem if the future mining includes these amphibole bearing talc-carbonate rocks. They should therefore be avoided in the mining plans.

Chemically, the ore is very pure with respect to damaging elements, as the content of the elements Cd, Pb, Ag, As, and radioactive U and Th are below the detection level. Since the ore is going through a magnetic separation when producing the final product, the content of Fe and Cr and other elements bounded to magnetite/chromite will be considerably lower.

The average whiteness of all -96 samples is > 77 % (Rx, magnetically separated), while the largest ore pocket has an average whiteness > 79 %, which is very positive and of the best so far in the Altermark area together with a few of the lenses in the present talc mine.

Keywords: industrimineraler	hvithet	
talk	røntgendiffraksjon	
karbonat	geokjemi	fagrapport

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APPENDIX

1. INTRODUCTION

The talc deposit at Nakkan, Altermark (Fig. 1), just west of Mo i Rana was discovered 1992 by aero-magnetic measurements, modelling (Karlsen & Olesen 1991) and subsequent drilling. Previous investigations are summarised by Karlsen (1995, 1996) and by internal reports by E. Rian and the present author. In order to know whether or not the deposit has good enough quality to be followed up by further drilling it is necessary to make conclusions about the quality of the deposits from the existing data. It is also important to consider the potential for discovering additional deposits in the surrounding area.
In this report the quality of samples from the Nakkan deposit is investigated by microscopy, XRD and XRF analyses. Interpretation of geophysical data will be presented in another forthcoming report.

Microscopic investigation and XRF analyses have been carried out earlier (Karlsen 1995) on other parts of the deposit. The present study focuses on drill cores from 1996, and is a follow-up work from field description made by Karlsen (1996).
The 1996 drill cores indicate that the talc-carbonate zone is asymmetrically oriented around the serpentinitic core, as the thickest parts occur outside the assumed location of a pressure shadow developed at the end of the elongated serpentinite body. If mining will take place in the future, these thick zones will be the target. It is therefore of special interest to describe the ore quality at these sites.
Restricted parts of the talc-bearing rocks at Nakkan contain fibrous amphibole (Karlsen 1996). In certain cases this could be damaging to the quality, due to the potential negative health effect, due to the law regulations on asbestos and due to the maintanence of this law.

In addition to improve the general mineralogical knowledge of the Nakkan deposit there are special interests 1) to find out by microscopy if the conclusions made after drill core mapping in the field (Fig. 4) was correct or if any of the assumed pure talc-carbonate zones contains fibrous amphibole not detected by the field mapping, 2) to define the characteristics of amphibole bearing talc-carbonate rocks and the amphiboles, 3) to get further knowledge of the mineralogy of internal veins that cut the Nakkan serpentinite, 4) find out if parts of the ore that by Karlsen (1996) were termed «Possible ore» (Fig. 4) has ore quality or not.
The most important part is to find out if the quality of the thickest parts of the ore is satisfying, since these parts will be the most obvious target for mining.
Furthermore, the report comments the result of whiteness measurements carried out by Norwegian Talc AS.

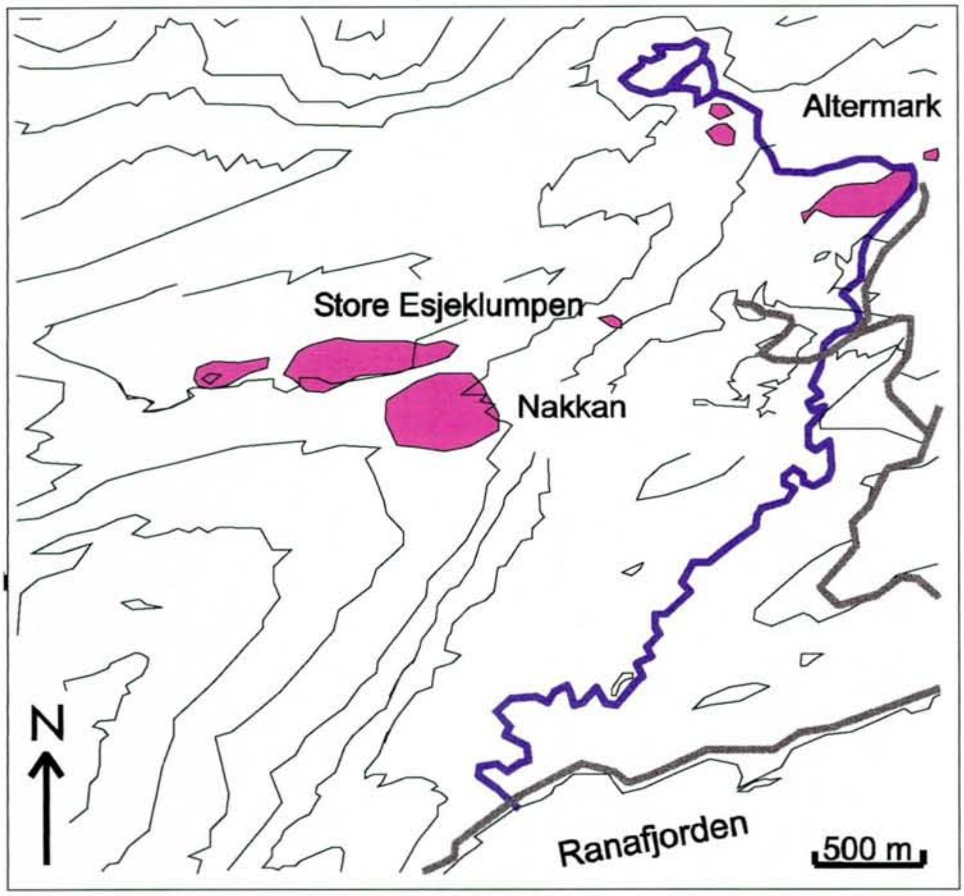

Figure 1. *Location of ultramafites (pink colour) and the Nakkan deposit (below surface).*

2. GENERAL OCCURRENCE OF TALC ROCKS

In general, two types of economically important talc ores exist;

1. Talc ores made by metasomatism of serpentinite
2. Talc ores made by metasomatism of dolomite

The two types give ores that are slightly different:

	Serpentinite associated	**Dolomite associated**
Chemistry, whole rock	Traces of Ni and Cr	No Ni or Cr
Crystal chemistry of talc	Ni-bearing, rel. low Mg/Fe	High Mg/Fe, No Ni, close to theoretical formula
Carbonate species (when present)	Usually breunnerite, occasionally dolomite or magnesite	Dolomite

The «ultramafic talc» might occur as pure talc-schists or be mixed with carbonate, tremolite or chlorite. All these subtypes are being mined, but for different industrial applications.
Talc deposits that originate from *dolomites* are usually purer mineralogically, and in many cases they do not contain high amounts of other minerals. The best whiteness analyses are achieved from this type.

The industrial usage of the term «talc» is different from the geological as it includes a large number of rock types where the mineral talc occurs either as a major constituent or as a minor (Fig. 2).
The talc bearing rocks in Altermark are of the ultramafic type, made by metasomatic alteration of ultramafic rocks (Fig. 3).

The Altermark talc-carbonate rock typically consists of 35-65 % talc, 35-65 % carbonate, 0-8 % chlorite and 0.1-10 % magnetite/chromite. Trace amounts of antigorite are present close to serpentinites, while trace amounts of tremolite may be present along the outer contact towards the blackwall rocks. Important quality parameters for the Altermark talc ore are whiteness and mineralogy including content of fibrous minerals. Also other parameters, as for example oil absorption, are important but these will not be focused in this report. In the ultramafic type of talc-rocks, magnetite and chlorite are found to be the major whiteness-reducing minerals. Most of the magnetite is however removed by magnetic separation and is therefore not a problem. Chlorite is not removed by the process and the whiteness of the final product therefore depends on the content of chlorite.
Potentially fibrous minerals in ultramafic talc deposits are the serpentine species chrysotile, and the fibrous varieties of tremolite/actinolite and anthophyllite of the amphibole group. The types of serpentine minerals presented are governed by the P/T conditions during formation of the serpentine. Previous studies has shown that the metamorphism during metasomatism of the ultramafic lenses was prograde with a metamorphic peak around 640° and 10-15 Kb pressure. Such conditions favour the formation of the serpentine species antigorite. Chrysotile, on the other hand, is typical for much lower metamorphic grade. Field observations and mineralogical analyses clearly show that almost all serpentine is of the antigorite type with typical interpenetrating texture.

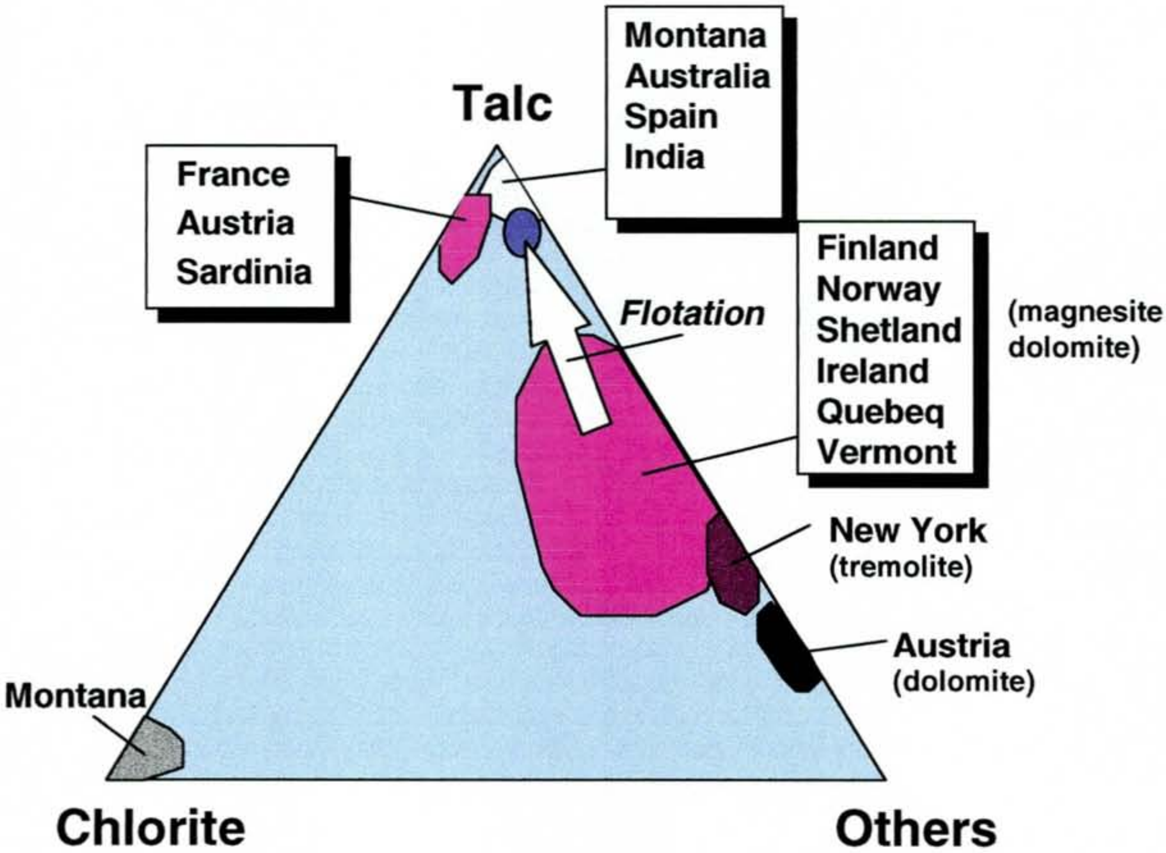

Figure 2. *Simplified mineralogical composition of industrial types of talc. The Norwegian type of talc is very similar to the Finnish talc, but the Finnish talc is floated to remove carbonate and sulphides. From Grange (1995).*

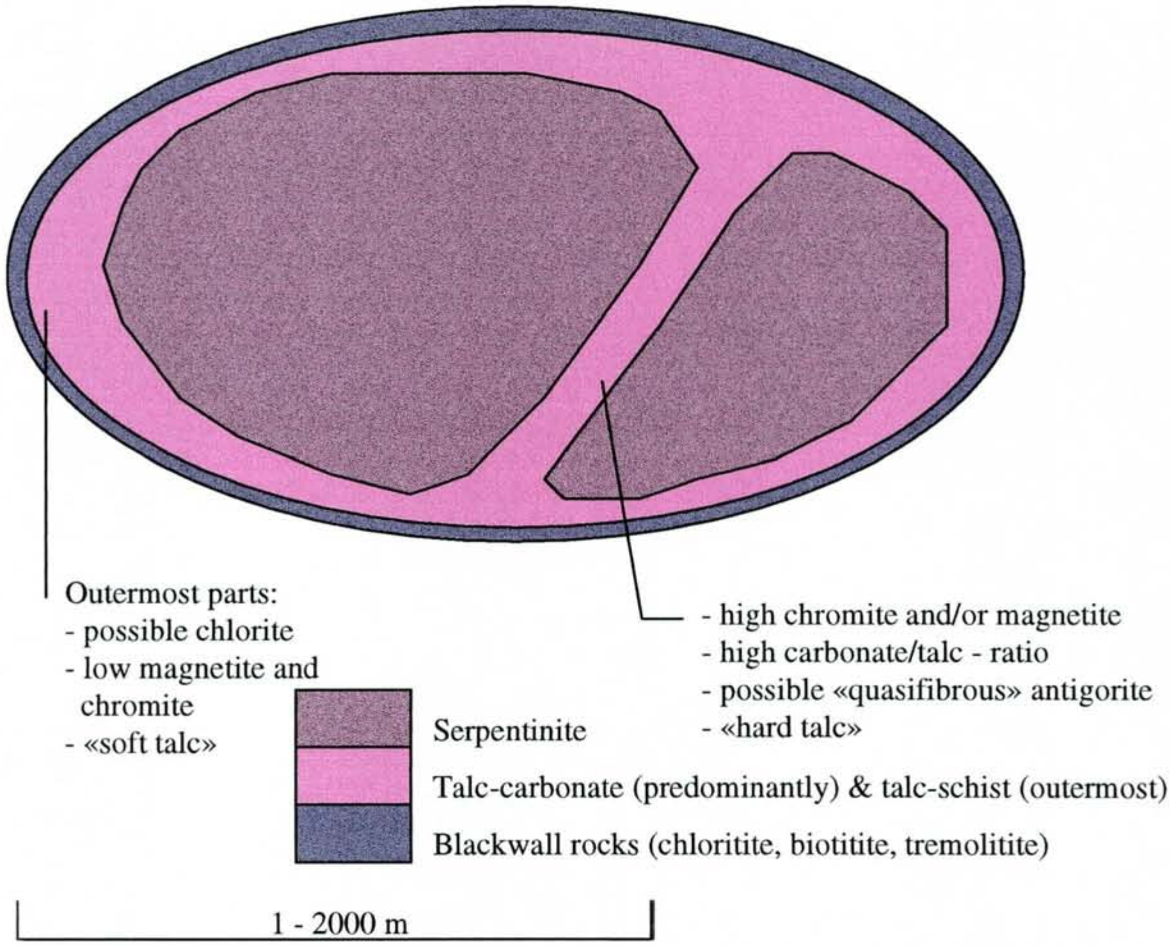

Figure 3. *Typical zoning of the Altermark ultramafic rocks. Some variable parameters related to the ore quality are also shown.*

3. PREVIOUS WORK

The field mapping of drill cores (Karlsen 1996 & Fig. 4) revealed that the drill cores contain large intersections of pure talc-carbonate rocks of apparently good quality. Internal parts of serpentine bearing rocks in the talc-carbonate intersections (drill holes NAK 9604, NAK 9612) indicate that serpentinite lenses might occur in parts of the ore. Relative large intersection of talc-carbonate within serpentine indicate that talc-carbonate veins in serpentinite occur in some of these intersections.

Karlsen (1996) reported content of fibrous amphibole within 16 of ca. 200 metres that were investigated by drill core inspection:

Drill hole	Talc-carbonate-intersection	Fibre-bearing	Fibre type
NAK 9604	334.25 - 342.30 m	334.25 - 336.50 m	Anthophyllite or tremolite
NAK 9606	153.69 - 164.10 m	All, but in variable proportions	Anthophyllite
NAK 9614	263.28 - 266.03 m	All	Anthophyllite

Most of this amphibole is more or less fibrous and occurs as white or light pink coloured radial aggregates, usually 0.5-4 cm in diameter. The light pink variety is always anthophyllite while the white variety either is anthophyllite or tremolite. Fibrous serpentine was not detected.

4. MINERALOGY

The general mineralogy of the Altermark talc samples is: talc, carbonate, chlorite and magnetite/chromite. Breunnerite, i.e. Fe-rich magnesite, is the dominant type of carbonate. In addition to these minerals serpentine, amphiboles, and sulphides may be present in subordinate amounts.

There are, however, some variations in mineralogy; 1) in all ultramafic lenses there are systematic mineralogical variations when passing from the core serpentinite towards the rim, and 2) there are mineralogical differences between the individual ultramafic lenses (Karlsen 1995).

Variations belonging to the first group are (Fig. 3):

a. Higher amounts of chlorite in the marginal parts of the talc bearing zone, especially close to the blackwall rim
b. Serpentine is absent in the outer parts of the talc zone, but is common near the serpentinite
c. Higher amounts of magnetite in the inner parts of the talc zone and in zones that cut the serpentinites, especially close to the serpentinite

Variations belonging to the second group are defined by different amounts of chlorite, amphibole and magnetite. E.g.within the mining area there are variations in chlorite content between the different lenses, resulting in different whiteness values. Another example is the high content of anthophyllite in the Remlia lens. Earlier studies of the Nakkan ultramafite suggest that 1) chlorite is very common on the basal part of the ultramafic body, and 2) the content of magnetite is higher than in the other ultramafic bodies. The reason for the high content of magnetic matter in previous analyses is that most of the samples come from thin zones of talc. In such zones the alteration to talc-carbonate has not been complete, resulting in higher magnetic content than in thick talc-carbonate zones.

4.1 Mineralogical composition of «pure» talc carbonate rocks

Microscopic data from samples taken from talc-carbonate rocks that earlier (Karlsen 1996) were described as pure talc-carbonate rocks is given in Table 1. The general composition is as previously known: 45-65 % talc, 40-55 % carbonate and lower amounts of chlorite and magnetite/chromite. Breunnerite is by far the most common type of carbonate. In some cases it is texturally zoned with a core defined by magnesite. The distinction between these varieties is often difficult, but in general the magnesite is allotrioblastic (i.e. the crystal shape is poorly developed) while breunnerite is more idioblastic (i.e. well developed crystal form) commonly with perfect cleavages. Also, inclusions tends to be more common in the magnesite. Dolomite is commonly easy to distinguish from those above because it contains distinct, broad twins.

The texture of the talc-carbonate rock is variable (Figs. 5, 6, 7) as some are rather massive and coarse grained while other are foliated and more fine grained (foliation defined by parallel grains of talc and by parallel oriented carbonate grains or -aggregates) or banded (alternating layers of talc and carbonates). In most cases the rock is porphyroblastic, with breunnerite defining the porphyroblasts surrounded by finer grained talc in the matrix. In general, the minerals in the talc-carbonate rock is rather idioblastic compared to the minerals in talc-carbonate rocks elsewhere, e.g. Stølsheimen.

The microscpic investigation shows that amphibole occurs in a few of the samples termed «pure talc-carbonate rock»; In the drill hole NAK 9606 at 174.5 m and 176.6 m amphibole occurs as very long prismatic/fibrous grains and as both normal prismatic and fibrous grains, respectively. The type of amphibole in these samples are diffcult to determine and should be checked by microprobe analyses. Extinction angles (see Section 4.2) are mostly straight in NAK 9606, 176.6 m, suggesting anthophyllite, while the angle in the other sample is straight for many grains, but inclined for others. In the drill hole NAK 9610 at 252.5m, 256.5m and 280.5m very few, small grains, that are almost not recognisable, are observed primarily as inclusions within breunnerite. Due to a very fine grain size in the last emntioned sample the classification is questionable. Due to straight extinction, the amphibole type is probably anthophyllite.

Except for drill hole NAK 9696 the microscopic investigation indicate that the talc-carbonate rocks are free from or contain very small amounts of amphibole. The microscopic investigation supports the conclusions made by Karlsen (1996), but it also makes clear that the borders of amphibolite bearing zones may be difficult to find without doing microscopic analyses.

The general low content of amphibole is supported by XRD analyses (Appendix), as amphibole was detected by certainty only in the sample NAK 9610, 252.5 m (Table 1) of the pure talc-carbonate rocks.

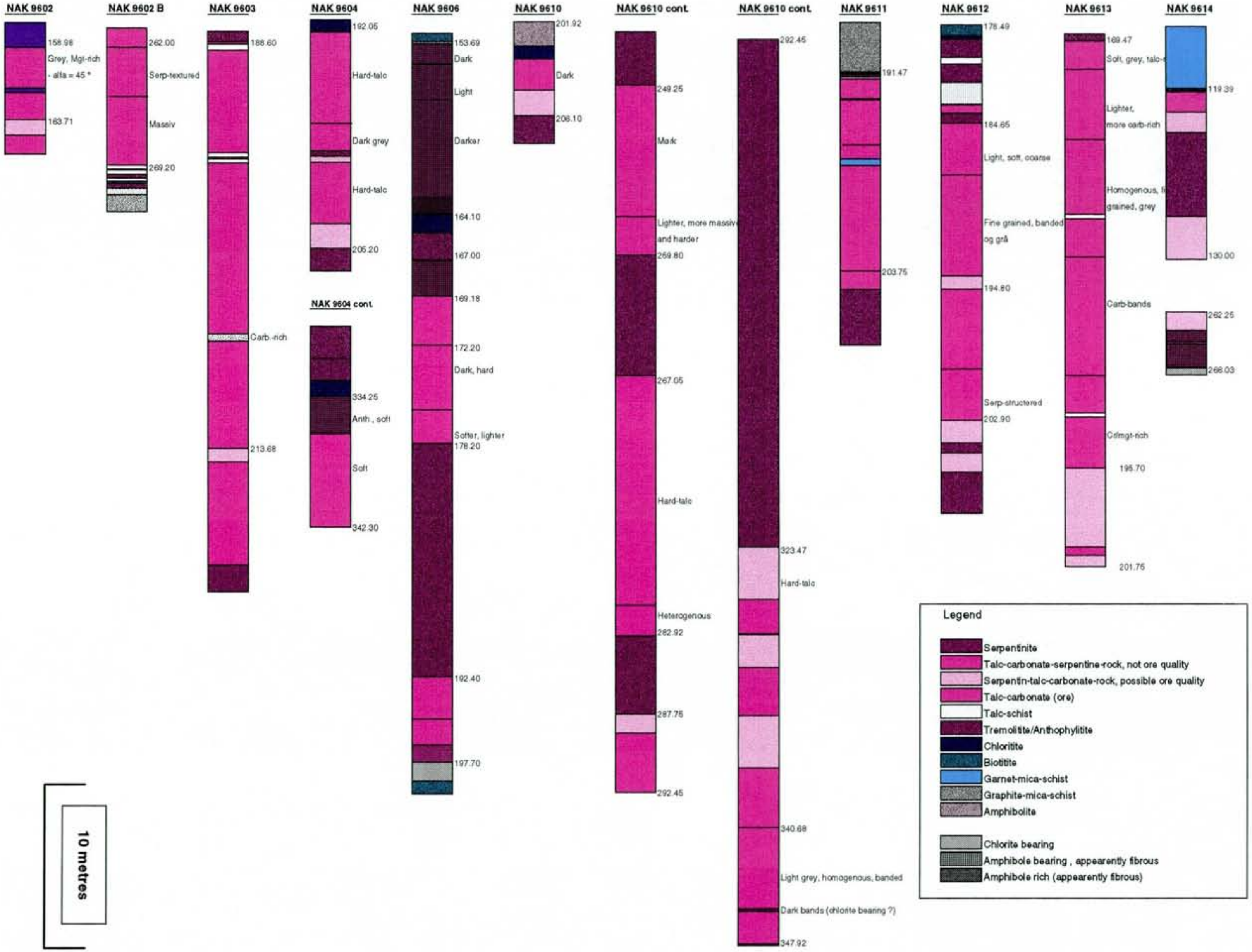

Figure 4. Drill core logs as presented by Karlsen (1996).

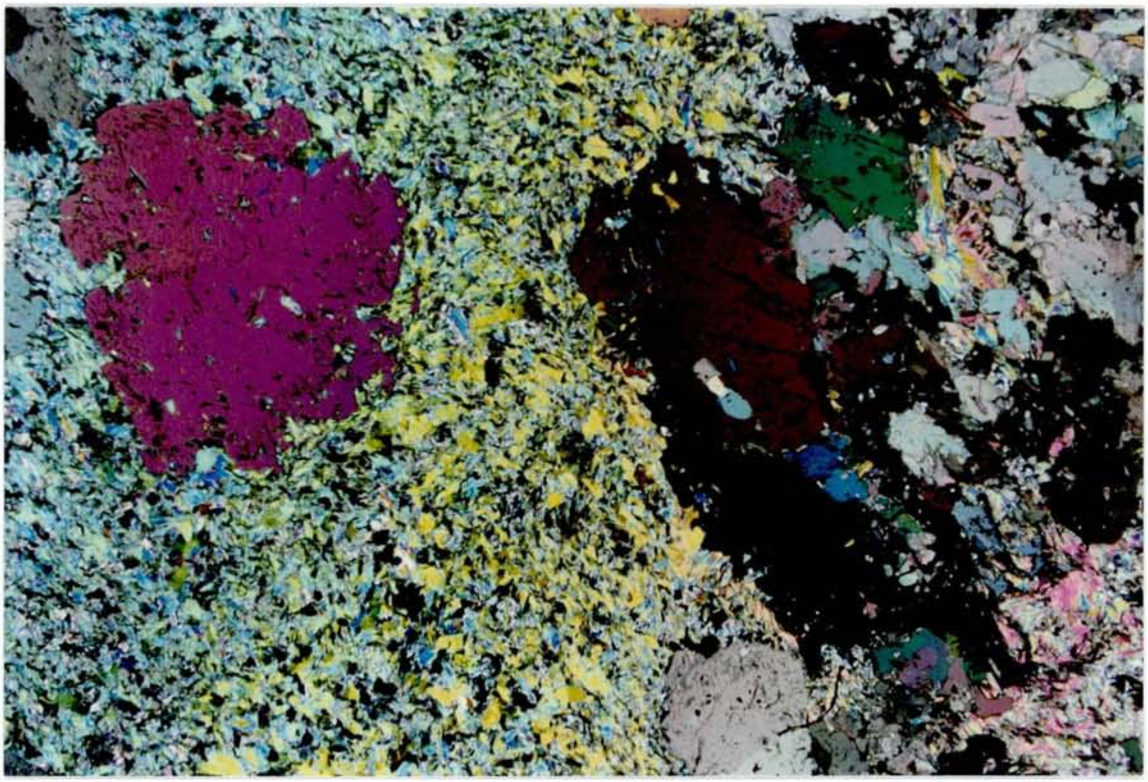

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Figure 5. *Microphoto of talc-carbonate ore. Large prophyroblasts = breunnerite, small yellow-blue grains = talc. Cross polarised light. Sample NAK 9604, 193.5 m.*

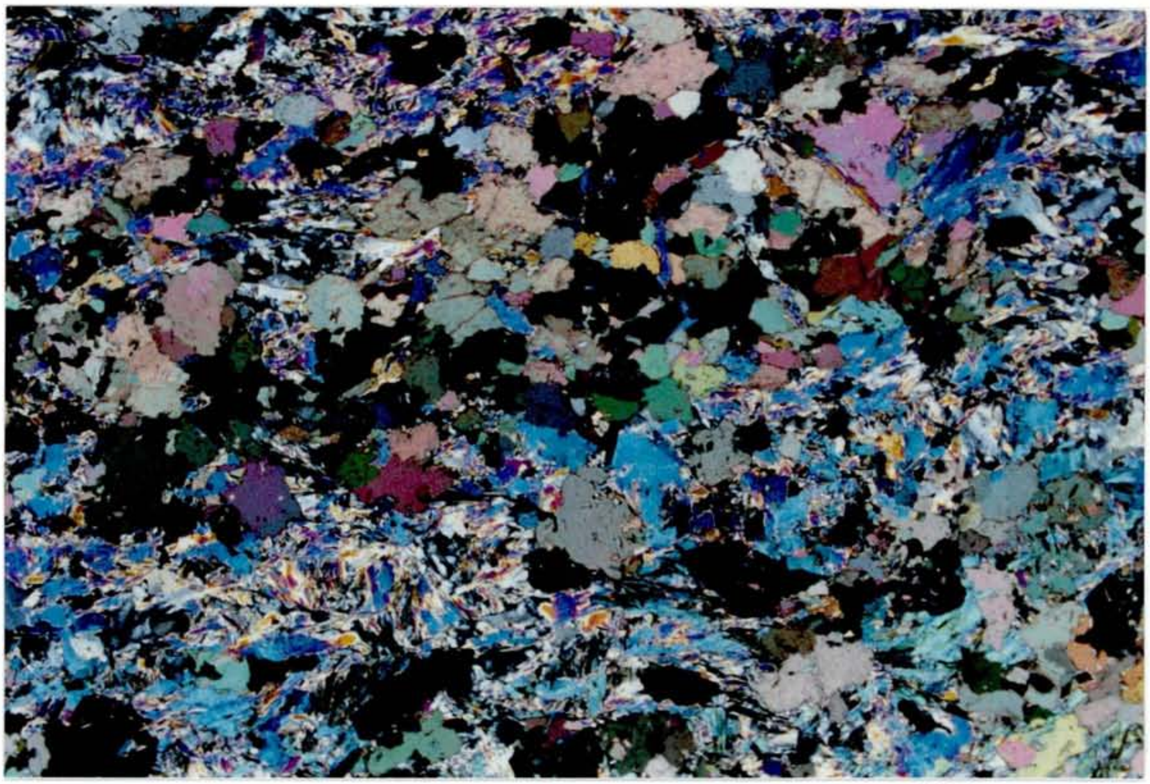

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Figure 6. *Microphoto of talc-carbonate ore. Breunnerite occurs within aggregates surrounded by talc (blue, pink). Cross polarised light. Sample NAK 9604, 195.5 m.*

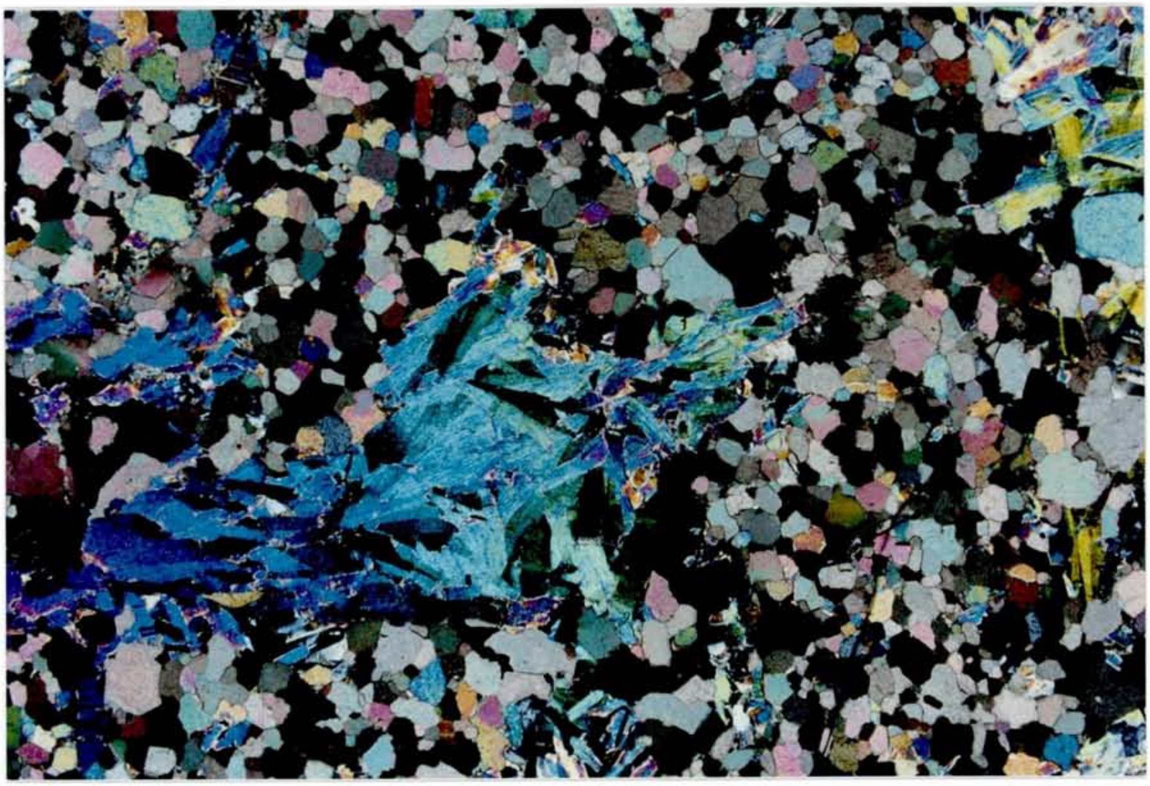

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Figure 7. *Microphoto of talc-carbonate ore. Talc (large blue crystals) occurs as idioblastic grains surrounded by a more fine grained polygonal mass of carbonate made up of recrystallised breunnerite. Cross-polarised light. Sample NAK 9604, 338.5 m.*

Table 1. ***Mineralogical composition of samples previously (Karlsen 1996) termed pure talc-carbonate rocks. The data confirms the interpretation made by the field mapping, with exception of the occurrence of amphibole in some of the samples. The content of amphibole in sample 6 was also documented by XRD - analyses (appendix).***

XRF/XRD - SAMPLES		1		2							6		7		8		9		10	11	12	13		14
Drill Core	9602 B	9603	9603	9603	9604	9604	9604	9604	9606	9606	9610	9610	9610	9610	9610	9611	9612	9612	9612	9612	9613	9613	9613	9613
Metres	266.5	191.5	199.5	201.5	193.5	195.5	203.5	338.5	174.5	176.6	252.5	256.5	272.5	280.5	342.5	199.5	197.5	185.5	190.5	200.5	169.9	174.5	180.5	188.75
Rock type	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	A-Tc-sch	A-Tc-sch	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb
Occurrence	Rim	Rim	Rim	Rim	Rim	Rim	Intern	Rim	Intern	Intern	Intern	Intern	Intern	Intern	Rim	Rim	Intern	Rim	Rim	Intern	Rim	Rim	Rim	Rim
Talc	xxxx i	xxxx i	xxxx i	xxxx i	xxxx i	xxxx i	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx i	xxxx i	xxx	xxxx	xxxx i	xxxx	xxxx i	xxxx i	xxxx i	xxxx i	xxxx	xxxx i	xxxx
Carb	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx			xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
Chl	x	xx	xx	x	x	xx	xx	x	xx	x				x	xx	x	x	x i	xx i	xx i		x	x i	xx
Mgt/Chr	x	xx	xx i	xx i	xx i	x	xx i	x	x	xx	xx	x	xx i	xx	xx	x	xx	xx i	xx	xx	xx	xx	xx	xx
Srp	i	xx	i		x i	i	x i				x	x i												
Amph									xxxx	xxx	i	i		x ?										
Carb-types	B		B	M/B	B»D	B»D	M/B	B, D			B	B	B	B	B	B>D	B	B>D	B, M	B	B	B>M	B»D	B
Grain size	Med	Med	Med	Med	Med		Med	Fine Carb, Med Tc	Fine - Med	Med	Med	Med	Fine	Very fine	Fine	Med-Coarse	Med-Coarse	Med-Coarse	Coarse	Fine - Coarse	Fine-Coarse	Med	Coarse	Med
Texture	Mas	Fol	Ban	Mas	Mas	Mas/ Fol	Mas	Mas	Fol	Fol	Mas-Fol	Mas	Mas	Fol	Fol/ Mas	Ban	Fol/ Mas	Mas	Fol/ Mas	Ban	Mas	Fol/ Mas	Mas	Fol/ Mas
Grain shape	Sub	Sub	Sub-Idio	Allo	Sub	Sub	Allo/ sub	Idio		Idio	Sub	Sub	Sub	Sub	Sub	Sub	Sub-Idio	Sub-Idio	Sub-Idio		Idio	Sub	Idio	Idio
Amph shape									Fib	Fib/ not fib	Long pris-matic													

xxxx = dominant	Tc = Talc	Chr = Chromite	B = Breunnerite	Sub = Subidioblastic (well developed grain shape)
xxx = common	Carb = Carbonate	Srp = Serpentine	D = Dolomite	Idio = Idioblastic
xx = accessory	Serp = Serpentinite	Amph = Amphibole	M = Magnesite	Allo = Allotrioblastic (poorly developed grain shape)
x = Very few grains (neglible)		Chl = Chlorite	Mas = Massive	M/B = Zoned magnesite/breunnerite
i = inclusion in carbonate		Mgt = Magnetite	Fol = Foliated	Ban = Banded

4.2 Characterisation of amphibole bearing talc-carbonate rocks

The general occurrence of amphiboles in the drill holes, based in field examination, is given by Karlsen (1996). In the present follow-up work the amphiboles have been investigated in somewhat more details by microscopation. The purpose is to characterise the amphibole in terms of type and grain shape.

Anthophyllite and tremolite is possible to distinguish by microscopy rather easily as anthophyllite has straight extinction while tremolite has oblique extinction in polarised light. Otherwise they are rather similar both in size, habit and appearance.

The microscopic investigation shows that most of the amphibole present in the investigated samples are anthophyllite (Figs. 8 & 9).

Of the samples investigated by XRD (Samples 4 & 5, Table 2), amphibole is detected only in sample 4.

Both anthophyllite and tremolite are difficult to detect in geochemical analyses (Table 4). The former does not contain any element which is not abundant in the ultramafites, while tremolite share Ca with carbonates.

Table 2. Microscopic data from samples previously known to be amphibole - bearing (Fig. 4).

XRF/XRD - SAMPLES	*4*		*5*	
Drill Core	*9604*	*9606*	*9606*	*9606*
Metres	*334.5*	*154.9*	*159.3*	*167.5*
Rock type	*Amph-Tc-Carb*	*Amph-Tc-Carb*	*Amph-Tc-sch*	*Tc-sch*
Talc	xxxx	xxxx	xxxx	xxxx
Carb	xxxx	xxxx		x
Chl	xx	xxx	xx	xxx
Mgt/Chr	xx	xx	x	
Srp				
Amph	xxx	xx	xxx	xx
Carb-types	D=B	D»B		B
Grain size	Med, but coarse Amph,	Med	Coarse Amph	
Texture	Mas	Mas/Fol	Fol and folded	Fol
Grain shape	Sub	Sub-idio	Sub	Sub-idio
Amph shape	Fibrous/Not fibrous	Not fibrous	Fibrous	Fibrous/Not fibrous

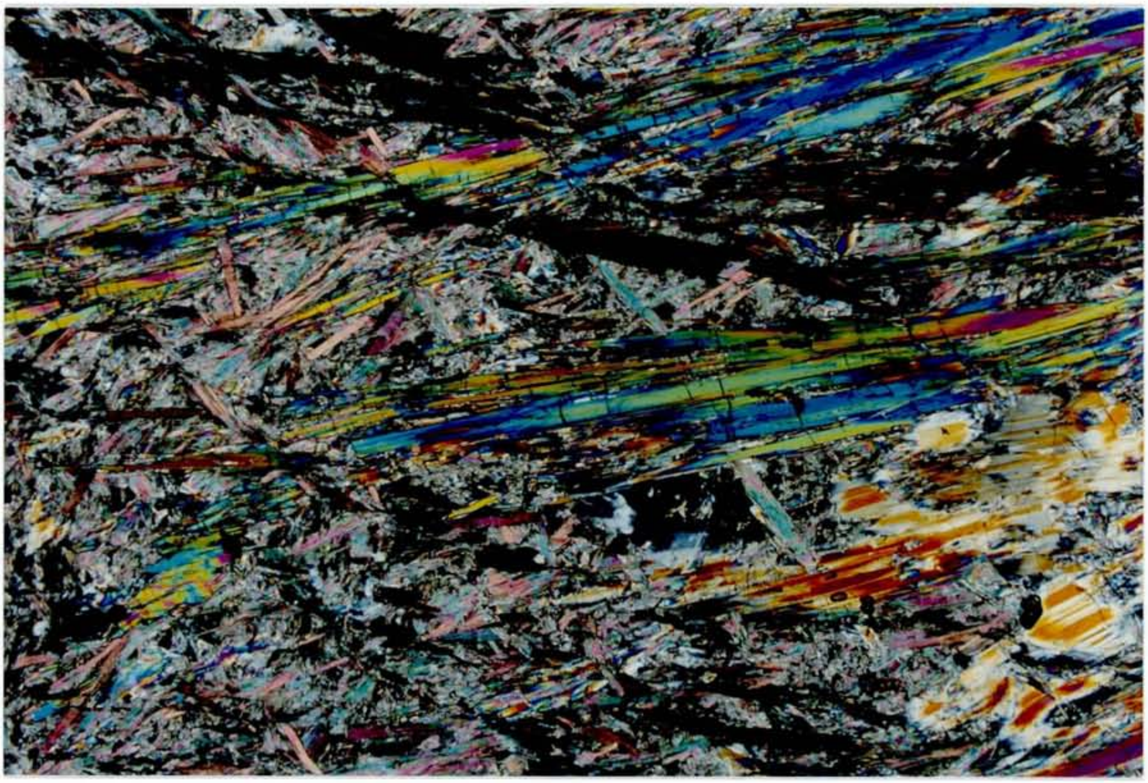

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Figure 8. *Microphoto of amphibole-talc rock. The amphibole in this sample (blue-green coloured long crystals), being represented by the species anthophyllite, can be termed fibrous because of their high length/width-ratio. Sample NAK 9606, 159.3 m.*

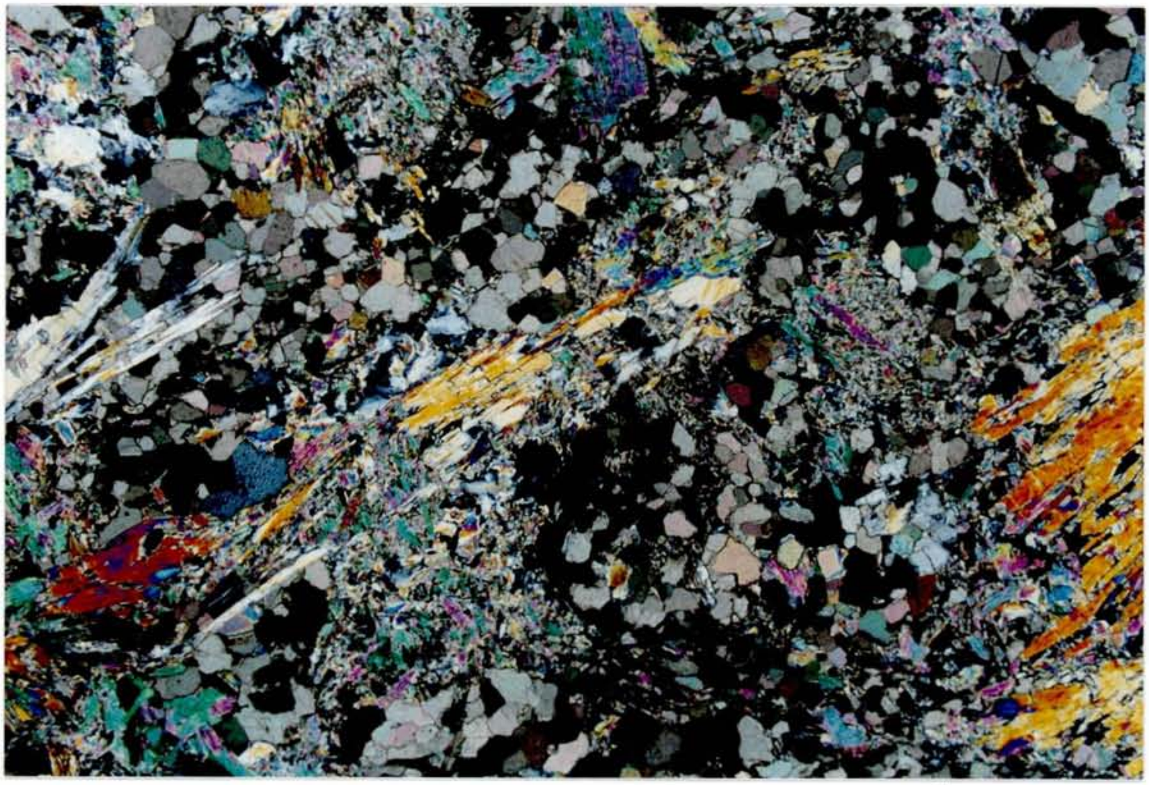

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Figure 9. *Microphoto of amphibole-bearing talc-carbonate rock. The amphibole (yellowish-brown crystals in the centre and to the right and almost white to the left), which is of the type anthophyllite, occurs in both fibrous and non-fibrous forms. Sample NAK 9604, 334.5 m.*

4.3 Composition of internal talc carbonate veins

Samples from the internal veins in the drill cores NAK 9610 and NAK 9604 (Fig. 4) have been microscoped (Table 1). The mineralogy is similar to the normal ore, except for trace amounts of antigorite serpentine as inclusions within carbonate and higher amounts of magnetite/chromite. Pseudofibrous antigorite was not detected, as it was in similar veins investigated by Karlsen (1995).

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Figure 10. *The carbonate in talc-carbonate veins that crosscut the serpentinite core typically contains inclusions of serpentine (small blue grains within large dark-coloured grains of breunnerite). This is also common in the talc-carbonate zone, close the serpentinite. Sample NAK 9604, 203.5 m.*

4.4 Composition of «Possible ore»

Drill core inspection of the present rock types is not always straight forwards due to the variation in colour and texture in both the serpentinite and the talc-carbonate rock combined gradual transition between these rocks.
During drill core inspection in the field (Karlsen 1996) some parts were termed «possible ore» (Fig. 4). One sample from such a zone (NAK 9613, 196.4 m) has been analysed (Table 3). It contains a mixture of talc, carbonate and some smaller amounts of serpentine. The magnetite/chromite content is relatively high. Whether a rock with such a mineralogical composition can be termed an ore, depends on its qualities after treatment by the normal production equipment.

Table 3. Microscopic data of a sample from what was earlier termed «Possible ore» (to the right) shown together with data from a serpentinite (to the left).

XRF/XRD - samples	*3*	*15*
Drill Core	*9603*	*9613*
Metres	*215.5*	*196.4*
Rock type	*Serp*	*«Possible ore»*
Talc		xxx
Carb	xxx	xxx
Chl		x
Mgt/Chr	xx	xx
Srp	xxxx	xx
Carb-types	M/B	B
Grain size	Fine	
Texture	Banded	Fol/ Mas
Grain shape	Allo/Sub	Sub

5. WHITENESS

Whiteness (Rx, Ry, Rz) of 3 metres long split drill cores were analysed by Norwegian Talc Altermark AS at the laboratory in Altermark. The results have been given in an internal report by Norwegian Talc AS. In the present report a graphic presentation and some general comments are given.

For simplification it is focused only on the Rx, the red colour. Rx data was also presented by Karlsen (1995) and a comparison is thereby possible. It is however important to be aware that Rx in the present analyses always is lower than Ry and Rz (in many cases > 1 %). This has not been the case in previous studies. The reason for this deviation should be checked up carefully, and a first step is to compare results from the Altermark laboratory with results from the same samples at the Knarrevik laboratory.

The average whiteness of 87 samples is as follows:

Rx, not magn. separated	Rx, magn. separated	Magnetite %
73,0	77,3	7,5

The measurements confirm the previous indications that the whiteness is high, and also that the magnetic proportion is somewhat higher than in the Store Esjeklumpen deposit and in the mine.

A closer look at the data also confirms two important matters; 1) the magnetic content gradually increases from the rim towards the core of the ultramafite (Fig. 13 compared to Fig. 4), and 2) in the outer half of the talc-carbonate zone the whiteness decreases towards the rim (Fig.12).

The first point is due to a gradual increase in the alteration from the inner parts towards the blackwall rim; magnetite decompose during talc-carbonate alteration just as serpentine, but uses more time. This means that the serpentine can be completely altered while rests of magnetite remains. The second point is due to an increase of chlorite towards the rim.

The drill holes in 1996 gave both good and bad news about the size of the deposits. It is quite clear that the talc-carbonate zone is rather unevenly distributed around the serpentinite core, and that the ore occurs in pockets. One such pocket is cut by the drill core NAK 9612 and NAK 9613. The average value of whiteness for these drill holes are as follows:

Rx, not magn. separated	Rx, magn. separated	Magnetite %
73,2	79,2	4,7

In normal production the whiteness is about 2 % higher than the present laboratory measurements. This means that it could be possible to produce a talc-carbonate product with whiteness > 81 % from this part of the ore.

Some large internal talc-carbonate zones were cut by the drill core NAK 9610. The average values of these zones are:

Rx, not magn. separated	Rx, magn. separated	Magnetite %
74,2	78,2	9,0

This is quite satisfactory both when it comes to whiteness and to magnetite content. Previous investigations have shown that the content of magnetite can be up to at least 20 % in such internal zones.

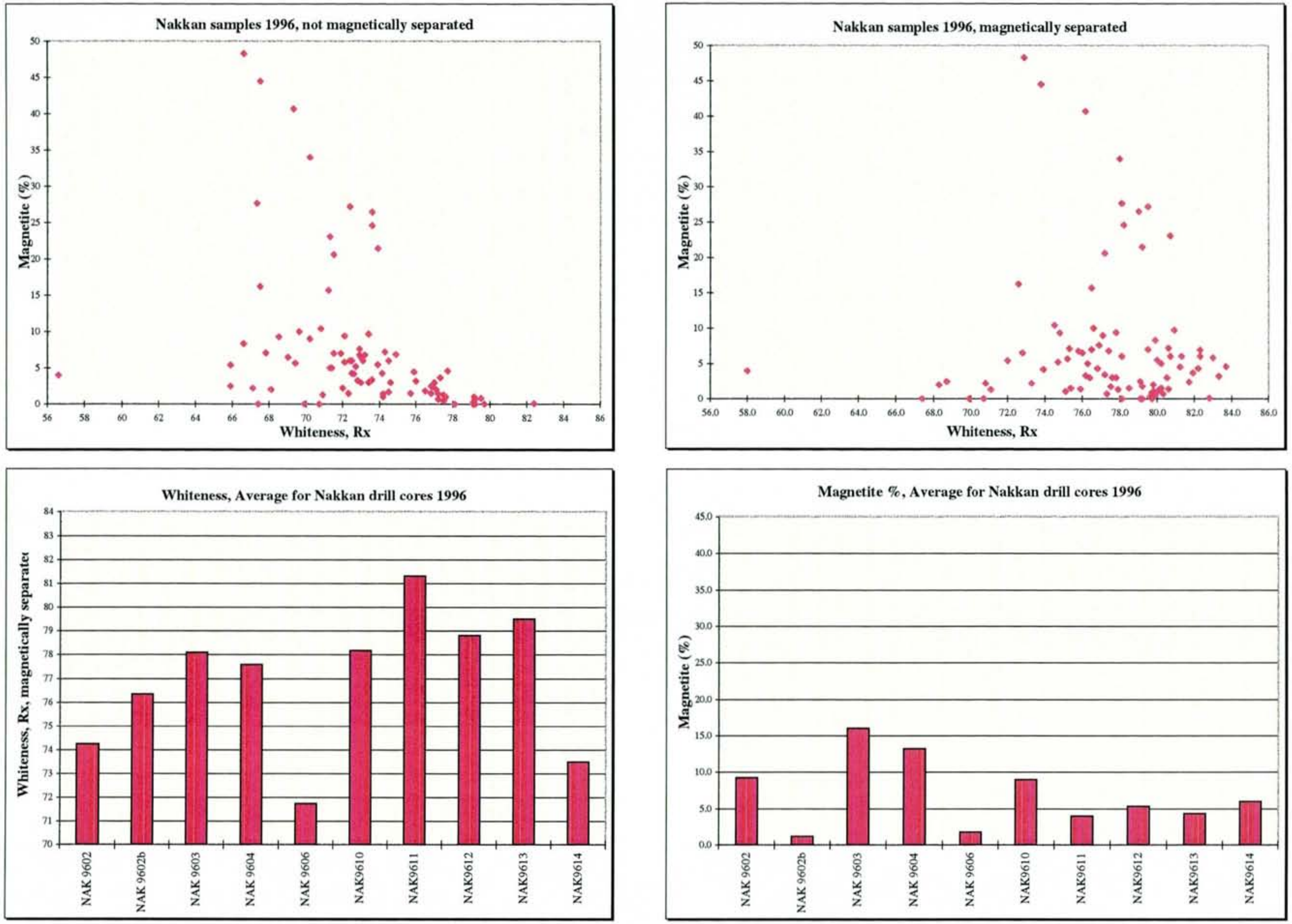
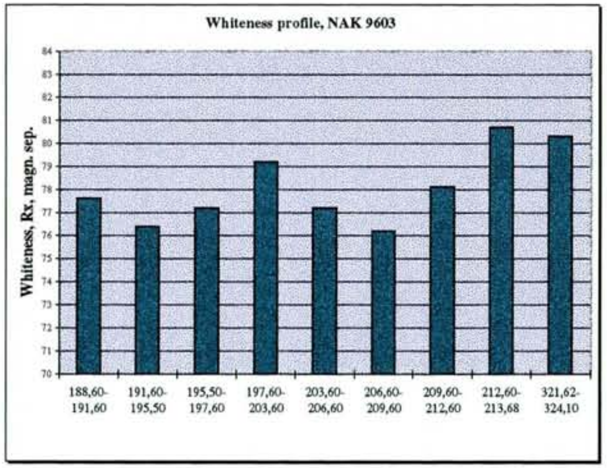
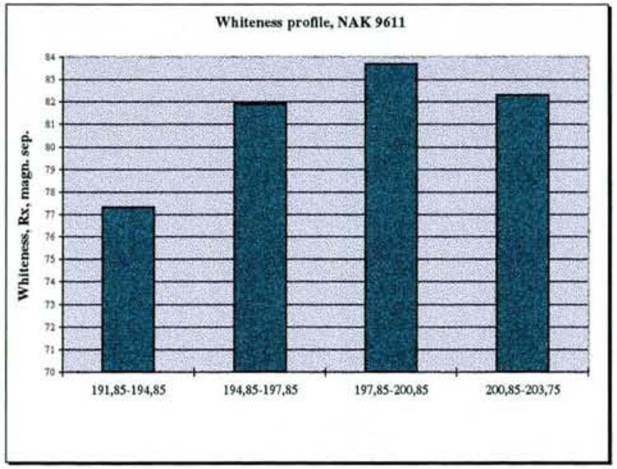
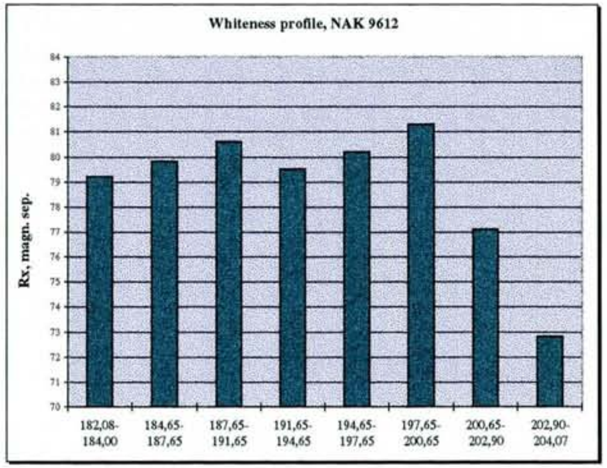


Figure 11. Summary plots of whiteness and content of magnetic matter ("magnetite").







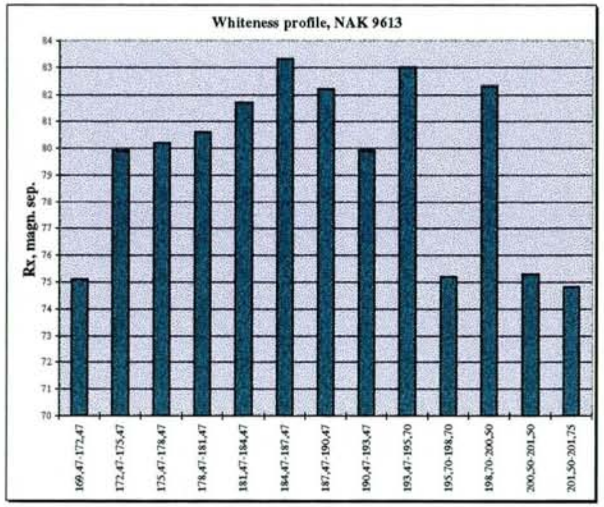
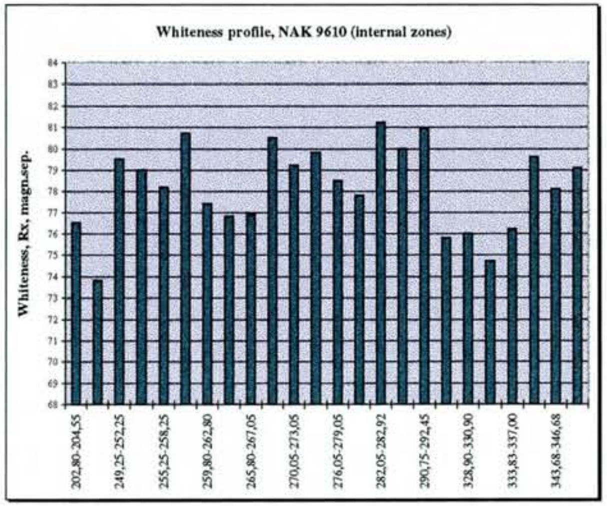
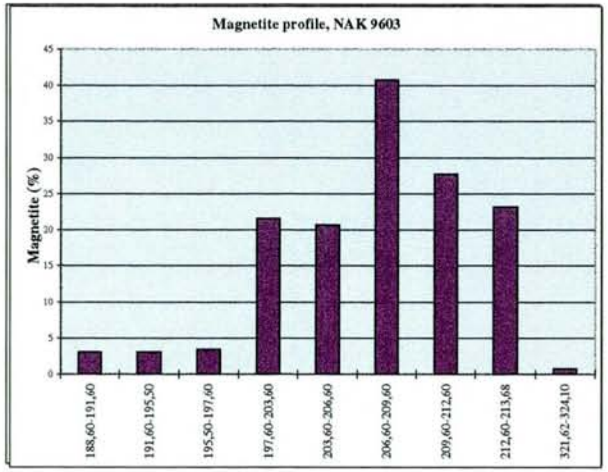
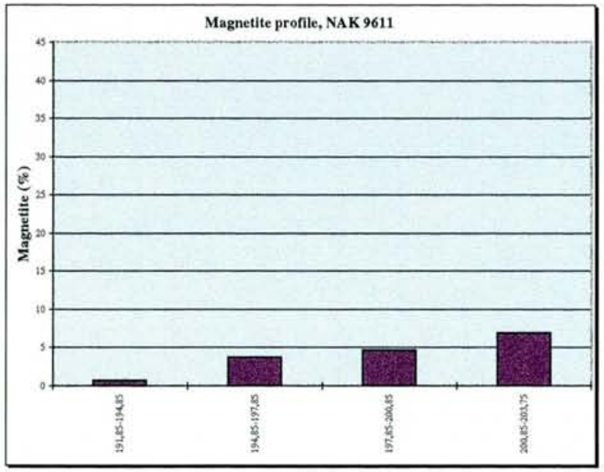
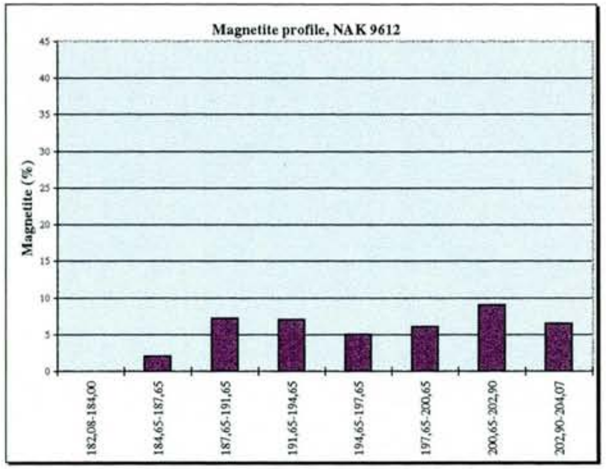


Figure 12. Whiteness profiles from Nakkan drill cores 1996.









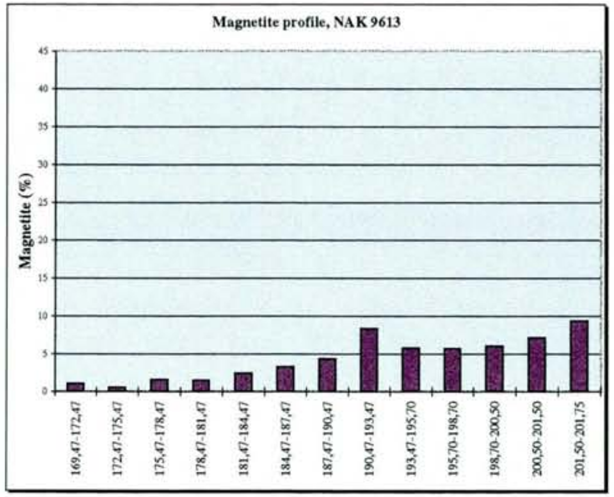
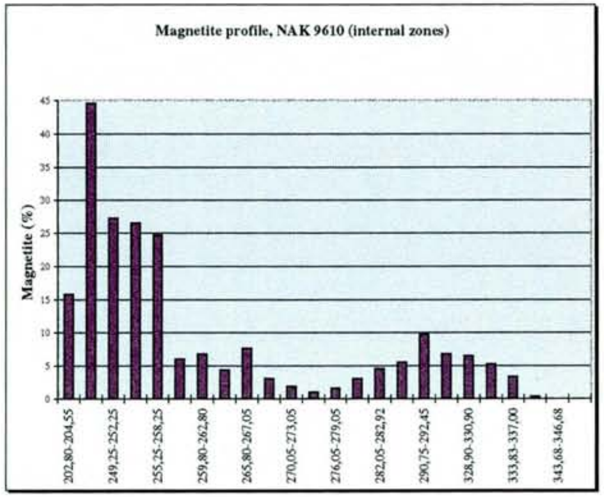


Figure 13. Magnetite profiles (i.e. magnetic proportion) from Nakkan drill cores 1996.



6. GEOCHEMISTRY

15 samples have been analysed with respect to major and trace elements (Table 4). The results are rather similar to what are to be expected based on previous studies (Karlsen 1995), and in general the chemical composition is typical for the talc-carbonate ores in Altermark. However, the present analyses involve several additional elements. The content of the most important of these will be commented below.

Since the talc-carbonate rocks from the Altermark talc mine always are magnetically separated in the production, the analysed chemistry is not representative of the final product. The magnetic separation removes magnetite and similar minerals like magnesiochromite and Fe-bearing chromite, and most of the Al_2O_3 content. The chemical difference between non-magnetically separated and magnetically separated samples is therefore mainly lower Fe-, Cr -, and Al contents in the latter.

Anal. no. 4, Table 4, has unually high contents of CaO. As shown in Table 1, this sample is amphibole bearing, and the amphibole type is anthophyllite. This means that the higher CaO-content is caused by dolomite.

Anthophyllite does not show up on the chemical analyses since it contains only MgO in addition to SiO_2 and OH. The situation is similar with serpentine. However, when the content of serpentine is high, this might be reflected on the chemistry by a lower LOI (Anal. no. 3, Table 4).

The trace element analyses suggest that the contents of most of the potentially health risky elements (Reimann et al. in prep.) are low; the content of the elements Cd, Pb, Hg, As, and radioactive U and Th are all below the detection level. Ni is however present in subordinate amounts. This is typical for the ultramafic type of talc, and there might be some restrictions in the application for this talc-type, e.g. in cosmetics. In the Altermark talc deposits, most of the Ni is bounded to the crystal lattice of talc, while the contents of Ni-bearing sulphides are very low. Ni is therefore not possible, or at least very difficult, to remove.

Since the ore goes through a magnetic separation in the regular production, the content of Fe and Cr and other elements bounded to magnetite/chromite will be considerably lower in the final product. It is also necessary to keep in mind that if flotation is taken into consideration, analyses of the flotation product will be very different from the presented talc-carbonate analyses. But, at least these results are promising.

An.no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Drill core	NAK 9603	NAK 9603	NAK 9603	NAK 9604	NAK 9606	NAK 9610	NAK 9610	NAK 9610	NAK 9611	NAK 9612	NAK 9612	NAK 9613	NAK 9613	NAK 9613	NAK 9613
Metres	191.5	201.5	215.5	334.5	159.3	252.5	272.5	342.5	197.5	190.5	200.5	169.9	174.5	188.75	196.4
Rock type	Tc-Carb	Tc-Carb	Serp	Trem-Tc-Carb	Tc-Carb+anth	Tc-Carb+anth	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Tc-Carb	Serp-Tc-Carb
SiO2	33.21	29.82	33.30	32.52	26.73	57.03	29.86	30.88	28.17	33.92	34.48	42.95	36.15	32.19	38.57
Al2O3	1.01	0.27	0.35	1.16	0.35	1.64	0.36	0.37	0.45	0.61	1.48	0.85	0.38	0.28	0.41
Fe2O3	6.73	6.70	6.36	5.70	6.95	6.41	6.20	6.14	6.66	6.00	6.42	5.48	5.93	6.20	6.40
TiO2	0.01	<0,01	<0,01	0.02	0.01	0.02	<0,01	<0,01	0.01	<0,01	0.02	0.01	<0,01	<0,01	<0,01
MgO	34.50	36.12	39.30	25.08	36.16	29.38	35.91	35.55	35.79	34.19	34.76	31.37	33.83	34.84	34.50
CaO	0.16	0.09	0.09	12.18	0.21	0.07	0.11	0.18	0.70	1.24	0.56	2.08	0.86	0.98	0.25
Na2O	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10
K2O	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
MnO	0.14	0.13	0.12	0.16	0.11	0.08	0.10	0.09	0.14	0.10	0.07	0.13	0.10	0.13	0.10
P2O5	<0,01	<0,01	<0,01	0.04	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
LOI	23.45	26.26	19.51	21.63	28.48	4.67	27.03	26.17	27.83	23.07	21.93	16.58	22.34	24.66	18.53
SUM	98.99	99.2	98.82	98.12	98.84	99.03	99.62	99.23	99.60	98.91	99.57	99.27	99.37	99.09	98.54
Mo	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
Nb	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
Zr	<0,0005	0.0006	<0,0005	0.0009	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
Y	<0,0005	<0,0005	<0,0005	0.0011	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
Sr	<0,0005	<0,0005	<0,0005	0.075	<0,0005	<0,0005	<0,0005	<0,0005	0.0008	0.0018	<0,0005	0.003	0.0012	0.0015	<0,0005
Rb	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
U	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Th	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Pb	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Cr	0.2607	0.1957	0.1870	0.2670	0.2325	0.2269	0.1877	0.1897	0.1698	0.2066	0.2270	0.1424	0.1845	0.0936	0.3924
V	0.0020	0.0016	0.0015	0.0027	0.0016	0.0021	0.0016	0.0014	0.0013	0.0013	0.0023	0.0017	0.0014	0.0009	0.0013
As	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	0.0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Sc	<0,0010	<0,0010	<0,0010	0.0016	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
S	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000
Cl	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000
F	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000	<0,1000
Ba	0.0011	<0,0010	<0,0010	<0,0010	0.0015	0.0016	0.0016	0.0013	0.0016	<0,0010	0.0013	0.0017	0.0017	0.0014	0.0015
Sb	<0,0010	<0,0010	0.0012	<0,0010	<0,0010	<0,0010	0.0010	0.0017	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Sn	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Cd	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Ag	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Ga	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	0.0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Zn	0.0026	0.0020	0.0022	0.0030	0.0022	0.0026	0.0028	0.0016	0.0019	0.0028	0.0022	0.007	0.0046	0.0009	0.0018
Cu	0.0019	<0,0005	0.0013	<0,0005	0.0017	0.0008	0.0006	<0,0005	0.0011	0.0016	0.0012	0.0011	0.0008	0.0011	0.0012
Ni	0.1605	0.1869	0.2174	0.1223	0.1499	0.0982	0.1495	0.1541	0.1408	0.1257	0.1300	0.1307	0.1326	0.1367	0.1484
Yb	<0,0010	0.0011	0.0015	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	0.0011
Co	0.0083	0.0085	0.0075	0.0067	0.0093	0.0062	0.0087	0.0084	0.0089	0.0075	0.0083	0.0067	0.0076	0.0075	0.0076
Ce	<0,0010	<0,0010	0.0011	<0,0010	0.0011	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	0.0012
La	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
Nd	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010	<0,0010
W	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030	<0,0030

Table 4. Results of XRF-analyses. Green = talc-carbonate rocks (ore), Red = amphibole bearing/rich talc-carbonate rocks, Blue = Serpentinite.

7. DISCUSSION

The composition of major parts of the Nakkan talc-carbonate ore is very similar to the talc-carbonate rocks in the mine and in Esjeklumpen, and therefore of high quality. Higher content of magnetite/chromite was indicated by earlier analyses (Karlsen 1995), but all these samples were taken from relatively thin ore bodies. The present analyses indicate that when the talc-carbonate zone is thick (drill holes NAK 9612 & NAK 9613) the magnetite content decreases.

Around drill holes 9606 and 9604 amphibole is abundant, respectively of the types tremolite and anthophyllite. In both cases internal zones of chloritite occur. In the case of tremolite Ca must have been gained from the surrounding rocks, probably along faults that have displaced the chloritite from the blackwall rim. A similar origin is possible for the anthophyllite, but without the adding of Ca. Those parts containing amphiboles with fibrous habit should be avoided during an eventual mining operation.

The chemistry of the talc-carbonate ore is typical ultramafic with elevated contents of Ni, Cr and Fe. As mentioned above, a lot of the Fe and Cr is removed by magnetic separation during production. Some of the Cr is present within the lattice of secondary chlorite which may be difficult to remove. Much of the Ni is present within the crystal lattice of talc and is not possible to remove, at least not with normal processing procedures. The contents of Ni and Cr will probably reduce the possibilities for application on typical small marked segments such as pharmaceutical and cosmetics. But the use in paints, paper, plastics and roofing is still possible. Today, the major market for Norwegian Talc is the paint industry. On the other hand, Finntalc Oy make talc-products for the paper industry from about the same kind of talc-rocks.

For most applications in paper and plastics it is necessary to have a powder with high whiteness.

Finntalc Oy makes pure talc products by removing the carbonate as well as Ni-sulphides by flotation. The whiteness on their talc is in the range 75 - 88 %. Their talc-carbonate ore is rather similar to the Altermark ore, except that it contains low amounts of magnetite/chromite, and relative high amounts of sulphides.
As a raw material for floated talc, the talc from Altermark probably is of high quality because of 1) idioblastic grain shapes, 2) coarse grain size, and 3) relatively high whiteness of non-floated products.
Idioblastic grain shapes probably make the mineral separation easier and better. A good mineral separation will probably also be favoured by the relatively coarse grain size. The coarse grain size also results in larger surface area when crushed, with a resulting higher brightness.

When high whiteness is needed for an application, talc of non-ultramafic origin is normally applied. There are two reasons for this; 1) talc with the highest whiteness (around 92 - 100 %) is possible to achieve only for the non-ultramafic type, and 2) non-ultramafic talc gives a high whiteness without any special treatment.

When comparing the Finnish talc with the Altermark talc it seems realistic to assume that a whiteness of 88-90 % is possible to achieve from the Altermark talc with proper processing equipment.

8. CONCLUSION

Investigations of drill cores from the Nakkan deposit indicate that the ore generally is of relatively high quality, as shown both by texture, mineralogy and whiteness. Large parts of the ore, the thickest parts included, have whiteness of 77-80 % and does not contain fibrous amphibole. Fibrous amphibole does however occur in restricted zones. The talc-carbonate rocks containing fibrous amphibole in drill hole NAK 9606 should not be termed ore, and should be avoided during future mining.
Veins of talc-carbonate that crosscuts the serpentinite core show a normal mineralogy, which means that they are possible to mine. More analyses are however necessary to confirm this.

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Appendix 1. Evaluation of tremolite & anthophyllite from XRD-analyses.

Vurdering av tremolitt&antofyllitt fra XRD-opptak

1. Bakgrunn

Vurdering tar utgangspunkt i at prøvene inneholder talk, karbonat, kloritt, magnetitt, kromitt i tillegg til mulighet for amfibol (som foreligger enten som tremolitt eller som antofyllitt) og serpentin (som foreligger som antigoritt)

2. Tolkningsgrunnlag

2.1 Vinkelområdet 9.5-11 °2θ.

Både tremolitt og antofyllitt har sterke topper i vinkelområdet 9.5-11 °2θ, se tabell 1. De fleste prøvene har en markant topp ved ca 9.4-9.6 °2θ (kfr. figur 1 og 2). Antofyllitt har en topp (25%) ved ca. 9.5 °2θ, men talk har også sin sterkeste topp i dette området (ca. 9.45 °2θ, se tabell 2) slik at eventuell topp fra antofyllitt i dette området vil være overlappet av talk. Vurderer derfor området 9.7-11 °2θ, i dette området er det kun prøve 4 og 6 som har signifikante topper (bestemt vba. peak search), kfr. tabell 3-4 samt figur 1.

2.2 Vinkelområdet 24-36 °2θ.

Tremolitt har en sterk topp ved ca. 28.5°2θ, de fleste prøver har en markant topp i dette området, men talk har en sterk topp (40%) ved ca. 28.6 °2θ og denne vil overlappe med event. tremolitt. Antofyllitt har sin sterkeste topp ved ca. 29.3°2θ, av prøvene er det kun prøve 4 og tildels prøve 6 som har signifikante topper i dette området, se figur 2. Både tremolitt og antofyllitt har noen relativt sterke topper(hhv. 75% og 60%) i området 27.2-27.6 °2θ, i dette området er det fire prøver som har relativt svake topper, hvor de høyeste av disse er for prøve 4 og 6.

3. Oppsummering

Med bakgrunn i de bestemte topper vha. "peak search" sammenstilt mot litteratur verdier for tremolitt og antofyllitt gir opptakene, for alle prøver med unntak av prøve 4 og 6, ***ikke*** indikasjon for påvisbare mengder av disse mineralene.

3.1 Prøve 4 og 6

Scandata og beregnede topper fra "peak search" for prøve 4 og 6 er fremstilt grafisk i figur 3 og 4 (hhv. i vinkelområdene 9-12 og 24-36 °2θ). Resultat fra softwarebasert identifisering ("score list") er gitt på sidene 9-12 og plott av diffraktogram fra denne identifiseringen med utvalgte mineraler innsatt er gitt i vedlegg 1 og 2.

Prøve 4. Med bakrunn i forutsetningene gitt under pkt. 1 inneholder opptaket noen topper som ikke forklares av de indikerte hovedmineralene, som nevnt under pkt. 2.1 og 2.2 har opptaket noen relativt svake topper som er noenlunde i overenstemmelse med antofyllitt. Resultat fra den softwarebaserte identifiseringen gir en relativ score på 0.40 for ferro-gedrite (antofyllitt grp.), 0.35 for antofyllitt og 0.26 for tremolitt. Basert på denne bakgrunn gir tolkningsgrunnlaget indikasjon på mulig innhold av antofyllitt. men da i relativt små mengder.

Prøve 6. Tilsvarende som for prøve 4. Resultat fra den softwarebaserte identifiseringen gir en relativ score på 0.29 for magnesioantofyllitt, 0.23 for antofyllitt og 0.21 for tremolitt (sodian). Tolkningsgrunnlag gir indikasjon på mulig innhold av magnesioantofyllitt, men sannsynlighet for antofyllitt i denne prøven er mindre enn for prøve 4.

Andreas Grimstvedt

Trondheim 16.06.1996 ***Andreas Grimstvedt***

Tabell 1 D-verdier og korsponderende 2θ-vinkler med tilhørende relative intensiteter for tremolitt og antofyllitt (oppgitt kortnr Mineral Powder Diffraction File JCPDS)

Tremolitt 12-0437		
d[Å]	°2θ	I/I_{maks}
8.98	9.8417	16
8.38	**10.5483**	**100**
5.07	17.4779	16
4.76	18.6260	20
4.51	19.6685	20
4.2	**21.1363**	**35**
3.87	22.9621	16
3.38	**26.3469**	**40**
3.27	**27.2499**	**75**
3.12	**28.5872**	**100**
2.938	**30.3995**	**40**
2.805	**31.8784**	**45**
2.73	32.7785	16
2.705	**33.0901**	**90**
2.592	**34.5770**	**30**
2.529	**35.4666**	**40**
2.38	**37.7683**	**30**
2.335	**38.5246**	**30**
2.321	**38.7662**	**40**
2.273	39.6187	16
2.163	41.7249	35
2.042	44.3242	18
2.015	44.9503	45
2.002	45.2583	16
1.892	48.0500	50
1.814	50.2560	16
1.649	55.6965	40

Tremolitt 23-0666		
d[Å]	°2θ	I/I_{maks}
9.03	9.7871	12
8.44	**10.4731**	**40**
4.51	19.6685	20
3.27	**27.2499**	**30**
3.13	**28.4940**	**100**
2.944	**30.3361**	**40**
2.805	31.8784	18
2.706	**33.0775**	**60**
2.59	34.6046	20
2.527	35.4956	20
2.331	38.5933	20
2.317	38.8358	16
2.162	41.7451	25

Antofyllitt 09-0455		
d[Å]	°2θ	I/I_{maks}
9.3	9.5023	25
8.9	**9.9304**	**30**
8.26	**10.7020**	**55**
5.04	17.5828	14
4.62	19.1957	14
4.5	19.7126	25
4.13	21.4987	20
3.9	22.7831	14
3.65	**24.3667**	**35**
3.36	**26.5065**	**30**
3.24	**27.5072**	**60**
3.05	**29.2578**	**100**
2.87	31.1378	20
2.84	**31.4752**	**40**
2.74	32.6555	20
2.68	**33.4078**	**30**
2.59	**34.6046**	**30**
2.54	**35.3080**	**40**
2.318	38.8184	20
2.29	39.3124	20
2.252	40.0038	14
2.142	42.1534	30
1.991	45.5224	16
1.839	49.5264	20
1.734	52.7486	30
1.693	54.1287	14
1.618	56.8596	30
1.583	58.2357	20

Tabell 2 D-verdier og korsponderende 2θ-vinkler med tilhørende relative intensiteter for talc

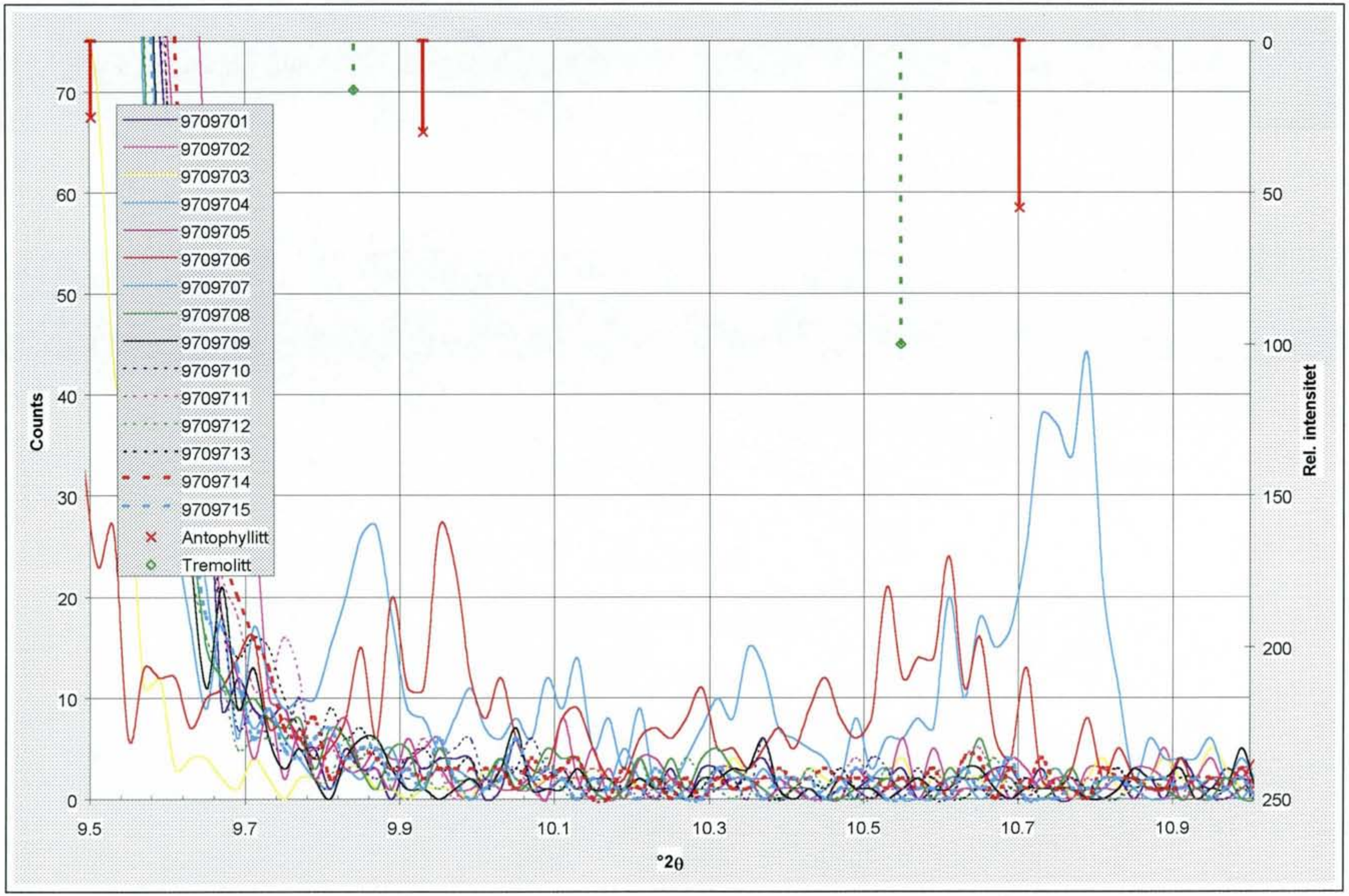
Talc 19-0770		
d[Å]	°2θ	I/I_{maks}
9.350	**9.4513**	**100**
4.670	18.9882	8
4.590	19.3223	45
4.560	19.4507	25
4.530	19.5808	12
3.120	**28.5872**	**40**
2.635	33.9955	18
2.627	34.1022	8
2.610	34.3312	14
2.597	34.5084	20
2.589	34.6184	14
2.496	35.9514	20
2.479	36.2065	30
2.464	36.4346	14
1.529	60.5026	55

Tabell 3 Beregnede topper ved bruk av «peak search»

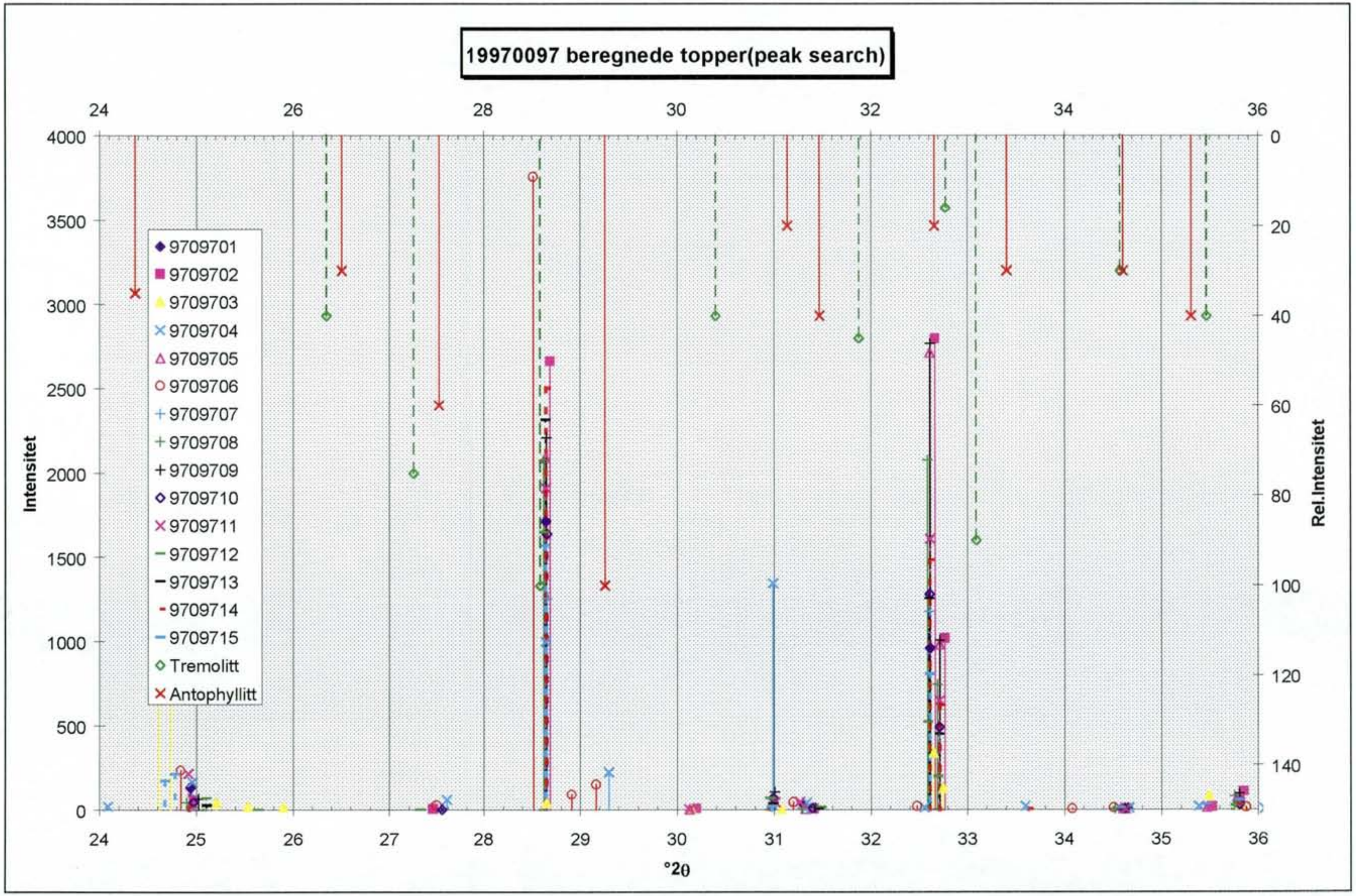
Angle [°2θ]	97097-01	Angle [°2θ]	97097-02	Angle [°2θ]	97097-03	Angle [°2θ]	97097-04	Angle [°2θ]	97097-05	Angle [°2θ]	97097-06	Angle [°2θ]	97097-07
6.230	188	6.275	42	9.510	90	6.240	216	6.240	50	6.105	125	6.185	17
9.495	3672	9.540	5256	11.350	5	9.500	2125	9.490	5388	9.365	4816	9.505	2642
12.430	234	12.465	92	12.240	2621	9.855	52	12.415	77	9.940	40	11.175	4
18.655	137	18.700	52	12.435	234	10.340	23	15.265	2	10.605	34	12.430	22
19.010	346	19.050	552	12.565	174	10.780	66	18.635	40	12.305	317	14.295	1
19.460	13	24.975	59	13.125	8	12.440	282	19.005	428	18.550	246	18.650	22
21.295	2	27.445	5	14.505	8	17.525	2	19.465	9	18.885	586	19.020	234
24.940	137	28.690	2663	19.000	11	18.680	182	24.945	44	19.385	13	19.425	14
28.645	1714	30.195	8	21.270	3	19.015	185	28.640	2088	21.430	21	24.945	21
31.305	34	31.410	6	24.615	807	19.690	31	30.125	4	24.840	234	28.655	1253
32.610	961	32.660	2798	24.735	660	21.560	25	31.320	8	27.480	28	31.340	4
34.590	6	32.765	1018	25.205	42	24.090	23	32.605	2714	28.515	3758	32.605	1176
35.805	58	34.625	8	25.530	19	24.960	169	32.710	980	28.910	92	32.715	449
36.770	6	35.520	18	25.895	16	27.590	64	34.605	7	29.165	151	34.610	8
38.505	18	35.845	110	28.650	41	28.645	999	35.465	17	31.195	46	35.790	58
38.775	10	38.550	34	30.145	4	29.300	225	35.780	74	32.475	20	38.515	19
40.760	4	38.830	12	31.075	3	30.990	1347	38.510	34	34.080	7	38.825	13
42.950	76	40.380	9	32.645	339	31.335	46	38.830	10	34.505	12	40.585	5
43.080	34	42.990	139	32.745	130	32.555	17	40.385	5	35.875	17	42.940	159
44.355	8	43.120	67	35.490	86	33.595	26	42.940	135	36.640	13	43.070	62
45.055	6	46.825	36	35.810	30	34.670	12	43.055	64	38.375	46	46.780	31
46.805	21	48.720	139	36.785	7	35.385	23	44.430	2	40.195	6	48.680	62
48.675	83	48.855	66	37.160	58	36.065	10	45.160	2	43.110	9	48.820	35
48.820	44	51.590	8	38.860	6	36.720	8	46.785	40	44.360	5	51.550	18
51.550	6	53.845	151	39.800	4	37.390	20	46.915	25	44.865	2	53.790	180
53.795	130	54.015	76	40.705	6	38.500	16	48.675	102	48.075	4	53.950	74
53.960	53	54.745	10	41.570	42	41.175	108	48.805	50	48.545	216	57.110	3
58.695	4	55.805	4	41.900	27	42.215	5	51.540	14	48.690	96	59.275	35
59.275	48	57.030	7	42.980	50	43.860	13	53.790	210	49.240	17	59.455	14
59.450	22	59.315	66	46.830	16	44.965	36	53.935	85	51.450	2	60.560	12
60.555	9	59.475	30	49.620	15	48.685	58	56.980	6	52.870	4	61.320	15
61.295	7	60.610	10	50.265	50	48.805	19	59.265	49	54.050	14	62.330	14
62.340	6	61.375	9	50.415	20	49.320	29	59.435	21	55.830	6	66.340	23
62.800	3	62.395	17	51.085	7	50.560	90	60.565	8	56.790	4	67.480	9
65.285	4	62.605	12	51.390	20	50.705	36	60.715	8	58.605	8	68.260	18
66.360	14	66.395	19	52.450	5	51.105	85	61.300	12	59.140	123	69.210	25
67.570	16	67.625	16	52.975	11	51.245	46	62.340	14	59.315	55	69.435	17
68.290	19	68.350	35	53.875	79	52.850	2	62.540	7	59.650	18		
68.480	9	68.535	26	54.015	34	54.390	4	66.345	22	60.435	14		
69.250	19	69.300	35	57.035	3	56.965	8	67.560	11	61.405	4		
69.455	8	69.510	17	57.655	3	58.630	8	68.280	48	62.765	6		
				58.885	14	59.270	28	68.490	18	65.365	12		
				59.990	14	59.435	14	69.230	31	65.800	13		
				60.525	16	59.770	23			67.495	29		
				61.230	16	60.615	8			67.670	18		
				62.085	19	61.695	12						
				62.585	11	63.465	21						
				63.000	12	64.545	34						
				64.215	16	64.725	17						
				66.390	8	65.200	12						
				68.355	6	65.865	12						
				69.310	14	66.755	10						
						67.415	19						

Tabell 4 Beregnede topper ved bruk av «peak search» forts.

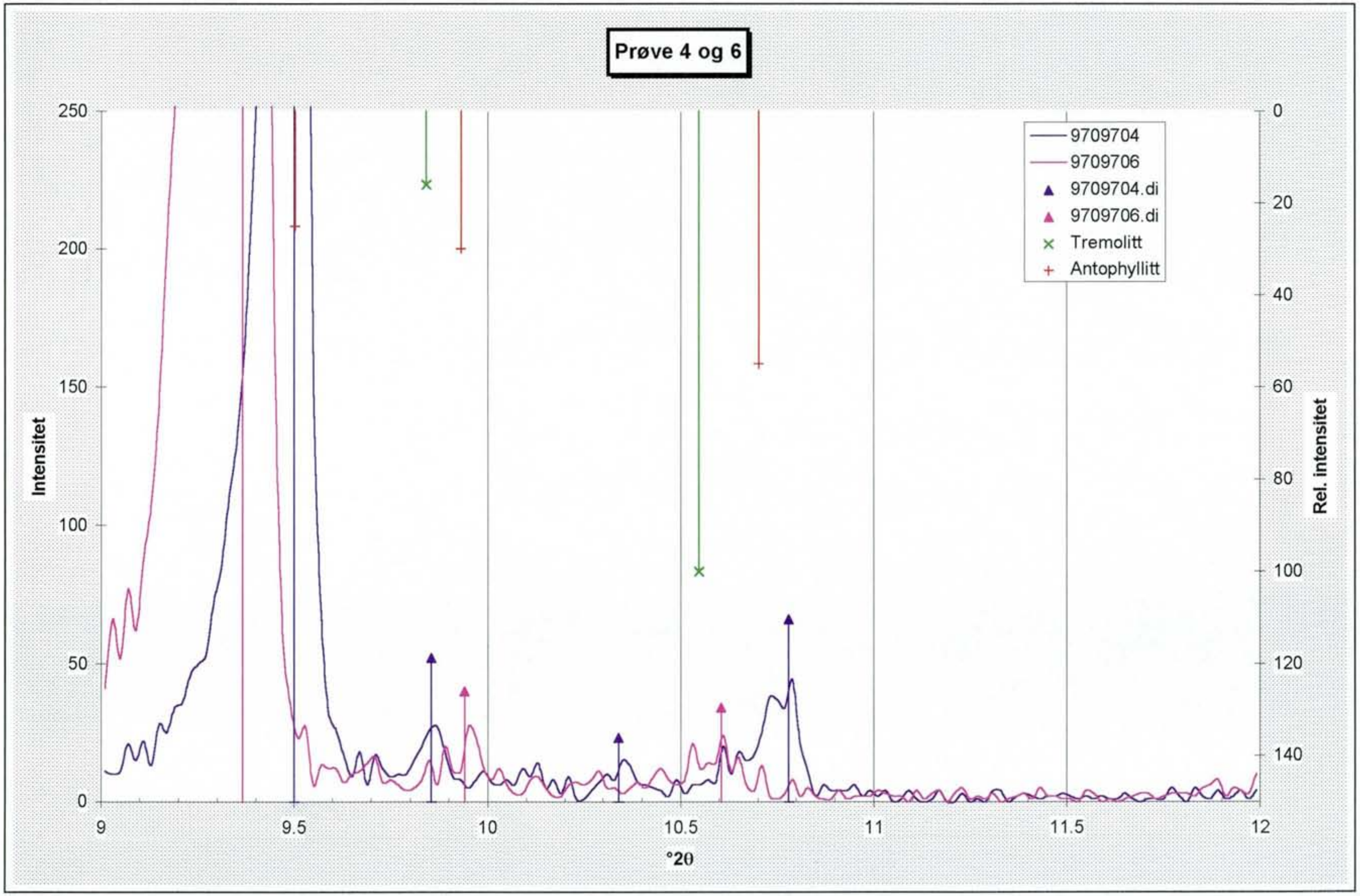
Angle [°2θ]	97097-08	Angle [°2θ]	97097-09	Angle [°2θ]	97097-10	Angle [°2θ]	97097-11	Angle [°2θ]	97097-12	Angle [°2θ]	97097-13	Angle [°2θ]	97097-14	Angle [°2θ]	97097-15
3.830	17	6.250	81	6.250	58	6.215	228	3.550	7	6.260	31	6.225	24	7.165	7
6.190	56	7.130	4	9.505	3080	9.500	3919	6.255	88	9.500	4356	9.500	5388	9.490	3036
8.035	7	9.505	4251	11.285	2	12.410	372	9.485	3226	12.475	53	11.630	2	12.260	497
9.475	4570	12.470	108	12.455	96	18.635	243	12.490	102	19.020	396	12.440	28	12.465	66
12.405	92	18.730	50	18.680	58	19.020	376	13.470	3	19.440	12	19.020	412	12.585	42
18.620	53	19.025	388	19.025	279	24.920	216	18.760	61	25.110	27	19.435	11	14.440	3
18.985	437	19.460	12	19.415	16	28.645	1910	19.000	266	28.645	2314	24.925	18	19.005	310
19.385	18	25.025	66	24.975	50	30.125	2	19.440	16	30.990	37	28.650	2500	19.465	14
24.905	46	28.650	2209	27.540	3	31.010	45	21.640	3	31.460	5	30.950	23	20.310	3
28.625	2079	31.005	106	28.655	1640	31.265	48	25.105	71	32.605	1253	32.610	1482	24.680	174
31.295	9	31.425	14	30.990	71	32.610	1608	25.640	3	32.710	449	32.715	620	24.785	213
32.585	2079	32.610	2767	31.400	12	32.710	650	27.320	3	34.595	5	33.630	4	28.640	1568
32.690	745	32.715	1005	32.605	1282	34.630	6	28.630	1648	35.805	56	34.600	6	30.975	18
34.525	5	34.650	10	32.710	493	35.795	56	30.960	69	38.500	27	35.790	31	32.610	807
35.755	83	35.805	96	34.620	8	37.705	2	31.490	15	40.555	6	37.445	4	34.575	11
38.480	30	38.490	18	35.805	34	38.510	29	32.590	520	42.930	77	38.510	34	35.460	32
40.500	5	38.795	16	36.155	19	38.830	6	32.695	199	45.035	2	38.630	13	35.805	56
42.905	85	40.420	7	38.510	22	40.535	4	34.565	10	46.775	24	38.840	8	37.300	8
44.390	2	42.940	166	38.845	10	42.945	92	35.765	27	46.910	17	40.425	6	38.505	20
44.975	9	43.065	72	40.460	7	43.070	42	36.815	8	48.675	121	41.195	24	38.820	18
46.750	28	45.080	4	41.175	11	44.330	13	38.490	26	48.815	61	41.310	16	40.615	6
48.650	121	46.780	42	42.955	94	45.035	7	40.495	7	50.630	4	42.935	67	41.600	10
48.795	46	46.925	24	45.100	5	46.780	21	41.145	11	51.115	10	45.025	4	42.950	61
51.525	9	48.680	128	46.785	21	48.675	106	42.945	34	51.565	7	46.780	35	43.075	34
53.750	132	48.810	55	48.680	96	48.810	45	45.055	4	53.785	142	46.905	18	46.790	26
55.820	4	51.550	14	48.810	44	51.125	4	46.815	10	53.945	58	48.675	142	48.670	83
59.255	55	53.775	216	50.585	11	51.530	10	48.650	98	59.255	59	48.810	61	48.825	37
59.415	27	53.935	98	50.785	3	53.790	119	48.790	45	59.430	31	50.605	3	50.420	8
60.535	8	55.900	5	51.115	6	53.950	52	50.550	12	60.565	9	51.130	6	51.545	8
60.715	6	59.265	66	51.540	9	54.625	10	51.085	12	61.320	6	51.565	45	53.020	3
61.270	7	59.425	28	53.790	130	55.830	4	53.780	61	62.330	10	51.710	22	53.805	98
62.315	12	60.580	10	53.940	61	57.060	2	53.930	26	62.860	2	53.780	98	53.970	46
66.305	20	61.315	10	54.555	11	58.570	9	55.960	4	63.515	6	53.950	40	57.020	2
67.550	14	62.320	15	57.005	6	59.275	55	59.245	52	65.510	4	55.850	4	59.275	46
68.210	30	64.590	3	59.280	50	59.445	20	59.415	22	66.325	16	58.440	3	59.440	19
68.425	12	66.335	38	59.445	22	60.600	12	60.540	12	67.550	16	59.275	69	60.555	15
69.185	24	67.590	18	60.555	13	61.360	4	61.395	3	68.285	17	59.445	30	61.305	10
69.390	9	68.270	49	60.940	5	62.325	7	62.850	5	69.220	23	60.535	10	62.340	12
		68.470	15	61.305	13	62.820	4	63.440	3			61.290	7	63.080	5
		69.220	37	62.340	9	65.175	8	65.645	5			62.320	7	64.500	4
		69.420	16	62.885	4	66.355	17	66.330	9			63.530	4	65.785	6
				63.615	5	66.565	18	67.585	19			66.335	12	66.350	17
				66.320	17	67.580	12	68.230	8			67.600	20	67.565	14
				67.585	15	68.280	36	69.185	17			68.290	36	68.305	14
				68.255	23	68.475	18					68.485	14	68.490	8
				68.480	9	69.215	21					69.230	20	69.235	18
				69.230	19	69.415	12					69.410	12	69.445	10



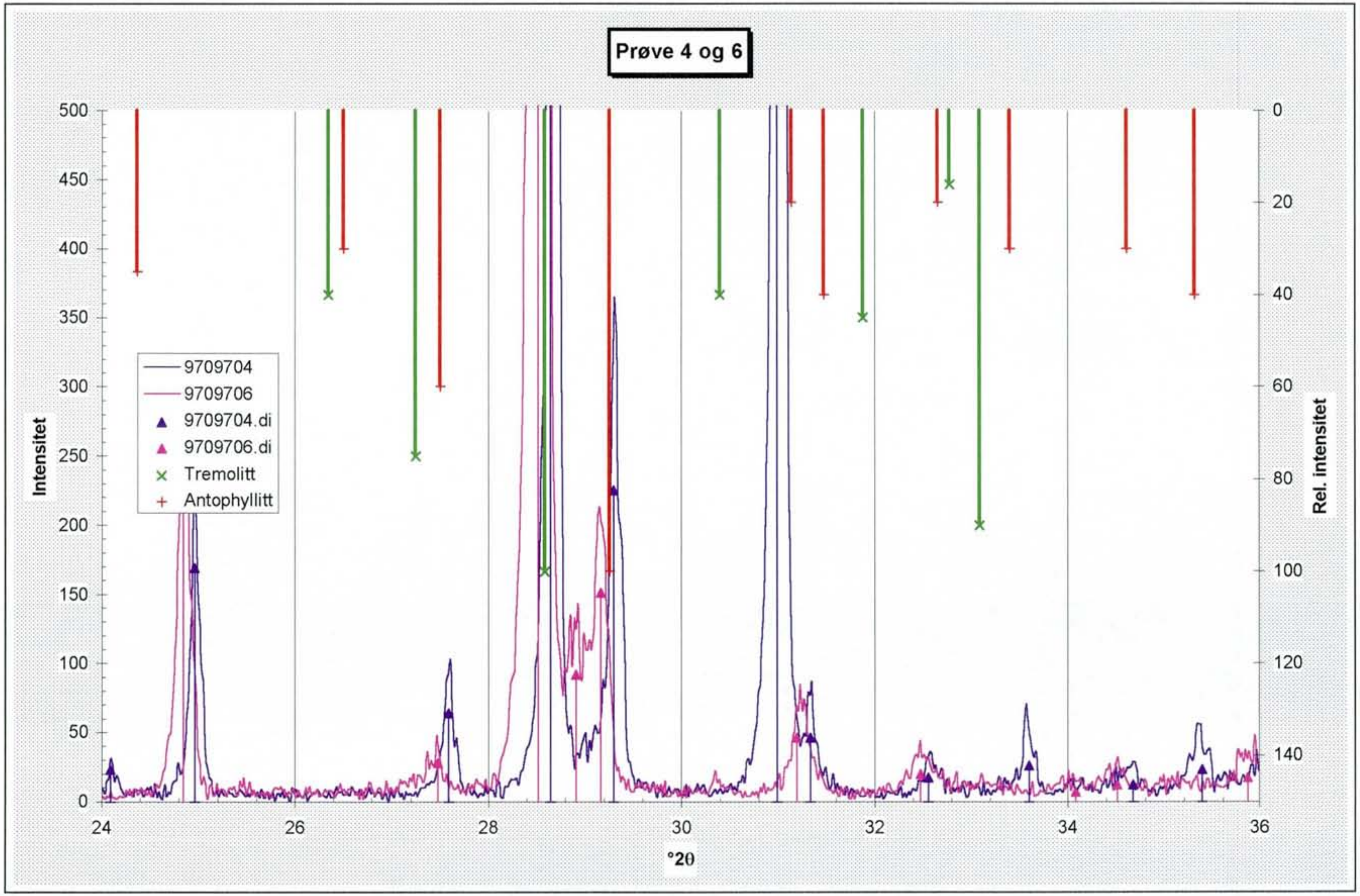
Figur 1 Scandata alle prøver vinkelområde 9.5-11°2θ. Linjer for tremolitt og antofyllitt inntegnet på sekundær aksen.



Figur 2 Beregnede topper vba. «peak search» for alle prøver vinkelområde 24-36°2θ. Linjer for tremolitt og antofyllitt inntegnet på sekundær aksen.



Figur 3 Scandata og beregnede topper vba. «peak search» for prøve 4 og 6. Linjer for tremolitt og antofyllitt inntegnet på sekundær aksen.



Figur 4 Scandata og beregnede topper vba. «peak search» for prøve 4 og 6. Linjer for tremolitt og antofyllitt inntegnet på sekundær aksen.

S C O R E   L I S T   L O N G:

```
Analysed DI file                  : C:\ANN\DATA\9709704.DI
Sample identification             : 19970097 pr.4
Last update of results file       : 13-jun-1997 10:56
Database used                     : C:\IDENTDB
```

MEASUREMENT PARAMETERS

```
Diffractometer                    : X'PERT
Start angle                       : 3.010
Final angle                       : 69.990
Step size                         : 0.020
Time per step                     : 1.0
Anode material                    : Cu
Focus                             : LFF
Date and time of measurement      : 11-apr-1997 20:59
```

PEAK SEARCH PARAMETERS

```
Minimum peak width                : 0.00
Maximum peak width                : 1.00
Peak base width                   : 2.00
Minimum significance              : 0.75
Number of peaks detected          : 53
```

SEARCH-MATCH PARAMETERS

```
Number of strong lines of the
reference patterns used in SEARCH : 5
Intensity threshold               : 3.02
Confidence threshold              : 10
Minimum specimen displacement     : -75
Maximum specimem displacement     : 75
Step size in specimen displacement: 25

Restrictions file    : MINERAL
```

	I	Card Id	#	Search score	Search displ	Match score	Rel m score	Conc	Displ	Formulas	Name
1		35-0667	1	53	75	14.45	0.72	9	109	CaZn(CO3)2	Minrecordite
2	*****	**11-0078**	**1**	**99**	**25**	**15.89**	**0.72**	**11**	**30**	**CaMg(CO3)2**	**Dolomite**
3		36-0426	1	96	75	18.13	0.70	19	87	CaMg(CO3)2	Dolomite
4		04-0452	1	71	75	4.75	0.59	8	109	BaF2	Frankdicksonite, syn
5		35-0729	1	46	-50	5.07	0.56	2	-27	GeO2	Argutite, syn
6		08-0464	1	54	-25	3.28	0.55	2	-26	CaS	Oldhamite, syn
7	*****	**12-0185**	**1**	**93**	**25**	**12.66**	**0.53**	**4**	**24**	**(Mg,Fe,Al)6(Si,Cr)**	**Clinochlore**
8		29-0853	1	85	75	13.25	0.51	3	109	Mg5Al(Si3Al)O10(OH	Clinochlore-1\ITM#l#l#b\RG
9		22-0712	1	88	-25	10.86	0.45	9	-30	(Ni,Mg,Al)6(Si,Al)	Nimite-1\ITM#l#l#b\RG
10		21-1152	1	50	75	4.06	0.45	0	85	MgAl2O4	Spinel, syn
11		04-0728	1	49	-75	8.07	0.45	1	-56	Ca3Mg(SiO4)2	Merwinite, syn
12		34-0782	1	42	-75	5.37	0.45	4	-74	(Zn,Al,Cu)3(Si,Al)	Fraipontite-1\ITO\RG
13		27-0166	1	54	25	2.66	0.44	0	37	CuFe2S3	Isocubanite, syn
14		39-1371	1	42	75	3.00	0.43	0	63	AlCu	Cupalite
15		16-0362	1	53	-50	9.31	0.42	1	-45	(Mg,Fe,Al)6(Si,Al)	Clinochlore-1\ITM#l#a\RG, ferr
16		38-1435	1	63	0	3.36	0.42	3	27	PbTe	Altaite, syn
17		42-1335	1	68	75	9.00	0.41	2	91	(Zn5Al)(Si3Al)O10(	Baileychlore-1\ITM#l#b\RG
18	*****	**11-0253**	**1**	**83**	**-25**	**11.33**	**0.40**	**3**	**-41**	**Fe5Al4Si6O22(OH)2**	**Ferro-gedrite**
19		31-0617	1	83	-25	11.33	0.40	3	-41	Fe5Al4Si6O22(OH)2	Ferrogedrite
20		07-0077	1	58	0	9.17	0.40	2	-10	Mg-Fe-Al-Si-Al-O-O	Clinoclore
21		40-0487	1	55	-75	7.56	0.40	1	-87	Mn3V(SiO4)(O,OH)3	Franciscanite
22		41-1404	1	50	50	2.35	0.39	1	84	CuFeS2	Putoranite
23		21-1157	1	67	50	11.95	0.39	5	62	HgI2	Coccinite, syn
24		12-0242	1	63	-75	10.01	0.38	1	-102	(Mg,Al)6(Si,Al)4O1	Clinochlore-1\ITM#l#l#b\RG
25		17-0341	1	58	0	7.63	0.38	3	12	YVO4	Wakefieldite-(Y), syn
26		11-0340	1	57	0	6.44	0.38	1	12	CeCO3F	Bastn\Plasite-(Ce)
27		02-1168	1	54	-75	3.03	0.38	2	-80	Pb5Fe4O10(Cl,OH)2	Hematophanite
28		25-0265	1	63	-50	2.24	0.37	3	-51	Cu3AsS4	Arsenosulvanite
29		16-0338	1	53	-25	8.19	0.37	1	-41	(Zn,Mn)2Mn5O12!4H2	Woodruffite
30		29-0998	1	60	-75	5.87	0.37	1	-52	K2CuSO4Cl2	Chlorothionite
31		07-0078	1	82	-75	8.75	0.36	1	-102	(Mg,Fe,Al)6(Si,Al)	Clinochlore-1\ITM#l#l#b\RG, fe
32		33-1315	1	58	25	12.03	0.36	1	9	Na9Zr4Ti2O9(CO3)8	Sabinaite
33		37-0471	1	63	-50	7.29	0.36	4	-51	CuFeS2	Chalcopyrite

	I	Card Id	#	Search score	Search displ	Match score	Rel m score	Conc	Displ	Formulas	Name
34		26-1211	1	47	-25	12.01	0.36	0	-41	Mg5Al(Si3Al)O10(OH	Clinochlore-\IT2M#I#Ib\RG
35		07-0165	1	52	-75	8.82	0.35	2	-102	(Mg,Al,Fe)6(Si,Al)	Clinochlore-1\ITM#I#I#b\RG
36		19-0751	1	74	50	11.97	0.35	1	69	Mg2Al3(Si3Al)O10(O	Sudoite-1\ITM#I#I#b\RG
37	*	**13-0558**	**1**	**76**	**25**	**9.13**	**0.35**	**2**	**30**	**Mg3Si4O10(OH)2**	**Talc-2\ITM\RG**
38		29-0965	1	43	-50	4.89	0.35	0	-62	PdNiAs	Majakite
39		29-0862	1	54	0	8.03	0.35	1	12	(Mg,Ni,Fe,Al)12Si6	Unnamed mineral [NR]
40	*	**42-0544**	**1**	**53**	**0**	**18.06**	**0.35**	**1**	**23**	**Mg5Fe2Si8O22(OH)2**	**Anthophyllite**
41		23-0592	1	44	-75	12.82	0.35	0	-91	SnNb2O6	Foordite, syn
42		41-0580	1	59	75	7.27	0.35	3	109	Mn4(AsO4)(OH)6	Jarosewichite
43		26-0527	1	42	50	3.10	0.34	4	84	Cu2FeGeS4	Briartite, syn
44		08-0108	1	45	75	4.81	0.34	0	80	PbWO4	Stolzite
45		09-0324	1	50	-50	8.58	0.34	1	-49	CuFe2S3	Cubanite
46		09-0455	1	5000	0	12.35	0.34	0	113	(Mg,Fe)7Si8O22(OH)	Anthophyllite
47		29-0854	1	78	-75	9.26	0.34	1	-52	Mg5Al(Si3Al)O10(OH	Clinochlore-\IT2M#I#Ib\RG
48		35-0752	1	46	-25	3.75	0.34	4	-30	CuFeS2	Chalcopyrite
49		07-0076	1	63	-75	8.74	0.34	1	-87	(Mg2.8Fe1.7Al1.2)(	Clinoclore, ferroan
50		29-0701	1	57	-75	8.66	0.33	4	-102	(Mg,Fe)6(Si,Al)4O1	Clinochlore-1\ITM#I#I#b\RG, fe
51		26-0307	1	42	75	16.48	0.33	1	70	Ca2Si2O5(OH)2!H2O	Suolunite
52	*	**36-0383**	**1**	**5000**	**0**	**4.27**	**0.33**	**1**	**88**	**(Mg,Fe)CO3**	**Magnesite, ferroan**
53		38-0424	1	57	-25	8.82	0.33	1	-55	(Ni5Al)(Si3Al)O10(	Nimite-1\ITM#I#a\RG
54		09-0455	1	58	50	11.72	0.33	1	60	(Mg,Fe)7Si8O22(OH)	Anthophyllite
55		18-1362	1	54	-25	3.86	0.32	0	-20	Th(Ca,Ce)(CO3)2F2!	Thorbastn\Plasite
56		33-0332	1	49	50	14.96	0.32	2	84	CeNbO4	Fergusonite-á-(Ce), syn
57		31-0823	1	42	50	9.85	0.32	1	45	(Mn,Mg)2SiO4	Tephroite, magnesian
58		07-0166	1	44	-75	7.58	0.32	1	-98	(Fe,Al,Mg)6(SiAl)4	Chamosite-IIb
59		12-0434	1	42	50	9.76	0.31	1	45	(Mn,Mg)2SiO4	Tephroite, magnesian
60		43-1456	1	67	75	8.46	0.31	2	91	Na0.55Mn2O4!1.5H2O	Birnessite, syn
61		36-0414	1	42	25	13.91	0.31	1	26	Na4Zr2TiO4(CO3)4	Sabinaite
62		25-0294	1	40	-25	11.07	0.31	1	-52	CuPbTlAs2S5	Wallisite
63		40-0493	1	54	-25	21.21	0.31	2	-35	Ba0.5(As2)0.5Ti2(V	Tomichite, barian
64		07-0171	1	47	-75	7.96	0.31	0	-87	Mg-Fe-Fe-Al-Si-Al-	Diabantite
65		10-0474	1	48	50	8.25	0.31	1	84	CuBiS2	Emplectite
66		06-0550	1	47	-75	4.84	0.30	2	-52	Ag4SeS	Aguilarite
67		15-0863	1	58	-50	7.86	0.30	1	-51	Bi2Te3	Tellurobismuthite, syn
68		11-0419	1	53	-75	5.73	0.30	1	-102	ThSiO4	Thorite, syn
69		13-0506	1	65	50	11.74	0.30	1	60	(Fe,Mg,Al)7Al2Si6O	Gedrite
70		22-1193	1	57	-50	10.83	0.30	1	-51	Ni9S8	Godlevskite
71		24-0506	1	76	25	14.99	0.30	1	30	(Mg5Al)(Si,Al)4O10	Clinochlore-1\ITM#I#I#b\RG
72		38-0429	1	56	75	6.89	0.30	1	56	CaMnFe(PO4)2(OH)!2	Wilhelmvierlingite
73		17-0512	1	53	-75	5.39	0.30	1	-102	CaB2O4	Calciborite
74		10-0407	1	42	50	5.09	0.30	1	49	(Mn,Cu,Mg)5(OH,Cl)	Magnussonite
75		16-0401	1	43	50	7.17	0.30	1	51	Mg7Si8O22(OH)2	Magnesioanthophyllite, syn
76		21-0128	1	44	75	17.30	0.30	0	56	Ca2Al3(SiO4)(Si2O7	Clinozoisite
77		29-0884	1	53	50	6.26	0.30	0	31	(Mn5Al)(Si3Al)O10(	Pennantite-1\ITM#I#a\RG
78		35-0723	1	46	-50	5.65	0.30	2	-49	Tl3AsS3	Ellisite
79		20-0235	1	63	0	17.50	0.30	1	34	Ca3Si2O7	Kilchoanite, syn
80		22-1103	1	54	-75	10.37	0.30	3	-56	Y2Si2O7	Keivyite-(Y), syn
81		08-0302	1	56	50	7.11	0.30	0	84	CaTh(PO4)2	Brabantite, syn
82		19-0083	1	44	75	7.08	0.29	2	91	(K2,Ag2,Ca,Ba)Mn4O	Todorokite, argentian
83		41-1366	1	5000	0	29.39	0.29	3	83	Ca2(Mg,Fe)5Si8O22(	Actinolite
84		01-0338	1	50	-25	4.11	0.29	2	-37	CaCl2	Hydrophilite, syn
85		22-0726	1	50	75	14.33	0.29	1	105	Mn5(SiO4)2(OH)2	Alleghanyite
86		18-0308	1	53	25	6.43	0.29	1	48	CaSn(BO3)2	Nordenskioldine
87		14-0640	1	53	75	11.10	0.29	1	109	Mg5(BO3)O(OH)5!2H2	Wightmanite
88		04-0116	1	47	75	11.65	0.29	1	98	Mg-UO2-CO3	Bayleyite anhydrate
89		08-0129	1	43	-25	5.82	0.29	1	-24	Ag3SbS3	Pyrostilpnite
90		21-0553	1	47	75	3.49	0.29	1	94	(Mn,Ca)Mn5O11!4H2O	Todorokite
91		17-0760	1	50	0	14.45	0.29	0	34	KCa14Si24O60(OH)5!	Reyerite
92		08-0479	1	5000	0	3.75	0.29	1	-88	MgCO3	Magnesite, syn
93		14-0454	1	46	75	4.62	0.29	0	87	Cu3As	Domeykite-á
94		13-0029	1	45	-75	6.01	0.29	1	-102	(Fe,Al,Mg,Mn)6(Si,	Chamosite-1\ITO#I#b\RG
95		12-0538	1	41	-75	11.09	0.28	0	-52	(Cu,Zn)PbVO4(OH)	Mottramite
96		05-0146	1	63	-75	8.06	0.28	1	-102	(Fe1.4Mg0.9Al0.5)(	Magnesian Chamosite
97		35-0668	1	56	0	8.60	0.28	0	34	PbZnAsO4(OH)	Arsendescloizite

SCORE LIST LONG:

Analysed DI file : C:\ANN\DATA\9709706.DI
Sample identification : 19970097 pr.6
Last update of results file : 13-jun-1997 12:03
Database used : C:\IDENTDB

MEASUREMENT PARAMETERS

Diffractometer : X'PERT
Start angle : 3.010
Final angle : 69.990
Step size : 0.020
Time per step : 1.0
Anode material : Cu
Focus : LFF
Date and time of measurement : 11-apr-1997 22:53

PEAK SEARCH PARAMETERS

Minimum peak width : 0.00
Maximum peak width : 1.00
Peak base width : 2.00
Minimum significance : 0.75
Number of peaks detected : 45

SEARCH-MATCH PARAMETERS

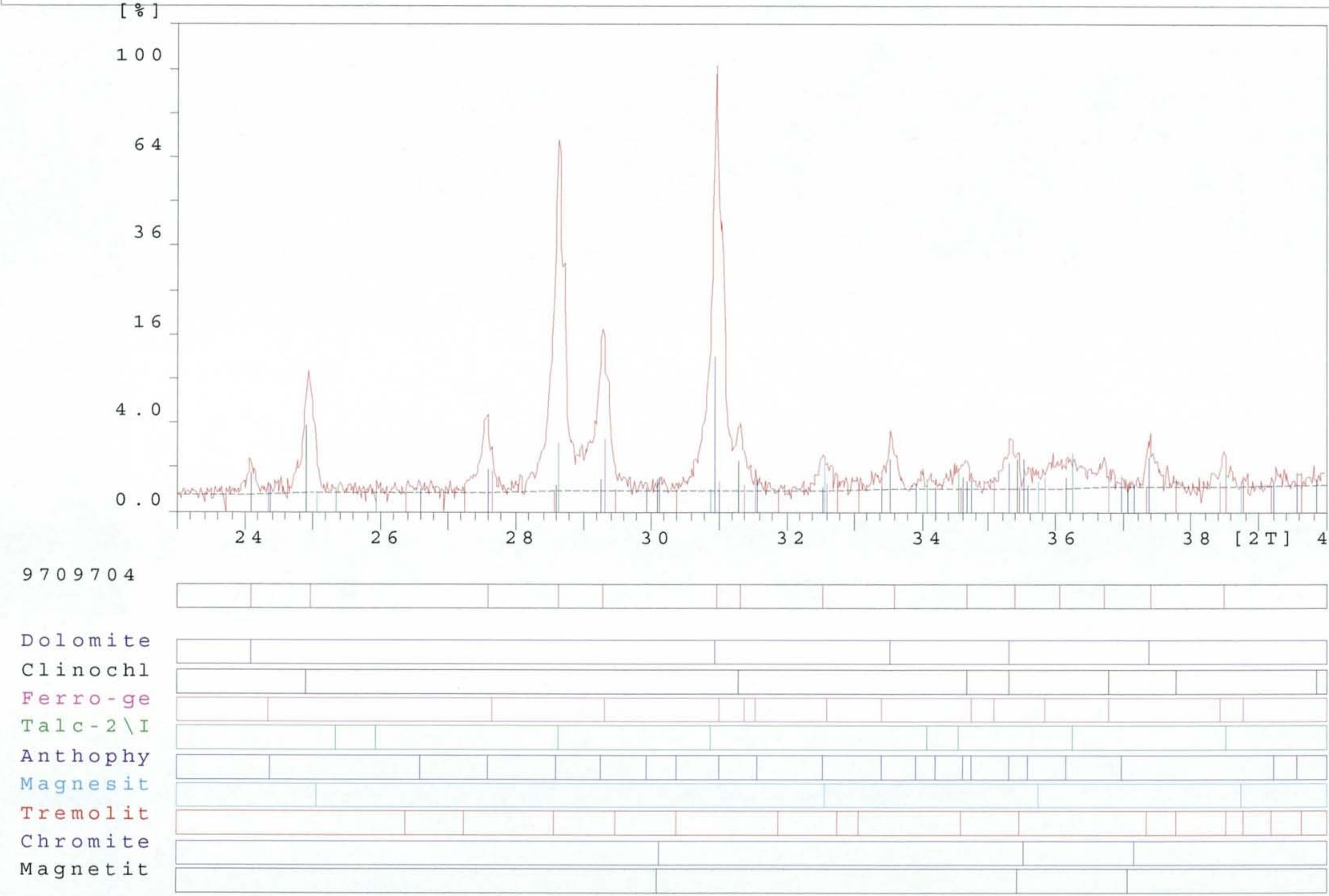
Number of strong lines of the
reference patterns used in SEARCH : 5
Intensity threshold : 3.02
Confidence threshold : 10
Minimum specimen displacement : -75
Maximum specimem displacement : 75
Step size in specimen displacement: 25

Restrictions file : MINERAL

	I	Card Id	#	Search score	Search displ	Match score	Rel m score	Conc	Displ	Formulas	Name
1	*	**29-0853**	**1**	**95**	**-75**	**13.64**	**0.52**	**1**	**-98**	**Mg5Al(Si3Al)O10(OH**	**Clinochlore-1\ITM#I#I#b\RG**
2		04-0452	1	58	0	4.11	0.51	4	34	BaF2	Frankdicksonite, syn
3		12-0267	1	40	-50	5.08	0.51	0	-23	(Zn,Fe,Mg)Al2O4	Gahnite (ferroan)
4		29-0704	1	63	75	3.46	0.49	3	109	(Mg,Mn,Fe,Zn)3(Si,	Baumite-1\ITT\RG [NR]
5		26-0527	1	79	50	4.32	0.48	3	77	Cu2FeGeS4	Briartite, syn
6		12-0185	1	65	-75	10.92	0.45	2	-102	(Mg,Fe,Al)6(Si,Cr)	Clinochlore
7		42-1335	1	63	-75	9.45	0.43	1	-98	(Zn5Al)(Si3Al)O10(	Baileychlore-1\ITM#I#b\RG
8		07-0217	1	48	75	4.90	0.41	1	74	K2SiF6	Hieratite, syn
9		22-0711	1	67	-50	8.88	0.40	3	-49	(Ni,Mg)3Si4O10(OH)	Willemseite
10		15-0734	1	57	50	5.03	0.36	1	55	3NaAlSiO4!NaOH	Cancrinite, syn
11		33-0332	1	45	-75	16.16	0.34	1	-94	CeNbO4	Fergusonite-á-(Ce), syn
12		33-0296	1	59	0	16.35	0.34	1	12	Ca11(SiO4)4O2S	Jasmundite
13		29-1236	1	58	50	8.16	0.34	1	66	Na2Mg3Fe2Si8O22(OH	Magnesioriebeckite
14		42-0565	1	50	50	5.37	0.34	1	38	Cu2FeGeS4	Briartite, syn
15		10-0391	1	40	75	9.39	0.34	1	56	Ca2MgSi2O7	Akermanite, syn
16		25-0285	1	46	50	3.67	0.33	1	80	Cu3(As,Sb)S4	Luzonite, antimonian
17		17-0214	1	54	-50	10.57	0.33	0	-16	ZnCa(OH)2SiO3	Clinohedrite
18		26-1115	1	53	-75	4.93	0.33	1	-59	CuSe2	Krutaite, syn
19		23-0302	1	50	75	8.54	0.33	1	109	(Fe,Mg,Mn)7Si8O22(	Dannemorite
20		29-0527	1	46	75	6.44	0.32	0	91	Cu2Al2(AsO4)2(OH)4	Luetheite
21	*	**08-0479**	**1**	**5000**	**0**	**4.16**	**0.32**	**0**	**134**	**MgCO3**	**Magnesite, syn**
22		10-0476	1	50	-50	4.47	0.32	0	-31	MnS2	Hauerite
23		43-1456	1	63	-75	8.62	0.32	3	-102	Na0.55Mn2O4!1.5H2O	Birnessite, syn
24		24-0053	1	56	25	7.93	0.32	1	13	Ba(NO3)2	Nitrobarite, syn
25		34-0166	1	53	0	23.39	0.32	0	-27	(Mg,Al)3(Si,Al)4O1	Vermiculite-2\ITM\RG
26		04-0773	1	52	0	5.05	0.32	1	10	Ba(NO3)2	Nitrobarite, syn
27		10-0183	1	58	75	7.24	0.31	0	91	(Mg,Al)6(Si,Al)4O1	Clinochlore-\IT2M#I#Ib\RG
28		27-0714	1	58	0	6.59	0.31	1	10	Na2(Fe,Al,Mg)5Si8O	Ferroglaucophane
29	*	**03-0881**	**1**	**40**	**-75**	**5.30**	**0.31**	**1**	**-59**	**Mg3Si4O10(OH)2**	**Talc**
30		24-0506	1	51	-75	15.38	0.31	0	-102	(Mg5Al)(Si,Al)4O10	Clinochlore-1\ITM#I#I#b\RG
31		27-0166	1	54	-50	1.84	0.31	1	-51	CuFe2S3	Isocubanite, syn
32		23-0301	1	53	75	3.05	0.30	1	63	(Fe,Mn)3Si2O5(OH)4	Greenalite
33		25-0546	1	46	75	7.56	0.30	1	98	Mn5Si4O10(OH)6	Bementite
34		27-1170	1	58	0	5.99	0.30	1	12	Fe5.5Mg1.5Si8O24H2	Grunerite, (Amosite)
35		13-0257	1	43	50	5.38	0.30	0	49	Mg3(OH)4Si2O5	Stevensite

	I	Card Id	#	Search score	Search displ	Match score	Rel m score	Conc	Displ	Formulas	Name
36	*	**16-0401**	**1**	**52**	**-25**	**7.01**	**0.29**	**0**	**-15**	**Mg7Si8O22(OH)2**	**Magnesioanthophyllite, syn**
37		11-0070	1	46	-75	8.15	0.29	0	-52	CaBSiO4(OH)	Datolite
38		35-0592	1	42	25	14.84	0.29	1	24	Ca2MgSi2O7	Akermanite, syn
39		24-0223	1	43	-75	5.81	0.29	1	-87	CaCl2	Hydrophilite [NR]
40		06-0358	1	42	50	2.60	0.29	1	84	CuGaS2	Gallite, syn
41		36-0383	1	5000	0	3.75	0.29	0	278	(Mg,Fe)CO3	Magnesite, ferroan
42	*	**13-0558**	**1**	**58**	**-75**	**7.45**	**0.29**	**1**	**-70**	**Mg3Si4O10(OH)2**	**Talc-2\ITM\RG**
43		29-0733	1	40	0	5.44	0.29	0	16	FeTiO3	Ilmenite, syn
44		06-0348	1	45	-25	9.37	0.28	1	-15	PbCO3-PbSO4-Cl-OH-	Wherryite
45		37-0447	1	88	25	19.47	0.28	3	9	Cu3(AsO4)(OH)3	Clinoclase
46		20-0386	1	52	50	5.64	0.28	0	49	Na3Mg4AlSi8O22(OH)	Eckermannite, syn
47		11-0556	1	52	75	10.60	0.28	1	74	(Ce,Ln,Y,Th)PO4	Monazite-(Ce)
48		17-0745	1	73	0	14.66	0.28	0	10	(Fe,Mg)7Si8O22(OH)	Grunerite
49		17-0725	1	61	75	14.09	0.28	0	80	(Fe0.9Mg0.1)7(OH)2	Grunerite
50		31-0631	1	61	75	14.05	0.28	0	80	(Fe0.9Mg0.1)7Si8O2	Grunerite
51	*	**11-0078**	**1**	**5000**	**0**	**6.05**	**0.27**	**0**	**296**	**CaMg(CO3)2**	**Dolomite**
52		09-0030	1	52	0	4.40	0.27	1	19	CaSn(OH)6	Burtite, syn
53		38-0465	1	58	25	24.45	0.27	0	30	Mn2(Fe,Mg)5Si8O22(	Dannemorite
54		13-0410	1	48	75	11.95	0.27	0	91	Ca4F2Si2O7	Cuspidine
55		25-0288	1	46	0	3.21	0.27	1	34	CuFeS2	Chalcopyrite
56		34-0136	1	41	-25	14.65	0.27	1	-44	MgAl2(PO4)2(OH)2	Lazulite
57		14-0215	1	58	-75	8.25	0.27	0	-80	(Ca,Sr)5((As,P)O4)	Fermorite
58		25-0456	1	57	75	8.96	0.26	0	70	Pb2Cu(SO4)(AsO4)(O	Arsentsumebite
59		41-1474	1	49	75	26.18	0.26	1	56	Ca4Si2O7F2	Cuspidine
60		09-0455	1	53	-75	9.41	0.26	0	-105	(Mg,Fe)7Si8O22(OH)	Anthophyllite
61		29-1422	1	58	75	9.37	0.26	1	76	(Zn,Cu)3(AsO4)2	Stranskiite
62		13-0506	1	55	-50	10.13	0.26	0	-77	(Fe,Mg,Al)7Al2Si6O	Gedrite
63		39-1356	1	43	50	13.72	0.26	1	49	Cu9Al(AsO4)2(SO4)1	Chalcophyllite
64		19-0629	1	5000	0	2.58	0.26	1	162	FeFe2O4	Magnetite, syn
65	*	**34-0140**	**1**	**5000**	**0**	**2.55**	**0.25**	**0**	**-108**	**FeCr2O4**	**Chromite, syn**
66		07-0391	1	43	-25	5.35	0.25	0	-44	(Na,Al,Ca,Fe)3Mn2(	Griphite
67		16-0154	1	40	-75	4.58	0.25	0	-59	Mn3O4	Hausmannite
68		26-1370	1	62	75	15.25	0.25	1	109	Na4(B5O7(OH)3)2!4H	Ezcurrite
69		36-0441	1	60	0	8.53	0.25	0	23	NaTa3O8	Natrotantite
70		17-0726	1	61	0	11.26	0.25	0	10	(Fe,Mg)7Si8O22(OH)	Cummingtonite
71		31-0636	1	61	0	11.26	0.25	0	10	(Fe,Mg)7Si8O22(OH)	Cummingtonite
72		29-0862	1	46	-75	5.75	0.25	0	-102	(Mg,Ni,Fe,Al)12Si6	Unnamed mineral [NR]
73		33-0654	1	40	25	12.64	0.25	1	41	(Fe,Mg)Al2(PO4)2(O	Scorzalite
74		14-0688	1	77	-75	9.84	0.25	1	-65	BiVO4	Clinobisvanite, syn
75		10-0398	1	51	-25	8.02	0.24	0	-37	(Y,Er)(Nb,Ta)2O6	Samarskite, heated
76		38-0475	1	44	50	20.96	0.24	1	45	NaMn6O12!3H2O	Todorokite
77		21-0553	1	58	-75	2.89	0.24	1	-63	(Mn,Ca)Mn5O11!4H2O	Todorokite
78		37-0471	1	46	-25	4.78	0.24	1	9	CuFeS2	Chalcopyrite
79		34-0188	1	46	-75	17.27	0.24	1	-94	ThSiO4	Huttonite, syn
80		12-0411	1	57	0	7.55	0.24	1	10	Ca2B6O9(OH)4!5H2O	Meyerhofferite
81		19-0751	1	52	-75	7.97	0.23	0	-102	Mg2Al3(Si3Al)O10(O	Sudoite-1\ITM#I#I#b\RG
82		38-0371	1	45	75	9.35	0.23	1	85	K3Ca28Zn4Al4Si40O1	Minehillite
83		20-1084	1	58	0	9.07	0.23	1	16	Na4B10.2O17.3!7H2O	Ezcurrite, syn
84		19-0231	1	42	-25	4.17	0.23	1	9	Ca4Fe2Si6O15(OH)6	Tungusite
85		39-0332	1	41	-75	11.56	0.23	1	-94	NaMn4Si5O14(OH)	Natronambulite
86		23-0218	1	43	-25	4.82	0.23	1	9	Pb4Cu(CO3)(SO4)2(O	Wherryite
87	*	**42-0544**	**1**	**5000**	**0**	**11.94**	**0.23**	**0**	**-100**	**Mg5Fe2Si8O22(OH)2**	**Anthophyllite**
88		42-0613	1	40	-50	4.58	0.23	0	-55	6Fe0.9S!5(Mg,Fe)(O	Tochilinite
89		21-0173	1	57	25	4.58	0.23	0	15	Ca2Y3Si3O12(OH)	Britholite-(Y)
90		31-0315	1	57	25	4.58	0.23	0	15	Ca2Y3Si3O12(OH)	Britholite-(Y)
91		12-0297	1	73	50	8.89	0.23	0	62	Cu3AsO4(OH)3	Clinoclase
92		29-0391	1	43	75	3.63	0.23	1	109	Ca2(UO2)3(PO4)2(OH	Phurcalite
93		38-0476	1	43	50	12.24	0.23	1	84	BaMn8O16	Hollandite
94		29-0308	1	51	-75	4.51	0.23	1	-65	Ca4Si2O6(CO3)(OH)2	Fukalite
95		33-0731	1	47	0	11.25	0.23	1	27	PbAl2(CO3)2(OH)4!H	Dundasite
96		40-0509	1	46	75	11.92	0.22	0	70	Na2Mn5FeAl(PO4)6	Bobfergusonite
97		41-1378	1	54	0	3.79	0.22	4	34	(Al,Li)MnO2(OH)2	Lithiophorite

Sample ident.: 19970097 pr.4 13-jun-1997 10:52

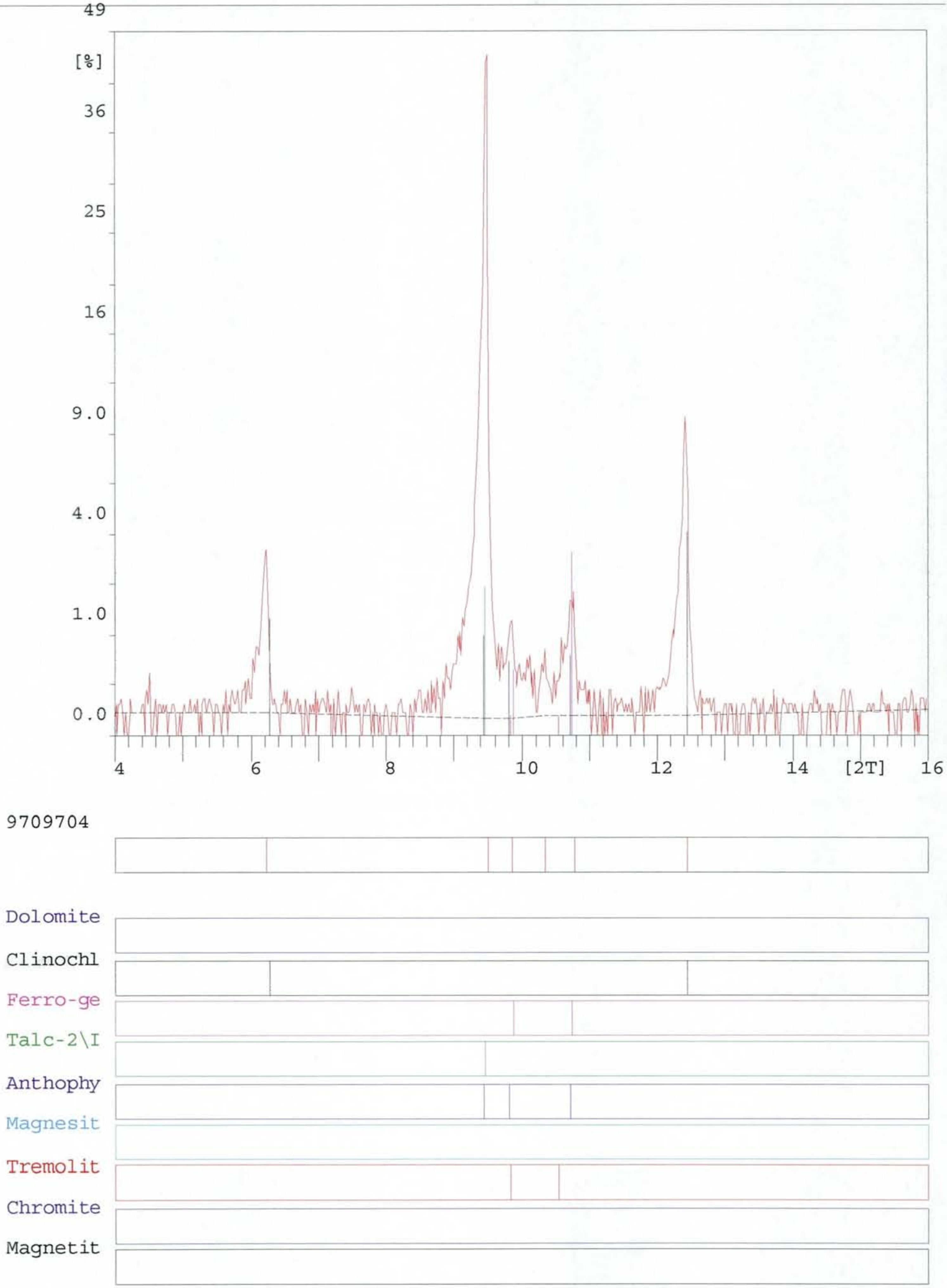


Vedlegg 1 side 1(3)

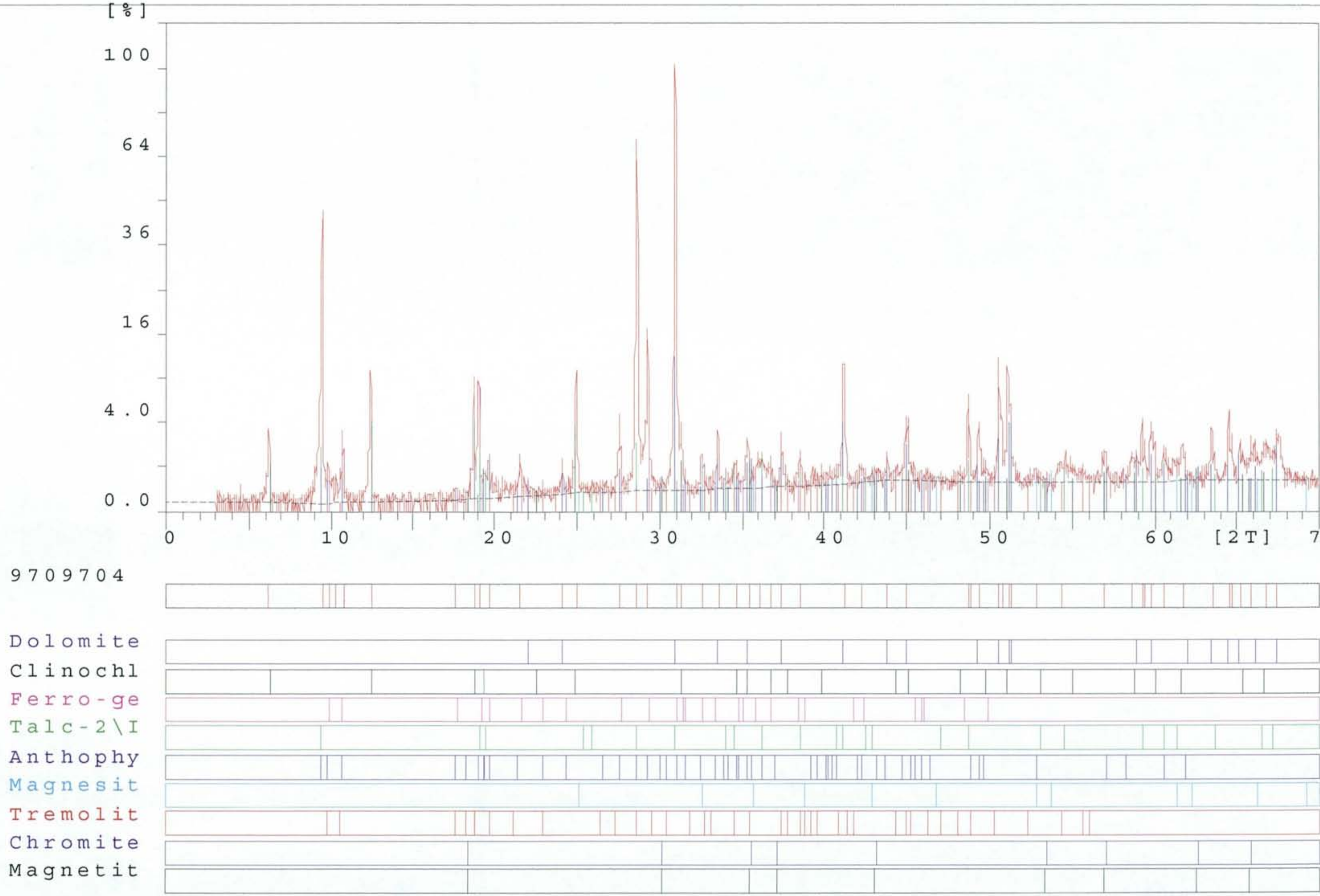
Vedlegg 1 side 2(3)

Sample ident.: 19970097 pr.4

13-jun-1997 10:56

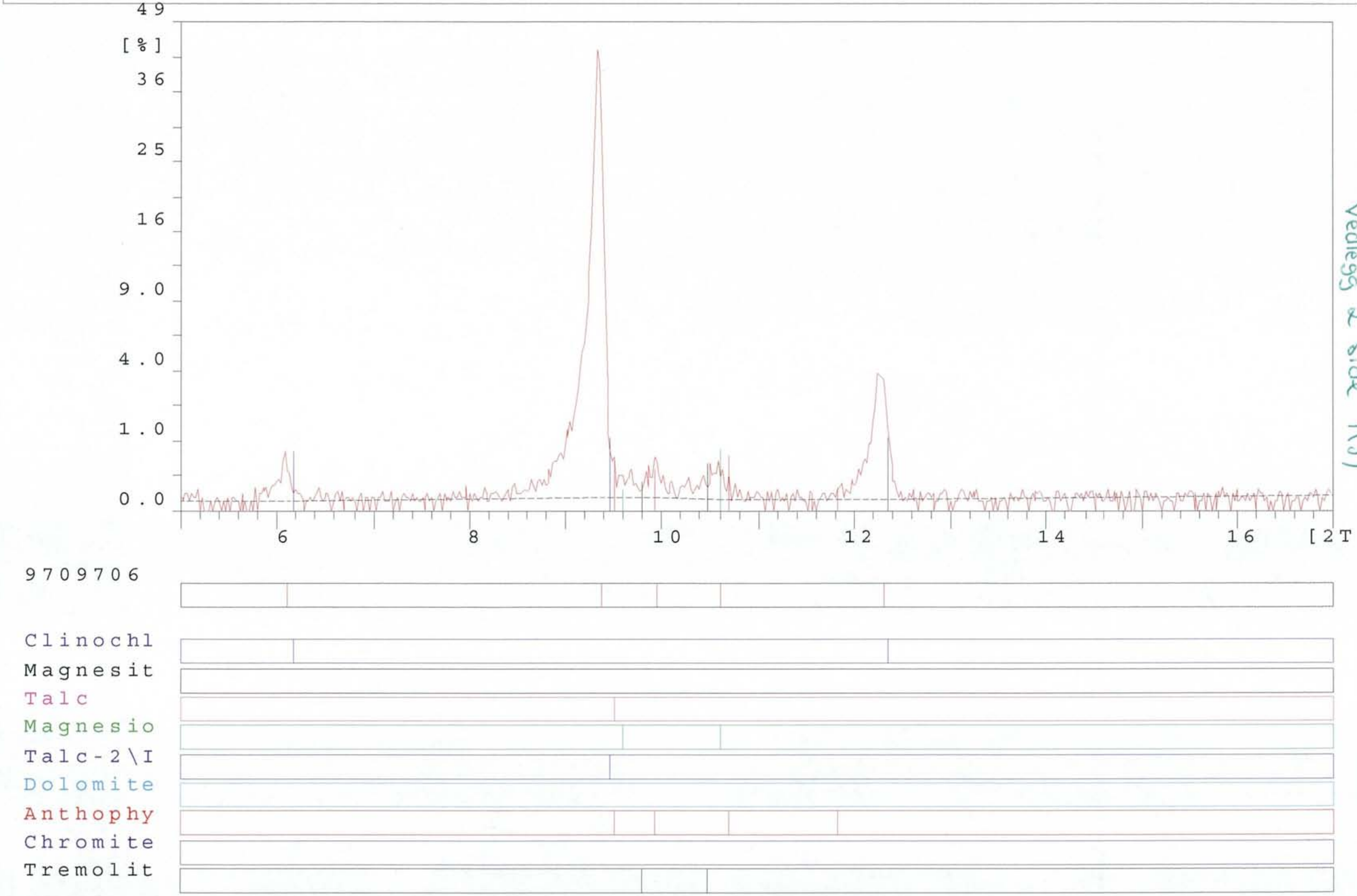


Sample ident.: 19970097 pr.4 13-jun-1997 10:58



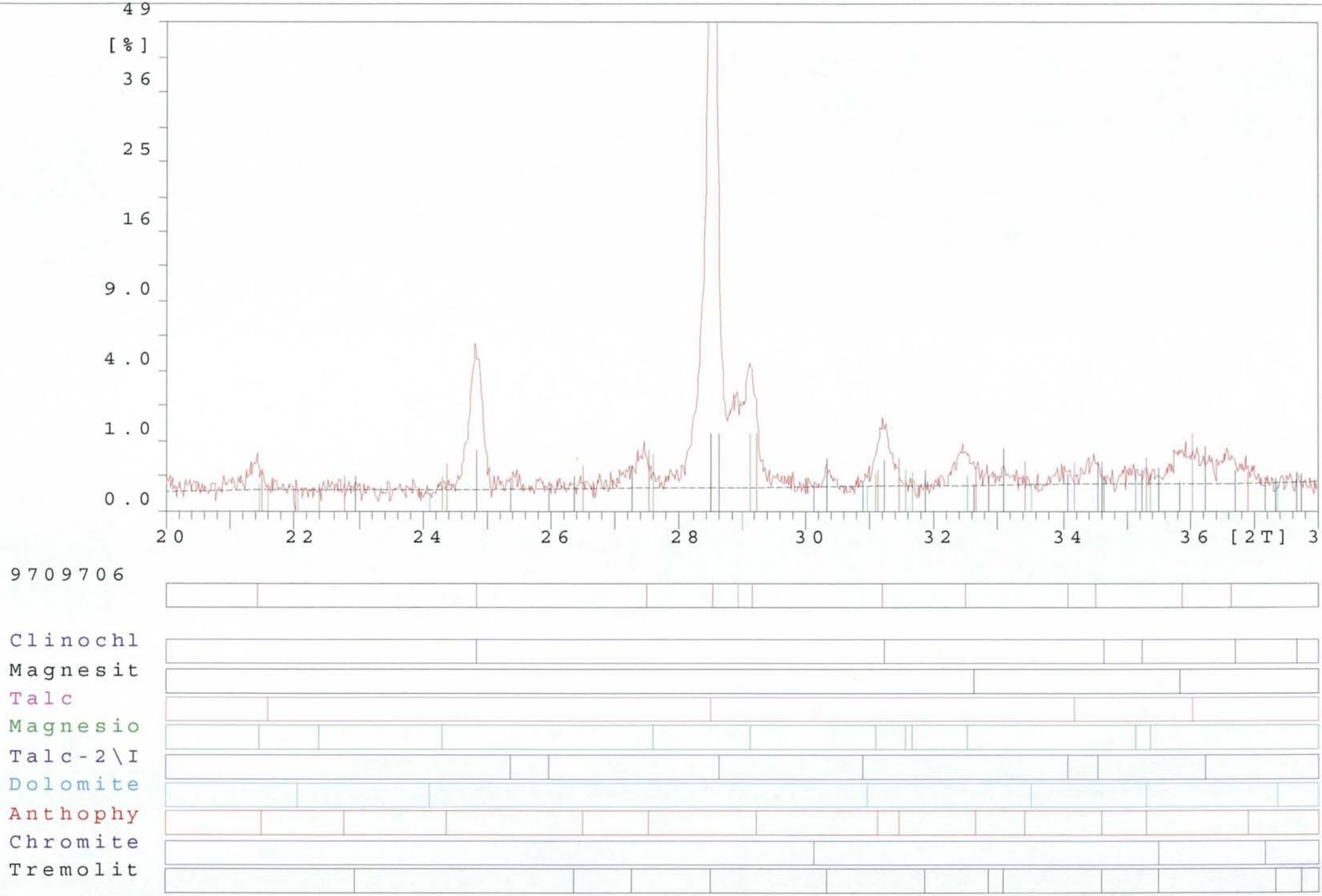
Vedlegg 1 side 3(3)

Sample ident.: 19970097 pr.6 16-jun-1997 12:00



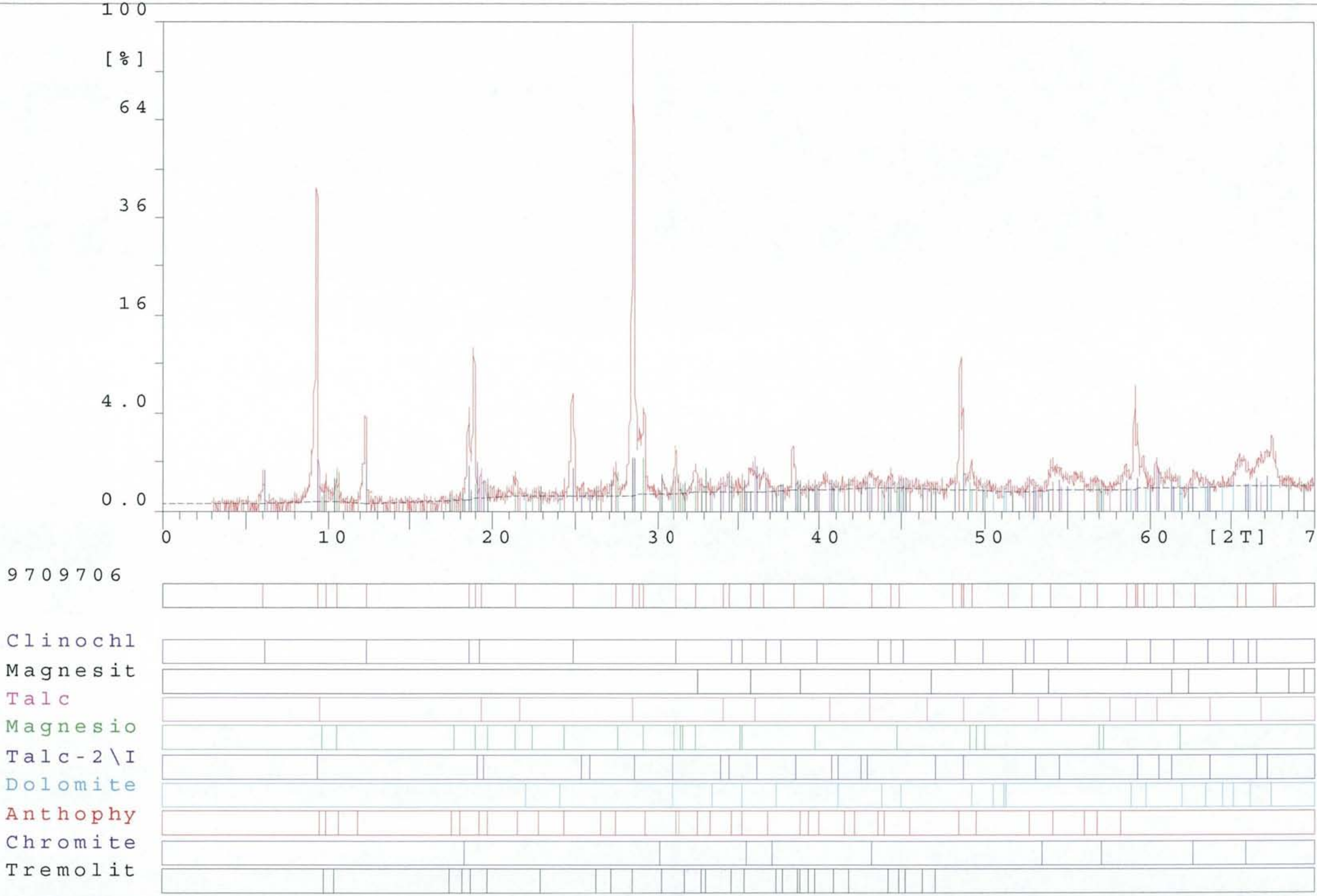
Vedlegg 2 side 1(3)

Sample ident.: 19970097 pr.6   16-jun-1997 12:03



Vedlegg 2 side 2(3)

Sample ident.: 19970097 pr.6 16-jun-1997 11:59



Vedlegg 2 side 3(3)