NGU-report no. 99.105

Chemistry and whiteness of talc-bearing rocks in Helgeland, northern Norway

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Report no.: 99.105	ISSN 0800-3416	Grading: ÅPEN

Title:
Chemistry and whiteness of talc-bearing rocks in Helgeland, northern Norway
Appendix to report 99.068.

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Client:
Norwegian Talc AS / NGU/ Nordlandsprogrammet

County:
Nordland

Commune:
Rana, Meløy, Rødøy, Misvær, Mosjøen.

Map-sheet name (M=1:250.000)
Mo i Rana, Mosjøen, Bodø

Map-sheet no. and -name (M=1:50.000)
Mo i Rana, Misvær 2029 II

Deposit name and grid-reference:

Number of pages: 9 Price (NOK): 30,-
Map enclosures:

Fieldwork carried out:	Date of report:	Project no.:	Person responsible:
Autumn 1998	04/10/99	281000	

Summary:

XRF-chemistry and whiteness for talc-bearing rocks reported in report 98.068 are described. The major element distributions are more or less typical for talc-carbonate assemblages. But some of the samples have higher CaO-content than normal, due to contents of tremolite/actinolite; some have low LOI due to sparse amounts of carbonates.

Concerning the minor element distribution, all the samples have typical ultramafic chemistry with elevated contents of Ni and Cr. In general, the samples have low contents of environmentally detrimental elements like Cd, Sn, Pb, U, Th and As.

The whiteness has been measured before and after magnetic separation. In general the whiteness-values are low. The low whiteness is not only caused by the natural colour, but also by weathering effects. Fresh samples have proven to be difficult to achieve without drilling. The maximum whiteness was measured at around 72%. A high quality talc product should normally have at least 76%.

Two deposits described in report 99.068 have received special attention. The *Kvanndalen deposit*, located just west of Altermark, which contains the assemblage talc-carbonate-olivine, contains a slightly higher amount of Fe_2O_3 than the Altermark talc due to higher amounts of magnetite. Whiteness was measured to be around 66-69%. However, analyses of the talc minerals alone by Norwegian Talc AS gave whiteness around 81-83%. Samples from the *Stolpelia deposit* in Misvær also gave whiteness around 69%. This deposit carries large amounts of chlorite, and therefore has high Al_2O_3 contents.

Keywords: industrimineraler	Røntgenfluorescens	
talk	hvithet	Fagrapport
ultramafitt		fagrapport

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INTRODUCTION

This report is a complementary report to report 99.068 "Status report on talc prospecting in Helgeland", and focuses on the whole rock chemistry (analysed by XRF) and whiteness of talc-bearing rocks described in this report. Numerous ultramafic bodies occur in nappes positioned around the basement windows at Høgtuva, Svartisen and Sjona. But common to all the bodies along the Helgeland coast, is that they contain very small amounts of talc, and instead contain olivine, pyroxene and amphibole. The explanation for this is that the grade of metamorhism increases from east to west and has been too high in the western areas to stabilise the common assemblage talc + carbonate, - an assemblage that is common in Altermark, just west of Mo i Rana. Despite the negative results in the coastal areas, a new deposit was detected that probably defines the westernmost limit of the "Altermark talc province". This deposit, which is termed the "Kvanndalen deposit" contains the assemblage talc-carbonate-olivine. Further north, at Misvær, the deposit termed the "Stolpelia deposit" proved to have an interesting mineralogical composition.

This report focuses on the XRF-chemistry and whiteness of some of the samples described in report 99.068. The reader is referred to that report for information on localities and description of the deposits.

INVESTIGATED SAMPLES

The investigated samples are shown in Table 1, together with results from microscopic composition (from Karlsen et al. 1999). Localities for the investigated samples are given by Karlsen et al. (1999).

From a mineralogical point of view, the samples from Bjørnålia can be disregarded as sources for talc primarily because of their low talc-content, but also because of high amphibole content. High amphibole content is also found in the samples from Leirskarddalen and from Druåsen in Misvær, and these samples are therefore of low interest only. The samples carrying the greatest interest are those from the Kvanndalen and Stolpelia deposist, as these are the only ones of commercial potential.

Table 1: Analysed samples of talc-bearing rocks with mineralogical composition (from Karlsen et al. 1999). n.a. = not analysed.

Sample	Deposit name	Talc	Carb.	Chlor.	Enstat.	Olivine	Amph.	Magn.	Sulph.	Serp
TAK 98_1a	Bjørnålia		3	35			60			
TAK 98_1c	Bjørnålia	5	5	45			45			
TAK 98_1d	Bjørnålia	5	5	60			30			
KvannK1G	Kvanndalen, K1	32.2	10.2	1.7		50		2.1		2.8
KvannK2F	Kvanndalen, K2	35	35	2		25		5		
KvannK2G	Kvanndalen, K2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Leir 1	Leirskarddalen	25	40	3			30		x	
Leir 2	Leirskarddalen	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
TAK 98_19	Esjeholmene	50	45	3				X		
Mis_tak	Stolpelia, Misvær	40	40	20					x	
Mi3_98	Druåsen, Misvær	40	10	30			20			
Mi4_98	Druåsen, Misvær	40	10	30			20			
Tro-talk	Tro	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

WHITENESS

The whiteness has been measured both before and after magnetic separation (Table 2). In general, the whiteness is rather low in all samples. In high quality talc products the whiteness should at least be 76%. A problem in talc-studies in Norway is that it is difficult to collect fresh samples, i.e. samples that have not been weathered. Ultramafic rocks have, in most cases, a brownish weathering surface due to leaching of iron, especially from carbonates and olivine. Of this reason the whiteness-numbers in Table 2 are considered to be too low.

Since the mineralogical study has shown that the deposits at Kvanndalen and Stolpelia are the only one of economic interest, possibly in addition to the deposit at Tro (not visited), comments are made only on these. The samples from Kvanndalen have whiteness values around 69 % after magnetic separation. This is too low for a possible product. However, another test on ore from this deposit was made in Altermark, giving a whiteness around 81 % on a sample where the non-talc-minerals had been removed (Table 3). The reason for this difference is that, in the samples studied at NGU, the olivine grains, as well as the carbonate, are somewhat weathered giving a brownish colour and low whiteness. The high whiteness of the pure talc-sample is coherent with the observations made in the field: the talc-crystals alone have high whiteness.

The sample from Stolpelia (Mis_TAK in Table 2) also have a whiteness around 69%. This is not surprisingly since the sample contains a large amount of chlorite (Table 1) which is a whiteness-reducing mineral in such ultramafic rocks. However, as shown in Table 2 the whiteness is rather similar before and after magnetic separation. This indicates that very small amounts of chlorite, if any at all, have been removed during magnetic separation. It might be that the whiteness would be increased significantly if the intensity of the magnets were increased sufficiently to remove chlorite.

CHEMISTRY

The studied samples show, in general, trace element chemistry typical for ultramafic rocks; they all carry abundant Ni and Cr (Table 4). Otherwise, the samples have low contents of typical environmentally detrimental elements such as Cd, Sn, Pb, U, Th and As. Deviation from this trend is recorded in 1) sample Leirskardd 1, where 36 ppm As has been measured, and in 2) TAK98_1d, where some few ppm of U were measured. All samples are low in S, due to low contents of sulphides.
When it comes to the major element distribution the variations are much higher, reflecting the different mineralogical composition of the samples. The LOI level is high in those samples that carry high amounts of carbonates, the Ca-content is high in those samples that carry tremolite/actinolite (amphibole), and the Al_2O_3-content is high in those samples carrying high amounts of chlorite (Tables 4 & 1).

For the most promising deposits, Kvanndalen and Stolpelia, the following comments are made:
Kvanndalen samples: the chemistry is not very different than what is common for talc-carbonate samples from the Altermark area (Karlsen 1995). The only difference is a higher content of Fe_2O_3 (Table 4), probably reflecting the higher content of magnetite (up to 5%) found in these samples (Table 1). The content of olivine in the Kvanndalen samples is not reflected in the chemical data.
The Stolpelia sample ("Mis_tak"): shows an elevated content of Al_2O_3 due to its relatively high content of chlorite (Table 1). A somewhat high Ca-content is caused by traces of dolomite. Otherwise, the chemistry is rather similar to talc-carbonate rocks from Altermark (Karlsen 1995).

Table 2: Whiteness of talc bearing rocks. The grain size, which is an important factor in whiteness measurements, has not been measured, but standard procedures at the NGU-laboratory have been followed.

Sample	Filter	Whiteness % - before magnet-sep.	Whiteness % - after magnet-sep.
TAK98_1	FMX	37.4	36.8
	FMY	38.0	37.3
	FMZ	34.5	33.7
	R457	34.5	33.8
TAK98_1 c	FMX	37.4	36.8
	FMY	38.0	37.3
	FMZ	34.5	33.7
	R457	34.5	33.8
TAK98_1 d	FMX	51.0	51.1
	FMY	51.3	51.4
	FMZ	48.3	48.2
	R457	48.3	48.3
Kvann K1G	FMX	67.9	69.1
	FMY	67.9	69.0
	FMZ	65.6	66.2
	R457	65.7	66.3
Kvann K2F	FMX	59.7	66.7
	FMY	59.7	66.5
	FMZ	58.8	64.5
	R457	58.9	64.6
Kvann K1G	FMX	63.8	67.9
	FMY	63.9	67.9
	FMZ	63.6	66.7
	R457	63.6	66.8
TAK98_19	FMX	69.7	71.2
	FMY	69.7	71.2
	FMZ	68.1	69.1
	R457	68.2	69.2
Mi_3_98	FMX	47.0	47.2
	FMY	47.4	47.5
	FMZ	47.5	47.6
	R457	47.6	47.7
Mi_4_98	FMX	47.0	47.2
	FMY	47.4	47.5
	FMZ	47.5	47.6
	R457	47.6	47.7
Mis_TAK	FMX	69.8	69.0
	FMY	69.9	69.1
	FMZ	67.2	66.2
	R457	67.3	66.3
Leirsk 1	FMX	73.1	71.4
	FMY	72.7	71.0
	FMZ	68.8	67.0
	R457	68.9	67.1
Leirsk 2	FMX	75.8	75.5
	FMY	73.6	73.3
	FMZ	61.0	60.7
	R457	61.1	60.9
Tro_talk	FMX	69.9	72.6
	FMY	70.1	72.7
	FMZ	69.9	72.0
	R457	70.0	72.1

Table 3: XRF-analyses of talc-related rocks from Helgeland. All numbers are given as weight %. Mag.sep. = magnetically separated.

Sample	Magnetite-content (%)	X	Y	Z
1: K2, Kvanndalen (pure talc)	12.5%	64.8 81.2 (mag.sep.)	65.1 80.9 (mag.sep.)	65.4 78.9 (mag.sep.)
2: K2, Kvanndalen	22.1%	62.1 77.5 (mag.sep.)	62.4 77.3 (mag.sep.)	62.7 75.1 (mag.sep.)

CONCLUSION

1. The studied samples of talc-bearing rocks all have chemical compositions typical for talc rocks derived from ultramafites.
2. The trace element distribution in the deposits is encouraging, as regards the low contents of harmful elements.
3. Whiteness measurements gave low values (up to around 72%), but most of the samples are probably contaminated by a weathering-related brownish colour.

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Table 4: XRF-analyses of talc-related rocks from Helgeland. All numbers are given as weight %.

Sample	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	MgO	CaO	Na_2O	K_2O	MnO	P_2O_5	LOI	Sum
Leirsk 1	50.76	1.19	7.10	0.01	30.53	1.06	<0.10	<0.01	0.09	0.02	9.83	100.60
Leirsk 2	34.90	0.62	5.49	<0.01	33.12	3.63	<0.10	<0.01	0.09	0.03	22.78	100.70
Kvann K 1	40.03	0.93	5.61	<0.01	34.98	0.09	<0.10	<0.01	0.06	<0.01	17.89	99.60
Kvann K1 grov	33.57	0.28	10.96	0.01	34.67	0.10	<0.10	<0.01	0.09	<0.01	19.12	98.82
Kvann K2f	21.30	0.17	10.46	0.02	37.34	0.16	<0.10	<0.01	0.17	<0.01	29.16	98.77
Mi-3-98	42.16	3.33	8.64	0.15	39.73	0.18	<0.10	<0.01	0.20	0.02	5.30	99.76
Mi-4-98	43.93	2.93	8.91	0.16	35.92	0.48	<0.10	0.01	0.14	0.05	5.82	98.42
TAK 98-1	39.97	11.52	12.36	1.11	20.92	6.94	0.58	0.66	0.17	0.20	5.78	100.21
TAK 98-1c	41.12	8.57	12.53	1.15	22.24	6.22	0.20	0.85	0.19	0.24	6.40	99.70
TAK 98-1d	45.84	18.86	7.92	1.13	9.56	10.28	3.04	0.11	0.12	0.21	3.04	100.11
TAK 98-19	29.95	0.42	6.51	0.01	36.33	0.07	<0.10	<0.01	0.11	<0.01	26.28	99.74
Mis-TAK	34.68	2.80	7.19	0.11	30.30	3.87	<0.10	<0.01	0.15	0.03	20.11	99.23
Tro-talk	31.59	0.36	7.16	<0.01	34.20	1.54	<0.10	<0.01	0.11	0.02	23.57	98.57

Sample	Mo	Nb	Zr	Y	Sr	Rb	U	Th	Pb	Cr	V	As
Leirsk 1	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.1952	0.0039	0.0036
Leirsk 2	<0.0005	<0.0005	0.0006	<0.0005	0.0025	<0.0005	<0.0010	<0.0010	<0.0010	0.0805	0.0025	<0.0010
Kvann K1	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.3809	0.0023	<0.0010
Kvann K1 grov	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.2107	0.0022	<0.0010
Kvann K2f	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.5267	0.0022	<0.0010
Mi-3-98	<0.0005	<0.0005	0.0011	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.2798	0.0058	<0.0010
Mi-4-98	<0.0005	<0.0005	0.0009	0.0006	0.0011	<0.0005	<0.0010	<0.0010	<0.0010	0.2381	0.0052	<0.0010
TAK 98-1	<0.0005	0.0009	0.0088	0.0010	0.0101	0.0014	<0.0010	<0.0010	<0.0010	0.1080	0.0124	<0.0010
TAK 98-1c	<0.0005	0.0011	0.0099	0.0014	0.0193	0.0019	<0.0010	<0.0010	<0.0010	0.1600	0.0129	<0.0010
TAK 98-1d	<0.0005	0.0008	0.0098	0.0016	0.0828	<0.0005	0.0013	<0.0010	<0.0010	0.0173	0.0106	<0.0010
TAK 98-19	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.3831	0.0013	<0.0010
Mis-TAK	<0.0005	<0.0005	0.0011	<0.0005	0.0390	<0.0005	0.0010	<0.0010	<0.0010	0.2056	0.0048	<0.0010
Tro talk	<0.0005	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0010	<0.0010	<0.0010	0.2226	0.0023	<0.0010

Sample	Sc	S	Cl	F	Ba	Sb	Sn	Cd	Ag	Ga	Zn	Cu
Leirsk 1	0.0011	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0029	<0.0005
Leirsk 2	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0015	<0.0005
Kvann K1	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0024	<0.0005
Kvann K1 grov	0.0010	<0.10	<0.10	<0.10	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0031	<0.0005
Kvann K2f	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0012	0.0030	<0.0005
Mi-3-98	<0.0010	<0.10	<0.10	<0.10	0.0012	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0048	0.0051
Mi-4-98	<0.0010	<0.10	<0.10	<0.10	0.0015	<0.0010	<0.0010	<0.0010	<0.0010	0.0013	0.0042	0.0103
TAK 98-1	0.0020	<0.10	<0.10	0.12	0.0106	<0.0010	<0.0010	<0.0010	<0.0010	0.0011	0.0080	0.0016
TAK 98-1c	0.0025	<0.10	<0.10	<0.10	0.0116	<0.0010	<0.0010	<0.0010	<0.0010	0.0017	0.0079	0.0092
TAK 98-1d	0.0015	<0.10	<0.10	<0.10	0.0050	<0.0010	<0.0010	<0.0010	<0.0010	0.0018	0.0045	0.0044
TAK 98-19	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0022	<0.0005
Mis-TAK	<0.0010	<0.10	<0.10	<0.10	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0069	0.0012
Tro-talk	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0029	<0.0005

Sample	Ni	Yb	Co	Ce	La	Nd	W
Leirsk 1	0.1485	<0.0010	0.0075	0.0013	<0.0010	<0.0010	<0.0030
Leirsk 2	0.1040	<0.0010	0.0083	<0.0010	<0.0010	<0.0010	<0.0030
Kvann K1	0.0929	<0.0010	0.0072	<0.0010	<0.0010	<0.0010	<0.0030
Kvann K1 grov	0.1180	<0.0010	0.0141	0.0025	<0.0010	<0.0010	<0.0030
Kvann K2f	0.1552	<0.0010	0.0125	0.0029	<0.0010	<0.0010	<0.0030
Mi-3-98	0.1672	<0.0010	0.0108	0.0018	<0.0010	<0.0010	<0.0030
Mi-4-98	0.1374	<0.0010	0.0094	0.0015	<0.0010	<0.0010	<0.0030
TAK 98-1	0.0611	<0.0010	0.0100	0.0047	<0.0010	<0.0010	<0.0030
TAK 98-1c	0.0838	<0.0010	0.0098	0.0036	0.0016	<0.0010	<0.0030
TAK 98-1d	0.0205	<0.0010	0.0052	<0.0010	<0.0010	<0.0010	<0.0030
TAK 98-19	0.1306	<0.0010	0.0127	0.0011	<0.0010	<0.0010	<0.0030
Mis-TAK	0.1581	<0.0010	0.0083	<0.0010	<0.0010	<0.0010	<0.0030
Tro-talk	0.1634	<0.0010	0.0094	<0.0010	<0.0010	<0.0010	<0.0030