Characterisation of raw material for Norwegian Talc AS
NGU-report no. 98.153

NGU
Norges geologiske undersøkelse
Geological Survey of Norway

Geological Survey of Norway
P.O.Box 3006 - Lade
N-7002 Trondheim, Norway
Tel.: 47 73 90 40 11
Telefax 47 73 92 16 20

REPORT

Report no.: 98.153	ISSN 0800-3416	Grading: Open

Title:
Characterisation of rock samples for Norwegian Talc AS

Authors: Tor Arne Karlsen & Lars Petter Nilsson	Client: Norwegian Talc AS
County:	Commune:
Map-sheet name (M=1:250.000)	Map-sheet no. and -name (M=1:50.000)
Deposit name and grid-reference:	Number of pages: Price (NOK): Map enclosures:

Fieldwork carried out:	Date of report: 14.12.1998	Project no.: 263113	Person responsible: Nigel Cl

Summary:

Rock samples of talc and dolomite have been characterised in terms of their chemistry and mineralogy (only reconnaisance study) on commision for Norwegian Talc AS. Impurities of apatite, amphibole, quartz and minor sulfides have been found in some of the foreign talc samples, while magnetite/chromite, chlorite and minor sulfides have been detected as impurities in Norwegian talc raw material. The dolomite sample is found to be very pure, although minor amounts of apatite and traces of mica exist. The results of the analyses have restricted value and are only guidelines for further work. Reconnaisance investigation on a single sample from each of the different deposits is insufficient because 1) important minerals might be missed and 2) variations in mineralogy and mineral chemistry are not taken into account.

Keywords: Dolomitt	Talk	Industrimineraler
		Fagrapport

CONTENTS

INTRODUCTION

A reconnaisance characterisation on rock samples has been carried out on commision for Norwegian Talc AS. Microscopy and, to a limited extent, electron microprobe have been used in addition to XRF chemical analyses and wet chemical analyses. More detailed analyses can be carried out should more detailed information be required.

CHEMISTRY

The theoretical composition of pure dolomite is as follows:
MgO: 21.86%
CaO: 30.41%
CO_2: 47.73%

Deposits of dolomite may have excess of CaO or MgO. The ratio CaO/MgO is normally in the range 1.4 - 1.7.

The chemistry of the Løgavlen dolomite (Table 1) has a CaO/MgO ratio of 1.26, which is rather low. This low ratio is caused by a rather high content of MgO, as well as a low content of calcite. Since the dolomite sample is found to be rather pure, the chemistry of the rock and the chemistry of individual grains (Table 2) should be comparable. However, the chemistry of two analysed grains have CaO/MgO ratios around 1.9. Too few analyses have been carried out to explain this discrepancy.

If the rock carried large amounts of calcite, this would give a high CaO/MgO ratio, - much higher than the present analysis.

The talc rock from Altermark shows high LOI (loss of ignition) due to its high content of carbonate (around 30-45 %). The high Fe_2O_3 number is caused by contents of magnetite, chlorite and Fe in the crystal lattice of talc. The values of Ni and Cr is much higher than those from the pure talc rocks from Egypt, Korea and China. Ni occurs partly in sulfides (pyrrhotite, pentlandite) and partly within the crystal lattice of talc. Cr_2O_3 occurs primarily within magnetite/Fe-chromite, but to some extent also within chlorite.

The talc rocks from Egypt, Korea and China have rather similar chemistry, and close to that of the mineral talc. The composition of the mineral talc is variable, but common SiO_2-content is in the range 60 - 63 %, while LOI is between 4.7 and 5.4%.

A somewhat high content of Al_2O_3 in the Egyptian and Korean talc might indicate the presence of chlorite or amphibole, but Al_2O_3 could also be sited within the crystal lattice of talc (not analysed). Amphibole has been identified by microscopy in the Korean talc (Fig. 8). The Ba-content is anomalously high in the Egyptian talc. The reason for this has not been clearified by certainty during the present work, but some very small grains that occur as inclusions within phosphates might be baryte ($BaSO_4$).

MINERALOGY

Løgavlen dolomite

Observed minerals: dolomite, apatite, mica.

This is a relatively coarse-grained and homogenous rock containing almost only dolomite. The crystals are well developed, i.e. idioblastic (Fig. 1). Some few grains of apatite occur mainly as inclusions within the dolomite. Based on the content of P_2O_5 in the rock (Table 1) < 0.01% apatite is present in the rock. One small mica-crystal is observed. Quartz has not been identified.

Altermark talc

Observed minerals: talc, carbonate (major minerals), chlorite, magnetite/chromite, sulfides (pyrrhotite + pentlandite + minor chalcopyrite).

The rock is relatively coarse-grained (Fig. 2) with approximately about equal amounts of talc and carbonate, both with well developed crystals.

Talc (50-55 %) occurs primarily as parallel oriented coarse flakes, but in small amounts as more fine-grained inclusions within carbonate grains.

Carbonate (40-45 %) occurs as large aggregates or as smaller single grains with more well-developed crystal shape. The aggregates and some of the single grains contain inclusions of fine-grained magnetite. The carbonates are mainly of the type breunnerite, while poorer magnesite is present in the cores of some of the aggregates.

Magnetite (3 %) occurs as small grains as clouds of inclusions within carbonate, and as larger single grains with well developed crystal shape in the matrix (Fig. 3). In addition, magnetite is present as disseminations along talc-cleavage planes (Fig. 4).

Accessories (< 1 %):

Chlorite is hardly observed along a few talc boundaries. Antigorite is hardly seen as inclusions within the core of large carbonates. Sulfides occur as shattered small grains, mainly within carbonates. To a much lesser extent sulfides occur as disseminated grains along talc cleavage planes. Pyrrothite is the most common sulfide, while pentlandite occurs to some lesser extent. Many of the sulfide grains contain lamellae of pentlandite within pyrrhotite. Chalcopyrite is observed in one grain together with pyrrhotite and pentlandite (Fig. 5). One small grain which is possibly sperrylite ($PtAs_2$), was detected.

Chinese talc (IT)

Observed minerals: talc, apatite.

Talc (>95%), which dominates the thin section (Fig. 6), occurs with two different grain sizes.
Apatite (ca. 0.1%, based on chemical data) is observed as a few hexagonal grains.

Egyptian talc

Observed minerals: talc, apatite, magnetite, sulfide, sylvine, gypsum/anhydrite, noble metal phase (?), baryte (?).

Talc (>98-99%) occurs primarily as very small grains in aggregates, surrounded by somewhat larger grains. Together, these two grain sizes define a mosaic texture (Fig. 7).
Apatite occur as small hexagonal crystals. The chemical content of 0.06% P_2O_5 calculates to approximately 0.1 % apatite.
Accesories:
Some very few grains of secondary magnetite and sulfides are observed, but in only neglible amounts. One grain is found to be zoned with a yellowish core and a bluish-greyish rim with well developed crystal shape, possibly represents a noble metal phase. The salt sylvine (KCl) (Fig. 12) also occurs in very small (neglible !) amounts, as does gypsum/anhydrite «desert-rose» (Fig. 11). Baryte was probably found as small inclusions within apatite.

Korean talc

Observed minerals: talc, amphibole, quartz, magnetite, sphene.

Talc (95%)
Amphibole (4-5%) as relatively coarse grains, concentrated in veins/aggregates (Fig. 8, 9).
Quartz (< 1%) occurs as small grains together with amphibole.
Accesories:
Magnetite occurs as a secondary mineral with well developed crystal shape. A few very small sulfide grains is observed whose identity has not been determined. Sphene is observed (Fig. 13), and is probably the cause of the content of 0.06% TiO_2 in the sample.

Chinese talc (WT)

Observed minerals: talc, sulfide.

Talc, makes up almost 100 % of the thin section (Fig. 10). One single large hexagonal sulfide grain is observed.

SUMMARY

A reconnaissance study of raw material for Norwegian Talc AS has been made. The most important observations are as follows:

- The dolomite sample from Løgavlen is very pure
- The Korean talc sample contains small amunts of quartz, and some amphibole and sphene
- The Chinese talc IT & WT contain almost only talc
- In the Egyptian talc sample several minerals are found, but in very small amounts: apatite, magnetite, sulfides, KCl (sylvine), gypsum/anhydrite. From XRF-data, an anomalous content of Ba is observed.
- The Altermark Talc sample is rich in the carbonate breunnerite, and contains also chlorite and magnetite as rock forming minerals. In addition, sulfides are present in very small amounts.

Detailed microscopic study of a representative suite of samples from each deposit / source should be accompanied by electron probe micro-analyses to detect all minerals present, give a chemical identity to each and also quantify their respective contents in the samples.

Table 1: XRF chemical data of the raw material. Contents given in Wt-%.

Ref. no	Sample name	SiO2 %	Al2O3 %	Fe2O3 %	TiO2 %	MgO %	CaO %	Na2O %	K2O %	MnO %	P2O5 %	LOI %	Sum %
1	Løgavlen dol	<0.01	<0.01	0.09	<0.004	23.87	30.16	<0.10	0.006	0.004	0.04	46.81	100.98
2	Altermark talk	36.11	0.24	7.63	0.010	33.32	0.16	<0.10	<0.01	0.110	<0.01	21.89	99.45
3	Kinesisk talk (IT)	58.94	<0.01	<0.01	<0.01	32.34	0.86	<0.10	<0.01	<0.01	0.06	6.79	98.98
4	Egyptisk talk	59.56	0.68	0.13	<0.01	31.83	0.40	<0.10	<0.01	0.020	0.08	5.59	98.29
5	Koreansk talk	60.91	0.92	0.79	0.060	30.86	0.06	<0.10	<0.01	0.020	0.02	4.97	98.59
6	Kinesisk talk (WT)	59.26	0.04	0.04	<0.01	32.23	0.41	<0.10	<0.01	<0.01	0.02	6.70	98.72

Ref. no	Sample name	Ba %	Sb %	Sn %	Cd %	Ag %	Ga %	Zn %	Cu %	Ni %	Yb %	Co %	Ce %
1	Løgavlen dol	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010
2	Altermark talk	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0019	<0.0005	0.1348	<0.0010	0.0112	<0.0010
3	Kinesisk talk (IT)	<0.0010	0.0015	<0.0010	<0.0010	<0.0010	<0.0010	<0.0005	<0.0005	0.0006	<0.0010	<0.0010	<0.0010
4	Egyptisk talk	0.0991	0.0018	<0.0010	<0.0010	<0.0010	<0.0010	0.0189	0.0060	0.0008	<0.0010	<0.0010	<0.0010
5	Koreansk talk	<0.0010	0.0013	<0.0010	<0.0010	<0.0010	<0.0010	0.0007	<0.0005	0.0005	<0.0010	<0.0010	<0.0010
6	Kinesisk talk (WT)	0.0027	0.0015	<0.0010	<0.0010	<0.0010	<0.0010	<0.0005	0.0006	0.0006	<0.0010	<0.0010	<0.0010

Ref. no	Sample name	La %	Nd %	W %	Mo %	Nb %	Zr %	Y %	Sr %	Rb %	U %	Th %	Pb %
1	Løgavlen dol	<0.0010	<0.0010	<0.0030	<0.0005	<0.0005	<0.0005	<0.0005	0.0055	<0.0005	0.0046	<0.0010	<0.0010
2	Altermark talk	<0.0010	<0.0010	<0.0030	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010
3	Kinesisk talk (IT)	<0.0010	<0.0010	0.0036	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0012	<0.0010	<0.0010
4	Egyptisk talk	<0.0010	<0.0010	0.0036	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0010	<0.0010	0.0045
5	Koreansk talk	<0.0010	<0.0010	<0.0030	<0.0005	<0.0005	0.0131	0.0006	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010
6	Kinesisk talk (WT)	<0.0010	<0.0010	0.0037	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010

Ref. no	Sample name	Cr %	V %	As %	Sc %	S %	Cl %	F %
1	Løgavlen dol	<0.0005	0.0010	<0.0010	0.0010	<0.10	<0.10	0.30
2	Altermark talk	0.2036	0.0013	<0.0010	0.0011	<0.10	<0.10	<0.10
3	Kinesisk talk (IT)	<0.0005	<0.0005	<0.0010	<0.0010	<0.10	<0.10	<0.10
4	Egyptisk talk	<0.0005	0.0019	<0.0010	<0.0010	<0.10	<0.10	0.32
5	Koreansk talk	<0.0005	<0.0005	<0.0010	<0.0010	<0.10	<0.10	0.18
6	Kinesisk talk (WT)	<0.0005	0.0006	<0.0010	<0.0010	<0.10	<0.10	<0.10

Table 2: EDS-electron microprobe analyses. N.a. = not analysed.

	Lø Dol_1	Lø Dol_2	Lø Dol_3	AT	IT_1	IT_2	Egy_1
	wt %	wt %	wt %	wt %	wt %	wt %	wt %
SiO2	0.00	0.03	0.00	0.14	70.31	69.73	0.23
TiO2	0.69	0.00	0.00	0.05	0.00	0.00	0.00
Al2O3	0.00	0.17	0.00	6.37	0.14	0.04	0.00
Fe2O3	1.58	0.17	0.00	38.19	0.00	0.00	0.00
MnO	0.00	0.09	0.00	0.59	0.00	0.14	0.26
MgO	32.94	34.86	0.00	0.95	29.32	30.14	0.01
CaO	64.80	63.62	59.51	0.21	0.00	0.00	59.07
Na2O	0.00	0.17	0.00	0.07	0.22	0.14	0.06
K2O	0.14	0.08	0.02	0.08	0.25	0.03	0.10
P2O5	0.00	0.24	40.74	0.00	0.03	0.03	39.72
SO3	0.12	0.00	0.00	0.00	0.00	0.03	0.17
Cr2O3	0.00	0.00	0.00	53.61	0.00	0.00	0.04
CuO	0.00	0.85	0.00	0.00	0.00	0.00	0.62
Cl	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SUM	100.27	100.28	100.27	100.26	100.27	100.28	100.28
	Dol	Dol	Apatite	Fe_Crom	Talc	Talc	Apatite

	Egy_1	Egy_2	Egy_3	Egy_4	Kor_1	Kor_2	Kor_3
	wt %	wt %	wt %	wt %	wt %	wt %	wt %
SiO2	0.23	0.17	46.35	12.30	28.32	99.29	45.35
TiO2	0.00	0.17	0.06	0.00	40.25	0.00	0.00
Al2O3	0.00	0.00	0.00	0.68	1.73	0.00	23.18
Fe2O3	0.00	0.23	0.27	3.64	0.40	0.00	8.69
MnO	0.26	0.00	0.89	1.82	0.00	0.00	0.00
MgO	0.01	0.00	18.09	1.13	0.03	0.12	3.29
CaO	59.07	57.88	0.64	37.24	29.25	0.00	19.19
Na2O	0.06	0.13	0.86	1.07	0.00	0.13	0.00
K2O	0.10	0.09	19.29	1.36	0.00	0.00	0.00
P2O5	39.72	40.27	0.06	39.75	0.11	0.17	0.00
SO3	0.17	0.26	0.35	0.05	0.10	0.23	0.28
Cr2O3	0.04	0.13	0.00	0.27	0.09	0.34	0.00
CuO	0.62	0.94	0.51	0.95	0.00	0.00	0.28
Cl	n.a.	n.a.	12.88	n.a.	n.a.	n.a.	n.a.
SUM	100.28	100.27	100.25	100.26	100.28	100.28	100.26
	Apatite	Apatite	Sylvine	Gypsum	Sphene	Quartz	Hybrid

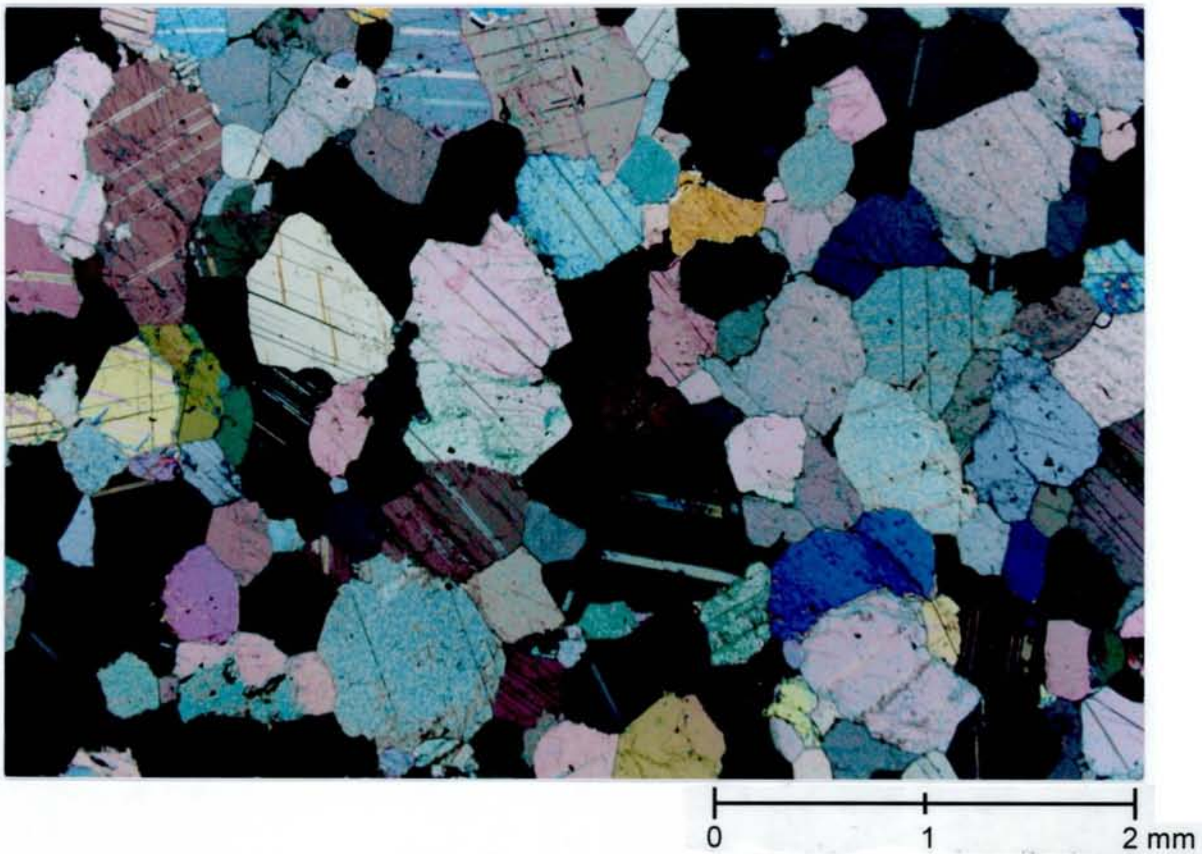

Figure 1: Photomicrograph of the Løgaven dolomite. The sample is very pure and contains almost only idioblatic dolomite. X-nicols.

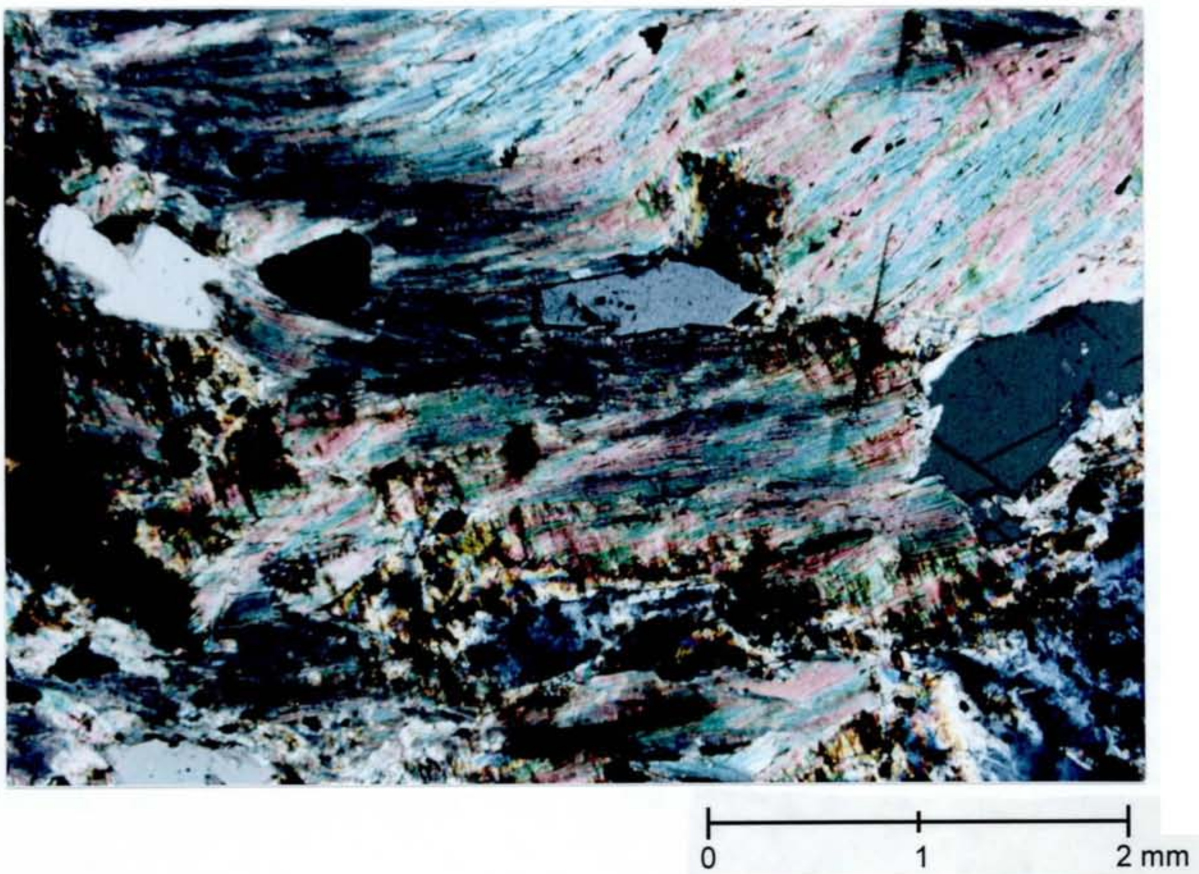

Figure 2: Microphoto of talc-carbonate from Altermark. X-nicols.

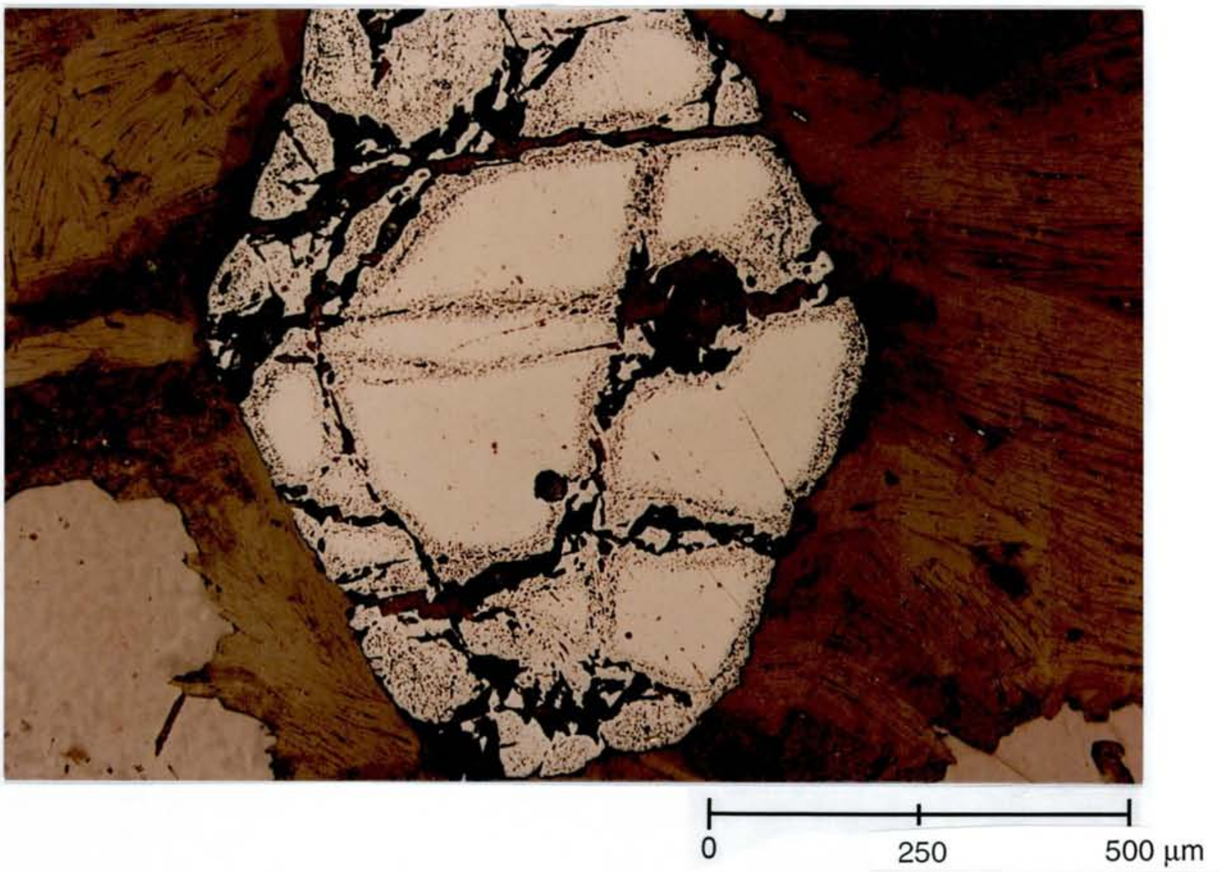

Figure 3: Microphoto of idioblastic ferrit-chromite with textural zoning (inclusions along the rim). Altermark talc. II-nicols.

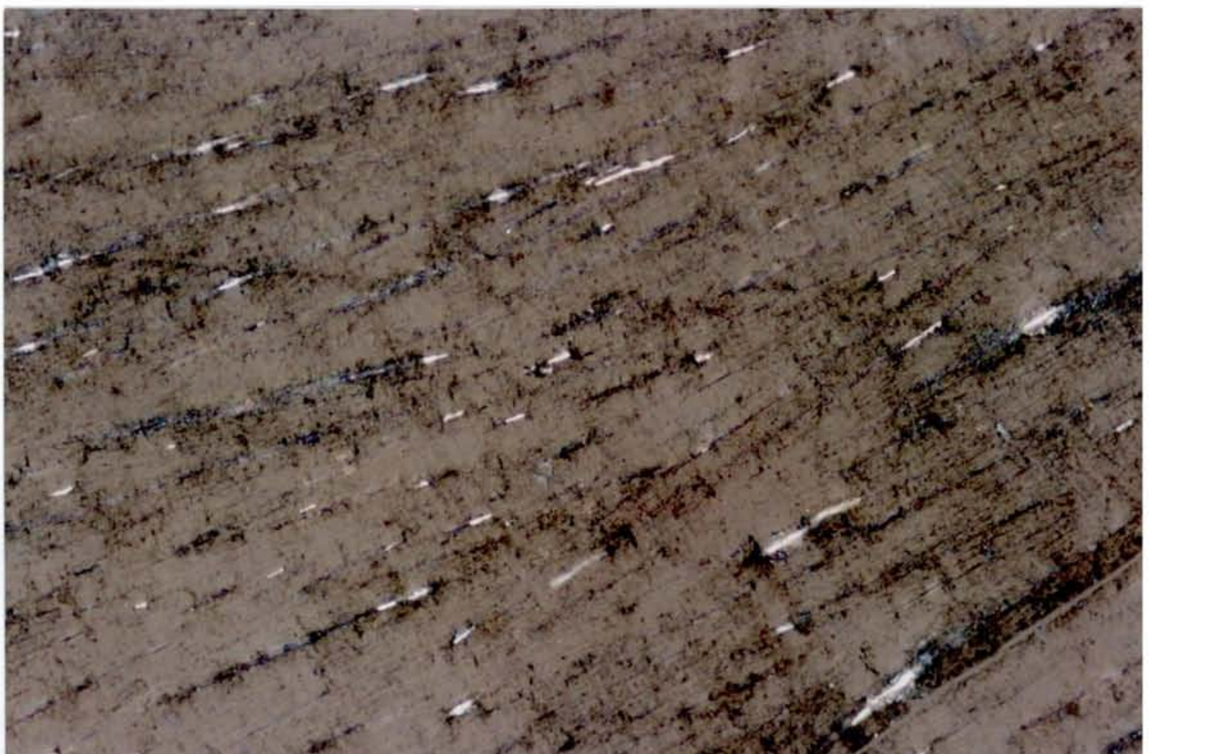

Figure 4: Microphoto of magnetite grown along talc-lamellae. This occurrence is also quite common for pyrrhotite. Altermark talc. II-nicols.

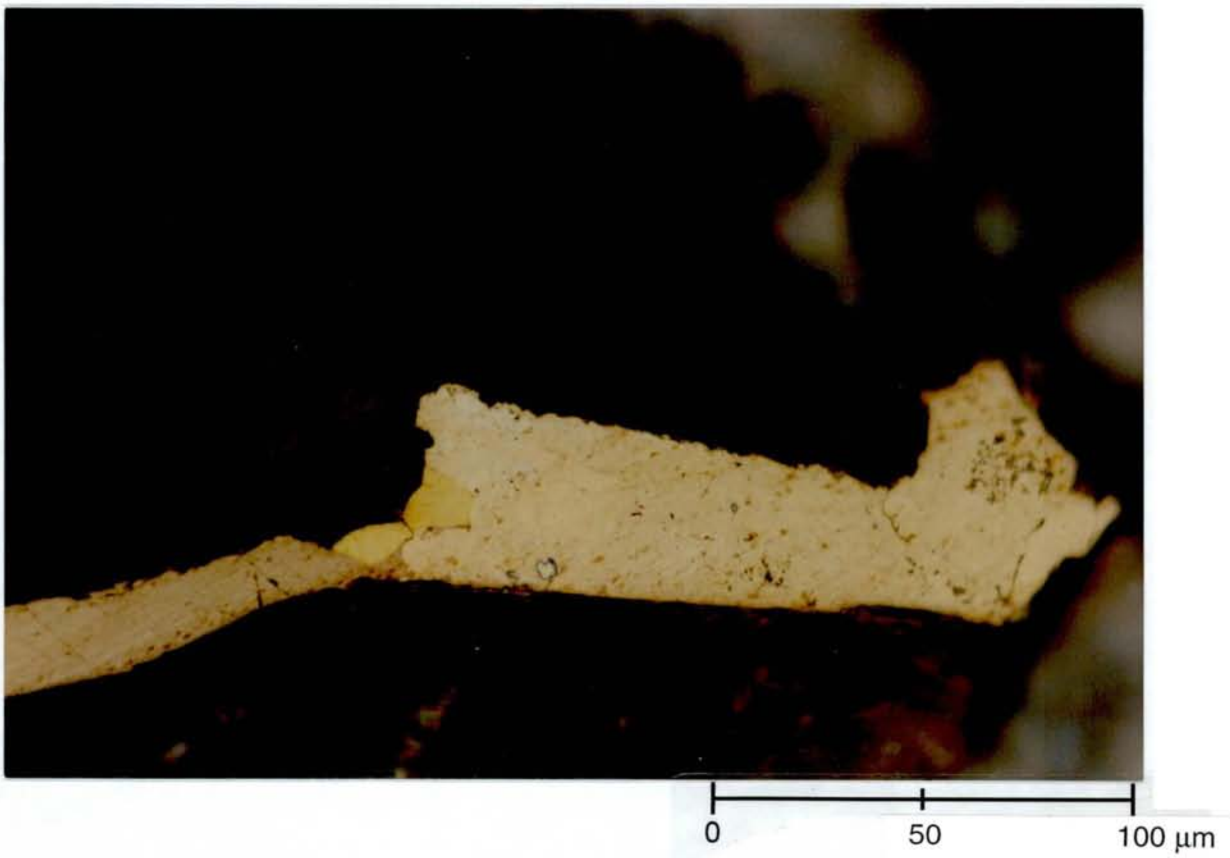

Figure 5: Microphoto of a sulfide grain carrying three different phases. Altermark talc. Yellow grains in the middle: chalcopyrite, brownish grain to the left: pyrrhotite. Large yellow-brownish grain to the right: pentlandite. II-nicols.

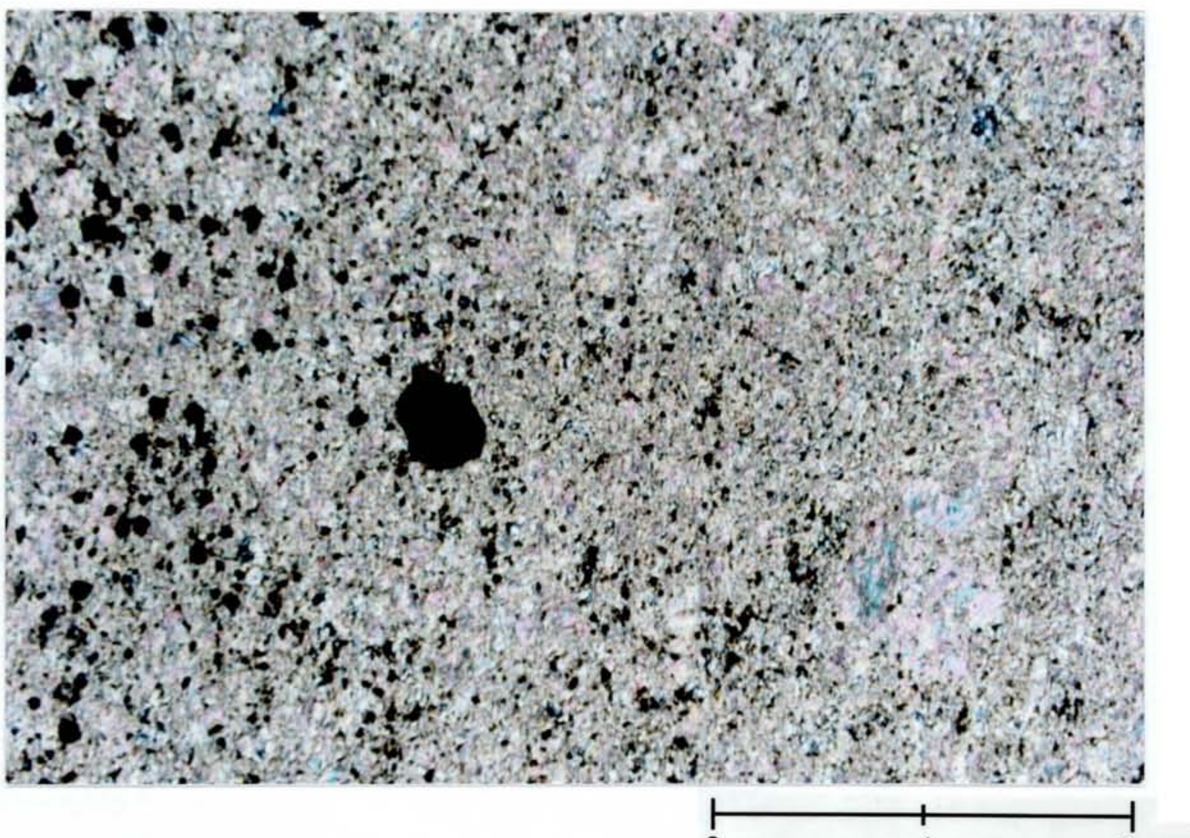

Figure 6: Microphoto of Chinese talc IT. The black dots are preparation errors, and not minerals. X-nicols.

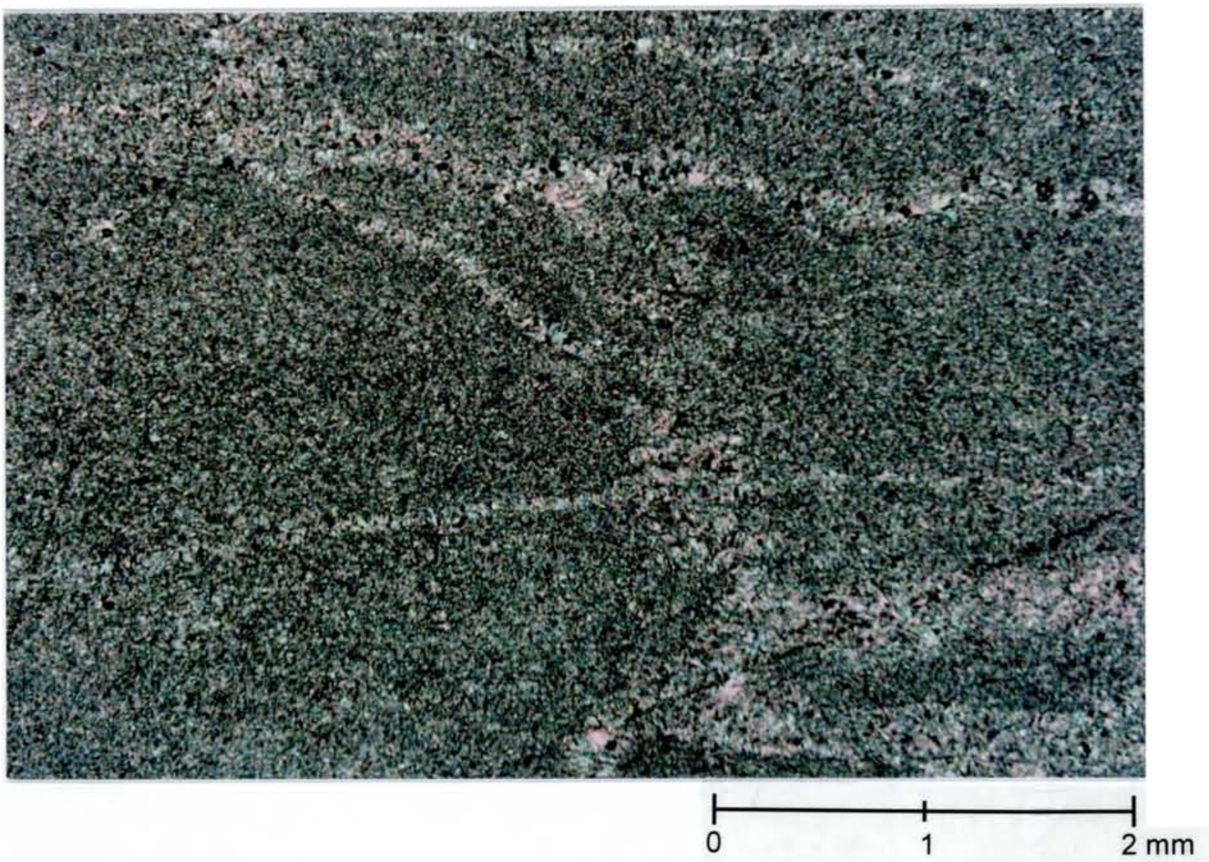

Figure 7: Microphoto of Egyptian talc. X-nicols.

Figure 8: Microphoto of Korean talc showing amphibole (purple, brownish) surrounded by talc. The uppermost black «vein» is a preparation error and not a mineral. X-nicols.

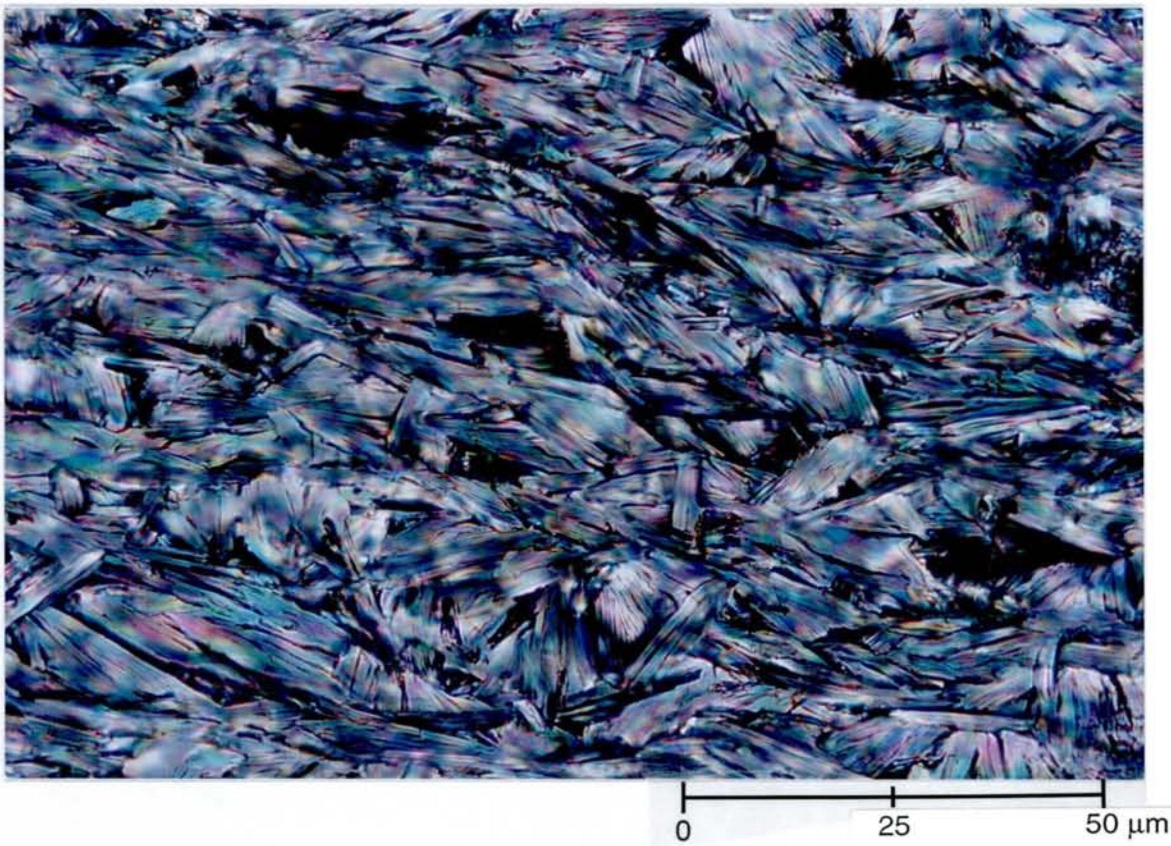

Figure 9: Close up view of talc from the Korean sample. The talc grains define an interpenetrating texture. X-nicols.

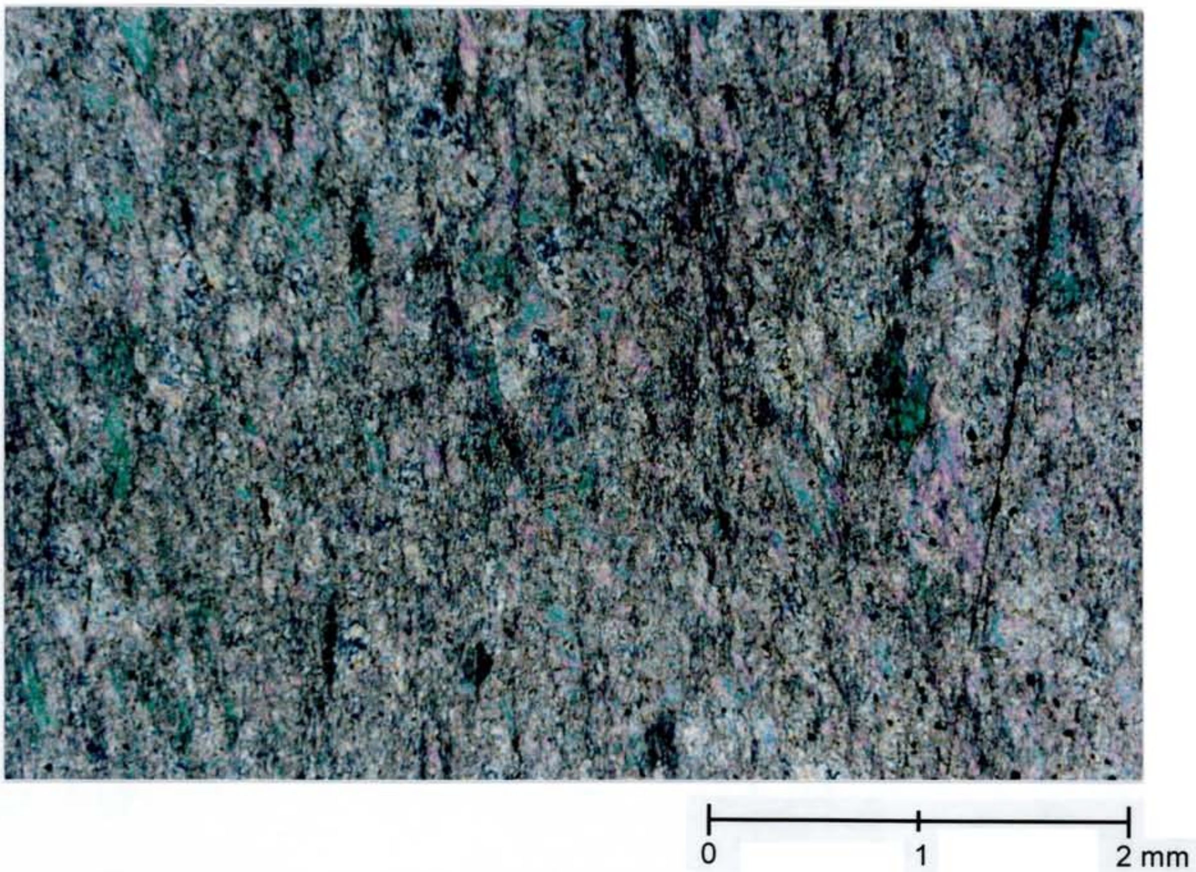

Figure 10: Photomicrograph of Chinese Talc WT.

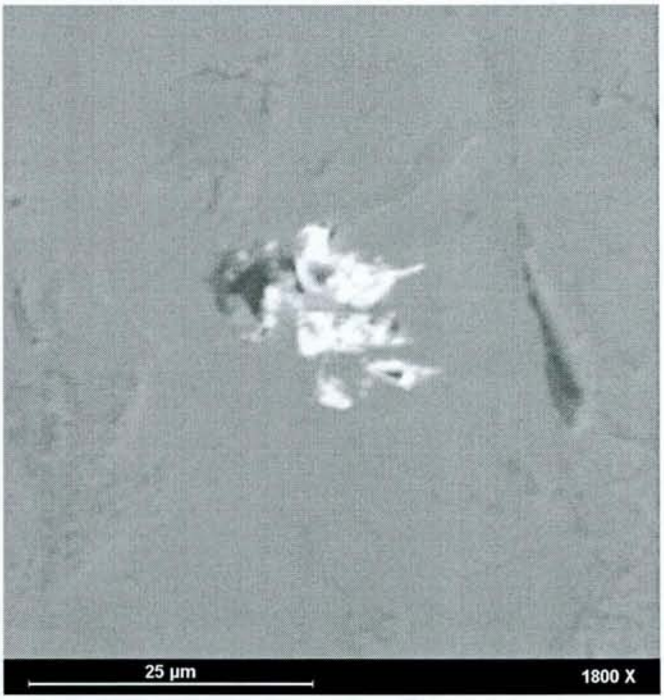

Figure 11: Desert rose of gypsum/anhydrite made by evaporation. Egyptian talc. Backscattered electron image.

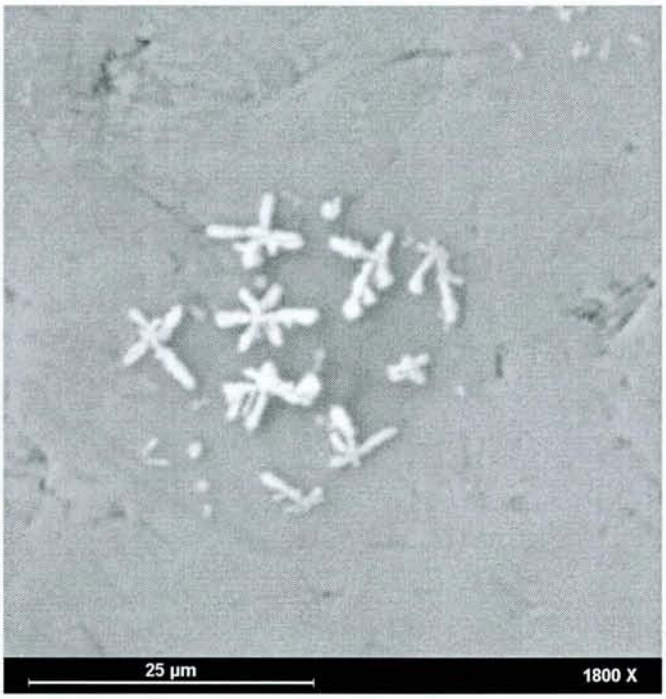

Figure 12: Crystals of sylvine (light-coloured) formed by evaporation. Egyptian talc. Backscattered electron image.

Figure 13: Sphene (light-coloured) situated in talc, amphibole and quartz in the Korean talc rock. Backscattered electron image.