Characterisation of products from beneficiation test.

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REPORT

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Title:
Characterisation of products from beneficiation test.

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Summary:

Chemical characterisation of flotation test material have been carried out on commision for Norwegian Talc AS. Comments on the chemistry with respect to the mineralogical content and to content of toxic elements are made.

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INTRODUCTION

A chemical characterisation by XRF on flotation test material from the Altermark deposit in Altermark has been carried out on commision by Norwegian Talc AS. In addition, wet chemical analyses of Se and Hg have been done. A number of comments on the chemistry are given.

COMMENTS ON THE CHEMISTRY

The results of XRF-analyses and wet-chemical analyses of Se and Hg are given in Table 1 & 2.

Most of the elements regarded as toxic have very low concentrations or are below detection level. The content of Ni is not possible to remove because it is sited in the crystal lattice of talc, substituting for Mg/Fe. The content of Cr is difficult to remove because it is sited in the crystal lattice of chlorite, in addition to that in spinels which is generally are removed by processing.

The general formula for the mineral talc is as follows:

$Mg_6[Si_8O_{20}](OH)_4$

Substitutions:
For Mg: Fe^{2+}, Fe^{3+}, Ni^{2+}, Mn^{2+}, Al
For Si: Al, Ti

In addition Ca and alkalis may substitute for Mg, but are more commonly sited between the layers in the sheet structure.

In ultramafic rocks, Fe and Ni is quite common, as in the Altermark talc. By comparing typical talc, - chlorite and - carbonate compositions from Altermark (see Appendix 1) with the XRF-data on flotation products it is possible to calculate the approximate amounts of chlorite, talc and carbonates (Table 3). The chemistry of these minerals are however, similar to other minerals in the rock, very variable in chemistry. In the talc lattice there are large variations in the Mg/Fe ratio and the content of Ni, while the Mg-carbonates show a wide big variation in the Mg/Fe ratio.

The method used for the estimation is as follows:

1. Chlorite is estimated based on the Al_2O_3 content
2. Talc is estimated based in the rest SiO_2 content
3. Carbonate is estimated based on the loss of ignition (LOI)

The error sources for this approximation are as follows:

1. Al_2O_3 occurs primarily within chlorite, but in low amounts also in chromite, serpentine and in amphibole when it is occasionally present.
2. The magnitude of LOI depends on the type of carbonate present. In the present calculations, breunnerite, which is the dominant carbonate, has been used. In the breunnerite the LOI value depends on the relationship between Fe and Mg in the structure.
3. Chlorites have different contents of Al_2O_3 depending on the location in the talc ore; the Al_2O_3 content is, in general, high in the external parts of the ore, and low in internal parts of the ore close to serpeninites. In the present calculation the external type of chlorite has been used.

Based on these formulae and the chemical table of the products the general mineralogical contents can be estimated (Table 3).

From Table 3 we can see that the sum is low for some of the products. This is so because they contain other minerals than chlorite, talc and carbonate. First of all, magnetite is significant, e.g. the Pin-mill product, which is the starting material, contains relatively much magnetite. The talc content has been increased to around 95 % in two of the final products, Talc-conc 2, Talc-conc 2 prod 2. In the same products the chlorite content has been lowered, and has probably led to higher whiteness values.
The rest-products contain high amounts of talc, and should be regarded as potential products.

The sulfide concentrate from ultramafic rocks is also a potential by-product (or main product). The sulfides from Nakkan contain a high proportion of pyrrhotite and are therefore of limited economic value. However, more analytical work using microscope/microprobe should be carried out to investigate this more properly. Such a study could be a part of a general study where the aim is to characterise mineralogically the different products in the flotation test.

Table 1: XRF-analyses of flotation products.

Ref	Sample	SiO2 %	Al2O3 %	Fe2O3 %	TiO2 %	MgO %	CaO %	Na2O %	K2O %	MnO %	P2O5 %	LOI %	Sum %
7	Pin mill product	34.32	0.41	6.38	0.010	34.18	0.78	<0.10	<0.01	0.110	<0.01	22.57	98.75
8	Non-magnetic	47.87	0.41	3.82	<0.01	32.35	0.76	<0.10	<0.01	0.050	<0.01	13.82	99.09
9	Talc-conc 1	56.83	0.20	3.03	<0.01	31.02	0.25	<0.10	<0.01	0.020	<0.01	7.50	98.87
10	Talc-conc 2, pr 2	59.21	0.08	2.69	<0.01	30.73	0.20	<0.10	<0.01	0.010	<0.01	6.01	98.97
11	Rest 1	33.27	0.76	5.13	<0.01	34.31	1.68	<0.10	<0.01	0.110	0.01	23.89	99.23
12	Rest 2	50.36	0.40	3.63	<0.01	31.88	0.83	<0.10	<0.01	0.040	<0.01	11.87	99.09
13	Rest 2, pr 2	54.32	0.24	3.22	<0.01	32.13	0.45	<0.10	<0.01	0.030	<0.01	9.45	99.84
14	Talc-conc 2	59.63	0.11	2.68	0.010	31.08	0.14	<0.10	<0.01	0.010	<0.01	5.56	99.22

		Mo %	Nb %	Zr %	Y %	Sr %	Rb %	U %	Th %	Pb %	Cr %	V %	As %
7	Pin mill product	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0010	<0.0010	<0.0010	0.2078	0.0014	<0.0010
8	Non-magnetic	<0.0005	<0.0005	<0.0005	<0.0005	0.0009	<0.0005	0.0010	<0.0010	<0.0010	0.0663	0.0006	<0.0010
9	Talc-conc 1	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.0364	0.0005	<0.0010
10	Talc-conc 2, pr 2	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.0178	<0.0005	<0.0010
11	Rest 1	<0.0005	<0.0005	<0.0005	<0.0005	0.0023	<0.0005	<0.0010	<0.0010	<0.0010	0.1205	0.0007	<0.0010
12	Rest 2	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0010	<0.0010	<0.0010	0.0671	0.0008	<0.0010
13	Rest 2, pr 2	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.0440	<0.0005	<0.0010
14	Talc-conc 2	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0010	<0.0010	<0.0010	0.0216	<0.0005	<0.0010

		Sc %	S %	Cl %	F %	Ba %	Sb %	Sn %	Cd %	Ag %	Ga %	Zn %	Cu %
7	Pin mill product	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0029	0.0021
8	Non-magnetic	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0027	0.0024
9	Talc-conc 1	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0028	0.0013
10	Talc-conc 2, pr 2	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0031	0.0009
11	Rest 1	0.0011	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0032	0.0040
12	Rest 2	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0036	0.0022
13	Rest 2, pr 2	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0045	0.0019
14	Talc-conc 2	<0.0010	<0.10	<0.10	<0.10	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0030	0.0009

		Ni %	Yb %	Co %	Ce %	La %	Nd %	W %
7	Pin mill product	0.1456	<0.0010	0.0085	<0.0010	<0.0010	<0.0010	<0.0030
8	Non-magnetic	0.1555	<0.0010	0.0073	<0.0010	<0.0010	<0.0010	<0.0030
9	Talc-conc 1	0.1465	<0.0010	0.0064	<0.0010	<0.0010	<0.0010	<0.0030
10	Talc-conc 2, pr 2	0.1393	<0.0010	0.0060	<0.0010	<0.0010	<0.0010	<0.0030
11	Rest 1	0.1713	<0.0010	0.0091	<0.0010	<0.0010	<0.0010	<0.0030
12	Rest 2	0.1561	<0.0010	0.0074	<0.0010	<0.0010	<0.0010	<0.0030
13	Rest 2, prod 2	0.1463	0.0013	0.0068	<0.0010	<0.0010	<0.0010	<0.0030
14	Talc-conc 2	0.1415	<0.0010	0.0060	<0.0010	<0.0010	<0.0010	<0.0030

Table 2: Wet-chemical analyses of Se and Hg.

	Se (mg/kg)	Hg (mg/kg)
Pin mill product	0.30	0.010
Talc-conc 1	<0.30	0.010
Talc-conc 2, Prod. 2	<0.30	0.010
Rest 1	0.32	0.010
Rest 2	<0.30	0.010
Talc-conc 2	<0.30	0.010
Confidenciality	*± 20%*	*± 10%*

Table 3: Estimated contents of major minerals based on the XRF chemistry and typical composition of the minerals.

PRODUCT	CHLORITE %	TALC %	CARBONATE %	SUM
Pin mill product	2.4	53.8	41.3	97.5
Non-magnetic	2.4	75.5	21.5	99.4
Talc-conc 1	1.2	90.5	7.5	99.1
Talc-conc 2, prod 2	0.5	94.6	4.3	99.4
Rest 1	4.4	51.1	43.8	99.3
Rest 2	2.3	79.5	17.2	99.0
Rest 2, prod 2	1.4	86.3	11.8	99.6
Talc-conc2	0.6	95.2	3.3	99.1

APPENDIX 1

Mineral compositions used as basis for estimation of mineralogical content from XRF data.

Typical analyses of talc and carbonate from Altermark:

Carbonate	
FeO(total)	11.68
MnO	0.12
MgO	39.33
CaO	0.28
SUM	51.41

	Talc	*Chlorite in rim*	*Chlorite in vein*
SiO2	62.43	30.40	32.84
TiO2	0.32	0.00	0.00
Al2O3	0.04	17.11	12.92
FeO (total)	1.05	6.30	3.98
MnO	0.00	0.06	0.04
MgO	31.63	31.31	36.06
CaO	0.00	0.03	0.03
Na2O	0.09	0.00	0.07
K2O	0.03	0.01	0.00
Cr2O3	0.09	2.75	1.28
NiO	0.22	0.11	0.25
Sum	95.90	88.08	87.47

APPENDIX 2

Photomicrographs of the different products.

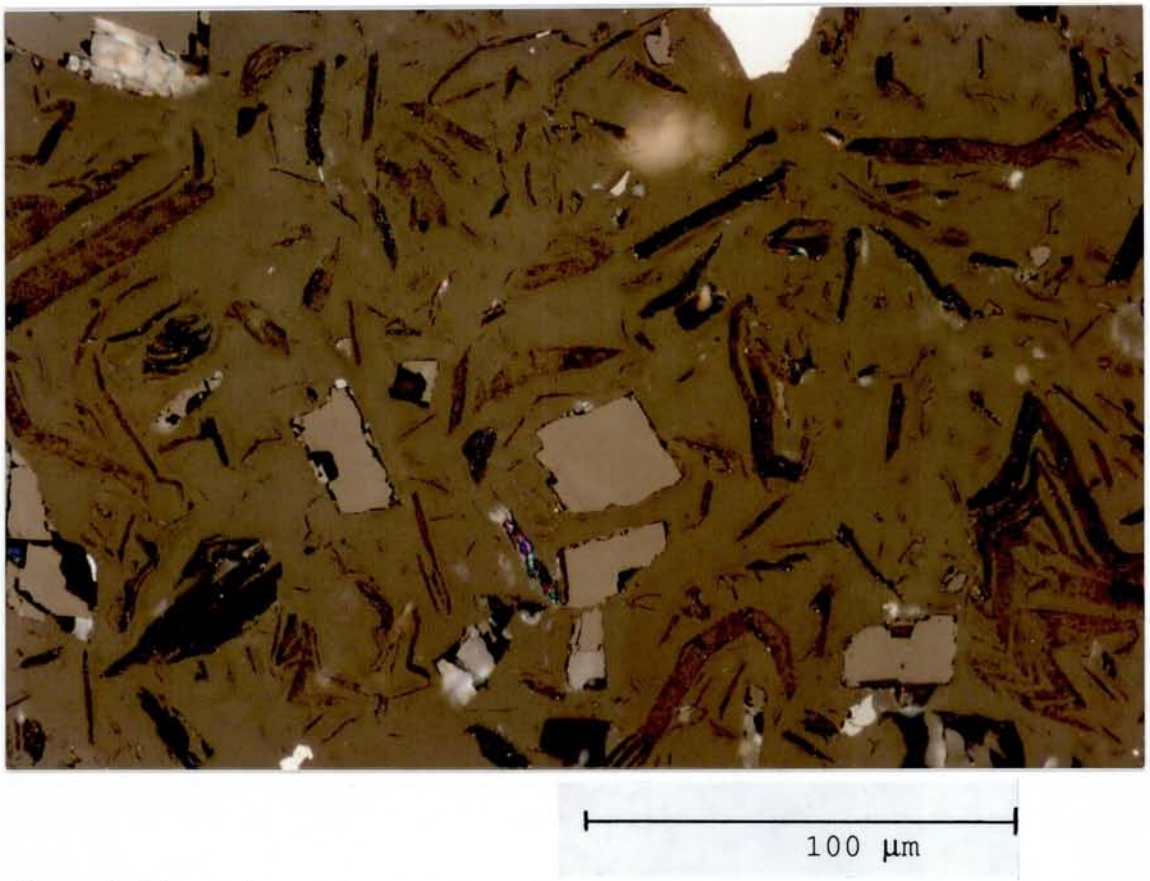

Figure 1: Photomicrograph of the Pin-mill product.

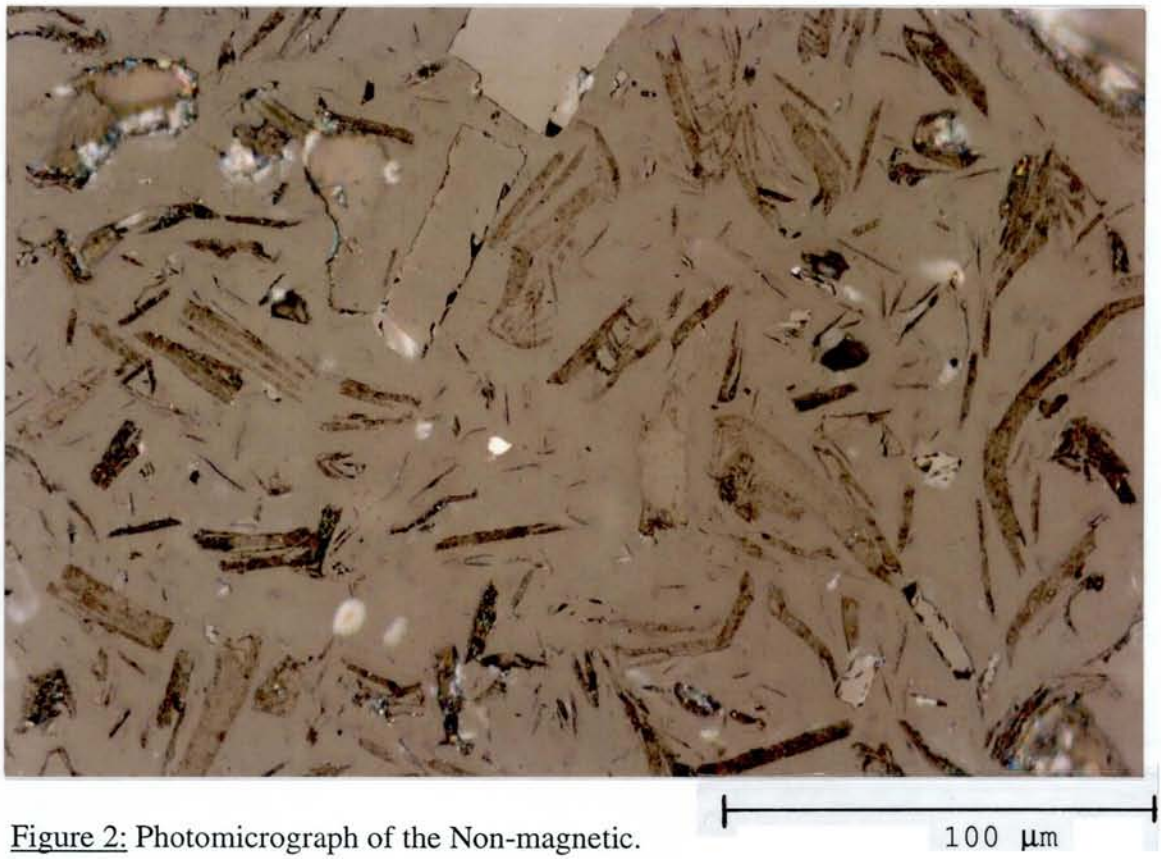

Figure 2: Photomicrograph of the Non-magnetic.

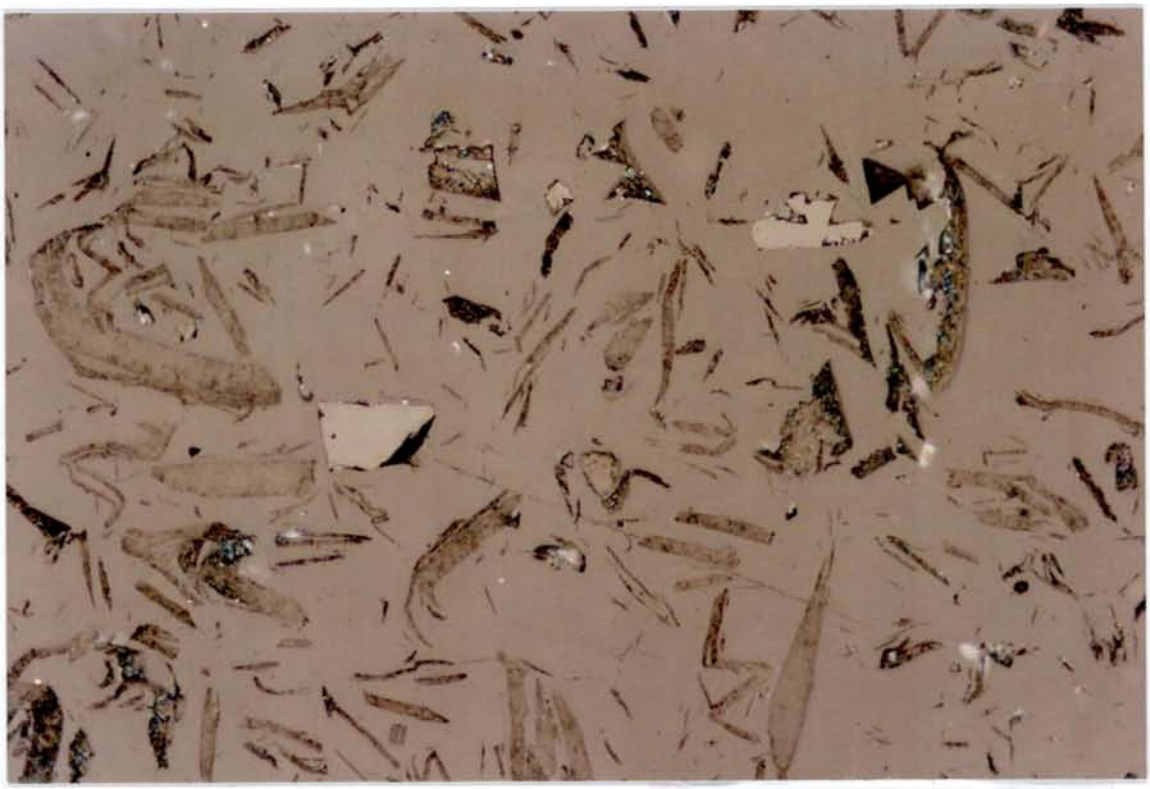

Figure 3: Photomicrograph of Talc-concentrate 1.

Figure 4: Photomicrograph of Talc-concentrate 2, product 2.

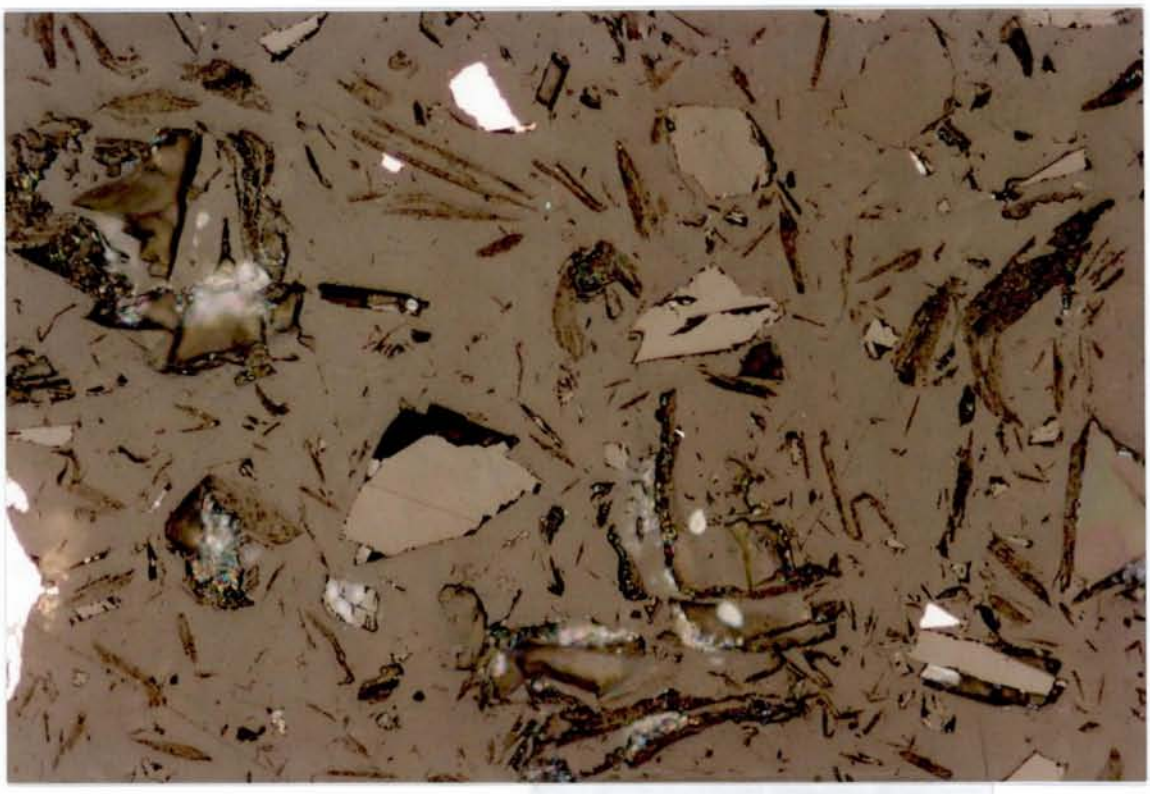

Figure 5: Photomicrograph of Rest 1.

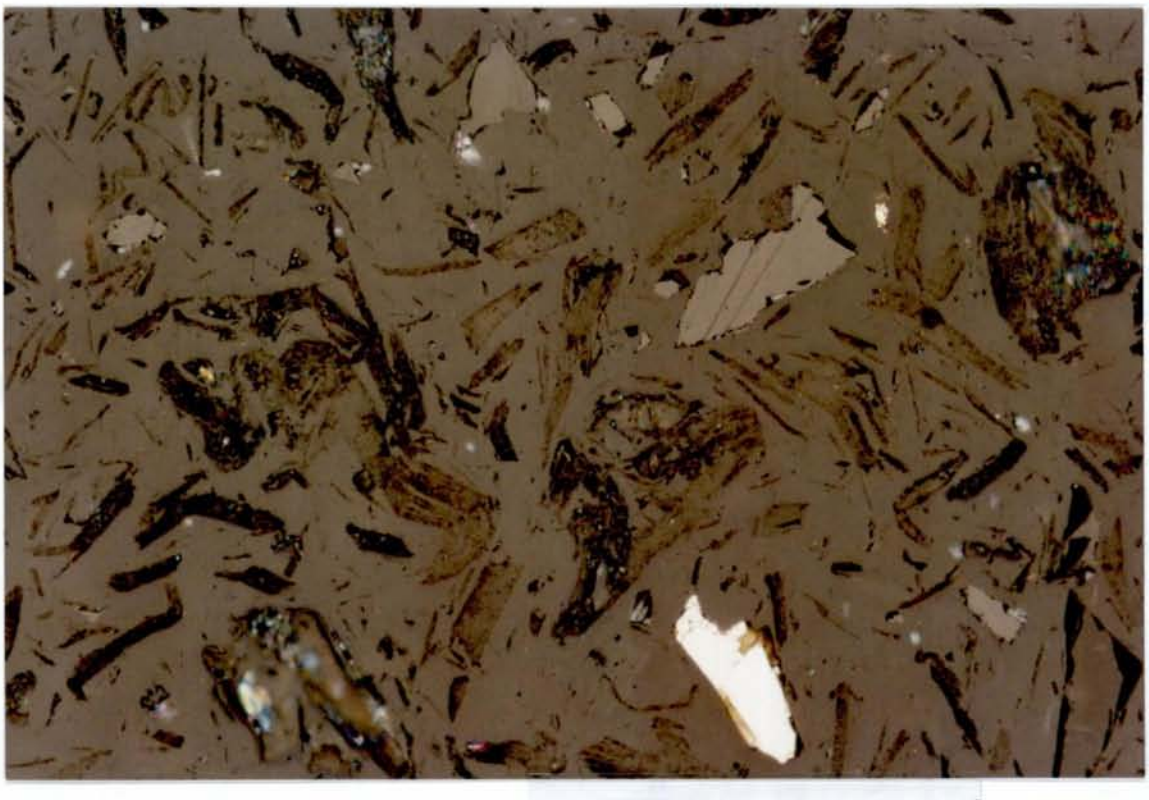

Figure 6: Photomicrograph of Rest 2.

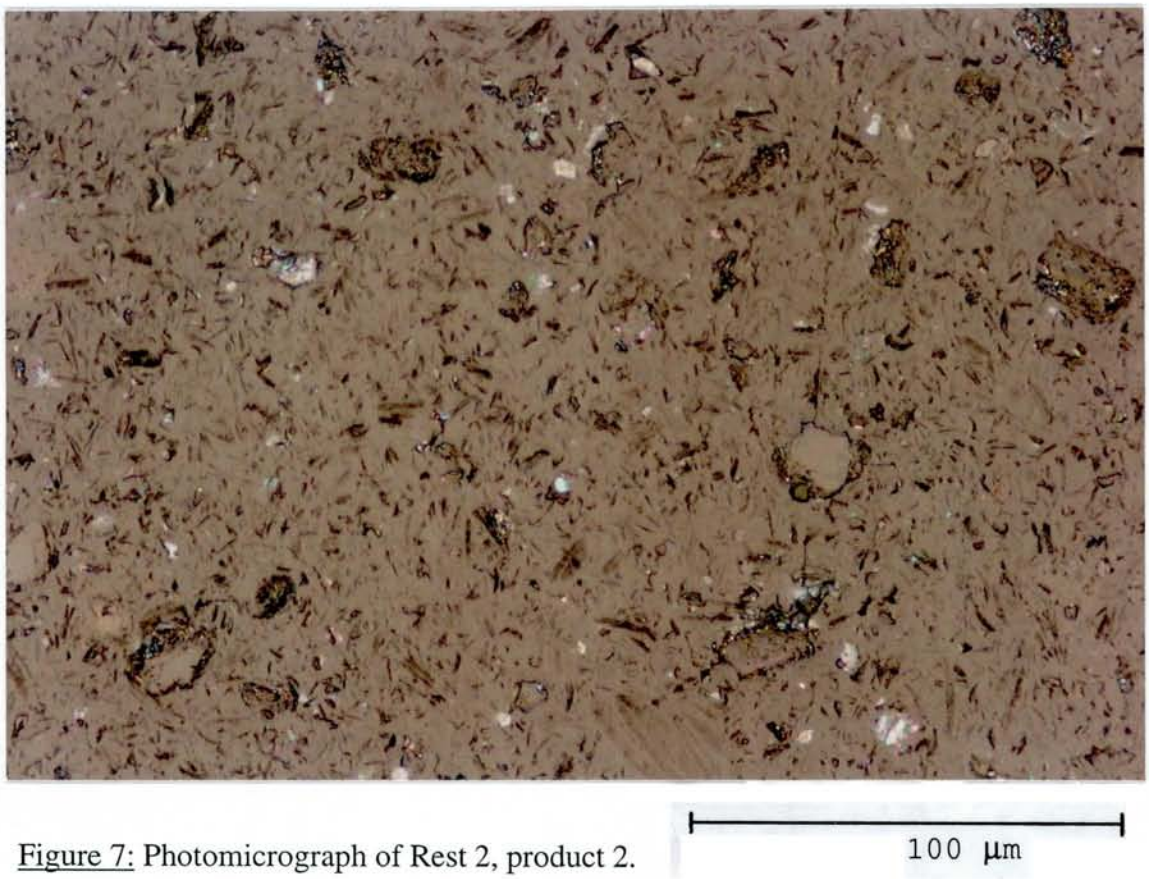

Figure 7: Photomicrograph of Rest 2, product 2.