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WATER-SOLUBLE SUBSTANCES IN KVANEFJELD LUJAVRITE

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Introduction

In the first description of Kvanefjeld lujavrite (1) no mention is made of water-soluble minerals, nor should they be expected in near-surface samples in view of the rainy climate of the region. However, the first core drilling in 1958 revealed the presence of villiaumite, NaF, which has a conspicuous red colour (2). Generally it does not occur in the uppermost 50-60 m of the rock.

Later investigations showed that the NaF found did not account for all the water extractable material. During storage some of the cores grew whiskers of an alkaline substance which contained no fluoride but organic compounds such as acetate and benzoate.

Pilot sample

In 1978 a sample of 14.000 tonnes was mined from a 900 m long tunnel about 150 m below surface level. During the work a highly basic condition of the tunnel wall was registered as well as a brownish colour of the run-off water.

A choice of 4.700 tonnes was shipped to Risø and placed at a prepared storage site. Due to the notorious toxicity of fluoride, precautions had been made as to the surveillance of the effluent from the ore heaps. After the first heavy rain it was found to assume a brownish colour which grew stronger until resemblance with coffee. At the same time pH rose to nearly 11. A remarkable viscosity was indicative of water glass. The brown colour could be ascribed to an organic substance much like humate.

Extraction experiment

Quantitative data were obtained as follows: Large lumps of rock, > 300 mm, were crushed to minus 7 mm and filled in a cylindrical vessel with a perforated bottom so as to form a column, 2 m high and 0,63 m in diameter. The content was 1000 kg.

The column was filled with water, which was circulated for some days until the density of the solution remained constant.

After the extract was drained off and measured to 109 l a series of washings was applied. Each consisted of 45 l of water and was circulated for two days. When the extraction yield per washing had dropped to below 1 per cent of the accumulated yield, the experiment was discontinued. The results are shown in Table I.

In the primary extract and the two first washings NaF amounted to 2,28% indicating a saturation under these circumstances. Sodium silicate starts at a higher value but is more rapidly washed out corresponding to a higher solubility. Humus is certainly lower than in the early rainwater extracts because the selected lumps of solid rock is less penetrable than the overall sample containing cracks and fissures.

Total inorganic matter extracted:		
	NaF	7,7 kg/ton
	Na_2O	3,0 kg/ton
	SiO_2	6,9 kg/ton

Particulars of the constituents

a) Villiaumite is unevenly distributed throughout the rock. Therefore the content should be indicated with reference to a defined sample. Near the surface it is absent but in some places small vugs show that it has originally been there. The dissolution still goes on as testified by the F^--content in the nearby river varying inversely with the water flow.

b) Sodium silicate has till now been recognized indirectly, but a new mineral, natrosilite, has been reported from the Lovozero massif, Kola peninsula, USSR, which has many points of resemblance with Ilimaussaq. Natrosilite has 33% of Na_2O and 67% of SiO_2. The surplus SiO_2 in the above extract may come from other minerals being attacked by the strong alkaline solution.

c) Humus is a decay product of plants, in particular parts like straw and wood containing much lignin which is very slowly decomposed by microbial attack. Lignin is a polymerized compound of uncertain composition containing benzene rings as well as oxygen and nitrogen in carboxylic, phenolic and amine groups. From the above mentioned strong solution a sample was precipitated

analysing:	C	37,9%	ignition residue	16,72%
	H	3,5%	inorganic S	1,23%
	organic S	0,92%		

Dating by C-14 gave the average $3850^{+}_{-}60$ years, that is to say at least some of the material must be of a relatively recent origin. Humus is extensively soluble not only in alkaline solution but also in water containing few ppm of F^-. Thus the natural environment is in favour of its transportation. However, it seems puzzling that the abundance of humus is higher at a certain depth than it is at the surface from where it is supposed to come.

(1) Ussing, N.V. 1912: Geology of the country around Julianehåb, Grønland. Meddr Grønland 38, 376 pp.

(2) Bondam, J. and Ferguson, J. 1962: An occurrence of Villiaumite in the Ilimaussaq intrusion, South Greenland. Meddr Grønland 172, 2, 12 pp.

	Dry matter (ignited) % W/V	NaF % W/V	"Na_2O" 1) % W/V	SiO_2 % W/V	Dry matter balance % W/V	Total Na 2) % W/V	Na from NaF % W/V	Na form Na_2O % W/V	Na balance % W/V
extract	8,224	2,28	1,74	4,20	0,003	2,68	1,25	1,29	0,14
wash 1	5,434	2,28	0,95	2,19	0,014	1,84	1,25	0,70	- 0,11
2	3,761	2,28	0,46	1,03	- 0,054	1,60	1,25	0,34	0,01
3	2,987	2,08	0,31	0,66	- 0,063	1,34	1,14	0,23	- 0,03
4	2,238	1,66	0,20	0,39	- 0,012	0,97	0,91	0,15	- 0,09
5	1,550	1,41	0,13	0,26	- 0,25	0,65	0,77	0,10	- 0,22
6	1,126	0,71	0,11	0,197	0,109	0,50	0,39	0,08	0,03
7	1,066	0,53	0,08	0,141	0,315	0,31	0,29	0,06	- 0,04
8	0,513	0,25	0,08	0,062	0,121	0,22	0,14	0,06	0,02
9	0,464	0,166	0,07	0,054	0,174	0,18	0,09	0,05	0,04
10	0,360	0,148	0,06	0,093	0,06	0,13	0,08	0,05	0,00
11	0,300	0,106	0,05	0,086	0,06	0,10	0,06	0,04	0,00

1) calculated from titration value

2) measured by atomic absorption

Table I