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Geochemistry and REE distribution in apatite from pyroxenite and carbonatite in the Lillebukt Alkaline Complex, Stjernøy, Finnmark, Northern Norway

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REPORT

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Title:
Geochemistry and REE distribution of apatite from pyroxenite and carbonatite in the Lillebukt Alkaline Complex, Stjernøy, Finnmark, Northern Norway

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Summary:

This report presents a chemical analysis of apatite from pyroxenite in the Lillebukt alkaline complex together with older analytical data on REE in apatite from the associated carbonatite. Published REE data on apatite from Siilinjärvi are also presented for comparison.

The apatite shows a strong enrichment in REE, up to 3000-4000 times chondritic values for LREE. The total REE (including Y) in apatite from the pyroxenite is 3605 ppm and in the carbonatite 3416ppm. However these values are not directly comparable since there is a difference in the number of analysed elements.

When compared, the apatites from carbonatite (Stjernøy and Siilinjärvi) show slightly lower LREE, elevated MREE and lower HREE than apatite from the pyroxenite.

Keywords:	Apatite	
Carbonatite	Rare earth elements	
Pyroxenite		

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1. INTRODUCTION

The purpose of this report is to present data from chemical analysis of apatite, in apatite-rich rocks from the Lillebukt alkaline complex on Stjernøy, Northern Norway and particularly to check the content of toxic heavy metals and the content and distribution of rare earth elements. The data permit only a very limited discussion on apatite petrogenesis.

To keep this report concise, the regional geology and the geological setting of the Lillebukt Alkaline Complex will not be repeated here. The reader is referred to the report by Gautneb & Ihlen (2009) for this information.

2. MATERIALS, METHODS AND RESULTS

The following samples are described in this report:

1) Sample **2009.0364**: this is apatite separated from pyroxenite sampled from apatite-rich pyroxenite dykes that occur along the eastern margin of the Lillebukt Alkaline Complex (see Gautneb & Ihlen 2009 for details).

2) Sample, **avstj**: this is "average" apatite separated from carbonatite in the Lillebukt alkaline complex, initially reported by Strand (1981); see also Gautneb & Ihlen (2009). The collector and exact locality are unknown,: the sample was analysed at the Mineralogical-Geological Museum in Oslo.

3) Sample **SI2**: In table 2 we included analyses of apatite from the Siilinjärvi carbonatite in Finland, reported by Kjarsgaard (1998).

The pyroxenite sample was crushed and sieved in several steps down to a grain size of < 250 microns.

Magnetic and mafic minerals where removed in several runs in a Frantz magnetic separator

A clean apatite concentrate was produced with several cleaning steps using heavy liquids, the final step using dibromemethane, with a density of $3.3 g/cm^3$.

The apatite concentrate was analysed with ICP-AES at NGU lab after digestion in an autoclave in 7 N HNO_3, and at ACME lab, Vancouver Canada, with ICP after four acid digestions (method 1T-MS).

Total results are shown in Table 1 and the REE values are shown Table 2 where an analysis of apatite from the Siilinjärvi carbonatite Finland (Kjarsgaard 1998) are included for comparison.

Table 1 Chemical analysis of apatite from pyroxenite, Lillebukt alkaline complex

Values reported in oxides were analysed at NGU lab, values reported as elements were analysed at ACME lab. Oxides are in weight %, elements in ppm except for Ag which is in ppb. Negative values are below detection limit

sample 2009.0364			
SiO_2	0.70	Ag (ppb)	25
Al_2O_3	0.11	As	2.1
FeO	0.33	Au	-0.1
TiO_2	0.02	Ba	12
MgO	0.00	Be	-1
CaO	51.84	Bi	-0.04
Na_2O	0.00	Cd	0.12
K_2O	0.00	Ce	1648.45
MnO	0.02	Co	-0.2
P_2O_5	40.56	Cr	1
S	0.05	Cs	-0.1
Sum	93.62	Cu	5.67
		Dy	32.5
		Er	11.8
		Eu	21.5
		Ga	4.47
		Gd	62.3
		Hf	-0.02
		Dy	32.5
		La	842.5
		Li	1.6
		Lu	1.1
		Mn	167
		Mo	0.10
		Nb	1.41
		Nd	676.8
		Ni	-0.1
		Pb	3.07
		Pr	166.7
		Rb	0.1
		Sb	0.05
		Sc	0.5
		Sm	82.4
		Sn	-0.1
		Sr	2885
		Ta	-0.1
		Tb	6.7
		Th	50.2
		Tm	1.2
		U	6.1
		V	49
		Y	131.8
		Yb	7.7
		Zn	-0.2
		Zr	4.5

Table 2 Y and REE content in apatite from pyroxenite and carbonatite from the Lillebukt Alkaline Complex Norway and Siilinjärvi carbonatite Finland, (Gautneb & Ihlen 2009, Kjarsgaard 1998)*

sample	2009.364	avstj	sl2
Y	131.8	219	150
La	842.5	546	663
Ce	1648.45	1011	1680
Nd	676.8	1187	962
Sm	82.4	216	139
Eu	21.5		36.5
Gd	62.3	113	72
Tb	6.7		
Dy	32.5	64	27.2
Er	11.8	57	
Tm	1.2		7.33
Yb	7.7	3.5	2.74
Lu	1.1		0.31
La/Lu_N	78.9		220
Sum REE	3605.65	3416.5	3960.08

**The values used for normalisation are from Nakamura (1974).*

For comparison apatite from the carbonatite in Lillebukt and from the carbonatite at the Siilinjärvi complex is also included.

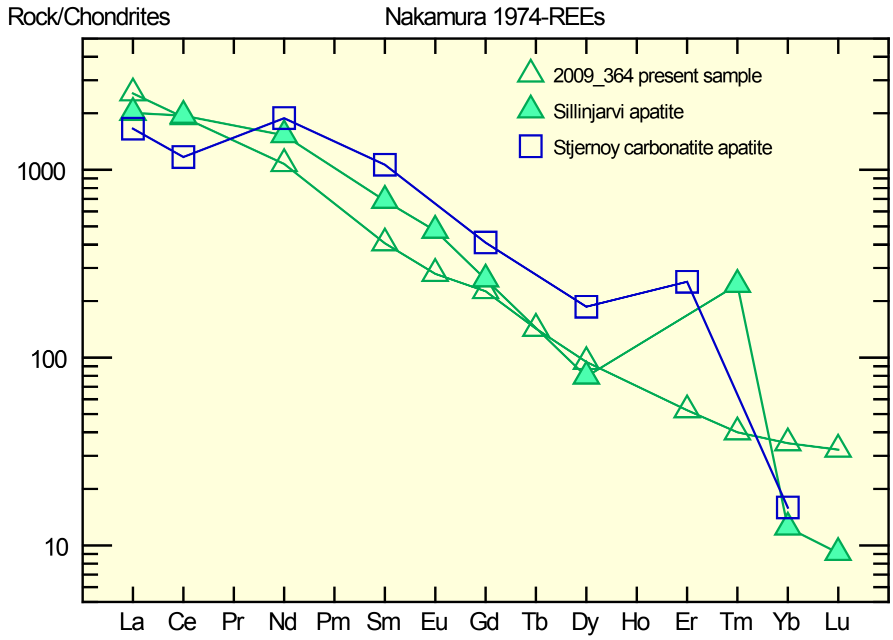
3. DISCUSSION

The contents of CaO (51.84%) and P_2O_5 (40.56%) are within the range of what is reported as normal values for pure apatite by Chang el al. (1996) and show that the mineral separation produced a clean concentrate.

The levels of undesired and toxic heavy metals such as As, Cd, Co, Ni, and Pb are all very low and less than 3 ppm

Apatite is known to show a strong enrichment of REE and particularly the LREE. This is clearly seen in Fig. 1. The LREE show concentrations 3000-4000 ppm higher than chondrites and the La/Lu_N ratio is 78.

The apatites from carbonatite, both from Stjernøy and from Siilinjärvi, show slightly lower LREE, elevated MREE and lower HREE than the apatite from the pyroxenite from Stjernøy. This is probably related to differences in enrichment of REE at the magmatic stage, due to the large compositional difference between pyroxenite and carbonatite magma, even from the same source region.



Figur 1 REE chondrite normalised values of apatite from pyroxenite and carbonatite from Stjernøy and carbonatite from Siilinjärvi. Normalisation according to values of Nakamura (1974).

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