

The discovery and characterisation of a new U mineral from Ilimaussaq Alkali Complex – Greenland

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The 17 X 8 km Ilimaussaq alkali complex is a Mid Proterozoic series of intrusions in the Gardar complex of Southern Greenland. It is dominated by agpaitic nepheline syenites that form a layered sequence. This laminated rock consists of alkali feldspars, arfvedsonite, nepheline, sodalite and often major naujakasite, together with a number of subordinate unusual sodium minerals such as villiaumite [NaF] and steenstrupine $[(\text{Ce}, \text{La}, \text{Na}, \text{Mn})_6(\text{Si}, \text{P})_6\text{O}_{18}(\text{OH})]$ [1]. The steenstrupine is a complex sodium rare earth silicate phosphate that is believed to be the main source of uranium in this ore.

Current metallurgical testing to produce a uranium concentrate initially, on upgrading the steenstrupine from crushed drill core. This involved flotation of the steenstrupine as a phosphate. This was successful in terms of phosphate concentration, but left a tail with low phosphate and significant levels of uranium. This indicated that some of the uranium was locked as a phosphate. Following the initial metallurgical testwork, an extensive EPMA investigation was conducted to locate the unknown uranium-bearing mineral, analyse its chemistry by EPMA and determine its crystallography by XRD [2].

Mapping combining WDS, EDS and CL data were undertaken using a JEOL 8500F and hierarchically clustered using the CHIMAGE software package [3]. The clustering algorithm identified approximately 5000 unique clusters of pixels with statistically indistinguishable WDS, EDS and CL intensities. Using novel software, the cluster tree was sorted to distinguish chemically meaningful clusters from the panoply of edge effects [4]. Phase identification of the clusters of interest was achieved via comparison of cluster compositions with a library of minerals and with bulk XRD analyses. The uranium bearing mineral was found to be a sodium zirconium silicate that contains less than 1 wt% uranium. The search procedure and determination of the mineralogy revealed the first signs of a microanalysis problem associated with the unknown uranium mineral in that it volatilised under the beam conditions employed for fast mapping (see Fig.1).

The major elements contained in the unknown uranium mineral were identified by EDS as Na, Si, Zr, with minor levels of Mn, Ca, U, Al and Y. Due to the ionic nature of the new uranium mineral beam damage was quickly found to be a problem and analyses were poor with Na being observed to migrate away from the beam under most conditions. The microanalysis solution was to employ an accelerating voltage of 15 kV, a low beam current of 2.3 nA, and defocus of the analysis spot to 10 - 15 micron. Grains larger than 30 microns were not located. Furthermore clean regions with low metamictisation and maintaining the highest degree of crystallisation, larger than 15 microns could not be located. An additional problem was that radiogenic decay products such as Pb were also often present within the new mineral making characterisation difficult.

The uranium mineral was found to have a composition close to kapustinite $[\text{Na}_{5.5}\text{Mn}_{0.25}\text{ZrSi}_6\text{O}_{16}(\text{OH})_2]$ however distinct differences in the Na, Zr and Si levels indicated it to be a previously unknown mineral. Subsequent XRD of individual grains, removed from the grain mounts after analysis, showed it to be a new uranium bearing mineral of composition given in Table 1. The low total is likely to be due to both some degree of metamictisation and a small amount of water.

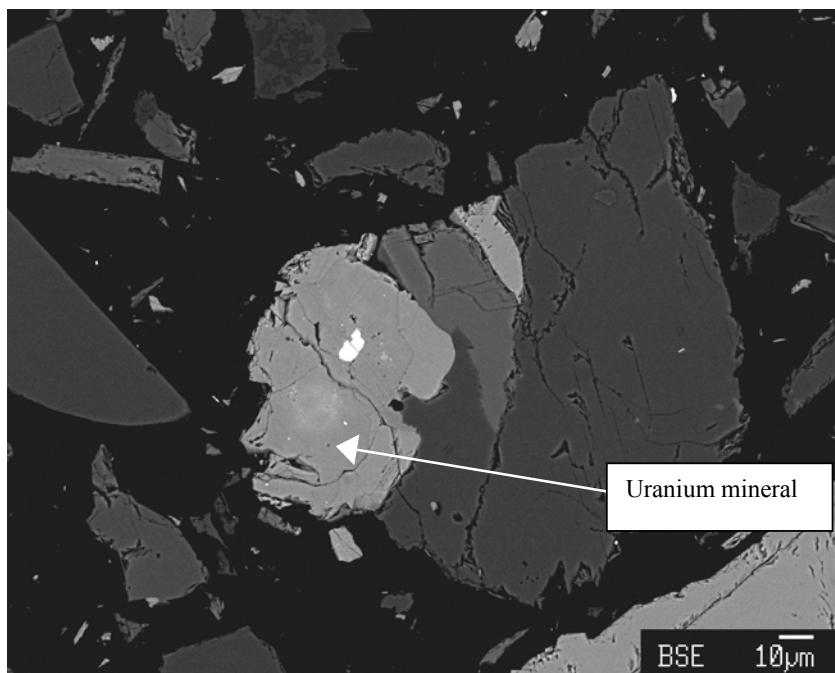


Fig. 1. New uranium bearing mineral, of composition given in Table 1, surrounded by Albite and Adularia. Large bright inclusion in new mineral is a REE phosphate.

	Si	Ca	U	Na	Zr	K	Fe	Y	Mn	Total
Analysis	51.2	1.1	0.64	23.4	12.6	.04	1.21	2.05	1.45	94.0

Table 1. Microanalysis of new uranium mineral located in an Ilimaussaq Alkali Complex, S. Greenland.

References

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