



Discovery of sapphirine in East Greenland

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An occurrence of sapphirine is described from the Kronprins Frederik Bjerge (about 67°N) in East Greenland. It occurs in an assemblage with phlogopite, spinel and orthopyroxene in a thin band in quartzo-feldspathic gneisses of granulite facies but may well be much more widespread in the area.

Sapphirine was first described from the Fiskenæsset region of southern West Greenland in 1808 by Giesecke (1910). It was formerly regarded as a rare mineral, but in recent years it has been reported with increasing frequency from amphibolite and granulite facies metamorphic terrains and even in xenoliths from kimberlites. In West Greenland sapphirine has been described by Ramberg (1948), Bøggild (1953) and Sørensen (1955). It occurs most prominently along the margins of the Fiskenæsset layered anorthosite complex in spectacular assemblages together with, among other minerals, kornerupine, ruby corundum and högbomite, and has been well documented by Herd (1972, 1973), Friend & Hughes (1981), Friend (1982), Ackermund *et al.* (1983) and Williams (1984).

During field work by the Geodætisk Institut, samples of mica-rich rock containing centimetre-sized crystals of a deep blue, erosion-resistant mineral were brought back to the base camp by T. Hauge Andersson, who had previously worked in the Fiskenæsset area and was familiar with sapphirine. The locality was subsequently visited by this author and further material was collected. It is situated on an eastward-oriented spur of the side of a high nunatak in an exceedingly remote area in the nunataks of Kronprins Frederik Bjerge (figs 1 and 2) and the exact locality is not easy to locate on existing maps (Geodætisk Institut 1:250 000, published 1974 after an original of 1933). However, the position was fixed by means of TRANSIT observations to 67° 22' 03"N, 34° 23' 23"W and this is believed to be accurate to less than 1" in both latitude and longitude.

At a distance, the rocks appear massive and brown in colour, characteristics which are taken to indicate that they are in granulite facies. Prior to the visit of GGU in 1986, only the Westminster East Greenland Expedition 1978 (Woolley *et al.* 1978) had visited this region and they reported massive gneisses with feldspathic banding north of 66° 50'N and occasional large recumbent folds.

In the inland part of the area they reported massive granite with large sheets of basic rock. In addition four occurrences of "distinctive lithologies, probably supra-crustal in origin" were reported. Most of the rocks are probably of Archaean age; in the south they are affected by Proterozoic deformation where retrogression to amphibolite facies gives them a greyish colour.

Sapphirine occurs in a thin, less than 1 m thick, band in the quartzo-feldspathic gneisses. This band is northward-trending and steeply-dipping and is followed along one side by a pseudotachylite of about 2 cm thickness and concordant with the foliation. Sapphirine forms crystals up to about 1 cm in size which stand out on the weathered surface due to their resistance to weathering.

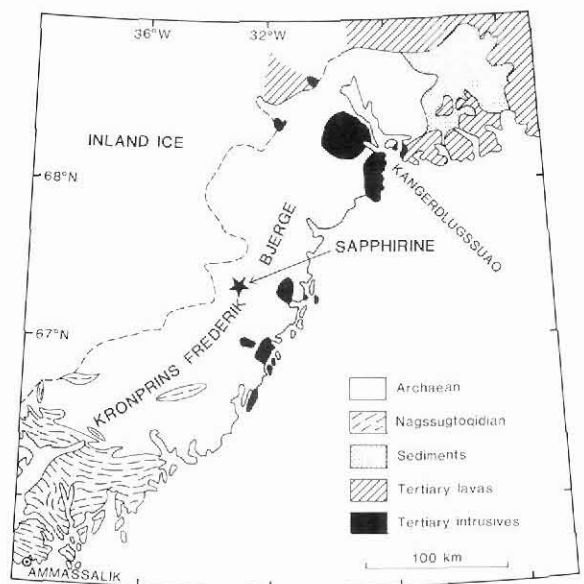


Fig. 1. Part of East Greenland showing regional geology after Myers *et al.* (1980) and location of the sapphirine locality. Broken line marks innermost extent of nunataks.

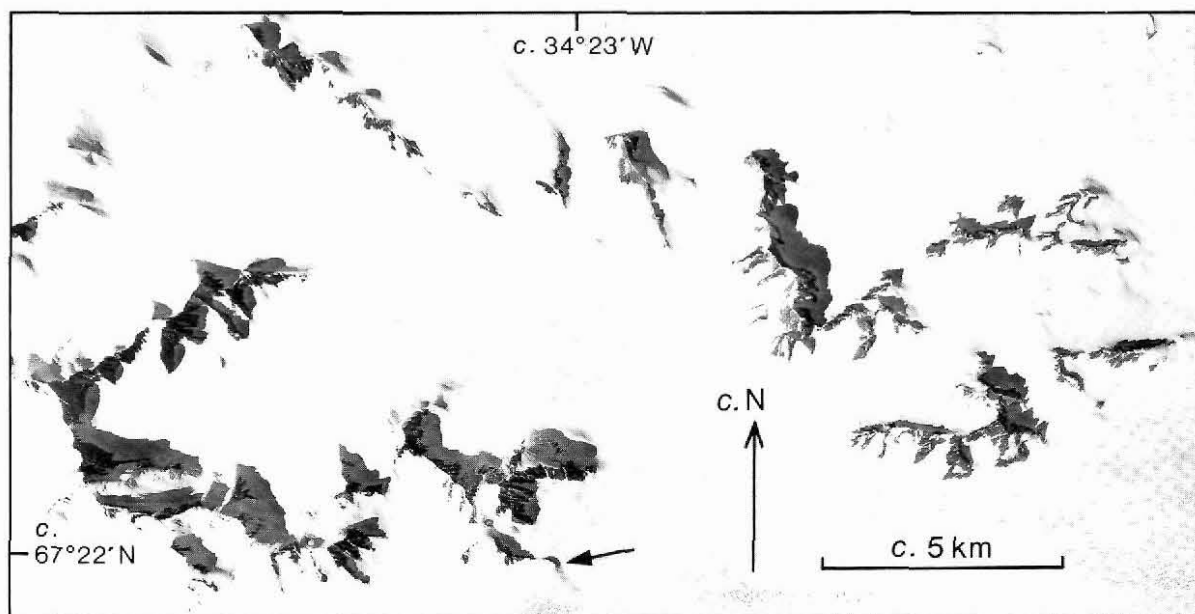


Fig. 2. Aerial photograph of the locality (shown by arrow).

It is of a deep, prussian blue colour and is accompanied by mica and a straw-coloured, bladed mineral, subsequently identified as orthopyroxene. Mica is the most voluminous mineral in all samples, but sapphireine may reach over 30% in some. Microscopic examination shows that green spinel is also an important constituent. Sapphireine is pale blue in thin section, in contrast to the material described by Williams (1984) from Fiskeneset, which was stated to be colourless in thin section. Microprobe analyses of the main minerals are shown in Table 1.

The formula for sapphireine is generally given as: $(\text{Mg}, \text{Fe})_{8-x}(\text{Al}, \text{Fe})_x^{\text{VI}}(\text{Si}_{6-x}, \text{Al}_x)^{\text{IV}}\text{O}_{20}$ with the major substitution being $\text{MgSi} \rightleftharpoons \text{Al}^{\text{IV}}\text{Al}$ (Higgins *et al.*, 1979). The composition given in Table 1 is unremarkable and appears to conform to this substitution. It is somewhat more Fe-rich than most Fiskeneset samples quoted by Herd (1973) with an $\text{Mg}/(\text{Mg} + \text{Fe})$ ratio of 0.87 as against 0.96–0.90, although Williams (1984) reported an example with this ratio of 0.84. Calculation of Fe^{3+} and Fe^{2+} by stoichiometry using the procedure described by Higgins *et al.* (1979) shows it to be unusually oxidized although the significance of this is unclear.

Spinel is close to its ideal composition, while phlogopite is very Mg-rich with a high Al_2O_3 content and a slight K_2O deficiency. The orthopyroxene is a bronzite, again with a lower Mg/Fe ratio than those of Fiskeneset. It has a high Al_2O_3 content, perhaps indicative of a high pressure of formation and typical of orthopyro-

Table 1. Minerals of sapphireine granulite, Kronprins Frederik Bjerge, East Greenland

	1	2	3	4
SiO_2	14.18	-	40.9	52.54
TiO_2	-	-	0.3	0.11
Al_2O_3	63.59	67.74	16.3	7.98
FeO	4.86	14.29	3.3	10.23
MnO	-	0.15	-	-
MgO	19.05	19.89	24.0	29.55
CaO	-	-	-	-
Na_2O	-	-	-	-
K_2O	-	-	9.8	-
	101.68	102.07	94.7	100.42

Numbers of ions					
basis	20 oxygens	32 oxygens	22 oxygens	3 oxygens	
Si	1.638	-	5.767	0.917	1.000
Ti	-	6.000	0.031	8.000	
Al^{IV}	4.632	-	2.202	0.081	0.083
Al^{VI}	4.000	4.362	15.798	16.000	
Fe^{3+}	0.362	0.202	0.502	-	0.998
Fe^{2+}	0.106	2.165	0.387	5.965	
Mn	-	0.024	8.101	-	0.768
Mg	3.300	5.912	5.076	-	
Ca	-	-	-	-	-
Na	-	-	-	-	-
K	-	-	1.764	-	-

GGU sample no. 312068.

1. Sapphireine: $(\text{MgFe})_2\text{Al}_4\text{O}_6[\text{SiO}_4]$, calculated by method of Higgins *et al.* (1979).

2. Spinel: $(\text{MgFe})_8\text{Al}_{16}\text{O}_{32}$.

3. Phlogopite: $\text{K}_2(\text{MgFe})_4[\text{Si}_6\text{Al}_2\text{O}_{20}](\text{OH}, \text{F})_4$.

4. Aluminous orthopyroxene: $(\text{MgFe})\text{SiO}_3$.

xenes from granulites and high pressure megacrysts in alkali basalt and kimberlites.

Calculation of distribution coefficients for partitioning of Fe^{2+}/Mg between sapphirine and spinel and orthopyroxene give values of 0.17 and 0.33 which is appreciably less than the values of 0.28 and 0.65 given by Higgins *et al.* (1979), but again the significance of this is unknown. There is no suggestion from the texture that this is a disequilibrium assemblage.

The compositions of the minerals indicate that this is an aluminous, subsilicic and highly magnesian assemblage which is typical for the occurrence of sapphirine. Whereas such compositions could arise from ultrabasic

igneous rocks, the small extent of this occurrence reinforces the idea that the protolith was sedimentary.

As the geology of this area is so poorly known, it is likely that this sapphirine-bearing assemblage is not unique and future workers are urged to be aware of this likelihood.

Acknowledgements. T. Hauge Andersson is congratulated for his observational powers and thanked for bringing this occurrence of sapphirine to the author's attention. Mineral analyses were made by J. G. Rønsbo using the Jeol microprobe at the Institute of Mineralogy, University of Copenhagen, which is financed by the Danish Natural Science Research Foundation.