Pseudo-fractionation trend of the Fiskenæsset anorthosite complex, southern West Greenland

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The Fiskenæsset anorthosite complex is a sheet of layered igneous cumulates, 350–400 m thick, which was intruded into volcanic rocks, now amphibolites (Escher & Myers, this report). It was later disrupted by the intrusion of an enormous amount of granitoid material, mainly as sheets during regional deformation, and was metamorphosed in amphibolite and hornblende granulite facies about 2850 m.y. ago (Black *et al.,* 1973). Fragments of similar rocks are widespread throughout the Archaean gneiss complex of Greenland, although the name Fiskenæsset complex is limited to the occurrences in the Fiskenæsset region (Bridgwater *et al.,* in press).

Previous work

The first attempts to understand the fractionation pattern of the intrusion were made by Bowden (1970) and Gormsen (1971), and these results are described at length by Herd (1972), Windley (1973) and Windley *et al.* (1973) (fig. 15). Windley *et al.* (1973, p. 2) concluded that the intrusion was "the differentiation product of a basaltic magma" and (op. cit., p. 73) "formed from a hydrous melt similar to the calc-alkali extrusive rocks series", with a decrease in total iron with differentiation. They considered that the marked upward increase in Fe/Mg ratio best defined the course of crystallisation of the intrusion.

New work

The major element content of whole rock powders of numerous samples from the Majorqap qâva outcrop of the anorthosite complex was recently determined. This outcrop is less deformed and preserves more of its igneous mineralogy than the rocks studied by Windley *et al.* (1973). Most rocks are composed of plagioclase and hornblende with a small amount of mica. The major igneous stratigraphy of the Majorqap

Table 2. Igneous stratigraphy of the Majorqap qâva outcrop, with the average proportions of the main minerals and average thicknesses of the main rock units

	Rock unit	Plagioclase	Hornblende
Top	Anorthosite 200 m	95	5
	Upper Leucogabbro 60 m	80	20
	Gabbro 40 m	50	50
Bottom	Lower Leucogabbro 50 m	80	20

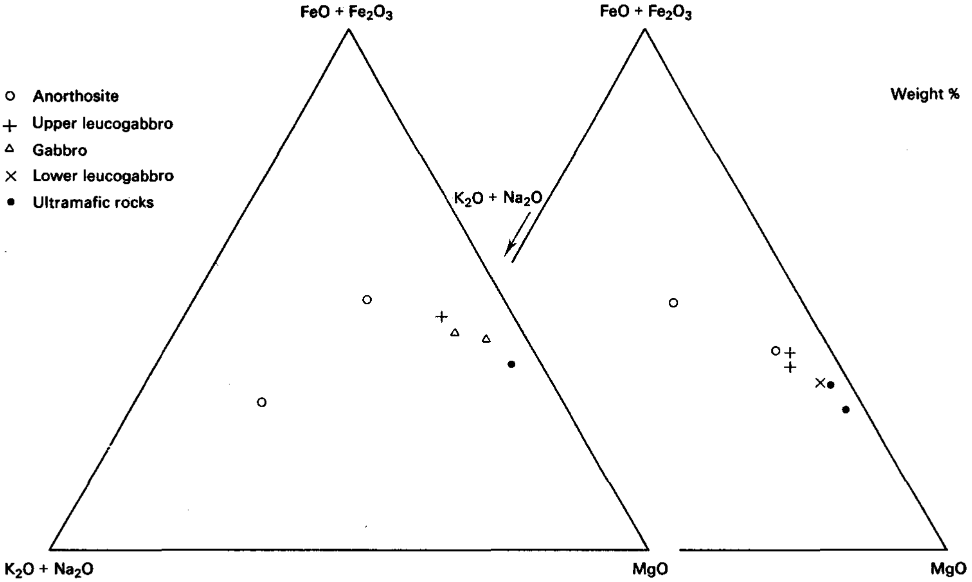

Fig. 15. AFM diagrams of whole rock analyses from two sections of the anorthosite complex on Qeqertarssuatsiaq showing rocks collected in ascending stratigraphic order, from ultramafic rocks to anorthosite (after Windley *et al.*, 1973, modified to show the same stratigraphic divisions as in fig. 16). The patterns were interpreted as the differentiation trends of the complex.

qâva outcrop is summarised in Table 2. In addition ultramafic layers, 1–2 m thick, also occur in the lower three units.

The distribution of 70 rocks from this succession are shown plotted on an AFM diagram in fig. 16. The distribution resembles a fractionation pattern, but this resemblance is more apparent than real. The points fall into groups related to rock type rather than to stratigraphic position. The leucogabbros from both the upper and lower leucogabbro units cluster together, and ultramafic rocks from the lower leucogabbro, gabbro and upper leucogabbro units form another cluster of points independent of their stratigraphic positions. Comparison of the many analyses of fig. 16 with the reconnaissance work by Windley *et al.* (1973) suggests that their differentation trend (fig. 15) may not be representative.

Discussion

An AFM diagram reflects about 21 % of the composition of a tholeiitic basalt, but only 4 %, 10 % and 18 % respectively of the composition of the anorthosite, leucogabbro and gabbro of the Fiskenæsset complex. These rock types, rich in calcium and aluminium, and poor in iron and alkalis, are therefore represented less adequately than tholeiitic basalt in an AFM diagram. Small differences in the relative amounts of plagioclase, hornblende and mica in the anorthosite samples are exaggerated on the AFM diagram. This is illustrated in fig. 16a which shows the distribution of 9

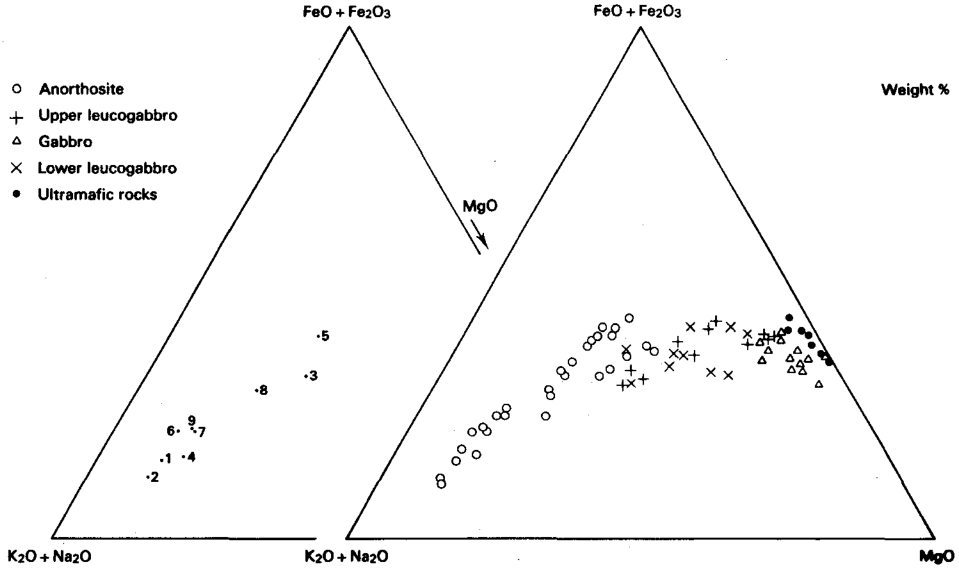

Fig. 16. AFM diagrams of whole rock analyses from the anorthosite complex at Majorqap qâva. *a* (left): samples collected at 25 m intervals in ascending stratigraphic order 1 to 9 from the anorthosite unit. *b*. (right): 70 samples from three sections across the main stratigraphic units showing a pseudo-fractionation trend.

samples of anorthosite collected at 25 m intervals through the anorthosite unit. The position of the samples on the AFM diagram bears no systematic relation to their stratigraphic position but may reflect small variations in the relative proportions of minerals in the rock samples.

The apparent fractionation trend shown on fig. 16b is similar to that obtained by Hutt (1974) from other sections of the Fiskenæsset anorthosite complex. Hutt suggested that the trend represents differentiation with less marked iron enrichment than that shown on fig. 15, and that the two trends may indicate two anorthosite intrusions with slightly different bulk compositions. It is suggested here that this difference is more apparent than real because of the inadequacy of the AFM diagram to represent these calcium-aluminium rich cumulates.

Conclusions

The distribution of points on fig. 16b shows that there are small but significant variations in Fe/Mg ratio between gabbro, leucogabbro and anorthosite samples. However, the broad spread of points representing leucogabbro and anorthosite samples mainly reflects variations in the proportions of plagioclase, hornblende and mica in the rocks. There is only a slight increase in the Fe/Mg ratio of anorthosite relative to leucogabbro. If this difference is the result of igneous fractionation, the amount of fractionation between the anorthosite at the top of the intrusion and the leucogabbro at the bottom is small. There is a greater difference between the Fe/Mg ratio of the gabbro samples relative to all the leucogabbro samples together than between samples from the upper and lower leucogabbro units, above and below the gabbro unit. Relative to the gabbro samples, the ultramafic rocks have similar, rather than lower, Fe/Mg ratios, probably because of the greater content of magnetite in the ultramafic rocks.

Many of the amphibolites into which the anorthosite complex was intruded appear to be derived from volcanic rocks with oceanic tholeiite composition (C. R. L. Friend, personal communication). This suggests that the composition of the earth's mantle was already similar to that at the present time before the intrusion of the anorthosite complex. If the anorthosite complex was derived by fractionation from magma of oceanic tholeiite composition, a mafic-rich fraction must have separated from the magma before it was intruded into its present host rocks, and any alkali-rich fraction which may have formed must also have been lost. Thus, the sill-like Fiskenæsset anorthosite complex may represent only a small part of the probable fractionation process by which it may have been derived from a tholeiitic magma.

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