

Reference

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Stratigraphy of the Fiskenæsset anorthosite complex, southern West Greenland, and comparison with the Bushveld and Stillwater complexes

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The Fiskenæsset complex is a thin layered sheet of deformed and metamorphosed anorthosite, leucogabbro, gabbro, peridotite and dunite, with numerous chromitite layers and lenses. It occurs in an Archaean terrain of amphibolite and granulite facies gneisses as layers up to 500 m thick with outcrop lengths of up to 25 km and as trains of fragments in gneisses, in a belt 50 km wide and 100 km long in the Fiskenæsset region (fig. 28). The Fiskenæsset complex has given an Rb/Sr whole rock age of 2810 ± 120 m.y. (Alexander *et al.*, 1973), and gneisses which cut it have given an Rb/Sr whole rock age of 2880 ± 50 m.y. (Moorbath & Pankhurst, in press) and a U/Pb zircon age of 2835 ± 10 m.y. (Pidgeon *et al.*, 1976). A Pb/Pb whole rock age of 2810 ± 70 m.y. from both anorthosite and gneiss from Fiskenæsset has been interpreted as the age of metamorphism (Black *et al.*, 1973).

The Fiskenæsset complex was intruded as a sill into basic volcanic rocks which are now amphibolites (Escher & Myers, 1975). It was then disrupted by thrusting and the intrusion of sheets of granitoid rocks which are now gneisses (Myers, 1976a & b) and these rocks were repeatedly deformed and metamorphosed. These events confused and blurred the original igneous stratigraphy of the Fiskenæsset complex, and the complete stratigraphy is no longer intact at any one locality.

Early descriptions of parts of the stratigraphy of the Fiskenæsset complex were given by Gormsen (1971), Windley (1971), Windley *et al.* (1973) and Hutt (1974), and more recently by Myers (1975). During 1975 the author visited all the main outcrops of the Fiskenæsset complex in order to correlate the stratigraphy throughout the whole Fiskenæsset region. A large number of new sections were measured and mapped in detail, and previously described sections were reappraised in the light of newly discovered way-up structures and the overall stratigraphy and structure of the region.

The complete stratigraphy of the Fiskenæsset complex deduced from this field study is shown in Table 9, where it is compared with the stratigraphy described from Qeqertarsuaat-

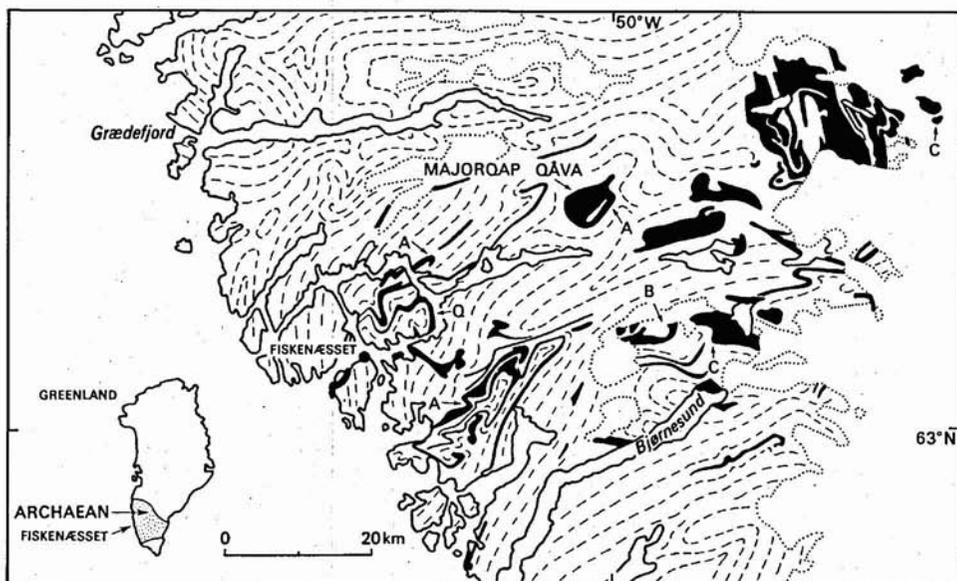


Fig. 28. Sketch map of the Fiskenæsset region, southern West Greenland, showing the distribution of the Fiskenæsset anorthosite complex (black), simplified compositional layering of gneisses and amphibolites (thin broken lines) and ice boundaries (dots); after Myers (1975). Q locates Qeqertarsuatsiaq; A, B and C locate suggested type localities of parts of the anorthosite complex.

siq by Windley (1971, 1973), and from Majorqap qåva by Myers (1975). The main addition to the previously described stratigraphy is a unit of gabbro on top of the anorthosite unit at the top of the whole succession, and the widespread occurrence of a unit of gabbro at the base of the sequence below the ultramafic unit. Thin distinctive horizons were also observed in widely scattered outcrops of the complex which suggest that most of the anorthositic

Table 9. Correlation of the stratigraphy of the Fiskenæsset anorthosite complex

Complete succession		Majorqap qåva		Qeqertarsuatsiaq		Maximum thickness in metres
Units	General deformed thickness in metres	Units	General deformed thickness in metres	Zones		
				Windley (1971)	Windley (1973)	
7 Upper gabbro	50			10 Pyroxene amphibolite 9 Ultramafic group	(metavolcanics) (grouped with metavolcanics)	50
6 Anorthosite	250	6 Anorthosite	200	8 Garnet anorthosite 7 Hornblende chromitite 6 Anorthosite		75 20 130
5 Upper leucogabbro	60	5 Upper leucogabbro	60	5 Ophitic gabbro	(leucogabbro)	250
4 Middle gabbro	40	4 Middle gabbro	40	4 Mafic gabbro	(dark gabbro)	60
3 Lower leucogabbro	50	3 Lower leucogabbro	60	3 Lower layered group	(leucogabbro)	100
2 Ultramafic unit	40	2 Ultramafic unit	30	2 Ultramafic group		100
1 Lower gabbro	50	1 Lower gabbro	10	1 Pyroxene amphibolite	(metavolcanics)	200

(after Myers, 1975)

layers and fragments of the whole region are part of the same intrusive complex rather than part of a number of intrusive complexes.

Stratigraphy of the Fiskenasset complex

The *lower gabbro unit* consists of layers of gabbro, melanogabbro and leucogabbro in which gabbro is dominant. The rocks are generally strongly deformed, thoroughly recrystallised and consist of plagioclase and hornblende. Igneous textures are only preserved in a few places.

The *ultramafic unit* consists of a number of cyclic mineral-graded sub-units of dunite, peridotite and hornblende rock, which are interpreted as olivine, olivine + pyroxene \pm hornblende, and pyroxene \pm hornblende cumulates respectively.

The *lower leucogabbro unit* mainly consists of both isomodal and mineral-graded layers of leucogabbro (plagioclase cumulate) with minor mineral-graded layers of dunite, peridotite, melanogabbro and gabbro. Igneous textures and minerals are well preserved in many places.

The *middle gabbro unit* is composed of isomodal gabbro, plagioclase + hornblende rock, with minor mineral-graded peridotite and gabbro-leucogabbro layers.

The *upper leucogabbro unit* mainly consists of coarse-grained isomodal leucogabbro (plagioclase cumulate). A number of mineral-graded peridotite layers are interlayered with plagioclase and plagioclase + chromite cumulates at the base of the unit, and in some places a major horizon of plagioclase + chromite cumulate occurs at the top of the unit. Igneous textures and minerals are well preserved in many places.

The *anorthosite unit* is generally more strongly deformed than the lower units and consists of anorthosite with small schlieren of leucogabbro with metamorphic textures. The anorthosite contains thin discontinuous layers of coarse-grained and less deformed plagioclase and plagioclase + chromite cumulates. The uppermost part of the unit contains more hornblende than the lower part, and it approaches leucogabbro in composition and contains numerous metamorphic garnets.

The *upper gabbro unit* consists of thin layers of gabbro and leucogabbro, plagioclase + hornblende rocks, with minor layers of dunite and peridotite. Magnetite occurs as a major cumulus mineral in both the plagioclase and ultramafic cumulates, and in some places it forms almost massive layers up to 50 cm thick.

Suggested type localities where the stratigraphy of the various units of the complex is best preserved are marked on fig. 28. Three places where the lower gabbro and ultramafite units are equally but not ideally preserved are marked A. The lower leucogabbro, middle gabbro, upper leucogabbro and lower part of the anorthosite units are best preserved at Majorqap qâva, the upper part of the anorthosite unit is best exposed at locality B and the upper gabbro unit at localities marked C.

Discussion

The overall stratigraphy of the Fiskenasset complex has close similarities with the major sequence of rock units of the better known Bushveld and Stillwater complexes (fig. 29).

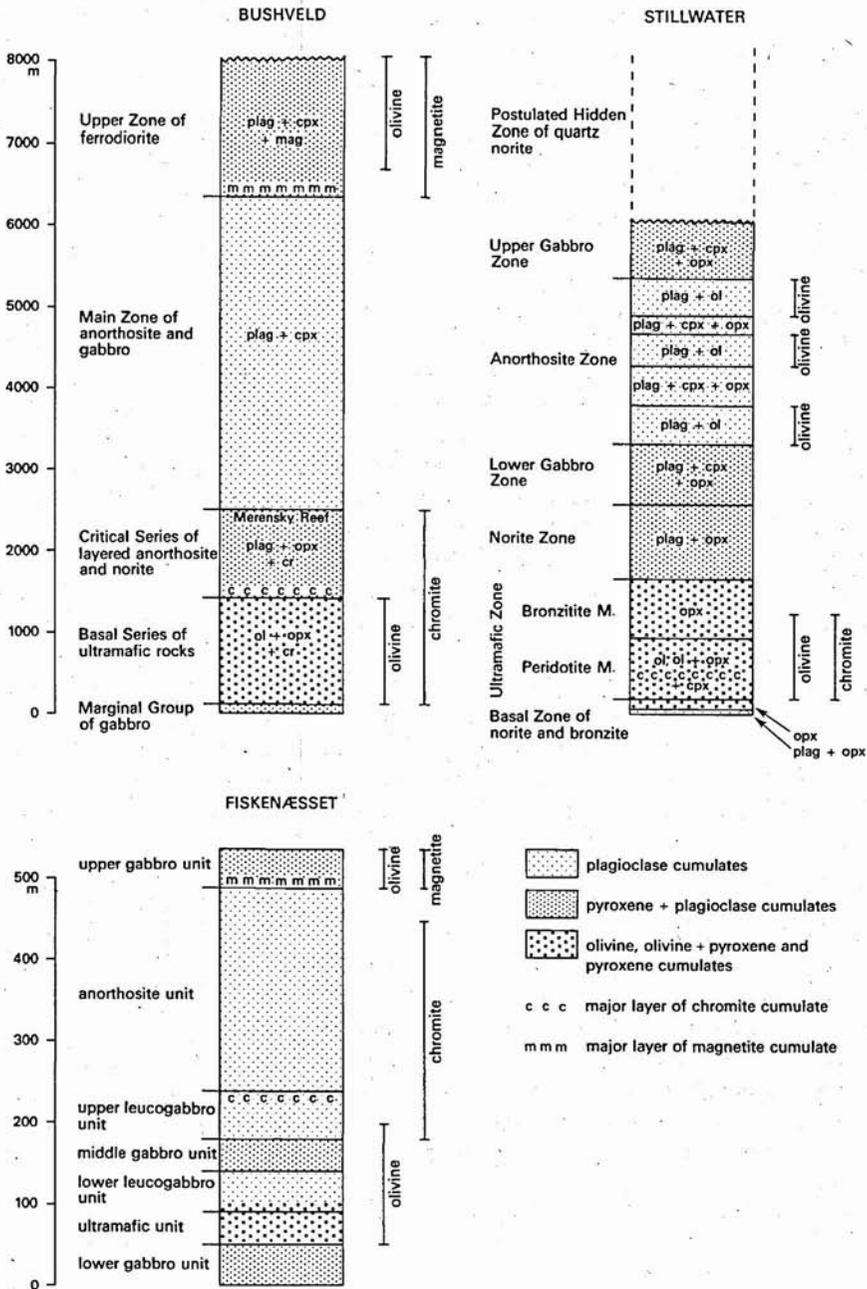


Fig. 29. Comparison of the simplified stratigraphies of the Bushveld, Stillwater and Fiskensæset complexes. Bushveld complex after Wager & Brown (1968, p. 351); Stillwater complex, Basal and Ultramafic Zones after Page & Nokleberg (1974), other zones after Hess (1960, p. 50). Note the different scale of the Fiskensæset complex compared with that of the Bushveld and Stillwater complexes. Abbreviations: plag – plagioclase, ol – olivine, opx – orthopyroxene, cpx – clinopyroxene, cr – chromite, mag – magnetite.

All these three layered intrusions are composed of a unit of gabbro at the bottom which is overlain successively by major units of ultramafic rocks, gabbro, and anorthosite, with a major unit of gabbro, norite or diorite at the top. All three intrusions, like the Skaergaard intrusion, show upward enrichment in iron (Wager & Brown, 1968). In the Bushveld and Fiskensæset complexes cumulus chromite was precipitated early and cumulus magnetite late in the sequence, as in the Cuillin layered intrusion of Skye (Wager & Brown, 1968, p. 423). Cumulus olivine was precipitated early (fig. 29), and then after its absence in the middle part of the Bushveld and Fiskensæset sequences, it appears as a cumulus phase in the uppermost part of the intrusions. A similar situation exists in the Skaergaard intrusion and is explained in terms of fractionation of the system $MgO-FeO-SiO_2$ (Wager & Brown, 1968).

The distribution of chromite in the Fiskensæset complex appears to be slightly different from that in the Bushveld and Stillwater complexes where chromite mainly occurs in the ultramafic zones with cumulus olivine and bronzite. In the Fiskensæset complex most chromite was precipitated after the accumulation of olivine in the lower part of the intrusion. Although this situation is very different from the Stillwater complex and the Basal Series of the Bushveld complex, it is similar to that in the Critical Series of the Bushveld complex where chromite was intermittently precipitated with bronzite and plagioclase and formed thin contrasting layers of plagioclase-rich and chromite-rich cumulates, similar to layers in the upper leucogabbro and anorthosite units of the Fiskensæset complex. When the thickness of the Fiskensæset complex is considered, the similarity between the Fiskensæset complex and the Critical Series of the Bushveld complex is even more marked.

The Fiskensæset complex differs from the Bushveld and Stillwater complexes in that it is strongly deformed and metamorphosed, and mainly consists of hornblende rather than pyroxene- or olivine-bearing rocks. But it is not known whether most of the hornblende was derived from igneous hornblende or pyroxene. In spite of modifications by deformation, the original thickness of the Fiskensæset complex does not appear to have approached the thickness of the Bushveld and Stillwater complexes.

Conclusions

The general stratigraphy of the Fiskensæset complex is therefore not as unusual, compared with the Bushveld and Stillwater complexes, as was thought previously (Windley *et al.*, 1973). Although each layered intrusion shows a unique sequence of events, the general sequence of crystallisation and the processes which governed it appear to be similar in these three major layered intrusions.

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Detailed mapping in the southern part of the Ilimaussaq alkaline intrusion, South Greenland

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Detailed mapping was continued during the 1975 field season in the southern part of the Ilimaussaq intrusion (Andersen *et al.*, 1973; Andersen, 1974). Work was aimed at elucidation of the age relationships between the main rock types: sodalite-foyaite, naujaite, black arfvedsonite-lujavrite and green aegirine-lujavrite.

One of us (S. A.) enlarged the detailed map of the lujavrite breccia by another 1.5 km² in the region of Agpat. The geological pattern in this area corresponds to that previously found around hill 435 m although it is now clear that two generations of green lujavrite can be distinguished in addition to the black lujavrite. The older generation of green lujavrite pre-dates the black lujavrite. In contrast, the younger generation is contemporaneous with the black lujavrite and formed from the same magma pulse. This development endorses the