Geology and Structure of Gjerøy, Nordland

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The island of Gjerøy is made up of acid gneisses with subordinate mixed gneisses which are tightly interfolded with banded gneisses and associated metasediments. The early tight folds are refolded to produce a large-scale interference pattern. Basic sheets which cut the migmatitic banding in the acid gneisses are themselves metamorphosed at amphibolite facies and folded by the earlier set of tight folds. The relationship of the banded gneisses and metasediments to the basic dykes is unclear and the problem of the stratigraphic ages of these rocks unresolved.

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Introduction

The island of Gjerøy (approx. 66°36'N, 12°20'E) lies 10 km north of the Arctic Circle and approximately the same distance west of the Norwegian mainland. Its geology has never been described but immediately adjacent areas have been mapped by Holmsen (1932), Rutland & Nicholson (1965) and Vreeken (1979). On large-scale compilation maps the area has been assigned to the basement (with parautochthonous cover) by Rutland & Nicholson (1965).

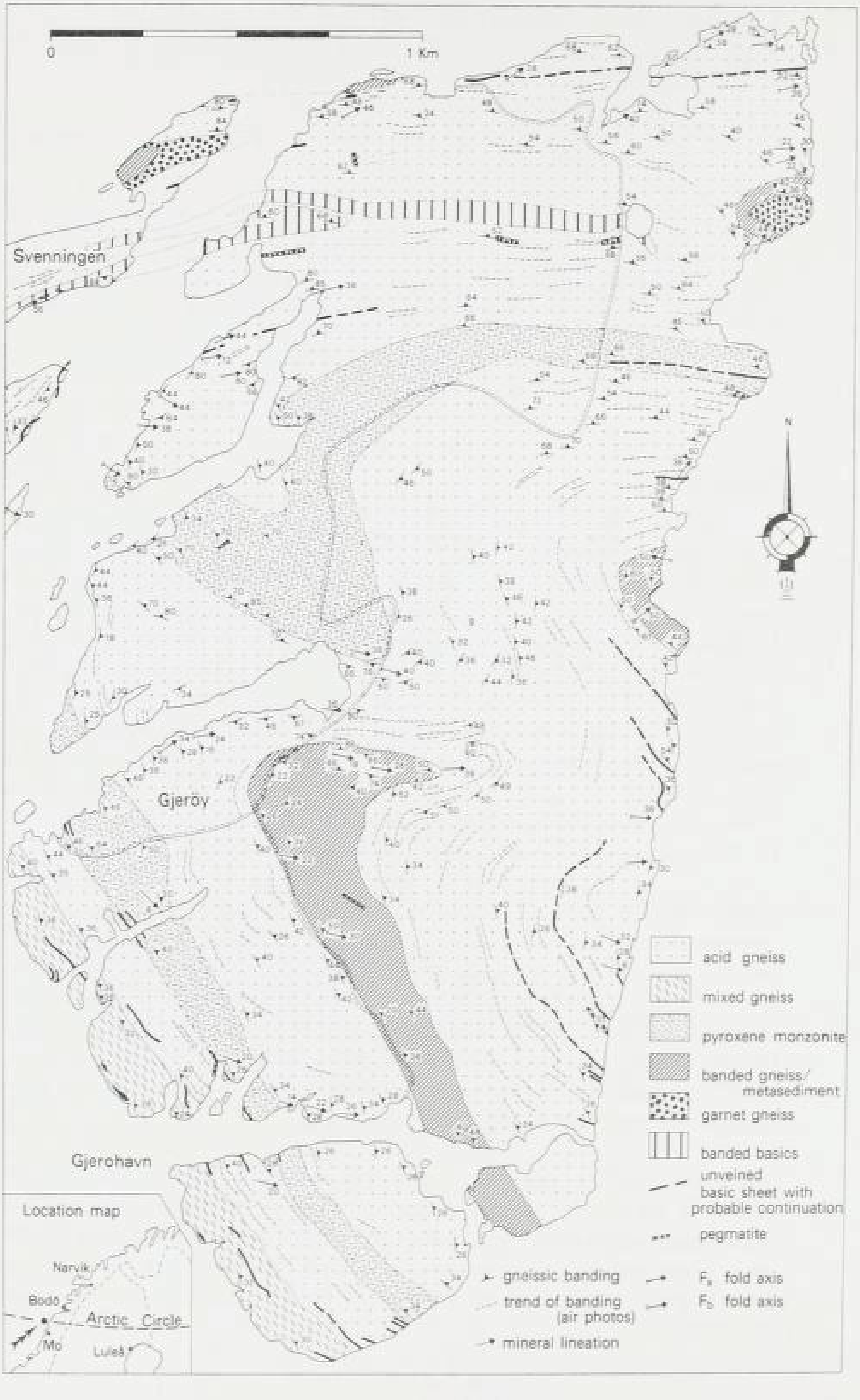
Reconnaissance mapping by the writer during the summer of 1979 shows the island to consist of veined granitic gneisses interfolded with paragneisses of similar metamorphic grade. A large-scale pattern of interference is produced by two sets of folds.

This paper with the accompanying map (Fig. 1) provides a short account of the lithologies, structures and geological history of the island.

ROCK TYPES

Acid gneisses: Most of the island is made up of coarse-grained microcline-rich quartzo–feldspathic gneiss with small amounts of khaki-brown biotite and often with a blue-green amphibole as well. Sodic plagioclase and microcline commonly occur together as perthites. A plane-parallel arrangement of quartz–feldspar veining sometimes produces a banding (Fig. 2f) which is itself paralleled by a weak mineral foliation defined largely by mica and amphibole. Elsewhere, veins are ptygmatically folded (Fig. 2a).

Mixed gneisses: This group of gneisses occupying the SW coastline and the NW tip of the island is more heterogeneous than the granitic gneisses, and has darker components occupying small pods and thin bands with diffuse boundaries. These mafic components contain a blue-green amphibole often accompanied by clinopyroxene. This rock type is transitional to the banded basics described below.


0
1 Km
Svenningen
Gjeröy
Gjerohavn
N
acid gneiss
mixed gneiss
pyroxene monzonite
banded gneiss/ metasediment
garnet gneiss
banded basics
unveined basic sheet with probable continuation
pegmatite
gneissic banding
trend of banding (air photos)
mineral lineation
F_a fold axis
F_b fold axis
Location map
Narvik
Bodö
Arctic Circle
Mo
Luleå

A string of pods of larger size runs parallel to the SW coast following the strike of the rocks and reappears on the island of Svenningen and in the NW tip of the island (Fig. 1). Some of them are feldspar-free and consist of hornblende, clinopyroxene and sometimes biotite. Another pod on the SW corner of the main island has a mottled appearance. In thin-section this appearance can be seen to be produced by large labradorite crystals which have enclosed equant epidote and clinopyroxene crystals.

Pyroxene monzonite: A distinctive rock because of its homogeneity and lack of veining, this monzonite/monzodiorite forms an important marker on the map (Fig. 1). The monzonite is often foliated and locally shows a faint banding (Fig. 2b). The dark minerals defining the banding are clinopyroxene and hornblende. In thin-section, plagioclase, alkali-feldspar, quartz, clinopyroxene and hornblende are interpreted as magmatic minerals whilst hastingsite is secondary and has replaced the pyroxene.

Banded gneisses and metasediments: Within fold cores in the central part of the island and on the east coast, a group of rocks occur which are made up predominantly of banded gneiss (Fig. 2d, 4a and 4b). The banding is defined by an alternation of quartz–biotite-rich and hornblende (±garnet)-rich layers. Calc-silicate rocks, together with sillimanite–biotite gneisses, garnet–biotite gneisses and occasional thin quartzites, make up the rest of this group. The banded gneisses and metasediments are grouped together by virtue of their close field association. The nature of the source material of the former rocks which show an extremely regular banding is obscure. On a mesoscopic scale the are S-tectonites (Flinn 1965, Lisle 1977) and resemble gneiss-types whose field appearance is deduced to have been brought about by the imposition of a finite strain of flattening-type and of large magnitude (Myers 1978).

The boundary between these rocks and the acid gneisses is everywhere sharp and concordant with the banding in rocks on both sides of the boundary, but a few isolated layers of garnetiferous gneisses occur well within the acid gneisses (Fig. 1).

Veined basics: A particularly thick sheet of basic gneiss of this type extends E to W across the north end of the island and is composed essentially of a hornblende, andesine and clinopyroxene (Fig. 2e). Other thin layers with similar field characteristics fall into this group and contain biotite. The occasional presence of small amounts of microcline and of veining in these basics suggests that they are older than the migmatization which took place in the granitic gneisses.

Unveined basics: The rocks for which this field name was used occur in thin sheets (Fig. 2c, 2f), sometimes folded or boudinaged and lacking the veining and internal lithological banding typical of the rocks described above. They are hornblende–biotite schists. The hornblende now has less of a blue tint than in

Fig. 1. Geological map of Gjerøy.

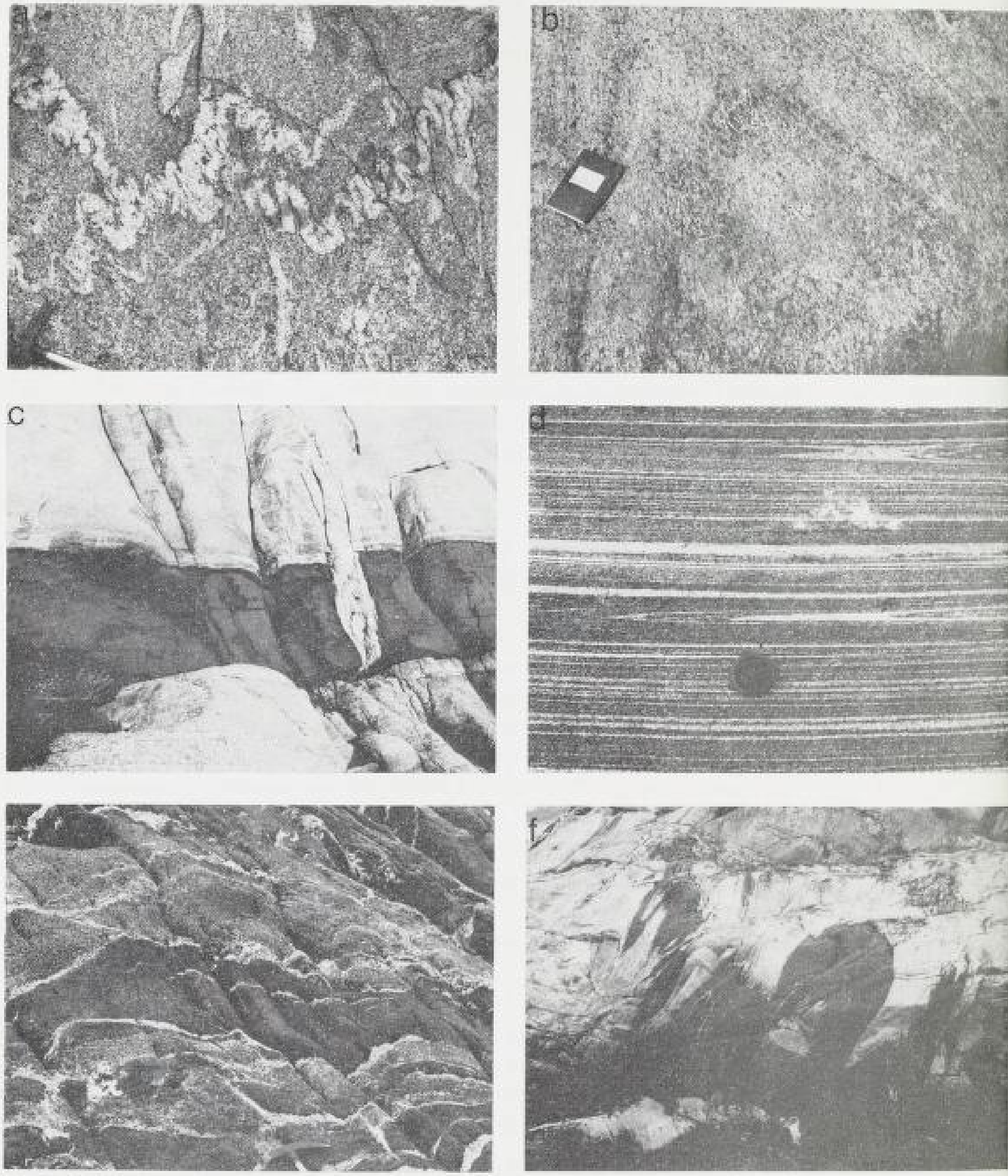


Fig. 2. Lithologies and structures. (a) Acid gneiss with ptygmatic veining. (b) Strongly foliated pyroxene monzonite. (c) Concordant unveined basic sheet. (d) Banded gneiss with isoclinal Fa folds. (e) Basic sheets with internal banding and veining, Svenningen. (f) Discordant unveined basics cutting acidic gneisses.

the veined basics and the plagioclase is andesine. In rare cases these sheets are discordant to the migmatic banding in the veined gneisses (Fig. 2f). These are

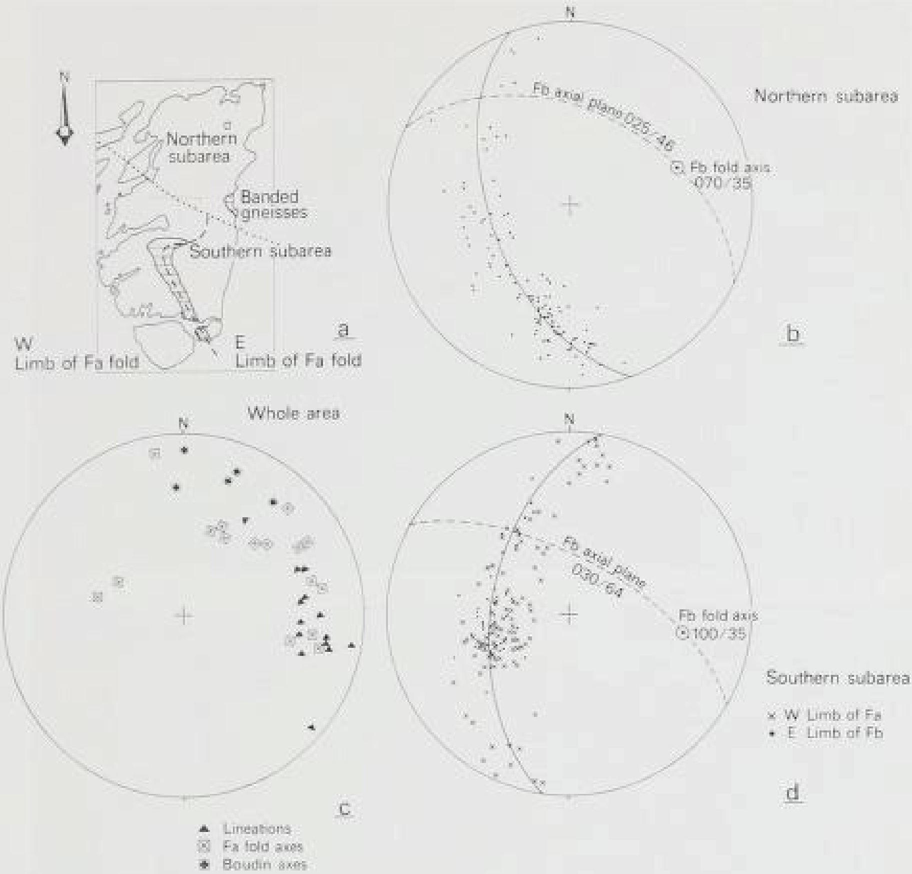


Fig. 3. Stereograms showing structural data, Gjerøy. (a) Location of subareas. (b) & (d) Equal-area plots of gneissic banding in the northern and southern subareas respectively. (c) Plot of other structures from the island as a whole.

interpreted as dykes intruded into the acid gneisses after migmatization of the latter. These rocks are finer grained than the basics mentioned earlier and lack pyroxene and microcline.

STRUCTURES

The configuration of the various geological units of the map is the result of the superimposition of a set of folds (termed Fb folds) with SE-trending axial surfaces upon a set of tighter folds (called Fa folds) whose axial surfaces are consequently of variable orientation.

Fa folding: Large-scale tight folds have produced a piling-up and interfolding of the lithological units. Although the axial planes of these folds have later been folded, they show a sheet dip in the direction of their axes. The geometry of the folds as seen in true profile can be appreciated by viewing the map (Fig. 1) down the plunge of the folds (eastwards with an angle of plunge of

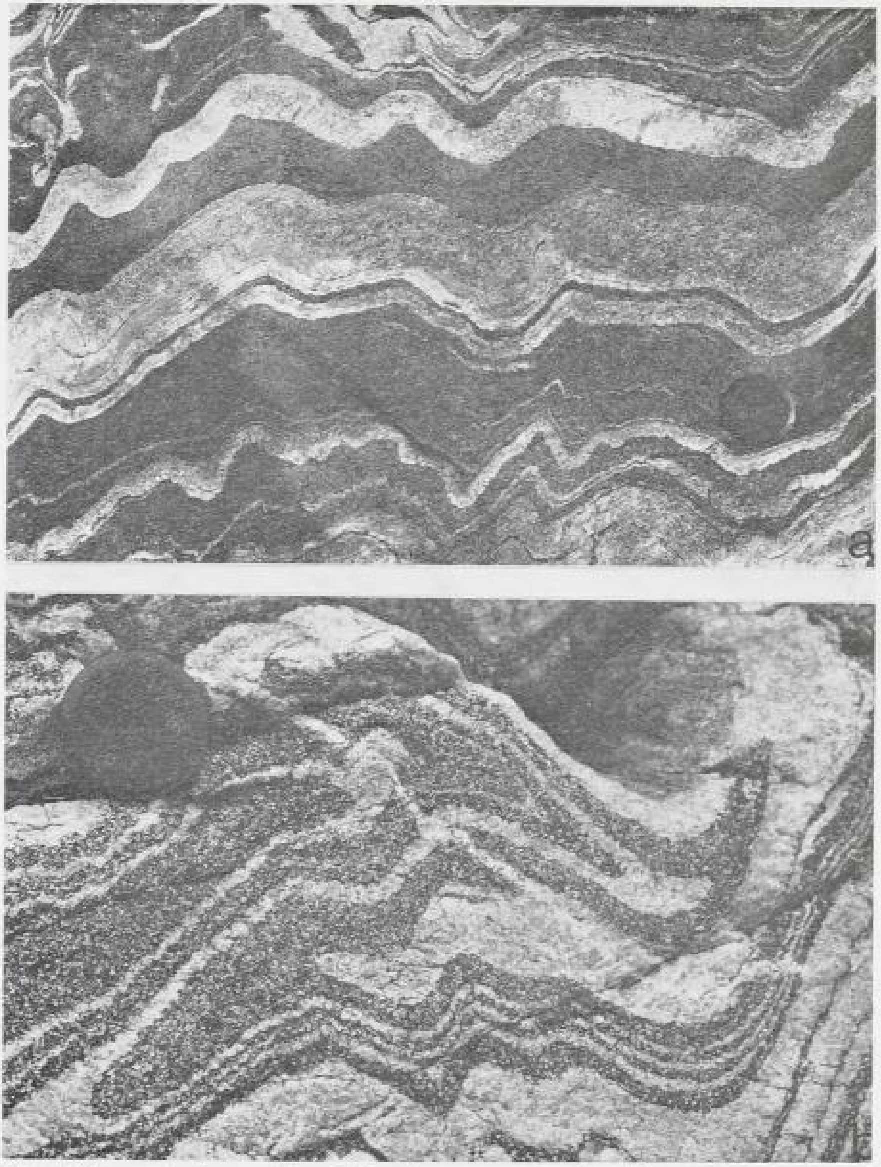


Fig. 4. Mesoscopic Ramsay Type 3 interference patterns (banded gneisses, Svenningen) comparable to the large-scale pattern of Fig. 1. The gentle to open Fb folds have steep axial planes and refold the tight to isoclinal recumbent Fa folds.

30°). On an outcrop scale these are tight to isoclinal folds with axial surfaces subparallel to the dominant gneissic banding (Fig. 2d, 2f). Equal-area plots of gneissic banding (Fig. 3a, 3b) therefore also reflect the variability of Fa axial surface orientations. This folding postdates the intrusions of the unveined basics as the latter show Fa folding (Fig. 2f) and it is possible that some folds in the acid gneisses (e.g. Fig. 2f) could be older than the Fa folds. A mineral foliation (and lineation) invariably seen parallel to the gneissic banding is assigned to a deformation which predates the Fa folding, whereas the foliation developed in the unveined basics is attributed solely to Fa deformation. Boudinage of these basic bodies is also assigned to the later deformation.

Fb folding: This folding is mesoscopically developed almost exclusively in the banded gneiss/metasediment lithologies (Fig. 2f). It deforms the lithological banding and mineral foliation without the development of a new axial plane foliation. The Fb axes and their axial planes vary considerably (cf. Fig. 3a, 3b) while those of the Fa folds (Figs. 1 and 3) vary with them and within the same range, indicating that their interference is of a coaxial type (Ramsay Type 3). In the banded gneisses, a rock type apparently suited for the development of mesoscopic folds, small-scale interference patterns occur equivalent to those developed on a large scale (Fig. 4a and 4b).

GEOLOGICAL HISTORY

The unveined basics have proved useful for distinguishing metamorphic events on this island. These sheets are discordant to a migmatitic banding in the granitic gneisses and these gneisses, which are muscovite-free, are considered to have attained at least amphibolite facies before the intrusion of the basic sheets. The metamorphism of the sheets themselves is also at amphibolite facies; a second metamorphism separated from the first by dyke intrusion. The second metamorphism would have to be vewed as simultaneous with Fa folding if the foliation in the dykes were regarded as associated with Fa folding itself. A third metamorphic event of low-grade character is recorded in the pyroxene–monzonite with the growth of stilpnomelane and hastingsite.

The age of the metasediments/banded gneisses poses a problem. The rocks are clearly older than the Fa folding but their relationship to the unveined basics is unclear. The lack of quartzo–feldspathic veining and K-feldspar in these rocks may be an indication of their age (i.e. younger than the migmatization) but the occurrence of sillimanite (one thin-section possesses two generations of this mineral) could be related to either of the first two metamorphic events. The age of the pyroxene–monzonite is similarly problematical. The foliation in this rock, seen in one instance to be axial planar to Fb folds (Fig. 2b), developed during the lower grade metamorphism. Complementary structural evidence of the age of the pyroxene–monzonite comes from the fact that the sheet itself is folded by Fb folds (Fig. 1), and the latter post-date the higher grade metamorphism as they fold the dominant foliation is most rock-types which is defined by amphibolite facies minerals.

These deductions about the relative age of structural, metamorphic, igneous and sedimentation events are set out in Fig. 5 where tie-lines are used to join two events whose relative ages are known.

REGIONAL COMPARISONS

Vreeken (1979), working on the Nordvernes area on the mainland due east of Gjerøy, argues for a Precambrian age for similar rocks which include meta-

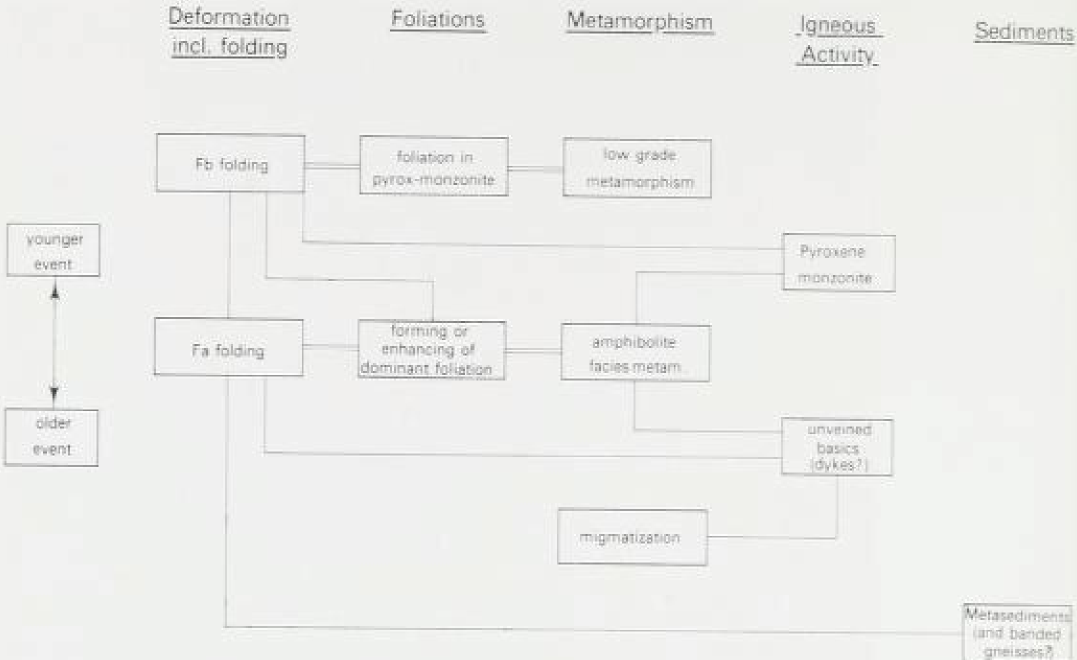


Fig. 5. Geological event network for Gjerøy. Pairs of geological events whose age relationships have been observed are linked by tie-lines. The younger member of such a pair occurs higher in the network than the older member of the pair. Events linked by a double tie-line are equivalent in age. Pairs of events not directly linked by tie-lines are events whose relative ages could not be determined by direct observation. In some cases however, the relative age of a pair of events can be inferred if events are indirectly linked by tie-lines. The relative height in the network of such events cannot be used as an indication of relative age unless the path defined by the tie-lines linking them are monotonic (always increase or decrease in age). Paths involving minima or maxima link events whose relative ages cannot be deduced.

sediments on the basis of the associated ultrabasic bodies. He does this by comparing the characters of these bodies with descriptions of such bodies from Precambrian and Palaeozoic rocks given by Moore & Qvale (1977). As similar bodies do not occur on Gjerøy, similar criteria cannot be applied. However, rocks of the Meløy Group, which according to Rutland & Nicholson (1965) are of Lower Palaeozoic age, are shown on the map of these authors to occur on the south end of Rødøy (the island immediately north of Gjerøy). The Gjerøy banded gneisses and metasediments differ from Meløy Group descriptions in being less psammitic and lacking calcareous lithologies. The possibility of a Precambrian age for the Gjerøy metasediments thus remains open.

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