Summary, discussion and conclusions

Recent developments in research of Archaean crustal processes increasingly favour that 'plate tectonics' was the principal geotectonic framework by the Middle Archaean and possibly even before (e.g. Condie, 1994), and this view forms a starting point for a discussion of the origin and setting of the Fiskefjord supracrustal association and orthogneisses. The two most important recent advances towards a general acceptance of plate tectonics in the Archaean are (a) a better understanding of the architecture of orthogneiss complexes by precise zircon dating supported by modern structural analysis, and (b) the realisation based on geochemical data and laboratory experiments that partial melting of wet ocean floor basalts may have produced voluminous Archaean tonalites and trondhjemites during subduction, if the subducted ocean floor was hotter than it is at present (see p. 93). In contrast, the locus of origin for more recent calc-alkaline magmas in convergent plate settings is the mantle wedge above the subducted oceanic plate.

Distinctive features of orthogneiss and the supracrustal association in the Fiskefjord area

The orthogneiss terrain of the Fiskefjord area, taken as a whole, resembles many other Archaean high-grade orthogneiss complexes in various parts of the world (e.g. compilation by Martin, 1994). There is substantial field evidence that the orthogneisses are younger than the supracrustal rocks. Most of them form a typical tonalite-trondhjemite-granodiorite (TTG) suite with felsic, predominantly sodic end members and only small volumes of younger granites. Dioritic and mafic tonalitic rocks, which are *c.* 200 Ma older than the main tonalites, represent an early continental nucleus (see Table 1). Geochemically the tonalites and trondhjemites are characterised by a fairly large range of major element compositions, negative Nb and Ta anomalies in spider diagrams normalised to mantle abundances, and steep chondrite normalised REE patterns with strongly depleted HREE. The Qeqertaussaq diorite with its unusual pattern of geochemical enrichment (much weaker than, but reminiscent of lamproitic rocks) forms a separate unit.

The early tonalitic orthogneiss precursors were intruded into the supracrustal rocks as sheets, which were subsequently multiply folded together with their supracrustal host rocks in a tectonic regime dominated by lateral forces. Subsequent tonalite-trondhjemite and tonalite-granodiorite intrusions into the folded orthogneiss–amphibolite associations formed large, composite, dome-shaped plutons, which only rarely contain supracrustal enclaves but in places carry fragments of cogenetic hornblende-plagioclase cumulate rocks. In addition, much smaller domes with cores of trondhjemitic compositions were formed. The accretion of orthogneisses culminated with thermal granulite facies metamorphism, and both this and subsequent widespread retrogression severely disturbed the LIL element contents of the orthogneisses. After the culmination of deformation and metamorphism the orthogneisses were partially remobilised, giving rise to localised sheets and small domes of granodioritic and granitic rocks that are contemporaneous with or postdate the retrogression.

It was shown above that homogeneous amphibolite is the most common member of the supracrustal association in the Fiskefjord area – notwithstanding the notion that the association may comprise more than one originally independent sequences intruded by *c.* 3220 and, in turn, 3000 Ma orthogneiss precursors. The chemical composition of the homogeneous amphibolite resembles that of modern ocean floor basalt except for a variable enrichment of mobile incompatible elements (illustrated by Sr, K, Rb, Ba, and Th on Fig. 24) and a lower TiO_2 content. The enrichment of mobile LIL elements in homogeneous amphibolite relative to modern MORB is likely to have been caused by contamination after emplacement and is probably not a primary feature. The supracrustal association contains fragments of large layered complexes which include cumulate noritic and ultrabasic rocks, but whereas ultrabasic lava is known from other parts of the Archaean craton of West Greenland (see next section), komatiitic rocks or high-magnesium basalts have not been recognised in the Fiskefjord area. Sheeted dyke complexes have likewise not been found; they may however be present but not recognised due to deformation and metamorphism. Metasediments are very insignificant, and quartz-rich clastic rocks are almost absent; furthermore, no basement to the supracrustal rocks has been identified. In spite of their poor and fragmented state of preservation the supracrustal rocks thus possess some similarities with ophiolite complexes.

Middle to Late Archaean supracrustal rocks in adjacent terranes within the Archaean block of southern West Greenland

Only a relatively small part of the Middle to Late Archaean supracrustal rocks in southern West Greenland have been investigated in detail, especially with regard to their geochemistry. Summaries of such studies have been presented by Rivalenti (1976) and Hall *et al.* (1990); see also references in Kalsbeek & Garde (1989). The supracrustal sequences are all dominated by tholeiitic amphibolites, but they occur within terranes of different ages (magmatic accretion of their orthogneiss hosts spans from *c.* 3050 to 2800 Ma) and some contain significant components of metasedimentary rocks. They are thus not directly comparable. The thickest and most complete sequences comprise both pillowed ultrabasic metavolcanic rocks and tholeiitic metabasalts besides other supracrustal rocks. In the Tasiusarsuaq terrane they occur at Ravn Storø and Bjørnesund (Fiskenæsset region), and in the Akulleq terrane at Ivisârtoq north-east of Godthåbsfjord (Andersen & Friend, 1973; Hall, 1980; Friend *et al.*, 1981; Chadwick, 1986, 1990; Hall *et al.*, 1987). Isortuarssup tasia, a thinner and geographically more restricted sequence in the Fiskenæsset region, was studied by Stecher (1981). The geochemical study by Weaver *et al.* (1982) at Qeqertarssuatsiaq in the same region mostly comprised amphibolites of gabbroic origin associated with anorthositic rocks. The Fiskenæsset region also contains small volumes of andesitic and more leucocratic metavolcanic rocks ('grey amphibolite'), which may have formed in an island arc setting (Wilf, 1982). Along the south-eastern margin of the Akia terrane a *c.* 2 km thick sequence dominated by amphibolites and possibly including komatiitic supracrustal rocks occurs on the Nuuk peninsula, Sadelø and Bjørneøen in outer Godthåbsfjord (Bridgwater *et al.*, 1976; Olsen, 1986; Appel & Garde, 1987; McGregor, 1993). Primary structures such as pillow lavas are fairly common in all these supracrustal rocks, the metamorphic grade is lower (middle to upper amphibolite facies), and most of them are more complete and less deformed than those preserved in the Fiskefjord area. However, a gradual transition from a coherent 'greenstone belt' sequence into fragmented supracrustal rocks in a 'high-grade grey gneiss – amphibolite' setting can be observed at Bjørnesund (Andersen & Friend, 1973; Garde *et al.*, 1991).

As in the Fiskefjord area, a basement to the supracrustal rocks has not been identified anywhere in the above mentioned areas. The supracrustal rocks in the Fiskenæsset region are intruded by Middle to Late Archaean orthogneisses and also tectonically interleaved with them, and the Ivisârtoq supracrustal rocks have been tectonically juxtaposed against early Archaean Amîtsoq gneisses (Hall & Friend, 1979; Chadwick, 1985, 1986). It was furthermore shown by Hall (1982) on chemical grounds that the Ivisârtoq metabasalts are unrelated to the Ameralik dykes, a major mafic Archaean dyke swarm that has intruded the nearby Early Archaean Amîtsoq gneiss.

The chemical compositions of the tholeiitic metabasalts at Ivisârtoq and in the Fiskenæsset region resemble that of the homogeneous amphibolite in the Fiskefjord area with respect to most major and trace elements, and it may be significant that they also have relatively low TiO_2 contents (see Hall *et al.*, 1990, p. 256). The main difference is the much lower LIL element content (e.g. $K_2O < 0.30\%$ and Rb <15 ppm) in most of the former rocks (Weaver *et al.*, 1982; Hall *et al.*, 1990), which is regarded by the author to reflect a more pristine state of preservation than in the Fiskefjord area. Friend *et al.* (1981) and Hall *et al.* (1990) discussed possible chemical affinities of the basic metavolcanic suites at Ivisârtoq, Ravn Storø and Isortuarssup tasia to modern tholeiitic basalts in various settings. They concluded that the metabasalts all have similar tholeiitic compositions, and although their chemistry alone does not indicate a direct affinity to any particular modern tholeiite setting, their field settings suggest an origin as ocean floor basalts. Regarding the amphibolites at Qeqertarssuatsiaq, Weaver *et al.* (1982) concluded on the basis of trace element data that an ocean floor setting is the most likely of several possible tectonic environments.

Discussion

Archaean upper mantle and oceanic crust

Both the field setting of the Fiskefjord amphibolites and their geochemical similarity with modern MORB – with the above mentioned qualifications – are compatible with an origin as ocean floor basalts. The same is true for other amphibolite-dominated supracrustal sequences in West Greenland. However, despite the recent trend towards a general acceptance of plate tectonics in the Archaean, unquestionable ocean floor sequences of Archaean age have not yet been identified (see p. 92), and it has not been settled if Archaean MORB had a composition similar to that of modern MORB. It is also still debated how important plate tectonics were in the Archaean, and if Archaean plate-tectonic processes were identical to those that are generally accepted to have operated since the Early Proterozoic. In as much as any interpretation of the supracrustal rocks in the Fiskefjord area must in the first place be evaluated against their poor state of preservation, it is not appropriate to introduce a lengthy discussion of each of these problems. However, a few central points are relevant in the present context.

One such point, which refers to the role of plate tectonics in general, is how the elevated interior heat production by radioactive decay in the Archaean earth was expressed in crustal processes. The fact that the metamorphic zonation of most Archaean continental crust suggests a moderate geothermal gradient implies that the excess heat from the mantle was channelled to the surface elsewhere. Komatiites provide unequivocal evidence of formerly superheated ultrabasic magma (probably from a deep mantle source), and are indicative of localised ambient mantle temperatures at least *c.* 200° and perhaps up to 400°C hotter than in post-Archaean times (e.g. Sleep & Windley, 1982; Jarvis & Campbell, 1983; Campbell & Jarvis, 1984; McKenzie, 1984). It has also been assumed that the Archaean oceanic crust was both hotter and thicker than at present (Sleep & Windley, 1982; Bickle, 1986) due to a steep geothermal gradient in the oceanic regions. The common assumption that the Archaean oceanic crust was on the average much more short lived than today (due to vigorous production of mantle-derived basaltic rocks) implies that it was also generally hotter, simply because cooling of the ocean floor is known to be a very slow process (see e.g. Martin, 1986, 1993; Drummond & Defant, 1990; Tarney & Jones, 1994). Some authors have taken this view even further, suggesting that the heat flow was so high that the uppermost part of the Archaean mantle was not sufficiently rigid to support plate-tectonic processes, and that the formation of continental crust – at least in the Early Archaean – took place by vertical sagging from oceanic plateaus much like those supposed to exist on Venus (Hamilton, 1993). However, komatiites, with their direct evidence of elevated Archaean mantle temperature, only make up a small proportion of surviving Archaean supracrustal rocks and are by no means ubiquitous in Archaean supracrustal terrains. Campbell *et al.* (1989), Campbell & Griffiths (1992) and others have suggested that while hot plumes produced localised komatiites, much more voluminous ocean floor basalts with MgO contents of less than 12% were produced by passive upwelling from mantle sources with 'normal' temperatures around 1300°C, located under mid-ocean ridges. In other words, the high mantle temperatures related to komatiite production need not have been characteristic for the Archaean upper mantle as a whole, were not necessarily reflected in elevated crustal geothermal gradients worldwide, and do not preclude the operation of plate tectonics in the Archaean.

Also the chemical evolution of the upper mantle in the early part of the Earth's history is uncertain (e.g. review by Bickle, 1990). Early to Late Archaean komatiites from several parts of the world are variably depleted in LREE and other incompatible elements and have positive εNd values (e.g. Collerson *et al.*, 1991; Bennett *et al.*, 1993), and a similar but less marked depletion occurs in associated tholeiitic basalts (e.g. Sun & Nesbitt, 1978; Campbell *et al.*, 1989). Although some of these rocks may have experienced later geochemical disturbance, this indicates that MORB-like, moderately depleted mantle had formed already by the Early and Middle Archaean, and is considered by some authors to have been a common source of mafic and ultramafic rocks. However, as pointed out, e.g. by Arndt (1994), komatiitic rocks are probably not an adequate sample medium for contemporaneous upper mantle. Besides, some komatiites and basalts in Archaean greenstone belts show evidence of crustal contamination, commonly in the form of high-MgO rocks which also have high contents of SiO_2 and incompatible elements and negative Nb anomalies, or they contain xenocrystic zircons of continental crustal origin. The evidence of contamination impedes estimates of the compositions of both the Archaean mantle itself and its direct melt products. The matter is further complicated by widely differing estimates of (a) the growth rate of the early continental crust (reviewed by Taylor & McLennan, 1985) and hence the net amount of overall mantle depletion during the Archaean, and (b) the patterns of Archaean mantle convection. The latter has an important bearing on the effectiveness of its contemporaneous chemical homogenisation (e.g. Bickle, 1990; Campbell & Griffiths, 1992) and (as stated above) whether komatiites can be used at all for estimates of upper mantle composition (Arndt, 1994). In conclusion, the composition of Archaean MORB may not in all respects have been close to that of modern MORB.

Controversy about the recognition of ancient oceanic crust in Archaean cratons adds to the uncertainty about Archaean crustal evolution in general and the role and nature of plate tectonics in particular, and is illustrated by a recent paper by Bickle *et al.* (1994). These authors examined a number of extensively studied Archaean greenstone belts in the world: the Belingwe greenstone belt in the Zimbabwe craton, the Barberton greenstone belt in the Kaapvaal craton, the Kambalda and other greenstone belts in the Yilgarn and eastern Pilbara cratons of Western Australia, and various greenstone belts in the southern Slave and Superior provinces of Canada including the Abitibi belt. All of these greenstone belts have been or are currently interpreted as (containing) remnants of oceanic crust, but for various reasons they were all rejected as such by the above cited authors. Several of the examined greenstone successions have (arguably) been laid down on a continental basement (some contain basal conglomerates), others show signs of contamination by continental crust during their ascent or emplacement, others again contain thick sequences of shallow-water sedimentary rocks, and none contain complete ophiolite sequences (as defined by the Geological Society of America, Anonymous, 1972). Bickle *et al.* (1994) concluded that although no indisputable fragments of Archaean oceanic crust have yet been found, it probably did exist. This conclusion is probably fairly representative for the current state of the debate, although there are also strong proponents that some Archaean greenstone belts do indeed represent ocean floor sequences (e.g. de Wit *et al.*, 1987; Kusky & Kidd, 1992). Bickle *et al.* (1994) suggest that the search for Archaean ophiolite complexes should continue in other tectonic environments such as for instance the Fiskenæsset region in the high-grade Archaean block of West Greenland. However, it has been shown above that an inherent problem with this suggestion is the progressively more fragmentary preservation and likelihood of chemical alteration associated with the most high-grade supracrustal sequences.

Generation of Archaean continental crust

Contrary to the situation in those Archaean greenstone belts where komatiites attest to very high mantle temperatures of their source areas, most Middle Archaean high-grade cratons do not provide evidence of elevated geothermal gradients, neither in the continental crust itself nor in its underlying mantle. This is true for the regions of Early Archaean Amîtsoq gneiss within the Akulleq terrane immediately adjacent to the Akia terrane (e.g. McGregor *et al.*, 1991) and is also well documented in other, younger parts of the Archaean block of southern West Greenland (see Kalsbeek, 1976, references to general descriptions in Kalsbeek & Garde, 1989, and thermal modelling by Wells, 1979, 1980).

It has long been known that some orthogneiss terrains in Archaean continental cratons have chemical compositions that differ in several important respects from those of their Proterozoic and younger counterparts. Most, but not all intermediate and felsic plutonic rocks in Archaean cratons are characterised by calcic to sodic TTG suites and a relative scarcity of true granites (e.g. in Scotland, Weaver & Tarney, 1981, and eastern Finland, Martin, 1987), whereas younger orthogneiss suites are calc-alkaline with common granitic end members. Another example of these general differences has recently been beautifully displayed by Steenfelt (1994) in her compilation of regional stream sediment data from West and South Greenland: the major boundary between the orthogneisses in the Archaean craton of southern West Greenland and the Lower Proterozoic Ketilidian orogen to the south with its large calc-alkaline Julianehåb batholith stands out on the regional K and Ca plots of stream sediment compositions. The Ketilidian batholith has distinctly higher K_2O and lower CaO than the adjacent Archaean orthogneiss – at least at the crustal levels now exposed north and south of the boundary. Steenfelt's data (1994 and personal communication, 1995), however, also show that there are exceptions to this pattern; some members of the Archaean orthogneisses in the Disko Bugt region and in the Nagssugtoqidian orogen have high K_2O/Na_2O ratios and are relatively low in Ca, whereas the opposite is the case for juvenile Proterozoic rocks in the Nagssugtoqidian orogen.

In addition to their characteristic major element compositions, Archaean orthogneisses generally have steep REE patterns with a strong depletion of HREE, upward curving HREE ends and absent or weak Eu anomalies (e.g. Taylor & McLennan, 1985; Martin, 1994). This is also true for the West Greenland Archaean (e.g. O'Nions & Pankhurst, 1974; Compton, 1978) and, as already shown, the Fiskefjord area in particular – except that retrogressed grey gneiss members have distinct positive Eu anomalies. The generally favoured interpretation of these REE patterns is that the TTG magmas left a residuum rich in hornblende and garnet, which retained the HREE.

The different compositions of Archaean and younger granitoids have suggested to many authors (e.g. Martin, 1987, 1993, 1994; Arkani-Hamed & Jolly, 1989; Drummond & Defant, 1990) that they were formed by different processes: Proterozoic and younger magmas of calc-alkaline affinity are produced at destructive plate margins by a multistage process that begins with partial fusion of the mantle wedge above the subducted (or underplated) ocean floor. The fluids necessary to sufficiently lower the mantle solidus are liberated from the cold subducting slab by solid state dehydration. Typical Archaean TTG suites were not formed by this process, because the ultimate partial melt products from the mantle are too potassic and have different trace element characteristics, e.g. flat REE curves. Conversely, recent experiments by Rapp *et al.* (1991) and Winther & Newton (1991) have convincingly demonstrated that partial melting of hydrous low-K tholeiitic basalt can produce tonalites and trondhjemites in one stage with major element compositions closely comparable to those of real rocks, while leaving a hornblende- and garnet-bearing residuum (see also van der Laan & Wyllie, 1992). Winther & Newton (1991) showed that this is possible at temperatures and pressures that can be realistically reached in a hot subducted slab of ocean floor (Arkani-Hamed & Jolly, 1989); it is an important prerequisite for the production of TTG melts that the basalt source being subducted is sufficiently hydrated, as otherwise smaller amounts of granitic melts are produced at higher temperature and pressure. Alternatively the appropriate physical conditions for partial melting could be met in the lower part of a tectonically thickened pile of hydrated (ocean floor) basalt. The former of these two alternatives seems to be the most attractive one, both in the light of the common speculation that the Archaean oceanic crust was young and hot (e.g. Drummond & Defant, 1990), and when compared with modern analogues. Thus Martin (1993) drew attention to the situation in south Chile where subduction of very young ocean floor is spatially related to the production of andesitic lavas with HREE depletion similar to that found in Archaean TTG suites (Stern *et al.*, 1984a, b).

Isotopic and tectonic evidence of Middle to Late Archaean plate tectonics in southern West Greenland

Two decades ago Bridgwater *et al.* (1974) emphasized the role of horizontal tectonics in Archaean crustal thickening and juxtaposition of different lithologies. The paper was mainly based on observations from the Godthåbsfjord and Fiskenæsset regions. These authors also suggested as a working hypothesis that the underlying driving force was horizontal movements in the mantle, perhaps related to plate-tectonic processes. Nevertheless, in order to account for observed radiometric ages within a given geographical region it was then commonly assumed that in the Archaean, crustal processes might last well over 200 million years in so-called crustal accretion and differentiation superevents (CADS, Moorbath, 1976) which had no direct modern analogues.

Between 1985 and 1988 it was realised with the aid of precise zircon age determinations and modern structural analysis (Friend *et al.*, 1987, 1988a; Nutman *et al.*, 1989) that the region south of Godthåbsfjord contains several Archaean blocks or tectono-stratigraphic terranes (*sensu* Coney, Jones & Monger, 1980) which have different ages, consist of different lithologies, and have different magmatic, structural and metamorphic histories which each took place during relatively short periods of time. Studies elsewhere in southern West Greenland (Nutman *et al.*, 1993; Friend & Nutman, 1994; Nutman & Kalsbeek, 1994) and in other Archaean cratons (e.g. Nutman, 1991; de Wit *et al.*, 1992; Williams *et al.*, 1992; Myers, 1995) have subsequently indicated that the prior existence of many individual terranes in Archaean cratons is probably the rule rather than the exception. The accretion and differentiation of Archaean continental crust is now envisaged to have taken place in individual, relatively quickly developed terranes or microcontinents, with the implication that 'plate tectonics' in some form was active and important at least from the Middle Archaean.

Archaean geotectonics

Some aspects of Archaean crustal igneous and tectonic processes are now well understood. As just outlined, the terrane concept provides strong evidence of Archaean plate tectonics, although only small volumes of new crust were formed during the juxtaposition itself. There is also substantial, and in the view of the present author convincing experimental evidence, supported by geochemical modelling and compatible with field observations, that new Archaean continental crust (tonalites, trondhjemites and granodiorites) was generated by subduction and partial melting of wet tholeiitic ocean floor basalts; the process differs from modern accretion of calc-alkaline island arcs and continental batholiths, which form by mantle melting.

Other important facets of Archaean geotectonics are still not resolved. There is disagreement about the composition and thermal structure of both the Archaean upper mantle and oceanic crust, first of all because no indisputable sample of Archaean oceanic crust has yet been identified anywhere in the world, and because it is not known if komatiites were natural products of the major processes that formed the oceanic crust, or exceptions created by localised hot mantle plume activity. In addition, the very high production of new continental crust in most Archaean cratons in the short interval between approximately 3000 and 2750 Ma requires an explanation.

Plate-tectonic scenario of the Fiskefjord area

The field relationships, compositions, ages and structural evolution of most orthogneiss and related rock units in the Fiskefjord area are compatible with and suggestive of a convergent plate-tectonic environment. These rocks (tonalitic-trondhjemitic grey gneiss and tonalite complexes) have compositions which are consistent with an origin from subducted oceanic crust by melting of hydrated basaltic rocks and modified by subsequent crystal fractionation in the lower crust; mantle components are only likely to have been directly involved in the genesis of the Nordlandet dioritic gneiss and the Qeqertaussaq diorite precursors, but in different ways.

The early structures in the grey gneiss, subhorizontal(?) thrusts and two or several phases of recumbent isoclinal folds, would comply with conditions formed by lateral stress fields which might be expected in progressively deeper levels of a convergent plate margin. Possible directions of plate motion and subduction would be broadly east–west during the main, Smalledal and Pâkitsoq phases of deformation. The succeeding emplacement of large dome-shaped plutonic complexes and development of vertical structures, broadly contemporaneously with and succeeding the peak of metamorphism, may have been achieved at a stage when subduction was ceasing, the production of new continental crust had culminated, and the accumulation of heat in the middle part of the new crust reached its maximum and declined.

Remobilisation of part of the earlier formed orthogneisses and emplacement of localised granitic rocks then took place, perhaps associated with contemporary redistribution of mobile elements in the deeper part of the crust. The narrow linear high-strain zones with horizontal structures, which form a long-lived structural element in the evolution of the Fiskefjord area, may have developed in response to a gradual change from convergence of the inferred plates to transcurrent motion along an approximately north–south path, where the crust was still sufficiently ductile.

The intrusion of post-kinematic diorite plugs is not interpreted as directly related to plate-tectonic processes but was more likely due to subsequent underplating by ultramafic magma and apparently linked to the formation of the norite belt in the adjacent area to the north.

While the plate-tectonic scenario outlined above for the orthogneisses in the Fiskefjord area and their structural evolution is in part based on positive evidence (especially referring to the geochemistry of the TTG suites), the origin of the supracrustal association is much more speculative. The heterogeneous and homogeneous amphibolites, partially preserved layered mafic-noritic-ultrabasic rocks, and sporadic metasediments may represent fragments of one or more ophiolite sequences, but remnants of a sheeted dyke complex have not been identified, and cherty layers are so far not known. There may have been more than one group, separated in time by the accretion of the Nordlandet dioritic gneiss. Further, it has not been firmly established how much of the homogeneous amphibolite has been derived from extrusive volcanic rocks, subvolcanic sills, sheeted dyke complexes, layered complexes, or combinations of these possibilities.

The homogeneous amphibolite was probably chemically altered during or after its emplacement, but important geochemical similarities with better preserved Archaean tholeiitic metabasalts from neighbouring regions can still be recognised. However, even the origin of the latter rocks has not been proven – partly because of their likely contamination and metasomatic alteration, and partly because the detailed composition of a hypothetical Archaean MORB is not known. Nevertheless, the author favours the opinion that the supracrustal rocks in the Fiskefjord area represent relict oceanic crust, due to (1) the fact that no basement of continental crust has been identified (coupled with widespread evidence that the supracrustal rocks have been intruded by the orthogneiss precursors), and (2) the nature and in particular great scarcity of metasediments.

The simple plate-tectonic model presented above requires that early intrusions of orthogneiss precursors would have to be emplaced into oceanic crust. Xenoliths and fragments of mafic supracrustal rocks are actually present both in dioritic and tonalitic grey gneiss, but the picture is complicated by the fact that some of the dioritic gneiss represents an earlier continental nucleus. Furthermore, in the absence of age determinations of the supracrustal units, still more complicated tectonic scenarios could easily be advanced.

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