THE AGE AND STATUS OF THE BASAL GNEISS COMPLEX OF NORTH-WEST SOUTHERN NORWAY

DENNIS ANTHONY CARSWELL

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This paper presents a review of the evidence concerning the age and status of the Basal Gneiss Complex of north-west southern Norway. There seems little doubt that both 'Caledonized' Pre-Eocambrian basement rocks and Eocambrian-Lower Palaeozoic cover rocks occur within this complex, although it is extremely difficult to discriminate between them in the field.

It is suggested that occurrences of eclogites, granulites and calcic anorthosites in this region may be restricted to the Pre-Eocambrian basement, and hence may provide the most reliable means of distinguishing between basement and cover rocks in the field.

D. A. Carswell, Department of Geology, University of Sheffield, Sheffield S1 3JD, England.

On the geological map of Norway (Holtedahl & Dons 1960) a large proportion of north-west southern Norway is indicated as consisting mainly of gneissic rocks, of various origin, with a structure wholly or in part Caledonian. Following Holtedahl (1944) this area is usually referred to as the 'Basal Gneiss Region' and the rocks within this area as the 'Basal Gneiss Complex'.

This paper presents an assessment of the often divergent and contradictory results and conclusions of previous workers on the question of the age and status of the Basal Gneiss Complex, in the light of the author's own prejudices, based on field observations in many parts of the region but in particular on recent work in the Romsdalsfjorden region.

Before proceeding it is advisable to discuss some of the geochronological terms which will be used in this paper.

At our present state of knowledge it is perhaps desirable to retain the much used term 'Caledonian' to describe in broad terms the age of the orogenic activity (essentially Lower Palaeozoic) within the Caledonian orogenic belt. Thus within this orogenic belt the deformation, metamorphism and igneous activity may be referred to as being of 'Caledonian' age.

In the past the term 'Caledonian' has also been used very loosely in a time-stratigraphic sense to imply the depositional age of the rocks subjected to deformation and metamorphism during Lower Palaeozoic times in this orogenic belt. It is now apparent, however, that rocks of diverse ages (Early Precambrian basement rocks and both Late Precambrian and Lower Palaeozoic cover rocks) have been subjected to 'Caledonian' deformation and metamorphism in various parts of the orogenic belt.

It is therefore desirable to abandon the use of the term 'Caledonian' in a time-stratigraphic sense, and this procedure will be followed in this paper despite the problems which arise through the present lack of internationally standardized time-stratigraphic terms for the Precambrian.

In this paper emphasis is placed on distinguishing between the sedimentary and igneous rocks formed, metamorphosed and deformed within the Caledonian orogenic belt which are referred to as the *cover rocks,* and the older *basement rocks* upon which the former were deposited. The terms supracrustal and infracrustal rocks (e.g. Bryhni & Grimstad 1970), which are chiefly used with lithological rather than age connotations, will be avoided where possible.

The cover rocks are thought to have been deposited following the extensive Sveconorwegian-Grenville deformation, metamorphism and plutonism of approximately 1200–900 m.y. age (Welin 1966, Kratz et al. 1968) and thus to have depositional ages mostly within the range 900–450 m.y.

The rather unsatisfactory time-stratigraphic term 'Eocambrian' has often been used in the literature with reference to the cover rocks (Sparagmites) of Late Precambrian age ($>$ 600 m.y.) in Norway. However, the use of this term throughout the Caledonides raises problems, and is probably only valuable if it is acceptable to place the base of the Eocambrian at about 900 m.y.

The age of the basal gneisses

Early field geologists (Reusch 1881, Kolderup 1923) regarded the gneisses as forming the Archean (Precambrian) basement to the Cambro-Silurian metasedimentary rocks observed to overlie them, to the east in particular. However, Holtedahl (1936, 1938, 1944) considered these gneisses to have been too strongly influenced by Caledonian metamorphism, migmatization, granitization and deformation to be regarded simply as Precambrian, and described the derivation of some of these gneisses by feldspathization of 'Caledonian' metasediments.

Gjelsvik (1951) and Kolderup (1952, 1960) also thought the gneisses to be primarily of Eocambrian or Cambro-Silurian origin, while more recently Hernes (1965, 1967) has argued that they represent a late Precambrian succession.

Strand (1960) stated that 'work in recent years has in some cases proved and in many cases strongly indicated that the rocks of the Gneiss region are of Caledonian age, in the sense that they were formed from sediments of Sparagmitian or Cambro-Silurian age by metamorphism and metasomatic alterations. It cannot be doubted that rocks of the original Precambrian basement occur in parts of the Gneiss region, but they certainly must be strongly influenced by Caledonian tectonics and be in a "Caledonized" state'.

This statement probably represents the most widely held present view of the basal gneisses.

An imaginative structural interpretation of the north-east part of the region, complying with this view, was advanced by Muret (1960). He postulated the existence of Pennine-style nappe structures with cores of relatively homogeneous Precambrian rocks and envelopes of more heterogeneous Eocambrian and Cambro-Silurian metasediments. Caledonian remobilization of the Precambrian basement rocks was thought to have produced the present general geometrical conformity between the rock series, although it was stated that relics of the original discordance are still in evidence.

The last few years have seen some interesting developments concerning the difficult and challenging problem of differentiating between Eocambrian-Silurian metasediments and transformed Pre-Eocambrian basement in this area. Bryhni (1966, Fig. 2) gave a tentative interpretation of the south-west part of the Basal Gneiss region in which he recognized the existence of a reworked Pre-Eocambrian basement complex (the Jostedal Complex) of relatively homogeneous gneisses (2 feldspar gneisses, migmatite and augen gneiss), overlain by a far more heterogeneous series of rocks (schists, gneisses, quartzite, marble, eclogite, amphibolite, peridotite, anorthosite, etc.) named the Fjordane Complex – thought to contain both rocks of Cambrian-Silurian age and older elements corresponding to the Jotun thrust masses (Fig. 1).

Further to the north-east in the Grotli area, Strand (1969) has mapped a contact on similar lithological grounds between a 'Caledonized' Precambrian basement, and an overlying rock sequence of postulated late Precambrian to Ordovician age.

In the Tafjord area just to the north of Grotli, Brueckner et al. (1968) have obtained a Rb-Sr whole rock isochron age of 1,000 ± 150 m.y. for comparable homogeneous basement gneisses. They also obtained a K-Ar biotite age of 383 ± 12 m.y. for these gneisses, implying that although of undoubted Pre-Eocambrian origin these gneisses have, as suspected, recrystallized during the Caledonian orogeny. Brueckner (1969, Fig. 5) followed Bryhni (1966), Strand (1969) and others in supposing that the structurally overlying heterogeneous rocks are of Eocambrian-Silurian age.

The age assumption for the Fjordane Complex, however, is based on rather tenuous lithological grounds, principally the presence of quartzites and peridotites. Gjelsvik (1953), Muret (1960) and Strand (1960) have all correlated quartzites in the Basal Gneiss region with the Eocambrian Sparagmite Complex to the east, and also the peridotites so common in parts of the Basal Gneiss region with occurrences of similar rock types in Cambro-Ordovician metasediments to the east. However, Strand (1949) stated that 'the quartzite of the Grotli area may equally well be Precambrian as Caledonian' and more recently Bryhni & Grimstad (1970) have mentioned that the quartzites and associated metamorphic supracrustal rocks of the Basal Gneiss region may possibly be correlated with similar rocks of the Precam-

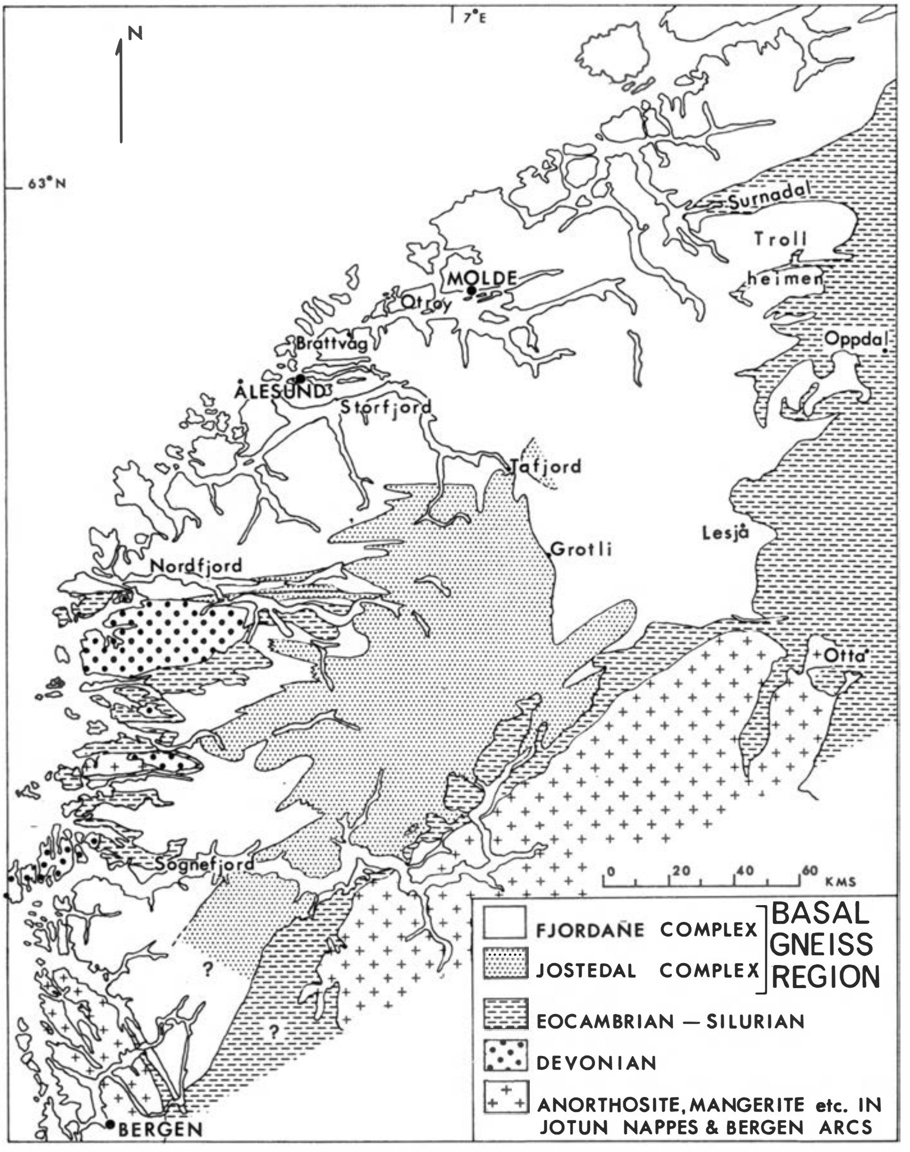

Fig. 1. Generalized geological map of the Basal Gneiss region and adjacent areas of southern Norway – based mainly on Holtedahl & Dons (1960). The outcrops of the Fjordane and Jostedal Complexes within the Basal Gneiss region largely follow the tentative interpretation of Bryhni (1966). The principal localities discussed in the text are indicated on this map.

brian 'Telemark suite' of southern Norway. They state that the age of the Fjordane Complex is not clear, but tentatively regard it as being of Precambrian or Eocambrian age.

An age correlation based on the presence of peridotites appears at least equally dubious. Peridotite intrusions are common in orogenic belts of all ages (Hess 1955), and as in the Basal Gneiss region (O'Hara & Mercy 1963, Lappin 1966, Carswell 1968a, 1968b), are now generally recognized to have been tectonically emplaced from deeper crustal levels or from the mantle (Wyllie 1967, Moores 1970). Thus during a particular orogeny, peridotite bodies may well be emplaced into both basement and cover rocks. Furthermore, peridotites are considerably more numerous in the Fjordane Complex of the Basal Gneiss region and differ from those in the Cambro-Silurian metasediments to the east in occasionally being garnetiferous and also containing inclusions of 'country rock' eclogites (that is, eclogites of the types commonly found as lenses within the gneisses).

In the Hestbrepiggan area on the south-east margin of the Basal Gneiss region, Banham & Elliott (1965) and Banham (1968) have described gneisses of varied lithology (including quartzite and amphibolite) thought to be of Pre-Eocambrian age, beneath overthrust Eocambrian-Silurian metasedimentary rocks.

Thus that part of the Basal Gneiss Complex consisting of relatively homogeneous granitic gneisses (Bryhni's Jostedal Complex) appears to have recently become justifiably accepted as being of Pre-Eocambrian age, but opinion is still divided regarding the other part consisting of more heterogeneous rocks (Bryhni's Fjordane Complex) although an Eocambrian-Silurian depositional age appears to be most favoured by previous workers.

The contact between the basal gneisses and undisputed Eocambrian–Silurian metasedimentary rocks

A large area of metasedimentary and metavolcanic rocks of undisputed Eocambrian-Silurian age occurs in the Trondheim region to the north-east of the Basal Gneiss region.

In the Oppdal-Trollheimen district the basal gneisses are overlain conformably by feldspathic psammites (Sparagmites) followed by micaschists, amphibolites, etc., often referred to as the Trondheim schists. Holtedahl (1938) and Barth (1938) considered the gneisses beneath the feldspathic psammites to be the products of feldspathization of Eocambrian sediments normally underlying Sparagmitian rocks. However, Rosenqvist (1941) discovered a quartz conglomerate at the base of the Sparagmitian rocks indicating he thought a Precambrian age for the underlying gneisses. Whatever their age, there seems little doubt and indeed general agreement that the underlying gneisses have suffered Caledonian metamorphism, migmatization and deformation.

In the valley areas of Lesja and Otta, Strand (1949) described zones of augen gneisses between homogeneous granitic basal gneisses and Eocambrian-Silurian metasediments to the east. The augen gneiss zones were said to represent a migmatite front, original plagioclase gneisses 'for the most part of Archean age' having been transformed to granitic gneisses by Caledonian granitization and potash feldspar introduction.

In this early paper Strand considered that there were strong arguments for an Archean (Precambrian) origin of the gneisses in great parts of the eastern Basal Gneiss region, although he was inclined to think that tracts of gneisses with quartzites and peridotites were of Eocambrian-Silurian age.

Oftedahl (1964) considered the basal gneisses to be of Pre-Eocambrian age and suggested that the concordant basement contact is possibly a primary effect, the Pre-Eocambrian rocks having been essentially unfolded when the Eocambrian and Cambrian rocks were deposited on them.

Further north, in northern Trøndelag, Birkeland (1958) reported that the younger overlying formations in many places rest with a profound unconformity on the basal gneisses. Oftedahl considered that Birkeland's conclusions were unsubstantiated but Peacey (1964) confirmed Birkeland's conclusion in describing the existence of a primary unconformity in the Tømmerås anticline area.

Roberts et al. (1970) concluded that elsewhere in the northern Trondheim region the Cambro-Silurian rocks rest with tectonic discontinuity upon Precambrian granite gneisses.

The geological map of Norway (Holtedal & Dons 1960) also shows a few isolated outcrops of Cambro-Silurian rocks in the western part of the Basal Gneiss region, between Sognefjorden and Nordfjord. Bryhni & Grimstad (1970) state that to their knowledge these rocks are always bounded by tectonic contacts from basal gneiss supracrustal rocks (Fjordane Complex).

Thus it appears to be becoming increasingly recognized that the contact between the basal gneisses and overlying undisputed Eocambrian-Silurian metasediments is in general a tectonic discontinuity, the structural conformity between the two rock series being a result of the Caledonian deformation they have both suffered.

The relationship between basement and cover rocks in the Surnadalen and Romsdalsfjorden regions

In the Surnadalen area of Nordmøre, Strand (1953) has described the occurrence of Cambro-Ordovician metasediments and metavolcanics (including greenschists, micaschists, micaceous gneisses, limestone and quartzite) which form a narrow synclinal extension of similar rocks in the Trondheim region. These rocks were said to be bounded on both sides by basal gneisses rich in potash feldspar. Both the basal gneisses and overlying rocks were considered to have been subjected to two episodes of Caledonian metasomatism, Na and Ca metasomatism followed by K metasomatism, and it was concluded that 'the upper part at least of the basal gneiss in this region is a Caledonian rock, formed from Caledonian material by metasomatic processes'.

Similar metasedimentary and metavolcanic rocks of postulated Eocambrian-Lower Palaeozoic age (Bugge 1934, Gjelsvik 1953, Hernes 1955) occur in the Romsdalsfjorden region, west south-west along the regional strike from Surnadalen.

Like Strand, Gjelsvik (1953) and Hernes (1955) considered the contact between the basal gneisses and overlying rocks to represent a Caledonian migmatization effect (a migmatite front) – the basal gneisses being extensively migmatized Eocambrian-Lower Palaeozoic rocks.

However, the present author has been studying the contact between basement gneisses and possible Eocambrian-Lower Palaeozoic cover rocks on the islands of Otrøy and Midøy on the northern side of Romsdalsfjorden. Here the abundance of relics of eclogite facies assemblages within the basal gneisses and their apparent absence amongst the overlying rocks where the basic rocks are almost invariably garnet amphibolites, was taken to support the view that the former may be significantly older than the latter and are thus probably part of the 'Caledonized' Pre-Eocambrian basement upon which the Eocambrian-Silurian cover rocks were deposited.

It was also noted that the postulated cover rock sequence includes thick sequences of psammites in addition to the more striking pelites and metavolcanics. Thus not all potash feldspar rich gneisses should be termed basal gneisses, as gneisses of this type occur within both rock complexes. As along the eastern margin of the Basal Gneiss region one is therefore again faced with the extremely difficult task of trying to differentiate between partly migmatized feldspathic psammites of Eocambrian-Lower Palaeozoic age and Pre-Eocambrian granitic injection gneisses.

Other evidence relevant to the question of the age of the Basal Gneiss Complex

Evidence from other parts of the Caledonian orogenic belt which has some bearing on the question of the age of the Basal Gneiss Complex will be considered in this section.

The occurrence of eclogites

Eclogite facies assemblages of two types occur within the Basal Gneiss region (Eskola 1921, Lappin 1966, Bryhni et al. 1969), namely eclogites associated with peridotite bodies, and eclogites directly enclosed in the gneisses (here termed 'country rock' eclogites).

Eclogite facies assemblages of the first type comprise rare indigenous layers of garnet peridotite, garnet websterite and rarely bimineralic eclogite within garnet free peridotite bodies. It has been argued (Carswell 1968a, 1968b) that such assemblages were probably developed in the upper mantle prior to the tectonic emplacement of these peridotite bodies into their present position.

'Country rock' eclogites, on the other hand, occur as tectonic lenses or boudins widely distributed over large areas of the Basal Gneiss region. They frequently contain modal quartz and sometimes kyanite.

Within the Caledonides eclogites associated with peridotites are extremely rare and apparently restricted to the Norwegian Basal Gneiss region. However, 'country rock' eclogites of comparable types have been reported from north-west Scotland (Alderman 1936), Spitsbergen (Gee 1964) and east Greenland (Kranck 1935, Sahlstein 1935).

Clinopyroxenes from 'country rock' eclogites have yielded K-Ar ages ranging from 780–5050 m.y. (MacDougall & Green 1964, Gayer et al. 1966, Miller et al. 1963). The fact that certain of these ages are undoubtedly erroneous, due to the presence of excess radiogenic argon, prohibits one reaching significant conclusions on the age of the primary eclogite assemblages.

K-Ar ages obtained from secondary amphibole in these eclogites range from 389–1745 m.y., while two secondary phlogopites from Norwegian eclogites gave K-Ar ages of 415 and 950 m.y., and Rb-Sr ages of 401 and 383 m.y. The interpretation of the significance of these ages is again uncertain though MacDougall & Green (1964) have argued that the amphiboles and micas did not contain excess argon, suggesting that secondary amphibole growth, at least in the Norwegian eclogites, was initiated at least 1800 m.y. ago, hence indicating an even older Precambrian age for the eclogite crystallization. The various younger amphibole and mica ages were thought to reflect partial or complete overprinting (argon loss) during subsequent metamorphic events, in particular during the Caledonian orogeny.

The eclogites in the Glenelg and Loch Duich areas of north-west Scotland occur in Lewisian rocks which form the basement for the later cover rocks (the Moines) – see Peach et al. (1910), Ramsay (1957a), Sutton & Watson (1958). These Lewisian rocks are mostly almandine-amphibolite facies schists and gneisses, but occasional partly retrograded pyroxene granulites are preserved. The marked interbanding of the Lewisian basement rocks and Moine cover in this region has been produced either by isoclinal folding (Peach et al. 1910), thrust slicing of the basement into the cover, or most probably (Ramsay 1957a) by a combination of both effects during the Caledonian orogeny.

Thus in the one part of the Caledonian belt where one is reasonably certain of the stratigraphic and structural relationship of the rocks enclosing the eclogites, it is apparent that the eclogites are restricted to the remobilized basement complex.

The geological relationships and radiometric age dates strongly suggest, but do not conclusively prove, that this is also the case for the Norwegian, Spitsbergen and east Greenland eclogite occurrences. In all four areas the eclogites occur as tectonic lenses or boudins of varying sizes but opinion is divided as to whether they are *in situ* crustal metamorphic rocks (Gjelsvik 1952, Hernes 1954, Kolderup 1960, Schmitt 1964, Bryhni et al. 1969, Bryhni et al. 1970) or tectonically emplaced lower crustal or even upper mantle rocks (O'Hara & Mercy 1963, Lappin 1966). However, even if tectonically emplaced their absence from undoubted Eocambrian-Silurian rocks, their observed presence as extensively retrograded and partly injected tectonic inclusions within Norwegian anorthosites (of presumed Precambrian age – see later section) and peridotites (personal observation), and the likelihood that the numerous small lenses of eclogite are deformed fragments of originally much larger masses all suggest that the eclogites were an integral part of the Pre-Eocambrian basement complex rather than Caledonian intrusive rocks.

The age of the granulite facies metamorphism

Relics of granulite facies gneisses occur associated with the eclogites on Otrøy and Midøy in the Norwegian Basal Gneiss region (Carswell 1968b). A similar association has been observed both in Scotland and east Greenland. To the best of my knowledge no regional scale granulite facies gneisses of proven Caledonian age exist within the Caledonides.

Further north in Norway, granulite facies gneisses in the Lofoten-Vesterålen area were originally thought to be of Caledonian age but have recently been reinterpreted by Heier & Compston (1969) as very old Precambrian basement (about 2800 m.y.) broadly comparable in age to the Scourian granulite facies metamorphism (about 2600 m.y.) of the Lewisian of northwest Scotland (Park 1970). In Norway as in Scotland, the granulite facies gneisses show varying degrees of modification by later metamorphism and deformation of Precambrian age – possibly both Laxfordian-Svecofennian (about 1600–1800 m.y.) and Grenville-Sveconorwegian (about 900–1200 m.y.) effects – and Caledonian age (roughly between 370–600 m.y.).

Indeed it would appear that all reliably dated pyroxene granulite facies terrains throughout the world are of Precambrian age (Spooner & Fairbairn 1970).

Basement-cover relationships in the Scottish Caledonides

It is also instructive to compare the Norwegian Basal Gneiss Complex controversy with that concerning the Lewisian 'inliers' within the Moines of central Ross-shire in Scotland. In this latter area the occurrence of Lewisian basement 'inliers' within the Moines was first recognized by the early field geologists (Peach et al. 1913), later discredited by Sutton & Watson (1952, 1954) and Ramsay (1957b) who considered these rocks to be an integral part of the Moine succession, but subsequently substantiated by Sutton & Watson (1962).

It is now generally accepted that the Lewisian rock masses of central Ross-shire represent fragments of the basement which was intensely deformed with, and thrust into, the overlying Moine cover rocks.

Further thrust sheets or nappe cores of Lewisian may also occur in the central part of the fold belt (Ramsay 1963) but it was noted that the original structural and metamorphic distinction between the Lewisian basement and Moine cover has become blurred by the super-position of Caledonian metamorphism, migmatization and probably four fold phases. Hence in the central parts of the fold belt it becomes extremely difficult or even impossible to distinguish certain types of basement and cover rocks, especially Lewisian quartzo-feldspathic gneisses and feldspathic Moine psammites – a comparable problem to the attempted discrimination between basement gneisses and Sparagmitian rocks in the Basal Gneiss region of Norway.

It would appear that in Norway as in Scotland the collision between the east Greenland and Fennoscandian continental blocks, which ultimately produced the Caledonian fold belt, resulted in the Pre-Ecambrian basement becoming extensively sliced up and thrust upwards and interfolded with the Eocambrian-Lower Palaeozoic cover rocks. On the margins of the fold belt (Moine and Jotun thrust belts), the orogenic compression resulted in thrust slices or nappes of both basement and cover rocks being driven outwards on to the unaffected continental forelands. In the Basal Gneiss region of north-west southern Norway one is apparently looking at a low level in the central part of the fold belt where the basement has been thrust into and interfolded with the cover rocks and has suffered Caledonian metamorphism and migmatization. Consequently the original metamorphic and structural distinctions between the basement and cover rocks have been largely eradicated by Caledonian effects, and one is largely reduced to attempting to discriminate between the two on dubious lithological grounds.

The age of the anorthosites

Anorthosite masses are frequently associated with peridotites and eclogites in the Fjordane Complex of the Basal Gneiss region (Bryhni 1966). The large rather massive and homogeneous sill-like anorthosite masses, as observed by the author in the Tafjord-Grotli area, consist almost entirely of labradorite composition plagioclase $An_{50\text{-}60}$ and thus may be classified as labradorite type massif-type anorthosites – Anderson & Morin (1969). Anderson (1969) and Herz (1969) have pointed out that all reliably dated anorthosite massifs of this type occur in Precambrian terrains – all older than 1000 m.y. They are commonly associated with either fresh or partly retrograded granulite facies rocks. The actual date of primary igneous crystallization of such anorthosites is uncertain, but for the Nain labradorite anorthosite in Canada, Anderson & Morin (1969) have postulated an age $>$ 2000 m.y. The possibility that all such anorthosites are extremely old has led to interesting recent speculation (Anderson & Morin 1969, Yoder 1969, Windley 1970) that calcic anorthosite bodies may represent relics of the primordial continental crust formed during an early phase (perhaps rapid degassing) of the earth's geochemical differentiation.

The anorthosites within the Basal Gneiss Complex, as commonly found elsewhere, have cataclastic fabrics (at least marginally) and tectonic contacts. They may therefore represent tectonically remobilized fragments of the proto-continental crust. However, as with the peridotite and eclogite inclusions in the Basal Gneiss Complex the recognition of tectonic contacts tells one little about how far these rocks may have moved through their enclosing gneisses in a 'cool' crystalline condition. As pointed out by Bryhni et al. (1970) the presence of tectonic margins need not always imply large scale tectonic movements, but may just be a reflection of intense deformation of rocks of widely differing mechanical properties. It is thus not clear whether the anorthosite bodies are indigenous to the gneiss complex or whether they have been tectonically emplaced from lower crustal levels.

However, whichever is the case their absence from undoubted Eocambrian-Silurian rocks in Norway and indeed the apparent world-wide restriction of such anorthosites to Precambrian terrains, strongly suggests a Pre-Eocambrian age for much of the Fjordane Complex of the Basal Gneiss region.

Furthermore, Bryhni et al. (1971) have recently interpreted the ^{40}Ar–^{39}Ar age spectrum of a pyroxene from an augen gneiss in 'Anorthosite Kindred' rocks from the Fjordane Complex of the Nordfjord area as indicating an original age $>$ 1550 m.y.

Concluding remarks

In theory there are several lines of geological evidence one might expect would assist one to differentiate between basement and cover rock complexes in an orogenic belt.

However, where the basement has been reactivated and consequently deformed, metamorphosed and migmatized, together with its cover during a subsequent orogeny, then the geological evidence becomes extremely blurred. In the central regions of an orogenic belt intensive deformation rapidly obliterates the evidence of earlier fold episodes and obscures the contact relationships with the production of a secondary tectonic concordance between the basement and cover. Metamorphic overprinting of the basement eradicates or at least obscures the metamorphic distinctions and also causes partial or complete isotopic re-equilibration, making the interpretation of radiometric dates difficult and often speculative. Migmatization of the cover rocks promotes lithological convergence and obscures primary lithological distinctions.

Unfortunately it is just such a geological situation one is faced with having to decipher in the Basal Gneiss region. A good approach to this problem is to, if possible, first observe the basement-cover relationships and the distinctive features of each where these rocks are in a relatively unmodified state at the margins of the orogenic belt. Working into the orogenic belt from the marginal Moine thrust zone, some success has been achieved in northern Scotland in differentiating between Lewisian basement inliers and Moine cover rocks on lithological grounds. However, the lengthy debate which has occurred concerning these basement inliers shows that even this approach is difficult.

Thus in the opinion of the present author, hopes of producing an accurate geological map of the Pre-Eocambrian basement and Eocambrian-Lower Palaeozoic cover relations in the Norwegian Basal Gneiss region probably depend largely on a confirmation by Rb-Sr isochron or ^{40}Ar-^{39}Ar dating techniques of the thesis advanced here, that occurrences of 'country rock' eclogites, granulites and calcic anorthosites in this region are restricted to the Pre-Eocambrian basement.

If this thesis is correct then much of Bryhni's Fjordane Complex (Bryhni 1966) as well as his Jostedal Complex must represent reactivated Pre-Eocambrian basement, and is perhaps older rather than younger than the Jostedal Complex.

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