Chapter II

GEOLOGY OF THE AREA

GENERAL REVIEW

Broadly speeking, the geological set up of the Union territory of Goa does not differ much from the adjacent state of Mysore (see Rama Rao, 1940). As a matter of fact the Precambrian rock formations of Goa are believed to be the northwestward continuation of the Mysore Dharwars. One of the earliest accounts of the geology of the territory was given by Pascoe (1950, p.93) who stated :

> The Portuguese province of Goa consists mainly of Dharwar rocks, very largely obscured by a covering of laterite. Gneissose rocks may occupy some of the hills and have been noted in the railway cutting at Dudh Sagar railway station. Among the rocks assignable to the Dharwars the following have been recorded : quartzite, magnetite, quartzite, haematite quartzite, limonite quartzite, sericite quartz schist, fine-grained biotite-quartz schist, phyllite, fine-grained grey limestone and basic igneous rocks. The limestones are thought to occupy the highest position in the local sequence. The beds are traversed by quartz veins.

Phyllites occur over a large part of the area under investigation. Sometimes they enclose banded ferruginous quartzites with occasional workable iron ores at several localities of which, Sirigao, Bicholim and Sanquelim have large deposits of iron ores. Most of these country rocks are covered extensively by a blanket of laterites which generally vary in thickness from place to place. The maximum thickness of the

laterites recorded from the area is about 30 m. They have generally a greater thickness over the phyllites than over the ferruginous quartzites. The other superficial deposit encountered at several places in the area is alluvium dropped by a network of sluggish streams and their tributaries.

The phyllites as well as the ferruginous quartzites in the area under review have the same NW-SE strike and north-easterly dips as that of the other Precambrian rock formations of Goa and also of the Dharwar schists of Mysore in the south.

The rocks are devoid of any such recognisable non-diastropic sedimentary structures as ripple marks, current bedding, etc. However, only bedding lamination is such a structure which is retained by the ferruginous quartzites. The phyllites as well as the ferruginous quartzites are isoclinally folded with their fold axes trending NW-SE. The ferruginous quartzites are represented by two major outcrops, one at Bicholim and the other near Sanquelim, at a distance of about 7 km from the former. Both of them have a general NW-SE trend and occupy a prominent ridge each at Bicholim and Sanquelim. Only the northwestern part of the Bicholim outcrop in the neighbourhood of Sirigao has developed an 'S'-shaped bend as a result of drag folding. The general appearance of the Sanquelim outcrop is 'V'-shaped. Besides these, a few more small and insignificant outcrops of ferruginous quartzites were encountered in the area but they are not shown on the map.

The lithological characters of the phyllites and quartzites

indicate that both of them are low grade regionally metamorphosed rocks.

The ferruginous quartzites had, however, undergone profound residual concentration as a result of which large deposits of iron ores were formed in these rocks.

STRATIGRAPHY

Newbold (1844, p.145) was one of the earliest known geologists to examine the Precambrian rocks of Mysore state in South India. He applied the term '' hypogene series '' to the crystalline complex of South India and included in this series schistose and gnessic rocks.

Later, King (1872, p.36) studied those rocks and grouped them separately with the '' Altered or transition rocks '' and '' crystalline rocks ''. He introduced the former group as '' Kadapah '' and '' Karnul '' and the latter as '' gneissic series ''.

Foote (1876, p.41) sub-divided the rocks of the '' gneissic series '' of King into two, viz., 1) the '' granitoid '', highly crystalline and massive and 2) '' schistose'', the less crystalline and often highly foliated and distinguished five principal varieties of the '' schistose '' group. They are hornblende schists, micaceous schists, chlorite-schists, hematite schists and talcose schists. In a later work, he (1866) proposed the name '' Dharwar '' to these Precambrian schistose group of Mysore.

It was Fermor (1909,p.1120), who made a general application of the term '' Dharwar '' in Indian stratigraphy and stated :

> The term Dharwar is a comprehensive one and can be applied to all the sedimentary schists lying below the Eparchaean unconformity. It is extremely probable that there are many breaks in the schistose formation in different parts of India, but we can hardly hope to be able to correlate such breaks in different parts of India with any degree of certainty, and hence must make use of a general term to include the whole of this series of schists without taking any notice of the breaks. The term 'Dharwar' seems to be the term to use thus.

Although, no further account of the geology of Goa is available from the previous literature yet there is a general agreement that a major portion of the territory is composed of rocks belonging to the Dharwar age. It is, therefore, obvious that no serious attempt whatsoever was made to suggest any definite correlation of the Precambrian rocks of Goa with any other similar rock formation of India.

The most common Precambrian schistose rocks in the area of investigation are phyllites. Several lentiform bandéd ferruginous quartzites and some non-ferruginous massive quartzites are interbedded with the phyllites. A number of metadolerite and dolerite dykes occur in the phyllites on the east and north of the area. Locally, the banded ferruginous quartzites have great economic importance because of their large reserves of iron ores.

The sequence of rock formation studied in the area under review is presented as follows :-

	Recent	Alluvium
	Sub-recent	Laterites
	Deccan Trap?	Dolerite
Precambrian :	Intrusive	Metadolerite
	Scistose formation.	Phyllites with banded ferruginous quartzite and some massive quartzites.

Highly lateritized phyllites extend from the south of Dudonem and Gauntana on the south of area to beyond Nanora, Ladpem ($15^{\circ}37'30''$: $73^{\circ}57'30''$) and Poriem on the north of Bicholim and Sanquelim (Fig.3).

In this connection it may be mentioned here that these phyllites belong to the northwestern part of a northwesterly plunging regional syncline which Gokul (1963) mapped in north-eastern Goa. The western limb of the syncline extends from Capora river, further north of the area, to south of Madei river on the south (Fig.2), where it joins the eastern limb of the syncline. This eastern limb is narrower than the western limb and consists of phyllites with some interbedded limestone and banded magnetite-quartzite on its northeastward extension. On this basis Gokul concluded that 'western strip' and 'eastern strip' of the phyllites in the northeastern portion of the territory form a major syncline between Mandovi river on the west and Nagargao ($15^{\circ}33'45''$: $74^{\circ}9'30''$), Dongurli ($15^{\circ}36'15''$: $74^{\circ}8'45''$), Choraundem ($15^{\circ}37'45''$: $74^{\circ}7'30''$) on the east. The axis of the

syncline roughly passes through Zormen (15°34'30" : 74°6'30"), Querim (15°36'15" : 74°4'30") and Siruli (15°37'30" : 74°4'). The closure of the syncline lies between Volpoi (15°32' : 74°8'15"), and Nunuz (15°30'30" : 74°7'30"). Gokul (1963) placed the phyllites with associated banded ferruginous quartzite, massive quartzite and limestone at the base of a number of other rock types, the succession of which in ascending order is quartz-chlorite-sericite schits, altered ultrabasics, granite gneiss, pegmatites and vein quartz, basic intrusives, Deccan trap, laterites and alluvium. He further classified the underlying phyllites and quartzites with the Dharwar schists.

Dhepe (1953) and D'cruz (1963) have also mentioned a more or less similar sequence of the Precambrian formations of Goa. D'cruz, however, placed the granite and granite gneiss below the Dharwar schists while Dhepe considered them as post-Dharwars, which may be the correct position.

LITHOLOGY

An account of the lithological characters of the various rock types encountered in the field is given below.

Phyllites

Extensive lateritization of the phyllites left only a few isolated outcrops wherefrom some fresh or partly altered rock samples could be collected. None of the phyllites, fresh or

weathered, show any trace of bedding lamination from which the relation between the schistosity and bedding-plane could be ascertained. Schistosity is rather well-developed in most cases. The rocks commonly have pinkish brown or brownish grey colour. Occasionally, however, there are some pale grey to greenish grey varieties of phyllites.

About a kilometer west of Curchirem (66.43 m) a few thin bands of pale greenish-grey or brownish-grey phyllites crop out. The outcrops are mostly fresh in the stream sections but on the banks they are covered by laterites. The fresh rocks are distinctly foliated but that does not give to the rock a silky sheen and moreover, along their foloiation they have a little tendency to split into thin slices. Joint and fracture planes are all stained dark brown due to infiltration of iron hydroxides.

Another small outcrop of phyllites in a much weathered state is exposed under a thin mantle of laterite along the Piligao-Bicholim road section about 1.6 km noth of Piligao ($15^{o}33'30''$: $73^{o}56'$). The junction between the overlying laterites and underlying phyllites is graditional. Due to the weathering the rock became very soft and rendered ocherous or clayey. Similarly weathered pinkish brown or brownish white phyllites were also observed in the tunnel No.4 of Sanquelim mines where they occupy the foot wall of the ore body and also in a few other open cast mine sections, particularly where the iron ores have been worked out and the foot-wall rocks were exposed. Thin bands of powdery

silica or small pockets of shaly or powdery iron ores are commonly associated with these phyllites.

A few thin strips of pale green to greenish grey phyllites associated with the common variety of phyllites, mentioned above, were encountered in the river Valvota near Poriem. The rocks are hard, compact and finely crystalline. Schistosity is developed but not so distinctly as the common variety of phyllites. These thin greenish phyllites appear to be a local variety which is restricted in occurrence only in the northern part of the area.

Banded Ferruginous Quartzite

The banded ferruginous quartzites do not constitute a separate horizon but occur as lentimular intercalations in the phyllites. Their outcrops range in width from a few meters to as much as 80 m and in length from a few meters to even upto 7 Km as in the case of Sirigao-Bicholim outcrop. Due to their greater resistance to weathering and erosion they generally form prominent ridges on which most of the present iron ore workings of Bicholim and Sanquelim are located. The ridges generally follow the NW-SE strike of the quartzites and also of the enclosing phyllites. The banding in the quartzites is due to the presence of parallel alternate dark ferruginous and white cherty quartzite laminations which are attributed to the original depositional feature of the rock. The ferruginous bands consist mostly of granular magnetite and scaly hematite. In most cases these bands are

very thin, regular and persisting. The individual bands varies in thickness from 0.5 to 3 mm or slightly more. The quartzites which are either bodily associated or occur in close proximity to the ore deposits are generally characterized by thinner bands (Plate I, fig.1), which even after folding have the same thickness. On the contrary the quartzites in localities away from the ore-deposits have either thicker bands (Plate I, fig.2) or none. The weathered variety of thinly laminated quartzites developed a tendency to break up easily into thin slices along their bedding planes and some along joint planes. Generally the rocks are fine-grained and compact.

Since the ferruginous quartzites happen to be the source rock of the iron ore deposits in the area, evidences of supergene alteration and concentration of iron ores from the initial to the final stage are present in them. Frequent preservation of the minor secondary structures, in addition to the bedding laminations in the iron ores, is a positive evidence of replacement of the parent rocks as a dominant process of ore formation in this case.

There are some minor bodies of massive or thick bedded quartzites which occur impersistently in the phyllites. A few isolated lenses of such quartzites occur along the upstream course of Bicholim river near Ona ($15^{o}37'30''$: $73^{o}57'30''$), Nanora and in a few other localities in the area. Their strike and dip are generally the same as that of the phyllites. No

deposit of iron ores has so far been reported from these quartzites. The massive variety of these quartzites is dark grey in colour, highly siliceous, fine-grained, hard and compact. Colour is variable in the case of thick-bedded quartzites which are less siliceous than the massive variety but greater than the ferruginous quartzites.

Basic Intrusives

The schistose rocks of the area are intruded by a number of dolerite dykes. Some of the dykes are over 6 m thick. The general strike trend of majority of the dykes range from NNE-SSE to NW-SE and the dip nearly vertical. The contacts of these dykes with the phyllites are usually recognisable except when completely covered by laterites. A number of such dykes occur between the Sanquelim bridge and Poriem on the river Valvota. Their outcrops are impersistent and often concealed in the laterites. Two outcrops of the dykes, of which one is bouldery, were also encountered about a Km southeast of Maulingaem (138.67 m). The rock is dark green to greenish grey in colour, hard and medium to fine-grained (Plate I,fig.3). The suite may possibly be of Deccan trap age. There is another suite of dykes that have some effect of metamorphism due to which they have been foliated to some extent. These foliated basic dykes, introduced here as metadolerite which may be older than the unaltered dykes mentioned above.

Laterites

The laterites, which range in thickness from a few meters to about 30 m, in the area are believed to be the products of supergene alteration of phyllites and the associated ferruginous quartzites. However, the ferruginous quartzites are comparatively less affected by lateritization than the phyllites. The laterites, which are derived from phyllites, are moderately aluminous and show typical pisolitic and vermicular structures (Plate I, fig.4). Their colour varies from light pink to light yellow, cream or pale brown. Generally they include small pockets of white or cream-yellow clayey materials. Occasional presence ofalimonite crust or coating made them harder than the normal varieties. Laterites that formed over the ore body are generally brick-red in colour, porous and highly ferruginous. They frequently include small crystals of secondary quartz. Locally the aluminous laterites are extensively quarried for use as road and building materials.

The aluminous laterites of the area were generally found occupying the flat-topped and low-lying hills, while the ferruginous ones occur as capping on the iron ridges and other prominent hills, as for example their occurrence on the Bicholim-Sirigao ridge and Sanquelim hill (97.03 m) can be cited.

GENERAL STRUCTURAL FEATURES

The nature of the present work necessitated study of some local structural features which have important bearing on the structure of the ore deposits. A fair attempt is made to present here the author's own observations on the general structural features of the area.

The hilly tract of Northern Goa begins from beyond the northeastern boundary of the area. The R.L. of the two prominent ridges in the region which are located at Salali ($15^{\circ}34'45''$: $74^{\circ}5'$) and Morlemgod ($15^{\circ}35'$: $74^{\circ}4'45''$) are 616.61 m and 573.75 m respectively. The trend of these ridges is roughly NNW-SSE which is more or less same as the regional strike of the Precambrian schistose rocks of the area under study, as well as to those of the neighbouring state of Mysore (see Krishnan, 1953).

Since widespread lateritization has greatly obliterated the structural details of the outcropping phyllites much of the useful data pertaining to the structure of the Precambrian rocks of the area were obtained from the banded ferruginous quartzites which on account of their greater resistence to weathering could retain many interesting structures.

From Sirigao, on the northwest, to Sanquelim on the southeast of the area, the strike of the phyllites is roughly NW-SE with northeasterly dips ranging from 30° to 50°. The structural trend of associated ferruginous quartzites is also

the same as the phyllites but usually they have higher northeasterly dips.

Therefore, most of the studies relating to the structure of the area were concentrated on the ferruginous quartzites of Sirigao-Bicholim and those of Sanquelim area. The structure of these iron-bearing ferruginous quartzites has been described in greater detail while discussing the structure of the ore deposits later in this text. However, it may be remembered that there are two different outcrops of ferruginous quartzites separated and surrounded by phyllites. The one which extends from Sirigao to Bicholim, is about 7 Km long and the other which occurs about 400 m northeast of the former has a length of about 1.75 Km. Both these outcrops have a general NW-SE strike. The general direction of dip and strike of a greater part of the longer Sirigao-Bicholim outcrop, between Sirigao hill (161.54 m) and Bicholim, remains unchanged except for some local variation. The amount of dip in this part generally varies from 45° to 80° NE. The northwestern part of the same outcrop takes an 'S'-shaped bend between Sirigao hill and Sirigao (Fig.3). From the Sirigao hill the outcrop swings round from NW-SE to almost N-S within a distance of one km beyond which it rebends and restores its general NW trend. Finally, the outcrop disappears below an alluvium at a distance of about 1.5 km NW of the last bend.

The Bicholim-Sirigao outcrop represents a northwest plunging isoclinal anticline, the limbs and axial plane of which dip northeastwards. The nose of this anticline is about 0.5 km

west of Sirigao where it plunges at an angle of 20° NW. The S-shaped outcrop of quartzites near Sirigao represents a drag fold which was most probably formed due to continuing differential shear movements accompanying the earlier deformation (see Narayanaswami, 1959, p.88). The axes of the cross-folds are sub-parallel to the axis of earlier isoclinal fold and their plunges are in the same general direction as the plunge of the latter. Narayanaswami (1959, 1966) also described several types of such drag folds affecting the folded rocks belonging to the nearby Dharwar rocks of Mysore and similar other Indian Precambrian formations elsewhere in the country.

The smaller outcrop of ferruginous quartzites, which occurs about 400 m northeast of the main Sirigao-Bicholim outcrop, appears to be the much eroded northeastern limb of the Sirigao-Bicholim anticline. The limb now stands separated from the southwestern limb of the anticline by phyllites and runs almost parallel to the latter. Its strike is NW-SE and dip varies from 50° to 60° NW.

The other outcrop of the ferruginous quartzites at Sanquelim in the southeastern part of the area, extends over a distance of about 2.5 km from west of Valvota river to Gauntana with a general NW-SE strike and northeasterly dips varying between 50° and 80°.

The southern part of this outcrop between the Sanquelim hill (97.03 m) and Gauntana bifurcates into two narrow outcrops

of ferruginous quartzites separated by a narrow strip of phyllites. Amount and direction of dips in this part are also consistent with the rest of outcrop.

Thus, between Valvota river and Gauntana, the ferruginous quartzites form a narrow 'V'-shaped outcrop which also represents an eroded isoclinal anticline plunging 30° NW. Its two limbs correspond to the two narrow outcrops of quartzites between Gauntana and Maulingiem (15°33'15" : 74°1'). The narrow strip of phyllites outcropping between two anticlinal limbs was exposed as a result of erosion of a greater part of the crest of the anticline.

It may now be summarily stated that all the major outcrops of banded ferruginous quartzites and the related phyllites in the area were intensely folded into northeasterly dipping and northwesterly plunging isoclinal anticlines. The northwestern anticline was offset by a drag fold which bent the outcrop near Sirigao in the form of 'S'. It is also obvious from the nature and relative position of the two outcrops of ferruginous quartzites that they were folded in an en echelon pattern into two anticlines plunging in the same direction. Since, these two folds occur in the western limb of a northwesterly plunging regional syncline, they have been identified as left-handed en echelon folds. Similar types of en echelon folds were also reported from several other places in the Precambrian terrain of South India (see Narayanaswamy, 1959).

CORRELATION

Rama Rao (1940) classified the Mysore Dharwars into three divisions viz., lower, middle and upper, which lie separated from one another by two distinct horizons of conglomerates. No Precambrian conglomerate was reported from Goa by any one of the previous workers. The present worker also did not encounter any such horizon in the area mapped by him. But, the presence of banded hematite-quartzites with iron ores, lithological homogeneity, structural trends and the grade of metamorphism of the Precambrian schistose rocks of Goa provided satisfactory criteria for correlating them with the Dharwars of the adjacent state of Mysore. On identical grounds Fermor (1936) and Krishnan (1960) attempted to correlate the Precambrian schistose rocks of Singhbhum, Orissa and Madhya Pradesh with the Mysore Dharwars. Krishnan (1960, p.101) remarked that the term Dharwar system

> serves to designate the schistose rocks older than the Eparchaeaan unconformity and to indicate the approximate homotaxial relationship of these formations in various parts of India.

Dunn (1940, p.308-309) while dealing with the stratigraphy of south Singhbhum expressed that it was inadvisable to correlate the schistose rocks, scattered over different parts of India, with the little known rocks of Dharwar type area. He preferred to retain the local names for the Precambrian rocks in different parts of India, and to restrict the term Dharwars to the schists of south India. A similar idea was also expressed by Pichamuthu (1963, p.86 ; 1967, p.6).

Rama Rao (1962, p.34-35) pointed out that the correlation of widely separated exposures of unfossiliferous schists on lithological similarities is usually unsatisfactory and unwarranted. Radhakrishna (1967, p.106) stated that

> There is nothing to warrant the supposition that the Dharwars were very extensive or that all the Dharwar patches in the Peninsula were once connected.

He further suggested that (p.109)

> The term Dharwars should be restricted to designate the archaean schists of only Mysore. The term Archaean is good enough to include the succession of schistose rocks of different areas like the Eastern Ghats, the Satpura and the Aravallis which may represent only a section of Dharwars or may be entirely different.

From the above consideration it is evident that there is still some difference of opinion regarding the stratigraphic position of these schistose rocks from different parts of India and their suitable correlation.

So far as Goa's Precambrian geology is concerned, the statements made by Dunn (1940), Rama Rao (1962), Pichamuthu (1963, 1967) and Radhakrishna (1967) do not probably hold good, partly because of the fact that the territory of Goa is not wide apart from the Dharwars of the type area in Mysore and partly due to lithological, structural and metamorphic similarities between the schistose rocks of Goa and atleast those occurring in the northern part of the Mysore Dharwars.

A possible explanation for the absence of any conglomeratic horizon in Goa may be that the two horizons of conglomerate in

Mysore are probably of local occurrences as they are restricted only to the Dharwar-Shimoga and the Gadag-Chitaldurg schist belts of northern Mysore. More justification for the above view was given by Rama Rao (1940, p.85-86) as follows :

> We cannot say whether the whole of the Dharwar system of Mysore can be correllated with any single series... This depends upon whether the two zones of unconformities recognised in the Dharwar Schists in Mysore are widespread and occur at the same horizon in the other archaean tracts of India or whether they are only local and confined to Mysore.

Fermor (1936, p.192), while discussing the correlation of the schistose formations of Singhbhum (Bihar) and Orissa, was first confused whether the term '' Dharwar '' should be applied to the '' old metamorphics '' or to the upper '' Iron Ore-Series '' . At first, the question seemed to be difficult for him to answer due to the presence of quartzites, mica and hornblends schists in both the series, but later on, he was guided by the presence of iron ore formation in one of them for the purpose of correlation. He concluded that

> The important masses of hematite-quartzite and hematite ore that occur in the Iron-ore series seem to provide the deciding factor in favour of the Iron-ore series being the equivalents of the Dharwars of South India.

He also suggested correlation on lithological grounds of the hematite-quartzite rocks and iron ore deposits of Chanda and Durg, Madhya Pradesh with the hematite deposits of Goa, Sandur and elsewhere in the Dharwar-Mysore-Nellore province and the Iron-Ore series of Singhbhum (p.155).

Krishnan (1960, p.154) recorded crystalline limestone, manganese-bearing rocks and iron ores from several Precambrian schistose areas of India. Such associations, according to him, can be satisfactorily used as a criterion for the purpose of correlation on the assumption that at a certain period of earth's history, such special types of sediments were deposited. He considered the banded ferruginous rocks and the iron ores, which characterize the Iron-Ore series of Chota Nagpur and Bastar, the Sakoli Series, the Chilpi Ghat Series, the Middle Dharwars of Mysore and the schistose rocks of Salem as broadly equivalent. However, in his concluding remarks he added that (p.156)

> The complexity of the Archaeans prevents us from attempting anything more than the above broad indication of correlation.

In the tabular correlation scheme (Krishnan, 1960, p.155) the Middle Dharwars of Mysore with the banded ferruginous quartzites were shown as equivalent to Bailadila Iron-Ore Series and the Sakoli Series of Bastar, Madhya Pradesh, and the Iron-Ore series of Bihar and Orissa.

It is obvious, therefore, that in the previous work considerable emphasis was laid on the lithology and presence of iron ore horizon for the purpose of correlation of widely separated Archaean terrains of India.

Rama Rao (1940, p.37), in his middle division of Mysore Dharwars mentioned a number of lithological units of which iron stone, limestone, argillites, quartzites and conglomerates

predominate. A number of these rocks is more or less identical to the Precambrian rock groups of Goa except the conglomerates. Among all the rock types, banded ferruginous quartzite is the most characteristic member associated with the phyllites of Goa, and which may be taken as a marker horizon for the presently suggested correlation.

Rama Rao (1940, p.57) further mentioned that the threefold division of Dharwar schists can only be recognised with certainty in the northern parts of the Mysore state. Therefore, it would not be unwarranted to presume that the basin of deposition during the Middle Dharwar period extended further north of Mysore into the territory of Goa where more or less similar rock units were encountered (see Radhakrishnan, 1967, p.104).

The other points of some significance to be stated in this connection are the similarities of lithological character of banded ferruginous quartzites, regional structure and the grade of metamorphism between the Dharwar schists of northern Mysore and the Precambrian schists of Goa.

The Dharwar schists of Mysore have a more or less NNW-SSE regional strike extending uniformly for about 600 Km from north to south. A larger part of the northern extremity of the Dharwars is limited by the Deccan traps which cover a large part of the country further north (Krishnan, 1953, p.5 ; Radhakrishnan, 1967, p.104). The regional strike of the phyllites and banded ferruginous quartzite of Goa is much the same as that

of the Dharwars of Mysore. Additionally, the en echelon drag folds, which are so common in Mysore, are also reported from the area under review.

The typical iron ore bearing Dharwar banded hematite - quartzites, associated with argillitic and chloritic schists of north Mysore, are finely banded consisting of ferruginous and siliceous layers (see Rama Rao, 1940, p.24). They are very much similar to the iron formations of Goa which occur in chlorite phyllites.

Further, it is a well-known fact that the grade of metamorphism of the Dharwar schists of Mysore progressively decreases from the south to north. The northern part of low grade metamorphism is characterised by the presence of chlorite schists, while in the southern part they have reconstituted developing kyanite, sillimanite, garnet, etc. (see Rama Rao, 1940, p.57-58 ; Krishnan, 1960, p.104). Complete absence of rocks of high grade metamorphic facies anywhere in Goa in association with the chlorite phyllites makes the rocks closely comparable to the low grade chlorite-schist facies of northern Mysore.

In the light of above statement comparing the Middle Dharwars of northern Mysore with the Precambrian schistose rocks of Goa on the basis of their lithological similarity and comparable grade of metamorphism, structural units and iron ore association, the author has enough justification to believe

that they are not only stratigraphically equivalent but also continuous. Hence the phyllites, banded ferruginous quartzites and the associated iron ores of Bicholim and Sanquelim should also be regarded as a part of the Dharwars irrespective of their territorial limitations.