STRUCTURAL AND TECTONIC ANALYSIS OF THE GRANITES, GNEISSES AND ASSOCIATED ROCKS OF THE MUNIRABAD AREA, RAICHUR DISTRICT, MYSORE STATE

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The structural and tectonic analysis of the granites, gneisses and the associated rocks of the Munirabad area is described. Field relations of the different rock types are described and discussed. Megafabric and petrofabric diagrams have been prepared. It is seen from these studies that antiform structure of the foliation is a relic feature and the metamorphic impress of the two periods of deformation, namely an earlier one during early Dharwar times and a later one during the Post-Dharwar times, are clearly discernible. Since the fabric study of a few rock types show preferred orientation in the fabric diagrams, the rocks are regarded as tectonites. The structural features associated with the two periods of deformations are briefly described and discussed.

Introduction

The area that forms the subject of this investigation is about 100 sq. miles in extent and lies between longitude 15° 15′ and 15° 24′ and latitude 76° 13′ and 76° 22′. It is composed largely of pink and grey granites and gneisses together with small patches of hornblende-tremolite gneiss, hornblende-biotite gneiss, and biotite gneiss belonging to the peninsular gneissic complex. Epidiorites, banded hematite quartzite and quartzite belonging to Dharwars occur locally. Dharwars and peninsular gneissic complex are intruded by the quartz-dolerites and enstatite-dolerites of the Post-Dharwar and Pre-Cuddapah period. An excellent summary of the description of the rocks of the peninsular complex has been given by Pascoe (1950) based on the works of the earlier officers of the Mysore Geological Department. The Champion gneiss, which was considered as the earliest epoch of igneous activity into the Dharwars, has now been regarded as probably the crushed member of the peninsular gneiss, and the peninsular gneiss has now been considered as the complex possibly containing acid rocks of many ages intruding into the Dharwar schists, often producing migmatitic, injection, streaky, augen and biotite gneisses (Krishnan 1960).

Very little literature is available on the rocks of the Munirabad area. All the earlier workers, like Foote (1876, 1886 and 1903), surveyed both flanks of the Tungabhadra river near Munirabad in connection with the investigation of the dam site. Pascoe (1950) states that the granitoid members of this region might include the granitoid members of the peninsular as well as the Closepet suite.

The geological mapping has been done on a scale 4″ = 1 mile and structural mapping has been done on the same scale and subsequently reduced to 2″ = 1 mile, following the methods outlined by Cloos and described by Balk (1937).

Geology of the area.—The country rocks belong to Dharwars and consist of epidiorites of igneous origin and banded ferruginous quartzites of sedimentary origin. Occurring adjacent to these rocks and often showing the gradational contact with them are a series of gneissic and granitic rocks forming a complex, which occupy the major part of the area and are termed 'Peninsular gneiss'. The present study has revealed that the granites and gneisses are definitely younger than the epidiorite and considerable time seems to have elapsed between the formation of the two rock types. The granites and gneisses have been intruded by the aplite and pegmatite veins and basic dykes and the latter ones are now represented by the epidiorites, meta-dolerites and quartz-dolerites.

The geological succession of the rocks of the Munirabad area, correlated with the Archaean succession established by Rama Rao (1940) in Mysore, is given below. The metamorphism and the deformation that the rocks have suffered is also indicated.

Metamorphism III	Quartz-dolerite, Meta-dolerite, Epidiorite and Enstatite-dolerite.		Post-Dharwar and Pre-Cuddapah.
Injection Metamorphism II.	Aplite and Pegmatite Biotite gneiss Hornblende-biotite gneiss Hornblende-tremolite gneiss	Migmatites	Peninsular gneissic complex.
	Grey gneiss Grey granite Pink gneiss Pink granite		
Regional Metamorphism I.	Quartzite		U. Dharwar.
	Banded Hematite quartzite		M. Dharwar.
	Epidiorite flow		L. Dharwar.

Field Relationships of the Rock Types

Epidiorite.—The epidiorite is the metamorphosed lava flows of lower Dharwar age and occurs as massive rocks three miles south-west of Munirabad railway station. It occupies an area of 3 sq. miles and forms the basement rocks of the Tungabhadra dam. It is green to olive green in colour, sparingly jointed, and exhibits occasionally a schistose texture.

Banded ferruginous quartzites and quartzites.—Banded ferruginous quartzite occurs on the low hill about 1½ miles west of Hosalli and on the hill △ 2229′ situated to the east of Tungabhadra dam. It occupies a total area

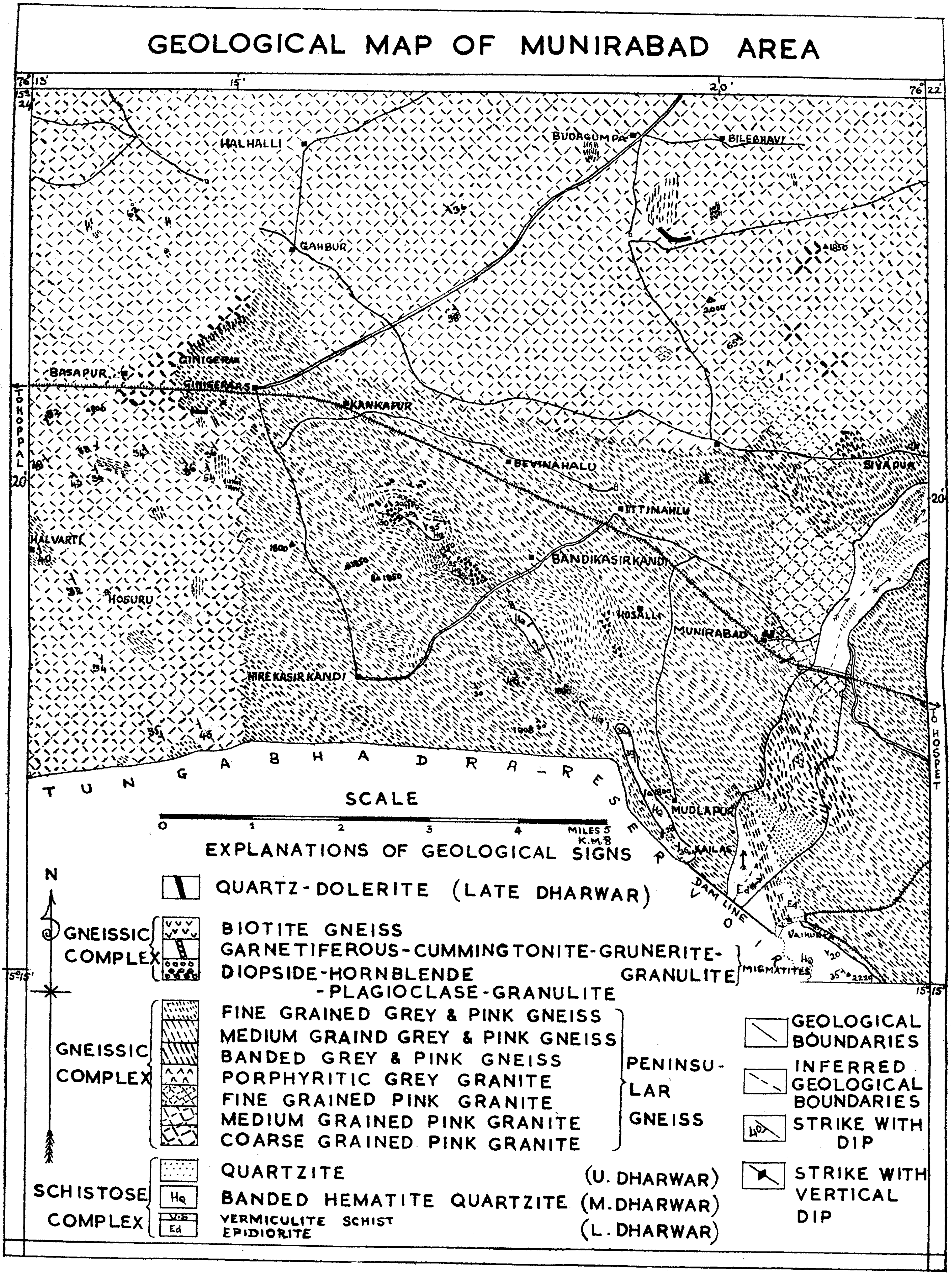

GEOLOGICAL MAP OF MUNIRABAD AREA
HALHALLI
BUDAGUMPA
BILEBHAVI
GAHBUR
BASAPUR
GINIGERA
KANKAPUR
BEVINAHALU
ITTINAHLU
SIVAPUR
HALVARTI
HOSURU
BANDIKASIRKANDI
HOSALLI
MUNIRABAD
HIREKASIRKANDI
MUDLAPUR
KAILAS
VAIKUNTA
DAM LINE
TO KOPPAL
TO HOSPET
TUNGABHADRA-RESERVOIR
SCALE
0 1 2 3 4 MILES 5
K.M. 8
EXPLANATIONS OF GEOLOGICAL SIGNS
N
QUARTZ-DOLERITE (LATE DHARWAR)
GNEISSIC COMPLEX
BIOTITE GNEISS
GARNETIFEROUS-CUMMINGTONITE-GRUNERITE-
DIOPSIDE-HORNBLENDE GRANULITE
-PLAGIOCLASE-GRANULITE
MIGMATITES
GNEISSIC COMPLEX
FINE GRAINED GREY & PINK GNEISS
MEDIUM GRAIND GREY & PINK GNEISS
BANDED GREY & PINK GNEISS
PORPHYRITIC GREY GRANITE
FINE GRAINED PINK GRANITE
MEDIUM GRAINED PINK GRANITE
COARSE GRAINED PINK GRANITE
PENINSULAR GNEISS
SCHISTOSE COMPLEX
QUARTZITE (U. DHARWAR)
BANDED HEMATITE QUARTZITE (M. DHARWAR)
VERMICULITE SCHIST
EPIDIORITE (L. DHARWAR)
GEOLOGICAL BOUNDARIES
INFERRED GEOLOGICAL BOUNDARIES
STRIKE WITH DIP
STRIKE WITH VERTICAL DIP

FIG. 1.

of about 5 sq. miles. The ferruginous quartzite shows a variable strike from N 20° W to N 40° W. The dip is moderate, between 35° and 45°, towards WSW in the hill ranges west of Hosalli and south of Bevinahalu, but on the hill $\triangle$ 2229′ it dips 60° along ENE and rests on epidiorite with angular unconformity. The banded ferruginous quartzite exhibits numerous small-scale features like the minor folds, slumpings, intraformational folds, and local faults. Joints are commonly seen striking NNW, NNE and EW.

Quartzites occur as small patches in the grey gneisses found to the north of the Tungabhadra dam. The biggest patch traced one furlong north of the dam runs for 200′ and has a width of 30′. It strikes N 35° W.

Pink and Grey Granites, Gneisses and the Associated Migmatite Gneisses

Granites, gneisses and the associated migmatites are the dominant rock types of the area, of which the pink granites and gneisses occupy an area of about 60 sq. miles, grey granites and gneisses cover 29 sq. miles and the migmatitic gneisses occupy nearly 3 sq. miles. The grey granites and gneisses form low-lying hills or gently undulating fertile plains, while the pink granites and gneisses form rugged scenery with bold hills having steep sides. Hornblende and tremolite gneiss, hornblende-biotite gneiss and biotite gneiss which constitute the migmatitic gneisses occur as small patches in grey granites and gneisses. The boundary between the pink and grey types, though transitional, can be made out with some difficulty.

The pink granites occupy the major part of the area. They exhibit mostly porphyritic to coarse-grained texture. The porphyritic granite is typically exposed at Budagumpa, Bilebhavi and Gahbur. Coarse-grained pink granite outcrops near Sivapur and Kerehalli. Medium-grained pink gneiss is found 1 mile east of Hirekasirkandi and $\frac{3}{4}$ mile south of Ginigere. Fine-grained pink gneiss outcrops 1 mile west of Hosalli temple, 1 mile south of Kankapur and near Bevinahalu. Banded pink gneiss is seen within the grey gneiss and pink porphyritic granite 1 mile south of Ginigere and near Sivapur and Budagumpa. The banded gneiss shows a pronounced foliation with prominent felsic and mafic layers. The foliation is generally parallel to the regional Dharwar strike.

The grey granites and gneisses are mostly confined to the southern and the south-western part of the area. They are generally grey in colour but as they approach the pink types the colour changes to light pink. Among the grey granites there are medium-grained, porphyritic and coarse-grained varieties and among the gneisses the rocks vary from fine- to coarse-grained and banded types. The grey granites and the gneisses are the most predominant varieties of this group and occur at a number of places showing imperceptible gradations, notably around Hosalli, Kankapur, Bandikasirkandi, Hirekasirkandi, Halvarti, and Ginigere. Porphyritic grey granite occurs as small outcrops 1 mile north of Sivapur and it grades into the porphyritic pink granite further northwards. Small patches of fine-grained grey gneiss are exposed ½ mile north of Tungabhadra dam. Grain size and textural variation are common among these varieties.

Migmatitic rocks are rich in ferromagnesian minerals and are found as small patches in the granites and gneisses. Migmatites from their mineralogical composition can be classified as hornblende-rich and biotite-rich granites and gneisses. The rocks are of not much importance from the point of view of the present investigation.

Structural Features

The granitic rocks of the area show various structural features like gneissosity, foliation, lineation, joints, slickensides and a few local faults. Slickensides are seen only along local zones of dislocation and they are not considered in the present study. The structures which have been studied in great detail are shown on the structural map (Fig. 2). Megafabric diagrams have been prepared for the joints and foliation planes and petrofabric analysis of quartz axes have been carried out for a few rock types.

Foliation

The gneissosity exhibited by the gneisses of the area are generally parallel to the foliation. The foliated gneisses are composed of platy minerals like hornblende, mica and felspars. These minerals show planar orientation and their largest face (010) lying in the plane of foliation. Two hundred foliation planes from each of the rock types, namely grey gneiss, pink gneiss, hornblende gneiss and biotite gneiss, have been studied in the field and the contour diagrams prepared from them are given in Fig. 3, *A*, *B*, *C* and *D*.

Fig. 3, *A* is the contour diagram of the 200 foliation planes from grey gneiss plotted on the southern hemisphere of an equal area projection. The foliation planes show preferred orientation and there are two very prominent maxima in the SW quadrant and two prominent maxima in the NE quadrant surrounded by a few spread-out contours and connected together by a weak NE/SW girdle. There are a few minor maxima in the NE and SW quadrants. Contour diagrams of the 200 foliation planes from each of the rock types, namely pink gneiss, hornblende gneiss and biotite gneiss, are represented in Fig. 3, *B*, *C* and *D*. It is obvious in these diagrams that the strike of foliation is coincident and it is N 38° W and dips at angles varying from 80° to 90° along S 52° W and 20° to 90° along N 52° E. The occurrence of a few contours spread out around the maxima suggests a local deviation of the strike of the foliation. There are a few minor maxima in the NW and SE quadrants

STRUCTURAL MAP OF MUNIRABAD AREA

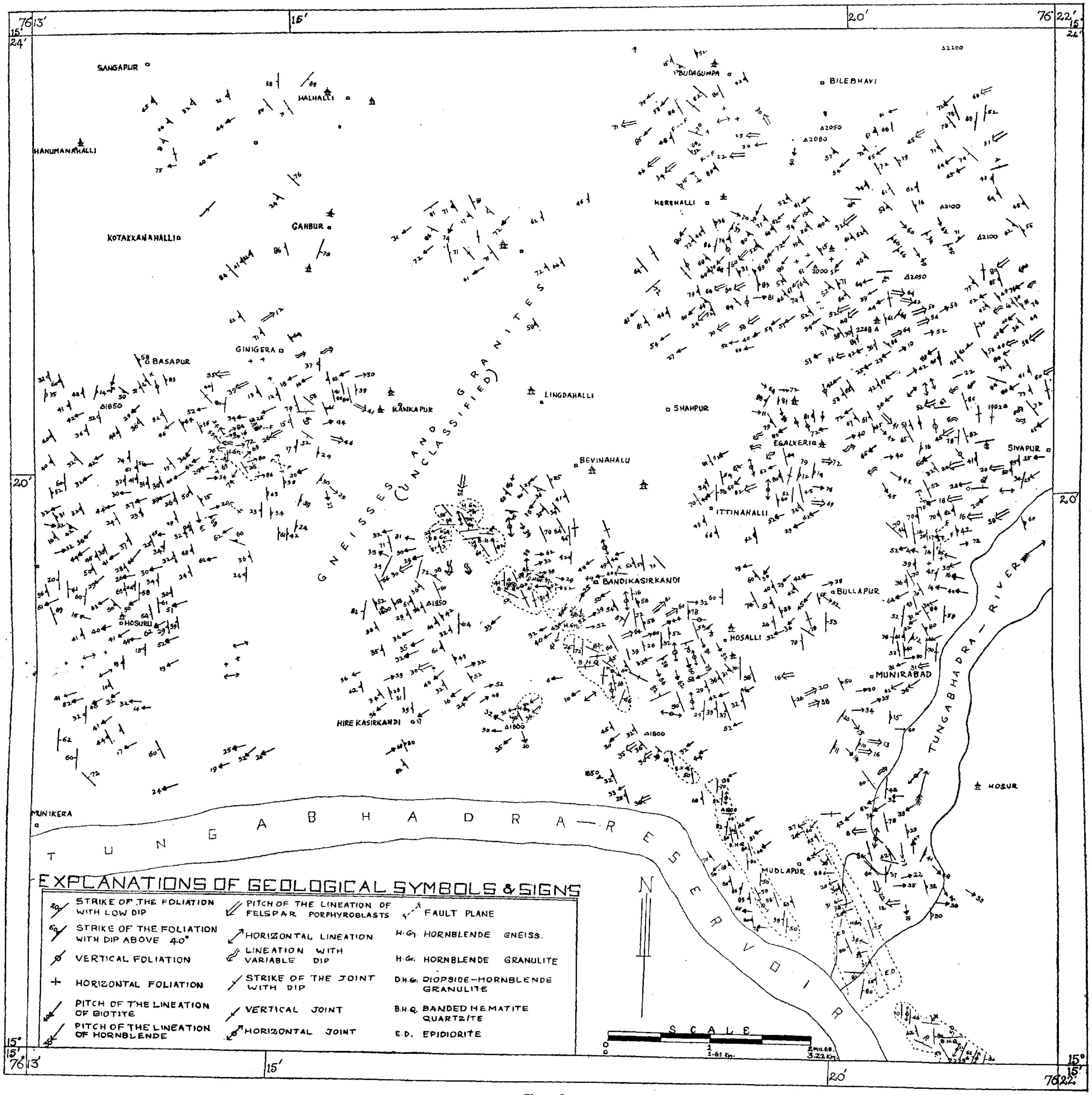


FIG. 2.

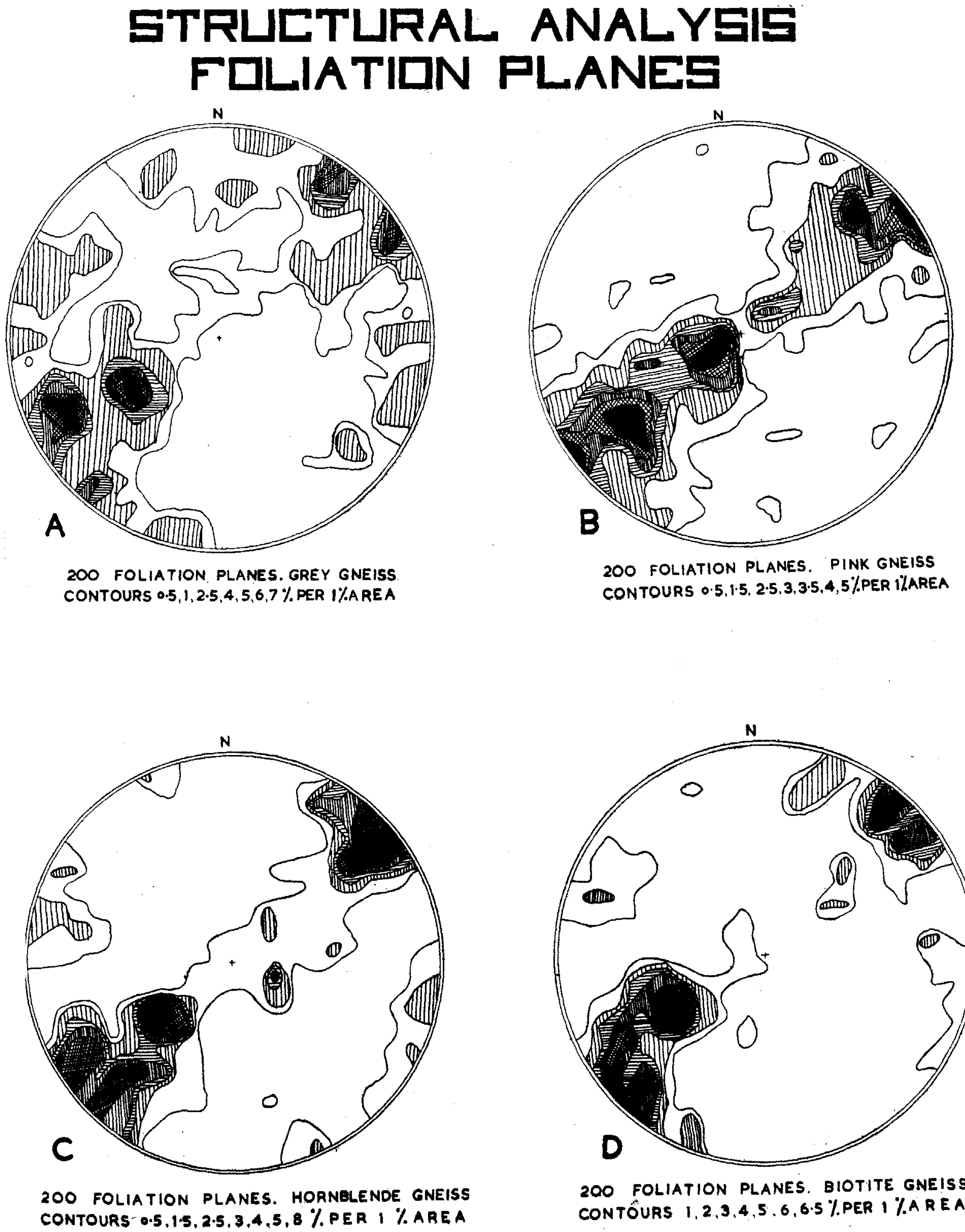


Fig. 3. Structural analysis: Diagrams of foliation planes.

suggesting the presence of a minor foliation striking NE and SW and dipping at steep angles along NW and SE directions.

From the study of the foliation planes of the grey gneiss, pink gneiss, hornblende gneiss and biotite gneiss in the field (Fig. 2) and in the laboratory (Fig. 3, *A*, *B*, *C* and *D*) it is seen that, though the strike of the prominent foliation is N 38° W, these gneisses show a swing in the foliation plane almost N/S around Bandikasirkandi, 1 mile west of Bevinahalu, on the eastern and western flanks of the hill Δ 2041′, along the Tungabhadra river course and 1 mile north of the Tungabhadra dam. This fact is shown by the foliation diagrams as explained earlier. The dip and strike of the foliation planes in these gneisses indicate that the foliation planes are asymmetrically folded into an anticline along N 38° W and the north-eastern limb dipping at steep angles between 20° and 90° and the south-western limb showing a variable dip from 80° to 90°. The asymmetrical antiform of the foliation is not due to the deformation of the granites and gneisses as the granites and gneisses are metamorphic and metasomatic in origin (Venugopal *et al.* 1958) and the petrological, structural and field evidences—like the concordant and gradational contact between the epidiorite and the associated rocks of Dharwar age and the granites and gneisses, the absence of thermal aureole at the contact and the parallelism of the enclaves and gneissosity to the regional Dharwar strike, and the occurrence of banded, streaky and foliated gneisses in regular succession grading from one to another parallel to the contact—point out that the foliation is secondary. Therefore, the form and structure of the foliation is a relic feature present and preserved in the gneisses due to the transformation of the folded Dharwar schists into rocks of granitic character metasomatically during late Dharwar times. The geometry and form of the foliation as deduced from the contour diagrams and from the field study indicate that it is an antiform, which is an imprint of earlier Dharwar schists showing a prominent foliation along N 38° W, which parallels the axial plane of the fold (axial-plane foliation = *b*-axis), and the direction of maximum compression is normal to the foliation (*a*-axis). The variable dip from 80° to 90° of the south-western limb and 20° to 90° of the north-eastern limb of the antiform needs explanation. This may be due to slumping or slipping of the original schistose rocks or rodding and gliding of the minerals along crystallographic planes or due to a subsequent deformation acting on the limbs of the earlier structure. In view of the occurrence of a minor foliation striking NE and SW, the authors are in favour of attributing the cause of the variation in the dip of the limbs of the antiform to a subsequent deformation, which has been discussed in the later part of the paper while analysing the joints, during which the force has acted as a couple along N 10° W and N 55° E. The foliation seems to have been subjected to a translatory movement and the flaky minerals have undergone gliding during the later deformation giving rise to the variation in dip. The minor deviation of the strike of the foliation may be due to the flowage set up during granitization. Since the later deformation (second episode) has induced growth of minerals during movement and has acted on the crystallines after the injection metamorphism, the style and geometry of the antiform of the rocks of Dharwar age (first episode) shown by the relic foliation have been probably unaffected except for the development of a minor foliation. In the absence of evidences in the granitic rocks, the authors are not in a position to throw more light on the effect of later deformation on the antiform shown by the foliation.

It is therefore concluded that the foliation in the gneisses is a relict structure and the form and geometry of the foliation is an inherited one from the previously existing Dharwar metamorphites and the forces in the area operated from north-east to induce a prominent foliation in a north-west to south-east direction in the original schistose rocks of the area (first episode). The area has been subjected to subsequent deformation during which the forces have acted as a couple to induce a minor foliation along N 55° E and S 55° W in most of the gneisses (second episode).

Lineation

The granites, gneisses and the associated rocks are composed of platy minerals like mica, felspars and hornblende and the lineations are observed in these minerals. These minerals show platy parallelism or planar structure with the largest face (001 or 010) lying parallel to the foliation planes and gneissosity. Lineations observed in these minerals have been differentiated and marked on the structural map (Fig. 2). Lineation generally pitches towards west and south-west, but pitching to the east and north-east is occasionally observed. Biotite present in the grey gneiss shows a radial lineation. This is purely a local feature, and it is seen in the grey gneiss 2 miles west of Hosalli and 1 mile south of Ginigere railway station. The radial lineation has developed due to the dispersal of the ferro-magnesian minerals from the pre-existing rocks by the invading solutions during injection metamorphism. The following features of lineation are observed in the rock types:

1. Lineation is due to the platy parallelism or planar structure exhibited by mica, felspar and hornblende, with the largest face (010) lying parallel to the foliation.
2. Wherever the form and structure of the original foliation are destroyed, the only macroscopic minerals present are the porphyroblasts of felspar (both plagioclase and microcline) and a little biotite.
3. There are basic patches predominantly consisting of hornblende and biotite drawn out parallel to the foliation and lineation.

Joints

Among the structures present in this area, joints are not only dominant but well developed. They have been marked on the structural map of the area (Fig. 2). The rocks are characterized by the foliated structure to which all joints and other structures are geometrically related.

1. Longitudinal joints which are parallel to the foliation and the planar structure.
2. Cross-joints which cut the planar structure at 90°.
3. Diagonal joints which cut the planar structure at angles of about 45° or less.
4. Flat-lying joints which dip at low angles and some are almost horizontal.

Among these, the longitudinal and diagonal joints are most predominant. Cross-joints are rare. Flat-lying joints are commonly seen in the rock types. Sometimes the joint planes of the longitudinal joints are filled with pegmatites. The longitudinal joints generally have a steep dip and some of them are vertical. Diagonal joints generally show steep dip and the joint planes are uneven and seem to be associated with some brecciation. Flat-lying joints have low dips and sometimes are almost horizontal and the joint planes are even and smooth.

The above observations are checked by analysing the joints from the epidiorite, grey gneiss, hornblende gneiss and porphyritic pink granite on Schmidt equal area projection, and they are given in Fig. 4, *A*, *B*, *C* and *D*. The relations of the joints to the planar structure are also studied. It is seen from these contour diagrams (Fig. 4, *A*, *B* and *C*) that the epidiorite, grey gneiss and hornblende gneiss show prominent longitudinal joints parallel to the foliation of the rocks (N 38° W) dipping at moderate to steep angles. Flat-lying joints with low angles of dip are generally present. Diagonal joints dipping at steep angles are seen in all the rocks. Cross-joints are rare and they are normal to the foliation and the planar structure and they also dip at steep angles. Fig. 4, *D* is the contour diagram of joints from porphyritic pink granite. The picture of the joint pattern is entirely different. The joints do not show any preferred orientation and they all dip at steep angles. Flat-lying joints are absent.

From the study of the joints in the field and by the analyses of the joints on the equal area projection it is seen that the joints reflect the deformation that the rocks have undergone at different times during Dharwar orogeny. The earliest episode is the formation of an antiform in the schistose rocks, the axial plane of the fold striking N 38° W, and the forces have acted along N 52° E during the early Dharwar period. As a result of the bending movements undergone by the metamorphites, longitudinal joints parallel to the *b*-axis

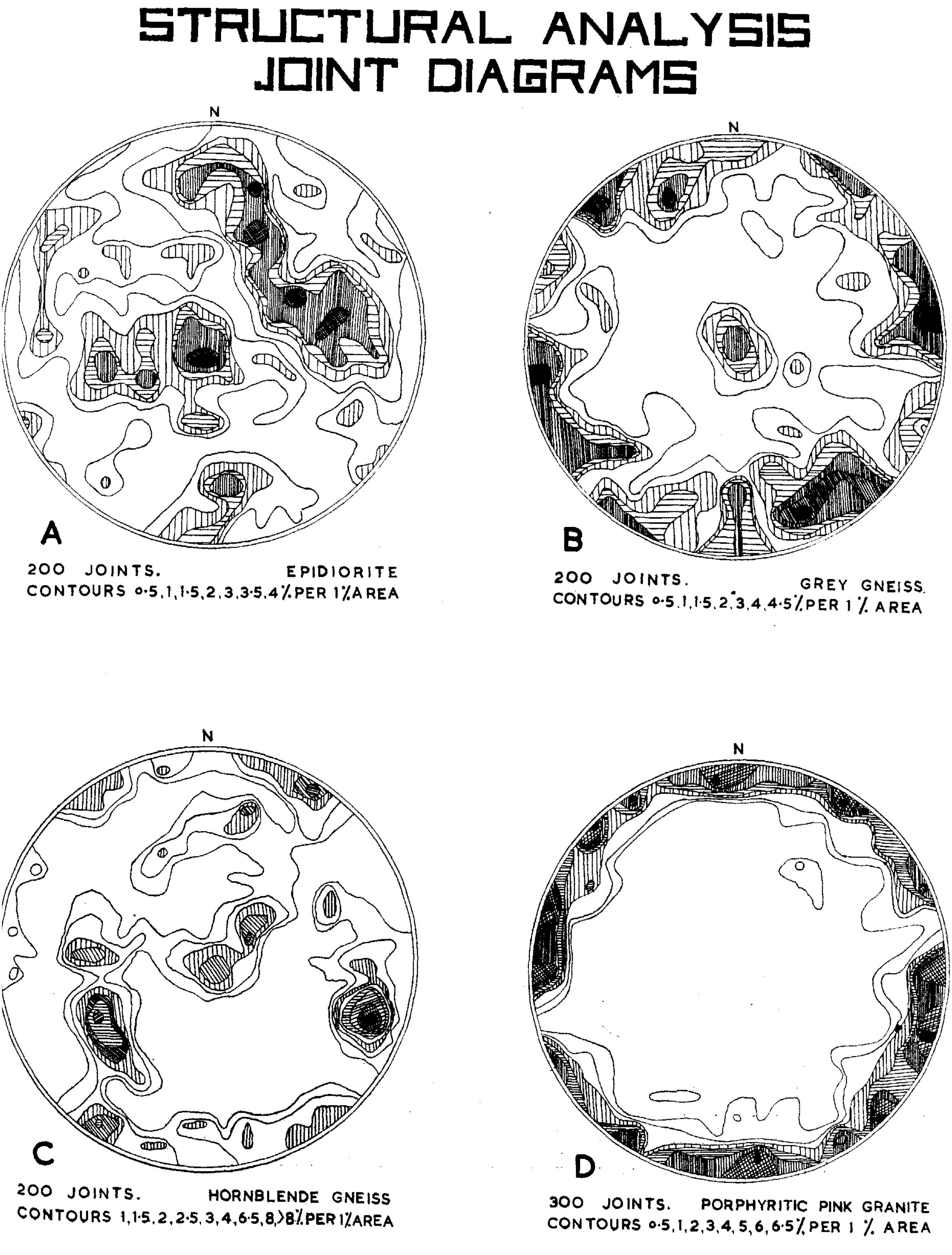


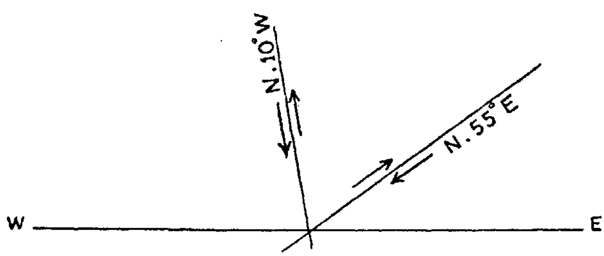
FIG. 4. Structural analysis: Joint diagrams.

of the fabric have developed (Fig. 4, *A*). The development of the schistosity and the axial plane foliation of the metamorphites are also attributed to the same forces.

Joints of the pink porphyritic granite do not show any preferred orientation (Fig. 4, *D*) as explained earlier. The formation of such joints are related to the upsurgence of highly mobile anatexic magma at higher energy level in the gneissic complex.

Cross-joints are quite subordinate and they are developed at right angles to the planar structure due to the elongation of the gneisses parallel to the lineation and foliation of the rock types. Flat-lying joints have developed in the epidiorites and gneisses of the area due to the stretching of the crystallines, or due to the cubial expansion of rocks under stress by subsequent erosion or due to the slight increase in volume after the metasomatic conversion of the country rocks into gneisses.

After the injection metamorphism during Post-Dharwar times the metamorphites were subjected to shearing forces or couples along N 10° W and N 55° E parallel to which (slip planes) diagonal joints have developed (Fig. 4, *B* and *C*). The directions of the force couples are shown below:



Along both these directions of the shearing forces there was movement. Movement was appreciable along N 55° E, parallel to which a minor foliation has developed, the reference to which has already been made in the earlier part of this paper. Sander (Turner 1948) was able to identify several distinct types of movement picture along the slip plane surfaces while investigating the fabric of certain Tyrolean slates and mica schists. Unequal development of sets of slip surfaces as noted in the present investigation is of common occurrence and such occurrences have been noticed by Becker, Sander, Eskola and others (Turner 1948).

Thus the diagonal joints, cross-joints and flat-lying joints are structures related to the deformation suffered by the rocks of the area after the injection metamorphism during the Post-Dharwar times, which are termed structures of the second episode to differentiate them from the structures of the first episode related to the regional metamorphism of the early Dharwar period.

PETROFABRICS

The petrofabric study of the grey gneiss and quartzite has been undertaken to determine the preferred orientation. Petrofabric diagrams prepared on sections cut perpendicular and parallel to the strike of the foliation of these rocks are represented in Fig. 6, *A–D*. In the case of quartzite the strike of the visible foliation of the adjacent gneisses has been taken into consideration while collecting the oriented specimens and the sections have been cut along definite planes. Block diagrams have been drawn (Fig. 5, *A* and *B*) to show the form and geometry of the visible foliation of the biotite gneiss and quartzite, in which petrofabric diagrams have also been given along appropriate planes to bring out the relation between the megafabric and microfabric.

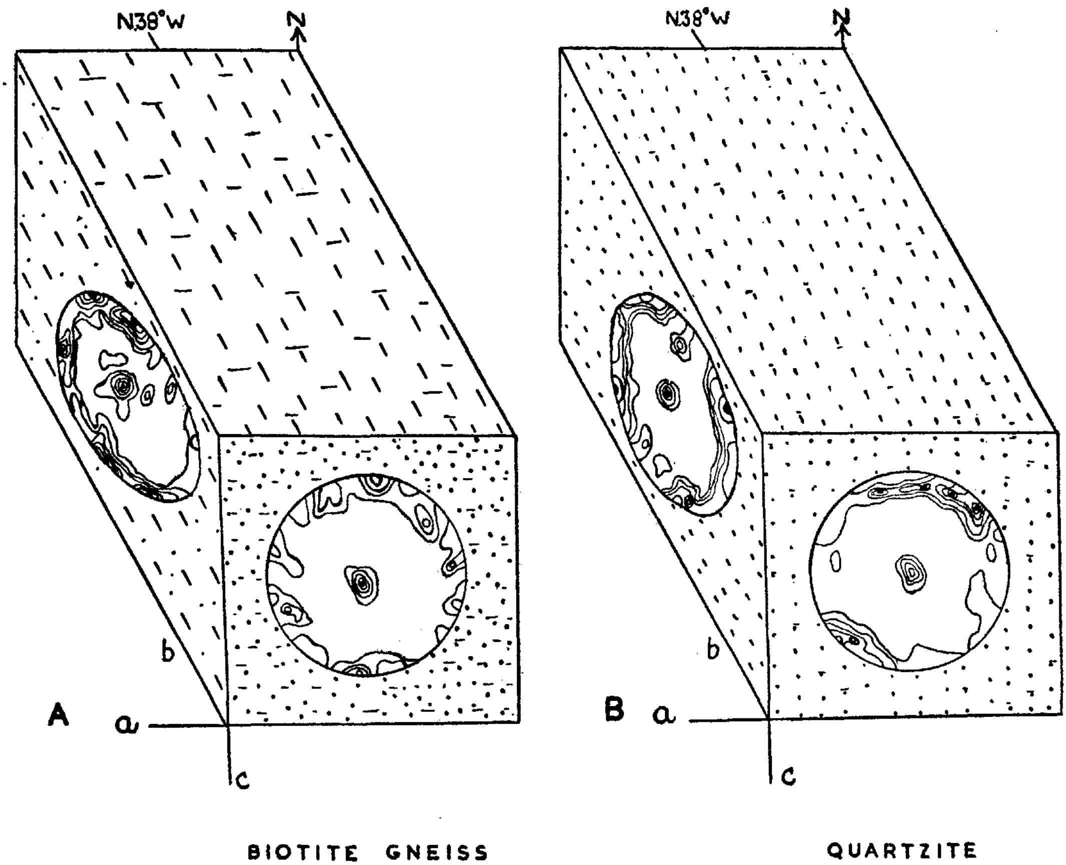


Fig. 5. Block diagrams: Showing the relation between the megafabric and the microfabric.

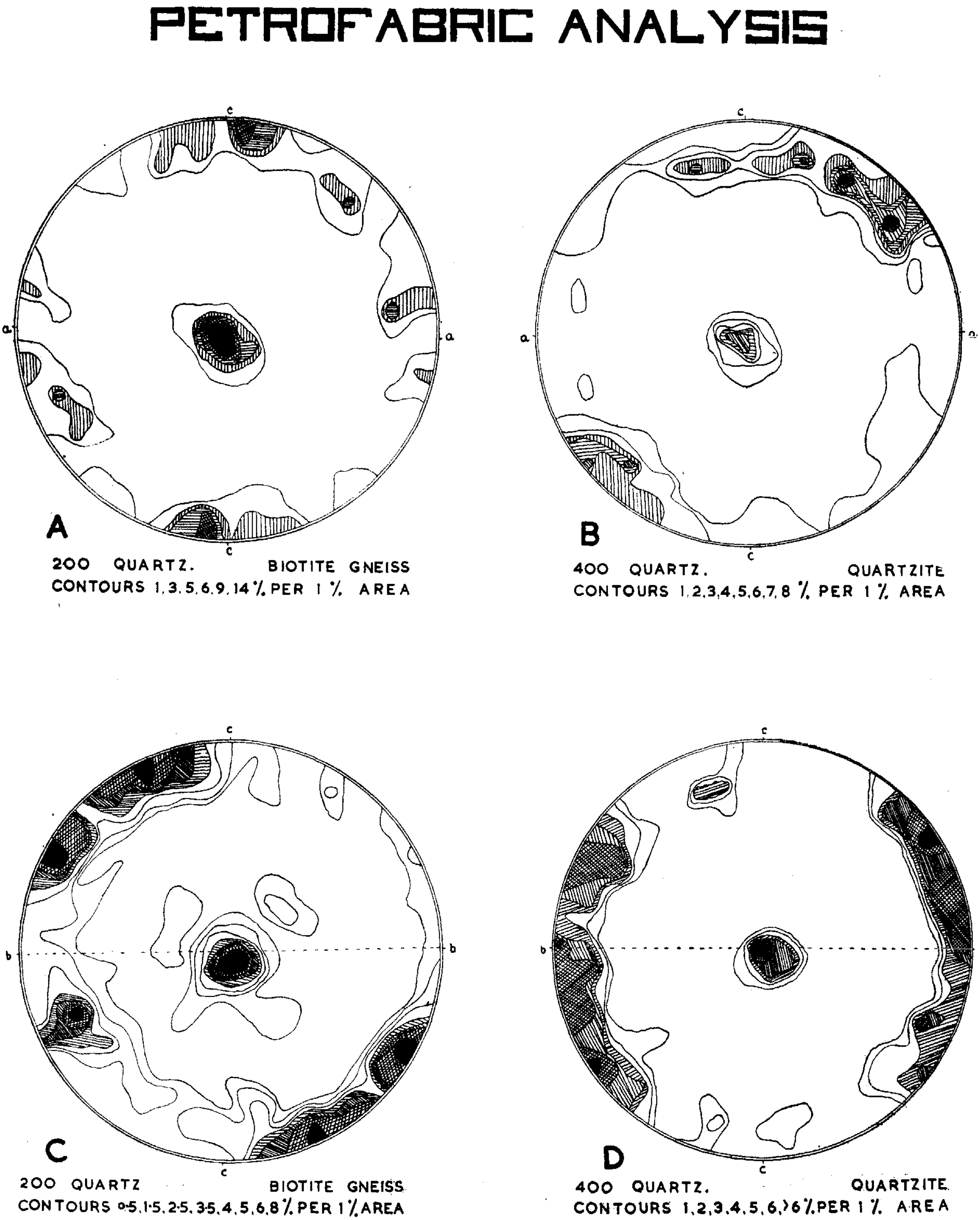


FIG. 6. Petrofabric diagrams from the Munirabad area.

Since the rocks of this area exhibited a prominent foliation and lineation parallel to *b*-axis, *a–c* diagrams of both the biotite gneiss and quartzite are prepared (Fig. 6, *A* and *B*). The *a–c* diagram of the biotite gneiss (Fig. 6, *A*) shows a central maximum along *b*, four maxima with a few minor maxima at the periphery forming a well-developed but not a complete girdle along the *a–c* plane and the maxima situated more or less symmetrically on either side of *a–b*. The central maximum corresponds to the *b*-axis of Sander and the girdle as rotation round it. The occurrence of the planar structure parallel to *b* in these rocks confirms that the central maxima is the *b* direction movement of Sander. Fig. 6, *B* is that of a quartzite cut perpendicular to the strike of the foliation (*a–c* plane) and the petrofabric pattern is similar to the *a–c* diagram of the biotite gneiss, but the *a–c* girdle is not well developed.

Fig. 6, *C* and *D* are the diagrams from biotite gneiss and quartzite cut parallel to the strike of the prominent foliation and perpendicular to the minor foliation. The *b–c* diagram of the biotite gneiss (Fig. 6, *C*) shows a well-pronounced maximum in the centre which appears to represent the *a*-axis of the fabric (maximum I of Sander 1930). Further, there are a number of prominent maxima at the periphery which are perpendicular to each other and situated almost asymmetrically about the fabric axes *b* and *c* and perpendicular to the central maxima. As they occur at an inclination of about 45° to the *S*-plane, they can easily be identified as the well-known symmetrical pair of maxima III. This combination of the maximum I with maximum III is typical for granulites and is described from German and Finnish rocks (Sander 1930, 1950; Schmidt 1926, and others). It is therefore interpreted that the central maximum corresponds to the *a* fabric axis and the girdle as rotation round it. There is a minor foliation parallel to *a* in this rock. The *b–c* diagram of the quartzite (Fig. 6, *D*) resembles the similar diagram of the biotite gneiss (Fig. 6, *C*). It is therefore seen that these rocks have two different types of foliations formed by different deformations at different times during the Archaean period referable to different petrofabric patterns. Therefore, the two features, foliations and petrofabric patterns, are related to each other showing two distinct deformations, one of early Dharwar times and the other of the Post-Dharwar period.

Since there is preferred orientation in all the diagrams studied of biotite gneiss and quartzite, the rocks can be classified as tectonites.

Conclusion

The structural and tectonic analysis of the rock types of the area indicates that the structures studied are all related to each other and they reflect the episodes through which the rocks have passed. The first event is during the early Dharwar times when the metamorphites were folded into an antiform striking N 38° W. Axial plane foliation is along N 38° W and the foliation is parallel to the b-axis. The direction of compression is normal to the foliation (a-axis). Longitudinal joints developed during the first episode. During the injection metamorphism at Post-Dharwar times there was very little deformation. The geometry and form of the antiform of the metamorphites of the first episode are seen by the relic foliations. Joints showing absence of preferred orientation have developed during the upsurgence of highly mobile anatexic magma in the gneissic complex.

After the injection metamorphism during the Post-Dharwar times metamorphites were subjected to shearing forces or couples along N 10° W and N 55° E resulting in the formation of slip planes (diagonal joints) along the directions in which the force couples have acted. Slip movement was more intense along N 55° E and a minor foliation has developed along the direction. Cross-joints and flat-lying joints are related to the events connected with this deformation.

The petrofabric study supports the above conclusions, namely that the rocks are tectonites and they show the fabric orientation of two periods of deformation. During the early deformation (first deformation) b-fabric axis which is parallel to the planar structure is also the direction of movement and the fabric elements have moved as a girdle around b in the a–c plane. During the subsequent deformation (second deformation) the fabric indicates a movement along a, along which a minor foliation has developed and the fabric elements have moved as a girdle around a in the b-c plane. The summary of the structural analysis of the area is given below:

SUMMARY AND INTERRELATION OF THE STRUCTURAL ELEMENTS

		Megafabric	*Microfabric*
Episode I	Regional Metamorphism (Early Dharwar).	Antiform structure axial plane foliation along b, longitudinal joints.	Movement along b in the a–c plane.
	Injection metamorphism (Post-Dharwar).	Joints without any orientation.	
Episode II	Regional metamorphism (Post-Dharwar and Pre-Cuddapah).	Diagonal joints, cross-joints, flat-lying joints.	Movement along a in the b–c plane.

Looked at in a broad way, the area under investigation reveals two regional foliations, one prominent N 38° W/S 38° E foliation, the strike of which is referred to as the Aravalli-Dharwar strike shown predominantly by the peninsular gneisses, and the other less prominent N 55° E/S 55° W foliation, the strike of which is called the Eastern Ghats strike, commonly shown by the Charnockites. It is surmised that the deformation responsible for the development of the foliation along the Eastern Ghats strike had very little effect on the crystallines of the Munirabad area. Thus the metamorphic impress of the second deformation over the earlier one is not much evident.

Possibly a detailed analysis of the neighbouring areas of the same metamorphic terrain might reveal much more evidence of the complex deformation shown by the area under investigation.

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