GEOLOGICAL SURVEY OF INDIA

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SYSTEMATIC GEOLOGICAL MAPPING IN PART OF GAYA DISTRICT, BIHAR (TOPO SHEET NO. 72H/02)
(PROGRESS REPORT FOR THE FIELD SEASON, 1968-69)

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SYSTEMATIC GEOLOGICAL MAPPING IN PART OF GAYA DISTRICT, BIHAR (TOPO SHEET NO. 72H/02)

By

A.K. Choudhury, Assistant Geologist

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ABSTRACT

During 1968-69 field-season approximately 230 sq km area was covered by geological mapping on 1:63360 scale part of Gaya district, Bihar, falling in Survey of India topo sheet No. 72H/02. The area represents a part of pre-Cambrian metamorphic terrain consisting chiefly of quartzite, mica schist, hornblende schist, and granite gneiss. The meta-sedimentary rocks occur as isolated patches within the granitic rocks. These often show gradational boundary with the adjacent gneisses. It appears from the field relations that the foliation in granite gneiss is mostly a relict of the schistosity in the pre-existing meta-sedimentary rocks. Field relationship and petrographic character of the granite gneiss of the area suggest that this has been formed by the introduction of feldspathic materials within the pre-existing meta-sedimentary rocks.

SYSMATIC GEOLOGICAL MAPPING IN PART OF GAYA DISTRICT, BIHAR (TOPOSHEET NO. 72H/02)

INTRODUCTION

In pursuance of the Field Season Programme of the Geological Survey of India for the year 1968-69 (vide item No. GM/3, page 2), the author carried out systematic geological mapping in a part of Gaya district, Bihar, from 24th January,'69 to 23rd April,'69. During the period about 230 sq km area was covered on a scale of 1:63,360.

Acknowledgement

The work was carried out under the guidance of Shri K.D. Shukla, Director, Bihar Circle, Geological Survey of India, who inspected the mapping at several critical points. The author wishes to express his gratitude to Shri Shukla for his valuable suggestions both during the field work and the preparation of the report.

Location and accessibility:

The area mapped lies in the south eastern part of Gaya district. It is bounded by North latitudes 24°30' and 24°40' and East longitudes 85°07' and 85°15' and forms the eastern parts of the Survey of India topo sheet No. 72H/02.

The area is approachable from the Grand Trunk Road southern boundary is only about 8-10km from this It can also-be approached .from Gaya via Wazirganj and Fatehpur. Wazirgang is about 25km east of Gaya on the Gaya-Nawada metalled road. From Wazirganj a 20km long metalled road leads southwards to Fatehpur, which is located near the NE corner of the area. The Dhanbad-Gaya section of broad gauge Grand Chord line of the Eastern Railway touches the north-eastern corner of the area. The nearest railway station is Paharpur near Fatehpur. From Fatehpur a road leads to Lakhaipur, just west of the area. Other of the area can be approached by cart tracks.

Physiography:

Major part of the area forms plain lands. The hill ranges over the south eastern part of the area while the If of the area is occupied by flat lands with hillocks. The whole area ranges in elevation from the plain lands in the northern part of the metres at the top of the hill lying west of Debo near the southeastern corner. The area is

drained by Dhadhar Natane, Paimar and other minor nalas along with its numerous tributaries. All the nalas flow towards north or west.

The climate of the area is extreme. During winter the climate is dry and cold but from the end of March to May the temperature is quite high, frequently exceeding 110°F. Dust storms are also common during hot months. Low to moderate rainfall is recorded during monsoon, which generally recedes from the area in early October.

The hilly parts of the area support a fairly thick vegetation consisting essentially of Sal (Shorea robusta), Palas (Butea fondosa), Palm (Dorassus flabellifer), Pipal (Ficus religiosa), Mahua (Bassia latifolia), Banyan (Ficus bengalenses), Mango (Mangifera indica) Bel (Aegle marilos), Bair (Zizyphus jujuba), Kend (Diospyros melenoxylon), Bamboo (Dendrostrictus), Aonla (Phyllanthus emblica) etc. Wild animals which are fairly abundant in the jungle tract, include bear, wolf, leopard, deer, sambar, bore etc.

Previous Work:

The area under report had not been mapped in any detail so far. Several geologists from the Geological Survey of India have, however, worked in the vicinity of the area under consideration. U.Prasad (1963-64) carried out reconnaisance survey of the area lying to the north of the present area. The author carried out systematic geological mapping in the areas lying north of the present area during the previous season.

II GEOLOGY AND ROCK TYPES

The area under report is mostly soil covered with only a few isolated hills and ridges. The main country rocks are granite and granite gneiss with a few outcrops of schists and quartzites (felspathised). The south-eastern part of the area consists chiefly of quartzites, hornblende schists, mica schists and granite gneiss. A small exposure of garnetiferous granulite was also noted in this area. The schistose rocks generally occupy the valleys but occasionally form hillocks. The quartzite and quartz veins form ridges. Current bedding and other sedimentary features are absent in the quartzites. The major part of the area is covered by alluvium consisting of variable thickness of alternating clay, sand, sandy clay and silt with calcareous concretions. The tentative stratigraphic sequence of the rock formations found in the area is given below:

Recent	Alluvium
	Pegmatite and. quartz vein.
	Granite and Granite gneiss.
Archaeans	Quartzite, garnet granulite.
	Mica schist, quartz mica schist and hornblende schist.

Mica schist and quartz-mica schist:

Small isolated patches, of mica schist and quartz-mica schist occur within granite gneiss country rock. The trend of schistosity is in conformity with the trend of the foliation of the gneisses. Typical exposures of mica schist are found near Debo and Deothika. In hand specimens, these schists consist of flakes and needles of muscovite, biotite and sericite with fine grains of quartz and feldspar.

Under the microscope (slide No. l) the mica schist shows elongated flakes of muscovite, biotite, fine grains of plagioclase and potash feldspar (sometimes perthitic). The feldspar grains (both plagioclase and potash feldspar) are altered to fine sericite and epidote grains. Accessory minerals present are epidote and some opaque minerals.

Quartzite:

Quartzite forms a part of the high hill ranges and are found to occur in the southeastern part of the area. It is generally white to light gray in colour and is devoid, of current bedding. The bedding planes are defined in places by crudely preserved

colour bandings, but more often the bedding cannot be easily deciphered. Close-space joints in the quartzite have made it further difficult to recognize the bedding planes. Under the microscope, quartzite shows abundant fine grains of quartz, and flakes of sericite and biotite. Recrystallized quartz grains show straight and sub-parallel contacts. Optical orientation varies from grain to grain and most of the grains show wavy extinction. Dusty inclusions are common in quartz grains.

Hornblende schist:

It occurs usually as patches and lenses within mica schist or gneisses. About 0.5 km west of Debo, however, it forms a prominent hill. The trend of schistosity in this hill is ENE-WSW in conformity with that found in the adjacent schists and the strike of the quartzite band. The trend of schistosity varies in different outcrops and patches within the area mapped with low to high dips both towards north and south. The contact between hornblende schist and mica schist is often gradational.

In hand specimens, it is a dark coloured rock consisting of needles of green hornblende, altered feldspar and pink coloured garnet. In thin section it shows presence of brown hornblende, quartz, feldspar, garnet, little biotite and some opaque minerals. Hornblende is the most prominent constituent, while brown biotite is present in small amount. Garnet is present in most outcrops but in varying amounts, plagioclase feldspar present is albite to oligoclase in composition. The mineral assemblage indicates that the original calcareous sediment was subjected to regional metamorphism upto garnet zone.

Garnetiferous granulite:

A small exposure of this rock type was noted about a kilometre west-southwest of Jhurang village in the south eastern part of the area. It occurs as boulders surrounded by soil. The contact between the granulite and the enclosing granite gneiss cannot be seen.

In hand specimens the rock is light in colour and consists of quartz, feldspar and garnet. Under the microscope (slide No.2) granulite shows flattened and lenticular quartz, potash feldspar (perthitic and non perthitic), plagioclase feldspar (andesine variety) garnet and scapolite as essential minerals. Plagioclase is unzoned and shows presence of polysynthetic twinning (albite law) and extinction angles 19°-22°. Garnet commonly contains quartz inclusions and is to some extent altered to chlorite which is greenish in colour slightly pleochroic and shows parallel extinction. Scapolite is having low refractive index, high birefrengence, straight extinction and is uniaxial

negative in character. Accessory minerals are epidote, sphene, and clinozoisite which is differentiated from epidote by its oblique extinction angle.

The abundance of quartz and feldspar and presence of plagioclase feldspar, garnet, epidote etc. in the rock indicate that the original sediment was probably a highly feldspathic sandstone. The actual grade of metamorphism is that of garnet. From mineral assemblage it can be said that regional metamorphism of non-calcareous feldspathic sediment has produced the present rock type.

Granite gneiss:

It occurs both as low, topped exposures and as hillocks within the plane country. The general trend of foliation of the gneisses varies from N70°E-S70°W to N 70°W-S70°E with steep dips both towards north and south at different places. At places the gneissosity is obliterated by the development of coarse grains of quartz and feldspar. In hand specimens, it is a leucocratic rock consisting of quartz, feldspar, muscovite and biotite.

Under the microscope (slide No. 5) it shows coarse sub-hedral to irregular grains of quartz, biotite, muscovite, chlorite, epidote, sphene and opaque minerals. Plagioclase grains (acid oligoclase to oligoclase) are generally saussuritised.

Fresh grains show lamellar twinning (according to albite law), carlsbad twin and albite-pericline twin. The potash feldspar shows perthitic and granophyric intergrowth. The different types of perthite present are string perthite, bleb perthite and patch perthite, due to the exsolution of albite lamellae. Flakes of biotite with basal cleavages show characteristic absorption colours in shades of brown.

Pegmatite:

These rocks occur as small elongated vein like bodies within the granite gneiss and mica schist. The trend of these pegmatite veins in being controlled either by the foliation or by joint planes of granite gneiss and mica schist. Most of the veins are very thin and vary in width from one half to one metre and are too small to be plotted. Quartz and potash feldspar are the main constituent minerals of the pegmatite bodies. The pegmatites which are rich in plagioclase feldspar are enriched in micas.

Quartz vein:

Numerous veins of quartz cut across almost all the rock types described

earlier. These veins generally intrude along foliation and joint planes in the country rock. Most of the quartz veins are too small to be plotted on the 1:63,360 scale.

Soil and alluvium:

Soil and alluvium occupy more than one the third of the area mapped. Typical alluvium is composed essentially of sand size quartz grains. The soil present in the area is mostly light grey to buff in colour. At places the soil is reddish in colour due to presence of iron compounds. The soil is generally fine grained in texture and is composed of mainly sand, silt, and clay with occasional concretions and nodules of impure calcium carbonate. The thickness of the alluvium in most of the places is less than 10m to 12m.

Origin of granitic rock:

The granitic rocks of this area show a marked degree of heterogeneity in mineralogical composition and texture, while a structural concordance between the granitic rocks and pre-existing meta-sedimentary rocks, is also observed in the field. Unreplaced and unaffected remnants of the meta-sedimentary country rocks occur within granite gneiss both as large patches and as small lenses and bands of schists and quartzites. These relict patches are generally elongated with their longer axes parallel to the regional foliation of the gneisses. The schistosity and the bedding planes in them appear to continue as foliation within the granite gneiss. These schists and quartzite patches generally show effects of felspathisation along the margins and are often found to grade imperceptibly into the gneisses.

The mineralogical assemblages in all these rocks exhibit considerable diversity in their composition. The percentage of mafic minerals- mostly biotite, muscovite and epidote- present in these varies widely from place to place. These features suggest that the granitic rocks were formed due to felspathisation of different types of original sediments.

III STRUCTURE

The different structural elements that are preserved in the area are described under the following groups: (1) Planar structures and (2) Linear structures.

Planar structures:

a) Stratification (S_1): In this area stratification is preserved in the quartzites .The bedding planes are defined by crudely preserved colour and compositional bandings.

b) Schistosity (S_2): It is an early diastrophic structure of the area. In schists it is defined by the parallel arrangements of flaky minerals namely muscovite, biotite sericite etc. The trend of the schistosity plane is, however, very much variable.

c) Mineral foliation (S_2): The mineral foliation is preserved in granite gneisses. The type of foliation is generally defined by the planar arrangements of mica flakes and also in places by the preferred dimensional orientation of mineral grains like feldspar and quartz.

d) Joints: Joint planes include strike joints, dip joint and oblique joints. These have been observed frequently within the quartzites and granites. In the granitic rocks most of the joint planes are steep dipping or vertical. Along the joint planes in granitic rocks pegmatite materials have intruded.

e) Fault: Several strike and oblique faults which are generally established by the presence of fault breccia and slicken sides have been observed in the area (Plate 1). In the southern part of the area, north of Matgarha, two minor faults are indicated by the presence of fault breccia zones. The one just north east of Matgarha runs for about one kilometre along N30°E direction. The other one is about two kilometre north of Matgarha and runs for about 1.5km. along N50°E direction. Three other faults are located in the eastern part of the area. Of these two parallel faults are located NNE of Goli and run along N45°W direction on either side of Dhadhar nala from north of Baluani for about 2.5km. The third fault running east-west, is located north of Bhawanri Kalan and was traced for about two kilometre from Dhadhar nala to east of Kusmahar.

Liner structures:

Mineral and pucker lineations are also present in this area. Mineral lineations are present in mica schist and granite gneiss, and are defined by the linear

arrangements of needles and elongated plates of mica and these are mostly in down dip direction. Pucker lineations defined by the small scale folds on schistosity planes, are preserved only at a few places. Due to lack of enough exposures showing mineral and pucker lineations throughout the area their relation with the major fold movements cannot be established with certainty.

Structural analysis:

The structural map of the area has been shown in (Plate I). It appears from the structural map that the strike of the foliation planes within granite gneiss shows more or less uniform trend in the northern and western part of the area. The generalised trend of foliation and schistosity drawn in the structural map gives a clear picture of the variations present in the foliation and schistosity trend. It shows wide swing of the foliation and schistosity direction in the southern part of the area. In this part the schistosity and foliation dips are towards both sides and have thus defined local antiforms and synforms. It probably indicates the effect of first generation of fold (B_1). The turning of attitudes of S_2 probably represent the effect of second generation of fold (B_2) which is superimposed on the first one. In order to make a systematic and statistical analysis of the major structural elements present in the area, four structurally homogeneous sectors have been chosen in such a way that within the individual sectors the trend of foliation or schistosity is almost uniform. All the four sectors have been shown in the structural map (Plate I). The "poles" (poles to the schistosity and poles to the foliation) have been plotted on equal area net to prepare ‘scatter diagrams’. These scatter diagrams have been shown in Plate II after one third reduction.

Sector-I: The foliation and schistosity planes in granitic and schistose rocks of this sector have more or less NE-SW strike with steep dips towards north-west. The poles of S_2 tend to form a NE-SW girdle with a single maximum and shows a plunge of 52° towards N35°W (Plate III fig-1).

Sector-II: In this sector S_2 shows a broad turning from NW-SE in the southern part to N10°E and E-W in the northern part of the area. The dips are generally moderate to steep. S_2 not apparently show any clear pattern, possibly due to non-cylindrical nature of folding arising largely from super position of two generations of folds. However, the depositor of the poles suggest influence of two fold, generations, one with WSW axial plunge and the other with shallow south-east plunge (Plate III, fig.2).

Sector-III: In this sector the general trend of S_2 is along NE-SW with minor local variations. The dips are both towards north and south. S_2 appears to form cross girdle.

Of these, the steeper girdle has P_1 plunging at 20° towards N35°E, whereas the other girdle is sub peripheral with P_2 plunging 60° towards S40°E.

Sector-IV: In this sector S_1 and S_2 strike N80°E-S80°W. In the western part S_1 and S_2 show a turning towards NW-SE direction. The dip varies from low to steep and is mostly towards north. Like most of the other sector. πS_2 (also-πS_1) show some scattering, but an inclined girdle with P_2 plunging 32° towards N47°E is depictable.

Summary of structural geometry:

It is very difficult to establish the structural history of an area mostly covered by alluvium and by granitic rock. However, from the data recorded and from the knowledge of the structural history of the adjacent area, the probable trend of deformation can be deduced. The first diastrophic movement in this area after the deposition and compaction of sediments is marked by the folding of the bedding planes (S_1) with the development of axial plane schistosity (S_2). This fold is designated here as B_1 fold. From the study of the S-diagram it can be said that the fold axis is sub-horizontal having gentle plunge towards NE direction (Plate-III. fig. 2, 3, 4). The main quartzite ridges of Rajgir area, lying to the north of the present area, also show a sub-horizontal fold axis having gentle plunge towards N50°E (Choudhury,1968) On these uniformly plunging folds was later superposed a second generation of folding (B_2) resulting in the scattering of plunge of the earlier folds. These later folds are generally steeper than the earlier set (Plate-III, fig. 1, 2, 3), with sub-vertical axial plane striking NW-SE. Though the axial planes of these folds, do not vary in orientation, the fold axes show different amounts of plunge. In the areas lying to the north of the present area the structural history also shows that due to the effect of second generation of fold the earlier fold axis was refolded along NW-SE axis.

IV METAMORPHISM

Observations made by the author in this area indicate that most of the areas covered by granitic rocks are in biotite zone of metamorphism. The grade of metamorphism appears to increase towards south-west where presence of high grade rocks like garnet granulite, garnet-hornblende schist are noted. Assemblages of metamorphic minerals like garnet, biotite and potash feldspar in the rocks of this area indicate that these rock-types were, subjected to high grade metamorphism of almandine-amphibole facies (Turner and Verhoogen, 1962).

Granitic activity in this area started at the closing phase of deformation and metamorphism and the pre-existing metamorphic rocks were gradually transformed into rocks of-granitic composition by the process of metamorphic replacement due to the introduction of a granitic solution of deep seated origin.

V ECONOMIC MINERALS

The area does not contain any large and economically exploitable mineral deposit. However, the following, mineral occurrences of minor importance have been noted in the area:

a) Mica: Minor occurrences of pegmatite veins carrying small books of muscovite are present about 0.5km east of Deothika. Some minor excavations in these localities indicate that attempts were made to extract mica. These quarries were probably abandoned due to lack of sufficient quantity of good, quality mica. Muscovite bearing pegmatite is also found in the area about one kilometre east of Debo. This area lies on the strike continuation of the mica bearing belt to Hazaribagh district. Some minor exploitations are in progress in this area.

b) Plagioclase feldspar: Large crystals of plagioclase feldspar associated with pegmatites are found in this area. Not much of potash feldspar is noted.

VI CONCLUSION

The area under investigation is largely covered by soil and alluvium but appears to be formed mainly by granite gneiss, which is found to contain patches, of earlier meta-sedimentary rocks like mica schist, quartzite, hornblende schist, garnet granulite etc. and also veins of pegmatite and quartz. The schists represent highly metamorphosed argillaceous sediments which often grade into the granite gneiss. The garnetiferous granulite occurs as a small exposure. It represents a highly metamorphosed noncalcareous felspathic sediments. The granite gneiss consists of quartz, potash feldspar, plagioclase and micaceous minerals. The foliation in the gneiss is conformable with the schistosity planes observed in the schist patches that occur within it. It appears from the field relations that foliation in granite gneiss is mostly a relict of the schistosity in the preexisting meta-sedimentary rocks. Field relationship and the petrographic character of the granite gneiss of the area suggest that this rock has been formed by the introduction of feldspathic materials, within the pre-existing metasedimentary rocks. Veins of pegmatite and quartz have intruded these granitic rocks later. Some minor zone of brecciation are present in the area.

The area is devoid of any large economically exploitable mineral deposits. Only minor occurrences of muscovite have been noted.

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LOCALITY INDEX

Name	Latitude				Longitude		
	Degree	Minute	Second		Degree	Minute	Second
Baluani	24	32	45		85	15	00
Bhawanri Kalan	24	33	30		85	12	30
Debo	24	30	15		85	14	00
Deothika	24	34	15		85	12	30
Gaya	24	47	45		85	00	00
Goli	24	33	15		85	14	30
Jhurang	24	32	15		85	14	00
Kusmhar	24	34	15		85	10	30
Mathgarha	24	30	30		85	10	45
Nawada	24	51	45		85	31	00
Paharpur	24	37	30		85	l2	30

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PLATE I: STRUCTURAL MAP OF THE PART OF GAYA DIST. (72H/02) (SCALE 1:125,270)

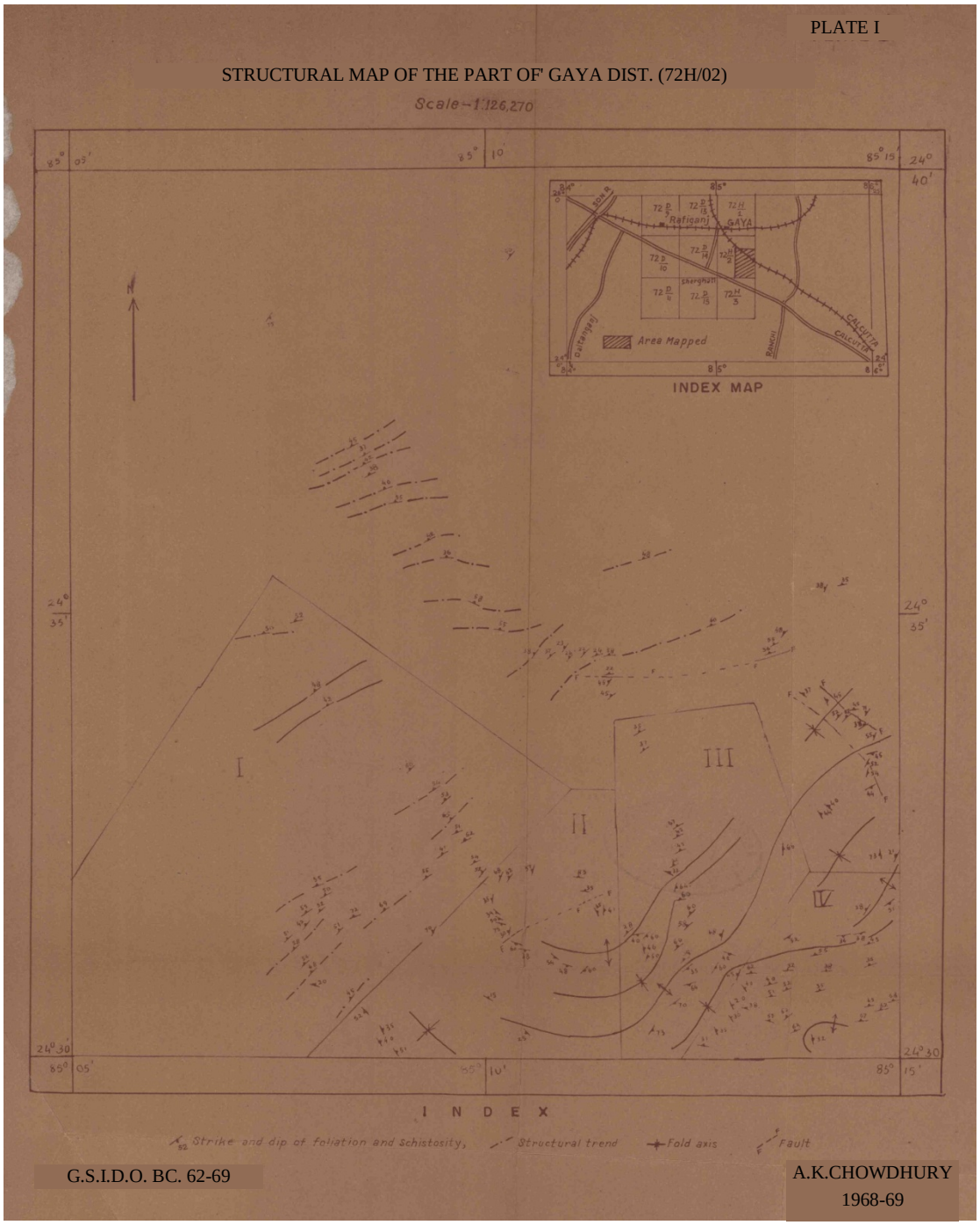
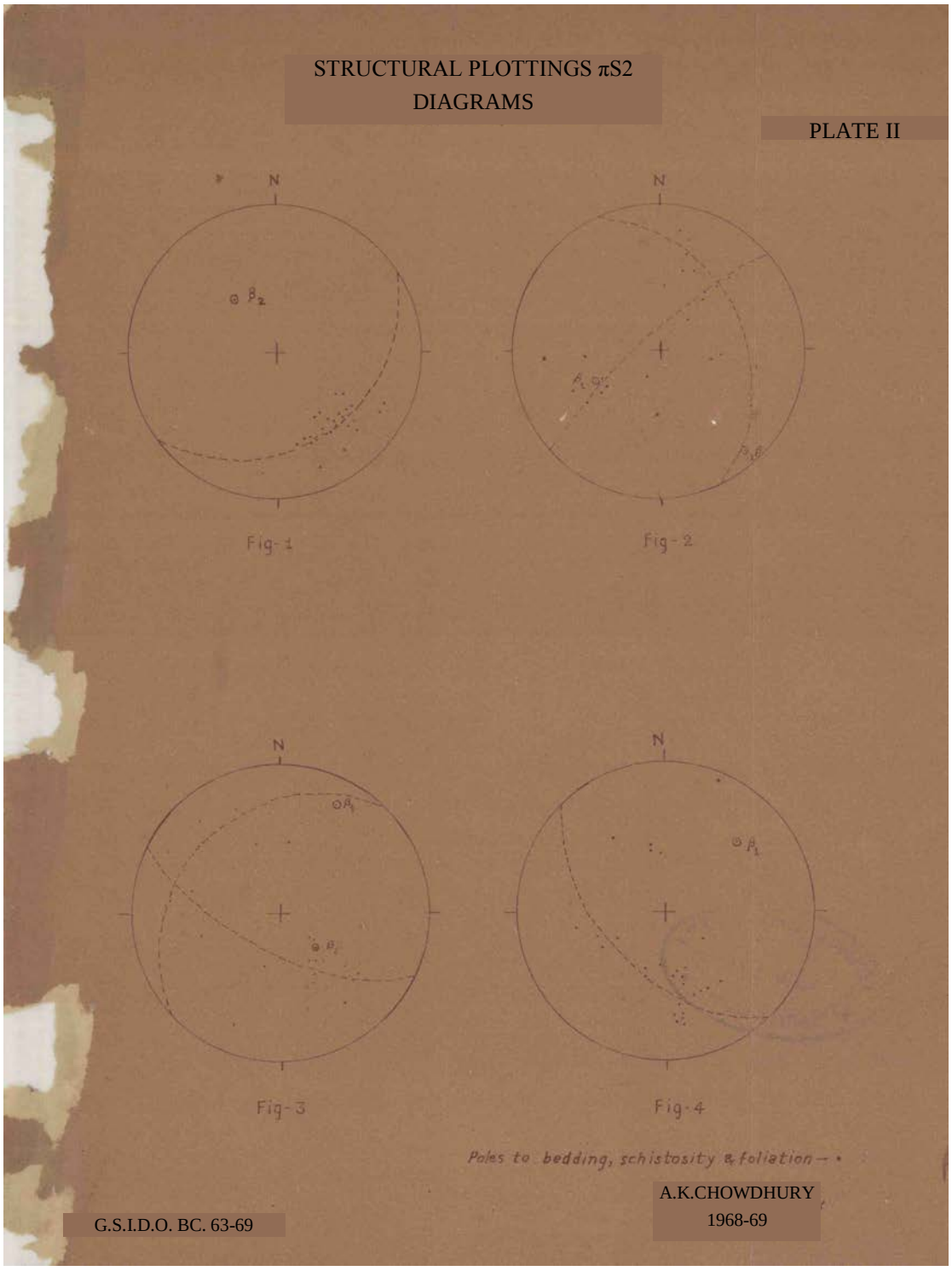


PLATE II: STRUCTURAL PLOTTINGS πS_2 DIAGRAMS

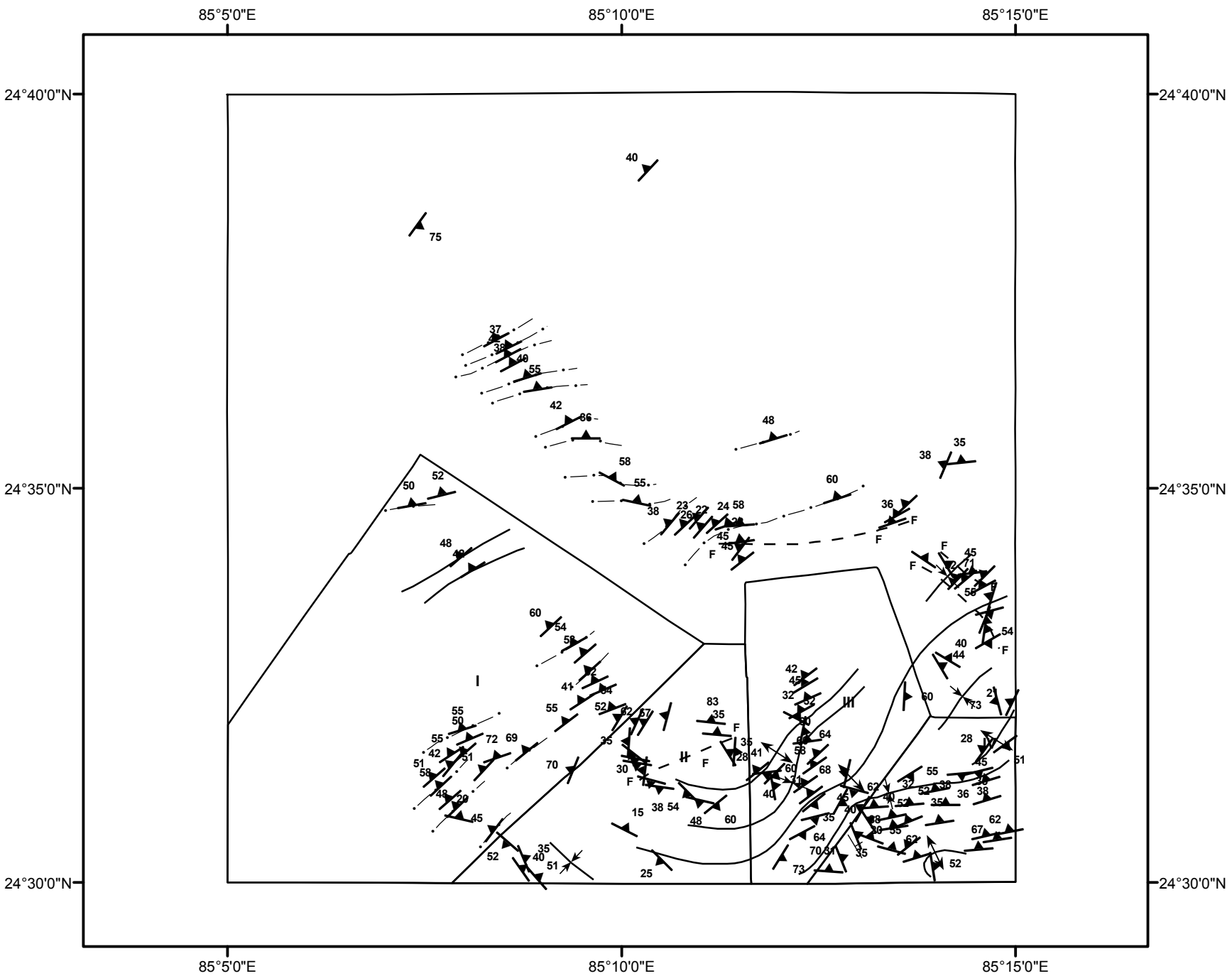


STRUCTURAL MAP OF THE PART OF GAYA DISTRICT (72 H/2)

PLATE-I

Scale-1:126,270

N



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F Fault

Fold axis

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