A FIELD GUIDE ON PROTEROZOIC SEDIMENTARIES AROUND RAMGUNDAM RAILWAY STATION, PRANHITA-GODAVARI VALLEY, ANDHRA PRADESH

ASRU K. CHAUDHURI and TAPAN CHAKRABORTY

GEOLOGICAL STUDIES UNIT, INDIAN STATISTICAL INSTITUTE
203, B. T. ROAD, KOLKATA 700 035, INDIA

THE GEOLOGICAL, MINING AND METALLURGICAL SOCIETY OF INDIA

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PREFACE

In co-operation with the Universities of Calcutta and Jadavpur, the Geological, Mining and Metallurgical Society of India organised a one day workshop to evolve some solutions to the problems faced by universities and colleges in India in imparting proper field training to their students at the under-graduate and graduate levels. Participants represented different employer organisations and some universities and other teaching institutions in India. The purpose of the workshop was to formulate a minimum academic programme of field work at under-graduate levels, to suggest some modalities for improvement of the standard of training, and to evolve procedures for improvement of opportunities and facilities so that maximum academic profit could be achieved with the constraints under which universities and colleges function.

It was decided that immediate follow up action is to be initiated by the Society, under the guidance of a subcommittee formed at the workshop, among other steps, on selection of a number of areas of different levels of complexities, and entrusting geologists familiar with these areas to prepare short field guides for each.

Some progress could be made with the choice of areas and of authors for preparation of field guides. The first of the "field guides" for a small area around Ramgundam (Andhra Pradesh) is being published after setting the manuscript in a format close to what the sub-committee had in mind. It is hoped that the guide will prove useful to the teaching institutions for whom these are meant. It is also hoped that this will serve as a model which can be improved upon and excelled in the succeeding attempts.

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INTRODUCTION

Middle to Late Proterozoic sedimentaries of the Pranhita-Godavari (P. G.) valley in Andhra Pradesh crop out in two narrow linear strips bordering the margins of a NW-SE trending central linear belt of Gondwana Supergroup rocks. They are flanked along their outer margins by a basement complex of Archaean age (Fig. 1, p. 6).

W. King (1881), the pioneer in working out the geology of P.G. valley, grouped the Proterozoics on the southwestern margin of the Gondwana belt into two major divisions, Pakhals and Sullavais. Subsequently, these two divisions separated by an angular unconformity were raised to the status of groups by other workers (Basumallick, 1967 ; Chaudhuri, 1985).

Almost a complete sequence of Pakhal and Sullavai groups is preserved in a small area around Ramgundam Railway Station (18°45′43″N : 79°26′4″E). Lithostratigraphic succession of the Proterozoics around the area presented in the geological map (Fig. 2, p. 10), nature of contacts of major lithostratigraphic units and their dominant lithology are given in Table 1 (p. 5).

Rocks are quite well exposed in small hills around the Rly. Station, but most instructive exposures with excellently preserved primary sedimentary features can be studied on and around a small hill (4906), about 3 km NE of the Rly. Station (Fig. 3, p. 11) referred to here as Ramgundam Gutta (Gutta=hill). There are large number of small stone quarries on the easterly sloping face of this hill and in the flat ground to its west that merit close examination of the stratification style and their vertical sequence.

The area is ideally suited for observation and study of many primary sedimentary and organo-sedimentary features and is also suitable for a training in mapping. There are a number of easily recognisable, sub-horizontally disposed, mappable units with well preserved contacts. Mapping is not plagued by structural complexities except for those wrought by a number of faults.

Visit to the opencast as well as underground coal mines of Singareni Collieries Co. Ltd. at Godavari Khani area may be an added attraction of the field work in this area.

Accessibility

The area to be mapped around the Ramgundam Rly. Station (Fig. 2) falls within the Survey of India Toposheet no. 56 N/5. It lies on the railway line (South-Central Railway) linking Madras with New Delhi, via Kazipet and Nagpur, and is about 750 km from Madras. It has also direct railway connection with Secunderabad (Hyderabad). Frequent bus services connect Godavari Khani (about 8 km east of Ramgundam Rly. Station) with Hyderabad ; travel time is approximately 6 hours by express buses.

Accommodation

Accommodation may be available with Singareni Collieries Co. Ltd. at Godavari

Khani. Accommodation may also be available with the National Thermal Power Corporation at Jyotinagar, between Godavari Khani and Ramgundam Rly. Station or with the Andhra Pradesh State Electricity Board at its township near railway station.

MAPPING TRAVERSES AND DESCRIPTIONS OF SOME SELECTED OUTCROPS

We suggest here three traverses, shown in Fig. 3, covering different parts of the area to be mapped. We also describe a few outcrops, numbered 1 through 15, in Fig. 3, which characterise the basic features of each of the major mappable lithounits. Majority of these outcrops will be encountered in the suggested traverses.

Purpose of taking the traverses before initiating the mapping is to familiarise the students with the major mappable units, and to plot the points of major geological surfaces on these traverse lines. This will facilitate subsequent tracing of the lithological contacts following their strike and in recognising fault planes that transect the litho-contacts.

OUTCROPS IN THE FLAT GROUND WEST OF THE NORTHERN PART OF RAMGUNDAM GUTTA

The Pandikunta Limestone is quite well exposed in a number of small quarries. It may be difficult to examine stratification style on freshly cut surfaces ; abandoned quarries or weathered surface exposures should be examined more critically.

Stop 1 :

Northernmost tip of Ramgundam Gutta, just east of the road to Ramgundam village, near a transformer post on the road (Fig. 3).

Few small cuttings on the hill slope expose ferruginous, micritic carbonate rocks. Two types of stratification are noted : i) thin wavy and lenticular beds, 1-2 cm thick, with very thin shale partings ; ii) slightly wavy to irregular, relatively massive, thicker beds with negligible shale partings (Fig. 4, p. 7). In the second type of beds, millimetre thin crinkly or undulatory algal lamination may be observed on weathered surfaces.

Alternation of units with these two stratification types is characteristic of the area around this stop which stratigraphically is in the middle part of Pandikunta Limestone.

Few tens of metres north of this stop, medium to thin beds of argillaceous limestone are quite disturbed. Abrupt steepening of beds, gentle warps and kink bands characterise the exposures on the northern slope of the small hills.

Stop 2 :

About 200 metres south of stop 1, limestone quarries on both sides of the road. Small sections to the east of the road are at a stratigraphically lower level than the section at stop 1.

There are two types of bedding style : (i) lenticular limestone beds with green and brown shale partings ; and (ii) massive, thicker beds without any parting. Bedding surfaces in both the types are quite irregular and fractured. Both types of beds are made up of algal stromatolites. Thin, crinkly algal laminations are best seen on weathered surfaces.

Two different types of stromatolite structures have developed here :

Type 1 : domal to club-shaped discrete columnar structures made up of stacked, convex-up laminae ; structureless lime-mud filling up the areas between the columns (SH-V type of Logan *et al.*, 1964). Few structures appear to branch upward.

Type 2 : Linear ridge-like or wall-like bodies that stand almost vertically on the substrate. In sections transverse to the elongation of the stromatolite bodies, the constituent laminae are convex-upward and vertically stacked one above another, while in longitudinal sections, the laminae are horizontal, slightly undulatory and often discontinuous. The interareas are filled up with massive lime-mud. Elongation of the structures has a highly preferred direction of orientation which may be used to indicate the current direction in the depositional environment (Chaudhuri, 1970 ; also see Hoffman, 1967).

Stop 3 :

About 200 metres south of stop 2, along the road, and just west of it.

Small exposure of reddish brown, medium grained, well sorted, glauconitic sandstone with a few coarse-grained beds. Bedding style is not well displayed, but there are suggestions of small, trough cross-beds.

Limestone just above glauconitic sandstone shows very well developed domal stromatolite structure (Fig. 5, p. 7). In these structures, individual algal laminae may be traced from one head to the other and the structures are mostly of LLH-C type (laterally linked hemispheroid—close) of Logan *et al.* (1964). Limestone just below glauconitic sandstone shows excellent development of large columnar structures, mostly SH-C type (Fig. 6, p. 7).

Nature of contacts of the two stromatolitic limestone units with the intervening glauconitic sandstone may be studied at this stop. Mode of occurrence of the stromatolitic units, either bioherm or biostrome, may be established through lateral tracing of these contacts.

OUTCROPS ALONG THE SCARP FACE OF RAMGUNDAM GUTTA AND AT ITS BASE

Stop 4 :

Almost at the top of the scarp, few tens of metres above the topmost limestone quarry on the N-S scarp.

Topmost part of Pandikunta Limestone is well exposed here. Limestone is micritic, plane to wavy bedded with thin shale partings. A few limestone beds are chertified, either partially or wholly, and silicification is strictly bedding parallel. Presence of remnant limestone within chert and preservation of wavy features in chert layers indicate its replacement origin. In partially replaced beds, chert occurs as small bedding parallel elliptical bodies.

Limestone is overlain by a thin interval of thin-bedded, highly ferruginised limestone and shale, with only a few unaltered or slightly altered limestone beds. There are a few chertified beds, and frequency of chert beds increases upwards ultimately leading to a zone of bedded chert.

Bedded chert is overlain by conglomerates and pebbly sandstones of the Damla Gutta Conglomerate. Similar profiles may be observed at several points just below the Damla Gutta Conglomerates.

Stop 5 :

Chert-pebble conglomerate ; the basal interval of Damla Gutta Conglomerate.

About 95% of the clasts are of chert with few clasts of limestone and ferruginous shale. Most of the clasts are very angular. Matrix-clast ratio varies widely in different beds and also varies laterally in a single bed. In some beds it is clast-supported, while in others it is matrix supported (Fig. 7, p. 8). Several types of bedding are observed.

Bedding style and nature of arrangement of clasts in this chert-pebble conglomerate is suggestive of debris flow and related sediment gravity flow deposits. Students should try to identify different types of bedding and relate them with probable modes of sediment emplacement.

Clasts should be critically examined to relate them with the source material which is essentially intrabasinal. Recognition of the source rock for the clasts may have important bearing on the local geology of the area.

Contact between Pandikunta Limestone and overlying Damla Gutta Conglomerate : This contact can be studied at several points on the scarp and at its base. This contact separates two very contrasting lithologies. There is no structural discordance between the two, and their contact has been interpreted as a major disconformity surface. Difference in topographic elevation of this surface at different points, occurrence of bedded chert as well as the chert-pebble conglomerate immediately below and above this surface are significant features in relation to this interpretation.

Stop 6 :

In the northern part of Ramgundam Gutta, near the road that goes on the scarp face to the pump house.

Well exposed section of Damla Gutta Conglomerate, stratigraphically above the chert-pebble horizon. Here it is represented by conglomerate, pebbly to gravelly sandstone and coarse sandstone (Fig. 8, p. 9). Sandstone and the sand matrix of the conglomerate is arkosic in nature. Pebbles are quite well rounded, and are mostly of vein quartz. There are some pebbles of chert, limestone, quartzite, granite, banded hematite quartzite and banded hematite jasper. Pebbly zones are laterally quite persistent, but are normally lenticular. Pebbles may be fairly closepacked where it is a clast-supported conglomerate, but in majority of the beds, pebbles float within sand matrix. Different types of bedding style is recognizable.

Type 1 : Frequency of pebble distribution is same throughout the thickness of the bed which appear as massive. Contacts with overlying sandy intervals are normally sharp.

Type 2 : Pebbles decrease upward both in size and in frequency, and conglomerate grades upward into sandstone.

Trough cross-beds are profuse in sandy intervals and in pebbly sandstone. Small, planar cross-beds are also quite common.

The conglomerate is conformably overlain by Ramgundam Sandstone. The contact is sharp and is very well displayed at this section.

E

Table 1

Rock Stratigraphic Succession, Ramgundam area

Gondwana Supergroup				
————— Unconformity —————				
	Sullavai Group		Venkatpur Sandstone	Medium to fine grained, salmon-red sandstone.
			Encharani Quartzite / Ramgiri Formation	Ramgiri Formation : Coarse to medium grained, often pebbly, purple to red arkosic sandstone. Encharani Quartzite : Medium to coarse grained, often pebbly, brownish red quartzose sandstone.
————— Unconformity (angular) —————				
Proterozoic Sedimentaries	Pakhal Group	Mulug Subgroup	Rajaram Limestone	Micritic limestone, intra-clastic limestone, green, calcareous shale and calcareous sandstone.
			——— gradational contact ———	
			Ramgundam Sandstone	Medium to fine grained, arkosic to subarkosic sandstone with minor amount of interbedded shale.
			——— sharp, locally intertonguing ———	
			Damla Gutta Conglomerate	Conglomerate, pebbly arkose and arkosic sandstone ; chert-pebble conglomerate at the base.
		——— Unconformity (disconformity) ———		
		Mallampalli Subgroup	Pandikunta Limestone	Micritic limestone with minor amount of intercalated shale, profuse algal stromatolite ; glauconit c sandstone ; a fericrete-silcrete horizon at the top.
			——— gradational contact ———	
			Jonalarasi Bodu Formation	Interbedded limestone and quartzarenite ; local sandy limestone, arkose and conglomerate.
————— Unconformity —————				
Basement Complex (undifferentiated)				

OUTCROPS IN THE DIP SLOPE OF RAMGUNDAM GUTTA

Stop 7 :

Ramgundam Sandstone in the northern part of the Gutta.

Medium to coarse grained subarkosic sandstone, with glauconite in several stratigraphic levels. Large number of quarries provide opportunities for detailed analysis of bedding style. Most of the quarries are parallel to the strike of beds, and there are a few at high angles. It may be possible to work out the sand body geometry by examining quarry faces at different orientations.

Two major facies is easily recognizable here.

Facies I : Beds, mostly within 10 to 30 cm thickness range, profusely cross-stratified, mostly small troughs (Fig. 9, p. 8). In some longitudinal sections, foresets in successive beds appear to have opposite orientation, resembling herringbone structure and indicating reversal of current flow direction. Such sections, however, are to be examined in both longitudinal and transverse sections to ascertain if the foresets are parts of really oppositely oriented troughs or the herringbone appearence is just a sectional effect. Interpretation of flow direction from single longitudinal section may be misleading and should be avoided.

Bedding surfaces, almost always, are marked by ripple marks. Straight-crested, slightly sinuous, and interference ripples producing a dimpled pattern are common (Fig. 10, p. 9). Ripple crests are generally smoothly rounded ; flat-topped ripples also occur at several places. Many bed-top

(Contd. p. 15)

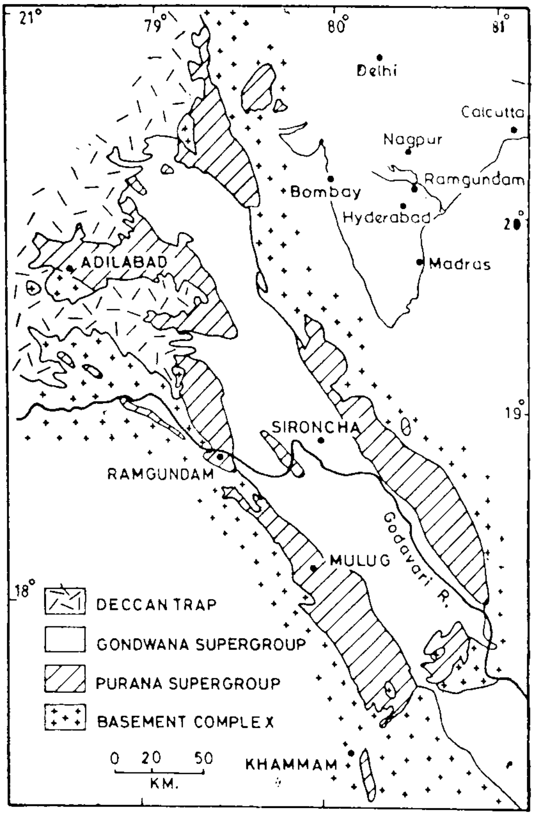

Fig. 1. Geological map of Pranhita-Godavari Valley (after Geological map of India, GSI, 1963). Inset : Index map of the area.

Fig. 4. Intercalation of stromatolite facies (middle) with wavy bedded facies (top and bottom) in Pandikunta Limestone.

Fig. 5. LLH-type stromatolite structure in Pandikunta Limestone.

Fig 6. LLH-type stromatolite passing upward into SH type stromatolite in Pandikunta Limestone. Note that the stromatolites grow upward from an erosional surface (hammer resting on it).

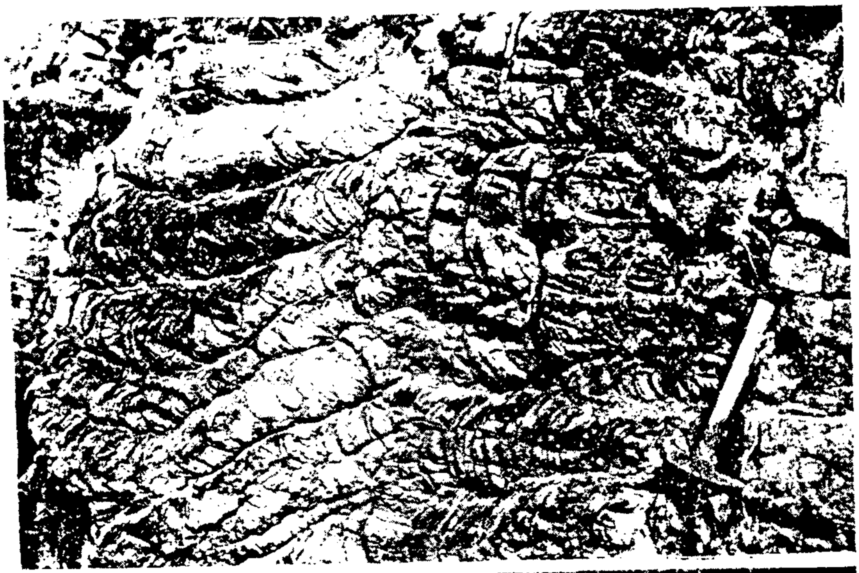

Fig. 4 (top left). Fig. 5 (bottom left). Fig. 6 (right)

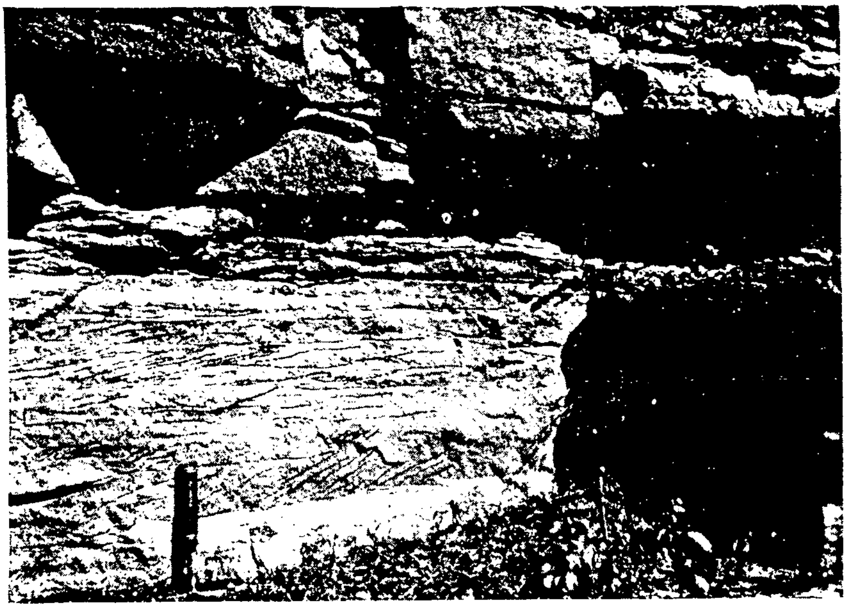

Fig. 7 (top). Chert-pebble conglomerate beds in the basal part of Damla Gutta Conglomerate. Note matrix supported nature of conglomerate and local occurrences of outsized clasts.

Fig. 9 (bottom). A quarry face showing coset of trough cross-beds, mostly in longitudinal section, in Ramgundam Sandstone (lower part). Note the presence of a thin unit of ripple laminated facies in between two trough cross-bedded units.

Fig. 8 (left). Gradation of massive conglomerate to trough cross-bedded pebbly sandstone in Damla Gutta Conglomerate. The troughs dip away from the observer. Note another pebbly zone near the top of the photograph.

Fig. 10 (right). Wave ripple in Ramgundam Sandstone. Note the bifurcation of the ripples crest and superimposition of second set of ripples.

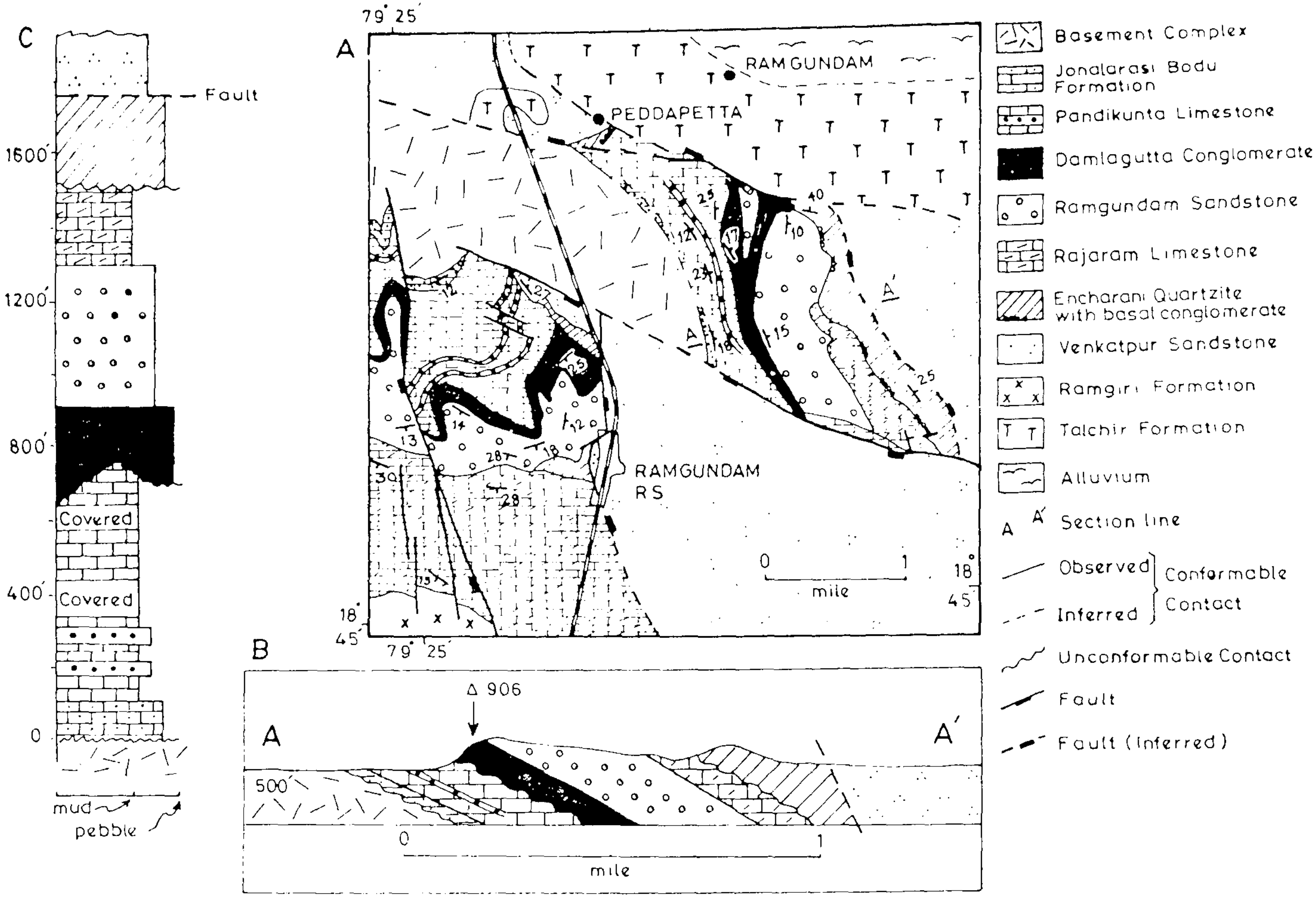

Fig. 2. a. Geological map of the area around Ramgundam Railway Station.
b. Geological section along A-A′ line.
c. Stratigraphic column (as measured in a line just north of A-A′). Horizontal scale indicates mean grain size of rocks in each Formation.

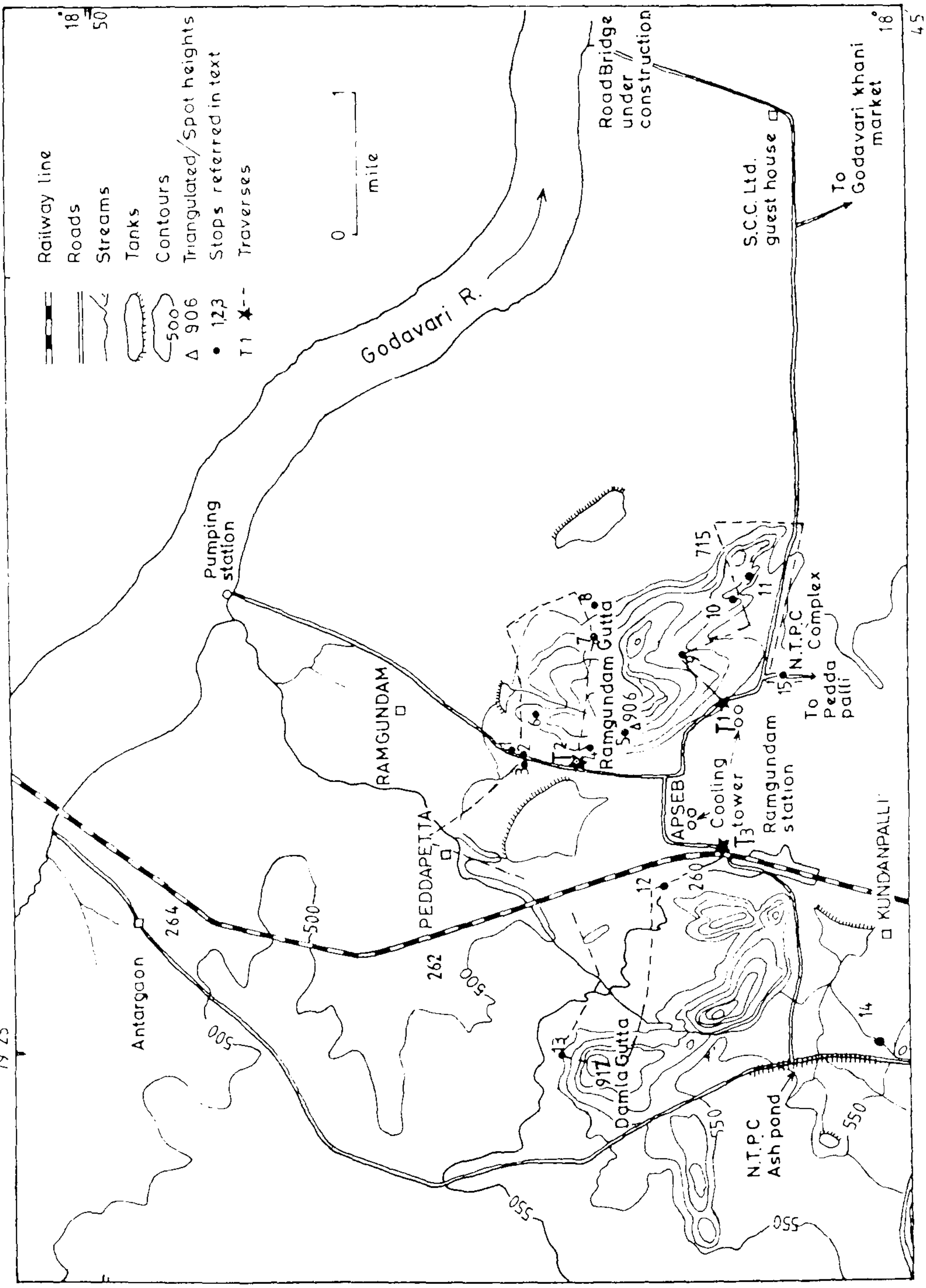

Fig. 3. Location map of Ramgundam and surrounding areas showing the stops referred to in the text.

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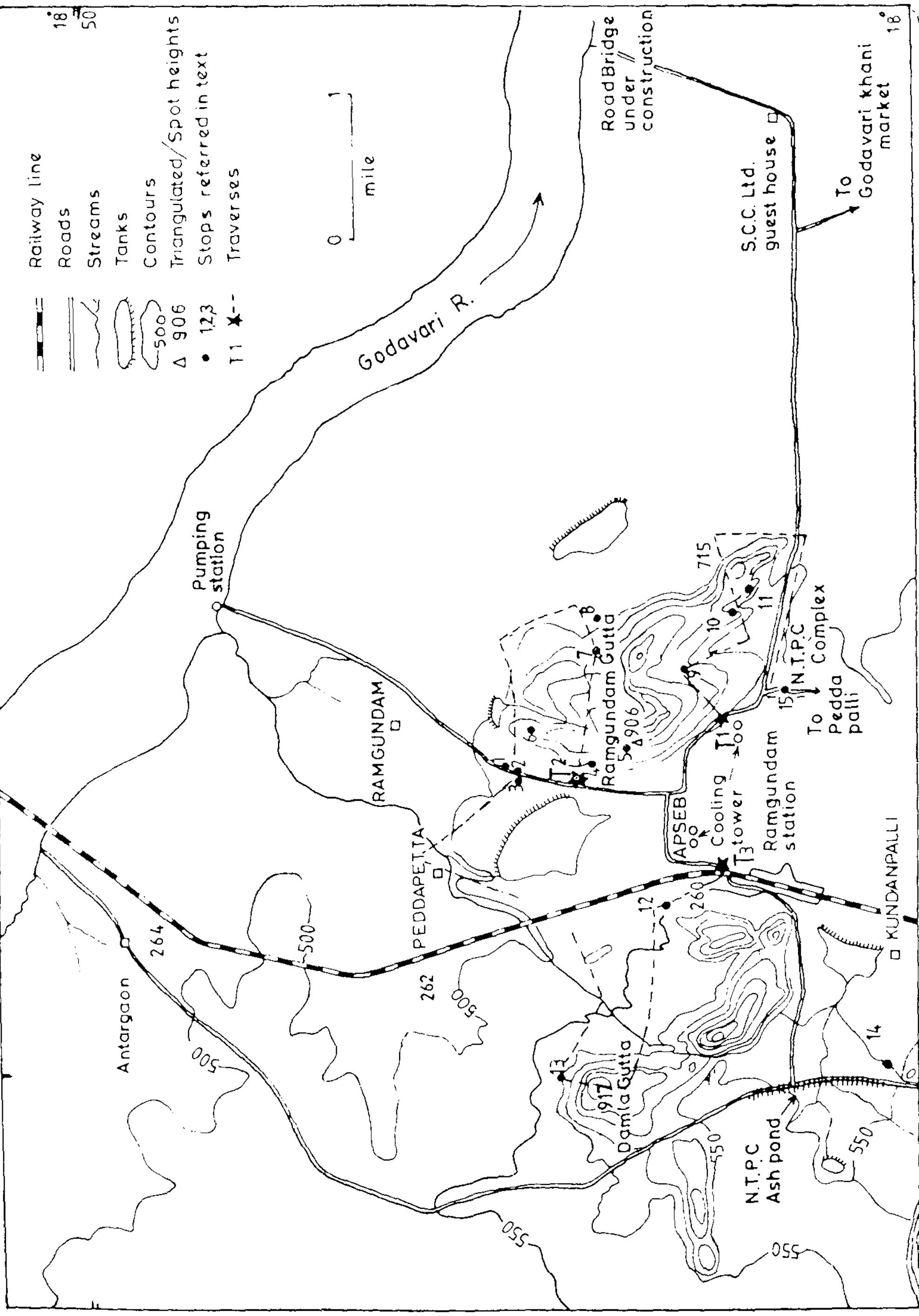

Fig. 3. Location map of Ramgundam and surrounding areas showing the stops referred to in the text.

Fig. 12 (top). Crinkled horizontal lamination (upper & lower parts of the photograph) in Encharani Quartzite.

Fig. 13 (bottom). Small, spindle shaped sand ridges in Ramgundam Sandstone. Note their en echelon pattern and their orientation at an angle to the ripple crests.

Fig. 14 (top). Stratification style in the lowest interval of Rajaram Limestone. Note the different orders in stratification, their regularity and incipient development of ripples.

Fig. 15 (bottom). Longitudinal section of a large set of planar tabular cross-bed in Encharani Quartzite with alternating coarser and finer grained foreset laminae. Note the vertical burrow like structure sharply cutting across the foresets and also note the nature of the size differentiated lamination with the structure.

Fig. 18.

Fig. 16 (top). Fig. 17 (bottom).

J

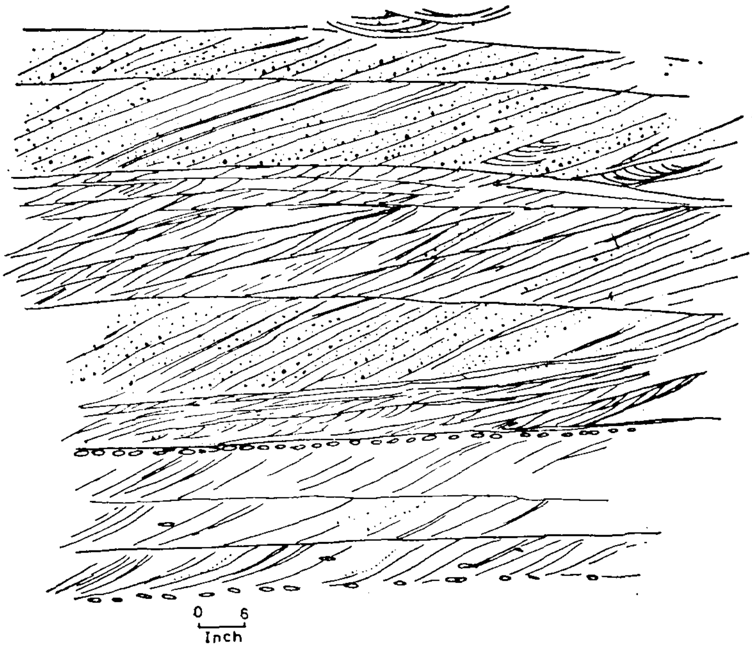

Fig. 11. Stratification style in Encharani Quartzite. Note the variation in scale and internal geometry of the planar cross-beds and note also the mode of occurrence of the granules.

surfaces contain concentrations of coarse sand grains and granules, much coarser than the grains within the beds, that occur in thin layers of uneven thickness.

Exposed dimpled and megarippled surfaces (Fig. 10) with concentrations of coarse grains are broadly undulating. Some of the positive relief features are lens shaped, have distinct linear trend with sharp crests and gently sloping margins, away from the crests. Geometry of individual sand bodies can be determined by walking along the quarries which terminate where the lenses pinch out (Chaudhuri and Howard, 1985).

Facies II : The beds are relatively thinner, on the average 3-7cm thick (Fig. 9), and are medium to fine grained, with occasional coarse layers. The beds are primarily

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Fig. 16. Bedding plane view of a vertical burrow-like structure. Note the concentric nature of the internal laminae.

Fig. 17. Algal laminite in the upper interval of Rajaram limestone. Note both upward and downward crinkling in the laminae.

Fig. 18. Closer view of typical cross-bedded and low angle laminated units in Venkatpur Sandstone. Scale is 30 cm long.

wavy to wave rippled. Ripple laminations, flasers and parallel bedding are also common. Thicker beds show small trough cross-bedding. Rill mark is a characteristic feature in these beds. Many of the beds, particularly thin parallel laminated ones alternating with mudstone, show load casts and several types of sole structures of current origin.

Ramgundam Sandstone at this locality is overlain by Encharani Quartzite and the contact is quite well exposed.

Stop 8 :

In the northern part of the Gutta.

Encharani Quartzite : Medium to very coarse-grained quartzite with poorly sorted but moderately well rounded grains and plenty of pebbles (Fig. 11, p. 15), or fine grained well sorted red quartzite.

Dominant primary structures are planar cross-beds, set thickness ranging from less than 10 cm to more than 60 cm. Foresets are mostly tabular, but some are slightly asymptotic at the base. Superimposed sets of planar cross-strata separated by planar erosional surfaces are quite common. Within some large sets, small sets of cross-beds, oriented opposite to the orientation of the larger sets, have developed at the toe of the foresets (Fig. 11).

Trough cross-beds are present, but are much less frequent.

Three modes of pebble occurrence can be noted here : (i) Small pebbles along large foresets ; (ii) well sorted pebbles in single grain thick, sheet like layers along the erosive upper bounding surface of large cross-beds or coset of smaller cross-beds (Fig. 11) ; (iii) pebbles of variable size range, reaching upto cobble size, as irregular pods, lenses or pebbly sandstone along curved to irregular erosion surfaces that may truncate upto few metres of underlying strata. These pebble beds, in contrast to the other two types, have more variable pebble composition, with commonly occurring chert and metaquartzite fragments and probably mark bases of large incised channels.

This third type of pebble bed can be seen in a quarry about ½ km south of stop 8 ; here it truncates a fine grained, reddish quartzose sandstone. This fine grained quartzite is a distinctive facies of Encharani Quartzite and is marked by thin sets of millimetre thick parallel lamination and small sets of millimetre thick foresets. Both parallel laminae and foreset laminae are delicately crinkled on a minute scale which can be noted only on careful observation (Fig. 12, p. 12). Bedding plane surfaces are marked by low amplitude, periodic undulations. Such crinkly lamination in fine, well-sorted sandstones are characteristic of eolian stratification formed through development and migration of adhesive ripples (Kocurek and Fielder, 1982).

Stop 9 :

Ramgundam Sandstone in the southern part of Ramgundam Gutta.

Character of Ramgundam Sandstone here is basically similar to that at stop 7. A remarkable feature is profuse development of desiccation cracks in wide variety of pattern throughout the exposures. They form polygons of different sizes or spindle-shaped sand filled ridges (Fig. 13, p. 12).

Ramgundam Sandstone here is overlain by Rajaram Limestone.

Stop 10 :

Within the valley, in southern part of Ramgundam Gutta, west of peak 715.

Rajaram Limestone : area is being extensively quarried ; good sections of limestone are exposed in the quarries.

Rajaram Limestone, in its basal part, is a alternating limestone-shale sequence. Limestone-to-shale ratio as well as thickness of limestone beds increases up the sequence. At the lowest level, the sequence is essentially a greenish shale, intercalated with thin beds (2-6 cm) of limestone. Upward, in the large quarries, the sequence is limestone with partings of shale. Limestone is deep purple, green to greenish yellow, micritic and very well bedded. Beds are slightly wavy, but are essentially flat and are quite persistent (Fig. 14, p. 13). Majority of the bed surfaces are rippled. Thicker beds are internally laminated, and the laminae are also rippled, wavy or lenticular (Fig. 14). Chertification in these thin constituent laminae is quite common.

This flat bedded, micritic limestone is followed upwards by a sequence of intraclastic limestone. Intraclasts are silicified, majority are of coarse sand size and are readily identifiable on weathered surfaces where they stand out as rounded, dull-white grains. Recognition of the intraclasts may be quite difficult in fresh surfaces. The limestone is thoroughly cross-bedded.

Quarry faces expose thick lenticular to wedge-shaped beds, internally cross-stratified, separated from each other by irregular or curved erosional surfaces. Examination of several quarry faces may reveal presence of shallow wide channels.

Stop 11 :

South-eastern tip of Ramgundam Gutta, top of 715 ft peak. Encharani Quartzite overlying Rajaram Limestone.

Cross-bedded coarse to medium grained quartzite. Tabular foresets of large planar cross-bed sets are often alternately coarse and medium grained ; size grading within individual foresets is quite common (Fig. 15, p. 13).

In this locality a peculiar structure resembling large vertical burrows occur profusely within the quartzite. The structures are closed at the bottom, cylindrical to U-shaped in section and circular to slightly elliptical in plan. Maximum observed diameter range from 30 cm to 396 cm and observed height varies from 32 cm to 243 cm. The structures sharply truncate stratifications in the host quartzite. Sediments within the structures are same, both in texture and in composition, as that of the host quartzites (Fig. 15, 16, p. 14) and the filling is either massive or laminated.

PAKHAL—SULLAVAI CONTACT IN THE RAMGUNDAM GUTTA

Encharani Quartzite overlies Rajaram Limestone in the southern part of Ramgundam Gutta, while in the northern part it overlies Ramgundam Sandstone. It may be difficult to establish exact nature of this contact by studying vertical stratigraphic profiles in two isolated points. There is no significant structural discordance. Moreover, measurement of attitudes of major depositional surfaces is problematic, and may even be misleading in profusely cross-bedded units like Encharani Quartzite. Continuous tracing of the contact would be required for a proper evaluation. Exposure conditions permit examination of direct contact of the Encharani Quartzite with the underlying formations (of the Pakhal Group) at several localities. Following points may provide clues for interpretation.

1. Evidence for erosional nature of the contact, and very irregular topography of this erosional surface at some points. At stop 11, the contact is almost near the top of the peak 715 ft, while it sharply comes down to a much lower elevation just north and north-west of the peak. Different alternatives to explain such topography are to be considered.

2. Presence of impersistent, lenticular bodies of conglomerates, with large pebbles and boulders of quartzite, limestone and chert, at several points along the contact. One such conglomerate body with very big quartzite boulders may be seen at the base of the Encharani Quartzite, about 1 km north of 715 ft peak. Lithologies of clasts in conglomerate should be compared with the underlying Pakhal lithologies.

3. Gradual overstepping of successively older horizons of the Pakhal Group by Encharani Quartzite, from south to north.

DAMLA GUTTA OUTCROPS

Stop 12 :

To the south of the stop conglomerate and pebbly sandstone (Damla Gutta Conglomerate) and subarkosic sandstone (Ramgundam Sandstone) are well exposed. To the west of it occurs the Pandikunta Limestone and Encharani Quartzite occurs in a narrow strip to the north of the stop. Characteristic features of these formations are well exhibited in these outcrops.

There is no direct contact between Encharani Quartzite and Damla Gutta Conglomerate, but they have discordant attitude. Evaluation of the reasons for this discordance may be attempted here.

Stop 13 :

North-eastern base of Damla Gutta.

Well exposed sections of algal laminites (Collinson and Thompson, 1982) in grey to dark grey microcrystalline limestone at the basal part of Pandikunta Limestone. Laminae are 1 to 2 mm thick, slightly wavy and crinkled on millimetre scale. Many of the laminae pinch out within short distance along the strike. Thin laminae of fine sands, separating limestone laminae, occur at places.

About 300 metres SSW of stop 13, a sequence of alternating units of algal laminites and quartzose sandstone (Jonalarasi Bodu Formation) is exposed in a low lying ridge. The ridge rises abruptly from the flat, low granite terrain. Algal laminites are similar to that at the base of Damla Gutta. Sandstone is medium to coarse grained, poorly sorted, and has developed as 1 to 2 cm thick plane beds. Upper surfaces of many of the beds are rippled, often with truncated crests. Development of plane beds in coarse sandstone points to deposition in high energy condition, and truncation of ripple crests indicate erosion on emergent surfaces in depositional environment.

KUNDANAPALLI OUTCROP

Stop 14 :

Uppermost part of Rajaram Limestone and basal part of Ramgiri Formation, about 1.5 km SSW of Ramgundam railway station.

Area around this stop exposes uppermost part of Rajaram Limestone and overlying Ramgiri Formation of Sullavai Group. Ramgiri Formation is exposed in low-lying ridges, and limestone is exposed in the low ground to the north. There is no structural discordance between the two units here, but the contact is sharp.

Limestone : It is massive, purple and red with blotches and spots of white. It is thinly laminated. It compositionally varies from argillaceous to highly sandy in places. Mud cracks of different scales and order are profusely developed.

Below this argillaceous and sandy zone, limestone is grey to dark grey, thin to medium bedded and microcrystalline. There are a few interbedded units of calcareous shale. Algal laminites, laterally linked stromatolite structures (Fig. 17, p. 14), mud cracks and intraformational lime pebble conglomerate characterise this horizon.

Ramgiri Formation : It is deep purple to red with blotches and spots of white, medium to coarse grained, poorly sorted arkose. Thin pebble layers are found quite frequently. The sandstone is thoroughly cross-bedded ; both planar and trough cross-beds of highly variable sizes are found. Cross-bedded coarser units are often separated by thin units of deep red fine sandstone.

NTPC ROAD OUTCROP

Stop 15 :

Venkatpur sandstone.

Sections in road cuttings along the western boundary of NTPC Complex. Best developed between the two NTPC railway lines.

Two major types of stratification can be seen to alternate with each other in this section.

Type 1 : Stratification consists of large planar cross-beds, about 50 cm to 150 cm thick (Fig. 18, p. 14).

Type 2 : Stratification in sets of thin parallel laminations (Fig. 18), set thickness normally varying within 20 cm to 1 m range, attaining a maximum thickness of 3 m. Present tectonic tilt varies between 10°-15° towards north east.

Large scale cross-beds

Two types of foreset bedding can be recognised :

i) 1 cm to 3 cm thick, medium to coarse grained, internally massive and/or normally graded, wedge shaped beds.

ii) Millimeter-thick laminations defined either by 1-2 grains of coarse sand or several grains of very fine to fine sand.

These fine foreset laminae occur in bundles, each bundle is separated from the other by low angle discordant surfaces.

Both types of foreset bedding generally occur within same cross-bed set.

Thin parallel laminations

Parallel bedded units consist dominantly of very fine to fine sand with some diffused laminae or stringers of coarse bimodal sand.

The laminae are alternately salmon red and white, 0.5 cm to 1 cm thick, and are slightly irregular to wavy in character. Close examination may reveal ill-defined ripple forms within these lamina. Variety of soft sediment deformation structures which include loaded ripples, water escape structure, disharmonic folds etc. characterise these beds.

Just south of the first railway line from the north, on the western side of the road, there occurs a unit characterised by stacked lenticular bodies of poorly sorted sand, apparently massive. The lower bounding surface of this composite unit is a concave-up erosional surface while the upper bounding surface is planar.

ACKNOWLEDGEMENT

We acknowledge Indian Statistical Institute for funding the research programme and providing all logistic facilities and remain thankful for permitting publication of the field guide. We gratefully acknowledge all our colleagues in the Geological Studies Unit of the Institute, past and present, for their encouragement and cooperation. We are particularly indebted to Prof. S. K. Chanda of Jadavpur University who had been closely associated with us since the inception of the work at Ramgundam. The manuscript was throughly revised and restructured in the required format by Prof. S. Sen.

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