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Stratigraphy and palaeogeography of the Godavari Supergroup in the south-central Pranhita-Godavari Valley, south India

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Abstract

The Proterozoic succession of the Pranhita-Godavari Valley (PG Valley), defined as the Godavari Supergroup, occurs in two NW–SE trending belts flanking the margins of the Valley. The Supergroup comprises several unconformity-bound sequences of group status, and exhibits strong regional variations in the distribution of different groups deposited in widely variable conditions, ranging from fan-alluvial setting to deep-water slope, base-of-slope and basinal environments. The lithologic assemblages indicate that the basin experienced multiple rifting, and tectonic environment varied from an unstable rift setting to a stable shelf regime. The Godavari Supergroup, with a complex history of stratigraphic evolution, is still plagued by multiple problems of classification and correlation that have long been the major impediments to basin analysis. In the present paper, the attributes of the genetically linked stratal packages, the unconformities separating them, and their correlation in the south-central part of the Valley have been critically evaluated to address the problems of regional stratigraphy. The Godavari Supergroup is bounded by two inter-regional unconformities, separating it from the underlying crystalline cratonic basement, and from the overlying Gondwana sedimentary rocks of late Paleozoic–Mesozoic age. The Supergroup, in turn, is subdivided into four major sequences by three regional unconformities in the south-central part of the Valley. Comparison of stratigraphic profiles at different points indicates that the thickness of the unconformity-bound sequences, or of individual formations, and also the number of formations, increases from the central part of the Valley towards the southeast. The stratigraphic relationships collectively suggest that the basin deepened and opened in a southeasterly direction. The basin in its southeastern part appears to have been much wider than the present day outcrop width, and to have been continuous with other adjoining Proterozoic basins. The central part of the basin was a relatively stable and positive area compared to the southern part, where the basin floor repeatedly moved across the base level to the order of several hundred meters. The amplitude of movements indicates tectonically controlled subsidence and uplift.

Keywords: Godavari Supergroup; Lithostratigraphy; Unconformities; Sequences; Palaeogeography; Proterozoic rifting

1. Introduction

The Pranhita-Godavari (PG) Valley is a major repository of Proterozoic sedimentary rocks in the Indian peninsula, and is generally believed to be an intracratonic rift basin. The basin filling sedimentary rocks, defined as the Godavari Supergroup (Chaudhuri and Chanda, 1991), are mildly deformed and weakly metamorphosed. Similar Proterozoic cratonic successions developed in several basins in the Indian peninsula during the Mesoproterozoic and Neoproterozoic, and were designated as 'Puranas' by Holland (1906). The available age data indicate that the Godavari Supergroup of the PG Valley, a major Purana basin, encompasses a vast time span of more than 600 Ma, (1330 ± 53 to 790 ± 30 Ma, Vinogradov et al., 1964; Chaudhuri and Howard, 1985; Chaudhuri et al., 1989). The succession of the Godavari Supergroup is punctuated by several major unconformities, a few of which are traceable throughout the basin. The unconformity-bound sequences exhibit well preserved signatures of deposition in wide ranging depositional environments, under variable tectonic and climatic regimes. The succession is ideally suitable for basin analysis, and provides opportunities to delineate different stages of basin evolution, and reconstruction of the palaeogeography. The analysis of the basin, however, is still impeded by several stratigraphic problems that have not yet been solved. Review of the existing literature clearly indicates that the geology of the Godavari Supergroup is still riddled with problems related to lithostratigraphic classification, and correlation of sequences in space and time. The complexity of the stratigraphy is rooted to a differential response of different parts of the basin to uplift or subsidence, unequal rates of erosion and deposition, and also to a complex history of sea level changes. The problem of correlation has also been compounded by fragmentation of the outcrops by a large number of faults of different generations, and separation of the outcrops into two linear belts by younger Gondwana sedimentary rocks.

The stratigraphic succession of the Godavari Supergroup has been studied by a large number of workers (King, 1881; Heron, 1949; Basumallick, 1967; Srinivasa Rao et al., 1979; Chaudhuri, 1985; Sreenivasa Rao, 1985, 1987). With the exception of the earliest work by King (1881), the majority of these studies are essentially local in nature. Regional aspects of stratigraphic development and depositional trends have not yet been adequately constrained to address the problem of correlation on a basin-wide scale, and allow for basin analysis.

This paper attempts to address the question of classification of genetically related sedimentary sequences at group level in the central and southern parts of the Valley, and to identify the regional unconformities. The stratigraphic and depositional trends in different groups, as well as behavior of regional unconformities, have been reviewed and analyzed to reconstruct the stratigraphic evolution and palaeogeography of the southern part of the basin. The analysis is based essentially on the review of published records and maps, supplemented by unpublished data where necessary.

2. Purana Basins of India

The large cratonic landmass of peninsular India witnessed the development of several large cratonic basins at the Palaeoproterozoic–Mesoproterozoic transition, and also during the Mesoproterozoic and Neoproterozoic (Chaudhuri et al., 1999). The basins hosted extensive deposits of terrigenous sediments, derived from the cratonic hinterland, and carbonates. The basin-filling deposits are very weakly metamorphosed, and are, in general, only locally deformed, and preserve the pristine sedimentary characteristics. The sedimentary successions are comparable with extensive cratonic deposits of North America (Sloss, 1963), Australia (Preiss and Forbes, 1981), and analogous Proterozoic–early Palaeozoic successions of other cratonic areas.

The origin of cratonic Proterozoic basins of peninsular India is still not well constrained. Chaudhuri et al. (2002) reviewed several aspects of the stratigraphy, sedimentology and structural geology in three major Purana basins, namely, the PG basin, Chattisgarh basin and Cuddapah basin (Fig. 1), and suggested that these basins developed as cratonic rifts. It is noted that localization as well as orientation of the basins are controlled by pre-existing week zones of Archaean age. The PG basin occurs as a NW–SE trending megalineament along a tectonic line marking the contact between two major Archaen nuclei, the Dharwar and Bastar cratons (Fig. 1). The Cuddapah basin occurs to the southwest of the PG Valley, covering an extensive area of the Dharwar cratonic block, whereas several Proterozoic outcrops of various dimensions occur in the Bastar cratonic block, to the northeast of the PG Valley. Though not established by detailed studies, the Proterozoic outcrops in the Bastar block are considered to represent a larger and continuous basin with a broadly north–south trend (Ahmad, 1958; Ramakrishnan, 1987). The basin-filling deposits were subsequently uplifted and fragmented into several isolated outcrops.

The available radiometric data indicate that the basin-filling successions, occurring in very close geographic proximity, had a temporally overlapping history of evolution. In the absence of detailed analysis of lithofacies, stratigraphy, and palaeogeography, the original extension of the basins cannot be estimated with a high level of confidence. However, lithologic similarities of stratigraphic horizons occurring in different basins prompted the early workers (e.g. King, 1881) to propose a correlation between them. This implies that the evolution of the PG basin, Chattisgarh basin and Cuddapah basin successions occurred within a large continuous depository that covered a very extensive area of the craton. A probable correlation between successions of the Cuddapah basin and the PG Valley has recently also been indicated by Sreenivasa Rao (1987).

3. Distribution of Proterozoic successions in the PG Valley

The Proterozoic successions in the PG Valley occur in two NW–SE trending linear outcrop belts along the two margins of the Valley, and can be traced for about 450 km, from Khammam in the southeast to Wardha in the northwest. The central part of the Valley is occupied by Gondwana rocks of late Palaeozoic–Mesozoic age that separate the Proterozoic outcrop belts. The Proterozoic rocks also occur in two small inliers that have been brought up by faults, within the Gondwana rocks. The Proterozoic rocks along the southwestern margin of the Valley unconformably overlie the Archaean basement, and are unconformably overlain by the Gondwana rocks. Along the north-eastern margin, the Proterozoic belt is bounded by two sub-parallel faults; one separates the Proterozoics from the Gondwanas, and the other separates the former from the crystalline rocks of the basement complex (Fig. 2).

4. Stratigraphic classification: status of knowledge

The stratigraphic classification of Proterozoic rocks of the PG Valley, mainly in its central and southern part,

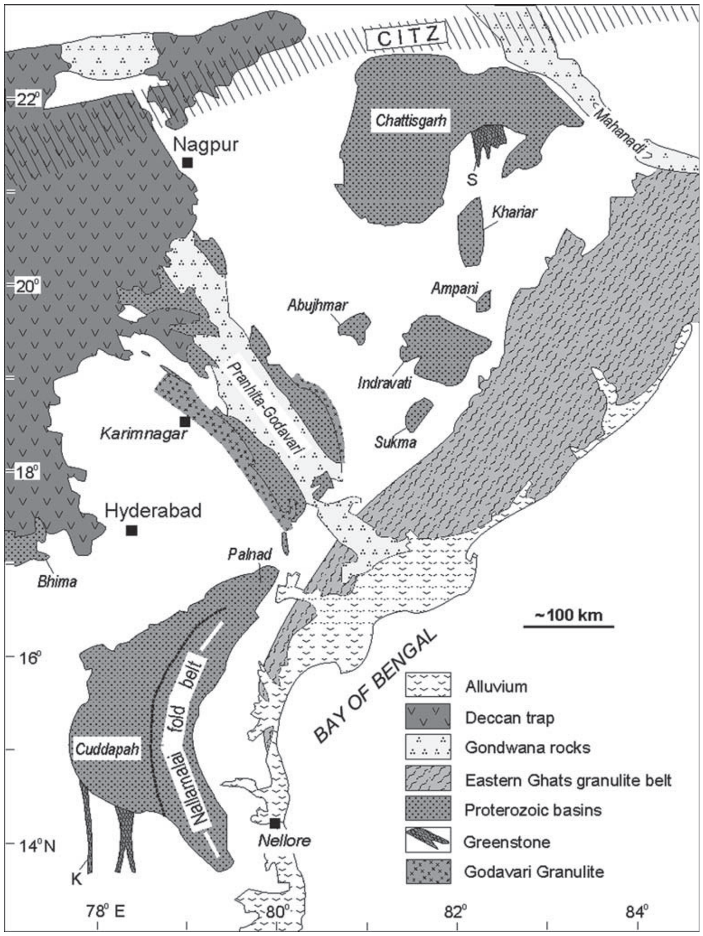

Fig. 1. Proterozoic intracratonic basins in peninsular India, south of the Central Indian tectonic zone (CITZ).

was first provided by King in 1881. He identified the sequence of Proterozoic rocks of the Valley as an unconformity-bound package between the granitic–gneissic rocks of the Archaean basement complex and the Upper Palaeozoic–Mesozoic Gondwana rocks, and classified it into two major stratigraphic units, separated by an angular unconformity. The lower unit was designated as Upper Transition series, whereas the upper one was designated as Sullavai series (Table 1). The Upper Transition series was further divided into a lower Pakhal subdivision consisting of sandstone, shale and limestone, and an upper Albaka subdivision containing only siliciclastic rocks. The Sullavai series consists primarily of red sandstone with subordinate conglomerate. King noted that the Pakhal subdivision occurs in both northeastern and southwestern outcrop belts. The distribution of the Albaka subdivision was not specifically described, though it was indicated that the Albaka subdivision occurs only in the northeastern belt. The relationship between these two subdivisions was also not elaborated (Table 1). Both these subdivisions, however, are unconformably overlain by the Sullavai series. Heron (1949) designated the mixed carbonate–siliciclastic sequence of the Pakhal subdivision occurring to the north of the Godavari river as the Penganga series. The Penganga series was subsequently redefined as the Penganga Group (Sreenivasa Rao, 1985; Chaudhuri et al., 1989), although its relationship with the Pakhal Group had not been established.

Basumallick (1967) studied the stratigraphic classification of the Proterozoic succession in the Mallampalli–Pakhal Lake area (Fig. 3) in the southwestern belt, that includes King's type areas for the Pakhal subdivision and the Sullavai series. He classified the Proterozoic formations into the Pakhal and Sullavai Groups, and identified an angular unconformity between the two groups. He also recognized an intra-Pakhal unconformity that divides the Pakhal Group into the lower Mallampalli Subgroup and the upper Mulug Subgroup (Table 1). The Mallampalli Subgroup is a fining-upward sequence that starts with conglomerate and sandstone, and terminates with limestone and calcareous shale. The lower part of the Mulug Subgroup also exhibits a similar motif. However, this lower part is overlain successively by a thick formation of supermature

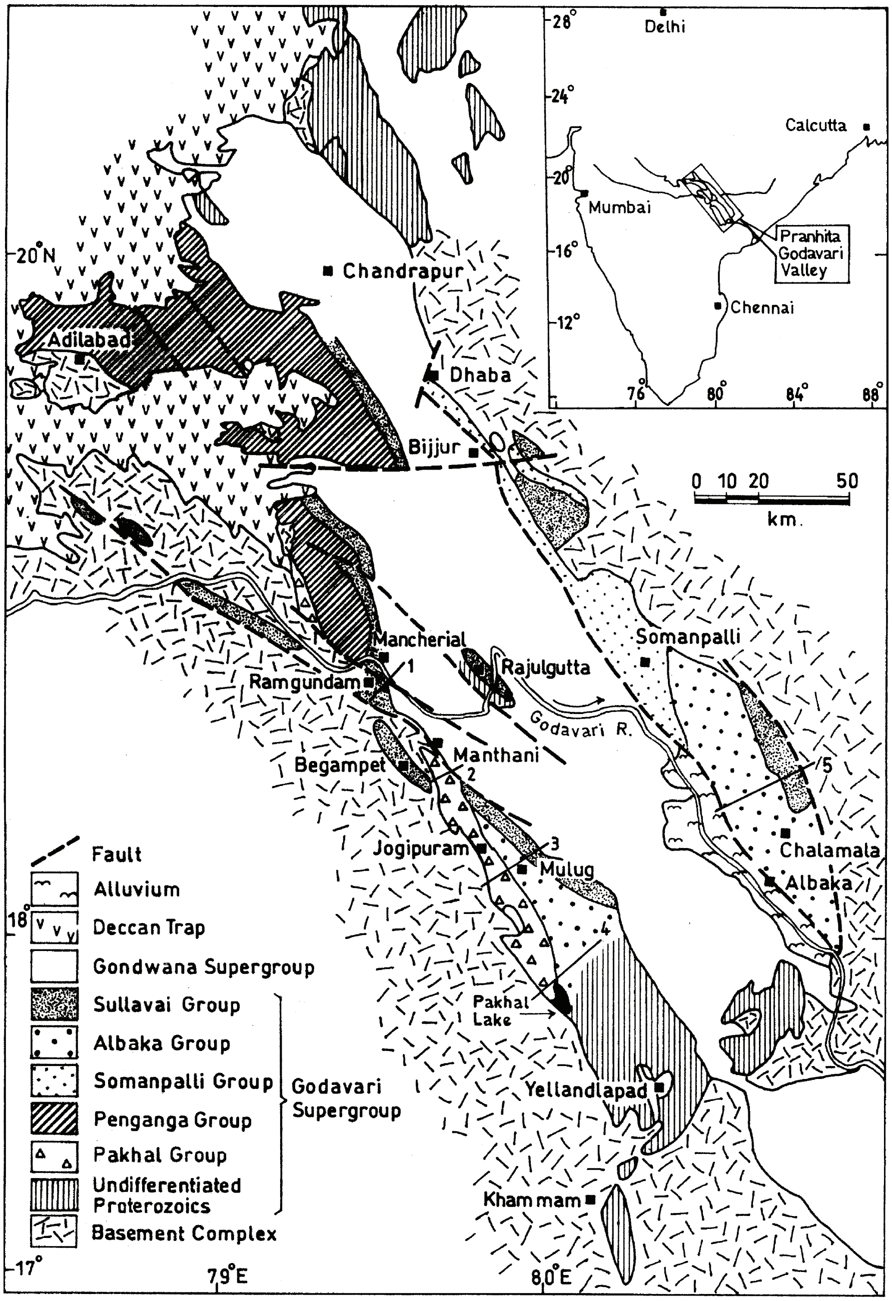

Fig. 2. Geological map of the Pranhita-Godavari Valley showing distribution of Proterozoic sedimentary rocks. Lines 1, 2, 3 and 4 are profiles shown in Fig. 6 and the lines 3 and 5 are profiles shown in Fig. 5.

quartzarenite, the Mulug Orthoquartzite, and a thick shale, the Mulug Shale (Table 1). Basumallick (1967) did not consider the possibility of the occurrence of rocks of the Albaka subdivision in his study area, and placed the Mulug Orthoquartzite and the Mulug Shale at the upper part of the Pakhal Group. However, both the formations appear to be radically different in the depositional motif from the Mallampalli Subgroup or the lower part of the Mulug Subgroup. Chaudhuri (1970a, 1985) identified three unconformity-bound sequences, the Mallampalli Subgroup, the Mulug Subgroup, and the Sullavai Group, around Ramgundam (Table 1) in the central part of the southwestern belt, about 120 km NW of Pakhal Lake (Fig. 2). The sequences at Ramgundam were correlated with the sequences established by Basumallick (1967). The Mulug Orthoquartzite and Mulug Shale or their equivalents, however, are absent in the Ramgundam area where the sandstones of the Sullavai Group unconformably overlie

Table 1
Lithostratigraphy of the Godavari Supergroup along the southwestern margin of the PG Valley. Comparison of classifications followed by earlier authors and the present author

King (1881) *(1)*	Basumallick (1967) *(2)*	Subba Raju et al. (1978) *(3)*	Chaudhuri and Howard (1985) *(4)*	Sreenivasa Rao (1987) *(5)*	Deb and Chaudhuri (Submitted) *(6)*	Chaudhuri (Present study) *(7)*
	Gondwana Supergroup ~~~ U ~~~ U ~~~		Gondwana Supergroup ~~~ U ~~~ U ~~~	Gondwana Supergroup ~~~ U ~~~ U ~~~	Gondwana Supergroup ~~~ U ~~~ U ~~~	Gondwana Supergroup ~~~ U ~~~ U ~~~
Sullavai Series: Kapra Sandstone (215) Venkatpur Sandstone (93) Encharani Quartzite (185) ~~~ U ~~~ U ~~~	Sullavai sandstones ~~~ U ~~~ U ~~~	PAKHAL SUPERGROUP Sullavai Group: Sullavai sandstone and conglomerate (1403) ~~~ U ~~~ U ~~~	Sullavai Group: Venkatpur Sandstone (300) Encharani Quartzite (90) ~~~ U ~~~ U ~~~	Sullavai Sandstone (990) ~~~ U ~~~ U ~~~	GODAVARI SUPERGROUP Sullavai Group: Venkatpur Sandstone (300) Encharani Formation (80) ~~~ U ~~~ U ~~~	GODAVARI SUPERGROUP Sullavai Group: Venkatpur Sandstone (?) Encharani Formation (90) ~~~ U ~~~ U ~~~
Upper Transition Series: Albaka subdivision (770)				Penganga Group: Putnur Limestone (100) Taklapalli Arkose (400) – F – F – F – F –	Penganga Group: Sat Nala Shale (?) Chanda Limestone (633) Pranhita Sandsone Nalla Gutta (154) Sandstone (512) ~~~ U ~~~ U ~~~	Albaka Group: Tippapuram Shale (1500) Somandevara Quartzite (400) ~~~ U ~~~ U ~~~
–?–?–?–?–?– Pakhal subdivision (1540)	PAKHAL GROUP Mulug Subgroup: Mulug Shale (2120) Mulug Orthoquartzite (440) Enchencheruvu Shale (120) Enchencheruvu Limestone (210) Enchencheruvu Chert (110) Jakaram Arkose (240) Jakaram Conglomerate (33) ~~~ U ~~~ U ~~~	Mulug Group: Mulug Shale (2500) Mulug Orthoquartzite (400) Mulug Arkose (200) Jakaram Conglomerate (10) ~~~ U ~~~ U ~~~	Mulug Subgroup: Rajaram Limestone (735) Ramgundam Sandstone (120) Damla Gutta Conglomerate (90) ~~~ U ~~~ U ~~~	PAKHAL SUPERGROUP Mulug Group: Laknavaram Shale (1500) Pattipalli Quartzite (300) Enchencheruvu Dolomite (300) Polaram Formation (500) Jakaram Arkose (230) ~~~ U ~~~ U ~~~	Pakhal Group Mulug Subgroup: Rajaram Formation (735) Ramgundam Sandstone (120) Jakaram Conglomerate (90) ~~~ U ~~~ U ~~~	Pakhal Group Mulug Subgroup: Rajaram Formation (330) Enchencheruvu Chert (110) Ramgundam Sandstone (240) Jakaram Conglomerate (33) ~~~ U ~~~ U ~~~
	Mallampalli Subgroup: Pandikunta Shale (100) Pandikunta Limestone (1270) Mallampalli Conglomerate (30)	Mallampalli Group: Pandikunta Shale (200) Mallampalli Dolomite (2200) Mallampalli Conglomerate (100)	Mallampalli Subgroup: Pandikunta Limestone (340) Jonalarasi Bodu Formation (50)	Mallampalli Group: Pandikunta Shale (340) Gunjeda Dolomite (300) Bolapalli Formation (185)	Mallampalli Subgroup: Pandikunta Limestone (340) Bolapalli Formation (50)	Mallampalli Subgroup: Pandikunta Shale (120) Pandikunta Limestone (1270) Bolapalli Formation (30)
~~ U ~~~ U ~~~ Basement complex	~~~ U ~~~ U ~~~ Basement complex	~~~ U ~~~ U ~~~ Basement complex	~~~ U ~~~ U ~~~ Basement complex	~~~ U ~~~ U ~~~ Basement complex	~~~ U ~~~ U ~~~ Basement complex	~~~ U ~~~ U ~~~ Basement complex

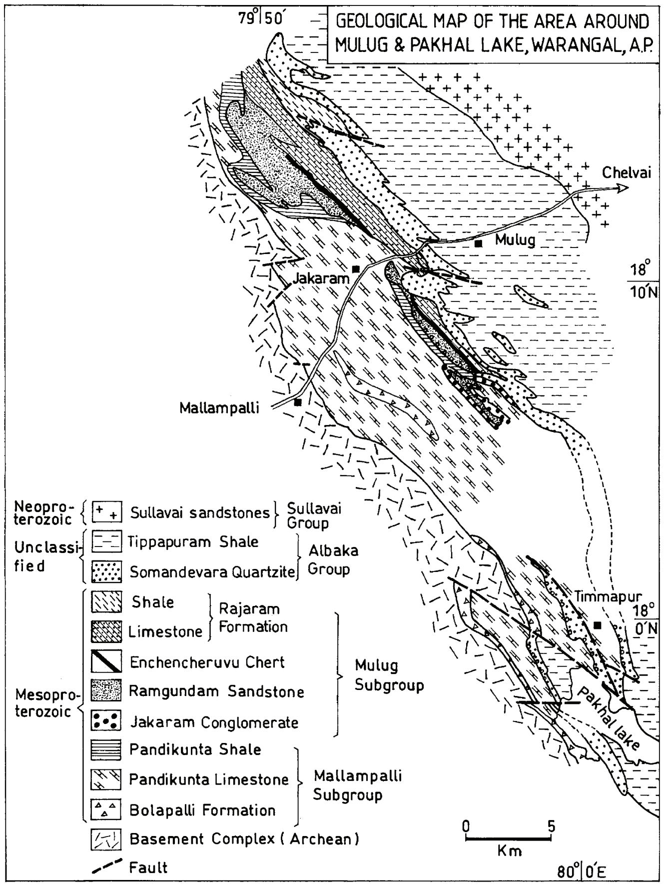

Fig. 3. Geological map of the Mulug–Pakhal Lake area (modified after Basumallick, 1967).

the limestones and calcareous shale (Rajaram Limestone) of the Mulug Subgroup. Sreenivasa Rao (1985) reported that another unit, the Penganga Group, occurs above the Pakhal Group in some parts of the Ramgundam area, south of the Godavari river. However, he inferred a fault contact between the two groups (Table 1). It has recently been established by Deb and Chaudhuri (submitted) that in the Mancherial–Ramgundam area, the Penganga Group unconformably overlies the Pakhal Group and is unconformably overlain by the Sullavai Group. The southernmost extent of Penganga outcrops is delimited by the NW–SE trending Kaddam fault (Fig. 1), a major lineament in the Valley. The unconformity between the Penganga Group and the overlying Sullavai Group was also observed at Mancherial by Chakraborty (1994). The succession in the Mancherial–Ramgundam area thus consists of three unconformity-bound sequences, the Pakhal (including Mallampalli and Mulug Subgroups), Penganga and Sullavai Groups, in ascending order (Table 1). In places, however, the Penganga Group is missing and the Sullavai Group occurs directly above the Pakhal Group. In the eastern part of the Ramgundam area, the Sullavai Group overlies the Pakhal Group, whereas in the western part, the Penganga Group overlies the Pakhal Group (Fig. 4).

Subba Raju et al. (1978) studied the Proterozoic successions in both the outcrop belts in the south-central part of the Valley. Their study area included the type section of the Pakhal Group in the Mulug–Pakhal Lake area, and the type locality of the Albaka subdivision in the Albaka range. They defined three unconformity-bound sequences in the southwestern belt as the Mallampalli Group, the Mulug Group, and the Sullavai Group, and referred the total exposed sequence as the Pakhal Supergroup. Their Mallampalli Group and the Mulug Group are equivalent to the Mallampalli Subgroup and the Mulug Subgroup, respectively, of Basumallick (1967). They classified the succession of the Albaka range into two major units separated by a disconformity, the lower Tippapuram Shale and the upper Chalamala Sandstone. The disconformity is indicated by a locally developed, about ~3 m thick conglomerate consisting of pebbles of vein quartz and feldspathic sandstone. The Tippapuram Shale and the Chalamala Sandstone were correlated with the Mulug Shale of the Mulug Group and the Sullavai Sandstone of the Sullavai Group, respectively (Table 2). The Chalamala Sandstone, according to Subba Raju et al. (1978), constitutes almost the entire geomorphic feature of the Albaka range. Srinivasa Rao et al. (1979) classified the Proterozoic sequence in the Albaka range and

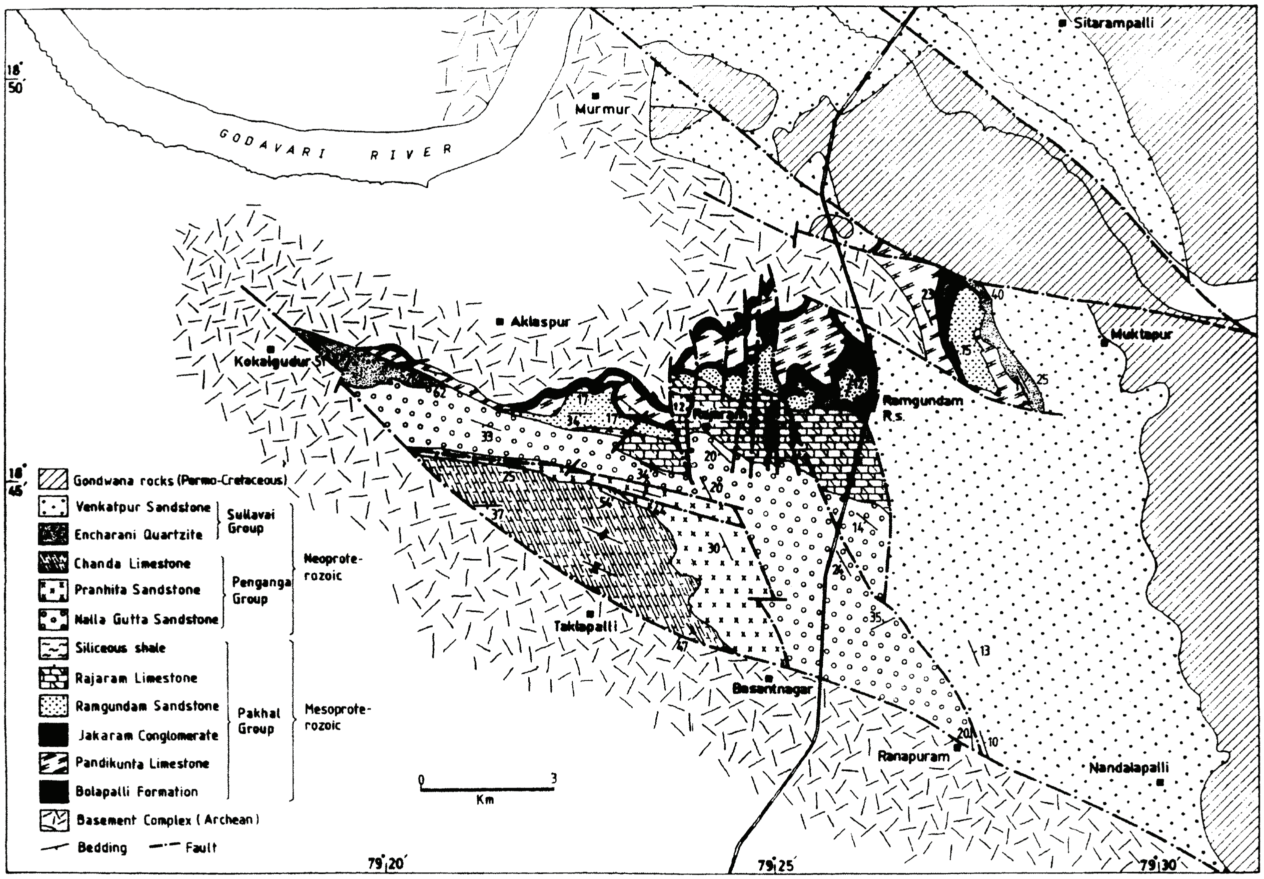

Fig. 4. Geological map of the Ramgundam area (modified after Chaudhuri, 1985).

in its foothills into three formations, the Somandevara Quartzite, the Tippapuram Shale, and the Albaka Sandstone, in ascending order (Table 2). They also identified another group of red arkose and conglomerate that unconformably overlies the Albaka Sandstone. They correlated the Somandevara Quartzite and the Tippapuram Shale, respectively, with the Mulug Orthoquartzite and Mulug Shale of the Mulug Subgroup, and equated the uppermost red beds with the Sullavai Group. They defined the Albaka Sandstone as an individual formation, in view of an inferred disconformity at its base, and combined the Mallampalli Subgroup, the Mulug Subgroup and the Albaka Sandstone into the Pakhal Group (Table 2). Sreenivasa Rao (1987) also followed the same classification as proposed by Srinivasa Rao et al. (1979) for the succession in the Albaka range. However, they redefined the Mallampalli and Mulug Subgroups as groups, and referred to the combined succession of the Mallampalli Group, Mulug Group, and the Albaka Sandstone as the Pakhal Supergroup (Table 2). Chaudhuri and Chanda (1991), on the other hand, combined the Somandevara Quartzite, the Tippapuram Shale and the Albaka Sandstone into the Albaka Group, analogous with the Albaka subdivision of King (1881). They further proposed to combine all the unconformity-bound sequences of the PG Valley into the Godavari Supergroup, named after the Godavari river, the trunk river draining the valley.

Geological mapping initiated by the Indian Statistical Institute on the mixed carbonate–siliciclastic sequence in the central part of the northeastern belt indicated that this sequence is radically different from the sequence of the Pakhal Group. The sequence around Somanpalli was defined as the Somanpalli Group by Saha and Ghosh (1997). Saha and Ghosh (1998) identified six formations (Table 2), which can be grouped into three broad associations. The lower one consists of sandstones, mudstones and limestones of the Somnur Formation and Bodela Vagu Formation deposited in mixed carbonate–siliciclastic platform. The middle association comprises the Tarur Nala Formation, Pedda Gutta Formation, and Kopela Shale. It represents a thick assemblage of black shale–black chert, pyroclastics with tuffaceous lava, volcaniclastics and litharenites. The assemblage bears the signatures of deposition in deep water environments in an unstable basin. The deep basin formed as a fault-bounded trough that resulted from extension and subsidence of the Somnur–Bodela Vagu platform (Saha and Ghosh, 1998). The uppermost association consists of sandstone and intercalated shale of the Po Gutta Formation. Saha and Ghosh

Table 2
Lithostratigraphy of the Godavari Supergroup along the northeastern margin of the PG Valley, and the correlation with the sequence along the southwestern margin. Comparison of classifications followed by earlier authors and the present author

Subba Raju et al. (1978)					Srinivasa Rao et al. (1979)				Sreenivasa Rao (1987)				Saha and Ghosh (1998)	Chaudhuri (Present study)	
		SW Belt, Mulug area		*NE Belt, Albaka area*			*SW Belt, Mulug area*	*NE Belt, Albaka area*			*SW Belt*	*NE Belt*	*NE Belt*		*NE Belt*
											Gondwana Supergroup ~~ U~~ / – F –	Gondwana Supergroup – F – F – F – F –			
PAKHAL SUPERGROUP	Sullavai Group	Sullavai sandstone and conglomerate (1403)	Sullavai Group	Chalamala Sandstone (300) Chalamala Conglomerate (3)		Sullavai Group	Sullavai Sandstone	Usur Sandstone (200) Doli Sandstone (975) Nambi Breccia (200)		Sullavai Group	Sullavai Sandstone (990)	Usur Sandstone Member (200) Doli Sandstone Member (975) Nambi Breccia Member (200)		Sullavai Group	Usur Sandstone Member (200) Doli Sandstone Member (975) Nambi Breccia Member (200)
		~~ U ~~~ U ~~~		~~~ U ~~~ U ~~~			~~~ U ~~~ U ~~~	~~~ U ~~~ U ~~~			~~~ U ~~~ U ~~~	~~~ U ~~~ U ~~~			~~~ U ~~~ U ~~~
										Penganga Group	Putnur Limestone (100) Taklapalli Arkose (400) – F – F – F – F –				
					PAKHAL GROUP			Albaka Sandstone (1500) Utlapalli Conglomerate (4) ~~~ U ~~~ U ~~~	PAKHAL SUPERGROUP			Albaka Sandstone (1000) ~~~ U ~~~ U ~~~	Po Gutta Sandstone (155) ~~~ U ~~~ U ~~~	Albaka Group	Chalamala Sandstone (1000)
	Mulug Group	Mulug Shale (2500) Mulug Orthoquartzite (400) Mulug Arkose (200) Jakaram Conglomerate (10)		Tippapuram Shale		Mulug Subgroup	Mulug Shale (2500) Mulug Orthoquartzite (400) Enchencheruvu Shale (120) Enchencheruvu Limestone (210) Enchencheruvu Chert (110) Jakaram Arkose (240) Jakaram Conglomerate (33)	Tippapuram Shale (1340) Somandevara Quartzite (915)		Mulug Group	Laknavaram Shale (1500) Pattipalli Quartzite (300) Enchencheruvu Dolomite (300) Polaram Formation (500) Jakaram Arkose (230)	Tippapuram Shale (1340) Somandevara Quartzite (915)	Kopela Shale (450) Pedda Gutta Chert Formation (250) Tarur Nala Formation (1250) Somnur Formation (1100) Bodela Vagu Formation (220)		Tippapuram Shale (1340) Somandevara Quartzite (915)
		~~ U ~~~ U ~~~					~~~ U ~~~ U ~~~				~~~ U ~~~ U ~~~		– F – F – F – F –		
	Mallampalli Group	Pandikunta Shale (200) Mallampalli Dolomite (2200) Mallampalli Conglomerate				Mallampalli Subgroup	Pandikunta Shale (100) Pandikunta Limestone (1270) Mallampalli Conglomerate (30)	~~ U ~~ / – F – ? Cherla Formation (150)		Mallampalli Group	Pandikunta Shale (340) Gunjeda Dolomite (300) Bolapalli Formation (185)	Cherla Formation (290)			
		~~ U ~~~ U ~~~					~~~ U ~~~ U ~~~	– F – F – F – F –			~~~ U ~~~ U ~~~	~~ U~~ / – F –			
		Basement complex					Basement complex	Basement complex			Basement complex	Basement complex			

(1998) suggested that the Po Gutta Formation overlies several formations of the Somanpalli Group with an angular unconformity. They equated the Po Gutta Formation with the Albaka Sandstone and indicated that the Kopela Shale may be correlated with the Tippapuram Shale, although this correlation would require more field work.

The resumé of previous work on stratigraphic classification and lithostratigraphic correlation points to a complex history of sedimentation, erosion, basin subsidence or uplift, sea level changes, and development of hiatuses. The complexity of basin-filling history was manifested as more and more areas were stratigraphically analyzed. As a consequence, the history of the stratigraphic subdivision and its changes through time also had a fairly complex history. The classification suggested by different workers is given in Tables 1 and 2, and the lithological composition of different units (on a formation level) is given in Table 3.

The resumé also reveals that the stratigraphic scenario of the PG Valley still has several major problems. The resolution of the problems holds the key to the analysis of the PG basin. The crux of the problem appears to center around the position of the formations in the Albaka range, their correlation with the formations in the southwestern belt, as well as their relationship with the carbonate dominated Pakhal, Penganga, and Somanpalli Groups. The Albaka formations, together with the red beds of the Sullavai Group that are undisputedly the youngest of the unconformity-bound sequences, constitute the most extensive siliciclastic depositional system in the PG Valley. The formations developed as large blanket deposits, and point to radical changes in the provenance, rate of sand generation, and sand supply in the basin, in contrast to the conditions prevailing during sedimentation of the Pakhal, Penganga and Somanpalli Groups. The relationship of the Somanpalli Group with the Pakhal or Penganga Groups also remains a major stratigraphic problem. The Somanpalli and Penganga Groups dominate the northern part of the PG Valley, where the Albaka Group appears to be completely absent. The stratigraphic evolution of the southern part of the basin, on the other hand, is almost symbiotically related to the Albaka–Pakhal question. The issues have eluded the stratigraphers since King (1881).

5. Albaka Group: its relationship to the Pakhal Group

The relationship of the Mulug Orthoquartzite and Mulug Shale with the subjacent Enchencheruvu Limestone/Shale (Table 1), or with other Pakhal formations, were studied in the Mallampalli–Pakhal Lake region. The quartzarenites occur everywhere over the underlying formations with a sharp contact (Fig. 3). The abrupt change from the low energy tidal flats and related environments of the Enchencherevu Limestone and Enchencherevu Shale to the high energy shoreface milieu of the Mulug Orthoquarzite points to sharp changes in the basin as well as in the provenance. Uplift of the provenance leading to a high sand influx is indicated. The changes collectively point to a forced regression and an unconformity. Although structural discordance and erosional stripping of underlying beds are not evident in all the profiles, the map (Fig. 3) shows that the Mulug Orthoquartzite overlies different formations of both Mulug and Mallampalli Subgroups at different places. The Mulug Orthoquartzite steps over successively older formations in a southeasterly direction, transgresses the sub-Mulug unconformity, and comes very close to the basement near the southwestern corner of the Pakhal Lake, transgressing almost the entire thickness of the Mallampalli Subgroup (Fig. 3; also, Sreenivasa Rao, 1987). The local presence of conglomerate at the base of the Mulug Orthquartzite is seen in Fig. 3, and is also reported by Sreenivasa Rao (1987). This conglomerate contains clasts of chert derived from the underlying Pakhal formations. Overstepping of the Mulug Orthoquartzite on different underlying formations, as well as occurrence of conglomerate with chert clasts, attest to physical discordance, major erosion and stripping of a thick sequence of Pakhal strata. It is inferred that the Mulug Orthoquartzite overlies a major hiatus. When the basin floor was uplifted, different intervals of the Pakhal sequence were removed by erosion. The cratonic hinterland was also uplifted and a large amount of sand was produced, generating a new cycle of siliciclastic sedimentation and a transgression.

Recognition of the unconformity at the base of the Mulug Orthoquartzite negates the logic for placing this orthoquartzite and the overlying Mulug Shale within the Mulug Subgroup. The formations are lithologically correlatable with the Somandevara Quartzite and Tippapuram Shale, respectively, as indicated by Srinivasa Rao et al. (1979) and Sreenivasa Rao (1987), and should be considered as a group or part of a group (Table 1). The names 'Mulug Orthquartzite' and 'Mulug Shale' for outcrops in the southwestern belt should thus be discontinued and the terms 'Somandevara Quartzite' and 'Tippapuram Shale' are here used for all the equivalent formations occurring in different parts of the basin (Tables 1–3). The Somandevara Quartzite, the Tippapuram Shale and the overlying thick sandstone unit, designated as the Albaka Sandstone by several workers (Srinivasa Rao et al., 1979; Chaudhuri and Chanda, 1991; Saha and Ghosh, 1998), represent a genetically related assemblage of shallow marine sandstones and shale. The ensemble bounded between the sub-Somandevara (post-Pakhal) hiatus and the sub-Sullavai (post-Albaka) unconformity constitutes almost the entire Albaka plateau, and represents King's (1881) Albaka subdivision (Tables 1 and 2). Srinivasa Rao et al. (1979) did not combine the Albaka Sandstone with the Somandevara Quartzite and Tippapuram Shale in view of an inferred break in deposition indicated by thin, impersistent bodies of conglomerate at the base of the Albaka Sandstone. Nevertheless, these conglomerate beds and pebble layers occur at the base as well as within the Albaka Sandstone, and

Table 3
Lithofacies and depositional setting of Proterozoic formations in the P.G. Valley

Bolapalli Formation	Directly overlies the basement crystallines with an unconformity. Dominated by arkosic sandstone, basal ~2 m being almost a 'granite-wash'. Subordinate conglomerate, with pebbles of granite, BIF, quartzite, etc. dolomitic limestone; calcareous component increases upward	Small alluvial fans intercalated with carbonates deposited in tidal flats and sabkhas
	Conglomerates and sand bodies are lenticular, thickness varies widely and abruptly. Symmetrical wave ripples, flat crested ripples, cross-bedding desiccation cracks, microbial laminites and algal stromatolites, salt pseudomorphs present	Stable shelf
Pandikunta Limestone	Gradationally overlies the Bolapalli Formation. Dominated by limestone and dolomitic limestone, with subordinate glauconitic sandstone, deposited as shoal bars. Algal stromatolites and microbial laminites profusely developed. Sandstones and sandy limestones preserve cross-stratification, desiccation cracks, ripple bedding; intraformational conglomerates occur locally	Tidal flat to shelf and stable shallow shelf
Pandikunta Shale	Calcareous shale with thin interbeds of limestone and sandstone	Shelf
Jakaram Conglomerate	Conglomerate, pebbly arkosic sandstones and sandstone. Pebbles are mostly of vein quartz, and chert. Discontinuous sand bodies show strong thickness variation. Sandstones are trough cross-stratified; well developed F-U sequences	Coastal alluvial fans , grading into thick sand deposits of tidal flats and shore faces
Ramgundam Sandstone	Arkosic to subarkosic sandstone, occurs as linear shaol bars and interbar deposits Profuse trough cross-strata, wave ripples, megaripples and desiccation cracks developed. Wavy bedding and flaser bedding are common	Tidal flats and shoreface environments
Enchencherevu Chert	Siliceous shale and bedded chert. Gradationally overlies the Ramgundam Sandstone	Shelf
Rajaram Formation	Siliceous limestone, intraclastic cross-stratified and wave-rippled limestone, dolomitic limestone; argillaceous limestone to calcareous shale in the upper part	Back-lagoon, tidal flat
Somandevara Quartzite	Subarkosic to quartzarenite, with small lenses of pebbly sandstone and conglomerate. Profuse cross-strata and ripple marks preserved	Storm dominated shore-face environments
Tippapuram Shale	Thinly laminated shale, at places sandy, with small intercalated lenses of quartzarenite with megaripples. Gradationally overlies the Somandevara Quartzite	Inner shelf
Chalamala Sandstone	Medium to fine grained subarkosic sandstone. Ripple marks, ripple lamination, cross-stratification, plane lamination, wrinkle marks, current crescents are common structures	Storm and tide dominated, shallow shelf, shoreface, tidal flat
Nalla Gutta Sandstone	Red to purplish, conglomerate, pebbly sandstone and arkose with large blocks of fresh feldspar, organized into successive C-U sequences, occur as thick wedges. Conglomerates, thick, massive to crudely bedded. Sandstones are coarse grained and cross-stratified	Alluvial fan and braid-plain deposits in fault controlled setting
Pranhita Sandstone	Grayish to buff, subarkosic to quartzose, cross-stratified sandstone grading upward to silty shale to shale forming F-U sequences. Trough and planar cross-strata, ripple marks and parting lineation present	Storm and tide dominated shoreface to inner shelf
Chanda Limestone	Medium bedded, lithographic limestone with thick intervals of siliceous limestone, bedded chert–Mn ore horizons at certain sections, and debris flow deposits of intraformational, auto-limeclastic conglomerates and calcarenites	Deep water carbonate platform with oxic to anoxic conditions. Conglomerates indicate fault controlled deposition in unstable shelf
Sat Nala Shale	Red to purple shale, without any coarse clastics; at places intercalated with siliceous limestone	Outer shelf to basinal deposits
Bodela Vagu Formation	Argillaceous and dolomitic limestone. Locally brecciated or intercalated with cross-stratified sandstone. Microbial laminites, algal stromatolites, molar tooth structures common in certain facies. Salt pseudomorphs and dessication cracks occur in the upper level	Subtidal to intertidal flats

Table 3 (*continued*)

Somnur Formation	Mixed sandstone–shale sequence; F-U and C-U sequences. Trough, cross-strata, asymmetric to interference ripple marks; dessication cracks present. Upper part shale dominated. Microbial laminites and stromatolites occur locally	Tide dominated intertidal flats, shoreface to shallow shelf
Tarur Nala Formation	Bedded chert–black shale, ash-beds, coarse grained 'graywacke', with massive normal or inverse graded beds, topped by slumped beds of shale/tuff	Unstable, shelf, slope, basinal deposits, at extensional stage of basin
Pedda Gutta Chert Formation	Lithologic assemblage analogous to that of the Tarur Nala Formation	
Kopela Shale	Gray-green and black shale and tuffaceous shale. Small lenses of cross-stratified sandstone at the basal part, and interbedded sandstone with wavy and flaser bedding at the upper part	Deep shelf to intertidal shallow subtidal environments
Po-Gutta Sandstone	Sandstone–shale intercalation grading upward to quartzarenite. Intercalated sandstone layers are wavy bedded; quartzarenite are dominantly trough cross-stratified	Lower to upper shore face
Encharani Formation	Red to reddish brown, coarse to medium grained arkose to quartzose sandstone, with rapid facies variation. Local development of thick conglomerate and pebbly sandstone. Sandstones are dominantly trough cross-stratified	Alluvial fan to braid plain deposits
Venkatpur Sandstone	Medium grained, red, quartzose sandstone, locally subarkosic. Large high angle cross-strata, large low angle, inversely graded foresets, adhesion ripple laminae occur commonly	Erg deposits
Kapra Sandstone	Buff to gray, coarse grained, arkosic to quartzose sandstone. Locally pebbly and conglomeratic. Sandstones are dominantly trough cross-stratified	Braided plain deposits

the proposed break appears to be diastemic and related to lower order sea level changes. The Somandevara, Tippapuram and Albaka formations have a combined thickness of about 3000 m (Table 2) and represent a very mature lithological assemblage deposited under stable shelf conditions (Srinivasa Rao, 1987; Table 3). The high maturity of the sediments points to slow uplift of the provenance and supply of sediments at a fairly steady rate. The accumulation of such a thick sequence within a shallow marine environment also reflects very slow subsidence of the depositional interface and may be attributed to innumerable transgressions and progradations that generated multiple diastemic surfaces. Following King's (1881) terminology, Chaudhuri and Chanda (1991) designated the assemblage the Albaka Group. In view of the definition of the assemblage as the Albaka Group, the uppermost unit, viz. the Albaka Sandstone of Srinivasa Rao et al. (1979) and others, is redesignated here as the Chalamala Sandstone after the name of a village in the southern part of the plateau (cf. Hedberg, 1976). The Chalamala Sandstone does not occur in the southwestern belt, where the arkosic sandstones of the Sullavai Group unconformably overlie the Tippapuram Shale (Fig. 5).

6. The Albaka Group: its possible relationship with the Somanpalli and Penganga Groups

The Albaka Group developed or is preserved mainly in the southern part of the Valley (Fig. 2). In the southwestern belt, it is bound by the underlying Mulug Subgroup and the overlying Sullavai Group (Table 1), whereas in the northeastern belt it is overlain by the Sullavai Group, and its lower contact has been obliterated by a major fault (Fig. 2). The occurrence of Albaka rocks is not reported in the northern part of the Valley (see also, Sreenivasa Rao, 1987) where the Penganga and Somanpalli Groups occupy the corresponding stratigraphic position between the Sullavai Group and the Pakhal Group, or the basement complex (Table 1). It appears that the southern and northern parts of the Valley had experienced distinctly different styles of evolution. Nevertheless, reconstruction of the relationship between the southern and northern sequences appears to be intimately interwoven with the question of the relationship of the Albaka Group with the Somanpalli and Penganga Groups. The field data with regard to the Albaka–Somanpalli–Penganga relationship is still not well constrained, and resolution of the problem would require further lithological mapping in several key areas. The distribution of these three groups in space suggests that the Albaka Group may be a lateral facies equivalent of the other two groups. The concept of individuality of cratonic sequences, however, strongly argues against correlating the Albaka sequence with either the Penganga or the Somanpalli sequence. It is now well established that stratigraphic sequences and subsequences, bound by major unconformities, display a degree of individuality (Sloss, 1991). The rocks of a particular sequence may look remarkably similar at widely separated localities

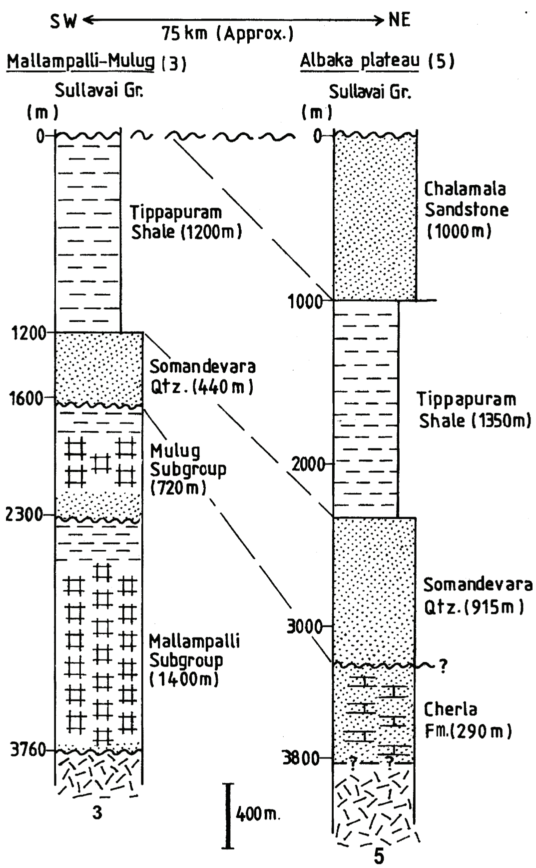

Fig. 5. Stratigraphic profiles showing the correlation between Proterozoic successions developed in the Mallampalli–Mulug area (SW) and the Albaka plataeu (NE).

when the basin (s) developed within similar palaeoclimaticzones or had an equivalent supply or lack thereof of detrital sediments. The distinctiveness of the sequences reflects phases in the evolution of the composition and thickness of the continental crust, aided by atmospheric evolution and episodic assembly and fragmentation of supercontinents (Sloss, 1991). The Albaka sequence not only lacks the limestones present within the other two units, but the siliciclastic rocks in the Albaka sequence are also distinctly different from those in the Penganga and Somanpalli sequences, indicating a different style of basin evolution (Table 3).

The Somandevara Quartzite, the intercalated sandbodies within the Tippapuram Shale, and the Chalamala Sandstone (Albaka Sandstone) all comprise submature to mature quartzose sandstone with profuse cross-stratification, plane lamination and ripple marks (Srinivasa Rao, 1987) (Table 3). The Albaka sequence exhibits signatures of sedimentation within shoreface to inner shelf environments, with a slow rate of sedimentation and basin subsidence. The Albaka sequence constitutes the most mature lithologic association in the PG Valley, and it closely resembles the products of sedimentation during the post-rifting stage of basin evolution (cf. Eriksson et al., 1993). The Penganga Group on the other hand, consisting of a thick wedge of conglomerate, coarse arkose and arkosic sandstones, and deep water limestone with a large number of fault-controlled intraformational, lime–clast debris-flow conglomerate and calcarenitic turbidite interbeds (Chaudhuri et al., 1989; Bose and Sarkar, 1991; Mukhopadhyay et al., 1997) attests to deposition as a syn-rift sequence. The Somanpalli Group, with an association of black shale–black chert, graywackes, and thick pyroclastic turbidites (Saha and Ghosh, 1998), also represents extension and rifting stage sedimentation in deep water shelf, slope and basinal environments of an unstable basin. The contrasting style of basin tectonics and sedimentation indicates that the Albaka Group could be younger than both the Penganga and Somanpalli Groups. The relationship between the Somanpalli and Albaka Groups, however, requires further elaboration. The absence of the Penganga sequence in the region south of the Kaddam fault, and of the Albaka sequence to the north of the fault, may be a combined effect of non-deposition or tectonic uplift and erosion. Tectonic uplift during the lacunas, or also during the depositional phase of a sequence, can be responsible for the stripping of hundreds of meters or even kilometers of older units from broad positive cratonic elements and from sharply delineated local uplifts (cf. Sloss, 1963, p. 102). The dramatic influence of sharply delineated tectonic uplift, through a combination of folding and faulting, is demonstrated by the superposition of the Sullavai Group on either the Penganga or the Pakhal Group in contiguous western and eastern parts of the Ramgundam area. The relationship attests to uplift of fault-bound blocks and stripping of the entire thickness (c. 1500 m) of the Penganga rocks from the eastern part where the Sullavai rocks directly overlie the Pakhal rocks (Fig. 4).

7. Unconformities, sequences and basin history

7.1. Unconformities and sequences

The recognition of unconformities in the Godavari Supergroup in the southern part of the PG Valley has resulted in the identification of four major sequences, the mixed siliciclastic–carbonate Mallampalli and Mulug Subgroups (Pakhal Group), and siliciclastic Albaka and Sullavai Groups. This has also opened up the possibilities of tracing stratigraphic–palaeogeographic changes through time. Lithological attributes of the formations of each group are summarized in Table 3.

The Mallampalli Subgroup is represented by a carbonate–quartzarenite assemblage with subordinate conglomerate and arkosic sandstone at the basal part. The carbonates are dolomitic limestones and are marked by profuse development of algal stromatolites (Chaudhuri, 1970b) and microbial laminites. The sequence represents a stable shelf association deposited in coastal and shallow shelfal environments. The salt-pseudomorphs at the basal part of the Mallampalli assemblage point to semi-arid climatic conditions (Chaudhuri et al., 1989). Semi-arid climatic regime and strong aeolian reworking on vegetation-free extensive surfaces are also indicated by the preponderance of highly rounded grains of quartz and fresh feldspar in different Pakhal sandstones. Aeolian action is considered the most effective process in rounding sand grains (Kuenen, 1959, 1960), and analysis of the textural attributes of Pakhal sands led Chaudhuri (1977) to attribute the high roundness of a population of sand grains, including large number of fresh feldspar grains, to aeolian reworking. The Mulug Subgroup, in contrast, is dominated by thick wedge of conglomerate and arkose in the lower part that was deposited as a series of fault-controlled fan and fan-delta sequences. This is followed upward by dolomitic limestones deposited in tidal flats, carbonate banks and shallow shelves (Chaudhuri and Howard, 1985). The lithologic assemblage and depositional motif attest to sedimentation of coarse clastics during extensional opening of the basin, followed by carbonate deposition during thermal relaxation and subsidence. The Albaka Group consisting of mature quartzose sandstone deposited in coastal and shoreface environments, and shallow shelfal shale (Srinivasa Rao, 1987) represents a stable shelf association with finely tuned balance between a slow rate of sand input and basin subsidence. The basal part of the Sullavai Group consists of extensive deposits of red to brown conglomerates, pebbly sandstones and arkosic sandstones with intercalated intervals of red quartzarenite deposited in alluvial environments. It is overlain successively by thick blankets of aeolianites deposited in erg environments (Chakraborty, 1991; Chakraborty and Chaudhuri, 1993) and a thick sequence of coarse grained white arkose derived from freshly exposed crystalline basement rocks. The basal as well as uppermost deposits of the Sullavai Group reflect episodic rifting and fault-controlled sedimentation, whereas the erg deposits point to stable condition of landforms and a semi-arid to arid climatic regime is inferred.

The sub-Mallampalli and the sub-Gondwana unconformities are clearly comparable with the inter-regional unconformities of Sloss (1991). The former denotes the break between the time of stabilization of the Indian cratonic crust and initiation of the Proterozoic basins at several parts of the craton, whereas the latter unconformity denotes the break between the closure of the Proterozoic basins and opening of the late Palaeozoic Gondwana basin. The sub-Mulug, the sub-Albaka, and the sub-Sullavai unconformitites are identifiable as basin-wide unconformities at present, although their inter-basinal extension across the adjoining Cuddapah basin has not yet been seriously tested.

The unconformity-bound sequences exhibit a systematic change in thickness along the length-wise profile of the Valley (Figs. 6 and 7). Fig. 6 exhibits the correlation between different profiles measured between Ramgundam and Pakhal Lake along the southwestern belt. In the Ramgundam area, the profile where the Sullavai Group overlies the Pakhal Group has been selected. The presentation made in the diagram is a schematic one, as areas with fault-controlled variations have been ignored to overcome local effects. Fig. 7 exhibits the profile of the unconformity surfaces and depicts their behavior along the length-wise direction of the Valley, as well as their inter-relationship.

7.2. Unconformities and their tectonic significance

To enter the stratigraphic record, sediments must be carried below base level, the equilibrium surface separating erosional and depositional regimes, either by a rise in sea level or by subsidence of the depositional site. The depositional interface in the PG Valley experienced periodic excursions across the base level resulting in uplift, erosion and development of unconformities, followed by subsidence and deposition. Furthermore, Fig. 7 indicates that the sub-Mallampalli, sub-Mulug and sub-Albaka unconformities experienced subsidence and uplift on the order of a kilometer or more in the region between Mallampalli and Pakhal Lake. The measured sections in Fig. 6 show that c. 1800–1850 m of Pakhal sequence was eroded during the sub-Albaka hiatus. The figure also depicts that the sub-Albaka unconformity surface rapidly subsided to accommodate more than 1500 m of Tippapuram Shale. The inferred amplitude of uplift, erosion, subsidence and creation of accommodation space is well beyond the range of sea-level rise and fall and suggests tectonically induced movement of the basin floor (cf. Sloss, 1984). The difference in the magnitude of vertical movement around Ramgundam and Pakhal Lake further attests that the basin floor did not operate as a monolithic block subject only to eustatic sea-level changes. Different parts of the basin responded differently to the applied tectonic forces. The Mallampalli–Pakhal Lake region rapidly rose and sank across the base level, compared to the Ramgundam region that acted as a relatively stable positive area. With possible arching, the sub-Sullavai unconformity successively overstepped the older sequences in the positive areas around Ramgundam and transgressed very close to the basement. The tectonic behavior of the basin and the depositional mode are 'oscillatory' (cf. Sloss, 1984), characterized by abrupt termination of a submerging episode through rapid cratonic uplift. This uplift was accompanied and caused by high angle faults that propagated from the basement and ultimately fractured and displaced the overlying sedimentary rocks.

7.3. Unconformities and basin palaeogeography

Episodic uplift and depression of the depositional interfaces, along with an increasing rate of movement in the southeastern direction compared to that in the more

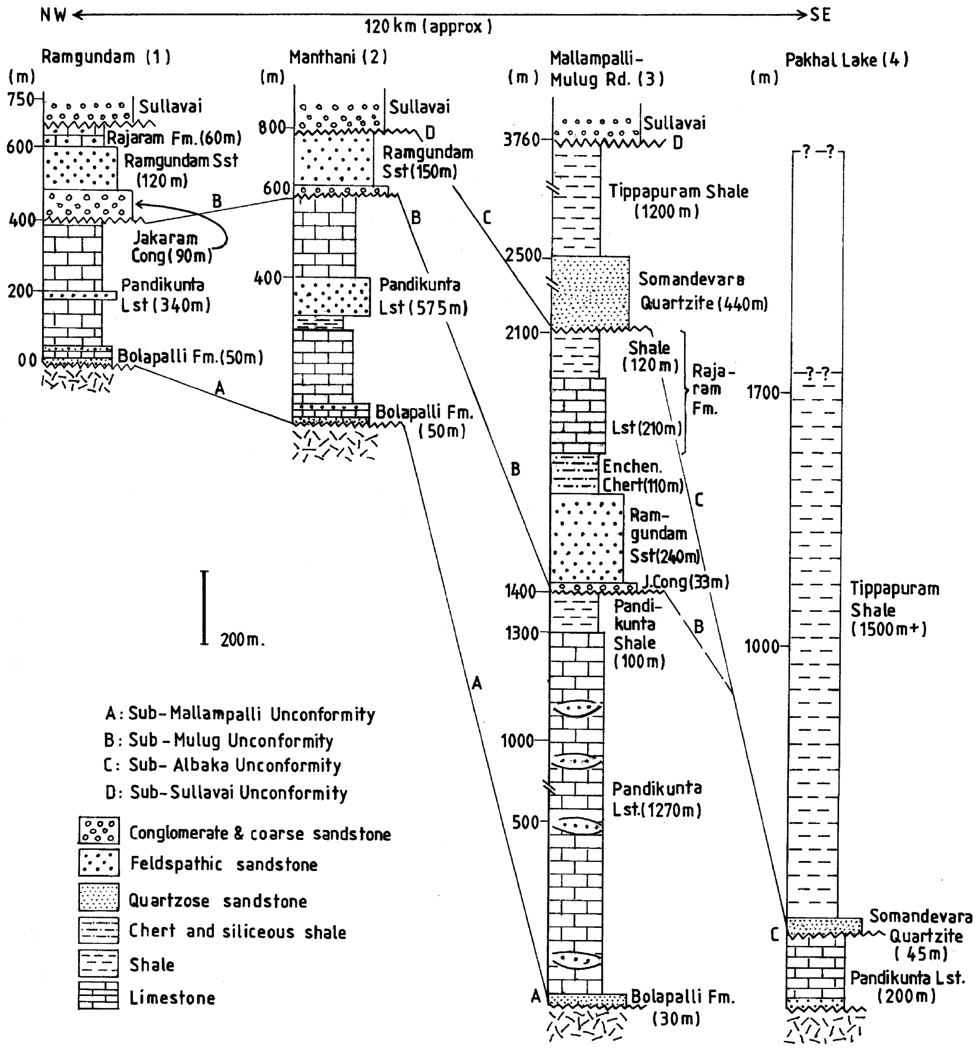

Fig. 6. Stratigraphic profiles showing differences in the Proterozoic successions along the southwestern belt, between Ramgundam and Pakhal Lake.

positive areas in the northwest, is indicated by the southeasterly slope of all the pre-Sullavai unconformity surfaces. The negative areas created accommodation space for thicker depositional units, reflected by the increasing thickness of the unconformity-bound sequences towards the southeast. Fig. 6 shows that the thickness of the sequences, the thickness of individual formations within the sequences, as well as the number of formations increase towards the southeast. The Pandikunta Limestone in the Mallampalli–Mulug road profile is 1270 m thick, whereas the Limestone is only 340 m thick in the Ramgundam profile. Likewise, the Ramgundam Sandstone is 120 m thick in the Ramgundam profile, but 240 m thick in the Mallampalli–Mulug road profile. The Pandikunta Shale (100 m) and Enchencherevu Shale (120 m) recorded in the Mallampalli–Mulug area pinch out and disappear in the Ramgundam area (Fig. 6).

The most dramatic changes are exhibited by the Albaka formations between the Mallampalli–Mulug road and the Pakhal Lake profiles (Fig. 6). The Somandevara Quartzite thins from a thickness of 440 to 45 m, whereas the Tippapuram Shale increases in thickness from 1200 to more than 1500 m. The increasing thickness of fine-grained clastics southeast of Pakhal Lake is also reported by Sreenivasa Rao (1987).

The stratigraphic trends indicate that the PG basin was subsiding, deepening and widening at a greater rate towards the southeast throughout the deposition of pre-Sullavai sequences, and the basin axis sloped towards the southeast. During the deposition of the Albaka sequence, the region around Pakhal Lake and further southeastward was transformed into a deep muddy shelf that accommodated the thick sequence of Tippapuram Shale. Characterization of the deep water Albaka shelf or of the Pakhal basin would require detailed sedimentological analysis near Pakhal Lake and further to the southeast. However, with the present state of knowledge, it is suggested that the basin in its

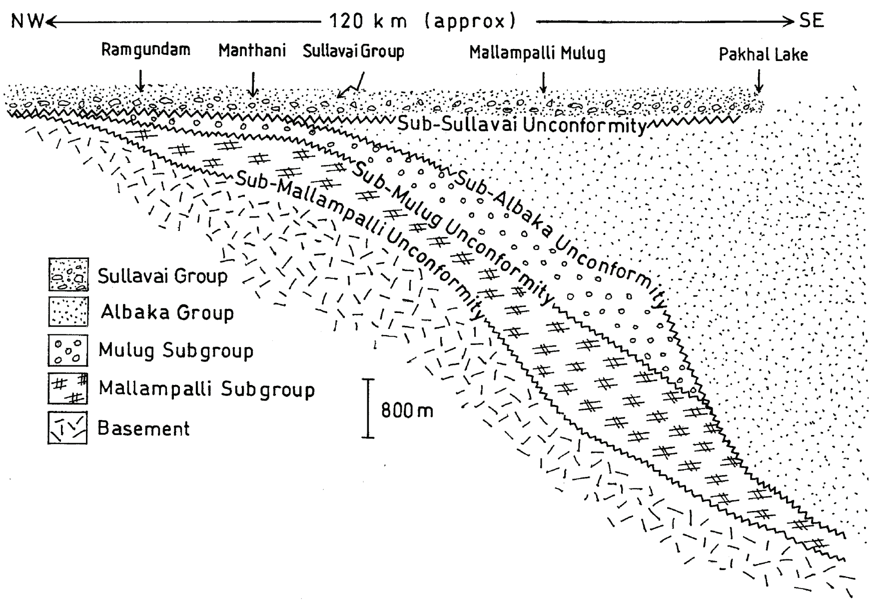

Fig. 7. Schematic diagram showing the correlation of regional unconformities in the southwestern Proterozoic belt of the PG Valley, and behavior of the unconformity surfaces along the length of the Valley.

southeastern part was much wider than the present day outcrop width. It is tempting to suggest that it was continuous with the outcrops of the Cuddapah rocks to the southwest during different stages of basin development (Fig. 8).

8. Concluding remarks and summary

The sequence concept applied here follows that of Sloss (1963), albeit on a much smaller scale. The sequences and subsequences identified are synonymous with lithostratigraphic groups and 'sub-groups', and are basin-wide elements. Of the bounding unconformities, two are truly inter-regional, whereas inter-regional extension of the others has not yet been tested. However, like the inter-regional cratonic sequences of North America, the PG Valley sequences occupy positions in a temporal framework as well as in purely spatial dimensions and are characterized by their unique features. These characteristics are imposed by large scale factors such as palaeoclimatic zones, rate of detrital sediment supply or lack thereof, basin margin as well as intrabasinal faults, the characteristics of sands supplied to the basin, and mode of emergence of the craton surfaces within the zone of erosion. Recognition of unique features within the sequences has greatly facilitated regional correlation of the lithologic assemblages, which often occur as isolated outcrops fragmented by deep-seated faults, or separated by overlying Gondwana rocks and Deccan volcanics.

Four sequences have been identified within the study area. Of these, the Albaka and the Sullavai sequences (the third and fourth, respectively, in the order of superposition) occur as widespread blanket deposits covering both sides of the Valley. The Pakhal and the Penganga sequences have been identified only along the southwestern margin. The extent of the Somanpalli Group or its relationship with the mixed carbonate–siliciclastic assemblage at Bijjur (Fig. 2) has not yet been fully explored. It has been suggested on the basis of lithology that the Penganga sequence may be correlatable with the sequence exposed around Bijjur (King, 1881; Heron, 1949). Mukhopadhyay and Chaudhuri (2002) have correlated the lithographic limestone occurring in a fault-block near Dhaba, about 20 km NW of Bijjur (Fig. 1), with the Chanda Limestone of the Penganga Group and inferred that the Penganga basin extended to both sides of the Valley. It may be possible to correlate the Somanpalli and Penganga sequences with that at Bijjur. Such a correlation would establish the Penganga/Somanpalli sequence as very extensive, covering both sides of the Valley.

The pre-Sullavai unconformities all slope down towards the southeast and the thicknesses of unconformity-bound sequences increase in the same direction, indicating that the basin became deeper and wider towards southeast compared to its central part around Mancherial–Ramgundam. The central part behaved as a positive area where the unconformities tend to converge. The negative area around the Mallampalli–Pakhal Lake region was episodically uplifted and depressed across the base level. The magnitude of these excursions attests to tectonically controlled large-scale movements of the basin floor. The reconstructed palaeogeography suggests the presence of a major seaway along the eastern margin of the Indian peninsula, in the area occupied by the present day

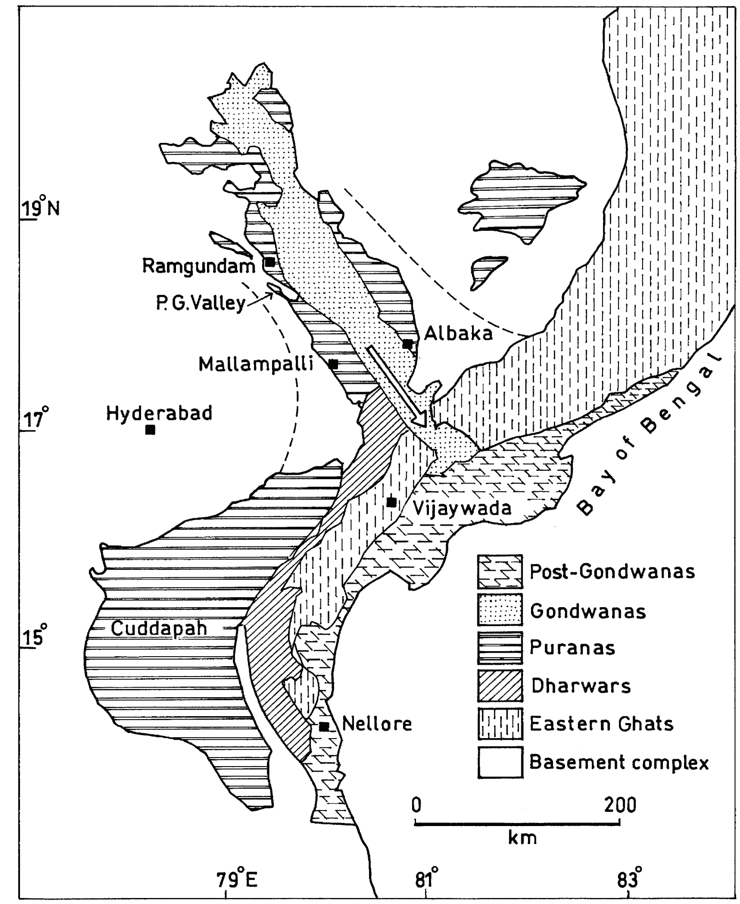

Fig. 8. Schematic palaeogeographic map of the PG Proterozoic basin.

Eastern Ghats belt. The basin palaeogeography further indictates that the basin margin extended far beyond the present day outcrop limit along both margins, and the southeastern part of the PG valley could have been continuous with temporally overlapping Cuddapah outcrops that occur southwest of the Valley.

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