Status of Kamthi Formation : lithological and palaeobotanical evidences

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On the basis of lithological, palynological and megafloral data the status of Kamthi Formation has been reviewed. Hitherto known Kamthi Formation which was said to be a time-transgressive unit (Permian-Triassic) actually represents a Triassic sequence overlying Permian sediments equivalent to Raniganj Formation. Presence of Permian taxa, viz., *Glossopteris, Vertebraria* and *Phyllotheca* in red claystone, ferruginous sandstone/shale unit (=Upper Member, Kamthi Formation) represent only the continuations of Permian taxa into the Triassic.

Key-words — Lithology, Megafossils, Palynofossils, Kamthi Formation, Panchet Formation, Triassic, India.

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सारांश

कामथी शैल-समूह की स्थिति : शैलिकीय एवं पुरावनस्पतिक प्रमाण

सुरेशचन्द्र श्रीवास्तव एवं नीरजा झा

शैलिकीय, परागाणविक एवं गुरुवनस्पतिजातीय आँकड़ों के आधार पर कामथी शैल-समूह की स्थिति की समीक्षा की गई है। कामथी शैल-समूह जो अभी तक एक अतिक्रामी इकाई (परमियन-ट्रायॅसिक) कही जाती थी वास्तव में परमियन अवसादों के ऊपर विद्यमान ट्रायॅसिक अनुक्रम का निरूपण करती है। *ग्लॉसॉप्टेरिस, वर्टीब्रेरिया* एवं *फिल्लोथीका* नामक परमियन कालीन वर्गकों की उपस्थिति से ट्रायॅसिक काल में परमियन कालीन वर्गकों की निरन्तरता व्यक्त होती है।

THE name 'Kamthi' was introduced by Blanford (1868) for a group of rocks exposed near military station 'Kamptee' close to Nagpur. The 'Kamthi Group' of rocks as described by Blanford (1877, p. 299) sensu stricto are composed of "grits, sometimes very hard at other times soft and frequently ferruginous. These are often intersected by bands in which the quartz and carbon are cemented together by peroxide of iron. The group also contains sandstone of various kinds, amongst which fine-grained slightly micaceous bed, white in colour with blotches and irregular streaks of red are abundant and the fine homogeneous argillaceous rocks which for want of better name called a compact shale, yellow below the surface, but becoming deep red when exposed". Similar rocks were later identified in Wardha-Godavari Valley in Maharashtra and Andhra Pradesh and in Mahanadi Valley, Orissa. In the latter area it was earlier known as Hingir Formation. Kamthi Formation is generally considered equivalent to Raniganj-Panchet Formation of Damodar Basin, Bijori Formation of Satpura Basin, Pali Formation of South Rewa Basin and Pachhwara Formation of Rajmahal Basin. In coastal tract of Godavari Graben Kamthi Formation was earlier referred as Chintalpudi sandstone.

The name 'Kamthi' has been used in different sense by different authors in different basins. Initially there was no intention to retain the name. It was thought that evidence might be accumulated soon to identify the rocks as the member of group already established in Damodar Basin (Hughes, 1877, p. 67). On the basis of fossil plants the Kamthi beds were correlated with Damudas while the mineral characters of Kamthi were different with that of both Iron Stone Shales and the Raniganj as this was devoid of iron stone shales and coal both. Thus the name 'Kamthi' continued to exist on account of its characteristic lithological attributes and its age was debated on the basis of palaeobotanical contents till recently. Now

Table 1—Status of Kamthi Formation in Godavari Graben

King (1881)	Sengupta (1970)	Raja Rao (1982)	Raiverman *et al.* (1985)	Kutty *et al.* (1988)	Pandey (1988)	Ramanamurty & Madhusudan Rao (1987) (1996)	Jha & Srivastava (1996)
KAMTHI	KAMTHI	KAMTHI: Upper Member	KAMTHI: KUDUREPALLI/ CHINTALPUDI	KAMTHI: Upper Member	KAMTHI	KAMTHI: Upper Member	KAMTHI: Upper Member (= Supra-Panchet/ Mahadeva)
		KAMTHI: Middle Member	KAMTHI: MANER	KAMTHI: Middle Member		KAMTHI: Lower Member	KAMTHI: Lower Member (= Panchet)
	IRON STONE SHALE	KAMTHI: Lower Member	KAMTHI: KHANPUR	INFRA KAMTHI: Litho-zone-4	Upper Coal Measures: Litho-facies-2	RANIGANJ: Upper	RANIGANJ
			KAMTHI: JAIPURAM	INFRA KAMTHI: Litho-zone-3	Upper Coal Measures: Litho-facies-1		
	BARAKAR	BARREN MEASURES	SINGARENI: POTAMADUGU/ BALHARSHAH	INFRA KAMTHI: Litho-zone-2		RANIGANJ: Lower	
			SINGARENI: BELAMPALLI	INFRA KAMTHI: Litho-zone-1	Middle Measures	BARREN MEASURES	
BARAKAR		BARAKAR	BARAKAR	BARAKAR	Lower Coal Measures	BARAKAR	
TALCHIR	TALCHIR	TALCHIR	TALCHIR	TALCHIR	TALCHIR	TALCHIR	

there is growing necessity for the uniformity in stratigraphic classification and terminology because the informal usage in the past has led to much confusions. An attempt has been made to ellucidate the current status of the Kamthi Formation in view of the lithological, palynological and plant fossil data accumulated during recent years. Before going into the details it is essential to understand the Kamthi in type area (*sensu stricto*) and its relationship in different basins.

STATUS OF KAMTHI FORMATION IN DIFFERENT BASINS

The Kamthi Formation as described by Blanford has been given in introduction. The status of Kamthi Formation in different basins is as follows :

Wardha	Kamptee	Godavari		Mahanadi
KAMTHI	KAMTHI	KAMTHI	Supra Panchet =Mahadeva	KAMTHI
			Panchet	
		RANIGANJ		RANIGANJ
Motur	Motur	BARREN MEASURES		? BARREN MEASURES

Within the Godavari Graben the stratigraphic status of 'Kamthi' Formation has been interpreted in different ways by different authors (Table 1).

Ramanamurty and Rao (1996) classified the Kamthi sediments (*sensu* Raja Rao, 1982) into Raniganj and Kamthi Formations, the latter divisible into two members. Jha and Srivastava (1996) in their classification considered the Lower Member being equivalent to Panchet Formation and Upper Member being equivalent to Supra-Panchet/Mahadeva Formation.

LITHOLOGICAL SET-UP

The lithological set-up of Kamthi Formation in Godavari Graben is given in Table 2.

Kamthi Formation (Raja Rao, 1982) in Wardha and Kamptee coalfields overlies Motur Formation (=Barren Measures) and underlies Lameta Formation with pronounced unconformity at both the ends.

In Mahanadi Valley the sediments unconformably overlying the Barakar Formation are included within the Kamthi Formation. It consists of fine to medium-grained sandstone, carbonaceous shales, coal bands with greenish sandstone, pink clays and pebbly

Table 2—Lithological set-up of Permian-Triassic sediments in three sub-basins of Godavari Graben. (A) indicates *sensu* Raja Rao (1982), and (B) *sensu* Jha and Srivastava (1996) and Ramanamurty and Madhusudan Rao (1996)

A		B		GODAVARI SUB-BASIN	KOTHAGUDEM SUB-BASIN			CHINTALPUDI SUB-BASIN		
FORMATION	MEMBER	FORMATION	MEMBER	U P P E R G O N D W A N A						
K A M T H I	UPPER	K A M T H I	UPPER	Predominantly ferruginous sandstone with subordinate siltstone and clay bands forming hills ranges	**Kamthi :** Coarse to pebble sandstone and clays. (SCCL, 1982, in Lakshminarayana & Murty, 1990).			**Kamthi :** Congolomeratic sandstone, ferruginous sandstone, siltstone and indurated claystone (Lakshminarayana & Murty, 1990)		
	MIDDLE		LOWER	Red/brown sandy calcareous clay and crossbedded sandstone		Bore Core MKD - 25	Chocolate brown siltstone/sandstone		Bore Core GC - 17	Pinkish, violet and yellow sst. and clay
				Greenish grey to green clay, siltstone intercalated with sandstone, micaceous at places			Greenish grey clay			Greenish grey sst. / siltstone
	LOWER		RANIGANJ	Mg-Cg greyish white sandstone with subordinate shale and coal seams			Mg-Cg greyish white sandstone Grey to black shale and coal seams			Fg-Mg. grey sandstone carbshale and coalseams
					Unconformity			Unconformity		
				BARREN MEASURES			BARREN MEASURES			BARREN MEASURES

sandstone at the top (Raja Rao, 1982). However, recent investigations through Kamthi Formation in Talcher and Ib-River coalfields have shown a close proximity with that of Godavari Graben and all the three litho-units are recognisable and correlatable (Table 3).

Remarks—The entire sedimentary sequence above the Barren Measures and below the Yerrapalli Formation in Godavari Graben assigned to Kamthi Formation by Raja Rao (1982) is actually divisible into three litho-units : (i) the lowermost unit consists of grey shale, carbonaceous shale, coal and sandstone, (ii) the middle unit comprises greenish-grey shale, clay and sandstone overlain by medium to coarse grained sandstone with pinkish red/brown/purple shales/clays, and (iii) the topmost unit consists of ferruginous sandstone with sub-ordinate siltstone, clay bands and pinkish red to purplish brown and yellow limnoic shales. Recent drillings and previous geological data in Kothagudem and Chintalpudi sub-basins have also shown the presence of three litho-units (Table 2).

Initially the Kamthi Formation (*sensu* Blanford, 1872; Hughes, 1877) was distinguished from Raniganj Formation on the basis of absence of coal or carbonaceous deposits or even carbonaceous markings. Now there are sufficient evidences for the presence of coal seams in lowermost litho-unit in Godavari, Wardha and Mahanadi valleys which exhibit gross lithological similarity with Raniganj Formation of Damodar Valley. The distinct lithological change occurs at the base of the middle unit represented by greenish grey clay, shale and sandstone and is equivalent to the Panchet Formation of Damodar Basin (Table 4). This transition is clearly demonstrated in Mailaram, Budharam areas of Godavari Graben, Bazargaon area of Kamptee Coalfield and Chendipada Block of Talcher Coalfield. The Upper Member of the Kamthi Formation forming prominent ridges in Godavari Graben exhibits

Table 3—Lithological set-up of Permian-Triassic sediments in Wardha, Kamptee and Mahanadi Basins. (A) indicates *sensu* Raja Rao (1982), and (B) *sensu* Jha and Srivastava (1996) and Ramanamurty and Madhusudan Rao (1996)

A		B		WARDHA		KAMPTEE	MAHANADI	
FORMATION	MEMBER	FORMATION	MEMBER					
KAMTHI	UPPER	KAMTHI	UPPER	Pinkish / red / brown variegated sandstone, reddish siltstone and shale	Bore Core DGW-6	Dark brown ferruginous sandstone, conglomerate lenses, red/brick red and yellow lemnoic shales	Conglomerates, ferruginous sandstone and red shales	
	MIDDLE		LOWER	Red / brown sandy clay, coarse bedded sandstone Greenish grey shale and sandstone	Bore Core MWCK-2	Coarse grained sandstone with blotches and streaks of red and purple shale Greenish grey clay, shale and sandstone	Bore Core TCW-6 & TP-8	Pink clays and pebble sandstone Greenish sandstone clay and shale
	LOWER	RANIGANJ		Fg. sst., grey to black shale, micaceous at place		Grey shale, carb shale sandstone and coal		Fg.-Mg. sandstone, carbonaceous, shale and coal seams

gross lithological similarity with that of "Kamthi Group" described by Blanford (1868) and Hughes (1877) and later on by others, both in adjacent Wardha Valley as well as Mahanadi Basin.

This topmost unit shows lithological similarity to the Supra-Panchet/Mahadeva Formations. Now Subramanian, 1962 (in Raja Rao, 1982) and Chakraborty *et al.*, 1967 (in Raja Rao, 1982) appears to be more correct by classifying the post Barakar sequence in Talcher Coalfield into Raniganj, Panchet and Mahadeva Formations. The palynological data in bore core TCW-6 and TP-8 (Tiwari *et al.*, 1991; Tripathi, 1996) from Talcher Coalfield also shows presence of Raniganj and Panchet palynoflora.

Sah and Shingte (1996) have described the lithological succession in Kamptee Basin in which the litho-unit of Kamthi Formation compares the Upper Member of Kamthi Formation in Godavari Graben. However, they consider it to be Late Permian in age. Brown coloured, ferruginous fine to coarse-grained and gritty sandstone and yellow clay sequence represents the Kamthi Formation (*sensu* Ramanamurty & Madhusudan Rao, 1996; *sensu* Jha & Srivastava, 1996) and should be Triassic in age. However, the subsurface data from bore core DGW-6 (Srivastava & Bhattacharyya, 1996) suggest a complete sequence comparable to that of Godavari Graben. The palynological succession in this bore core also shows resemblance with the palynoflora of Raniganj and Kamthi Formations of Godavari Graben.

Consequent upon the identification of strata equivalent to Raniganj Formation, the sediments overlying the Raniganj Formation and underlying the Yerrapalli Formation in Godavari Graben are therefore, referred to as 'Kamthi Formation'. The lithological setup of Kamthi Formation does not exactly matches with that of Panchet Formation of Damodar Valley, hence the name 'Kamthi' has been retained to represent Early Triassic strata in Wardha-Godavari, Kamptee and Mahanadi Basins.

PALYNOSEQUENCE

A number of bore cores drilled across the Kamthi Formation (sensu Raja Rao, 1982) have been studied palynologically in Godavari (Srivastava & Jha, 1988, 1990, 1992a, 1992b, 1995), Kothagudem and Chintalpudi (Srivastava & Jha, 1993, 1994) sub-

Table 4—Lithostratigraphic status of Kamthi Formation in Godavari Graben

Ramanamurty & Madhusudan Rao 1987	1996			Raja Rao (1982)		Jha & Srivastava (1996)		Lithology
Ferruginous sandstone with subordinate siltstone, claybands forming hill ranges	KAMTHI	KAMTHI	UPPER MEMBER	KAMTHI	UPPER MEMBER (400 m)	KAMTHI	UPPER MEMBER = SUPRA PANCHET/ MAHADEVA (400 m)	Ferruginous sandstone with subordinate siltstone and clay bands
Alternating sequence of red/ brown sandy calcareous clay and coarse bedded sandstone	PANCHET		LOWER MEMBER		MIDDLE MEMBER (1000 m)		LOWER MEMBER = PANCHET FORMATION (500 m)	Red-brown sandy calcareous clays and cross bedded sandstone
Greyish white to greenish grey sandstone, grey shale/clay with carbonaceous matter	RANIGANJ	UPPER						Greenish grey, shale and sandstone
Coarse sandstone with subordinate shales and coal seams		LOWER			LOWER MEMBER (200 m)		= RANIGANJ FORMATION (700 m)	Coarse sandstone, grey shale, clays and coal seam

basins, Wardha Valley, Kamptee Coalfield (Srivastava & Bhattacharyya, 1996) and Mahanadi Valley (Tiwari, Tripathi & Jana, 1991; Tripathi, 1997). The palynoassemblages in different basins have been summarised in Table 5.

Ten distinct palynoassemblages have been recognised in the succession above the Barren Measures and below the Upper Member of Kamthi Formation (*sensu* Jha & Srivastava, 1996). These palynoassemblages can be categorised under two groups; the older group dominated by striate disaccates (assemblages 1-6 from bottom) belongs to Late Permian and is recorded in Raniganj Formation having grey shales, sandstone, carbonaceous shale and coal seams. The younger group having taeniate, non-striate disaccate pollen and cingulate cavate spores (assemblage 7-10) belongs to Early Triassic and is identified in greenish grey shale and sandstone sequence of the Lower Member of Kamthi Formation. Red ferruginous sandstone/siltstone of Upper Member do not yield palynofossils.

No published palynological record from Kamthi Formation of Kothagudem sub-basin exists till date. However, recently dominance of striate disaccates chiefly *Faunipollenites* and *Striatopodocarpites* and low percentage of some stratigraphically significant taxa, viz., *Lunatisporites, Guttulapollenites, Corisaccites, Chordasporites, Weylandites* and *Falcisporites,* indicating Late Permian (Raniganj) affinity, has been recorded in carb shale-coal sequence of bore core MKD-25 from Kothagudem area.

An Early Triassic palynoassemblage containing *Falcisporites* and *Playfordiaspora* alongwith *Goubinispora, Klausipollenites, Lunatisporites, Rajmahalispora, Callialasporites, Densoisporites, Chordasporites, Weylandites, Hamiapollenites, Crescentipollenites* and *Lundbladispora* has been recorded from Krishnavaram area of Chintalpudi sub-basin (Srivastava *et al.*, MS). Similarly in Mahanadi Basin Permian palynoassemblages (*Striatopodocarpites-Faunipollenites* assemblage and *Striatopodocarpites-Densipollenites* assemblage) have been recorded in compact grey shale-coal sequence in bore-core TP-8, Talcher Coalfield (Tripathi, 1996). In this bore core also the Early Triassic palynoassemblage marked by *Striatopodocarpites* + *Lundbladispora* associated with *Playfordiaspora, Lunatisporites, Alsophyllidites, Goubinispora, Densoisporites,*

Table 5—Permian-Triassic palynoassemblages in Godavari, Wardha, Kamptee and Mahanadi basins. (A) indicates *sensu* Raja Rao (1982), and (B) *sensu* Jha and Srivastava (1996) and Ramanamurty and Madhusudan Rao (1996). Fauni. = *Faunipollenites*; Striatopodo. = *Striatopodocarpites*; Cori. = *Corisaccites*; Guttula. = *Guttulapollenites*; Falci. = *Falcisporites;* Striates= Striate disaccates

AGE	A	B	ASSEMBLAGE	GODAVARI GRABEN			WARDHA	KAMPTEE	MAHANADI		LITHOLOGY
				GODAVARI	KOTHAGUDEM	CHINTALPUDI			Ib River	Talcher	
E. TRIASSIC	MEMBER	KAMTHI (LOWER)	10. *Lundbladispora* + *Densoisporites*	* * *						*Striatopodocarpites Lundbladispora*	Greenish grey clay/shale intercalated in sandstone
			9. *Lunatisporites* + *Verrucosisporites*	* * *						*Striatopodocarpites Lunatisporites*	
			8. Striates + *Callumispora*				* * *				
			7. Striates + *Falcisporites* + *Playflordiaspora*			* * *		* * *			
PERMIAN	MIDDLE	RANIGANJ	6. *Striatopodocarpites Corisaccites* + *Guttulapollenites*	* * *							Grey shale, sandstone, carb. shale and coal seam sequence
			5. *Striatopodocarpites* + *Crescentipollenites*	* * *			* * *	* * *		* * *	
			4. *Striatopodocarpites Densipollenites*	* * *	* * *	* * *		* * *		* * *	
	LOWER		3. *Striatopodocarpites Parasaccites*	* * *							
			2. *Faunipollenites Striasulcites*	* * *	* * *	* * *				Striates + *Gondisporites*	
			1. *Faunipollenites Striatopodocarpites*	* * *	* * *	* * *			* * *		

Cyathidites, Concavissimisporites, Foveotriletes, Guttatisporites, Polycingulatisporites has been recorded in greenish sandstone overlying grey shale-coal sequence.

Remarks—The dominance of striate disaccate pollen has been observed in Late Permian palynosequence in other basins in India as well other Gondwana continents. Taeniate, non-striate disaccates and cingulate cavate spores mark the onset of Triassic. This palynofloral transition is clearly observed in Mailaram, Budharam and Krishnavaram areas of Godavari Graben, Bazargaon area of Kamptee Coalfield and in Talcher Coalfield of Mahanadi Basin.

Table 6

Plant Fossils	Area	Horizon/ Lithology	Reference
1. *Vertebraria, Glossopteris* & *Phyllotheca*	Chintalpudi sub-basin	Upper Member of Kamthi Formation siltstone & pinkish or red claystone unit associated with grey and buff sandstone	King (1881), Lakshminarayana & Murty (1990)
2. Fragmentary plant fossils resembling *Ptilophyllum*	Jaipuram	Upper Member pinkish shale/clay	Nageshwar Rao in Raja Rao, (1982)
3. *Alethopteris* spp. and *Pterophyllum* spp.	Godavari	—	Maheshwari (1992)

MEGAFLORAL EVIDENCES

Godavari Graben

Megaflora records from Kamthi Formation of Godavari Graben are very rare and have been summarised in Table 6.

Wardha and Kamptee Coalfields

Bunbury (1861) recorded megafossils from the Kamthi beds from Nagpur area which included *Phyllotheca, Cladophlebis, Pecopteris, Glossopteris, Taeniopteris, Noeggerathia* and *Vertebraria*. Besides,

a large number of Permian taxa were reported from similar beds near Chanda (Feistmantel, 1881; Agashe *et al.*, 1984), Nagpur (Hughes, 1877) and Kamptee area (Feistmantel, 1881). Chandra and Prasad (1981) have also recorded plant fossils from hard, compact ferruginous sandstone, buff purple and grey coloured coarse sandstone unit in Kanhargaon in Wardha Valley coalfields and Bazargaon area near Nagpur.

Mahanadi Basin

Ball (1877) first described plant fossils of the Kamthi beds from Mahanadi Basin. Subramanian and Rao (1960), Surange and Maheshwari (1970), Surange and Chandra (1975), and Chandra and Singh (1992) described plant fossils rich in *Glossopteris* from Handapa beds. Khan (1969) described *Senia reticulata* from Hinjrida Ghati section north of Handapa in Talcher Coalfield and treated these beds as equivalent to Raniganj Formation.

Pal *et al.* (1991) have recorded *Lepidopteris* and *Dicroidium* in addition to *Glossopteris* and *Neomariopteris* from Sarimunda Hill and a *Dicroidium* rich flora along with *Lepidopteris*, *Yabiella*, *Desmiophyllum* from locality near Pathargarh in Talcher Coalfield. They considered these beds equivalent to the Upper Member of Kamthi Formation and assigned Late Triassic age. *Dicroidium* is also reported from Talcher Coalfield (Coal Wing News 9(1) : 24) and Ib-River Coalfield (Mukhopadhyay & Paul, 1989; Chowdhury *et al.*, 1991) in pale brown shale band and red claystone and shale bed at the top of Kamthi successions. *Podozamites* associated with *Schizoneura gondwanensis* and *Phyllotheca* is recorded in red claystone bed of Kamthi Formation around Punjipathra area in Raigarh Coalfield (Chakraborty & Sengupta, 1995).

Remarks—It is usually considered that Glossopteris flora is an important age (Permian) indicator for the essentially nonmarine Lower Gondwana sequence. In view of the presence of *Glossopteris, Phyllotheca* and *Vertebraria,* etc., the Kamthi Formation was assigned to Late Permian in age. However, *Glossopteris* species continue to occur in Triassic also. The presence of *Glossopteris* along with *Lepidopteris* and *Dicroidium* has been recorded from equivalent beds near Sarimunda Hills close to Handapa (Pal *et al.*, 1991), and dated as Triassic. *Glossopteris angustifolia, G. browniana, G. communis, G.gopadensis, G. nidpurensis, G. retifera,* are known from Triassic sediments also. So the presence of Glossopteris in Kamthi Formation (Early Triassic) shows only the continuation of Permian flora into the Triassic. *Glossopteris* has also been recorded from Mahadevas of Auranga Coalfield (Ball, 1880), from Upper Member of Kamthi Formation in Godavari Graben (King 1881; Lakshminarayana & Murty, 1990), in Kamthi area (Feistmantel, 1881); and in Wardha Valley (Chandra & Prasad, 1981). In Mangli beds of Wardha Valley *Glossopteris* occurs along with *Estheria* (Tasch *et al.*, 1975). *Handapa* beds which are lithologically similar to Upper Member of Kamthi Formation contain a rich Glossopteris flora. About 50 per cent of the *Glossopteris* species known from Triassic of India are recorded in Handapa beds.

Dicroidium odontopteroides, D. dubium, D. dubium var. *hingirienstis* recorded from pale brown shale band (Chowdhury *et al.*, 1991), *Dicroidium* sp. (Pal *et al.*, 1991) in Talchir Coalfield and *Dicroidium* sp. from red claystone, shale bed of Upper Member of Kamthi Formation in Ib-River (Mukhopadhyay & Pal, 1989) suggest Early Triassic age for these beds.

The Kamthi sediments from clay quarries near Bazargaon (Chandra & Prasad, 1981; Kulkarni & Parmane, 1991) having plant fossils in all probability belong to the Upper Member of the Kamthi Formation. The authors have assigned Late Permian age to Kamthi sediments on the basis of plant fossil assemblage but in view of the order of superposition the Kamthi Formation is considered to represent Early Triassic.

DISCUSSION

The status of the Kamthi Formation has been debated ever since on the basis of the fossil contents and its age was considered to be Permian/ Triassic or Permian-Triassic.

Recent studies mainly from the sub-surface have allowed to classify the Kamthi Group of King, into Barren Measures (450 ± 50 m), Raniganj Formation (650 ± 50 m) and Kamthi Formation (Lower Member 500-600 m and Upper Member 450 ± 50 m), in order of superposition (Ramanamurthy & Madhusudan Rao, 1996). This classification is largely based on

lithological characteristics and mineral contents. It has been further modified through palynological studies and minor readjustment in the thickness of Lower Member has been suggested (Srivastava & Jha 1996). In sub-surface studies these sequences have been identified in bore hole GAM-7 from Mailaram area, bore-hole GBR-7 from Budharam area in Godavari Graben, bore-hole DGW-6 from Bazargaon near Nagpur, bore-hole MWCK-2 in Wardha Basin and bore-hole TCW-6 in Talchir Coalfield.

The Lower Member of Kamthi sediments (*sensu* Jha & Srivastava, 1996) in the above mentioned bore cores have revealed the presence of Panchet equivalent palynoflora. This sequence represents the Early Triassic (=Scythian) in Wardha-Godavari (Jha & Srivastava, 1996); Kamptee (Srivastava & Bhattacharyya, 1996) and Mahanadi basins (Tripathi, 1996).

The Upper Member of the Kamthi Formation in Godavari Graben compares closely with the rocks exposed in the type area near Kamthi. This member often gives rise to prominent topographic features in Wardha-Godavari and Mahanadi basins and shows overlapping nature with the underlying beds. This unit lithologically fits with the "Kamthi" strata often described by earlier workers like Blanford, Hughes and King.

The plant fossils described so far from Wardha Valley (Bunbury, 1861), Bazargaon area (Chandra & Prasad, 1981), Mahanadi (Chandra & Singh, 1992; Pal *et al.*, 1991) belong to this Upper Member of the Kamthi Formation.

It is very much desirable that similar such bore-holes are required to be drilled at shallower depths on the margin of Kamthi ridge in east of Jaipuram and west of Bhimaram Village in Godavari Graben and also east of Handapa or Madhupur in Talcher Coalfield in order to solve the stratigraphic status of the Kamthi Formation.

REFERENCES

Agashe SN, Gowda, PRN, Suresh FC & Geetha KR 1984. Recent advances in the palaeobotanical studies on Lower Gondwana strata of Chandrapur District, Maharashtra. *In* : Sharma AK *et. al* (Editors)—*Proc. Symp. Evolutionary botany and biostratigraphy, Calcutta 1979, A.K. Ghosh Commen. Vol., Curr. Trends Life Sci.* : 369-382.

Ball V 1877. On the geology of Mahanadi Basin and its vicinity. *Rec. geol. Surv. India* **10**(4) : 167-185.

Ball V 1880. On the Auranga and Hutar Coalfields and the iron ores of Palamow and Toree. *Mem. geol. Surv. India* **15**(1) : 1-127.

Blanford WT 1868. Coal near Nagpur. *Rec. geol. Surv. India* **22**(2) : 23-54.

Blanford WT 1872. On the description of geology of Nagpur and its neighbourhood. *Mem. geol. Surv. India* **9**(2) : 295-358.

Bunbury CJF 1861. Notes on a collection of fossil plants from Nagpur, central India. *Q. Jl geol. Soc. London* **17** : 325-346.

Chakraborty B & Sengupta S 1995. New fossil find. *Coal Wing News* **14**(2) & **15**(1) : 24.

Chakraborty SN, Das SN & Banerjee SP 1967. Final report on inves tigation by drilling in the central part of Talcher Coalfield, Orissa. *Unpublished Report. Geological Survey of India. In* : Raja Rao 1982.

Chandra S & Prasad MNV 1981. Fossil plants from the Kamthi Formation of Maharashtra and their biostratigraphic significance. *Palaeobotanist* **28-29** : 99-121.

Chandra S & Singh KJ 1992. The genus *Glossopteris* from the Late Permian beds of Handapa, Orissa, India. *Rev. Palaeobot. Palynol.* **75** : 183-218.

Chowdhury PN, Bose S & Pal AK 1991. A Middle Triassic age for the Kamthi Formation of Lower Gondwana, Ib River Basin, Orissa : New Palaeobotanical evidence. *Coal Wing News* **11**(1) : 12.

Feistmantel O 1881. The fossil flora of the Gondwana System. The flora of the Damuda and Panchet divisions. *Mem. geol. Surv. India Palaeont. indica*, ser. **12**(3): 1-149.

Hughes TWH 1877. The Wardha Valley coalfields. *Mem. geol. Surv. India* **13**(1) : 1-154.

Jha N & Srivastava SC 1996. Kamthi Formation - Palynofloral diversity. In : Guha PK *et al.* (Editors)—*Gondwana Nine* **1** : 355-368. Hindustan Publ. Co., New Delhi.

Khan AM 1969. *Senia reticulata*, a new plant fossil from the Raniganj rocks of the Talcher Coalfield, Orissa, India. *In* : Santapau H *et al.* (Editors)—*J. Sen Mem. Vol.* : 335-337. Bot. Soc. Bengal, Calcutta.

King W 1881. The geology of Pranhita-Godavari Valley. *Mem. geol Surv. India* **18**(3) : 150-311.

Kulkarni KM & Parmane PV 1991. Two pteridophytic fronds from Kamthi Formation, Bazargaon, district Nagpur, Maharashtra, India. *Birbal Sahni Birth Centenary Palaeobotanical Conference, Lucknow* : 72 (Abstract).

Kutty TS, Jain SL & Roy Chowdhury T 1988. Gondwana sequence of the northern Pranhita Godavari Valley: its stratigraphy and vertebrate faunas. *In* : Venkatachala BS & Maheshwari HK (Editors)—*Concepts, limits and extension of Indian Gondwana. Palaeobotanist* **36** : 214-229

Lakshminarayana G & Murty KS 1990. Stratigraphy of the Gondwana formations in the Chintalpudi sub-basin, Godavari Valley, Andhra Pradesh. *J. geol. Soc. India* **36**(1) : 13-25.

Maheshwari HK 1992. Provincialism in Gondwana floras. *Palaeobotanist* **40**: 101-127.

Mukhopadhyay SK & Pal AK 1989. Records of *Dicroidium* sp. from Ib-River and ichnofossils from South Karanpura, Auranga and Raniganj basins. *Coal Wing News* **9**(2) : 8.

Pal PK, Chakraborty U, Ghosh AK & Ghosh A 1991. Triassic plant megafossils from the Kamthi Formation of Talchir Coalfield, India—a new report. *Indian J. Geol.* **63**(2) : 119-125.

Pandey BC 1988. Kamthi—a new concept. *In* : Venkatachala BS & Maheshwari HK (Editors)—*Concepts, limits and extension of Indian Gondwana. Palaeobotanist* **36** : 51-57.

Raja Rao CS 1982. Coalfields of India-2. Coal resources of Tamil Nadu, Andhra Pradesh, Orissa and Maharashtra. *Geol. Surv. India. Bull.* ser. A **45** : 9-40.

Ramanamurty BV & Madhusudan Rao C 1987. A new classification of Lower Gondwana (Permian) lithostratigraphy of Ramagundam area, Godavari Valley Coalfield, Andhra Pradesh. *In* : Singh RM (Editor)—*Proc. Nat. Sem. Coal Resources India 1986* : 112-120. Banaras Hindu University, Varanasi.

Ramanamurty BV & Madhusudan Rao C 1996. A new lithostratigraphic classification of Permian (Lower Gondwana) succession of Pranhita - Godavari Basin with special reference to Ramagundam coalbelt, Andhra Pradesh, India.*In* : Guha PK *et al.* (Editors)—*Gondwana Nine.* **1** : 67-78. Hindustan Publ. Co., New Delhi.

Sah R & Shingte SK 1996. Depositional history of Kamptee Basin, northern part of Pranhita-Godavari Valley Graben, Maharashtra, India. *In* : Guha PK et al. (Editors)-*Gondwana Nine.***1** : 723-735. Hindustan Publ. Co., New Delhi.

Sengupta S 1970. Gondwana sedimentation around Bheemaram (Bhimaram), Pranhita-Godavari Valley, India. *J. Sed. Petrol.* **40** : 140-170.

Srivastava SC & Bhattacharyya AP 1996. Permian-Triassic palynofloral succession in sub-surface from Bazargaon, Nagpur District, Maharashtra. *Palaeobotanist* **43**(2) : 10-15.

Srivastava SC, De B, Jha N & Ganguli B (MS). "A Triassic palynoflora from Krishnavaram Area, Chintalpudi sub-basin". *In* : *National Seminar on recent advances in geology of coal and lignite basins of India*, at G.S.I. Calcutta, November, 1997.

Srivastava SC & Jha N 1988. Palynology of Kamthi Formation in Godavari Graben. *In* : Venkatachala BS & Maheshwari HK (Editors)—*Concepts, limits and extension of Indian Gondwana. Palaeobotanist* **36** : 123-132.

Srivastava SC & Jha N 1990. Permian-Triassic palynofloral transition in Godavari Graben, Andhra Pradesh. *In* : Jain KP & Tiwari RS (Editors)—*Vistas in Indian palaeobotany. Palaeobotanist* **38** : 92-97.

Srivastava SC & Jha N 1992a. Permian palynostratigraphy in Ramakrishna puram area, Godavari Graben, Andhra Pradesh, India. *Geophytology* **20**(2) : 83-95.

Srivastava SC & Jha N 1992b. Palynostratigraphy of Permian sediments in Manuguru area, Godavari Graben, Andhra Pradesh. *Geophytology* **22** : 103-110.

Srivastava SC & Jha N 1993. Palynostratigraphy of Lower Gondwana sediments in Chintalpudi sub-basin, Godavari Graben, Andhra Pradesh, India. *Geophytology* **23**(1) : 93-98.

Srivastava SC & Jha N 1994. Palynological dating of Lower Gondwana sediments in Sattupalli area, Chintalpudi sub-basin, Andhra Pradesh, India, *Palaeobotanist* **42**(2) : 169-173

Srivastava SC & Jha N 1995. Palynostratigraphy and correlation of Permian-Triassic sediment in Budharam area, Godavari Graben, India. *J. geol. Soc. India* **46** : 647-653.

Subramanian KS 1962. Progress Report on the geological mapping of the Talchir Coalfield, Orissa. *Unpublished report*, Geological Survey of India. *In* : Raja Rao (1982).

Subramanian KS & Rao CN 1960. *Glossopteris* from Mahadevas of Hingrida, Talcher Coalfield, Orissa. *Proc. 47th Indian Sci. Congr. Bombay* part 3 (Abstract) : 278.

Surange KR & Chandra S 1975. Morphology of the gymnospermous fructifications of the Glossopteris flora and their relationship. *Palaeontographica* **B149** : 153-180.

Surange KR & Maheshwari HK 1970. Some male and female fructifications of Glossopteridales from India. *Palaeontographica* **B129** : 178-192.

Tasch P, Sastry MVA, Ghosh SC, Rao BRJ, Rao CN & Shah SC 1975. Indian Gondwana Estheriids and significance of continental fit. *In* : Campbell KSW (Editor)—*Gondwana, Geology 3rd Int. Symp. Gondw. Stratigr.* : 443-452. Canberra, Australia.

Tiwari RS, Tripathi A & Jana BN 1991. Palynological evidence for Upper Permian Raniganj coals in western part of Talcher Coalfield, Orissa, India. *Curr. Sci.* **61**(6) : 407-420.

Tripathi A 1996. Early and Late Triassic palynoassemblage from subsurface Supra-Barakar sequence in Talcher Coalfield, Orissa, India. *Geophytology* **26**(1) : 109-118.