

## Kamthi—a new concept

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King had described 'Kamthi beds' as the group of rocks disconformably overlapping the Permian coal measures in an otherwise extremely soil covered areas in the Wardha Godavari Graben. Some of the later workers while projecting on the surface the lithics encountered in the sub-surface drilling in the Godavari Valley Coalfield subdivided these beds into lower, middle and upper horizons, by considering them to have gradational contacts, to account for the biota revealed from these litho-units.

A reappraisal of the basic geoscientific data base (geological and geophysical) and the interpretations from the surface and the sub-surface lithics have undisputedly shown that the pattern of Gondwana sedimentation in the Godavari Valley, during the Palaeozoic and Mesozoic periods, has been in an oscillating and continental fluvial regime governed by the basin configuration and palaeodrainage inter-related to their development in time and space.

The palynofossil content unequivocally proves the presence of the Upper Permian lithics lying buried under the Lower Triassic (Kamthi) sediments. The latter having a widespread expanse in the graben, from the northwest to the southeast, which is believed to be due to the further deepening of the basin floor at the time of their sedimentation.

The possibility of Kamthi constituting the basal part of the enlarged Maleri sequence of the Triassic lithics is very much indicated thereby defining the base of the Triassic in the Godavari Graben. It is, thus, considered undisputed that the Kamthi is nothing more than a concept in the geological history of this part of the Godavari Graben which is defined by its mode of occurrence as governed by the associated tectonism.

**Key-words**—Stratigraphy, Lithology, Tectonism, Kamthi Formation, Godavari Valley (India).

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### सारांश

कामथी—एक नवीन अवधारणा

बी० सी० पान्डे

किंग ने चट्टानों के उस समूह को जो कि वर्धा-गोदावरी द्रोणिका में अत्यधिक मिट्टी से ढके क्षेत्रों में परमी युगीन कोयला संस्तरों के ऊपर असमान रूप से विद्यमान था 'कामथी संस्तर' नाम दिया। बाद में कुछ शोध-कर्त्ताओं ने इन संस्तरों को क्रमिक संपर्श तथा जीविता के आधार पर अधरि, मध्य एवं उपरि संस्तरों में विभक्त किया। मूलभूत भूवैज्ञानिक एवं भूभौतिकीय आँकड़ों की पुनः समीक्षा से तथा सतही एवं उपसतही शैलों की व्याख्या से यह निस्संदेह व्यक्त हुआ है कि पुराजीवी एवं मध्यजीवी कल्प में गोदावरी घाटी में गोंडवाना अवसादन अस्थिर एवं नदीय काल में हुआ है तथा इसमें द्रोणी के आकार एवं पूराजलप्रणाली की विशेष भूमिका रही है। उपलब्ध परागाणुओं की मात्रा से अधरि त्रिसंधी (कामथी) अवसादों के नीचे दबी उपरि परमी शैलों की उपस्थिति स्पष्ट रूप से सिद्ध हो जाती है। अधरि त्रिसंधी अवसाद इस द्रोणी में उत्तर-पश्चिम से दक्षिण-पूर्व तक बृहत् रूप से विकसित थे और ऐसा अनुमान है कि इनका इतना विस्तार इनके अवसादन के समय घाटी की अधिक गहराई बढ़ जाने के कारण हुआ। इस प्रकार निस्संदेह यह प्रस्तावित किया गया है कि गोदावरी द्रोणिका के इस भाग के भूवैज्ञानिक इतिहास में कामथी एक अवधारणा के अतिरिक्त कुछ अधिक नहीं है जिसमें सहयुक्त विवर्तनिकता की सक्रिय भूमिका रही है।

IN the paper on "Kamthi—a new concept" let it be understood that the matter is not as new as it might appear to be speculating. Yet it carves a new dimension emboldened by the data base evidence and thus lends support to what the originator had perhaps intended when he proposed it.

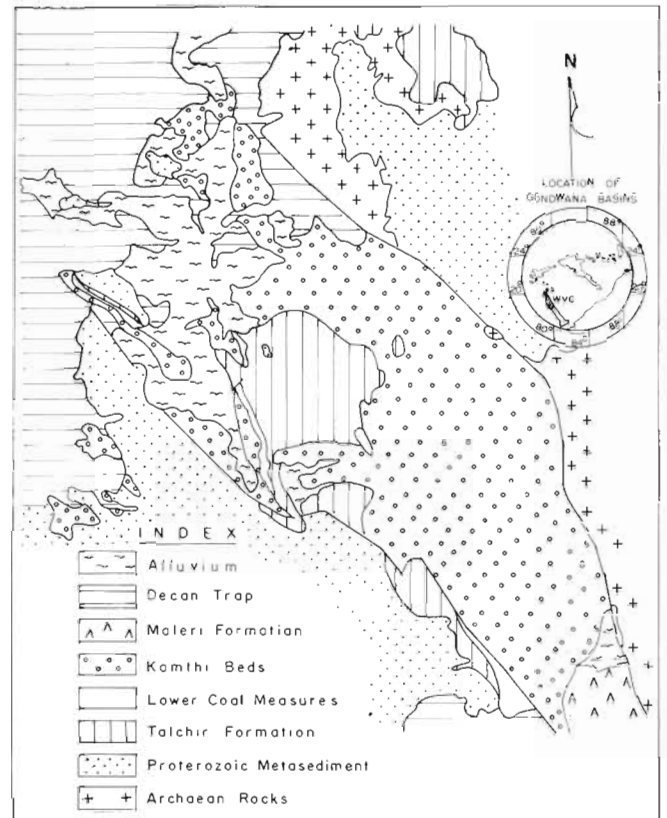
Many controversies have arisen when the available data base has been placed in the geological time frame based on vaguely defined standards. Such a synthesis has often presented an ambiguous picture and one such area is the 'Kamthi' in the stratigraphy of the Godavari Graben.

Though 'Kamthi' may not encompass connotation in a broader perspective yet it does highlight the regional problem which may have a bearing on a much wider plane, particularly when this term is being used increasingly to define the undifferentiated Gondwana lithics in other basins also. It is, therefore, essential to have the proper understanding of the facts which controvert the widely believed conception and it is better to look back to the original description of the Kamthi beds.

*King's view*—King (1881) described "Kamthi Beds" as the group of rocks which disconformably overlap the Permian coal measures in the Pranhita-Godavari-Graben and assigned them an Upper Permian to Lower Triassic age. These beds were considered peculiar in their geological and structural relationship with the underlying rocks in the litho-sequence. It is in this state that these beds were differentiated from the rocks otherwise known from the Kamptee Coalfield.

*Fox's view*—Fox (1934) identified a number of coalfields within this master basin based on the scantily scattered exposures of the coal-bearing rocks and named them after the locality where they occurred, viz., Bandar Coalfield, Warora Coalfield, Chanda Coalfield, Tandur Coalfield, etc. The coal in these coalfields was stated to be lying buried under the cover of the younger Kamthi sediments which were found to be water-bearing and any mining planned through a pair of inclines was with heavy cost on the pumping. Furthermore, coal being of inferior quality, it could not attract much attention in the market for the run off mining cost far exceeded prevalent sale price of the coal

*Later views*—Later workers of GSI (1960-66), while examining the potentiality of this master basin for regional sub-surface exploration by drilling to prove new mine blocks, came to the conclusion that these isolated coal measures, as a matter of fact, continue underneath the younger sediments, both along their strike and along the dip. It is then, that the concept of the existence of the master graben came to be established.



**Text-figure 1**—Geological map of Wardha Valley Coalfield, Maharashtra.

With the progressive accumulation of the sub-surface data some of which had been sporadically analysed palynologically an attempt was made to project the data base on the otherwise densely covered terrain from the bore-holes.

Consequently, what resulted was the subdivision of the Kamthi into three litho-stratigraphic units, named as the 'Lower (cf. Raniganj)' the 'Middle' (cf. Lower Panchet) and the 'Upper' unit, conformably lying one over the other in an ascending order and with gradational contacts between them. This sequence was further believed to be resting over the unit, designated as the "Barren Measures", which overlies the coal-bearing Barakars in the Godavari Sub-basin, again with a gradational contact.

The Godavari Sub-basin constitutes only a part of the larger Pranhita-Godavari Graben and in the other sub-basins 'Kamthi' sediments continued to be believed to be resting with an angular disconformity over the underlying coal measures. In order to conceive it in the way it had been projected the question arises as to when and how such a mode of sedimentation is possible? As is well known, in a gradational contact the beds rest one over the other in an undisturbed sequence in terms of time and space. On the other hand, in an overlap the older

beds lie buried under the cover of the younger sediments representing the time transgression.

The controversy, thus, created by the assumption of a gradational contact in the Lower Gondwana lithosequence in a restricted part of the graben as against the disconformable angular overlap widely believed in the remaining part of the graben has necessitated a relook at the facts bringing the contradictions in the basic concept.

It was also essential because charged to locate new shallow blocks for mining by the corporate body of the public sector it had become essential that the subsurface drilling be conducted in the identified areas where coal can be proved at shallower depths. But while executing the operations, based on the assumptions as outlined above, it was found that most often the surface geological maps prepared largely on the soil covered terrains were hardly conducive to match the requirement. While some bore-holes were passing through the basal lithics with no coal, the others were getting closed much above in the sequence without touching the coal seams. It was, therefore, essential that the data base had to be reassessed and processed thoroughly before embarking on any prognostication.

### PERMIAN LITHOSTRATIGRAPHY

As a result, it was found that the Permian lithic content comprises :

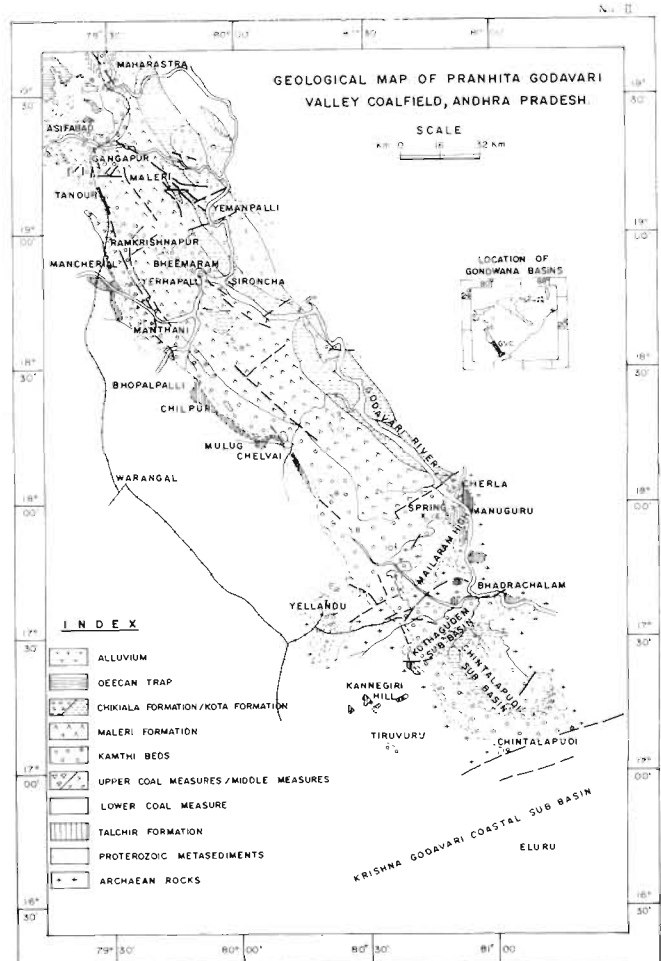
1. Talchir and basal Lower Coal Measure (dipping 18° to 20°), overlapped by younger sediments with dips 8° to 10° on the surface geological outcrop maps (Text-figs 1, 2).

2. Younger Lower Coal Measure beds with coal seam; rock sequence with no thicker coal zone (now designated : Middle Measures) and the Upper Coal Measures (being yet another coal-bearing horizon higher up in the sequence), encountered only in the sub-surface. These do not show in any outcrop except in the river section in the Ramagundem area, where they are exposed due to the 'V' erosion of the younger formation by the rivers Godavari and Maner. The alluvial cover, in a recent survey conducted by NGRI in this area, had been found to be around 120 m (Personal communication).

A close look at the lithic pile encountered in the bore-holes shows :

(a) Lower coal-bearing rocks having two types of facies :

i) Basal facies which is predominantly a coarse grit, 90 to 120 m in thickness, with few shale/carbonaceous shale bands.



**Text-figure 2**—Geological map of Pranhita-Godavari Valley Coalfield, Andhra Pradesh.

ii) Top facies, 150-250 m thick, with lithics exhibiting fining upward cycle and bearing a number of coal seams.

(b) The sediments of Middle Measures include medium to coarse-grained sandstones interbedded with shales and clays. The pale green colour, so characteristic of them, is generally dominating in the middle part.

(c) The Upper Coal Measures again consist of the two lithofacies :

i) The lower 200 m which includes a 20 m thick coal and shale intermixed seam along with the six other thin coal seam/bands stratified with the medium-grained felspathic sandstone, clays, shale and carbonaceous shale.

ii) The upper 600 m thick stratified sequence of sandstones, shale and clays of variegated colours between grey, white, mauve, pale green and grey, the latter colours pre-dominating higher up in the succession. The argillaceous content, however, is relatively more in proportion in the sequence of the Upper Coal Measures.

**Table 1—Palaeogeographic and palaeoclimatic distribution (Mesozoic) in Godavari Graben**

Geographic Location	Lower elevation	Lower to medium elevation	Higher elevation	Medium elevation	Coastal
Ecology	Landform Dinosaurs	Aquatic Reptiles	No fauna	Dwarfed fauna (?)	Marine & fresh water (mixed)
Fauna	Dominant	Dominant			
Flora	Evergreen type vegetation	Mediterranean type vegetation	Alpine type vegetation	Coniferous type vegetation	Coastal type vegetation
Palaeoclimate	Humid warm	Warm & cold alternate	Cold	Cold dry	Coastal humid

### BIOTA CONTENT

The biota worked out by the Birbal Sahn Institute of Palaeobotany shows :

A. Lower Coal Measure beds have three palynozones (2 to 4) comparable to the Lower and Upper Karharbari and Lower Barakar. The Upper Barakar biota is strikingly missing.

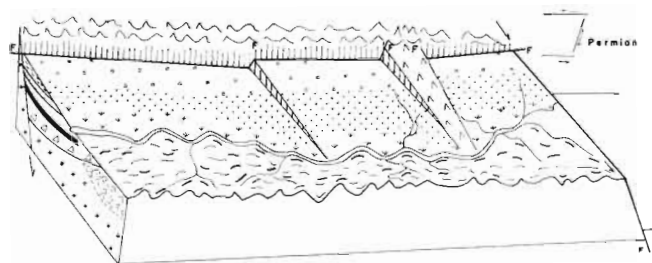
B. Middle Measure biota is correlatable to the floral assemblage of Barren Measures of the type area.

C. In the Upper Coal Measure the basal litho-units show palynoflora of the Lower Raniganj affinity and the upper lithics mark close similarity to the Upper Raniganj and Lower Panchet beds of Raniganj Coalfield.

The youngest palynozone, however, contains some Triassic elements which show proximity of the beds to the Upper Permian and Lower Triassic transition. Any bed disconformably overlying these beds by reason of its superposition, therefore, must have to be younger in age.

The characteristic features noted in the Permian lithic, thus, are :

1. The Basal Barakar has only linear exposures at the fringes.
2. Inliers of the older meta-sediments (Proterozoic) are present at some of the locales along the central axis indicating a basement high.



**Text-figure 3**—Schematic diagram, Stage 1 : Permian.

3.(a) Coal is found in two horizons with a no thicker coal zone in between them.

(b) Coal in the lower horizon is of economically viable thickness and is comparatively free of the dirt bands than that found in the upper horizons where it is intimately intermixed with the shale.

4. There is evidence to prove that the *pari passu* deposition of the lithics has been controlled by the periodical activation of the marginal faults and the cross faults.

5.(a) The sedimentation has been in two longitudinal basins separated by a mid-longitudinal ridge remnants of which are still found on the surface peeping through the cover of the younger rocks.

(b) The basin configuration, as revealed by the Bouger anomaly maps of the ONGC, also corroborates the tectonic frame-work of the Permian beds.

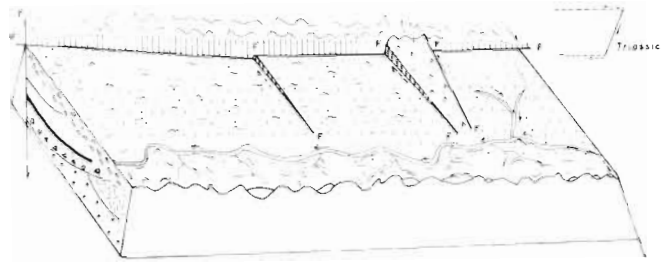
### KAMTHI BASIN

Kamthi sediments, on the other hand, show a much wider expanse for deposition from the north-west to the south-east. The entire graben is also interconnected by these sediments for they are found at the same horizon in all the coalfields. This, perhaps, is as a result of the activation along the marginal faults controlling the sedimentation which further deepened the depositional floor. As a result, the younger sediments came to rest not only over the earlier laid sediments but also directly over the basement rocks.

The latter phenomenon is more pronounced along or towards the western margin where undoubtedly it provided an undisturbed uneven palaeo-surface at the time of the sedimentation. The various Lower Gondwana inliers/outliers outside the limits of the coalfields are undisputed examples lending support to such a stipulation.

**Table 2—Facies variation in a part of the Gondwana Sequence in Godavari Valley Coalfield**

			Kota beds	Overlying rocks		
<i>Unconformity</i>						
Upper Gondwana	Upper to Lower Triassic	Maleri Series	Dharma-ram	: essentially a sand stone facies		
			Maleri	: essentially a clay facies		
			Bheema-ram	: essentially a sand-stone facies		
			Yerrapalli	: essentially a clay facies		
		Kamthi	: essentially a sand-stone facies			
<i>Angular overlap</i>						
Lower Gondwana	Upper to Lower Permian	Damuda Series	Upper Coal Measures (cf. Rani-ganj & Lower Panchet)	: essentially sand-stone, shale & clay with interbeds of carbonaceous shale and coal towards the base		
			Middle Coal Measures (cf. Barren Measures)	: essentially sand stone, interbedded with shale, clay and carbonaceous shale		
			Lower Coal Measures (cf. Lower Barakar, Upper and Lower Karhar-bari)	: essentially sand-stone and shale inter-stratified with carbonaceous shale and coal-seams		
			Talchir	: essentially sand-stone, shale and tillites.		
		<i>Unconformity</i>				
		Basement of Proterozoic and Azoic rocks				



**Text-figure 4—Schematic diagram, Stage 2 : Advent of Triassic (Kamthi).**

Goleti coalbelt, Godavari Sub-basin. The coal in the incrop regions has analysed to show it to be oxidised, a position analogous to that found in the present day coal outcrops (Personal communication). It is undoubted, therefore, that this marks the palaeoerosional surface of the coal seam over which the clay sequence has been deposited. The question whether the clay sequence belongs to the Middle Measures (Middle Permian) or still higher up in the sequence, i.e., the clay horizons of the Maleri sequence, is still open.

The sum up, such a wider basinal floor for the deposition in the western side of the graben boundaries reveals that :

- i) The palaeo-floor was much wider over which the Kamthi and younger sequence were deposited.
- ii) The fault contacts now seen along the western contacts of the Gondwana fields are later date phenomena.

The eastern margin, nonetheless, presents a sharp contact. The Upper Gondwana rocks are abutting against it in the Godavari and Chintalpudi sub-basins, the latter being a recent find by the officers of Geological Survey of India (the Southern Region, Personal Communication).

The geothermal manifestation in the Bugga-Manuguru-Parnshila areas close to the eastern marginal fault and the fact that the epicentre of the 1969 Bhadrachalam earthquake, remnants of which are still noticed in the underground workings of Manuguru underground mine, lay near its vicinity are indications that this fault system may still be an active plane.

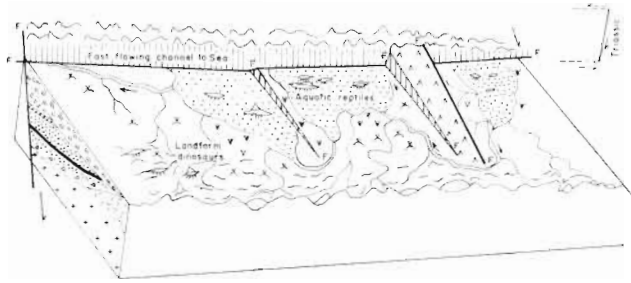
The eastern marginal fault plane had greatly contributed to the pari-passu deposition of the Gondwana lithics. It had been periodically activated so as to mould the depositional floor and it is undisputed that it perhaps is still behaving as an active plane.

**KAMTHI LITHOLOGY**

The Kamthi beds comprise a litho-sequence of medium- to coarse-grained sandstone with low to

The dilemma of the geoscientists, of the Directorate of Geology and Mining, Govt. of Maharashtra, of finding coal under the cover of the younger sediments (Kamthi) further westwards to the realm of the Wardha Valley Coalfield, in the hollows of the Deccan Traps, outlines that the basin floor for these sediments was much wider, particularly in the western side, and covered more lands than is presently exposed. The faulting presently seen, marking the western limits of these lithics, is a later date structural disturbance and is possibly pre-Trappean in age.

Further, a thick sequence of clay lithics (over 170 m) has been reported in the bore-hole drilled by the Singareni Collieries Company Limited, and is found to overlie the Lower Coal Measures in the bore-holes drilled in the Dorli Mining Block in the



**Text-figure 5**—Schematic diagram, Stage 3 : Mesozoic (post-Kamthi).

scanty matrix. They are whitish to pale brownish in colour but at places exhibit ferruginous/calcareous nature. The grain size varies from medium to coarse and cross-bedding structures are invariably observed. The porosity and permeability is such that invariably at depths they constitute a good aquifer zone for developing the artesian conditions. Two of the GSI bore-wells, which showed a head of over 10 m, have been dedicated to the nation and are maintaining a continuous flow of the water.

The basal beds of these sandstones, however, show remarkable similarity to the underlying Barakar feldspathic sandstones possibly due to the latter having provided the immediate provenance for generation of its sediments and often create confusion in the building up of the litho-sequence in the bore-hole. The Kamthi sandstones show interstratification of the intraformational pebble beds and the pebble size is generally very small, hardly ranging above 5 cm. These create lots of problems, while negotiating them, in the sub-surface drilling. The sandstones are interbedded with siltstones, shales and clays. The siltstone beds are ferruginated and very hard. The interbeds are intermittent at the base but become more profuse towards the top. The sandstone, being loose and friable, erodes off easily and the terrain is occupied mostly by the soil or the jungle.

The Kamthi facies exhibit in a single cycle of deposition the ferruginated siltstone/claystone at the base which is overlain by the finer clayey clastics, pale brown ferruginous sandstones and is succeeded towards the top by the medium to coarse grained, cross bedded sandstones, more often ferruginated or calcareous in nature.

The cycle, which shows coarsening upwards, is present in entirety or as a truncated sequence and repeats a number of times until it is overlain by the beds of the Yerrapalli clays (Maleri sequence). At places, particularly in the upper part of this facies sequence, the ferruginated siltstones/claystones are very hard and compact and closely resemble the quartz-arenite rock.

## KAMTHI TECTONO-SEDIMENTATION

The fact that the Kamthi sediments have been laid over a wider basin with an angular overlap over the Permian lithics, undoubtedly, indicates relative deepening of the depositional floor due to the greater movement along the eastern marginal fault resulting in the widespread transgression of the depositional waters.

The post-Kamthi sedimentation is an argillo-arenaceous sequence, which dates from Lower/Middle to Upper Triassic, based on the vertebrate fauna. These are believed to be representing continental fluctuating fluvial sediments deposited under the reducing energy regime in the restricted (post-Kamthi) retreating basins during the Early Mesozoic times. Recent findings of these deposits in the Chintalpudi Sub-basin also indicates that they follow the same trend.

Remarkably, there is no record of such beds in the adjoining northern Wardha Valley Coalfield although the palaeo-drainage of the times is believed to be towards north-west. This gap in the data base, therefore, deserves an immediate attention. The tectono-sedimentation outline can be better understood by the cartoons shown in Text-figures 3-5 and Table 1.

## DISCUSSION

The Kamthi beds appear to constitute the basal lithics of the argillo-arenaceous Maleri sequence of King (1881). The fact that the Maleri sequence commences with a clay facies (Yerrapalli), which is a deeper but relatively calm water lithic free from the turbulent current action, makes one suspect that the inundated waters earlier must have receded to create such a sedimentological environs for their deposition. Another increase in the water domain must have been responsible for the deposition of the sand facies (Bheemaram) on whose recession the clay (Maleri) were laid down. The top sand facies (Dharmaram) makes yet another inundation of water in the depositional realm.

Now with the inclusion of the Kamthi sequence in this cyclic pattern of inflow and outflow of water one can surmise a tectono-sedimentological condition where the widespread periodic inundation of water is indicated by the sand facies (Kamthi) and the undisturbed argillaceous lithic pile (Yerrapalli), higher up in the sequence, signifies the retreat and stagnation point of these inundating waters.

In keeping with this review of the sedimentation cycle the enlarged Maleri Series now can be assumed to begin with a sand facies and alternate with clay facies until the close of Triassic period (Table 2).

There is strong evidence to consider the Kamthi beds (estimated to be more than 300 m) to constitute the basal part of the enlarged Maleri sequence of the Triassic sequence. The Permo-Triassic boundary in such an event will lie at the angular disconformable plane at the base of the 'Kamthi' beds. Although many questions on sedimentation are yet to be resolved but it is undisputed that the 'Kamthi' cannot by itself constitute an independent 'Formation' on its own merit.

In terms of general geology, however, it is more like a concept in this part of the Indian Gondwana Province as defined by its mode of occurrence and its sedimentation is governed by the associated tectonism.

The main points emanating, thus, are :

(a) Kamthi denotes younger horizon overlapping the Permian lithics and hence cannot be sub-divided, as is being suggested.

(b) Coal is found in two horizons with an included no thicker coal zone in the Permian lithics which lie buried under the initial cover of the Kamthi sediments.

(c) Bouger Anomaly maps of the ONGC show two basinal trends separated by a mid-longitudinal palaeoridge in the master basin.

(d) Eastern marginal fault is still an active plane.

(e) Coal in the eastern longitudinal basin shows higher rank (feebly caking; index below 7) due, perhaps, to the geothermal manifestation.

The questions which, however, still remain unanswered are :

1. Outlet channels to the Narbada sea (?) from the master basin during the Upper Gondwana times when the palaeo-drainage is believed to be towards north-west. It is especially so because there is no record of the presence of these beds in the northern Wardha Valley Coalfield. In this connection, is it not desirable to look for them along the eastern marginal fault, more towards its central part?

2. Presence or absence of Upper Permian lithics under the 'Kamthi' cover in the Wardha Valley Coalfield.

3 The demarcation of the nodal point of separation of the continental fluvial Upper Gondwanas from the coastal Upper Gondwana in the Chintalpudi sub-basin, the cause and reason.

4. The north-western limits of the Pranhita-Godavari master basin. Where do they lie?

A search into these is believed to be much revealing and rewarding.

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