Permian-Triassic palynofloral transition in Godavari Graben, Andhra Pradesh

Suresh C. Srivastava & Neerja Jha


Palynological investigation of bore hole GAM7 from Mailaram area (Paloncha Neck) in Godavari Graben has revealed five assemblages. Assemblages I to IV represent Late Permian, being dominant in striate disaccate pollen. Assemblage V denotes an Early Triassic age in view of the preponderance of Lunnatisporites pellucidus and Vernosia sp. The changeover from striate-disaccate to trilete phase is quick and sharp indicating a palynological break. The transition from Permian to Triassic in this part of Godavari Graben occurs in a paraconformable sequence. The Permian Triassic boundary passes within a gap of 12 m and a definite presence of Panch Panchy palynoflora is established.

**Key-words**—Palynology, Godavari Graben, Permian-Triassic, (India).

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THE Gondwana outcrops in Godavari Graben extend over a length of about 350 km with an average width of 55 km. There is a well-defined constriction in the Paloncha-Kothagudem area where the average width narrows down to about 6 km. The bore-hole GAM7 studied here was drilled in Mailaram area (Paloncha Neck) by the Geological Survey of India.

**PALYNOASSEMBLAGES**

The vertical distribution of various quantitatively significant palynota as in bore-hole GAM7 is shown in Histogram 1. In all, five palynoassemblages have been demarcated as under:

**Assemblage I**—This assemblage, recorded at 453 m depth, is dominated by striate-disaccate pollen, chiefly Striatopodocarpites (40%) and Faunipollenites (32%). Other important genera are Verticopollenites (4%) and Labirites (5%). Densipollenites (2%) and Crescentipollenites (2%) appear in low percentage while the trilete spores are very rare.

**Assemblage II**—Recorded between 423 to 231 m, this assemblage is characterised by the dominance of Striatopodocarpites (35%) and Faunipollenites (29%). Densipollenites increases up to 12 per cent at 423 m but the average value remains around 6 per cent. Crescentipollenites (2%) still remains insignificant. Lunatisporites, Vertirepites, Kerdosporites, Guttulapollenites, Lundbladispora, Flacipsorites, Klausipollenites, etc. appear for the first time. In addition, Gondisporites, Weylandites, and
Singraulit pollenites occur in low percentage only. The percentage of trilete spores also increases as Lopbritites occurs up to 13 per cent between 260-271.75 m depth level.

Assemblage III—At the depth of 206.45 m, striate disaccate pollen are still the dominant elements of the palynoflora (Striatopodocarpites 32% + Fautispollenites 17%). Crescentitk pollenites rises to 20 per cent. Columnisporites (14%) has a restricted distribution. Kodosporites (4%) and Lunatisporites record a slight increase.

Assemblage IV—This association is recorded at 178.45 m. The striate disaccate (Striatopodocarpites 33%) pollen continue to dominate the palynoflora. Here, the subdominance is formed by Guttulapollenites (29%). Corisaccites and Falcisporites (8% each) also increase in percentage. The genera, like Phidiasporites, Triguitrites, Iraquispora, Cyathidites, Concaussimisporites, are restricted to Assemblage IV. Osmundacidites attains its maximum value at 178.45 m.

Assemblage V—It is recorded at 166 m depth level. The striate-disaccate pollen show a sharp decline and are replaced by taeniate pollen genus Lunatisporites (32%); Verrucosisporites (10%) exhibiting a fair rise in frequency. Taeniaepollenites and Guitatisporites (3%) are restricted to Assemblage V. Klauspfiomites (4%), Playfordiaspora (3%), Ringosporites (4%), Polyopodiidites (6%) and Alispores (7%) increase in percentage. Aletes (10%) also mark a significant increase.

**DISCUSSION**

Five palynoassemblages demarcated in bore-hole GAM 7 essentially fall under two groups:

1. Assemblages I to IV are chiefly dominated by striate-disaccate pollen.
2. Assemblage V shows a dominance of taeniate pollen, alongwith cingulate-cavate trilete spores.

The dominance of disaccate pollen in Assemblages I-IV is comparable to the Late Permian palynofloras known from various basins of India. However, the occurrence of the following genera in the present sequence has been observed for the first time in Godavari Graben.

1. Kodosporites appears in Assemblage II and becomes significant in Assemblage III in Godavari Graben, whereas in Singrauli (Tiwari & Srivastava, 1984) and Raniganj (Singh & Tiwari, 1982) coalfields this genus occurs sporadically.
2. *Columinispores* is well represented in Assemblage III. The only other record in India, though low in percentage, is from Raniganj Coalfield (Singh & Tiwari, 1982) from where similar forms have been described as *Striatisporites*. This genus has been recorded from Barabasa Coal Measures of Australia (Foster, 1979), Late Permian of Africa (Jardine, 1974; Anderson, 1977) and Autunian of France (Alpern & Doubinger, 1973).

3. Presence of *Triquitrites*, *Iraquispora*, *Phidiaesporites* in Assemblage IV and *Taeniapollenites* in Assemblage V forms the first record from the Indian subcontinent. *Ringosporites*, *Kraeuselisporites*, *Cyathidites* and *Concavissimispores* present in Assemblage IV are also recorded from Panchet Formation of Raniganj Coalfield (Tiwari & Singh, 1983) but the percentage is low as compared to the Godavari Graben. Most of the above genera present in Assemblage IV along with *Guilulapollenites* and *Corisaccites* bear a close comparison with the assemblage recorded from Chhidru Formation in Salt Range (Balme, 1970). The common taxa in Assemblage IV of Godavari Graben and Chhidru Formation of Salt Range (West Pakistan) are *Leiotriletes* sp., *Lophotriletes* sp., *Cyathidites* sp., *Cyclogranisporites arenosus*, *Osmundacidites semenucus*, *Triquitrites proratus*, *Iraquispora labrata*, *Polypodiidites* sp., *Polytopisporites* sp., *Playfordiaspora cancellosa* (= *Guthboerlisporites cancellous*), *Lunatisporites novitaunensis* (= *Taeniaesporites novitaunensis*), *Vitreisporites pallidus*, *Falcisporites stabili*, *Klausispores schaubergi*, *Striatopodocarpites* (= *Protophleopus* microcorpus), *Ringosporites* (= *Neveisporites*) fussulatus, *Verrucosisporites nanumanius*, *Densispores indicus*, *Schizosporis* sp.

Assemblage IV also compares with the *Protophleopus* microcorpus Zone (*Falcisporites* Superzone) of Australia in view of the common occurrence of *Protophleopus* (= *Striatopodocarpites*), *Falcisporites* and *Playfordiaspora* (Rigby et al., 1987). The Late Permian palynoflora of Madagascar (Goubin, 1965) also compares with Assemblage IV in view of the occurrence of *Guilulapollenites hannonicus* and *G. gondwanensis*.

Assemblage V, the youngest palynozone in borehole GAM7, records the conclusive evidence of the presence of Lower Triassic in Godavari Graben. This assemblage compares with *Lunatisporites* and *Verrucosisporites* Assemblage from the Panchet Formation of Raniganj Coalfield (Tiwari & Singh, 1983).

The palyno-assemblage from Budharam Area (Srivastava & Jha, 1988) in Godavari Graben is older than the Assemblage V recorded here in view of higher percentage of *Lundbladispora* and

### PLATE 1

(All coordinates refer to Leitz Laborlux 1 microscope and all photographs are magnified × 500.)

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Slide/BSIP no.</th>
<th>Coordinates</th>
<th>Notes</th>
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</thead>
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<tr>
<td><em>Playfordiaspora cancellosa</em></td>
<td>BSIP 10013</td>
<td>103.3 × 68.2</td>
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<tr>
<td><em>Polypodiidites</em> sp.</td>
<td>BSIP 10015</td>
<td>109 × 62.8</td>
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<tr>
<td><em>Taeniaepollenites</em></td>
<td>BSIP 10012</td>
<td>96.5 × 65.6</td>
<td></td>
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<tr>
<td><em>Lundbladispora</em> sp.</td>
<td>BSIP 10014</td>
<td>104 × 67.9</td>
<td></td>
</tr>
<tr>
<td><em>Guilulapollenites</em> sp.</td>
<td>BSIP 10002</td>
<td>104.6 × 58.8</td>
<td></td>
</tr>
<tr>
<td><em>G. gondwanensis</em></td>
<td>BSIP 10005</td>
<td>105 × 56.6</td>
<td></td>
</tr>
<tr>
<td><em>Falcisporites</em> sp.</td>
<td>BSIP 10003</td>
<td>101 × 55.5</td>
<td></td>
</tr>
<tr>
<td><em>Verrucosisporites</em> sp.</td>
<td>BSIP 10001</td>
<td>105 × 55.5</td>
<td></td>
</tr>
<tr>
<td><em>T. nanumanius</em></td>
<td>BSIP 10001</td>
<td>98.7 × 52</td>
<td></td>
</tr>
</tbody>
</table>
Densoisporites which precedes the tæniate phase in Damoder Graben. The increase in percentage of Klausipollenites, Ringopoulosites, Playfordiaspora, Lundbladispora, Polypodiiidites and Alisporites further indicates its affinity with Lower Triassic palynoflora. _Taeniaepollenites_, another rare tæniate genus in the present assemblage, and Guttatisporites restricted to Assemblage V only are also known from the Triassic of the Netherlands (Visscher, 1966). Guttatisporites has also been observed in low percentages in Panchet Formation of Damoder Valley Coalfield, India (Tiwari & Singh, 1983).

_Lunatisporites pellucidus_ Zone (Falciisporites Superzone) of Australia (Ribey et al., 1987) compares with Assemblage V in view of the common occurrence of _Lunatisporites pellucidus_. Similarly, the assemblage of Mianwali Formation, Salt Range (Balme, 1970) is comparable in having _Lunatisporites pellucidus_ zone. The species common in the presently identified Assemblage V and Mianwali Formation, Salt Range are _Osmundacidiidites senectus_, Ringopoulosites (= Nevisisporites) fossulatus, _Ringopoulosites ringus_, Densoisporites playfordi, _Kraeuselisporites_ sp., _Playfordiaspora cancellosa_ (= Gutboerlisporites cancellosus), _Lunatisporites_ (= _Taeniaesporites_) pellucidus, L. (= _Taeniaesporites_) novialensis, Falciisporites stabilis, Klausipollenites schaubergeri, _Verrucosisporites narnianus_.

The present palynological evidence indicates that Assemblages I-IV belong to Late Permian while Assemblage V conclusively shows Early Triassic affinity. The change-over from Late Permian to Early Triassic between 178-166 m is sharp and well defined which is evident from a sudden change of striate-disacate dominant assemblage to tæniate disacate dominant assemblage. This conclusion is further substantiated by the study of palynofloral succession from Raniganj Coalfield (Tiwari & Singh, 1986) while a complete succession of Late Permian palynofloras is present in bore hole GAM7 up to 178 m, there is a distinct absence of two palynoassemblages (P-1 _Striatopodicarpiites + Klausipollenites_, P-11 _Verrucosisporites + Callumispora_) which should precede the present _Lunatisporites + Verrucosisporites_ Assemblage. This indicates a palynological break, though minor, in the palynological succession of bore core GAM7 between 178 to 166 m. The above palynological assemblage has not been recorded in the present study. The 12 meter strata which consists of greenish grey sandstones, did not yield microfossils.

Lithostratigraphically, the sediments up to 453 m in bore-hole GAM7 represent the Lower and Middle members of the Kamthi Formation (sensu Raja Rao, 1982). The Lower Member, between 272.75-453 m, is rich in carbonaceous shale and coal, alternating with white sandstone. The overlying greenish-grey sandstone with greenish-grey shales/clay up to 136 m depth are devoid of coal. The sediments above 136 m are represented by coarse-grained, ferruginous cross-bedded sandstone and alternating sandy shales. The entire sequence above 272.75 m is normally considered to represent the Middle Member of the Kamthi Formation.

Recently, Ramanamurthy and Rao (1987) have reconsidered the lithostratigraphic succession of the Lower Gondwana sediments in Ramagundam area of Godavari Graben and have raised the status of Lower Member and the lower part of the Middle Member to be equivalent to Raniganj Formation while the upper part of the Middle Member (represented by an alternate sequence of red/brown, sandy, calcareous clays and cross bedded sandstones) to be equivalent to the Panchet Formation. However, lithology attributed to Panchet Formation by Ramanamurthy and Rao (1987) in Godavari Graben does not conform to the lithology of Panchet Formation of the Damoder Basin—the type area. The present palynological finding in bore-hole GAM7 also shows that Panchet palynoflora commences much earlier within the green sandstone and clay sequence. Thus the Permian-Triassic boundary transgresses in the upper part of the Middle Member of Kamthi Formation (sensu Raja Rao, 1982) and Upper Raniganj (sensu Ramanamurthy & Rao, 1987).

Lithozone 3 of the Infra-Kamthi Formation (Kutty et al., 1988), encompasses the Middle Member of the Kamthi Formation of earlier workers. This zone contains the _Endothiodonta Cistecephalus_ fauna representing Late Permian ?Late Early Permian. The lithological attributes of lithozone 3 may represent a part of the sequence studied in bore-hole GAM7 where the palynological transition has been observed. In view of the above discussion, it now appears certain that the younger part of Middle Member of the Kamthi Formation (sensu Raja Rao, 1982), represented by green sandstone and clay, and the overlying coarse-grained ferruginous sandstone with alternating sandy shale should represent the Panchet Formation in Godavari Graben. The first appearance of prevalent red colour of sandstones and clay representing Panchet Formation, as opined by Ramanamurthy and Rao (1987), does not corroborate with the present investigation. However, it appears difficult to demarcate a lithological boundary between the Raniganj and Panchet formations in bore-hole GAM7 as the sandstones and shales with greyish-green tint continue downwards having Late Permian assemblages and, therefore, the
CONCLUSION

Palynological analyses record the presence of definite Lower Triassic sediments in bore-hole GAM7, Mailaram Area (Paloncha Neck), Godavari Graben. The Permian-Triassic boundary is located within Middle Member of the Kamthi Formation. The palynofloral transition from Protobaploxyptinus (= Striatopodocarpites) microcorpus to Lunatisporites pellucidus Zone indicates a palynological break, though minor in the succession. The palynofloral change-over from Permian to Triassic does not commence a lithological change, hence the lithological Permian/Triassic boundary remains to be established. It is further suggested that the Permian-Triassic change-over occurs in a paraconformable sequence.

The sediments containing Lunatisporites-Verrucosisporites assemblage may be equivalent to the sediments containing Assemblage IIIA in Damoder Valley. Thus the lithic attributes of the Panchet Formation in Godavari Graben could be represented by greyish-green sandstone and clays overlain by predominantly coarse to medium-grained, cross-bedded sandstone and sandy, calcareous shale which are present in bore-hole GAM7 from the surface up to 166 m depth. Assemblage IV and V, which have a close comparison with a similar succession in Salt Range, impart a palaeogeographic provincialism during the period.

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We sincerely thank the authorities of the Coal Wing, Geological Survey of India for valuable help rendered during the collection of bore-core samples.

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