Tectono-Stratigraphy of the Pakhal Basin, Warangal (Rural) District of Telangana State With Special Reference to the Bollapally and the Pattipally Area

Dr. S. Ramesh[1], Dr. P. Swamy Sharan[2] & Prof. K. David[3]

Department of Geology,
Kakatiya University, Warangal – 506009.
Telangana State – INDIA

ABSTRACT: The Proterozoic (middle-late) rocks of the Pakhal basin (6000 mts thick) situated in the south central part of the peninsular shield, extends through the state of Telangana, Madhya Pradesh and Maharashtra in a general NW-SE direction along the Pranhitha-Godavary valley. The sediments of the basin crop out as two mutually parallel NW-SE trending belts, with about a 40 kms wide stretch of Gandwana sediments separating them. These Proterozoic sediments are divisible broadly into the Pakhal super group, Penganga group and the Sullavai sandstone in that ascending order, each separated from the older unit by an angular unconformity. The Pakhal non-conformably rest over the Archaean basement. The Pakhal super group is divided into the Mallampally group, Mulug group and the Albaka sandstone. (Srinivasa Rao, 1984) The Mallampally and Mulug group are represented by variable proportions of conglomerate arkose, shale, phyllite, dolomite and quarzite. The sediments were initially folded on NW-SE to NE-SW tending axes and later cross folded on East-West axis. In the south eastern part of the basin the sediments were metamorphosed leading to the development of staurolite, andalusite and garnet in the argillaceous and tremolite and actinolite in the carbonate units.

Keywords: Tectono-stratigraphy, Pakhal basin, Bollapally, Pattipally

Introduction

The Pakhal outcrops occur in three patches extending from Sirpur at the northern border to Kothagudem in NW-SE direction of Telangana. Pakhal sediments are exposed over a length of 350 kms along the strike direction of major geological groups parallel to the direction of the Godavari valley which is NW to SE. The Pakhal basin extends in three districts namely Warangal, Karimnagar and Adilabad districts of Telangana. Pakhal is 1600 mts thick consisting of arenaceous, argillaceous and calcareous rocks. The Mallampalli group is exposed between the Maneru river and the Pakhal lake area. In this group, oldest formation is the Mallampalli conglomerate, which consists of boulder conglomerate, arkose and quartzite. Mallampalli conglomerate is overlained by the Mallampalli dolomite unit which consists of dolomite and dolomitic limestones with inter beds of grit, arkose, glauconitic sandstone, chart, shale and calcarenite. This dolomite grades into a shale forming the top unit of the Pandikunta shale.

The Proterozoic (middle to late) rocks of the Pakhal Basin (6000 mts thick) situated in the south central part of the peninsular shield, extends through the state of Telangana and Maharashtra in a general NW-SE direction along the Pranhitha-Godavary valley. The sediments of the basin crop out as two mutually parallel NW-SE trending belts, with about a 40 kms wide stretch of Gandwana sediments separating them. These proterozoic sediments are divisible broadly into the Pakhal super group, Penganga group and the Sullavai sand stone in that ascending order, each separated from the older unit by an angular unconformity. The Pakhal non-conformably rest over the Archaean basement.

The Pakhal super group is divided into the Mallampally group, Mulug group and the Albaka sand stone (Srinivasa Rao, 1984) Figure No. 01.

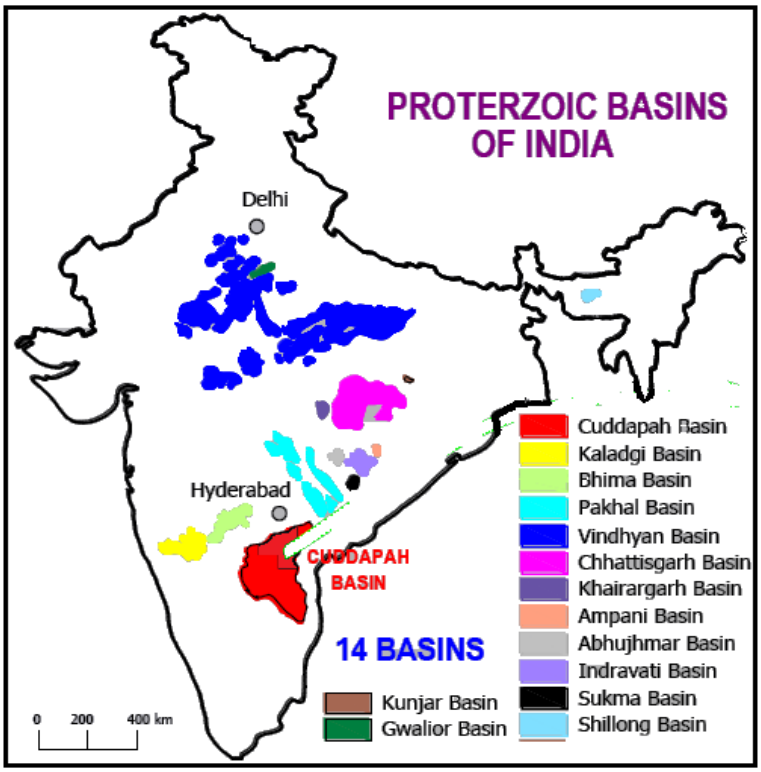

Figure No. 01: Proterozoic Sedimentary Basins of India

The Mallampally and Mulug group are represented by variable propotions of conglomerate arkose, shale, phyllite, dolomite and quarzite. The sediments were initially folded towards the NW-SE to NE-SW tending and later across folded on East-West axis. In the south eastern part of the basin the sediments were metamorphosed leading to the development of staurolite, andalusite and garnet in the argillaceous and tremolite and actinolite in the carbonate units.

The Pakhal super group comprises about 6000 mts thick succession of arenaceous, argillaceous and calcareous rocks. The sediments show a general decrease in coarseness fro bottom to top representing at least two major cycle of deposition corresponding to the lower and upper formation of the Pakhal group.

The succession divisible into 2800 mts thick lower formation and 3500 mts thick upper formation comprises coarse pebbly sandstones. conglomerates, silicious limestones, shales and slates respectively.

Geology of the area

Presence of glauconite, bedded chert and high MgO contents in corbonates moderate to well sorted nature of sediments and secondary over growth of feldspar indicate the marine epi-neritic environment of deposition. The Pakhal basin, along the Godavari graben that consists of Pakhal super group of rocks, largely comprises of mafic intrusions and meta-sedimens of Palaeoproterozoic and Sullavai group of meta-sediments of Neoproterozoic age. Most of the Proterozoic basins in India, viz., the Vindhyan, Cuddapah and Pakhal basins have experienced long hiatus between the upper and lower group of rocks.

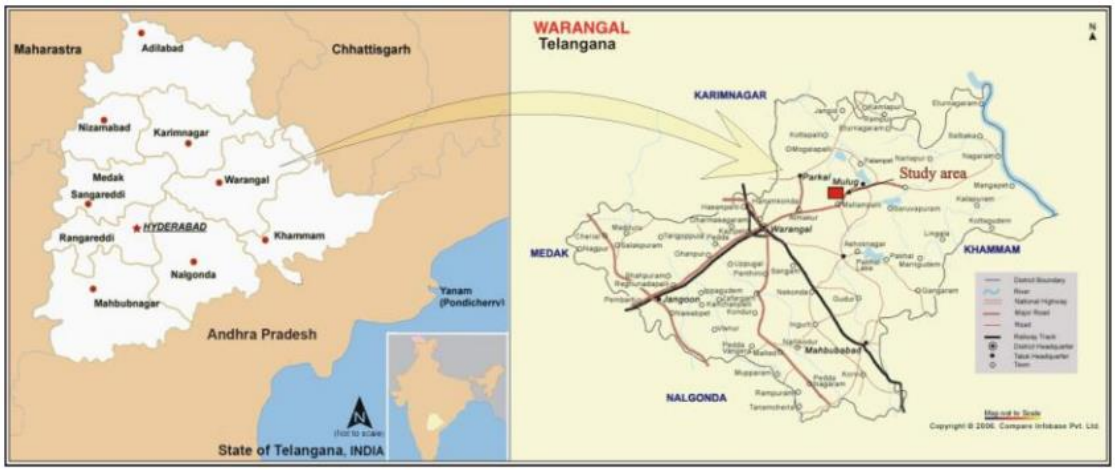

Figure No.02. Location map of the study area

Pakhal group of rocks is exposed on either sides of the NW-SE trending Gondwana rift within the confines of the Godavari graben. Based on the intensity of deformation, grade of metamorphism and their geographic distribution, the rock types in the southwestern sector of the Pakhal basin can further be subdivided into two different litho-tectono-stratigraphic units. The Mallampalli group is composed essentially of shale and carbonate with a basal conglomerate. The deposition of these sediments took place in a continental, lacustrine to fluvial environment with possible incursion of the sea periodically shown by glauconitic arenites and stromatolitic carbonates (shallow water). The Mallampalli group again show similar environmental conditions being a sucession of clastics with some chemical formations included. The stromatolitic beds were formed in intertidal zone and the chert beds and nodules are also as shallow water. It is possible that rifting was activated from time to time during the deposition of entire Mallampalli-Mulug sequence.

The Sullavai group of rocks was deposited in a terrestrial milieu crossbedding and ripple marks are extensively developed in these clastics. The litho stratigrphic sequence of the Proterozoic sedimentaries of the eastern and western belts is presented separately in Table No.01. The aggregate stratigraphic thickness of the sediments in the basin varies from about 750 mts in Ramagundam in NW to about 4000 mts at Mallampalli Mulug in SE constrained the age of marine deposition of the Mallampalli sub-group, Mulug Subgroup and Penganga group using 40Ar/39Ar geochronology on glauconite.

Table No.01. Lithostratigraphic classification of Pakhal Basin, by Basumallick (1967)

<table>
<tr><td rowspan="9">PURANASUPERGROUP</td><td rowspan="9">PAKHAL GROUP</td><td>Sullavai Group</td><td>Sullavai Sandstone</td></tr>
<tr><td colspan="2">----------Dis-conformity----------</td></tr>
<tr><td rowspan="6">Mulugu Sub-group</td><td>Mulug Shale
Mulug Shale
Enchencheruvu Shale
Enchencheruvu Limestone
Enchencheruvu Chert
Jakaram Arkose
Jakaram Conglomerate</td></tr>
<tr><td colspan="2">----------Dis-conformity----------</td></tr>
<tr><td rowspan="3">Mallampalli Sub-group</td><td rowspan="3">Pandikunta Shale
Pandikunta Limestone
Mallampalli Conglomerate</td></tr>
<tr><td colspan="4">----------Non-conformity----------</td></tr>
<tr><td colspan="4">Granites and Metamorphics</td></tr>
</table>

Table No.02: The Regional Stratigraphy of the Pakhal basin

Sullavai Group	Quartzite sandstone (including arkosic and conglomeratic beds).
Mulug Group	Shale (with intercalated quartzite) Quartzite Shale (partial calcareous, with inter beded limestone and calcarenites) Limestone (with nodules of chert and stromatolitic beds) Bedded chert and siliceous shale Arkose (with limestone, siltstone and glauconitic beds) Conglomerate.
Mallampalli Group	Laterite Shale Limestone (stromatolitic with interbeded arkose, glauconitic beds, chert and shale) Conglomerate.

Indicating the formation of level correlation between the two belts. Details regarding the lithology and sedimentary structures of each litho-unit (formation/member), as also its relationship with superjacent and subjacent units,. Details regarding the geographic locality after which each lithostratigraphic unit is designated.. The lateritization in the area has taken place during Proterozoic age continued intermittently upto the recent period. The geological map of the Proterozoic sediments of the Godavari valley is presented in Table No. 03 & Figure No.03.

Table No. 03. Lithostratigraphic succession of the Proterozoic Pakhal basin of Pranhita-Godavari valley given by Srinivasa Rao (1987)

<table>
<tr><td colspan="3">Western Belt</td><td>Eastern Belt</td></tr>
<tr><td colspan="3">Sullavai Sandstone</td><td>Usur Sandstone Member
Doli Sandstone Member
NambiSandstone Member</td></tr>
<tr><td colspan="3">----------Angular Un-conformity----------</td><td>--Dis-conformity---------</td></tr>
<tr><td colspan="2" rowspan="2">PENGANGA GROUP</td><td colspan="2">Putnur Limestone</td></tr>
<tr><td colspan="2">Takallapalli Arkose</td></tr>
<tr><td colspan="4">----------Fault----------</td></tr>
<tr><td colspan="4">Albaka Sandstone</td></tr>
<tr><td colspan="4">----------Dis-conformity ------</td></tr>
<tr><td rowspan="8">P A
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OUP</td><td rowspan="5">MULUG GROUP</td><td>Laknavaram Shale</td><td>Tippapuram Shale</td></tr>
<tr><td>Pattipalli Quartzite</td><td>Somandevra Quartzite</td></tr>
<tr><td>Enchencheruvu Dolomite</td><td></td></tr>
<tr><td>Polaram Formation</td><td>Cherla Formation</td></tr>
<tr><td colspan="2">Jakaram Arkose</td></tr>
<tr><td colspan="3">----------Dis-conformity----------</td></tr>
<tr><td rowspan="3">MALLAM PALLY GROUP</td><td colspan="2">Pandikunta Shale / Karlai Shale</td></tr>
<tr><td colspan="2">Gunjeda Dolomite/ Bayyaram Quartzite</td></tr>
<tr><td colspan="2">Bollapalli Formation</td></tr>
<tr><td colspan="4">----------Non-conformity ----------</td></tr>
<tr><td colspan="4">Granites and Metamorphics</td></tr>
</table>

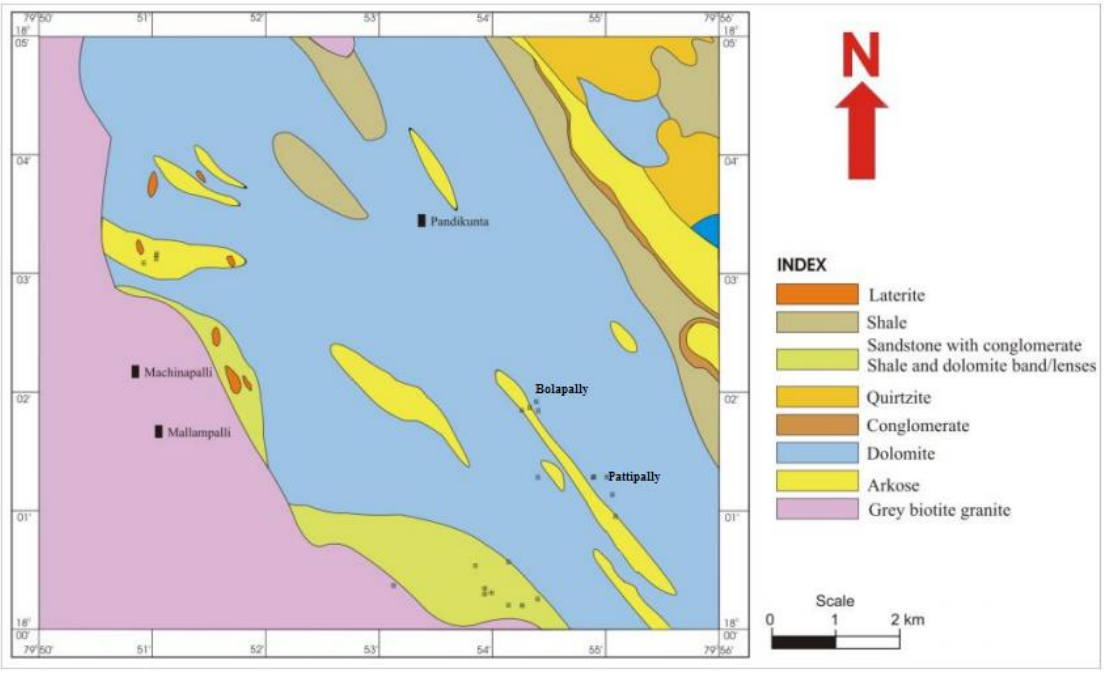

Figure No.03. Geological map of Mallampally group of Pakhal basin

Geological mapping of this basin carried out in 1960 and 1970's has established the stratigraphy and broad structural fabric of the basin (Rao, 1987). The Mallampalli Group which is the bed rock and is highly weathered and decomposed resulting in the formation of laterite.

In the south western part, the pakhal sediments are folded and metamorphosed. The basin is known for dolomite, iron ore and copper mineralization.

Much more work has not been done in the pakhal basin after 1960's as recorded from the various Research Institutions and publications. The previous work is not based on modern sedimentological concepts. Detailed petrological and structural studies are lacking in this part. For over 30 years no work has been done in this part of Telangana State.

TECTONO-STRATIGRAPHIC EVOLUTION OF THE PAKHAL BASIN

In the view of the above, detailed petrological studies involving traverse mapping along Narsampet, Mallampally, Mulug, Cheriala to bring out the sedimentation history of the basin.

The detailed mapping thorough petrography, geochemistry and sedimentological studies are aimed to bring out the history of the lower pakhals around Bollapally and Pattipally area. This involves systematic Sedimentalogy includes structural details, lithology preparation, and also palaeo-current data. The Pakhal basin being concerned mainly with integration of the mapping and petrological data, has been able to bring out details of regional importance, concerning structure, lithology, basin history and tectonics.

Basumallick (1967) abandoned the unconventional terms such as Pakhal Series, Albaka Stage, Sullavais etc., and proposed a lithostratigraphic classification for these un-fossiliferous Purana rocks of Mallampalli Mulug area. Within Pakhal group, he recognised two sub-groups, namely lower Mallampalli Sub group and upper Mul ug Sub group. He has recognised in all 11 formations within Pakhal group. According to him, the Archean-Pakhal contact is a plane of 'nonconformity', which rules out Mahadevan's idea of the Pakhal as older than the adjacent Peninsular granites, and the Pakhal-Sullavai contact is a plane of dis-conformity, which is contrary to King's idea of a 'strong angular unconformity' on the one hand, and to here on his idea of 'gradational passage' on the other.

Subba Raju et al. (1978) also considered Pakhal-Sullavai contact to be a plane of dis-conformity. They have modified Basumallick's classification, upgraded the subgroups into groups and in tegrated the Mallampalli, Mulug, and Sullavai groups into Pakhal super group. Their lithostratigraphic classification of Pakhal Super group and they have made a comparison between Pakhal and Cuddapah super group and have correlated Mallampalli, Mulug and Sullavai with the Papaghani, Nallamalai and Krishna groups respectively. According to them, Godavari valley is a unique basin which hosts them and Pakhal as well as freshwater Gondwana sediments. They have considered Penganga beds of here on as the northwestern extension of Mallampalli group and Penganga limestone and shale sequence is considered to be representing the sediments of the deeper parts of the basin.

Srinivasa Rao (1987) revised the lithostratigraphy of the Proterozoic (Middle to Late) Pakhal basin of the Pranhita-Godavari valley. According to him, these Proterozoic sediments are divisible broadly into the Pakhal super group, Penganga group and the Sullavai sandstone in that ascending order each separated from the older unit by an angular unconformity. The Pakhal super group is further divided into the Mallampalli group, Mulug group, and Albaka sandstone. Within each group different formations are recognized by him.

The extension of Penganga into the area south of Godavari as a separate entity occurring between the Pakhal and Sullavai. According to him, Penganga sediments represent a separate depositional episode distinctly different from underlying Pakhal and overlying Sullavai, and hence to these sediments he accorded the status of a separate group. Within Penganga group, he recognized two formations namely Takallapalli arkose representing shore face deposits, and Putnur limestone belonging to neritic environment. He has correlated these Penganga group sediments with Kurnool group. Chaudhari et al. (1989) in Adilabad area, recognized three formations namely Pranhita sandstone, Chanda limestone, and Sat-Nala shale with in Penganga group. Their stratigraphic succession of Penganga Group is given in Table 2. According to them, Penganga limestones and shales were deposited in deep water environment and mostly represent debris flow deposits. The radiometric dating of glauconite from these limestone gives an age of 770 + 30 Ma, and hence they have considered the Penganga group as the youngest of all Proterozoic sequences of Pranhita-Godavari valley.

There are still many gaps left in our knowledge concerning the basin in the field of modern aspect in sedimentological studies and geochemistry and structural features in relation to the basin.

Basic data concerning thickness of units, palaeo-current direction sedimentary structures and lithological evidences should be collected along selected strips bring out the development of specific sedimentary horizons in the different formation of the basin.

The petrographic, geochemical and geomorphological studies of the Pakhal super group and its associated volcanism have not been done so for to any significant external systematic petrographic, geochemical and geomorphological studies are bound to help in a big way in brought out the structure of the basin evolution, including palaeo-geomorphic feature related to the sedimentary cycle.

Discussion and Conclusion

In the Pakhal basin, folding and metamorphism is confined to the South-Eastern end of the belt around Yellandlapad in Khammam district of Telangana State. There is no development of kyanite in the Pakhals as stated but ottrelite is reported from the Pakhals. The Pakhal Group is constituted by the Mallampalli and Mulug Subgroups and consists of an overall fining upward sequence with coastal alluvial to shallow marine conglomerates and arkosic to subarkosic sandstones grading into limestones and dolomites deposited in coastal marine environments, such as tidal flats, lagoons and intertidal and high-energy banks.

Paleogeography reconstructions suggest that during Pakhal times the Pranhite–Godavari Sedimentary Basin was a continental margin marine basin that opened to the east to the area occupied by the present day Eastern Ghats Mobile Belt (EGMB).

The Pakhal basin includes un-metamorphosed (except locally) and un-fossiliferous sediments of the Pakhal super group, unconformably overlain by the rocks of Penganga and Sullavai groups. Conglomerate, arkose, shale, dolomite and quartzite characterise the Pakhals, while arkose and limestone characterise the Pengangas and sandstone, the Sullavais. Iron oxides (haematite) is known from the ferrugenous grits and quartzites of Pakhals (?) extending from Bayyaram to Nilavanch in the western flank of Pranhita-Godavari valley. The coarse-grained, flat bedded, yellowish arkosic, cross-bedded sandstones of Kamthi formation of Gondwana super group overlay the Pakhal group of rocks.

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