"Rocks, like everything else are subjected to change and so also our views on them."

F.Y. LOEWINSON-LESSING (1936)

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RESUMÉ

CHAPTER 9
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The rocks of the Gondwana Supergroup in the P.G. basin are flanked on either sides of Pre-Cambrian sediments, metasediments and igneous rocks with unconformable contact in the west and tectonic contact in the east. It is divided into a lower and an upper Group which are further sub-divided into various formations viz. Talchir, Barakar, Barren Measures, Lower and Middle Kamthi in the Lower Group (Permian) and Upper Kamthi, Maleri, Kota an Chikiala in the Upper Group (Triassic-Early Cretaceous).

The P.G. basin exhibits two major structural linear trends in NW-SE and NE-SW direction. The NW-SE lineaments paralleling the basin axis and represented by boundary faults correspond to Dharwarian trend, while the NE-SW lineaments, transverse to the basin and represented by faults responsible for segmentation of the basin into various blocks, correspond to the Eastern Ghat trend. Gravity structural and remote sensing data indicate that rift related gravity -block faulting movement due to extension caused by asthenosphere upwelling and subsequent cooling was responsible for the evolution of Pranhita-Godavari Gondwana basin.

Within the study area the rocks of L.G.G. are exposed linearly in a NNW-SSE trend with the successive younger formation occurring in the more eastern part. In the western part of the area they are flanked unconformably by the Proterozoic rocks of Sullavai and Pakhal groups. The Lower Gondwana rocks show a dip of 5 to 15 towards NE. A series of NNW-SSE to NW-SE trending longitudinal faults and NE-SW trending transverse faults criss-crosses the study area. The longitudinal faults have resulted in the repetition of formations along the strike in the central part of the area. Near Chinnur basement inlier abuts against Gondwana rocks in the east along a prominent longitudinal faults. The transverse faults were responsible in shifting of the strike of various lithounits. From the disposition of outcrops and nature of contacts, and the fault pattern it is concluded that movement along NNW-SSE trending vaults began after the deposition of Talchir sediments and became pronounced during the end of the Lower Gondwana sedimentation. The NE-SW trending transverse faults were formed due to early Cretaceous tectonic disturbances caused by breaking of the India plate from Gondwanaland and prominent upliftment of the Eastern Ghat.

On review of the existing lithostratigraphic classification of P.G. basin, it has been found that the stratigraphic positions of Talchir, Barakar and to some extent Barren Measures find unequivocal acceptance in all proposed classifications, where as the status of Kamthi Formation is characterised by differing views and introduction of formation names of type section in Damodar valley. In light of the present investigation, the present author has arrived at the conclusions that as per the lithostratigraphic code of nomenclature, it is not possible to bring the Kamthi stratigraphy within the framework of type section of Damodar valley. The present author feels the equivalence can certainly be maintained between the Kamthi member and the type locality formations, but renaming them after Ranigunj, Panchet, etc., in the stratotype will lead to much complexity in the stratigraphy of Kamthi sequence of rocks, which has for years, known to be belonging to L.G.G. rocks of Permian.

Rocks belonging to the Proterozoic Supergroup can be easily identified in the field as topographic high forming elongated hill ridges running for several kilometers in a NNW-SSE trend.

The L.G.G. succession begins with Talchir Formation which shows the presence of 3 broad lithofacies - Diamictitie facies, Shale-siltstone facies and Sandstone facies. Poor sorting, high polymodality of size distribution and relative rounded nature of clasts (diameter ranging from 1 cm to 30 cm) embedded in a brownish-green silty matrix characterise the diamictite unit. The diamictites occur at two stratigraphic positions within the Talchir Formation. The shale facies includes olive green needle shales, khaki and maroon clays and silty shales. The sandstone facies constitutes the uppermost part of Talchir Formation. They are white to buff yellow in colour. Associated with sandstones are conglometric horizons which are orthoconglomeratic (petromict) in composition. At places, the conglomerates show embedded clasts of lower shaly unit.

The Post-Talchir Lower Gondwana (PTLG) deposits include Barakar Formation, Barren Measures formations and Lower and Middle Kamthi members in ascending order. Of these, the Middle Kamthi Member is a dominantly argillaceous unit with alternating layers of sandstones. The Barakar, Barren Measures formations and Lower Kamthi Member are sand units with intercalations of finer clastics. Barakar Formation and Lower Kamthi Member are characterised by the presence of coal seams, which are absent in the Barren Measures Formation. In the field rocks belonging to Barren Measures Formation can be identified and distinguished from those of the Barakar Formation and Lower Kamthi Member by its reddish-brown appearance, which is attributed to high ferruginous content.

Exposures of Barakar Formation consist of weathered, white to greyish white, medium to pebbly coarse grained, feldspathic, loosely cemented sandstones with argillaceous and at places calcareous matrix and subordinate shale bands and coal seams. Among the sedimentary structures observed, trough cross-bedding, tabular cross-bedding and horizontal bedding are common in decreasing order of abundance.

Exposures of Barren Measures Formation are charcterised by medium to coarse grained greenish grey to reddish brown sandstones with subordinate variegated clays and grey to dark grey shales. Horizontal, trough and tabular cross beddings are observed within the sandstones. Current structures shown by the cross beddings vary between 310° and 325°.

Surface exposures of Kamthi Formation, which is very meager, consists of grey white, frequently calcareous, medium to coarse grained sandstone with few carbonaceous layers and shale bands. Exposures of Middle Kamthi Member can be best observed along the Mancherial-Chinnur road. The lower part of this member consists of alternating sequence of greenish gray shales and sandstones, while the upper part consists of red; variegated clays with medium grained sandstone layers. At places the clays are characterised by nodules of calcareous material.

The Middle Kamthi Member is unconformably overlain by the Upper Kamthi Member which is a coarse grained arenaceous facies with a prevelant red colour.

Study of borewell lithologs of Barakar and Barren Measures Formations and Lower Kamthi Member gives a more clear picture on lithofacies variation within them. Six broad lithofacies can be recognized. They are i) pebbly very coarse grained sandstone (A1), ii) coarse to medium grained sandstone (A2), iii) medium to fine grained sandstone (A3), iv) intercalation of fine sandstone, siltstone and shale (B), v) carbonaceous shale and shale (C) and vi) coal and shaly coal (D).

The last mentioned facies is absent in Barren Measures Formation. Closer examination of the lithologs further reveals that they comprise a number of cycles of fining upward sequence. The vertical variation of which is mostly not systematic and exhibits a truncated and haphazard nature comprising of two, three or four of the lithofacies described above in various combinations. The cycles vary in thickness from 25 meters to 5 meters. Facies A3 shows maximum variation in bed thickness within different cycles and is thicker, on an average, than any other facies.

Granulometric analyses of L.G.G. sands indicate that they were deposited in a fluvial system characterised by variation in stream hydraulics and channel pattern. Cumulative results obtained from various textural tools of environmental interpretations reveal that within the fluvial framework, short lived interplay of mechanisms, similar to other environments, were operative during the various stages of Lower Gondwana sedimentation.

Results of analyses indicate that the sandstones of Talchir, were transported and/or deposited not by a typical fluvial process, *sensu stricto*, but by a bottom density stratification. Genetically, the Talchir sandstones can be termed as undaturbidites.

Based on relative dominance of various size classes and other textural data, the sands of PTLG were inferred to be deposited in a typical fluvial environment characterised by changing channel pattern from a high speed braided during the Barakar to a sluggish meandering type during the Middle Kamthi time. During the intermediate Barren Measures and Lower Kamthi time the fluvial system was an anabranching type.

Based on framework mineralogy (Quartz, feldspar and rock fragments) and relative proportions of matrix, sands of all LGG can be classified and termed as arkosic wacke as per Dott's (1964) classification. The Upper Kamthi sandstones exhibit a complete change in mineralogy, being devoid of feldspars.

Diagenetic studies of the sandstones reveal that fluctuations in climatic conditions during various stages of Lower Gondwana sedimentations left distinct imprints on the authigenic, and to a certain extent on the framework mineralogy of the sands. From the overall Q:F:Rx ratio and compositional maturity (Q/F+Rx) the sandstones and the nature of early formed authigenic minerals (chlorite and kaolinite), it can be concluded that the climate during the Lower Gondwana sedimentation changed from cold, semi-arid (Talchir) to temperate humid (Barakar) to warm semi-arid (Barren Measures) to warm semi-humid (Lower and Middle Kamthi) to warm humid (Upper Kamthi).

Diagenetic changes within detrital micas show significant signatures of depth-related process. Presence of authigenic micas concentrated in clusters within the pre-existing matrixes of Barren Measures sandstones suggest that these sands have already attained phyllomorphic stages. This reached an advanced stage in the Barakar sandstones, which are typified by equilibrium assemblages of biotite-chlorite and muscovite-chlorite.

Paragenetic sequence of mineral formation within LGG sands can be divided into two stages. The first stage, mainly controlled by climate is of locomorphic type, where substitution of detrital clay matrix by chlorite, kaolinite and smectite took place. The second paragenetic sequence is dominated by redoxomorphic, phyllomorphic and locomorphic stages of clastic diagenesis. During these stages replacement and alteration of detrital and authigenic grains and recrystallization of authigenic clay matrixes into neoformed micas took place. Calcite and iron-oxide cement were precipitated during this stage. These stages were influenced by Eh-Ph and to some extent depth controlled diagenetic processes.

Interferences drawn from the results of X-ray diffractograms of Lower Gondwana clays and shales, are in concurrence with those obtained by the petrographic and provenance studies. Dominance of quartz with 100% intensity peak in shales and clays indicate the derivation of sediments from granitic and gneissic terrain.

Detrital mineralogy, quartz typology and heavy mineral assemblages of Lower Gondwana sandstones in conjunction with the palaeocurrent direction within various formations imply that the granitic-gneissic terrain of Dharwar Craton lying to the south and south-west of the present day basin constituted the chief provenance for the Post-Talchir Lower Gondwana sediments of the Godavari sub-basin within which the source area was more expansive and possibly induded the Bastar Craton also. Based on the absence of sillimanite (which is a very characteristic and dominant mineral of high grade metamorphic suite of Eastern Ghat rock), within the heavy mineral assemblages from the study area and different parts of the basin, it is broadly conjectured that role of Eastern Ghat as a source area for the Lower Gondwana sediments was not very significant.

Gondwana sedimentation started within the deposition of Talchir sediments in a glacial environment. Based on the lithologic, sedimentary, stratigraphic nd palaeogeographic features, it is concluded that the unsorted diamictite occurring at the base of the Talchir Formation were laid down as ground moraines by different lobes of the valley glaciers rather than by a continuous ice-sheet, within the embryonic depression of the basement around individual basement prominences. The sediments overlying the basal tillite may be classed as periglacial deposits laid down by glacial meltwater. Variation in glaciation and deglaciation by various ice-fronts account for the variability in thickness and nature of sediment associations in different parts of the basin. Marine influence within P.G. Talchir deposits, was not as extensive as in Son valley or Satpura basin. It is envisaged that deglaciation and subsequent eustatic sea-level rise might have inundated the sporadic low lying areas.

Post-Talchir Lower Gondwana deposits of the study area, can be regarded as a by-product of various sub-environments of an alluvial plain. Present day disposition of younger Gondwana Formations in the successively more eastern part of the basin to slow synsedimentary faulting along the eastern margin, due to which the basin floor suffered northeasterly tilt resulting in lateral shift of the fluvial system towards the east. Synsedimentational intrabasinal faulting in form of differential and selective subsidence of the basin floor was responsible for variation in thickness and truncated nature of fining upward cycles within the Post-Talchir Lower Gondwana deposits. The sedimentary cycles are thus authocyclic.

The north-northwesterly flowing fluvial system during the PTLG sedimentation was characterised by a progressive change in channel pattern from a high speed braided river during Lower Barakar to a single channeled meandering one, during the Middle Kamthi through a mixed-load anabranching river systems during the Middle-Upper Barakar, Barren Measures and Lower Kamthi times. Mutual interaction among source rocks, climate and intrabasinal subsidence was the main factors in controlling the channel pattern and consequent sedimentation during the Lower Gondwana time in Pranhita-Godavari basin.

During the last 3 decades, we have focussed on Gondwana Problems and have come up with arguments to support ours and counter-arguments to negate others interpretations. No author is exception to this view.