Abstract

The Gondwana basins of Peninsular India occur mainly along three trends, namely Sone-Damodar-Narmada, Mahanadi and Godavari river valley basins. The present investigation was carried out in parts of Talchir Gondwana basin, which constitutes the southern most member of the Lower Gondwana basins within the Mahanadi valley basin. It is a northwest-southeast trending elongate basin covering an area of about 3150 sq.-km. The generalised stratigraphic succession of Talchir Gondwana basin is given by Raja Rao (1982). However, for the present purpose of study Talchir Formation has been redesignated as Talchir Group.

The area investigated is located along the southern boundary of the Talchir basin (Long. 85°0′ E - 85°17′E; Lat. 20°51′N - 21°0′N) and occupies approximately 536.5 sq.-km area. In the study area, both Talchir Group and Lower Damuda Group unconformably overlie the Precambrian basement rocks of Eastern Ghats. The Talchir sediments occurring close to the contact with the Precambrian basement rocks, in many places, are folded and faulted suggesting post depositional faulting. The Talchir Group is composed of conglomerate, diamictite, fine to coarse grained sandstone, fine sandstone, siltstone and marlstone with shaly alternations, turbidite and rhythmite. This Group can be divided further into three formations based on lithology, texture, sedimentary structures and stromatolite occurrences i.e. Lower, Middle and Upper Talchir Formations. Mainly, diamictite, pebble to boulder conglomerate and coarse to very coarse grained sandstone occupy the Lower Talchir Formation. Middle Talchir Formation is constituted of fine sandstone-shale, siltstone-shale, stromatolite bearing marlstone-shale, fine to coarse grained sandstone, pebbly sandstone, turbidites and rhythmites. Ripple drift cross-laminated siltstone, marlstone, shale and stromatolites constitute the Upper Talchir Formation. The lower Damuda beds overlying the Talchir Group with a gradational, erosional contact belong to Karharbari and Barakar Formation in the study area. Thick, conspicuous and wedge shaped boulder conglomerate mark the contact zone between Karharbari Formation and Barakar Formation. Karharbari Formation consists of conglomerate, pebbly sandstone, medium to coarse grained sandstone, rare shales and a thin coal seam. Barakar Formation consists of fine to coarse grained sandstone, siltstone, shale, carbonaceous mud, coal seams and rare conglomerate.

The aim of the present study is to prepare a sedimentation model of the Lower Gondwana rocks in the study area. This problem has been attempted mainly based on field mapping on the scale of 1:25,000, detailed field data collection and laboratory analysis. The field data include the measurement of stratigraphic sections, attitude of the beds, preparation of lithologs from all the available sections and lithofacies present in each Formation, primary sedimentary structures, biogenic features present and palaeocurrent measurements. The laboratory analysis includes petrographic analysis of rock samples, x-ray diffraction analysis and Scanning-Electron-Microscopic study of stromatolite-bearing marlstones.

Conglomerate, diamictite, sandstone and mudstone are three broad lithofacies identified from Talchir Group in the study area. Matrix supported conglomerate and diamictite include scour and fill cross-stratified conglomerate (Gmc), horizontally stratified conglomerate (Gms), massive conglomerate (Gmm), graded conglomerate (Gmg) and stratified diamictite facies (Dms). Greenish to off white coloured sandstone lithofacies consist of horizontally stratified sandstone (Sh), shallow ellipsoidal scour & fill sandstone (Ssc), trough cross-stratified sandstone (St), planar cross-stratified sandstone (Sp), graded sandstone (Sg), massive sandstone (Sm), convolute bedded sandstone (Sd), rippled sandstone (Sr) and channel sandstone (Sch). Fine grained sandstone and mudstone facies are mostly interbedded and include siltstone-shale, siltstone-siltyshale, marlstone-shale, ripple drift cross-laminated siltstone-shale, turbidite and rhythmite facies. Marlstones are mostly stromatolite bearing and occur at different stratigraphic level which is so far unknown from Gondwana rocks. Based on lithofacies association and their relationships, Talchir exposure in the area is divided into four sub-areas i.e., Bedashar (Sector I), Karnapur (Sector II), Tentolei (Sector III) and Sarang (Sector IV).

In the Bedashar sub-area, coarse lithofacies association comprising matrix rich conglomerate and coarse sandstone occupies mainly the Lower Talchir Formation. The fine lithofacies association occurs in both Middle and Upper Talchir Formation where coarse channel sandstone facies at two different stratigraphic levels of Middle Talchir Formation are observed. Presence of alternate stratified conglomerate and sandstone, predominant scour and fill structures, rapid lateral as well as vertical variations in facies associations, poor sorting, rounded-subrounded clasts and crude fining up sequences suggest a braided river deposition in glaciofluvial outwash depositional environment. Scour & fill conglomerate facies (Gmc) is

predominant in the basal part of the Lower Talchir Formation and grades upward to lithofacies Sg and Sh forming a fining up sequence. The cyclic repetition of such crude fining up sequences may suggest a frequent lateral shift of gravelly braid bars. The basal conglomerate overlying Precambrian rock shows occasional faceted and tortoise shell shaped pebbles supporting a deposition by glacial drift. However, striated pavements, striations and grooves on gravel clast surface etc., characteristic of true glacial phase, are absent. The distal outwash plain, near the lake margin, is dominated by poorly sorted, coarse sandstones comprising mainly of the lithofacies Ssc, St and Sh of lower flow regime and shows decrease in current competency and stream power. The lithofacies St, Sh, Sp and Ssc observed in vertical section possibly represent a sandy channel bar. Thick, vertically stacked, trough cross-stratified sandstone (St) was deposited as migrating dunes in interbar channels. Alternate, stratified conglomerate (Gms) and sandstone (Sh) was deposited within a longitudinal bar, during flash flood. Isolated, cobbles to large boulders within coarse sandstones may be coarser ice-rafted materials in the sandstones of proglacial outwash deposits. Presence of lenticular bodies of fine sandstone-shale, siltstone-siltyshale and marlstone-shale within basal conglomerate facies may have been deposited in small pools within the outwash plain. Similar outwash deposits occupy the Lower Talchir Formation in the southern part of sectors II, III & IV. The upper part of the distal outwash deposits in sector I is drumlinised, which is absent in rest of the sectors.

Middle Talchir Formation consists of interbedded sandstone and shale, interbedded siltstone and shale, interbedded marlstone and shale along with calcareous channel sandstone in Sector I, II and III and pebbly sandstone, fine to coarse sandstone, interbedded massive sandstone and shale along with rhythmites in Sector IV. The Upper Talchir Formation consists of interbedded marlstone and shale and alternate ripple drift cross laminated sitlstone and shale, occurring only in Sectors I, II and III. The lithofacies association, sedimentary structures etc. suggest that the Middle and Upper Talchir Formations represent lake deposits. These lake deposits are best developed in Bedashar Sub-area(Sector I). The lake characterised by shoreline shifting from south to north. In Bedashar area, initial sandy shore facies (S-1) shifts to north forming a calcareous shoreline (S-2) and finally further north again sandy shoreline (S-3). During shifting lake shore, the lake extended upto Karnapur area (Sector II) to the east where both shoreline facies S-2 and S-3 continue. To the further east in the Tentolei sub-area (Sector-III) only shoreline (S-3) is present. In Sarang sub-area (Sector IV) occurs a lake delta facies, calcareous facies is preserved to the east of Sarang beyond the area of investigation. Dominance of sandy and calcareous facies in different stages of lake development suggests strong climatic variation from dry to wet climates. Presence of stromatolites and oncolites within dark grey - black coloured shale and marlstone in the lake sediments suggests strong anaerobic (reducing) condition in the lake. Evidences like presence of mud-cracks, trail marks, plant remains etc. suggest emergence of the shallow near parts of the lake at different stages. It is also suggested that time t o time there was upliftment of the lake basin that caused shoreline shifting to the north and enlargement of the lake basin to the east. It is suggested that the area was surrounded by highlands from where piedmont glaciers descended down and deposited glacial, fluvio-glacial and glacio-lacustrine sediments. The area occupied by the present Gondwana sediments was shallow area in regional scale with irregular topography. Within this area, some parts sank at a faster rate where glacial sediments accumulated. In the present case, sinking and sedimentation began in Bedashar sub-area where lake sedimentation took place. Whereas in the area to the south and southwest it was mainly glacial outwash deposit. At a later stage, due to mild tectonic effect southern margin of the basin was uplifted in stages and caused shoreline shifting along with lake widening and enlargement to the east.

After completion of Talchir sedimentation the glacier completely retreated from the area and the climate gradually changed from cold glacial to warm and humid. At this time Damuda Group (Karharbari Formation) was laid down over the surface of Talchir deposits.

Karharbari Formation consists of dominant bed load sediments, mainly very coarse to coarse sandstone and lag conglomerates with minor mud and clay and is interpreted as deposits of braided river system. The tectonism that caused lateral extension of Talchir basin did not die out completely. Time to time , older faults in the Precambrian basement rocks as well as in Talchir rocks were rejuvenated and provided ideal geomorphic situation for the deposition of Karharbari Formation. An analysis of the channel sand body in Karharbari Formation also suggests dominance of braided stream during Karharbari sedimentation. The lithofacies association and their relationship suggest that Karharbari sedimentation took place mainly by sandy braided stream system

The overlying Barakar shows an unconformable relation with the Karharbari Formation marked by a thick conglomerate bed. Barakar Formation consists of fine to coarse grained sandstone, siltstone, shale carbonaceous mud and coals along with lag conglomerate and interpreted as being deposited in meandering

stream system. An analysis of the channel systems during Barakar time also shows a shift in the channel morphology and hydrology. Barakar channels were mostly meandering with wide flood plains where huge quantities of coal are found.

During the sedimentation of Damuda Group, channel pattern underwent an evolutionary change as sedimentation progressed. The braided stream pattern during Karharbari sedimentation changed over meandering pattern during Barakar sedimentation. From Karharbari time to Barakar time, streams became shallower and narrower; channel floor slope, flow velocity and rate of discharge also reduced. This progressive change in palaeomorphology and palaeohydrology suggest a gradual and progressive decline in topographic profile during the sedimentation of Damuda Group. This further suggests very limited influence of tectonism during Damuda sedimentation.