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# Red beds in the Cuddapah Basin, eastern Dharwar craton, India: Implications for the initiation of sedimentation during the Proterozoic Oxygenation event

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**ABSTRACT**
Based on the field, petrological and geochemical studies we make a detailed report on the occurrence of Proterozoic red beds from the intra-cratonic Cuddapah basin of South India. Studies in old Kadiri Ghat – K. K. Kottala section in SW part of the Cuddapah Basin indicate the presence of extensive red bed sequence with varied mineralogical, textural and lithological composition forming part of the Gulcheru Formation in the Paleoproterozoic Cuddapah Super group. Studies further reveal that a greater part of the clastic sedimentary rocks from the lowermost Gulcheru Quartzite of Papaghni Group to Bairenkonda Quartzite of Nallamalai Group are ferruginous. The present studies also highlight the existence of a thick sequence (~ 400 m) of ferruginous lithic arenite interbedded with a non-clastic reddish jasper and dolomite sequence in the middle part of Tadpatri Formation of Chitravathi Group in Mallela section and an iron oxide rich ferruginous siltstone (with 37 % $Fe_2O_3$) in lower part of Bairenkonda Quartzite in Nandyal-Nandikanuma pass section of Nallamalai Group. An age of 1.9 Ga for the mafic-ultramafic sill emplacement in Tadpatri Formation within the Chitravathi Group of Cuddapah Supergroup indicates the age of deposition of the host sediments to be older than this date. Considering the 1900-2000 Ma age of Vempalle dolomites, it is inferred that the Gulcheru red beds were deposited around 2.1 Ga; a period that corresponds to the global oxygenation event and a period that witnessed deposition of red beds in the platform type of Proterozoic basins in the world.

**Key words:** Red beds, Proterozoic Cuddapah basin, Eastern Dharwar Craton, Sedimentation, Oxygenation event

## INTRODUCTION

The Proterozoic Cuddapah basin of the Eastern Dharwar Craton (EDC) is bounded by Archaean greenstone belts and Peninsular Gneissic Complex to the west and south respectively, while 2.7 Ga Nellore schist belt (NSB) is present towards east (Ravikant, 2010). The basin covers an area of 44,500 sq km and extends over a length of 440 km in N-S direction with a maximum width of 145 km in the central part of the basin Figure 1.

The basin hosts the Paleoproterozoic Cuddapah Supergroup of rocks with clastic and non-clastic sequences and associated igneous rocks and the Neoproterozoic Kurnool Group of rocks with essentially a clastic and non-clastic sequence (Nagaraja Rao et al., 1987). In the Cuddapah Supergroup, the lithounits constituting the lower Papaghni and Chitravathi Groups are unmetamorphosed (Nagaraja Rao et al., 1987, Tripathy and Saha, 2013), while the rocks belonging to the upper Nallamalai Group are subjected to multiple phases of deformation (Saha, 2002; Chetty, 2011). "Red beds" are essentially clastic sedimentary rocks that may consist of rudaceous, arenaceous and argillaceous sequences, which are predominantly red in color due to the presence of Fe oxides; mainly hematite. Study of red beds offers important information concerning past climates and depositional environments (Mc Laren, 1978). The two major periods of red beds, dolostones and marine sulphate deposition in the Fennoscandian greenstone belt are Paleoproterozoic in age; 2.3 and 2.0 Ga (Melezhik et al., 2005). Strahler (1981) also reported formation of thick red beds during the Proterozoic. The appearance of red beds in the stratigraphic record is often cited as evidence for the Great Oxygenated Event (Holland, 2006). Extensive deposition of arenaceous and argillaceous red beds are recorded in the Early Proterozoic Aphebian sequences in Superior Craton of Canada (Chandler, 1980). The present paper brings to light the occurrence of Proterozoic red beds in the Gulcheru Formation of the Cuddapah Supergroup and infers that the initiation of sedimentation in the Cuddapah basin corresponds to the 2.1 Ga Proterozoic oxygenation event.

## Geological Setting

Thick sequences of clastic and non-clastic sedimentary rocks along with a wide range of igneous rocks forming

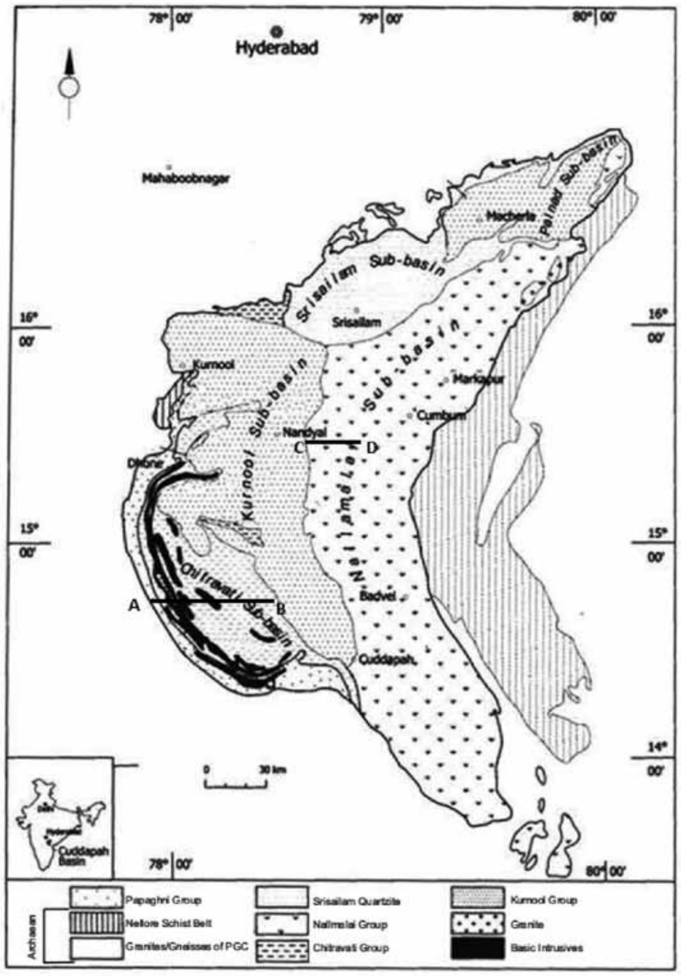


**Figure 1.** Geological map of the Cuddapah basin showing sub-basins (after Nagaraja Rao et al., GSI 1987), A-B Old Kadiri Ghat section-Pulivendla-Mallela section, C-D Pacherla-Nandikanuma pass-Diguvametta section.

part of the Paleoproterozoic Cuddapah Supergroup are well exposed in the Old Kadiri Ghat – K.K. Kottala - Pulivendula section, Lingala section, Tonduru- Mallela section in the SW part of Cuddapah basin and Nandyal-Giddaluru section of Nallamalai Fold Belt (NFB) in EDC. Reddish clastic sedimentary beds occur in form of deep reddish brown conglomerate, coarse grained ferruginous pebbly arenite and coarse to medium grained cross bedded ferruginous arenite in the Gulcheru Formation in Old Kadiri Ghat – K.K. Kottala - Pulivendla section Figure 2. Similarly, red beds are also found in the basal Gulcheru Formation near Veldurti along Veldurti-Ramallakota section (Bhattacharjee, 2015 pers.com.). Quartzites with variable iron contents have been reported at various stratigraphic horizons in the Cuddapah basin (Pulla Reddy et al., 1990). In Lingala section a reddish brown conglomerate horizon is overlain by reddish cross bedded arenite. A thick sequence (~ 400 m) of ferruginous lithic arenite interbedded with a non-clastic reddish jasper and dolomite is recorded in the middle part of Tadpatri Formation of Chitravathi Group in Mallela section, while an iron oxide rich ferruginous siltstone (with 35.61 to 37 % $Fe_2O_3^T$) overlain by a thick sequence of cross bedded ferruginous arenite is well exposed in the lower part of Bairenkonda Quartzite in Pacherla-Nandikanuma pass-Diguvametta section along the western margin of the section of Nallamalai Fold Belt (NFB).

## DISCUSSION

### Gulcheru Red beds in old Kadiri ghat – K.K. Kottala section

Resting over the Archaean granite basement, the lowermost sedimentary rock deposited in the Proterozoic Cuddapah basin at the base of Gulcheru Quartzite in the Old Kadiri Ghat – K.K. Kottala section is a deep reddish brown pebbly horizon Figure 3a varying in thickness from 15 cm to 70 cm. The pebbles are mainly represented by rounded to sub rounded clasts of quartz that float in relatively finely grained hematite rich ferruginous cement. Red beds

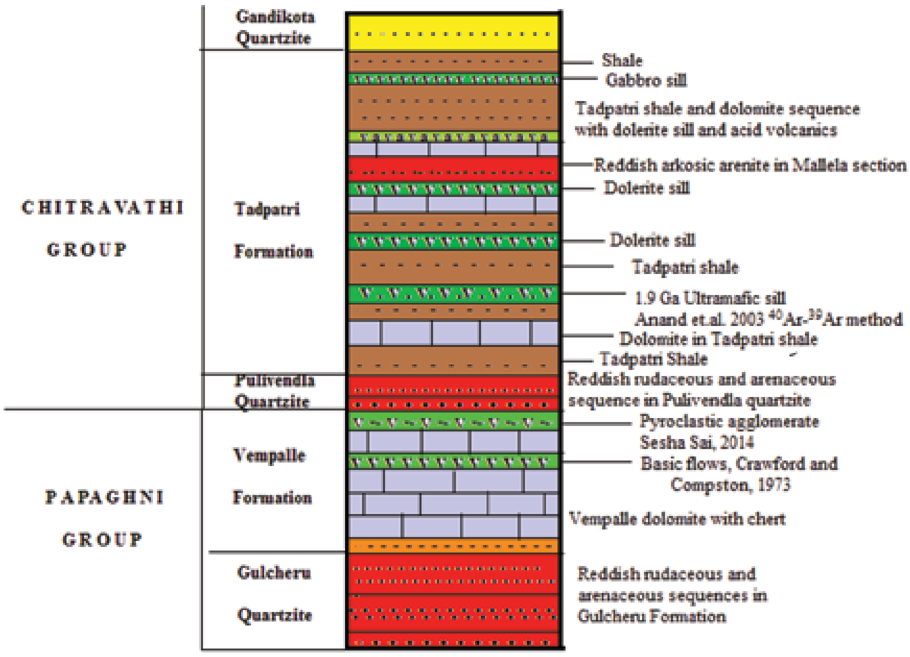


**Figure 2.** Litholog showing the red clastic sequences in Papaghni and Chitravathi Groups in the old Kadiri ghat – Pulivendla – Lingala – Mallela section in the Proterozoic Cuddapah basin (log not to scale).

are clastic sedimentary rocks stained red by hematite (Chandler, 1980). Larger quartz ranges from 4 mm to 1cm i.e. particle size ranging from granule to pebble, while the finer detrital quartz in the matrix range in size from 0.8 mm to 1 mm i.e. medium to coarse size sand particles. The pebbly horizon grades into a cross bedded reddish arenite Figure 3b. Rounded to sub rounded clasts of K-feldspar and microcrystalline chert are noticed in sub ordinate along with the quartz within the reddish arenite studies from the middle and upper part of Gulcheru Formation. Microscopic studies indicate that fine reddish iron oxide cement is conspiciously noticed in Gulcheru red beds Figure 3c. In conformity with the petrological observations the Gulcheru beds analysed high $SiO_2$ ranging from 83.03 to 86.95 %, $K_2O$ ranging from 2.22 to 3.47 % and $Al_2O_3$ ranging from 5.19 to 9.6 %, while the $Fe_2O_3^T$ contents in these red beds vary from 2.68 to 3.12 % Table-1. In K.K. Kottala – Pulivendla section an extremely fine grained ferruginous siltstone interbedded with dolomite is recorded in the lower part of Vempalle Formation.

## Ferruginous arenite in Pulivendla Formation – Lingala section

Pulivendla Quartzite, the oldest lithounit of the Chitravathi Group is well exposed in Lingala section in SW part of Cuddapah basin. A NNW-SSE striking reddish brown conglomerate (~ 6 m thick) essentially composed of 85 to 90 % of well-rounded to sub rounded chert clasts bound by iron oxide (0.89 % $Fe_2O_3^T$) occurs at the base of Pulivendla Quartzite. The chert clasts vary in size from 0.6 cm to 2.5 cm. The conglomerate horizon is overlain by (~ 80 m thick) medium to fine grained ferruginous arenite (1.03 % $Fe_2O_3^T$) with a sharp contact Petrographically the arenite is composed of chert, chalcedony and quartz clasts in decreasing order of abundance. The lithounits show shallow dips of 8 to 10º due east. Tadpatri shale with intercalated dolomite overlies the Pulivendla quartzite.

## Ferruginous lithic arenite of Tadpatri Formation – Mallela section

Mallela section is located between Pulivendla and Muddanuru transect in SW part of the Cuddapah basin. In Mallela section a thick horizon (~ 400 m) of ferruginous lithic arenite (6 to 11 % $Fe_2O_3^T$) interbedded with non-clastic reddish jasper Figure 3d and dolomite sequence is well exposed in middle part of the Tadpatri Formation of Chitravathi Group Table-2. Petrographic studies reveal that the ferruginous lithic arenite is glauconite bearing Figure 3e and composed of sub rounded quartz clasts, glauconite, carbonate and chert fragments. Mineral chemical analyses through Electron Probe Micro Analyser (EPMA) indicate that the $K_2O$ content in glauconite range from 7.94 to 9.64 %, indicating their evolved nature (Odin and Matter, 1981). Chert fragments are oval and well rounded Figure 3f. Both clasts and lithic fragments are bound by deep brownish ferruginous material. Chert and carbonate clasts make about 40 to 45 % of the rock. Bulk chemical analysis

**Table 1.** Major oxide and trace element analyses (XRF) of the ferruginous clastic beds from the Proterozoic Cuddapah Supergroup of Rocks, Eastern Dharwar Craton, South India.

| | Gulcheru Formation | | | Pulivendla Formation | | Tadpatri Formation | | | | Bairenkonda Formation | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Oxide% | CGR-1 | CGR-2 | CGR-3 | CPR5 | CPR6 | CTR7 | CTS8 | CTS8A | CTS9 | CBR10 | CBR11 |
| $SiO_2$ | 83.03 | 88.64 | 86.95 | 98.22 | 97.92 | 73.799 | 58.91 | 57.82 | 65.52 | 60.2 | 58.2 |
| $TiO_2$ | 0.4 | 0.27 | 0.45 | 0.04 | 0.04 | 0.28 | 0.89 | 0.89 | 0.57 | 0.15 | 0.15 |
| $Al_2O_3$ | 9.6 | 5.19 | 6.62 | 0.38 | 0.55 | 7.2 | 13.54 | 12.94 | 16.09 | 1.26 | 1.22 |
| $Fe_2O_3$ | 2.68 | 3.12 | 2.79 | 0.89 | 1.08 | 11.07 | 9.59 | 10.42 | 1.57 | 35.61 | 37.61 |
| MnO | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.04 | 0.05 | 0.05 | 0.02 | 0.01 | 0.01 |
| MgO | 0.65 | 0.42 | 0.4 | 0.18 | 0.21 | 4.13 | 6.85 | 6.85 | 1.45 | 1.29 | 1.29 |
| CaO | 0.05 | 0.04 | 0.05 | 0.12 | 0.11 | 0.31 | 1.25 | 1.25 | 1.11 | 0.18 | 0.18 |
| $Na_2O$ | 0.06 | 0.05 | 0.05 | 0.03 | 0.03 | 1.41 | 5.44 | 5.44 | 7.45 | 0.05 | 0.05 |
| $K_2O$ | 3.47 | 2.22 | 2.62 | 0.08 | 0.07 | 1.72 | 3.35 | 3.35 | 6.13 | 1.2 | 1.2 |
| $P_2O_5$ | 0.03 | 0.04 | 0.08 | 0.03 | 0.03 | 0.05 | 0.1 | 0.1 | 0.08 | 0.05 | 0.05 |
| Total | 99.99 | 100.01 | 100.01 | 99.97 | 100.05 | 100.009 | 99.97 | 99.11 | 99.99 | 100 | 99.96 |
| Element | Trace element analyses (in ppm) | | | | | | | | | | |
| Cr | 60.77 | 39.98 | 34.37 | 20.96 | 41.63 | 99.98 | 125.45 | 124.24 | 19.72 | 44.88 | 46.54 |
| Ni | 35.28 | 36.31 | 34.64 | 35.90 | 42.58 | 41.41 | 52.94 | 51.32 | 30.94 | 16.90 | 15.80 |
| Rb | 61.18 | 49.71 | 56.04 | 9.53 | 11.81 | 40.06 | 68.68 | 67.52 | 111.69 | 18.26 | 18.62 |
| Y | 18.86 | 21.34 | 20.57 | 5.51 | 6.33 | 21.01 | 34.95 | 35.04 | 92.62 | 2.22 | 2.23 |
| Zr | 57.98 | 66.14 | 248.92 | 7.95 | 3.16 | 204.81 | 89.99 | 89.24 | 998.32 | 6.50 | 6.48 |

**Table 2**. Sedimentary succession in southwestern part of the Proterozoic Cuddapah basin.

| | | GROUP | FORMATION | SUCCESSION |
|---|---|---|---|---|
| PALEOPROTEROZOIC | CUDDAPAH SUPERGROUP | NALLAMALAI GROUP | CUMBUM PHYLLITE | Greyish phyllite / slate with intercalated dolomite / tuffaceous sequence / arenite |
| | | | BAIRENKONDA (NAGARI) QUARTZITE | Ferruginous arenite with intercalated phyllite<br>Ferruginous arenite with intercalated reddish haematite rich siltstone |
| | | CHITRAVATHI GROUP | GANDIKOTA QUARTZITE | Quartz arenite<br>Glauconite bearing sub arkosic arenite<br>Greyish shale |
| | | | TADPATRI SHALE | Shale / Ferruginous arkosic arenite<br>Reddish brown ferruginous litharenite and dolomite with banded jasper and felsic volcanics<br>Finely laminated pale greenish shale with intercalated stromatolitic dolomite (with mafic-ultramafic sills) |
| | | | PULIVENDLA QUARTZITE | Reddish quartz arenite<br>Reddish sub lithic arenite<br>Reddish matrix supported conglomerate |
| | | PAPAGHNI GROUP | VEMPALLE FORMATION | Mafic Pyroclastic zone<br>Stromatolitic Dolomite / chert (mafic sills/flows)<br>Reddish ferruginous siltstone<br>Ferruginous chert breccia |
| | | | GULCHERU QUARTZITE | Reddish sub lithic arenite<br>Reddish arkosic arenite<br>Ferruginous matrix supported polymict conglomerate |
| | | ARCHAEAN BASEMENT (GRANITE-GNEISS-GREENSTONE) | | |

**Table 3.** Mineral chemistry of glauconite from Tadpatri Red beds of the Proterozoic Cuddapah Basin determined by Electron Probe Micro Analyser (EPMA)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 50.45 | 50.25 | 51.40 | 51.59 | 50.06 | 51.98 | 50.38 | 50.51 | 51.26 | 45.82 | 47.02 | 46.12 |
| $TiO_2$ | 0.15 | 0.04 | 0.06 | 0.03 | 0.06 | 0.03 | 0.08 | 0.07 | 0.04 | 0.06 | 0.02 | 0.02 |
| $Al_2O_3$ | 16.32 | 16.39 | 16.43 | 23.56 | 24.12 | 21.45 | 23.64 | 22.26 | 22.47 | 24.11 | 24.18 | 24.12 |
| FeO | 10.87 | 11.59 | 10.73 | 5.21 | 5.05 | 4.96 | 6.26 | 6.63 | 6.93 | 6.97 | 6.89 | 6.68 |
| MnO | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 | 0.01 | 0.04 | 0.05 | 0.03 | 0.01 |
| MgO | 3.32 | 3.40 | 3.31 | 2.43 | 2.45 | 2.36 | 2.53 | 2.76 | 2.64 | 4.74 | 4.73 | 4.37 |
| CaO | 0.17 | 0.12 | 0.10 | 0.16 | 0.12 | 0.18 | 0.21 | 0.31 | 0.22 | 0.31 | 0.36 | 0.32 |
| $Na_2O$ | 0.12 | 0.10 | 0.10 | 0.11 | 0.15 | 0.10 | 0.14 | 0.17 | 0.20 | 0.11 | 0.14 | 0.14 |
| $K_2O$ | 9.12 | 8.93 | 9.12 | 9.45 | 9.64 | 9.12 | 9.54 | 9.22 | 9.34 | 7.94 | 8.05 | 8.38 |
| $P_2O_5$ | 0.01 | 0.01 | 0.03 | 0.01 | 0.03 | 0.00 | 0.00 | 0.03 | 0.02 | 0.00 | 0.04 | 0.01 |
| Total | 90.56 | 90.84 | 91.29 | 92.56 | 91.69 | 90.21 | 92.79 | 91.97 | 93.16 | 90.11 | 91.46 | 90.17 |


**Figure 3a.** Photograph showing pebbly red bed at the base of Gulcheru Formation in K.K.Kottala section. **Figure 3b.** Photograph showing cross bedded reddish arenite in Gulcheru Formation, Motnutalapalli. **Figure 3c.** Photomicrograph in plane polarised light (PPL)showing fine reddish iron oxide cement in Gulcheru red bed, Old Kadiri Ghat- K.K.Kottala section **Figure 3d.** Photograph showing reddish jasper intercalated with dolomite in Tadpatri Formation, Mallela section. **Figure 3e.** Glauconite (in PPL) within the ferruginous lithic arenite of Tadpatri Formation. Note the opaque ferruginous binding material. **Figure 3f.** Microphotograph in Xed showing well rounded oval shaped chert clast within the ferruginous lithic arenite in Tadpatri Formation. Note the opaque ferruginous binding material.

through XRF spectrometry reveal that the total $Fe_2O_3$ content range between 9.59 to 11.07 %. The relatively high MgO contents between 4.13 and 6.85 % (Table-3) is attributed to the dolomite lithic fragments in the reddish brown ferruginous lithic arenite. Abundance of carbonate and cryptocrystalline chert lithic fragments in ferruginous lithic arenite indicate relatively short lived action of mechanical energy involved during post depositional process. Both chert and carbonate clasts are derived from the older Vempalle Formation from within the basin. Presence of glauconite indicates role of marine diagenesis during the lithification of the Tadpatri ferruginous lithic arenite, which must have occurred prior to 1.9 Ga i.e.; the age of emplacement of ultramafic sill in Tadpatri Formation (Anand et al., 2003).

## Bairenkonda quartzite – Pacherla-Nandikanuma pass section

Intercalated sequence of NNW-SSE striking ferruginous siltstone and cross bedded ferruginous sandstone with gentle easterly dips occur in Bairenkonda Formation in Pacherla-Nandikanuma pass section along the western margin of the section of NFB. Well rounded grains of quartz with iron oxide coating are noticed in ferruginous quartz arenite. This unit is interbedded by a thinly laminated ferruginous siltstone horizon, which is the most conspicuous ferruginous bed recorded with significant iron content in the Proterozoic Cuddapah basin. It is made of 10 - 15 % of very fine grained detrital quartz that floats in essentially dominantly ferruginous (hematite) material. The rock gives a cherry red to deep brown streak and contains total $Fe_2O_3$ between 35.61 to 37.61 % (Table-1). Ferruginous siltstone horizon varies in thickness from 2m to 3.5 m. It is thinly laminated and the individual laminae vary from 0.7 to 0.8 cm.

## Interbedded dolomite and red bed sequences

Stratigraphic sequences constituting the Papaghni, Chitravathi and Nallamalai Groups of the Cuddapah Supergroup are charecterized by rudaceous, arenaceous and argillaceous rocks of clastic origin interbedded with dolomite and chert of non-clastic origin with variable thickness. Stromatolitic dolomites have been recorded in Vempalle and Tadpatri Formations in the basin (Gururaja and Chandra, 1987). The Vempalle Formation of the Proterozoic Cuddapah basin has a well developed sequence of carbonate rocks, which are interbedded with shales, siltstones and chert. The stromatolitic carbonates show banding of alternate carbonate and cherty layers. The latter are rich in organic matter indicating prevalence of profuse biogenic activity (Mathur et al., 2014). Stromatolites of Vempalle Formation, characteristic of the Paleoproterozoic period have been proposed to be formed by cyanobacterial filaments (Sharma and Shukla, 1998). Geological, isotopic, and chemical evidence suggest that the Paleoproterozoic Great Oxygenation Event (GOE) happened at 2.3 Ga (Zimmer Carl, 2013). Cyanobacteria that appeared about 200 million years before the GOE began producing oxygen by photosynthesis. Before the GOE, any free oxygen they produced was chemically captured by dissolved iron or organic matter. The GOE was the point when these oxygen sinks became saturated and could not capture all of the oxygen that was produced by cyanobacterial photosynthesis (Flannery and Walter 2012). The interval 2.2-1.8 Ga has both carbon isotopic evidence for a stepwise increase in the organic reservoir and also paleosol evidence for an $O_2$ increase (DesMarais, 1997). The pattern of Fe retention in paleosols and the record of mass independent fractionation in sulphur isotopes confirm that the transition to more oxidising conditions took place during Paleoproterozoic (Sreenivas and Murakami, 2005). Early Proterozoic red beds occur at the western, north western and near the northern margin of the Kapavaal Craton (Truswell, 1990). In the Fennoscandian greenstone belt, the two major periods of red beds, dolostones and marine sulphate deposition are Proterozoic in age between 2.3 and 2.0 Ga (Melezhik et al., 2005). The Paleoproterozoic Great Slave Supergroup of Canada contains numerous red beds, glauconitic horizons and sedimentary uranium deposits (Stanworth and Badham, 1984). The increase in the global oxygen levels in atmosphere had a direct impact on the prolific growth of stromatolites both in Vempalle and in Tadpatri carbonates. Occurrence of Red beds, abundant carbonates and stromatolites is widely recorded during Paleoproterozoic (Figure 4). The Paleoproterozoic red beds are deposited in the more stabilised platform type of sedimentary basins worldwide.

## Implications

The timing of initiation of sedimentation in the Proterozoic Cuddapah basin of EDC is an extremely important ongoing subject, since a clear understanding on this aspect will throw light on the onset of deposition in the platform type of sedimentary basin in Dharwar Craton and on the Indian sub-continent. Since it is difficult to date the sedimentary rocks, associated magmatic rocks provide limiting ages. A 12 km long forsterite olivine-phlogopite-enstatite rich ultramafic sill is emplaced in the lower part of the Tadpatri Formation (Sesha Sai, 2010). Several attempts to date this sill have been made (eg. Bhasker Rao et al., 1995; Chatterjee and Bhattacharji, 2001 and French et al., 2008). An age of 1.9 Ga by $^{40}Ar$–$^{39}Ar$ laser fusion was constrained for the phlogopite mica from mafic-ultramafic sill complex of Tadpatri Formation (Anand et al., 2003), which can be considered as the limiting lower most age for

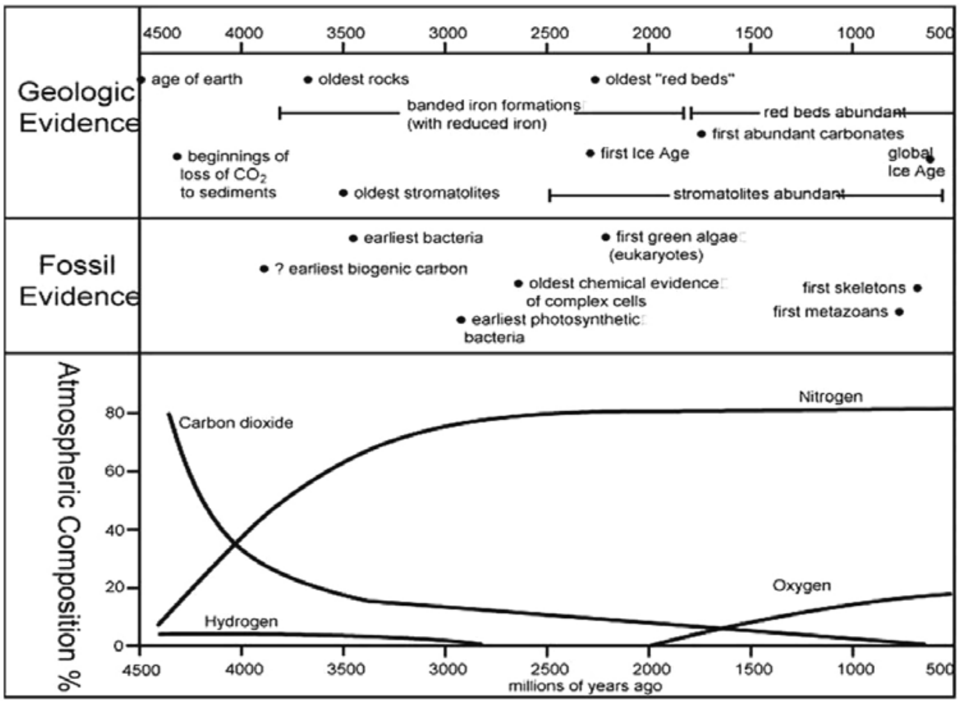


**Figure 4.** Diagram showing the occurrence of Red beds and stromatolitic carbonates during Paleoproterozoic. After Brimblecombe and Davies (1981); modified by David. G. Smith (1981).

deposition of the Tadpatri Formation. No upper age limit estimates of deposition of these sediments are currently available. Globally the oldest red beds recorded are the early Proterozoic Red beds, which appeared only after free oxygen was released into the atmosphere, beginning about 2.1 to 1.8 billion years ago. During the period 2.45–1.85 Ga atmospheric oxygen levels rose to values estimated to have been between 0.02 and 0.04 atm. The shallow oceans became mildly oxygenated (Holland, 2006). Paleomagnetic studies aid significantly in the reconstruction of past plate motions. Palaeomagnetic studies of red beds contributed to unravel the palaeogeography of the 1.8 Ga King Leopold glaciation in the Kimberley Group of Western Australia (Phillip and Williams, 2008). Interbedded ferruginous sandstones, siltstones and jasper are recorded in the Koolpin Formation of Pine Creek Supergroup in the Early Proterozoic (2.0 – 1.8 Ga) El Sherana and Edith basins in Northern Australia (Friedmann, 1990). PbSL studies revealed an age of deposition, diagenesis, dolomitisation and syn-diagenetic uranium mineralization, in the Vempalle dolomites at 1900-2000 Ma (Rai et al., 2015); thus indicating an older age for the Gulcheru red bed sequence referred in the present study in Old Kadiri - K. K. Kottala section of Cuddapah basin. Detailed field and petrological studies as part of the present work have proven that the red beds constitute a significant volume of the clastic sediments in the Gulcheru Formation of the Cuddapah Super group of rocks. The limited geochronological constraints indicate the possibility of deposition of these rocks during Paleoproterozoic.

## CONCLUSIONS

The present studies reveal that the deposition of the red bed sequences in the Cuddapah Supergroup of rocks in the Proterozoic Cuddapah basin in EDC correlate with a major Paleoproterozoic Oxygenation Event. Considering the 1.9 Ga age of emplacement of mafic-ultramafic sills in Tadpatri Formation (Anand et al., 2003), it can be inferred that a greater part of sedimentation in the Paleoproterozoic Cuddapah Supergroup was already deposited prior to 1.9 Ga. Based on the 1900-2000 Ma age of Vempalle dolomites (Rai et al., 2015) it is inferred that the Gulcheru red beds were deposited around 2.1 Ga; a period that corresponds to the global oxygenation event and a period that witnessed deposition of red beds in the platform type of Proterozoic basins in the world.

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## Compliance with Ethical Standards

The authors declare that they have no conflict of interest and adhere to copyright norms.

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