© 2016 IJSRSET | Volume 2 | Issue 4 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Textural Characteristics and Clay Mineralogy of the 'Red Beds' From the Khanapur Plateau, Maharashtra, India

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ABSTRACT

The Khanapur plateau surface is consisting chiefly of 'Red beds' which rest uncomfortably over the bed rock basalt which has its weathering profiles. They occurs fan-shaped sedimentary deposits especially in the area around Menganwadi village, Balavadi and Adsadwadi. The sediment can be considered as heterogeneous mixture of various sizes with dominance of fine grained materials. The poorly to very poorly sorted nature of 'Red beds' indicate that the sediments are most probably deposited in fluvial environment as traction current due to river action. Mineralogy, the XRD and IR and microscopic analysis were used for four constituents; clayey materials, opaques, lithic fragments and iron oxides. However, thus detrital natural minerals have reveal as well as effects of weathering, erosion and transportation. The secondary precipitation of silica and calcite has been taken place along the fractures, bedding planes and cavities or voids in the strata. The SEM show the dominance of fine detrital clays and iron oxides in the 'Red beds' and effects of solution. The kaolinite mineral appears to be eroded and /or corroded indicated to its detrital and transported in nature.

Keywords : Textural Characteristics, Red Beds, Detrital And Transported In Nature

I. INTRODUCTION

A. The area of investigation

The area under the present investigation forms a part of the Western Ghats of India which run in an approximately north-south direction parallel to the coastline for a distance of over 1500 km from the Tapi River in the north to Kanyakumari in the south. The Western Ghats are characterized by a conspicuous escarpment running parallel to their crest, the western side of these being marked by low-lying coastal plain and the eastern side by high lands referred to as the Deccan Plateau. The Plateau dissected by a number of east-flowing rivers. This upland region itself is constituted of a number of plateau and one of the prominent plateau is the Khanapur Plateau (Elzien, 1992, Elzien, 2013a). Khanapur Plateau is included within the Survey of India topographic sheet No. 47 K/11-16. It is bounded by Latitudes 17o 04' 06"; 17o 19' 27"N and Longitudes 74o 33' 35"; 74o 55' 00"E (Fig. 1). The Khanapur Plateau covered an area of about 580 km2. The Plateau covers the parts of the Khanapur and Atpati talukas of the Sangli District of Maharashtra. The 'Red Beds' occur as isolated patches of varying areal extent at different localities. The 'Red Beds' outcrop observed in the western part around the villages of Menganwadi, Balavadi, Jadharwadi, Khanapur, Tamkhandi, Ainwadi, and Adsadwadi in addition to another outcrops in the eastern part.

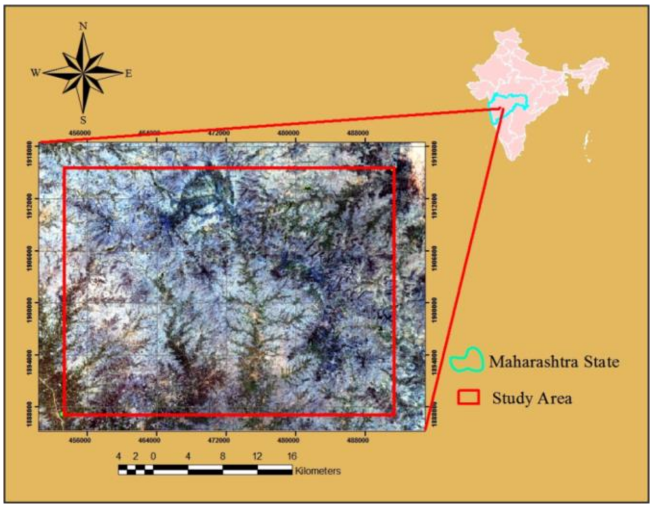

Figure 1. Sketch map and Landsat image show the area under investigation

B. Geology

The Deccan Trap Basaltic Lava flows and activities of Cretaceous age (**Radhakrishna, 1991**) covered greater parts of Maharashtra, Madhya Pradesh and Karnataka States. The Khanapur Plateau is a part of the Deccan Trap. The Khanapur Plateau is unconformable overlain by Reddish-brownish coloured deposits of Paleocene (??) (**Elzien, 1992**). Alluvio-colluvial sediments of Quaternary in the streams flood area and extensive development of calcretes has been observed (**Elzien, 1992; Patil and Surana, 1992; Goudie, 1983; Klappa, 1983, Elzien, 2013a 2013b**). Thick deposits of waterfall tufa has shown the presence of variety of plant fossil assemblages indicates that the tufas are 8000 to 10.000 y BP in age (**Pawar et al. 1988**). Intense development of calcretes observed in the 'Red beds' areas partially or totally replaced the 'Red beds' or ferrallitic soils (**Elzien, 2013b**). The calcretes also occur along the fractures and joint planes in partially weathered or weathered basalt or inter-flow unit underlying the soils. Similarly, concretions of calcretes occur along the stratification or bedding planes in the 'Red beds' and alluvio-colluvial deposits (**Elzien, 1992**).

C. Mode of occurrence of 'Red Beds'

The Khanapur Plateau surface is constituted chiefly of 'Red beds' which rest unconformably over the bedrock basalt which has its weathering profiles. The field studies have shown that the 'Red beds' are detrital in nature and are composed chiefly of deep Red to Reddish-brown coloured (**Elzien, 1992**). Poorly sorted, massive and/or stratified materials, (**Plate 1 A**) containing wide range of particle sizes from boulder to silt and clay. The material is heterogeneous in its lithological composition and is dominated by Reddish-brown. The beds are characterized by conspicuous columnar joints (**Plate 1 B**) that have led to the development of steep escarpments along the margin of the 'Red beds' (**Elzien, 2013b**).

D. Sedimentary features of 'Red beds'

The 'Red Beds' occur as 'fan-shaped' sedimentary deposits especially in the area around Menganwadi village, Balavadi and Adsadwadi. The field relationship of the 'Red beds' is highly obscured due to their subsequent erosion and chemical weathering. The 'Red beds' were probably deposited in a series of alluvial fans which are characterized by coarse sediments at their apices and fine in their middle and lower sections. The poorly sorted and heterogeneous lithological nature of the Khanapur 'Red beds' suggests that the material was deposited either as debris-flow deposit or as water-laid deposit (**Reineck and Singh, 1980**). The Khanapur ' Red beds' exhibit well defined stratification or bedding (**Plate 1 C & D**), the bedding surfaces being visible due to textural or compositional changes in the individual beds of the sedimentary sequence. The basal sections of the Khanapur 'Red beds' especially in the Adsadwadi area exhibit crude planar stratification due to the parallel arrangement of boulder and cobbles set in a fine silty-clayey matrix (**Plate 1 E**). Bedding is also evident from the parallel arrangement of coarser pebbly material along the bedding planes (**Plates 1 F & G**). The Khanapur 'Red beds' have preserved a variety of other primary sedimentary structures. Though the preservation of these primary sedimentary structures is very poor, they highly useful in understanding sedimentary processes and the conditions of sediment deposition as their character is controlled by current velocity, water depth, grain-size and sedimentation rate (**Pettijohn, 1957;Reineck and Singh, 1980 and Lindholm, 1987**). A crude planar cross stratification is observed in the silt-clay rich upper section of the 'Red beds' from the Menganwadi area (**Plate 2 A**). It consists of internal laminae or foreset laminae inclined to the principal surface of sedimentation.

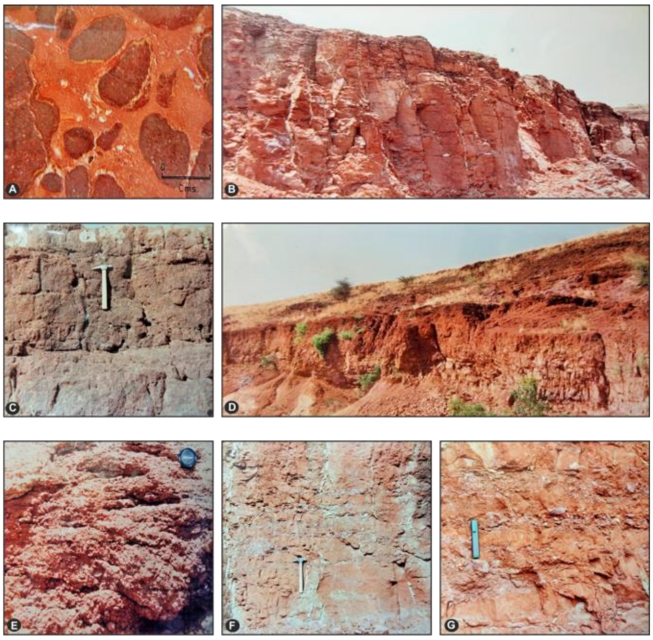

Figure 2. Plate 1. A. Microphoto Shows The Wide Range Of Particles From Boulder To Silt And Clay That Characterized Most Parts Of The Khanapur Plateau 'Red Bed'. B. Steep Escarpment Along The Margin Of The 'Red Bed ' Formed By Columnar Joints. C & D. Stratification And Bedding Primary Structures

Of The Khanapur 'Red Bed'. E. Crude Planar Stratification in the Adsadwadi Area. F & G. Parallel Arrangement of Course Pebbly Materials Along The Bedding Planes.

The ‘Red beds’, at a number of places show cut and fill structures. The field studies have shown that the palaeochannels are filled in with coarser bedload composed chiefly of highly weathered basalt boulders and cobbles. In Balavadi ‘Red beds’ area, approximately east-west oriented palaeochannels have been recorded. These at right- angles with those of the present day north-south oriented drainage lines. This indicates the change in the fluvial regime in this region during the post-‘Red beds’ deposition during the Quaternary period. Another important sedimentary feature is the randomly oriented pebbles in silt-clay rich stratified sections of the ‘Red beds’. However, at places, the pebbles arranged parallel to the bedding and sometimes impart crude graded bedding to the strata (**Plate 2 B**). The development of this type of graded bedding has been attributed to sedimentation from suspension in which all grain-size are carried together in the initial but later get settled according to sizes in a quiet environment (**Pettijohn, 1957**).

II. METHODS AND MATERIAL

During Four sequential field works, nearly 17 profiles have sampled and carefully studied for different lithological, primary and secondary structures. Out of these profiles only three ones were selected (**Fig.2**), the profiles are named: a. Adsadwadi profile ‘Red Beds’ (10 samples); b. Balavadi profile ‘Red Beds’ (samples) and c. Menganwadi profile ‘Red Beds’ (5 samples). The samples were obtained to grain size analysis distribution analysis depending on **Krumbein**, (**1934**). In addition to the above three profiles more two were selected for mineralogy and micromorphology of ‘Red Beds’ those are: d. Bhavani Khadi ‘ Red Beds’ profile and e. Landgewadi ‘Red Beds’ profile, using different techniques such as petrological microscope, XRD, IR in frequency range from 400cm^{-1} to 4000 cm^{-1} using KBr as a medium to prepare the absorption cell, and SEM. The mechanical analysis followed **Carver** (**1971**), **Friedman** and **Johnson** (**1982**). It was carried out by using 13 ASTM sieves with mesh size ranging from -1.0Ø to 74.50Ø with half phi interval. The statistical parameters result given by **Folk** and **Word** (**1957**).

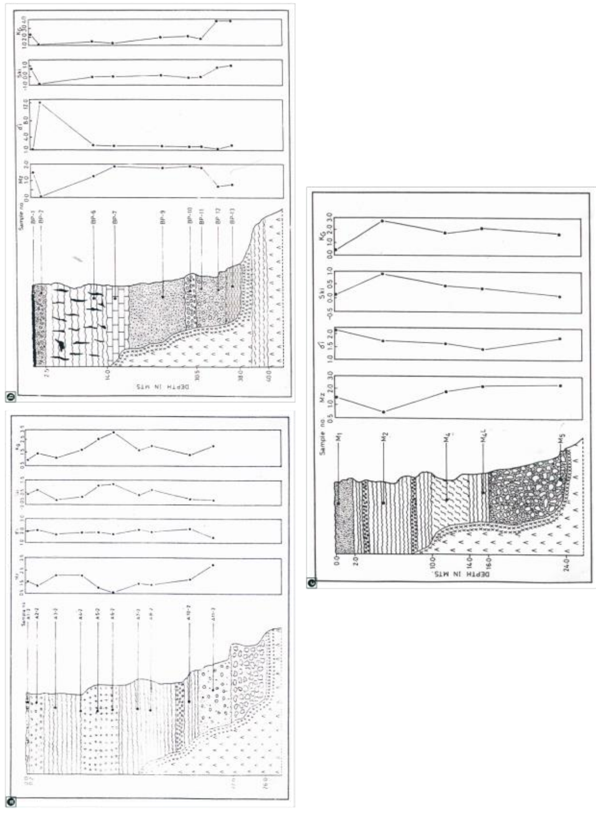

Fig. 2 Variation of the graphic measures with depth for the Adsadwadi (a), Balawadi (b) and Menganwadi

III. RESULTS AND DISCUSSION

A From the statistical data the frequency and cumulative curves of the profiles were shown in **Fig. 3**, they give evidences that the ‘Red beds’ in the region exhibit a wide variation in grain sizes. The variations mean (M_Z), standard deviation (σ_I), Skewness (SK_I) and Kurtosis (K_G) values with depth represented in **Fig. 2**. From those results, it is evident that the sediments of the ‘Red beds’ can be considered as heterogeneous mixture of various sizes with dominance of fine grained materials. However, some beds contains coarse grained (M_Z ranging from -0.083Ø to 0.65Ø) vertically and horizontally. In this regards, It is pointed out by **Friedman** (**1967**) that the graphic mean (M_Z) is not very sensitive to depositional environment. The standard deviation (σ_I) range from 1.28 Ø to 2.304 Ø indicate that the ‘Red beds’ sediments are poorly sorted (**Plate 1 A**). The (σ_I) values against depth do not indicate any variation in Adsadwadi profile but in Balavadi and Menganwadi profiles, on the contrary show wide vertical variation. The very poorly to poorly sorted nature of ‘Red beds’ indicate that the sediments are most probably deposited in fluvial environment characterized by a unidirectional flow (**Friedman, 1967**). Values of inclusive graphic shows (SK_I), show wide variation

(0.147 Ø to 0.370 Ø), (0.030 Ø to 0.79 Ø) and (0.12 Ø to 0.45 Ø) of the three profiles respectively. The majority of samples with positive values indicate the dominance of the fine material. Therefore, the ‘Red beds’ sediments characterized by platykurtic and in some samples either mesokurtic or leptokurtic. However, the moment measures were calculated from the cumulative curves (**Fig. 3**) and give an indicative that the ‘Red beds’ sediments are poor sorted, leptokurtic and medium to fine grained sediments.

From the four statistical parameters values the ‘Red beds’ sediments are heterogeneous nature with the dominant of fine grained population (**Pettijohn, et al. 1972**). The vertical variation in all parameters can be attributing to a number of episodes of sediments deposition under subaerial fluvial environmental conditions.

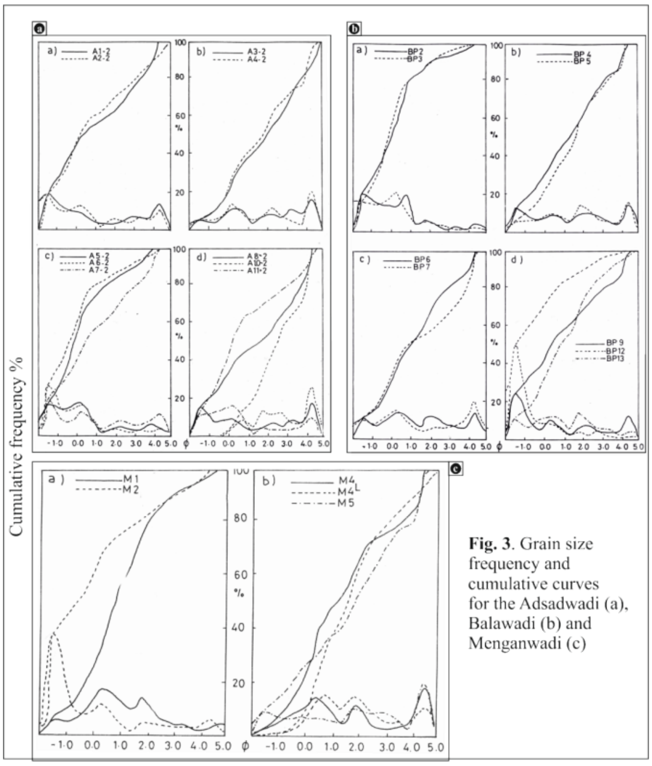

Fig. 3. Grain size frequency and cumulative curves for the Adsadwadi (a), Balawadi (b) and Menganwadi (c)

A. Environment of sediments deposition

Results of the statistical parameters have been used to interpretation the environmental deposit (**Passega, 1957-1964**; **Friedman, 1967**; **Moiola and Weiser, 1968**; **Passega and Byramjee, 1969**). **Passega**, (**1957-1964**) and **Passega** and **Byramjee,** (**1969**) plotted median, M against C-first percentile to construct (CM) diagram that has been used for environmental analysis. From the CM plots for the ‘Red beds’ the CM plots in the region (**Fig. 4**) it is evident that ‘Red beds’ sediments appear to have been deposited as traction current deposits. The majority of the plots lie away from the field of traction current deposition. Further, the ‘Red beds’ sediments indicate their rolled nature with a mixture of highly fine (>100 M < 200 M; C >1000 micron) and coarse (> 200 M; < 1000 C micron) components. The heterogeneous nature with respect to the grain-size characteristics suggested that the sediments were initially deposited as colluvium which on subsequent reworking by fluvial processes led to the development of the ‘Red beds’.

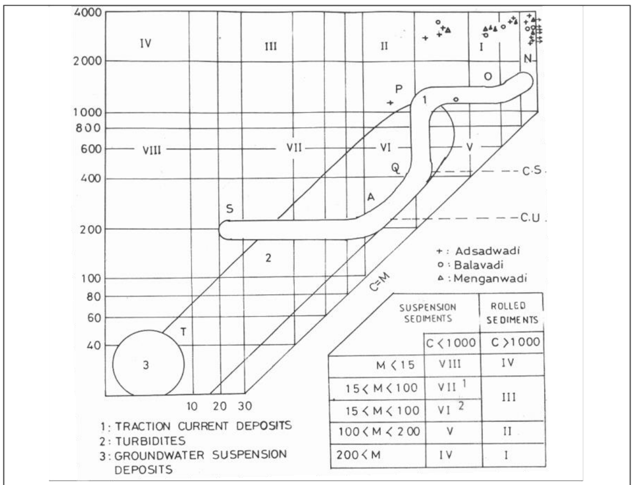

Fig. 4 C-M pattern for “Red Bed” from Khanpur plateau, Maharashtra

✓ Bivariate Diagrams

Many workers have developed a number of bivariate plots involving various statistical parameters. The authors prepared a number of bivariate plots in an attempt to distinguish between various depositional environments, such as ;(M_Z) vs (σ_I), (SK_I) vs (σ_I), first percentile vs (σ_I), simple Skewness (α_s) vs simple sorting measure (So_s), mean cubed deviation (α_3) vs (σ_I), and (M_Z) vs (σ_I), for the ‘Red beds’ in the Khanapur Plateau region (**Fig. 2**). It is clear that the sediments are of fluvial in origin and their deposition due to river action.

✓ Log Probability Curves

Visher (**1969**) pointed out that the number, amount, size range, mixing and sorting of suspension, saltation and creeping (rolling) vary systematically in relation to the provenance, sedimentary processes and sedimentary dynamic. **Fig. 5** shows the probability curves of the three profiles and used to interpret the environment of ‘Red beds’ deposition in the Khanapur Plateau. They give an evidence that the origin of the

'Red beds' sediments refer to fluvial and probably represent reworked colluvial deposits or water-laid, rock debris or mud deposits.

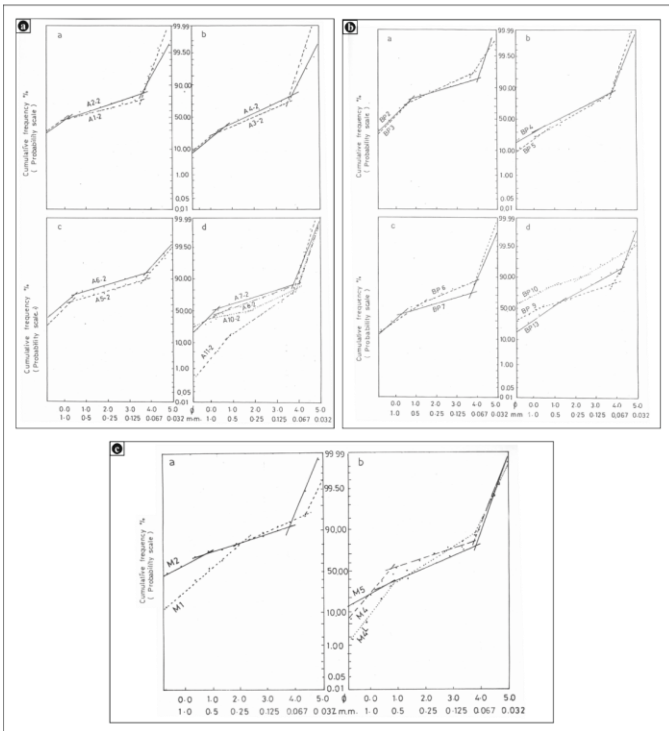

Fig. 5 Arithmetic probability curves for Adsadwadi (a), Balawadi (b) and Menganwadi (c), (after Visher, 1969)

B. Mineralogy of 'Red Beds'

Four important constituents of 'Red beds' include clayey material, opaque, lithic fragments and iron oxides. The fragments composed of plagioclases and pyroxenes that are highly altered and exhibit iron oxide staining and clay along the fractures and cleavages (**Plates 2 C & D**). The opaque are chiefly made up of magnetite and ilmenite, where specularite and hematite are secondary origin. The magnetite grains show the effect of chemical weathering in the form of etch-pits (**Plates 2 E & F**). The hematite occurs in nodular form as a result of dissolution and precipitation under pedogenic environment. The nodules appear to be of detrital nature and derived from the pre-existing 'Red beds' or laterites occurring at higher elevation and later transported along with silt and clay, finely divided to iron oxides and lithic fragments of basalt (**Plate 1 A**).. Magnetite, ilmenite, rutile, apatite, monazite and perovskite occur in subordinate amount. Thus detrital nature minerals have reveal as well as exhibited effects of weathering, erosion and transportation.

C. Clay minerals and related minerals

✓ XRD results

Samples from the above profiles are dominated by iron minerals such as hematite and goethite in addition to clay minerals (**Fig. 6**). The kaolinite and halloysite appear as minor peaks. The presence of nacrite and calcite occurring in association with 'Red beds' and have been due to secondary precipitation of calcium carbonate in 'Red beds' are account of pedogenic processes. The lower-most of the 'Red beds' from Menganwadi shows the presence of nontronite iron rich minerals belong to montmorillonite group.

✓ IR results

It was carried out to supplement the XRD data. The analysis revealed the presence of both two and three-layer type clay mineral. The IR (**Table 1, 3, 6**) results have shown a variety of iron minerals as hematite goethite and limonite and other non-clay minerals like calcite and silica (**Figs. 7**). However, huntite occurs as subordinate and between kaolinite and halloysite. The fire clay, ball clay and varieties of kaolinite were identified and have been ascribing to the presence of nontronite and rich smectite mineral group (**Van Der Marel** and **Buetelspacher, 1976**). Non-clay minerals such as calcite, dolomite, magnesite, quartz and tridymite occurring in association with the clay minerals in the 'Red beds' and have been developed due to pedogenic processes. Clay Minerals and related assemblages of the 'Red beds' do not show any profile differentiation vertically or horizontally. This suggests that the formation of clay minerals is not related to pedogenic processes and their present due to sedimentary processes.

Table 1: Grain-size frequency distribution for the Adsadwadi "Red Beds" Khanapur Plateau.

Sample No. / Class Interval In Phi	A_{1-2} Top →	A_{2-2}	A_{3-2}	A_{4-2}	A_{5-2}	A_{6-2}	A_{7-2}	A_{8-2}	A_{10-2}	A_{11-2} Bottom
-1.50 TO -1.00	19.02	18.18	5.009	4.51	16.14	26.28	19.30	10.875	15.63	0.08
-1.00 TO -0.50	11.66	10.18	3.690	4.44	14.08	12.67	8.06	12.030	6.97	0.17
-0.50 TO 0.00	9.64	10.77	6.280	7.20	15.50	13.41	7.29	13.760	7.71	0.61
0.00 TO 0.50	8.71	12.91	10.976	13.27	17.20	16.24	11.88	16.270	8.89	4.58
0.50 TO 1.00	4.75	7.63	10.569	8.85	8.38	8.84	8.37	10.330	4.77	8.62
1.00 TO 1.50	3.31	1.95	3.408	5.21	1.88	2.16	2.76	1.517	3.19	4.46
1.50 TO 2.00	3.73	5.65	6.747	6.92	3.13	3.88	5.16	4.710	4.42	14.04
2.00 TO 2.50	3.97	4.82	8.030	11.69	3.35	3.18	7.80	3.920	7.33	11.31
2.50 TO 3.00	7.30	4.28	6.387	6.87	4.40	2.26	5.45	3.910	5.71	13.03
3.00 TO 3.50	6.83	5.57	10.950	4.39	3.06	2.71	4.44	3.870	8.70	7.20
3.50 TO 4.00	5.98	4.84	8.250	2.97	2.74	1.77	7.44	4.950	7.67	6.68
4.00 TO 4.50	13.86	10.31	16.460	20.15	6.67	4.16	10.98	10.580	17.61	25.77
>4.50	1.25	2.91	3.229	2.80	3.48	2.45	1.08	3.270	1.39	3.45

Table 2: Grain-size frequency distribution for the Balavadi "Red Beds" Khanapur Plateau.

Sample No. / Class Interval In Phi	BP_1 Top →	BP_2	BP_6	BP_7	BP_8	BP_9	BP_{10}	BP_{11}	BP_{12} Bottom
-1.50 TO -1.00	10.31	46.58	24.26	8.13	9.28	5.79	12.94	15.56	19.52
-1.00 TO -0.50	05.90	12.37	9.01	6.51	5.34	5.46	7.29	13.87	13.75
-0.50 TO 0.00	10.72	7.71	4.93	10.57	9.12	6.57	6.33	16.21	13.53
0.00 TO 0.50	10.86	8.30	10.69	13.85	12.47	8.89	8.90	20.62	12.51
0.50 TO 1.00	11.55	6.07	7.20	8.56	10.12	8.57	8.10	11.54	18.92
1.00 TO 1.50	0.5.71	2.42	2.61	3.49	4.98	6.03	5.24	3.68	3.36
1.50 TO 2.00	13.91	4.18	6.11	2.85	9.40	13.96	9.38	5.04	5.66
2.00 TO 2.50	8.61	2.28	7.35	4.69	9.68	11.36	9.98	4.03	3.36
2.50 TO 3.00	6.00	4.69	4.32	4.22	5.92	5.97	7.88	3.34	00.76
3.00 TO 3.50	5.47	1.49	3.69	5.64	4.65	5.62	4.86	1.36	1.98
3.50 TO 4.00	2.97	1.11	3.73	8.69	4.07	4.81	3.33	1.74	1.14
4.00 TO 4.50	4.38	1.16	12.58	18.73	12.48	15.86	13.96	2.40	3.87
>4.50	3.61	1.65	3.51	4.07	2.48	1.12	1.81	00.63	1.60

Table 3: Grain-size frequency distribution for the Menganwadi "Red Beds" Khanapur Plateau

Sample No. / Class Interval In Phi	M_1 Top →	M_2	M_4	M_4^L	M_5 Bottom
-1.50 TO -1.00	6.56	36.92	2.87	0.35	9.07
-1.00 TO -0.50	5.26	9.33	6.71	1.30	6.03
-0.50 TO 0.00	9.55	8.31	9.94	4.12	6.94
0.00 TO 0.50	17.35	11.74	15.45	12.55	6.25
0.50 TO 1.00	14.34	6.48	11.68	15.74	6.20
1.00 TO 1.50	9.14	2.13	4.89	10.02	4.60
1.50 TO 2.00	14.07	4.86	12.32	15.44	10.86
2.00 TO 2.50	7.10	4.06	7.89	11.21	8.59
2.50 TO 3.00	4.05	3.22	2.61	5.78	9.19
3.00 TO 3.50	3.96	3.09	3.38	6.05	7.19
3.50 TO 4.00	1.72	2.91	4.60	4.35	2.52
4.00 TO 4.50	2.98	6.38	17.65	11.24	20.33
>4.50	3.91	0.55	-	3.53	2.40

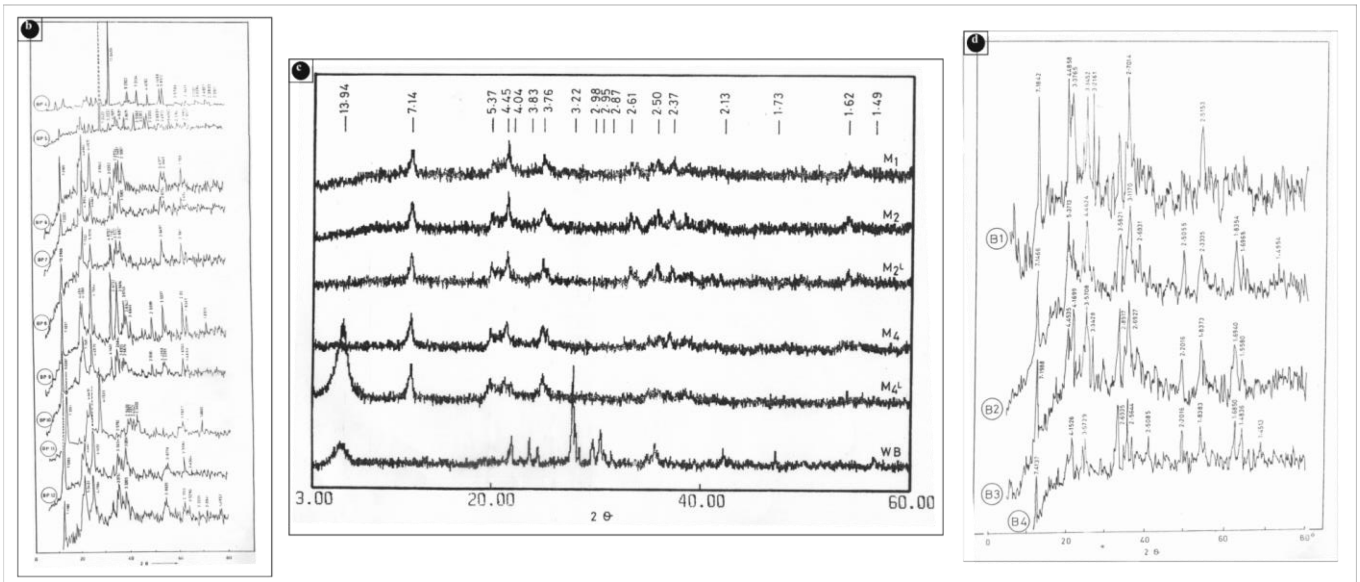

Fig. 6. X Ray diffractograms for the Balawadi (b), Menganwadi © and Blawani Khadi (d).

✓ **Secondary precipitates**

The upper horizons of the 'Red beds' show the intense effect of pedogenic processes that have resulted in the precipitation of silica and calcium carbonate as well as the formation of iron oxide nodules in the near surface. The effects of calcification in the form of variety of calcretes types are intense and similarly, the effects of dissolution and reprecipitation of iron oxide led to the formation of nodules (**Plates 2 G & H**). However, the precipitation of secondary of silica and calcite (**Plates 2 I & 3 A**) have been taken place along the fractures, bedding planes in granular spaces and solution and cavities or voids in the strata. It is observed that the 'Red beds' materials is replaced either by silica (**Plate 3 B**) or by calcite (**Plate 3 C**). Nodular iron oxide in Khanapur and Landgewadi 'Red beds' sections are show intense effect of repetitive dissolution and reprecipitation of iron oxides along with secondary silica and calcite (**Plates 3 D & E**).

✓ **Scanning electron micrographs (SEM)**

It is shown the dominance of fine detrital clays and iron oxides in the 'Red bed' and the effects of solution. The solution cavities are lined with limonite which shows a typical botryoidal structure. Some cavities filled by recrystallized hematite and kaolinite (**Plate 3**

F & G). A thin tiny platy kaolinite mineral (**Plate 3 H & I**) appears to be eroded and/or corroded indicating it's detrital and transported nature.

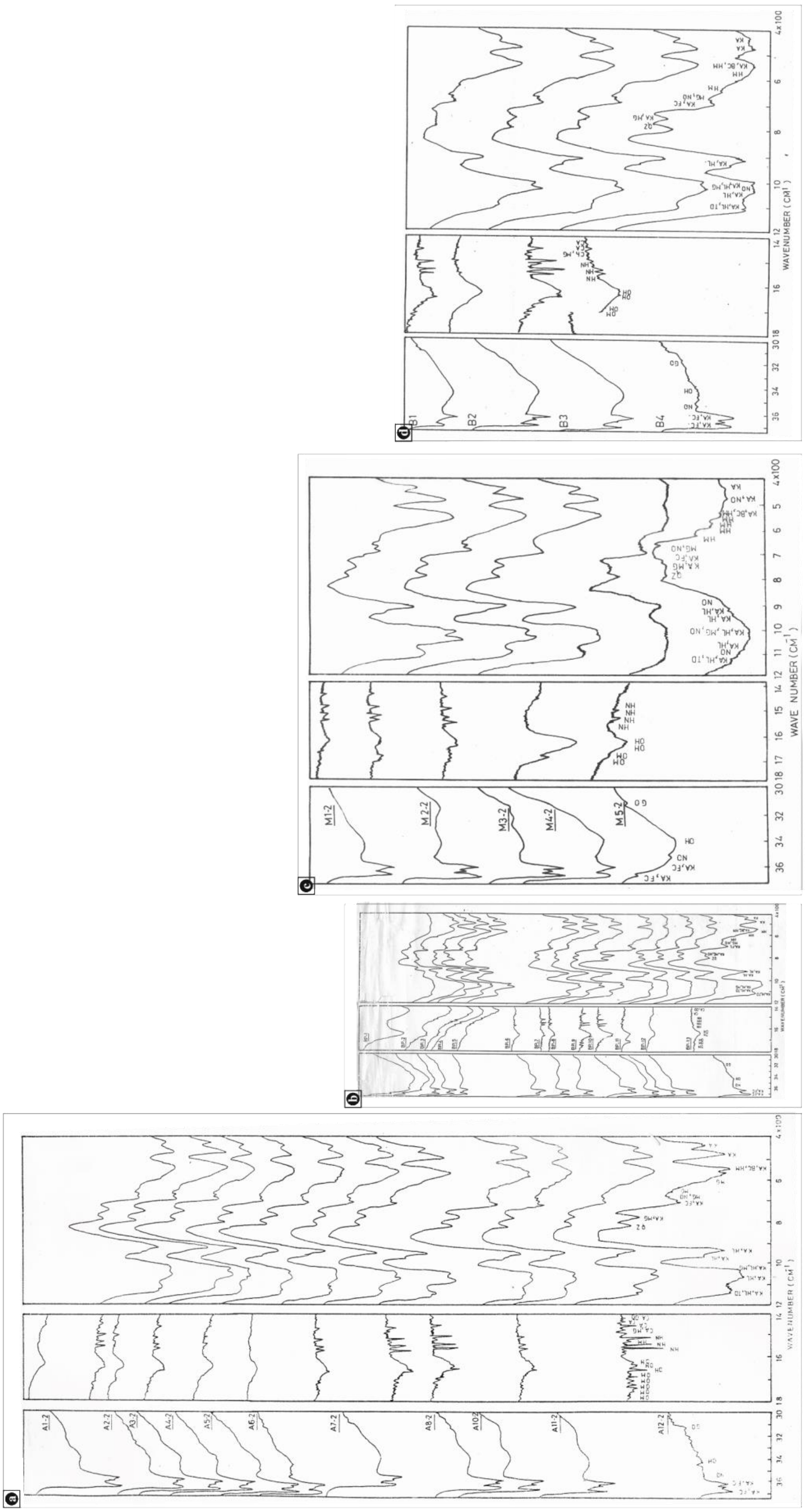

Fig. 24 IR Spectra for the Adsadwadi (a), Balawadi (b), Menganwadi © and Bhavani Khadi (d).

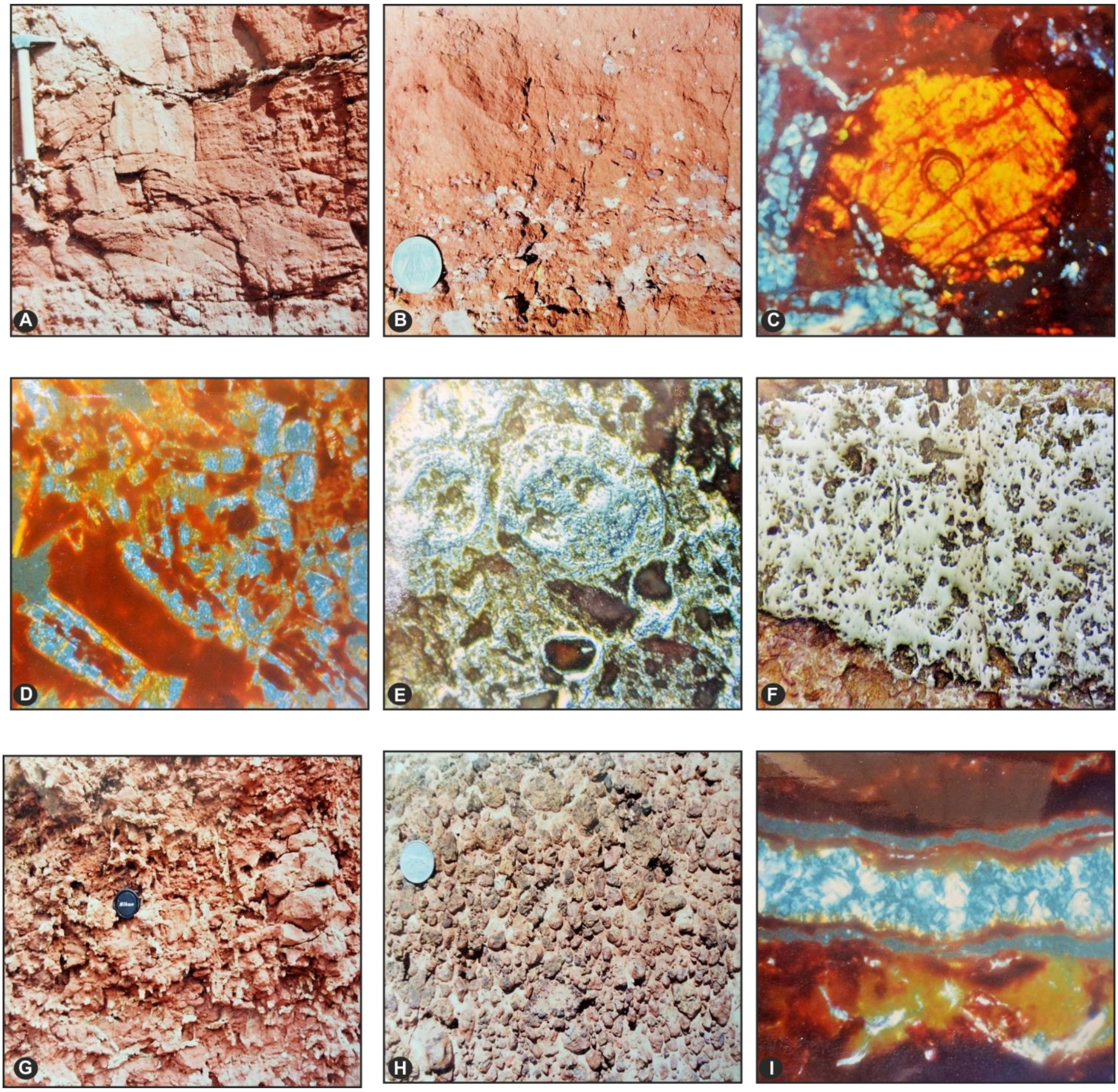

Plate 2. A. Crude planar cross stratification in the silt clay rich upper section of the 'Red bed', Menganwadi area. **B.** Pebbles arranged parallel to the bedding plane and impart crude graded bedding, Menganwadi area. **C & D.** Two microphoto show lithic fragments composed of plagioclases and pyroxenes that are highly altered and exhibit iron oxide staining and clay along the fractures and cleavages**. E & F.** SEM Photos of magnetite grains show the effect of chemical weathering in the form of etch-pits**. G & H.** The effect of calcification in the form of variety of calcretes types and the effects of dissolution and reprecipitation of iron oxide led to the formation of nodules. **I.** A microphoto shows the precipitation of secondary of silica along the bedding planes.

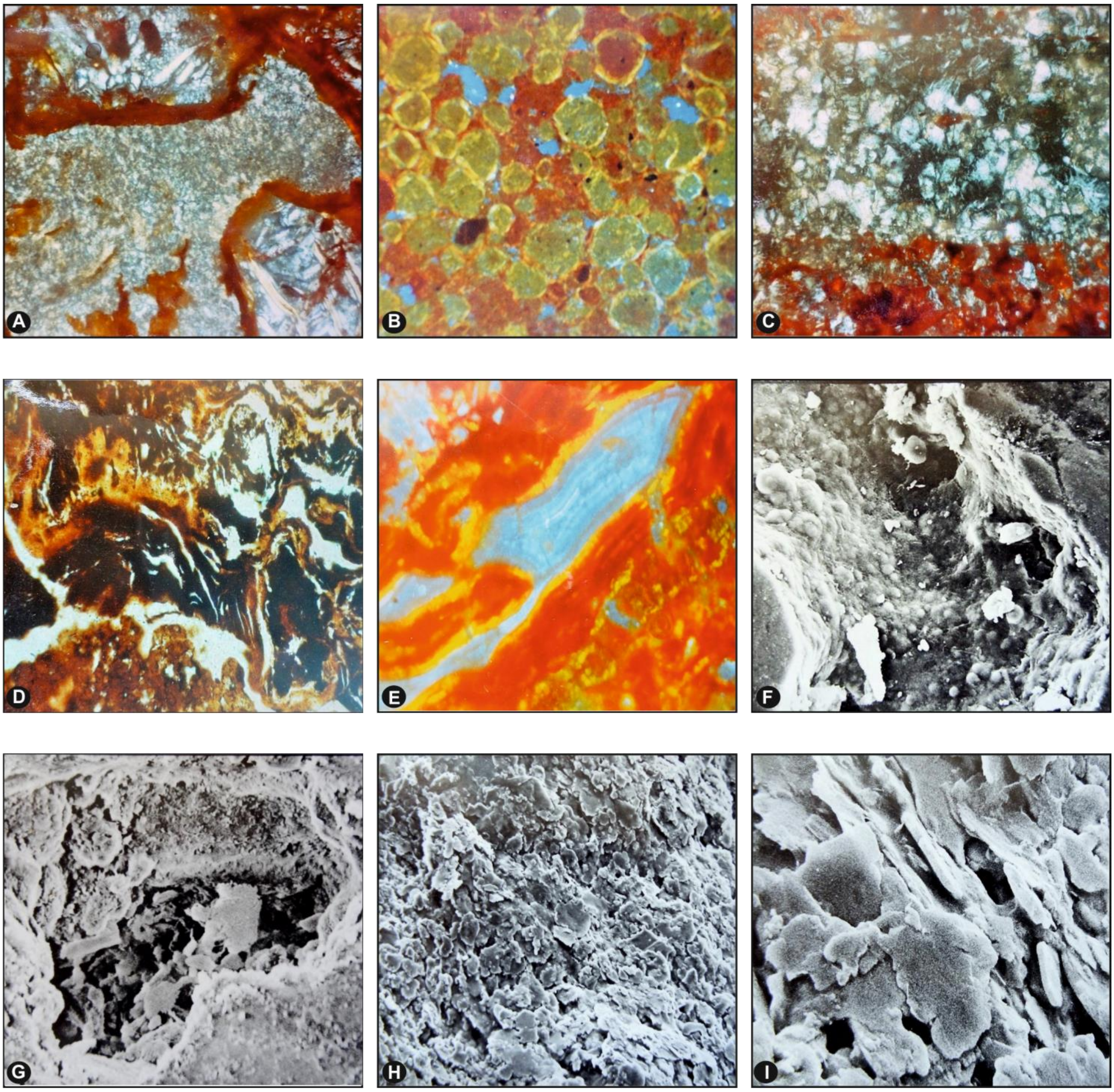

Plate 3. A. the precipitation of secondary calcite has been taken place along the cavities in the strata. **B & C.** The 'red beds' materials are replaced either by silica or by calcite. **D & E.** Nodular iron oxide show intense effect of repetitive dissolution and reprecipitation of iron oxides along with secondary silica and calcite, Khanapur and Landgewadi 'red beds' sections. **F & G** SEM photos show that the solution cavities filled by recrystallized hematite and kaolinite. **H & I.** SEM photos of thin tiny platy kaolinite mineral appear to be eroded and/or corroded indicating it's detrital and transported nature.

IV. CONCLUSION

The 'Red Beds' occur as 'fan-shaped' sedimentary deposits especially in the area around Menganwadi village, Balavadi and Adsadwadi. The basal sections of the Khanapur 'Red beds' especially in the Adsadwadi area exhibit crude planar stratification due to the parallel arrangement of boulder and cobbles set in a fine silty-clayey matrix (**Plate 1 E**). Bedding is also evident from the parallel arrangement of coarser pebbly material along the bedding planes (**Plates 1 F & G**). The change in the fluvial regime in this region during the post-'Red beds' deposition during the Quaternary period. The heterogeneous nature with respect to the grain-size characteristics suggested that the sediments were initially deposited as colluviums which on subsequent reworking by fluvial processes led to the development of the 'Red beds'. It is clear that the sediments are of fluvial in origin and their deposition due to river action. Mineralogy, four important constituents of 'Red beds' are; clayey material, opaques, lithic fragments and iron oxides. The kaolinite and halloysite appear as minor, nacrite and calcite occurring in association with 'Red beds' and have been due to secondary precipitation of calcium carbonate in 'Red beds' are account of pedogenic processes. Clay minerals and related assemblages of the 'Red beds' do not show any profile differentiation vertically or horizontally. This suggests that the formation of clay minerals is not related to pedogenic processes and their present due to sedimentary processes. The 'Red beds' materials were replaced either by silica or by calcite. In Khanapur and Landgewadi 'Red beds' sections are show intense effect of repetitive dissolution and reprecipitation of iron oxides along with secondary silica and calcite. Some cavities filled by recrystallized hematite and kaolinite. A thin tiny platy kaolinite mineral appear to be eroded and/or corroded indicating it's detrital and transported nature.

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