

Review Article *Homo Erectus* & Pale anthropological Record in the Narmada Rift Valley Madhya Pradesh & Gujarat State

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Abstract— The Narmada Rift valley is conspicuous ENE-WSW to E-W trending prominent composite structural system across Indian sub-continent. It consists of various blocks which are dislocated and faulted along various faults and lineaments in space and time. The Narmada Rift System consists of various sub-basins like Hiran, Sher, Shakkar, Dudhi, Tawa, which are minor basins are integrated and in built part of main rift System. These sub basins possess imprints of rifting and sinking events. These imprints are recorded in terms of manifestation and signature on landscape, drainage, of land form elements, present and paleo-meandering signature, river terraces, cut of meanders, paleo-channels, scars, rock cut terraces, entrenchment and linear and curvilinear scars. These sub basins have developed transverse to the main axis of Narmada rifting and had deep cut across the quaternary blanket. The evolution of Narmada graben is differential and asymmetrical with rifting and sinking valley floor. The Narmada basin contains fossiliferous Pliocene–Pleistocene volcanic fabrics sediments and volcanic rocks which were occupied by early hominid populations. The Main Narmada rift is both symmetrical and asymmetrical in different segments along its length of about 1300 km. Several paleoanthropological localities, archeological sites ranging in age from the Pliocene-Pleistocene times were discovered within these basins. The discovery of Human Skull *Homo erectus* form boulder conglomerate bed of Hathnora formation Khan (1992) by Sonakia (1984) De Lumley, and Sonakia, (1985): in Sehore district M.P. India was first fossil skull of fossil man from Indian sub-continent. It is correlated with *Homo-eructs* of China on Quaternary Platform is found to be the oldest homo-erectus in Asia Khan et.al (2013)

The known Pliocene Pleistocene paleoanthropological localities have given us information about ancestors who were habitants and sparsely concentrated in the Narmada rift valley. This is not a coincidence, because the volcanic and tectonic activities that were responsible for the formation of the rift basins and formed the ideal loci of Quaternary sedimentation & created ideal environments for the proliferation of life and the preservation of faunal and floral remains. The Quaternary volcanic eruption, ash fall, repeated tectonic dislocation and were responsible for the quick burial and preservation of fossils during diagenesis. The assemblages of sediments and granulometric parameters, diagenetic processes involving silicification, calcification, feldspathization, clay formation, and pedogenesis all played vital roles in fossil preservation in the sediments. The various rock fabrics, ash bed, paleo-sole inter bedded with the fossiliferous sediments also provide temporal information about geologic processes, faunal evolution, paleo-environment, and early hominid behavior and lithic technology.

The skull cap of Narmada Man *Homo erectus* was found in Narmada Valley near village Hathnora (22° 52' N; 77° 52' E) in fossiliferous boulder conglomerate, in district Sehore, M.P., India. The skull cap is completely fossilized undistorted, renal vault nearly complete except few left supra-orbital and statures are nicely preserved. The various morphological features and robust form of skull and excessive thickness of the bones indicate that it belongs to adult male individual (Sonakia, 1984). The discovery of skull cap of *Homo erectus* in fossiliferous boulder conglomerate in association of other mammalian fossil is recorded in stratigraphic column of Quaternary deposits at the depth of 83 m, where estimated total thickness of deposits is about (325 m). This blanket consist of sediments of three domain viz. glacial, fluvio-glacial and fluvial, which were deposited in distinct environment during Pleistocene to Holocene time (Khan & Sonakia (1992), (Khan et.al. in press). The statistical analysis of sediments from these different domain in vertical column has been conducted to ascertain the environment of sedimentation and trace the breaks in climate (Khan et.al. in press). An attempt has been made for the first time Khan et.al (2013) to correlate the various stratigraphic columns of associated hominid fossils of Narmada valley (325 m) India and that of Luo-chuan sequence, (90-120 m) Chenjiawo (50 m) and Congwangling sequence (36 m) of China on unified Quaternary platform tied up and developed at mean sea level. The study revealed that the depth of occurrence of Narmada skull cap on unified Quaternary platform is about (83 m) as compared to with that of Chenjiawo and Gongwangling of China which occur at very shallow depth of 38 and 26 m respectively. The estimated age of Narmada Man based on these parameters is about 1.38 m.y. (+), which is greater than *Homo erectus* of Chenjiawo 0.65 m.y. and Gongwangling 1.15 m.y. of China An Zhisheng and Ho Chuan Kun (1989). On the merits of correlation of stratigraphic columns of Quaternary of Narmada, accumulation of sediment, rate of sedimentation, palaeo-environments, lithostratigraphy and biostratigraphic position of boulder conglomerate in unified Quaternary Platform, author consider it as one of the earliest and oldest *Homo erectus* in Asia. Khan et.al (2013). The study of morphometric parameters of skull cap of Narmada man and palaeo-environmental setting of Hominid locality in Narmada Rift System indicates that it belongs to an adult male individual and lived in dry cold and seasonally humid climate in Narmada Valley during middle Pleistocene time.

Index Terms— anthropological Record, Rift Valley, Homo Erectus, Boulder conglomerate, fluvial, fluvio-glacial, glacial, *Homo erectus*, *Homo sapiens* Pleistocene, river, Madhya Pradesh, Gujarat, Quaternary Platform, sedimentation *Homo sapiens*, *Homo erectus*

1. INTRODUCTION

Narmada River originates at Amarkantak at an elevation of about 1057m above m.s.l. it descended from the mountainous tract traversing over a distance of 1280km across the middle of the Indian sub-continent to join the Gulf of Cambay, near Baroda in Gujarat state. The river course of Narmada is conspicuously straight, controlled by E-W lineament. It descends down the mountainous tract through deep and steep gorges in straight sinuous to meandering pattern with average sinuosity index of 1.38, which at places exceeds 1.55 for some selected segments of Narmada channel. It almost flows E-W along the Lineament over a length of 1300 Kilometers across the middle of Indian sub-continent to debouch into the Gulf of Cambay in the Arabian Sea. The area of study around Homonid locality Hathnora forms the part of central sector of Narmada, is bound by Vindhya in the north and Satpura range to the south; the area in between these two upland is found to be ideal locus of sedimentation as witnessed by the presence of multicyclic sequence of Quaternary terraces in the valley (Table No_1) on the surface and possess thick sequence of concealed quaternary sediments up to the depth of 320 m as witnessed by bore hole logs and data of state and Fardal agencies drilled under various projects Khan et.al (2012) Khan et.al (2013) Khan et.al (2014) Khan et.al (2015) Khan et.al (2016) Khan et.al (2016). (Plate No_1)

TABLE No_1 MORPHOSTRATIGRAPHY OF THE NARMADA ALLUVIUM

| Terrace Origin | Elevation above MSL | Nature of its Morphostatigraphy |
|-----------------|---------------------------|---|
| NT ₀ | 260-280 m | Depositional Light grey to dark grey sand and silt |
| NT ₁ | Erosional / 280-300- m | Light grey to dark grey sand and silt Depositional with rock pebble sand and silt |

| | | |
|------------------|-----------|---|
| NT _{2A} | 300-320 m | Depositional Grey & brown sand and silt. |
| NT _{2B} | 320-340m | Depositional Yellow brownish clay with silt Erosional / |
| NT _{2C} | 340-360 m | Depositional Yellow brownish clay with silt with Dark brown oxidized clay silt |
| NT _{3A} | 360-380 m | Depositional Dark brown, dark yellow clay silt Brownish red clay and silt with Calc-matrix. |
| NT _{3B} | 400 m | Erosional/ Depositional Dark brown, dark yellow clay silt Brownish red clay and silt with Calc-matrix |

2. REVIEW OF THE LITERATURE

Splishbury (1833) was first to initiate the paleontological studied of Quaternary deposits of Narmada valley. Princep (1832) described the Splishbury collection, which now forms the part of fossil collection in British museum. Falconer (1859) and Yedekker (1880, 1882, 1884) have given the detail account of vertebrate fauna from Narmada valley. Theobold (1860, 1881) was first to study the Quaternary deposits of Narmada in Hoshangabad and surrounding area. He referred the Quaternary deposits of Narmada is of Pleistocene age. He divided these deposits in lower and upper Groups and reported an axe from reddish clays of the Upper Group. In the following year Late (1881) recorded a human cranium (transported), which was identified as *Homo sapien*, supposed to have come from conglomerate bed of Lower Group. Unfortunately the cranium specimen was lost in the museum of the Asiatic society of Bengal, hence the find remained inconsequential. Pilgrim (1905) reported various stone implements and considered

the deposits to be Pleistocene age. De Terra and De Cardian (1936), De Terra and Petterson (1939) correlated these deposits with the Pleistocene of Northern India. Broadly they agreed to the classification of Narmada in to lower and upper Group as opined by Theobald (1860). West, W.D. (1962) The *Homo sapien* cranium, which Theobald thought, came from the conglomerate bed, according to them it could have come from a younger deposit. They collected many Paleolithic tools, and stone implements but they were unsuccessful in coming across any mammalian fossil. Based on fossil assemblage and stone implements they compared the Quaternary of Narmada with those of Middle Pleistocene of North Western India characterized by fauna *Elephas antiquus* (mammalian). Hoojier (1963) and Khatri (1980) studied various paleontological aspects of Quaternary deposits of Narmada valley. Triparthi (1968) compared and correlated the Quaternary deposits of Godavari Valley with the sediments of Narmada Alluvium, on the basis of fossil assemblage and stone implements. According to him the Narmada fauna was equivalent to older alluvium fauna of Indo-Gangetic plain and slightly older than that of Kurnool cave deposits. Roy, A.K. (1971), studied various aspects of ground water of Narmada valley. Gupta (1974) studied geological and geomorphologic aspects of parts of Narmada valley. Adyalkar (1975) studied paleogeography of Narmada in relevance to ground water potential. Biswas and Dassarma. (1981) Badam (1979) and Dassarma (1979) studied the fossil assemblage of Quaternary strata of Narmada valley.

Khan (1984) carried out detailed geological, geomorphological and sedimentological studies and identified three prominent terraces in the Central sector of the Narmada. (Khan Sonakia 1992), studied Quaternary deposit in vertical column in relevance to occurrence of Human Skull and reported glacial and fluvio- glacial deposit in Narmada valley for the first time. The boulder bed which yielded Hominid fossil for the first time reported to be of glacial - fluvial origin Khan & Sonakia (1992). Beside occurrences of association of ash beds with fossiliferous boulder conglomerate Khan & Rahate (1991) indicates some distant volcanic source.

Khan and Sonakia (1992) reported for the first time glacial and interglacial deposit in the Narmada valley, Central India which is represented by arid and humid cycles. Magneto-statigraphic studies are being carried out by Rao, et.al (1997). The lithostratigraphy of Narmada valley described by Khan (1984), Khan & Benarjee (1984), Khan & Rahate (1990-91), Khan & Sonakia (1992), Khan *et al* (1991), Rahate & Khan (1985), Khan (1991), Khan & Sonakia (1992), Yadav & Khan (1996).

The Quaternary deposits of Narmada have been studied in detailed in last three decade and lithostratigraphy of Narmada valley has been updated (Khan 1984, Khan & Benarjee 1984, Khan & Rahate 1990-91-90 Khan & Sonakia 1992, Khan *et al* 1991, Rahate & Khan 1985, Khan *et al.* 1991, Khan 1991, Khan *et al.* 1992, Yadav & Khan 1996. The Narmada valley embodied almost whole of the Quaternary deposits time span from the lower Pleistocene to Holocene (Khan & Sonakia (1992). Khan (1912), Khan (2012), Khan et.al (2013) Khan et.al (2014), Khan (2015), Khan et.al (2015) Khan et.al (2015) .The results of sedimentological studies Khan (2015), Khan et.al (2016), Khan et.al 2016, Khan et.al (2016) quartz grain morphology, Paleosole study Khan (2014),in recent years detailed aspects of heavy mineral assemblage, Khan et.al 2016 sedimentary structures, Khan et.al (2016) Quaternary tectonics & sedimentation, Khan et.al 2016 geomorphphic evolution Khan et.al (2016), have been attempted of Quaternary column of Hominid locality in central sector of Narmada, revealed the presence of complete sequence of quaternary sediments in Narmada rock basin viz Glacial, fluvio-glacial ad fluvial domain whereas the boulder conglomerate which has yielded human skull which is of fluvio-glacial origin Khan & Sonakia (1991) In addition Khan et.al (2016), Khan et.al (2016) studied Quaternary deposits of major tributaries across the transverse sections of Narmada valley and correlated various geological, geomorphological and sedimentological aspects.

3. QUATERNARY GEOLOGY OF HOMINID LOCALITY HATHNORA (22° -52 'N-77° 52' – E)

The area around Hathnora area is occupied by thick Quaternary sediments which represent various domain of sedimentation. Based on sedimentological characters, depositional environments, and erosional processes and their correlation with depositional / erosional terraces revealed that quaternary blanket is consisting of three domains of sediments viz glacial, fluvio-glacial and fluvial. The lower most units (Boulder bed) is of glacial origin, the boulder conglomerate of glacio-fluvial (Khan *et. al* 1991) and fluvial terraces are of fluvial paleo- domain of Narmada. The top four formations Sohagpur, Shahganj, Hoshangabad and Janwasa are designated as (NT₀-NT₃). Boulder conglomerate is assigned an independent formational status based on distinct lithology and fossil assemblage. The sequence of Quaternary events and the history of sedimentation of Narmada indicate that the upper 70m top 90m of the Narmada alluvium was deposited in two distinct aggradations episode with a distinct and well defined break in sedimentation in rift system. The dissection of the quaternary blanket resulted two terraces (NT₃-NT₂), after break in sedimentation. The sediments of this aggradations episode constitute three lithostratigraphy units Sohagpur, Shahganj, Hoshangabad formation. The sediments of the alluvial phase are underlain by a boulder bed of glacio-fluvial origin. Thus, the fossiliferous boulder conglomerate, the basal unit of alluvium marks a disconformity between the lower glacial-boulder layer and upper fluvial sediments. The fossiliferous basal boulder conglomerate is being of middle Pleistocene age (Khan 1992). The Quaternary sediments in Narmada valley comprise of three distinct groups of deposits viz. glacial, fluvio- glacial and fluvial; their age, litho constituents, environments of deposition and associated geomorphic elements are given in the (Table 1,2 Plate No_2 to 5)

The Narmada valley forms a ENE-WSW lineament and these Quaternary deposits in it are confined to trough like basin, with profound asymmetry in northern and southern valley walls. The Narmada valley in Peninsular India forms a prominent lineament with profound geomorphologic and geological asymmetry between the northern and southern valley walls, giving it a tectonic

significance. The alluvial deposits of the Narmada valley represent the thickest Quaternary deposits in peninsular India. These sediments were deposited in faulted and sinking platform under structural riparian rift trench remained silent and unrevealed. The quaternary blanket of Narmada consists of sediments of various domain which were deposited in different environment in vertical chronology in faulted trough in time and space.

On the merits of detailed study of sediments Quaternary deposits of Narmada valley divide in to three distinct group viz. glacial, fluvio- glacial and fluvial; their age, litho constituents, environments of deposition and associated geomorphic elements are given in the Table_2,3 below:

Table No_2 Quaternary deposits of Narmada Valley

| Age | Quaternary formations | Litho constituents | Environments of Deposition | Associated geomorphic Phenomena |
|--------|--|--|------------------------------------|---|
| 1 | 2. | 3. | 4. | 5. |
| Recent | Younger Alluvium Fluvial terraces / fluvial deposit of present domain of Narmada | Reworked sediments, mostly rock gravel consisting boulder, cobble, pebble of quartzite, gneiss, granite, schist, basics, slate, phyllite, limestone & shale in a matrix of | Channel & flood plain environments | Point bars, channel bars, present day active flood plane and channel braids: Fluvial terrace: NT-0. |

| | | | | |
|------------------|---|---|-------------------------------------|--|
| | | coarse to fine sand | | |
| Holocene | Fluvial terraces / older alluvium / Sediment of paleo-domain of Narmada | Coarse gravel consisting of boulder, cobble, pebble, of quartzite gneiss granite, schist, phyllite, state, fossiliferous limestone, shale & basic rocks in a matrix of coarse to fine sand. | Channel & flood plain environments. | Fluvial terraces of Narmada NT-0 ₁ to NT-3. |
| Late Pleistocene | Fluvio-glacial deposits | Sub-angular to sub rounded boulder, cobble, pebble of quartzite, gneiss, granite schist with subordinate amount of limestone, slate, phyllite & basic rocks with coarse to fine sand | Fluvio-glacial environments | Fluvio-glacial deposits "FGT" |

| | | | | |
|-------------|-----------------|--|---------------------|------------------------|
| | | & silt. | | |
| Pleistocene | Glacial deposit | A heterogeneous mix of sub-angular to angular boulder and cobble of predominantly gneiss, granite, schist, & quartzite with subordinate amount of slate phyllite and shale together with very fine sand, silt & clays. | Glacial environment | Glacial deposits "GT". |

The statistical parameters viz MZ, STD, SKI, and KG of 150 sediment samples were computed from vertical column of 550 m of Quaternary blanket of Narmada. The synchronized study of these parameters revealed that the quaternary blanket consists of sediments of three domain exhibiting three distinct phases of sedimentation viz glacial, fluvio-glacial and fluvial.

The study of statistical parameters and their binary relation distinctly display contrasting and relative heterogeneity in sediment characteristics throughout across the Quaternary blanket in Narmada valley. The study of sediments display diagnostic characteristics of glacial, fluvio-glacial and fluvial environment at different depth and levels 000.m to150, 150 to 350, and 350 to 550 m from glacial, fluvio-glacial fluvial, and fluvial

deposit (202 samples). The critical analysis of these parameters exhibits sediment textural linkage to long evolution in glacial, fluvio-glacial and fluvial environment in time and space in increasing antiquity in the valley. The characteristics inherited by the sediments from pre-existing domain of sediments are glacial & terrestrial & environment. The diagenetic and diagnostic features; varying degrees of heterogeneity, sediment angularity roundness, degree of sorting indicate evolution and sedimentation of quaternary sediments in a high-energy turmoil glacial environment on tectonically dislocated and unstable platform. The sediments confined up to 150 m below ground level represent paleo fluvial domain of Narmada and represent multi cycle sedimentation under varying energy condition on oscillating platform. The vertical variation in increasing antiquity in textural parameters and distinct breaks at specific level identified indicate changes of environments of sedimentation in vertical columns from glacial at the bottom of valley trough subsequently followed by fluvio-glacial and further overlain by fluvial deposits which is related with change of climate and tectonic in watershed of Narmada.

The binary relation of these parameters effectively used in differentiating and fencing the sediments of these domains and their environment of sedimentation in time and space.

The binary plots of co-efficient of sorting v/s kurtosis and coefficient of sorting v/s mean diameter have been used as effective tool in delineating an area of occupation of glacial and its activity. The plots of skewness v/s mean diameter and kurtosis v/s mean diameter have also been found effective to some extent in delineating areas glacial and fluvial activity. The fluvio glacial sediments in all the above plots show most erratic behavior and are not to be bounded by any pair of parameters. But however, the plot kurtosis v/s skewness is positive to some extent in demarcating a flexible boundary between glacial and fluvio-glacial sediments.

4. QUATERNARY TECTONICS & SEDIMENTATION

In Hatnora in the central sector of Narmada valley Quaternary deposits are confined in trough like basin, with profound asymmetry in northern and southern valley walls. The Narmada in this segment embodies the quaternary landscape with stepped sequence of Narmada terraces (NT1 to NT3), where Boulder conglomerate exposed at the base of these deposits. The Boulder conglomerate is persistent horizon and represent distinct fluvial-glacial phase of sedimentation. It is underlain by Boulder bed which is concealed under younger sediments in the valley. The Quaternary landscape embodies the imprints of tectonism which revealed that sedimentation had been controlled by mechanics of SONATA LINEAMENT ZONE. The Quaternary deposits of Narmada valley represent the thickest were deposited in faulted and sinking platform under structural riparian rift trench which remained silent and unrevealed. The work so far carried out is restricted to quaternary deposits of exposed section of 18 m, so far no work has been done on concealed strata of quaternary deposits their source of sediments, mode of transportation deposition tectonic environment of sedimentation and overall sedimentological aspects to conceive the model of quaternary sediment. The lack of concealed deposits and environment of sedimentation of these deposits which handicapped the systematic search of human remains with precise strata in synchronization of mechanics of tectonics and sedimentation in rift valley. The records of search of human skull and its remains revealed that the search was mostly random and confined to hominid locality Hathnora from where skull of Homo erectus was reported by Sonakia (1984) and thereafter. except Sankhyan, A. R. (1997b) no further addition in tracing the human remains and its evolution is made. The present studies on various aspects of sedimentology of exposed section and bore hole logs across the vertical column of about 180 m in the light of tectonism and environment sedimentation in vertical chronology in faulted trough in time and space may provide clues in understanding the modal of quaternary deposits and in search of human skull and its remains.

The Quaternary sediments of Narmada represent the thickest deposit in Central India in faulted and

sinking platform under structural riparian rift trench which remained undisclosed and unrevealed. In the present work 202 sediment samples were collected from exposed section and bore hole logs across the vertical column 550 m (Khan et.al (2016)). These sediments were deposited in different environment in vertical chronology in faulted trough in time and space which have been differentiated. The statistical parameters viz MZ, STD, SKI, and KG of sediment samples were computed from vertical column of 550 m Quaternary blanket of Narmada. The synchronized study of these parameters revealed that the quaternary deposits consists of sediments of three domain viz glacial, fluvio-glacial and fluvial representing Boulder bed, Boulder conglomerate and Fluvial terraces (NT1 to NT3), which were deposited from Pleistocene to Upper Pleistocene time. The study of various parameters their binary relation, their concentration of plots cluster and trends and patterns in revealed three breaks in vertical column 120 m, 210m and 280 m in increasing antiquity in Narmada valley. The clusters of plots of mean size and sorting, mean size and skewness and kurtosis can be ascribed to delineating a boundary between the glacial and fluvio glacial and fluvial sediments. The concentration of plots separates 87 % sediments fluvial domain fluvio-glacial 94% of the fluvial-glacial from glacial. The glacial sediments are un-oriented and un-organized, fluvio-glacial moderately organized whereas, the sediments of fluvial domain are well organized in synchronization shape size sorting and sequential, display a balance harmony and ecology in conformity of sedimentation .. The statistical parameters viz MZ, STD, SKI, and KG of samples were computed from Quaternary deposits. The synchronized study of these parameters revealed that the quaternary blanket consists of sediments of three domain viz glacial, fluvio-glacial and fluvial representing Boulder bed, Boulder conglomerate and Fluvial terraces (NT1 to NT3), which were deposited in linear trench from Pleistocene to Upper Pleistocene time in increasing antiquity on unstable platform . Khan et.al (2015), Khan et.al (2016).

In Narmada Rift system presence of the Katni Formation with angiosperm flora suggests that

sedimentation continued during Mio-Pliocene in localized lakes. The relative disposition of such lakes and subsequent deformation and structural dislocation on oscillating valley platform clubbed with rifting and faulting during Quaternary period has shifted the site of the lakes towards the present alluvium-covered area between Harda and Jabalpur as presumed: where as the present study of various aspects of Quaternary blanket in SONATA lineament ZONE revealed that quaternary sedimentation was a sequential and continuous process in rift valley system from Mio-Pliocene Pleistocene time, has deposited complete sequence of glacial, fluvio-glacial lacustrine and fluvial deposits with changing environments and climate in time chronology. The present disposition of quaternary blankets in Son Narmada Tapti and Purna basin is due to post deposition Quaternary tectonics which is solely responsible for dislocation, faulting and shifting of different blocks and distorting quaternary blanket ecology in rift system. The occurrence of Boulder bed and Boulder Conglomerate in Son Narmada Tapti and Purna with similar rock assemblages and suites of rock fabrics, heavy mineral assemblages, and quartz grain morphology in critical and crucial sections across the SONATA LINEAMENT ZONE strongly support tearing and rifting of quaternary blanket during late Pleistocene time. The presence of thick boulder bed in Harda inliers area, such as at Chandgarh and north east of Barwaha, boulder bed in confluence are of Tapti and waghur around Khadgaon in Tapti valley Khan et.al (1984) supports this assumption.

The present an integrated analysis of the stratigraphy of the Quaternary deposits of the Narmada valley; is based on multiple criteria of morphostratigraphy, soil stratigraphy, tephra stratigraphy, lithological assemblage, biostratigraphy volcanic ash bed and polarity. Based on critical data analysis the stratigraphy of quaternary deposit of Narmada Valley has been attempted for the first time. The Quaternary alluvial sequence of the Narmada Valley is well known for its rich and diverse mammalian fossil content and Paleolithic tools (Princep, 1833; Splisbury, 1837, 1844, 1883; Falconer, 1859; Theobald, 1860, Lydekker, 1880, 1882, 1884; DeTerra and Patterson, 1939; Khatri, 1961 & 1966;

Choubey, V.D. 1970, Dassarma, 1979; Badam, 1979; Biswas and Dassarma, 1981; Kennedy, K.A.R. (1991) Khan and Sonakia, (1992). It further gained prominence with the find of skull cap of *Homo erectus* (Sonakia 1984) and volcanic ash beds Khan et.al (1984) & Khan et.al (1992,) Basu et. al. 1987).Based on analysis of multiple thematic data the stratigraphic classifications are summarized in (Table No _2,4 & Plate No_1 to_5)

5. HOMINID LOCALITY HATHNORA INDIAN HOMO ERECTUS & EVOLUTION (22°-52' N-77° 52' – E)

The skull cap of Narmada man *Homo erectus* Narmadanesis was found in near village Hathnora (22 ° 52" N; 77 ° 52" E) in fossiliferous boulder conglomerate, (Sonakia, 1984) at an elevation of about 268m above the m.s.l. and at the depth of about 83m in Central_Narmada Valley. These deposits are underlain by glacial deposits and overlain by fluvial deposits of palaeo-domain of Narmada. The Quaternary sequence of Hathnora is described by Khan & Sonakia (1992).

The boulder conglomerate at Hominid locality Hathnora consist of stratified hard compact basal unit comprising of rock fragments of different shape and size of granite, quartzite, sandstone, agate, chalcedony, chert, basalt and calcareous nodules tightly cemented in the matrix of brown, red and grayish sand and silt. These rock clastics constitute various sub-litho units and are supported by grey and brownish, cross bedded sand. The sub-litho units consists of mostly pebble supported horizons which contains vertebrate fossils, stone implements, like chopper, scraper hand axes and core flakes mostly of quartzite, flint, chalcedony and quartzite.

A mandible of Lantian hominid at Chenjiawo (China) was found in paleosole (S6) and at the depth of 38 m in the loess deposits A Zhisehng et. al (1989). Assumingly a roughly uniform accumulation rate of sedimentation in the line of Ma. et.al. (1978) estimation of age, the date of the Lantian mandible at Chanjiawo is computed to be about 0.65 m. m.y.r. Ho-chuan at the depth of 26m which were deposited in typical fluvial environments. In view of recovery of skull cap of

Homo erectus (Narmada Man) from older deposits and from deeper level (83m.) as compared to Chinese Hominid, the claim of Lantian Hominid of Congwangling (1.15 m.y.r.) after A Zhisehng et. al. (1989)\ needs re-evaluation of reassessment of its age.

The rock basin of Narmada is occupied by the Quaternary sediments of three domains viz. glacial, fluvio- glacial and fluvial which were deposited in distinct environments during Quaternary time. The glacial deposit comprised of thick pile of sediments occupied base of rock basin and was deposited by glacial activities in dry and cold climatic condition during early Pleistocene time. The boulder conglomerate constitute fossiliferous horizon of Narmada, deposited in fluvio-glacial environments (interglacial). It is a marker horizon of Quaternary sedimentation in Narmada Valley and as well in Central India its disposition and relation with other deposits in the valley, indicates a significant change in regional climate from cold dry to warm and humid, during which the sediment were re-worked from glacial front intermittently and deposited in the valley over a very long time. The skull cap of *Homo erectus* (Narmada Man) and other fauna recorded along with calc- nodules within the boulder conglomerate; suggest that warm climatic phase prevailed long time.

The Lantian hominid cranium at Gongwangling was found in silty loess at the depth of about 26 m. and it Luochuan standard sequence the fossil bearing stratum un-doubted to the middle part of silty loess L-15 which at Luochuan was dated to be 1.09 to 1.20 m.y.r. The hominid fossil and associated faunas were discovered in the middle part of silty layer; the age of the fossils at Gongwanling can be pinpointed narrowly to 1.15 m.y.r. This dates differs from the earliest (0.75-0.80 m.y.r.) of Ma. et. al. (1978) and from 1 m.y.r. estimate of Cheng et. al. (1978). The Lantian fossil hominid at Gondwangling is considered as earliest *Homo erectus* in China. Ho Chuan Kun (1986).

In India Narmada basin considering the one of a main loci of Quaternary sedimentation, and assuming the uniform accumulation rate of sediment in the basin in the line of Ma. et. al. (1978)

Yobin Sun & Zhisheng, An (2005) and comparing the Narmada sequence of Quaternary deposit (325 m.) with those of Luochuan standard sequence of Chenjiawo and Congwangling sequence of China. The skull cap of *Homo erectus* (Narmada Man) recovered from the boulder conglomerate of fluvio-glacial origin in middle part of Quaternary column from deep level of Narmada, at the depth of 83 m. above glacial deposits, in association of ash bed, as compared to Chenjiawo Hominid from inter bedded sequence of paleo- sols loess and silty loess at the depth of 38 m. and Congwangling 26 m. from paleo-sols which are younger than Narmada deposits.

The Narmada skull cap of *Homo erectus* which is recovered from the vom of basal unit of boulder conglomerate at the depth of 83 m. (278 m. above m.s.l.) is estimated to be of upper segment of lower Pleistocene age. It is older than the *Homo erectus* of Chenjiawo, Congwangling of China which were recovered from paleo-sole and loess deposit at the depth of 38 and 26 m. The Quaternary sequence of Narmada (325 m.) as compared to Louchuan (136 m.) sections of China on unified Quaternary platform is older and represents the complete and type sequence of Quaternary sedimentation in Narmada Rift System in Central India. The occurrence of skull cap of early man at the depth of 83 m. in basal unit of boulder conglomerate of fluvio-glacial origin in Narmada Valley is one of the earliest and oldest *Homo erectus* in Asia Khan et.al (2013) .Plate No _3, 4, 5).

6. TECTONICS AND THE PALEONTOLOGICAL AND PALEO-ANTHROPOLOGICAL RECORD IN THE NARMADA RIFT SYSTEM

The Narmada Rift System provides a unique setting for Quaternary geological sedimentological pedological paleontological and archeological investigations which indicates human origins and evolution. Skeletal and cultural remains of hominids have been recovered from many locations within the basins. The Important paleontological paleoanthropological and archeological sites occur within the Narmada Rift System. The most of localities occur on the rift floor

in between Jabalpur_Harda, in the east and Barwaha _ Rajpipla in the west in the valley.

The present work was initiated in 1982 and continued over a decade, during the tenure tremendous data on various aspects was of Quaternary geology, sedimentology, pedology, archaeology, tectonic, neotectonic and other related studies were carried out and accordingly acquired and accrued tremendous data from the ground by systematic field work, by working on official assignment as part of government duty. The virgin and previously unknown areas of the rift basins were studied and inventory of paleoantological and paleoanthropological resources were made. The survey indicated the potential of the Mio-Pliocene Pleistocene time and late and early Pleistocene Quaternary sediments of the Narmada Rift System for paleoantological paleoanthropological research.

The remarkable preservation of faunal and floral remains in the Pliocene–Pleistocene sedimentary rocks was possible because of quick burial by sediments. Moreover, these source rocks of rift system the Quaternary sediments and interbedded tuffs provided the necessary chemical components for the preservation of the fossils during diagenesis. There is a strong link between these dynamic processes, rapid sediment deposition, and fossil preservation. The most important primary and contextual data (fossils and artifacts) were embedded and preserved in sedimentary deposits until the recent exposure by tectonic driven erosional processes. The time-stratigraphic data obtained from tephra interbedded with fossiliferous Quaternary sedimentary deposits provided an important framework for the study of hominid origins, evolution, adaptations, and cultural changes. The paleoantological Paleoanthropological information from these localities is remained closely associated with Quaternary sedimentary deposits boulder conglomerate and boulder bed often related to the trench Quaternary sedimentation , formation and development of rift and linear basin caused by repeated uplift, and the development of rift basins that began in the middle to late Pliocene and Pleistocene period. The unfortunate part of theses deposits is that due repeated tectonic

dislocation and faulting they are dislocated and distorted, at present are concealed under the thick pile of sediments of present and paleo domain of Narmada of late Pleistocene and Holocene time. These deposits do not provide adequate opportunity to researcher to study the human remain as postulated, except limited section which are exposed in river section.

The boulder conglomerate of fluvio-glacial origin which yielded human skull from Hathnora formation Sonakia (1982) Khan & Sonakia (1992) is exposed impermissibly in scarp section of Narmada at few places only. The type section of Boulder Bed and Boulder Conglomerate which are potential sediments of human remains of Pliocene Pleistocene time are hidden and concealed under sediments of present and paleo domain of Narmada in the valley. The quaternary sequence and depth of occurrence of skull cap, rate of sedimentation of Hominid locality Hathnora (22°52'77"52') (325 m) India, has been correlated with the Quaternary of Luochuan (90-120 m) Chenjiawo (50m) and Congwanling sequence (36 m) of China on unified coded model of Quaternary platform tied up and developed at mean sea level to ascertain the depth of occurrence and of age of skull cap of Narmada *Homo erectus* Sonakia (1984), at the rate of sedimentation (83 m) Khan et.al (1213) which indicates that the human skull *Homo erectus* of Narmada is oldest in Asia.

Moreover, pyroclastic rock fabrics, calcareous siliceous and ferruginous material which constitute the fossil bearing horizons are of glacial and fluvio-glacial origin are interbedded between the sediments of fluvial domain at the top and sediments of boulder bed of glacial origin at the bottom. These sedimentary deposits; the pyroclastic rocks contribute to fossil preservation and act as chronometric controls. The calcareous siliceous and ferruginous feldspar lavas and tuffs, and mafic lava flows provide temporal constraints for the timing of volcanic and tectonic activities, rift evolution, sedimentation, and the hominid remains and artifacts.

In Narmada valley the most of the hominid remains and associated artifacts in the would have

been found associated with Miocene Pliocene–Pleistocene sediments in increasing antiquity unfortunately same are not exposed due rift system and tectonic setting. In the rift system the type development of Quaternary blanket is confined between Jabalpur_Harda section, which posses the complete sequence of all three domain in increasing antiquity from the bottom of the rift trench Boulder bed (glacial), Boulder conglomerate (fluvio-glacial) sediments of paleo-domain of Narmada (fluvial). The intense tectonic activities within the basins of the Narmada Rift System during the Neogene and Quaternary periods have destroyed fossil record except the fossiliferous horizons exposed in river sections. The erosional-sedimentary cycle has persisted in the rift valley environment for millions of years as a result of the interplay between depositional and erosional forces driven by tectonic processes; there are numerous gaps in the fossil record, particularly in the important time period between Mio-Pliocene Pleistocene times. It is pertinent to the understand the origin of Hominid during the late Miocene, but it is difficult to disclose mysteries of human evolution in Narmada due to concealed nature of these deposits in rift system, however the complementary part of Tapti-Purna Quaternary blanket may be potential and possessive of human remain and should be studied to trace further the imprints of fossil man taking in to account of SONATA LINEAMAN ZONE as single ecosystem for evolution of man in Indian subcontinent (Plate No.4,5,6).

7. TECTONISAM, VOLCANISM, SEDIMENTATION PROCESSES AND FOSSIL PRESERVATION

The geological history of Narmada is characterized and has received huge of voluminous Deccan basaltic lava flows in the southern margin represented by Satpura and Vidhyan sedimentation represented by cuesta on the northern margin which have sharp cut across the deep valley floor of pre Cambrian basement. The rift linear trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The mafic and siliceous volcanic

activity is both isolated and simultaneous and their disposition is mostly asymmetric across the rift zone. The Quaternary sedimentation incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rifting and sinking environment, block faulting and segmental and linear displacement and dislocation, uplifting and isolated domal up-lift, Neogene rifting and Quaternary sedimentation and rift-bound Pliocene–Pleistocene rifting and volcanic activity specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System. The Quaternary sedimentation was triggered by tectonic activities / up lift and climatic changes. The provenance for these sediments is the weathering products of eroding pre-Cambrian, meta-sediments, sedimentary and volcanic rocks along the watershed upland, rift escarpments and shoulders; faulted and uplifted blocks, volcanic fissure zones, and plateaus within and outside the rift. The Narmada Rift System, bounded by adjacent plateaus rising 300–700 m above the rift floor, consists of number symmetrical and asymmetrical faulted blocks, escarpment, rock cut terraces, rock floors and segments of micro half graben. Although rift-related basins started to form during the late Oligocene to early Miocene times, the Narmada Rifts were fully defined by middle to late Miocene time and further by Quaternary tectonics to late Pleistocene.

The Narmada rift system basins provided a unique setting for dynamic ecosystems that were characterized by rift-related subsidence and coeval sedimentation also created ideal loci of Quaternary sedimentation and environment for the accumulation of sediments, volcanic fabrics burial, diagenesis, and preservation of organic remains. Because rifts formed after widespread Quaternary sedimentation occurred and voluminous sediments in the rift basins were accumulated by glacial activity consequential upon the lowering of temperature and climatic changes in the region. Following the deposition of the sediments in a rift basin, mechanical compaction creates pore water circulation, leading to dissolution of calcareous, ferruginous and material, increased alkalinity of the fluids, and precipitation of new diagenetic mineral phases like clays, and carbonates which provided the necessary components for the

replacement, cementation, and preservation of fossils within fluvio-glacial fluvial and lacustrine sediments. For instance, in the case of vertebrate fossils, diagenetic minerals infill pore spaces in bone and thus preserve 3-D structure during burial and post burial isomorphic substitution of fluoride for hydroxyl groups in bone apatite, thereby changing bone carbonate hydroxyl apatite to the less soluble carbonate Fluor-apatite (Posner et al., 1984; Lucas and Prevot, 1991). The Miocene–Pliocene–Pleistocene lake deposit of Katni on the eastern rift shoulder was created by faulting, topographic control, or isostatic depression similar to that of other Rift system.

8. SUMMARY AND DISCUSSION

Abundant faunal remains in rift settings, including hominids Sonakia (1984), suggest that the Narmada Rift System created productive ecosystems during Pliocene–Pleistocene time. The volcanic rocks within the fossiliferous sediments provide temporal information for calibrating and sequencing hominid and other faunal evolution. The detailed study geological, sedimentological, geochemical, aspects of interbedded tephra quartz grain morphology of sediments of quaternary strata paleo-sole and geochronological studies of different localities for establishing accurate biostratigraphic and lithostratigraphic data, sedimentation rates, paleo-environmental and tectonic histories of different sediment columns in area along with the rift system, Interbedded volcanic rocks, allow determination of the time of rifting, the beginning of sedimentation, sedimentation rates, and the oscillation of rift platform from glacial, fluvio-glacial lacustrine to fluvial environments. The cyclic environmental transitions recorded in the sedimentary sequences of the rift basins are caused by tectonic activities (uplift and subsidence), changes in relief, and climatic variations. The climatic changes in uplift, topographic and landscape features, coupled with block faulting, rifting and sinking platform, created basins for the accumulations of thick lacustrine and fluvial sediments sequences with terrestrial and aquatic fossils. The sequential change in the sediment facies from finely bedded lacustrine deposits to fluvial sediments are

commonly noted in the sedimentary sequences and reflect environmental and tectonic changes that can be temporally determined. Moreover, regional correlation based on the chemistry and geochronology of interbedded tephra has made it possible to establish accurate stratigraphic relations that are useful for pale- environment reconstruction and evolutionary studies of fossil remains in the Narmada rift valley Khan et.al. (2013). Regional tephra correlation is being used increasingly to link sites together, and has already established that similar tephra layers are known from other parts of rift valley, as well as from other basin and peninsular India Basu, Biswas, and Acharyya, S.K. (1987); Achariya,(1993), Khan, (1992) Khan et.al. (2013). There is a great potential for further correlation of tephra in the rift system and marine sediments in the Arabian Sea. The Arabian Sea has a continuous record of deposition that extends to at least 7 million years. The Quaternary sediments interbedded with tephra within the age range of the ODP Ocean Drilling Program 721/722 stratigraphic sections of the Arabian Sea are also present within the rift floor and the western rift margin of the region. The chemical and chronological correlations of ash beds within the rift sequences of have been made with ashes described in marine sections. Detailed correlations based on orbitally calibrated time scales of pale magnetic stratigraphy Rao (1985) within Quaternary sediments of rift deposits will provide ties to establish global climate changes based on the terrestrial and marine sediments of the rift system.

The provinces of sediment are mostly from crystalline basement, volcanic, sedimentary, meta basic and sedimentary rocks, were responsible for quick burial of fossils in the rift system. The composition of the source rocks and sediments aided fossil preservation during diagenesis. For example, carbonate, limestone, feldspathic gneiss, marl and clay were credited for the excellent preservation of fossils and footprints by providing fine-grained ashes and carbonate compounds that quickly lithified (Hay, 1986; Pickford, 1986). According to Pickford (1986), fossil preservation in sediments derived from silica rocks (□6 wt% silica) is generally poor when compared with sediments from Ca- rich source rocks (□10

wt% CaO). However, most of the fossil-rich fluvial, lacustrine, fluvio-glacial sediments of the Narmada were the products of mafic and silicic rocks, basaltic lavas and limestone from east, north east and north central area of rift system. The silicic and mafic rock fabric and a matrix least stable in a fluvial lacustrine and fluvio-glacial depositional environment because of hydrolysis during burial, compaction, and diagenesis Fisher and Schmincke, (1984). In this kind of depositional environment, fossiliferous sediments with terrestrial and aquatic fauna and plant remains are generally exposed to mineralized aqueous solutions that are released during diagenetic processes. These processes include silicification, calcification, pedogenesis, clay formation, and feldspathization that begin from the time of deposition to moderate burial. The paleosols, clay deposits, and limestone beds underlying basalts are commonly noted in the area and may have aided in fossil preservation through calcification and silicification processes in a water-saturated environment. Thus, basaltic rocks greatly contributed to the preservation of the fossil record in the rift basins by providing sediment for quick burial and secondary minerals from water-rock interaction for cementation and replacement of organic remains. Moreover, because of tephra layers in sedimentary basins of different geologic periods, processes such as faulting, rifting, sedimentation and diagenesis, impact of climatic changes, age of fossils, nature and acquisition of archeological implements, and the origin, distribution, and functional significance of early hominid artifact assemblages can be deciphered. However, evidence of the effects of tectonics on fauna and flora are distinct and its signatures on dislocation and concealing of fossiliferous horizons are uncontrolled and ill defined in the ecosystem in the valley during the Pliocene–Pleistocene periods. The boulder conglomerate which yielded the skull cap of *Homo erectus* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due to concealed and hidden nature of Mio-Pliocene Pleistocene deposits whci are potential for human remains in rift system and display inconsistency in exposure of fossiliferous horizon due faulting, dislocation ad subsidence of

Quaternary blanket of Narmada rift system due to Quaternary tectonics. (Plate No 4,5)

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10. CONCLUSION

The Narmada Rift valley is conspicuous ENE-WSW to E-W trending prominent composite structural system across Indian sub-continent. It consists of various blocks which are dislocated and faulted along various faults and lineaments in space and time. The Main Narmada rift is both symmetrical and asymmetrical in different segments along it's the length of about 1300 km. In the valley several paleoanthropological localities, archeological sites ranging in age from the Pliocene-Pleistocene times, were discovered. The discovery of Human skull *Homo eructsu* form boulder conglomerate bed of Hathnora Sonakia (1984) form Hathnora formation, Khan & Sonakia (1992) was first fossil man from Indian sub-continent. This *Homo eructsu* is correlated with *Homo erectus* of China on Quaternary Platform and

is considered to be one of the oldest *Homo eructsu* in Asia Khan (2013). The boulder conglomerate of Fluvio-glacial origin which yielded human skull from Hathnora formation Sonakia (1982) Khan & Sonakia (1992) is exposed impersistently in the rift system except in the river section of Narmada. The type section of Boulder Bed and Boulder Conglomerate which possess potential of human remains of Pliocene Pleistocene time are hidden and concealed under sediments of present and paleo domain of Narmada. The *Homo erectus* of Narmada has been correlated with the *Homo erectus* of China on Quaternary platform on the merits of rate of sedimentation and depth of occurrence quaternary column(83 m) Khan et.al (1913) is estimated to be the oldest in Asia. Moreover, rock fabrics, calcareous siliceous and ferruginous material which constitute the fossil bearing horizons are of glacial and fluvio-glacial origin are interbedded between the sediments of fluvial domain at the top and sediments of boulder bed of glacial origin at the bottom. These sedimentary deposits, the rocks fabrics contribute to fossil preservation and acted as chronometric controls. The calcareous siliceous and ferruginous feldspar lavas and tuffs, and mafic lava flows provide temporal constraints for the timing of volcanic and tectonic activities, rift evolution, sedimentation, and the hominid remains and artifacts which is witnessed by the numerous archeological sites associated with the floors of the rift system. In Narmada rift system the Pliocene–Pleistocene which occurs in the rift trench system in increasing antiquity, unfortunately same are dislocated and subjected to the series of structural deformation are not exposed due rift system with present tectonic setting. However the type development of Quaternary blanket is confined in Jabalpur_ Harda section , which posses the complete sequence of all three domain in increasing antiquity from the bottom of the rift trench in increasing antiquity, from Boulder bed (glacial), Boulder conglomerate (fluvio-glacial) sediments of paleo-domain of Narmada (fluvial).The study of crucial section revealed that of the quaternary blanket of rift system, only upper sequence of quaternary sediments up to the upper horizon of Boulder Conglomerate is exposed in scarp section of Narmada, where as middle and lower sequence of part of Boulder

Conglomerate and Boulder bed is concealed due to close nature of rift system. (Plate No. 5) The intense tectonic activities within the basins of the Narmada Rift System during the Neogene and Quaternary periods has not only disturbed fossiliferous horizons but at places have destroyed fossil record. The erosional-sedimentary cycle has persisted in the rift valley environment for millions of years as a result of the interplay between depositional and erosional forces driven by tectonic processes; there are numerous gaps in the fossil record, particularly in the important time period between Mio-Pliocene Pleistocene times. It is pertinent to the understand the origin of Hominid during the late Miocene, but it is difficult to disclose mysteries of human evolution in Narmada due to concealed nature of these deposits in rift system, however the complementary part of Tapti-Purna Quaternary blanket may be potential and possessive of human remain and should be studied to trace further the imprints of fossil man taking in to account of SONATA LINEAMAN ZONE as single ecosystem for evolution of man in Indian subcontinent. On the merits of correlation of stratigraphic columns of Quaternary of Narmada Rift System , accumulation of sediment, rate of sedimentation, palaeo- environments, lithostratigraphy and biostratigraphic position of boulder conglomerate on unified Quaternary Platform, author consider it as one of the earliest and oldest *Homo erectus* in Asia. Khan et.al (2013). The study of morphometric parameters of skull cap of Narmada man and palaeo-environmental setting of Hominid locality in Narmada Rift System indicates that it belongs to an adult male individual and lived in dry cold and seasonally humid climate in Narmada Valley during middle Pleistocene time.