Journal Homepage: - www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI: 10.21474/IJAR01/2748
DOI URL: http://dx.doi.org/10.21474/IJAR01/2748
ISSN NO. 2320-5407

RESEARCH ARTICLE

IMPRINTS OF PLEISTOCENE SEDIMENTATION IN NARMADA RIFT VALLEY, CENTRAL INDIA.

Dr. A. A. Khan[1] and Dr. Maria Aziz[2].

1. Ex. Director, Geological Survey of India and Director, Rajeev Gandhi Proudyogiki Mahavidyalaya, Bhopal-462042, M.P India.
2. Director, Pri-Med Care, Lewisville Texas 75067 USA.

Manuscript Info

Manuscript History

Received: 15 November 2016
Final Accepted: 17 December 2016
Published: January 2017

Abstract

The SONATA LINEAMENT ZONE embodies the two Quaternary basins of tectonic origin on the two margins of Satpura Crustal Block. The Satpura block traversed by enechelon system of faults and lineaments is characterized by thinner crust (33-38 km deep, basement depth >2.5 km) with series of ENE-WSW trending gravity high (viz. Sendwa, Khandwa, Chicholi, Tikaria etc.) with amplitudes of 10-35 mgal. The chain of gravity high indicates extensive magmatism and emplacement of derivatives at shallow crustal levels. The associated Narmada South (Satpura North) fault and Satpura South Fault marking the two hinges of the Satpura block are fundamental in nature and extend to Moho level. The Narmada Quaternary basin in the north and Tapti-Purna basin in the south are two Graben which formed prominent loci of sedimentation in lineament zone. The area of lineament zone studied tectonically encompasses two crustal provinces of Central India Shield, namely, the Northern Crustal Province (NCP) and the Southern Crustal Province (SCP). The two provinces are separated by a crustal level shear zone, referred as Central Indian Suture.The zone has been a major locus of episodic tectonism and Quaternary sedimentation with evidences of reactivation. The E-W to ENE-WSW trending Narmada and Tapti lineament from a prominent tectonic belt (SONATA) in midplate continental India.

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent was an ideal loci for accumulation of sediments.The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and linear displacement and dislocation, uplifting and isolated domal up- lift, Neogene rifting and Quaternary sedimentation. The rift-bound Pliocene–Pleistocene rifting and volcanic activities specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System which form the base of quaternary deposits. The Narmada rift system basin platform provided a unique setting for dynamic ecosystems that were

Corresponding Author:- Dr. A. A. Khan.
Address:- Ex. Director, Geological Survey of India and Director, Rajeev Gandhi Proudyogiki Mahavidyalaya, Bhopal-462042, M.P India.

characterized by Rift-related subsidence and coeval sedimentation and has also created an ideal loci of Quaternary sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, digenesis, and preservation of organic remains. The present disposition of Narmada blanket of Narmada, Tapti-Purna and Son in SONATA LINEAMENT ZONE revealed that the rift occured after widespread Quaternary sedimentation and accumulation of sediments in the linear trench by glacial activity in late Pleistocenc.The Fluvio-glacial phase is represents by boulder conglomerate which has formed the persistent horizon in the valley. The Narmada has in the area under study has sculptured the alluvial tract into stepped sequence forming four alluvial terraces along its course. These are designated as NT0 to NT3, NT0 being the youngest terrace and NT-3 the oldest terrace where the sub terraces are designated NT2-A is NT2-B, NT2 B, besides NT2-C, NT3-A & NT3-B in increasing order of antiquity. These are both erosional and depositional terraces and confined at an elevation of, between 280 to 310-380, are separated by the scarp both of curvilinear and linear in nature facing towards river side. These are abandoned flood plains represent the level of former valley floor in the area, and were formed by cumulative climato-tectonic changes in the watershed of Narmada in the Quaternary times.

The Indian Plate is currently moving northeast at 5 cm/yr (2 in/yr), while the Eurasian Plate is moving northeast at only 2 cm/yr (0.8 in/yr). This is causing the Eurasian Plate to deform, and the Indian Plate to compress leading to tectonic activity along major fault zones. In tectonically active areas sedimentary basins undergo phases of both crustal extension and contraction leading to basin inversion and hence display features typical of subsidence and uplift. Geomorphic attributes and deformation in late Quaternary sediments are the indicators of active tectonic activity in any sedimentary basin. The geomorphic evolution in such reactivated basins is primarily due to complex interaction between sedimentation processes and tectonics. The peninsular India has been undergoing high compressive stresses due to the sea-floor spreading in the Indian Ocean and locking up of the Indian plate with the Eurasian plate to the north. Much of this N-S directed stresses have been accommodated by the under thrusting of the Indian plate below the Eurasian plate. A part of these compressive stresses are accumulated along the Narmada-Son Fault (NSF), a major E-W trending crustal discontinuity in the central part of Indian plate. The Quaternary tectonic activity recorded in the Narmada valley possibly, has wider ramifications when viewed in the larger perspective of the Indian plate on Quaternary sedimentation. This suggests a renewed phase of extreme compression of the Indian plate, which led to tectonic insecurity and may cause tumors and earth quake in peninsular India. The Narmada Rift valley forms a ENE-WSW lineament where Quaternary deposits are confined in a trough like basin on unstable platform which 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 domains which were deposited in different environment in vertical chronology in faulted trough in time and

space. The Quaternary blanket consists of sediments of three domains viz. glacial, fluvio- glacial and fluvial, which were deposited in distinct environments during Quaternary time. The Boulder Bed (20 to 260 m.) below ground level is of glacial origin, comprised of thick pile of sediments occupied at the base of rock basin and were deposited by glacial activities in dry and cold climatic condition during early Pleistocene time. The fossiliferous bed Boulder conglomerate (260 to 278 m. above m.s.l.) is of fluvio-glacial origin and top four formations in increasing antiquity are Sohagpur, Shahganj, Hoshangabad and Janwasa (278 to 350m. above m.s.l.) are of fluvial origin and represent the complete sequence of Quaternary sedimentation in Narmada valley & Central India Khan & Sonakia (1992). The boulder conglomerate 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 for very long time.

The skull cap of *Home erectus* (Sonakia1984) and other fauna recorded along with calc- nodules near village Hathnora (22 ° 52" N; 77 ° 52" E) in fossiliferous boulder conglomerate; named as Hathnora formation Khan & Sonakia (1992) is found to be associated with volcanic Ash bed of Quaternary age in the area around Hathnora, and upstream Khan et.at. (1991). The two levels of horizons of Ash bed identified are designated as NAB-I and NAB-II in ascending antiquity in the valley. The Ash bed NAB-1 is associated lower litho units of boulder conglomerate which is well preserved and persistent where as NAB-II is associated with younger deposits. The NAB-1 contains three micro layer (L-1 to -L3) and NB-II two micro layers (L-4 to L-5) in increasing antiquity.The Ash bed is associated with Hathnora formation at the depth of 78 m in Quaternary column and occurrences skull cape *of Homo erectus* at the depth of 83 m in decreasing antiquity from the top assumed that Toba eruption have taken place later than existence of *Homo erectus* which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash is NAB-I NAB-II at the depth of 72 m with the younger deposit revealed the second cyclic fall of Toba ash which certainly have had influenced on hominines and had collective and cumulative impact on *Homo erectus* (Sonakia1984) *Homo sapiens* (Thobold 1860, 81), in Narmada valley and Indian sub-continent.The Toba eruption was a mega event of very great magnitude and intensity, far greater than any known historical eruption, suggesting it had very devastating impact and repercussions. It has change the global climate environment and ecology. It is significant to note that the occurrences and association of two marked horizons at different levels further reveal that the cyclic eruption and settling of volcanic matrix has taken place with pause in the valley during sedimentation

The study of grain morphology of glass matrix, their relation with other minerals shape, size, and texture of fragments and sediments of pyroclastic origin suggest that sediments were brought from distant source in the form of thick cloud containing dust matrix and volcanic ash which was highly explosive and siliceous in nature and remained in atmosphere for quite long time. The height of the eruption column

appears to be considerable. It is postulated that the tephra preserved as disconnected bodies within the river valley sediments represent rapidly settled ash falls from a volcanic ash cloud which formed a canopy over a large part of river basins for longer time of Peninsular India where sedimentation was on in different river basins including Narmada valley. The discontinuity of Ash bed in Narmada valley and Indian subcontinent is attributed to be associated with column of volcanic eruption, quantum of volcanic matrix, wind direction, moisture density of air and rate of fall of matrix on oscillating platforms of sedimentation in different basin. It is significant to note that the occurrences and association of two marked horizons at different levels further reveal that the cyclic eruption and settling of volcanic matrix was with pause in the valley which perhaps related with pause in volcanic eruption

The volcanic eruption and consequential ash fall has created severe dislocation in ecology and environment and adversely affected hominines in Narmada valley and Indian subcontinent. It is witnessed by association of Ash bed NAB-I with Hathnora formation at the depth of 78 m in Quaternary column and occurrences skull cape *of Homo erectus* at the depth of 83 m in decreasing antiquity from the top assumed that Toba eruption have taken place later than existence of *Homo erectus* which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash is NAB-II at the depth of 72 m with the younger deposit revealed the second cyclic fall of Toba ash which have had influenced collective and cumulative the *Homo erectus* (Sonakia1984) *Homo sapiens* (Thobold 1860, 81), in Narmada valley and Indian sub-continent.

The study of cyclic Toba ash fall and using phytogeographic data, Oppenheimer (2003) argues that *Homo. Sapiens* occupied India before ~74 ka and may have undergone "mass extinction" as a result of the Toba eruption. The argument of Oppenheimer (2003) is in strong conformity with the present observation of authors. As sediment & Ash bed sequence of Quaternary column of Narmada (325m) and occurrences of fossil of skull cape *of Homo erectus* (Sonakia1984) at 83 m & human cranium *Homo sapiens* (Thebold 1960,1981) (transported) have rarest occurrences of human fossils in Narmada valley and subcontinent which also confirm the intensive impact of volcanic ash fall on these hominines and their consequential mass extinction caused by mega dislocation in ecology and environment by volcanic eruption

The Narmada skull cap of *Homo erectu*s 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 erectu*s 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 erectu*s in Asia.

The statistical analysis of sediments form 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 Luochuan sequence,(90-120 m) Chenjiawoe (50m) and Congwanling 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).

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 erectu*s 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 erectu*s 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 erectu*s in Asia. (Table No HE_1 to _3 & Plate No HE_ 1 to 9)

The Paleo- anthropological 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 these deposits is that due repeated tectonic dislocation and faulting they are displaced dislocated and distorted the presently they are only exposed in limited section of meandring loop of Narmada river in valley at the base of NT2 and mostly concealed under the thick pile of sediments of present and paleo domain of Narmada of late Pleistocene and Holocene time. The disposition of boulder conglomerate and hidden its nature does not provide an adequate opportunity to researcher to study the human remain as postulated, except in limited section where they are exposed. 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.

The rift system and platforms of sedimentation bear the imprints of and evidence of the effects of tectonics on fauna and flora are distinct, however the signatures of subsidence 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 eructs* 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 in rift system and inconsistency in exposure of fosilifrous horizon of Narmada rift system which is the handicapp in search of further human remains in Narmada valley after Khan et.al (2016), Khan et.al (2016), Khan et.al (2016)

The Quaternary blanket has been studied complete in three dimention and abot 907 sediment were collected to study of statistical parameters heavy mineral assemblage, quatrz grain morphology, quartz grain morphology of paleosole, ash bed and other aspect accross the deph of about 480 m. The study reveled that their binary relations 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 (150 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 digenetic 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 Khan et.al (2015). The study of statistical parameters across the entire thickness of Quaternary deposits revealed three breaks in sedimentation at 350 -290,190-220,100-150 which represent glacial, Fluvioglacial and Fluvial environment of in increasing antiquity in from bed rock in Narmada valley.

The qualitative and quantitative studies of heavy minerals of Quaternary deposits of different domain revealed five prominent heavy mineral suites viz, opaque suite; amphibole-pyroxene suite, biotite-muscovite-chlorite suite, garnet, sillimanite, kyanite, staurolite suite

and zircon, rutile, tourmaline suite.. The mineral of stable group viz. rutile, zircon and tourmaline show uniform distribution in the entire domain of terraces in the area of study.The zircon rutile, tourmaline and sphene are highly stable minerals though their abundance is common in quaternary deposit, hence considered to be very significant. The grain morphology and imprints of sedimentation these mineral bear are of immense significance in understanding the source of sediment, its nature of transportation, mode of transport, kinetics of medium and sedimentation. The zircon rutile tourmaline and sphene minerals occur as accessories mineral, mostly released from rock fabrics comprising boulder bed and were subjected to different degree of wear and tear and physical condition of weathering transport and deposition, the micro imprints acquired by different condition of sedimentation revealed the intense grounding and bed traction of sediments from the source. The striations on these minerals indicate intense glacial activity in the initial stage of sedimentation. These are generally angular to highly angular in shape and show very poor indices of sphericity and roundness typical of glacial environments. Occasionally sub-hedral partly broken prismatic crystals of tourmaline are also in these deposits.The study revealed that sediments were primarily derived from metamorphic source comprising of kyanite-paragonite, muscovite schist, gneiss, garnet mica schist, and Para-amphibolite tourmaline garnet metasedimentarias and meta-volcanic. Apart these minerals are also reworked from older Quaternary deposits from Boulder bed glacial deposit, Boulder conglomerate of fluvio-glacial deposit and fluvial terrace and higher and other older terraces of fluvial domain. These heavies were basically transported from the sources area by glacial fluviol-glacial and fluvial agencies to the present site of their occurrence. The configuration of minerals, rock clastic, ground mass, imprints and impact of tectonics revealed the intense grounding and bed traction of sediments from the source to site of sedimentation.

The Narmada before debouching into Gulf of Cambey a conspicuous quaternary blanket is encountered. This segment is about 90 km in length and forms the southern margin of the N–S extending Gujarat alluvial plains .A significant feature of the lower Narmada valley is the deposition of a huge thickness of Tertiary and Quaternary sediments in a fault controlled rift trench. To the south of the ENE–WSW-trending Narmada–Son Fault (NSF), the Tertiary rocks and basaltic flows of Deccan Trap Formation occur on the surface while to the north they lie in the subsurface and are overlain by Quaternary sediments .However, the overlying Quaternary sediments having a maximum thickness of 800 m (Maurya et al., 1995).

The tectonic uplift of the lower Narmada valley during the Early and Late Holocene suggests inversion of an earlier subsiding basin. Such inversions of the basin have been common in the Tertiary times and are well recorded in the sediments of that age (Roy, 1990). A symmetric convergence of the NT-1,NT-2 terraces , diagonal disposition of paired equivalent of terraces across the channel , divergent and linear disposition of cliff of NT-3 terrace in conformity of NSF revaeled constant subsidence of basin and in response to frequential movement of geotectonic activity along the NSF.

The strongest supporting evidence for the Early Holocene tectonic uplift of the area comes from the sea-level curves of the west coast of India which suggest a tectonic component of about 40 m at this time (Rao et al., 1996). In the Lower Narmada valley the Mid–Late Holocene Quaternary valley deposits is the product of a Holocene high

sea-level-induced deposition in a deeply incised valley trench trough highly influenced by NSF. The Mid–Late which resulted in both estuarine and fluvial sedimentation in the lower reaches. A significant slowing down of tectonic uplift facilitated the encroachment of the sea into the valley and the creation of a depositional wedge, which extended up to the deep in land foothills. The 5–10-m exposed thickness of the valley-fill sediments reveals tide dominated estuarine deposition in the lower reaches and fluvial deposition upstream of the tide reach.

The pre-existing quaternary platform of NT-3 of middle Pleistocene prior to induced sedimentation of tidal transgression was strongly induced by tectonic impulses of NSF. The relative disposition of terraces (NT-2 NT-3), cliff alluvial bluff and scarp, reveals that the present mouth of the Narmada river has retained roughly the originally funnel shape of the estuary formed during the Mid–Late Holocene. However, the size of the estuary is now considerably reduced in space and time with sedimentation and compressive tectonic environment. The stepped sequence of terraces NT0 to NT2A NT2B NT2C NT3A, NT3B) their dispodition, their convergence & divergence, cyclic and non cyclic nature and mutual inter relation revealed at least three mega phases and four micro phases of up rise of sea level related with tectonics of the area in late to upper pleistocene time.

The incursion and transgression of tides, present estuarine reach contains several islands, which are coeval with the terrace surface above the present tidal range. Hence, they are the products of estuarine processes of the Mid–Late Holocene and not those of the present day. Funnel shaped morphology and increasing tidal energy landward are characteristics of tide-dominated estuaries (Wright et al., 1973). Existing data suggest that the Mid–Late Holocene sea level has remained at the same level up to the present with minor fluctuations (Chappel and Shackleton, 1986; Hashimi et al., 1995). The Mid–Late Holocene sediments show tilting of 10–20 which is more pronounced in the vicinity of the NSF suggesting that the incision and uplift of the valley-fill terraces well above the present day tidal limits is related to the continued differential uplift along NSF. Evidence of tectonic uplift has been reported from the coast also in the form of raised mudflats occurring 2–4 m above present sea level (Merh, 1993). Currently, the river occupies the northern margin of the Early Holocene channel belt and is clearly more sinuous. It exhibits a narrow channel with wide meanders inside wide belts of Mid–Late Holocene terraces (NT-3) a typical pattern of under fit streams (Dury, 1970).

……....

Introduction:-

The Narmada river originates from the Amarkantak plateau of Satpura Ranges in Rewa at an elevation of about 1057 m (220 40' -810 45') flows westerly course for about 1284 kms length across the middle of Indian subcontinent before entering Gulf of Cambay in the Arabian sea in Gujarat state.

The principal tributaries of Narmada are Hiran, Sher Shakkar, Dudhi, Tawa, Central sector where as Man, Madhumati, Heran and Orsang are in lower Narmada valley. These tributaries 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 rinsing and sinking valley floor. These tributaries possess imprints of rinsing sinking and rifting events. These imprints are recorded in terms of manifestation and signature on landscape, drainage, land form elements, present and paleo- meandering segment , river terraces, cut of meanders, paleo channels, scars, rock cut terraces, selectiv channel entrenchment linear and curvilinear cliff & scrapment.

The Quaternary tract of Narmada basin covers an area of about 12950 sq. km starting from west of Jabalpur ($23^0 07^0 790530$) to east of Harda (22^0 29'; 76^0 58') for a distance of about 320 km. It is found to be ideal locus of Quaternary sedimentation in Central India as witness by multi-cyclic sequence of Quaternary terraces in the valley. The general elevation of Narmada alluvial plain varies between265.7 and 274.3 m above the sea level. The general gradient of this plain in this stretch is about 1m /Km towards West. (Plate No_1 to 3)

Sedimentation:-

The Quaternary blanket occurs in the central part of valley in Jabalpur –Harda section and in Gurudeshwar – Bharouche section in lower of valley; where as in the other part in Harda –Mandleshwar section thin and isolated caps and strips of quaternary sediments are noticed on rock cut terraces and rock benches of country rocks. In Mandleshwar-Barwani, Dhadgaon- Tilakwarda the quaternary deposits are shallow to moderate in thickness and thin out to wards east. The isolated loci of accumulation and sedimentation along the entire length of 1300 kms of Narmada area controlled by the tectonics and structural frame work and sinking and uplift of fault bounded blocks and lineaments. It is well illustrated by neoseismic signatures and imprints on quaternary deposits and landscapes in the valley. The critical analysis of landscape profile evolution of drainage, quaternary terraces, river morphology and analysis of bore hole data of basement configuration of rock and quaternary deposits revealed that Jabalpur-Harda section valley segment suffered mega dislocation and sink to level of about 1150 m as compared to the adjoining blocks and created and has formed open rock basin and platform of quaternary sedimentation. This section display complete record of quaternary deposits of glacial, fluvio- glacial and fluvial sediments in increasing antiquity from the base. The study of bore data of ETO, CGWB, and GSI indicates that average thickness of quaternary deposits of Narmada is about 435 m. The quaternary deposits bear well preserved imprints of neotectonisam indicating that the Sonata lineament zone seismically is active and has direct bearing on quaternary landscape of rift valley. The Harda –Mandleshwar section predominenently portrays the sequence of cyclic and noncyclical rock cut terraces and rock cut platform and benches which are time equivalent to the quaternary terraces of central and lower Narmada valley Khan et.al (2014). In Mandleshwar-Barwani the quaternary sediment are of moderate to shallow in thickness which are incised along with the country rock by cyclic structural dislocation and tectonic activity along ENE WSW lineament fabrics and dynamic incision of stream. It is well documented in quaternary terraces and composite erosional terraces; rock cut terraces caped by quaternary sediments, river profile and channel morphology. The morphogenetic expression of the section revealed uplift of block. The Gurudeshwar-Bharouche embodies the thickest quaternary deposits which represents complete sequence from the base glacial fluvio-galcial fluvial, lacustrine and mud deposits.

The Narmada rift system basins provided a unique setting for dynamic ecosystems that were characterized by Rift-related subsidence and coeval sedimentation also created an ideal loci of Quaternary sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, digenesis, 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.

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. The Narmada flows along seismic tectonically active NSF which forms a fault controlled basin of a huge thickness of Tertiary and Quaternary

sediments. The thick blanket of Quaternary sediments occurs in the central part of valley in Jabalpur –Harda section and in Gurudeshwar – Bharouche section in lower of valley; where as in the other part in Harda –Mandleshwar section thin and isolated caps and strips of quaternary sediments are noticed on rock cut terraces and rock benches of country rocks.The Tilakwarda _Bharouch section display complete record of quaternary deposits of glacial, fluvio- glacial and fluvial sediments in increasing antiquity from the base.

Pleistocene Phase:-

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent, was an ideal loci for accumulation of sediments .The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing 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 which forms the base of quaternary deposits . 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 symmetrical faulted blocks, escarpment, rock cut terraces, rock floors and segments of micro half grabben. 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.

The Narmada rift system basin platform provided a unique setting for dynamic ecosystems that were characterized by Rift-related subsidence and coeval sedimentation also created linear depression for Quaternary sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, digenesis, 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.

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. The skull cap of *homo-eructus* 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 geological sedimentological geochemical study of interbedded tephra ,Quartz grain morphology of sediments of quaternary strata and palo-sole of and geochronological studies of from the different localities for establishing accurate biostratigraphic and lithostratigraphic data, sedimentation rates, and paleoenvironmental and tectonic histories of different sediment columns in area along the rift system. Interbedded volcanic rocks allow determination of the time of rifting, the beginning of sedimentation, sedimentation rates, and the oscillation 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, rinsing 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 those are useful for pale- environment reconstruction and evolutionary studies of fossil remains in the Narmada rift valley Khan et.al. (2012). 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 Achariya,(1995), Khan (1992) Khan et.al. (2012) Tiwari (1996). 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 with 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 (1996) 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.
Moreover, because of tephra layers in sedimentary basins of different geologic periods, processes such as faulting, rifting, sedimentation and digenesis, 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 inconsistency concealed nature of fosilifrous horizon due faulting, dislocation and subsidence of Quaternary blanket of Narmada rift system as such researcher and scientist failed to add any further knowledge to hominid discovery any further.

The Narmada Rift System consists of symmetrical basins that have been evolved in different stages of tectonisam. The 100 -120 km-wide ad 1300 km long rift bounded by Satpura in south and Vindhyan in north constitutes conspicuous ENE-WSW to E-W rift basin zone is filled with Pliocene–Pleistocene sediments, whereas some of them contain Miocene sedimentary deposits. Most of the sedimentary sequences contain faunal and floral remains including hominid species. Most of the basin-fill sediments were derived from topographically elevated rocks that are present within and outside the rift basins. Lava flows and tephra are interbedded with the fossiliferous sediments clastic sediments derived from .The provinces of sediment mostly from crystalline basement volcanic, sedimentary, meta basic and sedimentry rocks, aided in the cementation and preservation of organic remains by providing secondary minerals released during alteration in a burial environment. Quick burial minimized the effect of preburial taphonomic processes. Moreover, chemical constituents released by the alteration have provided critical temporal and spatial information without which the study of hominid evolution and paleoenvironmental reconstruction in the Rift System would have been impossible.

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 o fauna and flora are distinct and its signatures o dislocation and concealing of fossiliferous horizons are uncontrolled ad ill defined and the ecosystem in the rift system during the Pliocene–Pleistocene periods is not clear.The boulder conglomerate which yielded the skull cap of *Homo eructs* in Narmada rift from Hathnora remained only discovery of hominid fossil in last two and half decade due inconsistency concealed nature of fosilifrous horizon in Narmada valley. Historical or modern analogs illustrate the potential of the regional and sometimes global effects of such major silicic eruptions in the geologic past of sedimentation, sedimentation rates, and the oscillation from 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. Changes in topographic features, coupled with volcanic damming, created basins for the accumulations of thick glacial, fluvio-glacial lacustrine and fluvial sequences with terrestrial and aquatic fossils. Changes 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 rift valleys across India sub continent Regional tephra correlation is being used increasingly to link sites together, and has already established that similar tephra layers fro known area in Rift system.

The Boulder Bed and Boulder conglomerate which form the base of Quaternary sediments in Central sector of armada Rift Valley are not exposed in the lower Narmada valley. These deposits are concealed under the sediments of lacustrine and fluvial deposits in the valley. The presence of these deposits is confirmed by study of bore hole data and logs of State ad Federal agencies drill in lower Narmada valley under various projects.The boulder bed is diffrentiated in Hominid locality by extensive an intensive statistical analysis of sediment collected from bore hole logs for grain size parameters heavy mineral study quartz grain morphology of sediments and plaosole which have assited in identifying the sedimentological breaks in increasing antiquity in vertical coloumns and their correlation in other sections of Narmada Rift valley.

Early to Late Pleistocene phase:-

In the Narmada valley the River terraces (NT-1 NT-2) which represents sediments of Bharuch ad Tilakarda formation date back to the Late Pleistocene. The sedimentation commenced with the deposition of the marine basal clays during the last interglacial high sea level at f125 ka, which is presumed to be about + 7 m as revealed by the studies Regression of this sea led to the initiation of fluvial sedimentation. The fluvial sediments were deposited in to two phases of sedimentation with a sharp break marked by tectonic changes and related climatic changes. The fluvial flood plain deposit of Bharuch formation overlies the marine clays followed by the fluvial flood plain deposit of Tilakwarda formation. The sequence of these to formation is exposed in the cliff section which represents different sediment facies typical of fluvial environments .The sequence of sediments display imprints of compressive tectonic regimes of sedimentation. The southern margin of lower Narmada is marked by Narmada–Son Fault, the transformation of this geofracture in Tertiary to reverse fault in Quaternary is implicit in the seismic studies of the area (Roy, 1990). Additional evidence for prevalence of compressive stress regime in the lower Narmada basin is provided by numerous reverse faults (Fig. 2B) in the Neogene sediments exposed immediately to the south of Narmada–Son Fault (Agarwal, 1986). These evidences suggest that the sediments of both the formation were formed in a compressive tectonic environment. There are evidences of subsidence of basin which has been documented on landscape of basin which are authenticated by other studies exist from adjacent area of synsedimentary subsidence on alluvial plain sedimentation (Shuster and Steidtmann, 1987; Brown and Plint, 1994; Kraus and Middleton, 1987; Kraus, 1992; Jordan, 1981; Hagen et al., 1985).

Absence of soil profiles in the thick blanket of Quaternary sediments of the study area is indicative of synsedimentary subsidence of the basin.. It is unlikely that a high sinuosity channel will produce stacked system of fluvial deposits showing these aracteristics (Shuster and Steidtmann, 1987). Deformations in these sediments of the types described above are the direct manifestations of this subsidence. Strong similarity of the structural orientations of the deformation structures suggests subsidence in a thrusting environment along the NSF which is consistent with the subsurface studies. It is inferred a low sinuosity and relatively fixed river system in a slowly subsiding basin for the deposition of these sediments.Synsedimentary subsidence of the basin due to differential movement along the NSF is indicated by entrenched meander thick overbank sediments and the deformation structures. Folding and faults with reverse movement in the overbank sediments suggest a compressive stress regime along the NSF. A brief period of tectonic stability followed as suggested by the 4–5-m thick palaeosol (red soil), which is stratigraphically correlatable with the red soil exposed in the Mahi and Sabarmati river basins of Gujarat alluvial plains.

The alluvial fan in between f Tilakwarda and Rajpipla within the loop of Narmada is mono illustration of morphogenetic process associated with neotectonic event. The disposition of Quaternary blanket, fan deposit and other quaternary land forms are controlled and restricted by SONATA lINEAMENT to wards north. The convergence of fan deposits and its apex is not in conformity of piedmont sedimentation, it is also devoid of torrential stream net work, which firmly rule out to be endogenetic fan deposits and appears to up lift cut & past mass of older quaternary deposits along SONATA LINEAMENT.

The physiographic set up and drainage configuration of the Narmada the area of study demonstrate strong influence of tectonic and structure on development ad evolution of drainage. The Narmada enters in the area around Garudeshwar descends NW –SE direction cutting across NSA entering the quaternary tract. It further down stream of Tilakarda swing to wards west and suddenly become slow and sluggish and sinuous to meandering in channel pattern long the northern edge of upland ad ultimately debouches in the Gulf of Cambay. The disposition and convergence of drainage net in conformity of disposition of quaternary landscape demonstrates is anomalous further imprints and neosiesmic signatures on landscape profile reveled persistent instability of basin during sedimentation.
The tectonic uplift of the lower Narmada valley during the Early and Late Holocene suggests inversion of an earlier subsiding basin. Such inversions of the basin have been common in the Tertiary times and are well recorded in the sediments of that age (Roy, 1990). A symmetric convergence of the NT-1,NT-2 terraces , diagonal disposition of paired equivalent of terraces across the channel , divergent and linear disposition of cliff of NT-3 terrace in conformity of NSF constant subsidence of basin and in response to frequential movement and geotectonic activity along the NSF. The displaced Late Pleistocene sediments across NSF in the Narmada and Orsang Heran and Madhumati & Karjan valleys, the NNW tilting of the NT-1, NT-2 sediments litho units consisting of the Late Pleistocene sequence, the anomalous topographic slope in the same direction and the incised cliffs up to 25–30 m in the streams that flow along this slope in the area between NSF and the Narmada River, indicate unsynchronized neoseismic movements along the NSF during the Early Holocene. The displacement of sediments of NT-1 surface across the NSF indicates differential movement of about 35 m along the NSF during Early Holocene. The block

between the Narmada and Karjan rivers bounded by the NSF and the two other cross-faults suffered subsidence leading to the formation of a series, linear and curvilinear cuts of on terraces and flood plains. The 5–8-m incised cliffs of the streams also suggest that this block escaped the uplift induced large scale incision going on simultaneously in other areas of the lower Narmada valley. The occurrence of ravines and association of deep gullies with the river terraces is morph- tectonic manifestation caused by the sudden vertical movement and block adjustment due subsidence resulting to sudden collapse of water table and ground water regime in the area. The strongest supporting evidence for the Early Holocene tectonic uplift of the area comes from the sea-level curves of the west coast of India which suggest a tectonic component of about 40 m at this time (Rao et al., 1996).

Middle Holocene - Recent phase:-

In the Lower Narmada valley the Mid–Late Holocene Quaternary valley deposits is the product of a Holocene high sea-level-induced deposition in a deeply incised valley trench trough highly influenced by NSF. The Mid–Late Holocene which resulted in both estuarine ad fluvial sedimentation in the lower reaches. A significant slowing down of tectonic uplift facilitated the encroachment of the sea into the valley and the creation of a depositional wedge, which extended up to the deep in land foothills. The 5–10-m exposed thickness of the valley-fill sediments reveals tide dominated estuarine deposition in the lower reaches and fluvial deposition upstream of the tide reach. The pre-existing quaternary platform of NT-3 of middle Pleistocene prior to induced sedimentation of tidal transgression was strongly induced by tectonic impulses of NSF. The relative disposition of terraces,(NT-2 NT-3 cliff alluvial bluff and scarp , reveals that the present mouth of the Narmada river has retained roughly the originally funnel shape of the estuary formed during the Mid–Late Holocene. However, the size of the estuary is now considerably reduced in space and time with sedimentation and t compressive tectonic environment.

The incursion and transgression of tides, present estuarine reach contains several islands, which are coeval with the terrace surface above the present tidal range. Hence, they are the products of estuarine processes of the Mid–Late Holocene and not those of the present day. Funnel shaped morphology and increasing tidal energy landward are characteristics of tide-dominated estuaries (Wright et al., 1973). Existing data suggest that the Mid–Late Holocene sea level has remained at the same level up to the present with minor fluctuations (Chappel and Shackleton, 1986; Hashimi et al., 1995). The Mid–Late Holocene sediments show tilting of 10–20j which is more pronounced in the vicinity of the NSF suggesting that the incision and uplift of the valley-fill terraces well above the present day tidal limits is related to the continued differential uplift along NSF. Evidence of tectonic uplift has been reported from the coast also in the form of raised mudflats occurring 2–4 m above present sea level (Merh, 1993). Currently, the river occupies the northern margin of the Early Holocene channel belt and is clearly more sinuous. It exhibits a narrow channel with wide meanders inside wide belts of Mid–Late Holocene terraces (NT-3) a typical pattern of under fit streams (Dury, 1970).

In the Narmada valley the River terraces (NT-3) has occupied large area on the both bank of Narmada. It extends from Orsang river in the north east to Mahi river in the west from Baroda in the north to Bharuch –Aliabet in the southwest. In the southern bank of Narmada it is developed alround Ankleshwar and Rajpipla and further south. The average elevation of this surface is about 75 m above m.s.l, separated by both linear and curvilinear scarp from NT-2. The average height of cliff is about 40 m. The sediments comprised of this terrace are exposed in the cliff section. The oldest deposit of the exposed sediment successions a highly pedogenised mottled clay horizon showing vertisolic characters like extensive fracturing giving rise to blocky aggregates, seudo anticlines and hydro plastic slickenside along the fracture surfaces. .The sediments of this terrace are associated with a rich assemblage of shallow marine foraminifers. The basal unit consisting of rock pebbles with clays is overlain by thick fluvial sediments, which comprise alluvial plain facies. The pebbly unit which contains rock fragments of quartzite, granite basalt, and limestone sandstone is about 5.5.m thick, it is a persistent horizon and exposed in the cliff section. It is marker horizon, represent distinct phase of sedimentation in the valley. In the Narmada valley the River terraces (NT-3) which represent sediments of Ankleshwar formation. The fluvial sediments indicate deposition in single phase of fluvial sedimentation with a sharp break marked by tectonic changes and related climatic changes. The sequence of this formation is exposed in the cliff section, is marked by the major break in sedimtation as witnessed by the occurrence of persist pebble horizon at the base .This formation represent different sediment facies typical of fluvial environments .The sequence of sediments display imprints of compressive tectonic regimes on sedimentation. In the lower Narmada Valley alluvial fan as identified between Tilakwarda and Rajpipla within the loop of Narmada is mono illustration of morphogenetic process ad morph tectonic =manifestation associated with neotectonic event. The disposition of Quaternary blanket, fan deposit and other quaternary land forms are controlled and restricted by SONATA LINEAMENT. The convergence of fan deposits and its apex is indistinct

and not in conformity of piedmont sedimentation, further it is devoid of torrential stream net work and environment it firmly rule out to be endogenetic fan deposits. The present study of these deposits their disposition its composition indicate that these deposits are older deposits and brought to the present position by tectonic activity along SONATA LINEAMENT.

The boulder bed is diffrentiated in Hominid locality by extensive an intensive statistical analysis of sediment collected from bore hole logs for grain size parameters heavy mineral study quartz grain morphology of sediments and plaosole, which have assited in identifying the sedimentological breaks in increasing antiquity in vertical coloumns and their correlation in other sections of Narmada Rift valley.

The sediments of paleo-domain of Narmada conformably overlie the boulder conglomerate and represent the flood-plain fluvial facies of the Narmada. The sediments of the fancies predominantly consist of clay silt and sand, discontinuous nodules and plates. The beds are horizontal, exhibit upward fining sequence typical of fluviatile deposits .This domain may be divided into three formations based on lithology, sediment assemblage, shape and size of rock clastics, relative disposition and diagnostic sedimentary characteristics. These formations are, viz. (i) Shohagpur, (ii) Shahganj, and (iii) Hoshangabad Formations respectively. These formations represent the sediments the complete sequence of Narmada deposited in channel and flood plain environments during Upper Pleistocene time. (Plate No _5 to_8)

Neotectonics Tectonics & sedimentation:-

The Indian Plate is currently moving northeast at 5 cm/yr (2 in/yr), while the Eurasian Plate is moving northeast at only 2 cm/yr (0.8 in/yr). This is causing the Eurasian Plate to deform, and the Indian Plate to compress leading to tectonic activity along major fault zones. In tectonically active areas sedimentary basins undergo phases of both crustal extension and contraction leading to basin inversion and hence display features typical of subsidence and uplift. Geomorphic attributes and deformation in late Quaternary sediments are the indicators of active tectonic activity in any sedimentary basin. The geomorphic evolution in such reactivated basins is primarily due to complex interaction between sedimentation processes and tectonics. The peninsular India has been undergoing high compressive stresses due to the sea-floor spreading in the Indian Ocean and locking up of the Indian plate with the Eurasian plate to the north. Much of this N-S directed stresses have been accommodated by the under thrusting of the Indian plate below the Eurasian plate. A part of these compressive stresses are accumulated along the Narmada-Son Fault (NSF), a major E-W trending crustal discontinuity in the central part of Indian plate.The Quaternary tectonic activity recorded in the Narmada valley possibly,has wider ramifications when viewed in the larger perspective of the Indian plate. This suggests a renewed phase of extreme compression of the Indian plate, which led to tectonic insecurity and may causes tumores and eatrh quake in peninsular India. The manifastion of impact of compressional forces with the movement of Indian plates have resulteded reapd and frequention migration and changes in courses of Kosi, Sharda, Ghaggar, Ghagra and their tributaries in Ganga plain. The Himalayan river Ganga and Jamuna in intermontane region had unilateral chiselled fluvial terraces in western and eastern extrimity of river banks which are unpaired and non cyclic in nature indicating up lift and up rising of block in between these two mighty accedental river. Besides area also possess imprints of neotectonisam, hanging drainage, tilt in terraces, over stepping of alluvial fan and chopping of apex from main body of fan deposits along the fault and lineament hanging which further revealed that area is under stress and within the peheriphary zone of substration and collision Of Indian and Euratian plate. (Khan et al 2016)

In Narmada Rift system taking as single ecological unit for Quaternary sedimentation & tectonics and presence of the Katni Formation in central sector 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 -Jabalpur, Garudeshwar and Bharouch as presumed: where as the present study of various aspects of Quaternary blanket in SONATA LINEAMENT ZONE reveled 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 fluvial and tidal deposits with changing environments and climate in time & space . The present disposition of quaternary blankets in Son Narmada basin is due to post deposition Quaternary tectonics which is solely responsible for sedimentation, dislocation, faulting and shifting of different blocks and distorting 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 Narmada Rift valley formed a linear trench in the middle of Indian subcontinent was unique site for accumulation of sediments.The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and linear displacement and dislocation, uplifting and isolated domal up- lift, Neogene rifting and Quaternary sedimentation. The rift-bound Pliocene–Pleistocene rifting and volcanic activities specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System which form the base of quaternary deposits. The Narmada rift system basin platform provided a unique setting for dynamic ecosystems that were characterized by Rift-related subsidence and coeval sedimentation and has also created an ideal loci of Quaternary sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, digenesis, and preservation of organic remains. The present disposition of Narmada blanket of Narmada, Tapti-Purna and Son in SONATA LINEAMENT ZONE revealed that the rift occured after widespread Quaternary sedimentation and accumulation of sediments in the linear trench by glacial activity in late Pleistocenc.The Fluvio-glacial phase is represents by boulder conglomerate which has formed the persistent horizon in the valley. The Narmada has in the area under study has sculptured the alluvial tract into stepped sequence forming four alluvial terraces along its course. These are designated as NT0 to NT3, NT0 being the youngest terrace and NT-3 the oldest terrace where the sub terraces are designated NT2-A is NT2-B, NT2 B, besides NT2-C, NT3-A & NT3-B in increasing order of antiquity. These are both erosional and depositional terraces and confined at an elevation of, between 280 to 310-380, are separated by the scarp both of curvilinear and linear in nature facing towards river side. These are abandoned flood plains represent the level of former valley floor in the area, and were formed by cumulative climato-tectonic changes in the watershed of Narmada in the Quaternary times.(Khan et.al 2016).

The Quaternary landscape of Narmada comprises (NT-1 to NT-3) and their correlation with rest of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch suggest that it has evolved mainly due to tectonic activity along the SONATA LINEAMENT in a compressive stress regime. The sediments comprising these were deposited in a slowly subsiding basin during early Pleistocene middle Pleistocene and the Late Pleistocene. The Holocene period is marked by inversion, which had earlier suffered subsidence. The inversion of the basin is due to a significant increase in compressive stresses along the NSF during the Early Holocene, resulting in differential uplift of the lower Narmada valley. The continuation of the compressive stress regime due to ongoing northward movement of the Indian plate indicates that the NSF is a major candidate for future intraplate seismicity in the region.The alluvial fan in between f Tilakwarda and Rajpipla within the loop of Narmada is mono illustration of morphogenetic process associated with neotectonic event. The disposition of Quaternary blanket, fan deposit and other quaternary land forms are restricted by SONATA lINEAMENT to wards north. The convergence of fan deposits, geomorphic set up slope , impersistancy of apex and other convering points are not in ecology of piedmont sedimentation, hence it is firmly rule out to be endogenetic fan deposits ; the assemblage of sediment matrix rock fabrics and rock pethology and occurrence and disposition of these deposits indicate that it is uplifted cut mass of older quaternary deposits which has moved by tectonic activity from deep level of strata and has been pasted along SONATA LINEAMENT.(Khan et.al 2016).

There are evidences of the effects of tectonics on fauna, flora .and tephra layers associated with Quaternary deposits of Narmada Rift valley, have under gone faulting, rifting, and dislocation during sedimentation. The impact of structural disturbances and\evidence of the effects of tectonics on fauna and flora are distinct and their 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 eructs* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due inconsistency and concealed nature of fossiliferous horizon due faulting, dislocation and subsidence of Quaternary blanket of Narmada rift system as such researcher and scientist failed to add any further knowledge to hominid discovery in Narmada any further. The area is ubnder tremendous stress du to movement of India plate to wards north east and vertical adjustment of different blocks in the Sonata lineament zone. There appear there is significant increase in compressive stresses accumulating on an intracrustal fault like the NSF can transform a

previously subsiding basin into an uplifting one. The NSF has been characterized by a compressive stress regime throughout the Quaternary and variations in the degree of compression relative to the rates of plate movement are responsible for the late Pleistocene subsidence and the Holocene tectonic inversion in the Narmada it is witnessed by manifestation on drainage net work imprints of neotectonisam and shifting and tilt in terraces of Narmada and its tributaries. Khan et.al (2016).

The impact of structural disturbances and\evidence of the effects of tectonics on fauna and flora are distinct and their 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 eructs* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due inconsistency and concealed nature of fossiliferous horizon due faulting, dislocation and subsidence of Quaternary blanket of Narmada rift system as such researcher and scientist failed to add any further knowledge to hominid discovery in Narmada any further.

The Tapti-Purna graben is located south of Satpura which evolved as two separate basins of fluvio-lacustrine sedimentation, connected subsequently. The most conspicuous feature of the southern margin of the Satpura between longitude 74º and 78º is cospicous ENE-WSW to E-W trend of Tapti whcih display local swing at places. These trends characterizing Tapti crustal block, confiorm to structural grain of the area reflecting the convergence of Tapti and Gavilgarh faults enechelon system traversing Satpura foot hills, with a southerly convexity. The Quaternary basin areas in Tapti Crustal block are characterized by relatively thinner crust with moho depth of 33-37 km, shallow basement (<1 km) with higher density (+0.239m) mantle derivatives emplaced at shallow level (4-5 km; Rao K.V., 1997). The present studies taking entire quaternary sedimentation of SONATA LINEAMENT ZONE as single ecological system besides the tectonics on the either side of Satpura, it revealed that the area of SONATA LINEAMENT ZONE formed a single loci of sedimentation and there was contionus and sequential deposition of sediments from Pleistocene to Upper Pleistocene time, it is witnessed by quaternary events morphogenetic expression disposition of river terraces their mutual relation, lithostratigraphic, correlation across Narmada , Tapti –Purna and Son valley Khan (in press). The Narmada and Son are two linear basins north of Satpura and Tapti-Purna in south, was a single eliptical trench which has provided a patform of Quaternary sedimentation in Central INdia The present expression and configuration and fregmented disposition of quaternary blankets of Son Narmada, Tapti and Purna is due to tearing, faulting, dislocation subsidence, up rise of various blocks and reactivation of structural fabrics with in the SONATA LINEAMENT ZONE. (Khan 2016).

The Quaternary deposits of Tapti comprised of Boulder conglomerate, fluvial deposits of paleo- domain of Tapti and Fluvial deposits of present domain of Tapti. The Boulder deposits forms the base of Quaternary deposits overlying directly of basaltic rock embodied with older deposits in the basin. It revealed that inception of quaternary sedimentation occurred in the rock basin south of Stapura in Tapti which has outer rim of basin in the west and restricted by strong N-S structural trend and striking ranges in the west. It is contradictory to the openion of earliear worker (Tiwari, 1996) and others. The quaternary deposits of wardha upper Pleistocene-Holocene age (50 m) (Tiwari 1985) forms the eastern fringe of Tapti Basin; it is seprated from Tapti-Purna basin by episodes activation of the eastern block during Quaternary period Khan (in press). The present studies within single ecology of geomorphology and in hormony of sedimentation in lineament zone in increasing antiquity revealed that Tapti-Purna was a single basin, formed a mega tectonic depression which was hospitable to sedimentation incepted from Plesistocene and continued up to Upper Pleistocene –Holocene time.The present expression is due to neotectonisam in the lineament zone. In Tapti basin the bouler conglomerate occurs as persisten horizon at the base of quaternary deposit which represents specific phase of sedimentation in the basin , it is time equvalent to the boulder conglomerate of Narmada and further add that the sedimentation on eithr edge of Satpura and in the SONATA LINEAMENT ZONE was contamparary and simultaneous, which further revealed quaternary deposits of Tapti are early to middle Pleistocene in age and related to the early reactivation of Tapti lineament.The association of rock cut terraces, rock cut benches, strent lines and rock cut sacr in Tapti and waghour rivers demonstrate mighty reactivation of Tapti lineament during the early stages of sedimentation. The cyclic reactivation has vertically incised and cut country rocks in to rock cut benches in stepped sequence; where as in the Purna valley a gape was been created by reactivation of Tapti- Purna linament it has resulted a convering point of accumulation of sediments. The sequential analysis of deposits and its relation with drainage and its evolution indicate it was a persistent locus which was hospitable to sedimentation.Khan (2016).

The Purna basin embraces hanging drainage and configuration of basin is closed which indicates that a deep gape was created by vertical and cyclic subsidence of fault bouond block south of Satpura after inception of sedimentation in Tapti in west which was hospitable to accumulate sediments. The thick pile of sediments comprised of five lithostratigraphic units viz. Ferruginised gravel and Sand, Red Silt Formation, Brown Silt Formation, Light Grey Silt Formation and Dark Grey Silt Formationwhere as Tapti Basin which has only three units viz. Boulder Conglomerate at the base on rock basin followed by quateranry deposits of paleodomain and present quateranry deposits of Tapti which are older deposits. The present studies within single tectonic and geomorphic ecology and in hormony of sedimentation in increasing antiquity revealed that Tapti-Purna was a single basin which formed a mega tectonic depression in the east was hospitable sedimentation from Plesistocene to Upper Pleistocene –Holocene in increasing antiquity from west to east due tectonics slope and topographic configuration south of Satpura. The quaternary deposits of wardha upper Pleistocene-Holocene age(50 m) (Tiwari 1985) forms the eastern fringe of Tapti Basin, it is seprated from Tapti-Purna basin by episodes activation of the eastern block during Quaternary period Khan (2016). (Plate No _4).

Volcanic Ash Bed & Sedimentation:-

The Quaternary tract of Narmada basin covers an area of abut 12950 sq.km starting from west of Jabalpur ($23^0 07^0 790530$) to east of Handia (22^0 29'; 76^0 58') for a distance of about 320 km. It is found to be ideal locus of Quaternary sedimentation in Central India, as witnessed by multi-cyclic sequence of Quaternary terraces in the valley. The total estimated thickness of Quaternary sediments in the central sector of Narmada is about 325 m. where the level of Ash bed occurrence has been identified at the depth between 75-83 m of Quaternary column of valley. The Quaternary blanket consists of sediments of three domains viz. glacial, fluvio- glacial and fluvial, which were deposited in distinct environments during Quaternary time. The Boulder Bed (20 to 260 m.) below ground level is of glacial origin, comprised of thick pile of sediments occupied at the base of rock basin and were deposited by glacial activities in dry and cold climatic condition during early Pleistocene time. The fossiliferous bed Boulder conglomerate (260 to 278 m. above m.s.l.) is of fluvio-glacial origin and top four formations in increasing antiquity are Sohagpur, Shahganj, Hoshangabad and Janwasa (278 to 350m. above m.s.l.) are of fluvial origin and represent the complete sequence of Quaternary sedimentation in Narmada valley & Central India Khan & Sonakia (1992).

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 study of these concealed sediments, their sedimentary environments and sedimentation and correlation both in vertical and horizontal columns indicates that the lower most units, Boulder bed (20 to 260 m. below ground level) is of glacial origin, where as the fossiliferous bed Boulder conglomerate (260 to 278m. above m.s.l.) is of fluvio-glacial and top four formations in increasing antiquity Sohagpur, Shahganj, Hoshangabad and Janwasa (278 to 350m. above m.s.l.) are of fluvial origin and represent the complete sequence of Quaternary sedimentation in Central India Khan & Sonakia (1992).). The boulder conglomerate 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 for very long time. (Table No AB- 1-3 & Plate No AB-1).

The Boulder conglomerate is a persistent marker horizon in Narmada valley its disposition and relation with other deposits 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 *Home erectus* (Sonakia1984) and other fauna recorded along with calc- nodules near village Hathnora (22 ° 52" N; 77 ° 52" E) in fossiliferous boulder conglomerate; named as Hathnora formation Khan & Sonakia (1992). It is found to be associated with volcanic Ash bed of Quaternary age in the area around Hathnora, and upstream Khan et.at. (1991), the two levels of horizons of Ash bed are identified and designated as NAB-I and NAB-II in ascending antiquity in the valley. The Ash bed NAB-1 is associated lower litho units of boulder conglomerate which is well preserved and persistent where as NAB-II is associated with younger deposits. The NAB-1 contains three micro layer (L-1 to -L3) and NB-II two micro layers (L-4 to L-5) in increasing antiquity.

In Narmada valley the association of Ash bed NAB-I with Hathnora formation at the depth of 78 m in Quaternary column and occurrences skull cape *of Homo erectus* at the depth of 83 m in decreasing antiquity from the top assumed that Toba eruption have taken place later than existence of *Homo erectus* which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash is NAB-II at the depth of 72 m with the younger deposit revealed the second cyclic fall of Toba ash which certainly have had influenced on hominines and had collective and cumulative impact on *Homo erectus* (Sonakia1984) *Homo sapiens* (Thobold 1860, 81), in Narmada valley and Indian sub-continent. Oppenheimer (2003) argues that *Homo. Sapiens* occupied India before ~74 ka and may have undergone "mass extinction" as a result of the Toba eruption. The argument of Oppenheimer (2003) is in strong conformity with the present observation of authors. As sediment & Ash bed sequence of Quaternary column of Narmada (325 m) and occurrences of fossil of skull cape *of Homo erectus* (Sonakia1984) at 83 m & human cranium *Homo sapiens* (Thebold 1960,1981) transported have existed prior to fall of Toba ash and they are among the few who inspite of mass extinction caused by mega dislocation in ecology and environment related with volcanic eruption survived in Narmada Valley. It is further documented by the rarest occurrences of these fossils in subcontinent which also confirm the intensive impact of volcanic ash fall on these hominines and their consequential mass extinction.

The study of assemblage of glass matrix of Ash bed, grain morphology of glass their- relation with other minerals shape, size, texture of litho fragments of pyroclastic origin suggest that sediments were brought from distant source by Aeolian agencies in the form of thick cloud containing volcanic dust, rock matrix and different gases which remained in atmosphere for very long time and settled down across the Indian sub continent during the different phases of river sedimentation. Further study of Ash bed material and silica revealed diagnostic morphological characters of glass shards which are typical of silica volcanism (Heiken, 1972, 1974) and show close similarity with those reported from the Quaternary tephra beds of the Narmada , Son, Purna and Kukdi basins (Basu et. al., 1987; Khan et.al. 1991 Basu and Biswas, 1991; Singaraju and Shivaji, (1991) Mukhopadhyay, (1992). It is significant to note that the occurrences and association of two marked horizons at different levels further reveal that the cyclic eruption and settling of volcanic matrix has taken place with pause in the valley.(Khan 2013& Khan 2015)
The Toba eruption of 74 ka was distinctly and clearly a mega event of very great magnitude and intensity, far greater than any known historical eruption, suggesting it had very devastating impact and repercussions. It has change the global climate environment and ecology. It is significant to note that the occurrences and association of two marked horizons at different levels further reveal that the cyclic eruption and settling of volcanic matrix has taken place with pause in the valley during sedimentation (Plate No_1, 2 &_9)

Volcanic Ash Fall & Sedimentation:-
The 74,000 year-old super eruption of the Toba volcano, located in northern Sumatra, is recognized as one of Earth's largest known eruptions and was certainly the largest of the Quaternary period (Smith and Bailey, 1968). It is presumed that it have led to both global climatic and environmental deterioration and had a impact on decimation of modern human populations (Rampino et al., 1988; Rampino and Self, 1992, 1993a) (Rampino and Self, 1993b; Ambrose, 1998, 2003a, 2003b; Rampino and Ambrose, 2000).

However, the severity of Toba's impact on climate and hominins has been contested and debated by scientist (Oppenheimer, 2002; Gathorne-Hardy and Harcourt-Smith, 2003). Geological, paleontological and archaeological evidence from the Indian subcontinent provides an excellent opportunity to address these issues. The intensity and scale of the Toba super eruption was multidimensional and its coloumn of eruption was so vast that it forma canopy of volcanic matrix led to the deposition of a blanket of volcanic ash across the continents and river valleys over India, Malaysia, the Indian Ocean, and the Arabian and South China Seas. Resulting persistent terrestrial tephra deposits have been documented in a number of river valleys throughout India. (Khan et.al 1991 Acharyya and Basu, 1993; Shane et al., 1995; Westgate et al., 1998). The occurrence of volcanic ash has been located in Narmada, Tapti, Purna Son valleys. These occurrences are associated and preserved with archaeological, paleontological sites in these valleys.

In Narmada valley and Indian sub continent the Environment and climate during late pleistocene has been significantly affected after Toba eruption, according to Rampino et al. (1988) the size of Toba at 74 ka could have induced a volcanic winter, similar to predicted nuclear winter scenarios, as modeled by Turco et al. (1983, 1990). The injection of vast amounts of gaseous aerosols and volcanic dust and matrix into the atmosphere, which follow large volcanic eruptions, is predicted to have detrimental and decisive consequences for changes of global climate. Past historical eruptions, such as Tambora in 1815 (Stothers, 1984) and Pinatubo in 1991 (McCormick et al., 1995),

have provided evidence of post-eruption climatic deterioration and climatic. With the eruption of Toba having been far larger than both of these historical eruptions, its consequences are therefore assumed to have been far more devastating.

The imprints of divesting impacts in the area of study and specific on human population are matter of scientific concerned and yet to be investigated. The studies conducted of Ash bed associated with Quaternary deposits of Narmada Valley consist of sediments of two domain viz. deposits of interglacial domain (Boulder conglomerate-Hathona formation) and fluvial deposit of paleo-domain of Narmada. The boulder conglomerate is fossil ferrous horizon of Narmada and has yielded skull cap of Homo erectu Sonakia (1984) (Khan & Sonakia 1991) .It is marker horizon and represents interglacial phase in the history of Quaternary sedimentation in Narmada Valley. The occurrence of ash bed reported from Quaternary sediments o f Narmada are associated with two horizons of ash beds of middle and upper Pleistocene age (Khan et.al.1991). These ash beds are designated as NAB-I and NAB-II consisting of five layers designated as (L1 to L5) in ascending antiquity in the valley.The Ash bed NAB-1 (L1- to L-3) is associated with upper gritty units of boulder conglomerate (Hethnora formation) and is identified at an elevation of about 290m. Above m.s.l.l The Ash bed NAB-II (L-4 to L5) is associated with upper units of clay silt deposits of palco-domain of Narmada (Shahganjg formation) and is identified at an elevation of 310m. above msl.The study of grain morphology of glass matrix, their- relation with other minerals shape, size, texture of lithic fragments and association of other ashy sediments of pyroclastic origin suggest that sediments were brought from distant source by Aeolian agonies, during the different phases of sedimentation in Narmada Valley. It is observed that in stratigraphic coloumn two horizons of Ash bed occurred at the vertical distance of about 20 m. which indicate that there were two phases of settling volcanic ash in Narmada valley and Indian subcontinent as a whole with significant time break. The element of time break is in terms of sedimentation perceptible appears to be related with global climatic changes induced by the super volcanic eruption. These ash beds are used as tool in correlation of different quaternary deposits and archeological sites in the valley. The occurrences of two horizons of Ash bed and their deposition by settling of volcanic dust with time gape suggest induced and defused atmospheric conditions in Narmada valley for a very long time after volcanic eruption.

The atmosphere contaminated by volcanic ash volcanic matrix and huge amount of gases and dust particles had definitely affected the atmosphere and climate had have led to temporarily darkened skies in the Narmada valley and Indian subcontinent for very long time.

The study of grain morphology of glass matrix, their- relation with other minerals shape, size, texture of lithic fragments and association of other ashy sediments of pyroclastic origin suggest that sediments were brought from distant source by Aeolian agonies, during the different phases of sedimentation in Narmada Valley.
It is commonly argued that if Toba was truly devastating for H. sapiens then comparable bottlenecks should also be seen in many other species.

The critical three dimensional study of the area around Hathnora ($22^{o}52'77^{o}52'$) between Vindhyachal and Satpura mountains vast industry sites of the same palaeo lithic implements have been located along the edge and pediment slope of the Vindhyan and basaltic upland. These sites appear to have been inhabited by Narmada hominid and its contemporaries for generations together the left over stone industry sites and unfinished material haphazardly indicate sudden dissemination and migration of hominines in search of shalter and safe places after volcanic eruption .The reporting of remains of H. sapiens.

In the area of Bhembetaka about 20 Kms north of hominid locality of Hathnora and relicts of rocker sheltuter and ancient human signaturedocuments the dispersal of hominines after the eruption of volcanic matrix and its fall Wakankar, V.S., 2002 .The association of skull cap Sonakia, A (1984) and Sankhyan (2007) described two new hominine fossils from Netankheri up stream of Hathnora in the Central Narmada valley. They include a partial left humeral diaphysis and a distal shaft fragment of the left femur associated with hathnora formation Khan & Sonakia 1992 and analysis of quartz grain morphology of sediment columns of Hathnora and quartz grain morphology of paleosole across the quaternary strata of bore hole sampling across 556 m of rock basin revealed that Homo eructus of Narmada partly sustain in the glacial and fluvio-glacial environment which is documented and witnessed by Hathnora formation which marks the end hostile climate and environment of sedimentation in Narmada valley Khan (2013).The study of quartz grainand their micro structures of paleo- soil identified in concealed blanket of quaternary deposits display relatively heterogeneity in Sediment characteristics throughout across the Quaternary coloumn of hathnora section in central Narmada valley. The quartz grain of paleo soil and sediments display

digonestic charactersics of glacial fluvio-glacial and fluvial concealed environment of sedimentation at different depth. The significant breaks in grain morphology of quartz grain , surface texture and associated elements and granular matrix in the sequence of quaternary strata is recorded at to ,150, 350 and 350 and beyond which linked to long evolution of of glacial fluvioglacial and fluvial environment of sedimentation in time and space in increasing antiquity in the valley from the base Khan (2013).In view of the recorded observation the concealed quaternary strata to the level of about 350 m below ground level further needs attention of geoscientist for the search of human remains in Narmada valley.

The skull cap of Home erectus (Sonakia1984) and other fauna recorded along with calc- nodules near village Hathnora (22 ° 52" N; 77 ° 52" E) in fossiliferous boulder conglomerate; named as Hathnora formation Khan & Sonakia (1992). It is found to be associated with volcanic Ash bed of Quaternary age in the area around Hathnora, and upstream Khan et.at. (1991). The two levels of horizons of Ash bed identified are designated as NAB-I and NAB-II in ascending antiquity in the valley. The Ash bed NAB-1 is associated lower litho units of boulder conglomerate which is well preserved and persistent where as NAB-II is associated with younger deposits. The NAB-1 contains three micro layer (L-1 to -L3) and NB-II two micro layers (L-4 to L-5) in increasing antiquity.
The study of assemblage of glass matrix of Ash bed, grain morphology of glass their- relation with other minerals shape, size, texture of litho fragments of pyroclastic origin suggest that sediments were brought from distant source by Aeolian agencies in the form of thick cloud containing volcanic dust, rock matrix and different gases which remained in atmosphere for very long time and settled down across the Indian sub continent during the different phases of active quaternary sedimentation. Further study of Ash bed material and silica revealed diagnostic morphological characters of glass shards which are typical of silica volcanism (Heiken, 1972, 1974) and show close similarity with those reported from the Quaternary tephra beds of the Narmada , Son, Purna and Kukdi basins (Basu et. al., 1987; Khan et.al. 1991 Basu and Biswas, 1991. It is significant to note that the occurrences and association of two marked horizons at different levels further reveal that the cyclic eruption and settling of volcanic matrix has taken place with break and pause in the valley related with eruption volcanic dust and storm. (Khan 2013& Khan2015).

The Toba eruption of 74 ka was distinctly and clearly a mega event of very great magnitude and intensity, far greater than any known historical eruption, suggesting it had very devastating impact and repercussions. It has change the global climate environment and ecology.

The occurrences of these skull caps with short range of their occurrences in the stratigraphic column of Narmada with the Ash beds horizon NAB-I and NAB-II and specially with the Hathnora formation one at the top at an average elevation of about 268-273 m above the mean sea level and other with younger deposits had revealed the close association with volcanic activity with their existence. The Toba Ash fall is also in very close range with the sequence of sedimentation and occurrences with both the skull caps, which certainly has its impact on the middle and late Pleistocene Hominines in Narmada valley and Indian subcontinent.

The oldest fossil from India is represented by the Narmada hominine dated to not less than 236 ka (Cameron et al., 2004), or to some time in between 150 and 250 ka (Kennedy, 2001:167). Modern human remains have been discovered in an undated Late Paleolithic context at Bhimbetka rock shelter III-A-28 (Wakankar, 2002:5) which is situated about 70 km north of Hominid locality Hathnora and from three cave sites in Sri Lanka, dating from 27.7 ka (Kennedy 1999, 2001).Using phytogeographic data, Oppenheimer (2003) argues that H. sapiens occupied India before ~74 ka and may have undergone "mass extinction" as a result of the Toba eruption. The later argument is in conformity with the observation of authors as it is well illustrated by close association of Ash bed and Homo erectus of in sediment sequence of Quaternary column of Narmada.

The volcanic eruption and consequential ash fall has created severe dislocation in ecology and environment and adversely affected hominines in Narmada valley and Indian subcontinent. It is witnessed by association of Ash bed NAB-I with Hathnora formation at the depth of 78 m in Quaternary column and occurrences skull cape of Homo erectus at the depth of 83 m in decreasing antiquity from the top assumed that Toba eruption have taken place later than existence of Homo erectus which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash is NAB-II at the depth of 72 m with the younger deposit revealed the second cyclic fall of Toba ash which have had influenced collective and cumulative the Homo erectus (Sonakia1984) Homo sapiens (Thobold 1860, 81), in Narmada valley and Indian sub-continent.

The study of cyclic Toba ash fall and using phytogeographic data, Oppenheimer (2003) argues that Homo. Sapiens occupied India before ~74 ka and may have undergone "mass extinction" as a result of the Toba eruption. The argument of Oppenheimer (2003) is in strong conformity with the present observation of authors. As sediment & Ash bed sequence of Quaternary column of Narmada (325m) and occurrences of fossil of skull cape of Homo erectus (Sonakia1984) at 83 m & human cranium Homo sapiens (Thebold 1960,1981) (transported) have rarest occurrences of human fossils in Narmada valley and subcontinent which also confirm the intensive impact of volcanic ash fall on these hominines and their consequential mass extinction caused by mega dislocation in ecology and environment by volcanic eruption. (Plate No 1, 2 &_9).

Indian Homo erectus China man & Sedimentation:-

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 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) & Khan et.al 2016).

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 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 digenesis. The assemblages of sediments and granulometric parameters, digenetic 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, pale -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 stratigrphic 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 form 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 Luochuan sequence,(90-120 m) Chenjiawoe (50m) and Congwanling 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 startigraphic 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) Khan2016). (Plate No 1 to _9).

Paleosole & Sedimentation:-

In addition to study of tephra the study of morphology of quartz grain of Quaternary sediment study of morphology quartz grain of paleo soil and present soil of Quaternary deposits of Narmada has been attempted for the first time to

supplement the data to decipher formation of paleo soil and present soil and over all environment of sedimentation of quaternary deposit in Narmada valley.

The statistical analysis of soil samples has been conducted from the representative and crucial section in the hominid locality of Hathnora in Narmada valley and Mean Size (MZ), Inclusive Graphic Standard Deviation, Inclusive Graphic Skewness (SKI) and Inclusive Graphic kurtosis have been computed. These parameters assist in the characterization of the samples by providing a concise summary of particle size distribution which provides a basis for an interpretation of the environments of source of derivation transport and deposition.

This study of quartz grain and their microstructures of fifteen paleosoil identified in the concealed blanket of Quaternary deposit display relative heterogeneity in sediment characteristics throughout across the Quaternary column of Central Narmada valley. The study quartz grain of soil and 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 fluvial , fluvio-glacial and , glacial deposit (72 samples +25). The majority of quartz grain population show characteristic surface textures linked to long evolution in fluvial, fluvio-glacial and glacial environment of sedimentation in time and space in increasing antiquity in the valley. There exist a direct relationship between grain-size characteristics and the shape and surface texture of grains. The variations in shape and size of grain assemblages and imprints of particular microstructures in specific population 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 distinctly related with change of climate and tectonic changes in increasing antiquity in Narmada valley.

The study revealed that dissolution and precipitation features on quartz grain surfaces including pits, silica precipitation, crystal growth and adhering forms were present in soils at all positions. Evidence of mechanical damage including conchoidal fracture, angular edges, rounded edges and cracks were also recorded on quartz grains in valley. The statistical analysis of soil indicates particle size distributions that changes in size sorting due to glacial alluvial and colluvial transportation in valley. It is noticed that in valley sand content increases and clay content decreases from valley flanks to the central part, this assemblage increases in vertical column of quaternary blanket in valley. There is a large increase in the clay content in the toe slope soil due transport of sediments from collivium front by reworking, winning of sediments which increases towards central parts of valley. (Plate No_5 to 8).

Quartz grain morphology & Sedimentation:-

The grain morphology of quaternary deposits in vertical coloumn across the depth of 320 m from the exposed section of strata and bore log samples from ETO , CgWB , GSI and other state and fadral agencies were studied . The surface texture of quartz sand grains in sediments of different domain is important elements which register and record the entire process of sedimentation tectonisam of mega and micro events source of sediment, erosion trnsportation and deposition of materials (Xiao et al., 1995; Helland et al., 1997). The weathering intensity may be revealed by surface rounding, etching or overgrowth on quartz grains (Asumadu et al., 1987; Marcelino et al., 1999).Hence in addition to the study of morphology of quartz grain of paleo soil morphology quartz grain of Quaternary sediment in increasing antiquity from the base of rock basin has been attempted for the first time to supplement the data to decipher the environment of sedimentation of quaternary deposit in Narmada valley. The representative samples were collected across the in crucial exposed cliff sections in vertical column and from the bore hole logs to identify the spatial variation in quartz grain morphology of quartz sand grain morphology and partical size distribution using SEM techniques .

The study revealed that dissolution and precipitation features on quartz grain surfaces including pits, silica precipitation, crystal growth and adhering forms were present in sediment strata at all positions. Evidence of mechanical damage including conchoidal fracture, angular edges, rounded edges and cracks were also recorded on quartz grains in valley. The statistical analysis of sediments il indicates particle size distributions that changes in size sorting due to glacial alluvial and colluvial transportation in valley. It is noticed that in valley sand content increases and clay content decreases from valley flanks to the central part, this assemblage increases in vertical column of quaternary blanket in valley. There is a large increase in the clay content in the toe slope soil due transport of sediments from collivial front by reworking, winning of sediments which increases towards central parts of valley.
This study of quartz grain revealed fifteen microstructures of quartz grain in the concealed blanket of Quaternary columns of Hominid locality Hathnora sections I to IV, which display relative heterogeneity in sediment characteristics across the Quaternary column of Central Narmada valley. The study quartz grain of sediment and

soil 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 fluvial , fluvio-glacial and , glacial deposit (72 samples +25). The majority of quartz grain population show characteristic surface textures linked to long evolution in fluvial, fluvio-glacial and glacial environment in time and space in increasing antiquity in the valley.

There exist a direct relationship between grain-size characteristics and the shape and surface texture of grains. The variations in shape and size of grain assemblages and imprints of particular microstructures in specific population and distinct breaks at specific level identified indicate changes of environments of sedimentation in vertical columns from glacial deposits at base of valley subsequently followed by fluvio-glacial and further overlain by fluvial deposits distinctly related with change of climate and tectonic changes in the region.

The study of quartz grain and fine siliceous matrix their analysis of shape size and surface textures from Quaternary columns of Harhnora section I to IV from deep bore sediment logs up to the depth of 550m indicate that occurrence of concealed blanket of Quaternary sediments deep in Narmada linear trench deposited in turmoil tectonic environment under dry and cold condition. Its configuration and its relation to the bed rock indicate that glacier was the dominant transport agent during lower and middle Pleistocene time and sediment were deposited on uneven platform in narrow and tight trench.. The depositional mechanisms were strongly influenced by tectonic and dry environment of sedimentation.

The grain morphology shapes and surface textures of sand-sized quartz grains from the sediments of various domains of Narmada Valley were studied to characterize and understand source of sediments, nature of weathering process, transport of sediments and overall environment of deposition and sedimentation. The study of sediment and fine matrix revealed that sediments were deposited in rinsing and sinking platform on tectonically adjusted blocks under different environments. The sediment assemblage is highly heterogeneous, assorted hybrid, and its distribution and its configuration is iritic and unpredictable. The source of sediments is multi provenance and there is strong mixing of sediment from multi sources of sediments including pre-existing Quaternary front of sedimentation. The configuration of sediments in the tectonic trench appears to be influenced by readjustment of various blocks in various phases the entire bulk of sediments were deposited a high-energy of glacial fluvio glacial and fluvial environment.

The initial stage of glacial sedimentation in deep Narmada rift trench is highly influenced by tectonics of SONATA lineament Zone. However, a fluctuation in energy condition in the sediment blanket has disclosed that detrital material dominantly derived from metamorphic meta- sedimentary and basaltic terrain by direct abrasion.

The 250- to 315-um-sized quartz fraction is characterized by a high percentage of sub angular grains (4 0%- 7 0%) at the depth of about 116 m b.g.l. The populations of the grain at upper Quaternary strata are surrounded and original morphic elements persist over quartz grain. The quartz grain indices between 166-255 m b.g.l depicts decrease in roundness and majority of population of grain show increasing percentage of angularity (40-60 %), further down quartz grains beyond 255 m b.g.l display high degree of angularity in isotropic pattern. The sub rounded grains have poor population and angular grains (10%-_0%), which are dominant over rounded grains (0 _5 %-), while well-rounded grains are minor (0%_2%). These grain-shape distributions indicate texturally immature sediments. The presence of both angular, sub angular to sub rounded grains suggests a mixing of grains with different degrees of wear and from several sediment sources. The variation of association associated constituents (mica, feldspar, carbonate, shale) also is indicative of multiple sediment sources. The grain-shape variations from sample to sample, particularly with the rock types in litho logic units are of different order and subjected. Amplitude However, these grain shapes do indicate consistency across the thickness of Quaternary blanket. It is observed that the shape and size manly influenced by lithology and weathering processes which they are subjected, the indices of angularity indicates a general upward decrease of grains. However, the percentage of sub rounded grains does not increase significantly, and the well-rounded grains are present in the upper part of the blanket. This indicates a change of sediments homogeneous to wards heterogeneity and display inverse relation of size and shape and iritic dumping of sediments by glacial activity.

The concealed Quaternary sediments in lower segment (456m) is characterized by sediments that may contain a high percentage coarser-grained fraction and very low percentage of of fine sand. The percentage of rounded grains increases and the percentage of angular grains decreases when the fine sand content or the mean size increases. The percentage of well-rounded grains varies independently, but usually is lower when the fine sand content is higher.

The low proportion of sub rounded grains as well as well-rounded grains in the coarser-grained sediments are insignificant very rare and is inconformity with the modality of interpretation of these grains having been deposited under dynamic condition on platform of tectonic dislocation and instability during sedimentation by glacial agencies in the SONATA Lineament Zone the configuration of quaternary deposits with bed rock revealed that sedimentation is strongly influenced by repeated structural dislocation and anisotropic and asymmetric faulting.
The representative samples from stratigraphic sequence contain grains which show several different types of microstructures. Impact features Parallel striations grinding features Crescent-shaped features Solution of quartz Silica deposits Silica pellicle. Quartz crystal overgrowths Pressure-solution features. 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 fluvial , fluvio-glacial and , glacial deposit (72 samples). The majority of quartz grain population show characteristic surface textures linked to long evolution in fluvial, fluvio-glacial and glacial environment in time and space. An indication of glacial evolution (parallel striations or grinding features) was observed in samples (10%-60% of grains) in 35 samples from different levels between 390 to 525 m the percentage of grains showing a glacial origin having parallel striations, fresh silica pellicles, and polished silica pellicles and fresh impact features. As such evidences of glacial, fluvio-glacial and fluvial evolution is marked in the lower startigraphic columns of Narmada. In addition some of grains exhibit fresh quartz overgrowths, old aeolian features, and silica pellicles at some level of sedimentation. This indicates a mixing of grains from different provenances. The parallel striations and fresh impact features are diagnostics of glacial environment and demonstrate consistency in occurrence. This implies a change of environment of sedimentation from glacial to fluvio-glacial and fluvial. This variation is accompanied by a decrease in the percentage of rounded grains and in the fine-sand fraction. The parallel striations are polished, were observed. The composite illustration of fresh striations and polishing of grains support to glacial environment of sedimentation in Narmada valley during lower Pleistocene time. The density of grains possessing such diagnostic elements of glacial origin decreases up ward in vertical column and their consistency has inverse relation which indicates sequential change of environment from glacial, to fluvio-glacial and fluvial in chronological sequence up ward in the Narmada trough.

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. A direct relationship between grain-size characteristics and the shape and surface texture of grains is observed. The variations in shape and size of grain and assemblages and imprints of particular microstructures in specific population 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 distinctly related with change of climate and tectonic changes in the Region. This study revealed diversity in the sediment sources and in the transport agents before the last stage of sedimentation on tectonic platform of SON NARMADA LINEAMENT ZONE.

The study of quartz grain form surface and subsurface quaternary blanket enveloped in the tectonic trench 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 fluvial , fluvio-glacial and , glacial deposit (72 samples + 25). The majority of quartz grain population show characteristic surface textures linked to long evolution in fluvial, fluvio-glacial and glacial environment in time and space. An indication of glacial evolution (parallel striations or grinding features) was observed in samples (10%-60% of grains) in 35 samples from different levels between 390 to 525 m the percentage of grains showing a glacial origin having parallel striations, fresh silica pellicles, and polished silica pellicles and fresh impact features. As such evidences of glacial, fluvio-glacial and fluvial evolution is marked in the lower startigraphic columns of Narmada. In addition some of grains exhibit fresh quartz overgrowths, features, and silica pellicles at some level of sedimentation. This indicates a mixing of grains from different provenances. The parallel striations and fresh impact features are diagnostics of glacial environment and demonstrate consistency in occurrence. This implies a change of environment of sedimentation from glacial to fluvio-glacial and fluvial. This variation is accompanied by a decrease in the percentage of rounded grains and in the fine-sand fraction. The parallel striations are polished, were observed. The composite illustration of fresh striations and polishing of grains support to glacial environment of sedimentation in Narmada valley during lower Pleistocene time. The density of grains possessing such diagnostic elements of glacial origin decreases upward in vertical column and their consistency has inverse relation which indicates sequential change of environment from glacial, to fluvio-glacial and fluvial in chronological sequence up ward in the Narmada valley The study of statistical parameters across the entire thickness of Quaternary deposits revealed three breaks in sedimentation at 350 -290,190-220,100-150 in the valley where as an breaks in Hominid locality Hathnora I to IV section s is at 280m,at 210m and at 35m in

increasing antiquity from the base of rock basin which represent glacial, fluvioglacial and fluvial environment of sedimentation in the Narmada valley.The correlatin of different sequential and sedimentological breaks indiacte subsidence and up lift of different blocks ans platform of sedimentation due to tectonic and neotectonic activity. (Plate No_5 to _8).

Paleoanthropological Record & Sedimentation:-

The area around Hominid locality of Hathnora area is occupied by thick Quaternary sediments which represent various domain of sedimentation. Based on sedimentological characters, depositional environments, and erosional processess 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 or glacial origin, the boulder conglomerate of glacio-fluvial (Khan *el. al* 1991) and fluvial terraces are of fluvial paleo- domain of Narmada. The top four formations Sohagpur, Shahganj, Hoshangabad and Janwasa are designated as (NT_o-NT_3). 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 (NT_3-NT_2), 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).

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 erectu*s 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 erectu*s 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 erectu*s in Asia.

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 stratigrphic 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 form 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 Luochuan sequence,(90-120 m) Chenjiawoe (50m) and Congwanling 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). (Plate No 1 to _9)
The Narmada Rift System provides a unique Quaternary landscap as sites of sedimentation setting which indicates human origins and evolution. Skeletal and cultural remains of hominids have been recovered from many locations within the basins. The most of localities occur on the rift floor in between Jabalpur_Harda, in the east and Tilakwarda _Bharouch in central in the west in the valley.The virgin and previously unknown areas of the rift basins were studied and inventory of paleoantoological 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 paleoantoological 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 digenesis. 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 paleoantoological 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 ad 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 scientist and researcher to study the human remain as postulated, except in limited section where they are exposed.

In Narmada valley the most of the hominid remains and associated artifacts in the would have been found associated with Miocene Pliocene– Pleistocene sediments of boulder be an d boulder conglomerate 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, and Tilakwarda _Bharouch which posses the complete sequence of all three domain in increasing antiquity in chronology in vertical coloumn from the bottom of the rift trench viz 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 fossiferous 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.

The Narmada skull cap of Sonakia (1984), including other fossil assemblage 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 pale environmental and tectonic histories of different sediment columns in area along of 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, rinsing 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 fancies 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 with 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 rift system and platforms of sedimentation bear the imprints of and evidence of the effects of tectonics on fauna and flora are distinct, however the signatures of subsidence 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 eructs* 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 in rift system and inconsistency in exposure of fo**s**ilifrous horizon of Narmada rift system which is the handicapp in search of further human remains in Narmada valley after Sonakia (1984). **(**Plate No_5 to 8).

Sediment statistics & sedimentation:-

The SONATA LINEAMENT ZONE embodies the two Quaternary basins of tectonic origin on the two margins of Sapura Crustal Block. The Satpura block traversed by enechelon system of faults and lineaments is characterized by thinner crust (33-38 km deep, basement depth >2.5 km) with series of ENE-WSW trending gravity high (viz. Sendwa, Khandwa, Chicholi, Tikaria etc.) with amplitudes of 10-35 mgal. The chain of gravity high indicates extensive magmatic and emplacement of derivatives at shallow crustal levels. The associated Narmada South (Satpura North) fault and Satpura South Fault marking the two hinges of the Satpura block are fundamental in nature and extend to Moho level. The Narmada Quaternary basin in the north and Tapti-Purna basin in the south are two Graben which formed prominent loci of sedimentation in lineament zone. The area of lineament zone studied tectonically encompasses two crustal provinces of Central India Shield, namely, the Northern Crustal Province (NCP) and the Southern Crustal Province (SCP). The two provinces are separated by a crustal level shear zone, referred as Central Indian Suture. The zone has been a major locus of episodic tectonism with evidences of reactivation.

The Narmada Rift valley forms ENE-WSW lineament where Quaternary deposits are confined in a trough like basin on unstable platform which 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 domains which were deposited in different environment in vertical chronology in faulted trough in time and space.

The Quaternary sedimentation in Narmada Rift valley incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and linear displacement and dislocation, uplifting and isolated domal up- lift, Neogene rifting and Quaternary sedimentation. The rift-bound Pliocene–Pleistocene rifting and volcanic activities specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Rift System which form the base of quaternary deposits. The Narmada rift system basin platform provided a unique setting for dynamic ecosystems that were characterized by Rift-related subsidence and coeval sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, digenesis, and preservation of organic remains.

The present disposition of Narmada blanket of Narmada, in SONATA LINEAMENT ZONE revealed that the rift occurred after widespread Quaternary sedimentation and accumulation of sediments in the linear trench by glacial activity in late Pleistocenc.The Fluvio-glacial phase is represents by boulder conglomerate which has formed the persistent horizon in the valley. The Narmada has in the area under study has sculptured the alluvial tract into stepped sequence forming four alluvial terraces along its course. These are designated as NT0 to NT3, NT0 being the youngest terrace and NT-3 the oldest terrace where the sub terraces are designated NT2-A is NT2-B, NT2 B, besides NT2-C, NT3-A & NT3-B in increasing order of antiquity. These are both erosional and depositional terraces and confined at an elevation of, between 280 to 380 are separated by the scarp both of curvilinear and linear in nature facing towards river side. These are abandoned flood plains represent the level of former valley floor in the area, and were formed by cumulative climato-tectonic changes in the watershed of Narmada in the Quaternary times Khan et.al (2016).

The study of statistical parameteres of MZ, STD, SKI, and KG of different domains of sediments in chronology and staratigraphic coloumns their relation in time space, their binary relation, trends of plots, their correlation with different coloumns in Jabalpur _Bharuch section. The Quaternary deposits of Narmada valley represent the thickest sequence (320 m) which was 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 few exposed section of 18 m of river as such on work has been done on concealed strata of quaternary deposits. The synthesis of various parameters their binary relation, concentration of plots their pattern and trend revealed that the quaternary deposits consists of sediments of three mega lithostartigraphic units viz Boulder bed, boulder conglomerate and fluvial deposits. The fluvial deposits include sediments of paleo-domain of Narmada and present domain of Narmada which constitute fluvial terraces (NT1 to NT3) of Narmada. These three domains of sediments were deposited, from Pleistocene to Upper Pleistocene time in increasing antiquity in the valley.

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 (150 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 digenetic 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 Khan et.al (2015). The study of statistical parameters across the entire thickness of Quaternary deposits revealed three breaks in sedimentation at 350 -290,190-220,100-150 in the valley where as an breaks in Hominid locality Hathnora I to IV section s is at 280m,at 210m and at 35m in increasing antiquity from the base of rock basin which represent glacial, fluvioglacial and fluvial environment of sedimentation in the Narmada valley.The correlatin of different sequential and sedimentological breaks indiacte subsidence and up lift of different blocks ans platform of sedimentation due to tectonic and neotectonic activity.

The study of statistical parameters of Hathnora sections I, II, III, & IV 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 (150 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 digenetic 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 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. As whol 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.
(Plate No _5 to 8).

Heavy Minerals & Sedimentation:-
The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent was hospitable linear depression for accumulation of sediments. The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from glacial, followed by fluvio-glacial, lacustrine and fluvialactivity.The platform of sedimentation had rinsing and sinking environment, block faulting and linear displacement and dislocation, uplifting and isolated domal up- lift. The Neogene rifting and quaternary sedimentation, 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 which form the base of quaternary deposits.

The Narmada Valley in the Hathnora area is occupied by thick Quaternary sediments. These sediments are classified based on sedimentary depositional environments, sedimentological characters and correlation with depositional / erosional terraces. The lowermost units (Boulder conglomerate) is or glacio-fluvial origin (Khan *el al* 1991) whereas the rest of fluvial origin. The top four formations (Sohagpur, Shahganj, Hoshangabad and Janwasa) are classified based on morphostratigraphic state (NT_o-NT_3), degree of oxidation, calcification and compaction. Janwasa formation comprises of sediments of active channel deposition and is the older three (Sohagpur, Shahganj, Hoshangabad formation) are related to older flood plains deposits of paleo-domain of Narmada and are grouped under older alluvium. Boulder conglomerate of fluvio-glacial origin 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 a single aggradations episode with minor pauses when dissection of the alluvium produced two terraces (NT_3-NT_2). The sediments of this aggradations episode constitute three lithostratigraphy units viz. Boulder conglomerate, Sohagpur and Shahganj 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 represent three distinct group of deposits viz. glacial, fluvio- glacial and fluvial; which was deposited in distinct enviroment in Quaternary times.

The Hathnora Sections _I to IV (22° 52" N; 77° 58" E) are located around village Hathnora between Sardarpur_Hoshangabad along Narmada from where the 203 sediment samples are collected for heavy mineral studies. In river section about 18 m scrap of sediments consisting of Boulder conglomerate and fluvial terraces deposit is exposed in increasing antiquity. The Boulder bed is hidden and concealed in the area under younger deposits as such samples have been taken from ongoing bore hole drilling log between the depths of 90 to 201 m below the surface for heavy mineral study. The qualitative and quantitative studies of heavy minerals of Quaternary deposits of different domain revealed five prominent heavy mineral suites viz, opaque suite; amphibole-pyroxene suite, biotite-muscovite-chlorite suite, garnet, sillimanite, kyanite, staurolite suite and zircon, rutile, tourmaline suite.

The Quaternary blanket has been studied in three dimention and about 907 sediment were collected to study of statistical parameters hevy mineral assemblage, quatrz grain morphology, quartz grain morphology of paleosole, ash bed and other aspect acoss the deph of about 480 m. The study reveled that their binary relation distinctly displays 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 (150 samples). 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 qualitative and quantitative studies of heavy minerals of Quaternary deposits of different domain from the same samples revealed five prominent heavy mineral suites viz, opaque suite; amphibole-pyroxene suite, biotite-muscovite-chlorite suite, garnet, sillimanite, kyanite, staurolite suite and zircon, rutile, tourmaline suite.. The mineral of stable group viz. rutile, zircon and tourmaline show uniform distribution in the entire domain of terraces in the area of study.The zircon rutile, tourmaline and sphene are highly stable minerals though their abundance is common in quaternary deposit, hence considered to be very significant. The grain morphology and imprints of sedimentation these mineral bear are of immense significance in understanding the source of sediment, its nature of transportation, mode of transport, kinetics of medium and sedimentation. Their relative frequency in critical column bear significance as regard to tectonic set up of various rock units in the watershed. The contrasting grain morphology of these heavies in the various domains of quaternary deposits is useful in tracing the environments of their deposition. Minerals with low stability such as hornblende, hypersthene, Illuminate and biotite are more significant as regards to the correlation and chronological status of quaternary deposit. These minerals show variable degree of stability and morphological characteristics, hence these parameters have been taken into account is deciphering the mode of environment of sedimentation and correlation of quaternary deposits in Narmada Valley.The zircon rutile tourmaline and sphene minerals occur as accessories mineral, mostly released from rock fabrics comprising boulder bed and were subjected to different degree of wear and tear and physical condition of weathering transport and deposition, the micro imprints acquired by different condition of sedimentation revealed the intense grounding and bed traction of sediments from the source. The striations on these minerals indicate intense glacial activity in the initial stage of sedimentation. These are generally angular to highly angular in shape and show very poor indices of sphericity and roundness typical of glacial environments. Occasionally sub-hedral partly broken prismatic crystals of tourmaline are also in these deposits.

The study revealed that sediments were primarily derived from metamorphic source comprising of kyanite-paragonite, muscovite schist, gneiss, garnet mica schist, and Para-amphibolite tourmaline garnet metasedimentarias and meta-volcanic. Apart these minerals are also reworked from older Quaternary deposits from Boulder bed glacial deposit, Boulder conglomerate of fluvio-glacial deposit and fluvial terrace and higher and other older terraces of fluvial domain. These heavies were basically transported from the sources area by glacial fluviol-glacial and fluvial agencies to the present site of their occurrence. The mode of transportation, environment of deposition and energy system of transporting media has greatly affected the frequency of concentration of heavies, their grain morphology and stability in that particular domain of deposit. These minerals, mostly released from rock fragments and other fabrics comprising boulder bed, subjected to intensive wear and tear and physio-chemical environment of weathering transport and deposition, the micro imprints acquired by different condition of sedimentation revealed the intense grounding and bed traction of sediments from the source. The striations on these minerals indicate glacial activity in the initial stage of sedimentation. These suites of minerals are stable as compared to the other suite of minerals of these deposits although these mineral are associated with all domain of quaternary deposits but show different frequencies of their occurrence and physical characters, shape size shpericity and roundness and bear the micro imprints acquired by different condition of sedimentation revealed the intense grounding and bed traction of sediments from the source. The striations on these minerals indicate glacial activity in the initial stage of sedimentation. These are generally angular to highly angular in shape and show very poor indices of spericity and roundness typical of glacial environments. The configuration of minerals, rock clastic, ground mass, imprints and impact tectonics revealed the intense grounding and bed traction of sediments from the source to site of sedimentation.The striations on these minerals indicate glacial activity in the initial stage of sedimentation. These are generally angular to highly angular in shape and show very poor indices of spericity and roundness typical of glacial environments. The configuration of minerals, rock clastic, ground mass, imprints and impact tectonics revealed the intense grounding and bed traction of sediments from the source to site of sedimentation.

The study of heavy mineral suites of Quaternary deposits in the area is suggestive of Narmada Boulder Bed, which forms the base of quaternary deposits is of glacial origin Boulder Conglomerate of Fluvio-glacial origin and river terraces of Narmada are fluvial origin, the sediments comprising these domain measuring 325 m thickness has mixed sediments source comprising of Lower protozoic and middle protozoic rocks consisting of gneisses granite metabolic, amphibolites, meta-sedimentries, high grade biotitie gneisses, muscovite gneisses, kyanite, paragonite, muscovite – schist , gneiss, garnet-mica schist, para amphibolite, tourmaline garnet, meta – sedimentaries and meta - volcanics and Gondwana rocks. (Khan et.al 2016) (Plate No_5 to 8).

Hominid Locality Hathnora & sedimentation:-

The Narmada Rift valley in the vicinity of Hominid locality Hathnora was a tectonic depressin associated with a linear trench in the middle of valley it was an ideal locus for accumulation of sediments. The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block, faulting, uplifting, Neogene rifting, Quaternary sedimentation, 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 which forms the base of quaternary deposits. The quaternary landscape in this segment is confined in trough like basin which embraces the 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 underlian by Boulder bed which is concealed under younger sediments in the valley.The Quaternary landscape embodies imprints of tectontonisam which revealed that sedimentation had been controlled by mechanics of SONATA LINEAMENT ZONE.

The Quaternary deposits of Narmada valley represent the thickest deposits in faulted and sinking platform under structural riparian rift trench which is undisclosed and remained unrevealed. The work so far arried out is restricted to quaternary deposits of exposed section of 18 m of river section only, no work has been done on concealed strata of quaternary deposits below th Boulder conglomerate source of sediments, mode of transportation, deposition tectonic and environment of sedimentation to conceive the model of quaternary sediment. The inadequate data of concealed quaternary strata, environment of sedimentation, their diaposition and correlation in vertical chronology in time and space restricted the systemmetic 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 around to hominid locality Hathnora from where skull of Homo erectus was reported by Sonakia (1984) 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 280 m in synchronisation of tectonisam and environment sedimentation in vertical chronology in faulted trough may provide clues in understanding the modal of quarternary deposits in rift valley and in search of human skull and its remains.

In Narmada Rift valley about 202 samples collected from hominid locality from exposed sections and bore hole logs across the vertical column 550 m for study to trace environments of sedimentation in Pleistocene to Holocene time. The statistical parameters viz MZ, STD, SKI, and KG of sediment samples were computed of 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 deposits of paleo-domain of Narmada (NT1 to NT3). The study of various parameters their binary relation, their concentration of plots cluster and trends and patterns revealed three breaks in vertical column at 000.m to150, 150 to 350, and 350 to 550 m in increasing antiquity in Narmada valley. The extensive and intensive analysis of statistical parameters heavy mineral quartz grain morphology, paleo sole analysis ash bed matrix depict contrasting diagnostic characters of sediments in chronology of quaternary sequence in vertical columns. The statistical parameters and binary clusters of plots of mean size and sorting, mean size and skewness, mean size and kurtosis are used in delineating and fencing boundary between the glacial and fluvio glacial and fluvial sediments. The concentration of these 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 to shape size sorting, and display a balance harmony and ecology in conformity of sedimentation .Khan et.al (2015) which is also authnticated by heavy mineral assemblage of sediments of quaternary coloumn (2016).

The boulder bed which yielded Hominid fossil from boulder conglomerate reported to be of fluvio-glacial origin for first time (Khan & Sonakia 1992). Beside occurrences of associated of ash beds with fossileferous boulder conglomerate (Khan & Rahate 1991) Achariya 1993 indicates volcanic source. It appears that close to the completion of cycle of deposition of the boulder bed there was vilolent volcanic eruption in around Middle to uper Pleistocen time which was subsequently settled down across the globe and in the pennisular India during the quaternary sedimentation. The occurrences of association of two marked horizons at different levels further revealed the cyclic eruption and settling of volcanic matrix was occurred with a pause during sedimentation. Khan et.al. (1991). 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. 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 lithostratigraphy and sedimentological aspects were studied and in the Narmada valley (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 complete sequence of Quaternary deposits from lower Pleistocene to Holocene (Khan & Sonakia (1992). Khan, et.al (1912), Khan (2012) et.al Khan (in press) , Khan (in press),.The results of sedimentological studies Khan (2015), quartz grain morphology, Khan (2014), quartz grain morphology,Palesole Quaternary column section in Hominid locality in central sector of Narmada revealed the presence of complete sequence of quaternary sediments in Narmada rock basin viz Glacial, fluvio-glacial and fluvial domain whereas the boulder conglomerate which has yielded human skull is of fluvio-glacial origin from Khan & Sonakia (1991).The Quartz grain morphology of sediment column Khan (2014) Quartz grain morphology of different paleo- sole, , Khan (2014), Ash bed Khan & Maria (2012) Khan & Maria (1912) Heavy mineral assemblage Khan (2016) tephra stratigraphy, Khan et.al (1991) Acharya, S.K. and Basu, P.K. (1993) Khan etal (2014) Khan et.al.(2015) Ash fall and its impects (2015) Khan (2016) magnetostratigraphy, and bio-stratigraphy and correlation of sediment columns intra valley wise , inter valley wise and on unified Quaternary Platform Khan et.al (2012) focusing on hominid localities of China have been studied on quaternary platform which have given new insight on the age of the Narmada *Homo erectus.*.
The Quaternary deposits of the Narmada valley represent the thickest Quaternary deposits in peninsular India which were deposited in a tectonic trench of SONATA LINEAMENT ZONE., the sedimentation has been controlled and synchronised by mechnisam of tectonisam during entire span of sedimentation from Lower Pleistocene to Holocene time. The association of fossils and stone implements with Quaternary deposits of Narmada are well described, quarries on various aspects on geology geomorphology, sedimentolgy, provenance of sediments, stream kinetics, stratigraphy, chronology ,tectonics, neotectonic, subsurface geometry, and overall model of Quaternary sedimentation of Narmada in faulted and oscillating rift trench remained silent and disclosed and unrevealed hidden miseries needed attention.

In the present studies revealed mega sedimentological three breaks in vertical column at 000.m to150, 150 to 350, and 350 to 550 m in increasing antiquity in increasing antiquity from th base which represent boulder bed boulder conglomerate and sediments of paleo domain in chronology and sequence representing Pleistocene, middle Pleistocene and upper Pleistocene phase of sedimentation in Narmada Rift valley.

The binary clusters of plots of mean size and sorting, mean size and skewness, mean size and kurtosis are used in delineating and fencing boundary between the glacial and fluvio glacial and fluvial sediments. The concentration of these 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 to shape size sorting, and display a balance harmony and ecology in conformity of sedimentation .Khan et.al (2015) Khan et.al (2016) which is also authnticated by heavy mineral assemblage of sediments of quaternary coloumn Khan et.al (2016), Khan et.al (2016), Khan et.al (2016), Khan et.al (2016) .

In Narmada rift valley the quaternary sediments are accumulated in two section viz Jabalpur-Harda section and Guredhwar and Bharouch section where as in other area Harda to Gurudeshwar section of valley rock cut terraces, rock cut platform and benches are notices which at many places over lie by caps and strips quaternary deposits representing the former level of valley floor of Narmada. The rock cut terraces and rock cut benches are time equivalent to NT1 to NT3 which have developed in Jabalpur-Harda and Gurudeshwar –Bharouche sections.Khan et.al (2016). The Quaternary events of the Narmada portys three prominent terraces and two sub terraces in these

sections which are designated NT1 to NT3 and sub terraces NT2-A is NT2-B, NT2 B, besides NT2-C, NT3-A & NT3-B besides NT-0 in the valley. They have been designed NT_O to NT3, (280 to 400 m), NT_O being the low level terrace above the present-day course of the river, NT_1-the younger terrace both of cyclic ad o cyclic nature. The NT_3 terrace occurs as elongated strip and isolated caps and lenses along the margin of valley flanks has divergent relative disposition. These land forms indicate vigorous and abrupt incision of valley floor due to relatively & repaid uplift of watershed area during Upper Pleistocene time. The NT1to NT_2 are the major depositional terrace and have both convergent & divergent mutual disposition with other terrace. These terraces further downstream have matched equivalents along the valley flanks, whereas in the up stream section the matched equivalents are rare. The conspicuous divergent relation of these terraces the valley reveals successive uplift of catchments area and consequential incision of valley floor and adjustment of base level of Narmada during Upper Pleistocene time.

The sequence of quaternary dposits in this segment of rift system was deposited on uneven platform of valley floor of turmoil nature in tight and narrow basin which depicts cyclic transitional environmental of the rift basins are caused by tectonic activities (uplift and subsidence), changes in relief, and climatic variations. The climatic changes in uplift, coupled with block faulting, rinsing and sinking platform, created basins unstable platform for the accumulations of thick lacustrine and fluvial sediments sequences with terrestrial and aquatic fossils.The 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 eructs* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due inconsistency and concealed nature of fosilifrous horizon due faulting, and subsidence of Quaternary blanket of Narmada rift system as such researcher and scientist failed to add any further knowledge to hominid discovery.in Narmada valley The study of statistical parameters across the entire thickness of Quaternary deposits revealed three breaks in sedimentation at 350 -290,190-220,100-150 in the valley where as an breaks in Hominid locality Hathnora I to IV section s is at 280m,at 210m and at 35m in increasing antiquity from the base of rock basin which represent glacial, fluvioglacial and fluvial environment of sedimentation in the Narmada valley.The correlatin of different sequential and sedimentological breaks indiacte subsidence and up lift of different blocks ans platform of sedimentation due to tectonic and neotectonic activity.
(Plate No_5 to 8).

Sea level fluctuation and sedimentation:-
The Narmada before debouching into Gulf of Cambey a conspicuous quaternary blanket is encountered. This segment is about 90 km in length and forms the southern margin of the N–S extending Gujarat alluvial plains .A significant feature of the lower Narmada valley is the deposition of a huge thickness of Tertiary and Quaternary sediments in a fault controlled rift trench. To the south of the ENE–WSW-trending Narmada–Son Fault (NSF), the Tertiary rocks and basaltic flows of Deccan Trap Formation occur on the surface while to the north they lie in the subsurface and are overlain by Quaternary sediments .However, the overlying Quaternary sediments having a maximum thickness of 800 m (Maurya et al., 1995) still remain unclassified. Drill data from some of the deepest wells in the basin have revealed occurrence of Deccan Trap at depths of 6000 m followed by an Archaean basement (Roy, 1990). The Tertiary sediments, outcropping to the south of the NSF, represent the full sequence from Eocene to Pliocene overlying the Deccan Trap and show extensive deformation in the form of several ENE–WSW-trending anticlinal highs and ENE–WSW and E–W-trending reverse faults (Fig. 2A). Neotectonic studies along the NSF have been singularly lacking. However, some studies dealing mainly with the channel form, fluvial processes and hydrological aspects have been restricted to the middle and upper reaches of the Narmada River (Kale et al., 1994; Rajaguru et al., 1995; Gupta et al., 1999).

The Narmada–Son Fault (NSF) divides the Indian plate into two halves and has a long tectonic history dating back to the Archaean times (Ravishankar, 1991). The NSF trends in ENE–WSW direction and is laterally traceable for more than 1000 km. It demarcates the Peninsular India into two geologically distinct provinces: the Vindhyan–Bundelkhand province to the north and the Deccan province to the south. Ravishankar (1991) regards the Narmada–Son Fault as a part of the composite tectonically controlled zone in the middle of the Indian plate and termed it as the SONATA zone (abbreviated form of Son–Narmada–Tapti Lineament zone). The Narmada and Tapti Rivers all throughout their course follow these tectonic trends. Other synonyms used in literature to describe this zone include Narmada–Son Lineament (Choubey, 1971), Central Indian Shear (CIS) (Jain et al., 1995) and Central Indian Tectonic Zone (CITZ) (Radhakrishna and Ramakrishnan, 1988; Acharyya and Roy, 2000). Geophysical studies in the central part of this zone reveal this to be a zone of intense deep-seated faulting (Reddy et al., 1995). The zone

witnessed large-scale tectonothermal events associated with large granitic intrusions around 2.5– 2.2 and 1.5–0.9 Ga (Acharyya and Roy, 2000). It was again reactivated during the Deccan volcanic eruption during Late Cretaceous–Palaeocene (Agarwal et al., 1995). Profuse occurrences of E–W-trending dykes suggest that the zone formed the main centre of eruptive activity (Bhattacharji et al., 1996). The entire zone is presently characterized by high gravity anomalies, high-temperature gradient and heat flow and anomalous geothermal regime (Ravishankar, 1991) suggesting that the zone is thermo mechanically and seismically vulnerable in the framework of contemporary tectonism (Bhattacharji et al., 1996). The westward extension of this zone into the lower Narmada valley exhibits a less complex structural setting. Data on the NSF in this part is mainly the result of extensive geophysical surveys for commercial exploitation of petroleum reserves in the subsurface. In the lower Narmada basin, it is expressed as a single deep-seated fault (NSF) confirmed by the Deep Seismic Sounding studies (Kaila et al., 1981). Seismic reflection studies have firmly established that the NSF is a normal fault in the subsurface and becomes markedly reverse near the surface (Fig. 2B) (Roy, 1990). Reactivation of the fault in Late Cretaceous led to the formation of a depositional basin in which marine Bagh beds were deposited (Biswas, 1987). The NSF remained tectonically active since then with continuous subsidence of the northern block, designated as the Broach block, which accommodated 6–7-km thick Cenozoic sediments (Biswas, 1987). The total displacement along the NSF exceeds 1 km within the Cenozoic section (Roy, 1990). However, the movements along this fault have not been unidirectional throughout. The general tendency of the basin to subside has been punctuated by phases of structural and tectonic inversion (Roy, 1990). The N–S-directed compressive stresses during the Early Quaternary, folded the Tertiary sediments into a broad syncline, the Broach syncline, in the rapidly subsiding northern block (Roy, 1990). The Broach syncline extends from the NSF to the Mahi river in the north. The E–W trending axis of this syncline lies to the north of the Narmada river. Corresponding anticlinal structures are found in the Tertiary rocks exposed in the southern up thrown block (Fig. 2A and B). Historical and instrumental records indicate that the compressive stresses still continue to accumulate along the NSFdue to continued northward movement of the Indian plate. This is evidenced by the fault solution studies of the earthquakes at Broach (23 March 1970) and Jabalpur (22 May 1997), which suggest a thrusting movement (Gupta et al., 1972, 1997; Chandra, 1977; Acharyya et al., 1998). However, the underlying cause of the seismicity in the NSF zone is not yet understood (Quittmeyer and Jacob, 1979).

The Narmada River in its lower reaches defends in sinuous to meandering pattern which is solely guided by ENE to WSW to E_W lineament and its sympathetic fractures .it has chiseled the land scape in to terraces , valley flats which form the prominent landscape of quaternary terraces breaking the monotony of close topograoghy.The Narmada down stream of Garudeshwar flows in a general WSW direction where it display meanders with wavelengths of 5–8 km The Orsang, Aswan,Men and Bhuki are the major rivers joining the Narmada from the north. The Karjan River, which drains a major part of the trappean uplands in the lower Narmada valley, meets the Narmada from the south. The other tributary, the Madhumati River drains the western fringe of the trappean upland. In between the Karjan and Madhumati rivers there are several north flowing small streams meeting the Narmada at various points. The net work of drainage in the lower Narmada is structurally controlled and developed and work under the mechanism of neosiesmic ecology of pulsation variance evident by river terraces ,linear scarp. The presence of ravineous tracts with incised deep gullies of 20–25 m. is manifestat ion of deep seated water table due to subsidence of block along the lineament zone. The disposition of river terraces, entrenched meanders and alluvial cliff 15–30 m are suggestive of neotectonic activity in the area. The display of active Narmada channel configuration of terraces, meander scrolls, entrenched meander revealed misfit nature of Narmada in the area. The present channel of Narmada is strongly influenced by NSF and display persistent tendency to shift towards north due geotectonic activity along the fault. It also authenticate that there is perceptible up rise in the southern block of fault and subsidence of northern block which resulted into gliding and shift of Narmada to wards north.

The tectonic uplift of the lower Narmada valley during the Early and Late Holocene suggests inversion of an earlier subsiding basin. Such inversions of the basin have been common in the Tertiary times and are well recorded in the sediments of that age (Roy, 1990). A symmetric convergence of the NT-1,NT-2 terraces , diagonal disposition of paired equivalent of terraces across the channel , divergent and linear disposition of cliff of NT-3 terrace in conformity of NSF constant subsidence of basin and in response to frequential movement ad geotectonic activity along the NSF. The displaced Late Pleistocene sediments across NSF in the Narmada and Orsang Heran and Madhumati & Karjan valleys, the NNW tilting of the NT-1, NT-2 sediments litho units consisting of the Late Pleistocene sequence, the anomalous topographic slope in the same direction and the incised cliffs up to 25–30 m in the streams that flow along this slope in the area between NSF and the Narmada River, indicate unsynchronized neoseismic movements along the NSF during the Early Holocene. The displacement of sediments of NT-1 surface across the NSF indicates differential movement of about 35 m along the NSF during Early Holocene. The block

between the Narmada and Karjan rivers bounded by the NSF and the two other cross-faults suffered subsidence leading to the formation of a series, linear and curvilinear cuts of on terraces and flood plains. The 5–8-m incised cliffs of the streams also suggest that this block escaped the uplift induced large scale incision going on simultaneously in other areas of the lower Narmada valley. The occurrence of ravines and association of deep gullies with the river terraces is morpho-tectonic manifestation caused by the sudden vertical movement and block adjustment due subsidence resulting to sudden collapse of water table and ground water regime in the area.

The strongest supporting evidence for the Early Holocene tectonic uplift of the area comes from the sea-level curves of the west coast of India which suggest a tectonic component of about 40 m at this time (Rao et al., 1996).

In the Narmada valley the River terraces (NT-3) has occupied large area on the both bank of. It extends from Orsang river in the north east to Mahi river in the west from Baroda in the north to Bharuch –Aliabet in the southwest. In the southern bank of Narmada it is developed alround Ankleshwar and Rajpipla and further south. The average elevation of this surface is about 75 m above m.s.l, separated by both linear and curvilinear scarp from NT-2. The average height of cliff is about 40 m. The sediments comprised of this terrace are exposed in the cliff section. The oldest deposit of the exposed sediment successions a highly pedogenised mottled clay horizon showing vitriolic characters like extensive fracturing giving rise to blocky aggregates, pseudo anticlines and hydro plastic slickenside along the fracture surfaces. .The sediments of this terrace are associated with a rich assemblage of shallow marine foraminifers. The basal unit consisting of rock pebbles with clays is overlain by thick fluvial sediments, which comprise alluvial plain facies. The pebbly unit which contains rock fragments of quartzite, granite basalt, and limestone sandstone is about 5.5.m thick, it is a persistent horizon and exposed in the cliff section. It is marker horizon, represent distinct phase of sedimentation in the valley.

In the Lower Narmada valley the Mid–Late Holocene Quaternary valley deposits is the product of a Holocene high sea-level-induced deposition in a deeply incised valley trench trough highly influenced by NSF. The Mid–Late ey which resulted in both estuarine and fluvial sedimentation in the lower reaches. A significant slowing down of tectonic uplift facilitated the encroachment of the sea into the valley and the creation of a depositional wedge, which extended up to the deep in land foothills. The 5–10-m exposed thickness of the valley-fill sediments reveals tide dominated estuarine deposition in the lower reaches and fluvial deposition upstream of the tide reach.

The pre-existing quaternary platform of NT-3 of middle Pleistocene prior to induced sedimentation of tidal transgression was strongly induced by tectonic impulses of NSF. The relative disposition of terraces (NT-2 NT-3) cliff alluvial bluff ad scarp, reveals that the present mouth of the Narmada river has retained roughly the originally funnel shape of the estuary formed during the Mid–Late Holocene. However, the size of the estuary is now considerably reduced in space and time with sedimentation and t compressive tectonic environment. The stepped sequence of terraces NT0 to NT2A NT2B NT2C NT3A, NT3B) their dispodition, their convergence & divergence, cyclic and non cyclic nature and mutual inter relation revealed at least three mega phases and four micro phases of up rise of sea level related with tectonics of the area in late to upper pleistocene time.

The incursion and transgression of tides, present estuarine reach contains several islands, which are coeval with the terrace surface above the present tidal range. Hence, they are the products of estuarine processes of the Mid–Late Holocene and not those of the present day. Funnel shaped morphology and increasing tidal energy landward are characteristics of tide-dominated estuaries (Wright et al., 1973). Existing data suggest that the Mid–Late Holocene sea level has remained at the same level up to the present with minor fluctuations (Chappel and Shackleton, 1986; Hashimi et al., 1995). The Mid–Late Holocene sediments show tilting of 10–20j which is more pronounced in the vicinity of the NSF suggesting that the incision and uplift of the valley-fill terraces well above the present day tidal limits is related to the continued differential uplift along NSF. Evidence of tectonic uplift has been reported from the coast also in the form of raised mudflats occurring 2–4 m above present sea level (Merh, 1993). Currently, the river occupies the northern margin of the Early Holocene channel belt and is clearly more sinuous. It exhibits a narrow channel with wide meanders inside wide belts of Mid–Late Holocene terraces (NT-3) a typical pattern of under fit streams. (Khan2015) (Dury, 1970). (Plate No_3, 4, 5 to 8)

Plate No.1

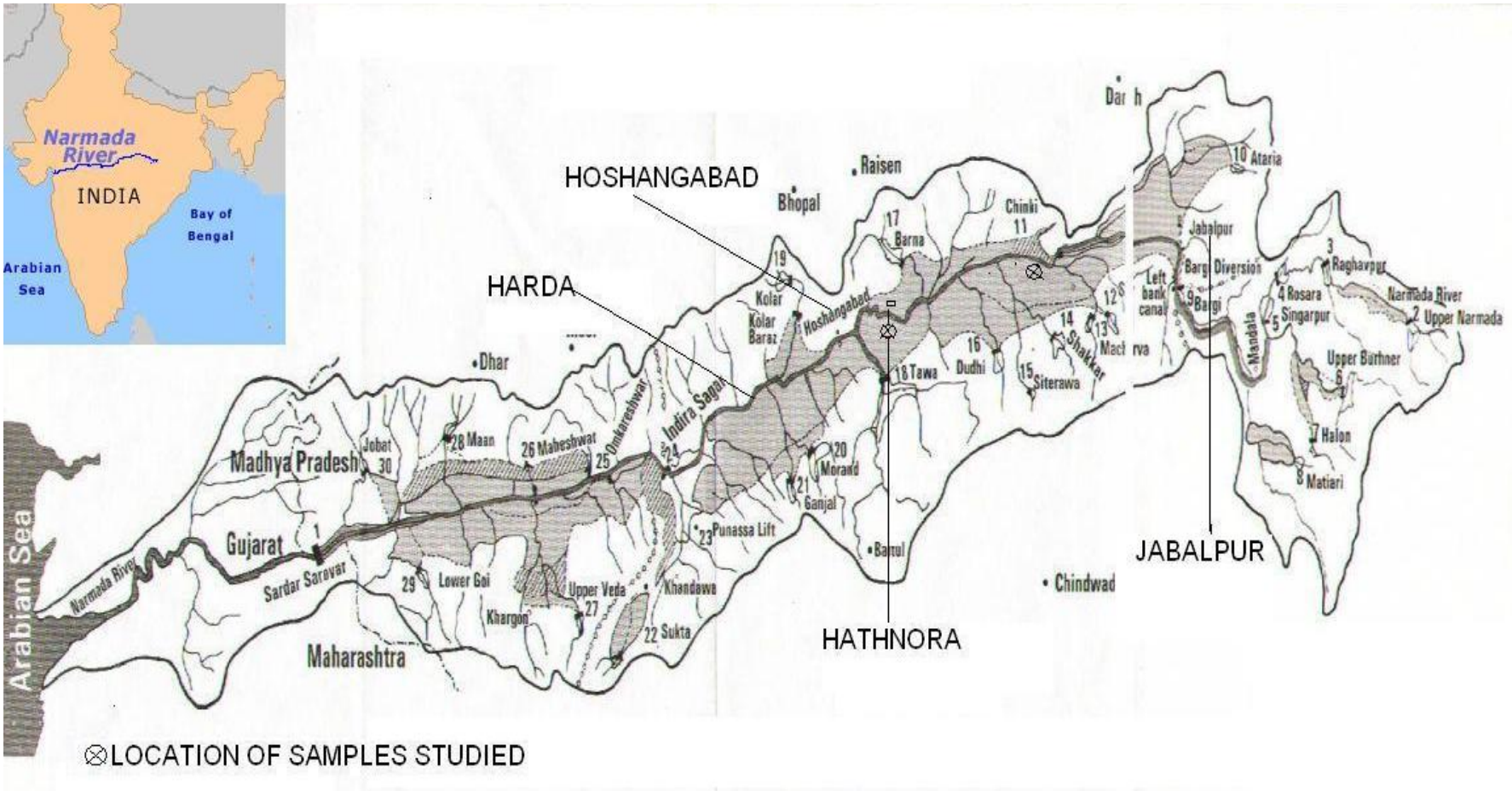
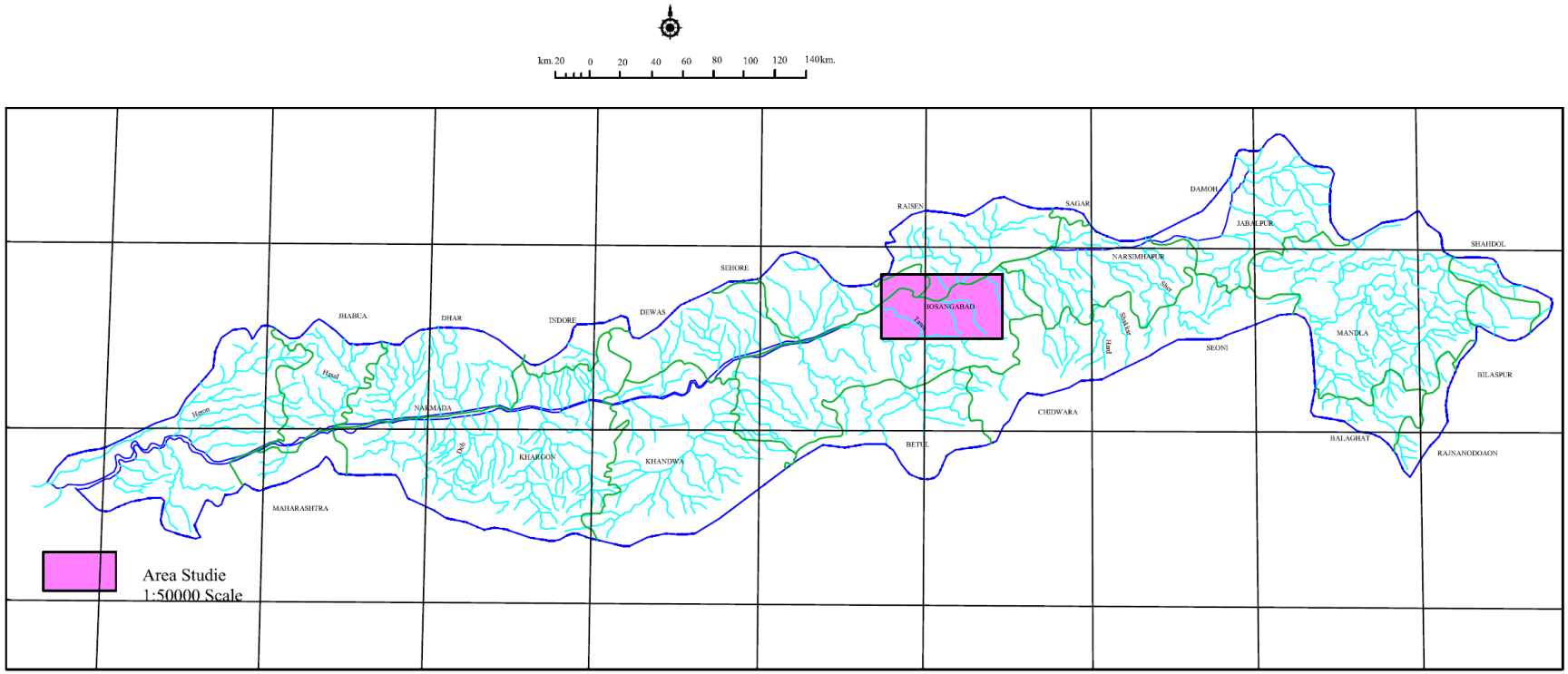

Narmada River
INDIA
Bay of Bengal
Arabian Sea
HOSHANGABAD
HARDA
HATHNORA
JABALPUR
Bhopal
Raisen
Dhar
Madhya Pradesh
Gujarat
Maharashtra
Arabian Sea
Narmada River
Sardar Sarovar
Indira Sagar
Punassa Lift
Barna
Chinki
Kolar
Kolar Baraz
Hoshangabad
Tawa
Dudhi
Siterawa
Shakkar
Morand
Ganjal
Barul
Chindwad
Jobat
Maan
Maheshwar
Omkareshwar
Lower Goi
Khargon
Upper Veda
Khandawa
Sukta
Ataria
Jabalpur
Bargi Diversion
Left bank canal
Bargi
Raghavpur
Rosara
Singarpur
Mandala
Narmada River
Upper Narmada
Upper Burhner
Halon
Matiari
⊗LOCATION OF SAMPLES STUDIED

Plate No.2

AREA OF STUDY OF QUATERNARY GEOLOGY OF HATNORA, NARMADA VALLEY,M.P.,INDIA



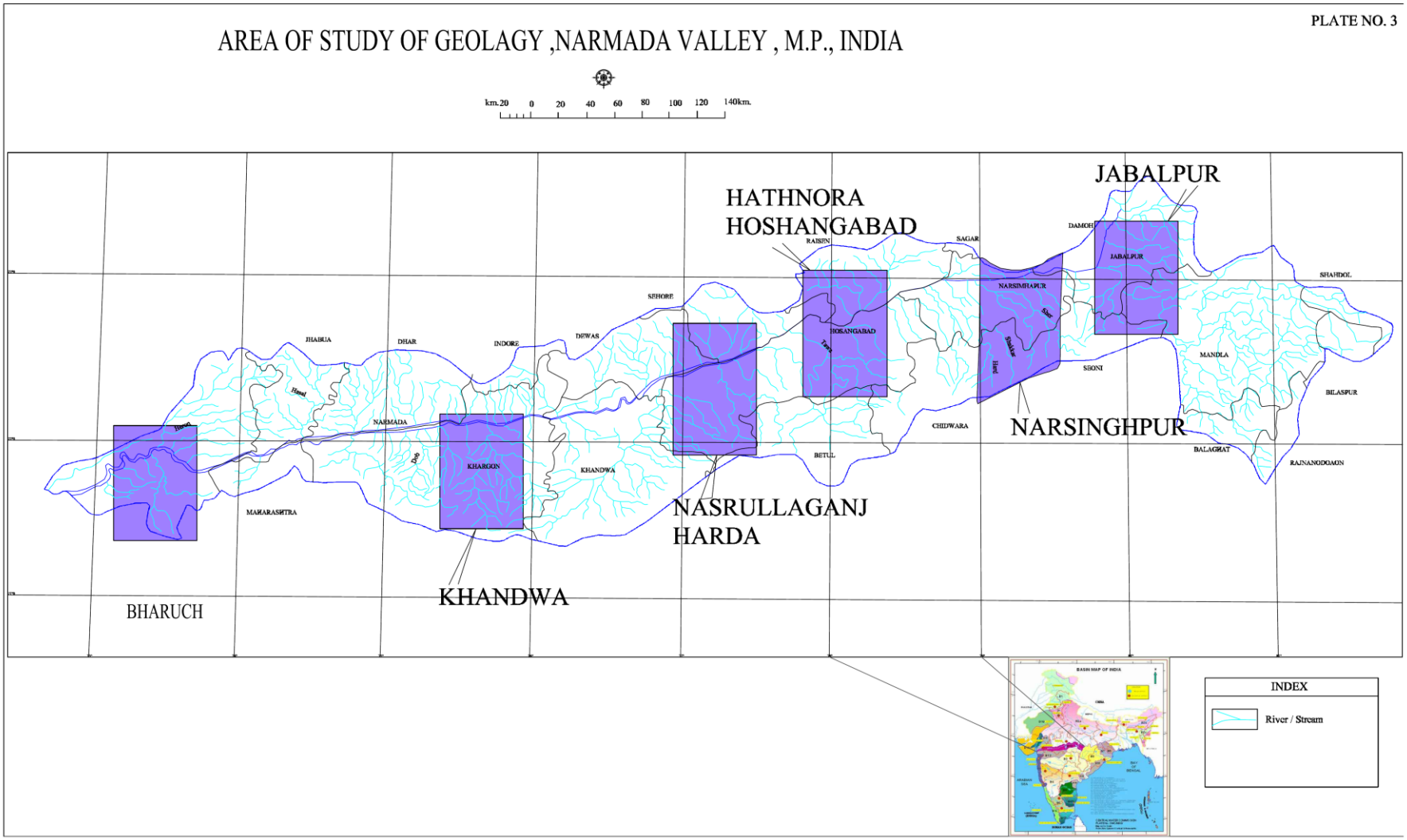
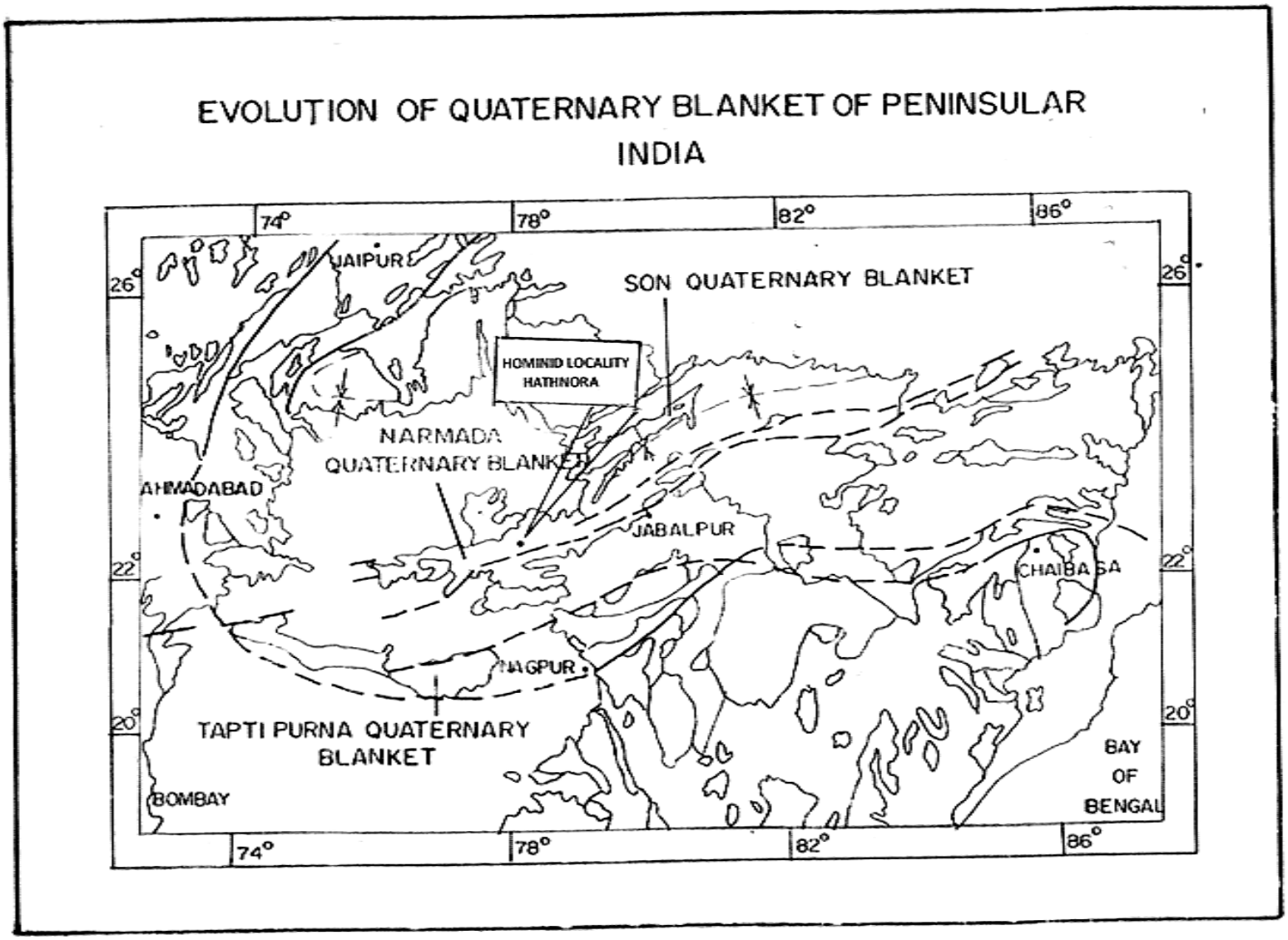


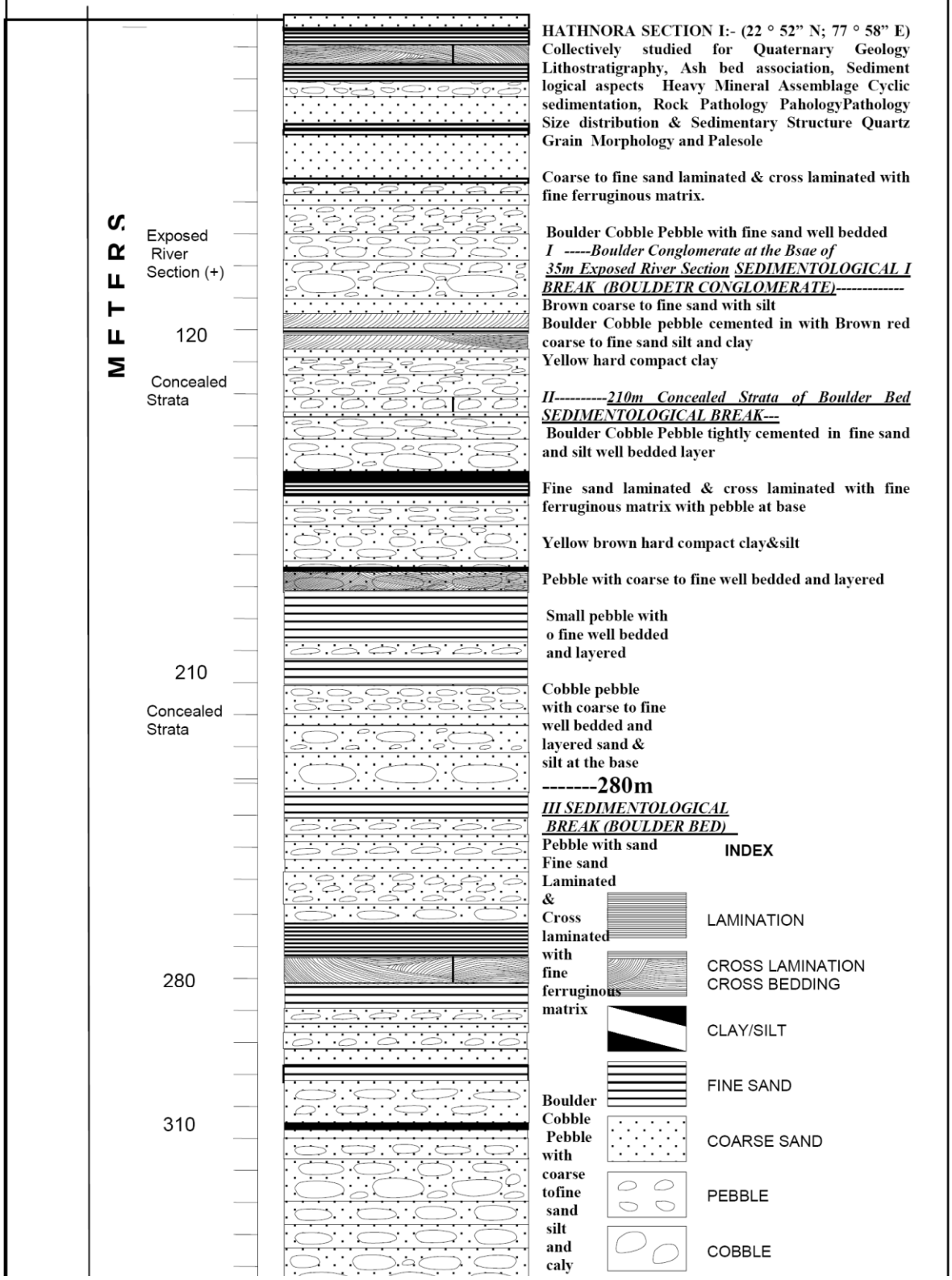
PLATE NO. 3
AREA OF STUDY OF GEOLAGY ,NARMADA VALLEY , M.P., INDIA
km. 20 0 20 40 60 80 100 120 140km.
JABALPUR
HATHNORA
HOSHANGABAD
NARSINGHPUR
NASRULLAGANJ
HARDA
KHANDWA
BHARUCH
JHABUA
DHAR
INDORE
DEWAS
SEHORE
RAISEN
SAGAR
DAMOH
JABALPUR
NARSIMHAPUR
HOSANGABAD
SHAHDOL
SEONI
MANDLA
BILASPUR
BALAGHAT
RAJNANDGAON
CHIDWARA
BETUL
KHARGON
NARMADA
MAHARASHTRA
INDEX
River / Stream

Plate No. 4


EVOLUTION OF QUATERNARY BLANKET OF PENINSULAR INDIA
74°
78°
82°
86°
26°
22°
20°
JAIPUR
SON QUATERNARY BLANKET
HOMINID LOCALITY
HATHNORA
NARMADA
QUATERNARY BLANKET
AHMADABAD
JABALPUR
CHAIBASA
NAGPUR
TAPTI PURNA QUATERNARY
BLANKET
BOMBAY
BAY
OF
BENGAL

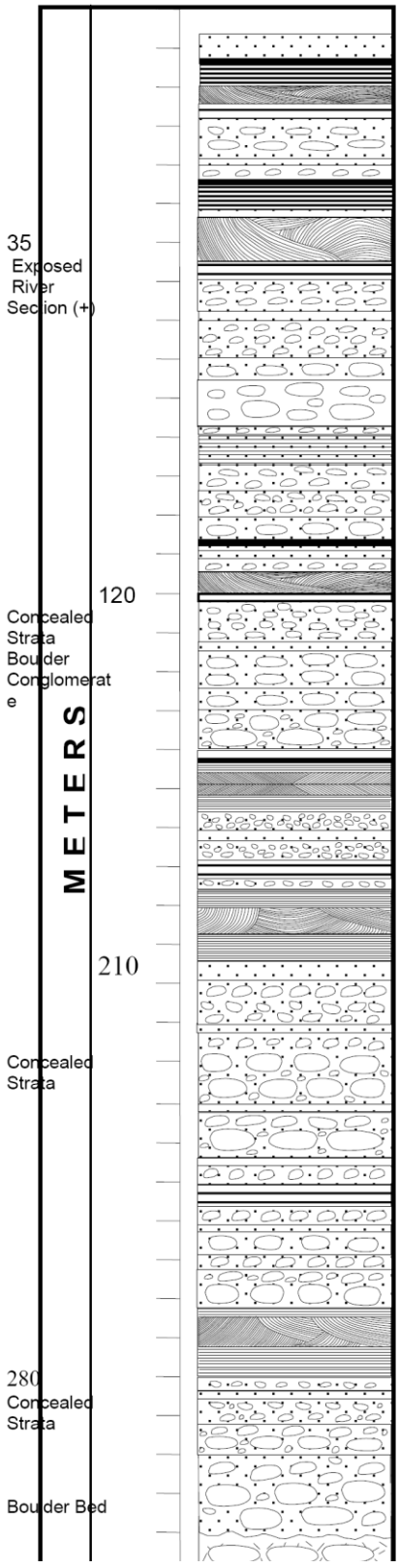
HATHNORA SECTION _ I: - (22 ° 52" N; 77 ° 58" E) Plate No QG__5

QUATERNARY GEOLOGY COMPOSITE LITHOSTRATIGRAPHIC SECTION OF QUATERNARY DEPOSITS OF PALEO DOMAIN OF NARMADA AND CONSEALLED STRATA BASED ON STUDY OF EXPOSED STRATA & BORE HOLE LOGS.



HATHNORA SECTION _ II:- (22 ° 52" N; 77 ° 58" E) Plate No QG_6

QUATERNARY GEOLOGY COMPOSITE LITHOSTRATIGRAPHIC SECTION OF QUATERNARY DEPOSITS OF PALEO DOMAIN OF NARMADA AND CONSEALLED STRATA BASED ON STUDY OF EXPOSED STRATA & BORE HOLE LOGS



HATHNORA SECTION II:- (22 ° 52" N; 77 ° 58" E) Collectively studied for Quaternary Geology Lithostratigraphy, Ash bed association, Sediment logical aspects Heavy Mineral Assemblage Cyclic sedimentation, Rock Pathology PahologyPathology Size distribution & Sedimentary Structure Quartz Grain Morphology and Palesole

Coarse to fine sand laminated & cross laminated with fine ferruginous matrix.

Cobble Pebble with fine sand well bedded

I -----Boulder Conglomerate at the Bsae of 35m Exposed River Section

SEDIMENTOLOGICAL BREAK ----------

Yellow hard compact clay

Boulder Cobble pebble cemented in with Brown red coarse to fine sand silt and clay

II----------210m Concealed Strata of Boulder Bed ***SEDIMENTOLOGICAL BREAK (BOULDER BED)***

Boulder Cobble Pebble tightly cemented in fine sand and silt well bedded layer

Fine sand laminated & cross laminated with fine ferruginous matrix with pebble at base
Brown coarse to fine sand with silt
Pebble with coarse to fine well bedded and layered
Fine sand laminated & cross laminated with fine ferruginous matrix
Fine sand laminated & cross laminated with fine ferruginous matrix with pebble at base

Small pebble with o fine well bedded and layered

Cobble pebble with coarse to fine well bedded and layered sand & silt at the base

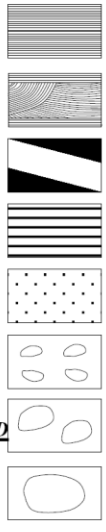
Fine sand Laminated & cross laminated with fine ferruginous matrix

III----280m

SEDIMENTOLOGICAL (BREAK (BOULDER BED

Boulder Cobble Pebble with coarse to fine sand silt and caly

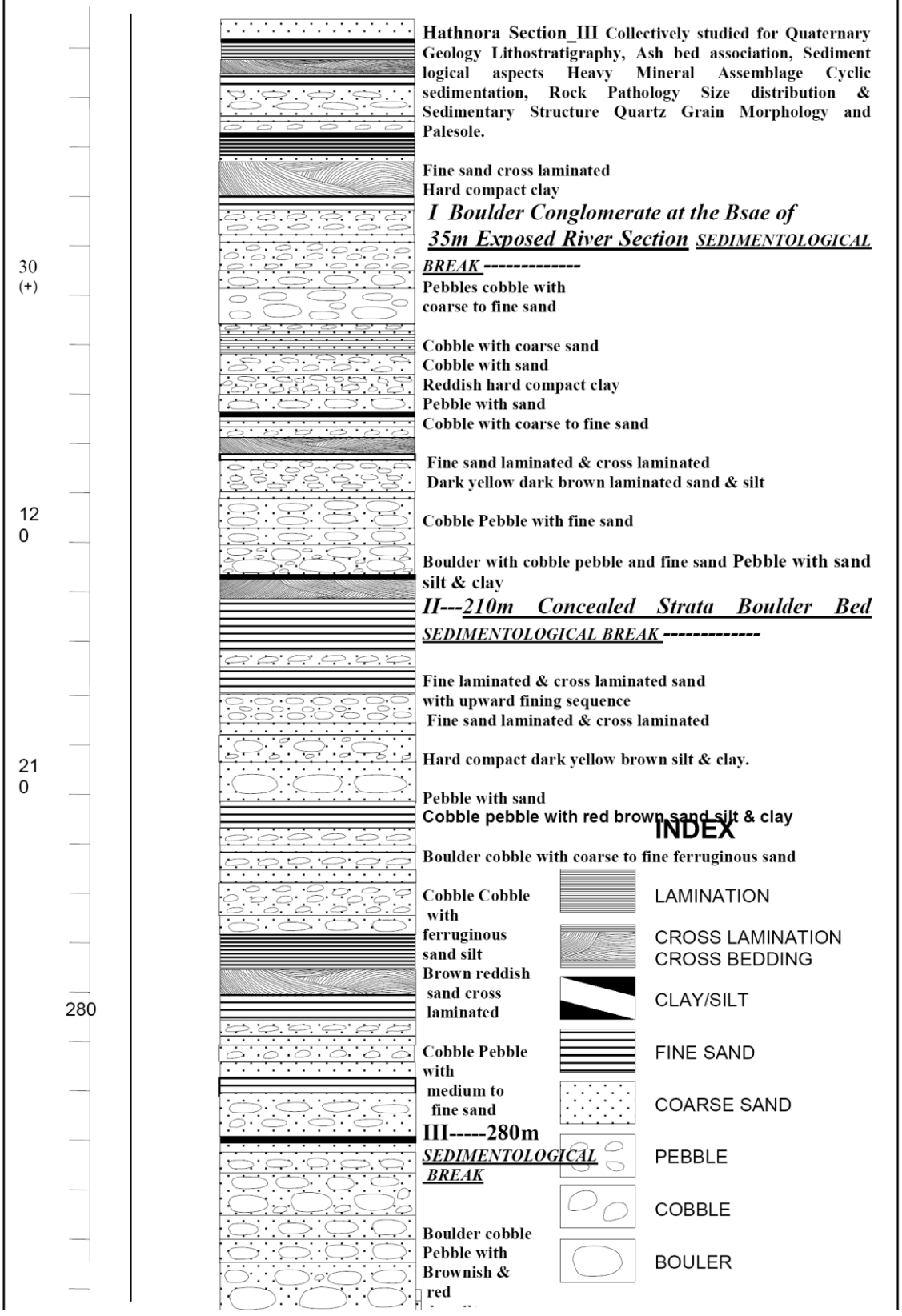
INDEX



LAMINATION
CROSS LAMINATION CROSS BEDDING
CLAY/SILT
FINE SAND
COARSE SAND
PEBBLE
COBBLE
BOULER

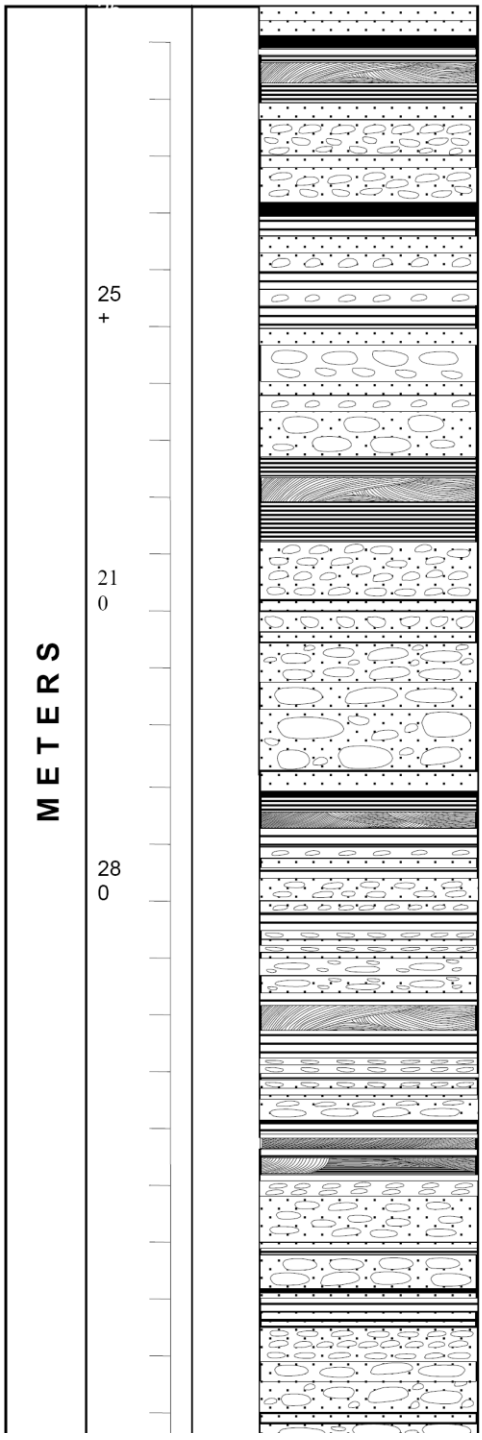
HATHNORA SECTION_III- (22 ° 52" N; 77 ° 45" E) Plate No QG_7

QUATERNARY GEOLOGY COMPOSITE LITHOSTRATIGRAPHIC SECTION OF QUATERNARY DEPOSITS OF PALEO DOMAIN OF NARMADA AND CONSEALLED STRATA BASED ON STUDY OF EXPOSED STRATA & BORE HOLE LOGS



HATHNORA SECTION_ IV:- (22 ° 52" N; 77 ° 40" E) Plate No QG_8

QUATERNARY GEOLOGY COMPOSITE LITHOSTRATIGRAPHIC SECTION OF QUATERNARY DEPOSITS OF PALEO DOMAIN OF NARMADA AND CONSEALLED STRATA BASED ON STUDY OF EXPOSED STRATA & BORE HOLE LOGS



Hathnora Section IV:- (22 ° 52" N; 77 ° 40" E) Collectively studied for Quaternary Geology Lithostratigraphy, Ash bed association, Sediment logical aspects Heavy Mineral Assemblage Cyclic sedimentation, Rock Pathology Size distribution & Sedimentary Structure Quartz Grain Morphology and Palesole

Pebble cobble
With sand
Hard compact clay

Coarse snd with pebbles

Coarse sand well bedded

I-----Boulder Conglomerate-at the Bsae of – 35m Exposed River Section

SEDIMENTOLOGICAL BREAK ----------

Cobble with sand

Boulder Cobble with coarse to fine sand

Fine sand laminated & cross laminated Hard compact caly at base

II----------210m Concealed Strata of Boulder Bed ----------

Boulder Cobble Pebble tightly cemented in fine sand and silt well bedded layer

Boulder Cobble with coarse to fine sand

Medium cobble with pebble and fine sand

Boulder Cobble pebble with red brown sand silt & clay

Boulder cobble with coarse to fine ferruginous sand

Cobble with ferruginous sand silt

III-------280m ***SEDIMENTOLOGICAL BREAK***

Pebble with fin e sand

Pebble with fine sand

Fine sand cross Laminated

Pebble cobble With sand

Pebble well bedded with in sand

coarse to fine sand

Boulder cobble

Pebble with sand

INDEX

LAMINATION

CROSS LAMINATION
CROSS BEDDING

CLAY/SILT

FINE SAND

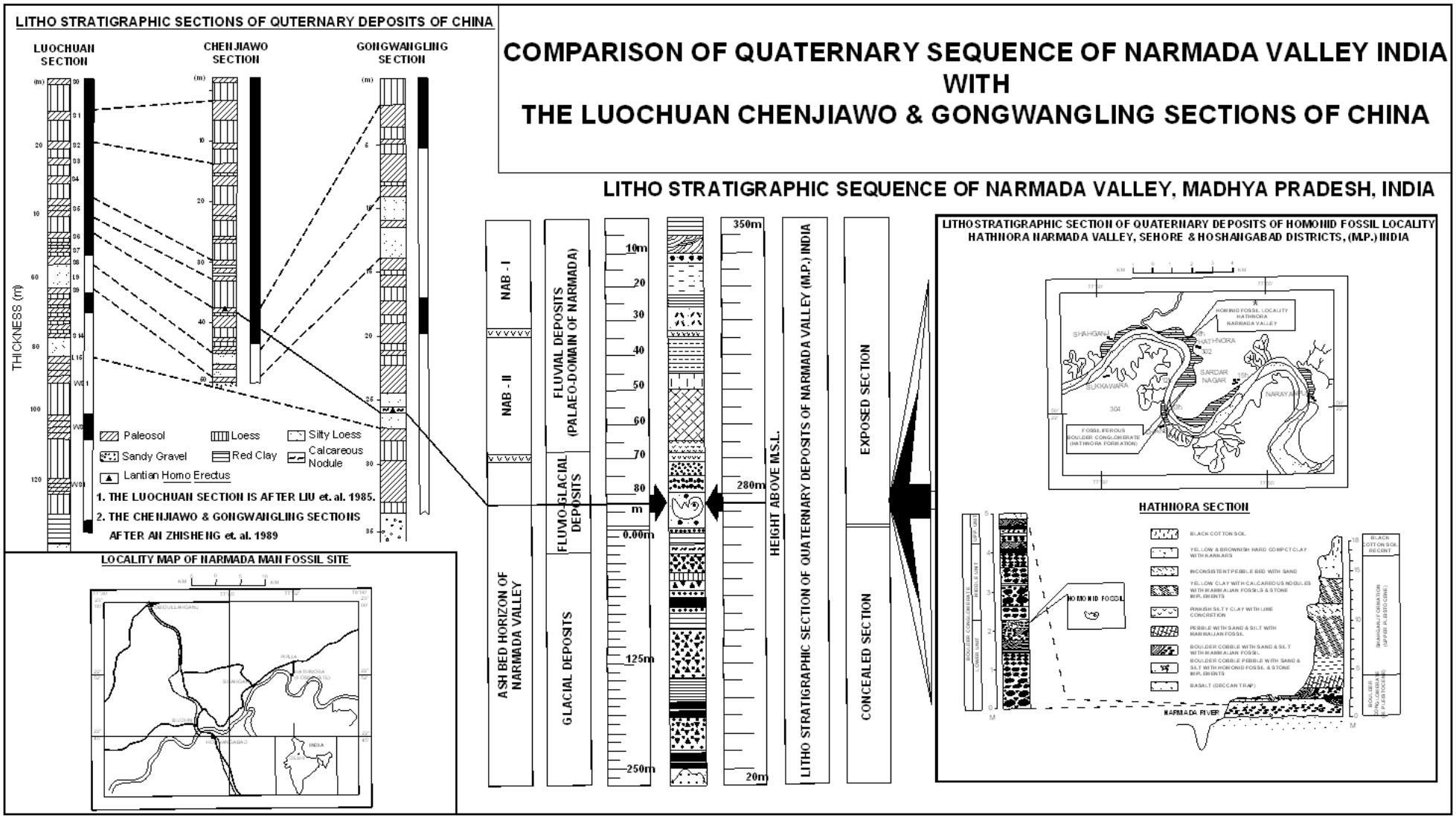
COARSE SAND

PEBBLE

COBBLE

BOULER

Plate No.9


LITHO STRATIGRAPHIC SECTIONS OF QUTERNARY DEPOSITS OF CHINA
LUOCHUAN SECTION
CHENJIAWO SECTION
GONGWANGLING SECTION
THICKNESS (m)
Paleosol
Loess
Silty Loess
Sandy Gravel
Red Clay
Calcareous Nodule
Lantian Homo Erectus
1. THE LUOCHUAN SECTION IS AFTER LIU et. al. 1985.
2. THE CHENJIAWO & GONGWANGLING SECTIONS AFTER AN ZHISHENG et. al. 1989
LOCALITY MAP OF NARMADA MAN FOSSIL SITE
COMPARISON OF QUATERNARY SEQUENCE OF NARMADA VALLEY INDIA WITH THE LUOCHUAN CHENJIAWO & GONGWANGLING SECTIONS OF CHINA
LITHO STRATIGRAPHIC SEQUENCE OF NARMADA VALLEY, MADHYA PRADESH, INDIA
NAB - I
NAB - II
FLUVIAL DEPOSITS (PALAEO-DOMAIN OF NARMADA)
FLUVIO-GLACIAL DEPOSITS
GLACIAL DEPOSITS
ASH BED HORIZON OF NARMADA VALLEY
HEIGHT ABOVE M.S.L.
LITHO STRATIGRAPHIC SECTION OF QUATERNARY DEPOSITS OF NARMADA VALLEY (M.P.) INDIA
EXPOSED SECTION
CONCEALED SECTION
LITHOSTRATIGRAPHIC SECTION OF QUATERNARY DEPOSITS OF HOMONID FOSSIL LOCALITY HATHNORA NARMADA VALLEY, SEHORE & HOSHANGABAD DISTRICTS, (M.P.) INDIA
HATHNORA SECTION
HOMONID FOSSIL
NARMADA RIVER

Conclusion and summary:-

The Indian Plate is currently moving northeast at 5 cm/yr (2 in/yr), while the Eurasian Plate is moving northeast at only 2 cm/yr (0.8 in/yr). This is causing the Eurasian Plate to deform, and the Indian Plate to compress leading to tectonic activity along major fault zones. In tectonically active areas sedimentary basins undergo phases of both crustal extension and contraction leading to basin inversion and hence display features typical of subsidence and uplift. Geomorphic attributes and deformation in late Quaternary sediments are the indicators of active tectonic activity in any sedimentary basin. The geomorphic evolution in such reactivated basins is primarily due to complex interaction between sedimentation processes and tectonics. The peninsular India has been undergoing high compressive stresses due to the sea-floor spreading in the Indian Ocean and locking up of the Indian plate with the Eurasian plate to the north. Much of this N-S directed stresses have been accommodated by the under thrusting of the Indian plate below the Eurasian plate. A part of these compressive stresses are accumulated along the Narmada-Son Fault (NSF), a major E-W trending crustal discontinuity in the central part of Indian plate.The Quaternary tectonic activity recorded in the Narmada valley possibly,has wider ramifications when viewed in the larger perspective of the Indian plate. This suggests a renewed phase of extreme compression of the Indian plate, which led to tectonic insecurity and may causes tumores and eatrh quake in peninsular India.

In Narmada valley the association of Ash bed NAB-I with Hathnora formation at the depth of 78 m in Quaternary column and occurrences skull cape *of Homo erectus* at the depth of 83 m in decreasing antiquity from the top assumed that Toba eruption have taken place later than existence of *Homo erectus* which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash is NAB-II at the depth of 72 m with the younger deposit revealed the second cyclic fall of Toba ash which certainly have had influenced on hominines and had collective and cumulative impact on *Homo erectus* (Sonakia1984) *Homo sapiens* (Thobold 1860, 81), in Narmada valley and Indian sub-continent. Oppenheimer (2003) argues that *Homo. Sapiens* occupied India before ~74 ka and may have undergone "mass extinction" as a result of the Toba eruption. The argument of Oppenheimer (2003) is in strong conformity with the present observation of authors. As sediment & Ash bed sequence of Quaternary column of Narmada (325 m) and occurrences of fossil of skull cape *of Homo erectus* (Sonakia1984) at 83 m & human cranium *Homo sapiens* (Thebold 1960,1981) transported have existed prior to fall of Toba ash and they are among the few who inspite of mass extinction caused by mega dislocation in ecology and environment related with volcanic eruption survived in Narmada Valley. It is further documented by the rarest occurrences of these fossils in subcontinent which also confirm the intensive impact of volcanic ash fall on these hominines and their consequential mass extinction. (Table No AB-1-3) & Plate No AB-2-8).

The study of assemblage of glass matrix of Ash bed, grain morphology of glass their- relation with other minerals shape, size, texture of litho fragments of pyroclastic origin suggest that sediments were brought from distant source by Aeolian agencies in the form of thick cloud containing volcanic dust, rock matrix and different gases which remained in atmosphere for very long time and settled down across the Indian sub continent during the different phases of river sedimentation. Further study of Ash bed material and silica revealed diagnostic morphological characters of glass shards which are typical of silica volcanism (Heiken, 1972, 1974) and show close similarity with those reported from the Quaternary tephra beds of the Narmada , Son, Purna and Kukdi basins (Basu et. al., 1987; Khan et.al. 1991 Basu and Biswas, 1991; Singaraju and Shivaji, (1991) Mukhopadhyay, (1992). It is significant to note that the occurrences and association of two marked horizons at different levels further reveal that the cyclic eruption and settling of volcanic matrix has taken place with pause in the valley.

The occurrences of these skull caps with short range of their occurrences in the stratigraphic column of Narmada with the Ash beds horizon NAB-I and NAB-II and specially with the Hathnora formation one at the top at an average elevation of about 268-273 m above the mean sea level and other with younger deposits had revealed the close association with volcanic activity with their existence. The Toba Ash fall is also in very close range with the sequence of sedimentation and occurrences with both the skull caps, which certainly has its impact on the middle and late Pleistocene Hominines in Narmada valley and Indian subcontinent.

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 stratigrphic 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 form 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 Luochuan sequence,(90-120 m) Chenjiawoe (50m) and Congwanling 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 startigraphic 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).

This study of quartz grain and their microstructures of paleosoils identified in the concealed blanket of Quaternary deposit display relative heterogeneity in sediment characteristics throughout across the Quaternary column of Central Narmada valley. The study quartz grain of soil and 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 fluvial , fluvio-glacial and , glacial deposit (72 samples +25). The majority of quartz grain population show characteristic surface textures linked to long evolution in fluvial, fluvio-glacial and glacial environment of sedimentation in time and space in increasing antiquity in the valley. There exist a direct relationship between grain-size characteristics and the shape and surface texture of grains. The variations in shape and size of grain assemblages and imprints of particular microstructures in specific population 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 distinctly related with change of climate and tectonic changes in increasing antiquity in Narmada valley.

The study of quartz grain form surface and subsurface quaternary blanket enveloped in the tectonic trench 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 fluvial , fluvio-glacial and , glacial deposit (72 samples + 25). The majority of quartz grain population show characteristic surface textures linked to long evolution in fluvial, fluvio-glacial and glacial environment in time and space. An indication of glacial evolution (parallel striations or grinding features) was observed in samples (10%-60% of grains) in 35 samples from different levels between 390 to 525 m the percentage of grains showing a glacial origin having parallel striations, fresh silica pellicles, and polished silica pellicles and fresh impact features. As such evidences of glacial, fluvio-glacial and fluvial evolution is marked in the lower startigraphic columns of Narmada. In addition some of grains exhibit fresh quartz overgrowths, features, and silica pellicles at some level of sedimentation. This indicates a mixing of grains from different provenances. The parallel striations and fresh impact features are diagnostics of glacial environment and demonstrate consistency in occurrence. This implies a change of environment of sedimentation from glacial to fluvio-glacial and fluvial. This variation is accompanied by a decrease in the percentage of rounded grains and in the fine-sand fraction. The parallel striations are polished, were observed. The composite illustration of fresh striations and polishing of grains support to glacial environment of sedimentation in Narmada valley during lower Pleistocene time. The density of grains possessing such diagnostic elements of glacial origin decreases upward in vertical column and their consistency has inverse relation which indicates sequential change of environment from glacial, to fluvio-glacial and fluvial in chronological sequence up ward in the Narmada valley.

In Narmada valley the most of the hominid remains and associated artifacts in the would have been found associated with Miocene Pliocene– Pleistocene sediments of boulder be an d boulder conglomerate 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, and Tilakwarda _Bharouch which posses the complete sequence of all three domain in increasing antiquity in chronology in vertical coloumn from the bottom of the rift trench viz 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 fossiferous 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. The rift system and platforms of sedimentation bear the imprints of and evidence of the effects of tectonics on fauna and flora are distinct, however the signatures of subsidence 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 eructs* 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 in rift system and inconsistency in exposure of fo**silifrous horizon of Narmada rift system which is the handicapp in search of further human remains in Narmada valley after Sonakia (1984).

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 (150 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 digenetic 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 Khan et.al (2015). The study of statistical parameters across the entire thickness of Quaternary deposits revealed three breaks in sedimentation at 350 -290,190-220,100-150 which represent glacial, Fluvioglacial and Fluvial environment of in increasing antiquity in from bed rock in Narmada valley.

The study revealed that sediments were primarily derived from metamorphic source comprising of kyanite-paragonite, muscovite schist, gneiss, garnet mica schist, and Para-amphibolite tourmaline garnet metasedimentarias and meta-volcanic. Apart these minerals are also reworked from older Quaternary deposits from Boulder bed glacial deposit, Boulder conglomerate of fluvio-glacial deposit and fluvial terrace and higher and other older terraces of fluvial domain. These heavies were basically transported from the sources area by glacial fluviol-glacial and fluvial agencies to the present site of their occurrence. The mode of transportation, environment of deposition and energy system of transporting media has greatly affected the frequency of concentration of heavies, their grain morphology and stability in that particular domain of deposit. These minerals, mostly released from rock fragments and other fabrics comprising boulder bed, subjected to intensive wear and tear and physio-chemical environment of weathering transport and deposition, the micro imprints acquired by different condition of sedimentation revealed the intense grounding and bed traction of sediments from the source. The striations on these minerals indicate glacial activity in the initial stage of sedimentation. These suites of minerals are stable as compared to the other suite of minerals of these deposits although these mineral are associated with all domain of quaternary deposits but show different frequencies of their occurrence and physical characters, shape size shpericity and roundness and bear the micro imprints acquired by different condition of sedimentation revealed the intense grounding and bed traction of sediments from the source. The striations on these minerals indicate glacial activity in the initial stage of sedimentation. These are generally angular to highly angular in shape and show very poor indices of spericity and roundness typical of glacial environments. The configuration of minerals, rock clastic, ground mass, imprints and impact tectonics revealed the intense grounding and bed traction of sediments from the source to site of

sedimentation.The striations on these minerals indicate glacial activity in the initial stage of sedimentation. These are generally angular to highly angular in shape and show very poor indices of spericity and roundness typical of glacial environments. The configuration of minerals, rock clastic, ground mass, imprints and impact tectonics revealed the intense grounding and bed traction of sediments from the source to site of sedimentation.

In Hominid locality of hathnora about 202 samples collected from Section I to IV from the exposed sections and bore hole logs across the vertical column 550 m for study to trace environments of sedimentation in Pleistocene to Holocene time. The statistical parameters viz MZ, STD, SKI, and KG of sediment samples were computed of 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 deposits of paleo-domain of Narmada (NT1 to NT3). The study of various parameters their binary relation, their concentration of plots cluster and trends and patterns revealed three breaks in vertical column at 000.m to150, 150 to 350, and 350 to 550 m in increasing antiquity in Narmada valley

The study further revealed statistical parameters to gather with heavy mineral assemblage, quartz grain morphology, paleo sole analysis ash bed matrix depict contrasting diagnostic characters of sediments in chronology of quaternary sequence in vertical columns. The statistical parameters and binary clusters of plots of mean size and sorting, mean size and skewness, mean size and kurtosis are used in delineating and fencing boundary between the glacial and fluvio glacial and fluvial sediments. The concentration of these 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 to shape size sorting, and display a balance harmony and ecology in conformity of sedimentation .Khan et.al (2015) Khan (2016)Khan (2016)

The Narmada before debouching into Gulf of Cambey a conspicuous quaternary blanket is encountered. This segment is about 90 km in length and forms the southern margin of the N–S extending Gujarat alluvial plains .A significant feature of the lower Narmada valley is the deposition of a huge thickness of Tertiary and Quaternary sediments in a fault controlled rift trench. To the south of the ENE–WSW-trending Narmada–Son Fault (NSF), the Tertiary rocks and basaltic flows of Deccan Trap Formation occur on the surface while to the north they lie in the subsurface and are overlain by Quaternary sediments .However, the overlying Quaternary sediments having a maximum thickness of 800 m (Maurya et al., 1995).

The Narmada River in its lower reaches defends in sinuous to meandering pattern which is solely guided by ENE to WSW to E_W lineament and its sympathetic fractures .it has chiseled the land scape in to terraces , valley flats which form the prominent landscape of quaternary terraces breaking the monotony of close topograoghy.The Narmada down stream of Garudeshwar flows in a general WSW direction where it display meanders with wavelengths of 5–8 km The Orsang, Aswan,Men and Bhuki are the major rivers joining the Narmada from the north. The Karjan River, which drains a major part of the trappean uplands in the lower Narmada valley, meets the Narmada from the south. The other tributary, the Madhumati River drains the western fringe of the trappean upland. In between the Karjan and Madhumati rivers there are several north flowing small streams meeting the Narmada at various points. The net work of drainage in the lower Narmada is structurally controlled and developed and work under the mechanism of neosiesmic ecology of pulsation variance evident by landscape manifestation.

The tectonic uplift of the lower Narmada valley during the Early and Late Holocene suggests inversion of an earlier subsiding basin. Such inversions of the basin have been common in the Tertiary times and are well recorded in the sediments of that age (Roy, 1990). A symmetric convergence of the NT-1,NT-2 terraces , diagonal disposition of paired equivalent of terraces across the channel , divergent and linear disposition of cliff of NT-3 terrace in conformity of NSF constant subsidence of basin and in response to frequential movement ad geotectonic activity along the NSF.

The strongest supporting evidence for the Early Holocene tectonic uplift of the area comes from the sea-level curves of the west coast of India which suggest a tectonic component of about 40 m at this time (Rao et al., 1996).

In the Lower Narmada valley the Mid–Late Holocene Quaternary valley deposits is the product of a Holocene high sea-level-induced deposition in a deeply incised valley trench trough highly influenced by NSF. The Mid–Late ey which resulted in both estuarine and fluvial sedimentation in the lower reaches. A significant slowing down of

tectonic uplift facilitated the encroachment of the sea into the valley and the creation of a depositional wedge, which extended up to the deep in land foothills. The 5–10-m exposed thickness of the valley-fill sediments reveals tide dominated estuarine deposition in the lower reaches and fluvial deposition upstream of the tide reach.

The pre-existing quaternary platform of NT-3 of middle Pleistocene prior to induced sedimentation of tidal transgression was strongly induced by tectonic impulses of NSF. The relative disposition of terraces (NT-2 NT-3) cliff alluvial bluff ad scarp, reveals that the present mouth of the Narmada river has retained roughly the originally funnel shape of the estuary formed during the Mid–Late Holocene. However, the size of the estuary is now considerably reduced in space and time with sedimentation and t compressive tectonic environment. The stepped sequence of terraces NT0 to NT2A NT2B NT2C NT3A, NT3B) their dispodition, their convergence & divergence, cyclic and non cyclic nature and mutual inter relation revealed at least three mega phases and four micro phases of up rise of sea level related with tectonics of the area in late to upper pleistocene time.

The incursion and transgression of tides, present estuarine reach contains several islands, which are coeval with the terrace surface above the present tidal range. Hence, they are the products of estuarine processes of the Mid–Late Holocene and not those of the present day. Funnel shaped morphology and increasing tidal energy landward are characteristics of tide-dominated estuaries (Wright et al., 1973). Existing data suggest that the Mid–Late Holocene sea level has remained at the same level up to the present with minor fluctuations (Chappel and Shackleton, 1986; Hashimi et al., 1995). The Mid–Late Holocene sediments show tilting of 10–20j which is more pronounced in the vicinity of the NSF suggesting that the incision and uplift of the valley-fill terraces well above the present day tidal limits is related to the continued differential uplift along NSF. Evidence of tectonic uplift has been reported from the coast also in the form of raised mudflats occurring 2–4 m above present sea level (Merh, 1993). Currently, the river occupies the northern margin of the Early Holocene channel belt and is clearly more sinuous. It exhibits a narrow channel with wide meanders inside wide belts of Mid–Late Holocene terraces (NT-3) a typical pattern of under fit streams (Dury, 1970).

References:-

1. Aziz Maria & Khan, A.A. (2016) Homo erectus & Homo sapien in spectrum of volcanic ecology Narmada valley Madhya Pradesh India International Jpourrnal of scientific & Engineering Research Vol.7 issue 11, pp 692 – 703 November 2016
2. Aziz Maria & Khan, A.A. (2016) Review Article of Correlation of Vom of Indian Homo Erectus with China Man International Jpourrnal of scientific & Engineering Research Vol.7 issue 11, pp539-546 November 2016
3. Acharya, S.K. and Basu, P.K. (1993): Toba ash on the Indian subcontinent and it simplication for correlation of late Pleistocene alluvium.Quaternary Research, No.-14. Pp10-14.
4. Acharyya, S. K., & Basu, P. K. (1993). Toba ash on the Indian sub continent and its implications for the correlation of Late Pleistocene Al- Copyright © 20
5. Acharyya, S.K., Kayal, J.R. and Roy, A. 1998 “Jabalpur Earthquake of May 22, 1997: Constraint from after Shock Study”, Journal Geological Society of India, Vol. 51, pp. 295-304. Agarwai, B.N.P., Das, L.K., Chakraborty, K. and Sivaji, C.H. 1995 “Analysis of the Bouger anomaly over central India: A
6. Acharyya, S.K., Kayal, J.R. and Roy, A. 1998 “Jabalpur Earthquake of May 22, 1997: Constraint from L.K., Chakraborty, K. and Sivaji, C.H. 1995 “Analysis of the Bouger anomaly over central India: A
7. Acharyya, S.K., Kayal, J.R. and Roy, A. 2000, Tectono thermal history of the central India tectonic zone and reactivation of major faults, Jour.Geol.Soci. India 55,239-256.
8. Bhattaacharji,S; Chatterji,N; Wampler J.M. 1996 Zones of Narmada Tapti area activation and Deccan volcanisam: geochronological and geochemical evidences.In Deshmukh,S.S; nair ; k.K.K. (Eds)Deccan Baslts. Gondwana geological society, Nagpur PP 329-340
9. Bhattacharji,S.,Chatterjee,N.,Wampler,J.M.,(1996).ZonesofNarmada–Tapiriftre activation and Deccanvolcanism : geo-chronological and geochemical evidence. In: Deshmukh,S.S.,Nair,K.K.K.(Eds.),DeccanBasalts.GondwanaGeologicalSo-ciety,Nagpur,pp.329–340.
10. Biswas,S.K.,(1987).Regionaltectonicframework,structureandevolutionofwesternmarginalbasinsofIndia.Tectonophysics135,307–327.
11. Chamyal,L.S.,Khadkikar,A.S.,Malik,J.N.,Maurya,D.M.,(1997).SedimentologyoftheNarmadaAlluvialFan, WesternIndia.Sediment.Geol.109,263–279.
12. Chappel,J.,Shackleton,N.J.,1986. Oxygen isotopesand sea level. Nature324,137–140.
13. Dury,G.H.,(1970).Generaltheoryofmeanderingvalleysandunder-fitstreams.In:Dury,G.H.(Ed.),RiverandRiverTerraces.Macmillan,London,pp.264–275.

14. Khan A.A. & Balchandran,V (1974-75) Records Volume109 of Gelogical survey Of India partI,pp.59
15. Khan A.A. 1984 Geology of Geomorphological studies in parts of Narmada Basin, Sehore Dist. Of M.P. GeolSurv. Of India Progress Report (Unpublished).
16. Khan, A.A. & Banerjee, S.N. (1984) Geology and Geomorphological studies in the parts of Narmada Basin, Sehore district of M.P. Un Pub. Report. Geol. Surv. India.
17. Khan, A.A. (1984) Geological and Geomorphological studies around Tapti-Vagher confluence district Jalgaon, Maharashtra. Geol, Surv. India Rec. V.113 pt 6 pp 99-109
18. Khan A.A. and Bajerjee, S.N. 1985: Geomorphological and geological studies of Quaternary sediments in collaboration with project Crumansonata in parts of the Narmada basin, Sehore, Dewas and Hoshangabad districts unpublished Geol. Surv. Ind. Progress Report.
19. Khan, A.A. (1990) Geomorphology of Narmada Valley Of Jabalpur_ Handia Section Unpublished G.S.I Note.
20. Khan, A.A., and Rahate, D.N (1990-91 & 1991-92) Geological and Geomor -phological studies in parts of Narmada Basin) parts Hoshangabad and Narshingpur district, M.P. Geol. Surv. Of India Unpublished Progress Report.
21. Khan, A.A.(1991).Geological studies of Harda – Barwaha basin in parts of Dewas, Sehore, Hoshangabad and Khandwa districts with the Aid of Satellite imagery and Remote Sensing Techniques, Geol. Surv. Ind, Rec. Vol; 126 pt-6
22. Khan, A.A, Rahate, D.N. (1991) Volcanic Ash from Quaternary deposits of Narmada Valley Central India. Proceed, of 78th session of Indian Sci. Cong. Association. (Abstract) pt. III pp 28-29
23. Khan, A. A, Rahate, D.N, Fahim, M & Banerjee, S.N.(1991) Evaluation of Quaternary terrace of lower Narmada valley , Districts Sehore and Hoshangabad, Madhya Pradesh
24. Khan, A.A., Rahate, D.N; Shah; (1991) M.R. and Fahim; M. volcanic Ash from Quaternary deposits of Narmada valley central India. Indian science Congress 1991
25. Khan, A., &Sonakia, A. (1992). Quaternary deposits of Narmada with special reference to the hominid fossil. *Journal of the Geological Society of India, 39,* 147-154.
26. Khan, A.A, Rahate, D.N,, FAHIM, M. and Banarjee,S.N (1992) Evaluation of Geology and Geomorphology in Central Narmada Valley (Districts Sehore and Hoshangabad, Madhya Pradesh) Scientific Publishers, Jodhpur.
27. Khan, A.A; Rahate D.N, Fahim, M. and Banarjee, S.N. (1992): Evaluation of Geology and Geomorphology in Central Narmada Valley (Districts Sehore and Hoshangabad, Madhya Pradesh) Scientific Publishers, Jodhpur
28. Khan A.A. 1994 Geological and Geomorphological studies around Tapti-Vagher confluence district JaloaonMaharastra, Geol. Surv. Of India, Rev. Vol. 113 pt. 6 pp 99 – 109.
29. Khan A.A. & Maria Aziz (2012)"Homo erectus On Unified Quaternary Platform in India and China a Correlation & Sequential Analysis". Status Published Research Scapes International Journal Vol I, Issue IV October -December 2012. (ISSN: 2277-7792)
30. Khan. A.A. & Aziz, Maria (2012) "Homo Erectus & Homo Sapiens In Spectrum Of Volcanic Ecology, Narmada Valley (M.P) India"Status Published Research Scapes International Multidisciplinary Journal VolI, Issue III July-September 2012
31. Khan, A.A. & Aziz; Maria (2013) Homo Erectus & Homo Sapien in Spectrum of Volcanic Ecology, Narmada valley (M.P.) India Research scapes vol. i issue -4 pp-161 -178
32. Khan A.A; & Joshi O.P. (2014) Geology Lithostratigraphy And Correlation of Basaltic Lava Flows of Parts of Western Madhay Pradesh With Special Reference To Megacryst Bearing Horizons And Geotechnical Aspects For Heavy Engineerging Structures
33. Khan, A.A & Aziz, Maria (2014-15) Tectonics Evolution, Quaternary Sedimentation, And The Paleoanthropological Record InThe Narmada Rift System (m.p.) Central India Khan*, A.A. Aziz, Maria International Journal for Research and Technological Sciences Vol. 1, Issue 1 (2014) 91-93 ISSN -2349-0667.
34. Khan A.A. & Aziz, Maria (2015) Quaternary Tectonics & Sedimentation in Narmada Rift Valley, With Special Reference to Garudeshwar and Bharuch Section Gujarat State India, ISSN 2320-5407 International Journal of Advanced Research (2015), Volume 3, Issue 3, 430-457 430 Journal homepage: http://www. journalijar. com.
35. Khan, A.A. & Aziz; Maria (2014-2015). Quaternary volcanic Eruption Toba Ash fall its impact on Environment of late Pleistocene Hominines in Indian subcontinent with Special Reference to Narmada Valley. International journal of Research in Technological sciences vol.1, Issue 2 & Vol-2 issue-1 July -January 2014 January-June 2015 PP1-18 (ISSN-2349-0667)
36. Khan, A.A. Aziz; Maria (2015) A critical analysis of statistical parameters of quaternary deposit of Hominid locality, Hathnora, Narmada valley, distirctsehore (M.P), India Jour. Of Agriculture, Foresty and Environment al Science Vol.IIssue.I July –Aug 2015 .I pp 17-29 ISSN 2454-2792.

37. Khan A.A. & Aziz, Maria (2016) Heavy Minerals assemblage of quaternary column of hominid locality Hathnora, Nnarmada valley district SehoreM.P India. ISSN 2320-5407 International Journal of Advanced Research (2016), Volume 4, Issue 7, 1748-1780 Journal homepage: http://www. journalijar. com.
38. Khan A.A. Maria Aziz. (2016) Quaternary tectonics & geomoprhic evolution of Narmada vally, its impact on tracing the remains of Homo erectus and other quaternary fauna & flora. ISSN 2320-5407 International Journal of Advanced Research (2016),
39. Khan, A.A & Aziz, Maria (2014-15) Tectonics Evolution, Quaternary Sedimentation, And The Paleoanthropological Record InThe Narmada Rift System (m.p.) Central India Khan*, A.A. Aziz, Maria International Journal for Research and Technological Sciences Vol. 1, Issue 1 (2014) 91-93 ISSN -2349-0667.
40. Khan A.A. & Aziz, Maria (2015) Quaternary Tectonics & Sedimentation in Narmada Rift Valley, With Special Reference to Garudeshwar and Bharuch Section Gujarat State India, ISSN 2320-5407 International Journal of Advanced Research (2015), Volume 3, Issue 3, 430-457 430 Journal homepage: http://www. journalijar. com
41. Khan, A.A. & Aziz; Maria (2014-2015). Quaternary volcanic Eruption Toba Ash fall its impact on Environment of late Pleistocene Hominines in Indian subcontinent with Special Reference to Narmada Valley. International journal of Research in Technological sciences vol.1, Issue 2 & Vol-2 issue-1 July -January 2014 January-June 2015 PP1-18 (ISSN-2349-0667)
42. Khan, A.A. Aziz; Maria (2015) A critical analysis of statistical parameters of quaternary deposit of Hominid locality, Hathnora, Narmada valley, distirct sehore (M.P), India Jour. Of Agriculture, Foresty and Environment al Science Vol.I Issue.I July –Aug 2015 .I pp 17-29 ISSN 2454-2792
43. Khan, A.A & Aziz Maria &. (2016) Review Articale Narmada Rift valley & Quaternary Sedimentation International Jpourrnal of scientific & Engineering Research Vol.7 issue 11, pp 526-538 November 2016
44. Merh,S.S.,1993.Neogene–Quaternarysequence in Gujarat:a review. J.Geol.Soc.India21, 259–276
45. Merh,S.S.,Chamyal,L.S.,1997.The Quaternary geology of Gui-jarat Alluvial Plains. Proc.IndianNatl.Sci. Acad.63,1–98.
46. Hashimi, N.H., Nigam, R., Nair, R.R., Rajagoplan, G., 1995.Hol-ocenesea level fluctuations on western Indian continentalmar-gin: an update. J.Geol.Soc.India 46, 157–162.
47. Roy, A.K. 1971 Geology and Ground Water Resources of Narmada Valley Bult of Geol
48. Ravi Shankar, 1987 : History and status of geothermal exploration in the Central Region (M.P. & Maharashtra). Rao, Geol. Surv. Ind., 115, pt. 6 , pp. 7-29.
49. Roy, A.K. 1971 Geology and Ground Water Resources of Narmada Valley Bult of Geol Surv. Of Ind Series B. Engineering Geology and Ground Water Geology.
50. TheobaId, W. 1860. On the Tertiary and alluvial deposits of the Central portion of the Nerbudda valley. *Memoirs of Geol. Sort, India,* 2: 279,298.
51. Sonakia A. 1984 The Skull Cap of Early man and associated mammalian fauna from Narmada Valley alluvium Hoshangabad area. Madhya Pradesh, India Rec. GeolSurv. India Vol. 113, Pt. 6 pp 159-172
52. Sankhyan, A. R. (1997b). A new human fossil find from the Central Narmada basin and its chronology. *Current Science, 73,* 1110-1111.
53. Williams, M.A.J., Clarke, M.F., 1984. Late Quaternary Environments in north-central India. Nature 308, 633–635.
54. Williams, M.A.J., Clarke, M.F., 1995. Quaternary geology and prehistoric environments in the Son and Belan valleys, north central India. In: Wadia, S., Korisettar, R., Kale, V.S. (Eds.), Quaternary Environments and Geoarchaeology of India. Geological Society of India, Bangalore, pp. 282–308.
55. Williams, M.A.J., Royce, K., 1982. Quaternary geology of the Middle Son Valley, north central
56. India: implications for prehistoric archaeology. Palaeogeography, Palaeoclimatology, Palaeoecology 38, 139–162.
57. Williams, M.A.J., Royce, K., 1983. Alluvial history of the Middle Son Valley, north central India. In: Sharma, G.R., Clark, J.D. (Eds.), Palaeoenvironments and Prehistory in the Middle Son Valley. Abinash Prakashan, Allahabad, pp. 9–21.
58. William & Clarke , M.F 1995 Quaternary Geology and Prehistoric environment in Son and Belan valleys, North Central India , Geol..Soc. Ind. Mem .32, pp 282-308.l
59. Wright,L.D.,Coleman,J.M.,Thom,B.G.,(1973).Processes of chan-nel development in a high-tide-range environment:Cambridge Golf-Ord Riverdelta, Western Australia. J.Geol.81,15–41.