HOMO ERECTUS & HOMO SAPIENS IN VOLCANIC ECOLOGY WITH SPECIAL REFERNCE TO HOMONID OCCURRENCES IN NARMADA VALLEY, CENTAL INDIA.

ABSTRACT :

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 near Baroda in Gujarat state. It enters the fertile alluvial plain and passes through the gorge of about 19 kms long consisting of Marble rocks near Jabalpur.It then takes westerly turn through the alluvial tract, situated between the Satpura and Vindhyan hills. The river course of Narmada conspicuously straight and is controlled by ENE_WSW to E_W lineament, is bounded by Vindhyan in the north and Satpura in the south. The valley has maximum width of about 32 kms.

The Quaternary Blanket of Narmada basin covers an area of abut 12950 sq. km starting from west of Jabalpur ($23^0 07^0 790530$) to Bharouch (22^0 29'; 76^0 58') in Gujarat state for a distance of about 1300 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 between 265.7 and 274.3 m above the sea level. The general gradient of this plain in this stretch is about 1m /Km towards West. The Quaternary deposits of the Narmada valley contain the richest vertebrate fossil assemblage including only known Hominid fossil from the Indian sub-continent (Sonakia 1984) The boulder bed which yielded Hominid fossil from boulder conglomerate reported to be of glacial & fluvial origin for first time(Khan & Sonakia 1992). Beside occurrences of association 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 violent volcanic eruption in around Middle to uper Pleistocen time and subsequent 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 during sedimentation. 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 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 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 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 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. 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.

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 (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).

1.00 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 near Baroda in Gujarat state. It enters the fertile alluvial plain and passes through the gorge of about 19 kms long consisting of Marble rocks near Jabalpur.It then takes westerly turn through the alluvial tract, situated between the Satpura and Vindhyan hills. The river course of Narmada conspicuously straight and is controlled by ENE_WSW to E_W lineament, is bounded by Vindhyan in the north and Satpura in the south. The valley has maximum width of about 32 kms.

The Quaternary Blanket of Narmada basin covers an area of abut 12950 sq. km starting from west of Jabalpur ($23^0 07^0 790530$) to Bharouch (22^0 29'; 76^0 58') in Gujarat state for a distance of about 1300 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 between 265.7 and 274.3 m above the sea level. The general gradient of this plain in this stretch is about 1m /Km towards West. The Quaternary deposits of the Narmada valley contain the richest vertebrate fossil assemblage including only known Hominid fossil from the Indian sub-continent (Sonakia 1984) The boulder bed which yielded Hominid fossil from boulder conglomerate reported to be of glacial &

fluvial origin for first time(Khan & Sonakia 1992). Beside occurrences of association 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 violent volcanic eruption in around Middle to uper Pleistocen time and subsequent 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 during sedimentation. 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).(FigNo_1)

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 pale- 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 & Maria (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 platformwhich have given new insight on the age of the Narmada *Homo erectus.*

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 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 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 ,

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.1.1 Previous Work

The Quaternary sediments of Narmada valley represent the thickest deposits in peninsular India Khan and Sonakia (1992). Beside association of fossils and tool assemblage these deposits are also associated with Ash bed Khan et.al (1991). The major climate events and consequential resultant sedimentary weathering and geomorphic events are well dated by radio carbon dating in the Son valley, and Kukdi valley of western Maharashtra, by fission track age of the associated tephra beds. Chronology of the earlier Quaternary events (Middle and Lower Pleistocene). Magneto-statigraphic studies are being carried out by (Rao, et.al 1997).

In recent years occurrences of volcanic ash beds in association with the Quaternary sediments has been reported from different river basins of Indian subcontinent, Acharya, et.al. (1993). the first report on occurrence of Quaternary volcanic ash in India was by Williams and Royee (1982). Acharya, et.al (1993) described toba ash and used it as tool for correlation of late Pleistocene alluvium. William& Clarke (1995) and subsequently similar occurrences were reported by several workers. Khan et.al (1991) identified two horizons of Ash bed one above the boulder conglomerate and other in the younger deposit. He further reported various micro layers in these beds and designated as L-1 to L-5 in increasing antiquity of Quaternary stratigraphic column.

.1.2 Present work

Khan, et.al. (1991) reported & described Ash bed from Narmada valley associated with Hathnora formation in the central sector of Narmada valley. He described two levels of Ash Beds and their micro units. The present paper documents the results of chemical, petrographical mineralogical, X- ray analysis and study of Quartz grain morphology of Ash bed and their micro layers NAB-I (L-1 to L-3) and Ash bed NAB- II (L-4 to L-5) form the Hathnora formation which has yielded the skull cap of Homo erectus (Narmada Man) Sonakia (1982). Besides the impact of Ash Fall on hominines due to volcanic eruption and dislocation of ecology and environments is also attempted.

.2.00 Quaternary deposits of Hominid locality Hathnora Narmada Valley.

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.

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent 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 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 and form 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 sequence of quaternary deposits depicts cyclic environmental transitions 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. (2012). The 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,(1993), Khan (1992) Khan et.al. (2012) Tiwari (1996).

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 their signatures on concealed 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) remainedonly discovery of hominid fossil in last two and half decade due inconsistency concealed nature of fossiliferous 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 any further.

In the Narmada valley the River terraces (NT-1 NT-3) represent sediments of Sohagpuur, Shahganj and Hoshangabad formations,and date back to the Late Pleistocene. The sedimentation commenced with a break in sedimentation after deposition of sediments of boulder form the base of rock basin. The break is represented by boulder conglomerate which is the persistent horizon and represents a specific phase of sedimentation in the rift valley. The sediments of paleo fluvial domain of Narmada were deposited in to two phases of sedimentation with a sharp break marked by tectonic and related climatic changes. The sediment of first phase of paleo domain of Narmada represented by Sohagpur formation overlies the boulder conglomerate followed by the fluvial flood plain deposit of Shahganj 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. The other evidences evidence for prevalence of compressive stress regime in the central sector of Narmada basin is provided by numerous reverse faults 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.The entrenched meander and cut off meander on the southern bank around Tamcharand Balkar South of Hathnora, channel braiding in Narmada and Tawa in south west of Hathnora is due to sudden loss of bed slope arepositive evidences of subsidence of southern block. It may also be inferred a low sinuosity in Narmada channel and sudden entrenchment between Dehri and Shahganj of about 12 m furthe revealed that area is under slow subsidence unstable and relatively fixed river system in a slowly subsiding basin for the deposition of these sedimentsin a thrusting environment along the NSF which is consistent with the subsurface studies.The disposition of terraces, entrenched meander, entrenched scar, configuration of stream net work highly braided nature of Tawa river suggest that area is under compressive stress along the NSF. The dispositiondivergence and convergence of drainage net in conformity of quaternary landscape is anomalous, further imprints and neosiesmic signatures on landscape profile reveled persistent instability of basin during sedimentation.

The tectonic uplift of the 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.In Narmada river section dislocation in the litho units deformation in muddy layer bulding in clayey strata and sediments across NSF, 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 12 -16 m in the streams in the area, indicate pulsational unsynchronized neoseismic movements of Narmada graben along the NSF during the Early Holocene.

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 Narmada valley. The occurrence of ravines and association of deep gullies north of Hatnora is morph tectonic manifestation caused by the sudden vertical movement and block adjustment due subsidence resulting to sudden collapse of sedimentation platform. 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- 1-2) & (Plate No AB-1(Plate No HE_1, 2,3)

.3.00 The Volcanic Ash Bed

The Quaternary deposit of Narmada Valley consists of sediments of three domain viz. deposits glacial, fluvio-glacial (interglacial) and fluvial. The boulder conglomerate is fossiliferous horizon of Narmada and has yielded skull cap of Homo erectus Narmadenesis Sonakia (1984). The Ash bed is found associated with Hathnora formation Khan et.at.(1991), in the area around Hathnora, upstream of Hathnora, Gurwara , Sardapur. The two horizon of Ash bed are identified in Boulder conglomerate (Hathnora formation). These 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 quite persistent and well preserved. The NAB-1 (L1 to L 3) contains three micro layer and NB-II (L-4 to L-5) two micro layers in increasing antiquity. The lower unit of boulder conglomerate is associated with NAB-I, where as NAB-II is associated with younger deposits. The study of grain morphology of glass matrix, their relation with other minerals shape, size, and texture of lithic fragments and association of other ashy sediments of pyroclastic origin suggest that sediments were brought from distant source by Aeolian agencies which fell and settled down during the different phases of sedimentation in valley. The Ash bed NAB-I is embedded within the reddish brown sand silt and in the upper pebbly girty unit of boulder

conglomerate (Hathnora formation). It is grayish yellow, pink in colour fine grained and contain quartz, plagioclase, magnetite, rutile and litho fragments. The glass dominates over other minerals and few grains depict growth of radiating crystal or microlits. Fresh grains of plagioclase quartz and transparent glass are present in litho fragments in hyalo-ophitic fashion. The quartz grains are angular to sub-rounded, transparent, and fresh and contain grains of opaque as inclusion minerals. The crystal of quartz show sharp extinction. The plagioclase glass laths are angular in shape and crystals depict polysynthetic twining and normal zoning. The rutile and magnetite are anhedral in shape and occur as accessory minerals. The X-ray diffraction study of lower Ash bed NAB-I (Hathnora formation) indicates that it comprised of montmorillonite, quartz, albite and illite as major clay minerals and keolinite and calcite occur as traces.

The Ash bed NAB-II is associated with yellow, reddish, brown, clay and silt of fluvial deposits Khan et. al. (1992). It is pinkish grey, light brown in colour, fine grained, porous and non-plastic in nature. The average thickness is about 25 cms. The various minerals identified in the ash bed are glass, paragonite, quartz, plagioclase, which is mostly angular to sub-round in shape. The glass is found abundantly as small angular fragments, laths; shreds are present in ground mass matrix. These are colorless grains show very low relief and are isotropic in nature. The lithic fragments depict hyalo-ophitic texture. Fresh laths of plagioclase are next in abundance and depict polysynthetic twining. A few crystal show normal zoning. The quartz grains are angular to sub-angular shape and show sharp extinction. Beside few grains of anhedral clay particles and lithic fragments are also observed. The X-ray diffraction studies of upper Ash bed horizon NAB-II reveal that it predominantly consists of quartz, albite, illite, kaolinite as major clay minerals and montmorillonite in traces. The results of chemical analysis are presented in (Plate Fig No AB - 2 & Table No AB-1 Plate No QG_28 to _31 Plate No QGH_13)

The study of grain morphology of glass matrix, their inter-relation with other minerals shape, size, texture of lithic fragments and association of other ash sediments of pyroclastic origin, indicate that they are the product of highly explosive silica volcanism. Pumice shards tend to develop from relatively high viscosity rhyolitic magmas with temperature less than 850 C whereas cuspate shards are most likely to develop from low viscosity rhyolitic magma with temperature more than 850 C suggest that sediments of pyroclastic origin and were brought from distant source by Aeolian agencies, after extrusive volcanic activity in middle and upper Pleistocene time.

4.00 Petrography and Chemistry

The representative samples of Ash beds from column of Quaternary sequence were collected analyzed and studied for Petrographical and chemical aspects. The results are depicted in Table No AB-2, Plate No Fig No AB-.3 to 8

The volcanic component of the tephra in all the samples is represented by colour less and transparent, unaltered, coarse to fine ash sized glass shards. The morphology of shards was studied under both petrological and scanning electronic microscopes. The shards include bubble wall shards and pumice, with the former dominating over the latter. These are highly angular and range in size from 10 to 435, with a majority in 60 to 100 size class.

Pumice fragments are fibrous in nature and show parallel or sub parallel alignment of pipe vesicles. These commonly have straight margins, but curvilinear and irregular (contorted) margins also occur, and these patterns determine the shape of the pumice fragment. Adjacent pipe vesicles may coalesce to form a single structure within the pumice fragment. Most of the pipe vesicles are flattened in cross-section with length to width ratio always greater than 20. Entrapped, unreformed and stretched bubbles may occur either singly or together within a pumice fragment Tubular shards derived from fragmentation of pumice are also present. (Khan et.al. in press).

Morphological characters of these shards 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) and Shivaji, (1991); Mukhopadhyay, 1992).

It has been established that a broad relationship exists between color and chemical composition of shards and also that the chemical composition of parent magma which determines to a large extent the shard morphologies (Fisher and Schmincke, 1984; Heiken, 1972, 1974). The tephra under study confirm to be of acidic composition on the above criteria. Refractive index and SiO_2 content of glass have an inverse relation relating to glass shards of the tephra from the Narmada basin. The RI values show a narrow range of from 1.498 to 1.500, as determined by liquid immersion method.

The chemical analyses by wet chemical method of Narmada Ash Beds NAB-I (L-1 toL-3) and NAB-II (L-4 to L-5) were carried out and results are incorporated in (Table No AB-2) & Plate / Figure No AB-3 to 8)

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. There are many Questions and quarries from many quarters, however, as to the scale of these repercussions is concerned these were of sizeable magnitude and had significantly influenced middle and late Pleistocene Hominines in Narmada valley and Indian subcontinent. The effects of Toba eruption on the global scale has remarkably registered its impact with varying signature in Indian subcontinent depending upon the height of column, wind direction moisture density, matrix load and chemical composition of different gases association. The occurrences of Toba beds and their disposition in the Quaternary columns across different basins in Indian subcontinent are more on regional scale. As regard to Narmada basin the hazardous effects of Toba might have been localized, whereby individual habitats or ecosystems were affected, yet other areas in region remained unscathed.

There are quarries and questions that necessitate consideration of two separate aspects of the eruption; first, the consequences of possible rapid global climatic deterioration and second, the direct effects of the ash-fall on hominines and their environments in Narmada valley and in Indian subcontinent.

The association of Ash bed NAB-I with Hathnora formation at the depth of 78 m in Quaternary column of Narmada and occurrences skull cape of Homo erectus of Narmada at the depth of 83 m assumed that Toba eruption might have taken place later than that of existence of Homo erectus which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash bed NAB-II at the depth of 72 m with the younger deposits indicates the second cyclic of fall of Toba ash which might have influenced the younger Hominines i.e Homo erectus & Homo sapiens**,** in Narmada valley. Though the correlation and assessment has its own limitation due to limited occurrence of human remains in Indian subcontinent. In this context it may be mentioned here that Theobold (1860, 1881) was first to study the Quaternary deposits of Narmada in the following year Late (1881) recorded a human cranium (transported), which was identified as Homo sapiens, supposed to have come from conglomerate bed of Lower Group. Unfortunately the cranium specimen was lost in the museum of the Asiatic society of Bengal, hence the find remained inconsequential. The fossil of human cranium Homo sapiens and skull cape of Homo erectus (Sonakia1984) are only human remains from Indian subcontinent and associated with lower Group of conglomerate bed. 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.

5.00 NEOTECTONICS AND SEDIMENTATION

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 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

5.00 HOMO ERUCTUS. AND ASH BED

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. (Fig No $ to&)

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 dislocated ad 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 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 Sonakia (1984).

The Quaternary blanket has been studied in three dimention and abot 900 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 revealed 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.

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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 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 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).

Plate No HE-1 The Narmada Fossil is a part of a part of a skull cap;(bottom) its artificial reconstruction (Photographs Courtesy: Arun Sonakia)

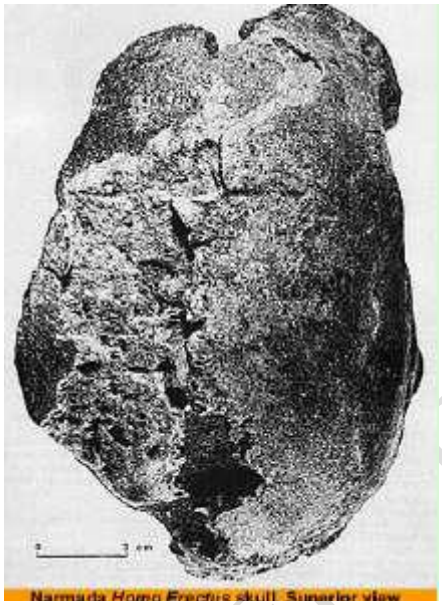

Plate No HE-2 Narmada Homo eructus Skull Superior View

Plate No HE-3 Narmada Homo eructus Skull Basllar View

6.00 . CONCLUSION

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.

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent 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 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 and form 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.

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 their signatures on concealed 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) remainedonly discovery of hominid fossil in last two and half decade due inconsistency concealed nature of fossiliferous 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 any further.

The Quaternary deposit of Narmada Valley consists of sediments of three domain viz. deposits glacial, fluvio-glacial (interglacial) and fluvial. The boulder conglomerate is fossiliferous horizon of Narmada and has yielded skull cap of Homo erectus Narmadenesis Sonakia (1984). The Ash bed is found associated with Hathnora formation Khan et.at.(1991), in the area around Hathnora, upstream of Hathnora, Gurwara , Sardapur. The two horizon of Ash bed are identified in Boulder conglomerate (Hathnora formation). These 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 quite persistent and well preserved. The NAB-1 (L1 to L 3) contains three micro layer and NB-II (L-4 to L-5) two micro layers in increasing antiquity. The lower unit of boulder conglomerate is associated with NAB-I, where as NAB-II is associated with younger deposits. The study of grain morphology of glass matrix, their relation with other minerals shape, size, and texture of lithic fragments and association of other ashy sediments of pyroclastic origin suggest that sediments were brought from distant source by Aeolian agencies which fell and settled down during the different phases of sedimentation in valley. The Ash bed NAB-I is embedded within the reddish brown sand silt and in the upper pebbly girty unit of boulder conglomerate (Hathnora formation). It is grayish yellow, pink in colour fine grained and contain quartz, plagioclase, magnetite, rutile and litho fragments. The glass dominates over other minerals and few grains depict growth of radiating crystal or microlits. Fresh grains of plagioclase quartz and transparent glass are present in litho fragments in hyalo-ophitic fashion. The quartz grains are angular to sub-rounded, transparent, and fresh and contain grains of opaque as inclusion minerals. The crystal of quartz show sharp extinction. The plagioclase glass laths are angular in shape and crystals depict polysynthetic twining and normal zoning. The rutile and magnetite are anhedral in shape and occur as accessory minerals. The X-ray diffraction study of lower Ash bed NAB-I (Hathnora formation) indicates that it comprised of montmorillonite, quartz, albite and illite as major clay minerals and keolinite and calcite occur as traces.

The Ash bed NAB-II is associated with yellow, reddish, brown, clay and silt of fluvial deposits Khan et. al. (1992). It is pinkish grey, light brown in colour, fine grained, porous and non-plastic in nature. The average thickness is about 25 cms. The various minerals identified in the ash bed are glass, paragonite, quartz, plagioclase, which is mostly angular to sub-round in shape. The glass is found abundantly as small angular fragments, laths; shreds are present in ground mass matrix. These are colorless grains show very low relief and are isotropic in nature. The lithic fragments depict hyalo-ophitic texture. Fresh laths of plagioclase are next in abundance and depict polysynthetic twining. A few crystal show normal zoning. The quartz grains are angular to sub-angular shape and show sharp extinction. Beside few grains

of anhedral clay particles and lithic fragments are also observed. The X-ray diffraction studies of upper Ash bed horizon NAB-II reveal that it predominantly consists of quartz, albite, illite, kaolinite as major clay minerals and montmorillonite in traces. The results of chemical analysis are presented in (Plate Fig No AB - 2 & Table No AB-1 Plate No QG_28 to _31 Plate No QGH_13)

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. There are many Questions and quarries from many quarters, however, as to the scale of these repercussions is concerned these were of sizeable magnitude and had significantly influenced middle and late Pleistocene Hominines in Narmada valley and Indian subcontinent. The effects of Toba eruption on the global scale has remarkably registered its impact with varying signature in Indian subcontinent depending upon the height of column, wind direction moisture density, matrix load and chemical composition of different gases association. The occurrences of Toba beds and their disposition in the Quaternary columns across different basins in Indian subcontinent are more on regional scale. As regard to Narmada basin the hazardous effects of Toba might have been localized, whereby individual habitats or ecosystems were affected, yet other areas in region remained unscathed.

The association of Ash bed NAB-I with Hathnora formation at the depth of 78 m in Quaternary column of Narmada and occurrences skull cape of Homo erectus of Narmada at the depth of 83 m assumed that Toba eruption might have taken place later than that of existence of Homo erectus which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash bed NAB-II at the depth of 72 m with the younger deposits indicates the second cyclic of fall of Toba ash which might have influenced the younger Hominines i.e Homo erectus & Homo sapiens**,** in Narmada valley. Though the correlation and assessment has its own limitation due to limited occurrence of human remains in Indian subcontinent. In this context it may be mentioned here that Theobold (1860, 1881) was first to study the Quaternary deposits of Narmada in the following year Late (1881) recorded a human cranium (transported), which was identified as Homo sapiens, supposed to have come from conglomerate bed of Lower Group. Unfortunately the cranium specimen was lost in the museum of the Asiatic society of Bengal, hence the find remained inconsequential. The fossil of human cranium Homo sapiens and skull cape of Homo erectus (Sonakia1984) are only human remains from Indian subcontinent and associated with lower Group of conglomerate bed. 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 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 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 dislocated ad 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 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 Sonakia (1984).

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Table no. 1: Quaternary Events and Sedimentation in Narmada Valley

Age	**Climatic events**		Geomorphic events (khan e1.a1.1992)		Weathering events	sedimentary events after Tiwari 2001	Tepra Events Khan et.al 1991	Palaeo - Magnetic events Y.Rao et. al 1997	Tectonic events		Sedimentary events sedimentation after khan et.al 1992
4 ka Late Holocene	Onset of aridity	up warping /climatic changes/ ecstatic changes	Inset terrace formation (NT_0)		----------	Ramnagar formation Boaras formation	----------	----------		Relative disposition divergent/Terrace paining	Amber/Indrakdar/Amba Janswasa formation unicycle
6Ka-13ka, Middle to Early Holocene	Good Monsoon		15m to 30m of entrancing of river (NT_1)	IV	Vertisol	Boaras formation	----------	----------			Hoshangabad Formation polycycle
13ka to 25ka, late upper Pleistocene	Arid		5 to 10m of entrancing of river of flood plain(NT_2A)	V	----------	Hirdepur Formation	Reworked Tepra	Brunhes normal polarity			Shahganj Formation
	Humid		Aggradations Degration of Flood Plain continued		Brown soil	--------	--------	--------			Polycycle
75ka	----------		--------		--------	--------	Tepra	Brunhes Normal polarity			Polycycle
75ka to 118 ka early upper Pleistocene	Arid		Aggradations Degration (NT_2B)	IV	--------	Baneta Formation	NA_B-II	Brunhes Normal polarity			Demarwar Formation

									Rejuvenation of south Satpura fault purna Tapti Valley		
					Yellow Clayey Soil	--------	--------	Brunhes Normal polarity			Polycycle
	Arid		Agradation & Degradation (NT_2C)	III		Surajkhund Formation	--------	Brunhes Normal polarity			Shivpur Formation
	----------		----------		Red Soil	----------	----------	Matuyama Reverse polarity			
									Formation of structural basin in the purna valley		Polycycle
	Arid		Agradation & Degradation (NT_3A)	II	----------	Dhansi Formation	-----	Matuyama Reverse polarity			Nasrullahganj Formation
									Formation of structural basin in the Central Narmada valley		Polycycle
Middle Pleistocene	Humid		Agradation & Degradation((NT3)		Laterite /latosol	Pilikarar formation	------	-----	-----		Sohagpur Formation
	warm /cold		Agradation &			Hathmora formati	NA_B-I	structural basin in			Boulder Conglomerate

			Degradation of Glacial front			on (conglomerate)		Narmada			
Lower Pleistocene	warm /cold		Agradation Degradation by Glacial			Boulder conglomerate (Base not exposed)		structural basin in Narmada			Boulder Bed

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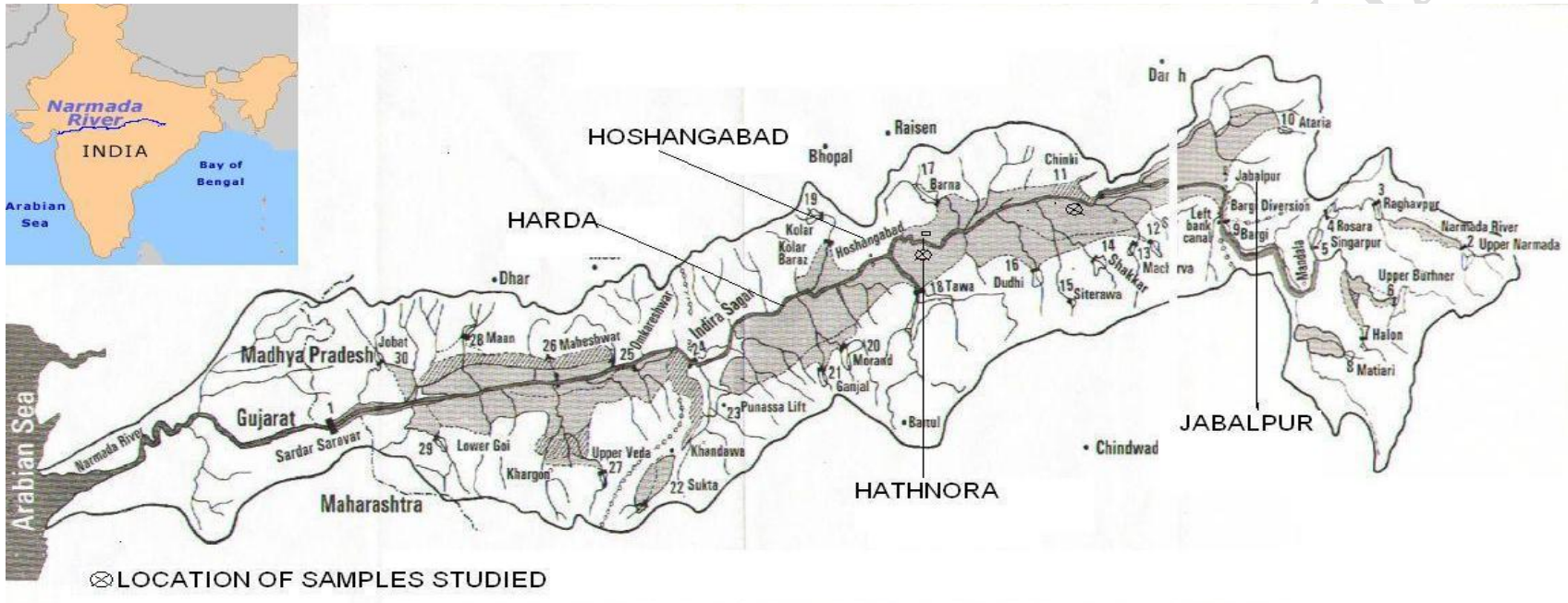
Table No.2, Chemical analyses of Ash Bed
Hathnora_Sardapur Section Central Narmada valley India .

Oxide%	**SiO_2**	**TiO_2**	**Al_2O_2**	**$Fe2O_3$**	**FeO**	**MnO**	**CaO**	**MgO**	**Na_2o**	**K_2O**	**P_2O_5**	**H_2O^+**	**Total**
Ash Bed –I													
1	62	0.92	15.14	5.3	0.9	0.1	3.4	1.41	1.66	2.6	0.19	6.38	**100**
2	63.75	1.04	13.4	4.4	1.25	0.08	2.5	2.57	1.91	2.7	0.12	6.28	**100**
3	66	0.56	14.8	2.8	1.09	0.05	2.25	1.21	2.09	3.56	0.31	5.28	**100**
4	68.3	0.33	12.58	1.6	1.08	0.05	2.5	2.14	2.42	3.72	0.08	5.2	**100**
5	68.99	ND	16.34	3.03	ND	0.33	4.99	0.9	ND	5.42	ND	ND	**100**
6	78.55	ND	15.56	1.55	ND	ND	3.68	0.66	ND	ND	ND	ND	**100**
Ash Bed –II													
1	62.99	0.92	15.44	5.23	0.9	0.2	2.5	1.42	1.63	2.9	0.18	5.69	**100**
2	63.72	1.07	14	4.2	1.32	0.08	2	2.57	1.91	2.7	0.12	6.31	**100**
3	66.7	0.55	14.93	2.7	1.09	0.05	2.5	1.22	2.09	3.55	0.32	4.3	**100**
4	66.41	0.33	13.2	1.6	1.08	0.05	2.34	2.12	2.42	3.72	0.08	6.65	**100**
5	74.1	ND	12.57	4.03	ND	0.34	2.65	0.9	ND	5.41	ND	ND	**100**
6	76.3	ND	15.99	2.55	ND	ND	4.5	0.66	ND	ND	ND	ND	**100**
Ash Bed –I (L-1)													
1	68.46	0.92	13.99	4.23	0.9	0.2	2.1	1.42	1.63	1.9	0.18	4.07	**100**
2	64.72	1.07	14.5	3.2	1.32	0.08	4.54	1.57	1.91	2.7	0.12	4.27	**100**
3	67.75	0.55	12.49	2.6	1.09	0.05	2.63	1.2	2.09	3.57	0.3	5.68	**100**
4	70.41	0.33	7.32	1.6	1.08	0.05	4.88	2.12	2.42	3.72	0.08	5.99	**100**
5	76	ND	10.5	5.03	ND	0.34	2.82	0.9	ND	4.41	ND	ND	**100**
6	77.44	ND	10.25	6.55	ND	ND	5.1	0.66	ND	ND	ND	ND	**100**
Ash Bed –I (L-2)													
1	67.9	0.92	11.1	5.23	0.9	0.2	2.7	1.43	1.64	1.9	0.2	5.88	**100**
2	68.72	1.07	4.4	3.2	1.32	0.08	5.6	1.55	1.91	2.7	0.22	9.23	**100**
3	70.95	0.55	10.75	2.6	1.09	0.06	2.15	1.2	2.08	2.57	0.3	5.7	**100**
4	73.41	0.33	3.58	1.6	1.08	0.05	4.86	2.14	2.4	3.74	0.09	6.72	**100**
5	77.08	ND	9.5	5.03	ND	0.34	2.75	0.9	ND	4.4	ND	ND	**100**
6	78.44	ND	9.48	5.55	ND	ND	5.87	0.66	ND	ND	ND	ND	**100**
Ash Bed –I (L-3)													
1	69.75	0.92	10.07	3.23	0.9	0.2	3.5	1.43	1.64	1.9	0.18	6.28	**100**

2	69.72	1.07	6.4	3.2	1.32	0.08	5.6	1.55	1.91	2.7	0.14	6.31	**100**
3	74.75	0.55	8.75	2.6	1.09	0.06	1.62	1.22	1.08	2.55	0.3	5.43	**100**
4	72.41	0.33	6.58	1.6	1.08	0.05	4.86	2.14	2.4	2.74	0.09	5.72	**100**
5	75.08	ND	8.5	5.03	ND	0.34	5.75	0.9	ND	4.4	ND	ND	**100**
6	79.44	ND	9.48	4.55	ND	ND	5.87	0.66	ND	ND	ND	ND	**100**
Ash Bed –II (L-4)													
1	69.75	0.92	10.07	4.23	0.9	0.2	3.5	1.53	1.54	1.9	0.18	5.28	**100**
2	68.72	1.07	4.4	2.2	1.32	0.08	7.6	1.52	1.91	2.7	0.17	8.31	**100**
3	75.75	0.55	7.75	2.6	1.09	0.06	2.31	1.22	1.08	2.52	0.3	4.77	**100**
4	72.41	0.33	4.58	1.6	1.08	0.05	5.86	2.14	2.4	2.74	0.09	6.72	**100**
5	76.08	ND	6.5	5.03	ND	0.34	6.07	0.9	ND	5.08	ND	ND	**100**
6	79.44	ND	9.48	5.55	ND	ND	4.87	0.66	ND	ND	ND	ND	**100**
Ash Bed –II (L-5)													
1	62.75	0.92	13.07	5.23	0.9	0.2	4.5	1.53	1.54	1.9	0.18	7.28	**100**
2	71.72	1.07	5.4	2.2	1.32	0.08	5.6	1.52	1.91	3.7	0.17	5.31	**100**
3	73.75	0.55	8.97	2.6	1.07	0.07	2.99	1.22	1.08	2.52	0.3	4.88	**100**
4	76.41	0.33	3.58	1.6	1.08	0.05	1.18	4.14	2.4	2.74	0.09	6.4	**100**
5	79.08	ND	6.5	4.03	ND	0.32	4.75	0.9	ND	4.42	ND	ND	**100**
6	79.44	ND	8.48	5.55	ND	ND	5.87	0.66	ND	ND	ND	ND	**100**

1050

Fig No_1

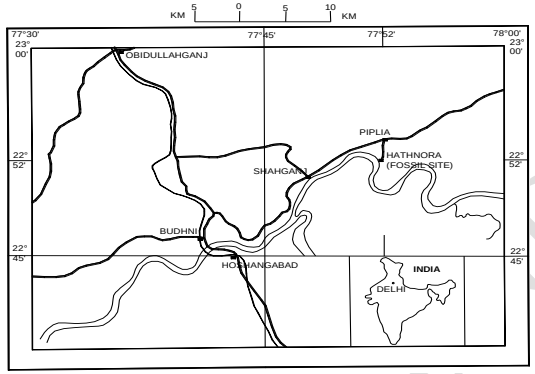


FifNo_2

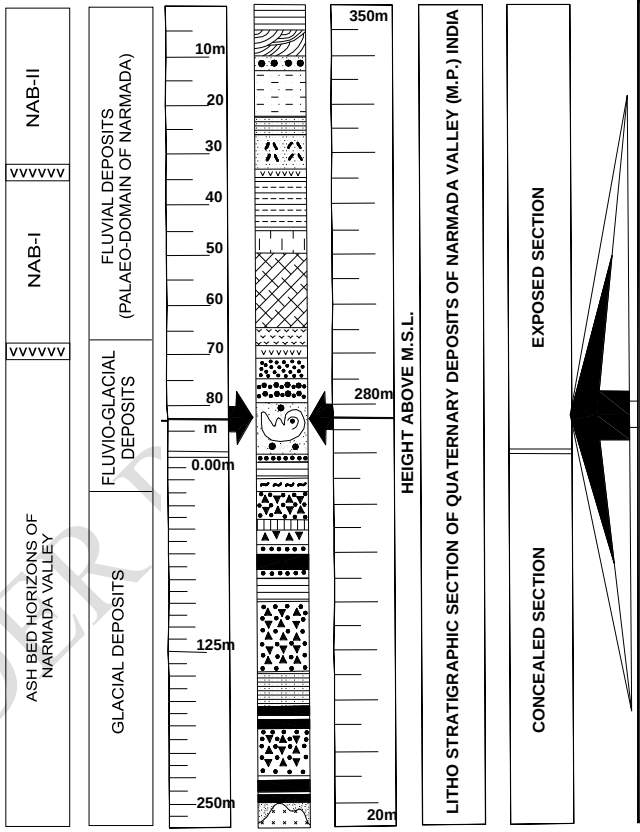
Plate Figure No AB-1

HOMO ERECTU AND OCCURRENCE OF VOLCANIC ASH BED IN NARMADA VALLEY, M.P. INDIA

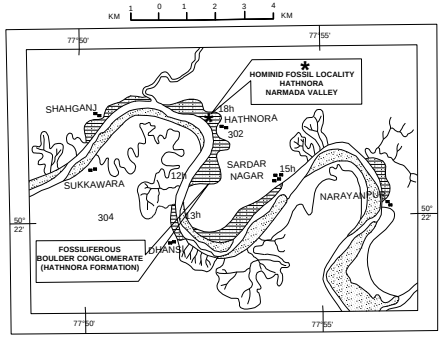
LOCALLY MAP OF NARMADA MAN



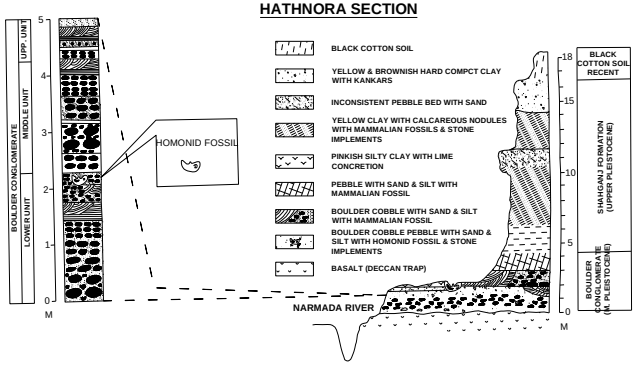
LITHO STRATIGRAPHIC SEQUENCE OF QUATERNARY DEPOSITS NARMADA VALLEY



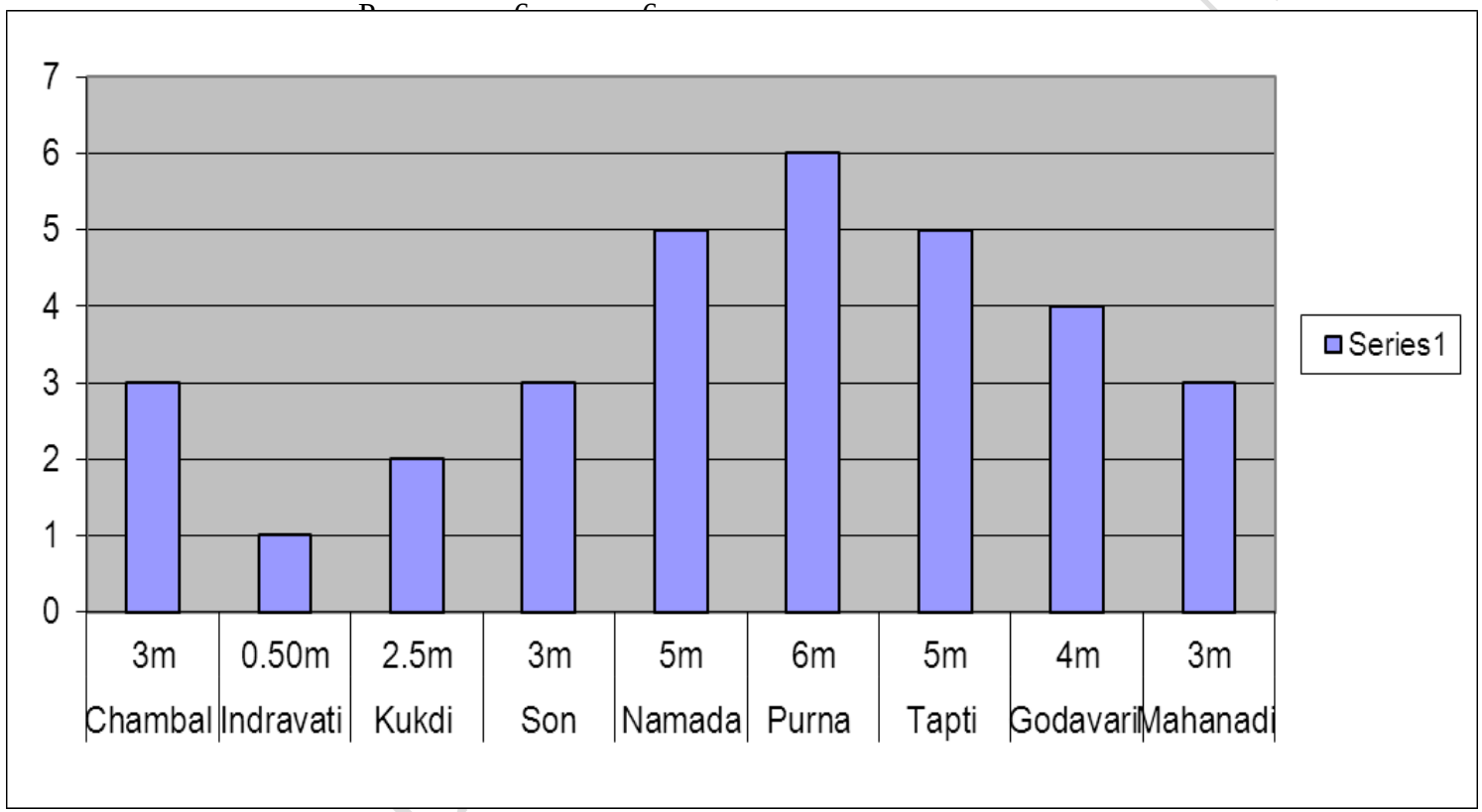
LITHOSTRATIGRAPHIC SECTION OF QUATERNARY DEPOSITS OF HOMONID FOSSIL LOCALITY HATHNORA NARMADA VALLEY, SEHORE & HOSHANGABAD DISTRICTS, (M.P.) INDIA



HATHNORA SECTION



Son	3m	3
Namada	5m	5



Fig+3 Average thickness of

Ash beds in IndianRivers

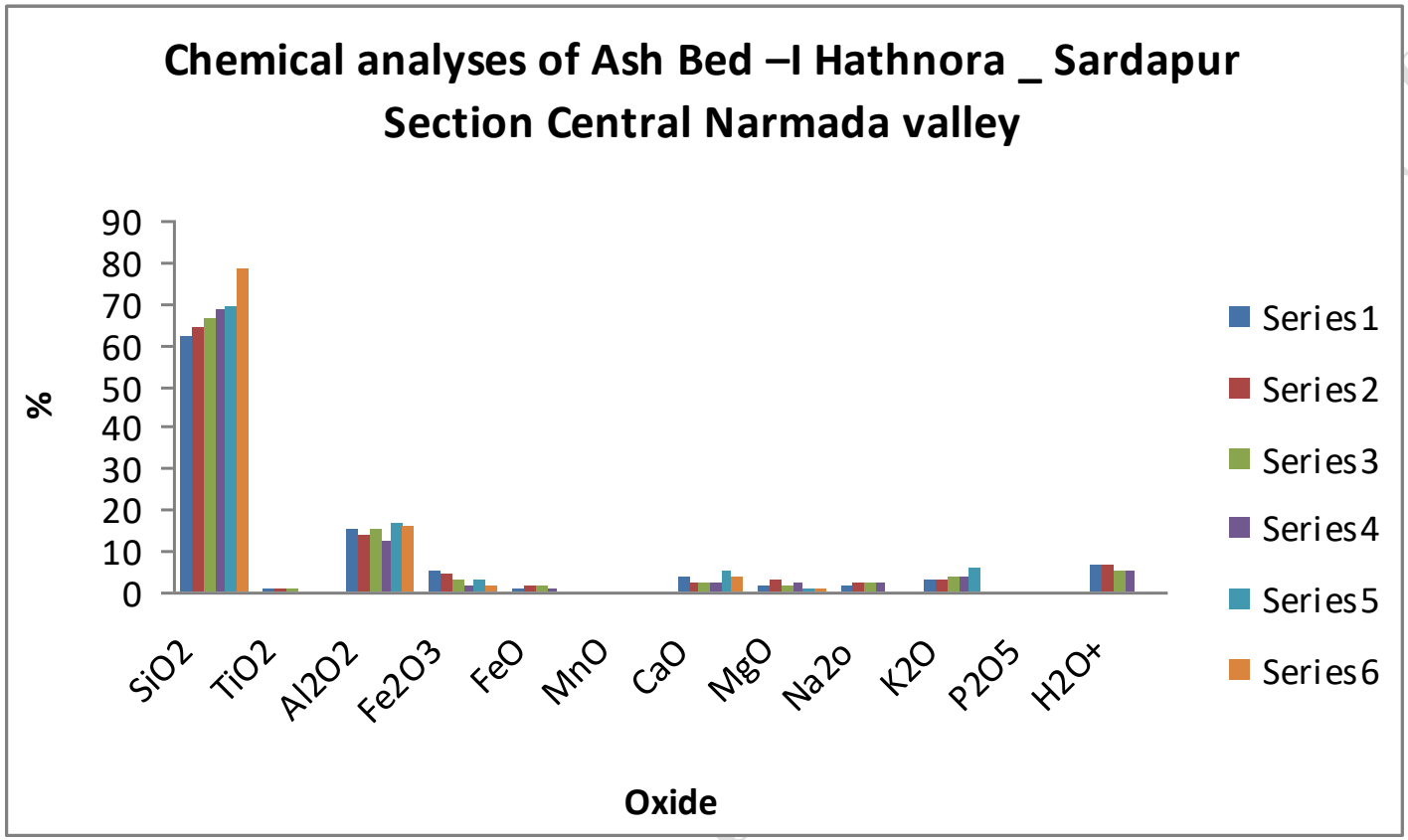


Fig No 4

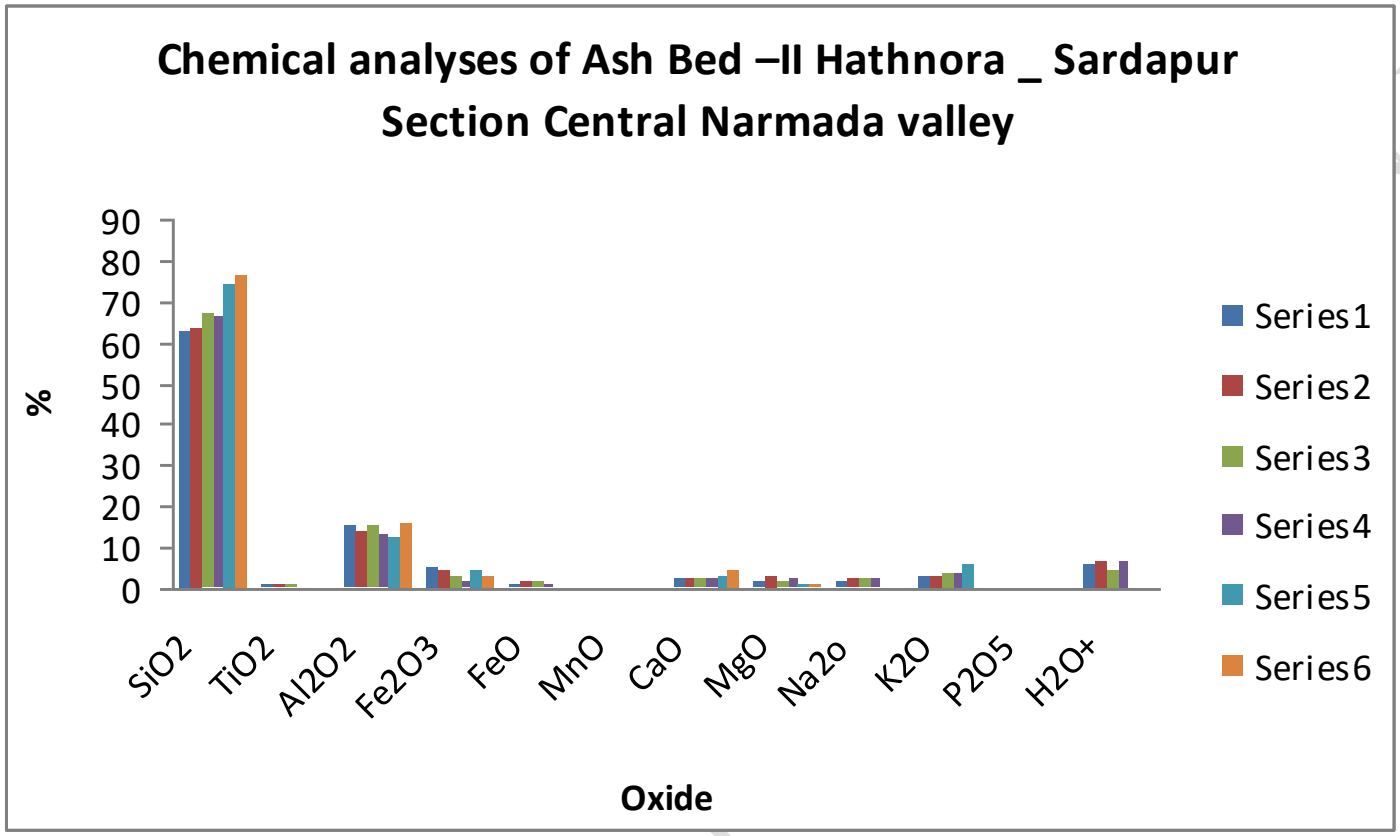


Fig No 5

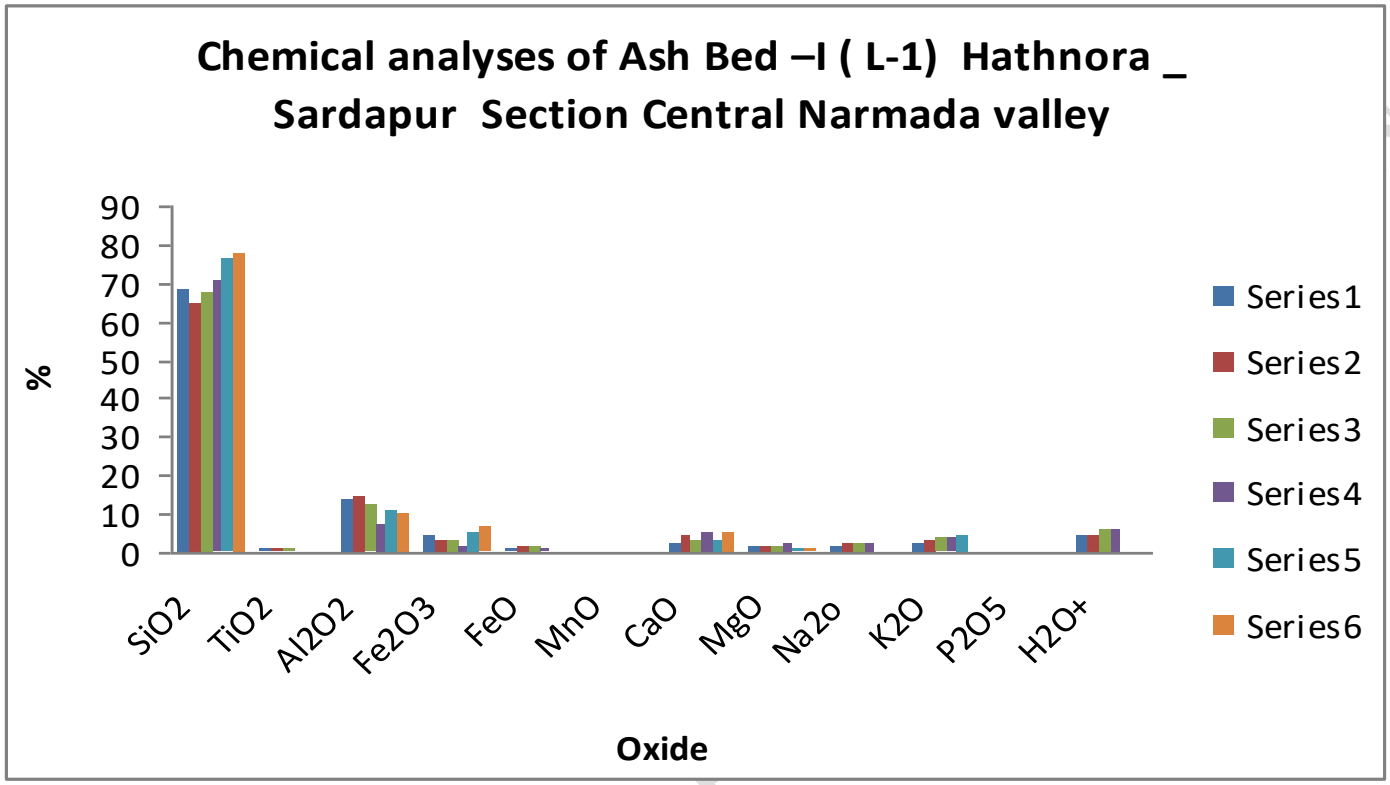


Fig No 6

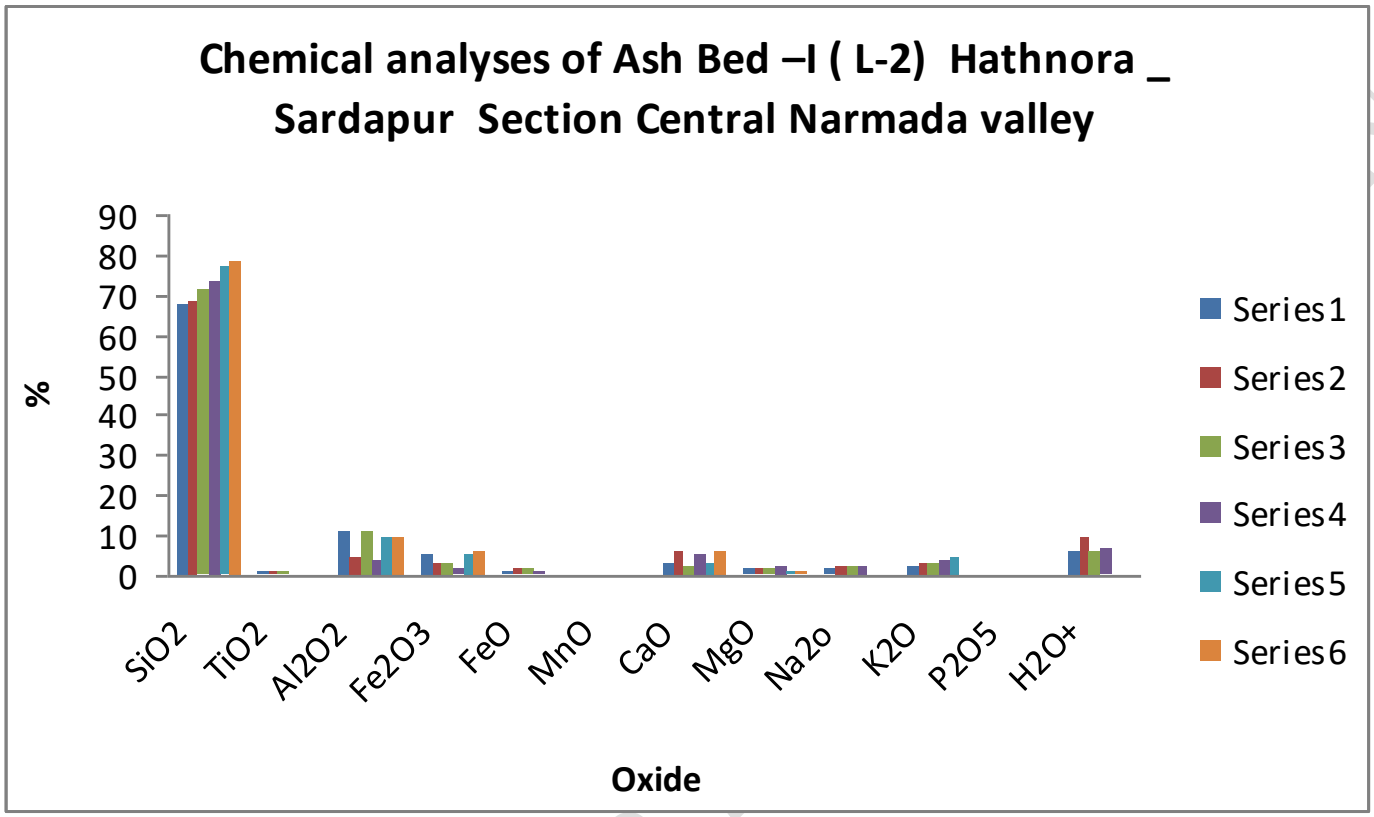
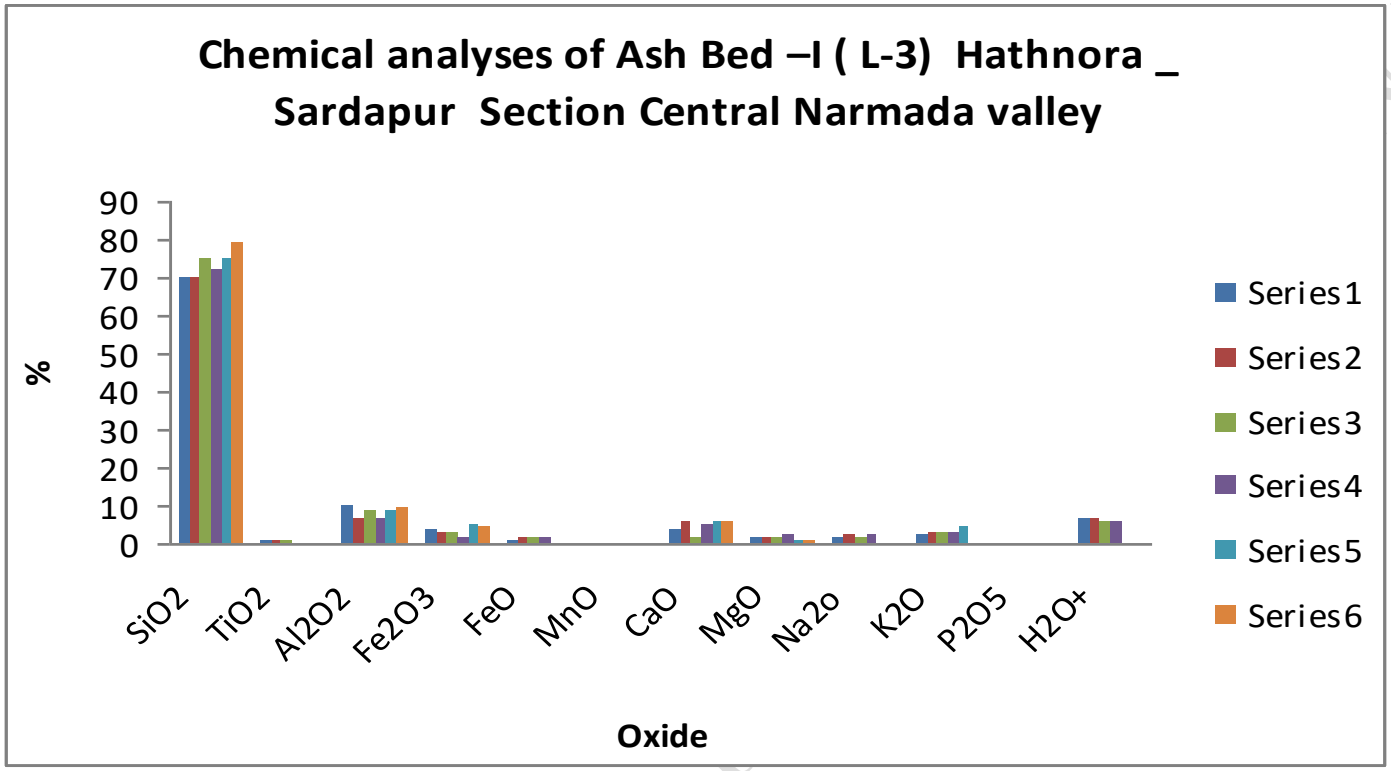


Fig No 7



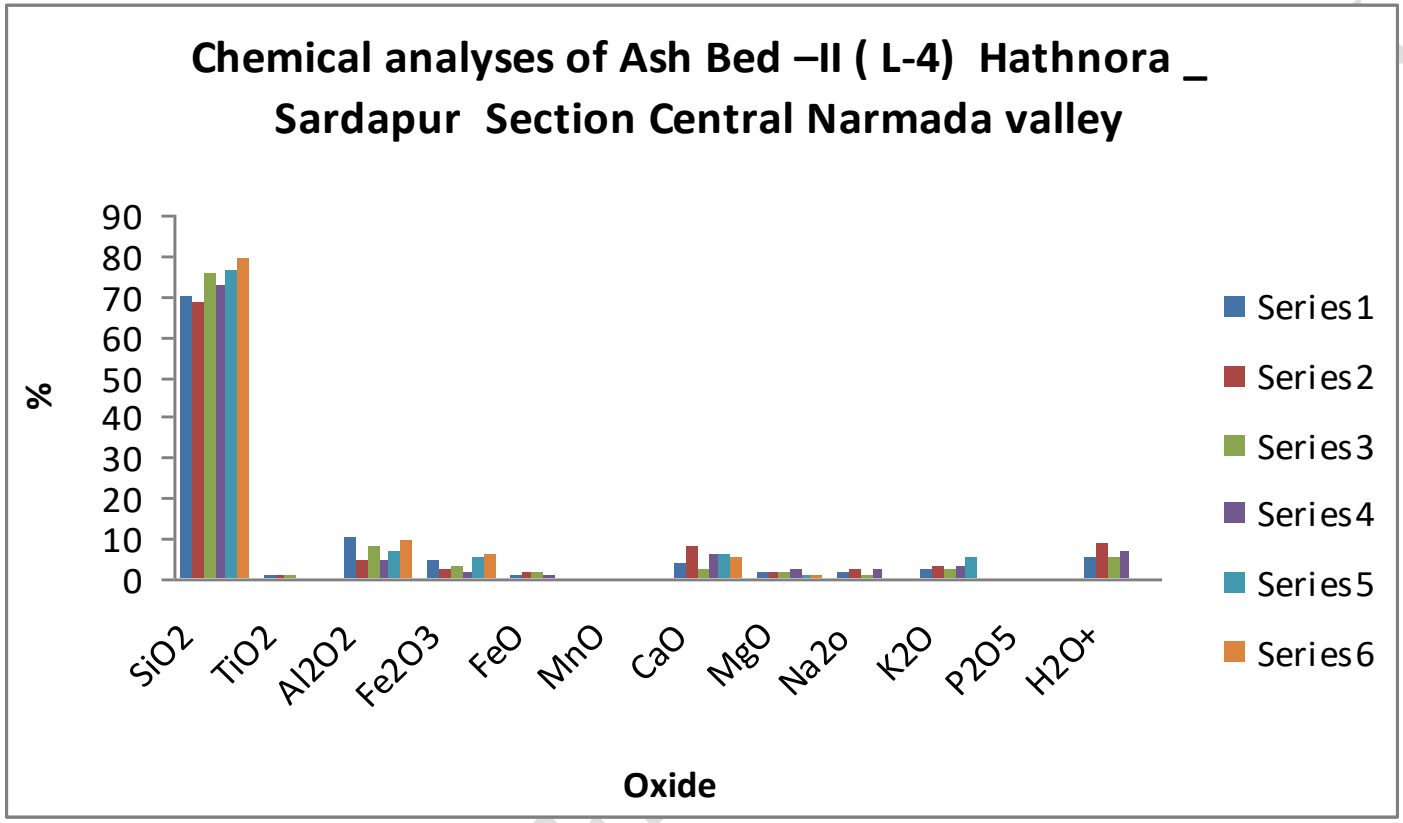
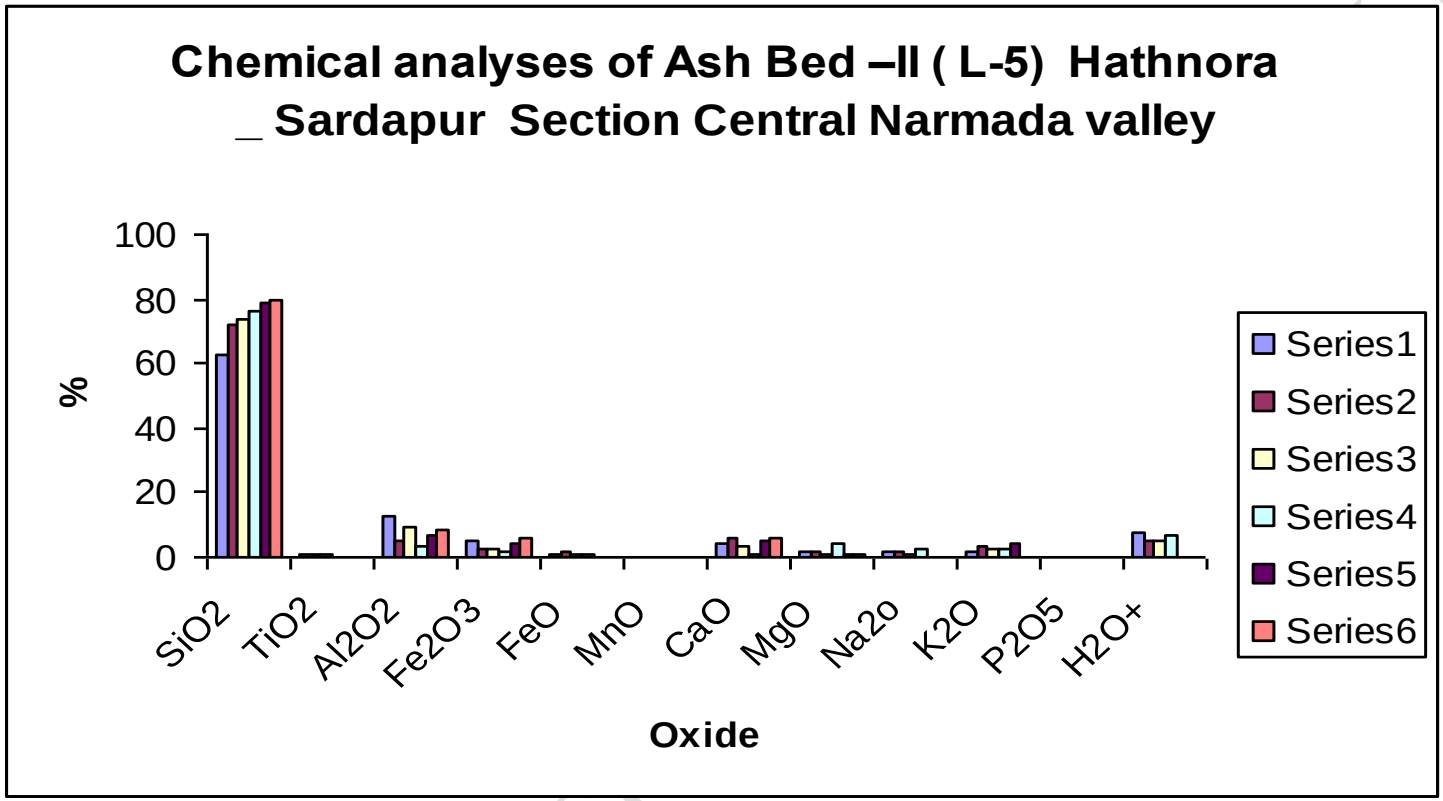


Fig No 8


Chemical analyses of Ash Bed –II (L-5) Hathnora _ Sardapur Section Central Narmada valley
100
80
60
40
20
0
%
SiO2
TiO2
Al2O2
Fe2O3
FeO
MnO
CaO
MgO
Na2o
K2O
P2O5
H2O+
Oxide
Series1
Series2
Series3
Series4
Series5
Series6