HOMO ERECTUS & HOMO SAPIENS IN SPECTRUM OF VOLCANIC ECOLOGY, NARMADA VALLEY, (M.P.); INDIA

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ABSTRACT

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 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.

KEY WORDS: Ash beds, Boulder conglomerate, fluvial, fluviao-glacial, glacial, *Homo erectus, Homo sapiens* Pleistocene, Quaternary Platform, sedimentation

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. The course of Narmada is conspicuously straight and is controlled by ENE_WSW to E_W lineament, bounded by Vindhyan in the north and Satpura in the south. The valley has maximum width of about 32 kms.

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 witness 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 between the depths of 75-83 m of Quaternary column in unified Quaternary Platform.

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). (Table No.1)

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.

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.

SEQUENCE OF QUATERNARY SEDIMENT OF NARMADA VALLEY

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 1 & Figure No.!)

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 (Fig No.1 & 2 Table No.1)

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.

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.2. (Fig No.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.2) & (Figure No 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.

CONCLUSION

The Quaternary deposit of Narmada consists of sediments of three domain viz. deposits glacial, fluvio-glacial (interglacial) and fluvial. The Boulder bed identified at the bottom of basin is of glacial origin, Boulder conglomerate-(Hathnora formation) in the form of persistent wedge is of fluvio-glacial origin and fluvial deposit of palaeo-domain of Narmada is of fluvial origin, Khan & Sonakia (1992). The boulder conglomerate is fossiliferrous horizon of Narmada and has yielded skull cap of *Homo erectus* (Narmada Man) (Sonakia 1984). It is marker horizon and represents interglacial phase in the history of Quaternary sedimentation.

The Ash bed is associated with column of Quaternary sediments of Narmada with Hathnora formation and younger deposits. These are two horizons 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 is well preserved and persistent horizon, where as NAB-II is discontinuous dissected and isolated in nature and associated with younger deposits. The Ash bed NAB-1 contains three micro layer (L-1 to -L3) and NAB-I1 two micro layers (L-4 to L-5) respectively.

The study of Ash bed matrix revealed the presence of various minerals like glass, paragonite, quartz, plagioclase, which is mostly angular to sub-round in shape. The glass is found abundantly as small angular fragments, laths, shreds as ground mass in lithic fragments. These colorless grains show very low relief and are isotropic in nature. The quartz grains are angular to sub-angular shape and show sharp extinction. The X-ray diffraction studies of Ash bed revealed that it is predominantly consist of quartz, albite, illite, kaolinite as major clay minerals and montmorillonite in traces.

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.

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