

 <p>ISSN NO. 2320-5407</p>	<p>Journal Homepage: - www.journalijar.com</p> <p>INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)</p> <p>Article DOI: 10.21474/IJAR01/1732 DOI URL: http://dx.doi.org/10.21474/IJAR01/1732</p>	 <p>INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR) ISSN 2320-5407</p> <p>Journal homepage: http://www.journalijar.com Journal DOI: 10.21474/IJAR01</p>
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RESEARCH ARTICLE

SONATA LINEAMENT ZONE & EVOLUTION OF NARMADA, TAPTI-PURNA BASIN & SON VALLEY, WITH SPECIAL REFERENCE TO HOMINID LOCALITY HATHNORA CENTRAL INDIA.

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Manuscript Info

Manuscript History

Received: 12 July 2016
Final Accepted: 22 August 2016
Published: September 2016

Key words:-

Abstract

The SONATA LINEAMENT ZONE embodies the two Quaternary basins of tectonic origin on the two margins of Satpura Crustal Block. The Satpura block traversed by enechelon system of faults and lineaments is characterized by thinner crust (33-38 km deep, basement depth >2.5 km) with series of ENE-WSW trending gravity high (viz. Sendwa, Khandwa, Chicholi, Tikaria etc.) with amplitudes of 10-35 mgal. The chain of gravity high indicates extensive magmatism and emplacement of derivatives at shallow crustal levels. The associated Narmada South (Satpura North) fault and Satpura South Fault marking the two hinges of the Satpura block are fundamental in nature and extend to Moho level. The Narmada Quaternary basin in the north and Tapti-Purna basin in the south are two Graben which formed prominent loci of sedimentation in lineament zone. The area of lineament zone studied tectonically encompasses two crustal provinces of Central India Shield, namely, the Northern Crustal Province (NCP) and the Southern Crustal Province (SCP). The two provinces are separated by a crustal level shear zone, referred as Central Indian Suture. The zone has been a major locus of episodic tectonism 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 conspicuously has straight course which is controlled by ENE-WSW to E-W lineament, it is bounded by Vindhyan in the north and Satpura in the south, it has been exposed to the repeated post erosional and depositional activities and subjected to anisotropic and asymmetric tectonic dislocation which has culminated diversified morphogenetic expression. It further reshaped landscape architect which has categorised different regions and had undergone the process of tectonic evolution and chiseling of terrain by dynamic erosional and depositional activity in into various morphogenetic regions, land form elements, configuration of drainage, topography, erosional platform, denudation ridges, structural units linear valleys, strike hills, valley gapes, escarpments and river terraces. The cumulative dynamics of structural deform, rinsing and sinking platform of Narmada has manifested imprints of concealed mechanism of tectonics, geothermic

activity, seismicity neoseismic events and surface manifestation. In addition the valley gapes and valley trench provided ideal sites for sedimentation in Narmada Purna –Tapti and Son valley.

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, uplifting and isolated domal up- lift, Neogene rifting and tearing. 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 environment for the accumulation of sediments volcanic fabrics, burial diagenesis 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 occurred after widespread Quaternary sedimentation and accumulation of sediments in the linear trench by glacial activity in late Pleistocene. The Fluvio-glacial phase is represented by boulder conglomerate which constitute 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, between 260 to 380 are separated by the scarp both of curvilinear and linear in nature facing towards river side. These are abandoned flood plains of Narmada and represent the level of former valley floor. These were formed by cumulative climato-tectonic changes in the watershed of Narmada in the Quaternary times.

The Tapti-Purna graben is located south of Satpura which evolved as two separate sub basins of fluvio-lacustrine sedimentation, connected subsequently with reactivation. The most conspicuous feature of the southern margin of the Satpura between longitude 74° and 78° is conspicuous ENE-WSW to E-W trend of Tapti which display local swing at places. These trends characterizing Tapti crustal block, conform to structural grain of the area reflecting the convergence of Tapti and Gavilgarh faults enechelon system traversing Satpura foot hills, with a southerly convexity. The Quaternary basin area in Tapti Crustal block are characterized by relatively thinner crust with moho depth of 33-37 km, shallow basement (<1 km) with higher density (+0.239g/cm³) mantle derivatives emplaced at shallow level (4-5 km; Rao K.V., 1997).

The present studies taking entire quaternary sedimentation of SONATA LINEAMENT ZONE as single ecological system besides the tectonics on the either side of Satpura revealed that the area of SONATA LINEAMENT ZONE formed single loci of sedimentation and there was continuous and sequential deposition of sediments from Pleistocene to Upper Pleistocene time. It is witnessed by quaternary

events morphogenetic expression disposition of river terraces, their mutual, relation, lithostratigraphy, correlation of terraces across Narmada, Tapi –Purna and Son valley Khan (in press). The Narmada and Son are two linear basins north of Satpura and Tapi-Purna in south was a single elliptical trench which has provided a platform of Quaternary sedimentation in Central India. The present expression and configuration of this trench is fragmented and disposition of quaternary blankets of Son Narmada, Tapi and Purna is due to tearing, faulting, dislocation subsidence, up rise of various blocks and reactivation of structural fabrics with in the SONATA LINEAMENT ZONE.

The Quaternary deposits of Tapi comprised of Bouledre conglomerate, fluvial deposits of paleodomain and present domain of Tapi. The Boulder conglomerate forms the base of Quaternary deposits overlying directly on basaltic rock and embodied with older deposits in the basin. It revealed that inception of Quaternary sedimentation occurred in the rock basin south of Satpura in Tapi which had outer rim of basin in the west restricted by strong N-S structural trend and striking ranges. It is contradictory to the opinion of earlier worker (Tiwari, 1996) and others. The Quaternary deposits of Wardha in the east upper Pleistocene-Holocene age (50 m) (Tiwari 1985) forms the eastern fringe of Tapi Basin; it is separated from Tapi-Purna basin by episodes activation of the eastern block during Quaternary period Khan (in press). The present studies within single ecology of geology tectonics and in harmony of sedimentation in lineament zone, in increasing antiquity revealed that Tapi-Purna was a single basin, formed a mega tectonic depression which was hospitable to sedimentation during Pleistocene to Upper Pleistocene –Holocene time. The present expression of basin is due to Quaternary tectonics in the lineament zone.

In Tapi basin Boulder conglomerate occurs as persistent horizon at the base of quaternary deposit which represents specific phase of sedimentation in the valley, it is time equivalent to the boulder conglomerate of Narmada and has witnessed that the sedimentation on either edge of Satpura and in the SONATA LINEAMENT ZONE in single ecology was contemporaneous and simultaneous with Narmada, which further revealed that quaternary deposits of Tapi are early to middle Pleistocene in age and related to the early reactivation of Tapi lineament. The association of rock cut terraces, rock cut benches, strand lines and rock cut scar in Tapi and Wainghour rivers demonstrate mighty reactivation of Tapi lineament during the early stages of sedimentation. The cyclic reactivation has vertically incised and cut country rocks into rock cut benches in stepped sequence; whereas in the Purna valley a gape was been created by reactivation of Tapi-Purna lineament was converging point and was hospitable to accumulation of sediments and sedimentation.

The Purna basin embraces hanging drainage and configuration of basin is closed indicates that loci of sedimentation was a deep gape and undergone vertical and cyclic subsidence after inception of sedimentation. The thick pile of sediments comprised of five lithostratigraphic units viz. Ferruginised and oxidized cobble silt and clay Formation, Ferruginised assemblage of pebble brown silt Formation, Red coarse sand, silt clay Formation and Dark grey

medium sand, yellow silt and clay Formation and Grey clay silt Formation, where as Tapti Basin has only three units viz. Boulder Conglomerate at the base on rock basin followed by quaternary deposits of paleodomain and present quaternary deposits of Tapti which are older deposits. The present studies within single tectonic and geomorphic ecology and in harmony of sedimentation revealed that Tapti-Purna was a single basin which formed a mega tectonic depression in the east, was hospitable to sedimentation from Pleistocene to Upper Pleistocene –Holocene. The quaternary deposits of Wardha is Upper Pleistocene-Holocene age (Tiwari 1985) forms the eastern fringe of Tapti Basin, it is separated from Tapti-Purna basin by episodes activation of the eastern block during Quaternary period Khan (in press).

In the present work collective and comprehensive study of Quaternary deposits and river terraces in SONATA LINEAMENT ZONE Khan (1984), Khan (1985), Khan et.al (1982), (1984) Khan (1991), (1992) Khan et al. 1991, Khan 1991, Khan et al. 1992, Yadav & Khan 1996. The Narmada valley embodied almost whole of the Quaternary deposits time span from the lower Pleistocene to Holocene (Khan & Sonakia (1992). Khan (1992), Khan (2012), Khan et.al (2013) Khan (2014), Khan et.al (2015), Khan et.al (2015) Khan et.al (2015) Khan (2015) et.al, Khan (2014), (2014), Khan et.al(2016), Khan et.al(2016) revealed the presence of complete sequence of quaternary sediments in Narmada rock basin viz Glacial, fluvio-glacial and fluvial domain, where as the boulder conglomerate which has yielded human skull Sonakia (1984) is of fluvio-glacial origin Khan & Sonakia (1991) indicate that SONATA LINEAMENT ZONE has an elliptical and elongated depression evolved and emerged by repeated reactivation, the grabens evolved on either side of Satpura were contemporary and sedimentation was simultaneous and composite in Central India. The present disposition and expression of these blanket is fragmented, has conceived its position with repeated tearing, faulting, due cyclic reactivation of different fabrics of SONATA LINEAMENT ZONE (In press).

The Quaternary studies in Tapti-Purna valley region have further indicated presence of a depression along Yaval-Adavad-Akot-Bawanbir area, through which an arm of the Arabian Sea (?) extended causing salinity in this region. The depression was filled up by sedimentation. The Neotectonic activities resulted in further deepening of this basin and as a result alluvium at places reached below present mean sea level. The Narmada graben similar situation occurred which further witnessed that Tapti-Purna was single basin and there was continuous sedimentation from Pleistocene to Upper Pleistocene-Holocene time. The present framework of the basin is due to Quaternary tectonics and reactivation of SONATA LINEAMENT ZONE.

The Quaternary blanket of Son Valley in central India (23.00 to 24.00° 78.00 to 80.00 N) had deeply incised into river terrace related with cyclic tectonic adjustment of various blocks in SONATA LINEAMENT ZONE. These terraces are designated ST0 to ST3 in between 280 m to 310 m above m.s.l increasing antiquity from the river bed. The exposed thickness of quaternary deposits is about 30. The study of the lineament and structural elements indicates that Son

negotiate its course along the strong ENE-WSW to E-W trend which is sympathetic to the trend of Narmada and Tapi. The structural fabrics display the imprints of neotectonism which is reflected in the reshaping of landscape and Quaternary terraces. These terraces display both convergence and divergence in their relative disposition in the valley, are both cyclic and non cyclic in nature which further authenticates cyclic reactivation of Son in synchronisation of SONATA LINEAMENT ZONE

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Introduction:-

The Narmada River originates at Amarkantak at an elevation of about 1057m above m.s.l. it descends from the mountainous tract traversing over a distance of 1300 km across the middle of the Indian sub-continent to join the Gulf of Cambay, in Arabian Sea near Bharuch in Gujarat state. The river course of Narmada is conspicuously straight, controlled by E-W lineament. It negotiates across down the mountainous tract through deep gorges in straight sinuous to meandering pattern with average sinuosity index of 1.38, which at places exceeds 1.55 for some selected segments of channel. It is bound by Vindhya in the north and Satpura ranges in the south; the area in between these two upland is found to be ideal loci for Quaternary sedimentation as witnessed by the presence of multicyclic sequence of Quaternary terraces in the valley. These terraces represent the former levels of valley floors formed by cumulative erosional and depositional activities of the river system.

Crustal provinces:-

SONATA LINEAMENT ZONE embodies the two Quaternary basins of tectonic origin on the two margins of Satpura Crustal Block discerned on the basis of ground geophysical studies and DSS profiles (Kaila, 1988). 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 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 Satpura Range, trending ENE-WSW forms a prominent morpho tectonic unit in Central India, bound by Lat. 20°43'N & 23°30'N and longitudes 73°52'E and 81°30'E, between Rajpipla, (Gujarat) in the West and Maikal Ranges (Madhya Pradesh) in the east. The Satpura block is flanked in the North by Collinear Valleys of Narmada and Son and in the South by Tapi-Purna; Kanhan, Pench and Wainganga rivers flow across the southern slopes in the eastern part.

The area studied tectonically encompasses two crustal provinces of Central India Shield, namely, the Northern Crustal Province (NCP) and the Southern Crustal Province (SCP) (Acharyya and Roy, 1998; Roy, 1988). The two provinces are separated by a crustal level shear zone, referred as Central Indian Suture (CIS) (Jain et al. 1995). The southern part of the NCP, containing the Satpura and Son Narmada (SONA) valley geographic domain, is known as Central Indian Tectonic Zone (CITZ; Radhakrishna and the CITZ are marked by Narmada North Fault (NNF) in the north and CIS in the south (Acharyya, 1999). The Jabalpur earthquake affected area lies in SONA lineament zone which forms the northern units of CITZ. The SONA zone is about 1600 km long and 150 km-200km wide, extending from the southern margin of Kathiawar peninsula in the west to the margin of Vindhya basin in the east (Crewford, 1978; Ahmad, 1964). The zone has been a major locus of episodic tectonism with evidences of reactivation. The E-W to ENE-WSW trending Narmada and Tapi lineament from a prominent tectonic belt (SONATA) in midplate continental India. The Narmada tectonic line and its presumed eastward extension, Son, have been considered as a major Precambrian deep crustal features (Auden, 1949; West 1962) and possibly a palaeo-rift (Nayak 1990) extending hundreds of kilometers in E-W direction (Mishra 1987, 1992). Pascoe (1959) recognized the Narmada lineament as a rift at its western ends however, its eastward extension and the relative timing of the Narmada rifting and Deccan Trap eruption remained unknown. Khan et.al (1914) studied the Deccan Trap in

western extremity of Narmada Rift valley of Quadrangle 46I, 46 J, 46 M, 46 N covering an area about 45000 sq. km bounded by latitude 22 00 00 to 24 00 00 N and longitude 74 00 00 to 76 00 00 which indicate repeated cyclic and intermittent eruption of basaltic lava along ENE-WSW to E-W trending lineament in synchronization of mechanics of SONATA LINEAMENT ZONE which directly rest over the Proterozoic rocks south of Jabhua (46J). The complete sequence of lava flows is noticed in (46N) in Narmada valley.

The area studied evolved in response to topography and landscape profile in tectonic zone and reactivated superimposition of drainage of pre-existing topography, lithology and structure. The Narmada Son lineament zones represent an interaction of lithology, structure and climate, illustrating time dependent reactivation history west, (1962 ;) Choubey, (1971). The central part of Jabalpur earthquake affected area is characterized by Quaternary blanket of Narmada terraces (NT1 to NT3), whereas the area towards north exhibits units of Vindhyan syncline, with valley and montane topography comprising hogbacks and cuestas. Further north, the syncline has wide plateau with prominent scarp overlooking the Indo-Gangetic plains. Towards south in the Satpura block geomorphic units of extrusive origin with different levels of plateau, units of structural origin on the Mesozoic sediments and units of denudational origin culminate into high hill ranges with steep slope.

The Narmada valley in eastern and central segment exhibits a combination of a mixed topography and quaternary plain with inselbergs, highlands and trappean plateau. The area in north and south of Jabalpur-Narsighpur-Hosangabad are occupied by plateau. The central part is a valley gape occupied by Quaternary sediments which have been accumulated in linear trench. This alluvial plain is drained by Narmada, Gaur, Hiran, Sher, Shakkar, Dudhi, Tawa and Ganjal rivers and their tributaries. On the basis of altitudinal variation, five prominent geomorphic surfaces between 310 m and 585 m above MSL have been identified. The average elevation in the plain is around 390m MSL with the gradient from east to west. The plain is dotted with low inselbergs and mesas. The plateau in the southern sector attains an elevation of 585m MSL near Bamhni and in the northern area, the elevation is around 501m MSL near Bichhua village. In the eastern sector, Barela and Sihora area attain an elevation of 526m and 508m MSL respectively. The southern plateau has a general ENE-WSW trend, while the northern plateau extends E-W. The highland and plateau show evidences of several cycles of erosion during the geological time. The plain of Gaur, Hiran and Narmada are accretional in nature.

The Narmada plain is studded with ENE-WSW elongated ridges bearing imprints of polyphase folding in the Sihora Sleemanabad area. Denudational ridge in the Deccan Traps of Barela-Mandla region, show imprints of dominant ENE fabric.

All along the southern margin of Vindhyan, dominant geomorphic forms are hogbacks and cuestas, while towards north, plateau, mesa and butte are prominent geomorphic feature. This geomorphic pattern indicates post Vindhyan and pre-Gondwana reactivation of NNF (North Narmada Fault). Conspicuous level-differences in the Gondwana-Deccan Trap contact surfaces reflect the nature of the main ENE fault and cross fault in the Satpura ranges. Elongated plateau, mesa and butte in Deccan Traps of Seoni-Mandla-Balaghat-Jabalpur district the dominant structural control over the evolution of landforms. South Western regional gradient of laterite capping in the Amarkantak region indicates adjustment of plantation surfaces during Tertiary period (Roy Chowdhury et al., 1964).

The Quaternary landscape of Narmada in Jabalpur-Harda section and Gurudeshwar-Bharouch section is represented by river terraces (NT1 to NT3) and sub terraces NT2-A to NT2-D, NT3-A & NT3-B besides NT-0, between 260 m to 310-315 in increasing order of antiquity. Besides Sher, Shakkar, Dudhi, Tawa Hiran Madhumati, Herane tributaries of Narmada also embrace auxiliary terraces which bear imprints of neotectonism Khan et al (1984), Khan (1991), Khan (1992) and Khan, et al. (2012) Tiwari and Bhai, (1997). (Adyalkar, (1975); Ravishankar, (1987); Dubey and Saxena (1987); Tiwari (1990), (1996), Tiwari et al.. (1996). The Satpura block proximal to these basins, has a known history of seismicity (Chandra 1977); the Son Narmada Tapi (SONATA) zone is established as a seismo- tectonically potential zone of intra-plate/Stable Continental Region (SCR) and seismic activity. The Quaternary geology, lithostratigraphy and geomorphology of Narmada valley has been updated in recent years 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 et.al (1991), Khan & Sonakia (1991)

Khan et al. (1992), Yadav & Khan (1996). The Narmada valley embodied almost whole of the Quaternary deposits time span from the lower Pleistocene to Holocene (Khan & Sonakia (1992). Khan (1992), Khan (2012), Khan et.al

(2013) (2014), Khan (2015), Khan et.al (2015) Khan et.al (2015). The results of sedimentological studies Khan (2015), quartz grain morphology, Khan (2014), Paleosol study of type Quaternary column section in Hominid locality in central sector of Narmada Khan (2014), Khan (2015) and Khan et.al (2016) 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 Hathnora Sonakia (1984) and represents specific phase of sedimentation.

Evolution of Quaternary Basin:-

Narmada Basin:-

The "Narmada Quaternary basin" and "Tapti-Purna Quaternary basin" have been postulated to have evolved as grabens on either side of prominent "Satpura Horst". However the evolution of Satpura as a major Horst need to be reviewed keeping the following points in view (Ravishankar, 1997): (i) The graben on either shoulders are not continuous; These are restricted to the limited lengths with an overlap of 1° longitude (ii) The crustal blocks on which the Quaternary basins are set, have different attributes the Narmada block having thickened crust (39-42km) and Tapti block with relatively thinner crust (33-37km) (iii) The Quaternary basins are within enechelon system of faults (iv) Binding faults do not have the same extent of throw in their Strike Continuity e.g. Gavilgarh fault which is estimated to have Quaternary component of vertical throw of the order of 400m in Purna basin and 425m in Salbardi area has only 25m throw in the Upper Wardha Basin (Tiwari, 1985) and (v) through basins on either shoulders are prima facie coeval in temporal sense, lateral differences in reactivation have been noted; e.g. the activity in Purna initiated in Early Pleistocene but Tapti sector got reactivated only in Upper Pleistocene; probably. And subsequently it was much later in Wardha sector (Tiwari, 1985)

The two Quaternary basins of tectonic origin are located on the two margins of Satpura Crustal Block discerned on the basis of ground geophysical and DSS profiles studies (Kaila, 1988). 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. Extensional mechanism has been invoked to explain crustal attenuation in the block. 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 on Narmada and Tapti Crustal blocks flanking the Satpura block.

Thus, the domains of Quaternary basins linked with fault lines of known seismogenic potential need a comprehensive evaluation, reviewing the tectonics neotectonics seismicity and seismo tectonics and geo- tectonics of the SONATA area. This forms the scope of present work the two Quaternary basins viz Narmada and Purna-Tapti constitute graben zone embodies the mega blankets of Quaternary deposits of Central India, are embedded within the tectonic zone. These Quaternary blankets have recorded and preserved the imprints of tectonics, neotectonic and tectonic events occurring since Pre- Cambrian time.

The landscape geo-architect of the area and drainage, landscape profile configuration drainage river terrace, basin boundaries Quaternary sedimentation have been studied in present work and correlated with geomorphic events, weathering events, sedimentation, tephra events, occurrences and paleomagnetic studies in Central India in Narmada basin revealed sequence of major Quaternary events as identified and established is given in the Table No QGMT-16 (Plate No_I & II).

Homo erectus tectonics & sedimentation:-

The catchment area of the river, bordered by the Satpura and Vindhya Mountain Ranges, stretches over an area of 98,796 km² (38,145.3 sq mi). It is situated between longitudes 72°32' and 81°45' east and latitudes 21°20' to 23°45' north, on the northern edge of the Deccan Plateau. The catchment area encompasses important regions in Madhya Pradesh, Gujarat, and Maharashtra.

The Quaternary tract of Narmada basin covers an area of about 17950 sq. km starting from west of Jabalpur (23°07'79 05 30) to east of Harda (22° 29'; 76° 58'), and Gureshwar and Bharouche section in Gujarat state for a distance of about 1320 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 Narmada conspicuously has straight course is controlled by ENE_WSW to E_W lineament, is bounded by Vindhyan in the north and Satpura in the south it is exposed the repeated post erisional and depositional activities and subjected to anisotropic and asymmetric tectonic dislocation which has culminated diversified morphogenetic units and region which further undergone to process of tectonic evolution and chiseling of terrain by dynamic erosional and depositional activity resulting in and reshaping the terrain into various morphogenetic units and land form element, configuration of drainage, topography, physiographic , erosional platform, planation surfaces, denudation ridges, structural units linear valleys, strike hills, valley gapes, escarpments and river terraces. The cumulative dynamics of structural deform, rinsing and sinking platform of Narmada has also manifested concealed cyclic mechanism of tectonics and geothermic activity, seiesmicity, neosiesmic events which have their surface illustration manifestation in the valley. In addition the valley gapes and valley trenches provided ideal sites for sedimentation for formation of quaternary platform, pediment, pediplain, peniplain and river terraces.

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, linear displacement, uplifting, Neogene rifting and and rift-bound Pliocene–Pleistocene rifting and volcanic activity, specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System which form the base of quaternary deposits. The rift system and basin platform provided a unique setting for dynamic ecosystems that were characterized by Rift-related subsidence and coeval sedimentation also created an ideal loci of Quaternary sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, digenesis, and preservation of organic remains. The disposition of quaternary deposits, drainage configuration basin boundary and neotectonics of the area revealed that rifts was formed after widespread Quaternary sedimentation occurred and voluminous sediments in the rift basins were accumulated by glacial activity, it is also witnessed by present disposition of quaternary blankets of SONATA LINEAMENT ZONE.

Table No QGMT _16, 17

The ENE-WSW trending Narmada Quaternary basin, bounded by longitude 77°E and 80°E is located on Narmada crustal block extending in the east over Mahakoshal Greenstone belt; the block is characterized by relatively thickened crust with Moho at depths of 39-42 km (Conard at 12km depth, Kaila, 1988), ascribed to subcrustal underplating. The western part of the basin lies between Kantaphor and Tamia Bouguer Gravity low; the eastern segment beyond Piparia ridge (Tiwari and Bhai, 1997) overlies Udaipura-Narsinghpur-Sihora gravity high area, with underlying volcano-sedimentary sequence of Mahakoshal Group. Tikaria Gravity high reflecting emplacement of high density material lies to the south of the basin. The adjascent Satpura block in the north is characterized by high heat flow ($85 \pm 23 \text{ mW/M}^2$) with thermal springs of Anthoni (Lat. $23^\circ 35' \text{N}$, Long. $78^\circ 36' \text{E}$, Temp. $56\text{--}58^\circ \text{C}$) and Samoni (Lat. $22^\circ 36' \text{N}$ Long. $78^\circ 21' \text{E}$, Temp. 45°C) in the west and Babeha (Lat. $24^\circ 44' \text{N}$ Long. $80^\circ 18' \text{E}$, Temp. 38°C) in the east.

The Narmada basin is bounded by Narmada north and Narmada south faults, located in the apex zone of northward convexity in the Narmada south fault. At places (e.g. around Hoshangabad), the northern limit of the basin transcends Narmada north faults. The Quaternary lithic fill rests over Gondwana sediments, Mahakoshals, Deccan Trap, Granites and Bijawars (Khan and Shah, 1977). A chain of detached/isolated slices of Mahakoshal volcano-sedimentary rocks are noted on southern fault bound margin Tiwari and Bhai, (1997). The detailed sedimentological analysis of quaternary sediments of surface, of both paleo and present domain of Narmada, bore hole sediments form 320 m below the surface , analysis of paleo-sole horizon ,quartz grain morphology of both e quaternary sediments and tephra soil and tephra stratigraphy, lithological assemblage, biostratigraphy and magnetostratigraphy have identified seven lithostratigraphic units on the surface of fluvial domain of Narmada, where the boulder bed represent the glacial phase at the base of Narmda trench; boulder conglomerate fluvio- glacial phase and sediments of paleo and presnet domain of Narmada River terraces (NT1 to NT3) in increasing antiquity. The sediments of boulder bed and boulder comglomerate are concealed and not fully exposed in the valley. The lithostratigraphy of Quaternary from Lower Pleistocene to Holocene has been established (Khan et.al 1991).

The Quaternary events of the Narmada portys three prominent terraces and two sub terraces which are designated NT1 to NT3 and sub terraces NT2-A is NT2-B, NT2 B, besides NT2-C, NT3-A & NT3-B besides NT-0 in increasing order of antiquity. The terraces are described in detail separately. These are both erosional and depositional terraces and confined at an elevation of, between 280m to 310-315. The NT1 is being the youngest terrace and NT3- B it is being the oldest terrace identified in the valley .The realative disposition of these teraces is shown in the Table No QGMT_15.

In the pre Quaternary period in Narmada valley nine plantation / erosional surfaces are identified between the elevation 300 to 500 m above the mean sea level on pre cambrian, Gondwana and Deccan basaltic rocks. These surfaces are characterized by different diagnostic erosional and depositional characteristics and associated landform elements. These surfaces are developed in decreasing antiquity in response tectonic /climatic/eustatic changes in the area.

The Quaternary plain of Narmada display fluvial terraces of the stepped topographic benches, which from the prominent Quaternary landscape flanking Narmada Valley, indicate the former levels of flood-plain or valley floor. These land forms have been formed by combined action of erosion and depositional process of stream, the up warping in the hard ward ends and consequent climatic change in the post-Pleistocene time.

In the upper reaches the Narmada and its Tributaries traverse through the mountain ranges forming tight gorges, straight to sinuous channel pattern and very narrow strip of flood plain when it debouches in the area around Jabalpur, Hoshangabad their flood plain broadens out to the width of 0.5 to 1.5 km. The Narmada in this area splits out into numerous subchannel embracing a large number of sand-bars, point-bars, channel braids and established vegetated island, and shows a conspicuously braided pattern indicating a sudden loss in bed slope after entering the Narmada valley and an almost graded stage.

The terraces on hard rock are erosional surfaces were recognized by their elevation, continuity on longitudinal profile with relicts rock benches, rock cut terraces and breaks in the slope in the valley. The terraces do not show uniform characteristic of weathering pattern or deposit and have been identified by their relationship with plantation surface / Erosional plane E-1 to E-9 , among these E-9 is the highest (300 m to 500m m.s.l.) and by its wide distribution appears to be the plantation surfaces. The plantation surface occurs irrespective of lithology and rock types in the valley and distinctly characterized by elevation and digonestic elements of erosional activity and peneplanation.

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. These terraces are separated by the scarp both 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. In Narmada NT0 and NT1 area depositional terraces whereas NT2 & NT3 are erosional terraces. These are both depositional and erosional terraces which are cyclic and non cyclic in nature and paired equivalent on both side of river. The Narmada exhibits swelling and pinching nature along its course of 1300 kms, between Amarkantak amd Bharouch the channel course of Narmada is mainly controlled by ENE-WSW lineament and its sympathetic fractures. The Narmada in Jabalpur _ Harda and Gurdeshwar _ Bharouch section embodies prominent blanket of Quaternary deposits which display stepped sequence of river terraces. These terraces are seprated by linear and curvilinear scarp facing river. In Jabalpur _Harda section Hiran Dudhi, Shakker, Sher and tawa are the prominent tributaries. In Gurudesh _ Bharouch section Narmada flows in a general WSW direction where it display meanders with wavelengths of order of 5–8 km. The Orsang, Aswan, Men and Bhuki are the major tributaries joining Narmada from the north. The Karjan River, which drains a major part of the trappean uplands in the lower Narmada valley, meets the Narmada from the south. The other tributary, the Madhumati river drains the western fringe of the trappean upland. In between the Karjan and Madhumati rivers there are several north flowing small streams meeting the Narmada. The net work of drainage in the lower Narmada is structurally controlled and developed and work under the mechanism of neosiesmic ecology of pulsation variance evident by river terraces, linear scarp. The presence of ravenous tracts with incised deep gullies of 20–25 m. is manifestation of deep seated water table due to subsidence of block along the lineament zone. The disposition of river terraces, entrenched meanders and alluvial cliff 15–30 m are suggestive of neotectonic activity in the area. The display of active Narmada Channel configuration of terraces, meander scrolls, entrenched meander revealed misfit nature of Narmada in the area. The present channel of Narmada is strongly influenced by NSF and display persistent tendency to shift towards north due geotectonic activity along the

fault. It is also further authenticated that there is perceptible up rise in the southern block of fault and subsidence of northern block which has manifested and resulted into gliding and shift of Narmada towards north. The study of active channel of Narmada associated land form elements, channel course geometry and digonistics of landform elements to gather with and the braided appearance to the channel indicates the heterogeneity of the present river bed and also its decrease in load carrying capacity towards the later phase in the history of channel system. The disposition of river terraces, entrenched meanders and alluvial cliff 15–30 m are suggestive of neotectonic activity in the area. The display of active Narmada Channel configuration of terraces, meander scrolls, entrenched meander revealed misfit nature of Narmada in the area. The present channel of Narmada is strongly influenced by NSF and display persistent tendency to shift towards north due geotectonic activity along the fault. It is also further authenticated that there is perceptible up rise in the southern block of fault and subsidence of northern block as witnessed by disposition of fluvial terraces in Narmadachannel in the lower Narmada valley.

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

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

In Homnid locality Hathnora of Narmada valley is occupied by thick Quaternary sediments which are classified on the basis of statistical parameters, quartz grain morphology of sediments, quartz grain morphology of quartz grain of paleosole, heavy mineral assemblage, and ash bed sedimentary features and environments of sedimentation. The lowermost units (Boulder bed) is of glacio-fluvial origin (Khan et al 1991) whereas the rest of fluvial origin. The top four formations (Sohagpur, Shahganj, Hoshangabad and Janwasa) are classified based on morphostratigraphic state (NT₀-NT₃), degree of oxidation, calcification and compaction. Janwasa formation comprises of sediments of active channel deposition and is the older three (Sohagpur, Shahganj, Hoshangabad formation) are related to older flood plains deposits of paleo-do-main of Narmada and are grouped under older alluvium. Boulder conglomerate of fluvio-glacial origin is assigned an independent formational status based on distinct lithology and fossil assemblage.

The sequence of Quaternary events and the history of sedimentation of Narmada indicate that the upper 70m top 90m of the Narmada alluvium was deposited in a single aggradations episode with minor pauses when dissection of the alluvium produced two terraces (NT₃-NT₂). The sediments of this aggradations episode constitute three lithostratigraphy units viz. Boulder conglomerate, Sohagpur and Shahganj formation. The sediments of the alluvial phase are underlain by a boulder bed of glacio-fluvial origin. Thus, the fossiliferous boulder conglomerate, the basal

unit of alluvium marks a disconformity between the lower glacial-boulder layer and upper fluvial sediments. The fossiliferous basal boulder conglomerate is being of middle Pleistocene age Khan 199. On the merits of detailed study of sediments Quaternary deposits of Narmada valley divide. In Narmada three distinct group of sediments viz. glacial, fluvio- glacial and fluvial; are identified their age, litho constituents, environments of deposition and associated geomorphic elements are given in the Table I below:

Table -I: Quaternary Geology of Narmada Valley

Age	Quaternary formations	Lithe constituents	Environments of Deposition	Associated geomorphic Phenomena
1	2.	3.	4.	5.
Recent	Younger Alluvium Fluvial terraces / fluvial deposit of present domain of Narmada	Reworked sediments, mostly rock gravel consisting boulder, cobble, pebble of quartzite, gneiss, granite, schist, basics, slate, phyllite, limestone & shale in a matrix of coarse to fine sand	Channel & flood plain environments	Point bars, channel bars, present day active flood plane and channel braids: Fluvial terrace: NT-0.
Holocene	Fluvial terraces fluvial deposits / older alluvium & Sediment of paleo- domian of Narmada	Coarse gravel consisting of boulder, cobble, pebble, of quartzite gneiss granite, schist, phyllite, state, fossiliferous lime stone, shale & basic rocks in a matrin of coarse to fine sand.	Channel & flood plain environments.	Fluvial terraces of Narmada NT- 0 ₁ to NT-3.
Late Pleistocene	Fluvio- glacial deposits	Sub-angular to sub rounded boulder, cobble, pebble of quartzite, gneiss, granite schist with subordinate amount of limestone, slate, phyllite & basic rocks with coarse to fine sand & silt.	Fluvio glacial environments	Fluvio-glacial deposits "FGD"
Pleistocene	Glacial deposit	A heterogeneous mix of sub- angular to angular boulder and cobble of predominately gneiss, granite, schist, & quartzite with subordinate an amount of slate phyllite and shale together with very fine sand, silt & clays.	Glacial environment	Glacial deposits "GD".

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

The Narmada Rift System provides a unique setting for Quaternary geological sedimentological pedological paleontological and archeological investigations which indicates human origins and evolution. Skeletal and cultural remains of hominids have been recovered from many locations within the basins. The Important paleontological paleo-anthropological and archeological sites occur within the Narmada Rift System. The most of localities occur on the rift floor in between Jabalpur_Harda, in the east and Barwaha _ Rajpipla in the west in the valley.

The remarkable preservation of faunal and floral remains in the Pliocene–Pleistocene sedimentary rocks was possible because of quick burial by sediments. Moreover, these source rocks of rift system the Quaternary sediments and interbedded tuffs provided the necessary chemical components for the preservation of the fossils during diagenesis. There is a strong link between these dynamic processes, rapid sediment deposition, and fossil preservation. The most important primary and contextual data (fossils and artifacts) were embedded and preserved in sedimentary deposits until the recent exposure by tectonic driven erosional processes. The time-stratigraphic data obtained from tephra interbedded with fossiliferous Quaternary sedimentary deposits provided an important framework for the study of hominid origins, evolution, adaptations, and cultural changes. The paleoanthropological 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 and distorted and are concealed under the thick pile of sediments of present and paleo domain of Narmada of late Pleistocene and Holocene time. These deposits do not provide adequate opportunity to researcher to study the human remain as postulated, except limited section where they are exposed.

The Jabalpur- Harda section posses the complete sequence of all three domain of sediments in increasing antiquity from the bottom of the rift trench Boulder bed (glacial), Boulder conglomerate (fluvial-glacial) sediments of paleo-domain of Narmada (fluvial). The intense tectonic activities within the basins of the Narmada Rift System during the Neogene and Quaternary periods have destroyed fossil record except the fossiliferous horizons exposed in river sections. The erosional-sedimentary cycle has persisted in the rift valley environment for millions of years as a result of the interplay between depositional and erosional forces driven by tectonic processes; there are numerous gaps in the fossil record, particularly in the important time period between Mio-Pliocene Pleistocene times. It is pertinent to the understand the origin of Hominid during the late Miocene, but it is difficult to disclose mysteries of human evolution in Narmada due to concealed nature of these deposits in rift system, however the complementary part of Tapti-Purna Quaternary blanket may be potential and possessive of human remain and should be studied to trace further the imprints of fossil man taking in to account of SONATA LINEAMENT ZONE as single ecosystem for evolution of man in Indian subcontinent. However, evidence of the effects of tectonics on fauna and flora are distinct and their signatures on concealing strata of fossiliferous horizons of boulder conglomerate are uncontrolled and ill defined in the ecosystem in the valley during the Pliocene–Pleistocene periods. The boulder conglomerate which yielded the skull cap of Homo erectus in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due to concealed and hidden nature of Mio-Pliocene Pleistocene deposits in rift system and inconsistency in exposure of fossiliferous horizon due faulting, dislocation and subsidence of Quaternary blanket of Narmada.

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

Hominid locality Hathnora Indian Homo erectus & Evaluation (22°-52 'n-77° 52' – e):-

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

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

A mandible of Lantian hominid at Chenjiawo (China) was found in paleosol (S6) and at the depth of (38 m) in the loess deposits A Zhisheng et. al. (1989). Assuming a roughly uniform accumulation rate of sedimentation in the line of Ma. et.al. (1978) estimation of age, the date of the Lantian mandible at Chanjiawo is computed to be about 0.65 m.y.r ; Ho Chuan at the depth of (26m) which were deposited in typical fluvial environments. In view of recovery of skull cap of Homo erectus (Narmada Man) from older deposits and from deeper level (83m.) as compared to Chinese Hominid, the claim of Lantian Hominid of Congwangling (1.15 m.y.r.) after A Zhisheng et. al. (1989) needs re-evaluation of reassessment of its age.

The rock basin of Narmada is occupied by the Quaternary sediments of three domains viz. glacial, fluvio- glacial and fluvial which were deposited in distinct environments during Quaternary time. The glacial deposit comprised of thick pile of sediments occupied base of rock basin and was deposited by glacial activities in dry and cold climatic condition during early Pleistocene time. The boulder conglomerate constitute fossiliferous horizon of Narmada, deposited in fluvio-glacial environments (interglacial). It is a marker horizon of Quaternary sedimentation in Narmada Valley and as well in Central India, its disposition and relation with other deposits in the valley, indicates a significant change in regional climate from cold dry to warm and humid, during which the sediment were re-worked from glacial front intermittently and deposited in the valley over a very long time. The skull cap of Homo erectus (Narmada Man) and other fauna recorded along with calc- nodules within the boulder conglomerate; suggest that warm climatic phase prevailed long time. The Lantian hominid cranium at Gongwangling was found in silty loess at the depth of about 26 m. and it Luochuan standard sequence the fossil bearing stratum un-doubted to the middle part of silty loess L-15 which at Luochuan was dated to be 1.09 to 1.20 m.y.r. The hominid fossil and associated faunas were discovered in the middle part of silty layer; the age of the fossils at Gongwangling can be pinpointed narrowly to 1.15 m.y.r. This dates differs from the earliest (0.75-0.80 m.y.r.) of Ma. et. al. (1978) and from 1 m.y.r. estimate of Cheng et. al. (1978). The Lantian fossil hominid at Gondwangling is considered as earliest Homo erectus in China. Ho Chuan Kun (1986).

In India Narmada basin considering the one of a main loci of Quaternary sedimentation, and assuming the uniform accumulation rate of sediment in the basin in the line of Ma. et. al. (1978) Yobin Sun & Zhisheng, An (2005) and comparing the Narmada sequence of Quaternary deposit (325 m.) with those of Luochuan standard sequence of Chenjiawo and Congwangling sequence of China. The skull cap of Homo erectus (Narmada Man) recovered from the boulder conglomerate of fluvio-glacial origin in middle part of Quaternary column from deeper level of quaternary sequence 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 pale sole which are younger than Narmada deposits. Wu X Yang et.al (1966), Wu M (1980), Wu.X Wang (1985)

The Narmada skull cap of Homo erectus which is recovered from the vom of basal unit of boulder conglomerate at the depth of (83 m) i.e. (278 m. above m.s.l.) is estimated to be of upper segment of lower Pleistocene age. It is older than the Homo erectus of Chenjiawo, Congwangling of China which were recovered from paleo sole and loess deposit at the depth of (38 m) 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 Central India Khan & Maria (2012). The occurrence of skull cap of early

man at the depth of 83 m. in basal unit of boulder conglomerate of fluvio-glacial origin in Narmada Valley is one of the earliest and oldest *Homo erectus* in Asia.

Khan & Maria (2012). (Plate No. III)

The results statistical analysis of Quaternary deposits of Narmada of Hominid locality Hathnora Section I-IV where the average measured thickness of exposed and concealed quaternary deposits is about 325 m. (22°-52' N-77° 52' – E) Narmada Valley Central India Khan (2016).

The Geomorphology of Fluvial terraces their salient and diagenetic elements are described in Table No **QGMT 1_to_7**. (Plate No_I & II).

(i) Tapti-Purna Basin

The most conspicuous feature of the southern margin of the Satpura between longitude 74° and 78° is the chain of gravity high viz. Amalner (30 mgal) and Burhanpur Raver (25 mgal) with an arcuate trend swerving from NW-SE near Shahada to E-W and ultimately to ENE-WSW east of Burhanpur; NW-SE trending Bhusawal-Chopda low, obliquely transects the high is noted further south between Jamner and Nandura and around Daryapur in Purna valley. These swerving gravity trends characterizing Tapti crustal block, conform to structural grain of the area reflecting reflecting the convergence of enechelon system of swerving faults (viz. Tapti fault and Gavilgarh fault) traversing Satpura foot hills, with a southerly convexity. The twin Quaternary basins of Tapti. The alluvial basin areas in Tapti Crustal block are characterized by relatively thinner crust with moho depth of 33-37 km, shallow basement (<1 km) with higher density (+0.239g/cm³) mantle derivatives emplaced at shallow level (4-5 km; Rao K.V., 1997). The area is characterized by high heat flow (108±9.5mW/M²) with series of hot-springs viz. Anakdeo (Lat. 21°43'N, Long.74°26'E. Temp. 42.5°C) Kundwa (Lat.21°13'N, Long. 77°E, Temp. 37.5°C), Ramtalao (Lat.27°17'N, Long.75°24'E, Temp. 39°C), Unapdeo (Lat.21°16'N, Long.75°26'E, Temp. 58-60°C), Nazardeo (Lat.21°16'N, Long.75°23'E. Temp 39°C) etc. on the Satpura foot hills and Indwa (Lat.21°31'N, Long.74°27'E, Temp. 37°C), Khadgaon (Lat 21°4'N Long.75°41. E Temp 32°-35°C) on the southern margin of the alluvial basin.

The Tapti-Purna alluvial basins evolved as two separate basins of fluvio-lacustrine sedimentation, connected subsequently. The work on basin frame work, lithostratigraphy and neotectonics have been well documented by Adyalkar, (1975); Ravishankar (1987, 1995); Dubey and Saxena (1987); Tiwari and Mukhopadhyay, (1989); Tiwari, (1990, 1996). As per records and merits of earlier worker it was presumed that Tapti –Purna were two separate basin of sedimentation the present studies taking entire quaternary sedimentation of SONATA LINEAMENT ZONE as single geological system besides the tectonics on the either side of Satpura, it revealed that the area of SONATA LINEAMENT ZONE formed a single locus of sedimentation and there was continuous and sequential deposition of sediments from Pleistocene to Upper Pleistocene time it is witnessed by quaternary events morphogenetic expression disposition of river terraces their mutual correlation relation, lithostratigraphic correlation across Narmada, Tapti –Purna and Son valley. Khan (in press). The Narmada and Son are two linear basins north of Satpura and Tapti-Purna is single elliptical trench which has provided a platform for sedimentation. The expression and fragmented disposition of quaternary blanket of Son Narmada, Tapti and Purna is due to tearing faulting dislocation subsidence and up rise of various blocks and reactivation of structural fabrics with in the SONATA LINEAMENT ZONE.

Studies further indicate evolution of Tapti basin during Pleistocene tectonic activity (Rahate & Khan, 1985). The Narmada, Tapti and Purna basins thus represent graben structures developed during Pleistocene with steep faults on one side and a set of step faults on the other margin (Nair et al, 1988). Neo-tectonic activity is inferred along many of these faults, suggesting that the faults are still active (Khan et.al 1984, Khan et al 1990, Khan 1993, Ravi Shankar and Dubey 1984; Tiwari, 1985).It is further revealed that there are six major lineaments viz Son-Narmada, Tapti, Khandwa, Dhar, and Shahdol, a number of minor lineaments were also identified.

The Tapti - Purna graben is situated on southern margin of satpura, where Tapti is main which originates from the Satpura ranges in the north east of Damjpur. It is formed by mingling of numerous perennial streams draining from the various points in the Satpura ranges forming the stream in the mountainous tract itself; after debouching from the hills the river follows a straight or sinuous course, the sinuous index being of the order of 1.35. In the area under study commencing east of Bhusawal, the Tapti flows west in a straight to sinuous pattern forming conspicuous stepped sequence of fluvial terraces, besides several other geomorphic features, both of the erosional and the depositional domains in the alluvial tract and the older Deccan traps country. Pascoe (1964) and Krishnan (1968),

assigned Pleistocene age of the Quaternary deposit of Tapi basin. Venkatraman (1969) studied the mineral potentiality of the area. The present study is an attempt has been to fill up gap in basic information by giving an account the geomorphic events and processes in particular reference to the evolution of geomorphology geomorphic units and understanding the evolution of the landscape in space and time.

The Quaternary sequence of Tapi consist of three units viz. boulder conglomerate, older alluvium and younger alluvium. The boulder conglomerate form the base of exposed section indicating break in sedimentation. It is equivalent to boulder conglomerate of Narmada and other river of Paninsular River. The area depicts four geomorphological units in viz, present day flood plain of the Tapi and the Vaghur rivers, terraces of the Tapi and Vaghur, the ravenous tract, and the mounds of Deccan trap. Each unit is characterized by diagnostic geomorphic expression of landform elements. The geomorphic features identified in the area are point bars, sand bars, channel braids, relict scarps, alluvial bluff, rock cut benches and braided channels. The study suggests the presence of a NW-SE trending fault along the Vaghur river. This is indicated by the distribution of geomorphic surfaces, landform elements, anomaly in the channel morphology, association of entrenched meander displacement in the fluvial surfaces, association of rock cut terraces and distinct variation in ground water condition on either banks of the Vaghur, evidence of neo-tectonic activity along this fault are reflected by tilting and shifting of terrace blocks, dislocation and displacement in sub-litho units of terrace deposits of both of the Tapi and Vaghur rivers.

The Deccan basalt is overlain by boulder conglomerate and the contact of these two formations is seen in the Vaghur river section near Kadgaon. The thickness of conglomerate varies from 2.5m around Kadgaon to about 16 m on the left bank of the Vaghur, north – east of Shelgaon near the confluence of the Vaghur and the Tapi at Kadgaon (21 09: 75 41 30) area Khan (1984) which is equivalent to the boulder conglomerate of Narmada and its 16 m section in the the Kadgaon area is exposed on the left bank of the Vaghur river, directly over lying the Deccan Traps and is exposed due to faulting. The contact of these two formations in this area is very sharp and infilling of the cavities and erosional hollows over the lava surface by the sedimentary material are seen at several points. Some of the fillings are of concretionary material indicating that both exogenic and endogenic processes were involved in the formation of the infillings.

The boulder conglomerate in this area consists of sub-rounded to rounded discoidal, tabular and bladed rock fragments, ranging in size from small pebble to boulders of dark greenish black basalt, grey vesicular basalt, quartzite quartz, agate, chert and jasper in an unopposed matrix of coarse to fine sand, silt and clay. Three sub-litho units of 1.5 m , 0.5 m and 0.5 m thickness respectively are identified from bottom to top in the boulder conglomerate, primarily on the size gradation of the coarser clastics.

The older alluvium comprises the flood plain deposits in the paleo-domain of the Tapi and occupies large area along the Tapi and the Vaghur. This unit overlies the conglomerate bed and at places directly rests over the Deccan trap. The exposed thickness of this unit varies from 5 to 20 m and the average thickness is 14.5 m as studied in the river section. It consists of yellowish brown, brown clay and silt with bands of fine sand. Broadly two sub-litho units can be identified. The basal member consists chiefly of reddish brown, silt and clay. The upper sub-unit is dark yellow to dark brown clay with sub-ordinate amount of silt. The exposed thicknesses of these two units are about 15 m. These units are horizontally bedded and contain intercalated bands of reddish silty and clay and grayish matrix. These bands are quite persistent in nature and vary in thickness from 5 to 8 cm. The calcareous layers are commonly associated with these deposits in the area. These units display variation in composition vertically column. The upper horizons are predominantly clayey in nature, whereas the lower horizons are silty in composition and often contain thin layers of fine sand and occasional calc-layers.

The younger alluvium represents active flood plain deposits of the Tapi and its tributaries. These deposits are restricted to the present day channel courses and adjoining to land area. It consists predominantly of sand, with lenticular beds of highly assorted boulders, cobbles, pebbles of basalt, quartzite, quartz, agate, jasper and chert. The inferred exposed thickness of this deposit in the area is about 5 m.

The study of various aspects of Quaternary blanket, its configuration and extension revealed the deposition of the sediments has been taken place in elongated oval depression tapering to wards west in linear converging trench. The sediments were deposited on oscillating and persistently sinking platform in related with mechanism of adjustment of various blocks in tectonic zone. The quaternary terraces and associated landform elements are the illustrative

manifestation of tectonic changes in water shade region during Quaternary time. The Tapti tectonic zones south of Satpura possess imprints of Neotectonism and geothermal manifestation.

The Purna valley comprised of thick pile of Quaternary deposits consisting of five lithostratigraphic units viz. Ferruginised gravel and Sand, Red Silt Formation, Brown Silt Formation, Light Grey Silt Formation and Dark Grey Silt Formation. As compared to this, Tapti Basin which has only three units viz. Boulder Conglomerate, Older Alluvium and Younger Alluvium, the Older Alluvium further divided into three units viz. Brown Silt Formation, Light Grey Silt Formation and Dark Grey silt formation. This suggests that sedimentation in Tapti basin started earlier in Early Pleistocene whereas in Purna basin sedimentation commenced later in Upper Pleistocene; the Tapti – Purna formed single locus which was hospitable to the sedimentation. The Tapti quaternary deposits in present set up are at higher position but it embodied the older deposits which form base with rock basin which appears to be due to tectonic uplift and reactivation of Tapti lineament Khan (1982) Khan, (1984) it is contradictory to the opinion of (Tiwari, 1996). The quaternary deposits of Wardha upper Pleistocene-Holocene age(50 m) (Tiwari 1985) forms the eastern fringe of Tapti Basin, it is separated from Tapti-Purna basin by episodes activation of the eastern block during Quaternary period Khan (in press). The present studies within single geomorphic ecology and in harmony of sedimentation in increasing antiquity revealed that Tapti-Purna was a single basin which formed a mega tectonic depression which was hospitable to Quaternary sedimentation from Pleistocene to Upper Pleistocene –Holocene.

Quaternary studies in Tapti-Purna valley region have further indicated presence of a depression along Yaval-Adavad-Akot-Bawanbir area, through which an arm of the Arabian Sea (?) extended causing salinity in this region. The depression was filled up by sedimentation. Neotectonic activities resulted in further deepening of this basin and as a result alluvium at places reached below present mean sea level. Similar situation has also been observed locally in the Narmada Valley which further witnessed that Tapti-Purna was single basin and there was continuous sedimentation from Pleistocene to Upper Pleistocene-Holocene time. The present framework of the basin is due to Quaternary tectonics and reactivation of SONATA LINEAMENT ZONE.

Tapti has sculptured the alluvial tract into stepped sequence forming four alluvial terraces along its course. These are designated as TAT-0 to TAT-3, the TAT-0 being the youngest terrace and TAT-3 the oldest terrace. TA stands for Tapti river and T0-T3 are terrace numbers. These terraces are separated by the scarp both 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 climatotectonic changes in the watershed of Tapti in the Quaternary times. In the Vaghur three terraces are identified. These are mainly erosional terraces and were formed in the alluvial fill of the Tapti by subsequent stream Vaghur by cyclic incision. These terraces are much younger than the terraces of Tapti. The Tapti exhibits swelling and pinching nature along its course, in the area at an alternate stretch which appears to have been controlled by the concealed structural element. The width of the channel in the area varies from 250 m to 600 m. The widest course is 325 m near Bharkheda. The diagnostic landforms and features identified in this unit are active flood plains, point bar, channel bar, channel braids, lateral bank cutting and incisional scarp. The disposition of these landform elements has given the braided appearance to the channel, which perhaps indicates the heterogeneity of the present river bed and also its decrease in load carrying capacity towards the later phase in the history of channel system.

The Vaghur is a tributary of the Tapti which rises from the Deccan Upland of the Ajanta ranges near Firdospur which drains across the southern Deccan pediment of these ranges, joins Tapti near Shelgaon. The stream is straight of sinuous in nature in the upper part, it became sinuous to meandering in the area under study displaying tight meandering pattern of index order of 1.52. The various land forms and features identified in the Vaghur are point bar sand bar, meander scar, incisional scarp of active flood plain. The landform elements consist of unconsolidated surrounded to rounded rock fragments of basalt, quartzite, quartz chert and jasper with coarse to fine sand. The Vaghur meets with Tapti at Shelgaon. In the around confluence and down stream of Tapti the following evidences of neotectonism have been recorded. The Vaghur has a northwest-southeast course and displaying typical meandering in the channel course before joining east-west flowing Tapti river near Shelgaon. During the course of investigation the following observations are recorded indicating thereby possible existence of a fault.

The association of rock cut benches and scar at lower level along the left bank of the Vaghur near Kadgaon, indicates anomalous high kinetic condition of channel system towards later phases in the history of the river sedimentation and this reactivation in the stream kinetics indicates some movement along NW-SE trending fault.

The tilt in some of the terrace blocks, towards east or west by about 5 in the paired terraces on either side of the bank of the Vaghur away from the channel in the vicinity of Shelgaon, indicates up warping in the area, perhaps due to release of accumulated energy/movement along the NW-SE trending fault/lineament.

In Shelgaon section of Tapti, perceptible displacement in the various sub-litho units of gravel and sand beds has been seen which indicate the recent movement in the area along the NW-SE trending fault. The association of entrenched meander with the Vaghur river course north east of Kadgaon suggests reactivated entrenchment of the river bed by the channel, perhaps due to sudden up warping of the area in recent past. A shift of about half of 3.5 meter in the terrace block north east of Shelgaon is also one of positive evidences of neotectonic activity in the area. The geothermal aspects of the area were also taken in account in deciphering the possible existence of a fault and associated neotectonics activity in the area.

The study revealed that structural attributes of Tapti-Satpura region, Ravishankar, (1987), that Tapti-Purna valleys are actively subsiding grabens bound by Satpura Horst in the north and Ajanta-Buldhana plateau in the south. Based on explorations for geothermal studies in Gavilgarh fault which forms the northern binding fault for Purna basin, it is shown that vertical throw towards south is of the order of 1000 m. Out of this about 425m is estimated to be Quaternary component. Occurrence of Quaternary alluvium in "Tapti graben" at 200 m below mean sea level (m.s.l) and in Purna basin at 110 m below m.s.l further corroborates neotectonic activity along Satpura foot hill fault system. Reviewing vertical and lateral movements, large scale vertical block foundering and right lateral shifting along cross faults. Tiwari, (1996), has shown three episodes of neotectonic activity : (1) Lower Pleistocene displacement along ENE-WSW fault, initiating deposition of Rad Silt Formation ; the activity is restricted to Purna valley (2) Upper Pleistocene displacements along ENE-WSW faults in association with Chandur Bazar and Jalgaon Jamod Cross-Faults in Purna valley and in combination with Chopda North Bhusawal faults in the Tapti valley initiating deposition of Brown Silt Formation and (3) Upper Pleistocene to Lower Holocene displacement along ENE-WSW fault, causing deposition of boulder bed in activity is restricted to Purna valley. Late Pleistocene/Holocene activation along Gavilgarh Fault is also indicated in Upper Wardha basin; a throw of 25m is inferred. (Tiwari, 1985). Absence of signatures of seismic activity in the Quaternary fill and uninterrupted sedimentation between these neotectonic episodic movements is conspicuous and indicates that a part of foundering of the sedimentary basins had occurred with a seismic creep.

In Tapti basin the boulder conglomerate occurs as persistent horizon at the base of quaternary deposit which represents specific phase of sedimentation in the basin, it is time equivalent to the boulder conglomerate of Narmada revealed that the sedimentation on either edge of Satpura and in the SONATA LINEAMENT ZONE was contemporaneous and simultaneous, which further revealed quaternary deposits of Tapti are of early to middle Pleistocene in age and related to the early reactivation of Tapti lineament. The association of rock cut terraces, rock cut benches, stream lines and rock cut scar in Tapti and Vaghur rivers demonstrate mighty reactivation of Tapti lineament during the early stages of sedimentation. The cyclic reactivation has vertically cut country rocks into rock cut benches in stepped sequence; whereas in the Purna valley a gape has been created by reactivation of Tapti-Purna lineament which was converging point of accumulation of sediments. The sequential analysis of deposits and its relation with drainage and its evolution revealed that it was a persistent locus which was hospitable to sedimentation. The basin of Purna constitutes hanging drainage and configuration of basin is closed which is contradictory to the opinion of (Tiwari, 1985) & Ravishankar, (1987). In the present work the collective and comprehensive study of Quaternary deposits and river terraces in lineament zone Khan 1984, Khan et.al (1982), (1984) Khan (1991), (1992) Khan (1985), indicate that Sonata lineament zone has a elliptical and elongated depression emerge by repeated reactivation of faults and initial sedimentation has been taken place in single ecology and a composite quaternary blanket was formed in Central India. The present disposition and expression of this blanket is fragmented and has conceived its position with repeated tearing, faulting, up rise and subsidence of various blocks due cyclic reactivation of different fabrics of SONATA LINEAMENT ZONE (In press).

The Geomorphology of Fluvial terraces their salient and diagnostic elements are described in Table No. QGMT 8_ to_11. (Plate No_I & II).

(i) The Son valley:-

The Son originates near Amarkan-tak in Madhya Pradesh, just east of the headwater of the Narmada River, and flows north-northwest through Madhya Pradesh state before turning sharply eastward where it encounters the southwest-northeast-running Kaimur Range. The Son parallels the Kaimur hills, flowing east-northeast

through Uttar Pradesh, Jharkhand and Bihar states to join the Ganges just above Patna. Geologically, the lower valley of the Son is an extension of the Narmada Valley, and the Kaimur Range an extension of the Vindhya Range. Dehri on sone and Sonbhadra are the major cities situated on Son River.

The Son River at 784 kilometres (487 mi) long is one of the largest rivers of India. Its chief tributaries are the Rihand and the North Koel. The Son has a steep gradient (35–55 cm per km) with quick run-off and ephemeral regimes, becoming a roaring river with the rain-waters in the catchment area but turning quickly into a fordable stream. The Son, being wide and shallow, leaves disconnected pools of water in the remaining part of the year. The channel of the Son is very wide (about 5 km at Dehri on sone) but the floodplain is narrow, only 3 to 5 kilometres (2 to 3 mi) wide. In the past, the Son has been notorious for changing course, as it is traceable from several old beds near its east bank. In modern times this tendency has been checked with the anicut at Dehri, and now more so with the Indrapuri Barrage in Bihar.

The Son (784 km long) is one of the longest rivers of India and the longest of the southern tributaries feeding into the River Ganges. It flows, as does the Narmada River, along the line of a major E-W tectonic lineament, the Narmada fault (Williams and Royce, 1982). Originating in Madhya Pradesh, just east of the Narmada River, the Son flows north northwest and cuts through Middle Proterozoic limestone and shale of the Vindhyan Super Group (Singh, 1980) and Middle-Pleistocene and Holocene alluvial plains, before turning eastwards to encounter Middle Proterozoic sandstones of the Kaimur Range (Morad et al., 1991). The modern channel has incised the metamorphic bedrock to a depth of about 30–35 m, forming deposits of fluvial sand (Williams and Royce, 1982). Throughout its history, the passage of the Son river has been strongly influenced by climatic factors (reflected in changes in its floodplain deposition and channel down cutting), since the river is constrained laterally as a consequence of its geological setting (Sharma and Clark, 1982).

The area of study includes the river-cut cliffs in the alluvial zone between the confluence of the Rehi and Son rivers and Khunteli (or Khuteli). The reported YTT deposits (Acharyya and Basu, 1993) and [Jones and Pal, 2005] comprise a discontinuous tephra bed covering an area of ~90 km². Between Rehi and Ghoghara (first described by Williams and Royce in 1982), lateral variations within the ash deposits are minimal, and the ash layer appears repeatedly at a height between 4 and 6 m above the present river bed.

The Son River alluvial basin includes terraced surfaces flanked by floodplains, point-bar and alluvial fan deposits. The main river channel is bounded by a series of Middle and Late Pleistocene and Early-Holocene sedimentary terraces that reach altitudes of as much as 30 m, and deeply-incised seasonal channels. The terrace, incised by the modern Son River, has been intensively studied due to the presence of the YTT marker and the coincidence of archaeological sites, where Middle Palaeolithic and Neolithic artefacts have been found ([Sharma and Clark, 1982], [Williams and Royce, 1982], [Williams and Royce, 1983], [Jones and Pal, 2005], [Jones and Pal, 2009] and [Haslam et al., 2010]).

The Son valley in north-central India preserves extensive Quaternary alluvial deposits, these deposits include the sediments of paleo domain and present domain of Son besides colluvium deposits along the obsequent slope of Vindhyan upland. The boulder conglomerate / gravel bed is also identified at the base of these deposits in the valley. These deposits are associated with lithic assemblage ranging from Lower Paleolithic to microlithic, a rich corpus of fossilized faunal remains, and ash deposits from the 74,000 year-old Toba supereruption. The Middle Son valley preserves a long and rich record of hominin occupation from all periods of the Palaeolithic that is rarely paralleled by other sites in India. Quaternary sedimentary sequences are exposed throughout the valley and incision of these deposits by the Son river has resulted in the exposure of extensive cliff sections, some 38 m-high (Thapar, 1979). Geological studies revealed the quaternary blanket of Son comprised of four distinct formations each is characterized by distinct lithology, lithic assemblage, rock clastics and sand, clay & silt matrix. These formations in increasing antiquity are Sihawal, Patpara, Baghor and Khetaunhi formations, the latter being the most recent (Williams and Royce, 1982, 1983; Williams and Clarke, 1984, 1995). The Son river chiseled three terraces across the quaternary deposits which form the stepped sequence in the valley separated by linear or curvilinear scarp. These terraces are designated as ST0 to ST3 between the elevations of 280 to 310 m above the m.s.l. These terraces are both display convergence and divergence in their relative disposition in the valley and are cyclic and non cyclic in nature. Table No QGMT- 12 to 14.

Four formations have been historically ascribed to the alluvial deposits of the Son Valley. In chronological order they are: Sihawal Formation, Patpara Formation, Baghor Formation and Khetaunhi Formation ([Williams and Royce, 1982], [Williams and Royce, 1983], [Williams and Clarke, 1995] and [Williams et al., 2006]). The geological context of the incised terrace is unclear, mainly due to the absence of absolute dates and robust stratigraphic correlation (Jones and Pal, 2009).

Several models have been proposed for the geomorphological evolution of the alluvial plain of the Middle Son Valley through the period Early Pleistocene to Late Holocene ([Williams and Royce, 1982], [Williams and Royce, 1983], [Williams and Clarke, 1995] and [Williams et al., 2006]). These authors analysed the large-scale evolution of the river based on differences between the four formations and distinct climatic regimes. A stratigraphical model (at 1 km scale) of the emplacement of all the four formations within the river basin was also proposed by Williams and Clarke (1995) and modified by Williams et al. (2006).

The Quaternary blanket of Son Valley is located 100 km south from Allahabad and 130 km southwest of Varanasi, in north central India (23.00 to 24.00° 78.00 to 80.00 N) it is deeply incised in to river terrace related with cyclic tectonic adjustment of various segments and blocks in SONATA LINEAMENT ZONE. These terraces are designated ST0 to ST3 in between 280 m to 310 m above m.s.l increasing antiquity from the river bed. The exposed thickness of quaternary deposits is about 30. The study of the linament and structural indicates that Son negotiate its course along the strong ENE-WSW to E-W trend which is sympathetic to the trend of Narmada and Tapi. The structural fabrics display the imprints of neotectonism which is reflected in landscaping of Quaternary terraces of Son river. These terraces display both convergence and divergence in their relative disposition in the valley and are cyclic and non cyclic in nature. Table No QGMT- 12 to 14. (Plate No_I & II)

Summary & conclusion:-

The SONATA LINEAMENT ZONE embodies the two Quaternary basins of tectonic origin on the either 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 Tapi-Purna basin in the south are two Graben which formed prominent loci of sedimentation in lineament zone.

The area of lineament zone studied tectonically encompasses two crustal provinces of Central India Shield, namely, the Northern Crustal Province (NCP) and the Southern Crustal Province (SCP). The two provinces are separated by a crustal level shear zone, referred as Central Indian Suture. The zone has been a major locus of episodic tectonism with evidences of reactivation. The E-W to ENE-WSW trending Narmada and Tapi lineament from a prominent tectonic belt (SONATA) in midplate continental India. The Narmada tectonic line and its presumed eastward extension, Son, have been considered as a major Precambrian deep crustal features (Auden, 1949; West 1962) and possibly a palaeo-rift (Nayak 1990) extending hundreds of kilometer in E-W direction recognized the Narmada lineament as a rift at its western ends however, its eastward extension and the relative timing of the Narmada rifting and Deccan Trap eruption remained unknown. The western extremity of Narmada Rift valley falling in Quadrangle 46I, 46 J, 46 M, 46 N covering an area about 45000 sq. km bounded by latitude 22 00 00 to 24 00 00 N and longitude 74 00 00 to 76 00 00 has been studied Khan (2015) which indicate repeated cyclic and intermittent eruption of basaltic lava along ENE-WSW to E-W trending lineament and its mechanism. The base of basaltic lava and its contact with underlying Proterozoic rocks is exposed south of Jhabua (46J), the thickness of basaltic lava sheet increases towards South-East and East. The basaltic lava eruption is cyclic and intermittent and diagenetically related with the mechanism of tectonic activity of lineament zone. The collective study of tectonic set up, lava eruption quaternary sedimentation, surface manifestation and geo-physical data revealed that the Son-Narmada and Tapi lineament together represent an intraplate rift with a central (Satpura Block) horst bounded on either side by grabens: the Narmada graben on the north and the Tapi graben to the south. In Narmada and Tapi-Purna graben areas the faults are listric. These listric normal faults cut across the basement, the Gondwana sedimentary formations, the overlying Deccan flows and the Quaternary deposits. The Quaternary blanket in Narmada, Tapi and Son has imprints of neoseismic signatures which revealed that area is still active.

The study of tectonic set up of Narmada valley, surface manifestation and geo-physical data shows that the Son-Narmada and Tapi lineament together represent an intraplate rift with a central (Satpura Block) horst bounded on either side by grabens: the Narmada graben on the north and the Tapi graben to the south (Mishra et al, 1999). In certain areas (especially in the Tapi area) the faults are listric. These listric normal faults cut across the basement, the Gondwana sedimentary formations, the overlying Deccan flows and the Quaternary alluvium

The Narmada Graben is located in between Jabalpur – Bharouch covering an area of about 17950 sq. km which falls between longitudes 72°32' and 81°45' east and latitudes 21°20' to 23°45' north, on the northern edge of the Deccan Plateau. The average width of graben is about 32 km and length is about 1320 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 Narmada conspicuously has straight course is controlled by ENE-WSW to E-W lineament, is bounded by Vindhyan in the north and Satpura in the south it is exposed the repeated post erosional and depositional activities and subjected to anisotropic and asymmetric tectonic dislocation which has culminated diversified morphogenetic units and region which further undergone to process of tectonic evolution and chiseling of terrain by dynamic erosional and depositional activity resulting in and shaping the terrain into various morphogenetic units and land form element, configuration of drainage, topography, physiographic, erosional platform, planation surfaces, denudation ridges, structural units linear valleys, strike hills, valley gapes, escarpments and river terraces. The cumulative dynamics of structural deform, rifting and sinking platform of Narmada has also manifested concealed cyclic mechanism of tectonics and geothermic activity, seismicity, neoseismic events and in surface manifestation. In addition the valley gapes and valley trenches provided ideal sites for sedimentation for formation of quaternary platform, pediment, pediplain, peniplain and river terraces.

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 rifting and sinking environment, block faulting and segmental and linear displacement and dislocation, uplifting and isolated domal up-lift, Neogene rifting and Quaternary sedimentation and rift-bound Pliocene–Pleistocene rifting and volcanic activity specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System 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 also created an ideal loci of Quaternary sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, diagenesis, and preservation of organic remains. Because rifts formed after widespread Quaternary sedimentation occurred and voluminous sediments in the rift basins were accumulated by glacial activity consequential upon the lowering of temperature and climatic changes.

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 Jabalpur- Harda section possesses the complete sequence of all three domain of sediments in increasing antiquity from the bottom of the rift trench Boulder bed (glacial), Boulder conglomerate (fluvial-glacial) sediments of paleo-domain of Narmada (fluvial). The intense tectonic activities within the basins of the Narmada Rift System during the Neogene and Quaternary periods have destroyed fossil record except the fossiliferous horizons exposed in river sections. The erosional-sedimentary cycle has persisted in the rift valley environment for millions of years as a result of the interplay between depositional and erosional forces driven by tectonic processes; there are numerous gaps in the fossil record, particularly in the important time period between Mio-Pliocene Pleistocene times. It is pertinent to understand the origin of Hominid during the late Miocene, but it is difficult to disclose mysteries of human evolution in Narmada due to concealed nature of these deposits in rift system, however the complementary part of

Tapti-Purna Quaternary blanket may be potential and possessive of human remain and should be studied to trace further the imprints of fossil man taking in to account of SONATA LINEAMENT ZONE as single ecosystem for evolution of man in Indian subcontinent. However, evidence of the effects of tectonics on fauna and flora are distinct and its signatures on dislocation and concealing of fossiliferous horizons are uncontrolled and ill defined in the ecosystem in the valley during the Pliocene–Pleistocene periods. The boulder conglomerate which yielded the skull cap of *Homo erectus* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due to concealed and hidden nature of Mio-Pliocene Pleistocene deposits in rift system and inconsistency in exposure of fossiliferous horizon due faulting, dislocation and subsidence of Quaternary blanket of Narmada rift system.

The Boulder Conglomerate which is of fluvio-glacial origin and has yielded human skull from Sonakia (1982) Khan & Sonakia (1992) is exposed impermissibly in scarp section of Narmada at few places only. The type section of Boulder Bed and Boulder Conglomerate which are potential sediments of human remains of Pliocene Pleistocene time are hidden and concealed under sediments of present and paleo- domain of Narmada in the valley. The quaternary sequence and depth of occurrence of skull cap, rate of sedimentation of Hominid locality Hathnora (22°52'77°52') (325 m) India, has been correlated with the Quaternary of Luochuan (90-120 m) Chenjiawo (50m) and Congwanling sequence (36 m) of China on unified Quaternary platform tied up and developed at mean sea level to ascertain the depth of occurrence and of age of skull cap of Narmada *Homo erectus* Sonakia (1984), at the depth of (83 m) Khan et.al (1993) indicates that the human skull *Homo erectus* of Narmada is oldest in Asia.

The Tapti-Purna graben is located south of Satpura which evolved as two separate basins of fluvio-lacustrine sedimentation, connected subsequently. The most conspicuous feature of the southern margin of the Satpura between longitude 74° and 78° is conspicuous ENE-WSW to E-W trend of Tapti which display local swing at places. These trends characterizing Tapti crustal block, conform to structural grain of the area reflecting the convergence of Tapti and Gavilgarh faults enechelon system traversing Satpura foot hills, with a southerly convexity. The Quaternary basin areas in Tapti Crustal block are characterized by relatively thinner crust with moho depth of 33-37 km, shallow basement (<1 km) with higher density (+0.239g/cm³) mantle derivatives emplaced at shallow level (4-5 km; Rao K.V., 1997).

The Tapti-Purna alluvial basins evolved as two separate basins of fluvio-lacustrine sedimentation, connected subsequently as per records and of earlier worker. The present studies taking entire quaternary sedimentation of SONATA LINEAMENT ZONE as single ecological system besides the tectonics on the either side of Satpura, it revealed that the area of SONATA LINEAMENT ZONE formed a single loci of sedimentation and there was continuous and sequential deposition of sediments from Pleistocene to Upper Pleistocene time, it is witnessed by quaternary events morphogenetic expression disposition of river terraces their mutual correlation relation, lithostratigraphic correlation across Narmada, Tapti–Purna and Son valley Khan (in press). The Narmada and Son are two linear basins north of Satpura and Tapti-Purna is single elliptical trench which has provided a platform of sedimentation. The present expression and configuration and fragmented disposition of quaternary blankets of Son Narmada, Tapti and Purna is due to tearing, faulting, dislocation subsidence, up rise of various blocks and reactivation of structural fabrics within the SONATA LINEAMENT ZONE.

The Tapti has sculptured the Quaternary blanket into stepped sequence forming four river terraces along its course. These are designated as TAT0 to TAT3, TAT0 being the youngest terrace and TAT-3 the oldest terrace increasing order of antiquity. These are both erosional and depositional terraces and confined at an elevation of, between 270 to 370, 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 study of various aspects of Quaternary blanket river terraces of Tapti, Purna and their tributaries their disposition configuration and extension revealed the deposition of the sediments has been taken place in elongated oval depression tapering to wards east in linear converging trench. The sediments were deposited on oscillating and persistently sinking platform in related with mechanism of adjustment of various blocks in tectonic zone. The quaternary terraces and associated landform elements are the illustrative manifestation of tectonic changes in water shed region during Quaternary time. The Tapti tectonic zones south of Satpura possess imprints of Neotectonism and geothermal manifestation.

The Deccan basalt is overlain by boulder conglomerate and the contact of these two formations is seen in the Vaghur river section near Kadgaon. The thickness of conglomerate varies from 2.5m around Kadgaon to about 16 m on the left bank of the Vaghur, north – east of Shelgaon near the confluence of the Vaghur and the Tapti at Kadgaon (21 09: 75 41 30) area Khan (1984) which is equivalent to the boulder conglomerate of Narmada and its 16 m section in the Kadgaon area is exposed on the left bank of the Vaghur river, directly over lying the Deccan Traps and is exposed due to faulting. The contact of these two formations in this area is very sharp and infilling of the cavities and erosional hollows over the lava surface by the sedimentary material are seen at several points. Some of the fillings are of concretionary material indicating that both exogenic and endogenic processes were involved in the formation of the infillings.

The Purna valley comprised of thick pile of Quaternary deposits consisting of five lithostratigraphic units viz. Ferruginised gravel and sand, Red silt formation, Brown silt formation, Light grey silt formation and Dark grey silt formation, as compared to Tapti basin which has only three units viz. Boulder Conglomerate, Older Alluvium and Younger Alluvium, the Older Alluvium further divided in to three units viz Dark brown and silt formation, Red clay silt formation and Dark yellow, grey clay silt formation. This suggests that sedimentation in Tapti basin started earlier in Early Pleistocene, whereas in Purna basin sedimentation commenced later in Upper Pleistocene; the Tapti –Purna formed single loci which was hospitable to the sedimentation. The Tapti quaternary deposits in present set up are at lower position with embodied older deposits and conglomerate at the base which forms the base with rock basin it is contradictory to the opinion of (Tiwari, 1996) and others. The quaternary deposits of Wardha upper Pleistocene-Holocene age(50 m) (Tiwari 1985) forms the eastern fringe of Tapti Basin, it is separated from Tapti-Purna basin by episodes activation of the eastern block during Quaternary period Khan (in press). The present studies within single geomorphic ecology and in harmony of sedimentation in increasing antiquity revealed that Tapti-Purna was a single basin which formed a mega tectonic depression which was hospitable to sedimentation which was inceptioned from Pleistocene and continued up to Upper Pleistocene –Holocene time .

In Tapti basin the boulder conglomerate occurs as persistent horizon at the base of quaternary deposit which represents specific phase of sedimentation in the basin. it is time equivalent to the boulder conglomerate of Narmada revealed that the sedimentation on either edge of Satpura and in the SONATA LINEAMENT ZONE was contemporaneous and simultaneous, which further revealed quaternary deposits of Tapti are early to middle Pleistocene in age and related to the early reactivation of Tapti lineament. The association of rock cut terraces, rock cut benches, stream lines and rock cut scar in Tapti and Wardha rivers demonstrate mighty reactivation of Tapti lineament during the early stages of sedimentation. The cyclic reactivation has vertically cut country rocks in to rock cut benches in stepped sequence; whereas in the Purna valley a gap has been created by reactivation of Tapti- Purna lineament which was converging point of accumulation of sediments. The sequential analysis of deposits and its relation with drainage and its evolution revealed that it was a persistent locus which was hospitable to sedimentation. The basin of Purna constitutes hanging drainage and configuration of basin is closed which is contradictory to the opinion of (Tiwari, 1985) & Ravishankar, (1987)? In the present work the collective and comprehensive study of Quaternary deposits and river terraces in lineament zone Khan 1984, Khan et.al (1982), (1984) Khan (1991), (1992) Khan (1985), indicate that Sonata lineament zone has a elliptical and elongated depression emerge by repeated reactivation of faults and initial sedimentation has been taken place in single ecology a composite quaternary blanket was formed in Central India. The present disposition and expression of this blanket is fragmented and has conceived its position with repeated tearing, faulting, up rise and subsidence of various blocks due cyclic reactivation of different fabrics of SONATA LINEAMENT ZONE (In press).

Quaternary studies in Tapti-Purna valley region have further indicated presence of a depression along Yaval-Adavad-Akot-Bawanbir area, through which an arm of the Arabian Sea (?) extended causing salinity in this region. The depression was filled up by sedimentation. Neotectonic activities resulted in further deepening of this basin and as a result alluvium at places reached below present mean sea level. Similar situation has also been observed locally in the Narmada Valley which further witnessed that Tapti-Purna was single basin and there was continuous sedimentation from Pleistocene to Upper Pleistocene-Holocene time. The present framework of the basin is due to Quaternary tectonics and reactivation of SONATA LINEAMENT ZONE.

The Son valley in north-central India preserves extensive Quaternary alluvial deposits, these deposits include the sediments of paleo domain and present domain of Son besides colluvium deposits along the obsequent slope of Vindhyan upland. The boulder conglomerate / gravel bed is also identified at the base of these deposits in the valley. These deposits are associated with lithic assemblage ranging from Lower Paleolithic to microlithic, a rich corpus

of fossilized faunal remains, and ash deposits from the 74,000 year-old Toba supereruption. The Middle Son valley preserves a long and rich record of hominin occupation from all periods of the Palaeolithic that is rarely paralleled by other sites in India. Quaternary sedimentary sequences are exposed throughout the valley and incision of these deposits by the Son river has resulted in the exposure of extensive cliff sections, some 38 m-high. The present studies revealed that the quaternary blanket of Son comprised of four distinct formations each is characterized by distinct lithology, lithic assemblage rock clastics and sand, clay & silt matrix. These formations in increasing antiquity are Sihawal, Patpara, Baghor and Khetaunhi formations, the latter being the most recent (Williams and Royce, 1982, 1983; Williams and Clarke, 1984, 1995). The area of study includes the river-cut cliffs in the alluvial zone between the confluence of the Rehi and Son rivers and Khunteli (or Khuteli). The reported YTT deposits (Acharyya and Basu, 1993] and [Jones and Pal, 2005) comprise a discontinuous tephra bed covering an area of ~90 km². Between Rehi and Ghoghara (first described by Williams and Royce in 1982), lateral variations within the ash deposits are minimal, and the ash layer appears repeatedly at a height between 4 and 6 m above the present river bed. The Son river chiseled three terraces across the quaternary deposits which form the stepped sequence in the valley separated by linear or curvilinear scarp. These terraces are designated as ST0 to ST3 between the elevations of 280 to 310 m above the m.s.l. These terraces are both display convergence and divergence in their relative disposition in the valley and are cyclic and non cyclic in nature.

The Quaternary blanket of Son Valley in central India (23.00 to 24.00° 78.00 to 80.00 N) it is deeply incised in to river terrace related with cyclic tectonic adjustment of various segments and blocks in SONATA LINEAMENT ZONE. These terraces are designated ST0 to ST3 in between 280 m to 310 m above m.s.l increasing antiquity from the river bed. The exposed thickness of quaternary deposits is about 30. The study of the linament and structural indicates that Son negotiate its course along the strong ENE-WSW to E-W trend which is sympathetic to the trend of Narmada and Tapti. The structural fabrics display the imprints of neotectonism which is reflected in landscaping of Quaternary terraces of Son river. These terraces display both convergence and divergence in their relative disposition in the valley and are cyclic and non cyclic in nature.

In the present work collective and comprehensive study of Quaternary deposits and river terraces in SONATA LINEAMENT ZONE Khan (1984), Khan (1985), Khan et.al (1982), (1984) Khan (1991), (1992) Khan et al. 1991, Khan 1991, Khan et al. 1992, Yadav & Khan 1996. The Narmada valley embodied almost whole of the Quaternary deposits time span from the lower Pleistocene to Holocene (Khan & Sonakia (1992). Khan (1992), Khan (2012), Khan et.al (2013) Khan (2014), Khan et.al (2015), Khan et.al (2015) Khan et.al (2015) Khan (2015) et.al, Khan (2014), (2014), Khan et.al(2016), Khan et.al(2016) 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 Sonakia (1984) is of fluvio-glacial origin Khan & Sonakia (1991) indicate that SONATA LINEAMENT ZONE has an elliptical and elongated depression evolved and emerged by repeated reactivation, the grabens evolved on either side of Satpura were contemporaneous and sedimentation was simultaneous and composite in Central India. The present disposition and expression of these blanket is fragmented, has conceived its position with repeated tearing, faulting, due cyclic reactivation of different fabrics of SONATA LINEAMENT ZONE (2016).

The Narmada graben in specific possesses the complete sequence of all three domain of sediments in increasing antiquity from the bottom of the rift trench Boulder bed (glacial), Boulder conglomerate (fluvial-glacial) sediments of paleo-domain of Narmada (fluvial). The intense tectonic activities within the basins of the Narmada Rift System during the Neogene and Quaternary periods have destroyed fossil record except the fossiliferous horizons exposed in river sections. The erosional-sedimentary cycle has persisted in the rift valley environment for millions of years as a result of the interplay between depositional and erosional forces driven by tectonic processes; there are numerous gaps in the fossil record, particularly in the important time period between Mio-Pliocene Pleistocene times. It is pertinent to understand the origin of Hominid during the late Miocene, but it is difficult to disclose mysteries of human evolution in Narmada due to concealed nature of these deposits in rift system, however the complementary part of Tapti-Purna Quaternary blanket may be potential and possessive of human remain and should be studied to trace further the imprints of fossil man taking in to account of SONATA LINEAMENT ZONE as single ecosystem for evolution of man in Indian subcontinent. However, evidence of the effects of tectonics on fauna and flora are distinct and their signatures on concealing strata of fossiliferous horizons of boulder conglomerate are uncontrolled and ill defined in the ecosystem in the valley during the Pliocene–Pleistocene periods. The boulder conglomerate which yielded the skull cap of *Homo erectus* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due to concealed and hidden nature of Mio-Pliocene Pleistocene deposits in rift system and inconsistency in exposure of fossiliferous horizon due faulting, dislocation and subsidence of Quaternary blanket of Narmada. The present status of data base the Boulder Conglomerate which is of fluvio-glacial origin and has only yielded human skull from vom of Narmada Sonakia (1982) Khan & Sonakia (1992) is exposed impermissibly in scarp section of Narmada at few places only. The type section of Boulder Bed and Boulder Conglomerate which are potential sediments of human remains of Pliocene Pleistocene time are hidden and concealed under sediments of present and paleo-domain of Narmada in the valley. The quaternary sequence and depth of occurrence of skull cap rate of sedimentation of Hominid locality Hathnora ($22^{\circ}52'77''52'$) (325 m) India, has been correlated with the Quaternary of Luochuan (90-120 m) Chenjiawo at the depth of (50m) and Congwanling sequence at the depth of (36 m) of China on unified Quaternary platform, tied up and developed at mean sea level to ascertain the depth of occurrence and of age of skull cap of Narmada *Homo erectus* Sonakia (1984), which is recovered from at the depth of (83 m) in quaternary column of Narmada Khan et.al (1992) indicates that the human skull *Homo erectus* of Narmada occurred at deepest and oldest sequence of quaternary deposit of Narmada is oldest in Asia.

TABLE NO QGMT-1	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NARMADA VALLEY							Paniplain/ Pediplain	Pediplain / pediment
locality: JABALPUR Central I	River bad	NT0	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3- C	PP	P PD
Age	HOLOCENE								
lavation above MSL (m)	340	345	355	365	375	380	400	415	430
Geomorphic break (m)	0.00	5.00 Alluvial section / Bank Scarp	10 Alluvial f section Bank Scarp	10 Alluvial section with rep[itation of sediment cycle	10 Alluvial section with well layered sediments	5.00 Alluvial Bluff section with rock cut terrace at base	20 Alluvial Bluff with rock cut terrace at base.	15 Paniplain with gentle slope	15 Pedipail with sloping surface
Elavation above RB (m)	0.00 River bad Braided Channel, Point Bar, Side	5.00	15.00	25.00	35.00	40.00	60.00	65.000	80.00to
Slope	-----Towards west-----		-----TowardsSSW-----		-----Towards west-----			Towards south	Towards south
Nature of surface	-----Depositional -----				-----Erosionall -----			Erosional	Erosional
Cycle Sedimentation	-----Polycycle -----					-----Not exposed-----			
Orientation of W-Axes		ENE-WSW,E- W	E-W	ENE-WSW	ENE-WSW	E-W	E-W		
Plunge of L-Axes		-----Towards East-----		-----Towards NE-----		-----Towards NE-----			
Relative disposition	Convergent	Divergent /	Divergent	Divergent	Divergent	-----Convex slope-----			
Paired/Unpaired	Unpaired	Unpaired	Paired	Paired	Paired	-----Paired / Isolated Patches-----			
Nature of scarp	-----Curvilinear-----		-----Linear-----		-----Curvilinear-----				
Sedimentary feature	-----Not exposed-----			Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features					
Terrace shape	Cusate-----		Rectangular		-----Elongated & RecangularIsolated cap				
Land use pattern	-----Inhabitation and cultivation-----								
Composition/Litho constituents arranged in probable order of abundance /The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	River bad : Quartzite, granite, gneiss, sandstone, limestone, Augate, Jaspar,Chart schist, basaltt, phyllite, slate, sand and silt. NT0 : Quartzite, gneiss, granite, , sandstone limestone, basic, phyllite, slate, shale, sand and silt. NT1 : Quartzite, gneiss, basic, schist, granite sandstone, phyllite, slate, shale sand and silt. NT1-A : Quartzite, granite, gneiss, schist, basic, phyllite, slate, shale, sand silt and clay. NT2-B : Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay. NT2-C : Quartzite limestone, gneiss, granite,sandstone, basic schist, phyllite, slate, sand, silt and clay NT3-A : Quartzite limestone, gneiss, granite, basalt schist, slate, sand, silt and clay. NT3-B : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, silt and clay. Boulder Conglomerate : Sub angular to sub rounded boulder cobble pebble of Quartzite, gneiss, basic, schist, granite sandstone, Phyllite , slate, shale sand and silt. The fine matrix of sand ,clay and silt is cross bedded, laminated with cut and features Boulder Bed: sub angular to angular, sub round hybrid and heterogeneous assorted rock febric of Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay.								

TABLE NO QGMT-2	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							Peniplain Pediplain	Pediplain
Locality :HATHNORA	River bad	NT0	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PP	PD
Age	HOLOCENE								
Elavation above MSL (m)	280	290	300	305	315	325	330	333	338
Geomorphic break (m)	0.00	10.00	10.00	5.00	10.00	10.00	5.00	8.00	13.00
Elavation above RB (m)	0.00	10.00	20.00	25.00	35.00	45.00	50.00	55.00	60.00
Slope	- ---Towards west & NS		Towards west		Towards west & NS-SW,			S-SSW	S-SSW
Nature of surface	Erosional Rock cut surface / Depositional				Erosional / Depositional and valley fill Erosional / Relict			Erosional /	Erosional /
Cycle Sedimentation	Section depicts up ward cyclic sequence with incomplete cycle NT0 , NT1 Polycyclic with breaks / with upward fining NT2-A, NT2-B NT2-C					section covered by forest			
Orientation of L -Axis	Braided	ENE- WSW to E-W,	ENE- WSW to, E-W,	ENE-W NW- NE-SW	ENE- WSW, E- W	E-W & NW- SE	ENE-WSW, E-W NW-SE		
Plunge of L-Axis		-----Towards East & NE		-----Towards East & NE		To wards East & NE			
Relative disposition	Convergent		Divergent		Divergent		Divergent		Divergent
Paired/Unpaired	Unpaired		Unpaired	Paired	Paired	Paired	Paired / Isolated Patches		
Nature of scarp	-----Curvilinear-----		Curvilinear	-----Linear-----			Linear-----	-----Linear-----	
	-----Linear with convex slope covered by forst and collovium material -----								
Sedimentary feature	Graded bedding , Cross bedding, Lamination, cross lamination			Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features					
Terrace shape	----- Crescent / Cuspate-----		----- Rectangular----- Isolated cap						
Land use pattern	-----Inhabitation / cultivation-/ Forest cover area-----								
Composition/Litho constituents arranged in probable order of abundance /The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	River bad : Quartzite, gneiss, granite, meta basic , , basalt sandstone, limestone , Augate, Jaspar, , slate, , schist sand and silt. NT0 : Quartzite, gneiss,, basalt, ,granite, meta basic , limestone, sandstone, phyllite, slate, shale, sand and silt NT1 : Quartzite, gneiss, meta basic , basalt, granite sandstone, lime stone, schist phyllite, , shale Augate, sand and silt. NT1-A : Quartzite, granite, gneiss, meta basic sand stone, lime stone slate schist,phyllite, , shale, sand silt and clay. NT2-B : Quartzite gneiss, granite, limestone, sandstone, schist, slate meta basic, sand, silt and clay. NT2-C : Quartzite gneiss, granite, sandstone, limestone, basalt and meta basic schist, , phyllite slate Jaspar, sand, silt and clay NT3-A : Quartzite gneiss, granite, meta basic basalt limestone, sand stone slate schist, , sand, silt and clay. NT3-B : Quartzite, gneiss, granite, basalt limestone sandstone, schist, phyllite, slate,sand, silt and clay. Boulder Conglomerate : Sub angular to sub rounded boulder cobble pebble of Quartzite, gneiss, basic, schist, granite sandstone, Phyllite , slate, shale sand and silt. The fine matrix of sand ,clay and silt is cross bedded, laminated with cut and features Boulder Bed: sub angular to angular, sub round hybrid and heterogeneous assorted rock febric of Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay.								

SALIENT FEATURES OF FLUVIAL TERRACES IN TYPE AREA OF JABALPUR IN NRMADA VALLEY VALLEY(i)

TABLE NO QGMT-3	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NARMADA VALLEY							Pediplain	Pediplain
Locality : HOSHANGABAD-BABAI	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PP	PD
Age	HOLOCENE								
Elavation above MSL (m)	260	270	280	285	295	310	315	318	322.00
Geomorphic break (m)	0.00	10.00 Alluvial section	10.00 Alluvial section	5.00 Alluvial section	10.00 Alluvial section o n rock cut base	15.00 Alluvial section o n rock cut base	5.00 Rock cut surface with thin layer of recent sediments	5.00 Breaks grdual with and soil cover	4.00 Distinct breaks with rock relicts and imprints of erosional activity.
Elavation above RB (m)	0.00	10.00	20.00	25.00	35.00	50.00	55.00	58.00	59.00
Slope	- ---Towards west & SW		Towards west & SW		Towards west & SW				
Nature of surface	Channel braiding Erosional / Depositional			Erosional / Depositional. valley fill Erosional / Relict & isolated caps o rock cut benches			Erosional /	Erosional /	
Cycle Sedimentation	River bed with channel braids , poit bar, sand bars , braided channel. NTo , NT1 section depicts up ward cyclic sequence with incomplete cycle. NT2-A, NT2-B NT2-C display Polycyclic with breaks / with upward fining					section not exposed and covered by forest and colluvium /scree deposit			
Orientation of L -Axis	Braided / Graded	ENE-WSW to E-W,	ENE-WSW to, E-W,	ENE-W NW- to N-E-	ENE-WSW, E-W NW-SE	E-W & NW-SE	ENE-WSW, E-W		
Plunge of L-Axis		-----Towards East-----		-----Towards NE-SE &E-W		To wards Eeast and NE			
Relative disposition	Convergent		Divergent		Divergent		Divergent		
Paired/Unpaired	Unpaired		Unpaired	Paired	Paired	Paired	Paiired / Isolated Patches		
Nature of scarp	-----Curvilinear----		Curvilinear	-----Linear-----		-----Linear-----		-----Linear-----	
Sedimentary feature	Graded bedding , Cross bedding, Lamination, cross lamination			Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features					
Terrace shape	----- Cresent / Cuspate-----		----- Rectangular-----		Isolated cap				
Land use pattern	-----Inhabitation / cultivation-/ Forest cover area-----								
Composition/Litho constituents arranged in probable order of abundance /The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	River bad : Quartzite, gneiss, granite, meta basic , , basalt , sandstone, limestone Augate, Jaspar, , slate, , schist sand and silt. NTo : Quartzite, gneiss,, basalt ,granite, meta basic , limestone, sandstone, phyllite, slate, shale, sand and silt NT1 : Quartzite, gneiss, meta basic, basalt, granite sandstone, lime stone, phyllite, schist shale Augate, sand and silt. NT1-A : Quartzite, granite, gneiss basalt , meta basic sand stone, lime stone slate schist,phyllite, , shale, sand silt and clay. NT2-B : Quartzite gneiss, granite, limestone, sandstone, schist, slate meta basic, sand, silt and clay. NT2-C : Quartzite gneiss, granite, sandstone, limestone, basalt and meta basic schist, , phyllite slate Jaspar, sand, silt and clay NT3-A : Quartzite gneiss, granite, meta basic basalt limestone, sand stone slate schist, , sand, silt and clay. NT3-B : Quartzite, gneiss, granite, basalt limestone sandstone ,schist, phyllite, slate,sand, silt and clay. Boulder Conglomerate : Sub angular to sub rounded boulder cobble pebble of Quartzite, gneiss, basic, schist, granite sandstone, Phyllite , slate, shale sand and silt. The fine matrix of sand ,clay and silt is cross bedded, laminated with cut and features Boulder Bed: sub angular to angular, sub round hybrid and heterogeneous assorted rock febric of Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay.								

TABLE NO QGMT-4	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							Paniplain Pediplain	Paniplain Pediment
Locality: NASRULLAHGANJ- HANDIA-HARDA SECTION	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PP	PD/PP
Age	HOLOCENE								
Elavation above MSL (m)	255	265 Alluvial Bluff Bank Scarp	270 Alluvial Bluff Bank Scarp	280 Alluvial Bluff Bank Scarp	290 Alluvial Bluff section / Rock Cut Terraces	300 Alluvial Bluff section / Rock Cut Terraces	310 Alluvial Bluff section / Rock Cut Terraces	315 Slope Gradual with distinct breaks	320 Slope withdistinct breaks
Geomorphic break (m)	0.00 River bad Braided Channel, Point Bar, Side Bar	10.00	10.00 Alluvial Bluff Bank Scarp	10.00	10	10.00	10.00	5.00	5.00
Elavation above RB (m)	0.00	10.00	20.00	30.00	40.00	50.00	60.00	65.00	70.00
Slope	-----Towards west & SW---		-----Towards west and SW-----		-----Towards west & SW-----				
Nature of surface	-----Depositional -----				-----Erosionall -----				
Cycle Sedimentation	-----Polycycle -----					-- Section not not exposed-----			
Orientation of W-Axes		ENE-WSW to E- W	ENE-WSW to, E- W	ENE-WSW	ENE-WSW, NW- SE	E-W & NW- SE	ENE-WSW, NW-SE E-W		
Plunge of L-Axes		-----Towards west-----		-----Towards NE-----					
Relative disposition	Convergent		Divergent	Divergent	Divergent	Divergent	Divergent		
Paired/Unpaired	Unpaired		Unpaired	Paired	Paired	Paired	Paired / Isolated Patches		
Nature of scarp	-----Curvilinear---		Curvilinear	-----Linear-----		-----Linear-----			-----Linear-----
	-----Linear-----								
Sedimentary feature	Graded bedding , Cross bedding, Lamination, cross lamination				Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features				
Terrace shape	----- Cuspate-----		----- Rectangular-----			Isolated cap			
Land use pattern	-----Inhabitation and cultivation----- Forest covered area								
Composition/Litho constituents arranged in probable ord/The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape. er of abundance	River bad : Quartzite, gneiss, granite, basalt, sandstone, limestone , Augate, Jasper, schist, , slate, sand and silt. NTo : Quartzite, gneiss,, basalt, ,granite, , sandstone limestone, phyllite, slate, shale, sand and silt NT1 : Quartzite, gneiss, , basalt, granite sandstone, phyllite, , basic, schist shale sand and silt. NT1-A : Quartzite, granite, gneiss, meta basic sand stone, lime stone schist, basic, phyllite, slate, shale, sand silt and clay. NT2-B : Quartzite gneiss, granite, sandstone, limestone, meta basic schist, , slate, sand, silt and clay. NT2-C : Quartzite gneiss, granite, sandstone, limestone, basic schist, phyllite, slate, sand, silt and clay NT3-A : Quartzite gneiss, granite, meta basic basalt limestone, sand stone schist, slate, sand, silt and clay. NT3-B : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, meta basic sand, silt and clay. Boulder Conglomerate : Sub angular to sub rounded boulder cobble pebble of Quartzite, gneiss, basic, schist, granite sandstone, Phyllite , slate, shale sand and silt. The fine matrix of sand ,clay and silt is cross bedded, laminated with cut and features Boulder Bed: sub angular to angular, sub round hybrid and heterogeneous assorted rock febric of Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay.								

TABLE NO QGT-5 Locality: GURUDESHWAR	River bad	NT0	NT1	NT2-A	NT2-B	NT2-C	NT3-A NT3-B NT3-C	Paniplain/ Pediplain PP/PD	Pediment / PD
Age	HOLOCENE								
Elavation above MSL (m)	90	95	200	210	220	225	230 Rock cut terraces rock Scar	234	240
Geomorphic break (m)	0.00	5.00 Alluvial Face	10.00 Alluvial Bluff Section Steep Alluvial face	20.00 Steep Alluvial fac Composite Rock Face	40.00 Rock cut Terraces rock Scar Rock Face	45.00 Rock cut Terraces rock Scar Rock Face Rock Face	50.00 Rock cut Terraces rock Scar Rock Face Composit Rock Face	4.00 Gradual	6.00 Distinct with breaks and rock rlicts and imprints of neotectonic activity
Elavation above RB (m)	0.00 River bad Channel, Point Bar, Side Bar	5.00 Rock Face and Alluvial Bluff	10..00 Rock Face and Alluvial Bluff	20..00 Alluvial Bluff Rock Face	40.00 Rock Face	46.00 Rock Face	51.00 Rock cut Terraces rock Scar	55.00	61.00
Slope	-----Towards west & SW-----			-----Towards west and SW--		-----Towards west & SW----- --		Towards west & SW-	Towards west & SW-----
Nature of surface	-----Depositional , Cresent shape elongated -----				Errosomal Rock cut terraces and Rock scar -----Erosional - --Liearn scar line ----		-----Erosional - -		Erosional --- -
Cycle Sedimentation	Up ward fining cycle ----- --- -Polycycle -----					Rock cut scars -- Section not not exposed-----		Erosional -- -	Erosional ---
Orientation of W-Axes		ENE-WSW to E-W	ENE-WSW to, E-W	ENE-WSW	ENE-WSW, NW-SE	E-W & NW- SE	ENE-WSW, NE-SW E-W		
Plunge of L-Axes		-----Towards west, South North West & West -----		-----Towards SW-----		Rock cut terraces and Scar			
Relative disposition	Convergent	Divergent	Divergent	Divergent	Divergent	Divergent			
Paired/Unpaired	Unpaired		Paired	Paired	Paired	unpaired	Paired sharp Strand lines		
Nature of scarp	-----Curvilinear----		Curvilinear	-----Linear-----		-----Linear-----		-----Linear-----	
	-----		-----Linear-----		Rock cut scars		-----Erosional lines		
Sedimentary feature	Braided Channel, Channel bar Point bar coalescence Channel bar, Side bar , Graded bedding , Cross bedding, Lamination, cross lamination			Terrace Section Scarp section Punasa Dam site Trench , Damsite Foundation Excavation ,Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features					
Terrace shape	----- Cusate-----		----- Rectangular-----						
	Rock cut scar			Sharp edge scar			Isolated cap		
Land use pattern	-----Barren -----Inhabitation and cultivation----- Forest coverd area								
Composition/Litho constituents arranged in probable order of abundance	River bad Braided Channel, Point Bar, Side Bar. With very coarse to very fine sand , silt & Clay : Quartzite Gneiss, granite, quartzite, basalt, sandstone, limestone, Augate, Jaspar, schist, , slate, sand and silt. NT0 : Gneiss,quartzite, gneiss,, basalt, ,granite, , sandstone limestone, phyllite, slate, shale, sand and silt NT1 Quartzite, gneiss, , basalt, granite sandstone, phyllite, , basic, schist shale sand and silt.								

NT1-A	Quartzite, granite, gneiss, meta basic sand stone, lime stone schist, basic, phyllite, slate, shale, sand silt and clay.
NT2-B	Rock cut scar
NT2-C	Rock cut scar
NT3-A	Rock cut scar
NT3-B	Rock cut scar Note : NT3-A , B Rock cut Scar , Strand lines , rock cut dissected nicks

GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NARMADA VALLEY

TABLE NO QGT-6 Locality: TILAKWARDA	River bad	NT0	NT1	NT2-A	NT2-B	NT2-C	NT-3	Paniplain/ Pediplain PP/PD	Pediment PP/PD
Age	HOLOCENE								
Elavation above MSL (m)	85	90	96	110	115	120	130 Rock cut Terraces rock Scar	133	138
Geomorphic break (m)	0.00	05.00 Alluvial Face	11.00 Alluvial Bluff Section Steep Alluvial face	25.00 Steep Alluvial fac Composite Rock Face	30.00 Rock cut Terraces rock Scar Rock Face	35.00 Rock cut Terraces rock Scar Rock Face Rock Face	45.00 Rock cut Terraces rock Scar Rock Face Composit Rock Face	48.00 Gradual	53.00 Distinct with breaks and rock rlicts and imprints of neotectonic activity
Elavation above RB (m)	0.00 River bad Channel, Point Bar, Side Bar	08.00 Rock Face and Alluvial Bluff	15..00 Rock Face and Alluvial Bluff	20..00 Alluvial Bluff Rock Face	25.00 Rock Face	35.00 Rock Face	45.00 Rock cut Terraces rock Scar	50.00 Rock surface with soil cover	55.00 Pediment surface
Slope	-----Towards west & SW-----		-----Towards west and SW-----		-----Towards west & SW-----				
Nature of surface	-----Depositional , Cresent shape elongated ----- Errosional			Rock cut terraces and Rock scar -----Erosional ---Lienar scar line ----				Erosional	Erosional
Cycle Sedimentation	Up ward fining cycle ----- -Polycycle -----				Rock cut scars -- Section not not exposed-----				
Orientation of W-Axes		ENE-WSW to E- W	ENE-WSW to, E-W	ENE-WSW, NW- SE	ENE-WSW, NW- SE	E-W & NW- SE	E-W	ENE-WSW, NE-SW E-W	
Plunge of L-Axes		-----Towards west, South North West & West -----				-----Towards SW-----		Rock cut terraces and Scar	
Relative disposition	Convergent	Divergent	Divergent	Divergent	Divergent				
Paired/Unpaired	Unpaired	Paired	Paired	Paired	unpaired	Paired sharp Strand lines			
Nature of scarp	-----Curvilinear-----	Curvilinear	-----Linear-----		-----Linear-----		-----Linear-----		
	-----	-----Linear-----	Rock cut scars		-----Erosional lines				

Sedimentary feature	Braided Channel, Channel bar Point bar coalescence Channel bar, Side bar , Graded bedding , Cross bedding, Lamination, cross lamination	Terrace Section Scarp section Punasa Dam site Trench , Damsite Foundation Excavation ,Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features
Terrace shape	----- Cuspate----- Rectangular----- Rock cut scar Sharp edge scar Isolated cap	
Land use pattern	-----Barren-----Inhabitation and cultivation----- Forest coverd area	
Composition/Litho constituents arranged in probable order of abundance	River bad Braided Channel, Point Bar, Side Bar. With very coarse to very fine sand , silt & Clay : Quartzite Gneiss, granite, quartzite, basalt, sandstone, limestone, Augate, Jaspar, schist, , slate, sand and silt. NT0 : Gneiss,quartzite, gneiss,, basalt, ,granite, , sandstone limestone, phyllite, slate, shale, sand and silt NT1 Quartzite, gneiss, , basalt, granite sandstone, phyllite, , basic, schist shale sand and silt. NT1-A Quartzite, granite, gneiss, meta basic sand stone, lime stone schist, basic, phyllite, slate, shale, sand silt and clay. NT2-B. Rock cut scar NT2-C Rock cut scar NT3-A Not Developed NT3-B Not Developed NT3-C Not Developed	

GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NARMADA VALLEY

TABLE NO QGT-7 Locality: BHARUCH	River bad	NT0	NT1	NT2-A	NT2-B	NT2-C	NT3-A NT3-B NT-C	Paniplain/ Pediplain Paniplain/ Pediplain PP/PD	Pediment /PD
Age	HOLOCENE								
Elavation above MSL (m)	60	70	80	90.00	--	--	NT3-A 105	PP/PD	PD
Geomorphic break (m)	0.00	10.00 Alluvial Face	20.00 Alluvial Bluff Section Steep Alluvial face	30.00 Steep Alluvial fac Composite Rock Face	Not Developed	Not Developed	45 .00 m Alluvial Bluff Section Steep Alluvial face -----	50.00 Gradual	55.0000 Distinct with breaks and rock relicts and imprints of geotectonic activity
Elavation above RB (m)	0.00 River bad Channel, Point Bar, Side Bar	10.00 Rock Face and Alluvial Bluff	20..00 Rock Face and Alluvial Bluff	30..00 Alluvial Bluff Rock Face	Not Developed	Not Developed	45 .00 m Alluvial Bluff Section Steep Alluvial face ----	55.00	60.00
Slope	-----Towards west & SW----- -		-----Towards west and SW-----		-----Towards west & SW-----			Towards west	Towards west
Nature of surface	-----Depositional , Cresent shape elongated --- -- Errosional -----			Rock cyut terraces and Rock scar -----Erosional ---Lieanr scar line ----			Erosional	Erosional	
Cycle Sedimentation	Up ward fining cycle ----- ----- Polycycle -----				Rock cut scars -- Section not not exposed-----				

Orientation of W-Axes		ENE-WSW to E-W	ENE-WSW to, E-W	ENE-WSW, NW-SE	ENE-WSW, NW-SE	E-W & NW-SE	ENE-WSW, NE-SW E-W
Plunge of L-Axes		-----Towards west, South North West & West -----		-----Towards SW-----		Rock cut terraces and Scar	
Relative disposition	Convergent	Divergent	Divergent	Divergent	Divergent		
Paired/Unpaired	Unpaired	Paired	Paired	Paired	unpaired	Paired sharp Strand lines	
Nature of scarp	-----Curvilinear----	Curvilinear	-----Linear-----		-----Linear-----	-----Linear-----	
	-----Linear-----			Rock cut scars	-----Erosional lines		
Sedimentary feature	Braided Channel, Channel bar Point bar coalescence Channel bar, Side bar , Graded bedding , Cross bedding, Lamination, cross lamination			Terrace Section Scarp section Punasa Dam site Trench , Damsite Foundation Excavation ,Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features			
Terrace shape	----- Cusate-----		----- Rectangular-----				
	Rock cut scar		Sharp edge scar		Isolated cap		
Land use pattern	-----Barren -----Inhabitation and cultivation----- Forest covered area						
Composition/Litho constituents arranged in probable order of abundance	River bad Braided Channel, Point Bar, Side Bar. With very coarse to very fine sand , silt & Clay : Quartzite Gneiss, granite, quartzite, basalt, sandstone, limestone, Augate, Jaspar, schist, , slate, sand and silt. NT0 : Gneiss,quartzite, gneiss,, basalt, ,granite, , sandstone limestone, phyllite, slate, shale, sand and silt NT1 Quartzite, gneiss, , basalt, granite sandstone, phyllite, , basic, schist shale sand and silt. NT1-A Quartzite, granite, gneiss, meta basic sand stone, lime stone schist, basic, phyllite, slate, shale, sand silt and clay. NT-3 Alluvial Bluff Section Steep Alluvial face ----- NT2-B. Not Developed NT2-C Not Developed ----- NT3-A Not Developed NT3-B Not Developed -----						

GEOMORPHOLOGY AND DIGONESTIC ELEMENTS TAPTI VALLEY

(i) Locality: Bhusawal Jalgaon-I District M.S

TABLE NO QGT-8									
Digonestic elements	River bad	TT0	TT1	TT2	TT3	PQTT4 A partly penipalantion	PQTT4 B partly penipalantion	PQTT5 penipalantion	PQTT6 penipalantion
Age	HOLOCENE								
Elevation above MSL (m)	295	300	310	315	325	335	340	345	355
Geomorphic break (m)	0.00	5.00	15.00	20.00	30.00	35.00	40.00	45.00	55.00
Elevation above RB (m)	0.00	5.00	15.00	25.00	35.00	45.00	55.00	60.00	70.00
Slope	-----Towards East-----		-----Towards SE-----		-----Towards SSW-----			SSW	SSW
Nature of surface / landform elements	-----Depositional ----- Point bar, channel bar sandbar, flood plain,alluvial fan valley fill ,erosional scarp linear trenches , linear scarp deep gulling ,ravines				Sloping surfaces with relict benches and platform,scree deposit, relict mounds, incisional linear trenches and related Erosional Process			Planner surface relict benches and platform	Planner surface relict benches and platform with relicts of erosional activity
Cycle Sedimentation	-----Polycycle -----					----Section not exposed-----		----Section not exposed-----	----Section not exposed-----

Orientation of W-Axes		ENE-WSW,E-W	E-W	ENE-WSW	ENE-WSW	E-W	E-W
Plunge of L-Axes		-----Towards East-----	-----Towards NE-----				
Relative disposition		Convergent	Divergent / Divergent	Divergent	Divergent		
Paired/Unpaired		Unpaired	Unpaired	Paired	Paired	Paired / Isolated Patches	
Nature of scarp		-----Curvilinear-----	-----Linear-----				
Sedimentary feature		Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features	- Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features -----Not exposed-----				
Terrace shape		Cusate-----	Rectangular -----	Elongated & Recangular	Isolated cap		
Land use pattern		-----Inhabitation and cultivation-----					
Composition/Litho constituents arranged in probable order of abundance / The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.		River bad : Quartzite, granite, gneiss, sandstone, limestone, slate Augate, Jaspar,Chart schist, basaltt, phyllite, slate, sand and silt. TTo : Quartzite, gneiss, granite, , sandstone limestone, basic, phyllite, slate, shale, sand and silt. TT1 : ST2-B : Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay. TT2- : Quartzite limestone, gneiss, granite,sandstone, basic schist, phyllite, slate, sand, silt and clay ST3 : Quartzite limestone, gneiss, granite, basalt schist, slate, sand, silt and clay. TT3- : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, silt and clay. PQT4A,BPQTA5,6 Deccan basaltic surface partly covered by scree, coluviam deposit and residual soil Deccan basaltic surface basaltic platform partly covered by scree, coluviam deposit and residual soil					

GEOMORPHOLOGY AND DIGONESTIC ELEMENTS TAPTI VALLEY

(i) Locality: Confluence of Tapti & Waghaur Jalgaon District M.S

TABLE NO QGT-9									
Digonestic elements	River bad	TT0	TT1	TT2	TT3	PQTT4 A	PQTT4 B	PQTT5 penipalantion	PQTT5 penipalantion
Age	HOLOCENE								
Elevation above MSL (m)	292	298	305	312	322	330	335	337	342
Geomorphic break (m)	0.00	6..00	7.00	7.00	10.00	8.00	5.00.00	2.00	5.00
Elevation above RB (m)	0.00	6.00	13.00	20.00.	30.00	38.00	43.00	45.00	50.00
Slope	-----Towards west-----		-----Towards SSW-----			-----Towards west-----		SSW	SSW
Nature of surface	-----Both Erosional & Depositional ----- Active flood plain Point bar, sandbar, alluvial fan valley fill ,erosional scarp linear trenches deep , gulling ,ravines area under active post depositional and erosional influence				Sloping surfaces with relict benches and platform,scree deposit, relict mounds, incisional linear trenches and related Erosional Process			Planner surface relict benches and platform with imprints of	Planner surface relict benches and platform with imprints of

							erosional activity	neotectonism	
Cycle Sedimentation	-----Polycycle -----					Section not exposed		Basaltic lava sheets/ lava flows	Basaltic lava sheets/ lava flows
Orientation of W-Axes		ENE-WSW,E-W	E-W	ENE-WSW to E-W	ENE-WSW	E-W	E-W		
Plunge of L-Axes		-----Towards East-----	-----Towards NE-----						
Relative disposition	Convergent		Divergent / Divergent		Divergent	Divergent			
Paired/Unpaired	Unpaired	Unpaired	Paired	Paired	Paired	Paired / Isolated Patches			
Nature of scarp	-----Curvilinear-----		-----Linear-----						
Sedimentary feature	Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features				- Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features -----Not exposed-----				
Terrace shape	Cusate-----		Rectangular -----		Elongated & Rectangular		Isolated cap		
Land use pattern	-----Inhabitation and cultivation-----								
Composition/Litho constituents arranged in probable order of abundance / The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock fabrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape	River bad : Quartzite, granite, gneiss, sandstone, limestone, slate Augate, Jaspar,Chart schist, basaltt, phyllite, slate, sand and silt. TTo : Quartzite, gneiss, granite, , sandstone limestone, basic, phyllite, slate, shale, sand and silt. TT1 : ST2-B : Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay. TT2- : Quartzite limestone, gneiss, granite,sandstone, basic schist, phyllite, slate, sand, silt and clay ST3 : Quartzite limestone, gneiss, granite, basalt schist, slate, sand, silt and clay. TT3- : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, silt and clay. PQT4A Deccan basaltic surface partly covered by scree, colluvium deposit and residual soil PQT4 B Deccan basaltic surface basaltic platform partly covered by scree, coluviam deposit and red soil								

GEOMORPHOLOGY AND DIGONESTIC ELEMENTS TAPTI VALLEY

(i) Locality: Shahpur - Dhule District M.S

TABLE NO QGT-10									
Digonestic elements	River bad	TTo	TT1	TT2	TT3	PQTT4 A partly penipalantion & Pedimentation	PQTT4B partly penipalantion & Pedimentation	PQTT5 penipalantion	PQTT6 penipalantion
Age	HOLOCENE								
Elevation above MSL (m)	285	290	295	310	320	325	330	335	338
Geomorphic break (m)	0.00	5.00	10.00	20.00	30.00	35.00	45.00	50.00	53.00
Elevation above RB (m)	0.00	5.00	15.00	25.00	35.00	45.00	55.00	60.00	63.00
Slope	-----Towards westt-----		-----Towards SW-----			-----Towards west -----		Towards west	Towards west
Nature of surface	Both Erosional & Depositional Active flood plain , older flood plain , active channel					Sloping surfaces with relict benches and		Planner surface relict benches	Planner surface relict benches

	flood plain Point bar, sandbar ,alluvial fan valley fill ,erosional scarp linear trenches deep gulling ,ravines				platform,scree deposit, relict mounds, incisional linear trenches and related Active Erosional Process			and platform with imprints of neotectonism and erosional activity	and platform with imprints of structural deformation and geotectonics
Cycle Sedimentation	-----Polycycle-----					-----Not exposed-----		Basaltic lava sheets/ lava flows seprated by red bole	Basaltic lava sheets/ lava flows of composite characters
Orientation of W-Axes		ENE-WSW,E-W	E-W	ENE-WSW	ENE-WSWto EW & SE-SW		--	-	
Plunge of L-Axes		-----Towards East-----		-----Towards NE-----					
Relative disposition	Convergent		Divergent / Divergent		Divergent	Divergent	Drvergent		Divergent
Paired/Unpaired	Unpaired		Unpaired	Paired	Paired	Paired	Paired / Isolated Patches		
Nature of scarp	-----Curvilinear-----				-----Linear-----				
Sedimentary feature	-----Not exposed-----			Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features					
Terrace shape	Cuspate-----			Rectangular		Elongated & Recangular		Isolated cap	
Land use pattern	-----Inhabitation and cultivation-----								
Composition/Litho constituents arranged in probable order of abundance /The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape	River bad : Quartzite, granite, gneiss, sandstone, limestone, slate Augate, Jaspar,Chart schist, basallt, phyllite, slate, sand and silt. TTo : Quartzite, gneiss, granite, , sandstone limestone, basic, phyllite, slate, shale, sand and silt. TT1 : ST2-B : Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay. TT2- : Quartzite limestone, gneiss, granite,sandstone, basic schist, phyllite, slate, sand, silt and clay TT3 : Quartzite limestone, gneiss, granite, basalt schist, slate, sand, silt and clay. PQT4A,B PQTA5,6 Deccan basaltic irregular surface partly covered by soil, colluvium deposit and residual soil								

GEOMORPHOLOGY AND DIGONESTIC ELEMENTS TAPTI VALLEY

(i) Locality: Khamkheda II Dhule District M.S

TABLE NO QGT-11									
Digonestic elements	River bad	TTo	TT1	TT2	TT3	PQTT4- A partly penipalantion & Pedimentation	PQTT4-B partly penipalantion &	PQTT- 5 penipalantion	PQTT- 5 penipalantion
Age	HOLOCENE								
Elavation above MSL (m)	255	265	275	285	300	310	320	322	325

Geomorphic break (m)	0.00	10.00	10.00	10.00	15.00	10	10.00	2.00	3.00	
Elavation above RB (m)	0.00	10.00	20.00	30.00	45.00	55.00	65.00	67.00	70.00	
Slope	-----Towards west-----		-----Towards SSW-----		-----Towards west-----			Towards west	Towards west	
Nature of surface	Both Erosional & Depositional Point bar, sandbar, flood plain,alluvaial fan valley fill ,erosional scarp linear trenches deep gulling ,ravines				- Sloping surfaces with relict benches and platform,scree deposit, relict mounds, incisional linear trenches and related Active Erosional Process			Planner surface relict benches and platform at places relict of intensive erosional activity	Planner surface relict benches and platform at places relict of intensive erosional activity	
Cycle Sedimentation	-----Polycycle -----					-----Not exposed-----		A sequence of lava flows exposed in scarp section	A sequence of lava flows exposed in scarp section	
Orientation of W-Axes		ENE-WSW,E-W to E-W	E-W	ENE-WSW To E-W, NNE-SSW		ENE-WSW	Section not exposed -	-		
Plunge of L-Axes		-----Towards East-----	-----Towards NE-----							
Relative disposition	Convergent	Divergent /	Divergent	Divergent	Divergent	Divergent		Divergent		
Paired/Unpaired	Unpaired	Unpaired	Paired	Paired	Paired	Paired /	----- Isolated Patches-----			
Nature of scarp	-----Curvilinear-----		-----Linear-----							
Sedimentary feature	Graded bedding , Lamination, cross lamination & Cut and Fill features				Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features ---Not exposed-----					
Terrace shape	Cuspate-----		Rectangular		-----Elongated & Recangular n		Isolated cap			
Land use pattern	-----Inhabitation and cultivation----- Forest cover-----									
Composition/Litho constituents arranged in probable order of abundance / The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	River bad : Quartzite, gneiss, granite, sandstone, limestone, slate basat Augate, Jaspar,Chart schist, basallt, phyllite, slate, sand and silt. TTo : Quartzite, gneiss, granite, , sandstone limestone, basic, phyllite, slate, shale, Yellow,brown clay sand and silt. TT1 : ST2-B : Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay. TT2- : Quartzite limestone, gneiss, granite,sandstone, basic schist, phyllite, slate, sand, silt and clay TT3 : Quartzite limestone, gneiss, granite, basalt schist, slate, sand, Yellow ,brown silt and clay. PQT4A,BPQTTA5,6 Deccan basaltic irregular surface partly covered by yellow soil, colluvium deposit and residual lateritic soil yellow silt and clay . It is traverse by master joints , fractures and lineaments									
TABLE NO QGMT-12	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS OF SON VALLEY									

Locality: -----A	River bad	STo	ST1	ST2	ST3	PST4 A PQTT4 A partly penipalantion & Pedimentation	PST4B PQTT4 A partly penipalantion & Pedimentation				
Age											
HOLOCENE											
Elavation above MSL (m)	280	290	295	300	310	325	335				
Geomorphic break (m)	0.00	10.00	5.00	5.00	10	15	10				
Elavation above RB (m)	0.00	10.00	15.00	20.00	30.00	45.00	55.00				
Slope	-----Towards East-----		-----Towards SE-----		-----Towards Eastt-----						
Nature of surface	-----Depositional-----				-----Erosionall-----						
Cycle Sedimentation	-----Polycycle-----					-----Not exposed-----					
Orientation of W-Axes		ENE- WSW,E-W	E-W	ENE-WSW	ENE- WSW	E-W	E-W				
Plunge of L-Axes		-----Towards East-----		-----Towards NE-----							
Relative disposition	Convergent Divergent / Divergent Divergent Divergent										
Paired/Unpaired	Unpaired		Unpaired	Paired	Paired	Paired	Paired / Isolated Patches				
Nature of scarp	-----Curvilinear----- -----Linear-----										
Sedimentary feature	Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features			- Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features ----- Not exposed-----							
Terrace shape	Cuspate-----		Rectangular -----				Elongated & Recangular Isolated cap				
Land use pattern	-----Inhabitation and cultivation-----										
Composition/Litho constituents arranged in probable order of abundance / The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	River bad : Quartzite, granite, gneiss, sandstone, limestone, slate Augate, Jaspar,Chart schist, basalit, phyllite, slate, sand and silt. STo : Quartzite, gneiss, granite, , sandstone limestone, basic, phyllite, slate, shale, sand and silt. ST1 : ST2-B : Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay. ST2- : Quartzite limestone, gneiss, granite,sandstone, basic schist, phyllite, slate, sand, silt and clay ST3 : Quartzite limestone, gneiss, granite, basalt schist, slate, sand, silt and clay. ST3-B : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, silt and clay. PST4A : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, deep red , & grey and yellowish silt and clay. PST4 B : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, silt and clay.										

TABLE NO QGMT-13		GEOMORPHOLOGY AND DIGONESTIC ELEMENTS OF SON VALLEY							
Locality: -----B	River bad	STo	ST1	ST2	ST3	PST4 partly penipalantion & Pedimentation	PST5 partly penipalantion & Pedimentation	Vindhyan Up land	
Age	HOLOCENE								
Elavation above MSL (m)	275	280	290	300	310	320	330	350	
Geomorphic break (m)	0.00	5.00	10	10	10	10	10	20.00	
Elavation above RB (m)	0.00	5.00	15.00	25.00	35.00	45.00	55.00	75.00	
Slope	-----Towards East-----		-----Towards SE-----		-----Towards Eastt-----				
Nature of surface	-----Depositional -----				-----Erosionall -----				Deudational
Cycle Sedimentation	-----Polycycle -----					-----Not exposed-----		A sequence of sand stone silt stone & shale	
Orientation of W-Axes		ENE-WSW,E-W	E-W	ENE-WSW	ENE-WSW	--	-		
Plunge of L-Axes		-----Towards East-----		-----Towards NE-----					
Relative disposition	Convergent		Divergent / Divergent		Divergent	Divergent	Relief Area		
Paired/Unpaired	Unpaired		Unpaired	Paired	Paired	Paired	Paired / Isolated Patches		Relief Area
Nature of scarp	-----Curvilinear-----		-----Linear-----						
Sedimentary feature	-----Not exposed-----			Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features					
Terrace shape	Cuspate-----			Rectangular -----		Elongated & Recangular Isolated cap			
Land use pattern	-----Inhabitation and cultivation-----								
Composition/Litho constituents arranged in probable order of abundance/ The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	River bad : Quartzite, granite, gneiss, sandstone, limestone, slate Augate, Jaspar,Chart schist, basallt, phyllite, slate, sand and silt. STo : Quartzite, gneiss, granite, , sandstone limestone, basic, phyllite, slate, shale, sand and silt. ST1 : ST2-B : Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay. ST2- : Quartzite limestone, gneiss, granite,sandstone, basic schist, phyllite, slate, sand, silt and clay ST3-a : Quartzite limestone, gneiss, granite, basalt schist, slate, sand, silt and clay. ST3-b : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, silt and clay. PST4a : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, silt and clay. PST4 b : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, deep red , & grey and yellowish silt and clay.								

TABLE NO QGMT-14		GEOMORPHOLOGY AND DIGONESTIC ELEMENTS OF SON VALLEY								
(i) Locality: -----C	River bad	STo	ST1	ST2	ST3	PST4 partly penipalantion & Pedimentation	PST-5 partly penipalantion & Pedimentation	Vindhyan Up- land		
Age										
HOLOCENE										
Elavation above MSL (m)	270	275	280	290	300	310	315	335		
Geomorphic break (m)	0.00	5.00	10	10	10	10	5.00	20.00		
Elavation above RB (m)	0.00	5.00	15.00	25.00	35.00	45.00	50.00	70.00		
Slope	-----Towards East-----		-----Towards SE-----			-----Towards East-----				
Nature of surface	-----Depositional -----					-----Erosionall -----		Relief Area		
Cycle Sedimentation	-----Polycycle -----					-----Not exposed-----		A sequence of sand stone silt stone & shale		
Orientation of W-Axes		ENE- WSW,E-W	E-W	ENE-WSW To E-W	ENE-WSW	-	-			
Plunge of L-Axes		-----Towards East-----		-----Towards NE-----						
Relative disposition	Convergent		Divergent / Divergent		Divergent	Divergent	Relief Area			
Paired/Unpaired	Unpaired		Unpaired	Paired	Paired	Paired	Paired / Isolated Patches			
Nature of scarp	-----Curvilinear-----		-----Linear-----							
Sedimentary feature	-----Not exposed-----			Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features						
Terrace shape	Cuspate-----			Rectangular -----		Elongated & Recangular Isolated cap				
Land use pattern	-----Inhabitation and cultivation-----									
Composition/Litho constituents arranged in probable order of abundance /The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape	River bad : Quartzite, granite, gneiss, sandstone, limestone, slate Augate, Jaspar,Chart schist, basallt, phyllite, slate, sand and silt. STo : Quartzite, gneiss, granite, , sandstone limestone, basic, phyllite, slate, shale, Sand and silt. ST1 : ST2-b : Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay. ST2-a : Quartzite limestone, gneiss, granite,sandstone, basic schist, phyllite, slate, sand, silt and clay ST3 -b : Quartzite limestone, gneiss, granite, basalt schist, slate, sand, silt and clay. ST3-a : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, silt and clay. PST4, Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, sand, silt and clay.									

Table No QGMT-15 QUATERNARY TERRACES OF PALEO-FLUVIAL DOMAIN OF NARMADA VALLEY, M.P. INDIA

Fluvial Terrace & ITS Designation	Elevation above MSL	Nature of its Origin	Composition
NT0	260-280m	Depositional	Light grey to dark grey sand and silt
NT_1	280-300m	Depositional	Light grey to dark grey sand and silt with rock pebble sand and silt
NT_2A	300-320m	Erosional / Depositional	Grey & brown sand and silt
NT_2B	320-340m	Depositional	Yellow Brownish clay with silt
NT_2C	340-360m	Erosional/Depositional	Yellow brownish clay with silt with dark brown oxidized clay silt
NT_3A	360-380m	Depositional	Dark brown, dark yellow clay silt brownish red clay and silt with Calc-matrix.
NT_3B	400m	Erosional/Depositional	Dark brown, dark yellow clay silt Brownish red clay and silt with.

TABLE No QGMT -16: MAJOR QUATERNARY EVENTS IN CENTRAL INDIA

Age	Climatic events	Geomorphic features (khan el.a.l.1992)	Weathering events	Sedimentary events after Tiwari 2001	Teptra Event s Khan el.a.l.1991	Palaeo - Magnetic events Y.Rao el.a.l.1997	Tectonic events	Sedimentation events sedimentation after el.a.l.1992
4 ka Late Holocene	On set of aridity	Inset terrace formation (NT ₀)	-----	Ramnagar formation Boaras formation	-----	-----		Amber/Indrakdhar/Amba Janswasa formation unicycle
6Ka-13ka, Middle to Early Holocene	Good Monsoon	15m to 30m of entrenching of river (NT ₁)	I V	Boaras formation	-----	-----		Hoshangabad formation polycycle
13ka to 25ka, late upper Pleistocene	Arid	Older flood plain (NT _{2A})	V	Hirdepur Formation	Reworked Teptra NA _B -III	Brunhes normal polarity		Shahganj Formation
	Humid	Dissection of Baneta Formation		Brown soil	-----	-----		Polycycle
75ka	-----	-----	-----	-----	Teptra	Brunhes Normal		Polycycle

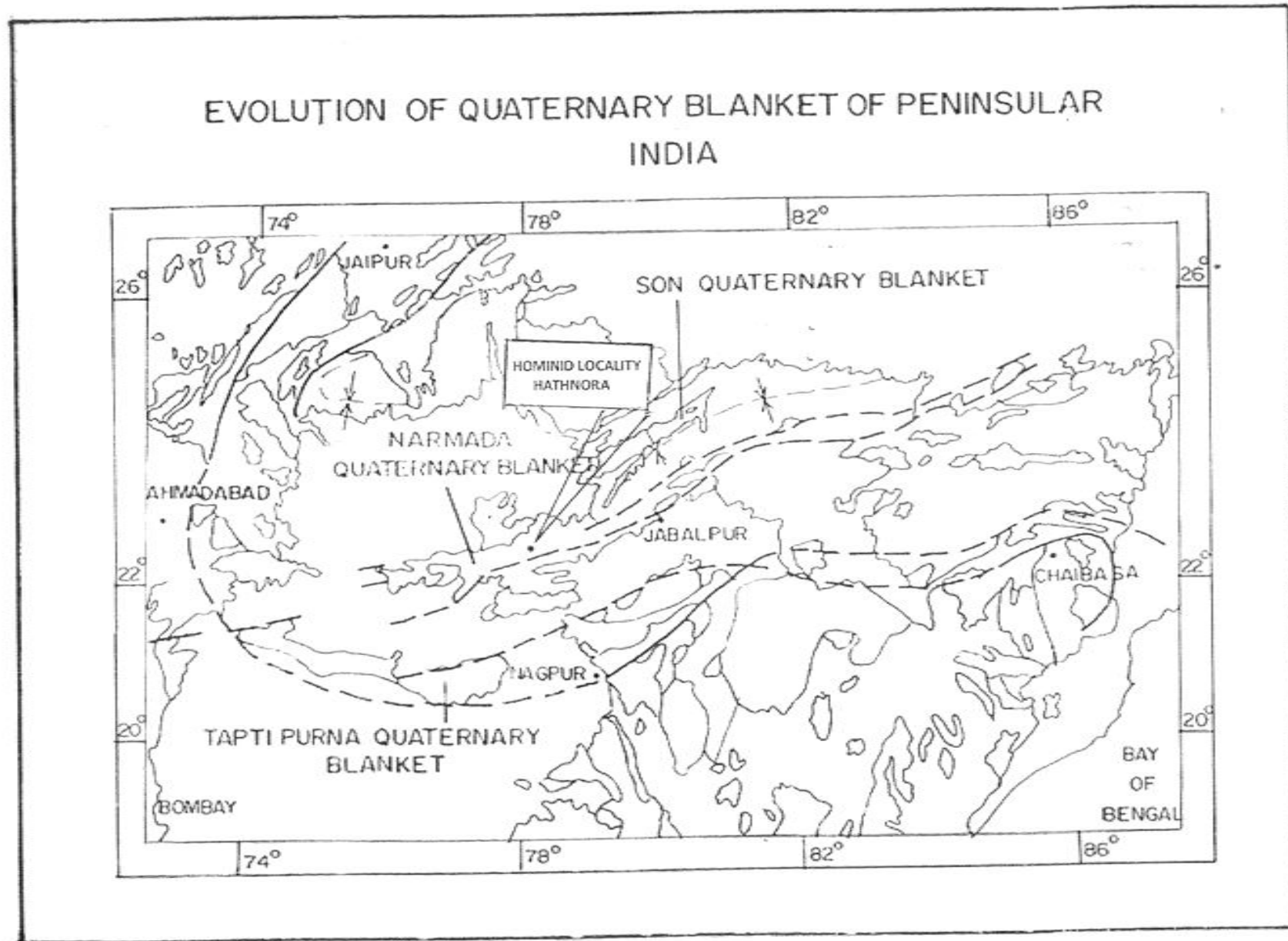
							polarity		
75ka to 118 ka early upper Pleistocene	Arid		Aggradation Degradation (NT ₂ B)	I V	-----	Baneta Formation	NA _B -II	Brunhes Normal polarity	
								Rejuvenation of south Satpura fault purna Tapti Valley	
					Yellow Clayey Soil	-----	-----	Brunhes Normal polarity	
Middle Pleistocene	Arid		Aggradation & Degradation (NT ₂ C)	II I		Surajkhund Formation	-----	Brunhes Normal polarity	
	-----		-----		Red Soil	-----	-----	Matuyama Reverse polarity	
								Formation of structural basin in the purna valley	
Lower Pleistocene	Arid		Aggradation & Degradation (NT ₃ A)	II	-----	Dhansi Formation	-----	Matuyama Reverse polarity	
								Formation of structural basin in the Central Narmada valley	
Lower Pleistocene	Humid		Aggradation & Degradation		Laterite/atosol	Pilikarar formation	-----	-----	

Lower Pleistocene	warm/cold		Agradation & Degradation			Hathmora formation (conglomerate)	NA _B -I	Entrenchment formation of structural basin in Narmada		
	warm/cold		Agradation & Degradation			Boulder conglomerate (Base not exposed)		Entrenchment formation of structural basin in Narmada		

Table No QGMT-17: QUATERNARY STRATIGRAPHIC SUCCESSION IN NARMADA VALLEY

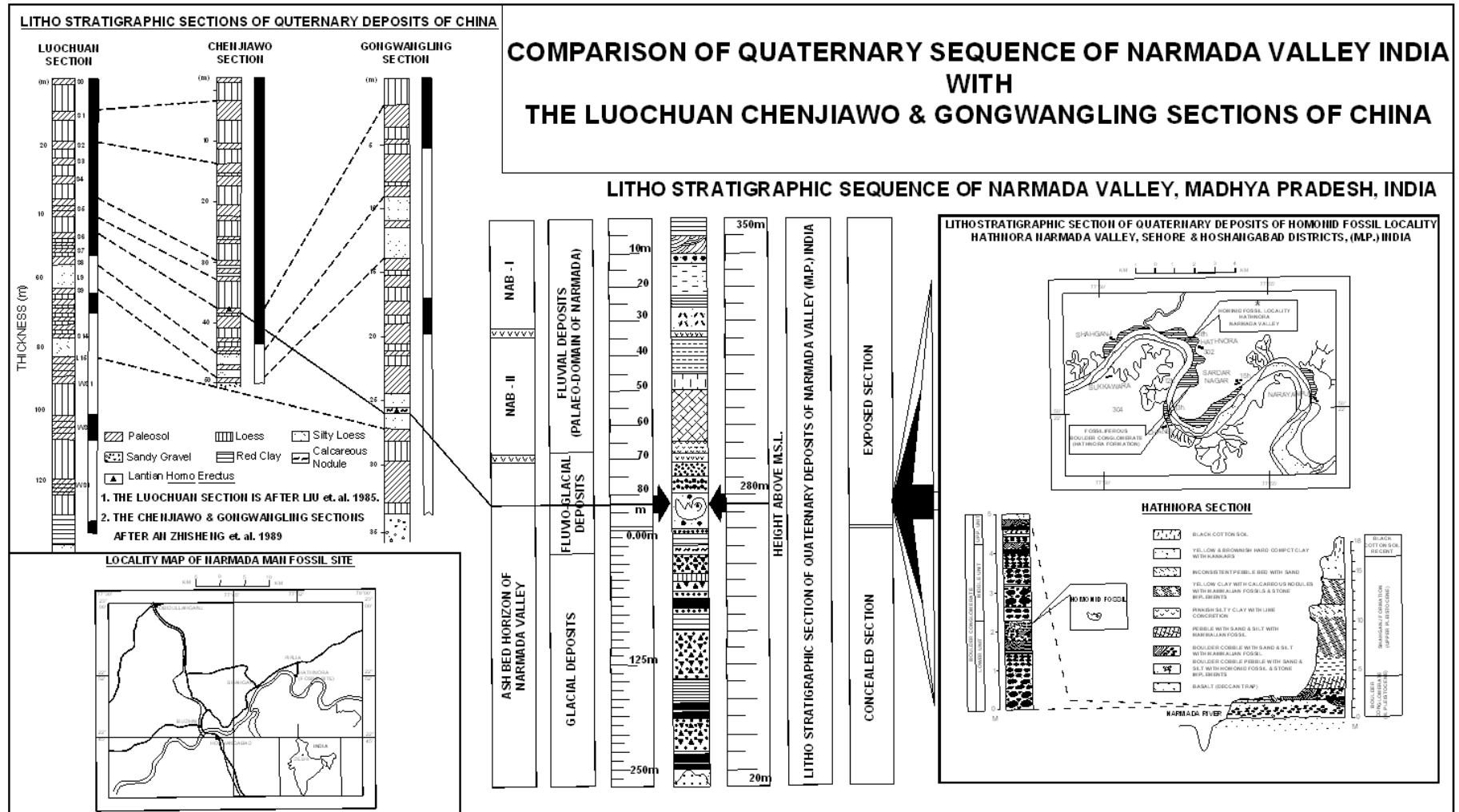
Recent Ambar/Indore/Kolar/Amba & Janwasa Formation Gravel, sand, silt and clays			
HOLOCENE	Hoshangabad/ Ramnagar Formation Age-Less than 4 ka(10m)	Gravel, sand, silt and clays of inset terraces.	Sand, silt. Khetaunhi fm of Son valley, Post black soil fm of western Maharashtra, Wardha fm Wainganga fm, Dark grey silt fm.
Dissection and Aggradations (15m to 30m of vertical dissection, formation of insect terraces)			
LATE UPPER PLEISTOCENE	Shahganj Formation/Hirdepur Formation Age-25 Ka to 13 Ka.(20m)	Vertical structure less grey sandy silt Grey silt and fine sand Reworked Tephra Cross bedded sand, calc. sandstone, conglomerate	Light grey silt formation of Tapti pura lower godavari, Wainganga, Hasdo, Mahanadi valley, Siri fm. Of Wardha wagher fm of son and Upper Bhima fm of western Maharashtra Hirdepur fm of Narmada Valley.
-----Dissection and Aggradations-----			
EARLY UPPER PLEISTOCENE	Demawar Formation/Baneta Formation Age-118 ka to 75 ka(15m)	Brown soil Brown calc. silt Volcanic ash Brown calc. Silt Dark carbonaceous clays Brown Calc. Salt Fine Sand Cross bedded sand, Clac. Sandstone, conglomerate.	Brown silt formation of Tapti Purna, Wainganga, Lower Godavari, Hasdo, Mahanadi valleys, Jamalpur fm. Of the Wardha valley, Patpara fm of Son valley, Bori fm. Of western Maharashtra. Baneta formation of the Narmada Valley.
-----Dissection and Aggradations-----			
MIDDLE PLEISTOCENE	Shivepur Formation / Surajkund Formation (15m)	Yellow Clayey soil steel grey and yellow clays Grey/ Brown silt Fine sand, cross bedded sand Gravels, Calc. conglomerate	Sihawal formation of Son valley. Surajkund formation of Narmada valley
-----Erosional unconformity-----			
LOWER PLEISTOCENE	Narsullahganj Formation / Dhansi Formation (20m)	Red soil Red homogenous sand Yellow and orange sand Brown silt Grey sand and silt	Red silt formation of Purna valley Dhansi Formation of Narmada valley.
-----Dissection/Erosional & Pediment-----			
LOWER PLEISTOCENE	Sohagpur Formation / Pilikarar Formation (15m)	Late rite/latosol Gravels/Pediment cover deposits	Ferricreted pediment cover of Lower Godavari, Wainganga Hasdo, Mahanadi and other smaller tributaries, Pilikarar formation of Narmada valley.
-----Disconformity-----			
LOWER PLEISTOCENE	Hathnora Formation (Boulder conglomerate)	Quantative, Gneiss, Limestone, sandstone, Basalt augate Jasper Chalcedony, Chert tight cemented in a matrix	Boulder Conglomerate of Tapti
-----Disconformity-----			
	Boulder Bed not exposed	Quartzite of Quantative gneiss , sandstone , augate basalt , Jasper chalcedony	Boulder Bed of Tapti
-----Unconformity -----Basement			

PLATE NO. 1



[illegible]

PLATE NO. 3



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