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RESEARCH ARTICLE

QUATERNARY TECTONICS & GEOMOPRHIC EVOLUTION OF NARMADA VALLY, ITS IMPACT ON TRACING THE REMAINS OF HOMO ERECTUS AND OTHER QUATERNARY FAUNA & FLORA.

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Abstract

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

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent which was an ideal locus for accumulation of sediments.The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of

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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 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 Quaternary landscape of Narmada comprises (NT-1 to NT-3) and their correlation with rest of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch section suggest that it has evolved mainly due to tectonicactivity along the SONATA LINEAMENT in a compressive stress regime. The sediments were deposited in a slowly in subsiding basin during early Pleistocene middle Pleistocene and the Late Pleistocene. The Holocene period is marked by inversion, which had suffered earlier subsidence. The inversion of the basin is due to a significant increase in compressive stresses along the NSF during the Early Holocene, resulting in differential uplift of the Narmada valley. The continuation of the compressive stress regime due to ongoing northward movement of the Indian plate indicates that the NSF is a major candidate for future intraplate seismicity in the region.

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

The Quaternary blanket occurs in the central part of valley in Jabalpur –Harda section and in Gurudeshwar – Bharouche section in lower of valley; where as in the other part in Harda –Mandleshwar section isolated caps and strips of quaternary sediments are noticed on rock cut terraces and rock benches of country rocks. In Mandleshwar-Barwani, Dhadgaon- Tilakwarda the quaternary deposits are shallow to moderate in thickness and thin out to wards east. The isolated locus of accumulation of sediments along the entire length of 1300 kms of Narmada is controlled by the tectonics and structural frame work and sinking and uplift of fault bounded blocks and lineaments. It is well illustrated by neoseismic signatures and imprints on quaternary deposits and landscapes signatures in the valley. The critical analysis of landscape profile evolution of drainage, quaternary terraces, river morphology and analysis of bore hole data of basement configuration of rock and quaternary deposits revealed that Jabalpur-Harda section valley segment suffered mega dislocation and sink to level of about 1150 m as compared to the adjoining blocks and has formed open rock basin and platform of quaternary sedimentation. This section display complete record of quaternary deposits of glacial, fluvio- glacial and fluvial sediments in increasing antiquity from the base.

In Narmada Rift system taking as single ecological unit for Quaternary sedimentation & tectonics and presence of the Katni Formation in central sector with angiosperm flora suggests that sedimentation continued during Mio-Pliocene in localized lakes. The

relative disposition of such lakes and subsequent deformation and structural dislocation on oscillating valley platform clubbed with rifting and faulting during Quaternary period has shifted the site of the lakes towards the present alluvium-covered area between Harda - Jabalpur, Garudeshwar and Bharouch as presumed: where as the present study of various aspects of Quaternary blanket in SONATA LINEAMENT ZONE reveled that quaternary sedimentation was a sequential and continuous process in rift valley system from Mio-Pliocene Pleistocene time, has deposited complete sequence of glacial, fluvio-glacial lacustrine fluvial and tidal deposits with changing environments and climate in time & space . The present disposition of quaternary blankets in Narmada basin is due to post deposition Quaternary tectonics which is solely responsible for sedimentation, dislocation, faulting and shifting of different blocks and distorting ecology in rift system. The occurrence of Boulder bed and Boulder Conglomerate in Son Narmada Tapti and Purna with similar rock assemblages and suites of rock fabrics, heavy mineral assemblages, and quartz grain morphology in critical and crucial sections across the SONATA LINEAMENT ZONE strongly support tearing and rifting of quaternary blanket during late Pleistocene time. The presence of thick boulder bed in Harda inliers area, such as at Chandgarh and north east of Barwaha, boulder bed in confluence are of Tapti and waghur around Khadgaon in Tapti valley Khan et.al (1984) Khan et al (2016) supports this assumption.
There are evidences of the effects of tectonics on fauna, flora .and tephra layers associated with Quaternary deposits of Narmada Rift valley, have under gone faulting, rifting, and dislocation during sedimentation. The impact of structural disturbances and\evidence of the effects of tectonics on fauna and flora are distinct and their signatures on dislocation and concealing of fossiliferous horizons are uncontrolled and ill defined in the ecosystem in the valley during the Pliocene–Pleistocene periods. The boulder conglomerate which yielded the skull cap of *Homo erectus* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due inconsistency and concealed nature of fossiliferous horizon, faulting, dislocation and subsidence of Quaternary blanket in Narmada rift system as such researcher and scientist failed to add any further knowledge to hominid discovery in Narmada any further .

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Introduction:-

The Narmada river originates from the Amarkantak plateau of Satpura Ranges in Rewa at an elevation of about 1057 m (220 40’ -810 45’) flows westerly course for about 1300 kms length across the middle of Indian subcontinent before entering Gulf of Cambay in the Arabian sea near Baroda in Gujarat state. It enters the fertile alluvial plain and passes through the gorge of about 19 kms long consisting of Marble rocks near Jabalpur.It then takes westerly turn through the alluvial tract, situated between the Satpura and Vindhyan hills. The river course of Narmada conspicuously straight and is controlled by ENE_WSW to E_W lineament, is bounded by Vindhyan in the north and Satpura in the south. The valley has maximum width of about 32 kms.

The principal tributaries of Narmada River are Sher and Sakkar in Narsingpur, the Tawa and Ganjal in Hoshangabad, and Gaur in Jabalpur. They all originate from the Satpura hills to the south of the trunk

channel. The only important tributary in the north is Hiran River, which emerge from the Vindhyan hills in Jabalpur district.
The river course of Narmada conspicuously straight and is controlled by ENE_WSW to E_W lineament, is bounded by Vindhyan in the north and Satpura in the south 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 deformation, rinsing and sinking platform of Narmada has also manifested concealed cyclic mechanism of tectonics and geothermic activity hydrological activity, seismicity, neosiesmic 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 flows along tectonically active NSF which forms a fault controlled basin of a huge thickness of Tertiary and Quaternary sediments. The thick blanket of Quaternary sediments occurs in the central part of valley in Jabalpur –Harda section and in Gurudeshwar – Bharouche section in lower of valley; where as in the other part in Harda –Mandleshwar section thin and isolated caps and strips of quaternary sediments are noticed on rock cut terraces and rock benches of country rocks. In Mandleshwar-Barwani, Dhadgaon- Tilakwarda the quaternary deposits are shallow to moderate in thickness and thin out to wards east. The isolated locus of accumulation and sedimentation along the entire length of 1300 kms of Narmada is controlled by the tectonics and structural frame work and sinking and uplift of fault bounded blocks and lineaments. It is well illustrated by neoseismic signatures and imprints on quaternary deposits and landscapes in the valley. The critical analysis of landscape profile evolution of drainage, quaternary terraces, river morphology and analysis of bore hole data of basement configuration of rock and quaternary deposits revealed that Jabalpur-Harda section valley segment suffered mega dislocation and sink to level of about 1150 m as compared to the adjoining blocks and created and has formed open rock basin and platform of quaternary sedimentation. This section display complete record of quaternary deposits of glacial, fluvio- glacial and fluvial sediments in increasing antiquity from the base. The study of bore data of ETO, CGWB, and GSI indicates and average thickness of quaternary deposits of about 435 m. The quaternary deposits bear well preserved imprints of neotectonisam indicating that the Sonata lineament zone seismically is active and has direct bearing on quaternary landscape of rift valley. The Harda –Mandleshwar section predominenently portrays the sequence of cyclic and noncyclical rock cut terraces and rock cut platform and benches which are time equivalent to the quaternary terraces of central and lower Narmada valley Khan et.al (2014). In Mandleshwar-Barwani the quaternary sediment are of moderate to shallow in thickness which are incised along with the country rock by cyclic structural dislocation and tectonic activity along ENE WSW lineament fabrics and dynamic incision of stream. It is well documented in quaternary terraces and composite erosional terraces; rock cut terraces caped by quaternary sediments, river profile and channel morphology. The morphogenetic expression of the section revealed uplift of block. The Gurudeshwar-Bharouche embodies the thickest quaternary deposits which represents complete sequence from the base glacial fluvio-galcial fluvial, lacustrine and mud deposits. This segment is about 90 km in length and forms the southern margin of the N–S extending Gujarat alluvial plains .A significant feature of the lower Narmada valley is the deposition of a huge thickness of Tertiary and Quaternary sediments in a fault controlled rift trench. To the south of the ENE–WSW-trending Narmada–Son Fault (NSF), the Tertiary rocks and basaltic flows of Deccan Trap Formation occur on the surface while to the north they lie in the subsurface and are overlain by Quaternary sediments. However, the overlying Quaternary sediments having a maximum thickness of 800 m (Maurya et al., 1995) The bore hole data of ONGC, CGWB, GSI of deep geology in the basin have revealed occurrence of Deccan Trap at depths of 6000 m followed by an Achaean basement (Roy, 1990) Khan et.al (2002). The Tertiary sediments, outcropping to the south of the NSF, represent the full sequence from Eocene to Pliocene overlying the Deccan Trap and show extensive deformation in the form of several ENE–WSW-trending anticline highs and ENE–WSW and E–W-trending reverse faults Khan et.al (2002). The quaternary landscape has been chiseled in to step sequence of terraces (NT1 –NT3) which are both paired and none paired in nature and are time equivalent to the terraces of central sector of Narmada. Table NO QTG _1, 2, 7 to_13

Quaternary Tectonics:-

The Indian Plate is currently moving northeast at 5 cm/yr (2 in/yr), while the Eurasian Plate is moving northeast at only 2 cm/yr (0.8 in/yr). This is causing the Eurasian Plate to deform, and the Indian Plate to compress leading to tectonic activity along major fault zones.

In tectonically active areas sedimentary basins undergo phases of both crustal extension and contraction leading to basin inversion and hence display features typical of subsidence and uplift. Geomorphic attributes and deformation in late Quaternary sediments are the indicators of active tectonic activity in any sedimentary basin. The geomorphic evolution in such reactivated basins is primarily due to complex interaction between sedimentation processes and tectonics. The peninsular India has been undergoing high compressive stresses due to the sea-floor spreading in the Indian Ocean and locking up of the Indian plate with the Eurasian plate to the north. Much of this N-S directed stresses have been accommodated by the under thrusting of the Indian plate below the Eurasian plate. A part of these compressive stresses are accumulated along the Narmada-Son Fault (NSF), a major E-W trending crustal discontinuity in the central part of the Indian plate.

The Quaternary tectonic activity recorded in the Narmada valley, possibly, has wider ramifications when viewed in the larger perspective of the Indian plate. This suggests a renewed phase of extreme compression of the Indian plate, which led to tectonic inversion along the NSF in the lower Narmada valley. Significant increase in compressive stresses accumulating on an intracrustal fault like the NSF can transform a previously subsiding basin into an uplifting one. The NSF has been characterized by a compressive stress regime throughout the Quaternary and variations in the degree of compression relative to the rates of plate movement are responsible for the late Pleistocene subsidence and the Holocene tectonic inversion in the lower Narmada valley. Chamya, L.S; (1997, 2000))

The Narmada rift system 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,). The two provinces are separated by a crustal level shear zone, referred as Central Indian Suture (CIS Jain et al. 1991, 1993). 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, 1998). 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 Vindhyan basin in the east. 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. 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 (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 Daccan Trap eruption remained unknown. However, the 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 longitude74 00 00 to 76 00 00 has been studied Khan et.al

(2002) Khan (1914). The correlation of structure and geo-physical data shows that the Son-Narmada and Tapti 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 Tapti graben to the south. In certain areas (especially in the Tapti area) the faults are listric. These listric normal faults cut across the basement, the Gondwana sedimentary formations, the overlying Daccan flows and the Quaternary alluvium. (Plate No _1)

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, of land form elements and as 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 sinking valley floor. Khan et.al (2002) Khan (in press)

In Himalaya the study of river terraces of Ganga complex in connection with eustatic changes and uplift tectonics revealed that Alaknanda consisting of (AT-0 to AT-6), Bhagirathi (BT-1 to BT-5), Bhilangna (BHT-1 to BHT4), Mandakini (MT-1 to MT-3), Nandakini (NT-1 to NT-3), Pindar (PT-1 to PT-3), Madhmeshwar Ganga (MDT-1 to MT-2), Bal Ganga, (BGT-1 to BG-2), and Patal Ganga(PGT-1) ad in Jamuna (JT-1 to JT-5) Khan (1981) attributed six mega phases of uplift Khan (1975-76), Khan (1976-77) (Khan 1988) Khan (1992) which has interrelation & balancing ecology synchronised by tectonics with Himalya and Indian Peninsula and in the south along Indian and Arbian sea which has direct bearing on movement of Indian plate. Further termination of lacustrine sedimentation has been attributed to tectonic activity during the Early Holocene (Kotlia et al., 2000). This suggests a major tectonic phase in the tectonic history of the Indian plate, evidence of which is also found along the NSF in the central part of the Indian plate. This suggests a renewed phase of extreme compression of the Indian plate, which led to tectonic inversion along the NSF in the lower Narmada valley. Significant increase in compressive stresses accumulating on an intracrustal fault like the NSF can transform a previously subsiding basin into an uplifting one. Since the NSF has been characterized by a compressive stress regime throughout the Quaternary, we believe that such variations in the degree of compression, which can in turn be interpreted in terms of varying rates of plate movement, alone is responsible for the Late Pleistocene subsidence and the Holocene tectonic inversion in the Narmada Rift valley. The Jabalpur earthquake May 1997, Uttarkashi Earthquake (1991) and Chamoli earthquake are manifestation of interplay of these plates.

Quaternary Sedimentation:-

Pleistocene Phase

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent was an ideal locus for accumulation of sediments .The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and segmental displacement, dislocation, uplifting and isolated domal up- lift, Neogene rifting and Quaternary sedimentation and rift-bound Pliocene–Pleistocene rifting 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 Quaternary sedimentation was triggered by tectonic activities / up lift and climatic changes. The provenance for these sediments is the weathering products of eroding pre-Cambrian, meta-sediments, sedimentary and volcanic rocks along the watershed upland, rift escarpments and shoulders; faulted and uplifted blocks, volcanic fissure zones, and plateaus within and outside the rift. The Narmada Rift System, bounded by adjacent plateaus rising 300–700 m above the rift floor, consists of number symmetrical and symmetrical faulted blocks, escarpment, rock cut terraces, rock floors and segments of micro half grabben. Although rift-related basins started to form during the late Oligocene to early Miocene times, the Narmada Rifts were fully defined by middle to late Miocene time.

The Narmada rift system basin platform provided a unique setting for dynamic ecosystems that were characterized by Rift-related subsidence and coeval sedimentation also created an ideal locus of Quaternary sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, digenesis, and preservation of organic remains. Because rifts formed after widespread Quaternary sedimentation occurred and voluminous sediments in the rift basins were accumulated by glacial activity consequential upon the lowering of temperature and climatic changes in the region.

The Miocene -Pliocene–Pleistocene lake deposit of Katni on the eastern rift shoulder was created by faulting, topographic control, or isostatic depression similar to that of other Rift system.

Abundant faunal remains in rift settings, including hominids Sonakia (1984), suggest that the Narmada Rift System created productive ecosystems during Pliocene–Pleistocene time. The volcanic rocks within the fossiliferous sediments provide temporal information for calibrating and sequencing hominid and other faunal evolution. The detailed geological sedimentological geochemical of interbedded tephra ,quartz grain morphology of sediments of quaternary strata and palo-sole of and geochronological studies of from the different localities for establishing accurate biostratigraphic and lithostratigraphic data, sedimentation rates, and paleoenvironmental and tectonic histories of different sediment columns in area along the rift system. Interbedded volcanic rocks allow determination of the time of rifting, the beginning of sedimentation, sedimentation rates, and the oscillation from glacial, fluvio-glacial lacustrine to fluvial environments. The cyclic environmental transitions recorded in the sedimentary sequences of the rift basins are caused by tectonic activities (uplift and subsidence), changes in relief, and climatic variations. The climatic changes in uplift, topographic and landscape features, coupled with block faulting, rinsing and sinking platform, created basins for the accumulations of thick lacustrine and fluvial sediments sequences with terrestrial and aquatic fossils. The sequential change in the sediment fancies from finely bedded lacustrine deposits to fluvial sediments are commonly noted in the sedimentary sequences and reflect environmental and tectonic changes that can be temporally determined. Moreover, regional correlation based on the chemistry and geochronology of interbedded tephra has made it possible to establish accurate stratigraphic relations that are useful for pale- environment reconstruction and evolutionary studies of fossil remains in the Narmada rift valley Khan et.al. (2012). Regional tephra correlation is being used increasingly to link sites together, and has already established that similar tephra layers are known from other parts of rift valley, as well as from other basin and peninsular India Achariya,(1993), Khan (1992) Khan et.al. (2012) Tiwari (1996). There is a great potential for further correlation of tephra in the Rift System and marine sediments in the Arabian Sea. The Arabian Sea has a continuous record of deposition that extends to at least 7 million years. The Quaternary sediments interbedded with tephra with within the age range of the ODP Ocean Drilling Program 721/722 stratigraphic sections of the Arabian Sea are also present within the rift floor and the western rift margin of the region. The chemical and chronological correlations of ash beds within the rift sequences of have been made with ashes described in marine sections. Detailed correlations based on orbitally calibrated time scales of pale magnetic stratigraphy Rao (1996) within Quaternary sediments of rift deposits will provide ties to establish global climate changes based on the terrestrial and marine sediments of the rift system.

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

Moreover, because of tephra layers in sedimentary basins of different geologic periods, processes such as faulting, rifting, sedimentation and diagenesis, impact of climatic changes, age of fossils, nature and acquisition of archeological implements, and the origin, distribution, and functional significance of early hominid artifact assemblages can be deciphered. However, evidence of the effects of tectonics o fauna and flora are distinct and its signatures o dislocation and concealing of fossiliferous horizons are uncontrolled ad ill defined and the ecosystem in the rift system during the Pliocene–Pleistocene periods is not clear.The boulder conglomerate which yielded the skull cap of *Homo eructs* in Narmada rift from Hathnora remained only discovery of hominid fossil in last two and half decade due inconsistency concealed nature of fosilifrous horizon in Narmada valley as such researcher and scientist failed to add any further knowledge to hominid discovery any further.

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The critical analysis of analogs illustrate the potential of the regional and sometimes global effects of such major silicic eruptions in the geologic past of sedimentation, sedimentation rates, and the oscillation from lacustrine to fluvial environments. The cyclic environmental transitions recorded in the sedimentary sequences of the rift basins are caused by tectonic activities (uplift and subsidence), changes in relief, and climatic variations. The tectonics dislocation and consequntial changes in landscape profile, reconfiguration of drainage topographic features, coupled with volcanic damming, created basins for the accumulations of thick glacial, fluvio-glacial lacustrine and fluvial sequences with terrestrial and aquatic fossils. The upward variation in sedimentry sequence from finely bedded lacustrine deposits to fluvial sediments are commonly noted and reflected in environmental and tectonic changes that can be determined. Moreover, regional correlation based on the chemistry and geochronology of interbedded tephra has made it possible to establish accurate stratigraphic relations that are useful for paleo environment reconstruction and evolutionary studies of fossil remains in the rift valleys across India sub continent The tephra occurrence is effectively used for reginal correlation increasingly to link sites valley wise and intravalley wise together, and has established that similar tephra layers occur in narmada rift system as well as in SONATA LINEAMENT ZONE..

The Boulder Bed and Boulder conglomerate which form the base of Quaternary sediments in central sector of Narmada Rift Valley is consistentltly exposed all along the length of valley. These deposits are concealed under the sediments of lacustrine and fluvial deposits in the valley. The presence of these deposits is confirrmed by study of bore hole data and logs of State ad Federal agencies drill in Narmada valley under various projects.

Late Pleistocene Phase:-

In the Narmada valley the River terraces in central and lower Narmada (NT1 to NT3) which represents sediments of Sohagpur, Sahganj, Hoshangabad and Bharuch and Tilakarda formation respectively date back to the Late Pleistocene. The sedimentation commenced with the deposition of the marine basal clays during the last interglacial high sea level at f125 ka, which is presumed to be about + 7 m as revealed by the studies Regression of this sea led to the initiation of fluvial sedimentation. The fluvial sediments were deposited in to two phases of sedimentation with a sharp break marked by tectonic changes and related climatic changes. The sequence of these to formation is exposed in the cliff section which represents different sediment facies typical of fluvial environments .The sequence of sediments display imprints of compressive tectonic regimes of sedimentation. The southern margin of lower Narmada is marked by Narmada–Son Fault the transformation of this geofracture in Tertiary to reverse fault in Quaternary is implicit in the seismic studies of the area (Roy, 1990). Additional evidence for prevalence of compressive stress regime in the lower Narmada basin is provided by numerous reverse faults in the Neogene sediments exposed immediately to the south of Narmada–Son Fault (Agarwal, 1986). These evidences suggest that the sediments of both the formation were formed in a compressive tectonic environment. There are evidences of subsidence of basin which has been documented on landscape of basin which are authenticated by other studies exist from adjacent area of synsedimentary subsidence on alluvial plain sedimentation.

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

The physiographic set up and drainage configuration of the Narmada the area of study demonstrate strong influence of tectonic and structure on development ad evolution of drainage. The Narmada enters in the area around Garudeshwar descends NW –SE direction cutting across NSA entering the quaternary tract. It further down stream of Tilakarda swing to wards west and suddenly become slow and sluggish and sinuous to meandering in channel pattern long the northern edge of upland ad ultimately debouches in the Gulf of Cambay. The disposition and convergence of drainage net in conformity of disposition of quaternary landscape is anomalous further imprints and neosiesmic signatures on landscape profile reveled persistent instability of basin during sedimentation.

The tectonic uplift of the lower Narmada valley during the Early and Late Holocene suggests inversion of an earlier subsiding basin. Such inversions of the basin have been common in the Tertiary times and are well recorded in the sediments of that age (Roy, 1990). A symmetric convergence of the NT-1,NT-2 terraces , diagonal disposition of paired equivalent of terraces across the channel , divergent and linear disposition of cliff of NT-3 terrace in conformity of NSF constant subsidence of basin and in response to frequential movement and geotectonic activity along the NSF. The displaced Late Pleistocene sediments across NSF in the Narmada and Orsang Heran and Madhumati & Karjan valleys, the NNW tilting of the NT-1, NT-2 sediments litho units consisting of the Late Pleistocene sequence, the anomalous topographic slope in the same direction and the incised cliffs up to 25–30 m in the streams that flow along this slope in the area between NSF and the Narmada River, indicate unsynchronized neoseismic movements along the NSF during the Early Holocene. The displacement of sediments of NT-1 surface across the NSF indicates differential movement of about 35 m along the NSF during Early Holocene. The block between the Narmada and Karjan rivers bounded by the NSF and the two other cross-faults suffered subsidence leading to the formation of a series, linear and curvilinear cuts of on terraces and flood plains. The 5–8-m incised cliffs of the streams also suggest that this block escaped the uplift induced large scale incision going on simultaneously in other areas of the lower Narmada valley. The occurrence of ravines and association of deep gullies with the river terraces is morph- tectonic manifestation caused by the sudden vertical movement and block adjustment due subsidence resulting to sudden collapse of water table and ground water regime in the area.

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

Middle Holocene—Recent Phase:-

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

The pre-existing quaternary platform of NT-3 of middle Pleistocene prior to induced sedimentation of tidal transgression was strongly induced by tectonic impulses of NSF. The relative disposition of terraces,(NT-2 NT-3 cliff alluvial bluff and scarp , reveals that the present mouth of the Narmada river has retained roughly the originally funnel shape of the estuary formed during the Mid–Late Holocene. However, the size of the estuary is now considerably reduced in space and time with sedimentation and t compressive tectonic environment

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

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

In the lower Narmada Valley alluvial fan as identified between Tilakwarda and Rajpipla within the loop of Narmada is mono illustration of morphogenetic process ad morph tectonic manifestation associated with neotectonic event. The disposition of Quaternary blanket, fan deposit and other quaternary land forms are controlled and restricted by SONATA LINEAMENT. The convergence of fan deposits and its apex is not in persistent and not in conformity of piedmont sedimentation further it is devoid of torrential stream net work and environment which firmly rule out to be genetically fan deposits The present study of these deposits its disposition its composition indicate that these deposits are older quaternary deposits and brought to the present position by tectonic activity along SONATA LINEAMENT Table NO QTG _1

The presence of the Katni Formation with angiospermic flora suggests that sedimentation continued during Mio-Pliocene in localized lakes. During Quaternary period, the site of the lakes shifted towards the present alluvium-covered area between Harda and Jabalpur due to Late Quaternery movements, the lake burst open and water rushed towards west through the present Narmada river channel. Presence of thick boulder bed in Harda inlier area, such as at Chandgarh and NE of Barwaha supports this assumption. These boulder beds carry boulders of Deccan basalts, apart from boulders of other intra -trappean formations.

Quaternary studies in Tapti-Purna valley region have 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 region.

Narmada Quaternary Graben:-

The Indian Plate is currently moving northeast at 5 cm/yr (2 in/yr), while the Eurasian Plate is moving northeast at only 2 cm/yr (0.8 in/yr). It is causing the Eurasian Plate to deform, and the Indian Plate to compress leading to tectonic activity along major fault zones.

In tectonically active areas sedimentary basins undergo phases of both crustal extension and contraction leading to basin inversion and hence display features typical of subsidence and uplift. Geomorphic attributes and deformation in late Quaternary sediments are the indicators of active tectonic activity in any sedimentary basin. The geomorphic evolution in such reactivated basins is primarily due to complex interaction between sedimentation processes and tectonics. The peninsular India has been undergoing high compressive stresses due to the sea-floor spreading in the Indian Ocean and locking up of the Indian plate with the Eurasian plate to the north. Much of this N-S directed stresses have been accommodated by the under thrusting of the Indian plate below the Eurasian plate. A part of these compressive stresses are accumulated along the Narmada-Son Fault (NSF), a major E-W trending crustal discontinuity in the central part of the Indian plate which has been release along the structural fabrics of SONATA LINEAMENT ZONE may be one of the causicative reason of earth quake in Gujarat state and central India in previous two decade. The imprints of tectonisam in Quaternary landscape in Narmada in upper and lower Narmada and hard rock terrain Mandleshwar and Barwani section are conspicuous features in Narmada rift valley Khan et.al (2002).

The Quaternary tectonic activity recorded in the lower Narmada valley, possibly, has wider ramifications when viewed in the larger perspective of the Indian plate. This suggests a renewed phase of extreme compression of the Indian plate, which led to tectonic inversion along the NSF in the lower Narmada valley. Significant increase in compressive stresses accumulating on an intracrustal fault like the NSF can transform a previously subsiding basin into an uplifting one. The NSF has been characterized by a compressive stress regime throughout the Quaternary and variations in the degree of compression relative to the rates of plate movement are responsible for the late Pleistocene subsidence and the Holocene tectonic inversion in the lower Narmada valley.The repurcessions of movement of Indian plate in regional prospective accross SONATA LINEAMENT ZONE to Himalaya are well preserved and recorded both on hardrock lanscape and quaternary land scape and in behaviour of Peninsular rivers Khan (1981) Khan et.al (1982) and Himalayan river Khan (1882)., Khan (1983), Khan et.al. (1881) (Khan et.al (1981) The Himalayan foot hill region where the rivers debouches in Indo Gangetic plain has distinct impact of movement of Indian plate, is manifasted in lower Himalaya and foot hill region Khan et.at (1980), the water divide between Ganga and Jamuna is under compressive stress and up rising as such both the rivers are opositely shifting as witnessed by concentration of river terraces on the western extrimity Ganga and eastern exrimity of Jamina is the cospicuous morhogenitic illustrattion in the region Khan et.al (1981) Khan et.al (1975-76) Nawani et.al (1981) Sehgal et.al. (1980). In the western Kashmir Himalya in Chenab basin around Katra the association of alluvial fans their assembalage, disposition & coalesance in radial pattern revealed buldging and pulsational up rise of the area in recent past Khan (1983), in Punjab Himalaya & foot hill region the anomolous behaviour of Ghaggarr, in Paonta saheb the configuration of terraces and westward shift of Jamuna, in Uttranchal Himalaya in foot hill region and further the constant migration of Ganga towards east, sequential decend of alluvial fans from southern slope of Himalayan ranges their coaleasance, stepped cut off of these fans their heads and tips acrooss across lineaments and faults illustrate the mega impact of movemnt of Indian plate on land profile and drainage along the outer Himalaya. In Indo Gangetic plain the manifestation are recorded in Ganga Yamuna Kosi Ghagra, Sharda Betwa, Tons and other rivers Khan et.al (1981) Khan et.al (1982), Khan et.al (1998).The shiting of channel course of Sharda Ghagra and Kosi may be correlated with the seimic events and aftershocks of major and minor earthquakes occurred in Himalayas and foot hill reqion form Hindukush to Minyamar Khan et.al (1981) Khan (1982).

In Son Narmada Tapti and their tributaries embodies the imprints of tectonics and neotectonisam on channels landsacpe profile physigraphy, drainage. It also display reconfiguration of drainge, mass wasting activity, geothermal activity, rock cut terraces and anomolous behaviour of channel systems are the conspicuous manifetation of impact of movement of Indian Plate Khan et.al (1982) Khan (1984) Khan et.al (2002) & Khan (2007).

In Central India the two Quaternary basins Narmada & Tapti are of tectonic origin are located 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. 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 and Narmada on the north are two Crustal blocks flanking the Satpura block. Khan et.al (2002) Khan (in press)

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, 2000). The Narmada valley gape is ideal locus of Quaternary sedimentation which persevere Glacial, Fluvio- glacial and fluvial deposit of pleistocene to Holocene times.

The ENE-WSW trending Narmada Quaternary basin, bounded by longitude 77ºE and 80ºE 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 volvcano-sedimentary sequence of Mahakoshal Group. Tikaria Gravity high reflecting emplacement of high density material (Verma and Bannrjee, 1992), lies to the south of the basin. The adjascent Satpura block in the north is characterized by high heat flow ($85\pm23mW/M^2$) with thermal springs of Anhoni (Lat.23º35'N, Long.78º36'E, Temp. 56-58ºC) and Samoni (Lat.22º36'N Long.78º21'E, Temp. 45ºC) in the west and Babeha (Lat.24º44'N Long.80º18'E, Temp. 38ºC) in the east.

The Quaternary tract of Narmada basin covers an area of abut 12950 sq. km starting from west of Jabalpur ($23^0 07^0$790530) to Bharouch (22^0 45'; 72^0 45') 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 between265.7 and 274.3 m above the sea level. The general gradient of this plain in this stretch is about 1m /Km towards West.

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, 1997). A chain of detached/isolated slices of Mahakoshal volcanosedimentary rocks are noted on southern fault bound margin. Tiwari and Bhai, (1997), on analysis of soil and tephrastratigraphy, lithological assemblage, biostratigraphy and magnetostratigraphy have identified seven lithostratigraphic units with a punctuated record of Quaternary from Lower Pleistocene to Holocene. A prominent from in the area after sedimentation of Pilikarar Formation, in Pre-Middle Pleistocene times. The activity during the period has resulted in the development of deep basin, with emergence of Hoshangabad Plateau and Piparia ridge, dividing the Narmada basin into three sub-basins. Activation along cross lineament/fault had given rise to trench like depression parallel to present course of Hiran river (Tiwari and Bhai, 1997), Thus the Dhansi Formation overlying Pilikarar Formation, has been ranked as tectogenic. Significant tectonic movements were noted in post Middle Pleistocene period prior to sedimentation of Baneta Formation; Subsequent Quaternary and Holocene sedimentation has dominantly been climatogenic The complete account of Quaternary lithostratigraphy has been up dated in the Narmada valley (Khan 1984, Khan & Benarjee 1984, Khan & Rahate 1990-91-90 Khan & Sonakia 1992, Khan & *et al* 1991, Rahate & Khan 1985, Khan *et al.* 1991, Khan 1991, Khan *et al.* 1992, Yadav & Khan 1996. The Narmada valley embodied almost whole of the Quaternary deposits time span from the lower Pleistocene to Holocene (Khan & Sonakia 1992).Khan & Sonakia (1991) sedimentology , Khan (in Press) Quartz grain morphology sediment column, Khan (in Press) Quartz grain morphology of pale- sole, , Khan (in Press) Heavy mineral assemblage Khan (in Press) tephrastratigraphy, , Khan et.al (1991) Khan & Maria (1912) magnetostratigraphy, and bio-stratigraphy and correlation of sediment columns intra valley wise , inter valley wise and on unified

Quaternary Platform Khan et.al (2012) focusing on hominid localities of China these deposits have given the new insight on the age of the Narmada *Homo erectus*. Discoveries of volcanic ash beds and palaeomagnetic reversal in these deposits for the first time for peninsular India are breakthroughs in fixing the chronologic position of the human skull. Fresh data on the age of the Narmada *Homo erectus* are also available by additional finds of fossil mammals and a detailed taxonomic study along with a thorough review of some families of mammals. The *Homo erectus* skull was discovered embedded in a conglomerate bed within the Quaternary alluvial deposits of the Narmada Valley. In Narmada Valley several biostratigraphic classifications have been suggested for Quaternary deposits. The conglomerate bed designated as Hathnora Formation which has a 19 m thickness at its type section and a 50 m compiled thickness and its exposure is limited within the mendring loop of Narmada. The section exposed is mostly by lateral cutting in the selected segment by lateral cutting, the major part of conglomerate bed is conealled under younger deposits. The Hathnora Formation which represnts boulder conglomerate is sandwiched between Boulder bed of glacial origin at the base showing Matuyama reversed polarity chron[3] (0.73 Ma) and the younger one of fluvial origin with tephra layer equivalent to Toba ash[4, 5] of 74,000 yrs BP. Some upper layers of these Narmada Valley alluvial deposits have also been proved to be older than 25,000 yrs BP by ^{14}C dating which represents youngest deposits of present domain of Narmada. Table NO QTG _2 & 3

The Quaternary blanket occurs in the central part of valley in Jabalpur –Harda section and in Gurudeshwar – Bharouche section in lower of valley; where as in the other part in Harda –Mandleshwar section thin and isolated caps and strips of quaternary sediments are noticed on rock cut terraces and rock benches of country rocks. In Mandleshwar-Barwani, Dhadgaon- Tilakwarda area the quaternary deposits are shallow to moderate in thickness and thin out to wards east. The isolated locus of accumulation of sediments and sedimentation along the entire length of 1300 kms of Narmada is controlled by the tectonics and structural frame work and sinking and uplift of fault bounded blocks and lineaments. It is well illustrated by neoseismic signatures and imprints on quaternary deposits and landscapes in the valley. The critical analysis of landscape profile evolution of drainage, quaternary terraces, river morphology and analysis of bore hole data of basement configuration of rock and quaternary deposits revealed that Jabalpur-Harda section valley segment suffered mega dislocation and sunk to level of about 1150 m as compared to the adjoining blocks and created and has formed a open rock basin and platform of sedimentation. This section display complete record of quaternary deposits of glacial, fluvio- glacial and fluvial sediments in increasing antiquity from the base. The study of bore data of ETO, CGWB, and GSI indicates and average thickness of quaternary deposits of about 435 m. The quaternary deposits bear well preserved imprints of neotectonisam indicating that the Sonata lineament zone seismically is active and has direct bearing on quaternary landscape of rift valley. The Harda –Mandleshwar section predominenently portrays the sequence of cyclic and noncyclic rock cut terraces and rock cut platform and benches which are time equivalent to the quaternary terraces of central and lower Narmada valley Khan et.al (2002) Khan et.al (2014). In Mandleshwar-Barwani the quaternary sediment are of moderate to shallow in thickness which are incised along with the country rock by cyclic structural dislocation and tectonic activity along ENE WSW lineament fabrics and dynamic incision of stream. It is well documented in quaternary terraces and composite erosional terraces; rock cut terraces caped by quaternary sediments, river profile and channel morphology. The morphogenetic expression of the section revealed uplift of block. The Gurudeshwar-Bharouche section embodies the thickest quaternary deposits which represents complete sequence from the base viz glacial fluvio-galcial fluvial, lacustrine and mud deposits. Table No QTG _4 to 6 Khan (in press)

The study of Narmada river terraces along the length of 1300 kms in between Jabalpur- Bharuch their correlation , in critical and crucial section their sediment sequence , drainage net work and its configuration , neo-seismic data imprints and signatures of modules of neo- deformation by compressive force, in relation to the movement of the Indian plate indicates that peninsular India has been undergoing high compressive stresses due to the sea-floor spreading in the Indian Ocean and locking up of the Indian plate with the Eurasian plate to the north. The study of Quaternary tectonics activity of Khandwa Sukta faults and Barwani faults Khan (in press) in the middle segment of valley , analysis of quaternary terraces of Tapti and their imprints of isoseismic events Khan (1984) in the confluence area of Tapti and Waghour, further authenticates the record that these N–S directed stresses have been accommodated by the under thrusting of the Indian plate below the Eurasian plate. The manifestation of this Phenomenon a part of these compressive stress is recorded along the NSF, a major E–W-trending crustal discontinuity in the central part of the Indian plate; further activities of significant magnitude are recorded from sea-level studies on the west coast and in the Himalaya Khan (1988), Khan et.al. (1976-77) located at the trailing and leading edges of the Indian plate Khan et.al (2002) Khan (1975-76) during the Early Holocene respectively.

In Narmada Rift system taking as single ecological unit for Quaternary sedimentation & tectonics and presence of the Katni Formation in central sector with angiosperm flora suggests that sedimentation continued during Mio-Pliocene in localized lakes. The relative disposition of such lakes and subsequent deformation and structural dislocation on oscillating valley platform clubbed with rifting and faulting during Quaternary period has shifted the site of the lakes towards the present alluvium-covered area between Harda -Jabalpur, Garudeshwar and Bharouch as presumed where as the present study of various aspects of Quaternary blanket in SONATA LINEAMENT ZONE reveled that quaternary sedimentation was a sequential and continuous process in rift valley system (Table No -3) from Mio-Pliocene Pleistocene time, has deposited complete sequence of glacial, fluvio-glacial lacustrine fluvial and tidal deposits with changing environments and climate in time & space . The present disposition of quaternary blankets in Son Narmada basin is due to post deposition Quaternary tectonics which is solely responsible for sedimentation, dislocation, faulting and shifting of different blocks and distorting ecology in rift system. The occurrence of Boulder bed and Boulder Conglomerate in Son Narmada Tapti and Purna with similar rock assemblages and suites of rock fabrics, heavy mineral assemblages, and quartz grain morphology in critical and crucial sections across the SONATA LINEAMENT ZONE strongly support tearing and rifting of quaternary blanket during late Pleistocene time. The presence of thick boulder bed in Harda inliers area, such as at Chandgarh and north east of Barwaha, boulder bed in confluence are of Tapti and waghur around Khadgaon in Tapti valley Khan et.al (1984) supports this assumption.

In the cambay area in lower Narmada basin in Narmada a significant feature is the deposition of a huge thickness of Tertiary and Quaternary sediments occur in a fault controlled rift trench. In the south of ENE–WSW-trending Narmada–Son Fault (NSF), the Tertiary rocks and basaltic flows of Deccan Trap occur on the surface while to the north they lie in the subsurface and are overlain by Quaternary sediments .However, the overlying Quaternary sediments having a maximum thickness of 800 m (Maurya et al., 1995) The bore hole data of ONGC, CGWB, GSI of deep geology in the basin have revealed occurrence of Deccan Trap at depths of 6000 m Khan (2002) Khan (in press) followed by an Achaean basement (Roy, 1990). The Tertiary sediments, outcropping to the south of the NSF, represent the full sequence from Eocene to Pliocene overlying the Deccan Trap and show extensive deformation in the form of several ENE–WSW-trending anticline highs and ENE–WSW and E–W-trending reverse faults. The quaternary landscape has been chiseled in to step sequence of terraces (NT1 –NT3) which are both paired and none paired in nature and are time equivalent to the terraces of central sector of Narmada. Table NO QTG _14, 15

The Quaternary sedimentation incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and segmental and linear displacement, dislocation, uplifting and isolated domal up- lift, Neogene rifting and Quaternary sedimentation, rift-bound Pliocene–Pleistocene rifting and volcanic activity specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System.

The Narmada Rift System, bounded by adjacent plateaus rising 300–700 m above the rift floor, consists of number symmetrical and symmetrical faulted blocks, escarpment, rock cut terraces, rock floors and segments of relicts of half grabben. Although rift-related basins started to form during the late Oligocene to early Miocene times, the Narmada rifts were fully defined by middle to late Miocene time.

The Narmada rift system provided a unique setting for dynamic ecosystems that were characterized by rift up lift and subsidence which has created ideal locus of Quaternary sedimentation and environment for the accumulation of sediments, volcanic fabrics sediments, burial, digenesis, and preservation of organic remains. The rifts formed after widespread Quaternary sedimentation occurred and voluminous sediments in the rift basins accumulated by glacial activity consequential upon the lowering of temperature and climatic changes in water shed region. The Miocene -Pliocene–Pleistocene lake deposit of Katni on the eastern rift shoulder was created by faulting, topographic control or isostatic depression within the rift system.

Impact of tectonics on fauna & flora:-

In Narmada Quaternary blanket posses abundant faunal remains in rift settings, including hominids Sonakia (1984), suggest that the Narmada Rift System created productive ecosystems during Pliocene–Pleistocene time. The volcanic rocks within the fossiliferous sediments provide temporal information for calibrating and sequencing hominid and other faunal evolution. The detailed geological sedimentological geochemical study of interbedded tephra ,Quartz grain morphology of sediments of quaternary strata and palo-sole of and geochronological studies Khan (2012), Khan (2013), Khan (2013) from the different localities for establishing the accurate biostratigraphic and lithostratigraphic data, sedimentation rates, and paleo- environmental and tectonic histories of different sediment columns revealed that inspite of tectonic dislocation subsidence and oscillation and rinsing and sinking platform of sedimentation there is intake sequential deposits in the rock basin representing the sediments of glacial fluvio-glacial, fluvial lacustrine and tidal environment along the rift system. Interbedded volcanic rocks allow determination of the time of rifting, the beginning of sedimentation, sedimentation rates, and the transition from glacial, fluvio-glacial lacustrine to fluvial environments. The cyclic environmental transitions recorded in the sedimentary sequences of the rift basins are caused by tectonic activities, changes in relief, and climatic variations. The climatic changes in uplift, topographic and landscape features, coupled with block faulting, rinsing and sinking platform, created basins for the accumulations of thick lacustrine and fluvial sediments sequences with terrestrial and aquatic fossils. The sequential change in the sediment facies from finely bedded lacustrine deposits to fluvial sediments are commonly noted in the sedimentary sequences and reflect environmental and tectonic changes that can be temporally determined. Moreover, regional correlation based on the chemistry and geochronology of interbedded tephra has made it possible to establish accurate stratigraphic relations that are useful for paleo- environment reconstruction and evolutionary studies of fossil remains in the Narmada rift valley Khan et.al. (2012).

In addition regional tephra correlation is being used increasingly to link sites together which has established that similar tephra layers are known from other parts of rift valley, as well as from other basin and peninsular India Achariya Biswas, (1998), Khan (1992) Tiwari (1992) Khan et.al. (2012). There is a great potential for further correlation of tephra in the Rift System and marine sediments in the Arabian Sea. The Arabian Sea has a continuous record of deposition that extends to at least 7 million years. The Quaternary sediments interbedded with tephra with within the age range of the ODP Ocean Drilling Program 721/722 stratigraphic sections of the Arabian Sea are also present within the rift floor and the western rift margin of the region. The chemical and chronological correlations of ash beds within the rift sequences have been made with ashes described in marine sections. Detailed correlations based on orbitally calibrated time scales of paleo magnetic stratigraphy Rao (1997) within Quaternary sediments of rift deposits, it will provide ties to establish global climate changes based on the terrestrial and marine sediments of the rift system.

The Narmada Rift System consists of asymmetrical basin that has been evolved in different stages of tectonisam. The 100 -120 km-wide ad 1300 km long rift bounded by Satpura in south and Vindhyan in north constitutes conspicuous ENE-WSW to E-W rift basin zone is filled with Pliocene–Pleistocene sediments, whereas some of them contain Miocene sedimentary deposits. Most of the sedimentary sequences contain faunal and floral remains including hominid species.

The tephra layers associated with Quaternary deposits of Narmada Rift valley have under gone faulting, rifting, and dislocation during sedimentation. The impact of structural disturbances and\evidence of the effects of tectonics on fauna and flora are distinct and their signatures on dislocation and concealing of fossiliferous horizons are uncontrolled and ill defined in the ecosystem in the valley during the Pliocene–Pleistocene periods. The boulder conglomerate which yielded the skull cap of *Homo eructs* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due inconsistency and concealed nature of fossiliferous horizon and subsidence of Quaternary blanket of Narmada rift system as such researcher and scientist failed to add any further knowledge to hominid discovery in Narmada any further .

The present Quaternary landscape of the lower Narmada valley which comprises of glacial deposit, fluvio glacial deposit and river terraces (NT-1 to NT-3) and their correlation with rest of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch , with the terraces of type area suggest that it has evolved mainly due to tectonic activity along the SONATA LINEAMENT in a compressive stress regime. The sediments were deposited in a slowly subsiding basin during early Pleistocene middle Pleistocene and the Late Pleistocene. The Holocene period is marked by inversion, which had earlier suffered subsidence. The inversion of the basin is due to a significant increase in compressive stresses along the NSF during the Early Holocene, resulting in differential uplift of the lower Narmada valley. The continuation of the compressive stress regime due to ongoing northward movement of the Indian plate indicates that the NSF is a major candidate for future intraplate seismicity in the region.

The Quaternary deposits entrapped in tectonic zone in the lower Narmada valley as claimed by Chamyal (2012) is alluvial fan as identified between Tilakwarda and Rajpipla within the loop of Narmada. It is mono illustration of morphogenetic process and morpho-tectonic manifestation associated with neotectonic event. The disposition of Quaternary blanket and other quaternary land forms are controlled and restricted by SONATA LINEAMENT. The convergence of fan deposits and its apex is not in persistent and in conformity of piedmont sedimentation, further it is devoid of torrential stream net work and environment which firmly rule out to be endogenetic of fan deposits The present study of these deposits its disposition its composition indicate that these deposits are older deposits moved from basement and brought to the present position by tectonic activity along SONATA LINEAMENT.

The occurrence of Boulder bed and Boulder Conglomerate in Son Narmada Tapti and Purna with similar rock assemblages and suites of rock fabrics, heavy mineral assemblages, and quartz grain morphology in critical and crucial sections across the SONATA LINEAMENT ZONE strongly support tearing and rifting of quaternary blanket during late Pleistocene time. The presence of thick boulder bed in Harda inliers area, such as at Chandgarh and north east of Barwaha, boulder bed in confluence are of Tapti and waghur around Khadgaon in Tapti valley Khan et.al (1984) Khan

There are evidences of the effects of tectonics on fauna and flora are distinct and its signatures on dislocation and concealing of fossiliferous horizons are uncontrolled and ill defined in the ecosystem in the valley during the Pliocene–Pleistocene periods. The boulder conglomerate which yielded the skull cap of *Homo eructs* in Narmada rift from Hathnora Sonakia (1984) remained only discovery as scientist have not attepmted to trace and concived the three dimention modal of fossiliferous boulder conglomerate and associated horizon as such paleontlogical studies and findings of fossil remains of Narmada only restricted to the river section fossiliferous strata.

There are evidences of the effects of tectonics on fauna, flora .and tephra layers associated with Quaternary deposits of Narmada Rift valley, have under gone faulting, rifting, and dislocation during sedimentation. The impact of structural disturbances and\evidence of the effects of tectonics on fauna and flora are distinct and their signatures on dislocation and concealing of fossiliferous horizons are uncontrolled and ill defined in the ecosystem in the valley during the Pliocene–Pleistocene periods. The boulder conglomerate which yielded the skull cap of *Homo eructs* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due inconsistency and concealed nature of fossiliferous horizon due faulting, dislocation and subsidence of Quaternary blanket of Narmada rift system as such researcher and scientist failed to add any further knowledge to hominid discovery in Narmada any further .

Table No QTG- 1:										
Quaternary Stratigraphy of the Narmada Valley (Jabalpur - Nusrullaganj - Harda Section)										
Chrono	**Megneto**	**Morpho-**	**Litho**	**Soil Stratigraphy**			**Tephra**	**Biostratigraphy**		
Stratigraphy	**Stratigraphy**	**Stratigraphy**	**Stratigraphy**	**Soil Type**	**Degree of Oxidation**	**Degree of Calcification**	**Stratigraphy**	**Faunal**	**Pollen**	**Paleoclimate**
								Assemblage	**Assemblage**	
	Not Done		Ramnagar Formation	I	Nil	Nil	…….	…….	……	
			Amber Formation					Upper		Present
		NT_O	Indra/Kolar formationAmba/	II	Nil	Low	……	Assemb lage	….	Climate
Holocen e		T_0 Deposi tional	Janwasa Formation							
		NT_1	Hoshangabad							Warm and
		T_1 Erosional	Formation	III	…..	…..	......	…..	….	Semiaerid
13 Ka Bp		Surfface								
	BRUNHES NORMAL	NT_2-A	Shahganj				NAB-III			Warm and
Upper		T_2 Depositio nal	Formation	IV	Low	Intense	volcanic Ash			Semiaerid
Pleiston cene		Surface					Transpo rted	Upper		
		NT_2-B	Demaur	V	Moderate	Moderate	NAB-II volcanic Ash	Assemb lage	Graminae Composit ae	↑
128 Ka Bp			Formation						Chenopo diacae	
Middle		NT_2-C	Shivpur	VI	High	Moderate	…….	Lower		
Pleiston			Formation					Assemb		

cene									lage		
700 Ka Bp			NT_3-A	Nusrullahganj	VII	Very High	Low	……			
	Matuyama			Formation							
	Reversed										
			NT_3-B	Sohagpur	VIII	Intense	Nil	……	Not Reported	…..	Warm and Humid
				Formation							
Lower	……… ……	………… …	Hathmora	………….Fluvio-glacial/deposit …………			NB-I	………………………………………			
Pleistocene				Formation							
				(Boulder conglomerale)							
………………………………… …….				(Boulder bed)	glacial/Fluvio-glacial/deposit			……………………………………………… ……			

Table No QTG -3:- Major Quaternary Events in Central India.

Age	**Climatic events**		Geomorphic features (khan e1.a1.1992)		Weathering events	Sedimentary events after Tiwari 2001	Tepra Events Khan e1 a1.1991	Palaeo - Magnetic events Y.Rao e1. al 1997	Tectonic events		Sedimentation events sedimentation after Khan et.al 1992
4 ka Late Holocene	On set of aridity	up warping /climatic changes/ ecstatic changes	Inset terrace formation (NT_0)		----------	Ramnagar formation Boaras formation	----------	----------		Relative disposition divergent/Terrace paining	Amber/Indrakdar/Amba Janswasa formation unicycle
6Ka-13ka, Middle to Early Holocene	Good Monsoon		15m to 30m of entrancing of river (NT_1)	I V	Vertisol	Boaras formation	----------	----------			Hoshangabad formation polycycle
13ka to 25ka, late upper Pleistocene	Arid		Older flood plain(NT_2 A)	V	----------	Hirdepur Formation	Reworked Tepra NA_B-III	Brunhes normal polarity			Shahganj Formation
	Humid		Dissection of Baneta Formation		Brown soil	--------	--------	--------			Polycycle
75ka	---------		--------		--------	--------	Tepra	Brunhes Normal polarity			Polycycle
75ka to 118 ka early upper Pleistocene	Arid		Aggradation Degration (NT_2B)	I V	--------	Baneta Formation	NA_B-II	Brunhes Normal polarity			Demarwar Formation
									Rejuvenatation of south		

									Satpura fault purna Tapti Valley		
					Yellow Clayey Soil	--------	--------	Brunhes Normal polarity			Polycycle
Middle Pleistocene	A Bid		Agradation & Degradation (NT$_2$C)	III		Surajkhund Formation	--------	Brunhes Normal polarity			Shivpur Formation
	--------		----------		Red Soil	----------	---------	Matuyama Reverse polarity			
									Formation of structural basin in the purna valley		Polycycle
Lower Pleistocene	A Bid		Agradation & Degradation (NT$_3$A)	II	----------	Dhansi Formation	-----	Matuyama Reverse polarity			Nasruhahganj Formation
									Formation of structural basin in the Central Narmada valley		Polycycle
Lower Pleistocene	Humid		Agradation & Degradation		Laterite/latosol	Pilikarar formation	------	-----	-----		Sohagpur Formation
Lower Pleistoce	warm/cold		Agradation			Hathmora formation	NA$_B$-I	Entrenchmal			

ne			& Degradation			(conglomerate)		formation of structural basin in Narmada			
	warm/cold		Agradation & Degradation			Boulder conglomerate (Base not exposed)		Entrenchmal formation of structural basin in Narmada			

--------------------------------------Unconformity --
Basement

Table No QTG- 4:- Geomorphology of Jabalpur Section Narmada Valley.
The Morphochronological sequence of Quaternary Surfaces increase antiquity

Bheraghat Surface (NTo)
(340 m above m.s.l.)
-------------------------- Aggradation and degradation of younger Alluvium.------------------------Lameta surface (NT1)
(340 to 345 m above m.s.l.)
-----------------------Aggradation and degradation of older Alluvium.-------------------------------Jabalpur surface (NT2)
(345 to 360m above m.s.l.)
-----------------------------Aggradation and degredation of older Alluvium--------------------------Nansar Surface (NT3)
(380 to 400 m above m.s.l.)
----------------------------- Aggradation and degradation of older Alluvium--------------------------
Barela surface
(400 to 420m above m.s.l.)
--------------------------------Dissection and partial aggradation. -----------------------------------
Lalmati surface
(440 to 460 m above m.s.l.) -
------------------------------- ------ peneplanation---
Tikhari surface
(460m and above)
---Peneplantation---
Gadhari surface
(480m and above)
--- Peneplanatio--

Table No QGT- 2 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 QTG- 5:-

Geomorphology of the area Around Narsimhpur Narmada Valley

(22.35N, 78.0078.15) (55 N/5, 9, 13; 55 I/4, 55 J/6, 13)

The Morphochronological sequence of Quaternary Surfaces increase antiquity

Narmada Terraces (NT)
(385 m to 390 m above MSL)
---------------------Aggradation & Degradation of younger Alluvium ----------------------
Narmada Terrace (NT1)
(390 m and above MSL)
----------------------Aggradation and degradation of younger Alluvium----------------------
Narmada Terraces (NT2)
(400 m and above MSL)
------------------------Aggradation and degradation of older Alluvium-------------------------
Narmada Terrace (NT3)
(380 to 420 m above MSL)
----------------------Aggradation and degradation of older Alluvium-------------------------
Lehata surface
(400 m and above MSL)
----------------------------------Peneplanation-----------------------------------
Chhepra Surface
(530 m and above MSL)
------------------------------------Peneplanation------------------------------------
Khama Surface
(550 m above MSL)
----------------------------------Peneplanation----------------------------------
Nangadevi Surface
(560 m above MSL)
-------------------------------------Nakatiya Surface-------------------------------------
(580 m above MSL)
-------------------------------------Peneplanation-------------------------------------
Khairpani Surface
(600 m. above MSL)
--------------------------------Peneplanation--------------------------------

Table No QTG-6:- Fluvial Terraces of the Narmada Alluvium.

Terrace Designation	Elevation above MSL	Nature of its Origin	Morphostatigraphy
NT0	260-280m	Depositional	Light grey to dark grey sand and silt
NT_1	280-300m	Erosional/Depositional	Light grey to dark grey sand and silt with rock pebble sand and silt
NT_2A	300-320m	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 QTG-7	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							Paniplain/ Pediplin	Pediplain/ pediment
locality: JABALPUR Central I	River bad	NTo	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 Pediplain 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---------		To wards south	To wards south
Nature of surface	---------------Depositional ---------------				---------------Erosionall ---------------			Erosional	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--------		-----------------------------Towards NE------------------------------			
Relative disposition	Convergent Divergent / Divergent Divergent Divergent -------------------------- Convex slope----------------------								
Paired/Unpaired	Unpaired Unpaired Paired Paired Paired Paiired / 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	**Cuspate------- 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, basallt, phyllite, slate, sand and silt.** **NTo : 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 QTG-8	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NARMADA VALLEY							Peniplain Pediplain	Pediplain
Locality :HATHNORA	River bad	NTo	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 NTo , 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 Paiired / 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	--------- Cresent / Cuspate------- ----------------------------- Rectangular-------------------------- Isolated cap								
Land use pattern	----------------------------------Inhabitation / cultivation-/ Forest cover area--------------------------								
Composition/Litho constituents arranged in	River bad : Quartzite, gneiss, granite, meta basic , , basalt sandstone, limestone , Augate, Jaspar, , slate, , schist sand and silt.								

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.	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, 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.

Table NO QTG-9	**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								
Elevation 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	Divergent	
Paired/Unpaired		Unpaired	Unpaired	Paired	Paired	Paired		Paiired / 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	--------- 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 QTG-10	**GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NARMADA VALLEY**							**Pediplain**	**Pediplain /pediment**
Locality: NASRULLAHGANJ-HANDIA-HARDA SECTION	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PP	PD
Age	HOLOCENE								
Elevation above MSL (m)	255	265	270	280	290	300	310	313	318
Geomorphic break (m)	0.00	10.00	10.00 Alluvial section	10.00 Alluvial section	10 Alluvial section	10.00 Alluvial bluff with rock cut base	10.00 Rock cut terrrace	3.00 Slope with breaks and micro nicks with soil cover	4.00 Distinct breaks with rock relicts and imprints of erosional activity.
Elavation above RB (m)	0.00	10.00	20.00	30.00	40.00	50.00	60.00	63.00	68.00
Slope	---------Towards west & SW--------			--------Towards west and SW---------		---------Towards west & SW---------		S-SSW	S-SSW
Nature of surface	--------Depositional ------				---------------Erosionall ---------------			Erosionall	Erosionall
Cycle Sedimentation	----------------------------Polycycle ------------------------------					-- Section not not exposed---------		- Section not not exposed	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	
Paired/Unpaired		Unpaired	Unpaired	Paired	Paired	Paired	Paiired / 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 coverd 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, basalt, sandstone, limestone , Augate, Jaspar, 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 QTG-11	**GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NARMADA VALLEY**							**Pediment Pediplain Paniplain**	**Paniplain Pediment**
Locality: NASRULLAHGANJ-HANDIA-HARDA SECTION	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PD/PP	PP/PD
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
Elevation 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	
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 coverd 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, Jaspar, 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 QTG-12	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NARMADA VALLEY							Pediment Pediplain Paniplain	Pediment Pediplain
Locality: BARWANI- I	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PD/PP	PD/PP
Age	HOLOCENE								
Elavation above MSL (m)	218 Incisional scarp	223 Bank cut scar	235 Alluvaial scarp	239 Alluvial section with rock face	242 Rock /Alluvial face	245 Alluvial section with rock face	257 Rock cut Terraces rock Scar	260 Gradual	262 Gradual
Geomorphic break (m)	0.00 Bank Scar	5.00 Rock and alluvial face	12.00 Steep Alluvial face with rock platform	4.00 Composite Rock Face	3.00 Composite cliff section with rock and recent sediments	3.00 Rock Face	12.00 Composit Rock Face	3.00 Breaks gradual with thin covers of soil	2.00 Breaks distinct with relict of intensive erosional activity.
Elavation above RB (m)	0.00 River bad Braided Channel, Point Bar, Side Bar	5.00 Rock Face and Alluvial Bluff	17..00 Rock Face and Alluvial Bluff	21..00 Rock cut face with thin vaneer of recent sediments rock Face	24.00 Rock cut face with thin vaneer of recent sediments	27.00 Composit Rock Face with thin sediments	39.00 Rock cut Terraces rock Scar	42.00 Distinct	44.00 Distinct
Slope	---------Towards west & SW---------		--------Towards west and SW---------		---------Towards west & SW----------			SW	SW
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	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	--------- 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 /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 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. NTo 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 Gneiss, granite, quartzite 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 Rock cut scar with thin vaneer of quaternary sediments with Gneiss, Quartzite gneiss, granite, meta basic sand stone basalt limestone, schist, slate, sand, silt and clay. NT3-B Rock cut scar with thin vaneer of quaternary sediments with Quartzite limestone sandstone, gneiss, granite, basalt slate, schist, phyllite, meta basic sand, silt and clay. Note : NT3-A , B Rock cut Scar , Strand lines , rock cut dissected nicks 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 QTG_13 Geomorphology & Digonestic Elements of Narmada valley Locality: GURUDESHWAR	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-A NT3-B NT3-C	Pediplain / Paniplain PD/PP	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 ------ Errosional ………….				Rock cut terraces and Rock scar --------Erosional ---Lieanr scar line -----			Erosional ---	Erosional ---

Cycle Sedimentation	**Upward 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**							
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.** **NTo 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**							

TABLE NO QTG_14 Geomorphology & Digonestic Elements of Narmada valley Locality: TILAKWARDA	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT-3	Pediplain / Paniplain PD/PP	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 ---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	--------- 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. NTo 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						

TABLE NO QTG_15 Geomorphology & Digonestic Elements of Narmada valley Locality:	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-A NT3-B NT-C	Pediplain/ Paniplain PD/PP	Pediment /PD

BHARUCH									
Age	HOLOCENE								
Elevation 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	**--------- 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.** **NTo 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 ---**	

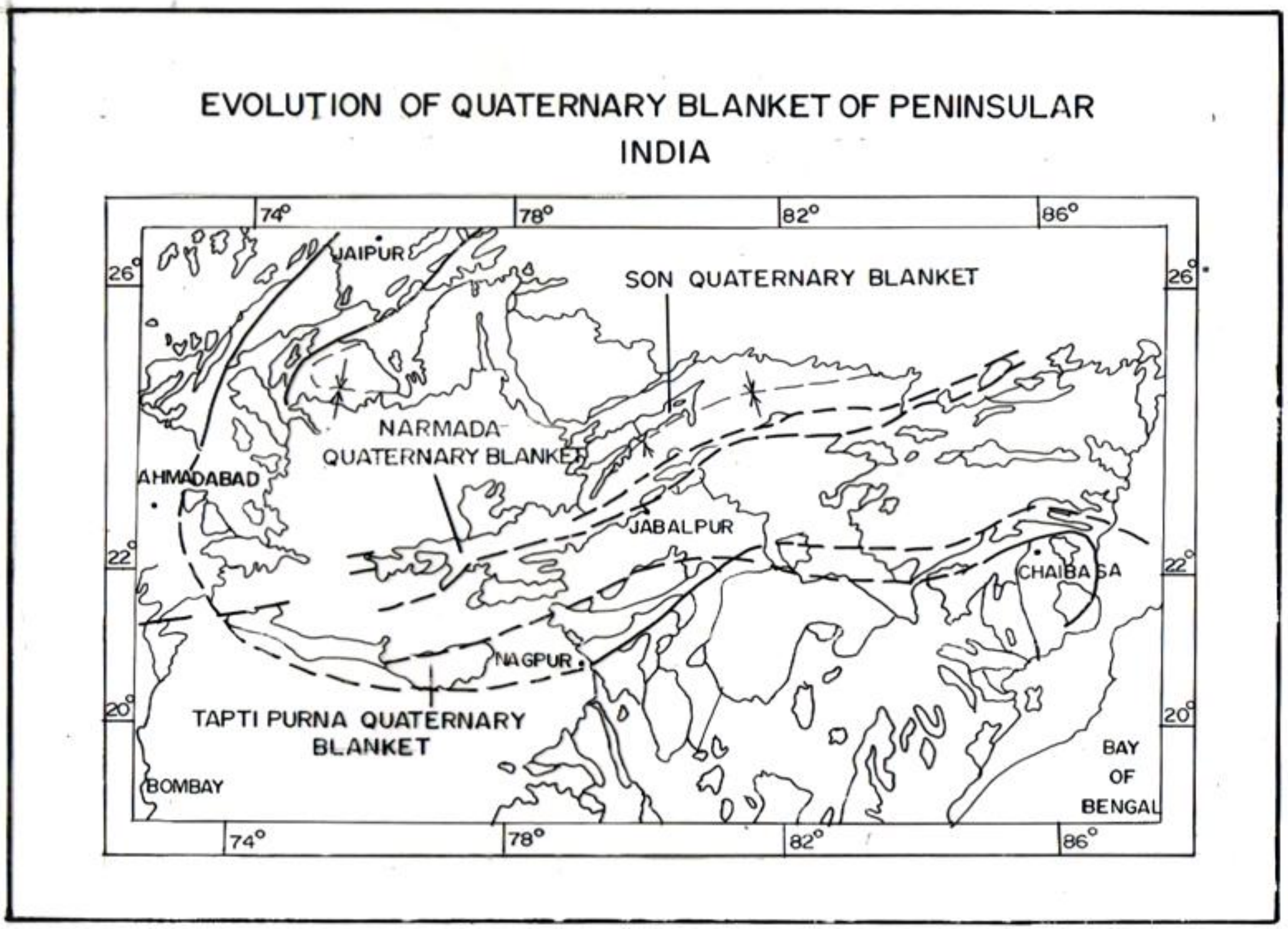
EVOLUTION OF QUATERNARY BLANKET OF PENINSULAR INDIA
74°
78°
82°
86°
26°
22°
20°
JAIPUR
SON QUATERNARY BLANKET
NARMADA QUATERNARY BLANKET
AHMADABAD
JABALPUR
CHAIBASA
NAGPUR
TAPTI PURNA QUATERNARY BLANKET
BOMBAY
BAY OF BENGAL

Plate No. 1

Conclusion:-

The Indian Plate is currently moving northeast at 5 cm/yr (2 in/yr), while the Eurasian Plate is moving northeast at only 2 cm/yr (0.8 in/yr). This is causing the Eurasian Plate to deform, and the Indian Plate to compress leading to tectonic activity along major fault zones.

In tectonically active areas sedimentary basins undergo phases of both crustal extension and contraction leading to basin inversion and hence display features typical of subsidence and uplift. Geomorphic attributes and deformation in late Quaternary sediments are the indicators of active tectonic activity in any sedimentary basin. The geomorphic evolution in such reactivated basins is primarily due to complex interaction between sedimentation processes and tectonics. The peninsular India has been undergoing high compressive stresses due to the sea-floor spreading in the Indian Ocean and locking up of the Indian plate with the Eurasian plate to the north. Much of this N-S directed stresses have been accommodated by the under thrusting of the Indian plate below the Eurasian plate. A part of these compressive stresses are accumulated along the Narmada-Son Fault (NSF), a major E-W trending crustal discontinuity in the central part of the Indian plate.

The Quaternary tectonic activity recorded in the Narmada valley, possibly, has wider ramifications when viewed in the larger perspective of the Indian plate. This suggests a renewed phase of extreme compression of the Indian plate, which led to tectonic inversion along the NSF in the lower Narmada valley. Significant increase in compressive stresses accumulating on an intracrustal fault like the NSF can transform a previously subsiding basin into an uplifting one. The NSF has been characterized by a compressive stress regime throughout the Quaternary and variations in the degree of compression relative to the rates of plate movement are responsible for the late Pleistocene subsidence and the Holocene tectonic inversion in the lower Narmada valley.

The present Quaternary landscape of Narmada valley which comprises of glacial deposit, fluvio glacial deposit and river terraces (NT-1 to NT-3) and their correlation with rest of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch , with the terraces of type area suggest that it has evolved mainly due to tectonic activity along the SONATA LINEAMENT in a compressive stress regime. The sediments comprising these were deposited in a slowly subsiding basin during early Pleistocene middle Pleistocene and the Late Pleistocene. The Holocene period is marked by inversion, which had earlier suffered subsidence. The inversion of the basin is due to a significant increase in compressive stresses along the NSF during the Early Holocene, resulting in differential uplift of the lower Narmada valley. The continuation of the compressive stress regime due to ongoing northward movement of the Indian plate indicates that the NSF is a major candidate for future intraplate seismicity in the region.

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

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

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

There are evidences of the effects of tectonics on fauna, flora .and tephra layers associated with Quaternary deposits of Narmada Rift valley, have under gone faulting, rifting, and dislocation during sedimentation. The impact of structural disturbances and\evidence of the effects of tectonics on fauna and flora are distinct and their signatures on dislocation and concealing of fossiliferous horizons are uncontrolled and ill defined in the ecosystem in the valley during the Pliocene–Pleistocene periods. The boulder conglomerate which yielded the skull cap of *Homo eructs* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due inconsistency and concealed nature of fossiliferous horizon due faulting, dislocation and subsidence of

Quaternary blanket of Narmada rift system as such researcher and scientist failed to add any further knowledge to hominid discovery in Narmada any further .

References:-

1. Acharyya, S.K., Basu, P.K., 1994. Reply to comments by S. Mishra and S.N. Rajaguru and by G.L. Badam and S.N. Rajaguru on "Toba ash on the Indian subcontinent and its implication for the correlation of Late Pleistocene alluvium". Quaternary Research 41, 400–402.
2. Acharyya, S.K., Kayal, J.R. and Roy, A. 1998 "Jabalpur Earthquake of May 22, 1997: Constraint from after Shock Study", Journal Geological Society of India, Vol. 51, pp. 295-304. Agarwai, B.N.P., Das, L.K., Chakraborty, K. and Sivaji, C.H. 1995 "Analysis of the Bouger anomaly over central India: A
3. Acharyya, S.K., Kayal, J.R. and Roy, A. 2000, Tectono thermal history of the central India tectonic zone and reactivation of major faults, Jour.Geol.Soci. India 55,239-256
4. Agarwal, G.C 1986.Structure and tectonic so exposed tertiary rock between Narmada an Kaim river in South Gujarat , Jour.Geol.Soci. India .27,531-542
5. Auden J.B., 1949 A Geological Discussions on the Satpura Hypothesis and Garo-Rajmahal Gap. Pr. Nal. Inst, Sci Ind., Vol. 15 pp 315-340
6. Auden, J.B. (1933): Vindhyan sedimentation in Son valley, Mirzapur district, U.P. Rec. Geol. Surv, India, V. 96(2).
7. Auden, J.B. 1949 "Dykes of Western India", Trans. Instt. Of sci. ind., V.3, pp. 23-157.
8. Bala Chandran V. & A.A. Khan. Proced. (1983) 76th Sci.Cong. Pt. III "Elucidation of Morphogenetic Expression of Eastern Part of Inter Mountains Dun Valley U.P.".
9. Bala Chandran V. & A.A. Khan. Proced. (1983) 76th Sci.Cong. Pt. III "Elucidation of Morphogenetic Expression of Eastern Part of Inter Mountains Dun Valley U.P.".
10. Bhattaacharji, S; Chatterji,N; Wampler J.M. 1996 Zones of Narmada Tapti area activation and Deccan volcanisam: geochronological and geochemical evidences.In Deshmukh,S.S; nair ; k.K.K. (Eds)Deccan Baslts. Gondwana geological society, Nagpur PP 329-340
11. Chamya ,L.S; Khadkikar, ,J.N Maurya ,D.M Bhandari Rachna Raj ,S (2002) late Quaternary geomorphic evolution of the lower narmada valley , western India , implication for Neotectonicactivity along the Narmad-Son fault.
12. Chamya, L.S; Khadkikar, A.S.Malik, J.N Maurya, D.M.1997. Sedimentology of the Narmada Alluvial Fan , WesternIndia . Sediment.Geol.109, 263-340
13. Chanda, S.K (1960) on certain structures of Heavy minerals of Assamtertiaries and their gelogical interpretation. Quart.Jour, Min.Met, India, vol 52, 141-444
14. Dubey U.S. & Khan A.A. "Quaternary Sedimentation and provenance of River Terraces deposits of Bhagirathi valley, Garhwal Himalaya, U.P. India" (Accepted at IV Regional Conference of Geology of South East Asia 1981, held at Manila, PHILLIPINES).
15. Gozi, P., (1968) On heavy mineral Zones in the geosynclineal serires –Recent studies in the north AlppenninesItaly Jour.Sed.Pet., 35, pp109-115
16. Ground Water 2007 National Seminar on Agriculture Developmentand rural Drinking water 4-5 April 2007 India
17. Jain, S.C., Nair, K.K.K.and Yedekar, D.B. (1991**):** Geology of Son-Narmad-Tapti lineament zone in Central India, in final report "on studies in phase II special project CRUMANSONATA" progress report (unpublished) Geol. Surr. Ind.
18. Jain, S.C., Yedekar, and D.B.and Nair, K.K.K (1991): Central Indian shears Zone, a major Precambrain Crustal boundary. Jour.Geol Soc. India Vol.37. pp.521 – 531.
19. Kaila, K.L.1988**:** Mapping the thickness of Deccan Trap flows from DSS studies and inferences about a hidden Mesozoic basin in Narmada-Tapti Region. Proc. workshop on Deccan Flood Basalts, December 1988. Geol. Surv. India. pp. 81-177.

20. Khan A.A & et al. (2002) A Multithematic Map & a Bilengual Geological Note entitled. District Resource Map-Raisen District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
21. Khan A.A & et al. (2002) A Multithematic Map & a Bilengual Geological Note entitled. District Resource Map-Khandwa District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
22. Khan A.A & et al. (2002) A Multithematic Map & a Bilengual Geological Note entitled. District Resource Map-Khargone District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
23. Khan A.A (1988) Geology of Geomorphology of Betwa Sub-basin parts of district Bhopal, Raisen & Vidisha, Madhya Pradesh. National Seminar on River Cultures of India". Indira Gandhi Rashtriya Manav Sangrahalaya, Bhopal.21-24, Sept.1998
24. Khan A.A. et.al(2002) & et al. District Resource Map-Sehore District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
25. Khan A.A. et al. (2002) District Resource Map-Raisen District, Madhya Pradesh.GSI publication © Government of India copyright 2002.
26. Khan A.A. & Aziz, Maria (2015) Quaternary Tectonics & Sedimentation in Narmada Rift Valley, With Special Reference to Garudeshwar and Bharuch Section Gujarat State India, ISSN 2320-5407 International Journal of Advanced Research (2015), Volume 3, Issue 3, 430-457 430 Journal homepage: http://www. journalijar. com.
27. Khan A.A. & Balchandran,V (1974-75) Records Volume109 of Gelogical survey Of India partI,pp.59
28. Khan A.A. & Dubey U.S. (1981). "A.Study of River Terraces of Ganga River Complex, Garhwal Himalayas" Man & Env. V. 1981.
29. Khan A.A. & Dubey U.S(1981). "Evolution of Quaternary land scape of Submountaine Jamuna Valley in Dehradun, U.P. and Sirmur M.P." Geol.Surv. India Rec. Vol. 112 Pt. 8.
30. Khan A.A. & Dubey U.S.(1982) "Quaternary environment in Mandakani Valley. A study & evaluation of Terraces and Human Civilization, Garhwal Himalayas, U.P."
31. Khan A.A. & et al 2002.A Multithematic Map & a Bilengual Geological Note entitled. District Resource Map-Khandwa District, Madhya Pradesh. GSI publication © Government of India copy right
32. Khan A.A. & et al. (1996) A multidisciplinary project Report entitled. Quarternary Geology of Narmada valley in Jabalpur, Narsingpur, Hoshangabad, Sehore & Raisen District Madhya Pradesh. (A project report for field seasons 1989-90 – 1992-93.(GSI Publication May, 1996)
33. Khan A.A. & et al. (2002). A Multithematic Map & a Bilengual Geological Note entitled. District Resource Map-Sehore District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
34. Khan A.A. & et al. A Quadrangle Geological Map with bilingual Geological note entitled. Jhabua Quadrangla Madhya Pradesh, Gujarat (46J) GSI Publication © Govt. of India copyright (Map under Publication)
35. Khan A.A. & et al. A Quadrangle Geological Map with bilingual Geological note entitled. Jabalpur Quadrangla Madhya Pradesh, Gujrat (55M) GSI Publication © Govt. of India copyright (Map under Publication)
36. Khan A.A. & et al. Seminar / Symposium / Scientific Conference Attended. Geomorphic Evolution of Quaternary Sedimentation in the Upper Ganga Basin, Garhwal Himalaya, Uttranchal Ground Water 2007.National Seminar on Agriculture Developmentand rural Drinking water 4-5 April 2007 India
37. Khan A.A. & et al. (2002). A Multithematic Map & a Bilengual Geological Note entitled. District Resource Map-Dhar District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
38. Khan A.A. & Maria Aziz (2012)"Homo erectus On Unified Quaternary Platform in India and China a Correlation & Sequential Analysis". Status Published Research Scapes International Journal Vol I, Issue IV October -December 2012. (ISSN: 2277-7792)

39. Khan A.A. & Nawani P.C. "Quaternary Geological and Geomorphological evaluation of Eastern part of Ganga Complex, Garhwal Himalayas, and India". (Accepted at IV Regional Conference of Geology of South, East Asia, 1981, held at Manila PHILLIPINES).
40. Khan A.A. & Srivastava M.C. (1983) Symp. Quat. Epi. In India. "An attempt on Morphogenetic appraisal of the Chenab Basin, District Udhampur of Jammu, J&K State".
41. Khan A.A. (In press) Jhabua Quadrangla Madhya Pradesh, Gujarat (46J) GSI Publication © Govt. of India copyright (Map under Publication)
42. Khan A.A. (1998) Geology of Geomorphology of Betwa Sub-basin parts of district Bhopal, Raisen & Vidisha, and Madhya Pradesh."National Seminar on River Cultures of India". Indira Gandhi Rashtriya Manav Sangrahalaya, Bhopal.21-24, Sept.
43. Khan A.A. "Geo-Dynamic". "Neotectonism in Himalaya" GSI Publication
44. Khan A.A. (1984) Geology of Geomorphological studies in parts of Narmada Basin, Sehore Dist. Of M.P. Geol Surv. Of India Progress Report (Unpublished).
45. Khan A.A. (1994) Geological and Geomorphological studies around Tapti-Vagher confluence district Jaloaon Maharastra, Geol. Surv. Of India, Rev. Vol. 113 pt. 6 pp 99 – 109.
46. Khan A.A. and Bajerjee, S.N. (1985): Geomorphological and geological studies of Quaternary sediments in collaboration with project Crumansonata in parts of the Narmada basin, Sehore, Dewas and Hoshangabad districts unpublished Geol. Surv. Ind. Progress Report.
47. Khan A.A. Dubey, U.s. and mahesh M.C. , (1985) An Attempt to study the sedimentry structures and paleo currents of Quaternary terraces of Alaknanda Valley , garhwal himalya , U.P.(Accepted for publicationin GSI Records 0f 1985
48. Khan A.A. et.al & (2002). District Resource Map-Khargone District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
49. Khan A.A. et.al (2007) Geomorphic Evolution of Quaternary Sedimentation in the Upper Ganga Basin, Garhwal Himalaya, Uttranchal
50. Khan A.A. Khan, (2002) et. al District Resource Map-Khandwa District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
51. Khan A.A. Khan, (2002) et al. District Resource Map-Jhabua District, Madhya Pradesh. GSI publication © Government of India copy right 2002.
52. Khan A.A. Quarternary Geology of Narmada valley in Jabalpur, Narsingpur, Hoshangabad, Sehore & Raisen District Madhya Pradesh. (A project report for field seasons 1989-90 – 1992-93) (GSI Publication May, 1996)
53. Khan A.A.(1981) "Sedimentary structures in Quaternary terraces, Manda Kini Valley, Garhwal Himalaya, U.P. 19
54. Khan A.A., & Aziz Maria ; (2013) Heavy Metals in Fly Ash of Singrauli Thermal Power Plants, Its impact On Environment and Ecology, A Sequential Analysis" Status Published Research Scapes International Multidisciplinary Journal VolI, Issue II April_ June 2013 .
55. Khan A.A., & Aziz, Maria Geoenvironmental Appraisal of The Area Around Singrauli Coal Field, District Singrauli Madhya Pradesh – A Case History (In Presss)
56. Khan A.A., & Dubey U.S. (1881-82) Evaluation of Quaternary Landscape of Intermontane Jamuna valley in Dehradun (U.P.) and Sirmur H.P. Rec. Geol. Surv. Indi. Vol. 112, part VIII, p. 125-135.
57. Khan A.A., Dubey U.S. & Shrivastava M.C. . An attempt on Morphogenetic expression of a part of U.P. & M.P. Himalayas besed on the LANDSAT Imagery. Proc. 74th Ind. Sci. Cong. Pt. III Abstract.
58. Khan A.A., (2002) et al. District Resource Map-Khandwa District, Madhya Pradesh. GSI publication © Government of India copy right 2002.
59. Khan A.A; & Joshi O.P. (2014) Geology Lithostratigraphy And Correlation of Basaltic Lava Flows of Parts of Western Madhay Pradesh With Special Reference To Megacryst Bearing Horizons And Geotechnical Aspects For Heavy Engineerging Structures
60. Khan, .A. Dubey U.S. & Saffdary S.H. Proc. 75th Ind.Sci.Cong. Pt. III. "Disposition of Lineaments in Techtonic Zone of Narmada – Son valley of parts Of Madhya Pradesh."
61. Khan, A. A, Rahate, D.N, Fahim, M & Banerjee, S.N.(1991) Evaluation of Quaternary terrace of

lower Narmada valley , Districts Sehore and Hoshangabad, Madhya Pradesh
62. Khan, A., & Sonakia, A. (1992). Quaternary deposits of Narmada with special reference to the hominid fossil. *Journal of the Geological Society of India, 39,* 147-154.
63. Khan, A.A & Aziz, Maria (2014-15) Tectonics Evolution, Quaternary Sedimentation, And The Paleoanthropological Record InThe Narmada Rift System (m.p.) Central India Khan*, A.A. Aziz, Maria International Journal for Research and Technological Sciences Vol. 1, Issue 1 (2014) 91-93 ISSN -2349-0667
64. Khan, A.A and Sonakia, A (1992) Quaternary deposits of Narmada with special reference to the Hominid Fossils, Jour. Geol. Soci. Of India Vol. 39 No2, pp 147-154
65. Khan, A.A et.al Multithematic Map & a Bilengual Geological Note entitled District Resource Map-Jhabua District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
66. Khan, A.A, Rahate, D.N,, FAHIM, M. and Banarjee,S.N (1992) Evaluation of Geology and Geomorphology in Central Narmada Valley (Districts Sehore and Hoshangabad, Madhya Pradesh) Scientific Publishers, Jodhpur.
67. Khan, A.A, Rahate, D.N. (1991) Volcanic Ash from Quaternary deposits of Narmada Valley Central India. Proceed, of 78^{th} session of Indian Sci. Cong. Association. (Abstract) pt. III pp 28-29
68. Khan, A.A. & Aziz; Maria (2013) Homo Erectus & Homo Sapien in Spectrum of Volcanic Ecology, Narmada valley (M.P.) India Research scapes vol. i issue -4 pp-161 -178
69. Khan, A.A. Aziz; Maria (2014) Tectonics Evolution, Quaternary Sedimentation, And the Paleoanthropological Record in the Narmada Rift System (M.P.) Central India, International journal of Research in Technological sciences vol.1, Issue I January 2014 PP198-233 (ISSN-2349-0667)
70. Khan, A.A. & Aziz; Maria (2014-2015). Quaternary volcanic Eruption Toba Ash fall its impact on Environment of late Pleistocene Hominines in Indian subcontinent with Special Reference to Narmada Valley. International journal of Research in Technological sciences vol.1, Issue 2 & Vol-2 issue-1 July -January 2014 January-June 2015 PP1-18 (ISSN-2349-0667)
71. Khan, A.A. & Aziz; Maria (2015). A biotic & Biotic Aspects of Fluorine occurrences in parts of Chindwara District (M.P.) India, A. International journal of Research in Technological sciences vol.1, Issue I January 2014 PP198-233 (ISSN-2349-0667)
72. Khan, A.A. & Banerjee, S.N. (1984) Geology and Geomorphological studies in the parts of Narmada Basin, Sehore district of M.P. Un Pub. Report. Geol. Surv. India.
73. Khan, A.A. & Dubey U.S. (1981) Evaluation of Quaternary Landscape of Intermontane Jamuna valley in Dehradun (U.P.) and Sirmur H.P. Rec. Geol. Surv. Indi. Vol. 112, part VIII, p. 125-135.
74. Khan, A.A. & Vatsa, U.S. (1987-88) Geoenvironmetal Appraisal of the area around Jabalpur City, Madhya Pradesh G.S.I... Rec. Vol 122 pt-pp 163-64.
75. Khan, A.A. (1988) Geomorphic Evaluation and Quaternary sedimentation in Upper ganga basin Garhwal himalya (U.P.) P.hD.Thesis
76. Khan, A.A. (1990) Geomorphology of Narmada Valley Of Jabalpur_ Handia Section Unpublished G.S.I Note.
77. Khan, A.A. Aziz; Maria (2015) A critical analysis of statistical parameters of quaternary deposit of Hominid locality, Hathnora, Narmada valley, distirct sehore (M.P), India Jour. Of Agriculture, Foresty and Environment al Science Vol.I Issue.I July –Aug 2015 .I pp 17-29 ISSN 2454-2792
78. Khan, A.A. Dubey, U.S. Sehgal M.N. & Awasthi. S.C. 1982 Jour.Geo.Soc. of India Vo. 23,. “Terraces in Himalayan tributaries of Ganges in Uttar Pradesh”.
79. Khan, A.A.(1991).Geological studies of Harda – Barwaha basin in parts of Dewas, Sehore, Hoshangabad and Khandwa districts with the Aid of Satellite imagery and Remote Sensing Techniques, Geol. Surv. Ind, Rec. Vol; 126 pt-6
80. Khan, A.A., and Rahate, D.N (1990-91 & 1991-92) Geological and Geomorphological studies in parts of Narmada Basin) parts Hoshangabad and Narshingpur district, M.P. Geol. Surv. Of India Unpublished Progress Report.
81. Khan, A.A., Rahate, D.N; Shah; (1991) M.R. and Fahim ; M. volcanic Ash from Quaternary deposits of Narmada valley central India. Indian science Congress 1991

82. Khan, A.A; Rahate D.N, Fahim, M. and Banarjee, S.N. (1992): Evaluation of Geology and Geomorphology in Central Narmada Valley (Districts Sehore and Hoshangabad, Madhya Pradesh) Scientific Publishers, Jodhpur
83. Khan,A.A. (1988) Minrology of Recent sediments of Alaknanda valley , Garhwal Himalya (accepted for Publication in GSI Records)
84. Khan, A.A. (1984) Geological and Geomorphological studies around Tapti-Vagher confluence district Jalgaon, Maharashtra. Geol, Surv. India Rec. V.113 pt 6 pp 99-109
85. Khan, A.A. Dubey U.S. & Srivastava M.C.(1981) "Morphogenetic Expression of Parts of Sarda-sub Basin, Distt. Lakhimpur Kheri, Sitapur and Behraich, U.P." (Accepted at IV Regional Conference of Geology of South East Asia 1981, held at Manila, PHILLIPINES).
86. Khan, A.A. (2002 `
87.
88.) et al. District Resource Map-Dhar District, Madhya Pradesh. GSI publication © Government of India copyright 2002.
89. Khan. .A. Proc. ISEG. Sym. Env. Mang. Rel. to Wat. Res. Devl. & Maj. Const. 1987. "Assesment of Mass wasting activities and their impact on Environment by Remote Sensing Techniques in Watershed region of River Bhagirathi in parts of Garhwal Himalaya, U.P."
90. Khan. A.A. & Aziz, Maria (2012) "Homo Erectus & Homo Sapiens In Spectrum Of Volcanic Ecology, Narmada Valley (M.P) India"Status Published Research Scapes International Multidisciplinary Journal VolI, Issue III July-September 2012
91. Khan et.al Quaternary Atlas (GSI) Quaternary Atlas maps of Central India
    15 Sheets and associated maps (under Publication)
92. Krynine (1942) Diffrential sedimentation and its products during one complete geosyncline cycleProc.Ist Pan Am. Cong.Eng Geol Vol2 pp537-561
93. Mishra, P.S., Venkatraman, N.V., Roy, Abhinaba and Tiwari, M.P., 1999**:** Seismotectonics evaluation of Quaternary sedimentary basins yoked with Satpura horst. Gondwana Geological magazine, Special Vol. 4, pp. 81-96.
94. Nawani P.C. & Khan. A.A(1981) "Imprints of Neotectonic Activities in Garhwal Himalaya, India". (Accepted at IV Regional Conference of Geology of South, East Asia 1981, held At Manila, PHILLIPINES).
95. Nayak, P.N.(1990) Deep crustal configuration of central India .Geol. Surv.Ind spec. pub 28, pp 67-98
96. Pascoe, E.H. 1973: A manual of geology of India and Burma, Vol. III, Govt. of India Publication.
97. Petijhon, F.G. (1957) Sedimentry rocks .2nd edition Harper& Brothers .New York p.718
98. Rahate, D.N Khan A.A. 1992. "Geomorphological Evaluation of the area around Varanasi, U.P. with the aid of Aerial Photographs and LANDSAT Imageries". Geol.Surv.India Rec. Vol. 113, Pt. 8. B.C. Poddar, K.K. Verma, M.P. Narmada Valley Project. GSI, Recod. Vol. 124, pt.6, pp.245-247. Evaluation of Quaternary terraces of Lower Narmada Valley, District Sehore & Hoshangabad, Madhya Pradesh. Proc.78th Ind.Sc.Cong.Part III (Abstract)
99. Roy, A.K. 1971 Geology and Ground Water Resources of Narmada Valley Bult of Geol Surv. Of Ind Series B. Engineering Geology and Ground Water Geology.
100. Sehgal, M.N. Khan A.A. & Ghosh. (1980) "Fluvial signatures in Yamuna Basin – Some observations and their Implication". (Paper Accepted at I.G.C. 1980, PARIS, FRANCE).
101. Sonakia A. 1984 The Skull Cap of Early man and associated mammalian fauna from Narmada Valley alluvium Hoshangabad area. Madhya Pradesh, India Rec. Geol Surv. India Vol. 113, Pt. 6 pp 159-172
102. Sonakia, A. (1991): Final report on Quaternary biostratigraphic studies of the Narmada valley alluviam and cave deposits of M.P. Progress report (unpublished) Geol. Surv. Ind.
103. Sonakia, A., Biswas, S., 1998. Antiquity of the Narmada Homo erectus, the early man of India. Current Science 75 (4), 391–392.

104. Tiwari, M.P., (1996) : Neo tectonism in Tapti - Puran valleys and its probable correlation with geothermal activity. Geothermal Energy in India, Eds. U.L.Pitale and R.N.Padhi, Geol. Surv. Ind., Special Publ, No. 45, pp. 325- 332.
105. Tiwari, M.P.(1999): Quaternary Lithostratigraphic formations of Cetral Indian river basins: their correlation and chronolgy. Gondwana Geological Magazine, Special Vol.4, pp. 17-31.
Tiwari, M.P.and Bhai.H.Y., (1997): Quaternay stratigraphy of the Narmada valley, Geol. Surv. Ind., Special Publication No.46, pp. 33-63.
106. Tripathi C. 1988 The Pleistocene alluvial deposits of Central India, Rec. GSI, Vol. 95 (2).
107. Van Andel, T.H (1950)- Provanancetransport and deposition Rhine sedimentsH. Veenmanen Zonen Wegennigen 129p. Netherland.
108. Venkat Rao, K; Chakarborty s;Rao ,K.J. Ramani,M.V.S; Maratha, S.D. & Borker, B.T. (1997) magnetostratigraphy of Quaternary fluvial sediments and tephra of Narmada valley , Central India Geo.Surv. Ind;Spl. Publi No.46 pp65-78