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RESEARCH ARTICLE

GEOMORPHOLOGY & NEOTECTONICS OF QUATERNARY DEPOSITSNARMADA VALLEY CENTRAL INDIA.

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Abstract

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Narmada River originates at Amarkantak at an elevation of about 1057m above m.s.l. It descendeds from the mountainous tract traversing over a distance of 1280km across the middle of the Indian sub-continent to join the Gulf of Cambay, near Baroda in Gujrat state. The area of study around Homonid locality Hathnora forms the part of central sector of Narmada, it is bound by Vindhyachal in the north and Satpura range to the south; the area in between these two upland is found to be ideal locus of sedimentation as witnessed by the presence of Quaternary landscape and multicyclic sequence of Quaternary terraces in the valley.The general elevation of Narmada alluvial plain varies between 00.00 to 65.00 m in lower Narmada and 65.00 to 95.00 m in upper Narmada valley above the sea level. The general gradient of this plain in this stretch is about 1m /km towards west.

The Narmada conspicuously has straight course is controlled by ENE_WSW to E_W lineament, is bounded by Vindhyan in the north and Satpura in the south it is exposed the repeated post erisional and depositional activities and subjected to anisotropic and asymmetric tectonic dislocation which has culminated diversified 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 elements, re-configuration of drainage, topography, physiographic, erosional platform, planation surfaces, denudation ridges, structural units linear valleys, strike hills, valley gapes, escarpments and river terraces. The cumulative dynamics of structural deform, rinsing and sinking platform of Narmada has also manifested concealed cyclic mechanism of tectonics, seiesmicity, neosiesmic events and in surface manifestation. In addition the valley gapes and valley trenches provided ideal sites and platform for accumulation&sedimentation.

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent was an ideal elongated depression for accumulation of sediments.The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from

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glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block, faulting, uplifting, isolated domal up- lift, Neogene rifting, Quaternary sedimentation, rift-bound Pliocene–Pleistocene rifting and volcanic activity specifically during glacial and fluvio-glacial phases are major component of the Quaternary period and tectonic processes of the Narmada Rift System which forms the base of quaternary deposits .

The Quaternary landscape of Narmada comprises (NT-1 to NT-3) and their correlation with rest of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch suggest that it has evolved mainly due to tectonic activity along the SONATA LINEAMENT in a compressive stress regime. The sediments comprising these were deposited in a slowly subsiding basin during early Pleistocene middle Pleistocene and the Late Pleistocene. The Holocene period is marked by inversion, which had earlier suffered subsidence. The inversion of the basin is due to a significant increase in compressive stresses along the NSF during the Early Holocene, resulting in differential uplift of the lower Narmada valley. The continuation of the compressive stress regime due to ongoing northward movement of the Indian plate indicates that the NSF is a major candidate for future intraplate seismicity in the regionKhan et.al (1991) Khan et.al (1985) (Khan2016).

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

The Quaternary river terraces of Narmada (NT1to NT3) entrapped in tectonic zone with rock cut terraces and scars are significant imprints of euestatic change / climatic changes in the valley during the sedimentation. The alluvial fan in between Tilakwarda and Rajpipla within the loop of Narmada Chamyal (2002) 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 towards north. It appears to be older quaternary deposits of Narmada which has moved from basement and has been pasted along SONATA LINEAMENT.

The Indian Plate is currently moving northeast at 5 cm/yr (2 in/yr), against the Eurasian Plate is at the rate of only 2 cm/yr (0.8 in/yr) 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 is accumulated along the Narmada-Son Fault (NSF), a major E-W trending crustal discontinuity in the central part of Indian plate.The Quaternary tectonic activity recorded in the Narmada valley possibly, has wider ramifications when viewed in the larger perspective of the Indian plate. This suggests a renewed phase of extreme compression of the Indian plate, which led to tectonic insecurity and may causes tumores and eatrhquake in peninsular India.Khan (2016). The analysis of imprints and signatures of Neotectoisam & data base of available models of neotectonic deformation of the Indian plate indicate 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 (Subramanya, 1996). The study of neotectonic activity of Khandwa Sukta faults and Barwani faults Khan (2017) in the middle segment of valley , study and analysis of quaternary terraces of Tapti and their imprints of neoseismic events (TT-1 to TT-3) Khan (1984) in the confluence area of Tapti and Waghour further document and authenticate that these 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 NSF, a major E–W-trending crustal discontinuity in the central part of the Indian plate. The perceptible tectonic activity of significant magnitude during the Early Holocene has been reported from sea-level studies on the west coast and in the Himalaya located at the trailing and leading edges of the Indian plate respectively.

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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 1284 kms length across the middle of Indian subcontinent before entering Gulf of Cambay in the Arabian sea near Baroda in Gujarat state. It enters the fertile alluvial plain and passes through the gorge of about 19 kms long consisting of Marble rocks near Jabalpur.It then takes westerly turn through the alluvial tract, situated between the Satpura and Vindhyan hills. The river course of Narmada conspicuously straight and is controlled by ENE_WSW to E_W lineament, is bounded by Vindhyan in the north and Satpura in the south, valley has maximum width of about 32 kms.

The principal tributariesof Narmada River are Sher and Sakkar in Narsingpur, the Tawa and Ganjal in Hoshangabad, and Gaur in Jabalpur- Harda section and in lower Narmada. Madhumati,Orsang Unch Heran, Aswan, Man are major rivers which constitute minor basins which are tectonically segmented & ecologically integrated as in built part of main rift System. These rivers originate from the Satpura hills to the south of the trunk channel. The only important tributary on the north is Hiran River, which emanates from the The Vindhyan hills in Jabalpur district. Most of these tributaries have short and precipitous course after they debouch from the hills.

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

The Narmada River flows ENE to WSW in the study area. The rock types exposed along the valley margins are Mahakoshals, Granites, Vindyans, Gondwanas, Lametas and Deccan Traps. In the western part of the valley, Vindyans and Deccan traps constitute the northern valley margin whereas Mahakosals, Gondwanas and Deccan traps make the southern valley margin. Vindhyans are not seen along the southern margin and Gondwanas do not outcrop along the northern valley margin. General outline of the northern valley margin is irregular, whereas southern valley margin is straight valley wall segments. Slope profile of the southern margin comprises a cliff and steep debris slope which terminates downwards into a piedmont.

The valley flanks of Narmada are occupied by piedmont belt runs all along and parallel to the southern valley wall in segments and slope profile of the northern valley wall comprises a cliff, a sleep debris slope and extended pediment with thin cover of alluvium. These are charterised by small isolated rocky mounts, butte, mesa and relict rock sheets within the alluvial area along the northern margin, where as southern flank by alluvial fans, colluvium deposits, rock debri and cones. In the eastern segment of the Narmada valley, the northern margin is straight and the southern is irregular in outline. The various rock types rock types exposed along the northern margin are Mahakoshals and Vindhyans, whereas along the southern margin Mahakoshals, Gondwanas, Lametas and Deccan trap. Obsequent slopes of shale and sandstone of the Vindhyans make impressive scraps defining the northern valley wall and the resequent slopes make table lands gently sloping away from the valley. The various slope profile of the northern valley margin depict, scarp, cliff, debris slope and pediments which are covered by the flood plain of the Hiran River. The pediment further decends in the valley form pediplain and ultimately to alluvial plain Pediments of the profile between valley wall segments and coalesce to form wide pediplain. The straight valley margins of Narmada are associated with the faults separating the Vindhayan basin in the north from the Gondwana basin in the south. These margins are paired and cyclic nature and irregular are appered to be controlled by faults. The configuration of subsequent drainage and geomorphic land form elements indicates that the southern margin fault has the Quaternary component

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 shaping the terrain into various morphogenetic units and land form element, configuration of drainage, topography, physiographic , erosional platform, planation surfaces, denudation ridges, structural units linear valleys, strike hills, valley gapes, escarpments and river terraces. The cumulative dynamics of structural deform, rinsing and sinking platform of Narmada has also manifested concealed cyclic mechanism of tectonics geothermic & hydrological activity, seiesmicity, 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 synoptic & regional study of the Narmada basin by LANDSAT IRS, MSS data on 1:25000 and 1:50000 between Jabalpur – Hoshangabad –Harda- Bharouch section of area bounded by lattitude 22° 15 and 23° 30 and longitude 74° 00 and 80° 30 in Narmada valley has led to recognition of twelve landform units belonging to three genetic classes, viz, denudational, extrusive and fluvial. A three stage, geomorphic model is proposed to explain the origin and evolution of the landscape during post Vindhyan time; (i) in the first stage, and orogenic crustal movements had lead to development of linear ENE-WSW rift systems initiating deposition of Gondwana sediments in an intra-cratonic basin south of the Vindhyan plateau; (ii) in the second stage,endogenic tectono-magmatic processes terminated the sedimentation cycle and resulted in formation of extensive lava plateaus over the Vindhyan and Gondwana landscape, the lavas, were extruded through extensive ENE-WSW trending feeder dykes; (iii) The third stage was characterized by post-Deccan Trap cymetogenic uplift along the Satpura axis, vigorous erosion sculpturing and entrenchment of the Narmada drainage basin with ENE aligned trunk channel culminating in the formation of the Narmada alluvial valley through multiple cycles of erosion and deposition during the Quaternary.

Based on study of altitudinal classes (1) The landscape is characterized by flat topography containing erosional surfaces, rivers and valley flats at an elevation of less than 400m altitude above MSL the (2) Prominent plateaus, plains and prominent sharp crested high hills between 500 and 650m altitude,; (4) High hills with prominent peaks and upper level plateau between 650 and 900m altitude. The ground slope is towards north from the Satpura hill range and towards south from the Vindhyan escarpment. The slope of the valley is towards west. The regional slope of the Vindhyan and the Gondwana plateaus as well as that of the Deccan lava plateau is towards north.

The Narmada Basin and its morphogenetic ecology of basin depicts dendritic and sub-parallel drainage in the central part of valley.The fault and fracture controlled trellis, parallel and sub rectangular drainage is common in the both northern and southern plateau and upland areas. The tributaries joining the Narmada River from the south show considerable meandering with development of flood plains mostly in their lower reaches near the confluence where as the tributaries from the north, however, do not show conspicuous meandering pattern. The morphomeric analysis and regional digonestics of disposition of relief platatues and geomorphic land forms and elements indicate that southern area has been suffrered sequential and cyclic subsidence and up lift where as norther margin was comparatively more stable. It is also evident by association of paleo-channel, cut of meanders, meander scrolls, strend lines, cut scars and terraces on southern bank of Narmada.

The principal tributaries of Narmada River are Sher Sakkar Dudhi inTawa and Ganjal in, Hiran& Gaur. The Man, Karjan, Madhumati, Heran and Orsang, Amravati Narmada valley originate from the Satpura and Vidhyan hills from south and north of the trunk channel the most of these tributaries have short and precipitous course after they debouch from the hills developed on the the pediment and pediplain surface of the Vindhyan plateau are influence by strcutural set up are being controlloed by faults. The northern tributaries make an acute angle with the trunk river, where as the southern tributaries maintain near perpendicular relation both with the higher order and trunk stream. The major morphographic elements are plateau; scarp, ridges and valleys show a marked parallelism and are aligned along ENE-WSW. The different levels of the plateau with high escarpment are also aligned in the same direction. The tributaries in most cases are transverse to the main geologic structure in the area. The tributaries originating from the Satpura carry more sediment and water discharge and show meandering and braided forms. The trunk valley starts widening around Narsimgpur and further broadens near Hoshangabad and beyond. The change of the Narmada river course near Jabalpur from nearly N-S to E-W direction is controlled by two major lineaments. In the area around Hoshangabad Narmada exhibits sinuous course which appears to be controlled by fractures having NE-SW trends.(Plate No_1 &_ 2)

Previous Work:-

The Narmada valley received adequate attention of earth scientist after recovery of Human skull from Quaternary deposits of Hathnora sonakia (1984) accordingly Quaternary deposits and its geomorphological aspects have been studied in detailed in last three decade and data base of various aspects has been updated (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 complete sequaence of Quaternary deposits in time span from the lower Pleistocene to Holocene (Khan & Sonakia (1992). Khan (1912), Khan (2012), Khan et.al (2013) Khan et.al (2014), Khan (2015), Khan et.al (2015) Khan .etal. (2015) .The results of sedimentological studies Khan (2015), in recent years, Quatenary tectonics & sedimentation, geomorphphic evolution have also been attemepted of Narmada Valley Khan et.al (1916), Khan et.al (1916). The study of geomorphology of Quaternary column and area of Hominid locality Hathnora has further supplemented data on evolution of the area Khan et.al (1916) in central sector of Narmada.The sediment statistics and sedimentology of in vertical coloumn (320) , revealed the presence of complete sequence of quaternary sediments in Narmada rock basin which comprise of sediments of viz glacial, fluvio-glacial ad fluvial domain wheras the boulder conglomerate which has yielded human skull which is of fluvio-glacial origin Khan & Sonakia (1991) Khan et.al (2016) Khan et.al (1991) Khan & Maria (1912) bio-stratigraphy aspects and correlatied sediment of Quaternary columns of hominid locality on unified Quaternary Platform Khan et.al (2012) focusing on hominid localities of China which have thrown new light on the age of the Narmada *Homo erectus*.

Present work:-

The present work is telefocus on study the varios aspsects of geomorphology and geomorphic veolution, Quaternary tectonics and sedimentation of Narmada valley in Jabalpur _ Bharouch Section with special reference to Hominid locality Hathnora and occurrence fossil man.The Narmada valley embodies two prominent Quaternary landscape viz in Jabalpur_Harda section in central Sector and Gurudeshwar_Bharouch Section in lower sector which were found to be ideal locus of sediment accumulation and Quaternary sedimentation as witnessed by multi-cyclic sequence of Quaternary terraces in the valley. The study of Quaternary landscape revealed that it has been posed to the repeated post erosional & depositional activities and subjected to anisotropic and asymmetric tectonic dislocation which has culminated diversified dented manifestation, it is further undergone to process of tectonic evolution and chiseling of rift valley by dynamic erosional and depositional activity resulting in reshaping of the terrain into various multi morphogenetic illustration. The delineation and reorganization of different units and land form element, sequential and renewed configuration of drainage, topography, physiography,plantation surfaces, denudation ridges, structural linear valleys, strike hills, valley gapes, escarpments and river terraces revealed that area has uudergone multicylic erosion and deposition unfrequential change tectonic set up in recent past.

The cumulative and cyclic deviation of concealed dynamics and structural deformation of unstable platform of Narmada further added with hidden cyclic mechanism of tectonics, geothermic, seismicity has chiseled surface and subsurface both of quaternary & pre-quaternary landscape in to present composit expression which defines evolution of basin by imprints of neotectonisam identified by various signatures on landscape profile in the valley.

In present paper the quaternary & pre-quaternary landscape its architech expression tectonics & noetectonics subsidence and uplift of fault bound blocks, platform of sedimentation, morphotectonics, impact of tectonics, channel morphology and river terraces have been studied and correlated with erosional cycles & geomorphic eventsin Narmada valley (Plate No_3.)

Geology:-

The Narmada basin is occupied by different of geological formations. The geological succession of these rocks is incorporated in Table No RGT-1

Table No RGT-1

Age	**Group**	**Rock formation**
Recent Quaternary	Alluvial Plains (Older and Newer Alluvium)	Unconsolidated sand, silt, clay.
Eocene Cretaceous	Deccan Trap Bagh and Lameta beds	Basalt Sandstone, Cherty Limestone
CretaceousPaleozoic	Gondwana Super Group : Jabalpur, Mahadeva	Boulder beds Sandstone, Shale, Clay, Limestone,CoalSeams
Pre Cambrian (Proterozoic)	Vindhyan Super Group : Bhander, Rewa, Kaimur, Semri. Bijawar Group Mahakoshal Group	Shale, Sandstone, Limestone porphyrtic granite , Quartz veain, and basic dykes Gneisses, phyllites, Chert and mete basics
Archaeans		Quartzites, Granites, Phyllites, Schists

Quaternary Geology:-

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent was an ideal depression for accumulation of sediments. The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from glacial activity, followed by fluvial-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and segmental and linear displacement. The instability of turmoil sedimentation platform, dislocation, uplifting and isolated domal up- lift, Neogene rifting, sedimentation and rift-bound Pliocene–Pleistocene rifting and volcanic activity specifically during glacial and fluvial-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System which form the base of quaternary deposits. The rift system and basin platform provided a unique setting for dynamic ecosystems that were characterized by rift-related subsidence and coeval sedimentation created an ideal ecologyand loci of Quaternary sedimentation and environment for the accumulation of sediments. The disposition of quaternary deposits, drainage configuration basin boundary and geotectonic of the area revealed that rifts was formed after widespread Quaternary sedimentation occurred and voluminous sediments in the rift basins were accumulated by glacial activity, it is also witnessed by present disposition of quaternary blankets of SONATA LINEAMENT ZONE. (Plate No_1)

The Narmada valley consists of sediments of three domain viz glacial, fluvio-glacial and sediment of paleo-domain of Narmada.

The glacial and fluvio-glacial deposits of Narmada unconformable overly the Vindhyan and the basaltic Deccan Trap rocks. The sediments consist of a Hetero-heterogeneous assemblage of sub-angular to angular, sub-rounded, unsorted, stratifiedrock fragments ranging from boulders to small pebbles, predominantly of quartzite, gneiss, sandstone, basalt, jasper, chart, gneiss, sandstone, basalt, chart, altered feldspar, ferruginous nodules, in a matrix of very coarse to very fine-sand, silt and clay. These clastics are highly angular, generally poorly sorted and isotropically imprecated. Fine sediments comprise of reddish grayish and greenish sand with appreciable amount of mica flaks, altered feldspar, brick-red and buff silt, greenish-brown silt and clay, and greenish, reddish and dark maroon hard and plastic clay. These fine sediments contain fairly good amount of ferruginous material, quartz, mica flakes and altered feldspar grain. Through these sediments are similar in composition to the other deposits of Narmada Valley, exhibit entirely different sedimentary pattern, sediment characters and mineral composition. These rock clastics are largely angular, very poorly sorted and demonstrate isotropic imbrications pattern in the valley. The sediments of glacial domain of Narmada occur between and average elevation of about 20-265 m above m.s.l. and were deposited in glacial environments during Pleistocene time. These deposits are concealed under boulder conglomerate in the valley.

The Fluvio-glacial deposits are represented by conglomerate bed that constituted the fossiliferous horizon of Narmada is sandwiched between older Alluvium and the glacio-fluvial bounder bed. This conglomerate bed is a very persistent marked horizon indicating a distance phase of sedimentation in the Narmada Valley. The boulder conglomerate predominantly consists of sub-rounded to well rounded boulder, cobble and pebble of quartzite, gneiss, sandstone, basalt, agate, jasper, chert, chalcedony tightly cemented in a matrix of sand and silt. The finer sediments include different grade of sand and silt, brown and maroon in color often laminated and cross laminated. The boulder conglomerate is fossil and skull cap of early man *Homo erectus* (Sonakia, 1984)

The boulder conglomerate consists of three sub-litho units; each sub-unit characterized by distinct rock fragment shape, size, lithological abundance and allied sediment characters. The sub-units are composed of variable assemblage of quartzite, gneiss, basalt, sandstone, agate, jasper, chalcedony, chart, sand and silt (Khan1992) These sub-litho units display fancies variation in the valley and upper units grades into gritty sandstone upstream of Hathnora.

The Fluvial sediments of paleo-domain of Narmada conformably overlie the boulder conglomerate and represent the flood-plain fluvial facies of the Narmada. The sediments of the fancies predominantly consist of clay silt and sand, discontinuous nodules and plates. The beds are horizontal, exhibit upward fining sequence typical of fluviatile deposits .This domain may be divided divided into three formations based on lithology, sediment assemblage, shape and size of rock clastics, relative disposition and diagnostic sedimentary characteristics. These formations are, viz. (i) Shohagpur, (ii) Shahganj, and (iii) Hoshangabad Formations respectively. These formations represent the sediments the complete sequence of Narmada deposited in channel and flood plain environments during Upper Pleistocene times.It consists of sediments of paleo-domain of Narmada. It is represented by a thick sequence of clay, silt-sand and rock gravels. The unit is divisible into three sub litho unit. The basal sub-unit is chiefly red and brownish sand, silt, clay containing appreciable amount of cal matrix. The average measured thickness of this sub-unit is about 6.25m. The middle sub-unit consists of yellow and brownish silt, clay with subordinate sand and occasional rock gravel lenses. The average measured thickness of this sub-unit is about 5.50m. The upper sub-units predominantly consist of compact yellow clay, silt and calcareous concretion. The average measured thickness of this sub-unit is about 3.25m.

The sediments of fluvial domain of Narmada identified between an elevations of 268 to 350 m above m.s.l. and were deposited in channel and flood plain environments during upper Pleistocene lime The sequence of Quaternary events and the history of sedimentation of Narmada indicate that the upper 70m top 90m of the Narmada alluvium was deposited in a single aggradations episode with minor pauses when dissection of the alluvium produced two terraces (NT_3-NT_2). The sediments of this aggradations episode constitute three lithostratigraphy units viz. Boulder conglomerate, Sohagpur and Shahganj formation. The sediments of the alluvial phase are underlain by a boulder bed of glaciao-fluvial origin. Thus, the fossiliferous boulder conglomerate, the basal unit of alluvium marks a disconformity between the lower glacial-boulder layer and upper fluvial sediments. The fossiliferous basal boulder conglomerate is being of middle Pleistocene age (Khan 1992)

The sediments of present domain of Narmada is represented by sediments of active flood plain, point bar and sand bar facies of present domain and consist of unconsolidated imbricated, stratified, polygonal sorted rock-gravel supported by very coarse to very fine-sand and is named as Janwasa formation, after the village Janwasa where is it best developed. The measured thickness in the valley is about 5m. (Table QGMT_1)

Narmada Basin (21 24_ 74 83) &Indian plate:-

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 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) Quartz grain morphology sediment column, Khan (2013) in Quartz grain morphology of pale- sole, , Khan (2013) Heavy mineral assemblage Khan (2016) 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 thrown new light on the age of the Narmada *Homo erectus*. The discoveries of volcanic ash beds Khan(1991) and palaeomagnetic reversal in these deposits for the first time for peninsular India are breakthroughs in fixing the chronologic position of the skull. The data aquired 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. . Several biostratigraphic classifications have been suggested for Quaternary deposits of Narmada. The conglomerate bed designated as Hathnora Formation it has a 19 m thickness at its type section and a 50 m compiled thickness. It is sandwiched between two formations, the older one Boulder bed of glacial origin 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.

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 only 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 down through 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 chronology of tectonic and neotectonic signaturesand collectively with the configuration of morphogenetic expression of the section revealed that it is uplifted block. The Gurudeshwar-Bharouche embodies the thickest quaternary deposits which represent complete sequence from the base glacial fluvio-galcial fluvial, lacustrine and mud deposits and it was a mega depression on western extimityof Narmada rift valley where mega sedimentation phase had occurred..

The study of Narmada river terraces along the length of 1300 kms in between Jabalpur- Bharuch their correlation , relative disposition, their elevation and slope their critical and crucial sediment sequence in type area, 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 (2017) 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 authenticate 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 located at the trailing and leading edges of the Indian plate during the Early Holocene respectively.

The presence of thick boulder bed in Harda inliers area, such as at Chandgarh and north east of Barwaha, boulder bed in confluence area of Tapti and waghur around Khadgaon in Tapti valley Khan et.al (1984) supports this assumption.

The Narmada rift system provided a unique setting for dynamic ecosystems that were characterized by rift up lift and subsidence which has created ideal loci 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.

The area studied tectonically encompasses two crustal provinces of Central India Shield, namely, the Northern Crustal Province (NCP) and the Southern Crustal Province (SCP (Acharyya and Roy, 1998; Roy, 1988). The two provinces are separated by a crustal level shear zone, referred as Central Indian Suture (CIS Jain et al. 1995). The southern part of the NCP, containing the Satpura and son Narmada (SONA) valley geographic domain, is known as Central Indian Tectonic Zone (CITZ; Radhakrishna and the CITZ are marked by Narmada North Fault (NNF) in the north and CIS in the south (Acharyya, 1999). The Narmada valley gape is ideal loci of Quaternary sedimentation which persevere Glacial, Fluvio- glacial and fluvial deposit of pleistocene to Holocene times. The ENE-WSW trending Narmada Quaternary basin, Bound 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 study of tectonic set up of Narmada valley, surface manifestation and geo-physical data shows that the Son-Narmada and Tapti lineament together represent an interpolate 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 (Mishra et al, 1999).

The Quaternary events of the Narmada portys three prominent terraces and two sub terraces which are designated NT1 to NT3 and sub terraces NT2-A is NT2-B, NT2 B, besides NT2-C, NT3-A & NT3-B besides NT-0 in increasing order of antiquity. The terraces are described in detail separately. These are both erosional and depositional terraces and confined at an elevation of, between 280m to 310-315. The NT1 is being the youngest terrace and NT3- B it is being the oldest terrace identified in the valley Khan et.al (1984) , Khan etal (1985) , Khan etal. (1991) Khan et.al (1992) Khan et.al (2016).The realative disposition of these teraces is shown in the (Table No _2 to _8).

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 Bharuch 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.

The Narmada Tapti and Son Valley with ENE-WSW trends form a conspicuous physiographic element and their disposition is supposed to be controlled by lineament tectonics. The Narmada-Son lineament is considered to be an active tectonic element (West, 1962) right from the Precambrian time. The Quaternary blanket in Narmada valley provides evidences of significant changes in channel kinetics of Paleo domain and present day domain of Narmada related with eustatic & sea-level fluctuation. The Quaternary deposits contained in the western asymmetric trench consist of sediments of various domains viz glacial, fluvio-glacial, fluvial, lacustrine and tidal flats later influenced by incursion of marine transgression and regression on tectonically active platform. It is evidenced by bore hole data and subsurface statistical analysis of sediments, quartz grain morphology of sediments, pale sole geometry and configuration of quaternary deposits in western segments of Narmada rift valley and SONATA TECTONIC ZONE.

The Narmada–Son Fault (NSF) divides the Indian plate into two halves and has a long tectonic history dating back to the Archaean times (Ravishankar, 1991). The NSF trends in ENE–WSW direction and is laterally traceable for more than 1000 km. It demarcates the Peninsular India into two geologically distinct provinces: the Vindhyan–Bundelkhand province to the north and the Deccan province to the south. Ravishankar (1991) regards the Narmada–Son Fault as a part of the composite tectonically controlled zone in the middle of the Indian plate and termed it as the SONATA zone (abbreviated form of Son–Narmada–Tapti Lineament zone). The Narmada and Tapti Rivers all throughout their course follow these tectonic trends. Other synonyms used in literature to describe this zone include Narmada–Son Lineament (Choubey, 1971), Central Indian Shear (CIS) (Jain et al., 1995) and Central Indian Tectonic Zone (CITZ) (Radhakrishna and Ramakrishnan, 1988; Acharyya and Roy, 2000). Geophysical studies in the central part of this zone reveal this to be a zone of intense deep-seated faulting (Reddy et al., 1995). The zone witnessed large-scale tectonothermal events associated with large granitic intrusions around 2.5– 2.2 and 1.5–0.9 Ga (Acharyya and Roy, 2000). It was again reactivated during the Deccan volcanic eruption during Late Cretaceous–Palaeocene (Agarwal et al., 1995). Profuse occurrences of E–W-trending dykes suggest that the zone formed the main centre of eruptive activity (Bhattacharji et al., 1996). The entire zone is presently characterized by high gravity anomalies, high-temperature gradient and heat flow and anomalous geothermal regime (Ravishankar, 1991) suggesting that the zone is thermo mechanically and seismically vulnerable in the framework of contemporary tectonism (Bhattacharji et al., 1996). The westward extension of this zone into the lower Narmada valley exhibits a less complex structural setting. Data on the NSF in this part is mainly the result of extensive geophysical surveys for commercial exploitation of petroleum reserves in the subsurface. In the lower Narmada basin, it is expressed as a single deep-seated fault (NSF) confirmed by the Deep Seismic Sounding studies (Kaila et al., 1981). Seismic reflection studies have firmly established that the NSF is a normal fault in the subsurface and becomes markedly reverse near the surface (Roy, 1990). Reactivation of the fault in Late Cretaceous led to the formation of a depositional basin in which marine Bagh beds were deposited (Biswas, 1987). The NSF remained tectonically active since then with continuous subsidence of the northern block, designated as the Broach block, which accommodated 6–7-km thick Cenozoic sediments (Biswas, 1987). The total displacement along the NSF exceeds 1 km within the Cenozoic section (Roy, 1990). However, the movements along this fault have not been unidirectional throughout. The general tendency of the basin to subside has been punctuated by phases of structural and tectonic inversion (Roy, 1990). The N–S-directed compressive stresses during the Early Quaternary, folded the Tertiary sediments into a broad syncline, the Broach syncline, in the rapidly subsiding northern block (Roy, 1990). The Broach syncline extends from the NSF to the Mahi River in the north. The E–W trending axis of this syncline lies to the north of the Narmada River. Corresponding anticlinal structures are found in the Tertiary rocks exposed in the southern up thrown block (Fig. 2A and B). Historical and instrumental records indicate that the compressive stresses still continue to accumulate along the NSFdue to continued northward movement of the Indian plate. This is evidenced by the fault solution studies of the earthquakes at Broach (23 March 1970) and Jabalpur (22 May 1997), which suggest a thrusting movement (Gupta et al., 1972, 1997; Chandra, 1977; Acharyya et al., 1998). However, the underlying cause of the seismicity in the NSF zone is not yet understood (Quittmeyer and Jacob, 1979).

The Quaternary landscape of Narmada comprises (NT-1 to NT-3) and their correlation with rest of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch suggest that it has evolved mainly due to tectonic activity along the SONATA LINEAMENT in a compressive stress regime. The sediments comprising these were deposited in a slowly subsiding basin during early Pleistocene middle Pleistocene and the Late Pleistocene. The Holocene period is marked by inversion, which had earlier suffered subsidence. The inversion of the basin is due to a significant increase in compressive stresses along the NSF during the Early Holocene, resulting in differential uplift of the lower Narmada valley. The continuation of the compressive stress regime due to ongoing northward movement of the Indian plate indicates that the NSF is a major candidate for future intraplate seismicity in the region.Khan et.al (1991) Khanet.al (1985) (Khan 2016)

The area is under stress du to movement of India plate to wards north north east and vertical adjustment of different blocks in the Sonata lineament zone. There appear there **is** significant increase in compressive stresses accumulating on an intracrustal fault like the NSF can transform a previously subsiding basin into an uplifting one. The NSF has been characterized by a compressive stress regime throughout the Quaternary and variations in the degree of compression relative to the rates of plate movement are responsible for the late Pleistocene subsidence and the Holocene tectonic inversion in the Narmada it is witnessed by manifestation on drainage net work imprints of neotectonisam and shifting and tilt in terraces of Narmada and its tributaries. Khan et.al (2015), Khan et.al (2015) Khan et.al (2016) Khanl (2017) (Plate No_1,2,3,11,12)

Geomorphology:-

Jabalpur_Hoshangabad Section:-

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

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent wish was 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 on unstable and turmoil platform, 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.The land scape chiseled to stepped sequence of terraces NT0, NT1, NT2 A, NTB, NT2C, NT3A NT3B. 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 Quaternary blanket which has been cut in to terraces NTo to NT3 which are confined between an average elevation of 120 to 400 m which represent sedimentation of paleo domain of Narmada on the surface beside concealled strata . Based on sedimentlogical characters, depositional environments, and erosional processes and their correlation with depositional erosional activity revealed that it comprised of sediments of four domains viz glacial, fluvio-glacial fluvial and tidal flats. The lower most units (Boulder bed) is or glacial origin, the boulder conglomerate of glacio-fluvial (Khan *el. al* 1991) and fluvial terraces are of fluvial paleo- domain of Narmada and tidal flats. The exposed blanket of quaternary blanket has been chiselled to to terraces (NT_o-NT_3). Sohagpur Shahganj Hoshangabad in central sector and Rajpipla, Tilakwarda and Bharuch in lower sector of Narmada which are correlated precisely and designated as (NT_o-NT_3).The Boulder conglomerate geomorphologically is exposed at the base in scarpment of NT2 but geologically is assigned an independent formational status but based on distinct lithology and fossil assemblage. This forms low level erosional & relicts platforms along the course of Narmada. The sequence of Quaternary events and the history of sedimentation of Narmada indicate that the upper 130 of the Narmada alluvium was deposited in two distinct aggradations episode with a distinct and well defined breaks in geomorphology & in sedimentation in rift system. The dissection of the quaternary blanket resulted two terraces (NT_3-NT_2), after break in sedimentation which is a persistent break all through out the valley both in alluvial fill area and hard rock terrain .The Sohagpur Shahganj, Hoshangabad formations in the central sector are correlated with the sediments of this aggradations episode & lithostratigraphy units of Rajpipla, Tilakwarda and Bharuch formation. The sediments of the alluvial phase are underlain by a boulder bed of glacio-fluvial origin. Thus, the fossiliferous boulder conglomerate, the basal unit of alluvium marks a disconformity between the lower glacial-boulder layer and upper fluvial sediments. The fossiliferous basal boulder conglomerate is being of middle Pleistocene age (Khan 1992).

The Quaternary blanket of Narmada in Jabalpur__Harda section has formed three terraces, besides its presented-day flood-plains, in the valley. These are designed (NT_O to NT3), NT_O being the lowest terrace above the present-day course of the river, $NT_{1\ ,}$ NT2 both are of cyclic and non cyclic nature. The NT_3 terrace occurs as elongated strip and isolated caps and lenses along the margin of valley flanks has divergent relative disposition. These land forms indicate vigorous and abrupt incision of valley floor due to relatively & repaid uplift of watershed area during Upper Pleistocene time. The (NT1-NT2) are the major depositional terrace and have both convergent & divergent mutual disposition with other terrace. These terraces further downstream have matched equivalents along the valley flank, whereas in the up stream section the matched equivalents are rare. The conspicuous divergent relation of these terraces the valley reveals successive uplift of catchments area and consequential incision of valley floor and adjustment of base level of Narmada during Upper Pleistocene time. The other land form elements of fluvial domain associated are point bar, sand bar, braided channel, meander scroll and cut of meander and paleo- channel. These terraces NT1 to NT3 of western sector are time equivalent to the three terraces of central Narmada and represents three sequential Quaternary events in SNONATA LINEAMENT ZONE in Central India Khan (1982) Khan (1984) Khan (1992) Khan et.al (2014).

The study of river terraces (NT-1, NT-2A, NT-2B, NT2C, NT3A, NT3B, NT3C,) along the entire length of 1280 kms of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch , their correlation disposition, sediment sequence comprehensive sedimentological columns in type area, drainage net work, Neo-seismic data of imprints and signatures of Neotectoisam & data base analysis of available models of neotectonic deformation of the Indian plate indicate 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 (Subramanya, 1996). The study of neotectonic activity of Khandwa Sukta faults and Barwani faults Khan (in press) in the middle segment of valley , study ad analysis of quaternary terraces of Tapti and their imprints of neoseismic events (TT-1 to TT-3) Khan (1984) in the confluence area of Tapti and Waghour further document and authenticate that these 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 NSF, a major E–W-trending crustal discontinuity in the central part of the Indian plate. The perceptible tectonic activity of significant magnitude during the Early Holocene has been reported from sea-level studies on the west coast and in the Himalaya located at the trailing and leading edges of the Indian plate respectively.

The present Quaternary landscape of ther 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 deposits 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 which is illustrated by imprints of noeotectonisam indicates that the NSF is a major candidate for future intraplate seismicity in the region.

The occurrence and relative disposition of terraces (NT-1 to NT-3), and rock cut terraces in Narmada indicate dominance of vertical incision of former valley floor by reactivation of lineament and fault repeatedly throughout the history of sedimentation.The terrace disposition, their interrelation, relative pairing revealed constant decrease of stream kinetics and energy condition of channel towards late Holocene time. (Table QGT_ 99,100) The disposition of landform and their relation with channel suggests that Holocene flood-plain processes and fluvial regime in the Narmada Rift Valley changed in response to decreasing rates of floodplain sediment accumulation and decelerating sea-level rise and that avulsion played a major role in flood-plain formation during the Holocene transgression.

The Narmada has major three terraces NT0to NT3, (280 to 400 m), besides its presented-day flood-plains in the valley. They have been designed NT_O being the low level terrace above the present-day course of the river, NT_1-the younger terrace both of cyclic ad o cyclic nature. The NT_3 terrace occurs as elongated strip and isolated caps and lenses along the margin of valley flanks has divergent relative disposition. These land forms indicate vigorous and abrupt incision of valley floor due to relatively & repaid uplift of watershed area during Upper Pleistocene time. The NT1to NT_2 are the major depositional terrace and have both convergent & divergent mutual disposition with other terrace. These are both erosional and depositional in nature and are separated by linear and curvilinear scarp and represent former valley floor. These terraces further downstream have matched The Quaternary in the central sector of Narmada display the stepped fluvial terraces breakig the monotony of topography , which from the prominent Quaternary landscape flanking Narmada valley, which indicating the former levels of flood-plain or valley floor. These land forms have been formed by combined action of erosional and depositional process of stream, the up warping in the hard ward ends and consequent climatic change in the post-Pleistocene time. equivalents along the valley flank, whereas in the up stream section the matched equivalents are rare. The conspicuous divergent relation of these terraces the valley reveals successive uplift of catchments area and consequential incision of valley floor and adjustment of base level of Narmada during Upper Pleistocene time.

The Quaternary landscape in Jabalpur –Harda Section in upper Narmada and is represented by prominent stepped sequence of river terraces (NT1 to NT3) of fluvial origin.These terraces are both erosional and depositional in nature and are separated by linear and curvilinear scarp and represent former valley floor. The other land form elements of fluvial domain associated are point bar, sand bar, braided channel, meander scroll and cut of meander and paleo-channel.The Fluvial terraces identified are designated in Upper & Lower Narmada NT1 to NT3 are time equivalent to each other and corresponds and represents Quaternary event Khan (1982) (1984) (1992) Khan et.al (2014). The terraces (NT1 to NT3) of Jabalpur _ Harda section section of Narmada valley are time equivalent to the three terraces (NT1 to NT3) of Gurudeshwar _ Bharuch section central sector of Narmada and Khan (1982) (1984) (1992) Khan et.al (2014).

The study of river terraces (NT-1, NT-2A, NT-2B, NT2C, NT3A, NT3B, NT3C,) along the entire length of 1280 kms of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch , their correlation disposition, sediment sequence comprehensive sedimentological columns in type area, drainage net work, Neo-seismic data of imprints and signatures of Neotectoisam & data base analysis of available models of neotectonic deformation of the Indian plate indicate 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 (Subramanya, 1996). The study of neotectonic activity of Khandwa Sukta faults and Barwani faults Khan (2017) in the middle segment of valley , study ad analysis of quaternary terraces of Tapti and their imprints of neoseismic events (TT-1 to TT-3) Khan (1984) in the confluence area of Tapti and Waghour further document and authenticate that these 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 NSF, a major E–W-trending crustal discontinuity in the central part of the Indian plate. The perceptible tectonic activity of significant magnitude during the Early Holocene has been reported from sea-level studies on the west coast and in the Himalaya located at the trailing and leading edges of the Indian plate respectively.

The present Quaternary landscape of the 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 deposits 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 which is illustrated by imprints of noeotectonisam indicates that the NSF is a major candidate for future intraplate seismicity in the region.

The occurrence and relative disposition of terraces (NT-1 to NT-3), and rock cut terraces in Narmada indicate dominance of vertical incision of former valley floor by reactivation of lineament and fault repeatedly throughout the history of sedimentation.The terrace disposition, their interrelation, relative pairing revealed constant decrease of stream kinetics and energy condition of channel towards late Holocene time. (Table QGT_ 99,100) The disposition of landform and their relation with channel suggests that Holocene flood-plain processes and fluvial regime in the Lower Narmada Rift Valley changed in response to decreasing rates of floodplain sediment accumulation and decelerating sea-level rise and that avulsion played a major role in flood-plain formation during the Holocene transgression.

The geomorphology and digonestic elements of Narmada valley in (Table No QGMT_3 to 19). The principal tributaries of Narmada River are Sher Sakkar Dudhi inTawa and Ganjal in, Hiran& Gaur. The Man, Karjan, Madhumati, Heran and Orsang, Amravati Narmada valley originate from the Satpura and Vidhyan hills from south and north of the trunk channel the most of these tributaries have short and precipitous course after they debouch from the hills. The area of sub basin of these tributatries is occupied by thick Quaternary sedimentsareclassified as older and younger alluvium on the basis of lithology sedimentological characters environments of sedimentation geological breaks. The banket of quaternary sediments of Sher Sakkar Dudhi inTawa and Ganjal, Hiran& Gaur.in Narmada valleyis chiseled in to two terraces besides present day flood plain. These terraces are designated as ST1 to ST2; SHT1 to SHT2, TT1 to TT2, and DT1 to DT2 resoectively.The landsacpe is entrenched and cut accross deep in quaternary blanket in to steeped sequence of terraces. These terraces are time equvalent to each other and have developed simultanoiosly during the same events.The incised blanket exposes lateral sedquence of quaternary sediment which depict hidden strata, unseen relict exposures of older deposits and signatures and imprints of neotectonisam.

Sher sub- basin (Latitude 23 30 longitutde 79 30):-

Sher is a major tributary of Narmada it has formed a sequence of two terrace around confluence with Narmada which are both of erosional and depositional nature. It drains from the southern satpura upland. The older fluvial surfaces (designated as $ST_{\_O}$ and $ST_{\_1}$) which are erosional in nature and have angular relationship with oldest terraces of Narmada. These terraces are easily discernible in the aerial photographs and satellite imagery. The terraces of Sher are multicyclic depositional terraces and depict characteristic of cut-and-fill features and cyclic sedimentation. These terraces are both paired, and non paired in the area under study. They are divergent in their relative disposition indicating increase rate of upper reaches and shortening interval of successive rejuvenation of the stream during the Holocene. The detailed description of salient feature of terraces has been presented in. (Table No.QGMT-89)

Shakkar sub- basin. (Latitude 23 30 longitutde 79 30):-

The Shakkar is another major tributary of Narmada it has catchments in southern upland of Satpura and Gondwana it forms straight stream pattern and mingles its course controlled by lineament. In the area it has formed two major fluvial terraces, besides its present-day flood-plain; designated SHT-1_1 to SHT-2.

The terraces SHT-1_1 to SHT-2.are both erosional depositional in nature. These terraces depicted sedimentary feature such as lamination, cross-lamination, cut and-fill feature and have undergone polycyclic sedimentation during the aggradations phase. These terraces display pairing and cyclic in nature. The terraces are generally divergent in their relative disposition indicating repaid rate of uplift of catchments area and shortening interval of successive rejuvenation of stream in different phase of sedimentation. The salient feature of the terraces of Tons valley is presented in table. (Table No.QGMT-90)

Dudhi sub- basin. (Latitude 23 30 longitutde 78 30):-
It is tributary of Narmada is rises from Deccan upland in the south and mingle with Narmada south west of Udaipur. It descends from straight sinuous to meandering pattern and has Chisselled in to two terraces designated DT_1 to DT_2 besides present flood plain. (Table No.QGGT-91)

Tawa sub- basin. (Latitude 23 45 longitutde 77 45:-
Tawa is a tributary of Narmada it raises from Gowanda and Deccan upland in Satpura mountain ranges on the southern flank of Narmada it has developed two terraces around Hoshangabad which are designated as TT_1 to TT_2. The active channel of Tawa has developed river braids point bar sand bars, channel ban of different size and dimension around the confluence with Narmada at Hoshangabad. (Table No.QGMGT-92)

Hiran sub- basin. (Latitude 23 15 longitutde 80 00):-
Hiranis a tributary of Narmada it raises from Vindhyan mountain ranges on the northern of Narmada it has developed two terraces around Jabalpur which are designated as HT_1 to HT_2. The active channel of Hiran has developed river braids point bar sand bars, channel bar of different size and dimension.A strip of active flood plain is developed along the river channel. (Table No QGMT_9 to_12 Plate No_1,2,3, 4 to_8, 11,12)

Geomorphology of Hathnora Section:-
The Narmada in Central sector along its tributaries has chiseled a trigger shaped basin between the Vindhyachal range in north and the Satpura in the south. The gape between these two physiographic highs is filled by thick pile of Quaternary sediments which constitute complete quaternary sequence, forms the valley flats of Narmada and represents the oldest Quaternary deposit of peninsular India.

The Quaternary blanket forms conspicuous landscape of river terraces in central segment of valley between representing the former level of valley floor of Narmada controlled by ENE –WSW to E-W lineament. The Narmada has formed three regional terraces besides its flood plain (NT0). These are polycyclic depositional terraces and are designated as NT1, NT2 and NT3 in increasing order of antiquity from the present course of river. These terraces are separated by linear or curvilinear scarp facing the river and designated and named as. Janwasa Surface :(NT0) Hoshangabad: (NT1) The Sahaganj surface (NT2) Sohagpur Surface (NT3) in increasing antiquity .

The NT1 is the youngest lowest terrace forming present flood plain of the Narmada and is marked by a scarp. It is restricted within the meandering loop of Narmada; is a depositional terrace and has convergent relation with older terraces and is of cyclic nature.The NT2 is a regional terrace occupying the central part of valley, separated by conspicuous scarps from NT3 and NT1 Terrace. It is an erosional terrace and forms the main alluvial plains of the Narmada. It is a cyclic terrace and has paired equivalents and exhibits divergent relationship, with NT3 and present day course of Narmada it is noticed along the outer flanks of the valley, resting either on the Vindhayan or Deccan basaltic rocks.The relative disposition of older terraces NT2 and NT3, their cyclic nature, and divergent relationship amongst each other and with the present course of river in the valley indicate high energy condition of Narmada during the formation of these terraces, perhaps due to climatic/tectonic changes in waterland of Narmada during Pleistocene time. The non-cyclic nature of NT1 and its convergent relation with NT2 and NT3 and present day course of Narmada indicates climatic changes towards the later history of sedimentation. The over all disposition of these terraces in the valley, their relative convergent and divergent relation and their relation to the present day course of river, indicates constant decrease in the rate of uplift in water shed and consequent decrease in energy condition of Narmada towards later Quaternary time.

The geomorphology and digonestic elements of Narmada valley in Table No QGMT_13 to 15)

Janwasa Surface :(NT0):-
It is the youngest surface of the Narmada in the area. It is noticed above the present day flood plain of Narmada at an average elevation of about 280 m above the m.s.l. This surface is characterized by lack of drainage, gentle slope and scanty vegetation. The geomorphic features associated with this surface are strand lines, meander scroll, and active flood plain. It is observed around Hoshangabad, Shahganj, Hathnora and Upstream of Sardarnagar.

Hoshangabad: (NT1):-
It is older than Narmada surface and named after Hoshangabad (22 15 – 77 43) town where it is best developed. The surface forms the morpho-stratigraphic unit and is identified at an average elevation of about 295 m, above m.s.l. around Hoshangabad, Sahaganj, Hathnora, Narayanpur, Dheri and Ramnagar. It is crescent shaped and is characteristically restricted within the meander of Narmada exhibiting diagonally disposed paired equivalents in the valley. It represents the sediments of palaeo-domain of Narmada predominantly consisting of sand, silt and rock gravel. The top soil mostly comprised of light yellow and grey clay silt of about 1.20 m. The depth of weathering varies from 0.35 to 1.50 m. and average depth is 1.15 m. The streams which drain this surface are mostly impersistent and partly of internal nature. These streams are generally sub-parallel to parallel and sub-dendritic in nature and appear to have been controlled by concealed fracture planes. The various erosional pattern identified in this surface are rill erosion and gulley erosion.

The Sahaganj surface (NT2):-
It is older than Hoshangabad surface, is identified at an average elevation of 310 m. above m.s.l. named after Sahaganj (22 51-77 47) the prominent village situated on this surface. It is a vast Quaternary surface and forms the central Narmada plain. It is separated from Hoshangabad surface (NT1) by conspicuous scarp along Narmada exposing thick sequence of Quaternary sediments in the bluff section. The bluff scarp of Narmada which persistently extends from Jabalpur to Harda along Narmada indicates sharp incision of valley floor by river which appears to be related with the reactivation of E-W trending lineament suggesting significant tectonic event in the Narmada valley in Quaternary time.The heights of sharp edge scarp vary from 11 to 20 m., the average height is about 16 m. which increases upstream.

The Sahahganj surface is separated from Sohagpur surface by a curvilinear scarp rising to the average height of about 18 m. Though the scarp is quite prominent and forms the stepped sequence of terraces in the valley, at places it is distorted by erosional processes, creep and mass wasting activities along the scarp faces. The development of linear convex slopes along the scarp due to accumulation of mass wasting debris is the prominent feature.

This surface is deeply incised by network of small gullies and has developed small linear tracts of ravines north of Narayanpur, north east of Sardarnagar on the northern bank, around Dhansi and north of Balgaon on the southern bank of Naramada. It displays typical undulating bad land topography with micro scarps of average height of 3.25 m. The prominent topographic breaks and undulations on this surface are noticed along subsequent and insequent stream rising from Vindhyachal in north and Satpura in south and draining in the valley. The extensive land dissection and intensive gullying on this surface is noticed along Narmada in Narayanpur, Hoshangabad, section around Sardarnagar, Hathnora, Sukkawara, east and south east of Sahahganj.

This surface forms the conspicuous landscape (NT2) of Narmada and represents the former level of valley floor. It consists of sediments of palaeo-domains of Narmada predominantly comprising of yellow, grey and reddish brown silt, clay sand and rock gravel. These sediments are capped by black cotton soil. The soil thickness varies from 1.35 m to 2.90 m. and average thickness is about 2.25 m. The weathered zone mostly follows the profile and an average depth of this zone is about 2.80 m. This surface is drained by sup-parallel to parallel streams which appears to have been controlled by concealed fractures and lineaments. The prominent streams draining this surface are Chandani Nadi, Dobi Nadi, Katkasari Nadi, Nanawara Nadi and Palkamti Nadi. The various erosional patterns in this surface are soil erosion, deep gully erosion and accelerated headward erosion.

The geomorphic features associated with this surface is a cut off meander identified around Tamcharu (22 47 30-77 53 10) on the southern bank of Narmada. The linear length of cut off meander is about 11 kilometers, width varies from 250 m to 750 m and average width is 575 m. It is marked by a scarp which rises to the height of about 10 m. The slope is 2-5 towards north. It represents the paleo-course of Narmada and is locally known as “Budhi Narmada”. The relative disposition of this cut off meander, slope elements and its relation to present course of Narmada indicate sudden shift of Narmada towards north consequent upon the reactivation in the energy system of channel in recent past.

Sohagpur Surface (NT3):-
It is oldest Quaternary surface (NT3) of the Narmada identified at an elevation of about 325 m. above m.s.l. and named after Sohagpur (22 15 – 77 59) the main town situated on this surface. It occupies large area in the south and south eastern corner of the area. It extends from Sohagpur in the east to the Rajpura in the west on the south bank

and from Makalbara in the east to Kewalajhir in the west on northern bank of Narmada. It occurs at about 40 m. above the present day channel of Narmada and has gentle slope towards the west.

It represents the sediments of flood plain facies of paleo-domains of Narmada consisting of yellow red and brownish silt, clay containing fairly good amount of calcareous concretion and ferruginous matrix. It is capped by black cotton soil measuring about 3.25 m. The depth of weathering follows the soil profile with an average depth of about 3.50 m. It is drained by Rain Nadi, Tangas Nadi and Palakmati Nadi which are sub-parallel to parallel and are influenced by concealed fracture and lineament. The various erosion pattern noted on this surface are rill erosion, gully erosion and headword erosion.

The geomorphology and digonestic elements of Narmada valley in (Table No QGMT_3 to 15 Plate No_6,11,12)

Geomorphology of Hoshangabad-Nasrullahgunj-Harda Section:-

The Narmada Tawa, Ganjal and other tributaries in lower central sector has sculpture elongated basin at the the stress point of Vindhyan strike in the north and faulted block of Satpura in the south which forms faulted a linear depression in the valley which forms ideal place for quaternary sedimentation. The gape between these two physiographic highs is filled by thick pile of Quaternary sediments which constitute complete quaternary landscape sequence of terraces of Narmada which represents the complete column of t Quaternary deposit of peninsular India. The Quaternary blanket breaking the physiographic monotony forms the stepped sequence of former floor of Narmada between 260 to 400 m above m.s.l. controlled by composite fabrics of ENE –WSW to E-W lineament. In this section Narmada has formed three regional terraces besides its flood plain. These are polycyclic depositional terraces and are designated as

NT-1 NT-2A, NT-2B, NT-2C and NT3 in increasing order of antiquity from the present course of river. These terraces are separated by linear or curvilinear scarp facing the river. The diagnostic and salient features of terraces are incorporated in the

Table No QGMT_21:-Morphostratigraphy of Quaternary landscaape

Terrace	Elevation above MSL	Nature of its Origin	Morphostatigraphy
NTo	260-280 m	Depositional	Light grey to dark grey sand and silt
NT_$_{1}$		Erosional /	Light grey to dark grey sand and silt
	280-300- m	Depositional	with rock pebbles and and silt
NT_$_{2}$A	300-320 m	Depositional	Grey & brown sand and silt.
NT_$_{2}$B	320-340m	Depositional	Yellow brownish clay with silt Erosional
NT_2C	340-360 m	Depositional	Yellow brownish clay with silt with
			Dark brown oxidized clay silt
NT_$_{3}$A	360-380 m	Depositional	Dark brown, dark yellow clay silt
			Brownish red clay and silt with
			Calc-matrix. Erosional/
NT_$_{3B}$	400 m	Depositional	Dark brown, dark yellow clay silt
			Brownish red clay and silt with Calc-matrix

Pre-Quaternary Surfaces:-

In this section four prominent Pre-Quaternary surfaces are developed on Vindhyan in the north Deccan Trap upland (55 N/5, 9, 13) in south of Narmada between 400 to 500 m . These are essentially erosional surfaces and were formed by regional peneplanation of the area. These surfaces are described in decreasing antiquity in the valley.

Palanspani Surface:-

The Palaspani is pre-Quaternary surface and is identified on Vindhyan up land in the north western extremity of the area at an elevation of about 400 m, above the m.s.l. and named after village Palaspani (22º 49" 30 '– 77 º 17" 30') which located in the Central part of this surface. This surface is thum in shaped, characterized by its distinct elevation and separated by a curvilinear scarp facing towards valley side.

This surface is covered by light yellow pinkish and brownish soil consisting of pre-dominently clay and slit with small rock granules of quartzite and sand stone. The depth of weathering in this surface varies from 0.30 m to 0.65

m and average depth is about 46.50 m. This surface is very low drainage density and is drained by every few streams let of sub-parallel to parallel nature. The various erosional pattern associated with this surface are mainly rill gully accelerated head word erosion.

Amirganj Surface:-

The Amirganj surface is developed in northwestern part in Vindhyan group of rock, consisting of Quartzite, sand stone and shale at an elevation of about 380 m. above the m.s.l. and named after Amirganj village (22 49 30 – 77 19 30) situated in the north eastern corner of the surface. It is younger than Palaspani surface and older than Bardha surface and separated by curvilinear scarp. The angularity in the scarp, with steep slopes point to structural control on erosional processes around this surface.

This surface is covered by light pinkish, gray light yellow and browns soil consisting of pre-dominantly clay and silt. The thickness of soil varies from 0.45 m to 2.20 m and average depth is about 1.65 m. The soil thickness increases south ward. The depth of weathering almost conincide with the soil profile, on the surface, except around Bhenosa (22 50 00 -77 18 00) where depth of weathering of order 4.25 is observed along the joint / fracture planes, which contain potable quality of ground water. The scarp of this surface has restricted the development of drainage on the steeply sloping Vindhyan cliff to east of Amirganj, south of Patalai and west of Gheti and drained by few streamlets which have very selectively cut across the scarp by accelerated headword erosion along the joint fracture / planes.

Bardha Surface:-

The Bardha surface has occupied northern part of area on Vindhyans at an elevation of about 340 m above the m.s.l. and named after Bardha (22 49 30 – 77 25 30) a prominent village in the west of this surface. It is younger than the Amirganj surface and older than the Chakaldi surface and separated by both linear and curvilinear scarp. The scarp angularity of these scarps and association of rings west of Nimwalkhera along the scarp face separating it from Chikalda surface suggest the pronounced structural control on the erosional process in the area. This surface is dotted by inselberg and butte the prominent educational elements depicting similarities in lithology, disposition height of peaks at various levels topographic breaks and slope elements thereby, suggesting polycyclic educational history of Vindhayan in the area.

It is covered by light pinkish, light brown to deep brown and grayish soil consisting of clay and silt as chief constituents. The thickness of soil range from 0.80 m to 2.35 m. and average thickness is 1.85 ms. The depth of weathered zone varies from 1.25 m. to 3.25 m. and average depth is 1.95 m. The depth of this zone increases toward south. The drainage developed on this surface is mostly sub-parallel to parallel in nature and seem to have been controlled by NLW trending set of fractures/Lineaments, as most of stream cut across the scarp of this surface along the angular / acute points.

Chakaldi Surface:-

t is a pediment surface and has occupied the large area between Vindhayan in the north and Nasrullahganj surface in the south at an elevation of about 320 m. above the m.s.l. and named after Chakaldi town (22 47 30- 77 22 30) located in the central part of this surface is in between 5- 8 towards south.

It is covered by light yellow, light brown, grey and deep yellow soil consisting of clay, silt and small rock fragments of quartzite, sand stone and basalt. The thickness of soil in this surface varies from 1.25 m. to 3.35 m., the average thickness is 2.55 m. The northern fringe of this surface along the Vindhyan hill ranges at place covered by colluvium which contain angular to highly angular rock fragments of quartzite sand stone and basalt. The prominent colluvium deposit is noticed west of Lanchar (22 47 00 – 77 16 00) The depth of weathering in the area of this surface varies from 2.75 m. to 4.55 m. and average depth is 3.85 m. It increase south ward. The depth of weathering at Lanchar (22 47 00 – 77 16 00) is 3.25 mts. At Katra (26 46 30 – 37 19 30) is 3.60 mts. At Chikalda (22 47 30 -77 22 30) is 4.30 mts. At Kheri (22 48 30 -77 24 30) is 2.45 mts. The depth of weathering increases towards south. The weathered zone of this surface contain appreciable amount of ground water is mostly tapped by large diameter open dug wells. It is drained by Kolar, Ambar and their tributaries, which are mostly sub-parallel to parallel in nature and appear to have been controlled by net work of NLS, NW-SE and NE-SW trending fractures and Lineaments which are cancelled under recent deposit of this area.

Nasrullahganj Surface:-

The Nasrullahganj surface (NT3) is oldest alluvial surface of Narmada identified at an elevation of about 300 m. above the m.s.l. and named after Nasruallahganj the main town in the area. This surfaces has occupied wide area between Salkampan (22 44 00 – 77 24 30) in the east and Chitgaon (22 44 00 – 77 15 00) in the West of Chikaldi (22 47 30 – 77 22 30) in the north and Mardanpur (22 38 00 – 77 27 00) in the south on northern bank, and Shilariya (22 31 30 – 77 28 30) in the east and Hathnapur (22 35 30 – 77 29 30) in the North and Taraniya (22 30 30- 22 27 30) in the south on the south bank of Narmada. It occurs as both continuous and disconnected patches which are generally long in shape having both divergent and convergent disposition, with respect to present day channel of Narmada (Terrace deposits) and comprises of to sub-rounded to well round boulder, cobble, pebble of quartzite, basalt, oneiss, sand stone, Augate, chert and Jasper with vary coarse to fine sand silt and clay. It is separated from Shivpur surface by erosional scrap which at places sub-dued by post depositional activity and human influence.

It consist of highly matured grey to black light brown to deep brown and reddish and deeply oxidized soil pre-dominantly consist of clay with silt and sand. The thickness of soil varies from 1.85 m. to 4.35 m and average thickness is 3.75 m. It increases southward. The depth of weathering in this surface show variable thickness it varies from 3.32 m. to 6.35 m and average depth is 4.75 m. The depth of weathering in this surface in the forest cover zones is more in contrast to the area which are under active cultivation. It is drained by Kolar and Ambar Nadi and their tributaries which are mostly sub parallel to parallel in nature and have cut deeply across, this surface forming small auxiliary terraces along this course. The courses of these streams are strongly influence by the concealed lineaments/joints as evident by their selective entrenchment, cyclic scarps and disposition of recent land form elements along their courses. The various erosional pattern identified in this surface are accelerated headword erosion.

Shivpur Surface:-

The Sivepur Surface (NT2) is younger than Nasrullahganj surface and is identified at an elebation of 280 m. above the m.s.l. and named after Shivepur (23 31 00-77 18 15) the main town situated on this surface. It is vast Quaternary surface and have occupied the area between Phulhara (22 41 30 – 77 29 30) in the east, Achang (22 33 30 – 77 15 05) in the west on the Southern bank of Narmada at an elevation of 280 m above m.s.l. It represent the flood plain deposits of paleodomain of Narmada consisting of pre-dominant sub-rounded to well boulder, cobble, pebble of quartzite, gneiss, basalt, sand stone, agate, chert, jasper, in the matrix of very coarse to fine sand, silt and clay.

This surface is generally is bounded by erosional scarps both from Nasarullahbanj surface and Shivepur surface, showing regional convergent and divergent disposition in the area. It's contact with both these surfaces is commonly erosional, at places transitional and over lapping due to convex slopes developed mostly due to debri slide and post depositional activities and consequent accumulation of sediment along the scarp faces. This land form unit is deeply incised by network of small gullies and have developed small mainliner tracts of ravine tracts north west of Nilkant (22 36 05-77 16 10) around Chameti (22 37 00 -77 17 00) on the northern bank of around Hamidpur (22 34 30 -77 17 30) east of Kalgaon (22 31 30 – 77 16 30) on the southern bank of Narmada. It shows typical undulation (bad land) with height of incisional micro scarps along the gullies reaching upto 3.5 m. The prominent topographic breaks and undulation in this surface due to extensive gullying along the seasonal streams is noticed around Digawar, Bsaniya Khurd, Shamugaon, Samalkhera and Ratanpur, Bansaniyadongar, Banard South of Pathra, around Amalaradongar (55F/6).

It consists of light yellow to deep yellow, light brown, grey and at places reddish soil consisting of clay as main constituents. The soil thickness varies from 1.35 m. to 2.85 m and average thickness is 1.83 m. The average depth of weathering in these surfaces is 3.25 m. It show moderate drainage streams which have active dissected this surface north of Nilkant (22 32 00 -77 16 30) north and east of Tilariya long the Kolar river, north of Parliya, around Hamidpur (22 34 30- 77 17 30) west of Kolgaon around Baseniyadongar, Pathra and Amblaradongar on the south bank of Narmada. The network of these stream have deeply incised the Nasrullahganj (NT3) surface across the scarp faces and have formed closely spaced small valleys having valley filled deposits of Recent sediements. These valleys have developed along the direction of accelerated head ward erosion of these streams. The prominent such valley fills are observed around Rehati (22 44 00 -77 26 15) along Babra river, around Rampura-Gadariya, southwest of Harpatpur south west of Kusumkul on the southern Bank. It is drained by sub-parallel to parallel streams. These Kolar and Ambar are the prominent streams on the northern bank of Indra and Ganjal on the Southern bank of Narmada, which have formed the low level terraces along their courses. The various erosional pattern associated with this surface are rill erosion, deep gully erosion and accelerated head ward erosion.

Demawar Surface:-

The Demawar surface (NT2B) is Crecent in shape and have occupied small areas in the meandering loope of Narmada around Demawar, Nilkant, on the north bank Ramgiri, Babri on the south bank of Narmada at an elevation of about 270 m. above m.s.l. and named after Demawar village (22 34 10 – 77 21 00). It is younger than Shivepur surface and older than Amba surface. It represent the old flood plain deposit of Narmada consisting of sub-rounded to well rounded boulder, cobble, pebble of quartzite , sand stone, basalt, Jaspar and chert with sand silt and clay. This surface is covered by light yellow to dark yellow, drey and light reddish soil having clay and silt as Chief constituents. The soil thickness varies from 0.50 m to 1.50 m.

The average thickness is 0.95 m. This thickness of soil profile increase northward. The average depth of weathering indentified in the areas of this surface is 1.20 m. This surface show very low drainage density and is drained by few sub-parallel to parallel streams mostly having flow direction parallel to Narmada.

Amba Surface:-

It is youngest Quaternary surface of Narmada and have occupied the meandering loope of Narmada at an elevation of about 260 m above m.s.l. around Amba Kund south of Nilkant, around Jajna. Alpa and Guari and named after Amaba, (22 34 10 -77 17 45) a prominent village situated on this surface. This surface show divergent disposition and have diagonally disposed paired equivalent along Narmada in the area. It represent flood plain deposits of Paleodomain of Narmada consisting of clay coarse to fine sand, silt and rock gravels. It consist of light yellow, grey soil principally comprising of clay and silt. The soil profile developed and measured average thickness is about 0.75 m. The depth of weathering restricted to 0.90 m

Kolar Surface / Ganjal Surface:-

The Kolar on the northern bank of Ganjal on the Southern bank have curved their coarses across Chikaldi, Nasrullahganj and Shivepur surfaces and have formed the sequence of small surfaces along their coarses named after Kolar and Ganjal rivers. These surfaces represent the flood plain deposit of Kolar and Ganjal consisting of pre-dominently coarse of fine sand, silt and clay. These surfaces show prominent geomorphic break and are separated by scarps, varying in height from 5 to 10 m. The average height of these scarps both along Kolar and Ganjal is 7.5 m. The height of scarp increases towards Narmada.

Indra Surface:-

These surfaces are developed along Indra river which cut across Shivepur surface, on the southern bank and joined Narmada east of Guari and named after Indra Nadi. These surfaces Pre-dominantly consist of very coarse to fine sand, silt, clay and rock gravel. These surfaces show prominent geomorphic break and are separated by scarp varying in height from 3.5 to 5 m, the average height of scarp is 4.25 m

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Ambar Surface:-

The surfaces are formed along the Ambar Nadi, which drain north western part of the area and have curved if coarse across the Chikaldi, Nasrullahganj and Shivepur surfaces. These surfaces are mostly elliptical, crescent in shape, and are restricted in the meandering loopes of channel and named after Ambar Nadi. These are separated by scarp varying in height 2.5 to 5 m. These represent the flood plain deposit and consist of coarse to fine sand, silt and clay.
The geomorphology and digonestic elements of Narmada valley in (Table No QGMT_1 to 15 (Plate No_8 &9)

Geomorphology of Garudeshwar_ Bharouch Section:-

The Narmada river e Grudeshwar and Bharouche section of Narmada bounded by latitude 21 30 to 22 31 North 72 50 to 74 15 East in parts of of Gujarat state negotiatiates in lower part of valley before debouching in Gulf of Cambay in Arabian Sea in Gujarat state. 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. It is occupied by thick Quaternary deposits of about 800 m which represent various domain of sedimentation. Based on sedimentlogical characters, depositional environments, erosional processes and their relation with depositional activity revealed that it comprised of four domains of sediments viz glacial, fluvio-glacial fluvial and tidal flats. The lower most units (Boulder bed) is, of glacial origin, followed by the boulder conglomerate of glacio-fluvial and subsequently by fluvial of paleo- domain of Narmada and tidal flats. The top Quaternary landscape is chisealed into three terraces NT1 to NT3 besides presentday flood plain NT0 which is represented by four formations Ankleshwar, Tilakwarda & Bharuch and Aliabat respectively. The Boulder conglomerate is assigned an independent formational status based on distinct lithology and fossil assemblage. The sequence of Quaternary events and the history of sedimentation of Narmada indicate which is exposed at the base of NT2. The upper 180 of the Narmada alluvium was deposited in two distinct aggradations episode with a distinct, well defined break in sedimentation in rift system. The dissection of the quaternary blanket resulted in to two terraces (NT_3-NT_2), after break in sedimentation. The sediments of this aggradations episode constitute three lithostratigraphy units viz Ankhleshwar, Tilakwarda and Bharuch formation. The sediments of the alluvial phase is underlain by a boulder bed of glacio-fluvial origin. Thus, the fossiliferous boulder conglomerate, the basal unit of alluvium marks a disconformity between the lower glacial-boulder layer and upper fluvial sediments. The fossiliferous basal boulder conglomerate is being of middle Pleistocene age..

Geomorphologically, the area between Garudeshwar and Bharuch in the the lower Narmada valley may be divided in to four units each characterized by distinct land form elements, pedology, drainage relief and morphogenetic expression viz i. Upland of basaltic lava flows Cretacious sandstones, Bag formation and Tertiary formation .ii. Quaternary blanket and alluvial tract iii. Alluvial Fan and piedmont zone vi. Coastal zone comprising mud flats v. Active flood plain and associated landform elements. The study area shows a large variety of geomorphic features like deep ravines, uplifted terraces, abandoned cliffs incised cliffy banks and entrenched meanders alluvial plain between the ENE–WSW-trending mountain front scarps and the Narmada river exhibit gentle slope towards north while the alluvial plain in the north of Narmada River show a gentle WSW slope. The Narmada river descending across the rugged and mountainous tract through deep and steep gorges in straight sinuous to meandering pattern entering in terminus segment of valley noce again open out to oval shaped depression which embraces a thick cake of quaternary blanket which has been cut in to NT1 to NT3. The lower segment of valley is controlled by conspicuous E-W lineament which formed unique platform of Quaternary sedimentation as witnessed by thick pile of quaternary sediments and the presence of multicyclic sequence of terraces. These terraces represent the former levels of valley floors formed by cumulative erosional and depositional activities of the river system.

The Narmada in its traverse across in its last leg in lower Narmada valley before entering Gulf of Cambay, in Gurudeshhwar _ Bharouch section it descends in sinuous to meandering pattern which is solely guided by ENE to WSW to E-W lineament and its sympathetic fractures. The landscap architect of valley has multithem manifestation of hidden mechanism of dynamics and Neotectonisam .In this segment Narmada has chiseled three terraces across its course breaking the monotony of land scape which are designated as NT1-NT3 besides its active flood plain. It downstream of Garudeshwar flows in a general WSW direction where it display meanders with wave lengths of 5–8 km .The Orsang, Aswan,Men and Bhuki are the major rivers joining the Narmada from the north. The Karjan River, which drains a major part of the trappean uplands in the lower Narmada valley, meets the Narmada from the south. The other tributary is Madhumati River drains the western fringe of the trappean upland. In between the Karjan and Madhumati rivers there are several north flowing small streams meeting the Narmada at various points. The net work of drainage in the lower Narmada is structurally controlled and they are guided by neosiesmic ecology of pulsation variance as evident by neoseismic signatures on Quaternary landscape The presence of ravenous tracts in northern bank of Narmada with incised deep gullies of 20–25 m is manifestation of sudden dislocation of ground water regime and water table to deeper level due to subsidence of block along the lineament zone. The disposition of river terraces, entrenched meanders and alluvial cliff 15–30 m are suggestive of neotectonic activity in the area. The display of active Narmada channel configuration of terraces, meander scrolls, entrenched meander revealed misfit nature. Narmada in the area. The present channel of Narmada is strongly influenced by NSF and display persistent tendency to shift towards north due geotectonic activity along the fault. It also authenticates that there is significant up rise in the southern block of fault and subsidence of northern block which resulted into gliding and shift of Narmada to wards north.

The Quaternary blanket of Narmada display the stepped sequence of fluvial terraces (NT_O to NT3), breaking the monotony of topography, which from the prominent Quaternary landscape flanking Narmada valley, indicating the former levels of flood-plain or valley floor. These land forms have been formed by combined action of erosional and depositional process of stream up warping in the head ward ends and consequent eustatic and related climatic change in the post-Pleistocene time.These terraces (NT_O to NT3), are both of cyclic and non cyclic nature. The NT0-NT1 are developed within the meandering loop of channel where as NT2 NT_3 are widely developed alon the flanks. In the upstream NT3 occurs as isolated caps and lenses along the margin of valley flanks which have divergent relative disposition. These land forms indicate vigorous and abrupt incision of valley floor due to relatively & repaid uplift of watershed area during Upper Pleistocene time. The NT1to NT_2 are the major depositional terrace and have both convergent & divergent mutual disposition with other terraces. These terraces further downstream have matched equivalents along the valley flank, whereas in the up stream section the matched equivalents are rare. The conspicuous divergent relation of these terraces in the valley reveals successive uplift of catchments area and consequential incision of valley floor and adjustment of base level of Narmada during Upper Pleistocene time. The other land form elements of fluvial domain associated are point bar, sand bar, braided channel, meander scroll and cut of meander and paleo- channel which are braided in nature confined to present channel indicating sudden lose of bed slope due up lift of the area.These terraces (NT1 to NT3) of Gurudeshwar _ Bharuch section of lower Narmada valley are time equivalent to the three terraces (NT1 to NT3) of Jabalpur _ Harda section central sector of Narmada and Khan (1982) (1984) (1992) Khan et.al (2014.The sequence of Narmada terraces is shown in the (Table No 3) Plate No 3 & 4). The salient and diagnostic features and elements of these terraces are incorporated in the (Table No 5-10.) (Plate No 1, 3 & 4).

The study of river terraces (NT-1, NT-2A, NT-2B, NT2C, NT3A, NT3B, NT3C,) along the entire length of 1300 kms of Narmada Rift between Jabalpur- Bharuch their correlation , relative disposition, their elevation and slope their critical and crucial sediment sequence in type area, 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 (Subramanya, 1996). The study of Quaternary tectonics activity of Khandwa Sukta faults and Barwani faults Khan (2017) 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 authenticate 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 located at the trailing and leading edges of the Indian plate during the Early Holocene respectively.

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

The Quaternary blanket in lower Narmada valley provides evidences of significant changes in channel kinetics of Paleo domain and present day domain of Narmada related with eustatic & sea-level fluctuation. The Quaternary deposits contained in the western asymmetric trench consist of sediments of various domains viz glacial, fluvio-glacial, fluvial, lacustrine and tidal flats later influenced by incursion of marine transgression and regression on tectonically active platform. It is evidenced by bore hole data and subsurface statistical analysis of sediments, quartz grain morphology of sediments, pale sole geometry and configuration of quaternary deposits in western segments of Narmada rift valley and SONATA TECTONIC ZONE.

The Quaternary river terraces of Narmada (NT1to NT3) entrapped in tectonic zone with rock cut equivalence and scars are positive significant imprints of euestatic change / climatic changes in the during the sedimentation. The alluvial fan in between Tilakwarda and Rajpipla within the loop of Narmada Chamyal (2002) 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 towards north. It appears to be older quaternary deposits of Narmada which has moved from basement and has been pasted along SONATA LINEAMENT. The westward extension of this zone into the lower Narmada valley exhibits a less complex structural setting it is expressed as a single deep-seated fault (NSF) confirmed by the Deep Seismic Sounding studies (Kaila et al., 1981). Seismic reflection studies have firmly established that the NSF is a normal fault in the subsurface and becomes markedly reverse near the surface (Roy, 1990). Reactivation of the fault in Late Cretaceous led to the formation of a depositional basin in which marine Bagh beds were deposited (Biswas, 1987). The NSF remained tectonically active since then with continuous subsidence of the northern block, designated as the Broach block, which accommodated 6–7-km thick Cenozoic sediments (Biswas, 1987). The total displacement along the NSF exceeds 1 km within the Cenozoic section (Roy, 1990). However, the movements along this fault have not been unidirectional throughout. The general tendency of the basin to subside has been punctuated by phases of structural and tectonic inversion (Roy, 1990). The N–S-directed compressive stresses during the Early Quaternary, folded the Tertiary sediments into a broad syncline, the Broach syncline, in the rapidly subsiding northern block (Roy, 1990). The Broach syncline extends from the NSF to the Mahi river in the north. The E–W trending axis of this syncline lies to the north of the Narmada river. Corresponding anticlinal structures are found in the Tertiary rocks exposed in the southern up thrown block (Fig. 2A and B). Historical and instrumental records indicate that the compressive stresses still continue to accumulate along the NSF due to continued northward movement of the Indian plate. This is evidenced by the fault solution studies of the earthquakes at Broach (23 March 1970) and Jabalpur (22 May 1997), which suggest a thrusting movement (Gupta et al., 1972, 1997; Chandra, 1977; Acharyya et al., 1998). However, the underlying cause of the seismicity in the NSF zone is not yet understood (Quittmeyer and Jacob, 1979).

It is situated a terminus point of basin which forms a oval depression which elongated and starched E-W direction ad truncated by crossed structural lineaments trending NW –SE, NE-SW direction. The quaternary blanket exposed to post deposition activity which subsequently chiseled by cumulative geostatic ad climatic changes resulting into various terraces, pre-quaternary and quaternary surfaces and landform elements of various domain and plantation surface. In the area Narmada channel course is both obstructed & guided and controlled by the cross lineament trending transverse to strongly dominated ENE-WSW to E-W SONATA LINEAMENT resulting in the channel dynamics to suddenly open out which at short range became sluggish as evident by the landscape manifestation of the area. The Garudeshwar and Bharuch section Narmada, descends in sinuous to meandering pattern, it is strongly influenced and guided by the SONATA lineament the major geofracture known as the Narmada-Son fault, which causes the river to flow westwards, opposite to the regional slope. The Narmada basin in the area consists of various sub- basins like Madhumati,Orsang Unch Heran,Aswan, as in built part of Men rivers constitute minor basins which are tectonically segmented & ecologically as in built part of rift System. (Plate 1)

The landscape architech composite expression of lower Narmada valley illustrate and indicate that the area is exposed to the repeated post erosional & depositional activities and subjected to anisotropic and asymmetric tectonic dislocation which has culminated diversified manifestation, which further undergone to process of tectonic evolution and chiseling of rift valley by dynamic erosional and depositional activity resulting in reshaping of the terrain into various multi morphogenetic illustration and reorganization of units and land form element, sequential and renewed configuration of drainage, topography, physiography, plantation surfaces, denudation ridges, structural linear valleys, strike hills, valley gapes, escarpments and river terraces. The cumulative concealed dynamics and structural deformation of rinsing and sinking platform of Narmada, hidden cyclic mechanism of tectonics, geothermic, seismicity and neotectonics has illustrated various signatures and imprints on landscape in the valley. In addition the valley gapes and valley trenches provided ideal sites for sedimentation for formation of quaternary platform, pediment, pediplain, peniplain and river terraces.

The Quaternary landscape in Jabalpur- Harda Section and Gurudeshwar _Bharuch Section represents stepped sequence of river terraces (NT1_NT3) where Harda _Barwani sction is represented by rock cut terraces and rock benches with thin cap of Quaternary sediments at places . The Harda _Barwani Section embodies prominent landscape of rock cut terraces, rock sheets which are time equvilent to (NT1_NT3) of central sector and lower sector of Narmada indicating cyclic rejuvenation of river due to uplift in watershed region of Narmada in Quaternary times. The fluvial terrace (NT_2) is conspicuous landscape and persistently developed along the valley, has divergent relative disposition and cyclic in nature and has paired equivalent. The inter relations of fluvial terrace and rock cut terraces, their relative disposition , divergence and convergence of older and younger terraces across the length of Narmada indicate mega linear tectonic dislocation across Peninsular India Khan (2014), Khan et.al (1991), Khan et.al (1992) Khan et.al (2015) Khan et.al (1991) Khan et.al (2016) Khan et.al (2016) Khan (2017) These (NT_O to NT3), NT_O being the lowest terrace above the present-day course of the river, NT_1, NT2 both are of cyclic and non cyclic nature. The NT_3 terrace occurs as elongated strip and isolated caps and lenses along the margin of valley flanks has divergent relative disposition. These land forms indicate vigorous and abrupt incision of valley floor due to relatively & repaid uplift of watershed area during Upper Pleistocene time. The (NT1NT2) are the major depositional terrace and have both convergent & divergent mutual disposition with other terrace. These terraces further downstream have matched equivalents along the valley flank, whereas in the up stream section the matched equivalents are rare. The conspicuous divergent relation of these terraces the valley reveals successive uplift of catchments area and consequential incision of valley floor and adjustment of base level of Narmada during Upper Pleistocene time. The other land form elements of fluvial domain associated are point bar, sand bar, braided channel, meander scroll and cut of meander and paleo- channel. These terraces NT1 to NT3 of western sector are time equivalent to the three terraces of central Narmada and represents three sequential Quaternary events in SNONATA LINEAMENT ZONE in Central India Khan (1982) (1984) (1992) Khan et.al (2014). (Table No QGMT_2)

The Quaternary blanket of Narmada in lower Narmada provides evidence for significant changes in channel kinetics of Paleo domain and present day domain of Narmada related with eustatic & sea-level fluctuation. The Quaternary deposits contained in the western asymmetric trench consist of sediments of various domains viz glacial, fluvio-glacial, fluvial, lacustrine and tidal flats influenced by incursion of marine transgression and regression on tectonically active platform. It is evidenced by bore hole data and subsurface statistical analysis of sediments, quartz grain morphology of sediments, pale sole geometry and configuration of quaternary deposits in western segments of Narmada rift valley and SONATA TECTONIC ZONE.

The area of study is occupied by Quaternary blanket of about 800 m which represent different domain of sedimentation. Based on sedimentlogical characters, depositional environments, and erosional processes and their correlation with depositional erosional activity revealed that it comprised of four distinct domains of sediments viz glacial, fluvio-glacial fluvial / lacutrine and tidal flats. The lower most units (Boulder bed) is of glacial origin, the boulder conglomerate which seprates glacial and fluvial deposit is persistent horizon and is of of glacio-fluvial (Khan *el. al* 1991) fluvial terraces are of paleo- domain of Narmada and tidal flats over top the fluvial deposits and confined along the coast line on the margin of gulf of Cambay.The top three formations Ankleshwar, Tilakwarda , Bharuch, and Aliabat are designated as (NTo-NT_3) represent thick and multiple sequences of Quaternary sediments. Khan (2015).

The Aliabet channel island which is entrapped in a meandering loope of Narmada on the mouth of Gulf of Cambay formation comprises of sediments of active channel deposit where as the older three Ankleshwar, Tilakwarda Bharuch (NTo- NT3) formation are related to older flood plains deposits of paleo-do-main of Narmada and are grouped under older alluvium. Boulder conglomerate of fluvio-glacial origin is assigned an independent formational status based on distinct lithology and fossil assemblage. Boulder conglomerate which forms rock cut terraces is assigned an independent formational status based on distinct lithology and fossil assemblage.

The Narmada in its lower Narmada valley before entering Gulf of Cambay, in Gurudeshhwar _ Bharouch section it descends in sinuous to meandering pattern which is solely guided by ENE to WSW to E-W lineament and its sympathetic fractures. The landscap architect of valley has multithem manifestation of hidden mechanism of dynamics and Neotectonisam .In this segment Narmada has chiseled three terraces across its course breaking the monotony of land scape which are designated as NT1-NT3 besides its active flood plain. It downstream of Garudeshwar flows in a general WSW direction where it display meanders with wave lengths of 5–8 km.

The Orsang, Aswan, Men and Bhuki are the major rivers joining the Narmada from the north. The Karjan River, which drains a major part of the trappean uplands in the lower Narmada valley, meets the Narmada from the south. The other tributary is Madhumati River drains the western fringe of the trappean upland. In between the Karjan and Madhumati rivers there are several north flowing small streams meeting the Narmada at various points. The net work of drainage in the lower Narmada is structurally controlled and they are guided by neosiesmic ecology of pulsation variance as evident by neoseismic signatures on Quaternary landscape.

The presence of ravenous tracts in northern bank of Narmada with incised deep gullies of 20–25 m is manifestation of sudden dislocation of ground water regime and water table to deeper level due to subsidence of block along the lineament zone. The disposition of river terraces, entrenched meanders and alluvial cliff 15–30 m are suggestive of neotectonic activity in the area. The display of active Narmada channel configuration of terraces, meander scrolls, entrenched meander revealed misfit nature. Narmada in the area. The present channel of Narmada is strongly influenced by NSF and display persistent tendency to shift towards north due geotectonic activity along the fault. It also authenticates that there is significant up rise in the southern block of fault and subsidence of northern block which resulted into gliding and shifting of Narmada to wards north.

The study of river terraces (NT-1, NT-2A, NT-2B, NT2C, NT3A, NT3B, NT3C,) along the entire length of 1300 kms of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch , their correlation disposition, sediment sequence comprehensive sedimentological columns in type area, drainage net work, Neo-seismic data of imprints and signatures of Neotectoisam & data base analysis of available models of neotectonic deformation of the Indian plate indicate 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 (Subramanya, 1996). The study of neotectonic activity of Khandwa Sukta faults and Barwani faults Khan (2017) in the middle segment of valley , study and analysis of quaternary terraces of Tapti and their imprints of neoseismic events (TT-1 to TT-3) Khan (1984) in the confluence area of Tapti and Waghour further document and authenticate that these 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 NSF, a major E–W-trending crustal discontinuity in the central part of the Indian plate. The perceptible tectonic activity of significant magnitude during the Early Holocene has been reported from sea-level studies on the west coast and in the Himalaya located at the trailing and leading edges of the Indian plate respectively.

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 comprising these were deposits 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 which is illustrated by imprints of noeotectonisam indicates that the NSF is a major candidate for future intraplate seismicity in the region.

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

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

The tectonic uplift of the lower Narmada valley during the Early and Late Holocene suggests inversion of an earlier subsiding basin. Such inversions of the basin have been common in the Tertiary times and are well recorded in the sediments of that age (Roy, 1990). A symmetric convergence of the NT-1,NT-2 terraces , diagonal disposition of paired equivalent of terraces across the channel , divergent and linear disposition of cliff of NT-3 terrace in conformity of NSF constant subsidence of basin and in response to frequential movement and geotectonic activity along the NSF. The displaced Late Pleistocene sediments across NSF in the Narmada and Orsang Heran and Madhumati & Karjan valleys, the NNW tilting of the NT-1, NT-2 sediments litho units consisting of the Late Pleistocene sequence, the anomalous topographic slope in the same direction and the incised cliffs up to 25–30 m in the streams that flow along this slope in the area between NSF and the Narmada River, indicate unsynchronized neoseismic movements along the NSF during the Early Holocene. The displacement of sediments of NT-1 surface across the NSF indicates differential movement of about 35 m along the NSF during Early Holocene. The block between the Narmada and Karjan rivers bounded by the NSF and the two other cross-faults suffered subsidence leading to the formation of a series, linear and curvilinear cuts of on terraces and flood plains. The 5–8-m incised cliffs of the streams also suggest that this block escaped the uplift induced large scale incision going on simultaneously in other areas of the lower Narmada valley. The occurrence of ravines and association of deep gullies with the river terraces is morph- tectonic manifestation caused by the sudden vertical movement and block adjustment due subsidence resulting to sudden collapse of water table and ground water regime in the area. The strongest supporting evidence for the Early Holocene tectonic uplift of the area comes from the sea-level curves of the west coast of India which suggest a tectonic component of about 40 m at this time (Rao et al., 1996). The geomorphology and digonestic elements of Narmada valley in Table No QGMT_16 to 21 (Plate No_7 & 10 11,12)

Summary &Conclusion:-

Narmada River originates at Amarkantak at an elevation of about 1057m above m.s.l. It descendeds from the mountainous tract traversing over a distance of 1280 km across the middle of the Indian sub-continent to join the Gulf of Cambay, near Baroda in Gujrat state. The area of study around Homonid locality Hathnora forms the part of central sector of Narmada, it is bound by Vindhyachal in the north and Satpura range to the south; the area in between these two upland is found to be ideal locus of sedimentation as witnessed by the presence of Quaternary landscape and multicyclic sequence of Quaternary terraces in the valley. The general elevation of Narmada alluvial plain varies between 00.00 to 65.00 m in lower Narmada and 65.00 to 95.00 m in upper Narmada valley above the sea level. The general gradient of this plain in this stretch is about 1m /km towards west.

The Narmada conspicuously has straight course is controlled by ENE_WSW to E_W lineament, is bounded by Vindhyan in the north and Satpura in the south it is exposed the repeated post erisional and depositional activities and subjected to anisotropic and asymmetric tectonic dislocation which has culminated diversified 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 elements, re-configuration of drainage, topography, physiographic, erosional platform, planation surfaces, denudation ridges, structural units linear valleys, strike hills, valley gapes, escarpments and river terraces. The cumulative dynamics of structural deform, rinsing and sinking platform of Narmada has also manifested concealed cyclic mechanism of tectonics, seiesmicity, neosiesmic events and in surface manifestation. In addition the valley gapes and valley trenches provided ideal sites and platform for accumulation& sedimentation.

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, uplifting, isolated domal up- lift, Neogene rifting, Quaternary sedimentation, rift-bound Pliocene–Pleistocene rifting and volcanic activity specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System which forms the base of quaternary deposits.

The glacial and fluvio-glacial deposits of Narmada unconformable overly the Vindhyan and the basaltic Deccan Trap rocks. The sediments consist of a Hetero-heterogeneous assemblage of sub-angular to angular, sub-rounded, unsorted, stratifiedrock fragments ranging from boulders to small pebbles, predominantly of quartzite, gneiss, sandstone, basalt, jasper, chart, gneiss, sandstone, basalt, chart, altered feldspar, ferruginous nodules, in a matrix of very coarse to very fine-sand, silt and clay. The sediments of glacial domain of Narmada occur between and average depth of about 320-265 below the surface and were deposited in glacial environments during Pleistocene time. These deposits are concealed under boulder conglomerate in the valley. The conglomerate bed that constituted the fossiliferous horizon of Narmada is sandwiched between older Alluvium and the glacio-fluvial bounder bed. This conglomerate bed is a very persistent marked horizon indicating a distance phase of sedimentation in the Narmada Valley. It is exposed in the bluff/scrap of Narmada around Sardar Nager, Hathnora, Surajgarh, Budhni, Hoshangabad, Khoksa, Tigharia, Demawar and Bhariya-Ghat at the base of terraces NT_2 (Khan, 1984). The boulder conglomerate predominantly consists of sub-rounded to well-rounded boulder, cobble and pebble of quartzite, gneiss, sandstone, basalt, agate, jasper, chert, chalcedony tightly cemented in a matrix of sand and silt. These deposits identified between an average elevations of 245 to 300 m above m.s.l. the basal unit of boulder conglomerate identified is marked at an elevation of about 268 m above m.s.l, exposed on the northern bank of Narmada around Hathnora (22° 52” N - 77° 52” E) at the depth of about 83 m in stratigraphic column of Quaternary sediments of Narmada.

				Table No QGMT_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	……	Assemblage	….	Climate
Holocene			T_0 Depositional	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 Depositional	Formation	IV	Low	Intense	volcanic Ash			Semiaerid
Pleistoncene			Surface					Transported	Upper		

			NT$_2$-B	Demaur	V	Moderate	Moderate	NAB-II volcanic Ash	Assemblage	Graminae Compositae	↑
128 Ka Bp				Formation						Chenopodiaceae	
Middle			NT$_2$-C	Shivpur	VI	High	Moderate	…….	Lower		
Pleistoncene				Formation					Assemblage		
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 conglomerale)	glacial/Fluvio-glacial/deposit			…………………………………………………….			

Table No Qgmt2:-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 e1.a1 1992
4 ka Late Holocene	On set of aridity	up warping /climatic changes/ eustatic changes	Inset terrace formation (NT$_0$)		----------	Ramnagar formation Boaras formation	----------	----------		Relative disposition divergent/Terrace pairing	Amber/Indrakdar/Amba Janswasa formation unicycle
6Ka-13ka, Middle to Early Holocene	Good Monsoon		15m to 30m of entrancing of river (NT$_1$)	IV	Vertisol	Boaras formation	----------	----------			Hoshangabad formation polycycle

13ka to 25ka, late upper Pleistocene	Arid		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)	IV	--------	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_2C)	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_3A)	II	----------	Dhansi Formation	-----	Matuyama Reverse polarity			Nasruhahganj Formation
									Formation of structural basin in the Central Narmada valley		Polycycle
Lower Pleistoce	Humid		Agradation		Laterite/latosol	Pilikarar formation	------	-----	-----		Sohagpur Formation

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

TABLE NO QGMT_3	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							Paniplain/ Pediplin	Pediplin / pedimen t
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 Pedipail with sloping surface
Elavation above RB (m)	0.00 River bad Braided Channel, Point Bar, Side	5.00	15.00	25.00	35.00	40.00	60.00	65.000	80.00to
Slope	---------Towards west--------			--------TowardsSSW---------		---------Towards west---------		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 QGMT_4	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							Penip lain Pedip lain	Pediplai n
Locality: PIPARIA-SOHAGPUR	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PP	PD
Age -- HOLOCENE------------- ---									
Elevation above MSL (m)	300	310	320	328	340	345	355	358	362
Geomorphic break (m)	0.00	10.00	10.00 Aluvial section	8.00 Aluvial section with sediment well bedded	12.00 Composit Rock cut terrace with recent sediments layer	5.00 Rock cut terrace with recent	10.00 Composit Rock cut terrace with recent sediments layer	13.00 Gradual	17.00 Distinct
Elavation above RB (m)	0.00	10.00	20.00	28.00	4000	45.00	55.00	58.00	62.00
Slope	- NS-SW---Towards west		NS-SW --			Towards west & NS-		S-	S-SSW

		Towards west		SW, NE-SW			SSW	
Nature of surface	Erosional / Depositional --			Erosional / Depositional. Erosional			Erosional& partly depositional	Erorosional
Cycle Sedimentation	Section depicts up ward cyclic sequence with incomplete cycle NTo , NT1.Polycyclic with breaks NT2-A NT2-B NT2-C						Cliff section not exposed NT3-B NT3-C	
Orientation of W-Axes		ENE-WSW to E-W, NW-SE	ENE-WSW to, E-W	ENE-W NW-NE-SW	ENE-WSW, NW-SE	E-W & NW-SE	ENE-WSW, NW-SE E-W	
Plunge of L-Axes		------Towards west------		--------Towards NE--------		----------------To wards NE--------------------		
Relative disposition	Convergent Divergent Divergent Divergent Divergent							
Paired/Unpaired	Unpaired Unpaired Paired Paired Paired Paiired / Isolated Patches section not exposed							
Nature of scarp	------Curvilinear---- Curvilinear --------- --------Linear------------------- --------Linear------------------------------ --------Linear--------------------------- In habitation & Cultivation --------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 and cultivation---------------------- Forest cover area -------------- In habitation & 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, gneiss, granite, basalt, sandstone, limestone , Augate, Jaspar, schist, , slate, sand and silt. NTo : Quartzite, gneiss,, basalt, ,granite, limestone, sandstone, phyllite, slate, shale, sand and silt NT1 : Quartzite, gneiss, meta basic , basalt, granite sandstone, phyllite, , schist shale sand and silt. NT1-A : Quartzite, granite, gneiss, meta basic sand stone, lime stone schistphyllite, slate, shale, sand silt and clay. NT2-B : Quartzite gneiss, granite, sandstone, limestone, schist, meta basic, slate, sand, silt and clay. NT2-C : Quartzite gneiss, granite, sandstone, limestone, basic schist, slate, phyllite, sand, silt and clay NT3-A : Quartzite gneiss, granite, meta basic basalt limestone, sand stone slate schist, , sand, silt and clay. NT3-B : Quartzite limestone sanstone, gneiss, granite, basalt schist, phyllite, slate, meta basic 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 QGMT_5	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY						Peniplain Pediplain	Pediplain
Locality	River	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B	PP	PD

:HATHNORA	**bad**						**NT3-C**		
Age	**HOLOCENE**								
Elevation 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**
Elevation 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**			**Erosion al /**	**Erosiona l /**
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	**Braide d**	**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 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	**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, 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.**								

surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	**NT3-B : Quartzite, gneiss, granite, basalt limestone sandstone, schist, phyllite, slate,sand, silt and clay. Boulder Conglomerate : Sub angular to sub rounded boulder cobble pebble of Quartzite, gneiss, basic, schist, granite sandstone, Phyllite , slate, shale sand and silt. The fine matrix of sand ,clay and silt is cross bedded, laminated with cut and features Boulder Bed: sub angular to angular, sub round hybrid and heterogeneous assorted rock febric of Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay.**								
TABLE NO QGMT_6	**GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA 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 sectio n 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.**
Elevation 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 shap	River bad : Quartzite, gneiss, granite, meta basic , , basalt , sandstone, limestone Augate, Jaspar, , slate, , schist sand and silt. NTo : Quartzite, gneiss,, basalt, ,granite, meta basic , limestone, sandstone, phyllite, slate, shale, sand and silt NT1 : Quartzite, gneiss, meta basic, basalt, granite sandstone, lime stone, phyllite, schist shale Augate, sand and silt. NT1-A : Quartzite, granite, gneiss basalt , meta basic sand stone, lime stone slate schist,phyllite, , shale, sand silt and clay. NT2-B : Quartzite gneiss, granite, limestone, sandstone, schist, slate meta basic, sand, silt and clay. NT2-C : Quartzite gneiss, granite, sandstone, limestone, basalt and meta basic schist, , phyllite slate Jaspar, sand, silt and clay NT3-A : Quartzite gneiss, granite, meta basic basalt limestone, sand stone slate schist, , sand, silt and clay. NT3-B : Quartzite, gneiss, granite, basalt limestone sandstone ,schist, phyllite, slate,sand, silt and clay. Boulder Conglomerate : Sub angular to sub rounded boulder cobble pebble of Quartzite, gneiss, basic, schist, granite sandstone, Phyllite , slate, shale sand and silt. The fine matrix of sand ,clay and silt is cross bedded, laminated with cut and features Boulder Bed: sub angular to angular, sub round hybrid and heterogeneous assorted rock febric of Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay.	

TABLE NO QGMT_7	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY						Pediplain	Pediplain /pediment
Locality: NASRULLAHGUNJ	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PP	PD
Age	HOLOCENE								
Elavation above MSL (m)	255	265	270	280	290	300	310	313	318
Geomorphic break (m)	0.00	10.00	10.00	10.00	10	10.00	10.00	3.00	5.00
Elevation 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 & SW		Towards west & SW			
Nature of surface	Channel braiding Erosional / Depositional				Erosional / Depositional. valley fill Erosional / Relict & isolated caps on rock cut benches / barren rock cut benches of basaltic rocks				
Cycle Sedimentation	River bed with rock cut benches , channel braids braided channel. NTo, NT1 section depicts thin veneer of quaternary sediments incomplete cycle. NT2-A, NT2-B NT2-C display Upward fining sequence with incomplete cycle.					Rock cut benches and platform.			
Orientation of L - Axis	Braide d / Grade	ENE-WSW to E-	ENE-WSW to, E-	ENE-W NW- to N-E-	ENE-WSW, E-W	E-W & NW-SE	ENE-WSW, E-W		

	d	W,	W,		NW-SE		
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---- -------- --------Linear------------------- --------Linear------------------ ---------- --------Linear--------------------------- --------Linear- with rock cut faces.------ --------------------- ---------						
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 / cultivation-/ Forest cover area------------------------ --						
Composition/Litho constituents arranged in probable order of abundance /The rock gravel of river terraces range in size from boulder to small pebble. The finer clastics comprise of very coarse to very fine sand, silt and clay. These rock febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	River bad : Quartzite, gneiss, granite, meta basic , , basalt , sandstone, limestone Augate, Jaspar, , slate, , schist sand and silt. NTo : Quartzite, gneiss,, basalt, ,granite, meta basic , limestone, sandstone, phyllite, slate, shale, sand and silt NT1 : Quartzite, gneiss, meta basic, basalt, granite sandstone, lime stone, phyllite, schist shale Augate, sand and silt. NT1-A : Quartzite, granite, gneiss basalt , meta basic sand stone, lime stone slate schist,phyllite, , shale, sand silt and clay. NT2-B : Quartzite gneiss, granite, limestone, sandstone, schist, slate meta basic, sand, silt and clay. NT2-C : Quartzite gneiss, granite, sandstone, limestone, basalt and meta basic schist, , phyllite slate Jaspar, sand, silt and clay NT3-A : Quartzite gneiss, granite, meta basic basalt limestone, sand stone slate schist, , sand, silt and clay. NT3-B : Quartzite, gneiss, granite, basalt limestone sandstone, schist, phyllite, slate, sand, silt and clay. Boulder Conglomerate : Sub angular to sub rounded boulder cobble pebble of Quartzite, gneiss, basic, schist, granite sandstone, Phyllite , slate, shale sand and silt. The fine matrix of sand ,clay and silt is cross bedded, laminated with cut and features Boulder Bed: sub angular to angular, sub round hybrid and heterogeneous assorted rock febric of Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay.						

TABLE NO QGMT_8	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA 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								
Elavation above MSL (m)	255	265	270	280	290	300	310	313	318
Geomorphic break (m)	0.00	10.00	10.00 Alluvial	10.00 Alluvi	10 Alluvi	10.00 Alluvi	10.00 Rock	3.00 Slope	4.00 Distinct

			section	al section	al section	al bluff with rock cut base	cut terrrace	with breaks and micro nicks with soil cover	breaks with rock relicts and imprints of erosional activity.
Elevation 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	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,								

surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	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 QGMT_9 SHER RIVER .	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							
Locality: CONFLUENCE WITH NARMADA NORTH OF NARSINGHPUR	River bad	STo	ST1	Pediplain -	Pediplain /pediment -	-	-	
Age	HOLOCENE							
Elavation above MSL (m)	330	335	340	345.00-	350.00	-	-	
Geomorphic break (m)	0.00	5.00 Alluvial section	10.00 Alluvial section	5.00 Gradual	5.00 Break in slope distinct	-	-	
Elevation above RB (m)	0.00	5.00	10.00	15.00-	20.00-	-	-	
Slope	Towards NW, NE		Towards NW, NE			S -SSW-		
Nature of surface	Channel braids / Erosional / Depositional valley fill				Erosional / partly depositional			
Cycle Sedimentation	River bed with rock cut benches, channel braids braided channel. STo, ST1 section depicts incomplete cycle with Upward fining sequence.					section not exposed_		
Orientation of L -Axis	Braided / Graded	NE-SE, NW-	NE-SE, NW-	_	_	_	_	
Plunge of L-Axis		------Towards SE ------		--------Towards SE----		To wards NE		
Relative disposition	-------------------------Convergent --							
Paired/Unpaired	Unpaired Paired / Unpaired							
Nature of scarp	------Curvilinear---- ------							
Sedimentary feature	Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features				--			
Terrace shape	------------- Cuspate----------------------							
Land use pattern	-------------Inhabitation / cultivation-/ Forest cover area-------------------------- ---							
Composition/Litho constituents arranged in probable order of abundance	River bad : Quartzite, gneiss, granite, meta basic , , basalt , sandstone, limestone ,Zeolite, Augate, Jasper, ,, schist sand and silt. STo : Quartzite, gneiss,, basalt, ,granite, basalt, meta basic , limestone, sandstone, slate, shale, sand and silt ST1 : Quartzite, gneiss, meta basic, basalt, granite sandstone, lime stone, phyllite, schist shale Augate, sand and silt.							

TABLE NO QGMT_10 SHAKKAR RIVER	**GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY**						
Locality: CONFLUENCE WITH NARMADA SOUTH EAST OF UDAIPURA	**River bad**	**SKTo**	**SKT1**	**SKT2**	**Pediplain**	**Pediplain /pediment -**	**-**	**-**
Age ---------------- ----	**HOLOCENE---**							
Elavation above MSL (m)	**327**	**330**	**335**	**340**	**345**	**350**	**-**	**-**
Geomorphic break (m)	**0.00**	**3.00**	**8.00 Alluvial section with composit sediments**	**5.00 Alluvial section with composit sediments**	**5.00 Gradual**	**5.00 Break in slope distinct**	**-**	**-**
Elavation above RB (m)	**0.00**	**3.00**	**8.00**	**13.00**	**18.00**	**23.00**	**-**	**-**
Slope	**Towards NW, NE, N-S**		**Towards NW, NE**		**SSW--------------------------------------**			
Nature of surface	**Channel meander, Channel braids / Erosional / Depositional valley fill**							
Cycle Sedimentation	**River bed with rock cut benches, channel braids braided channel. SKTo, SKT1 section depicts incomplete cycle with Upward fining sequence.**					**_**		
Orientation of L -Axis	**Braided / Graded**	**NE-SE, NW-**	**NE-SE, NW-**	**_**	**_**	**_**	**_**	
Plunge of L-Axis		**------Towards SE ------**		**--------Towards SE----**		**To NE**		
Relative disposition	**Convergent Convergent / Divergent**							
Paired/Unpaired	**Unpaired Paired / Unpaired**							
Nature of scarp	**------Curvilinear---- ------**					**Slope gradual**		
Sedimentary feature	**Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features**				**---**			
Terrace shape	**------------- Cuspate----------------------**							
Land use pattern	**-------------Inhabitation / cultivation-/ Forest cover area-------------------------- ---**							
Composition/Litho constituents arranged in probable order of abundance	**River bad : Quartzite, gneiss, granite, meta basic , , basalt , sandstone, limestone ,Zeolite, Augate, Jasper, ,, schist sand and silt. STo : Quartzite, gneiss,, basalt, ,granite, basalt, meta basic , limestone, sandstone, slate, shale, sand and silt ST1 : Quartzite, gneiss, meta basic, basalt, granite sandstone, lime stone, phyllite,**							

	schist shale Augate, sand and silt. --- Base is not exposed--

TABLE NO QGMT_11 TAWA RIVER	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							
Locality: CONFLUENCE WITH NARMADA AROUND HOSHANGABAD	River bad	TTo	TT1	TT2	Pediplain /pediment -	Pediplain /pediment -	-	
Age	HOLOCENE							
Elavation above MSL (m)	320	325	330	335	340-	345	-	
Geomorphic break (m)	0.00	5.00	5.00 Alluvial section with composit sediments	5.00 Alluvial section with composit sediments	5.00 Gradual	5.00 Breaks distinct with imprints of extensive erosional activity	-	
Elavation above RB (m)	0.00	10.00	15.00	20.00	25	30-	-	
Slope	Towards NW, NE.		Towards NW, NE		----------SSW----------------------------------			
Nature of surface	/ Erosional / Depositional valley fill / Dissected surface with Channel meander, Channel braids in present channel system				--Dessected -----------------------------------			
Cycle Sedimentation	River bed with, channel braids braided channel. TTo, TT, TT2 section depicts incomplete cycle with Upward fining sequence.					_		
Orientation of L - Axis	Braided / Graded	NE-SE, NW-	NE-SE, NW-	NE-SW	NE	NE	_	
Plunge of L-Axis		------Towards SE ------		--------Towards SE----				
Relative disposition	---Convergent --							
Paired/Unpaired	Unpaired Paired / Unpaired							
Nature of scarp	------Curvilinear---- ------ -- Gradual--							
Sedimentary feature	Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features				Cross bedding, Lamination, cross lamination			
Terrace shape	------------- Crescent / Cuspate----------------------							
Land use pattern	-------------Inhabitation / cultivation-/ Forest cover area--------------------------							
Composition/Litho constituents arranged in	River bad : Quartzite, gneiss, granite, meta basic,, basalt , sandstone, limestone ,Zeolite, Augate, Jasper, schist sand and silt. TTo : Quartzite, gneiss,, basalt, ,granite, basalt, meta basic , limestone,							

probable order of abundance	sandstone, slate, shale, sand and silt TT1 : Quartzite, gneiss, meta basic, basalt, granite sandstone, lime stone, schist shale Augate, sand and silt. TT2 : Quartzite, gneiss, meta basic, basalt, granite sandstone, lime stone, , schist shale Augate, sand and silt.

TABLE NO QGMT_12 HIRAN RIVER	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							
Locality: PATAN-BANTOLI AREA	River bad	HTo	HT1	HT2	Pediplain	Pediplain /pediment	-	-
Age	HOLOCENE							
Elavation above MSL (m)	335	340	345	350	353-	358-	-	-
Geomorphic break (m)	0.00	5.00	5.00 Alluvial	5.00 Alluvial section with rock cut base	3.00- Gradual	5.00 Breaks distinct with imprints of extensive erosional activity	-	-
Elavation above RB (m)	0.00	10.00	15.00	20.00	23.00	28.00-	-	-
Slope	Towards NW, NE.		Towards NW, NE		NE			
Nature of surface	/ Erosional / Depositional valley fill / Dissected surface with rock cut platform, Relict platform, Channel with Channel meander, Channel braids in present system				Erosional / dissected			
Cycle Sedimentation	River bed with, channel braids braided channel. HTo, HT-1 HT-2 section depicts incomplete cycle with Upward fining sequence.					section not exposed_		
Orientation of L - Axis	Braided / Graded	NE-SE, NW-	NE-SE, NW-	NE-SW	_	_	_	
Plunge of L-Axis		------Towards SW ------		--------Towards SW----				
Relative disposition	Convergent Convergent / Divergent							
Paired/Unpaired	Unpaired Paired / Unpaired							
Nature of scarp	------Curvilinear---- ------Gradual							
Sedimentary feature	Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features				Cross bedding, Lamination, cross lamination --			
Terrace shape	------------- Crescent / Cuspate----------------------							
Land use pattern	------------Inhabitation / cultivation-/ Forest cover area--------------------------							
Composition/Litho constituents arranged in probable order of	River bad : Quartzite, gneiss, granite, meta basic,, basalt , sandstone, limestone ,Zeolite, Augate, Jasper, schist sand and silt. HTo : Quartzite, gneiss,, basalt, ,granite, basalt, meta basic , limestone, sandstone, slate, shale, sand and silt							

abundance	**HT1 : Quartzite, gneiss, meta basic, basalt, granite sandstone, lime stone, schist shale Augate, sand and silt.** **HT2 : Quartzite, gneiss, meta basic, basalt, granite sandstone, lime stone, , schist shale Augate, sand and silt.**

TABLE NO QG MT-13	**GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY**							**Paniplain Pediplain**	**Pediplain /pediment**
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 Basaltic rock Overlain by Boulder Conglomerate Bank Section**	**300**	**305**	**315**	**325**	**330**	**333**	**338**
Geomorphic break (m)	**0.00**	**10.00 Alluvial Bluff section**	**10.00 Alluvial Bluff section/ Rock face**	**5.00 Alluvial Bluff section / Rock face**	**10 Alluvial Bluff section**	**10.00 Alluvial Bluff section**	**5.00 Alluvial Bluff section / Rock face**	**3 .00 Gradual without any distinct break.**	**5.00 Gradual without any distinct break**
Elavation above RB (m)	**0.00 River bad Braided Channel, Point Bar, Side Bar**	**10.00**	**20.00**	**25.00**	**35.00**	**45.00**	**50.00**	**53.00**	**58.00**
Slope	**- ---Towards west & NS**		**Towards west**		**Towards west & NS-SW,**			**S-SSE**	**S-SSE**
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**			

<table>
<tr><td>Relative disposition</td><td colspan="2">Convergent Divergent Divergent Divergent Divergent</td></tr>
<tr><td>Paired/Unpaired</td><td colspan="2">Unpaired Unpaired Paired Paired Paired Paiired / Isolated Patches</td></tr>
<tr><td>Nature of scarp</td><td colspan="2">-----Curvilinear---- Curvilinear --------- --------Linear--------------- --------Linear----------------- --------Linear--------- -Linear with convex slope covered by forst and collovium material ---</td></tr>
<tr><td>Sedimentary feature</td><td>The Deccan basalt exposed in river section is overlain by boulder conglomerate which display sedimentary structures like Graded bedding , Cross bedding, Lamination, cross lamination</td><td>Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features</td></tr>
<tr><td>Terrace shape</td><td colspan="2">--------- Cresent / Cuspate------- ----------------------------- Rectangular-------------------------- Isolated cap</td></tr>
<tr><td>Land use pattern</td><td colspan="2">----------------------------------Inhabitation / cultivation-/ Forest cover area--------------------------</td></tr>
<tr><td>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.</td><td colspan="2">River bad : The Deccan basalt exposed in river section is overlain by boulder conglomerate 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, 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 roun de ybrid and heterogeneous assorted rock febric of Quartzite limestone, gneiss, granite, schist, , slate, sand, silt and clay.</td></tr>
</table>

TABLE NO QGMT_14	**GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY**	**Paniplain**	**Pediplain**

								Pediplain	**//pediment**
Locality: SAHAGANJ	**River bad**	**NTo**	**NT1**	**NT2-A**	**NT2-B**	**NT2-C**	**NT3-B NT3-C**	**PP**	**PD**
Age	**HOLOCENE**								
Elavation above MSL (m)	**275**	**285 Basaltic rock Overlain by Boulder Conglomerate Bank Section**	**292,**	**298**	**310**	**320**	**323**	**327**	**332**
Geomorphic break (m)	**0.00**	**10.00 Alluvial Bluff section**	**7.00 Alluvial Bluff section/ Rock face**	**6.00 Alluvial Bluff section / Rock face**	**12 Alluvial Bluff section**	**10.00 Alluvial Bluff section**	**3.00 Alluvial Bluff section / Rock face**	**4.00 Gradual without any distinct break 0**	**5 Gradual without any distinct break.**
Elavation above RB (m)	**0.00 River bad Braided Channel, Point Bar, Side Bar**	**5.00**	**12.00**	**18.00**	**30.00**	**40.00**	**43.00**	**47.00**	**52.00**
Slope	**- ---Towards west & NS**	**Towards west**			**Towards west & NS-SW,**			**SSW**	**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 Boulder Conglomerate exposed at the base of River section**						**section covered by forest**	**section not exposed**	**section not exposed**
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	**The Deccan basalt exposed in river section is overlain by boulder conglomerate Graded bedding , Cross**				**Graded bedding , Cross bedding, Lamination, cross lamination & Cut and Fill features**				

	bedding, Lamination, cross lamination
Terrace shape	--------- Cresent / Cuspate------- ----------------------------- Rectangular-------------------------- Isolated cap
Land use pattern	----------------------------------Inhabitation / cultivation-/ Forest cover 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 : The Deccan basalt exposed in river section is overlain by boulder conglomerate containing 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, 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 & clay.**

TABLE NO QGMT_15	**GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY**							**Paniplain Pediplain**	**Paniplain Pediment**
4.00Locality: HOSHANGABAD-BABAI	**River bad**	**NTo**	**NT1**	**NT2-A**	**NT2-B**	**NT2-C**	**NT3-B NT3-C**	**PP**	**PD**
Age					**HOLOCENE**				
Elavation above MSL (m)	**260**	**270**	**280**	**285**	**295**	**310**	**315**	**318**	**322**
Geomorphic break (m)	**0.00**	**10.00 Alluvial Bluff section**	**10.00 Alluvial Bluff section**	**5.00 Alluvial Bluff section**	**10 Alluvial Bluff section**	**15.00 Alluvial Bluff section**	**5.00 Alluvial Bluff section**	**3.00 Gradual without any distinct break.**	**4.00 Gradual without any distinct break**
Elavation above RB (m)	**0.0 River bad Braided**	**10.00**	**20.00**	**25.00**	**35.00**	**50.00**	**55.00**	**58.00**	**62.00**

	Channel, Point Bar, Side Bar 0								
Slope	- ---Towards west & SW		Towards west & SW		Towards west & SW			SSW	SSW
Nature of surface	Channel braiding Erosional / Depositional				Erosional / Depositional. valley fill Erosional / Relict & isolated caps o rock cut benches			Erosiona l	Erosiona l
Cycle Sedimentatio n	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	Braid ed / Grad ed	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/Unpai red	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--------------------------								

TABLE NO QGMT_16	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							Paniplain Pediplain	Paniplain Pediment
Locality: BARWAHA SECTION-I	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PP/PDP	PP/PD
Age	HOLOCENE								
Elevation above MSL (m)	238	243	254	258	265	270	275	278	283
Geomorphic break (m)	0.00 River bad Braided Channel, Point Bar, Side Bar	5.00 Bank Scarp	5.00 Alluvial Bluff Bank Scarp Composite scarp	10.00 Alluvial Bluff Bank Scarp / Rock faces Composite scarp	8.00 Rock Cut scars / Rock faces	5.00 Rock Cut scars / Rock faces	5.00 Rock Cut scars / Rock faces	3.00 Breaks not distinct	5.00 Breaks distinct with rock relicts irregular imprints of morphotectonics

Elevation above RB (m)	**0.00**	**5.00**	**10..00**	**20..00**	**28.00 Rock Cut Terraces / Rock Cut Scar Rock Cut Faces**	**32.00 Rock Cut Terraces / Rock Cut Scar Rock Cut Faces**	**37.00 Rock Cut Terraces / Rock Cut Scar Rock Cut Faces**	**40.00. Irregular surface with relicts of erosional activity**	**45.00 Irregular surface with relicts of erosional activity.**
Slope	**---------Towards west & SW--------**		**--------Towards west and SW---------**		**---------Towards west & SW---------**				
Nature of surface	**--------Depositional ------ Errosional ………….**				**Rock cyut terraces and Rock scar --------Erosionall --------**				
Cycle Sedimentation	**----------------------------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 west ----**		**--------Towards SW--------**		**Rock cut terraces and Scar**			
Relative disposition	**Convergent Divergent Divergent Divergent Divergent**								
Paired/Unpaired	**Unpaired Unpaired Paired Paired unpaired Paiired / Isolated Patches**								
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	**----------------------------------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	**River bad : 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**								

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.	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 sanstone, gneiss, granite, basalt slate, schist, phyllite, meta basic sand, silt and clay. Note : NT3-A Rock cut Scar , Strand lines , rock cut dissected nicks

TABLE NO QGMT_17	GEOMORPHOLOGY AND DIGONESTIC ELEMENTS NRMADA VALLEY							Paniplain Pediplain	Pediplain Pediment
(i) Locality DHADGAON -I	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-B NT3-C	PP/PD	PP/PD
Age	HOLOCENE								
Elavation above MSL (m)	210	215 Bank cut scar	225 Micro scar	230 Alluvial bluff section	235 Rock /Alluvial section	240 Rock /Alluvial section	247 Rock cut Terraces rock Scar	250 Gradual	253 Gradual
Geomorphic break (m)	0.00	5.00 Alluvial Face	10.00 Alluvial Bluff Section Steep Alluvial face	5.00 Alluvial Bluff Section Steep Alluvial fac Composite Rock Face	5.00 Alluvial Bluff Section Rock cut Terraces rock Scar Rock Face	10.00 Alluvial Bluff Section Rock cut Terraces rock Scar Rock Face Rock Face	7.00 Alluvial Bluff Section Rock cut Terraces rock Scar Rock Face Composit Rock Face	3.00 Breaks Gradual with thin covers of soil	3.00 Breaks Gradual with thin covers of soil
Elavation above RB (m)	0.00 River bad Braided Channel, Point Bar,	5.00 Rock Face and Alluvial Bluff	15..00 Rock Face and Alluvial Bluff	20..00 Rock Face	25.00 Rock Face	35.00 Rock Face	42.00 Rock cut Terraces rock Scar	45.00 distinct	48.00 distinct

	Side Bar								
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 cyut terraces and Rock scar --------Erosional ---Lieanr scar line -----				Erosional	Erosional/ partly deposional
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	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,								

febrics are generally surrounded to well rounded and mostly spherical, oblate, prolate and bladed in shape.	**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.**

Geomorphology and digonestic elements
Nrmada valley

TABLE NO QGMT-18 Locality: TILAKWARDA / : GARUDESWAR	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT-3	Paniplain/Pediplain PP/PD	Pediment PP/PD
Age	HOLOCENE								
Elavation above MSL (m)	85	90	96	110	115	120	130 Rock cut Terraces rock Scar	133	138
Geomorphic break (m)	0.00	05.00 Alluvial Face	11.00 Alluvial Bluff Section Steep Alluvial face	25.00 Steep Alluvial fac Composite Rock Face	30.00 Rock cut Terraces rock Scar Rock Face	35.00 Rock cut Terraces rock Scar Rock Face Rock Face	45.00 Rock cut Terraces rock Scar Rock Face Composit Rock Face	48.00 Gradual	53.00 Distinct with breaks and rock rlicts and imprints of neotectonic activity
Elavation above RB (m)	0.00 River bad Channel, Point Bar, Side Bar	08.00 Rock Face and Alluvial Bluff	15..00 Rock Face and Alluvial Bluff	20..00 Alluvial Bluff Rock Face	25.00 Rock Face	35.00 Rock Face	45.00 Rock cut Terraces rock Scar	50.00 Rock surface with soil cover	55.00 Pediment surface
Slope	---------Towards west & SW--------		--------Towards west and SW---------		---------Towards west & SW---------				

Nature of surface	**--------Depositional ,Cresent shape elongated ------ Errosional ………….**	**Rock cut terraces and Rock scar -------Erosional ---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 DivergentDivergentDivergent**						
Paired/Unpaired	**Unpaired Paired PairedPaired 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**						

Geomorphology and digonestic elements
Narmada valley

TABLE NO QGMT_19 Locality: BHARUCH	**River bad**	**NTo**	**NT1**	**NT2-A**	**NT2-B**	**NT2-C**	**NT3-A NT3-B NT-C**	**Paniplain/Pediplain Paniplain/Pediplain PP/PD**	**Pediment /PD**
Age	**HOLOCENE**								
Elavation above MSL (m)	**60**	**70**	**80**	**90.00**	**--**	**--**	**NT3-A 105**	**PP/PD**	**PD**

Geomorphic break (m)	**0.00**	**10.00 Alluvial Face**	**20.00 Alluvial Bluff Section Steep Alluvial face**	**30.00 Steep Alluvial fac Composite Rock Face**	**Not Developed**	**Not Developed**	**45 .00 m Alluvial Bluff Section Steep Alluvial face ------**	**50.00 Gradual**	**55.0000 Distinct with breaks and rock relicts and imprints of geotectonic activity**
Elavation above RB (m)	**0.00 River bad Channel, Point Bar, Side Bar**	**10.00 Rock Face and Alluvial Bluff**	**20..00 Rock Face and Alluvial Bluff**	**30..00 Alluvial Bluff Rock Face**	**Not Developed**	**Not Developed**	**45 .00 m Alluvial Bluff Section Steep Alluvial face ----**	**55.00**	**60.00**
Slope	**---------Towards west & SW--------**		**--------Towards west and SW---------**		**---------Towards west & SW---------**			**Towards west**	**Towards west**
Nature of surface	**--------Depositional, Cresentshape 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 DivergentDivergentDivergent**								
Paired/Unpaired	**Unpaired Paired PairedPaired 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	**------------------Barren -----------------Inhabitation and cultivation--------------------- Forest**								

pattern	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 ---

Geomorphology and digonestic elements
Narmada valley

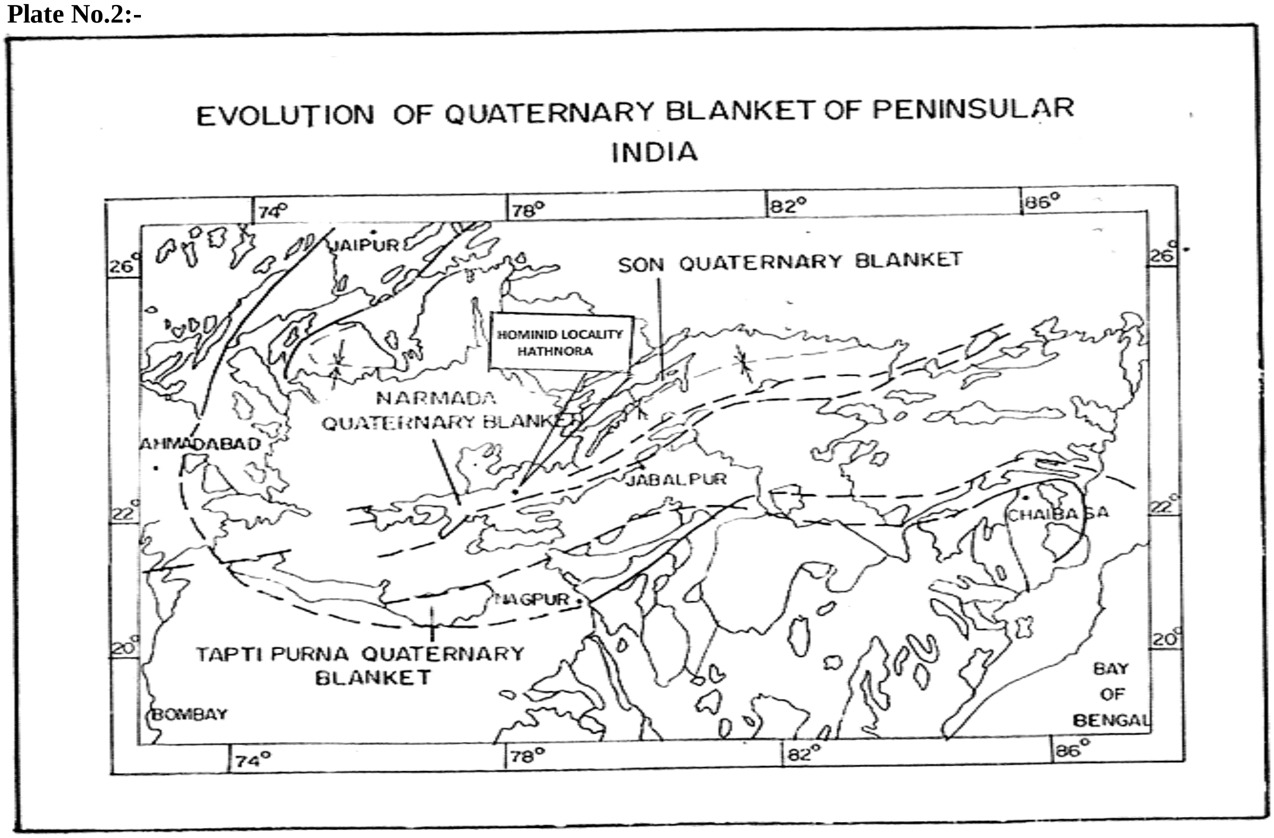
TABLE NO QGMT_20 Locality: ALIABAT	River bad	NTo	NT1	NT2-A	NT2-B	NT2-C	NT3-A NT3-B NT-C	Paniplain/Pediplain PP/PD	Pediment /PD
Age	HOLOCENE								
Elavation above MSL (m)	25	35	--	--	--	--	---	----	-----
Geomorphic break (m)	0.00	10.00 Alluvial Face	Not Developed	Not Developed	Not Developed	Not Developed	Not Developed	Not Developed	Not Developed
Elavation above RB (m)	0.00 River bad Channel, Point Bar, Side Bar	10.00 Rock Face and Alluvial Bluff	Not Developed	Not Developed	Not Developed	Not Developed	Not Developed	Not Developed	Not Developed
Slope	---------Towards west & SW--------		--------Towards west and SW--------		---------Towards west & SW---------			Towards west	Towards west
Nature of surface	--------Depositional, Cresentshape 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		

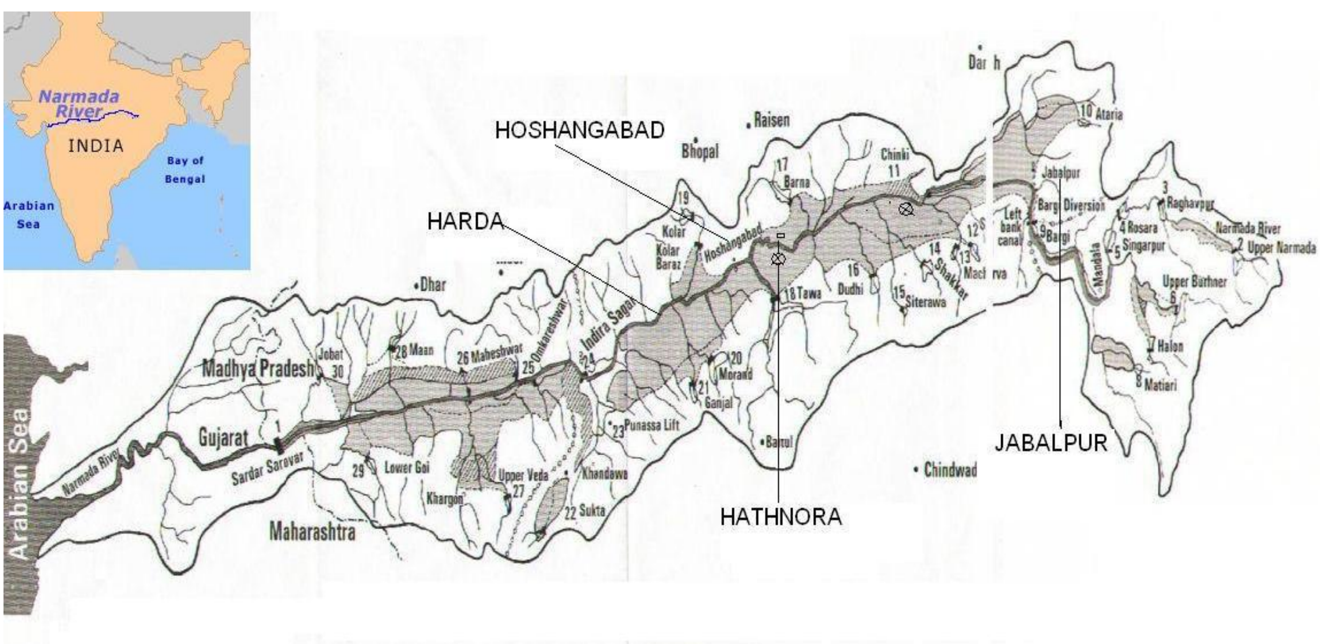
Plunge of L-Axes		**------Towards west, South North West & West ------**	**--------Towards SW--------**	**Rock cut terraces and Scar**
Relative disposition	**Convergent Divergent DivergentDivergentDivergent**			
Paired/Unpaired	**Unpaired Paired PairedPaired unpaired Paired sharp Strand lines**			
Nature 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	**NTo : Quartzite Gneiss, granite, quartzite, basalt, sandstone, limestone, Augate, Jaspar, schist, , slate, sand and silt. : NT1 Not Developed** **NT1-A : NT-3 Not Developed --** **NT2-B. : Not Developed NT2-C Not Developed ---** **NT3-A : Not Developed NT3-B Not Developed ---**			

				Table No QGMT- 21							
Quaternary Stratigraphy of the Lower Narmada Valley											
(Garudeshar- Bharuch 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			Aliabat Formation	I	Nil	Nil	…….	…….	……	
				Aliabat Formation = Tidal Flats					Upper		Present
			NT_O		II	Nil	Low	……	Assemblage	….	Climate

Holocene			T_0 Depositional								
			NT_1	Bharuch							Warm and
			T_1 Erosional	Formation	III	…..	…..	......	…..	….	Semiaerid
13 Ka Bp			Surface								
	BRUNHES NORMAL		NT_2-A	Tilakwarada-C				NAB-III			Warm and
Upper			T_2 Depositional	Formation	IV	Low	Intense	volcanic Ash			Semiaerid
Pleistoncene			Surface					Transported	Upper		
			NT_2-B	Tilakwarada-B	V	Moderate	Moderate	NAB-II volcanic Ash	Assemblage	Graminae Compositae	
128 Ka Bp				Formation						Chenopodiaceae	
Middle			NT_2-C	Tilakwarada-A	VI	High	Moderate	…….	Lower		
Pleistoncene				Formation					Assemblage		
700 Ka Bp			NT_3-A	Ankleshwar-B	VII	Very High	Low	......			
	Matuyama			Formation							
	Reversed										
			NT_3-B	Ankleshwar-A	VIII	Intense	Nil	......	Not Reported	…..	Warm and Humid
				Formation							
Lower	……… ……	…… …… …	(Boulder conglomerate)	………….Fluvio-glacial/deposit …………			NB-I	………………………… ………..			
Pleistocene											
………………………… …………….				(Boulder conglomerate)	Glacial/Fluvio-glacial/deposit			…………………………………… ………………			

Plate No.1:-
&
Plate No.2:-





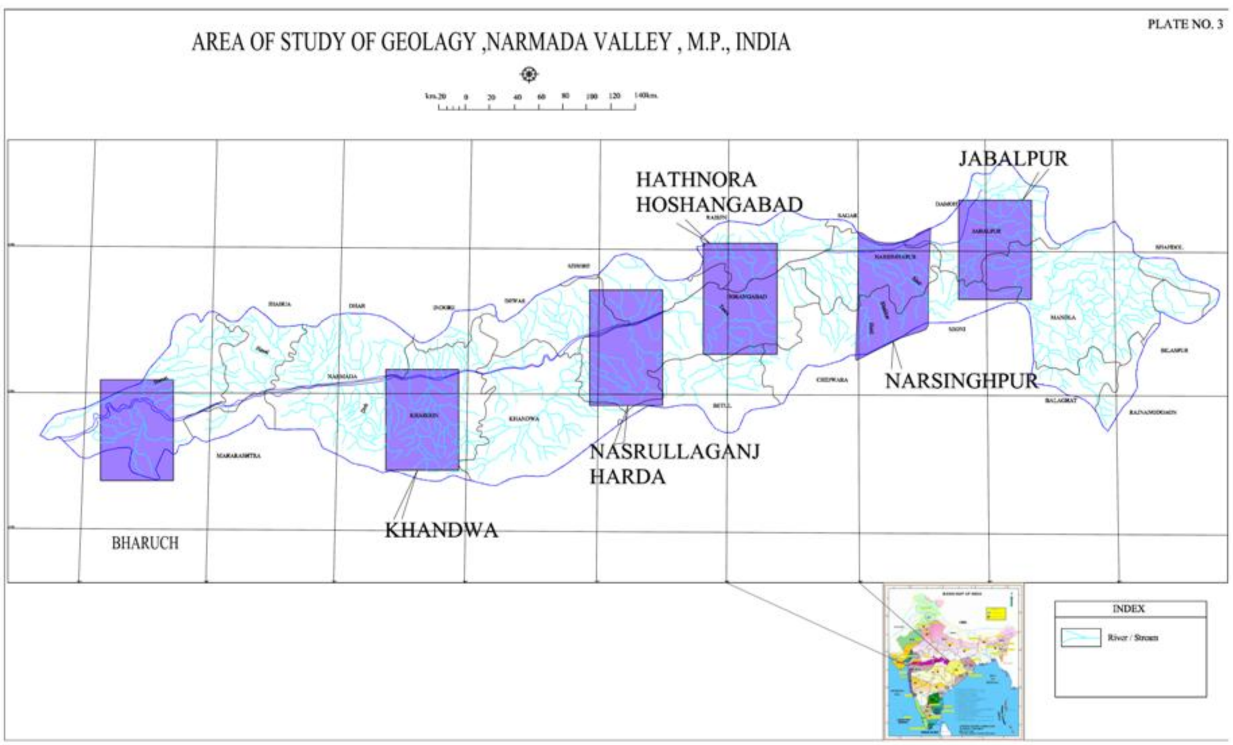


PLATE NO. 3
AREA OF STUDY OF GEOLAGY ,NARMADA VALLEY , M.P., INDIA
JABALPUR
HATHNORA
HOSHANGABAD
NARSINGHPUR
NASRULLAGANJ
HARDA
KHANDWA
BHARUCH
INDEX
River / Stream

Plate No.4:-

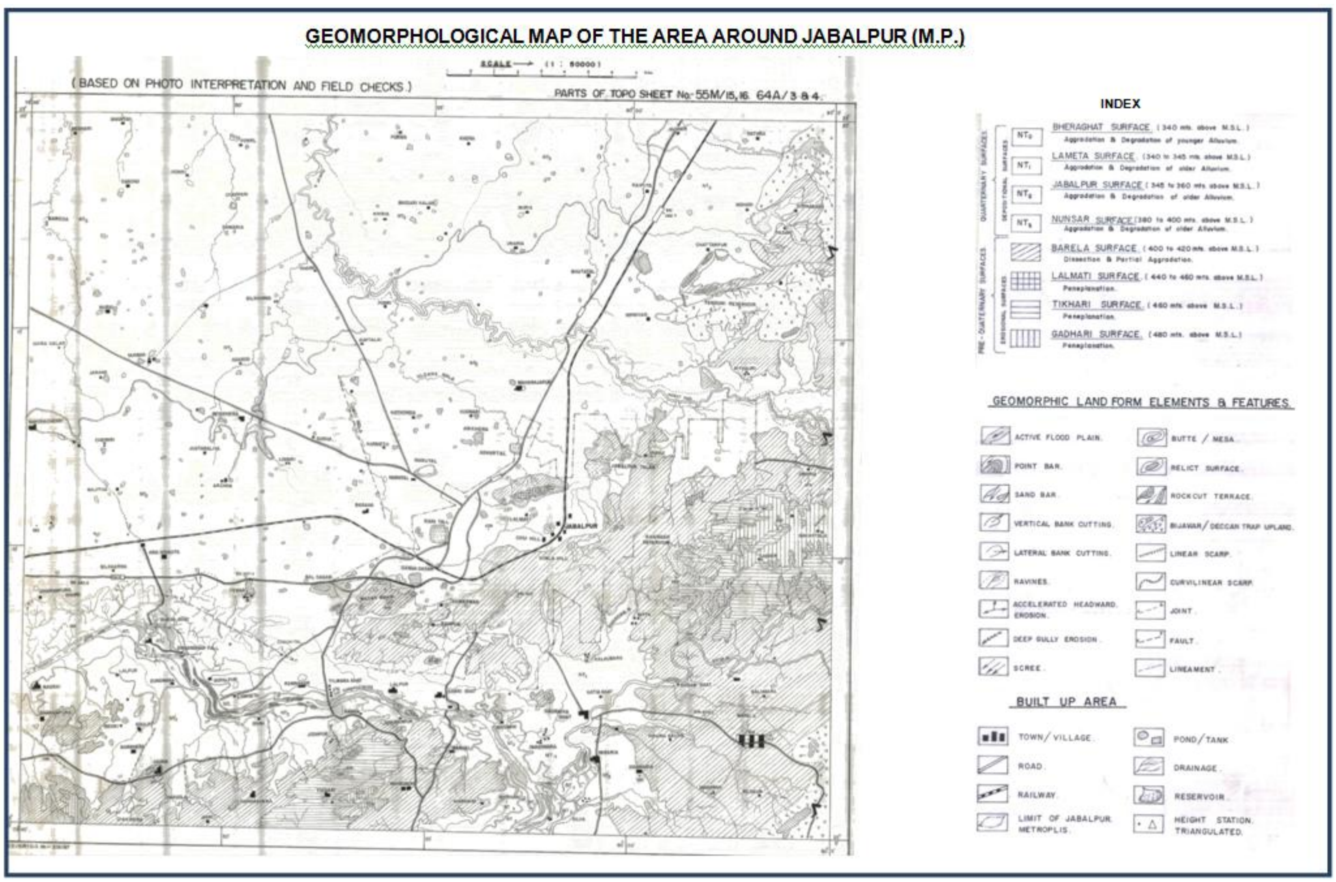

GEOMORPHOLOGICAL MAP OF THE AREA AROUND JABALPUR (M.P.)
(BASED ON PHOTO INTERPRETATION AND FIELD CHECKS.)
PARTS OF TOPO SHEET No- 55M/15,16 64A/3 & 4
INDEX
BHERAGHAT SURFACE
LAMETA SURFACE
JABALPUR SURFACE
NUNSAR SURFACE
BARELA SURFACE
LALMATI SURFACE
TIKHARI SURFACE
GADHARI SURFACE
GEOMORPHIC LAND FORM ELEMENTS & FEATURES
ACTIVE FLOOD PLAIN
POINT BAR
SAND BAR
VERTICAL BANK CUTTING
LATERAL BANK CUTTING
RAVINES
ACCELERATED HEADWARD EROSION
DEEP GULLY EROSION
SCREE
BUTTE / MESA
RELICT SURFACE
ROCKCUT TERRACE
LINEAR SCARP
CURVILINEAR SCARP
JOINT
FAULT
LINEAMENT
BUILT UP AREA
TOWN / VILLAGE
ROAD
RAILWAY
LIMIT OF JABALPUR METROPLIS
POND / TANK
DRAINAGE
RESERVOIR
HEIGHT STATION TRIANGULATED

Plate No.5:-

GEOMORPHOLOGICAL MAP OF NARMADA VALLEY PARTS OF RAISEN AND HOSHNAGABADM.P.

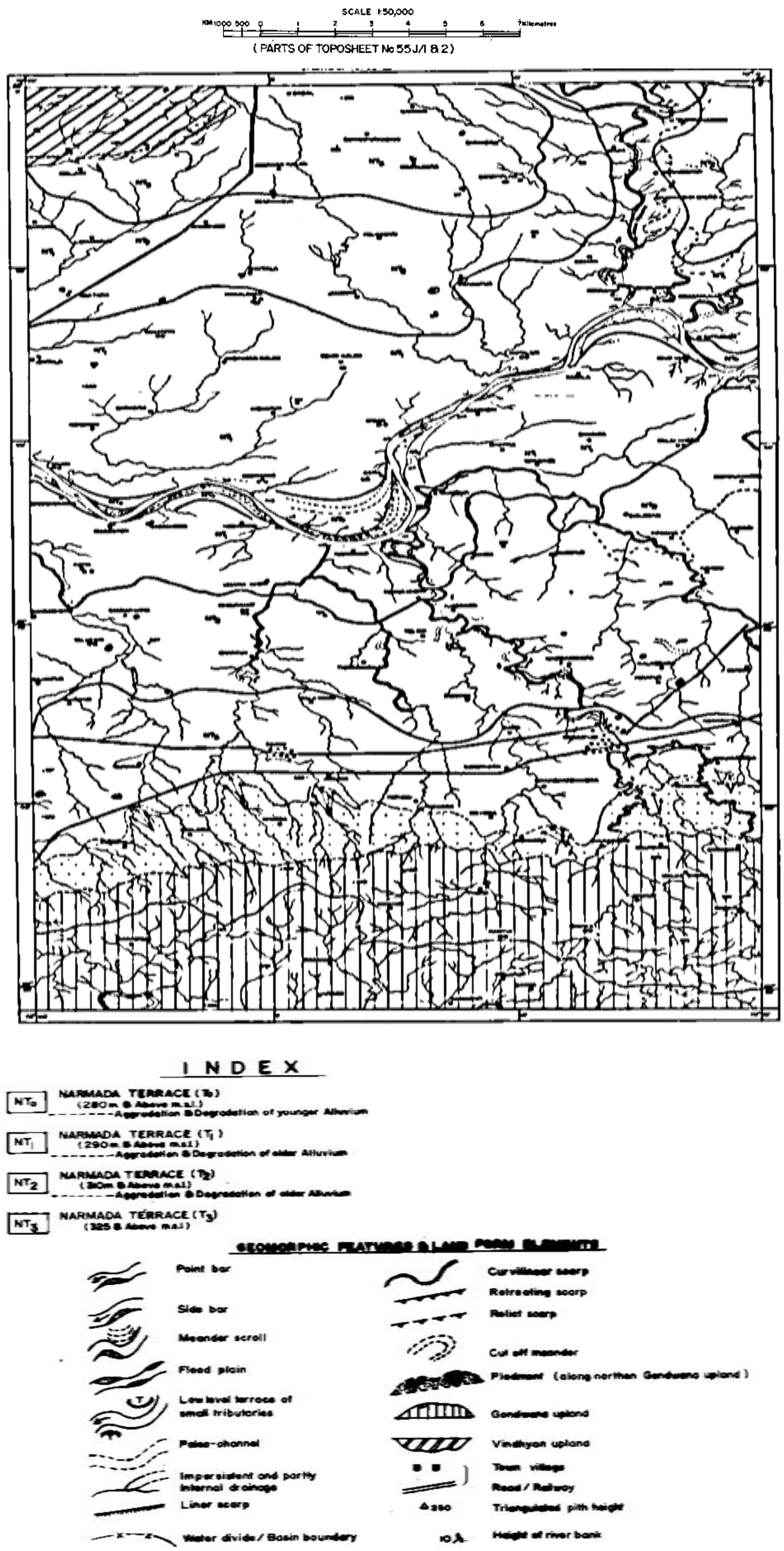


Plate No.6:-

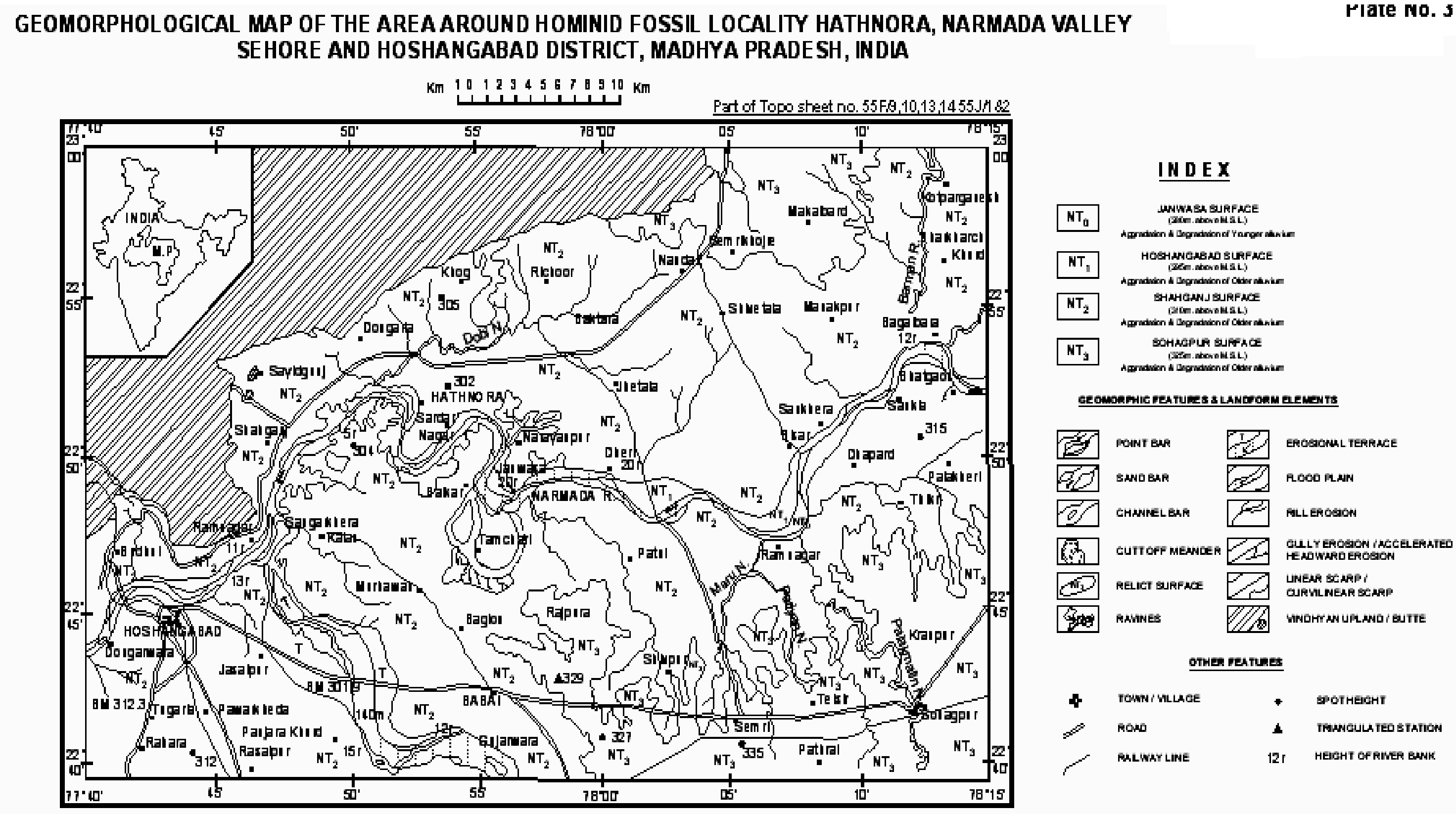


Plate No.7:-

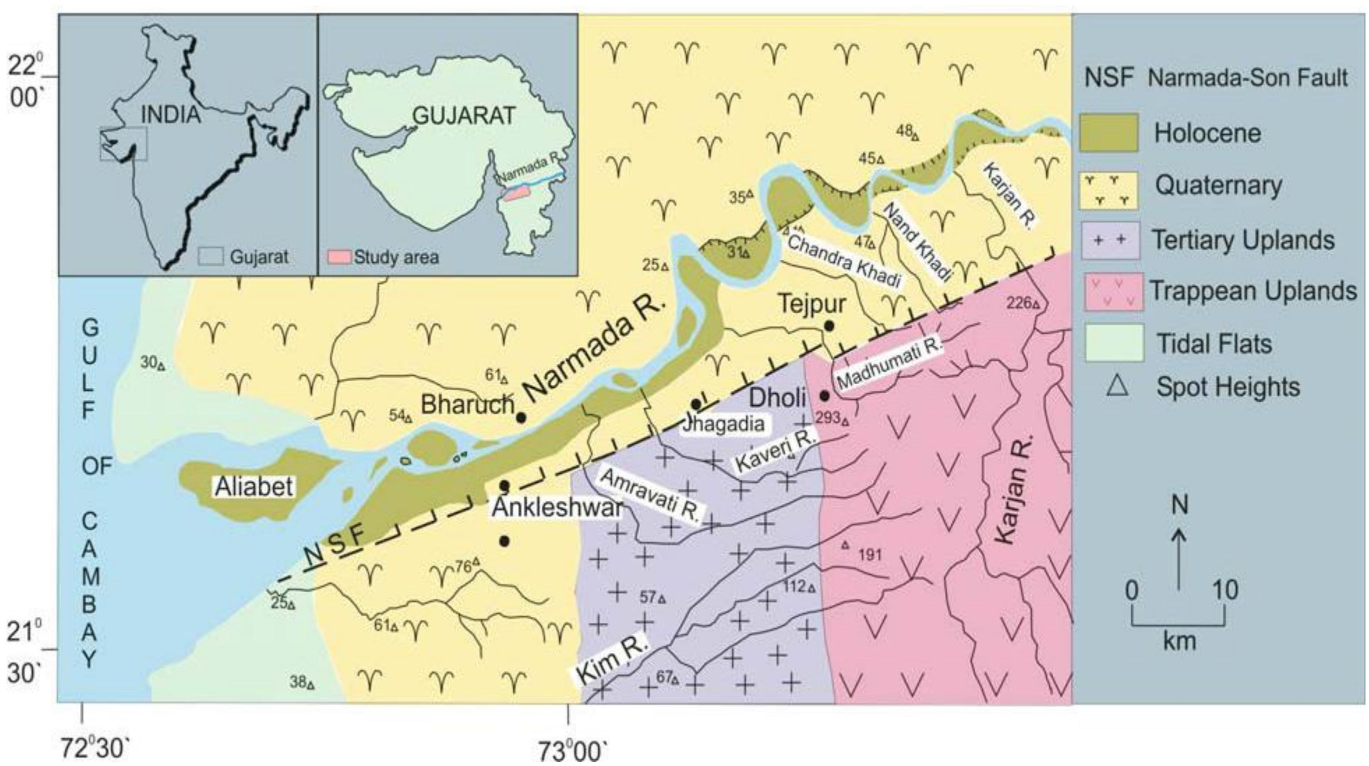
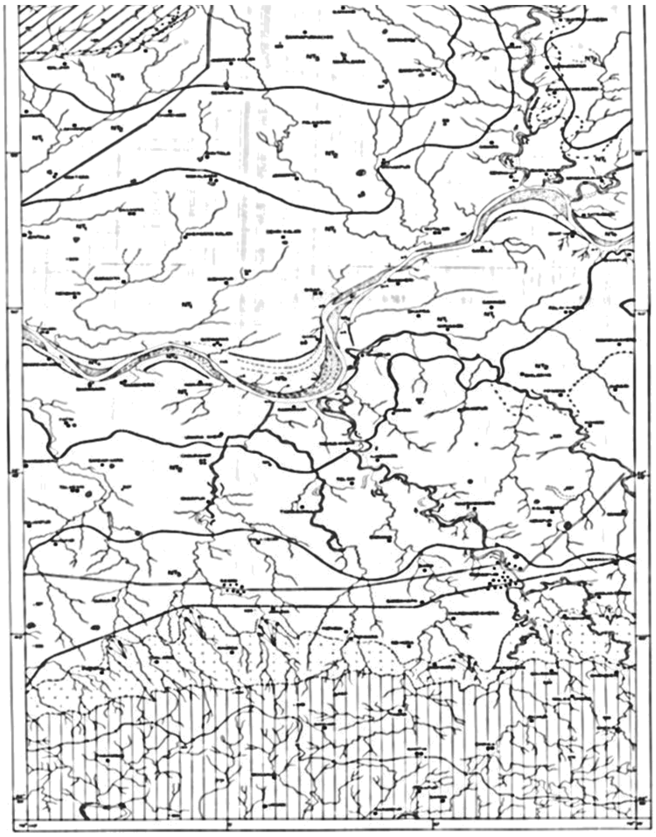


Plate No.8:-

GEOMORPHOLOGICAL MAP OF PARTS OF THE NARMADA BASIN SEHORE, DISTRICT, M.P.

PART OF TOPSHEETNO55F/586



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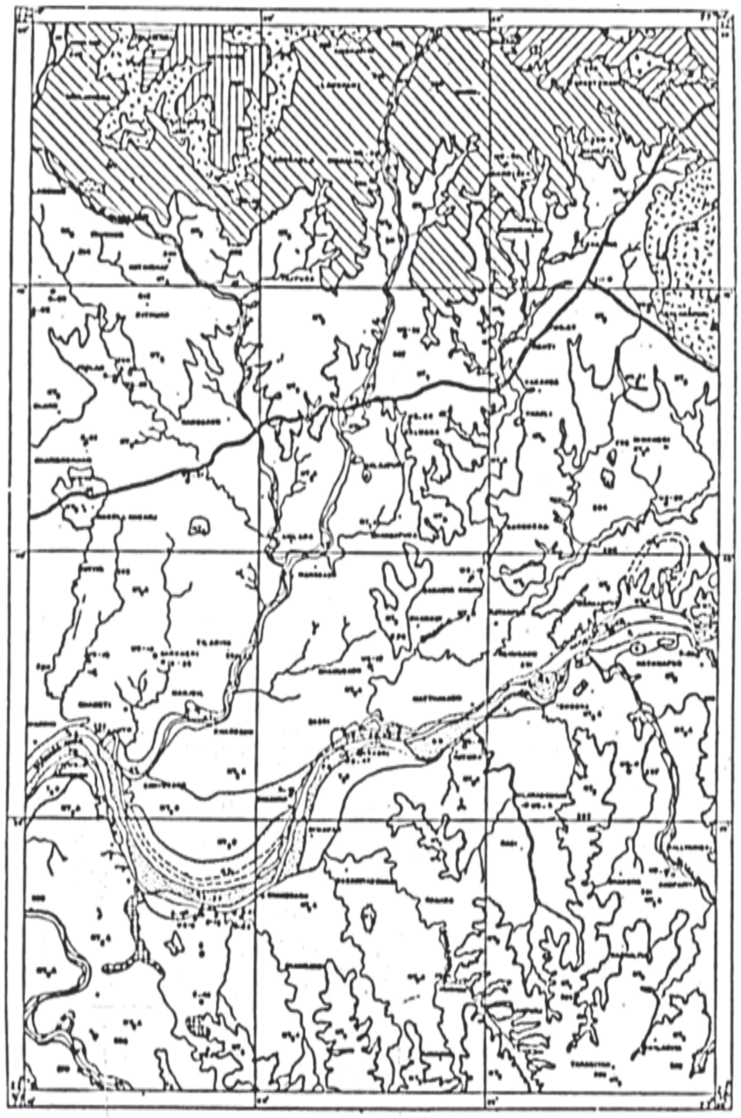
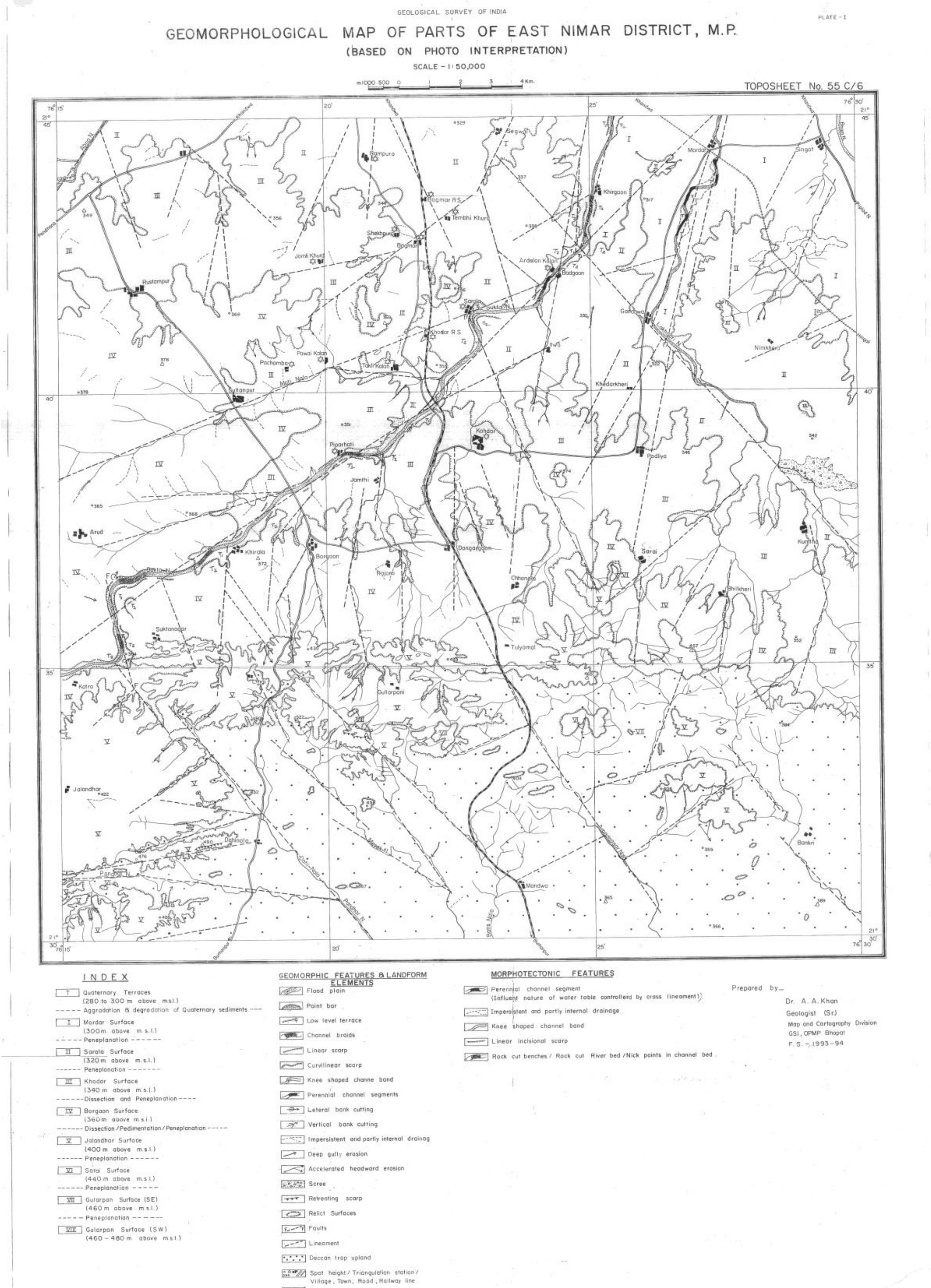


Plate No.9:-


GEOLOGICAL SURVEY OF INDIA
PLATE - I
GEOMORPHOLOGICAL MAP OF PARTS OF EAST NIMAR DISTRICT, M.P.
(BASED ON PHOTO INTERPRETATION)
SCALE - 1:50,000
TOPOSHEET No. 55 C/6
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MORPHOTECTONIC FEATURES
Perennial channel segment (Influent nature of water table controllerd by cross lineament)
Impersistent and partly internal drainage
Knee shaped channel band
Linear incisional scarp
Rock cut benches / Rock cut River bed / Nick points in channel bed
Prepared by
Dr. A. A. Khan
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F. S. - 1993-94

Plate No.10

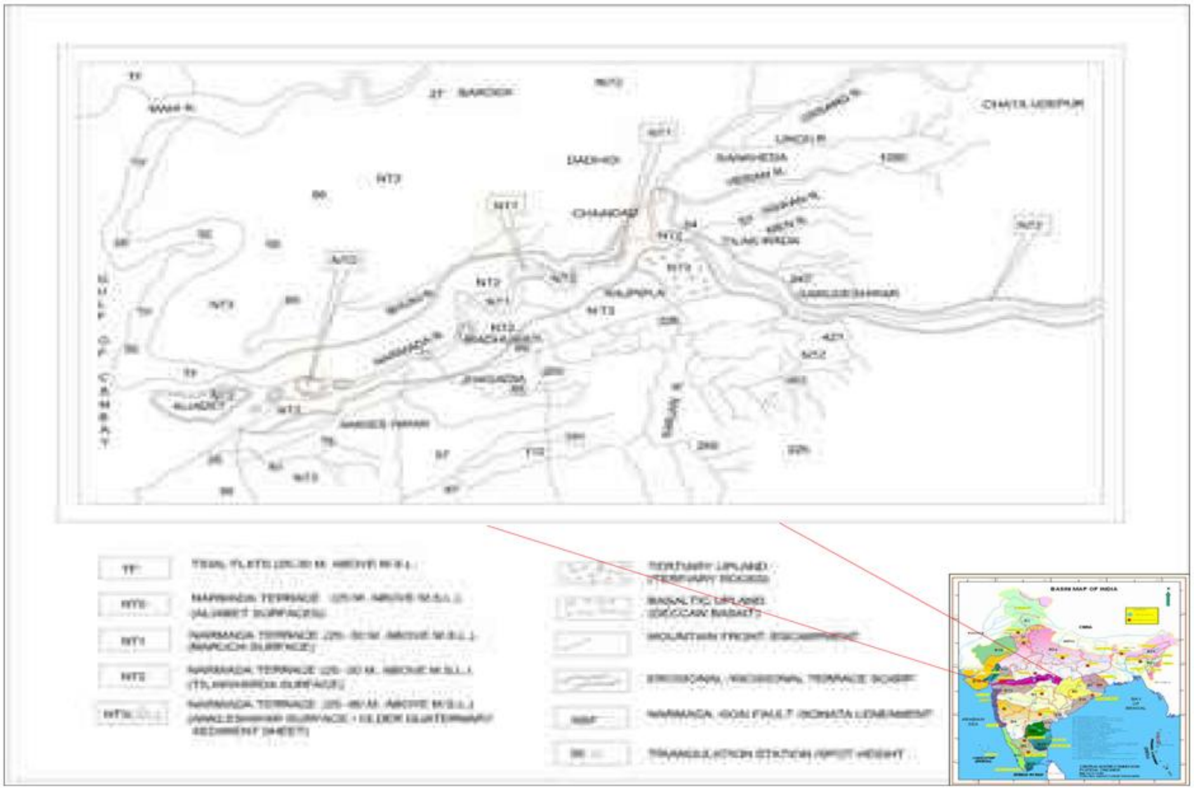
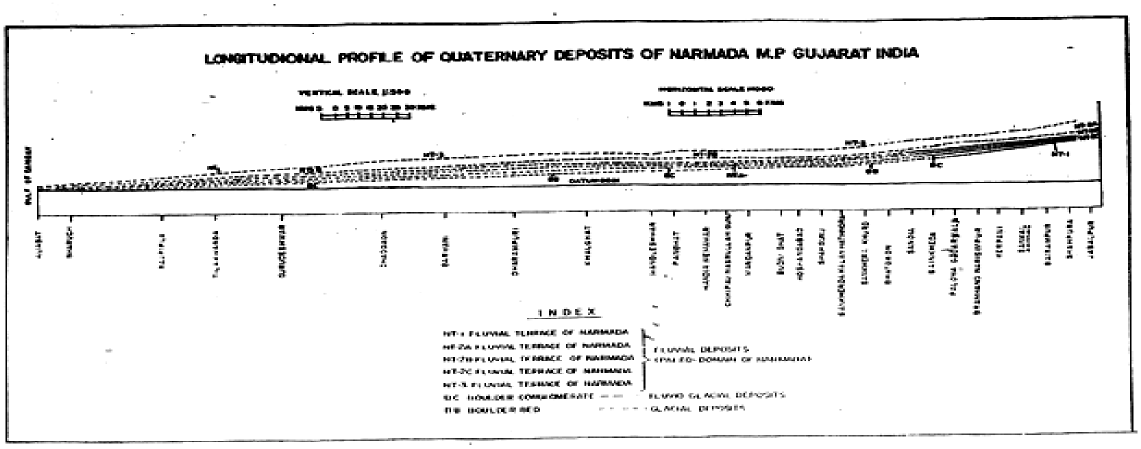
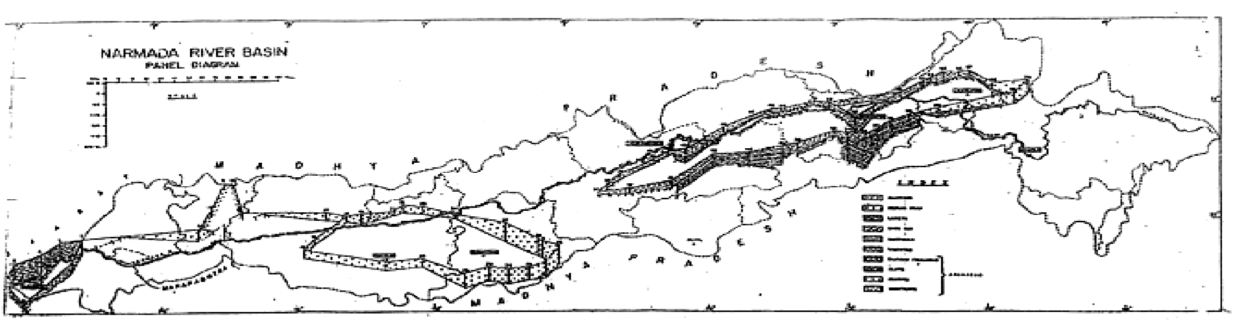


Plate No.11:-





The sediments of paleo-domain of Narmada conformably overlie the boulder conglomerate and represent the flood-plain fluvial facies of the Narmada. The sediments of the fancies predominantly consist of clay silt and sand, discontinuous nodules and plates. The beds are horizontal, exhibit upward fining sequence typical of fluviatile deposits .This domain may be divided divided into three formations based on lithology, sediment assemblage, shape and size of rock clastics, relative disposition and diagnostic sedimentary characteristics. These formations are, viz. (i) Shohagpur, (ii) Shahganj, and (iii) Hoshangabad Formations respectively. These formations represent the sediments the complete sequence of Narmada deposited in channel and flood plain environments during Upper Pleistocene times. The lowest Sohagpur Formation is named after Sohagpur town. The unit occurs along the outer flanks of Narmada Valley bounded by Vindhyachal range to the north and Satpura to the south. It consists of sediments of paleo-domain of Narmada. It is represented by a thick sequence of clay, silt-sand and rock gravels.

The Quaternary landscape of Narmada comprises (NT-1 to NT-3) and their correlation with rest of Narmada Rift Valley between Jabalpur-Harda and Harda - Bharuch suggest that it has evolved mainly due to tectonic activity along the SONATA LINEAMENT in a compressive stress regime. The sediments comprising these were deposited in a slowly subsiding basin during early Pleistocene middle Pleistocene and the Late Pleistocene. The Holocene period is marked by inversion, which had earlier suffered subsidence. The inversion of the basin is due to a significant increase in compressive stresses along the NSF during the Early Holocene, resulting in differential uplift of the lower Narmada valley. The continuation of the compressive stress regime due to ongoing northward movement of the Indian plate indicates that the NSF is a major candidate for future intraplate seismicity in the region.Khan et.al (1991) Khan et.al (1985) (Khan2016)

In Narmada rift valley the quaternary sediments are accumulated in two section viz Jabalpur-Harda section and Guredhwar and bharouch section where as in other area Harda to Gurudeshwar section of valley rock cut terraces, rock cut platform and benches are notices which at many places over lie by caps and strips quaternary deposits representing the former level of valley floor of Narmada. The rock cut terraces and rock cut benches are time equivalent to NT1 to NT3 which have developed in Jabalpur-Harda and Gurudeshwar –Bharouche sections.Khan et.al (2016). The Quaternary events of the Narmada portys three prominent terraces and two sub terraces in these sections which are designated NT1 to NT3 and sub terraces NT2-A is NT2-B, NT2 B, besides NT2-C, NT3-A & NT3-B besides NT-0 in the valley. They have been designed NT_O to NT3, (280 to 400 m), NT_O being the low level terrace above the present-day course of the river, NT_1-the younger terrace both of cyclic ad o cyclic nature. The NT_3 terrace occurs as elongated strip and isolated caps and lenses along the margin of valley flanks has divergent relative disposition. These land forms indicate vigorous and abrupt incision of valley floor due to relatively & repaid uplift of watershed area during Upper Pleistocene time. The NT1to $NT_2$are the major depositional terrace and have both convergent & divergent mutual disposition with other terrace. These terraces further downstream have matched equivalents along the valley flanks, whereas in the up stream section the matched equivalents are rare. The conspicuous divergent relation of these terraces the valley reveals successive uplift of catchments area and consequential incision of valley floor and adjustment of base level of Narmada during Upper Pleistocene time.

The Quaternary river terraces of Narmada (NT1to NT3) entrapped in tectonic zone with rock cut equivalence and scars are positive significant imprints of euestatic change / climatic changes in the during the sedimentation. The alluvial fan in between Tilakwarda and Rajpipla within the loop of Narmada Chamyal (2002) 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 towards north. It appears to be older quaternary deposits of Narmada which has moved from basement and has been pasted along SONATA LINEAMENT.

The study of Narmada river terraces along the length of 1300 kms in between Jabalpur- Bharuch their correlation , relative disposition, their elevation and slope their critical and crucial sediment sequence in type area, 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 (2017) 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 authenticate 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 located at the trailing and leading edges of the Indian plate during the Early Holocene respectively

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