Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/1980

DOI URL: http://dx.doi.org/10.21474/IJAR01/1980

RESEARCH ARTICLE

QUATERNARY SEDIMENTLOGY TECTONICS & SEDIMENTATION NARMADA RIFT VALLEY CENTRAL INDIA

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Manuscript Info

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Manuscript History

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

Key words:-

Abstract

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The SONATA LINEAMENT ZONE embodies the two Quaternary basins of tectonic origin on the two margins of Sapura Crustal Block. The Satpura block traversed by enechelon system of faults and lineaments is characterized by thinner crust (33-38 km deep, basement depth >2.5 km) with series of ENE-WSW trending gravity high (viz. Sendwa, Khandwa, Chicholi, Tikaria etc.) with amplitudes of 10-35 mgal. The chain of gravity high indicates extensive magmatic and emplacement of derivatives at shallow crustal levels. The associated Narmada South (Satpura North) fault and Satpura South Fault marking the two hinges of the Satpura block are fundamental in nature and extend to Moho level. The Narmada Quaternary basin in the north and Tapti-Purna basin in the south are two Graben which formed prominent loci of sedimentation in lineament zone. The area of lineament zone studied tectonically encompasses two crustal provinces of Central India Shield, namely, the Northern Crustal Province (NCP) and the Southern Crustal Province (SCP). The two provinces are separated by a crustal level shear zone, referred as Central Indian Suture. The zone has been a major locus of episodic tectonism with evidences of reactivation The manifestation in terms of imprints of activity are recorded on landscape profile and signatures of magnitute and intensity in recongiguration of drainage and mega channel behiviour in the area.

The Narmada Rift valley forms an ENE-WSW lineament where Quaternary deposits are confined in a trough like basin on unstable platform which forms a prominent lineament with profound geomorphologic and geological asymmetry between the northern and southern valley walls, giving it a tectonic significance. The alluvial deposits of the Narmada valley represent the thickest Quaternary deposits in peninsular India. These sediments were deposited in faulted and sinking platform under structural riparian rift trench remained silent and unrevealed. The quaternary blanket of Narmada

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consists of sediments of various domains which were deposited in different environment in vertical chronology in faulted trough in time and space.

The Quaternary sedimentation in Narmada Rift valley incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and linear displacement and dislocation, uplifting and isolated domal up-lift, Neogene rifting and Quaternary sedimentation. The rift-bound Pliocene–Pleistocene rifting and volcanic activities specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Rift System which form the base of quaternary deposits. The Narmada rift system basin platform provided a unique setting for dynamic ecosystems that were characterized by Rift-related subsidence and coeval sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, digenesis, and preservation of organic remains.

The present disposition of Narmada blanket of Narmada, in SONATA LINEAMENT ZONE revealed that the rift occurred after widespread Quaternary sedimentation and accumulation of sediments in the linear trench by glacial activity in late Pleistocenc.The Fluvio-glacial phase is represents by boulder conglomerate which has formed the persistent horizon in the valley. The Narmada has in the area under study has sculptured the alluvial tract into stepped sequence forming four alluvial terraces along its course. These are designated as NT0 to NT3, NT0 being the youngest terrace and NT-3 the oldest terrace where the sub terraces are designated NT2-A is NT2-B, NT2 B, besides NT2-C, NT3-A & NT3-B in increasing order of antiquity. These are both erosional and depositional terraces and confined at an elevation of, between 280 to 380 are separated by the scarp both of curvilinear and linear in nature facing towards river side. These are abandoned flood plains represent the level of former valley floor in the area, and were formed by cumulative climato-tectonic changes in the watershed of Narmada in the Quaternary times Khan et.al (2016)

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

The Boulder Conglomerate which is of fluvio-glacial origin and has yielded human skull from Sonakia (1982) Khan &Sonakia (1992) is exposed impersistently in scarp section of Narmada at few places only. The type section of Boulder Bed and Boulder *Conglomerate* which is potential of possessing of human remains of Pliocene Pleistocene time are hidden and concealed under sediments of present and paleo- domain of Narmada in the valley.

The present study is a systematic attemptin Narmada Rift valley along entire length of about 1300 Kms in Jabalpur _Bharuch section where five critical and crucial sectors were selected and examined viz viz Jabalpur section , Hoshangabad section, Harda section, Gurudeshwar section and Bharuch section and about 310 samples were collected both from exposed section and bore hole logs across the vertical column 550 m to understand regional modal of sedimentation, source of sediments, mode of transportation deposition tectonic environment and overal sedimentlogical aspects to conceive the model of Quaternary sedimentation in vertical chronology in faulted trough in time and space. The Quaternary deposits of Narmada valley represent the thickest sequence which was deposited in faulted and sinking platform under structural riparian rift trench which remained silent and unrevealed. The work so far carried out is restricted to few exposed section of 18 m of river as such no work has been done on correlation merits in vertical coloumn and horizontal scale on ground control of concealed strata of quaternary deposits.

The statistical parameters viz MZ, STD, SKI, and KG of sediment samples were computed from vertical column of 550 m of Quaternary blanket of Narmada. The synthesis of various parameters their binary relation, concentration of plots their pattern and trend revealed that the quaternary deposits consists of sediments of three mega stratigraphic strata viz Boulder bed, boulder conglomerate and fluvial deposits. The fluvial deposits include sediments of paleo-domain of Narmada and present domain of Narmada which constitute fluvial terraces (NT1 to NT3) of Narmada. These three domains of sediments were deposited, from Pleistocene to Upper Pleistocene time in increasing antiquity in the valley.

The study of statistical parameters and their binary relation distinctly display contrasting and relative heterogeneity in sediment characteristics throughout across the Quaternary blanket in Narmada valley. The study of sediments display diagnostic characteristics of glacial , fluvio-glacial and fluvial environment at different depth and levels 000m.to150, 150 to 350m, and 350 to 550 m from glacial, fluvio-glacial fluvial , and fluvial deposit. About 310 sediment samples were collected from theses domain both from bore hole and exposed stratafor sedimentological study. The critical analysis of these parameters exhibits sediment textural linkage to evolution and sedimentation in distinct three environment of glacial, fluvio-glacial and fluvial in time and space in increasing antiquity in the valley. The primery and digonestic characteristics inherited by the sediments of

Narmada valley is from pre-existing domain of glacial, fluvio-glacial origin. The digenetic and diagnostic features; varying degrees of heterogeneity, sediment angularity roundness, degree of sorting indicate evolution and sedimentation of quaternary sediments in a high-energy turmoil glacial environment on tectonically dislocated and unstable platform. The sediments confined up to 150 m below ground level represent paleo fluvial domain of Narmada and represent multi cycle sedimentation under varying energy condition on oscillating platform. The vertical variation in increasing antiquity in textural parameters and distinct breaks at specific level identified indicate changes of environments of sedimentation in vertical columns from glacial at the bottom of valley, subsequently followed by fluvio-glacial and further overlain by sediments of paleodomain of Narmada which is related with change of climate and tectonic in watershed. The binary relation of these parameters effectively used in differentiating and fencing the sediments of these domains and their environment of sedimentation in time and space Khan et.al (2015). The study of statistical parameters across the entire thickness of Quaternary deposits revealed three breaks in sedimentation at 350 - 290,190-220,100-150 in increasing antiquity representing glacial, fluvio-glacial and fluvial environment of sedimentation from the base in Narmada valley.

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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. The valley has maximum width of about 32 kms.

The Quaternary Blanket of Narmada basin covers an area of abut 12950 sq. km starting from west of Jabalpur ($23^0 07^0$790530) to Bharouch (22^0 29'; 76^0 58') in Gujarat state for a distance of about 1300 km. It is found to be ideal locus of Quaternary sedimentation in Central India as witness by multi-cyclic sequence of Quaternary terraces in the valley. The general elevation of Narmada alluvial plain varies between 265.7 and 274.3 m above the sea level. The general gradient of this plain in this stretch is about 1m /Km towards West.

The Quaternary deposits of the Narmada valley contain the richest vertebrate fossil assemblage including only known Hominid fossil from the Indian sub-continent (Sonakia 1984) .The boulder bed which yielded Hominid fossil from boulder conglomerate reported to be of glacial & fluvial origin for first time (Khan & Sonakia 1992). Beside occurrences of association of ash beds with fossileferous boulder conglomerate (Khan & Rahate 1991) Achariya 1993 indicates volcanic source. It appears that close to the completion of cycle of deposition of the boulder bed there was vilolent volcanic eruption in around Middle to uper Pleistocen time and subsequent settled down across the globe and in the pennisular India during the quaternary sedimentation. The occurrences of association of two marked horizons at different levels further revealed the cyclic eruption and settling of volcanic matrix during sedimentation. Khan and Sonakia (1992) reported for the first time glacial and interglacial deposit in the Narmada valley, Central India which is represented by arid and humid cycles. The lithostratigraphy of Narmada valley described by Khan (1984), Khan & Benarjee (1984), Khan & Rahate (1990-91), Khan & Sonakia (1992), Khan *et al* (1991), Rahate & Khan (1985), Khan (1991), Khan & Sonakia (*1992*), Yadav & Khan (1996).

The Quaternary lithostratigraphy and sedimentological aspects were studied and in the Narmada valley (Khan 1984, Khan & Benarjee 1984, Khan & Rahate 1990-91-90 Khan & Sonakia 1992, Khan & *et al* 1991, Rahate & Khan 1985, Khan *et al.* 1991, Khan 1991, Khan *et al.* 1992, Yadav & Khan 1996. The Narmada valley embodied complete sequence of Quaternary deposits from lower Pleistocene to Holocene (Khan & Sonakia (1992). Khan, et.al (1912), Khan (2012) et.al Khan (in press) , Khan (in press),.The results of sedimentological studies Khan (2015), quartz grain morphology, Khan (2014), quartz grain morphology,Palesole Quaternary column section in Hominid locality in central sector of Narmada revealed the presence of complete sequence of quaternary sediments in Narmada rock basin viz Glacial, fluvio-glacial and fluvial domain whereas the boulder conglomerate which has yielded human skull is of fluvio-glacial origin from Khan & Sonakia (1991)

The Quartz grain morphology of sediment column Khan (2014) Quartz grain morphology of different pale- sole, , Khan (2014), Ash bed Khan & Maria (2012) Khan & Maria (1912) Heavy mineral assemblage Khan (2016) tephra stratigraphy, Khan et.al (1991) Acharya, S.K. and Basu, P.K. (1993) Khan etal (2014) Khan & Maria (2015) Ash fall and its impects (2015) Khan (2016) magnetostratigraphy, and bio-stratigraphy and correlation of sediment columns intra valley wise , inter valley wise and on unified Quaternary Platform Khan et.al (2012) focusing on hominid localities of China have been studied on quaternary platformwhich have given new insight on the age of the Narmada *Homo erectus.* Plate No_1

Acknowledgement:

The author is grateful to Dr Shabina Khan Associated Professor of RGPM for her assistence in preparing the manuscript; tahnks are also due to Dr K.S Yadva for his kind assistence in data synthesis and synchronisation. The present paper is based on field work, data acquisition and laboratory analysis during official assignment of Geological Survey Of India (1984 to1996) hence the data base used for interpretation in present study is duly acknowleged.The data of bore hole logs & sediment samlpes collected from bore hole logs from GSI,CGWB, State & Fadral agencies for comprehansive interpretation is gratefully acknowleded.

Quaternary geology:-

Boulder Bed:-

Glacial/Fluvial-glacial deposits:-

The glacial and fluvio-glacial deposits of Narmada unconformable overly the Vindhyan and the basaltic Deccan Trap rocks. The sediments consist of heterogeneous assemblage of sub-angular to angular, sub-rounded, unsorted, stratified rock 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. The fine matrix of 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 sediments contain fairly good amount of ferruginous material, quartz, mica flakes and altered feldspar grain. Though 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 depth of 210 m was deposited in glacial environments linear trench during Pleistocene time. These deposits are concealed under boulder conglomerate in the valley.

Boulder Conglomerate:-

Fluvio-glacial deposits:-

The Vindhyan Group of rocks and Deccan Trap in the Central sector of the Narmada Valley form the basement for the Quaternary deposits. The conglomerate bed that constituted the fossiliferous horizon of Narmada is sandwiched between older Alluvium and the glacial bounder bed. This conglomerate bed is a very persistent marked horizon indicating a distinct 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 terrace NT_2 (Khan, 1984). The measured thickness of the exposed boulder conglomerate the average exposed measured thickness is about 5m.

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 brown and maroon sand and silt, which are often laminated and cross laminated. The boulder conglomerate yielded fossil 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 facies variation in the valley and upper units' grades into gritty sandstone upstream of Hathnora.

The basal unit of boulder conglomerate and is characterized by sub-rounded to rounded boulders cobbles, pebble of quartzite (38.50%), gneiss (18.50%) sandstone (14.50%), basalt (6.50%), agate and other rock fragments (3.50%). These clastic are tightly cemented in a reddish brown and maroon sand and silt which exhibit lamination, cross-lamination and cut and fill feature. It is capped by a pebbly layer containing vertebrate fossils and a human skull of early man (Sonakia, 1984). The average measured thickness of this layer is about 2.25m.

The middle sub-unit of boulder conglomerate characterized by an abundance of spherical, discoidal and bladed cobbles, pebbles of quartzite (31.50%), gneiss (14.00%), jasper (8.50%), sandstone (15.00%), basalt (10.50%), agate (12.50%), chart (6.50%) and other rock fragments chart (1.50%). These coarse clasitic are tightly cemented by a deep brown and maroon sand, silt and clay. The finer clastics display sedimentary feature like lamination, cross-bedding load structure, small ripples and, cut and fill feature. Besides the boulder conglomerate possess cross beded units of different angles. These are often truncated by a pebbly layer at the top. This sub-unit contents mammalian fossil and some stone implements. The average measured thickness of these sub-units is about 3.5 m.

The upper sub-units of the boulder conglomerate consists of sub-rounded to well-rounded pebble of quartz (23.50%), gneiss (11.50%), sandstone (14.50%), basalt (13.50%), agate (15.50%), jasper (11.50%), chart (8.00%) and other rock fragments (2.00%). These clastics are commented by grey and brownish sand and silt containing appreciable amount of calcareous matrix.

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.

The boulder conglomerate is of middle Pleistocene age equivalent to Siwalik boulder conglomerate (India), Trinil bed of Java (Indonesia) and boulder conglomerate of Tapti (Khan 1984). These deposits have yielded skull cap of early man, Homo erectus Narmadensis along with other mammalian fossils (Sonakia, 1984). The Ash bed of Quaternary age is recorded associated with these deposits around Timrawan upstream of Hathnora is of aeolian nature and perhaps indicates volcanic activity during middle Pleistocene time.

Flood plain deposit of paleo domain of Narmada:-

Fluvial deposit:-

The sediments of paleo-domain of Narmada conformably overlie the boulder conglomerate and represent the flood-plain fluvial facies of the Narmada. These sediments 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 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 unit is divisible into three sub litho unit. The basal sub-unit is chiefly red and brownish sand, silt, clay containing appreciable amount of calcariou 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 Sohagpur formation is often association with discontinues and persistent pebbly horizon containing well sorted polymodal gravel of quartzite, gneiss, basalt, agate, jasper and chart in the matrix of course to fine-sand. The gravel is general discoidal, spherical and exhibits higher indices of sphericity and roundness indicating their derivation from distance and mixed provenance during sedimentation.

The Shahganj formation is forms litho-stratigraphic unit overlying boulder conglomerate and occupies large area in the central part of the valley. It is exposed in the bluff section of Narmada around Narayanpur, Sardarnagar, Hathnora, Shahganj and Hoshangabad. This formation is equivalent to the Shivpur formation described by Khan (1984) from the down stream of Hoshangabad. It consists of sediments of palaeo-domain of Narmada. It is represented by clay, silt, sand accompanied by inconsistent pebbliferous bed containing quartzite, gneiss, basalt, chart, agate. The average measured thickness of this formation is about 15m. These sediments constitution three units each characterized by distinct lithology, rock classics and diagnostic sediment characters.

The Hoshangabad is the younger formation of the Narmada and is represented by the flood plain fancies. It forms a distinct morphostratigraphy unit; above the present day flood plain of Narmada. It is crescent-shaped and is confined within the meander looped of the Narmada. This formation comprises three units. The basal unit predominantly consists of rock gravels of quartzite, gneiss, basalt and agate imbricated in the grayish sand and silt. The middle unit is represented by unconsolidated imbricated matrix of sand and silt supported by bimodal sorted gravel of quartzite, basalt, agate and chart. The upper unit contains yellowish and brownish silt and clay with occasional calcium concretion. It is capped by black soil. The measured thickness of the units is 6.5m, 5.00m and 3.5m respectively. 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. (Plate No _5 to _10)

Narmada Graben Quaternary Tectonics & Sedimentation:-

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

The Quaternary tract of Narmada basin covers an area of about 17950 sq. km starting from west of Jabalpur ($23^0 07^0$79 05 30) to east of Harda (22^0 29’; 76^0 58’) , and Gureshwar and Barouche section in Gujarat state for a distance of about 1320 km. It is found to be ideal locus of Quaternary sedimentation in Central India as witness by multi-cyclic sequence of Quaternary terraces in the valley. The general elevation of Narmada alluvial plain varies between 265.7 and 274.3 m above the sea level. The general gradient of this plain in this stretch is about 1m /Km towards West. (Plate No_1)

The Narmada conspicuously has straight course is controlled by ENE_WSW to E_W lineament, is bounded by Vindhyan in the north and Satpura in the south it is exposed the repeated post erosional and depositional activities and subjected to anisotropic and asymmetric tectonic dislocation which has culminated diversified morphogenetic units and region which further undergone to process of tectonic evolution and chiselling 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 and geothermic activity 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, penplain and river terraces.

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 fluvial-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and segmental and linear displacement and dislocation, uplifting and isolated domal up- lift, Neogene rifting and Quaternary sedimentation and rift-bound Pliocene–Pleistocene rifting and volcanic activity specifically during glacial and 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 also created an ideal loci of Quaternary sedimentation and environment for the accumulation of sediments volcanic fabrics sediments, burial, digenesis, and preservation of organic remains. The disposition of quaternary deposits, drainage configuration basin boundary and 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.

The Narmada in the area under study has sculptured the alluvial tract into stepped sequence forming four alluvial terraces along its course. These are designated as NT0 to NT3 NT0 being the youngest terrace and NT-3 the oldest terrace. These terraces are separated by the scarp both curvilinear and linear in nature facing towards river side. These are abandoned flood plains represent the level of former valley floor in the area, and were formed by cumulative climato-tectonic changes in the watershed of Narmada in the Quaternary times. In Narmada NT0 and NT1 area depositional terraces whereas NT2 & NT3 are erosional terraces. These are both depositional and erosional terraces are cyclic and non-cyclic in nature and their paired equvalent occur on both side of river. The Narmada exhibits swelling and pinching nature along its course of 1300 kms, between Amarkantak amd Bharouch the channel course of Narmada is mainly controlled by ENE-WSW lineament and its sympathetic fractures. The Narmada in Jabalpur _ Harda and Gurdeshwar _ Bharuch section embodies prominent blanket of Quaternary deposits which display stepped sequence of river terraces. These terraces are seprated by linear and curvilinear scarp facing river.In Jabalpur _Harda section Hiran Dudhi, Shakker, Sher and Tawa are the prominent tributaries which fow along tranverse fault and fracture joining Narmada at acute angle. In Gurudesh _ Bharouch section Narmada flows in a general WSW direction where it display meanders with wave lengths of order of 5–8 km. The Orsang, Aswan, Man and Bhuki are the major tributaries in lower Narmada valley 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 at different p[laces . The network of drainage in the lower Narmada is structurally controlled and developed 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 geotectonic activity in the area. The display of active Narmada channel configuration of terraces, meander scrolls, entrenched meander revealed misfit nature of Narmada in the area. The present channel of Narmada is strongly influenced by NSF and display persistent tendency to shift towards north due geotectonic activity along the fault. It is also further authenticated that there is perceptible up rise in the southern block of fault and subsidence of northern block which has manifested and resulted into gliding and shift of Narmada towards north. The study of active channel of Narmada associated land form elements, cahnnel course geometry and diagnostics of landform elements togather with the braided appearance to the channel indicates the heterogeneity of the present river bed and also decrease in load carrying capacity of channel towards the later phase in the history of river system. 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 shifting of Narmada towards north.

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

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

In Homnid locality Hathnora in Narmada valley is occupied by thick Quaternary sediments which are classified on the basis of statistical parameters.quartz grain morphology of sediments, quartz grain morphology of quartz grain of paleosole, heavy mineral assemblage, and ash bed sedimentary features and environments of sedimentation. The lowermost units (Boulder bed) is or glacio-fluvial origin (Khan *el al* 1991) whereas the rest of fluvial origin. The top four formations (Sohagpur, Shahganj, Hoshangabad and Janwasa) are classified based on morphostratigraphic state (NT_o-NT_3), degree of oxidation, calcification and compaction. Janwasa formation comprises of sediments of active channel deposition and is the older three (Sohagpur, Shahganj, Hoshangabad formation) are related to older flood plains deposits of paleo-do-main of Narmada and are grouped under older alluvium. Boulder conglomerate of fluvio-glacial origin is assigned an independent formational status based on distinct lithology and fossil assemblage.
On the merits of detailed study of sediments Quaternary deposits of Narmada valley divide in to three distinct group viz. glacial, fluvio- glacial and fluvial; their age, litho constituents, environments of deposition and associated geomorphic elements are given in the Table I below:

In Narmada Rift system presence of the Katni Formation with angiosperm flora suggests that sedimentation continued during Mio-Pliocene in localized lakes. The relative disposition of such lakes and subsequent deformation and structural dislocation on oscillating valley platform clubbed with rifting and faulting during Quaternary period has shifted the site of the lakes towards the present alluvium-covered area between Harda and Jabalpur as presumed: whereas the present study of various aspects of Quaternary blanket in SONATA lineament ZONE reveled that quaternary sedimentation was a sequential and continuous process in rift valley system from Mio-Pliocene Pleistocene time, has deposited complete sequence of glacial, fluvio-glacial lacustrine and fluvial deposits with changing environments and climate in time chronology. The present disposition of quaternary blankets in Son Narmada Tapti and Purna basin is due to post deposition Quaternary tectonics which is solely responsible for dislocation, faulting and shifting of different blocks and distorting quaternary blanket ecology in rift system.

The occurrence of Boulder bed and Boulder Conglomerate in Son Narmada Tapti and Purna with similar rock assemblages and suites of rock fabrics, heavy mineral assemblages, 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 Rift System provides a unique setting for Quaternary geological sedimentological pedological paleontological and archeological investigations which indicates human origins and evolution. Skeletal and cultural remains of hominids have been recovered from many locations within the basins. The Important paleontological paleoanthropological and archeological sites occur within the Narmada Rift System. The most of localities occur on the rift floor in between Jabalpur_Harda, in the east and Barwaha _ Rajpipla in the west in the valley.

The remarkable preservation of faunal and floral remains in the Pliocene–Pleistocene sedimentary rocks was possible because of quick burial by sediments. Moreover, these source rocks of rift system the Quaternary sediments and interbedded tuffs provided the necessary chemical components for the preservation of the fossils during digenesis. There is a strong link between these dynamic processes, rapid sediment deposition, and fossil preservation. The most important primary and contextual data (fossils and artifacts) were embedded and preserved in sedimentary deposits until the recent exposure by tectonic driven erosional processes. The time-stratigraphic data obtained from tephra interbedded with fossiliferous Quaternary sedimentary deposits provided an important framework for the study of hominid origins, evolution, adaptations, and cultural changes.

The paleoantoological Paleo- anthropological information from these localities is remained closely associated with Quaternary sedimentary deposits boulder conglomerate and boulder bed often related to the trench Quaternary sedimentation, formation and development of rift and linear basin caused by repeated uplift, and the development of rift basins that began in the middle to late Pliocene and Pleistocene period. The unfortunate part of theses deposits is that due repeated tectonic dislocation and faulting they are dislocated ad distorted ad at present are concealed under the thick pile of sediments of present and paleo domain of Narmada of late Pleistocene and Holocene time. These deposits do not provide adequate opportunity to researcher to study the human remain as postulated, except limited section where they are exposed.

The Jabalpur- Harda section of Narmada possess the complete sequence of all three domain of sediments in increasing antiquity from the bottom of the rift trench Boulder bed (glacial), Boulder conglomerate (fluvial-glacial) sediments of paleo-domain of Narmada (fluvial). The intense tectonic activities within the basins of the Narmada Rift System during the Neogene and Quaternary periods have destroyed fossil record except the fossiferous horizons exposed in river sections.

The boulder conglomerate which yielded the skull cap of *Homo eructs* in Narmada rift from Hathnora Sonakia (1984) remained only discovery of hominid fossil in last two and half decade due to concealed and hidden nature of Mio-Pliocene Pleistocene deposits in rift system and inconsistency in exposure of fosiliferous horizon due faulting, dislocation ad subsidence of Quaternary blanket of Narmada rift system.

The Boulder Conglomerate which is of fluvio-glacial origin and has yielded human skull from Sonakia (1982) Khan &Sonakia (1992) is exposed persistently in scarp section of Narmada at few places only. The type section of Boulder Bed and Boulder *Conglomerate* which are potential sediments of human remains of Pliocene Pleistocene time are hidden and concealed under sediments of present and paleo- domain of Narmada in the valley. (Plate No _5 to_ 10)

The Statistical Computations:-

The statistical analysis of sediment sample of the area around Hathnora Narmada valley and particle size distribution curves were expressed on a Φ scale. Folk and Ward's (1957) graphical method was adopted to calculate mean size (Mz), sorting (σI), Skewness (SKI) and Kurtosis (KG). This method involves the measurement of several percentiles from cumulative curves (Φ5, Φ16, Φ25, Φ50, Φ75, Φ84 and Φ95). The formulae are as follows:

$$\Phi = -\log_2 G$$

where G = the grain size (mm) (i.e. sieve mesh opening)

Mean size

$$M_z = \frac{\Phi16 + \Phi50 + \Phi84}{3}$$

Sorting

$$\sigma_I = \frac{\Phi84 - \Phi16}{4} + \frac{\Phi95 - \Phi5}{6.6}$$

Skewness

$$SK_I = \frac{\Phi16 + \Phi84 - 2\,\Phi50}{2(\Phi84 - \Phi16)} + \frac{\Phi5 + \Phi95 - 2\,\Phi50}{2(\Phi95 - \Phi5)}$$

Kurtosis

$$K_G = \frac{\Phi95 - \Phi5}{2.44(\Phi75 - \Phi25)}$$

The computed textural parameters of sediments and their binary relation applied as tool in differentiating the various environments of Quaternary sedimentation the same key is used as tool to analyze and differentiate sediments of various domains in Narmada valley.

Boulder bed:-
Glacial Deposit:-
Mean Size (MZ):-

The average mean size (MZ) of sediments of Boulder bed at depth level between 350 to 290 m from the base is 0.09 Ø (coarse sand), it varies from -2.81 Ø to 2.8 Ø i.e., that the sediments consist of very coarse to fine sand. The mean size shows sharp decrease in size to wards upper sequence of ground surface from the basement. It shows decrease in its value but with strong fluctuations, which is attributed to the mixing of sediments brought by transporting agency. It is seen that the mean size constantly decreases with size fluctuations in between the level of 15 to 50 m form base of deposits in rock basin. The mean size thereafter display there is a sharp rise in size of sediment persistently upward. Increases in size of sediments and its variation in these deposits indicate the erratic anisotropic sedimentation on uneven platform where the transportation of sediments from the source occurred by traction in close and tight trough basin Khan et.al (2015) Khan et.al (2016)

The average mean size (MZ) of Boulder bed and associated sediments at depth level between 190-220m is 0.335 Ø (very coarse to very fine sand), it varies from -752.81 Ø to 0.335Ø i.e. the sediments consist of very coarse to fine sand. The maximum value of mean size is -2.53 Ø at the depth of about 90 m below surface and minimum 2.88 Ø near the outer limit of boulder bed in Jabalpur Narsinghpur Hoshangabad Harda Barwani Dhadgaon Tilakwarda Bharouch section. The mean size shows sharp decrease in size towards younger sequence from the basement in increasing antiquity. It seems that the mean size constantly decreases due to cyclic reworking of sediments in valley. The sediments of bore hole log show fluctuations in mean size between the level in between 110-165 form basement below the surface there after there is a sharp rise in size of sediment persistently. Increases in size of sediments and its variation in these deposits indicate the extensive mixing of sediment brought by glacier activity in Narmada valley. Khan et.al (2015)

The average mean size of (MZ) sediments of Boulder bed at the depth in between 100 to 150 m below the surface is 2.50Ø (Find sand). It ranges from -0.87Ø to 3.45 Ø i.e. the sediments consist of coarse to fine sand with silt and clay. The mean size of sediments exhibit heterogeneous association and show significant variation from bottom to top in increasing antiquity and stratigraphic column. The erratic behavior of size matrix and sudden rise in mean size is conspicuous features of these deposits. The size distribution in these strata concealed under the wedge of boulder conglomerate and not exposed fully attributed to be due to lack of incision of the quaternary blanket by Narmada.

Inclusive Graphic Standard Deviation (ð):-

The average value of standard deviation (ð) of sediments of boulder conglomerate at level 350 to 290 m is 0.930 Ø, i.e. the sediments are extremely poorly sorted, and it varies from- 0.196 to 2.180 Ø i.e. the sediments are poorly sorted to very poorly sorted. The statistical analysis of plots, correlation of different parameters indicates that out of 50 samples 10% are moderately sorted, 14 % poorly sorted and 76% are very poorly sorted. The sediments near the source are conspicuously exhibit poor sorting and show significant improvement down the stream with local variation. As a whole the sediments are poorly sorted to very poorly sorted are anisotropic and heterogonous in nature. The sediments display improvement in sorting in increasing antiquity towards younger deposits revealing repeated reworking of sediments from the outer rim of dump sediments by stream resulting due to change of climatic change.

The average standard deviation (ð) sediments of Boulder conglomerate in between 190-220m is 2.55 Ø (very poorly sorted whereas it varies from 2.399 Ø to 3.262 Ø i.e. the sediments are poorly sorted to extremely poorly sorted. The relative variation and average distribution indicate that 24% of samples are poorly sorted, 53 very poorly sorted and 23% are extremely poorly sorted. The sediments however, show slight improvement in sorting upward from the basement. As a whole the sediments of these deposits are extremely assorted and heterogeneous in nature.The average standard deviation (ð) is 2.35Ø (very poorly sorted). It varies from 1.42. Ø to 3.875 Ø i.e. the sediments are poorly sorted to extremely poorly sorted. The majority of the sample shows the range of standard deviation of order ranging from 2.00Ø to 3.355Ø. The study of interrelation of different parameters and analysis of binary relation revealed that 60% of sample show % extremely poor sorting, 25% very poor sorting,15 % very poor sorting. The sediments show no significant improvement in sorting in sediments sequence. The variation in sorting appears to have been related with mean size, which is greatly affected by lateral mixing of sediments in valley at various points.

Inclusive Graphic Skewness (SKI):-

The average (SKI) for sediments of boulder bed at depth in between the level of 100-150m is -0.064 Ø i.e. the sediments are negative skewed. It ranges from -0.45 Ø to +0.52 Ø i.e. the sediment are negative skewed to positive skewed, which indicate the tendency of gradual decrease in value of (SKI) in upstream direction as result of retreat of glacier activities and decrease in the transport capacity. The 46% of the sample shows the negative value and 44% positive value and 14 % very negative skewed. The sediments up to the level of 15 m from rock basin are very positive skewed to very negative skewed which seems to be due to mixing of sediments brought by cumulative glacial fluvial activities. The sediments show the strong tendency to be positive skewed.

The skewness (SKI) of sediments at level between 190-220m is 2.37Ø (very negative to positive skewed), it varies from, -0.332Ø to 2.25Ø (very negative skewed to positive skewed) respectively. The average and relative values of (SKI) of Quaternary deposit of Narmada suggest high load carrying capacity of transporting agency in the initial stages of sedimentation which was constantly declined towards later phase and stream was not capable to transport the sediment load from source to site of sedimentation.

The average sleekness (SKI) in between level 100 to 150 m is - 00258 Ø (very negative skewed. It ranges from -0.425 Ø to 02.20 Ø, which revealed that the sediments are very negative to positive skewed, 15% samples symmetrical 15% positive skewed 45% negative skewed 10% nearly symmetrical 5% positive skewed and 5% very positive skewed. The 55% samples in middle column of Quaternary strata between 75-150 m below the surface are coarse skewed and 45% fine skewed. The sediments exhibit erratic values of sleekness in sediments column between 30 to 120 m at depth below the surface. The sediments are assorted and as a whole show strong variation in departure towards coarseness as well as with fineness. The departure from symmetry appears to be related with deviation of mean size. In general the asymmetry passes from middle to upper segment are coarse skewed to fine skewed, which suggest constant variation in energy condition of the transporting system during sedimentation.

Graphic Kurtosis (KG):-

The average value between at depth level in between 350 to 290 is 0.716 Ø (platykurtic); whereas it varies from 0.49 to 1.10 Ø (very platykurtic to leptokurtic) suggest fluctuation in the energy condition of the glacier and most intense assorting in the sediments during sedimentation. Inspite of strong variation in (KG) there is tendency in increase in (KG) value towards downward of sequence. The average value of Kurtosis in between level of 190-220m (KG) is 2.35 Ø (mesokurtic). It ranges from 0.860 to 3.10 Ø (very platykurtic to very platykurtic).The interrelation of skewness with other parameters binary relation and indicate 6% samples are very leptokurtic, 50% mesocratic, 21%

leptokurtic, 23% are platykurtic. The 68% of samples in the lower strata of quaternary deposits at depth of about 150 m below the surface is (Masokurtic) where as in the middle segment of Quaternary deposits between 75-150 m 40% are meokurtic where as in the upper sediments column between 30 to 120 m at depth below the surface about 26 % sample are mesokurtic (masokurtic). The relative values of kurtosis in relation to the depth and configuration of the basin suggests oscillating platform of sedimentation in central part of valley related to the tectonic pulsation supplemented by change of climate and related in the energy condition of the system.

The average value of kurtosis (KG) at the depth in between the level of 100 to 150 m is 0.98 Ø (mesokurtic) whereas it varies from 0.60 to 1.85Ø (very platykurtic to very leptokurtic). The 6% samples are very leptokurtic, 50% mesokurtic, 21% leptokurtic, 23% are platykurtic. The 68% of samples in the lower strata below 150 m at depth is mesokurtic where as in the middle segment of Quaternary strata between 75-150 m 40% are mesokurtic where as in the upper sediments column between 30 to 120 m at depth below the surface 26 % sample are meokurtic.The relative values of kurtosis in relation to the depth and configuration of the basin suggests non static and oscillating platform of sedimentation in valley related to the tectonics and consequential change in the energy condition of the system

Boulder Conglomerate:-
(Fluvio glacial Deposit):-
Mean Size (MZ):-

The average mean size (MZ) of sediments of boulder conglomerate in between level 350 to 290 m is 1.032 Ø (medium sand) whereas it varies from -2.53 Ø to 3.12 Ø i.e. the sediments consist of very coarse to very fine sand. The size distribution of these deposits in the study area is extremely irregular and erratic out of 50 samples 10% of sample show range of mean size of order of 0.75 – 0.50, 21, 0.25 to 0.75, Ø 25%, 0.75 to 1.75, 35, 1.75 to 2.50 Ø and 19% beyond 2.50. The sediments close to the under lying Boulder bed the down sequence ranges is 0.75 to 0.50 Ø i.e. coarse to very coarse sand which constantly show decrease in mean size. The sediments in the vicinity of Hathnora along a level of 20 m show range of order of 1.25 to 2.75 with local variation. The sudden rise in mean size are of order 0.50 to 0.15, which indicates the intensive mixing of sediments brought from the stream resulting from the retreating of glacier at different point in the valley.

The average mean size in between level is 190-220m 1.228. Ø, it ranges from -2.580O to 2.55 Ø i.e the sediments consist of very coarse sand to fine silt and clay. The maximum value -2.580 Ø is noticed between 35 to 80 m below ground level along the exposed wedge of Boulder conglomerate in river section. As whole sediments are assorted and size of sediment is erratic and irregular. The (MZ) shows significant decrease in size from in selected levels in the concealed sediment below the ground level beyond 40 m depth. The further upward it shows significant decline in the size but with strong fluctuation, appears to be due to strong lateral mixing of sediments brought by the streams resulted consequent upon the meeting of glacier at various points in the valley Renick of Singh (1980).

The average mean size (MZ) of sediments of boulder conglomerate at depth level of 100 to 150 m is 1.032 Ø (medium sand). It varies from -2.53 Ø to 3.12 Ø i.e. the sediments consist of very coarse to very fine sand. The size distribution of these deposits in the study area is extremely irregular and erratic. The statistical analysis of average and relative values their interrelation , binary plots and depth perception depict 15% of sample show range of mean size of order of 0.75 – 0.50, 21, 0.25 to 0.75, Ø 35%, 0.75 to 1.75, 35, 1.75 to 2.50 Ø and 50% beyond 2.50. The sediments close to the under lying Boulder bed the down sequence ranges is 0.75 to 0.50 Ø i.e. coarse to very coarse sand which constantly show decrease in mean size. The sediments in the vicinity of Hathnora along a level of 20 m show range of order of 1.25 to 2.75 with local variation. The sudden rise in mean size indicates the intensive mixing of sediments and transportation of sediment by bed load traction under turmoil condition of sedimentation.

Inclusive Graphic Standard Deviation (ð) the average standard deviation (ð) of sediment of boulder conglomerate at depth level between level 350 to 290 m is 1.563 (extremely poorly sorted) whereas it varies from 0.95 to 2.50 Ø i.e. the sediments are(poorly sorted to very poorly sorted). The statistical analysis of skewnessits interrelation and binary relation indicate that 8% samples are moderately sorted, 10% poorly sorted and 82 % are very poorly sorted. The sediments near the source are conspicuously exhibit poor sorting. As a whole the sediments are poorly sorted to very poorly sorted and heterogonous in nature sand are typically of glacial origin.

The average standard deviation (ð) of sediments of boulder conglomerate at depth level in between 190-220 m is 1.462 (extremely poorly sorted), it varies from 0.75 to 2.42 Ø i.e. the sediments are poorly sorted to very poorly sorted. The average and relative valve revealed that 12% samples are moderately sorted, 28% poorly sorted and 60

% are very poorly sorted. The sediments near the source are conspicuously exhibit poor sorting. The analysis of data of standard deviation at different level of depth and its relation with mean and skewness revealed sediments are poorly sorted to very poorly sorted and heterogonous in nature and deposited on turmoil platform and by dragging and bed transportation in tight and narrow trench.

The average standard deviation **(ð)** at depth level between 100 to 150 m is 2.35Ø (very poorly sorted) which varies from 1.42. Ø to 3.875 Ø i.e. the sediments are poorly sorted to extremely poorly sorted. The majority of the sample shows the range of standard deviation of order ranging from 2.00Ø to 3.355Ø.The analysis of data and mutual relation of standard deviation indicate that 60% of sample show poor sorting, 20% very poor sorting and 20% extremely poor sorting. The sediments show no significant improvement in sorting in sediments column between 30 to 120 m below the surface. The variation in sorting appears to have been related with mean size, which is greatly affected by lateral mixing of sediments in valley at various points.

Inclusive Graphic Skeness (SKI):-

These sediments show skewnes (SKI) varies from -0.48 +0.97 Ø i.e. the sediments are skewed very negative skewed very positive. The average value of skewness (SKI) at depth level between 350 to 290 m is 0.078 Ø i.e. the sediments are fine skewed. Out of 50 samples 56% are much skewed positively, 14% skewed positive and 30% are skewed very negative. The average and relative value of sediments and their symmetry suggest the heterogeneous association of the sediments ranging from fine sand to gravel size. The skewness generally increases in increasing antiquity towards younger deposits.

These sediments show skewnes (SKI) varies from -0.380 +0.827 Ø i.e. the sediments are skewed very negative skewed very positive. The average value of skewness at the depth between 190-220 m is 0.059 Ø i.e. the sediments are fine skewed. Out of 50 samples 45% are much skewed positively, 15% skewed positive and 40% are skewed very negative. The average and relative value of sediments and their symmetry suggest the heterogeneous association of the sediments ranging from fine sand to gravel size. The analysis of of average and relative values their relation to the different depth level with mean size and standard deviation indicate deposition of sediments form the close source by reworking of sediment with change in climatic condition, it further revealed that sedimentation has been taken place in synchronization of mechanics of tectonisam.

The average skewness at depth level in between 100 to 150 m is - 00258 Ø (very negative skewed). It ranges from -0.425 Ø to 02.20 Ø, which revealed that the sediments are very negative to positive skewed, 20% samples symmetrical 15% positive skewed 35% negative skewed 10% nearly symmetrical 10% positive skewed and 10% very positive skewed. The 55% samples in middle column of sediment between 75-150 m below the surface are coarse skewed and 45% fine skewed. The sediments exhibit erratic values of skewness in sediments column between 30 to 120 m at depth below the surface. The sediments are assorted and as a whole show strong variation in departure towards coarseness as well as with fineness. The departure from symmetry appears to be related with deviation of mean size. In general the asymmetry passes from middle to upper segment are coarse skewed to fine skewed, which suggest constant variation in energy condition of the transporting system during sedimentation.

Graphic Kurtosis (KG):-

The average (KG) at depth level in between the level of 350 to 290 m is 1.316 (leptokurtic). It ranges from 476 Ø to 1.52 Ø platykurtic to very leptokurtic. The statistical analysis 35% of the are platykurtic 45% leptokurtic and 20% samples are mesokurtic. The assemblages of these sediments suggest the dominance of coarse sediments. These samples depict kurtosis value between 0.90 – 1.20 in vertical chronology of sedimentary column in between depth of 90-120 where the sedimentation is perhaps affected by f sediments brought by the rejuvenated stream under high kinetic channel system which brought sediment load predominantly from close source.

The average value of Kurtosis (KG) in between the level of 190-220m is 0.98 Ø (Mesokurtic). It ranges from 0.60 to 1.85Ø (very platykurtic to very leptokurtic).The analysis of data and interrelation of different parameters suggest that 6% samples are very leptokurtic, 50% mesokurtic, 21% leptokurtic, 23% are platykurtic. The 68% of samples in the lower strata below 150 m at depth is mesokurtic where as in the middle segment of between 75-150 m 40% are meokurtic where as in the upper sediments column between 30 to 120 m at depth below the surface 26 % sample are meokurtic.The relative values of kurtosis in relation to the depth and configuration of the basin suggests non static and oscillating platform of sedimentation of Narmada valley related to the tectonics and consequential change in the energy condition of the system.

The average (KG) at depth level in between 100 to 150 m is 1.316 (leptokurtic). It ranges from 476 Ø to 1.52 Ø platykurtic to very leptokurtic. The analysis of data depicts 65% of the sample are very platykurtic 25% Mesocratic 10% leptokurtic. The assemblages of these classes of kurtosis suggest the dominance of coarse sediments. The sediment assemblage is hybrid but it shows increasing sorting away from the source.

Fluvial deposits:-

(Sediments of paleo domain of Narmada):-

Mean Size (MZ):-

The average value of mean size of terrace NT-1 is 2.130 Ø (fine sand) and it ranges from 1.628 to 3.238 Ø (medium to fine sand), average value of mean size of terrace NT-2 (NT-2A, NT-2B, NT-2C). is 1.635 Ø (medium sand) and it ranges between -0.423 to 2.293 Ø (very coarse sand to fine sand). The average value of mean size of terrace NT-3 is The average value of mean size of terrace is 1.145 Ø (medium sand) and ranges from -0.622 to 1.733 Ø (medium sand to very fine sand). The average and range values of mean size reveal that the sediments of older terraces NT-2(NT-2A, NT-2B, and NT-2C). and NT-3 consist of very coarse to very fine sand where as younger terrace NT-1 (NT-2A, NT-2B) and NT2 predominantly medium to fine sand, except with very little variation, the mean size of sediments progressively decreased in decreasing antiquity of terraces which appears to be related with (a) repeated reworking of sediments, (b) steady decrease in load carrying capacity of channel towards the latter stages of sedimentation. The variation in mean size suggests the fluctuation in energy condition of channel related with climatic changes in the watershed area.

Inclusive Graphic Standard Deviation (ð):-

The average value of standard deviation for the sediments of NT-1 is 0.285 Ø (very well sorted) and it ranges from 0.257 to 0.385 Ø (well sorted to very well sorted), average value of sorting for the sediments of terrace NT-2 (NT-2A, NT-2B, NT-2C) is 1.525 Ø (moderately sorted) and it ranges from 0.233 to 0.396 Ø (well sorted to very well sorted), average value for the sediments of terrace NT3 is 0.376 (well sorted) and it ranges from 0.281 to 0.438 Ø (well sorted to very well sorted). The average and relative range values of standard deviation indicate that the sediments of older terraces NT3 are (moderately sorted to well sorted) NT2 (NT-2A, NT-2B, NT-2C), (well sorted to very well sorted) and NT1 well sorted to very well sorted and NTO are very well sorted. The sediments show progressive improvement in sorting from older terraces to younger terraces appears to be related with the mean size and energy condition of the channel, which constantly decrease towards the later phases of sedimentation. The size distribution curve reveals more than one population of sediments whereas the probability plot reveal that the terraces NT-1 to NT3 average consist of 57% and 43% traction and suspension 1oad respectively. The traction load decreases in decreasing antiquity of terraces in the valley.

Inclusive Graphic Skewness (SKI):-

The Skewness (SKI) average value of for terrace NT-1 is +2.33 Ø (positive skewed). It ranges from -0.775 to 0.325 Ø (very negative skewed to very positive skewed). Average value of skewness for terrace NT-2 (NT-2A, NT-2B, NT-2C) is +0.1.55 Ø (positive skewed), it ranges from -0.592 to 0.232 Ø (very negative skewed to positive skewed). Average value for terrace NT-3 is +0.338 (very positive skewed), it ranges from -0.0389 + 0.568 Ø (very negative skewed to very positive skewed).The sediments of terrace NT-1 is (strongly negative skewed) whereas the sediments NT2 to NT-3 are progressively positively skewed. The negative skewness is resultant of high energy condition whereas the positive skewness indicates low energy. The average and relative range values of skewness from NT-1 to NT-3 indicate there is decrease in energy condition of channel towards the late history of sedimentation.

Inclusive Graphic Kurtosis (KG):-

The Kurtosis (KG) average value of for terrace NT-1 is 0.193 Ø (very platykurtic) ,it varies from 0.234 to 0.327 Ø (platykurtic). Whereas average value for NT-2 (NT2-A, NT2-B, NT2-C) is 0.323 Ø (very platykurtic) and ranges from 0.253 to 0.537 Ø (very platykurtic). Average value for terrace NT3 is 0.617 (very platykurtic) and varies from 0.752 to 0.876 Ø (platykurtic to very platykurtic).The sediments of NT3 are platykurtic to very platykurtic and NT-1 to NT3 in nature. The average value of Kurtosis decreases upwards which indicate a normal peakednes s of sediments as well strong concentration of grains about median diameter. The relatively lower value of NT-1 indicates that most of the sediments the source of sediments have were derived from close proximity and nearest provenances. (Plate No _1 to 4)

Plate 1:-

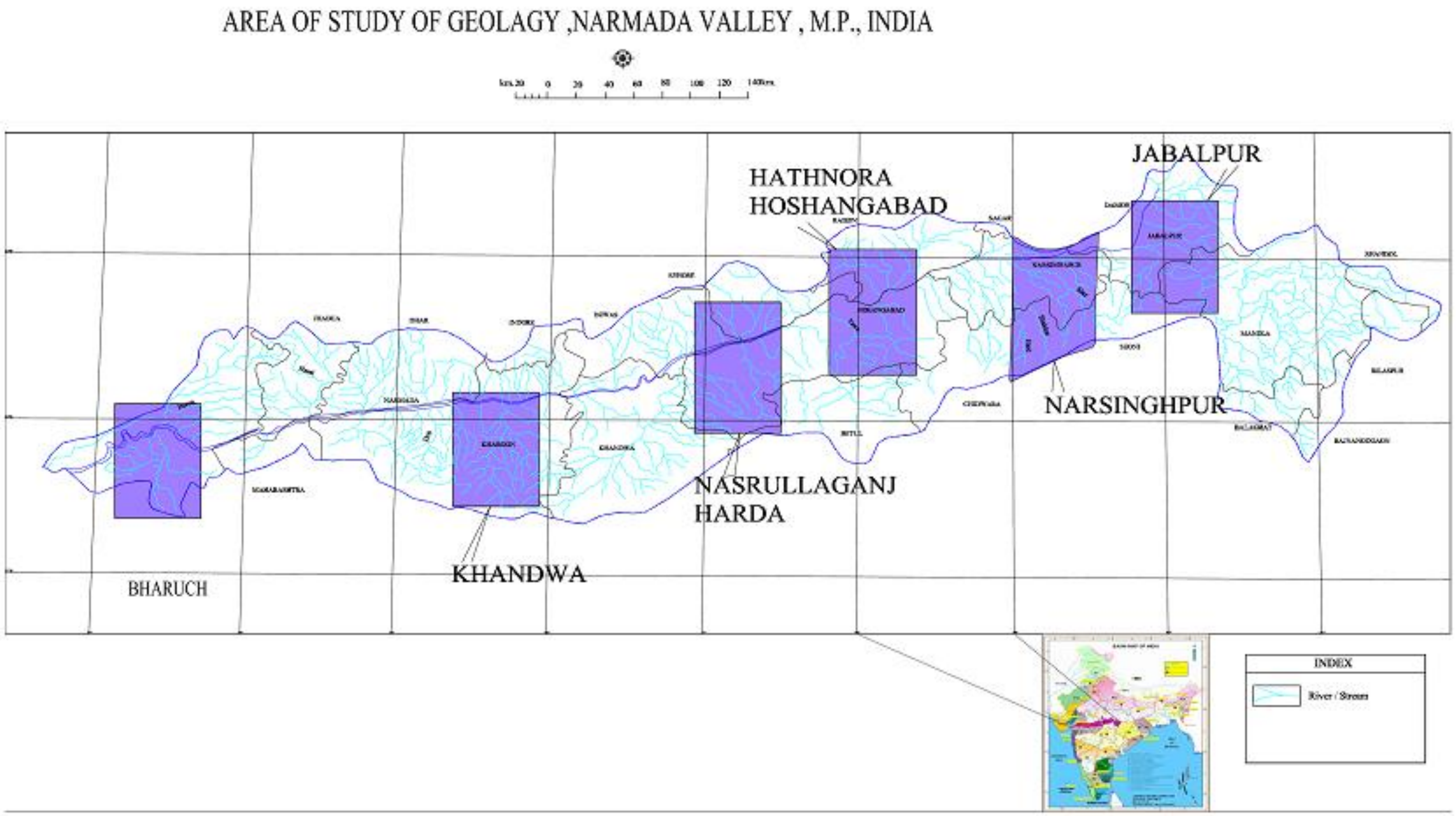

AREA OF STUDY OF GEOLAGY ,NARMADA VALLEY , M.P., INDIA
JABALPUR
HATHNORA
HOSHANGABAD
NARSINGHPUR
NASRULLAGANJ
HARDA
KHANDWA
BHARUCH
INDEX
River / Stream

Plate 2:-

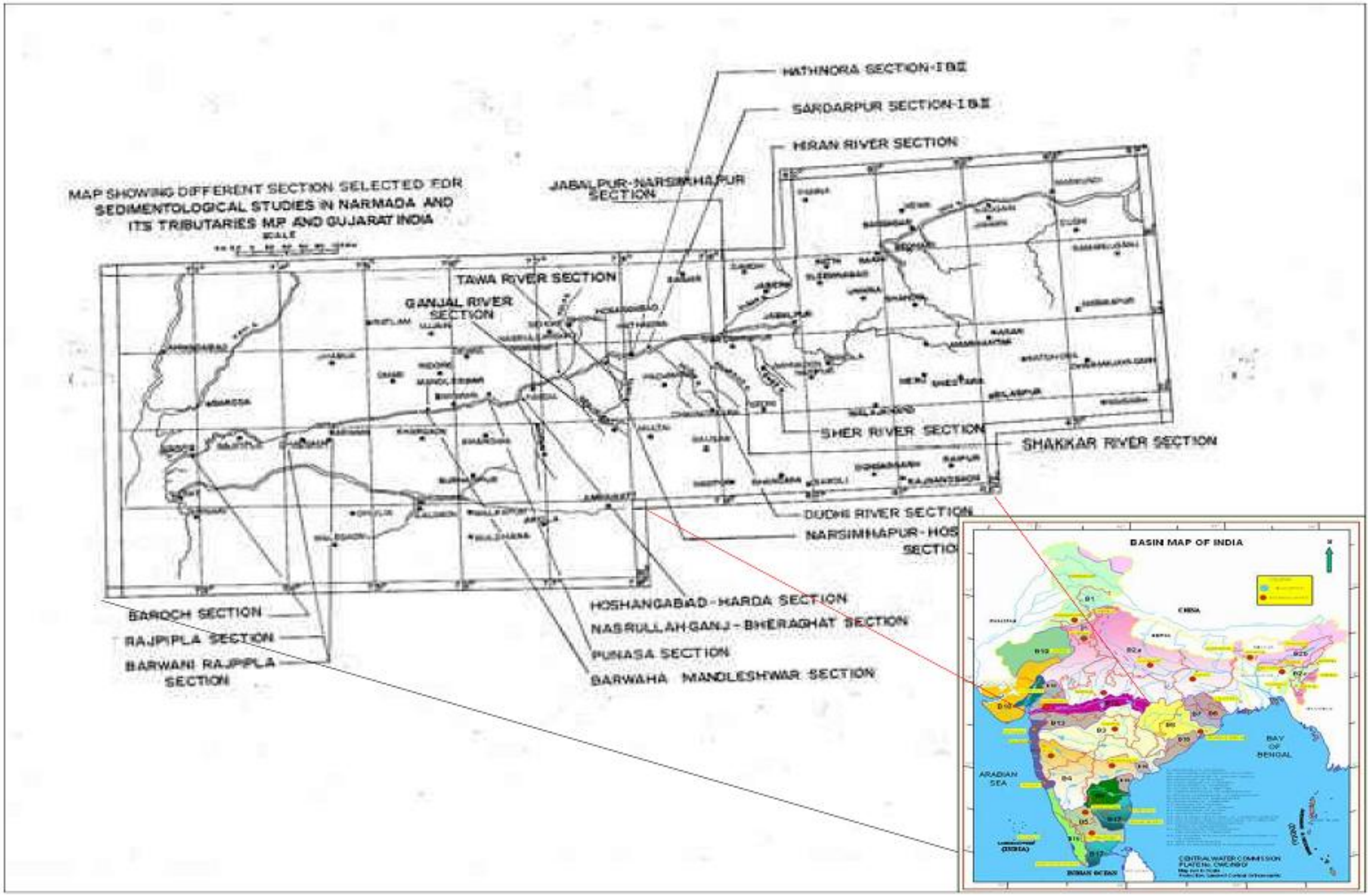

MAP SHOWING DIFFERENT SECTION SELECTED FOR SEDIMENTOLOGICAL STUDIES IN NARMADA AND ITS TRIBUTARIES M.P AND GUJARAT INDIA
HATHNORA SECTION-I & II
SARDARPUR SECTION-I & II
HIRAN RIVER SECTION
JABALPUR-NARSIMHAPUR SECTION
TAWA RIVER SECTION
GANJAL RIVER SECTION
SHER RIVER SECTION
SHAKKAR RIVER SECTION
DUDHI RIVER SECTION
NARSIMHAPUR-HOS SECTIO
BAROCH SECTION
RAJPIPLA SECTION
BARWANI RAJPIPLA SECTION
HOSHANGABAD-HARDA SECTION
NASRULLAH GANJ - BHERAGHAT SECTION
PUNASA SECTION
BARWAHA MANDLESHWAR SECTION
BASIN MAP OF INDIA
CHINA
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
CENTRAL WATER COMMISSION

Plate 3:-

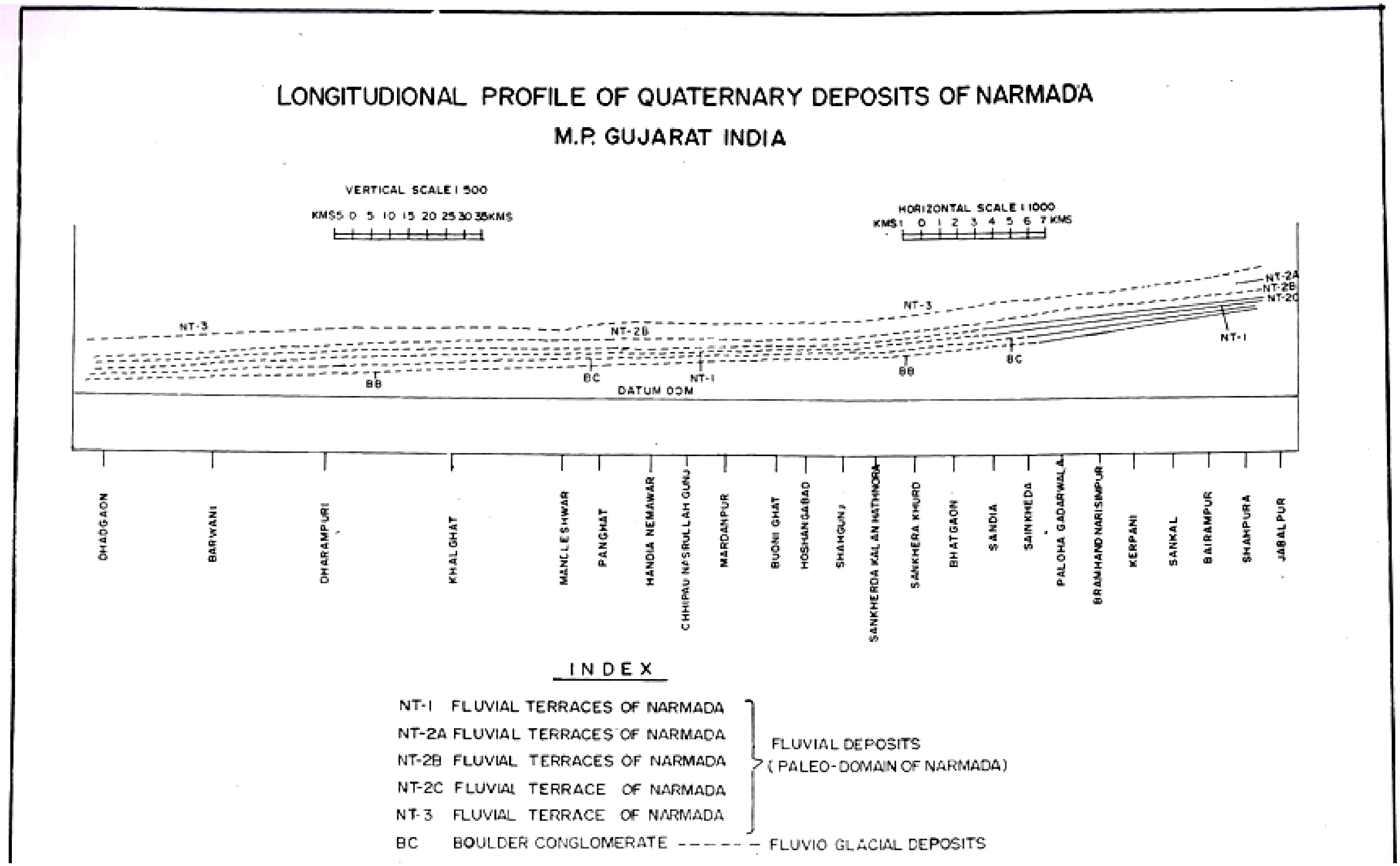

LONGITUDIONAL PROFILE OF QUATERNARY DEPOSITS OF NARMADA
M.P. GUJARAT INDIA
VERTICAL SCALE 1 500
KMS5 0 5 10 15 20 25 30 35KMS
HORIZONTAL SCALE 1 1000
KMS1 0 1 2 3 4 5 6 7 KMS
NT-3
NT-2B
NT-2A
NT-2C
NT-1
BB
BC
DATUM 00M
DHADGAON
BARWANI
DHARAMPURI
KHALGHAT
MANDLESHWAR
PANGHAT
HANDIA NEMAWAR
CHHIPAU NASRULLAH GUNJ
MARDANPUR
BUDNI GHAT
HOSHANGABAD
SANKHERDA KALAN NATHNORA
SANKHERA KHURD
BHATGAON
SANDIA
SAINKHEDA
PALOHA GADARWALA
BRAMHAND NARISIMPUR
KERPANI
SANKAL
BAIRAMPUR
SHAHPURA
JABALPUR
INDEX
NT-1 FLUVIAL TERRACES OF NARMADA
NT-2A FLUVIAL TERRACES OF NARMADA
NT-2B FLUVIAL TERRACES OF NARMADA
NT-2C FLUVIAL TERRACE OF NARMADA
NT-3 FLUVIAL TERRACE OF NARMADA
FLUVIAL DEPOSITS
(PALEO-DOMAIN OF NARMADA)
BC BOULDER CONGLOMERATE
FLUVIO GLACIAL DEPOSITS

Plate 4:-

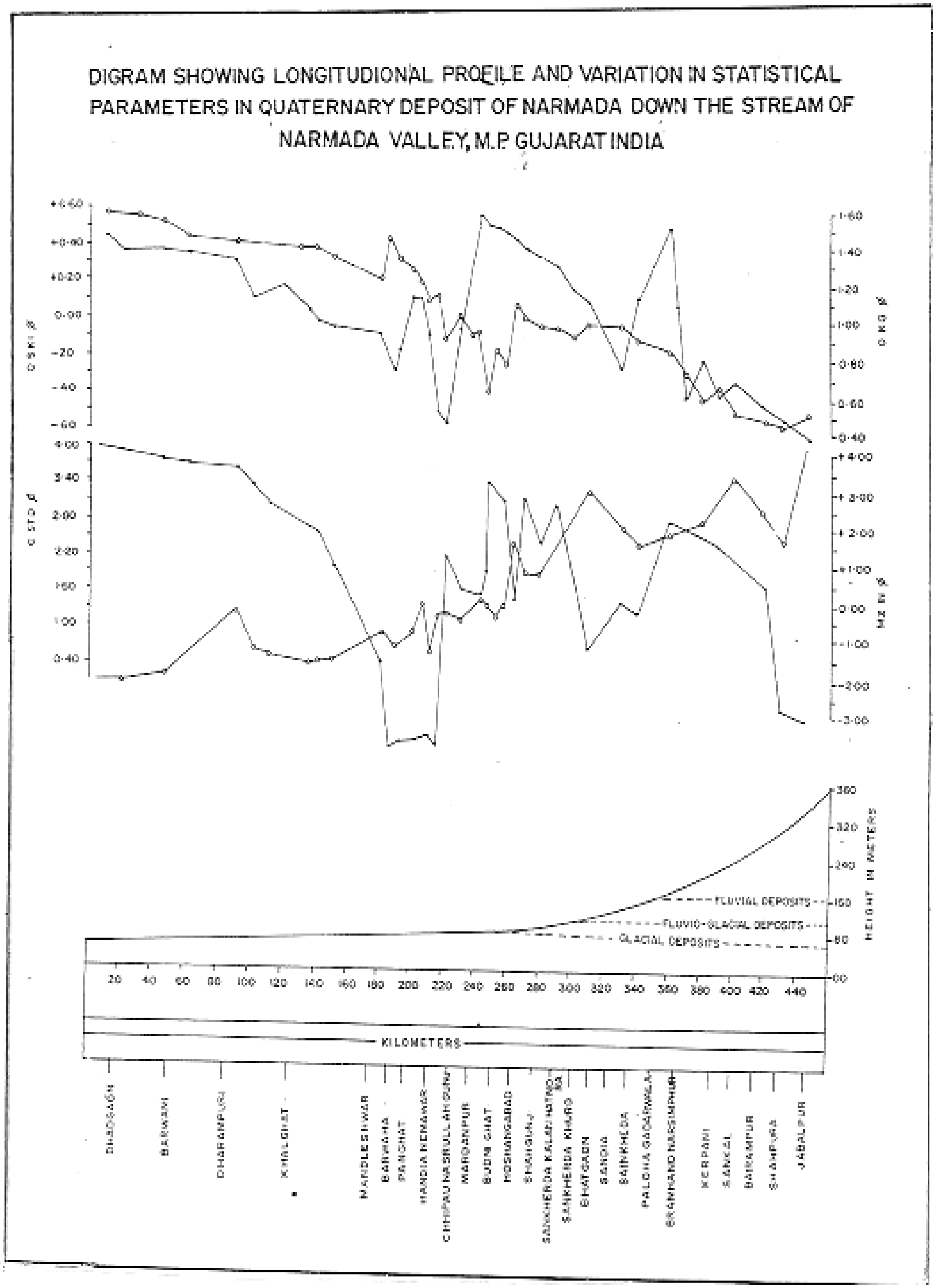
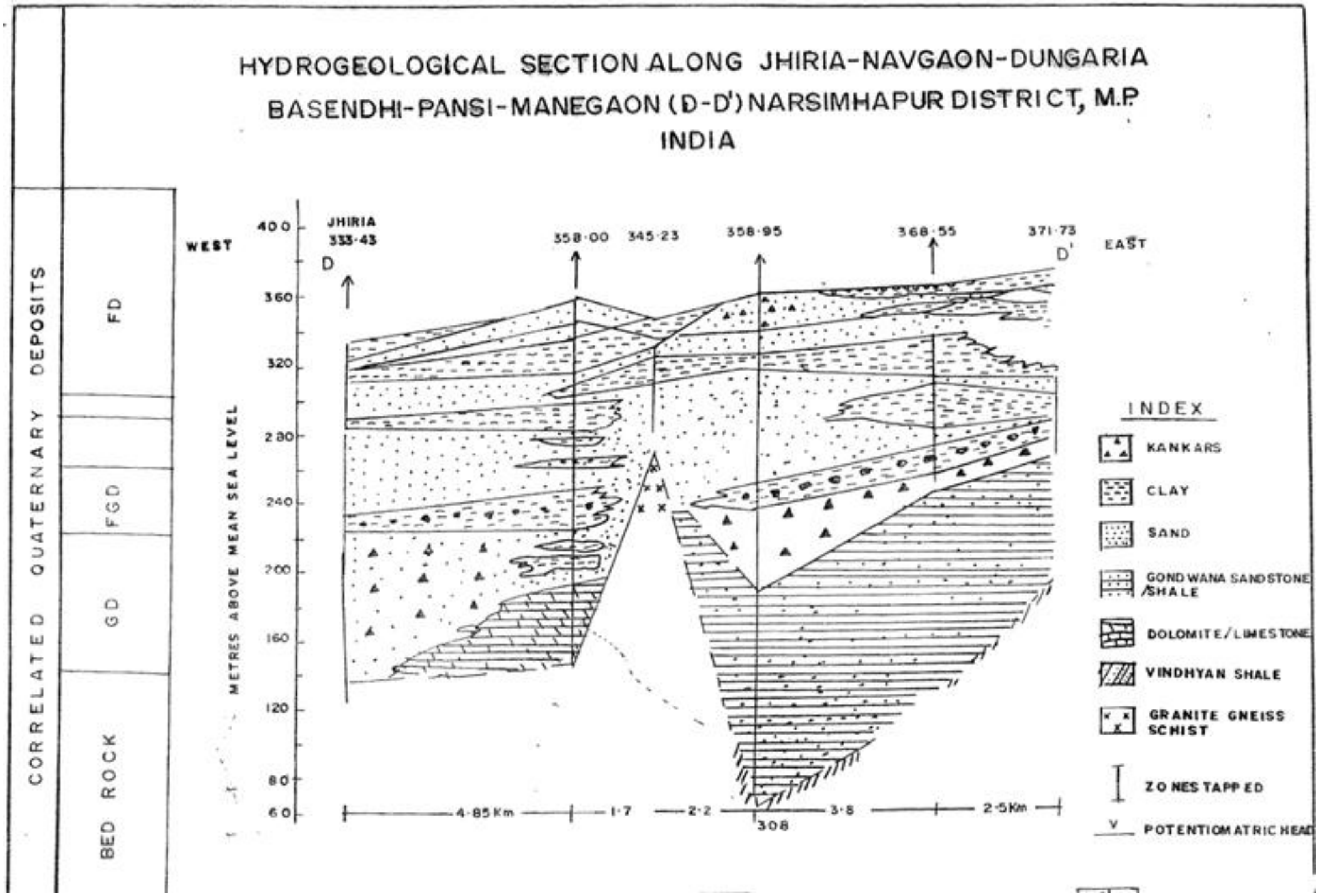

DIGRAM SHOWING LONGITUDIONAL PROFILE AND VARIATION IN STATISTICAL PARAMETERS IN QUATERNARY DEPOSIT OF NARMADA DOWN THE STREAM OF NARMADA VALLEY, M.P GUJARAT INDIA
FLUVIAL DEPOSITS
FLUVIO-GLACIAL DEPOSITS
GLACIAL DEPOSITS
HEIGHT IN METERS
KILOMETERS
BARWANI
DHARAMPURI
KHALGHAT
MANDLESHWAR
HOSHANGABAD
JABALPUR

Plate 5:-



Moified after CGWB (2000

Plate 6:-

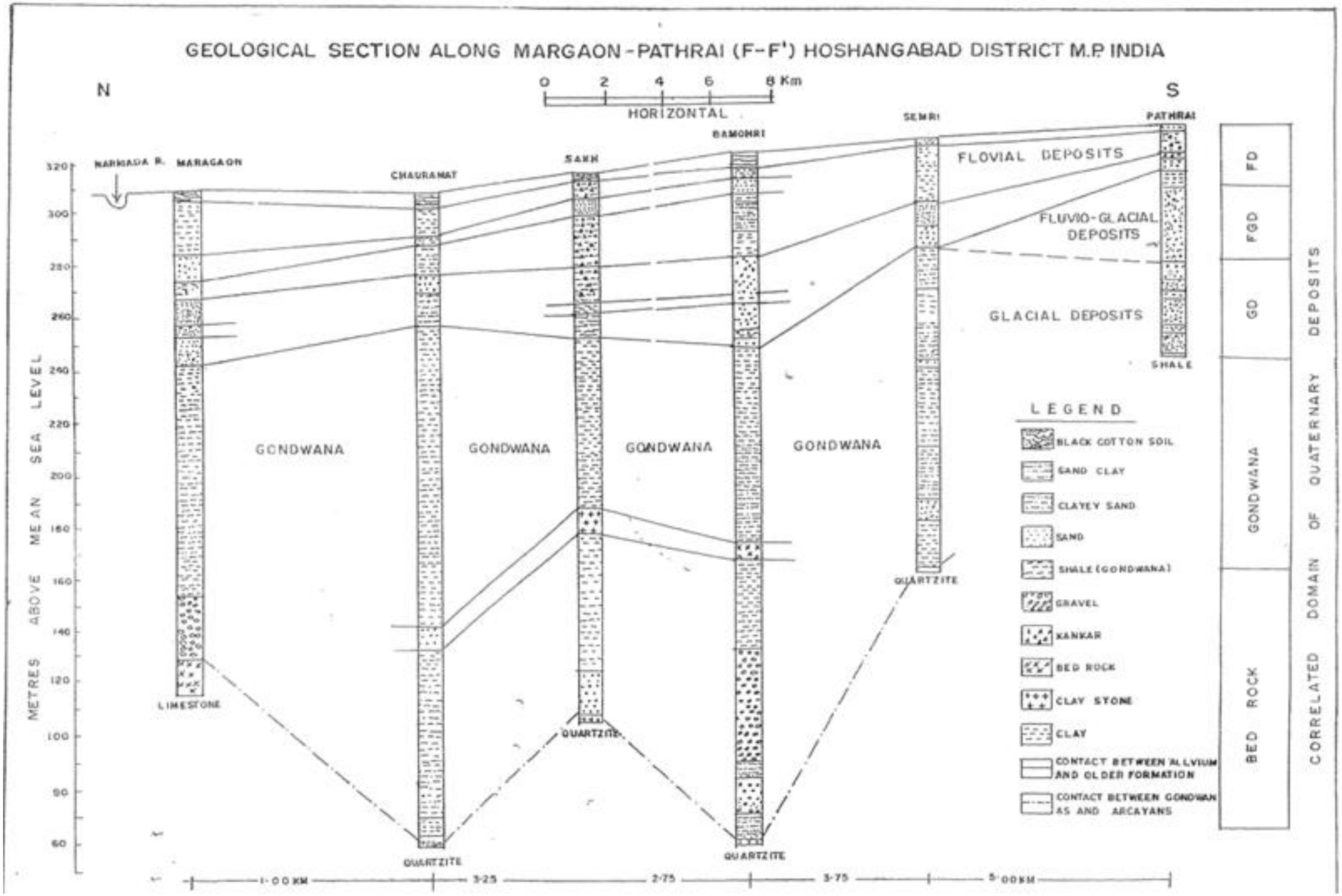
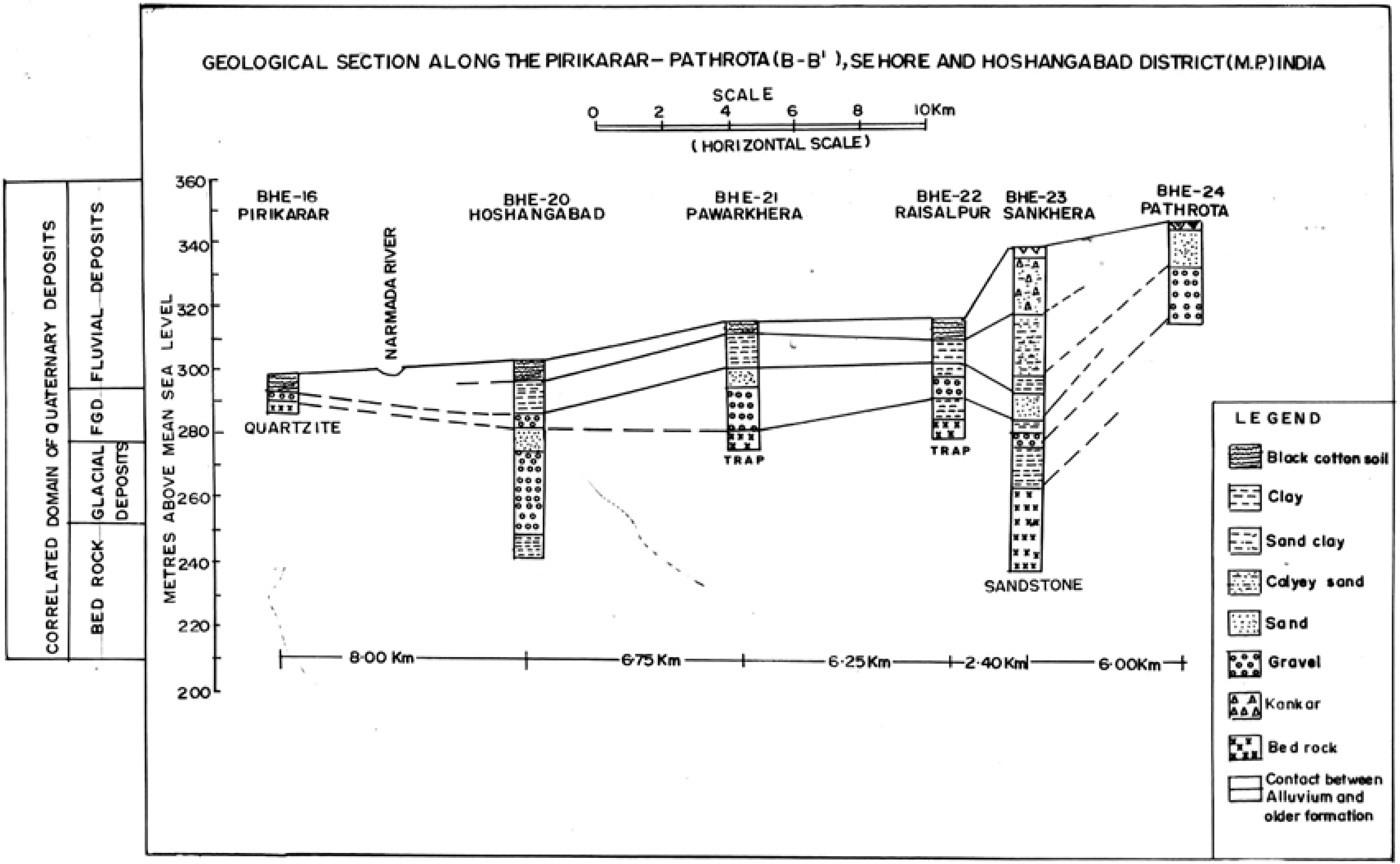
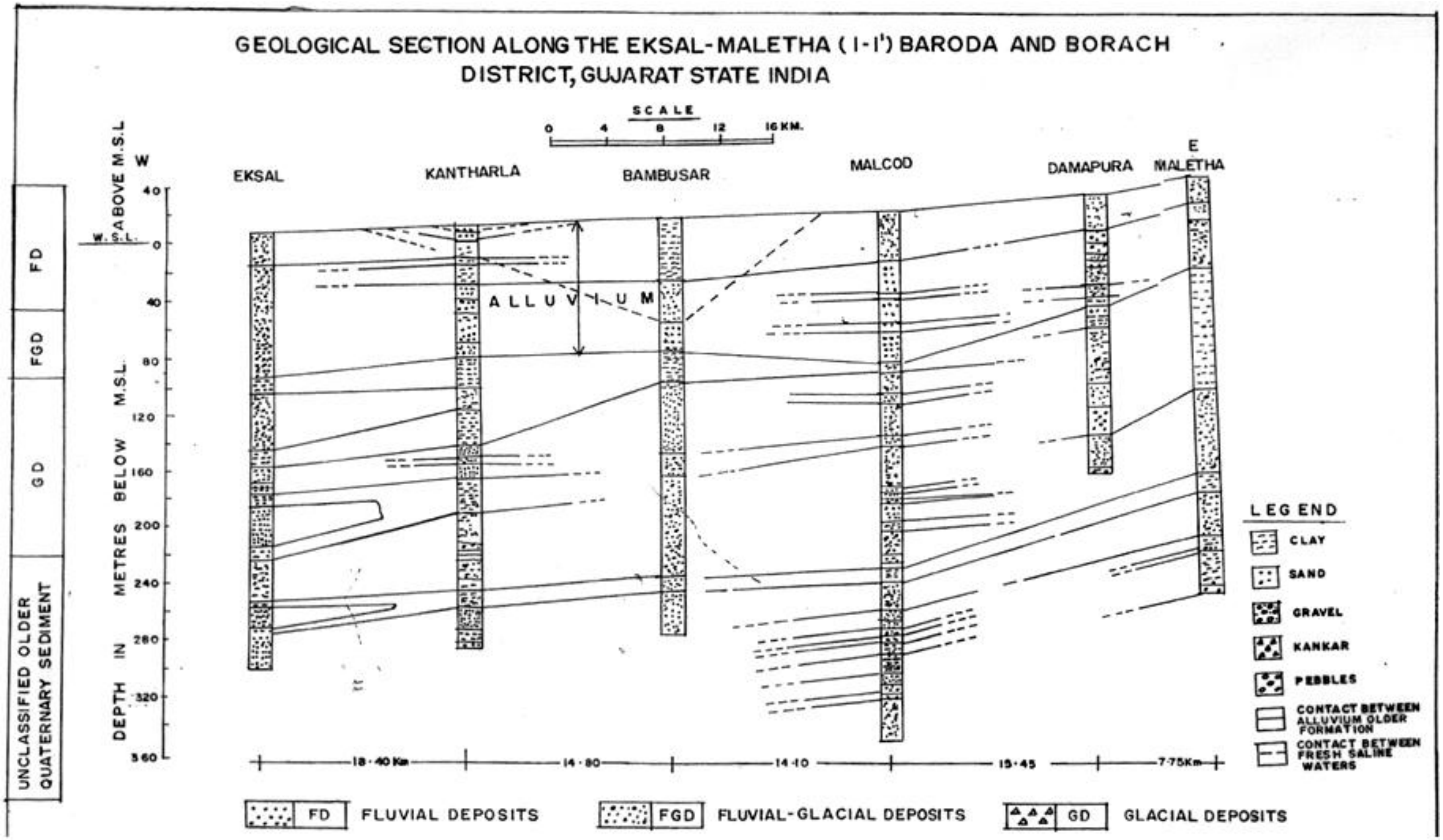

GEOLOGICAL SECTION ALONG MARGAON-PATHRAI (F-F') HOSHANGABAD DISTRICT M.P INDIA
N
S
0 2 4 6 8 Km
HORIZONTAL
NARMADA R.
MARAGAON
CHAURANAT
SAKH
BAMONRI
SEMRI
PATHRAI
FLOVIAL DEPOSITS
FLUVIO-GLACIAL DEPOSITS
GLACIAL DEPOSITS
SHALE
GONDWANA
GONDWANA
GONDWANA
GONDWANA
LIMESTONE
QUARTZITE
QUARTZITE
QUARTZITE
QUARTZITE
METRES ABOVE MEAN SEA LEVEL
320
300
280
260
240
220
200
180
160
140
120
100
80
60
1·00 KM
3·25
2·75
3·75
5·00 KM
LEGEND
BLACK COTTON SOIL
SAND CLAY
CLAYEY SAND
SAND
SHALE (GONDWANA)
GRAVEL
KANKAR
BED ROCK
CLAY STONE
CLAY
CONTACT BETWEEN ALLVIUM AND OLDER FORMATION
CONTACT BETWEEN GONDWANAS AND ARCAYANS
FD
FGD
GD
GONDWANA
BED ROCK
CORRELATED DOMAIN OF QUATERNARY DEPOSITS

Plate 7:-



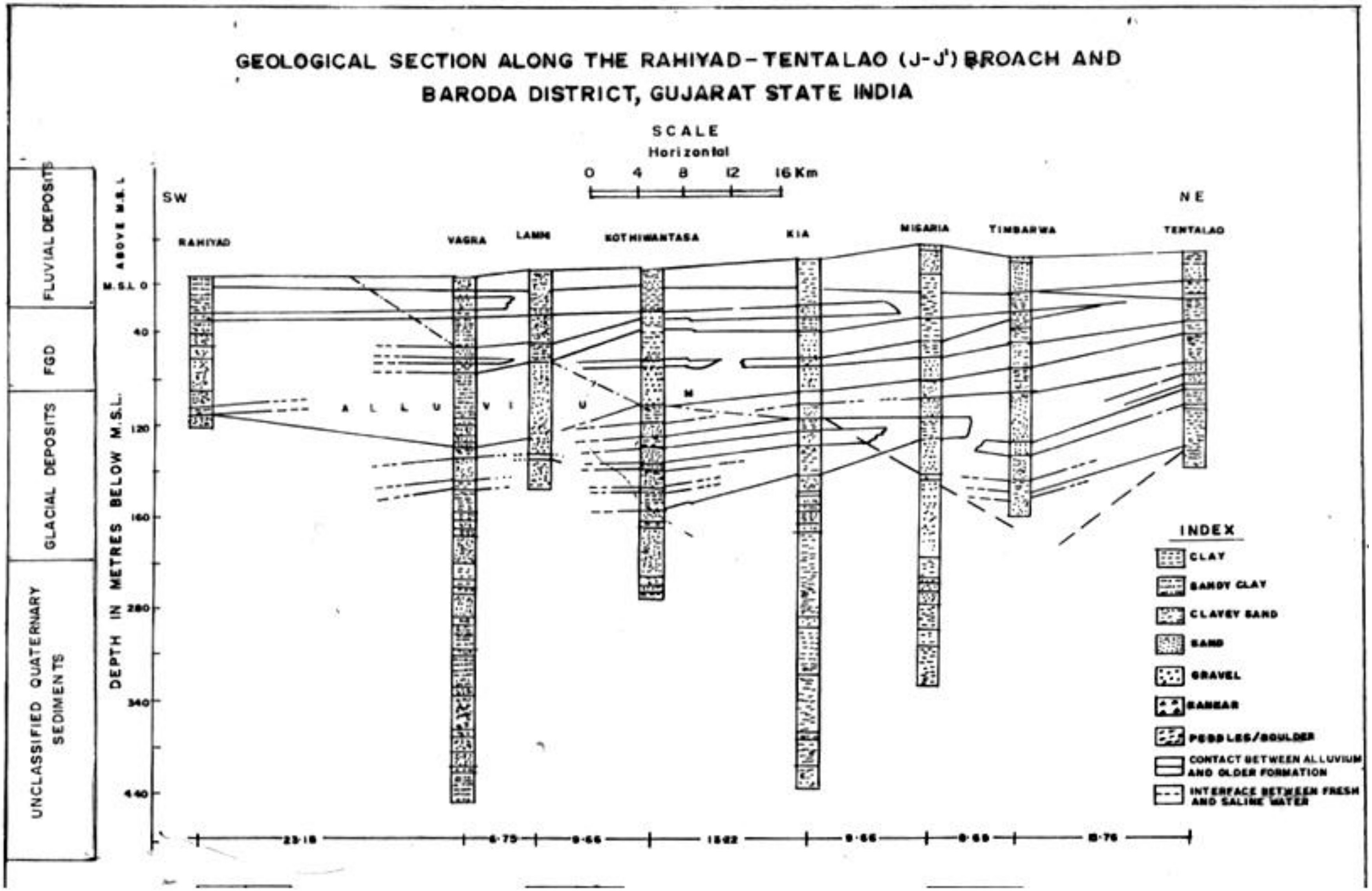
Moified after CGWB (2000)

Plate 8:-



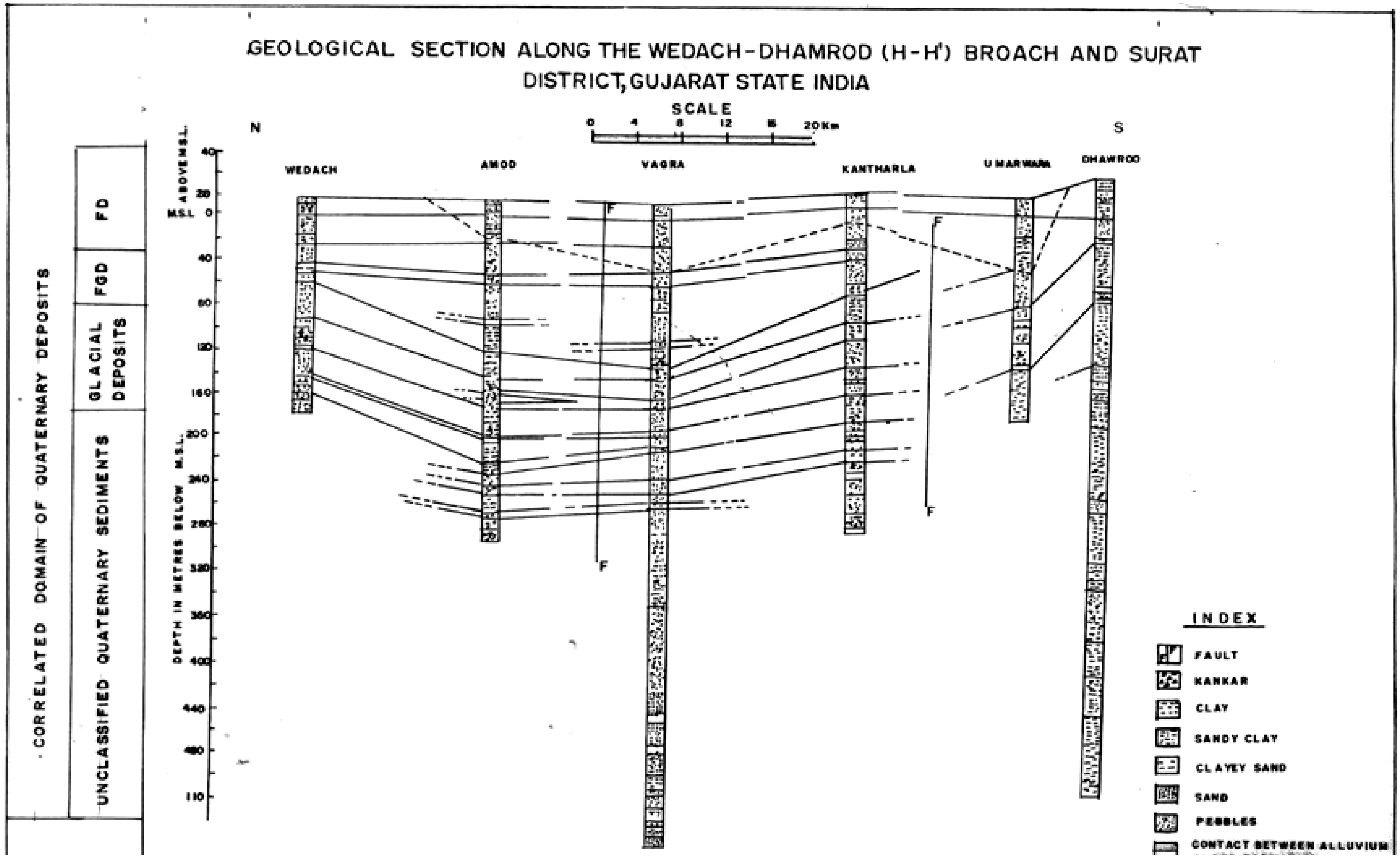
Moified after CGWB (2000)

Plate 9:-



Moified after CGWB (2000)

Plate 10:-



Moified after CGWB (2000)

Summary and Conclusion:-

The Homonid locality Hathnora is located in sehore district M.P.India on the right bank in Central sector of Narmada valley from where Sonakia (1984) recovered human kull of Homo erectus from boulder conglomerate. The exposed section of Quaternary deposits is about 18 m and boulder conglomerate is exposed at the base of river section. In the vicinity quaternary deposits are confined in trough like basin.the boulder conglomerate is partly concealled under overlying younger deposits of paleo domain of Narmada (NT1 to NT3) and boulder conglomerate is exposed only within the meandring loops of river due to lateral cutting. The boulder conglomerate is persistent horizon and represents the specific phase of sedimentation. It is under liyan by boulder bed and intersected in drilling logs of different of vicinity an average depth of about 180 m. The Narmada in this segment embodies the quaternarylandscape with stepped sequence of Narmada terraces (NT1 to NT3) which comprised of sediments of paleodomain of Narmada, where Boulder conglomerate exposed at the base of these deposits. The Boulder conglomerate is persistent horizon and represent distinct phase of fluvio-glacial phase of sedimentation. It is underlian by Boulder bed which is concealed in the valley.The Quaternary landscape on surface embodies the imprints of Geotectonic which revealed that sedimentation had strong influence and controlled by mechanics of SONATA LINEAMENT ZONE.

The Quaternary deposits of Narmada valley represent the thickest were deposited in faulted and sinking platform under structural riparian rift trench which remained silent and unrevealed. The work so far carried out is restricted to quaternary deposits of exposed section of 18 m, so far no work has been done on concealed strata of quaternary deposits their source of sediments, mode of transportation deposition tectonic environment of sedimentation and overall sedimentlogical aspects to conceive the model of quaternary sediment. The lack of concealed deposits and environment of sedimentation of these deposits which handicapped the systematic search of human remains with precise strata in synchronization of mechanics of tectonics and sedimentation in rift valley. The records of search of human skull and its remains revealed that the search was mostly random and confined to hominid locality Hathnora from where skull of Homo erectus was reported by Sonakia (1984); there after no further addition in tracing the human remains and its evolution is made. The present studies on various aspects of sedimentology of exposed section and bore hole logs across the vertical column of about 320m in the light of tectonisam and environment of sedimentation in vertical chronology in faulted trough in time and space may provide clues in understanding the modal of quarter nary deposits and in search of human skull and its remains.

The Quaternary sediments of Narmada represent the thickest deposit in Central India in faulted and sinking platform under structural riparian rift trench which remained undisclosed and unrevealed. In the present work 310 sediment samples were collected from exposed section and bore hole logs across the vertical column 320 m. These sediments were deposited in different environment in vertical chronology in faulted trough in time and space which have been differentiated.

In Hominid locality Hathnora in Section I to IV 202 sediment samples were collect from exposed section and bore hole logs across the vertical column of about 180 m. The statistical parameters viz MZ, STD, SKI, and KG of samples were computed from Quaternary deposits. The synchronized study of these parameters revealed that the quaternary blanket consists of sediments of three domain viz glacial, fluvio-glacial and fluvial representing Boulder bed, Boulder conglomerate and Fluvial terraces (NT1 to NT3), which were deposited in linear trench from Pleistocene to Upper Pleistocene timein increasing antiquity on unstable platform.

The average mean size of sediments of Boulder bed at depth level between 350 to 290 m is 0.09 Ø (coarse sand), it varies from -2.81 Ø to 2.8 Ø i.e., that the sediments consist of very coarse to fine sand. The mean size shows sharp decrease in size to wards upper sequence of ground surface from the basement. It shows decrease in its value but with strong fluctuations, which is attributed to be due mixing of sediments brought by transporting agency. It is seen that the mean size constantly decreases with size fluctuations in between the level of 15 to 50 m form base of deposits in rock basin. The mean size thereafter display there is a sharp rise in size of sediment persistently upward. Increases in size of sediments and its variation in these deposits indicate the erratic anisotropic sedimentation on uneven platform where the transportation of sediments from the source occurred by traction in close trough basin Khan et.al (2015) Khan et.al (2016).The mean size of sediments exhibit heterogeneous association and show significant variation from bottom to top in increasing antiquity and stratigraphic column. The average value of standard deviation of sediments of boulder bed at level 350 to 290 m is 0.930 Ø, i.e. the sediments are extremely poorly sorted, it varies from- 0.196 to 2.180 Ø i.e. the sediments are poorly sorted to very poorly sorted. The statistical analysis of plots, correlation of different parameters indicates that 10% samples are moderately sorted, 14 % poorly sorted and 76% are very poorly sorted. The sorting of sediments increases upward in increasing antiquity.

The skewness of sediments at level between 190-220m is 2.37Ø (very negative to positive skewed), it varies from, -0.332Ø to 2.25Ø (very negative skewed to positive skewed) respectively. The average and relative values of skewness of Quaternary deposit suggest high load carrying capacity of transporting agency in the initial stages of sedimentation which was constantly declined towards later phases of sedimentation. The average value of kurtosis between at depth level in between 350 to 290 is 0.716 Ø (platykurtic); whereas it varies from 0.49 to 1.10 Ø (very platykurtic to leptokurtic) suggest fluctuation in the energy condition of the glacier. The interrelation of skewness with other parameters and its binary relation indicate 6% samples are very leptokurtic, 50% mesocratic, 21% leptokurtic, 23% are platykurtic. The 68% of samples in the lower strata of quaternary deposits at depth of about 150 m below the surface is (masokurtic) whereas in the middle segment of Quaternary deposits between 75-150 m 40% are meokurtic and in the upper sediments column between 30 to 120 m at depth below the surface, about 26 % sample are (mesokurtic). The relative values of kurtosis in relation to the depth and configuration of the basin suggests oscillating platform of sedimentation in valley due related to the tectonic pulsation supplemented by change of climate and related in the energy condition of the system.

The average mean size of sediments of boulder conglomerate in between level 350 to 290 m is 1.032 Ø (medium sand) whereas it varies from -2.53 Ø to 3.12 Ø i.e. the sediments consist of very coarse to very fine sand. The size distribution of these deposits in the study area is extremely irregular and erratic out of 50 samples 10% of sample show range of mean size of order of 0.75 – 0.50, 21, 0.25 to 0.75, Ø 25%, 0.75 to 1.75, 35, 1.75 to 2.50 Ø and 19% beyond 2.50. The average mean size in between level is 190-220m 1.228. Ø, it ranges from -2.580O to 2.55 Ø i.e the sediments consist of very coarse sand to fine silt and clay. The maximum value -2.580 Ø is noticed between 35 to 80 m below ground level along the exposed wedge of Boulder conglomerate in river section. As whole sediments are assorted and size of sediment is erratic and irregular. The mean size shows significant decrease in size from in selected levels in the concealed sediment below the ground level beyond 40 m depth. The further upward it shows significant decline in the size but with strong fluctuation, appears to be due to strong lateral mixing of sediments brought by the streams resulted consequent upon the melting of glacier at various points in the valley. The average standard deviation of sediments of boulder conglomerate depth level 190-220 m is 1.462 (extremely poorly sorted), it varies from 0.75 to 2.42 Ø i.e. the sediments are poorly sorted to very poorly sorted. The average and relative valve revealed that 12% samples are moderately sorted, 28% poorly sorted and 60 % are very poorly sorted. The sediments near the source are conspicuously exhibit poor sorting. The analysis of data of standard deviation at different level of depth and its relation with mean and skewness revealed sediments are poorly sorted to very poorly sorted and heterogonous in nature and deposited on turmoil platform and by dragging and bed transportation in tight and narrow trench. The average kurtosis at depth level in between the level of 350 to 290 m is 1.316 (leptokurtic) whereas itt varies from 476 Ø to 1.52 Ø platykurtic to very leptokurtic. The statistical analysis of mutual relation of kurtosis and concentration of plots of binary relation depicy 35% of samples are platykurtic 45% leptokurtic and 20% samples are mesokurtic which indicates the dominance of coarse sediments brought by the rejuvenated stream under high kinetic channel system which brought sediment load predominantly from close source.

The average value of mean size of terrace NT-1 is 2.130 Ø (fine sand) and it ranges from 1.628 to 3.238 Ø (medium to fine sand), average value of mean size of terrace NT-2 (NT-2A, NT-2B, NT-2C). is 1.635 Ø (medium sand) and it ranges between -0.423 to 2.293 Ø (very coarse sand to fine sand). The average value of mean size of terrace NT-3 is The average value of mean size of terrace is 1.145 Ø (medium sand) and ranges from -0.622 to 1.733 Ø (medium sand to very fine sand). 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The sediments show progressive improvement in sorting from older terraces to younger terraces appears to be related with the mean size and energy condition of the channel, which constantly decrease towards the later phases of sedimentation. The size distribution curve reveals more than one population of sediments whereas the probability plot reveal that the terraces NT-1 to NT3 average consist of 57% and 43% traction and suspension 1oad respectively. The traction load decreases in decreasing antiquity of terraces in the valley. The Skewness (SKI) average value of for terrace NT-1 is +2.33 Ø (positive skewed). It ranges from -0.775 to 0.325 Ø (very negative skewed to very positive skewed). Average value of skewness for terrace NT-2 (NT-2A, NT-2B, NT-2C) is +0.1.55 Ø (positive skewed), it ranges from -0.592 to 0.232 Ø (very negative skewed to positive skewed). 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The statistical analysis of granulometric parameters their interrelation and concentration of binary plots are effectively used in delineating boundary between the glacial and fluvio glacial sediments. The cluster trend is organized and prefential it separates 87 % of the fluvial sediment from the 94% of the fluvio-glacial. The glacial sediments are un-oriented and unorganized,fluvio-glacial moderately organized whereas, the sediments of fluvial domain are well organized in synchronization in shape size sorting and sequential, display a balance harmony and ecology in conformity of sedimentation.

The binary relation of coefficient of sorting & skewness indicates that the fluvio glacial deposit sediments have very wide and open area of operation which is practically boundless and all inclusive and that the plots of sediments of fluvial deposits concentrate and cluster with in the short range of standard deviation and -0.45 to to-0.98 and skewness -0.20 to -0.45 which indicate that sediments are well sorted and subjected to the static environment of stream kinetics , a fair degree of accuracy a straight line may be drawn on sorting value 1.20 to limit all the fluvial sediments which may separate about 85.25 percent of glacial sediments. The linear concentration of plots encroaching the other domain discloses incursion of glacial sediments as depicted may be due to partial fluvial behavior of glaciers to wards the dying phase due to climatic changes and related change in energy of sedimentation. In the binary plot of coefficient of sorting & mean diameter indicates that about 80 % of -glacial sediments are wide spread and in close proximity of fluvio-glacial plots whereas the plots of fluvial sediments concentrate closely and confined with mean size +1.00 and sorting range 0.40 to 1.20. The rest however show the boundless erratic behaviors. The sediments plots are widely spread and do display any synchronized trend line which separates mainly the fluvial sediments from sediments of other domain in the area of study. The intensive and extensive study of sedimentlogical aspects of quaternary deposits up to depth level of 350 m in rock basin revealed impact of tectonics during deposition and mechanics of turmoil platform has synchronized rhythms of sedimentations in Quaternary times.The study of statistical parameters across the entire thickness of Quaternary deposits revealed three breaks in sedimentation at 350 -290,190-220,100-150 which represent glacial, Fluvioglacial and Fluvial environment of in increasing antiquity in from bed rock in Narmada valley.

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