The North Koel basin situated in the northwestern part of Chota Nagpur plateau is composed mainly of Archaean granite and gneissic rocks with patches of Dharwar rocks.

The following are the main geological formations, represented in the North Koel basin based on Memoirs of Geological Survey of India.

**Recent**
- Alluvium

**Tertiary to recent**
- Laterite and bauxite

**Cretaceous**
- Deccan Trap

**Cuddapah or earlier**
- Newer dolerites

**Upper**
- Mahadeva
  - erosional break
  - Panchet series
  - erosional break

**Lower**
- Raniganj series
  - erosional break
  - Barakar series
  - erosional break
  - Talchir series

----------- Unconformity -----------

**Chota Nagpur granite-gneiss**
- Vein rocks, pegmatite, quartz vein
  - Pseudo-diorite
  - granite & gneiss
  - Diorite
  - Ultra basic igneous rocks

**Dharwars-iron ore series older metamorphics**
- Phyllites, mica schists, quartzites,
  - lime silicate rocks and basic rocks
  - sillimanite bearing gneisses

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1. G.S.I. Memoir - Vol.78, Ch.III, pg.15
This basin exhibits a combination of igneous, sedimentary and metamorphic rocks. Metamorphics are the oldest rocks of the basin. The principal types of rocks under metamorphic group are as follows: hornblends schist, gneiss, biotite gneiss, amphibolite, epidiorite, phyllite, pegmatite, quartz vein, quartzite.

The igneous group of rocks consists of granite, basic dykes, Deccan Trap and diorite.

The sedimentary rocks belonging to Gondwana age lie unconformably over the Archaeans. These comprise sandstone, shale, coal seams, boulder bed and conglomerate.

Besides the above mentioned rocks laterite with bauxite is important over the 'Pat' lands.

Archaeans form 85 p.c. of the area of North Koel basin. Gondwanas cover 7.6 p.c. of the area. Alluvium of recent age occupies 3.6 p.c—a small area of the basin.

1. Alluvium of recent origin is concentrated in the Chechari basin and in the region near the confluence of North Koel river with Son river.

2. Laterite capped ridges, plateaus and hills in the areas above 900 m.


4. Archaeans forming the major part of the basin mainly Chota Nagpur granite gneiss and older metamorphics represented by phyllites schist quartzite and lime silicate rocks.

The regional distribution of the rocks in North Koel basin is discussed under the following lithostratigraphic units.

1. ALLUVIAL REGIONS:

There is accumulation of alluvium in the Chechari basin. Alluvium is also noticed near the confluence of North Koel river with Son river. This alluvium is of recent origin. There is soil cover in the lower part of Amanat Valley which is used for cultivation.
Alluvial soil of Chechari basin and laterite capped Orsa Pat in the north - Mirgi.

Lateritic terrain
Laterite covered Netarhat Pat in the north and dolerite dyke in the alluvial field - Mahuadann

Joints and cracks in sandstone in Satbahini nala - Balbal
LATERITIC REGION:

Laterite falls under two categories a) high level laterite occurring over the 'Pat' lands and b) low level laterite in the river valleys. The uniform thickness of these cappings and well defined scarp at their margins are notable features. The high level laterite is the residual product of weathering of Deccan Trap. Roy Chowdhury based on regional study of the area explained that the limit of trap flow coincides with the limit of laterite cappings. The thickness of laterite cappings on different type of gneisses and their inclusion like phyllite, mica schists etc. is uniform. High level laterite is developed 'in situ'

The laterite occurs over the hills and ridges and locally known as 'Pat' lands. The map (2.1) represents that laterite is prevalent in the southern part of the basin mainly on watershed of North Koel Basin. Laterite capped hills occur between 916-1080 m. altitude. Neturhat (84°16'E & 23°29'N) is remarkable laterite capped Pat region. The laterite capping on Bagru Pat which is source of North Koel river consists of bauxite. Other notable regions are Chuhimati (23°25'N & 84°24'E) Dohara Pahar 1064 m (23°25'N & 84°27'E), Bairisal (1030 m) (23°26'N & 84°30'E) north of Turwapat (1064 m) (23°29'N & 84°29'E), Jamira Pat (23°30'N & 84°1'E). The southwestern perimeter of Burha river shows laterite capping in areas above 912 m.

In the eastern part of North Koel basin high peaks around Datram (23°36'N & 84°16'E) represent laterite cappings. Karkat Pahar, Pokhra Pat, Mandu Pat etc. in the Auranga river basin are capped with laterite (23°30' - 23°37'N & 84°41'E) Low level laterite is available in upper course of Banki nadi which joins North Koel from the west. The mode of occurrence of low level laterite suggests detrital origin.

North of the line joining the northern most occurrence of trap viz. Lohandi (23°27'N & 84°41'E) Saida Pahar 23°37'N & 84°30'E) Joradumar Pahar (23°33'N & 84°16'E) and Jamira Pat (23°35'N & 84°02'E) do not support any capping of the laterite.

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3. **GONDWANA REGION**

The rocks of Gondwana age occur in three small basins: from west to east in 1) Hutar, 2) Daltenganj and 3) Auranga. These rocks of Gondwana age consist of Mahadeva, Panchet, Raniganj, Barakar and Talchir series. The Hutar Gondwana basin is oblong roughly in the SW to NE direction and covers about 200 km² area. Three major units - Mahadeva, Barakar and Talchir are recognized in this basin by the geologists of Geological Survey of India who have upheld the view of Ball (1886). The Auranga basin exhibits Mahadeva, Panchet, Raniganj, Barakar and Talchir series. Daltenganj basin consists of Barakar and Talchir.

a) **Mahadeva series**

Mahadeva series is the youngest of the Gondwana rocks. This consists of felspathic coarse grained sandstone which is pebbly and is succeeded by highly ferruginous coarse grained sandstone. Saphi river flows over sandstone. There are some notable flat topped hills Bihi (794 m), Manga (717 m), Khura Pahar. Mahadeva series form isolated hills in the Auranga basin e.g. a hill between Kaima and Sabanu. The Mahadeva of Auranga basin shows inward converging dips. Sandstone hills extend eastwards from Latehar to Udaipur. Mahadeva series is not noticed in Daltenganj area.

b) **Panchet series**

Panchet series developed only in Auranga basin contain alternating sandstone and shale. These rocks overlap Raniganj rocks on the eastern side and on the western side overlap the Barakar rocks. These rocks in turn are overlapped by younger Mahadeva series. Continuation of felspathic sandstone and shales towards the northeast in Rajdahanala and the north of Jagaldaga Mahadeva hill is noticeable. There is a large elongated exposure of Panchet south-east from Kaima to Sabanu. The south-western boundary is faulted.

c) **Raniganj series**

The Raniganj series belongs to lower Gondwana in age. The rocks of Raniganj series are found only in Auranga basin. These rocks overlap
the older Barakar rocks and in turn are overlapped by the rocks of Panchet and Mahadeva series. Raniganj series contains alternate layers of sandstone and shale. North west of Bendi village the rocks contain yellowish medium grained sandstone. Due to series of strike and transverse faults between Udaipur and Ban Hardi repetition of Barakar and Raniganj rocks is notable.

d) Barakar series:

Barakar series is exposed in all the three Gondwana basins. The rocks of Barakar series are well developed and show wide variation in the texture and grain size. About 3 km. south west of Barwadih village these beds rest over Talchir series. The basal beds are coarse grained massive sandstone with a slight greenish tinge which is succeeded by carbonaceous shales. The beds flatten between the confluence of the Kelha and Ghorasumi nala with the Deori nadi. The hilly area east of Deori nadi comprises coarse grained massive sandstone which are ferruginous. Due to the reversal of dip towards north along the southern part of Deori nadi older horizons are exposed. The sequence consists of fireclays, shales and flaggy sandstone. This entire horizon takes a southerly course south of Marwai village and then swings to the west finally abutting against the boundary fault towards south west of Marwai Kalan. South of the confluence of Satbahini nala with North Koel series grit with northerly dip is seen. The axis of the basin is towards north and the rocks belong to the southern limb of the basin. The conglomerate comprise of mostly angular to subangular silicified quartzite, vein quartz and granite gneiss. The North Koel river flows over ferruginous sandstone and west of North Koel a change in lithology takes place and the horizon overlying the coal bearing formation consist of sandstone and conglomerate.

The youngest sequence of Barakar beds is well exposed in Saphi nadi. The middle and upper Barakar rocks are developed only towards the western part of the field. The maximum thickness of the Barakar beds in this area is about 350 m.

The Barakar series is exposed in the Auranga basin between Bendi and Ambatikar. The Barakar boundary with Archaean is unconformable. Barakar series in Auranga basin shows a continuous lithological variation.
Barakar series of Daltenganj area consists of felspathic sandstone, carbonaceous shale, coal seam and minor shale bands. The beds are low dipping. In Jinjoli and Amanat river section coarse grained sandstone with pebble bed coal seam and siltstone is found. Pebble inclination and current bedding indicate current direction towards north. Younger Barakar rocks are found in Sadabaha and Libji nala. Towards north and east of Basu village a small patch of Barakar rocks with distinct erosional contact over the Talchir rocks is found. Along the southern bank of North Koel isolated exposures of coarse grained sandstone is notable.

e) Talchir series:

Talchir series is the oldest formation of sedimentary rocks of Gondwana age found in all the three basins lying unconformably over the Archaean rocks. The Talchir series is overlapped by the younger rocks therefore only small exposures of these rocks are recorded. Talchir series is exposed in the Deori valley in Barwadih village. Talchir rocks have greenish sandstone with a very thin boulder bed at the base. Erratics upto 1.5 cm in diameter, are recorded. The inclusions comprise sub-rounded to rounded granite gneiss, vein quartz, quartzite and amphibolite possibly derived from the Archaean terrain south of Barawadih village. The thickness of Talchir series is above 75 to 80 m. in this area. The Talchir beds are repeated due to strike faults. In the Saphi nadi west of Likhant hill small exposure of rocks are overlapped by the rocks of the Mahadeva series. From north of Parro village, in North Koel river a narrow strip of Talchir rocks extends to the west towards the Saphi nadi and abuts against the fault on the northwest. East of Saphi boulder bed disappears and gives place to shale and clay. East of North Koel river shales rest over the Archaean rock. Talchir rock is exposed about 3 km. south of the confluence of Ghorasumi nala with Deori nala.

In the Auranga basin Talchir rocks either are overlapped or faulted. West of Ambatikar the dips of the rocks are very steep and sometimes vertical. Satbahini nala shows Talchir rocks in its acute bend. South of Bendi these rocks are effected by a number of faults. Northwest of Latehar Talchir series is exposed. These sediments comprise yellowish green medium grained sandstone at the base and succeeded by shales.
The Daltenganj area shows the development of Talchir series comprising boulder beds towards basal part, Khaki greenish needle shales and clays with sandstones appearing towards the upper part. Boulder beds consist of boulders upto 2 m. in diameter. Near Daltenganj current bedded felspathic yellow sandstone is exposed. The Durgauti - Jingoli Amanat area shows unconformable contact with Archaean rocks. Talchir series shows that boulder bed is not always at the base. Towards south the size of boulders is bigger than the north.

4. THE ARCHAEOAN REGION:

The Archaean cover the major part of North Koel basin. The Archaean of the region are divided into two groups a) Chota Nagpur granite gneiss and b) Dharwar or iron ore series consisting of older metamorphics. The Archaean rocks are pre-Cambrian in age. Archaean rocks exhibit complexity of character. The crystalline metamorphosed sediments and gneissic rocks of the Archaean system form the major part of this system. The most common Archaean rock is gneiss which consists of foliated structure.

In the North Koel basin Dharwar inclusions in the gneiss consist mainly of hornblends schist, epidiorite, crystalline limestone and graphite schist, the most prevalent being hornblende schist. Biotite and sillimanite schist is not common in the area.

The Archaean rocks of North Koel basin are predominantly granites and gneisses showing greater diversity of texture than of mineral composition ranging from fine grained, through medium grained and porphyritic types to rocks that are almost pegmatitic. In mineral composition they differ from each other only in the relative amounts of microcline, orthoclase, plagioclase, biotite and hornblende. Locally garnet, diopside and cordierite are present in types which appear to be hybrids between the gneisses and schist. The prevalent rock in the southwest is a massive granite, some of it epidotised with abundant veins of pegmatite.

The gneissic rock also referred to as 'Bengal Gneiss' or 'Fundamental Gneiss' are at times very finely foliated and other times there is hardly any foliation or schistosity at all and the rock looking perfectly granitoid
The porphyritic granite rounded by fluvial action in the bed of Nakti nala - Mahuadanr

Metamorphics showing crumpling by the side of the North Koel river - Daltenganj
in appearance. Gneissosity is prominently developed in older metamorphics. These planar structures trend NE-W-SW mainly and in some cases N-E-S-W. The dip is steep to vertical.

The Upper North Koel basin is mainly composed of granite. Dhardhari river has deeply incised its valley and exposed the underlying granitic terrain. The same is true of Burha, Bohta and Bahera which have incised their valleys in alluvial and revealed granitic rock. Sheared granite is notable in Phuljhar basin; granite gneiss in and around Garu contain bands of older formation viz. sillimanite bearing gneisses and schists and calcium silicate rocks. The graphite rich band is noted near Tungri (23°43'N 84°10'E). In the area south of Latehar foliation trends are severing and indicate the presence of north-easterly plunging fold. The pink felspar adds colour to the landscape.

Schist is another important rock formation of North Koel basin. The southern part of Chechari basin exhibits hornblende schist. In Auranga basin also there are exposures of hornblende schist near Chandwa (23°40'N 84°45'E). The Archaean rocks surrounding the Auranga Gondwana basin consist of patches of quartz mica schist and hornblende schist. Mica schist is found at few places near Bandua. A small elongated patch of mica schist is found east of Sabano in the Amanat basin.

Porphyritic granite is evident south of Siriatonger in the course of Banki nadi. There is a small exposure of porphyritic granite north of Banki nadi near Sikni. This patch of granite is intruded by metadolerite. The epidotised gneiss is found in the central part of Banki basin. The region in lower North Koel valley is mainly composed of granite and porphyritic gneiss.

**Lime silicate:**

Lime silicate in a very thin band is noticed in Shelwadih (23°15'N 84°24'E) near the upper course of North Koel river. On the southern perimeter of Burha there is a thick exposure of lime silicate rock. Bands of coarse grained crystalline limestone is found west of Ladi (23°43'N 84°13'E) and south-east of Nareshgarh (23°40'N 84°25'E). Crystalline dolomite associated with the calcium silicate rock occurs north-west of Matang.
Epidiorites are found as thin bands in the granite gneissic terrain. An arc shaped epidiorite exposure is notable in Sanal (23°26'N 84°27'E) to Muge (in the southern part of the basin). Epidiorites are exposed in small patches in Danro and Amanat basin.

Quartz vein:
There are occasional inclusion of quartz vein in the country rock. The quartz vein transverses the country rock from SW to NE. North of Dhargardihi, south of Deogurva quartz vein is noticeable. Near Nawatola quartz magnetite rock is exposed. Amphiboles occur as narrow bands and small inclusion within the granite gneissic terrain. Amphiboles are found vertically in some parts of Amanat basin. Amphiboles are also found on the western perimeter of Danro river.

Quartzite:
There are thin bands of quartzite running from SW to NE in the southern part of North Koel basin.

Newer Dolerites:
Dolerites of the region are also referred to as Newer Dolerites. The youngest rock of the basin excluding alluvium and laterite are a series of basic intrusives which have penetrated along joints. There is considerable variety in texture; the grain of the rock depending to some extent on the width of the dyke. The dyke rock varies from a fine to a coarse dolerite. Dolerites are found in the basins of Chechari, Karkat, and Amanat and the Gondwana basin of Hutar.

Deccan trap:
Deccan trap is noticeable in the area west of Chuhimati. The top of Nawadih (1164 m) exhibits exposure of Deccan trap.

GEOLOGICAL STRUCTURE:
The southern part of North Koel basin represents a batholythic mass which represents the Archaean. There are some signs of folding and faulting in the basin. The foliation trends of metamorphic are severing and indicate a northeasterly plunging fold in the area south of Latehar in Auranga basin. The Auranga basin shows abundance of plunging and non plunging antiforms and synforms developed due to superposed fold movement.
A prominent shear zone trending east and west in Lat Mandu (23°44'N, 84°14'E) is notable. In the Auranga basin in the eastern part broad swings in metamorphics and also sharp deviation from the trend are noted due to the presence of a series of folds which show moderate plunges towards NNE to NE.

Structurally the rocks of Auranga Gondwana basin are highly faulted in some places. All the faults are normal gravity faults except a few towards the extreme eastern and western part of the Gondwana basin of Auranga where certain amount of horizontal displacement is noticed. The faults are of two generations and are post depositional in character.

The geology of the area east and west of Hutar village is complicated by a series of faults. There is a strike fault trending in N 75°E - S 75°W direction across the Koel river, south of Hutar. East of Tihar (84°0'E, 23°49'N) an interesting relationship between faulting and intrusive dyke is seen. An east-west trending dolerite dyke terminates abruptly against the northern boundary fault towards the west. On the east the dolerite dyke is again faulted which indicates that dolerite dyke is older than faulting. The direction of fault in Satbahini nala is east-west and a throw towards south. A major east-west fault crosses the nala and hotspring has developed north of Balbal. In comparison with the eastern part of Hutar Gondwana basin the northern and southern parts of the area are severely faulted.

All the faults of Hutar Gondwana basin except the one east of Balbal are normal gravity faults with fault plane inclination varying between 50° and vertical. In the northwestern part the faults appear to be of two ages as they show displacement among themselves.

The Daltenganj Gondwana basin shows two converging faults in Malla Nadi these two faults join south of Satbarwa village. There is large seepage of water close to the fault. The sandstone and clays show acute folding due to close association of two faults. South of Rajhara fault trending in east-west direction downthrows the rocks of Barakar series to the south and brings the Talchir rocks in a faulted contact on the north. The throw of the fault is 100 m. with the result that the youngest beds of the Barakar series are exposed in the region. Around Pachmo faulting have affected the Archaean and the Talchir series therefore the Archaean rocks have been exposed in the form of a horst. One of the faults trending in westerly direction north of Jaitu Khar is with a downthrow toward north. There is a boundary fault
between Talchir and Archaean rocks west of Maila nadi. This fault has a
downthrow towards the north-east and trends in a NW-SE direction. East
of Polpol village the two faults have squeezed the beds so that the rocks
have been folded. Faults are normal gravity faults and post Gondwana in
age.

The three Gondwana basins have faulted contact with Archaean rocks.

North of Dhangardih there is a fault at the southern boundary of the
ridge. There is one fault running north-east from Ahirpura upto Gantaria.
Another fault running parallel to this fault starts one and a half km north
east of Sart upto the north of Loka. The direction of this fault is also from
southwest to north-east. Limestone of Lower Gondwana age and porphyritic
granite of Archaean age is affected by these faults.

Gneissosity is prominently developed in the Archaean rocks of North
Koel basin. These planar structures trend in NE-SW direction in the southern
and eastern part of the area and ENE-WSW in northern part of the area.
Trend lines in the Archaean rocks reveal the Eastern Ghat strikes and Satpura
strike viz. NE and ENE-WSW respectively. The dip is steep to vertical.
The major shear zone bending north-south appears to be older in
age than the Talchirs. Another shear zone trends from Gosaindih (24°25'N,
84°15'E) to Ratnag (24°21'N, 84°10'E) is mostly represented by augen gneiss.
In the northern part of Amanat basin the foliation trend is north-south with
westerly dips of foliation ranging from 30° to nearly vertical. The major
direction of jointing is coincident with that of the strike.¹

GEOLOGICAL EVOLUTION :

The North Koel basin forming a part of Chota Nagpur plateau bears
distinct marks of great tectonic and orogenic displacements. The geological
history of this region is summarized by Dunn as follows: A long period of
erosion evening out the irregularities of gneissic and granitic Pre-Cambrian
land surface; an ice age in the Upper Carboniferous, major trough faulting
in the Permian times that brought into being the Damodar Valley when the
Gondwana rocks were laid down in fresh water lakes, uplift in the hot desertic
condition of Triassic days when some five thousand feet of Gondwana were
stripped away and massive sandstone of Mahadeva series (Middle Gondwana)

were formed a volcanic outbreak in the Jurassic; and minor faulting and tearing during Tertiary earth movements.

According to Dunn (1935) we have the following sequences of uplift in this part.

1. An early Tertiary peneplain uplifted to 304 m. to the south and with a tilt to the NE. It is represented by Netarhat and other plateaus.

2. A further uplift of perhaps 304 m. between middle and late Tertiary. This uplift was in the nature of a tilt to the north and north-east from the Hazaribagh plateau, but at the Son river the northern edge of the upwarp was more abrupt.

3. Further south after a long period uplift of 91 m.

4. A gradual rise in the south.

Tertiary period has been one of the parts of considerable movement.

The Archaean rocks represent a batholythic mass. The sedimentation in Gondwana basin is due to diastrophism. The rugged terrain of the region may be attributed to irregularities in the batholythic mass of Chota Nagpur.

The evolution of Gandwana basin may be assessed on the basis of nature of sediments. The peaks of rugged relief were covered with glaciers. In the first stage boulders and pebbles were deposited in the natural depressions which were transported by water for a shorter distance. The area experienced downwarping. Downwarped areas which coincided with earlier depressions preserved the boulder beds at the base of the Talchir beds. Where it did not coincide sedimentation of boulder beds, sandstones, shales were directly deposited on the Archaean basement e.g. Hutar and Daltenganj. The early glacio fluviatile deposits became fluviatile in the later part of Talchir series. Perhaps there was a barrier between Hutar and Daltenganj and the rocks of the source area differed from each other. The source area for three basins were mainly south and southwest although a westerly source was apparent in Daltenganj Gondwana basin. The evidence of paleoclimate shows variation from glaciation to alternating cold, to cool humid. During Barakar times climate was warmer as compared to Talchir time. The cool and humid climate

facilitated the rivers to deposit the sediment. There is also evidence of admixture of sediments from distant sources mainly from the south and west in younger Barakar rocks. The barrier between Hutar and Daltenganj in Talchir series was also remarkable in Barakar series.

The following combination of tectonic condition may be attributed to as one of the possible cause of sedimentation in Gondwana basin :-

1. Uplift in the source area and fast sinking in the basin
2. Low relief in the source and slow sinking in the basin.

Sandstone and coalseams share two different tectonic set up. Their appearance in sharp contact may represent that the basin area slowed down abruptly, the change occurred in sediment supply also. This may reflect the diversion in the course of the rivers which left behind vast marshes in which coal seams were deposited. In Auranga basin coal seams are associated with sandstone in the eastern part but in the western part coal is replaced by shale. The western part acted as a trap and presented the movement of clayey sediments to the east. Rate of sinking in the basin was not matched with the rate of uplift in the source area.

During the deposition of Raniganj series the climate was cool and humid represented by Glossopteris flora. The presence of montmorillonite in the rock indicates semi arid condition.

Sandstone of Panchet series are more mature than Raniganj series. This reflects that the progress of cycle of erosion would naturally contribute more mature sediments. The relief in source area may be medium. The Panchet rocks occur as sub-basins of Raniganj series. The tectonism of deposition may be assumed as a result of density stratification under seasonal rainfall or upwarping in the source area and downwarping in the basin area was comparatively small which resulted in the deposition of thin bands of sandstone and shale.

There is an erosional break between Panchet and Mahadeva series. These rocks occur in isolated basinal forms. The climate during Mahadeva time was warmer. High relief in source area and fast sinking in the basin may be probable cause of deposition of Mahadeva sandstone.
Soil erosion has exposed the roots of the trees - Kutmu

Gondwana soil suitable for agriculture - Barwadih.
After the deposition of Gondwana rocks the region was intruded by dolerite intrusions in Cuddapah or earlier times. Then the volcanic outburst in Jurassic time occurred which is represented by patches of Deccan Trap. The trap rocks were later converted to laterite and bauxite. The Tertiary era noticed earth movements in this part also which is reflected by several folds and faults. In the recent time alluvium in Chechari basin and in the region near the confluence of North Koel and Son river is notable.

The structure of the basin is complicated due to the presence of shear zone, faults and folds and the complex nature of lithology of the area.