ENGINEERING GEOLOGY DIVISION-3
NORTHERN REGION
GEOLOGICAL SURVEY OF INDIA

(FIELD SEASON 1986-87 & 1987-88)

A REPORT ON THE CONTINUATION OF GEOLOGICAL INVESTIGATIONS OF THE JAMRANI DAM PROJECT, RIVER GOLA DISTRICT NAINITAL, U.P. (WITH FIVE PLATES)

By

K. Anblagan
Geological Survey of India

(May 1988)

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BY

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(MAY 1988)

ABSTRACT

The Jamrani dam project envisages the construction of a 130m high dam across river Gola, mainly for irrigation in Bhabar area of Nainital district.

Lower Siwalik rocks comprising thick sandstone interbedded with siltstone and claystone occur at the site. Correlation of lithological bands exposed at the site on either abutments has been attempted.

Explorations so far completed at the dam site are discussed together with further explorations to be done at the site.

Based on the projected foundation/grade geology, the possible treatments have been discussed.

The geology of the reservoir area and the stability of its rim, as well as possible leakage problem are also disdussed.

The siltation problem of the proposed reservoir and the possible remedial measures to control the some have been highlighted.

The seismic status of the region, with reference to Main Boundary Fault has been discussed.

The possible alternative locations of the construction materials have been identified.

1. INTRODUCTION

The Jamrani dam project envisages the construction of a 130m high dam on river Gola near Jamrani village (20° 16' 0"; 79° 36' 36"; 53 0/11) in Nainital district, U.P. On completion, it would store 201 million cubic meter of water and provide irrigation to an additional 64,500 hectares of land in Bhabar area of Nainital district. Salient features of the project are furnished in the earlier reports. The geological investigations of the project, under progress since 1973, were continued during the field season 1986-87 and 1987-88 (i.e., 1.10.86 to 30.9.88 at the request of the Superintending Engineer, Jamrani dam Construction Circle, Kathgodam and in pursuance of the item No. EG/530/NR/UP/73/73 of the two field season progremmes of the Geological Survey of India.

(2) A list of earlier geological reports on the Jamrani dam project is furnished in ~~Appendix~~ Annexure-II, of this report. During the period under report, the author remained at Kathgodam as Resident Geologist for a total of 461 days. The field work conducted during the period, comprised the following :

Nature of work	Quantum of of work
1) Detailed Geological mapping of the area around the dam site on 1:1000 scale	0.18 sq.km.
2) 3-dimensional geological logging of exploratory drift at the quarry site on 1:100 scale.	30m
3) Detailed geological logging of drill holes.	70.5m.
4) Detailed geologcal mapping of the reservoir area on 1:7500 scale.	4.0 sq. km.
5) Traverse geological mapping on 1:50000 scale.	66 l. km.

2. The geological investigations were carried out and the writing up of this report has been accomplished under the guidance of Shri G.Pant. Director, Engineering Geology Division-3, Geological Survey of India, Lucknow.

II. GEOLOGY OF THE DAM SITE

3. The Jamrani dam site is located in the west-flowing reach of the river Gola, about 5 km downstream of Hairakhan temple (Nainital, U.P.). The width of the river at the site is about 70m and the crest length of a dam, 130m in height, would be nearly 430m, prior to the abutment stripping. The right bank of the river at the dam site is steeper (50°-60°) than the left bank, which is gentler (40°-45°). Rock is generally exposed on both the banks but the river section is covered by about 20m deep fill material. The rock exposures are more abundant on the right bank and the left bank has more of debris/vegetation cover. Detailed geological mapping of the proposed dam site, from 400m. Upstream of the dam axis to 450m downstream of the same and from river level (El ± 635) upto El ± 780m on the left bank and upto El ± 800m on the right bank had been carried out on 1:1000 scale till field season 1985-86. However, as the abutment stripping for founding the proposed dam was expected to extend farther higher up of the area already covered, it was decided to extend the mapping upto E.l. ± 830m on the right bank and E.l. ± 810m on the left bank. During the field seasons under report, the mapping of the right abutment has been extended upto E.l. 830m.

4. The Lower Siwalik rocks occurring at the dam site include sandstone, occasionally friable due to poor cementation, alternating with minor beds of siltstone and claystone. Thin bands of pebbly sandstone are also encountered at places. Cross bedding observed in the area indicate a normal order of superposition of the rocks. Some bands of sandstone

are also calcareous. Minor amount of shearing along the contact of sandstone claystone is seen at places. The geological details of the site are already discussed in the previous rports on the project and hence not repeated in this report. The rocks seen at the dam site are not much disturbed tectoinically. Their bedding generally strike NW-SW, with dip of 30° to 50° in north-east direction, i.e., upstream. The disposition of the bedding planes on the two banks do not show any perceptible difference, thereby, indicating that there is no major structural break/ disturbance, like fault, along the river.

5. For evaluating the pattern of bedding and joints at the site, 400 readings were noted. The data obtained was plotted on an equal area schmidts stereonet and has indicated the following discontinuities in order of preponderance.

Discontinuity	Maxima of pole concentration	Strike	Dip
Bedding	15%	N50°W	47°/N40°E, i.e., upstream
Joint, J-1	10%	N39°E	68°/N51°W, i.e., Downstream
Joint, J-2	10%	N60°E	66°/N30°W, i.e., - do -
Joint, J-3	3-5%	N70°W	57°/S20°W, i.e., towards left bank
Joint, J-4	3%	N80°E	57°/S10°E, i.e., -do-

6. The rock exposures at the dam site are more abundant on the right bank of the river, but the left bank is largely covered by debris, supporting thick vegetation. The isolated rock exposures on the left bank comprise mostly sandstone forming the cap rocks of the N-S, trending spurs. The 65-70m wide river bed section is occupied by about 20m deep riverborne material.

7. An attempt has also been made to correlate the rocks exposed on either abutments. However, in addition to the scanty/isolated rock exposures on the left bank, the other problem encountered in the correlation of rocks on the two banks, is the facies variation, shown by

individual bands along their strike, as exemplified by the 3-5 thick siltstone- claystone beds on the right abutment attenuated to 0.5m to 1.0m thickness on the left abutment (plate-1). Moreover, the strike of the beds show variations ranging from N35°W-S35°E to N55°W-S55°E with dips varying from 30° to 50°. The strike continuity of the individual bands from one bank to another have to be traced for about 100m to 120m on the wide river bed which is devoid of any rock exposure. The variation of the strike of the beds along their trace and the facies variation shown by individual beds, make it difficult to correlate the bands on one bank with these on the other. In the absence of any marker horizon the exercise of correlation faced many problems. Though the theoritical trace of contact of the beds do not exactly coincide with the actual contacts, as plotted on the map of the site, they do show a tendency to follow them. The difference observed could be assigned to minor variations in the strike and dip of the beds. A thick sandstone bed exposed along the axis of the dam on the left bank was traced to the right bank along its strike. However, on the right bank instead of a thick sandstone bed, the rock exposures comprise thin alternating beds of sandstone claystone and siltstone. But, still there exists a correlation.

III. EXPLORATIONS AT THE DAM SITE

8. The explorations at the dam site, completed earlier, are already discussed in detail in the previous reports. 25 holes have been drilled at the dam site so far for exploring the sub-surface conditions in the river bed and on the two abutments under the layouts of the dam and appurtenant structures, then proposed. Summarised geological logs of the first 20 holes, drilled prior to 1981, and detailed geological logs of the 5 holes drilled subsequently are available. A programme of further explorations at the site has been proposed vide an Study Note furnished to the project authorities in April 1987. The note is included as ~~appendix~~ Annexure-II to this report for ready reference. It has been recommended in the note that, four new drifts, two on either abutment may be excavated for better defining the limit of stripping on the abutment and supplementing the information obtained from the 4 nos (2 on each abutment), existing drifts, 43 more holes for exploring the layout, now proposed, have

been recommended under 3 categories of priorities A, B an
Of the 'A' category holes, located in the river bed, the
hole No.A-1 and to be drilled to a depth of 1H of the da
The other 'A' category holes are to be drilled upto a
depth equivalent to 1/2H of the dam. Among the 'B' categ
the holes to be drilled to a depth of 1/2H of the dam, T
holes B-7, B-9 and B-10 on the right bank and B-12, B-13
B-14 on the left bank, could be drilled to a depth of at
least 30m in the intitu rock for evaluating the foundatio
conditions in the dam base area. The other holes of 'B'
category and 'C' category could be drilled to 20m in bedr
In all the holes, water percolation tests have to be
carried out in the bedrock. It has also been recommended
in the note that more grouting tests at the dam site, mus
be conducted for assessing the overall groutability of th
rock and quantifying the spacing and depth etc of the
grout holes.

9. During the period under report one more drill hole (No.29) was completed at the dam site, which is described below.

LH-29

10. The LH-29 was located at an elevation of 689.70m, in front of the exploratory drift LL-1, on the left bank of t river. It was drilled down to a depth of 70.5m. It proved that the depth of overburden is limited to 1.2m. Lower Siwalik sandstone was encountered in the hole below the overburden and continued in most of the depth drilled thereafter, except ~~between~~ from 20.3-24.8m, 30.2-32.6m, 44.0-44.6m and 51-63.5m where siltstone and or clayshale bands were metwith. The core recovered from the drill hole shows signs of weathering down to 9.0m depth. The core recovery in the hole is generally good (70-100%) except from 18.0-20.5 and 30.0-33 where it is57% and 62% respectiv The permeability of the bedrock encountered in the drill hole is above 10 lugeons down to 27.0m depth, 5-10 lugeons between 27.0m and 36m depth, less than 5 lugeons between 36.0m and 60m depth and finally less than 1 lugeon down to the bottom of the hole. A detailed geological log of this drill hole is furnished on plate-II of this report.

IV. GEOLOGICAL STUDIES IN THE RESERVOIR AREA*

11. The Jamrani dam would store water between elevations 635m and 763m. The average gradient of the river in the reservoir area is 13m/km. The impounded reservoir would extend for about 9km. along the Gola valley and about 1.3km along the Lugar Valley spreading over an area of about 4.5 sq.km. The proposed reservoir would be bound in the north by the NW-SE trending Banana-Udiran bridge and in the south by the WNW-ESE trending Panitan-Okhaldunga-Synra ridge. The latter, at the proposed maximum reservoir level, has a width of more than 2.5km, between the valley of the Gola and Bhabar plains.

i) GEOLOGY:-

12. The reservoir, proposed to be impounded by the Jamrani dam is located, partly on Lower Siwalik and partly on Amritpur Granite. The Main Boundary Fault(MBF) marks

P.T.O.

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* Reviewer's Remark

Soon after submission of drafts of this report for 1986-88 and also of an earlier one for 1984-85 and prior to their scrutiny/ processing for distribution, the author proceeded on deputation to University of Roorkee and subsequently severed his official links with the G.S.I. The report for 1984-85 was scrutinised, processed and distributed soonafter but this report contained several points, which needed reconciliations, remained pending. Since its distribution has already been delayed inordinately, it has now been scrutinised and processed for distribution with reviewers' remarks at appropriate places.

Sd/= (G. Pant)

the contact between the two. The Lower Siwalik rocks, occurring in the north-western part of the reservoir, comprise thick sandstone beds inter-bedded with thin purple grey to dark grey claystone and siltstone beds. The brownish grey to greenish Lower Siwalik sandstones are generally fine to coarse-gradined, micaceous and moderately hard. A few softer bands of sanstone are also encountered occasionally. The Amritpur granite, which is medium to coarse-grained and greyish in colour, occupies the north- eastern part of reservoir. At places, it grades into quartz porphyry. In thin sections, the granite shows a typical porphyritic texture. Crenulation of quartz, kaolnization of feldspars and chloritization of micas indicate that these rocks have been subjected to intense shearing. ⊕ Cones of loose material, consisting of pieces of granite mixed with fines, observed on the right bank of the river Gola, near Pastola village and farther upstream, represent scree material and debris of minor rock slides from above the reservoir level.

⊕ Reviewers's Remarks

The features of the Amritpur granite, cited by the author, tend to indicate that the quartz present in the granite may be strained, and hence prone to alkali- silica reaction in aggregate form The aspect would need further detailed evaluation, espectially if the granite is intended to be used as aggregate material.

Sd/- (G. Pant)

13. The NW-SE trending Lower Siwalik rocks, occurring at the dam site and in the reservoir area dip consistently at moderate angles towards NE. Since the river flows, in general, towards WNW, the bedding mostly dips towards upstream, except at a few location, where the river takes turns locally. The generally, feebly developed foliation planes in the Amritpur Granite dip 30° to 40° towards NNE to NE. The granites are also traversed by closely spaced joints The WNW-ESE tredingM BF dips at steep angles towards ENE. In the reservoir area, the fault passes to the south of Sakula and Pastola villages on the right bank before cutting across the river Gola near Panota, about 3.5 km. upstream of the dam axis. On the left bank, it passes to the south of Hairakhan and then enters the Lugar stream near Lugar village, close to the maximum levle of the reservoir. The Fault is generally concealed under debris cover.

(ii). STABILITY OF SLOPES:

14. The Lower Siwalik rocks occurring at the dam site. generally strike across the river course and dip upstream. Therefpre , the chances of failures along the bedding plnnes are very little. Similarly, the slopes of the granitic terrain, bordering the reservoir do not indicate any major problems of instability.

15. There are no major active slide zones in the reservoir area. A study of the existing slides in the reservoir area indicate that a few of them falling in the category of potentially unstable zones, mostly in the Siwalik terrain, are generally shallow in depth and hence, not very significant. Of the 4 nos. slides observed in the area, all except the one near Khalajhala village, extend for a height ranging from 10-20m above be river level. In all these cases, the overlying sandstones have been mobilised along the bedding planes in the underlying claystones, wherever the river takes sharp turns and the toe of the sandstone is eroded. All these slides are

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Reviewers' Remark

The left bank at the dam site is nearly a dip slope and shows instability downstream of the same. Similar situations may be encountered elsewhere and may need further studies.

located within the proposed dead storage and as such they will have practically no impact because of the support provided by the water in the reservoir.

16. The scarp face of the slide on the steep valley face on the left bank⊕, near Khaaljhala village extend from El. +675m to just above the proposed reservoir level. This rock slide, located on the Siwalik rocks, is a shallow one guided by the steep south- dipping joints. The draw-down conditions of the reservoir (some dead sortage level El. 712m) may lead to further flattening of the valley slope However, since the bedding dip into the hill, the slide may not assume any significant magnitude.

17. The Amritpur Granite occurring to the north of Main Boundary Fault, mostly on the right bank of the river, is traversed by closely spaced joints. Under drawdown conditions, the moderately steep valley face many tend to get flattened with minor slope adjustments.

(iii) RESERVOIR LEAKAGE :

18. The sub-surface leakage from any reservoir depends on topography and the geology of the area. Since there are no Saddles close to the maximum water level of the reservoir, there will be no significant leakage from reservoir. The southern Panian- Okhaldunga-Syura ridge, having a base width of more that 2.5 km. at the maximum reservoir level, is made up of sanstones interbedded with claystone and siltstone. The claystone silstone bands would act as natural barriers against subsurface movement of water. The streams occurring on the northern slope of the Banana-Uchira ridge are well above the maximum water level of the reservoir. Hence the chances of leakage from the reservoir are negligible, if any.

⊕ Reviewer's Remark :

The description appears to tally with one slide near the village on the right bank of the River.

Sd/-
(G. Pant)

19. The MBF cuts across the Saklani- Banana ridge, on the right bank at about El ± 1100m ., Howeve, the seep-age of water, if any along the MBF zone will have to traverse a long distance of 3.5 km., before finding its way back into a tributory Valley down stream of the dam. Water percolation tests conducted in the inclined drill hole No. 26, put down in the thrust zone, have indicated the permeability of the thrust zone material to range from about 7-10 lugeon.* Since this value of permeability is almost the same as that of adjoining rocks, it is assessed that reservoir may not face any significant problem of leakage after impoundment of the reservoir.

(iv) SILTATION :

20. The 450 square km. catchment of Jamrani dam includes the main river Gola and its other smaller tributaries and the sub-basing of the river Kalsa in the north-west and the Lugar gad in the south-east. The study of sediment yield is relatively a complex problem as it is dependent on a number of factors. In a hilly terrain the sediments are derieved basically from the rocks and the nature of rock exposures, especially their weathering characters play an important role in determining the nature of sediments to bederieved. For example, the moderately hard sedimentary rocks of lower Siwalik and the Chlorite -sericite schist of the Ramgarh Group may produce more of finer sediments. Active landslides (such as Pandegaon slide in Kalsa valley and Babyar slide in Gola valley) are major sources of finer sediments. However the rock types such as as Amritpur Granite, Nagthat quartzite and Ramgarh porphyry as well as the metabasics, which occupy a large area (80%) of the catchment, may produce mostly coarser fractions. As such, it is inferred that the sediment yield in the catchment area may contain more of coarser than finer sediments.

Reviewer's remark:

The drill hole perhaps did not intersect the thrust zone. The granite interpreted in the hole from 2.80m-8.50m did not yield any core recovery and its existence at the location is doubtful. The water percolation tests in the drill hole were conducted in Siwalik sandstone.

Sd/= (G. Pant)

21. The annual sediment yield at the Jamrani dam has still not been evaluated in detail, though the project Authorities have tentatively adopted a value of 0.3 million cubic meters.

22. The extent of vegetation cover is an important factor in determining the areas more prone to erosion. Chandra et. al (1981) have obtained a factor called "Soil Cover Factor" from the data of satellite imageries of LANDSAT - I for studying the nature of vegetation cover in the catchment area. The following factors were dssigned to various types of vegetal cover -

Reserve forest -	0.2
Unclassified forest-	0.4
Shrubs and grass -	0.8
Arable land -	0.6
Waste Land -	1.0

23. The Jamrani catchment yielded a value of 0.27. On this basis, Chandra et. al. (1981), indicated that the Jamrani catchement is less prone to erosion as compared to nine other major catchments such as Bhakra (0.38), Matatila (0.57) Hirakud (0.34), Maithon (0.44) Gandhisagar (0.61), Panchat Hill (0.38), Nizamasagar (0.60), Tungabadra (0.59) and Mayurakshi (0.51).

24. Sharma and Tangri (1983) believed that the Gola river is not likely to pose much of siltation problem. According to them, there are natural barrages in the form of narrow gorges, which block the movement of most of the bed lead from higher reaches.* One such narrow gorge (5-10m wide) is present across Gola river in Babyar area, about 4-5 km upstream of the proposed maximum level of the reservoir.

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* Reviewers's remark:

If this was true, the type of bed load deposits seen in the Hairakhan-bhuraa section and elsewhere, farther upstream, should not have been there.

Sd/= (G. Pant)

Another very narrow gorge (about 5m wide) exists in Kalsa river in Maswari area, about 10 km upstream of the maximum reservoir level. These gorges block much of sediments being transported from higher reaches. According to them, the large scale meandering, observed in Hairakhan area and further upstream, indicates that the carrying capacity of the river in these reaches has been considerably reduced.

25. Selected traverses in Gola, Kalsa and Lugar valleys indicate that the sediment yield is likely to be more from the Kalsa river than that from the Gola and Lugar. In addition to the large and still active Pandegaon slide, there are a number of smaller slides in Kalsa valley in its reach from Malwatal to its confluence with Gola.*

26. In order to obtain, systematic data on sediment yield of both bed load and suspended load from catchment, it is necessary to set up a number of silt observation stations.

These studies would help in identifying those areas which contribute more silt so that proper remedial measures could be adopted.

27. Since landslides are the major sources of sediments, proper stabilisation measures to tackle them are necessary so that surface erosion of sediments could be minimised. Construction of check dams across stream courses at suitable locations in the catchment are likely to be helpful in effectively blocking the sediment transportation into the reservoir. The narrow reaches in the Kalsa and the Gola rivers provide suitable locations for check dams because the valley upstream of the gorges opens out thus providing more of storage.

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* Reviewer's remark:

It is already stated in para-15 that there are no major active slide zones in the reservoir area. The Pandegaon slide, in the Kalsa valley is located farther upstream.

Sd/= (G. Pant)

28. The proposed check dam in the narrow reach of Syanli area in Gola valley will be located with in 4-5 km from the Jamrani reservoir and would reduce the silt inflow from the Gola catchment into the reservoir, as the sediments from the upper reaches of the river will be trapped by this check dam. Two more check dams are suggested farther downstream; between this check dam and the reservoir level to further trapping of silt which may get generated in between the two.

29. In Kalsa valley, a check dam to be founded on bed rock may be located in Tara village area, in this narrow reach for blocking the silt from the upper elevations flowing into the Jamrani reservoir Four more check dams are recommenced in the downstream reach, because of the higher anticipated silt in-flow from Kalsa valley.

30. In Lugar valley, 3 check dams are recommended

An active slide is located on Lower Siwalik rocks near Patrani village, opposite the Lugar village. In additon to having a small check dam across the nala in which the slide occurs, two more chdck dams are recommended in Lugar area to trap the slide debris from reaching the reservoir. *

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* Keviewer's remark:

The author has recommendec three, five and five check dams in Gola, Kalsa and Lugar valleys respectively. The height of all the check dams is not specified but two of the check dams on river Lugar (as per the draft report) are to be 3-5m. However, the reviewer is extremely doubtful about the utility, the execution across mountanous rivers and the life span of such low dams.

Sd/= (G. Pant)

V. SEISMICITY OF THE AREA

31. The geological envoirnment of the Jamrani reservoir is characterised by an alternating sequence of sandstone siltstone and claystone. The Main Boundary Fault, the most important tectonic feature, seperating the Siwalik sedimentaries from the Leasser Himalyan rocks, passed through the reservoir. Though its seismic status is not fully known, the development of some important geomerphic features across the trace of the fault are worth considering. The MBF passes through Lugar village, to the east of the reservoir and farther east of the village, it follows the course of Lugar gad for some distance, before cutting across it to follow a south-easterly direction. Along the trace of the fault, the overburden, comprising slide debris and fluvial deposists, has developed a north-sloping scrap face in Lugar area over a distance of about 2 km. As a result, the south-flowing Kakachari stream takes a sharp westerly turn in the vicinity of the scrap face to join the Lugar straem. Some of the streams flowing parallel to the Kakachari stream farther on the east get terminated in the scarp area, forming a lake-like depression (plate-IV).

32. Since very recent deposits seem to have been uplifted along the trace at the MBF, it might indicate neotectonic activity along the MBF. However, Shri G.Pant, Director during his inspection of the area on 6.4.86 raised the question as to why the scarp face is restricted only over a distance of 2 km, where the overburden material occurs and is not traceable in areas where the rocks are exposed. According to him, the effects of the postulated uplift should have been better preserved by the rocks than by the overburden. He had argued that the apparent fault scarp, seen on the overburden material might represent, on e of the bank of the old river course : which

incidently coincides with the trace of the MBF. However, the complete absence of the trace of the scarp on the other bank of the nala on north, is an intriguing factor. Further, the general topography to the north of the scarp face is much undulating with a lake-depression in the centre of the area. The ground surface to the east and west of the lake-depression, have slopes 25-30° towards the lake. If the area to the north of the scarp face represented the old river course , it should have a smooth profile with the flow indicating towards west. As such, the author believes that the feature possibly represents neotectonic activity as a result of some local tectonic activity restricted over a short distance.

33. During the inspection of the area, Shri Pant had also observed that indications of past impoundment conditions along the Lugar river occur upstream of the Lugar village. According to Sharma and Tangri (1983), the shoal line deposits and a strand line that runs continuously even beyond Sajagaja village (located about 2.5 km. from Lugar) bear testimony for this. Accordingly, it is inferred that initially a major landslide took place in the Lugar area possibly related to some tectonic activity. The slide debris might have blocked the stream course leading to impoundment conditions and later the lake might have got breached to follow the present river course. The present scarp face seen in the area may be the result of recent tectonic activity. which may be of local significance. ⊕ The trace of the M.B.F further east and west does not show any indications of neotectonic activity. ⊕⊕

⊕ Reviewer's remark:

If the scarp is really related to recent tectonic activity, it should normally not be of local significance.

Sd/= (G. Pant)

34. Moreover, the geological environment of the proposed reservoir is characterised by alternations of claystone/sandstone in large part of the area and is similar to that at Bhakra, Ramganga and Pong dams in India and Mangla and Tarbela in Pakistan; Srivastava et al (1982) and Valdiya (1986) have pointed out that these dams have not shown any significant reservoir induced seismicity (R.I.S.), because of the presence of plastic rocks, which under deformation may show settlement without producing vibrations. In the Jamrani reservoir, the Amritpur granite is exposed towards the tail reaches, where the water level under impoundment may be very small. The sandstone - claystone sedimentary rocks are exposed in the deeper portions of the reservoir and the dam site. Therefore, it may be quite logical to conclude that there may not be much of an R.I.S. at the Jamrani reservoir. However, it is necessary to monitor the earthquake activities, if any, in the area by installing a set of seismological observatories (3 to 5) around the proposed reservoir area.

VI. CONSTRUCTION MATERIALS

35. It has been estimated that about 2 million M^3 of aggregate would be required for the construction of a concrete dam at the site. This quantity would be obtained from the river borne material within 3-5km downstream of the dam site. The suitability of these material for concrete aggregate is under evaluation by project authorities. A detailed quantitative evaluation of the material available is yet to be taken up by the project authorities. As an alternative, it is suggested that the possibility of using the fine grained variety of the Amritpur granite, exposed

to the north of the dam site around El.± 1000m for using as concrete aggregate may also be evaluated. The granitic area is approachable by the Anna-Babiyar road under construction by PWD, which traverses through Amritpur grani and takes a hair pin bend above the dam site. Sufficient quantity of aggregate could be obtained from this source, i it is found suitable after customary tests. Two possible locations for quarrying the aggregate have been examined. The first location lies in the Barajhala area, where the rocks are exposed close to Jamrani road level. These rocks are traversed by a number of joint sets. Here the blasted material can be transported by road. The second location lies at a higher elevations on the Anna-Babiyar road. The blasted material from here could be transported to the site by a ropeway.

36. The Barajhala drift at El.± 80M already discussed in th report for 1985-86 and the Anna-Babiyar road drift El.±980m on the PWD road were excavated by the project authorities with a view to assess the availability of suitable size of rock blocks for the masonry dam alternative. Coarse grained porphyritic granite is encountered in the Anna-Babiyar road drift (Plate V). Since the rocks encountered in these drifts are traversed by very closely ~~spread~~ spaced joints dipping in all directions, it may not be possible to obtain ~~rod~~ (or blocks for the masonry dam alternative from this source.

VI. CONCLUSIONS AND RECOMMENDATIONS

37. The Jamrani dam project envisages the construction of a 130m high concrete dam across the river ~~Hole~~ Gola in district Nainital, U.P. for an additional irrigation of 64500 hect of land in the Bhabar area of the district.

38. Rocks occurring at the dam site and in its vicinity are sandstone interbedded with clayshale and siltstone beds belonging to the Siwalik Group. The bedding in the rocks generally strike NW-SE and dip 30°-50° in NE direction, i.e. upstream which is a favourable disposition. Stereoset analys of joints metwith at the site have indicated the presence

of 4 prominent sets of joints. The different bands of rocks exposed on the two banks of the river at the dam site appear to indicate lateral continuity and, therefore, absence of any dislocation (fault) along the river course.

39. Since a concrete gravity dam is envisaged at the site, the difference in the physical parameters of the sandstone and siltstone/ claystone at the site would necessitate suitable dental treatment of the weaker bed for uniform dispersal of stresses. The available surface geological data projected at the likely foundation-grade (El± 610m) has indicated the presence of two thick claystone/ siltstone beds-one nearly at the centre and another at toe region, in addition to a few more thin claystone bands.

40. The Jamrani reservoir spreads partly on Lower Siwalik rocks and partly on Amritpur-Granite, Main Boundary fault marking the contact between them. There are no major active zones of slices in the area. A few of the unstable zones located on the Lower Siwalik rocks are shallow and insignificant. No excessive leakage is anticipated from the reservoir because of the favourable topographical and geological conditions.

41. A qualitative analysis of sediment transport from the catchment indicate that the annual sediment yield will have more of coarser than finer fractions. Because of the good vegetal cover in the catchment, it is less prone to erosion. The sediment yield may be more from the Kalsa valley than the other major valleys.

42. The dam site falls in zone IV of the Seismic Zoning Map of Incia. Major earthquakes, having magnitude 5 are located about 100km north and north-east of the dam site. Though the Main Boundary Fault has shown some ~~suspected~~ Suspected neotectonic activity in Lugar area, above the reservoir, it is felt that it is of local significance ⊕. Further, because of favourable geological environment of the reservoir, the area may not show significant increase in MIS due to reservoir impoundment. However, further studies in this regard are necessary.

⊕ See Reviewer's Remark on page - 16

43. The required construction material for the proposed Jamrani concrete dam is planned to be obtained from the Gol river bed within 3-5km downstream of the dam site. Two more alternative locations on the Amritpur Granite exposed to the north of the site were examined for a comparative evalu of suitability and economics.

ACKNOWLEDGEMENTS

The author wishes to acknowledge his thanks to the proj authorities for the facilities extended during the fieldwork.

ANNEXURE-I

LIST OF UNPUBLISHED REPORTS ON JAMRANI DAM PROJECT BY GSI

1. Bayal, H.M.(1973): A Geotechnical note on the Ranibagh and Jamrani Dam sites on Gola river, Nainital district U.P. (with five plates): F.S.1972-73.
2. Layal, H.M. (1973): Seconc geotechnical note on the interpretations of drilling data, Jamrani dam site, Gola river, Naihital district, U.P. (with three plates), F.S.1972-73.
3. Arora, C.L. et al ( ): Report on the geophysical investigations of conductec at the proposed dam sites over river Gola at Amritpur, Jamrani and Bhuria, district Nainital, U.P. (F.S.1972-73).
4. Layal, H.M. (1974): Third geotechnical note on the proposed dam and the appurtenant structures sites and interpretation of drilling data, Jamrani dam site, Gola project, Nainital district, U.P. (with three plates), F.S.1973-74.
5. Layal, H.M.(1975): Fourth geotechnical note on the Jamrani dam project, Gola river, Nainital district, U.P. (with seven plates), F.S.1973-74.
6. Layal, H.M.(1976): Fifth geotechnical report on the Jamrani dam project, Gola river, Nainital district, U.P. (with six plates), F.S.1974-75.
7. Layal, H.M. (1978): Sixth geotechnical note on the Jamrani dam project, Gola river, Nainital district, U.P. (with fourteen plates), F.S.1976-77.
8. Jain, M.S. (1974): A geotechnical review of the salient features of the Jamrani dam site, Gola river, Nainital district, U.P.
9. Saran, K.B, (1976): Report on the prefield photo-interpretation of Gola catchment area Nainital district, U.P. for engineering geological studies (unpublished report of Photogeology Livision, NH,GSI).

10. Jaitle, G.N. ( ): Geotechnical report on the Jamrani dam project, river Gola district, Nainital, U.P. (with two plates), F.S. 1979-80.

11. Tripathi, K.P.: Report on the geophysical investigations at the proposed dam site at Ranibagh over river Gola, district, Nainital, U.P. (F.S.1979-80).

12. Iyer, K.V., Anbalagan, K. Sanwal, K.K. ( ): Geotechnical report on the Jamrani dam project, Gola river Nainital district, U.P. (with eight plates), F.S.1980-81 to 1983.

13. Anbalagan, K. (1987): A report on the pre-construction stage geological investigations of the Jamrani dam project, river Gola, district Nainital, U.P. (with plate), F.S. 1985-86.

14. Anbalagan, K. (1988): A report on the geological studies of Jamrani dam project, river Gola, district Nainital, U.P. (with six plates), F.S.1984-85.

15. Anbalagan, K. (1990): A report on continuation of geological investigations of the Jamrani dam project, river Gola, district Nainital, U.P. (with five plates), F.S.1986-87 to 1987-88.

B. PUBLISHED REFERENCES

1. Chandra, S., Garde, R.S. Sharma, K.P. and Swamy, P.K. 1981: Reservoir sedimentation studies of Jamrani dam, School of Hydrology, University of Roorkee, Roorkee 1

2. Sharma, K.P. and Tangri, A.K. (1983): Aerial remote sensing techniques in geomorphological appraisal and evaluation of bed load movement in Gola catchment, district Nainita, U.P. Proc. Nat Symp on remote sensi in development and management of water resources pp. 157-165.

3. Srivastava, H.N. and Dube, R.K. (1982): Seismicity studies of some important dams in India, Proc. 4th Int. Cong. Engg. Geology, New Delhi, Vol.VIII, pp. 219-228.

4. Valdiya, K.S. (1986): Environmental Geology. Indian Context" Tata McGraw Hill Company, New Delhi.

PLATE-I

JAMRANI DAM PROJECT

GEOLOGICAL MAP OF THE DAM SITE SHOWING PROPOSED EXPLORATION PROGRAMME

(APRIL -1987)

SCALE

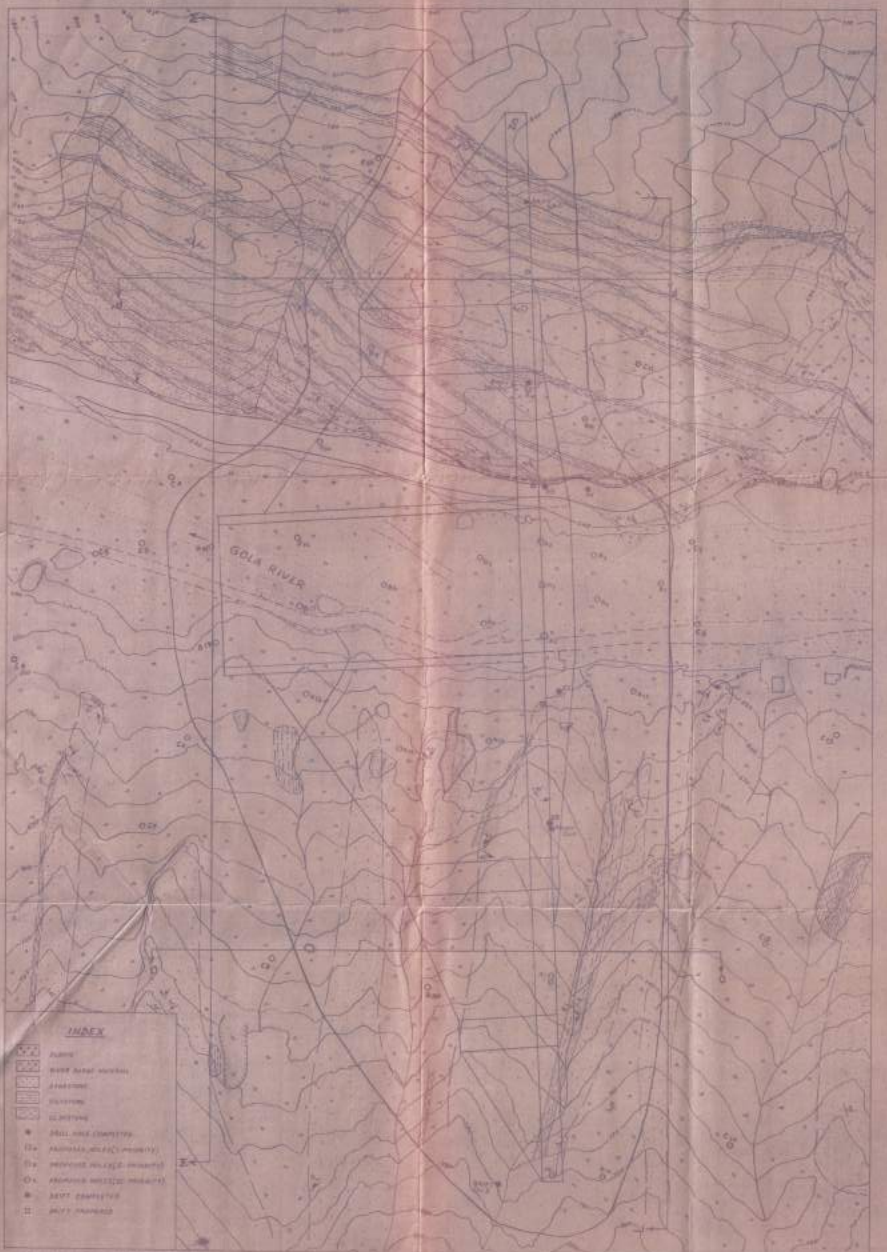


PLATE-

GEOLOGICAL LOG OF DRILL HOLE

PROJECT - [illegible]

STATE - [illegible]

FEATURE - [illegible]

STARTED - [illegible]

TYPE OF BIT [illegible] DIAMOND

CO-ORDINATES - [illegible]

COLLAR ELEVATION - [illegible]

COMPLETED - [illegible]

HOLE NO. - [illegible]

BEARING OF HOLE -

ANGLE WITH HORIZONTAL - 90°

TOTAL DEPTH - [illegible]

DEPTH METER	LITHOLOGY		STRUCTURAL CONDITIONS			PERCENT CORE RECOVERY	R.Q.D.	PERMEABILITY TEST		GENERAL OBSERVATIONS AND INTERPRETATIONS
	DESCRIPTION			DESCRIPTION						

OVERBURDEN

[illegible]

ROCK

[illegible]

INDEX

[illegible]

PLATE-3

JAMRANI DAM PROJECT

GEOLOGICAL SECTION ALONG DAM AXIS SHOWING THE LOCATION OF DRIFTS AND DRILL HOLES

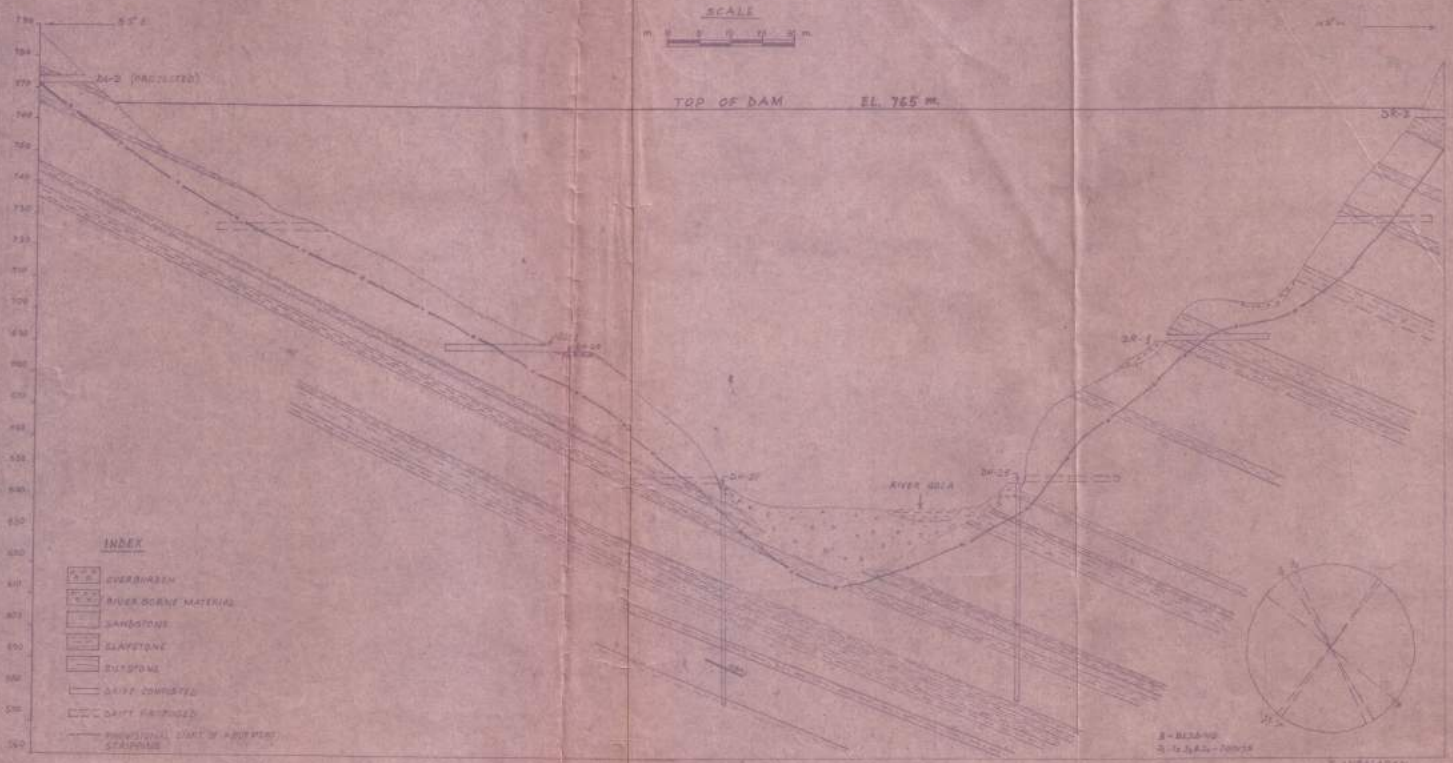
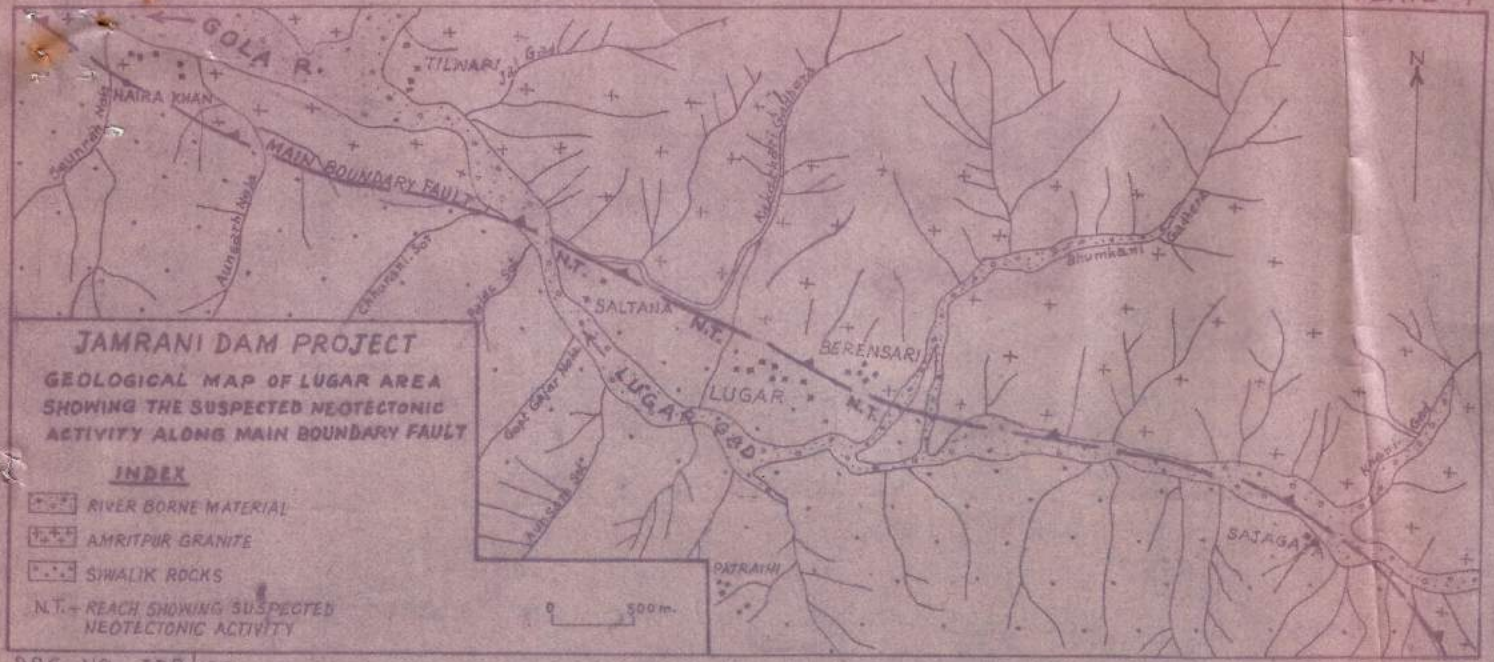


PLATE-4



JAMRANI DAM PROJECT

GEOLOGICAL MAP OF LUGAR AREA SHOWING THE SUSPECTED NEOTECTONIC ACTIVITY ALONG MAIN BOUNDARY FAULT

INDEX

- RIVER BORNE MATERIAL
- AMRITPUR GRANITE
- SIWALIK ROCKS
- N.T.– REACH SHOWING SUSPECTED NEOTECTONIC ACTIVITY

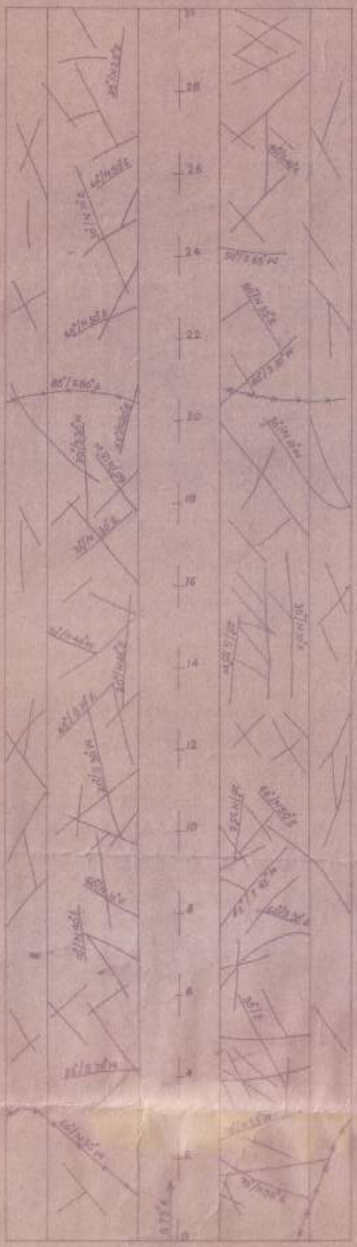
DRG. NO. JDP/122

R. ANBALAGAN
G.S.I.

PLATE – 5

JAMRANI DAM PROJECT

3-D GEOLOGICAL LOG OF ANNA-BABIYAR ROAD DRIFT



INDEX

AMOUNT OF DIP AND DIRECTION OF JOINTS

SHEAR ZONE

NOTE –

1. THE ELEVATION OF DRIFT IS ± 980 m.
2. THE ROCK ENCOUNTERED IN THE DRIFT IS GRANITE.
3. THOUGH THE ROCK IS VERY CLOSELY JOINTED, ONLY THOSE PROMINENT JOINTS HAVING LONGER CONTINUITY ARE PLOTTED.

DRG. NO. JDP/21

R. ANBALAGAN
G.S.I.
(K.S.P. 1986-87)