भारत सरकार

150

पत्रांक : /आर·पी·एस··1/अ·भू,-3 दिनांक :

प्रेषक :

निदेशक,
अभियांत्रिक भूविज्ञान प्रभाग-3,
बी-ब्लाक, सप्तम तल,
भारतीय भूवैज्ञानिक सर्वेक्षण,
सेक्टर- "ई" अलीगंज,
लखनऊ ।

सेवामें :

उप महानिदेशक,
उत्तरी क्षेत्र,
भारतीय भूवैज्ञानिक सर्वेक्षण,
सेक्टर- "ई" अलीगंज,
लखनऊ ।

विषय : भारतीय भूवैज्ञानिक सर्वेक्षण की रिपोर्ट/रिपोर्टो का वितरण ।

महोदय,

इस पत्र के अन्त में संकेतिक रिपोर्ट/रिपोर्टों, प्रत्येक की पांच प्रतिलिपियां उसके/उनके पांच सूत्रीय प्रपत्र की दो प्रतिलिपियों सहित अग्रसूचना/आवश्यक कार्यवाही हेतु प्रेषित है ।

भवदीय

संलग्नक : उपरोक्त

निदेशक
अभियांत्रिक भूविज्ञान प्रभाग-3

प्रष्ठांकन संख्या : 1436 /आर·पी·एस··1/अ·भू··3 दिनांक : 21/3/91

प्रतिलिपि रिपोर्ट/रिपोर्टों, प्रत्येक की एक प्रतिलिपि/दो प्रतिलिपियों सहित निम्नलिखित को अग्रसारित :

अ- सामान्य वितरण सूची :-

1- महानिदेशक, भारतीय भूवैज्ञानिक सर्वेक्षण, 27 जवाहर लाल नेहरू रोड, कलकत्ता-16 (एक प्रतिलिपि)
2- प्रभारी निदेशक, परिचालन भूतकनीकी एवं विशिष्ठ अनुसंधान, भारतीय भूवैज्ञानिक सर्वेक्षण, उत्तरी क्षेत्र, लखनऊ । (एक प्रतिलिपि)
3- प्रभारी निदेशक, प्रचालन उत्तर प्रदेश, उत्तरी क्षेत्र, भारतीय भूवैज्ञानिक सर्वेक्षण, लखनऊ (एक प्रतिलिपि)
4- निदेशक, अभियांत्रिक भूविज्ञान प्रभाग-1, भारतीय भूवैज्ञानिक सर्वेक्षण, उत्तरी क्षेत्र, लखनऊ (एक प्रतिलिपि)
5- निदेशक, अभियांत्रिक भूविज्ञान प्रभाग-2, भारतीय भूवैज्ञानिक सर्वेक्षण, उत्तरीक्षेत्र, लखनऊ । (एक प्रतिलिपि)
6- निदेशक, अभियांत्रिक भूविज्ञान प्रभाग-4, भारतीय भूवैज्ञानिक सर्वेक्षण, 159, वसंत विहार, देहरादून- 248001। (एक प्रतिलिपि)
7- निदेशक, भूस्खलन एवं भूकम्पविवर्तनिक प्रभाग, भारतीय भूवैज्ञानिक सर्वेक्षण, उ0ख0, लखनऊ (एक प्रतिलिपि)

....2/-

8- पुस्तकालयाध्यक्ष, केन्द्रीय पुस्तकालय, भारतीय भूवैज्ञानिक सर्वेक्षण, 27, जवाहर लाल नेहरू रोड, कलकत्ता-16 [दो प्रतिलिपियां]

9- पुस्तकालयाध्यक्ष, क्षेत्रीय पुस्तकालय, उत्तरी क्षेत्र, भारतीय भूवैज्ञानिक सर्वेक्षण, लखनऊ [दो प्रतिलिपियां]

10- पुस्तकालयाध्यक्ष, क्षेत्रीय पुस्तकालय पश्चिमी क्षेत्र, भारतीय भूवैज्ञानिक सर्वेक्षण, ए/3, सवाई जयसिंह रोड, जयपुर- 302006 [दो प्रतिलिपि]

11- पुस्तकालयाध्यक्ष, क्षेत्रीय पुस्तकालय, पूर्वी क्षेत्र, भारतीय भूवैज्ञानिक सर्वेक्षण, 12 एण्ड बी0, रसेल स्ट्रीट, कलकत्ता- 71 [दो प्रतिलिपियां]

12- पुस्तकालयाध्यक्ष, क्षेत्रीय पुस्तकालय, दक्षिणी क्षेत्र, भारतीय भूवैज्ञानिक सर्वेक्षण, बाडलागुडा कम्प्लेक्स, मंसुराबाद, बी0पी0ओ0, हैदराबाद- 500660 [दो प्रतिलि

13- पुस्तकालयाध्यक्ष, क्षेत्रीय पुस्तकालय, पूर्वोत्तर क्षेत्र, भारतीय भूवैज्ञानिक सर्वेक्षण, आशाकुटीर, लेतुमरवाह, शिलांग-793003, [दो प्रतिलिपियां]

14- पुस्तकालयाध्यक्ष, क्षेत्रीय पुस्तकालय, मध्यक्षेत्र, भारतीय भूवैज्ञानिक सर्वेक्षण, न्यूकम्प्लेक्स, नागपुर-440006, [दो प्रतिलिपि]

बo विशेष वितरण सूची- परियोजना अधिकारी एवं रिपोर्ट लेखक :- प्रत्येक को एक प्रति

15- प्रमुख अभियन्ता, सिंचाई विभाग (उ0प्र0), कैनाल कालोनी, [illegible]

16- मुख्य अभियन्ता (परिकल्प), सिंचाई परिकल्प संस्था रुड़की, उ0प्र0.

17- मुख्य अभियन्ता (उत्तर), सिंचाई विभाग, हल्द्वानी

18- अधोक्षण अभियन्ता, जामरानी बाँध निर्माण मंडल, डमुवा दूंगा, काठगोदाम

19- अधिशासी अभियन्ता, जामरानी बाँध निर्माण खंड डमुवा दूंगा, काठगोदाम

20- श्री जी0 के0 शर्मा, भूवैज्ञानिक, जामरानी बाँध कार्य डमुवा दूंगा, काठगोदाम (रिपोर्ट लेखक)

(विनोद कुमार)
कृते निदेशक
अभियांत्रिक भूविज्ञान प्रभाग-3

रिपोर्ट/रिपोर्टों का विवरण

वार्षिक कार्यक्रम 1988-89

A report on the pre-construction stage geological investigations of Jamrani dam project, river Gola district Nainital, U.P (with eight plates) by Vinod K. Sharma, G.S.I. (August 1990)

GEOLOGICAL SURVEY OF INDIA
NORTHERN REGION
ENGINEERING GEOLOGY DIVISION-3

(Annual Programme 1988-89)

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APPENLICES

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I. INTRODUCTION

The Jamrani dam project envisages the construction of a 130.6m high, roller compacted concrete dam, with a central Ogee spillway of 3630M^3/Sec capacity, on river Gola near village Jamrani (29°16'00"; 79°36'36"; 530/11), about 10km upstream of Kathgodam barrage in district Nainital, U.P. On completion, the dam would impound a reservoir of 208.6x10^6m^3 capacity. The installation of a hydel power station, of 15 MW capacity, downstream of the dam, is also uncer consideration.

2. The Bhabar belt of district Nainital has limited ground water potential and the Gola river is the only available source of water for agriculture, drinking and industrial purposes. The lean season flow of the river Gola is barely sufficient to meet the present drinking water need of the area. During the summer months, the area faces acute shortage of water which may become worse in the years to come. Therefore, the project, a vital requirement of the area, envisages storage of the monsoon discharge of the river Gola for providing assured supplies for irrigation and drinking purposes in Bhabar and part of Tarai, lying in Nainital, Bareilly and Rampur districts.

3. Geological investigations for the project were commenced in 1973 and various sites and proposals for the type of dam were considered. The Planning Commission had earlier approved the construction of a rockfill dam with an upstream concrete membrane at the Jamrani site. But, in October 1984, the Board of Consultants for the project favoured a roller compactec concrete dam at the site, which is now technically cleared by the Central Water Commission.

4. During the field season 1988-89, the geological investigations of the project were continued in pursuance of item No.EG/530/NR/UP/73/73 of the approved field Annual Programme of the Geological Survey of India, Northern Region, Lucknow. During the period under report,

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Abstract

It is proposed to construct a 130.60m high dam across river Gola, mainly for irrigation, drinking water needs f generating about 15 MW of power. The rocks occurring aroun the dam site are mainly sandstone, claystone/clayshale, siltstoneand pseudoconglomerate of Lower Siwalik Formati Farther towards north of the site, these rocks lie in juxtaposition with basic rocks and granite along the Main Boundary Fault (MBF). Detailed geological mapping of the fault zone near Amritpur (29°17'46"; 79°33'56"; 53O/11) was carried out to study the nature of the contact.

In the dam site area, exploratory drilling to evaluate the foundation conditions are in progress. The result of exploratory data reveal that the depth of bed rock in the river section is in the range of 11-21m. The bed rock encountered include fine to medium-grained sandstone (havin low strength) and bands of claysbale and siltstone. Differential thermal analysis and X-ray analysis for determination of mineral constituents of the various clayshale/ claystone bands have been carried out. A brief account of the possibilities of Reservoir Induced Seismicit (RIS) has been furnished in the report.

the author devoted 115 days for field work in the project area. The total quantum of work accomplished during the period includes detailed geological logging of drill holes aggregating to 292m in length. and geological mapping of 0.057 sq.km. area on 1:500 scale.

5. Shri L.P. Lhoundial, Director General, Geological Survey of India visited the Jamrani dam site on 5.9.88 after his visit to Nainital in connection with a seminar on "Issue of drinking water in Hill Region". Shri Lhoundial evinced keen interest in the geological set up of the project. The author explained to him the regional tectonic set up, geology of the dam site and likely foundation problems of the project site. The DG, GSI advised the author to take up detailed studies along the Main Boundary Fault zone, including petrographic examination of the rocks in the contact together with the studies of sedimentary structures around the project area. The studies were taken up as desired and are discussed in this report.

6. The geological investigations were carried out and the writing up of the report has been accomplished under the guidance of Shri G. Pant, Director, Engineering Geology Division-3, Geological Survey of India, Northern Region, Lucknow. Shri Pant inspected the geological work in progress at the dam site on 17.4.89 and 21.7.89.

II. REGIONAL GEOLOGY

7. The regional geology of the project area is already discussed in the previous reports on the project and, therefore, not being repeated in this report. However, briefly stated, the Jamrani dam site is located on the Lower Siwalik sandstone-siltstone-claystone sequence which is truncated by the Main Boundary Fault (MBF) towards north and is bound by the Bhabar talus fans towards the south. The Amritpur granite, which is generally greyish, medium to coarse grained, locally grading into quartz porphyry, occurs towards north of the MBF.

8. In the Jamrani Project area the MBF, which is a majo tectonic feature of the Himalaya, trends WNW-ESE and dip steeply towards NE direction. Many Geologists believe that the Fault is reactivated in geologically recent tim In the western part of Kumaon Himalaya neotectonic activ along the MBF has been noted by Krishnaswamy et al (1970) and Jalote**(1966). Valdiya*** et al(1984) observed some geomorphic developments in the Balia nala, indicative of neotectonic activity along the fault in that nala section In view of the foregoing, it is recommended that geodetic precision levelling across the MBF may be initiated to mo the movement along it, if any. The geodetic precision levelling is normally conducted by the Survey of India, Dehradun who could be contacted for further necessary acti in the matter.

III. GEOLOGY ALONG THE MAIN BOUNDARY FAULT

9. The main boundary fault (M.B.F.) is exposed about 3.5km upstream of the Jamrani dam site in the reservoir area and about 8km downstream of the site, near Amritpur village ($29^{\circ}17'46"$; $79^{\circ}33'56"$; 530/11). Detailed geological mapping of the M.B.F. zone, near Amritpur village was carried out on 1:500 scale, covering 0.0157 sq.km. area (Plate-II) to evaluate the nature of the fault in detail. Near the village basic rock, phyllite, quartzite and grey-coloured medium to coarse grained granite (Amritpur Granite) lie in juxtaposition with alternate sequence of sandstone, clayshale siltstone, and pseudoconglomerate of (Lower Siwalik along the Main Boundary Fault.

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*Krishnaswamy, V.S. et al (1970): "Recent Crustal movement in northwest Himalaya and Gangetic foredeep and related pattern of seismicity." Proc.4th. Symp. Earthquake Engineering, Roorkee University, Roorkee.

**Jalote, P.M.(1966): "Some observations on recent movements along Krol thrust, Rajpur, Dehradun. Proc 3rd Symp. Earthquake Engineering, Roorkee University, Roorkee.

***Valdiya, K.S. et al (1984): "Geomprphic Development across the active boundary thrust, an example from Nainital hills in Kumaon Himalaya, Joul. Geol. Soc. India V(25) 12, 1984.

10. The general trend of the Siwalik rocks near the Fault is N75°E-S75°W and they dip about 75° towards NW. The Siwalik sandstone, exposed near the thrust zone is mainly medium to coarse-grained, having accessory mineral assemblage of muscovite, garnet, tourmaline and biotite, showing preferred orientation parallel to bedding. Various sedimentary structures, such as current bedding, graded bedding are at places, displaced by a set of minor faults transverse to the MBF. These faults trend mainly in N20°-30°E direction and dip 60°-80° towards NE. The Lower Siwalik rocks at the location are followed by a zone of sheared quartzite (with manifestations of iron leaching in about 10-15m wide zone), lenses of quartzite (vein quartz) within highly pulverised schists phyllite, basic rocks (?) and granite. In the area covered by the mapping the following sequence of lithounits is encountered (Plate-II).

North

Amritpur Granite	Coarse-grained granite, Amphibolite(?) purple schist/ phyllite.	
Main Boundary Fault Zone	Sheared quartzite siltstone/clayshale	20-30m
Lower Siwalik Formation	Sandstone with elongated grains, claystone Medium-grained sandstone Clayshale (Chocolate/Red-coloured) Coarse-grained sandstone	

South

11. The thrust zone of 20-30m width is manifested by shearing, elongation of mineral grains in Siwalik, pulverised schist/phyllite and development of stretched lenses of vein quartz of Amritpur granite. Rock samples from within the Fault zone area, collected to study the microscopic features has been forwarded to the Petrology Division, GSI, NR, Lucknow and the results are still awaited.

IV. GEOLOGY OF THE DAM SITE

12. The dam site is located on the lower Siwalik rocks of the outer Himalaya, which are separated from the lesser Himalayan rocks, farther towards North by the Main Boundary Fault. Detailed geological mapping of the dam site area, on 1:1000 scale was carried out initially by Shri H.M. La during the field season 1976-77 and subsequently by Shri K. Anbalagan during 1981-84 and 1985-86 (Plate-III). The mapping has revealed that the dam site area is occupied by an alternate sequence of sandstone, siltstone clayshale. The sandstone is generally grey to brown in colour, micaceous, fine to coarse-grained and occasionally friable due to poor cementation and sometimes calcarous. The clayshale exposed at the site is grey, brown and purple in colour and is generally weathered near the surface with many shrinkage cracks. The bands of micaceous siltst are generally dark grey, moderately hard and well cemented. The rocks exposed at the dam site generally strike NW-SE with dip of 30°-50° in north-east direction, i.e., upstrea

13. The rock exposures on the right bank at the dam site are more abundant than on the left bank which is largely covered by debris/thick vegetation with very scant outcrops. The continuity of bands of sandstone, siltstone and clayshale from one bank of the river to the other is not visible. In order to determine whether or not the bands of sandstone, siltstone and clayshale exposed on the right bank (Plate-III) match with those exposed on the left bank, theoritical traces of some selected clayshal bands A, B, C and D (Plate-III) were drawn and projected on the left bank. The projected trace of clayshale band 'A' fell on the slide debris and hence could not be correlated. The trace of band 'B' exposed on the right bank nearly corresponded to the clayshale band exposed in a gully section on the left bank. Similarly, the trace of the band 'C' also correspond to one clayshale band exposed on the left bank. Hence, the continuity of the rock bands is more

or less established, which points out that there is no lateral displacement of the bands along the course of river. Though, quite a few such bands could be traced/correlated on either banks but, due to lateral facies variations in the rocks, some other bands of claystone and siltstones tend to attenuate and could not be traced/correlated on the other bank.

14. In order to determine the mineral constituents present in various clayshale bands exposed at the dam site, the X-ray and Differential Thermal Analysis (D.T.A.) were carried out on ten samples of clayshales. The objective of the analysis was to ascertain whether or not expansive clays (such as montmorillonite) which because of their swelling properties, under saturation, are harmful are present in the clayshale bands. The samples from the clayshale bands (plate-III) were collected and the analysis was made by the Mineral Physics Division, Northern Region, Geological Survey of India, Lucknow. The results of the tests indicate presence of montomorillonite in three bands (II, III and IV) of claystone/clayshale. However, the mineral occurs only in trace amount and its presence in the dam foundation may not be significant. The complete report of the X-ray and D.T.A. is furnished in appendices III and IV of this report.

V. SUB-SURFACE EXPLORATIONS

15. Subsurface explorations at the dam site, for obtaining data on the various components of the project, proposed from time to time, were commenced in 1973. In all, 29 drill holes, ranging from 15.50m to 100m in depth and aggregating 1033m length have been completed upto the end of programme under report, i.e. 1988-89 (plate-III). A summarised account of the data obtained from the different holes, completed so far, is furnished in Appendix-II of this report. For further details of any particular hole, if required, the concerned report may be consulted.

16. In order to obtain further detailed information about the foundation-grade geology at the dam site, an elaborate programme of sub-surface explorations was chalked out during

during the field season 1987-88 (Anbalagan, 1987). A number of holes classified into category A, B and C were recommended priority-wise. During the period under report, four drill holes (Nos. A-30, 31, 34 and 35) of the exploratory programme were completed at the dam site. A brief account of these drill holes is given below and their detailed geological logs are furnished in plate VI to plate IX.

17. In the description of the drill holes, the term RQD (Rock quality designation), as defined by Deere (1968), is modified procedure for indicating core recovery/quality of rock intersected in the holes. Pieces equal to or longer than 100 mm in length are counted and reported as percentage of the total run. The RQD ranges upto 25%, 25-50%, 50-75%, 75-90% and 90-100% correspond to very poor, poor, fair, good and excellent rock respectively.

The rock mass metwith in the drill hole(s) does not exhibit any visible sign of weathering. Only occassional limonitic staining along divisional planes is observed. Therefore, the bedrock intersected in the drill holes is designated as fresh. The bed rock permeability, determined by single/double packer method has been computed in terms of 'Lugeon' which is defined as the water loss in litres/meter/minute at pressure of 10kg/cm^2, maintained for 10 minutes. One lugeon corresponds approximately to a permeability of 10^{-5} cm/sec.

LH-30(A-4)

18. The hole was located at an elevation 687.54m on the right abutment along the dam axis. It was drilled down to a depth of 70m vertically. It encountered overburden down to 2.40m depth. Thereafter, Lower Siwalik sedimentary rocks comprising alternate bands of coarse, medium and fine-grain sandstone, claystone and siltstone of varying thickness were encountered. In general, the fine to medium-grained, well cemented, hard and compact sandstone constitutes about 43% of the total depth drilled. The maximum apparent thickness of the bands being 17m.

Coarse to very coarse sandstone/sandrock has poorly interlocked mineral grains and thus has low strength. This constitutes about 29% of the total depth of the hole. The siltstone and clayshale bands are grey or red in colour and vary in thickness from 30cm to 4.2m. Siltstone and clayshale bands together form about 23% of the total depth of the hole. These bands are generally soft and become plastic under saturated conditions. The percentage core recovery in the hole is generally between 70-90% but ranges from 20 to 100%. The RQD is generally fair (50-75%) to good (75-90%). It is, however, poor from 34-36m and 8.5 to 9m depth. This is mainly due to the presence of softer siltstone and clayshale bands. The bedrock permeability in the hole range from 1 to 41 lugeon (Plate-VI).

DH-31 (B-4)

19. The drill hole, located at an elevation of 635.34m in the river bed on the left flank, 25m downstream of the dam axis, was drilled vertically upto a depth of 71.15m and encountred overburden down to 20.10m depth. Thereafter, alternate bands of coarse sandstone/sandrock, medium to fine-grained sandstone, siltstone and clayshale of varying thickness were encountered. The coarse sandstone/ sandrock, which has low strength, together constitute 24.87%, while, well cemented and hard bands of fine to medium-grained sandstone constitute about 51% of the bedrock. The siltstone and clayshale bands are grey in colour and occur in small bands, ranging in thickness from 20cm to 3.30m. The siltstone and clayshale bands together form about 21% of the bedrock intersected in the hole (Plate-VII). The percentage core recovery in the rock ranges from 61 to 100% and generally is over 80-85%. In general, the RQD is poor (25-50%) to fair (50-75%). The bedrock permeability in the hole ranges from 1 to 25 lugeon.

LH-34 (B-2)

20. The drill hole was located at an elevation of 636.40m the left bank of the river, along the dam axis and was drilled vertically down to 70.75m depth. It encountered overburden material down to 12.75m depth and, thereafter, bands of coarse sandstone/sandrock, medium to fine-grained sandstone, siltstone/ and clayshale were encountered. The total percentage of hard compact, fine to medium-grain sandstone in the hole is 44.16% while that of softer bands of coarse sandstone/ sandrock, claystone and siltstone is 28.62%, and 20% and 7,5% respectively. The percentage core recovery in the hole, though ranging from 62% to 100%, in the rock section, is generally more than 90%. The RQD is generally fair (50-75%) to good (75-90%), but in some reaches, as between 12m to 16m, 58m to 61m and 67m to 70m, it is poor to very poor. The bedrock permeabili in the hole ranges from less than 1 to 33 lugeon (plate-VI

LH-35 (A-3)

21. The drill hole was located at an elevation of 638.19m in the riverbed on the left bank of the river along the dam axis. It was drilled vertically down to a depth of 70.50m. The overburden comprising river borne material was encountered in the hole from the surface down to 17.15m. Thereafter, the bed rock comprising bands of coarse sandstone/sandrock medium to fine sandstone, siltstone and clayshale was encountered. The fine to medium-grained sandstone is hard, well cemented and has good strength and constitute about 50% of rock section in the hole. The percentage of coarse sandstone/ sandrock is 24% while that of siltstone and clayshale put together is about 25%. The percentage core recovery is in general 70-95% but ranges from 7-97%. In one reach, between 51-54m, it is 7.3% and it may be due to presence of soft sandrock. The RQD in the holes varies between very poor (0-25%) to good (75-90%). The 'NIL' RQD obtained at places,

is attributed to shrinkage cracks in clayshale/siltstone. The bed rock permeability in the hole ranges from less than 1 to 5 lugeon (Plate-IX).

22. In the total length (282.40m) of drilling, accomplished so far in the holes described above, the percentage of well cemented, compact, fine to medium-grained sandstone ranges from 40-50% while coarse-grained sandrock and siltstone and clayshale constitute 25-30% and 8-20% respectively.

VI. TEST GROUTING

23. Result of the test grouting, carried out during the field season 1985-86 at the dam site on a plot of 3mx3m in square pattern has indicated, that the grout intake ranges from 10-33.3 kg/m. Stage-wise, the average grout intake was 14.6kg/m for 5-8m stage, 26.8kg/m for 8-11m stage. The efficacy of grouting was determined to be 96.5% and 53.4% in 8-11m stage and 11-14m stage, respectively.

24. However, as the test grouting carried out earlier is inadequate to arrive at a conclusive value, it is recommended that more grouting tests be conducted in a test plot, on sandstone unit, preferably within the dam seat area. A test plot 6mx6m in square pattern may be prepared and the inspection hole may be drilled at the centre of the square. Thereafter, pre and post-grouting permeability values may be determined in the inspection hole in different test stages to ascertain the efficacy of grouting/ cement intake/m etc. In case reduction of permeability is not obtained by the adopted spacing of the primary holes, the same may be reduced to 3m and so on to achieve the lugeon value within the limit considered permissible.

VII. RESERVOIR INDUCED SEISMICITY

25. The seismicity, associated with the impoundment of wa in large artificial reservoirs has been the focus of attention during the last few decades. This phenomenon is known as the "Reservoir Induced Seismicity" (RIS). Several scientists have attempted to correlate various factors with incidence of some earthquake as due to reservoir impoundment. Some of these factors are Reservoir water load, Pore pressure, Geological conditions, Backgrou seismicity Height of water level etc. However, a definite correlation of the factors has still not been firmly estab lished. To-day, if there are a few tens of dams exhibiting the phenomenon of RIS, there are hundreds others which have not shown any such thing. At the Jamrani dam project, the following factors seem to indicate that the RIS phenomenon may not be much of a significance.

26. In the Jamrani dam reservoir area, the sandstone, interbedded with clayshale and siltstone (Lower Siwalik) occupy a large area and dip upstream. Under deformation, such (plastic) rocks show settlement without producing vibrations.

27. The geological environment of the Jamrani dam is, thus, characterised by mainly plastic clayshale, siltstone and sandstone and may not materially alter the stress distribution subsequent to creation of the reservoir. It may be noted that the dams like Bhakra, Pong, Ramganga, constructed on similar rock types have not registered any RIS.

28. The background value of seismicity in the area and the height of water column of the proposed 130m high Jamrani dam is identical to that of several other executed projects in Himalayan terrain. The 225m high, straight gravity Bhakra dam on river Sutlej founded on lower Siwalik Sandstone, clayshale, siltstone sequence, which impounds a large reservoir, since 1962 has not shown any RIS.

Similarly, the 132m high Beas dam and 128m high Ramganga dam, both earth and rockfill, in operation since 1974, are founded on middle/upper Siwalik and middle Siwalik, respectively, have also not shown any RIS.

VIII. CONCLUSIONS AND RECOMMENDATIONS

29. The Jamrani Multipurpose dam project envisages the construction of a 130.60m high, roller-compacted concrete dam across river Gola in Nainital district, U.P. for irrigation and drinking water purposes and generation of 15 MW of power.

30. Rocks occurring at and around the dam site are coarse to fine-grained sandstone, interbedded with siltstone and clayshale, belonging to the Lower Siwalik Formation. The bedding in the rock generally strike NW-SE with 30°-50° dips in north-east direction, i.e. upstream which is a favourable disposition. The Siwalik formation lie in contact with Amritpur Granite exposed farther towards north of the dam site. The contact between the two rock types is marked by the Main Boundary Fault. Detailed geological mapping of the fault zone in Amritpur area has revealed that the contact is sheared, and elongation of mineral grains in Siwalik sandstone is evident at the contact.

31. A few workers have reported neotectonic activity along the Main Boundary Fault, farther towards west of the dam area. It is recommended that geodetic precission levelling across the trace of the MBF may be initiated in the area so that the activity, if any, could be monitored.

32. Continuity of some of the bands of cleyshale exposed at the dam site, on the right bank of the river has been established by theoritical completion of outcrop method. But, quite a few ofthe bands are not traceable across the river due to lateral facies variations. The D.T.A. and X-ray analyses were carried out for mineral constituents present in clayshale bands at the dam site. The presence of montmorillonite in traces determined in three bands only is consicered insignificant.

33. The exploratory drilling aggregating to 282.40m, completed in the dam site area during the period under report, reveal that the percentage of well-cemented, compact, fine to medium grained sandstone ranges from 40-50%, while the coarse-grained sandstone/sandrock and siltstone/clayshale constitute 25-30% and 8-20% respecti The RQD of the bedrock ranges from very poor to good and the permeability values are in the range between 1 t lugeon. The bedrock metwith in the drill hole is general fresh. No sign of weathering is recorded in the core except occasional limonitic leaching along joint planes.

34. It is recommended that test grouting may be conducte with a 6m square pattern and an inspection hole in the centre and the pre and post-grouting permeability be calculated. In case reduction in permeability is not recorded with the 6m spacing of the holes, the same may be reduced to obtain permeability values within the limit considered permissible.

35. A preliminary assessment indicate that the proposed reservoir may not show any significant incidence of the R.I.S. phenomenon.

ACKNOWLEDGEMENT

The author wishes to record his sincere thanks to the project authorities for the co-operation extended and facilities provided for carrying out the studies.

Sd/=

(VINOD K. SHARMA)

ENGINEERING GEOLOGY DIVISION-3,
GEOLOGICAL SURVEY OF INDIA,
B-BLOCK, SECTOR-E,
ALIGANJ, LUCKNOW.

Dated, 10th August 1990

APPENDIX-I

LIST OF UNPUBLISHED REPORT ON JAMRANI DAM PROJECT BY GSI

1. Dayal, H.M. (1973): A Geotechnical note on the Kanibagh and Jamrani Dam sites on Gola river, Nainital district U.P. (with five plates), F.S.1972-73.

2. Dayal, H.M. (1973): Second geotechnical note on the interpretations of drilling data, Jamrani dam site, Gola river, Nainital district, U.P. (with three plates), F.S.1972-73.

3. Arora, C.L. et al( ): Report on the gephysical investigations conducted at the proposed dam sites over river Gola at Amritpur, Jamrani and Bhuria district Nainital, U.P. (F.S.1972-73).

4. Dayal , H.M. (1974); Third geotechnical note on the proposed dam and the appurtenant structures sites and interpreation of drilling data, Jamrani dam site, Gola project, Nainital district, U.P. (with three plates), F.S.1973-74.

5. Dayal, 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. Dayal, 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. Dayal, 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 aalient 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 Division, NR,GSI.

Appendix - I (Contd.)

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 Kanibagh over river Gola, district Nainital, U.P. (F.S. 1979-80).

12. Iyer, K.V., Anbalagan, R, Sanwal, R.K. ( ): Geotechnical report on the Jamrani dam project, Gola river, Nainital district, U.P. (with eight plates), F.S.1980-81 to 1983-84.

13. Anbalagan, R. (1987); A report on the preconstruct stage geological investigations of the Jamrani dam project, river Gola, district Nainital U.P. (with plates), F.S.1985-86.

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

APPENDIX-II

JAMRANI DAM PROJECT

SUMMARY OF DRILL HOLE DATA

(COMPILED BY V.K. SHARMA F.S. 1989-90)

SL. NO.	DRILL HOLE NO.	ANGLE WITH HORIZONTAL	YEAR OF DRILLING	COLLAR ELEVATION (m)	LOCATION	DEPTH OF HOLE (m)	DEPTH OF OVERBURDEN (m)	DEPTH OF WEATHERING (m)	FRESH ROCK ELEVATION (m)	ROCK TYPE	RANGE OF PERMEABILITY (Lugeon)	WATER TABLE (m)	RANGE OF CORE RECOVERY (%)	DEPTH OF SHEARZONE	REMARKS	REPORT REFERANCE
1	DH-1	VERTICAL	1972-73	625·60	CENTRE OF RIVER, DAM AXIS	58·83	19·89	1·10	604·61	ALTERNATIVE SEQUENCE OF CLAYSTONE SILTSTONE AND SANDSTONE	3-4		25-98		DRILL HOLES IN RIVER BED AND ON THE ABUTMENTS	H.M. DAYAL F.S. 1972-73 (APRIL-1973)
2	DH-2	VERTICAL	1972-73	622·34	LEFT BANK OF RIVER, DAM AXIS	35·84	17·60	–	[illegible]	MEDIUM GRAINED MICACEOUS SANDSTONE	11-34	7·58	21-68			H.M. DAYAL F.S. 1972-73 (DECEMBER-1973)
3	DH-3	VERTICAL	1972-73	627·97	RIGHT BANK OF RIVER, DAM AXIS	35·43	5·18	–	623·79	FINE TO COARSE SANDSTONE WITH GREY CLAYSTONE, BROWN/GREY CLAYSTONE AND SILTSTONE	11-18	3·40	23-67			
4	DH-4	VERTICAL	1973-74	672·64	RIGHT ABUTMENT	58·09	4·57	–	668·07	FINE TO COARSE SANDSTONE WITH BANDS OF CLAYSTONE AND SILTSTONE		–	20-90	BETWEEN 23·15 m AND 30·26 m	DH-4 & 5 BEING LOCATED VERY CLOSE TO THE HILL SLOPE, THE DEPTH OF WEATHERING CAN NOT BE TAKEN AS REPRESENTATIVE	H.M. DAYAL F.S. 1973-74 (JANUARY-1974)
5	DH-5	VERTICAL	1973-74	674·14	LEFT ABUTMENT	45·72	3·64	9·15	661·[illegible]	MEDIUM TO COARSE SANDSTONE WITH OCCASIONAL CLAYSTONE (3·45m & 13·4m) AND SILTSTONE		–	33-95			
6	DH-6	VERTICAL	1974-75	[illegible]	RIVER BED, NEAR TOE OF LEFT BANK SLIDE	55·10	19·81	8·63	607·24	BROWN CLAYSTONE, SANDSTONE AND GREY PSEUDO-CONGLOMERATE		–	45-100			
7	DH-7	VERTICAL	1974-75	[illegible]	NEAR INLET PORTAL DIVERSION TUNNEL	48·46	–	21·33	648·98	SANDSTONE, GREY CLAYSTONE AND SILTSTONE PSEUDO-CONGLOMERATE		–	19-100			
8	DH-8	VERTICAL	1974-75	437·05	CENTRE OF RIVER BED, 200 m. UPSTREAM OF DAM AXIS	51·50	20·40	10·10	606·35	SANDSTONE, CLAYSTONE AND SILTSTONE		–	28-91		AT EARLIER PROPOSED CONCRETE MEMBRANE DAM	H.M. DAYAL F.S. 1974-75 (FEBRUARY-1976)
9	DH-9	VERTICAL	1974-75	638·62	LEFT BANK, ABOUT 200m UPSTREAM OF DAM AXIS	99·00	25·10	1·09	611·41	SANDSTONE, BROWN CLAYSTONE AND SILTSTONE		–	4-54			
10	DH-10	VERTICAL	1974-75	636·25	RIGHT BANK, 200 m. UPSTREAM OF DAM AXIS	99·41	13·74	–	622·51	SANDSTONE 48%, CLAYSTONE 11% AND SILTSTONE 41%		–	27-91	BETWEEN R.L. [illegible] m AND [illegible] m		
11	DH-11															
12	DH-12	VERTICAL	1974-75	[illegible]	LEFT BANK NEAR OF SPILLWAY WEIR 200 m. UPSTREAM OF DAM AXIS	88·50	–	6·27	604·00	SANDSTONE [illegible], CLAYSTONE [illegible] AND SILTSTONE [illegible]		–	2-84	BETWEEN R.L. 633·77-631·69 m		
13	DH-13	VERTICAL	1974-75	711·65	LEFT BANK SLIDE, CLOSE TO RIGHT PERIPHERY, 90 m DOWNSTREAM, DAM AXIS	100·00	13·50	28·50	669·65	SANDSTONE [illegible], CLAYSTONE [illegible] AND SILTSTONE [illegible]		–	8-100	BETWEEN [illegible]		
14	DH-14	VERTICAL	1976-77	727·50	TUNNEL ALIGNMENT AND SLIDE ZONE 150 m DOWNSTREAM OF DAM AXIS	51·00	–	7·50	720·00	SANDSTONE, SILTSTONE AND CLAYSTONE		–	–		AT PROPOSED TUNNEL ALIGNMENT	H.M. DAYAL F.S. 1976-77 (MARCH-1977)
15	DH-15															
16	DH-16															
17	DH-17															
18	DH-18	VERTICAL	1976-77		INLET PORTAL, DIVERSION TUNNEL	64·00	–	1·88		SANDSTONE, SILTSTONE AND CLAYSTONE		–	–		AT PROPOSED TUNNEL ALIGNMENT	
19	DH-19															
20	DH-20	VERTICAL	1976-77	[illegible]	LEFT BANK, 250 m DOWNSTREAM OF DAM AXIS	18·00	–	4·20	670·45	SANDSTONE, SILTSTONE AND CLAYSTONE		–	–		AT PROPOSED TUNNEL ALIGNMENT	
21	DH-21	VERTICAL	[illegible]	[illegible]	DAM AXIS, LEFT ABUTMENT	[illegible]	[illegible]	–	[illegible]	MEDIUM GRAINED SANDSTONE, CLAYSTONE AND SILTSTONE	<1-39	–	15·5-100		[illegible]	[illegible], R. ANBALAGAN, [illegible] F.S. 1980-81 TO 84
22	DH-22															
23	DH-23															
24	DH-24															
25	DH-25	VERTICAL	[illegible]	[illegible]	DAM AXIS, RIGHT ABUTMENT	[illegible]	1·60	–	[illegible]	MEDIUM GRAINED SANDSTONE, CLAYSTONE AND SILTSTONE	2-5	–	19·55-100			
26	DH-26	INCLINED [illegible]	[illegible]	[illegible]	MAIN BOUNDARY FAULT RIGHT OF GHURANI NALA	[illegible]	[illegible]	–	[illegible]	[illegible], CLAYSTONE AND SANDSTONE	8-10	–	[illegible]			R. ANBALAGAN F.S. 1985-86
27	DH-27	VERTICAL	1985-86	645·20	RIGHT BANK ROAD, 30 m UPSTREAM OF DAM AXIS	[illegible]	–	–	645·20	SANDSTONE [illegible], SILTSTONE 12·5 TO 13·5 m.		–	55-80		FOR PERFORMING GOODMAN'S JACK TESTS	
28	DH-28															
29	A-5/DH-29	VERTICAL	1987-88	[illegible]	LEFT BANK, DAM AXIS INFRONT OF DRIFT DL-1	10·50	1·25	5·00	[illegible]	SANDSTONE, SILTSTONE AND CLAYSTONE	<1-18	–	56-100			R. ANBALAGAN F.S. 1987-88
30	A-4/DH-30 (A)	VERTICAL	1988-89	687·54	RIGHT BANK, DAM AXIS INFRONT OF DRIFT DR-[illegible]	70·00	2·40	–	685·14	SANDSTONE, SILTSTONE AND CLAYSHALE	<1-18	[illegible]	20-100			V.K. SHARMA F.S. 1988-89
31	B-4/DH-31	VERTICAL	1988-89	635·34	LEFT BANK, RIVER BED	71·15	20·10	–	615·24	SANDSTONE (COARSE TO FINE), SILTSTONE AND CLAYSHALE	[illegible]	[illegible]	40-100			
32	B-5/DH-32															
33	A-2/DH-33															
34	B-2/DH-34	VERTICAL	[illegible]	[illegible]	DAM AXIS, RIVER BED	[illegible]	[illegible]	–	[illegible]	SANDSTONE (COARSE TO FINE), SILTSTONE AND CLAYSHALE	[illegible]	[illegible]	[illegible]			V.K. SHARMA F.S. 1989-90
35	A-3/DH-35	VERTICAL	[illegible]	[illegible]	DAM AXIS, RIVER BED	[illegible]	[illegible]	–	[illegible]	SANDSTONE (COARSE TO FINE), SILTSTONE AND CLAYSHALE	[illegible]	[illegible]	[illegible]			

DRG. NO. [illegible]

NOTE:
CLAYSTONE USED IN THE HOLES DRILLED EARLIER CORRESPONDS TO CLAYSHALE USED IN SUBSEQUENT HOLES.

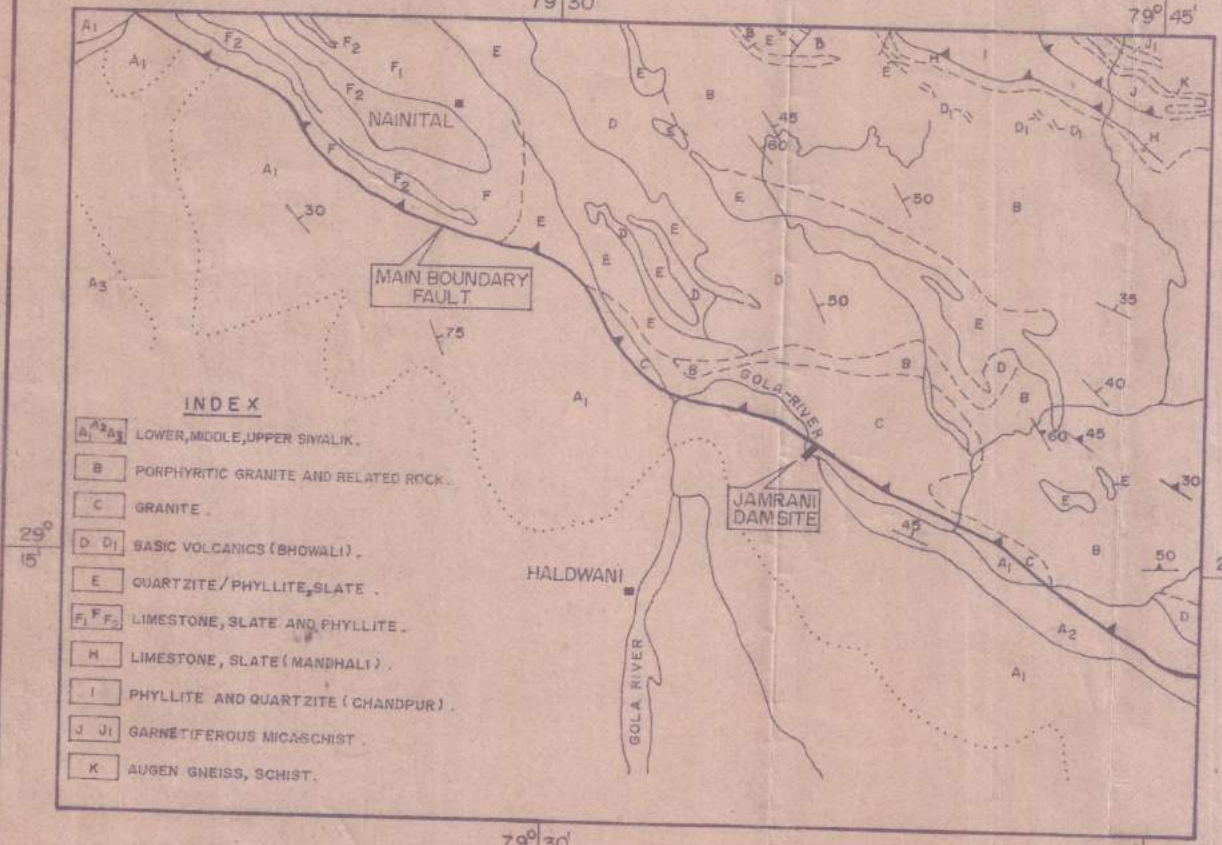
V.K. SHARMA
G.S.I.
F.S. 1989-90

Plate- I

JAMRANI DAM PROJECT
REGIONAL GEOLOGICAL PLAN AROUND THE DAM SITE

SCALE

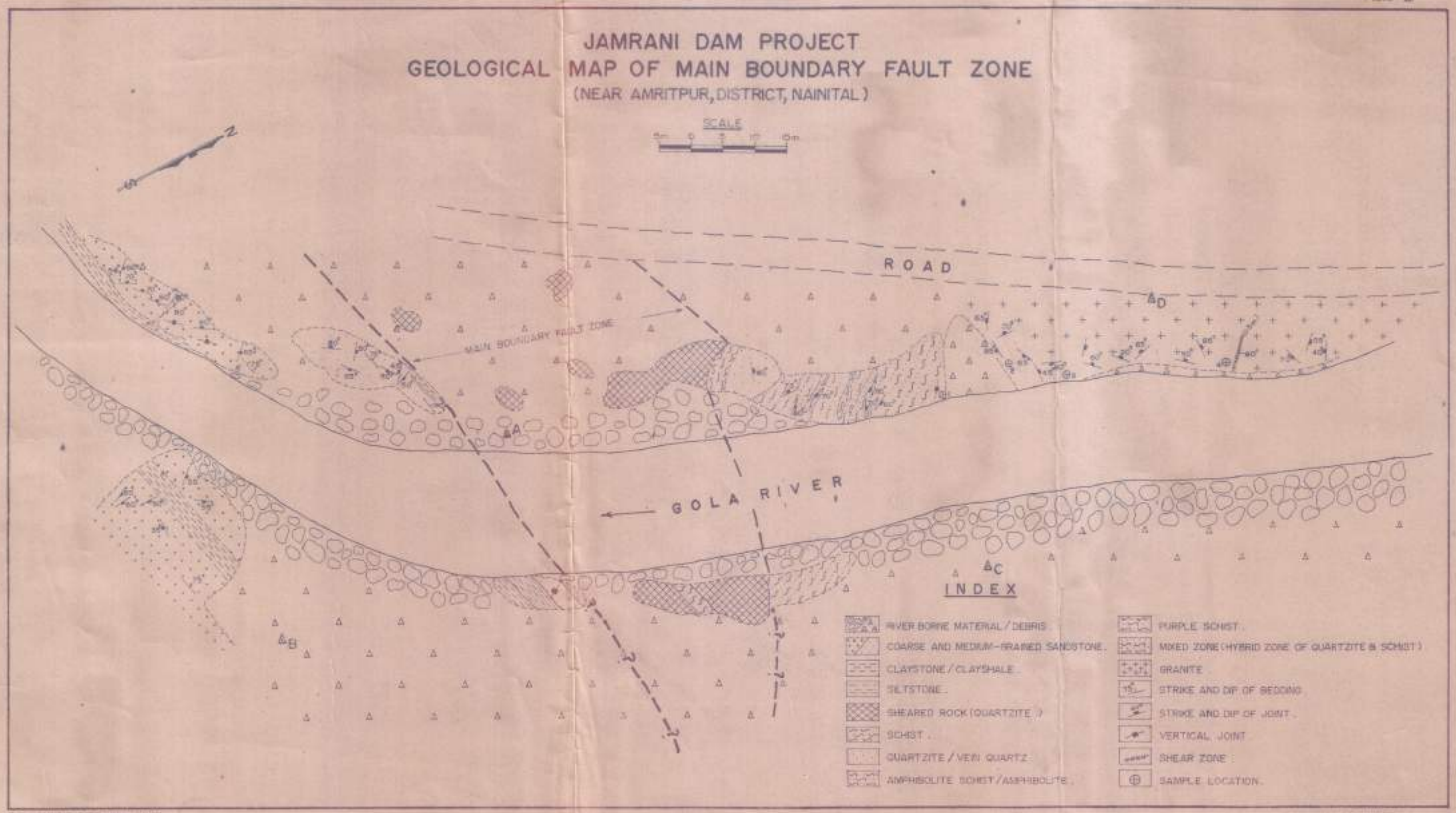
km 2·5 0 2·5 5 7·5 km.



G.S.I (NR) D.O. NO 15590-90.

V.K. SHARMA.
Geological Survey of India.
F.S. 1988-89.

JAMRANI DAM PROJECT
GEOLOGICAL MAP OF MAIN BOUNDARY FAULT ZONE
(NEAR AMRITPUR, DISTRICT, NAINITAL)



G.S.I. (NR) S.O. No 6569-90.

V.K. SHARMA
Geological Survey of India
F.S. 1988 - 89

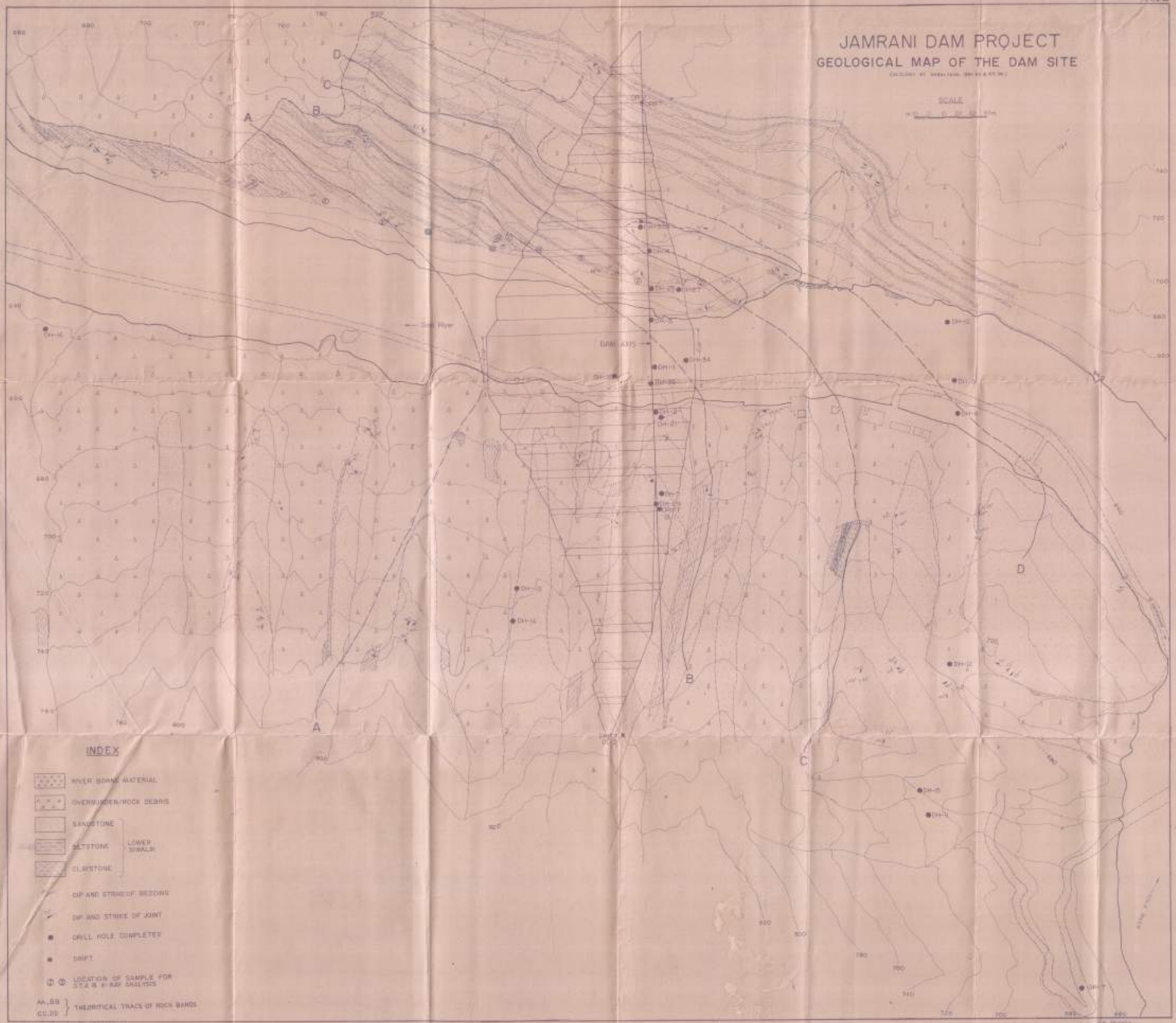
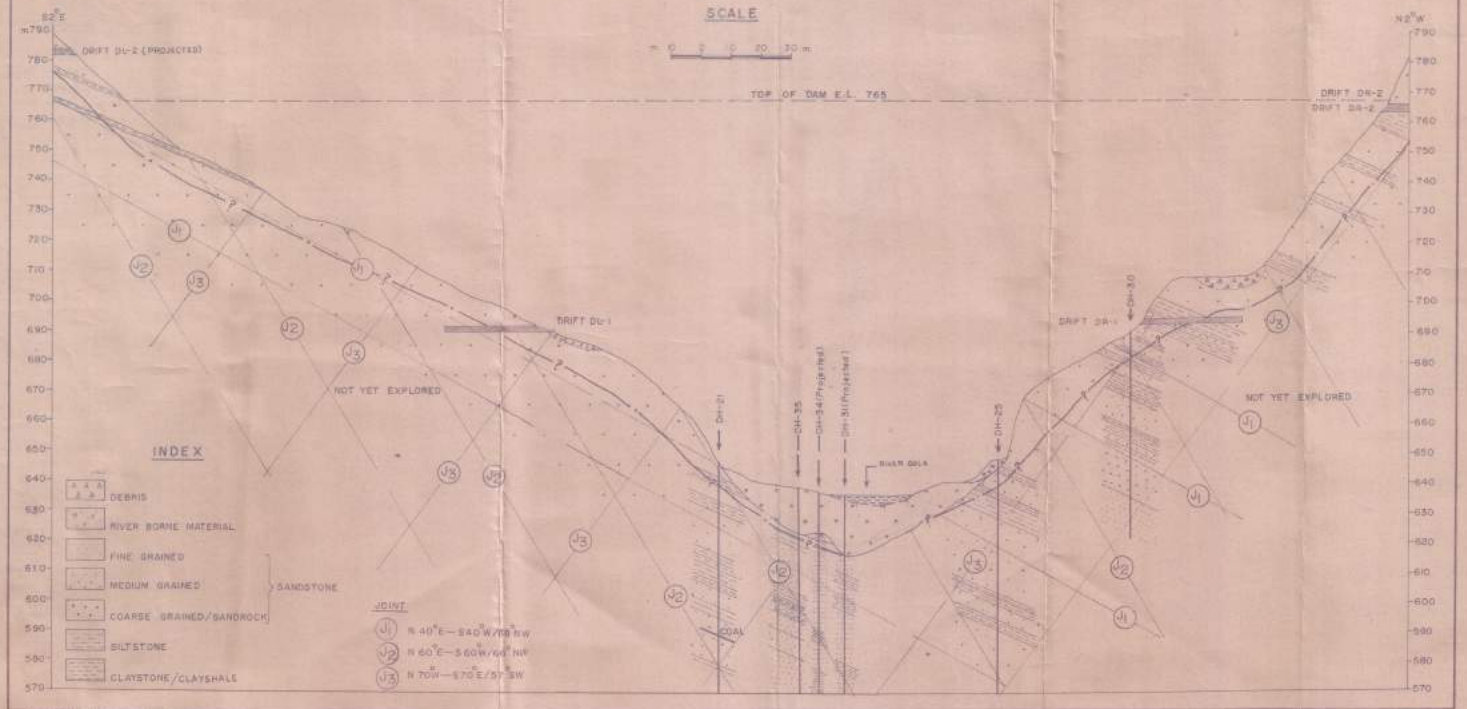

JAMRANI DAM PROJECT
GEOLOGICAL MAP OF THE DAM SITE
SCALE
INDEX
RIVER BORNE MATERIAL
OVERBURDEN/ROCK DEBRIS
SANDSTONE
SILTSTONE
CLAYSTONE
LOWER SIWALIK
DIP AND STRIKE OF BEDDING
DIP AND STRIKE OF JOINT
DRILL HOLE COMPLETED
DRIFT
LOCATION OF SAMPLE FOR ST & IS +825 ANALYSIS
AA,BB
CC,DD
THEORITICAL TRACE OF ROCK BANDS
A
B
C
D
DAM AXIS
Sirsi River

PLATE - II

JAMRANI DAM PROJECT

GEOLOGICAL SECTION ALONG THE DAM AXIS



G.S.I. IN-RI-DD-(561R-91 (PRASAD)

V.K SHARMA
G.S.I
F.S.1992-99

GEOLOGICAL LOG OF DRILL HOLE

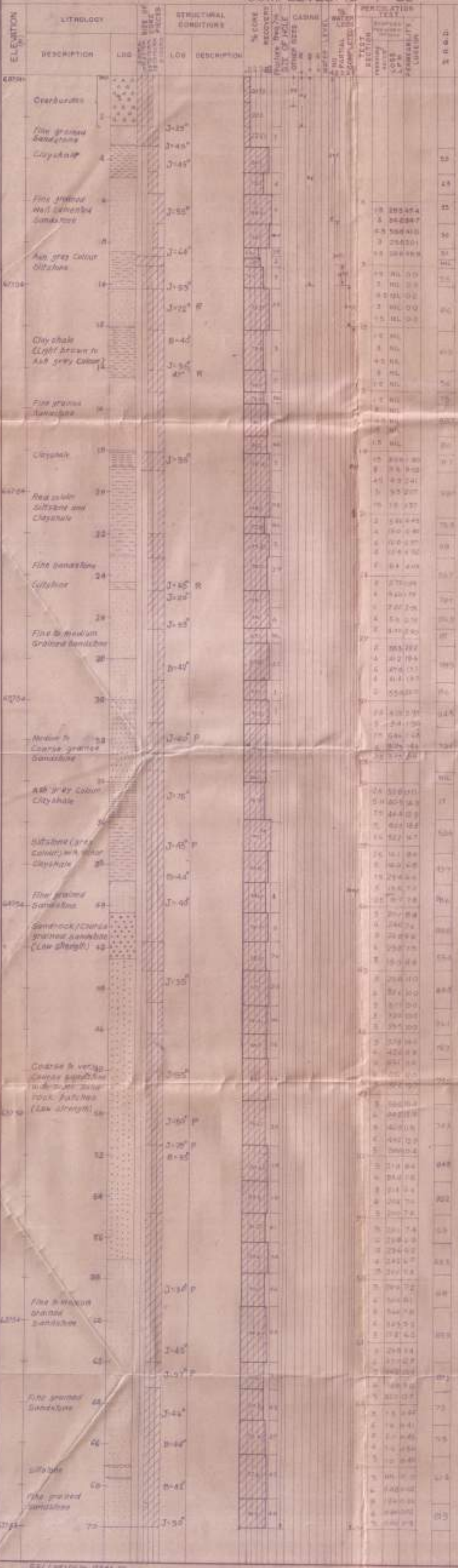
PROJECT: Jamrani dam project — HOLE No: DH-30(A-4)

STATE: Uttar pradesh — CO-ORDINATES: — BEARING OF HOLE:

FEATURES: Dam axis, right bank (In front of drift No DR-1) — COLLAR ELEVATION: 687.54 m. — ANGLE WITH HORIZONTAL: Vertical

GROUND ELEVATION: 687.535 m. — TOTAL DEPTH: 70 m

STARTED: 30-3-89 — COMPLETED: 18-4-89



SPECIAL OBSERVATIONS AND INTERPRETATIONS

OVERBURDEN 0-2.40m

The overburden extends from the surface down to the depth of 2.40m. it comprises debris/talus and scree material.

ROCK 2.40-70m

Lower Siwalik sedimentary rocks are encountered from 2.40m. down words comprising alternates bands of coarse, medium and fine grained Sandstone, Claystone/Clayshale and Siltstone of varying thickness.

Except for occasional limonitic staining Observed along divisional planes, The bedrock is fresh in the entire depth drilled.

In general, fine to medium-grained Sandstone is well cemented, hard and compact. it constitutes about 60% of the total rock section. The maximum thickness of bands being about 17 m.

Coarse to very coarse sandstone/Sandrock has poorly interlocked mineral grains and thus has low strength. This together Constitute about 10% of the rock section.

The siltstone and Claystone bands are grey to red in colour and vary in thickness from 30 cm to 4.2m. Siltstone and clayshale bands together form about 30% of the rock section. These bands are generally soft and becomes plastic under saturated conditions.

The percentage core recovery is good and range from 20% to 100% and generally between 70% to 90%.

The rock quality designation (RQD) is generally fair (50-75%) to good (75-90%). However in some segments it is poor to very poor (25-50%) as between 34-35m, 8.00 to 9.00m, Which is mainly due to the presence of softer siltstone and clayshale bands.

BED ROCK PERMEABILITY

The reported lugeon values from 9-27m depth are generally <5m. Below 27m depth, The reported lugeon values are generally between 5-9m (semi pervious). However, from 27-30m, 34-37m, 46-52m and 61-64m high permeability (>10 lugeon) is recorded.

J- Dip of joint
B- Dip of bedding
P- Planar
R- Rough

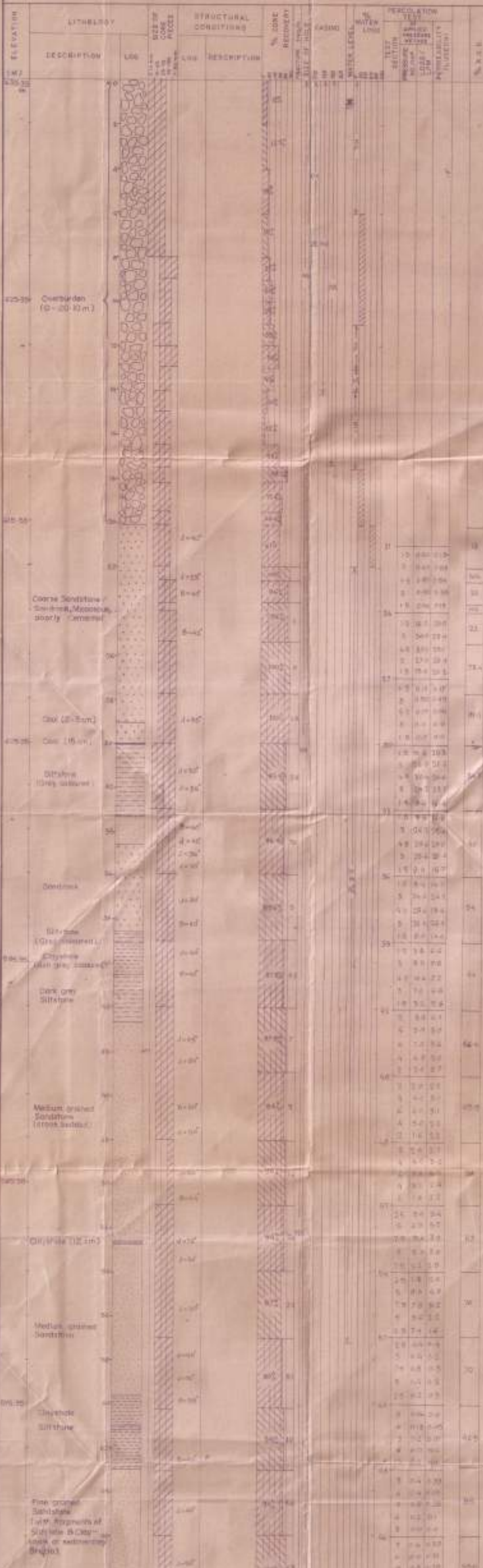
(V.K. SHARMA)
Geological Survey of India
(FS 1988-1989)

GEOLOGICAL LOG OF DRILL HOLE

PROJECT : Jamrani dam project
STATE : Uttar Pradesh
FEATURES : River bed upstream of dam axis in dam heel area
STARTED : 14-5-89

CO-ORDINATES
COLLAR ELEVATION 635·34 m
GROUND ELEVATION 635·16 m
COMPLETED 5-6-89

HOLE NO : DH-31 (B-4)
BEARING OF HOLE
ANGLE WITH HORIZONTAL : Vertical
TOTAL DEPTH : 71·15 m



SPECIAL OBSERVATIONS AND INTERPRETATIONS

OVERBURDEN (0-20·10m)

Overburden material comprising boulders of Quartzite, Phyllite, amphibolite, sandstone etc. extends from the surface down to the depth of 20·10m.

ROCK (20·10-71·15m)

Lower Siwalik sedimentary rocks are encountered from 20·10m downwards comprising alternate bands of coarse Sandstone / Sandrock, medium to fine grained Sandstone, Siltstone and Claystone of varying thickness.

No effect of weathering is observed and the rock is generally fresh.

The coarse Sandstone/Sandrock has low strength mainly due to poor interlocking of mineral grains. The maximum thickness of coarse Sandstone horizon is 8·8m.

The fine to medium grained Sandstone bands are well cemented, hard and constitute about 50% of the rock section met with in the hole.

The Siltstone and Claystone bands are grey in colour and occur as small bands ranging in thickness from 20 cm to 3·3 m. The Siltstone and Claystone are generally soft and becomes plastic under saturated conditions.

The percentage core recovery in rock range from 10 to 100% and generally over 80-85%. In general the rock quality designation (RQD) is generally poor (25-50%) to fair (50-75%).

BED ROCK PERMEABILITY

Water pressure test result indicate that the permeability values in general decrease with depth. [illegible] as the near surface region range is 6-25 lugeon. The permeability values decrease to 1-3 lugeon below 42 m.

J=JOINT WITH AMOUNT OF DIP
B=BEDDING WITH AMOUNT OF DIP
P=PLANAR

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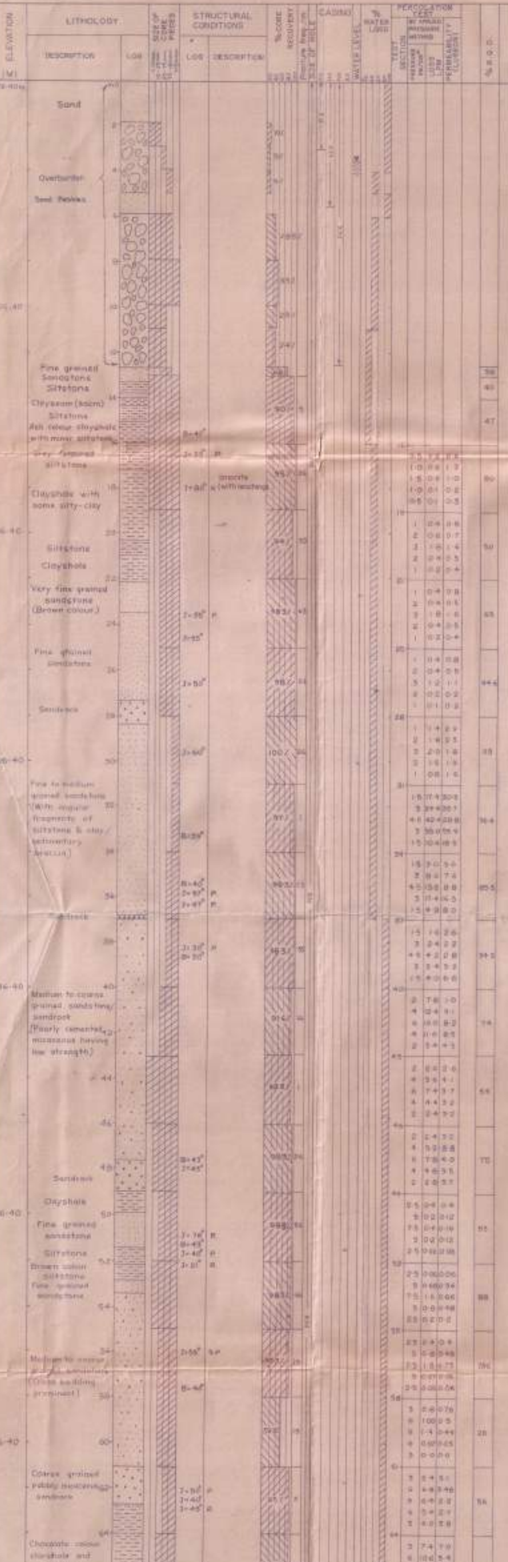
Geological Survey of India
F.S. 1988-89

GEOLOGICAL LOG OF DRILL HOLE.

PROJECT. Jamrani dam project		HOLE NO. DH-34(B-2)
STATE. Uttar Pradesh	CO-ORDINATES.	BEARING OF HOLE.
FEATURES. Dam site (left bank, river bed, downstream of dam axis).	COLLAR ELEVATION. 636·40m	ANGLE WITH HORIZONTAL. Vertical
STARTED. 8-6-89.	COMPLETED. 1-7-89.	TOTAL DEPTH. 70·75m


ELEVATION (M)
LITHOLOGY
DESCRIPTION
LOG
STRUCTURAL CONDITIONS
% CORE RECOVERY
CASING
WATER LEVEL
% WATER LOSS
PERCOLATION TEST
TEST SECTION
PERMEABILITY (LUGEON)
% R.Q.D.
Sand
Overburden
Sand Pebbles
Fine grained Sandstone
Siltstone
Clayseam (80cm)
Siltstone
Ash colour clayshale with minor siltstone
Grey coloured siltstone
Clayshale with some silty-clay
Siltstone
Clayshale
Very fine grained sandstone (Brown colour)
Fine grained sandstone
Sandrock
Fine to medium grained sandstone (With angular fragments of siltstone & clay / sedimentary breccia)
Sandrock
Medium to coarse grained sandstone / sandrock (Poorly cemented, micaceous having low strength)
Sandrock
Clayshale
Fine grained sandstone
Siltstone
Brown colour siltstone
Fine grained sandstone
Medium to coarse grained sandstone (Cross bedding prominent)
Coarse grained pebbly micaceous sandrock
Chocolate colour clayshale and siltstone
Medium grained sandstone

SPECIAL OBSERVATIONS AND INTERPRETATIONS

OVERBURDEN 0–12·75m

River borne material (RBM) comprising boulders and pebbles of Quartzite, Granite, Phyllite, basic rock, Sandstone and pebbles of Sand encountered upto the depth of 12·75m.

ROCK 12·75–70·75m

The rocks encountered after 12·75m depth are Fine to Medium grained Sandstone, Sandrock / Coarse Sandstone and bands of Clayshale & Siltstone belonging to lower Siwalik formation. The bed rock is generally fresh as no sign of weathering is observed however limonitic staining along some joints at depth was recorded.

Fine to Medium grained Sandstone are hard, compact and well cemented occupying about 44% of the rock section in the hole, while friable / softer bands of Sandrock, Clayshale and Siltstone altogether constitute 56% of the rock section.

The percentage core recovery in rock is generally between 80–90% and Rock quality designation (R.Q.D.%) is generally fair (50–75%) to good (75–90%) but in some of the reaches as between 12–16m, 56–61m and 67–70m stretch, it is poor to very poor.

BED ROCK PERMEABILITY

The water percolation test conducted at the depth ... and the permeability in general between 16–31m depth is ... lugeon and in 31–43m depth, it is between 4–9 lugeon and between 43–67m depth, it is ... lugeon. Two zones of high permeability (>10 lugeon) at 31–34m and 67–70m are interpreted. The lithology, % core recovery and the R.Q.D. are not in conformity with the presence of high permeable zone, hence it is recommended to further confirm the permeability in these zone with 1.5m test section interval to locate the permeable zone.

J = JOINT WITH AMOUNT OF DIP
B = BEDDING WITH AMOUNT OF DIP
R = ROUGH
P = PLANAR

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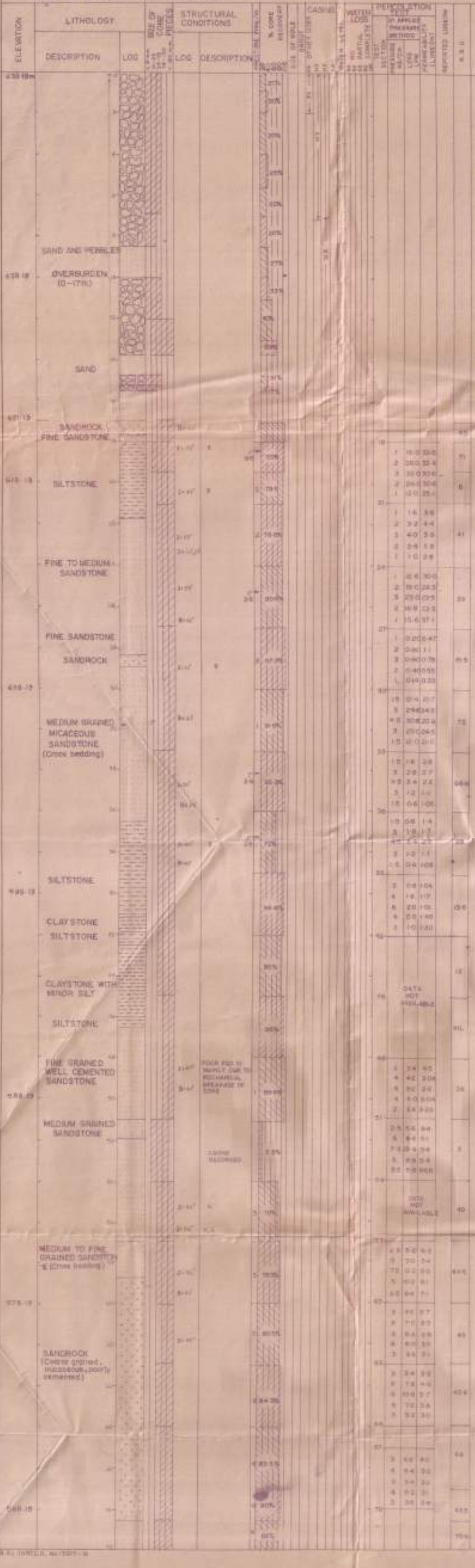
GEOLOGICAL LOG OF DRILL HOLE

PROJECT: Jamrani dam project
STATE: Uttar Pradesh
FEATURES: Left bank river bed along dam axis
STARTED: 9-6-1989
CO-ORDINATES:
COLLAR ELEVATION: 638.19
COMPLETED: 7-8-1990
ANGLE WITH HORIZONTAL: VERTICAL
HOLE NO.: A-3/DH-35
BEARING OF HOLE:
TOTAL DEPTH: 70m

TYPE OF BIT USED (WITH DEPTH):


ELEVATION
LITHOLOGY
DESCRIPTION
LOG
SIZE OF CORE PIECES
STRUCTURAL CONDITIONS
LOG
DESCRIPTION
% CORE RECOVERY
CASING
WATER LOSS
PERCOLATION TEST
REPORTED LUGEON
R.Q.D.
638.19m
SAND AND PEBBLES
OVERBURDEN (0-17m)
SAND
SANDROCK
FINE SANDSTONE
SILTSTONE
FINE TO MEDIUM SANDSTONE
FINE SANDSTONE
SANDROCK
MEDIUM GRAINED MICACEOUS SANDSTONE (Cross bedding)
SILTSTONE
CLAYSTONE
SILTSTONE
CLAYSTONE WITH MINOR SILT
SILTSTONE
FINE GRAINED WELL CEMENTED SANDSTONE
MEDIUM GRAINED SANDSTONE
MEDIUM TO FINE GRAINED SANDSTONE (Cross bedding)
SANDROCK (Coarse grained, micaceous, poorly cemented)
DATA NOT AVAILABLE
CORE NOT RECOVERED

SPECIAL OBSERVATIONS AND INTERPRETATIONS

OVERBURDEN (0-17m)

The overburden comprising fill material (river borne material) encountered from the surface down to 17.15m. The overburden is mostly boulders of quartzite, Phyllites, granite and sandstone etc. with few patches.

BED ROCK (17-70m)

The bedrock encountered in the drill hole comprises coarse-grained sandstone/sandrock, medium to fine grained micaceous sandstone and bands of clayshale and siltstone. In general, the fine to medium-grained sandstone is well cemented and the coarse-grained sandstone/sandrock is friable.

The bedrock encountered in the hole is generally fresh however limonitic leaching along joint planes is observed at many places.

Two horizons of siltstone/clayshale met within the hole have thickness of 3.6m (between 18m and 21.60m) and 10m (between 36.50m and 46.50m). The siltstone and clayshale are generally grey in colour and soft and have low strength. The percentage core recovery in the drill hole is in the range of 70-90%. Between 51m and 54m depth, the poor (7%) recovery may be attributed to some weakness/shear in the rock which is still not fully established.

The rock quality designation (RQD) is between very poor (0-25%) and good (75-90%).

BED ROCK PERMEABILITY

Data of 14 water percolation tests between 17m-70m indicate that the value of reported permeability ranges from 25 to [illegible] and, in general, the permeability value reduces below 32 m depth.

B - Dip of bedding
J - Dip of joint
P - Planar
R - Rough
S - Smooth

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