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Identification of Abiotic Edaphic Stressors of Deccan Trap at NIASM Site, Malegaon

A Geotechnical and Geological Study

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Cover Photos
Rose shaped Stilbites and green colour Heulandites (zeolites)

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1. Introduction

Geological formations have an important bearing on different types of abiotic stresses (Maurya and Vittal, 2011) and play an important role for the construction of reservoirs and buildings and therefore geological information makes the strong base for the geotechnical study for understanding and calculating the strength and safe bearing capacity of the foundation, which includes studying the nature and occurrence of the rocks, nature and frequency of flow activity, their mineralogical make up and alteration, if any.

To assess the subsoil strata from safe bearing capacity point of view, geotechnical investigation of soils and rocks using bore logs upto depth of 5m were carried out to reconstruct the past climate and the different types of stresses operating at the site. The bore log data were correlated with open pits upto the depth of 1-3 m to know the type of rock, their mineralogical make up and transformation to the soils vis-à-vis component responsible for abiotic stresses. Role of mineralogical assemblages particularly zeolite in developing different types of abiotic stresses has been established and well known in Vertisols of India (Bhattacharyya et al., 1999 and Pal et. al, 2006). The presence of Calcite also acts as soil modifiers as it releases Ca ions easily due to low hardness and solubility. Initiatives were taken at NIASM to document the extent of modification in soil properties by these modifiers. With this background information the present investigation was carried out which will add to our understanding the role of these minerals and materials from 1-5 m depth at the study site for further research work on these important issues. It will also provide an understanding the natural soil degradational process due to soil modifiers using field morphological and mineralogical associations on various edaphic stresses. Study will also be useful for its application on similar terrains exposed elsewhere.

2. Location and Access

Site is located between 18°09'18.86'N to 74°30'01.33'E at Malegaon Khurd, Baramati in Pune District of Maharashtra State in the semi-arid tract of the plains of Western Ghats with the elevation varying from 547-565 m MSL. It is well connected by road with major cities in the state and also by Central Rail Network to Pune via Daund Junction (Fig. 1a).

3. Methodology

Methodology used in present study has been divided in two parts. First part deals with the study of open pits, horizon characteristics and mineralogical assemblages in different watersheds. Second part constitutes the geotechnical aspects which deal mainly engineering properties of the rocks and soils using drill core dominantly in the upper reaches of the watershed.

Drilling and sampling of seventeen boreholes in soil and rock was carried out on the upper reaches of watershed using rotary drilling rig. Borehole in soil was advanced using rotary drilling method, while NX size double tube core barrel with diamond bit was used to drill in rock. Water was circulated to cool the drilling the bit. Ground water table was recorded after 24 hours of completion of drilling. On completion of drilling, soil samples were packed in plastic containers with proper identification tags. Rock cores were numbered and kept in core boxes.

Besides bore log, samples were also collected from the mini pits (GP 2-12) as well as from master pit (GP 1) at different intervals and are marked on map (Fig.1b).In addition to above, a drilling bore upto the depth of 385ft was also conducted to locate the nature of flow activity in the site.

Representative soil and rock samples of Bore Logs were analysed for their various geotechnical properties using standard procedures. Chemical analysis of soil and water of few representative samples were carried out as per established laboratory techniques. Nature of bore logs with mineralogical composition were studied and described as per standard norms.

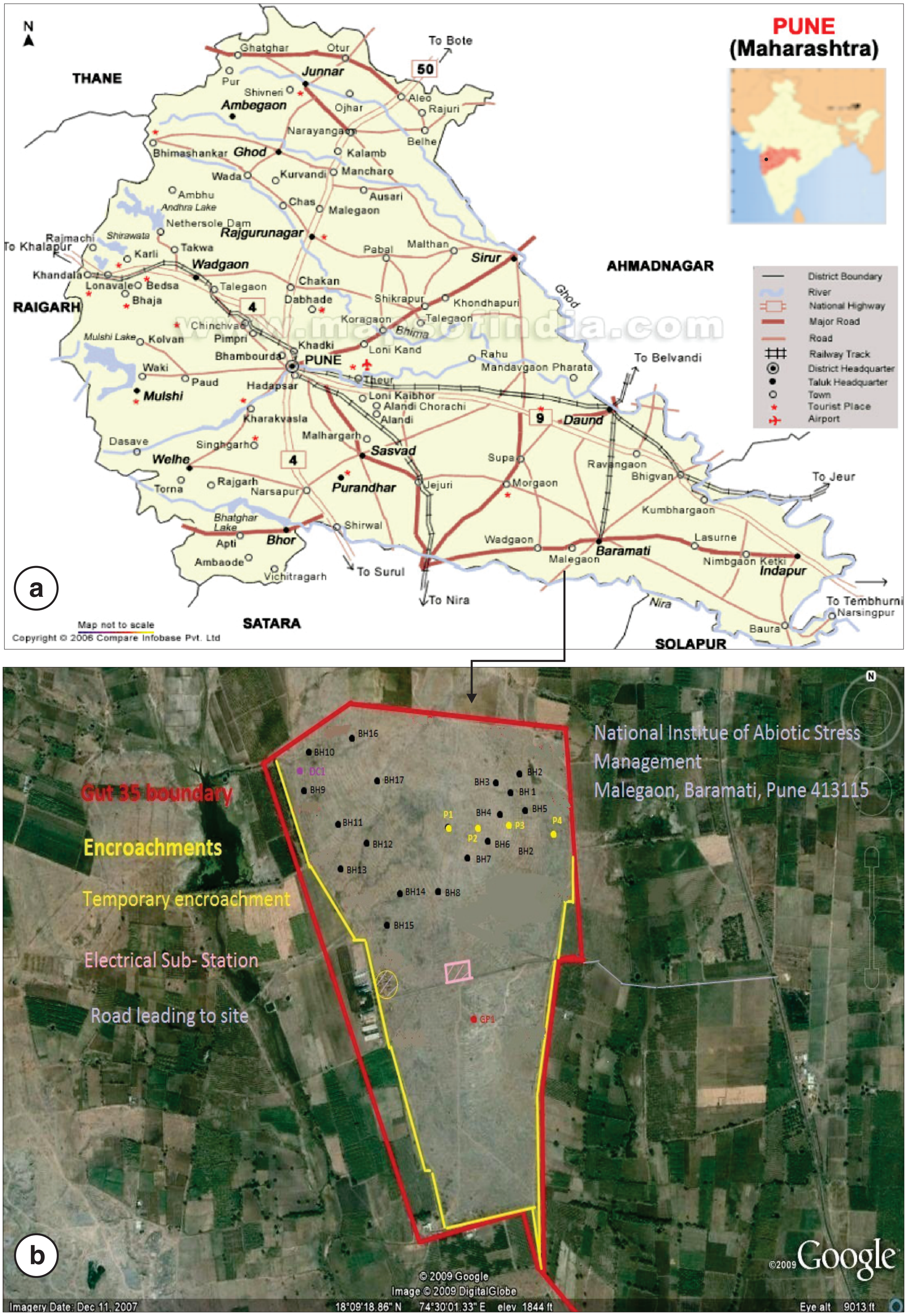

Fig.1. (a) Location of Baramati in Pune District and (b) Google Map of the NIASM site showing the location of the Bore Hole (BH1-17), Geological Profile (GP1-13) and Soil Profile (P1-4), Drill Core (DC-1)

4. Results and Discussion

4.1 Field Study

4.1.1 Profile Observation

Area is a subdued Deccan Trap basaltic plateau (Fig.2)

Fig. 2 A panoramic view of NIASM site showing dendritic drainage pattern

Field morphological observations on master profile of vesicular flows upto depth of 2.5 m with 9 horizons of varying thickness has been studied on the lower contour heights besides several mini pits of 1-2 m deep on the site of bore hole. The details of information on mini pits with respect to their geology, mineralogy and location are given in Geology of NIASM Site (Maurya and Vittal, 2011). A perusal of profile (Fig. 3) indicates that there are three flows, of which lower two are of same magmatic composition and a thickness of 1m each and are separated by intertrappeans (Fig. 4), an indicator of the climate change, which are converted to paleosols, while the upper flow consists of diverse mineralogical and lithological composition with variable thickness and morphological makeup. Soil thickness of the profiles is variable and transported in nature. Below this layer is a highly weathered vesicular basalt with full of discrete zeolite and zeolitic

Geological Profile	Depth (cm)	Horizon	Description
	00		Soil Horizon
	17		Highly weathered vesicular basalt with zeolitic vein
	27		Red Bolls horizon with fine grained zeolitic intercalations
	50		Altered vesicular basalt with pockets of clay intercalations
	65		Red Bolls horizon with intercalations of zeolitic material
	70		Highly fractured vesicular basalt with zeolite crystals
	83		Altered vesicular basalt with zeolite
	113		Altered vesicular basalt
	156		Altered vesicular basalt with zeolite veins
	231		

Fig. 3 Geo-flow in the area (Vesicular basalt)

vein which is most vulnerable, stress induced, degraded and mixed with soils (Fig. 5).

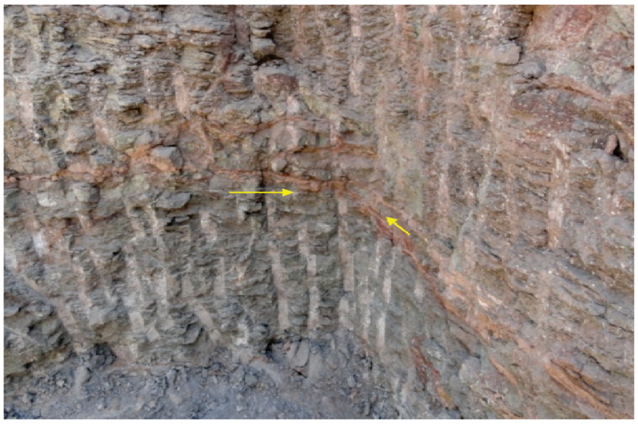

Fig. 4. Upper and Lower flows are separated by inter-trappeans (indicators of climate change) are converted to clay (paleosols)

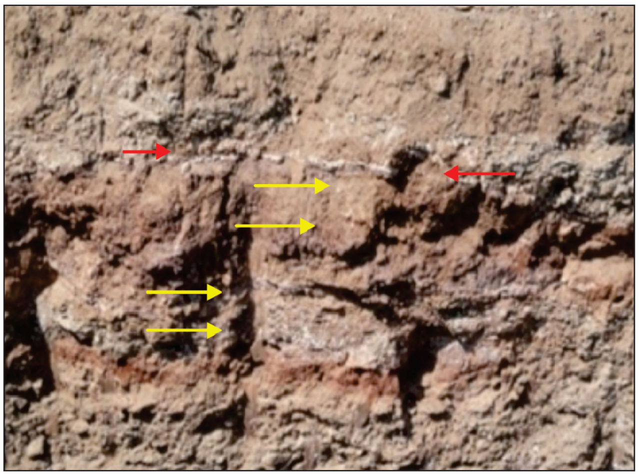

Fig. 5. Weathered zeolitic horizon (indicators of abiotic stresses) below soil layer with alternate horizons of red bolls

Successive layer is the alternate red boll horizon of variable thickness with fine grained zeolitic intercalations (Fig. 6). It is interesting to note that the intervening horizon between the two red bolls i.e. altered vesicular basalt with pockets of clay intercalations is free of zeolite. This is followed by highly fractured/altered vesicular basalt with zeolite crystals. These horizons also show the very peculiar solution cavities filled up with clay particles (Fig. 7 & 8) or hydrothermal/ secondary mineral crystallization of zeolites (Fig. 9 & 10) and are the important site for consideration during geotechnical investigations. The lower most horizons are again a fractured rock with presence of zeolite veins (Fig. 11) and therefore presence and absence of zeolite in whole profile section is an important bearing on edaphic stresses on the overlying soils.

Fig. 6. Fine grained zeolite with red bolls : an indicator of climate change

Fig. 7. Solution cavity inside the fractured rock : a location of stress measures inside the flows

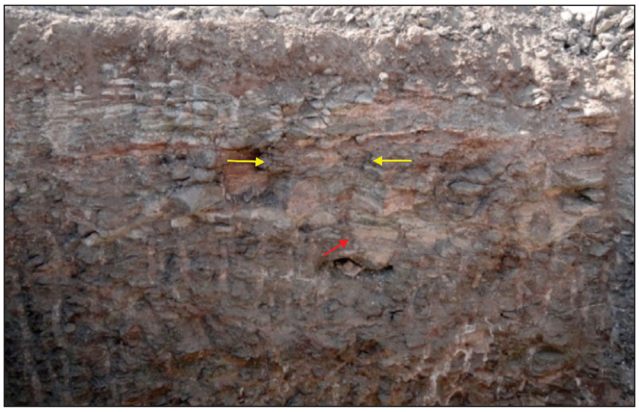

Fig. 8. Weathered, fractured and hydrothermally altered basalt from vesicular flow rocks just below the soil surface with solution cavities filled with zeolite which controls the abiotic stresses in the soils

Deep rotary drilling at site upto the depth of 385' indicate the alternate eruption of nonvesicular and vesicular magmatic flow with red bolls (Fig. 12). Thickness of individual flow may vary at deeper depth but the present study demonstrates that magma is rich in more viscous fluids resulting the eruption of non-vesicular basalts, a dominant rock in the area at deeper depth.

Fig. 9. Big solution cavity inside the fractured rock. These structures are the indicators and controllers of abiotic stresses in the weathered rocks/ soils

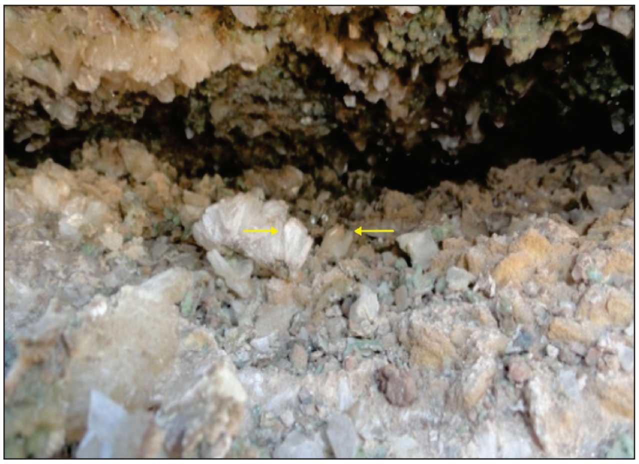

Fig. 10. Enlarged view of above showing nature of hydrothermal secondary mineral crystallization of zeolite in the cavities of basalt at depth of 1.5m below the ground

Fig.11. Lower most horizon of vesicular flow showing zeolite veins- an important regulator of abiotic stresses in the profile

Depth (Feet)	Horizon	Description
00		Non-Vesicular (Normal Basalt
175		Red Bolls Horizon
180		Non-Vesicular (Normal Basalt
280		Vesicular (Amygdular) Basalt
300		Hydrothermally altered Vesicular (Amygdular) Basalt
325		Non-Vesicular (Normal) Basalt
385		

Fig. 12. Drill Core upto the depth of 385' indicating non-vesicular-vesicular-non-vesicular flow

4.1.2 Mineralogical Observation

The minerals of late hydrothermal activity or secondary minerals are often developed in the traps, either as fillings in the amygdular cavities (Fig. 13 & 14) or as vein in the rocks (Fig. 15) are zeolite (stilbite) and calcite. Amongst the zeolites, sheaf-like aggregates of different forms of stilbite are the most common and widely distributed (Fig. 16). Development of rhombo-hedral calcite with well developed crystal faces is also present and occurs as vein and horizon below the soil (Fig. 17) along with zeolite. Both these minerals are the important indicators of climate change (Pal et al., 2006) and mostly responsible for degradational processes and development of different degree of abiotic stresses. These minerals are responsible for compactness of rock which in turn will give the compressive strength, important parameters in studying the geotechnical aspects for foundation.

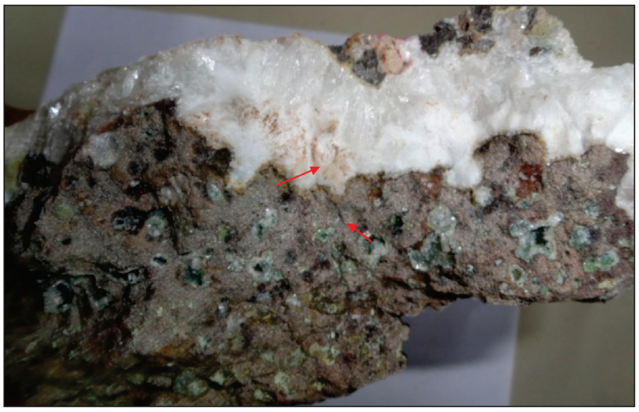

Fig. 13. Two stage zeolite crystallization from the cavities of amygdular basalt

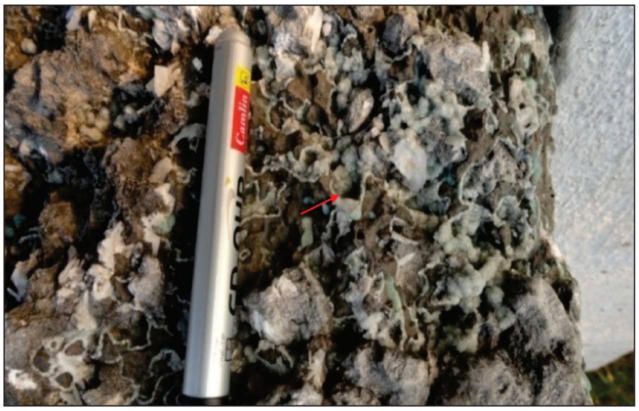

Fig.14. Basalt with zeolite veins

Fig.15. Growth of zeolite crystals from the cavities of amygdular basalt

Fig. 16. Well developed sheaf like aggregate of zeolite crystals from amygdular basalt

Fig. 17. Rhombohedral calcite crystals occur as horizon, which is an important abiotic stress component

4.1.3 Soil Formation

Four soil profiles have been studied on a catenary sequence to see their likely effects on abiotic stresses due to their topographic position and parent materials. It was observed that the soils are shallow to very shallow (5-23 cm deep), brown to pale brown colour with texture of loamy/silty sand, gravelly sandy loam to sandy clay loam and are associated with severe erosion, stones and rock out-crops. These soils are classified as Loamy-skeletal, mixed, isohyperthermic (Calcareous), Lithic Ustarthents and belong to the subgroups of Entisols (Fig. 18).

Fig. 18. Profile developed on side slope, 24 cm deep, A horizon 14-15 cm underlain by AC horizon of (15-23 cm) 8 cm and followed by C horizon, with sandy clay loam texture (Profile 2)

Association of the soil with the underlying rock on the summit and side slope show the gradation from lower to upper horizon indicating the in-situ development whereas the soils developed on shoulder and back slope do not show any gradational relationship and indicate that these soils were transported. These observations were correlated with master profiles and bore hole data (upto rooting depth) at the site for evaluating the possible role of edaphic stresses on agriculture in view of climate change effecting various soil process.

The lithological relationship between soil and the different layers of underlying rocks in the catenary sequence indicated that these two units are having the diverse nature in their engineering properties.

4.1.4 Drilling/Bore Hole Observations

The details of each location, its depth and other relevant information are given in the Table 1. Coring depth varied as per geological formations of the site and bore hole location.

Table 1. Depth of coring in soil and rock with bore hole number

Bore Hole No.	Depth in soil (m)	Coring in rock (m)
BH1	0.20	4.8
BH2	-	5.0
BH3	-	5.0
BH4	0.15	4.85
BH5	0.20	4.8
BH6	0.15	4.85
BH7	0.20	4.8
BH8	0.00	5.0
BH9	1.50	3.50
BH10	1.50	3.50
BH11	1.50	3.50
BH12	1.00	4.00
BH13	0.00	5.00
BH14	2.00	3.00
BH15	1.00	4.00
BH16	0.25	4.75
BH17	0.15	4.85

4.1.5 Subsoil Profile

Four types of stratum are encountered at the most of the sites as given below.

Stratum I: Silty/Loamy sand.

Stratum II: Highly disintegrated rock recovered as gravely loamy sand mixed with boulders (hard muram).

Stratum III: Highly to moderately weathered hydro-thermally altered (HTA), fine grained amygdaloidal basalt/with some zeolitic cavities, highly to moderately fractured weathered basalt.

Stratum IV: Fresh to moderately weathered hydro-thermally altered (HTA) fine grained compact basalt / fine grained grayish compact basalt/grayish amygdaloidal basalt/HTA amygdaloidal basalt with some zeolitic cavities.

Thickness of each layer encountered along with RQD (Rock Quality Designation) range as the case may be at the locations (Table 2). It shall be noted that the stratum listed below may not be encountered in the same order as listed.

Table 2. Thickness of each layer with RQD

BH No.	Layer I	Layer II	Layer III		Layer IV	
	Thick (m)	Thick (m)	Thick (m)	RQD %	Thick (m)	RQD %
BH-1	0.20	-	-	-	4.80	77-96
BH-2	-	-	-	-	5.00	73-85
BH-3	-	-	-	-	5.00	58-99
BH-4	0.15	-	-	-	4.85	87-89
BH-5	0.20	-	-	-	4.80	48-83
BH-6	0.15	-	-	-	4.85	42-81
BH-7*	0.20	-	-	-	4.50	50-79
BH-8	-	0.5	0.30	0	4.20	54-93
BH-9	0.15	1.35	1.00	0	2.50	32-95
BH-10	-	1.5	2.00	0-54	1.50	85
BH-11	0.1	1.4	1.5	0	2.00	56-74
BH-12	0.15	0.85	-	-	4.00	46-70
BH-13	-	-	-	-	5.00	39-58
BH-14	-	1.0	3.0	0-28	1.0	66
BH-15	-	-	2.0	0-23	3.00	45-87
BH-16	0.15	0.10	4.85	0-54	-	-
BH-17	0.15	0.70	1.7	39	2.50	59-72

*Layer III encountered below layer IV from 2.2-5 m

The lithological/mineralogical details of individual drill core (Figs. 19-35) and the details of Core recovery, RQD and other parameters are given in the bore logs (Figs. 36-52) and are attached as **Appendix -1.** All these figures are self explanatory.

The observed bore holes were correlated with respect to their contour height and flow type (Table 3). From the table it is observed that contour heights of different bore hole differ from 98-107 m. These variations are more prominent in non-vesicular-vesicular (103.0-106.75 m) flow. This indicates that Bore Hole have also different types of flow with variable lithological make up.

Table 3. Bore log with contour height

Bore Log No.	Contour Height (m)	Flow Type
BH1	105.00	Nonvesicular
BH2	103.75	
BH4	105.70	
BH5	103.50	
BH8	102.30	Vesicular
BH10	100.00	
BH11	100.50	
BH14	99.70	
BH3	106.75	Nonvesicular- Vesicular
BH6	103.50	
BH7	105.00	
BH16	104.00	
BH17	104.00	
BH9	99.00	Vesicular-Nonvesicular-Vesicular
BH12	100.00	
BH13	98.00	
BH15	98.50	

With the above lithological information on the individual drill core, all the seventeen bore logs were correlated to understand the nature of flow, their compatibility and mineralogical composition. It shows three episodes of volcanic activity which is indicated by non-vesicular (ordinary) and vesicular (amygdular) flows that occurred during Upper Cretaceous to Lower Eocene period (65-25 million years) (Krishnan, 1982). The details of these two types of flows have been described in Geology of NIAM site (Maurya and Vittal, 2010).

A perusal of these bore logs indicated four different combinations of flows from lithological variations point of view irrespective of their topographical position and contour height. *viz.* (i) Non-vesicular (bore log nos. 1, 2, 4 & 5) (ii) Vesicular (bore log nos. 8, 10, 11 & 14) (iii) Non-vesicular-Vesicular (bore log nos. 3, 6, 7, 16 & 17) and (iv) Vesicular-Non-vesicular-Vesicular (bore log nos. 9, 12, 13 and 15) (Figs. 53-54).

The textural and lithological variations of bore logs were correlated with several mini pits profile from boring site and a master open pit profile at the lower elevation with respect to their bearing capacity and strength and it has been observed that the two findings (i.e. profile pits and bore logs) are synchronous with each other on the upper reaches and differs on lower reaches. The reasons being due to variation in slope and contour heights, most of the rocks are fractured and weathered due to chemical action of water.

4.1.6 Water Level

During the boring water level was encountered in some of the boreholes as stated below in the Table 4. This may be for a shorter period. The correct method to determine ground water table is to install standpipe piezometer and monitor over a long period of time.

Table 4. Bore hole number with water level

Bore Hole No.	Water Level (m)
BH1	2.95
BH2	2.75
BH3	Water loss from 4.5m
BH4	3.3
BH5	3.45
BH6	Water loss from 4m
BH7	Water loss from 2m
BH8	Water loss from 4m
BH9	Water loss from 4.5m
BH10	Water loss from 3.25m
BH11	Water loss from 4.5m
BH12	Water loss from 4m
BH13	Water loss from 4m
BH14	Water loss from 3m
BH15	Water loss from 5m
BH16	2.85m
BH17	2.9m

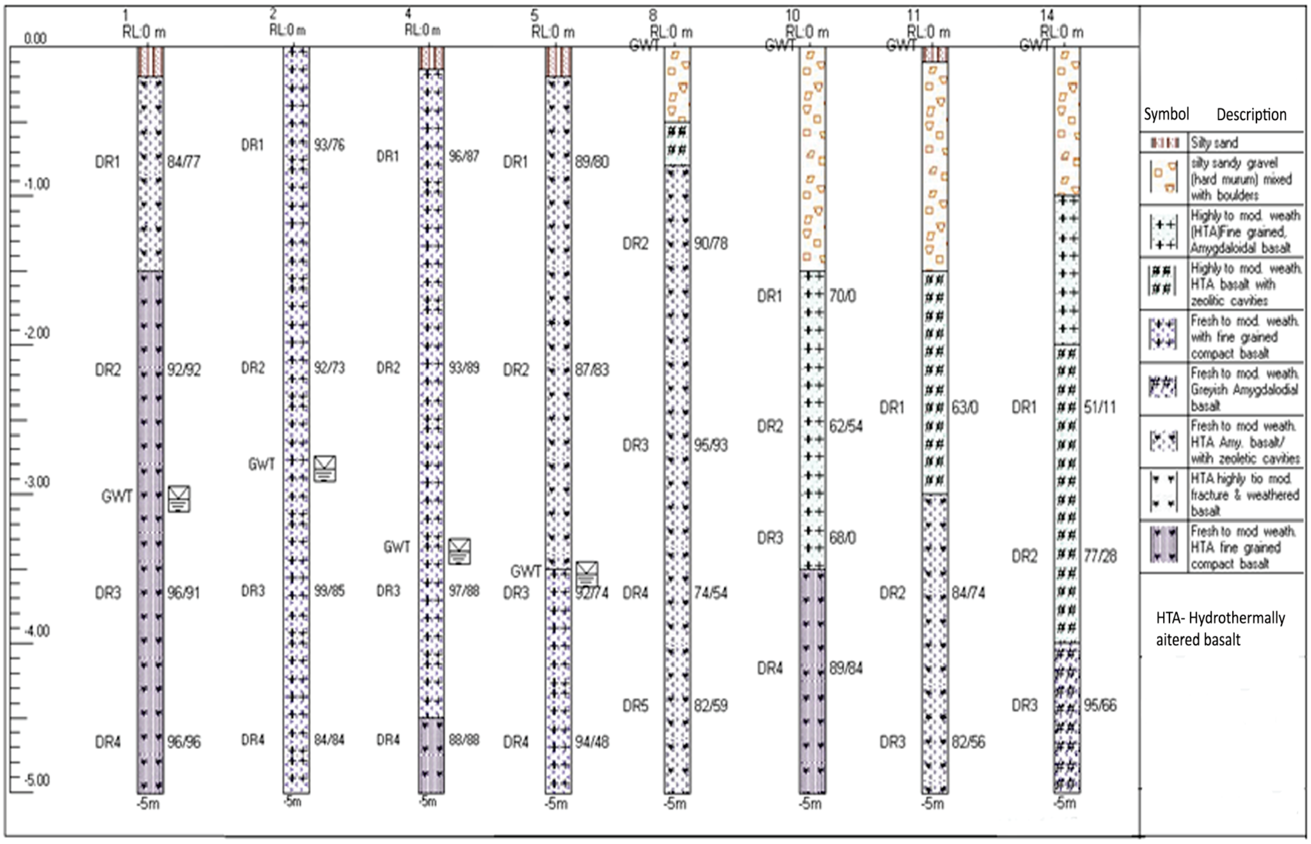

Fig. 53. Non-vesicular flow (bore holes nos. 1, 2, 4 &5) and Vesicular Flow (bore holes nos. 8, 10, 11 &14) with different horizons

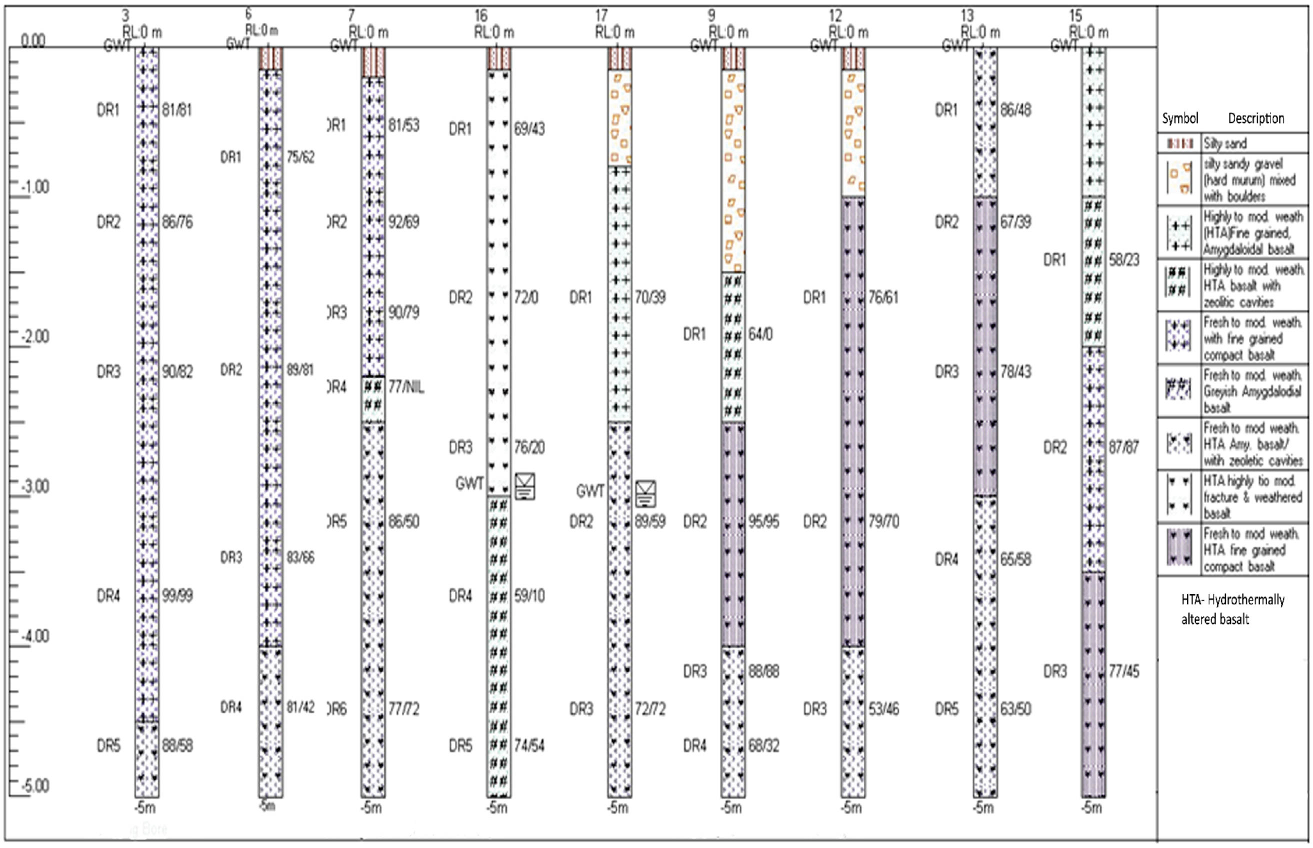

Fig. 54. Non-vesicular-Vesicular Flow (bore holes nos. 3,6,7,16 &17) and Vesicular- Non-vesicular -Vesicular Flow (bore holes nos. 9,12,13 &15) with different horizons

4.2 Laboratory Study

Representative drill core samples were selected and classified for the different laboratory testing/ investigations as stated below:

4.2.1 Rock Samples

Rock samples were tested for different geotechnical parameters to assess their feasibility for the foundation of different building blocks. The most common are i) Dry and Wet Density, ii) Percentage absorption and iii) Saturated Crushing Strength (Table 5).

Table No. 5 : Summary of rock test results

BH No.	Piece No.	Depth below Ground level	Diameter	Height	Dry mass	Dry Density	Saturated Mass	Saturated Density	Absorp-tion	Specific Gravity	Saturated Crushing Strength	Descrip-tion	Remark
		(m)	(cm)	(cm)	(gm)	gm/cc	(gm)	(gm/cc)	%		kg/cm2		
1	4	0.2-1.5	5.40	11.20	741.0	2.89	749.00	2.92	1.08	2.85	588.93	Grey	
1	15	3.0-4.5	5.40	11.20	728.0	2.84	734.00	2.86	0.82	2.80	679.51		
2	3	0.0-1.5	5.40	11.20	735.0	2.87	740.50	2.89	0.75	2.83	815.43		
2	23	3.0-4.5	5.40	11.20	711.5	2.78	724.50	2.83	1.83	2.74	135.92		
3	4	0.7-1.5	5.40	11.20	729.0	2.84	735.00	2.87	0.82	2.80	679.51		
3	19	3.0-4.50	5.40	11.20	709.0	2.77	715.00	2.79	0.85	2.73	362.42		
4	6	0.15-1.5	5.40	11.20	711.5	2.78	720.50	2.81	1.26	2.74	498.30		
4	17	3.0-4.5	5.40	11.20	726.0	2.83	733.00	2.86	0.96	2.79	498.30		
5	7	0.2-1.5	5.40	11.20	732.5	2.86	740.50	2.89	1.09	2.82	724.80		
5	19	3.0-4.5	5.40	11.20	724.5	2.83	731.00	2.85	0.90	2.79	447.48		
6	4	0.15-1.5	5.40	11.20	722.5	2.82	736.00	2.87	1.87	2.78	362.42		
6	20	3.0-4.0	5.40	11.30	709.5	2.74	721.00	2.79	1.62	2.63	447.48		
7	9	0.9-1.5	5.40	11.10	702.0	2.76	712.00	2.80	1.42	2.70	407.72		
7	24	2.5-4.0	5.40	11.10	611.0	2.40	628.00	2.47	2.78	2.35	181.21		
8	6	0.8-2.0	5.40	11.10	609.0	2.40	636.00	2.50	4.43	2.34	135.92		
8	18	3.5-4.0	5.40	11.20	632.0	2.47	665.00	2.59	5.22	2.43	135.92		
9	5	1.50-2.50	5.30	7.40	391.0	2.40	412.00	2.52	5.37	2.37	88.68	Pinkish Grey	Point load test
9	15	2.50-4.0	5.40	11.20	687.0	2.68	699.00	2.73	1.75	2.64	271.80		
9	23	4.5-5.0	5.40	11.20	720.0	2.81	728.00	2.84	1.11	2.78	200.40		
10	12	2.0-3.25	5.40	11.20	674.0	2.63	691.50	2.70	2.60	2.59	407.72	Grey	
10	14	2.0-3.25	5.40	7.40	378.0	2.23	386.00	2.28	2.12	2.45	40.08		
10	17	3.50-5.0	5.40	11.30	563.0	2.18	617.50	2.39	7.90	2.16	45.29		
11	4	2.0-3.0	5.50	9.00	526.5	2.46	545.50	2.55	3.61	2.39	71.46	Pinkish Grey	
11	20	4.5-5.0	5.50	9.70	498.0	2.16	506.00	2.20	1.61	2.42	107.32		
11	12	3.0-4.50	5.40	11.20	578.0	2.25	604.00	2.36	4.50	2.18	135.92		
12	8	1.0-2.50	5.40	9.00	488.5	2.37	504.00	2.45	3.17	2.33	75.49		
12	11	1.0-2.5	5.40	10.60	525.5	2.17	536.00	2.21	2.00	2.12	111.33		
12	16	2.50-4.0	5.40	10.30	554.0	2.35	583.00	2.47	5.23	2.31	87.03		
13	16	1.50-3.0	5.40	11.20	708.5	2.76	717.00	2.80	1.20	2.72	543.59	Grey	
13	7	0.0-0.8	5.40	11.20	618.5	2.41	624.00	2.43	0.89	2.36	187.04		

Contd....

13	125	3.0-4.0	5.40	11.20	610.0	2.38	637.00	2.48	4.43	2.35	90.58		
14	4	2.0-3.0	5.30	7.80	383.5	2.23	409.00	2.38	6.65	2.19	34.60	Pink	
14	19	3.0-4.0	5.40	5.70	291.0	2.23	309.00	2.37	6.19	2.22	116.60	Pink	Point load test
14	22	4.0-5.0	5.40	11.20	653.5	2.55	668.00	2.61	2.22	2.51	447.48	Grey	
15	9	1.0-2.0	5.40	9.40	540.5	2.51	558.00	2.59	3.24	2.46	39.42		
15	14	2.6-3.5	5.40	11.10	672.0	2.64	689.00	2.71	2.53	2.58	181.21		
15	29	3.5-5.0	5.40	11.10	605.0	2.38	633.50	2.49	4.71	2.32	135.92		
16	5	0.25-1.0	5.30	8.10	455.5	2.55	462.00	2.59	1.43	2.53	486.14	Grey	Point load test
16	41	3.0-4.5	5.40	11.10	605.0	2.38	636.00	2.50	5.12	2.33	90.58	Pink	
16	51	4.5-5.0	5.40	11.20	590.0	2.30	618.50	2.41	4.83	2.27	90.58	Pink	
17	7	1.0-2.5	5.40	11.20	711.5	2.78	719.00	2.80	1.05	2.68	860.72	Grey	
17	21	2.5-4.0	5.40	11.20	627.0	2.45	651.00	2.54	3.83	2.41	181.21		
17	25	4.0-5.0	5.40	11.10	628.5	2.47	647.00	2.55	2.94	2.42	181.21		

From the table it can be observed that most variable physical parameters are the saturated crushing strength followed by the water absorption. The reasons for this variation may be due to the non-homogeneous and fractured/ altered nature of rocks in different horizons and at variable depths at logging site.

4.2.2 Soil Samples

Geotechnical properties on a limited number of soil samples were carried out with respect to their mechanical analysis & moisture content (Table 6). From the table it can be observed that soils are dominantly gravely in nature (gravel upto 97%). Their moisture content varies with location of logging core.

4.2.3 Chemical Analysis of Soil & Water

Chemical tests were conducted to determine the sulphite, chloride content and pH on selected number of disturbed soil sample & water collected from borehole. Results (Table 7) indicated that the values are within limit, hence no special treatment is required.

4.2.4 Engineering Properties

Engineering analysis of the sub-soil was performed to determine net safe bearing capacity. Parameters obtained are based on various field and laboratory tests.

Rock is encountered at shallow depth and therefore it is considered that isolated pad foundation shall be used for buildings. Open foundation - Reference to IS 12070 “Design and Construction of Shallow Foundation on Rocks” and IS 13365 (part I) “Quantitative classification system of rock mass”. RMR (Rock Mass Rating) of the stratum at foundation depth is determined. Based on the RMR, IS12070 recommend safe bearing capacity value. According to IS 12070, allowable pressure will result (in raft up to 6 m thickness) in settlement less than 12 mm. It may be noted that in some of the boreholes calculations might indicate that higher bearing capacity is possible, lower value is recommended due to presence of alternate layers with low RQD and water loss were noticed in few boreholes.

Safe Bearing Capacity was calculated using six parameters for BH-1 for 1 m and 2 m depth (Table 8). Net safe bearing capacity to be adopted for pad foundations calculated using above parameters to be placed at different depth below the ground surface existing at the time of investigation is tabulated below (Table 9).

For foundations placed on rock, it is essential to ensure that there are no loose pockets on rock surface. In case of loose pockets or over excavation, it shall be filled by plain cement concrete. For foundations placed on gravelly silty sand (muram), prior to placement of PCC, compact bottom of excavation to 95% is filled up with modified proctor density using heavy vibratory roller.

Table 6. Summary of soil test results

Bore Hole No.	Depth below ground Level (m)	Moisture Content %	Mechanical Analysis % Gravel	% Sand	% Fine Sand
9	1.00	2.34	97.0	3.0	0.00
10	1.00	3.65	87.0	9.0	4.00
12	0.75	9.6	83.0	14.0	3.00

Table 7. Chemical Analysis of soil & water

S. No.	Location / Depth	SO_4 (mg/kg)	Cl (mg/kg)	pH
1	*BH2	15.47	18.65	7.80
2	BH-5	12.42	20.71	7.36
3	BH-8 / 0.5m	10.70	12.21	8.05
4	BH-9 / 1m	11.24	16.88	7.59
5	BH-11 / 1m	15.65	13.78	7.42
6	BH-16	10.2	12.68	7.89

**water-sample*

Table 8. Parameters for calculating safe bearing capacity from BH – 1 at Depth – 1 & 2 m

Parameter	Value	Rating
Depth - 1 m		
Strength of intact rock (MPa)	59-68%	7
Rock quality Designation	77-96%	17
Spacing of discontinuities	Wide to very wide	17
Conditions of discontinuities (<1mm)	-	23
Ground water condition	Wet	7
Adjustment for joint orientation	Fair	-7
Total		64
Depth – 2 m		
Strength of intact rock (MPa)	68%	7
Rock quality Designation	91- 96%	20
Spacing of discontinuities	very wide	20
Conditions of discontinuities (<1mm)	-	25
Ground water condition	Wet	7
Adjustment for joint orientation	Fair	-7
Total		72

Table 9. Net safe bearing capacity for different bore holes

Borehole No.	Depth of Foundation (m)	Net safe bearing capacity (T/m^2)
BH1, BH2, BH3, BH4, BH5	1.0 2.0	60 80
BH6, BH7	1.0 2.5	60 75
BH8	1.0 2.0	60 75
BH9	1.0 2.0	30 50
BH10	1.0 2.0	40 50
BH11	1.0 2.0	35 50
BH12	1.5 2.0	60 80
BH13	1.0 2.0	60 80
BH14	1.0 2.0	45 55
BH15	1.0 2.0	60 80
BH16	1.0 2.0	35 45
BH17	1.0 2.0	60 100

According to IS 12070 (table 3) classification of rock is II

From the study it has been observed that the average rainfall being 560 mm, and restricted to SW monsoon, the atmospheric drought will be a common experience. These dry spells combined with shallow and gravelly rhizosphere make the plant experience moisture stress almost immediately without allowing the plant resort to adaptation or mitigation measures. However, due to hard rock at shallow depth may lead to temporary water stagnation and combination of edaphic stresses also. Even the secondary minerals zeolites in the vesicular trap are highly prone to alteration and are rich source of calcium to the soils and plants. The high calcium combined with high pH may lead to restriction on availability of secondary and micronutrients.

Apart with impending increase in atmospheric temperatures due to climatic change, the rich calcium zeolites will weather faster and may accumulate on surface after sodium leaching. This may lead to increased runoff due to soil sealing/capping, thereby inhibits the plant phenological expression leading to desertification process. In the extreme eventuality of above process of separation of Ca and Na ions due to alteration of intensive leaching by reduced number of rainy days under retained average rainfall and high temperature due to climate change there may be a possibility of calcic and natric horizons underlain within a profile leading to extreme degradation. In view of all, it is desired that the present state of weathering may be retained by thick soil application on the surface. This may reverse the soil profile from non-supportive rhizosphere to enriched one. Eventually the vegetation will be a dominant factor reducing the ill effects of other parameters of degradation.

The contour height of the bore hole shows a considerable gap of 9m with variable flow and rock composition which is apparent from the Table 3. Study also shows that area has two types of flow i.e. nonvesicular and vesicular and a combination of these. This indicates that both types of magmatic eruption have occurred in the area which has also been demonstrated in deep drilling (Fig. 12). Due to low viscosity of magmatic fluids, vesicular flow are widely distributed on the ground, vis-à-vis higher viscous magmatic fluids of non-vesicular flow are normally below the ground and are exposed in the area whereas the upper horizon of vesicular flows has been removed/eroded due different weathering agencies.

Study on net safe bearing capacity of different bore holes for the foundation indicated that bore holes with rocks dominant of vesicular flow has very low value (35 –45 t/m^2 and 50-55 t/m^2 for 1 and 2 m depth respectively) whereas, bore holes with rocks dominant of nonvesicular flow and or association of nonvesicular-vesicular and vesicular-nonvesicular-vesicular flow has comparatively higher value (60 t/m^2 and 75-80 t/m^2 for 1 and 2 m depth respectively) (Table 9). This indicates that due to presence of highly compact mineral grains in non-vesicular flow (Figs. 19-22), rock strength will be high resulting higher net safe bearing capacity. Whereas, due to presence of amygdales/cavity in the vesicular flow (Figs. 23-26) the rock strength is low and therefore foundation will be weak resulting the lower net safe bearing capacity. This indicates that due to varying flow with diverse lithology the different treatment for the foundations are required to set up a strong base of different blocks.

Acknowledgements

This study is a part of ongoing project at the Institute on Site Geology. In this particular study the bores including analysis of engineering and chemical properties were made by M/S Soil Tech (India) Pvt. Ltd., Pune, for the Central Public Works Department, Pune as a part of the foundation analysis. Geological interpretations were made by the authors. Authors wholeheartedly thank the NIASM staff for their support.

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Appendix- I

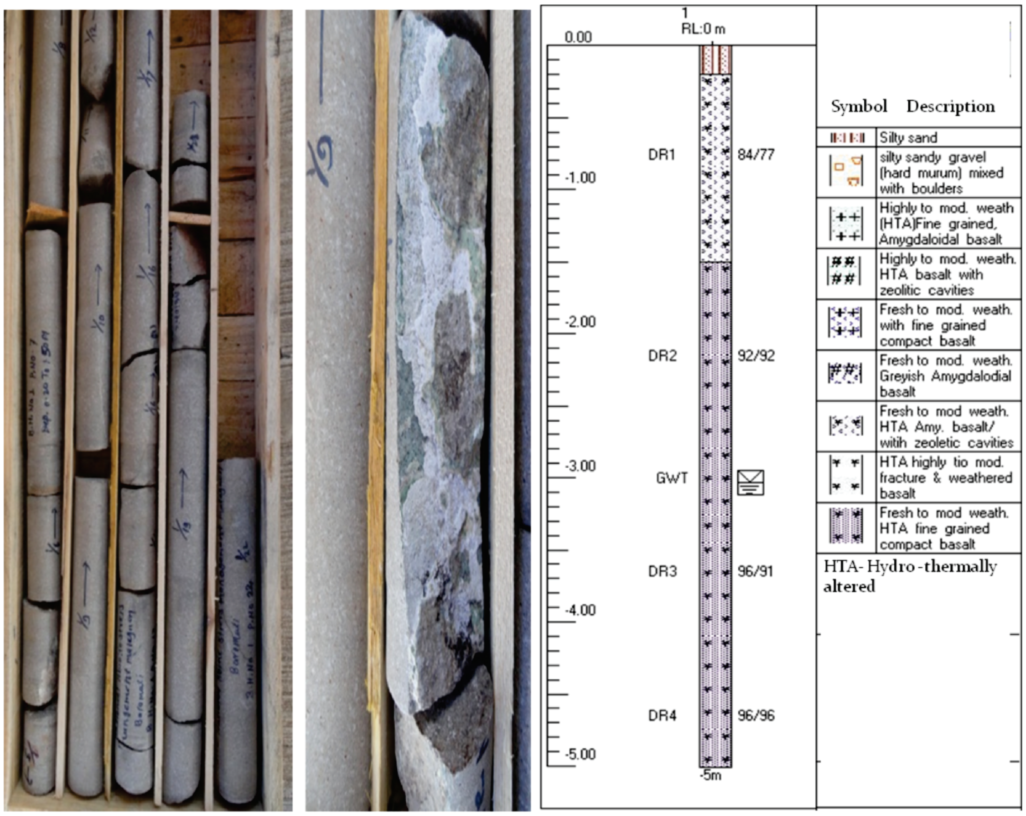


Fig. 19. Core samples from bore log 1 showing moderately weathered hydrothermally altered basalt from non-vesicular flow of 5 m thick

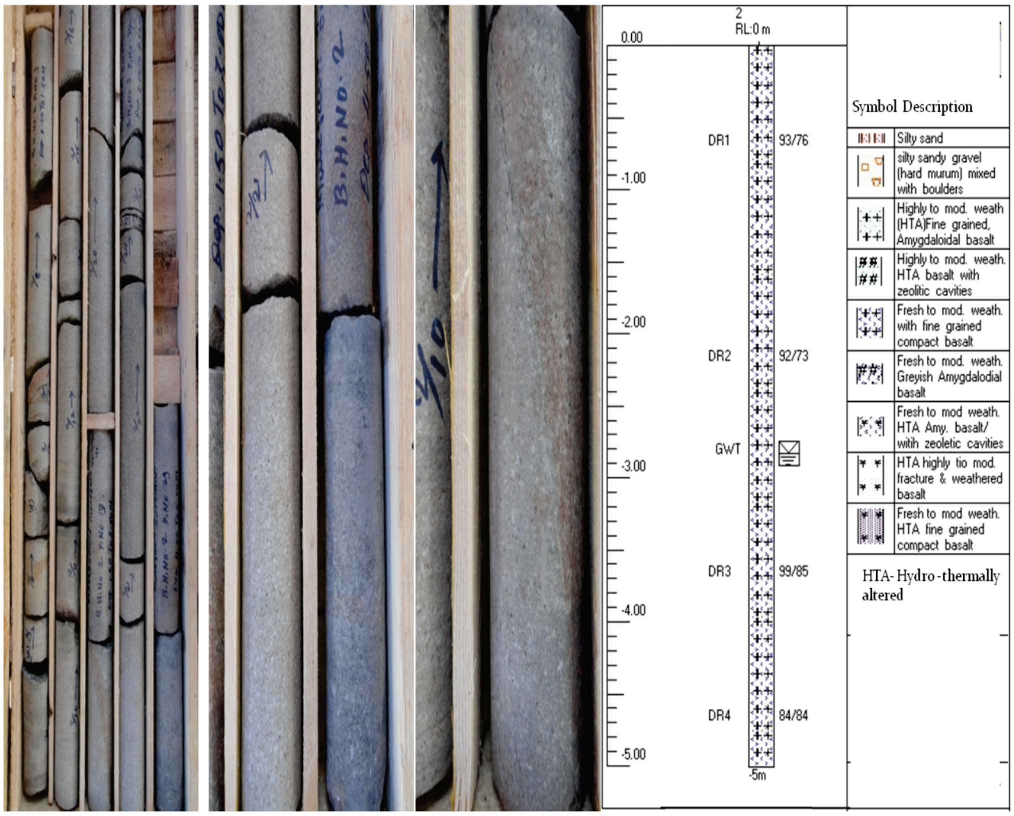


Fig. 20. Core samples from Bore Log 2 showing moderately weathered fine grained compact basalt from non-vesicular flow of 5 m thick

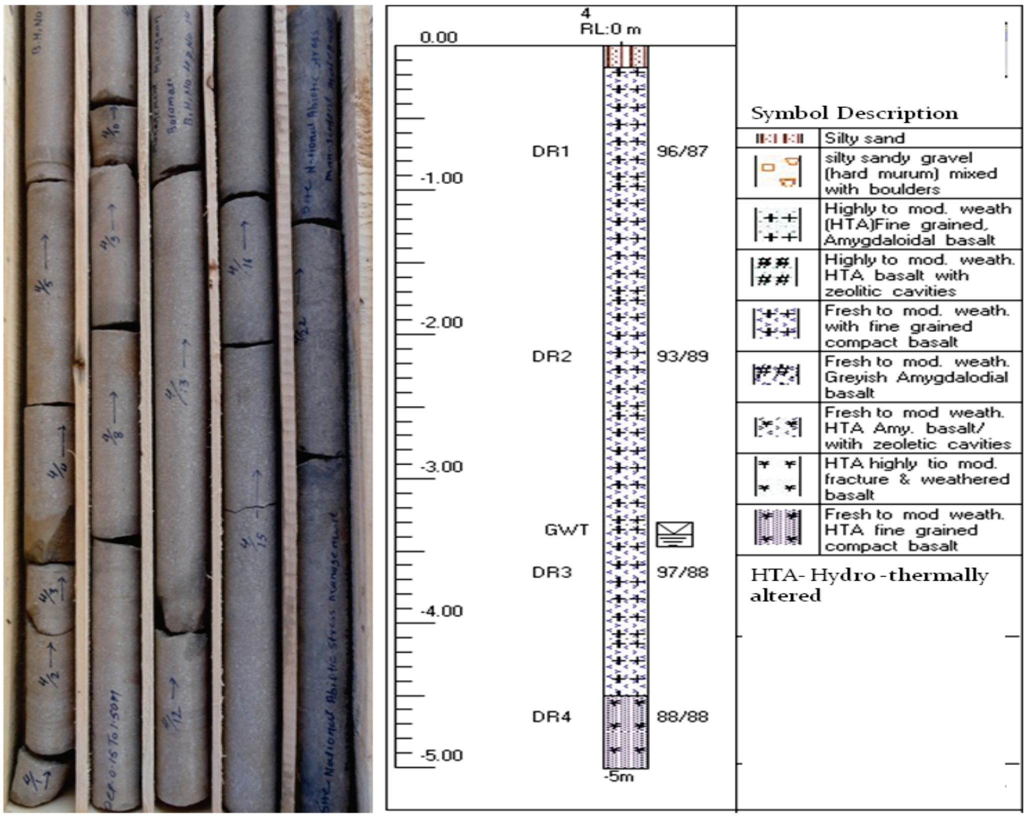


Fig. 21. Core samples from bore log 4 showing fresh to moderately weathered hydrothermally altered fine grained compact basalt from non-vesicular flow of 4.8 m thick

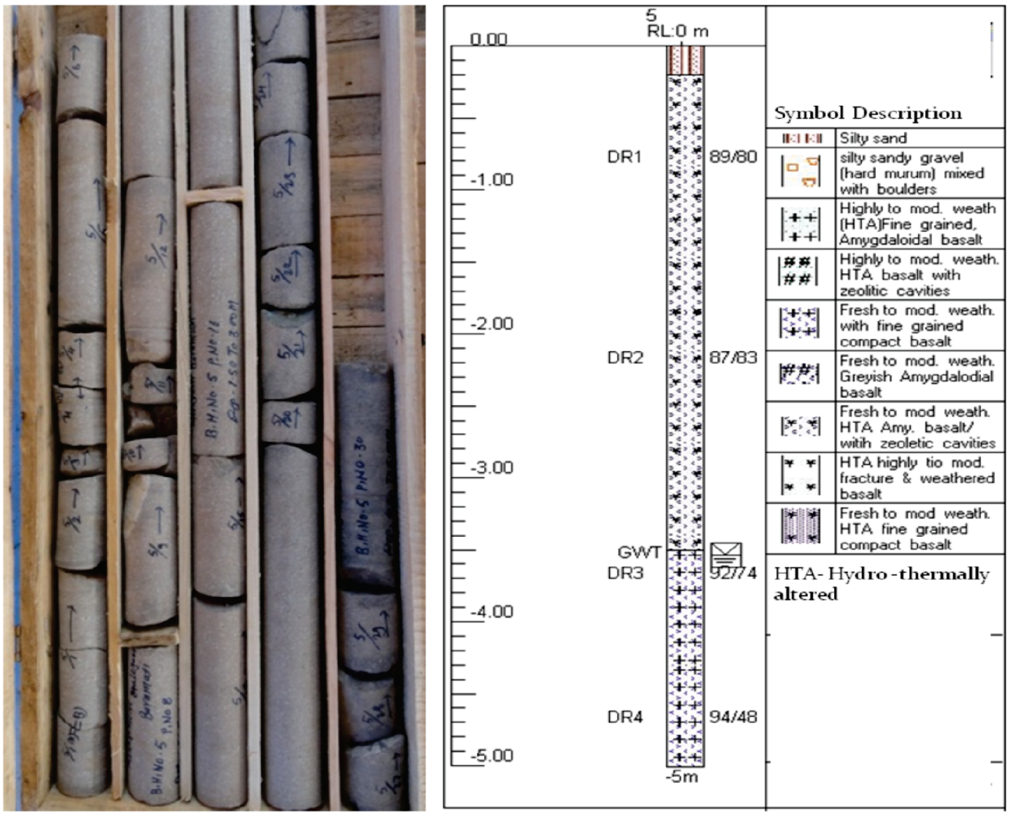


Fig. 22. Core samples from bore log 5 showing moderately weathered hydrothermally altered basalt of 3.3 m and moderately weathered with fine grained basalt of 1.5 m thick from non-vesicular flow

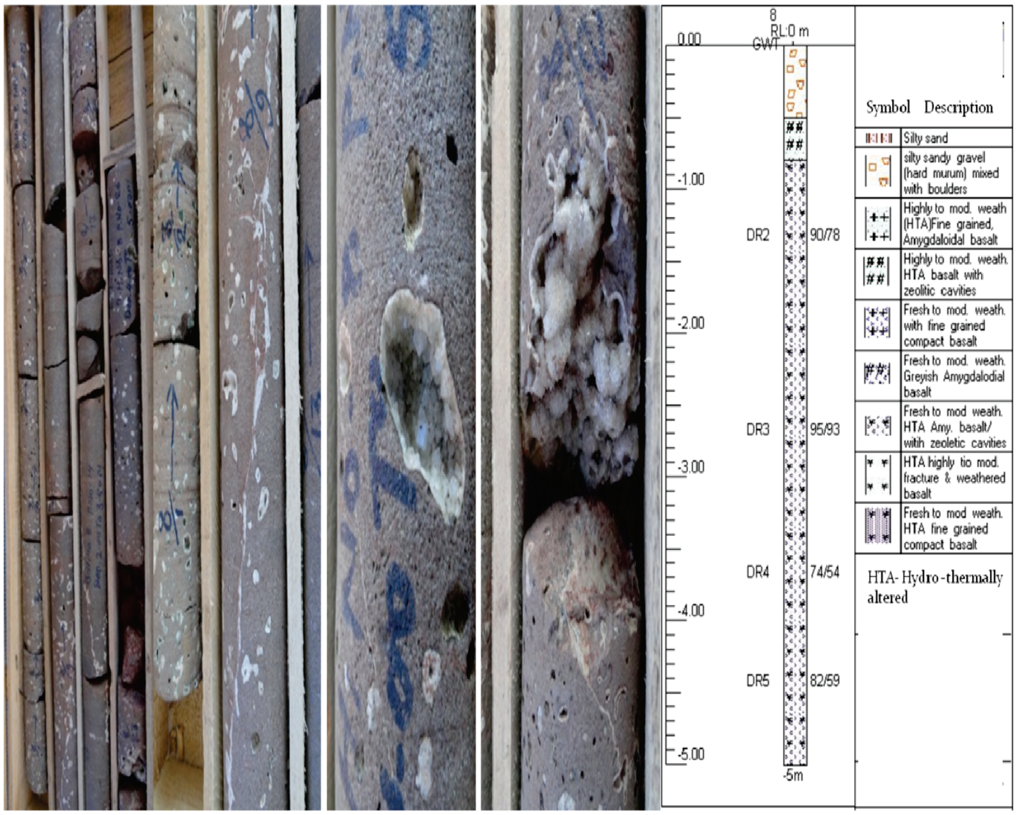


Fig. 23. Core samples from bore log 8 showing moderately weathered hydrothermally altered vesicular basalt of 4.2 m thick. The core is characterized by an enriched zone of 0.3 m thick well crystallized zeolite just below the gravel and boulder horizon. The upper most layer is the soil horizon of 0.5 m thick.

Fig. 24. Core samples from bore log 10 showing moderately high weathered HTA fine grained basalt of 2 m and moderately weathered, fine grained basalt of 1.5 m thick from vesicular flow. This HTA basalt s is overlain by gravel and boulder horizon of 1.5 m thick.

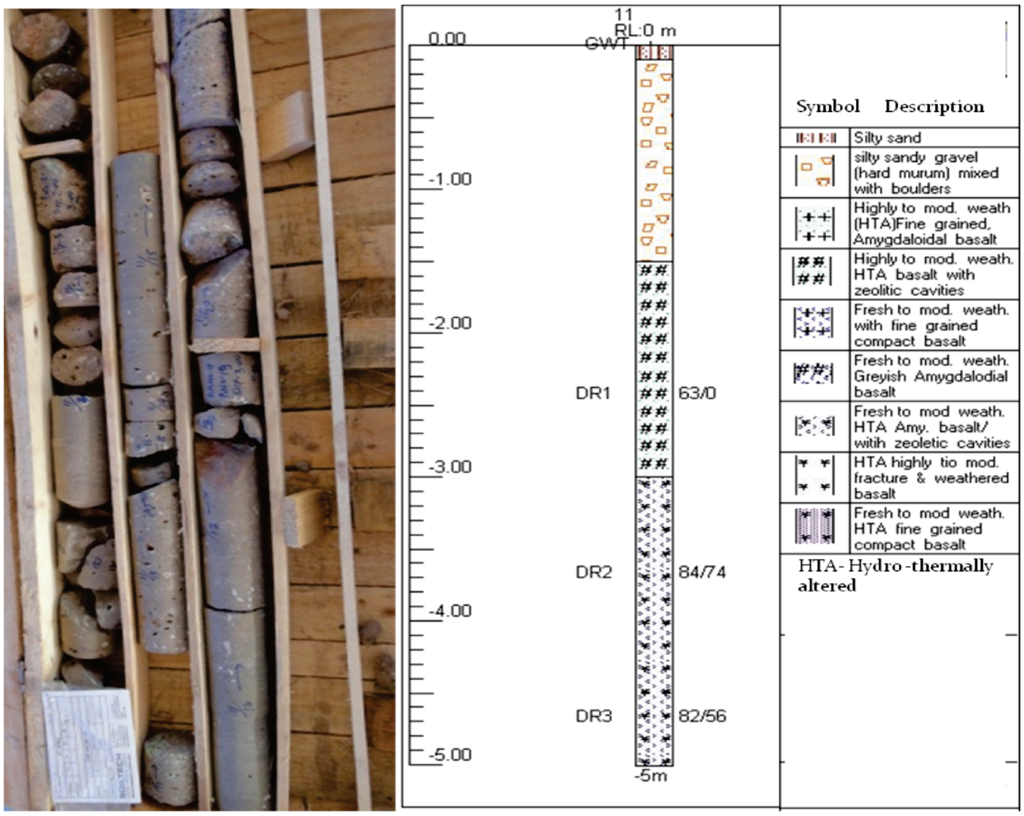


Fig. 25. Core samples from bore log 11 showing moderately to highly weathered HTA vesicular basalt of 3.5 m which is overlain by gravel and boulder horizon of 1.5 m thick

Fig. 26. Core samples from bore log 14 showing moderately to highly weathered HTA vesicular basalt of different grades with zeolite crystal growth of 4 m which is overlain by gravel and boulder horizon of 1m thick

Fig. 27. Core samples from bore log 3 showing fine grained compact basalt from non-vesicular flow of 4.5 m and moderately weathered hydrothermally altered basalt with zeolite crystal growth in vesicular flow of 0.5 m thick.

Fig. 28. Core samples from bore log 6 showing moderately weathered with fine grained compact basalt from non-vesicular flow of 3.8 m and moderately weathered hydrothermally altered basalt with zeolite crystals in the cavities of vesicular flow of 1 m thick

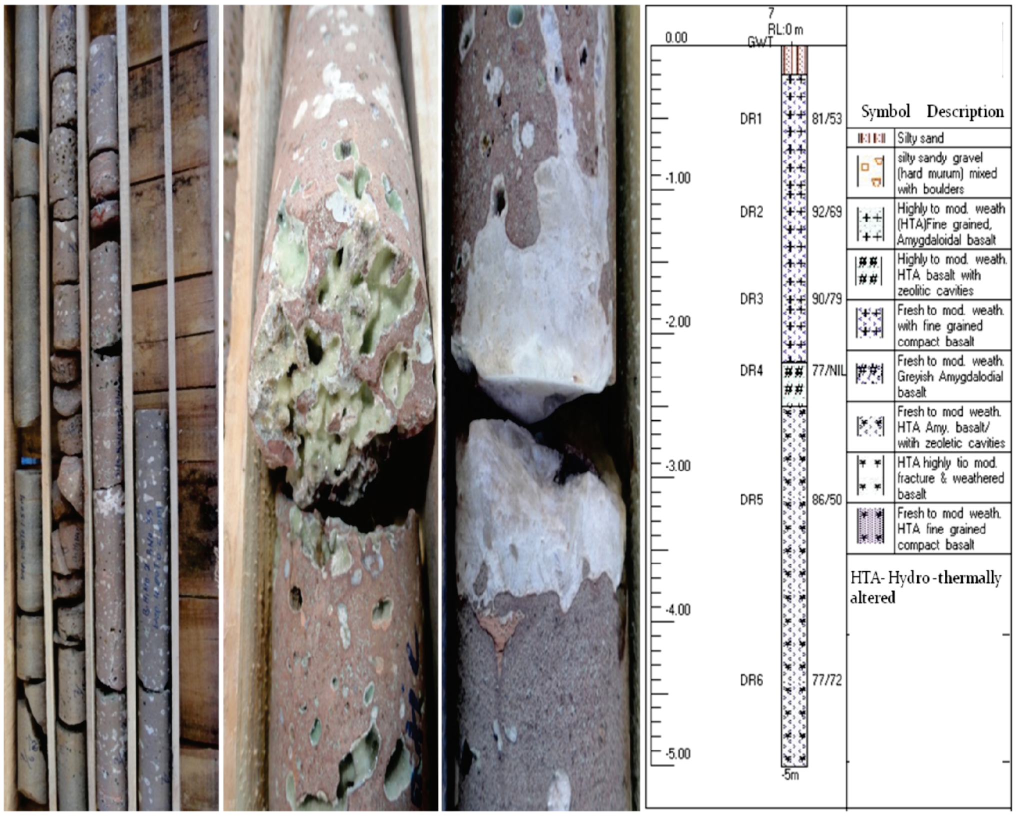


Fig. 29. Core samples from bore log 7 showing moderately weathered with fine grained compact basalt from non-vesicular flow of 2 m and moderately weathered hydrothermally altered basalt with zeolite in the cavities of vesicular flow of 2.5 m thick. A well crystallized zone of 0.3 m thick zeolites separates these two flows at the centre.

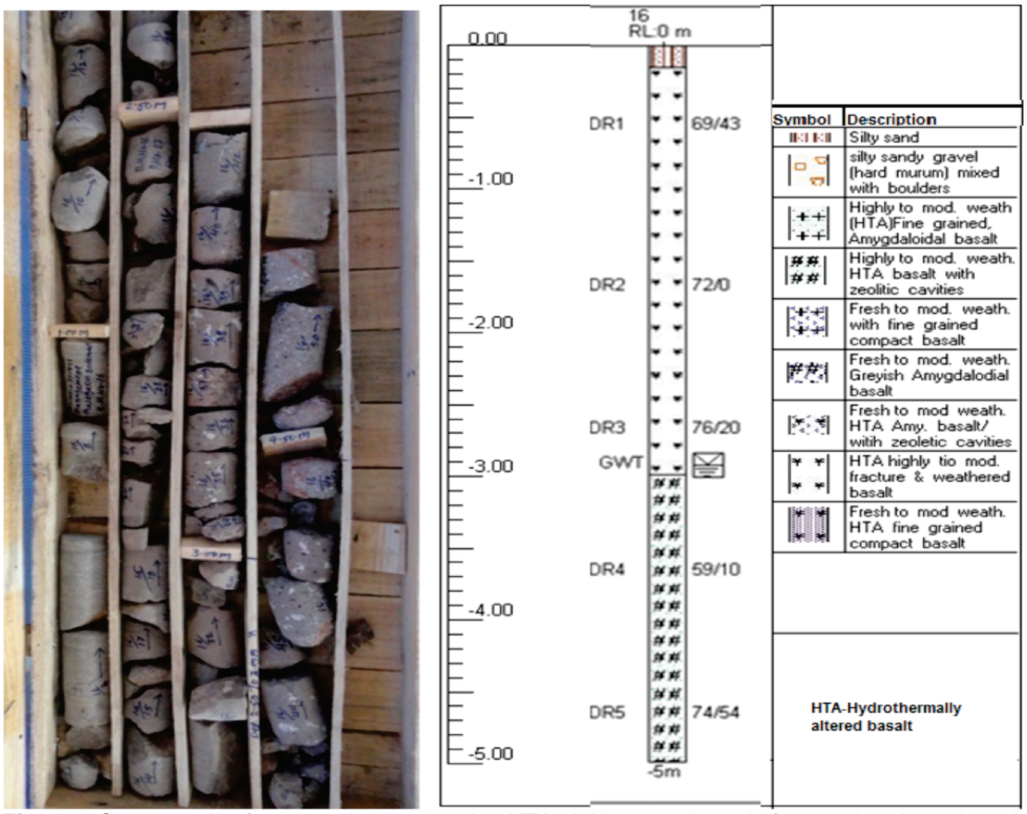


Fig. 30. Core samples from bore log 16 showing HTA highly to moderately fractured and weathered fine grained non-vesicular basalt of 2.8 m and highly to moderately weathered HTA basalt with zeolite of 2 m of vesicular basalt with soil horizon of 0.2 m thick

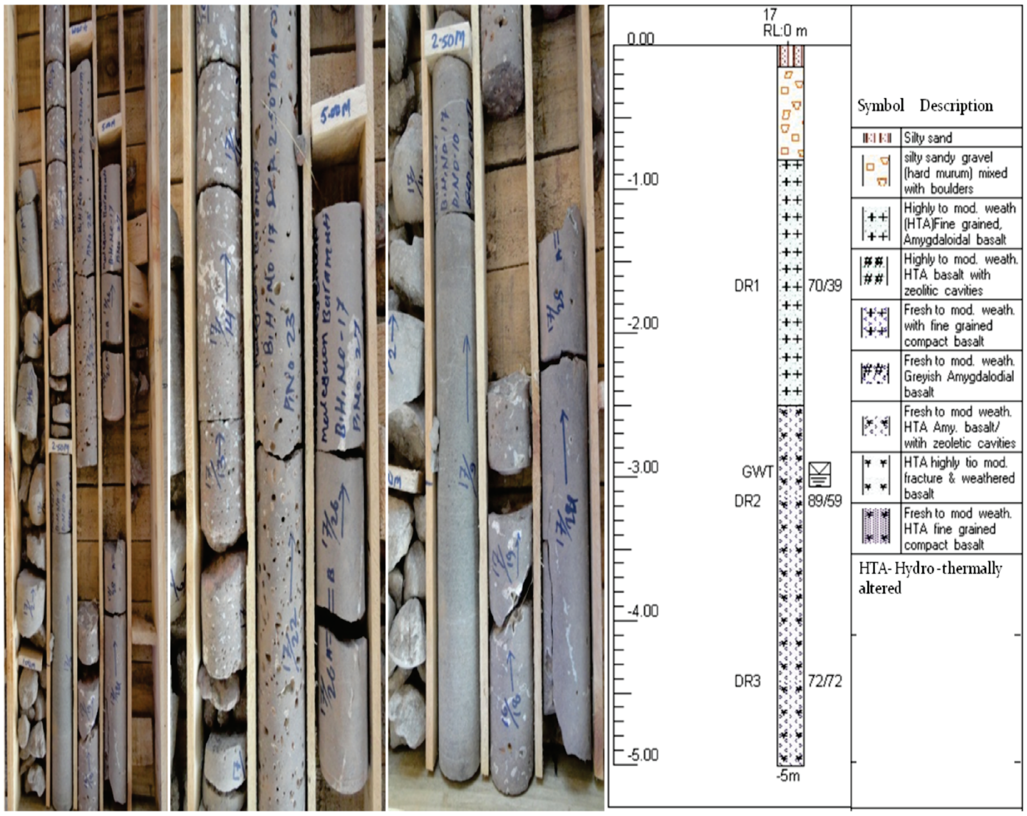


Fig. 31. Core samples from bore log 17 showing moderately to highly weathered HTA fine grained non-vesicular basalt of 1.7 m and fresh to moderately weathered HTA basalt with zeolite of 2.5 m of vesicular basalt which is overlain by gravel and boulder and soil horizon of 0.6 and 0.2 m thick respectively

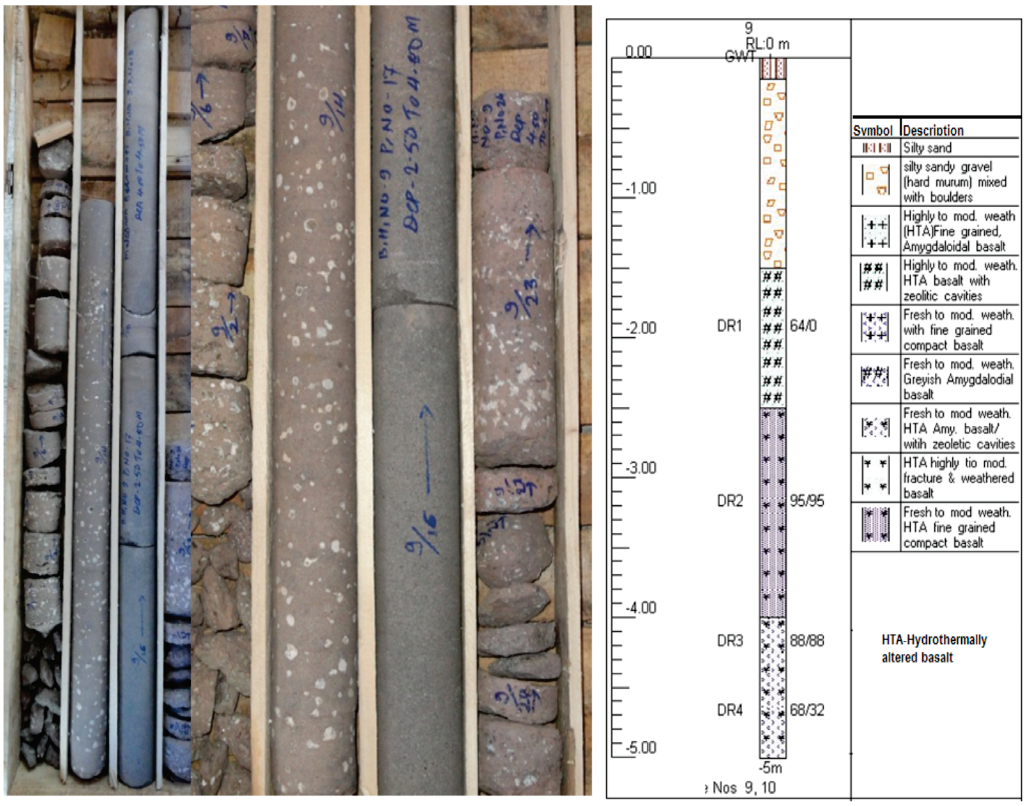


Fig. 32. Core samples from bore log 9 showing moderately weathered HTA with zeolite from vesicular flow of 1 m and moderately weathered HTA, fine grained compact basalt from non-vesicular flow of 1.5 m thick and again followed by the moderately weathered HTA with zeolite from vesicular flow of 1 m

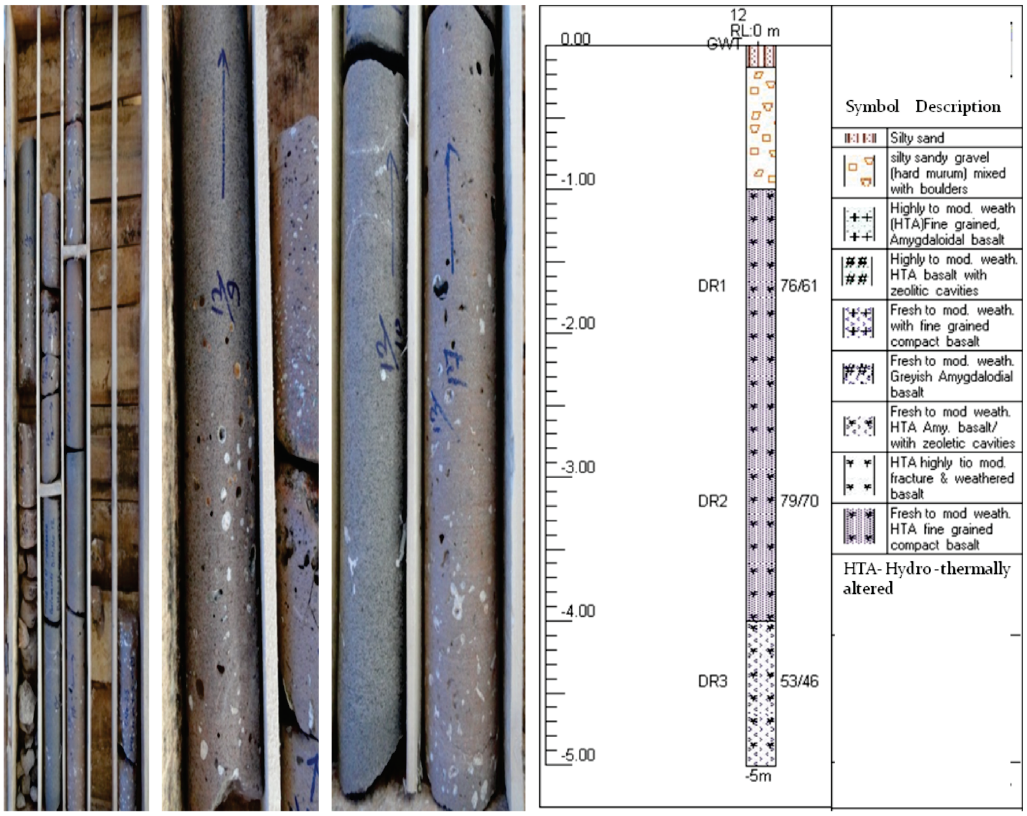
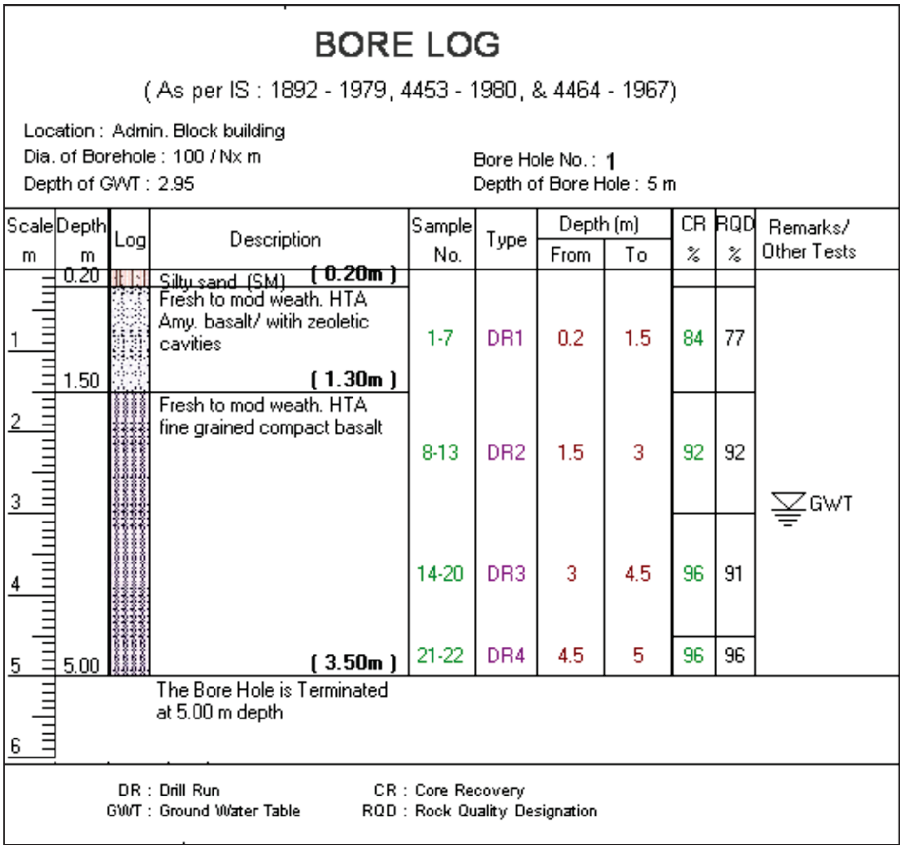


Fig. 33. Core samples from bore log 12 showing moderately weathered HTA with fine grained basalt from vesicular flow of 2 m followed by 1 m compact basalt of non-vesicular flow and moderately weathered HTA with zeolite crystals in the cavities of vesicular flow of 1 m thick. These basalts are overlain by gravel and boulder horizon of 1 m thick.

Fig. 34. Core samples from bore log 13 showing moderately weathered HTA basalt with zeolite from vesicular flow of 1 m and moderately weathered HTA, fine grained compact basalt from non-vesicular flow of 2 m thick and again followed by the moderately weathered HTA with zeolite from vesicular flow of 2 m

Fig. 35. Core samples from bore log 15 showing moderate to high weathered HTA fine grained vesicular basalt with zeolites of 2 m thick and moderately weathered HTA fine grained compact basalt from non-vesicular flow of 1 m and followed by 2 m thick of vesicular flow



BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Admin. Block building
Dia. of Borehole : 100 / Nx m
Depth of GWT : 2.95
Bore Hole No. : 1
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
	0.20		Silty sand (SM) **(0.20m)**							
1	1.50		Fresh to mod weath. HTA Amy. basalt/ witih zeoletic cavities **(1.30m)**	1-7	DR1	0.2	1.5	84	77	
2, 3, 4, 5	5.00		Fresh to mod weath. HTA fine grained compact basalt **(3.50m)**	8-13	DR2	1.5	3	92	92	GWT
				14-20	DR3	3	4.5	96	91	
				21-22	DR4	4.5	5	96	96	
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 36. %RQD of layer I - IV with depth in non-vesicular flow of bore hole No. 1

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Admin. Block building
Dia. of Borehole : 100 / Nx m
Depth of GWT : 2.75 m

Bore Hole No. : 2
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
			Fresh to mod. weath. with fine grained compact basalt	1-9	DR1	0	1.5	93	76	
				10-19	DR2	1.5	3	92	73	GWT
				20-27	DR3	3	4.5	99	85	
5	5.00		(5.00m)	28-29	DR4	4.5	5	84	84	
			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run CR : Core Recovery
GWT : Ground Water Table RQD : Rock Quality Designation

Fig. 37. %RQD of layer I - IV with depth in non-vesicular flow of bore hole No. 2

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Admin. Block building
Dia. of Borehole : 100 / Nx m
Depth of GWT : 3.3 m

Bore Hole No. : 4
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
	0.15		Silty sand (SM) (0.15 m)							
			Fresh to moderate weathered with fine grained compact basalt	1-7	DR1	0.15	1.5	96	87	
				8-14	DR2	1.5	3	93	89	
				15-21	DR3	3	4.5	97	88	GWT
	4.50		(4.4 m)							
5	5.00		Fresh to moderate weathered HTA fine grained compact basalt	22-23	DR4	4.5	5	88	88	
			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run CR : Core Recovery
GWT : Ground Water Table RQD : Rock Quality Designation

Fig. 38. %RQD of layer I - IV with depth in non-vesicular flow of bore hole no. 4

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Admin Block building
Dia. of Borehole : 100 / Nx m
Depth of GWT : 3.45 m

Bore Hole No. : 5
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
	0.20		Silty sand (SM) (0.20m)							
1			Fresh to mod weath. HTA Amy. basalt/ witih zeoletic cavities	1-8	DR1	0.2	1.5	89	80	
2				9-16	DR2	1.5	3	87	83	
3	3.50		(3.30m)							GWT
4			Fresh to mod. weath. with fine grained compact basalt	17-26	DR3	3	4.5	92	74	
5	5.00		(1.50m)	27-30	DR4	4.5	5	94	48	
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 39. %RQD of layer I - IV with depth in non-vesicular flow of bore hole no. 5

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Central Lab, Baramati
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL 4.00m

Bore Hole No. : 8
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
	0.50		Silty sandy gravel (hard murum) mixed with boulder (0.50m)							
	0.80		Higly to moderate weath- (0.30m)							
1			ered HTA Basalt with zeoletic cavities	1-8	DR2	0.8	2	90	78	
2			Fresh to moderate weathered HTA Amy basalt with zoletic cavities							
3				9-14	DR3	2	3.5	95	93	
4				15-18	DR4	3.5	4	74	54	
				19-26	DR5	4	5	82	59	
5	5.00		(4.20m)							
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 40. %RQD of layer I - IV with depth in vesicular flow of bore hole no. 8

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Type 6 Quarters
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL 3.25M

Bore Hole No. : **10**
Depth of Bore Hole : 5 m

Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
1.50		silty sandy gravel (hard murum) mixed with boulders (GP) **(1.50m)**							
3.50		Highly to mod. weath (HTA)Fine grained, Amygdaloidal basalt **(2m)**	1-8	DR1	1.5	2	70	0	
			9-12	DR2	2	3.25	62	54	
			13-15	DR3	3.25	3.5	68	0	
5.00		Fresh to mod weath. HTA fine grained compact basalt **(1.5m)**	16-19	DR4	3.5	5	89	84	
		The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 41. %RQD of layer I - IV with depth in vesicular flow of bore hole no. 10

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Type 4 Quarters
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL 4.5M

Bore Hole No. : **11**
Depth of Bore Hole : 5 m

Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
0.10		Silty sand (SM)							
1.50		Silty sand gravel (hard murum) mixed with boulders (GP) **(1.40m)**							
3.00		Highly to mod. weath. HTA basalt with zeolitic cavities **(1.5m)**	1-8	DR1	2	3	63	0	
5.00		Fresh to mod weath. HTA Amy. basalt/ witih zeoletic cavities **(2m)**	9-19	DR2	3	4.5	84	74	
			20-24	DR3	4.5	5	82	56	
		The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 42. %RQD of layer I - IV with depth in vesicular flow of bore hole no. 11

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Single Hostel
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL3M

Bore Hole No. : **14**
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	To	CR %	RQD %	Remarks/ Other Tests
1	1.00		silty sandy gravel (hard murum) mixed with boulders (GP) **(1.00m)**							
2	2.00		Highly to mod. weath (HTA)Fine grained, Amygdaloidal basalt **(1.00m)**							
3			Highly to mod. weath. HTA basalt with zeolitic cavities	1-10	DR1	2	3	51	11	
4	4.00		**(2m)**	11-21	DR2	3	4	77	28	
5	5.00		Fresh to mod. weath. Greyish Amygdalodial basalt **(1m)**	22-29	DR3	4	5	95	66	
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 43. %RQD of layer I - IV with depth in vesicular flow of bore hole no. 14

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Admin. Block building
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL at4.5m

Bore Hole No. : **3**
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	To	CR %	RQD %	Remarks/ Other Tests
1			Fresh to mod. weath. with fine grained compact basalt	1-3	DR1	0	1	81	81	
				4-8	DR2	1	1.5	86	76	
2				9-16	DR3	1.5	3	90	82	
3										
4	4.50		**(4.50m)**	17-19	DR4	3	4.5	99	99	
5	5.00		Fresh to mod. weath. HTA Amy basalt with zoletic cavities **(0.50m)**	20-23	DR5	4.5	5	88	58	
6			The Bore Hole is terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 44. %RQD of layer I - IV with depth in non-vesicular -vesicular flow of bore hole no. 3

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : School building, Baramati
Dia. of Borehole : 100 / Nx m
Depth of GWT : Water loss 4mts

Bore Hole No. : 6
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
	0.15		Silty sand (SM) (0.15m)							
1			Fresh to mod. weath. with fine grained compact basalt	1-9	DR1	0.15	1.5	75	62	
2				10-16	DR2	1.5	3	89	81	
3				17-23	DR3	3	4	83	66	
4	4.00		(3.85m)							
5	5.00		Fresh to mod weath. HTA Amy. basalt/ witih zeoletic cavities (1.00m)	24-36	DR4	4	5	81	42	
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 45. %RQD of layer I-IV with depth in non-vesicular-vesicular flow of bore hole no. 6

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : School building, Baramati
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL 2.20 m

Bore Hole No. : 7
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
	0.20		Siltu sand (SM) (0.20m)							
1			Fresh to mod. weath. with fine grained compact basalt	1-5	DR1	0.2	1	81	53	
				6-10	DR2	1	1.5	92	69	
2	2.20		(2.00m)	11-14	DR3	1.5	2.2	90	79	
	2.50		Higly to moderate weathered HTA Basalt with zeoletic	15-18	DR4	2.2	2.5	77	NIL	
3			Fresh to moderate weathered HTA Amy basalt with zoletic cavities	19-30	DR5	2.5	4	86	50	
4										
5	5.00		(2.5m)	31-35	DR6	4	5	77	72	
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 46. %RQD of layer I-IV with depth in non-vesicular-vesicular flow of bore hole no. 7

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Type 7 Quarters
Dia. of Borehole : 100 / Nx m
Depth of GWT : 2.85 m

Bore Hole No. : **16**
Depth of Bore Hole : 5 m

Depth m	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
0.15	Silty sand (SM) **(0.15m)**							
3.00	HTA highly to mod. fracture & weathered basalt **(2.9m)**	1-7	DR1	0.25	1	69	43	
		8-27	DR2	1	2.5	72	0	
		28-33	DR3	2.5	3	76	20	GWT
5.00	Highly to mod. weath. HTA basalt with zeolitic cavities **(2m)**	34-48	DR4	3	4.5	59	10	
		49-52	DR5	4.5	5	74	54	
	The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run CR : Core Recovery
GWT : Ground Water Table RQD : Rock Quality Designation

Fig. 47. %RQD of layer I-IV with depth in non-vesicular-vesicular flow of bore hole no.16

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Guest House
Dia. of Borehole : 100 / Nx m
Depth of GWT : 2.9 m

Bore Hole No. : **17**
Depth of Bore Hole : 5 m

Depth m	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
0.15	Silty sand (SM) **(0.15m)**							
0.80	Silty sandy gravel (hard murum) mixed with boulders **(0.65m)**							
2.50	Highly to moderate weathered (HTA) finegrained, Amygdaloidal basalt **(1.7m)**	1-10	DR1	1	2.5	70	39	
5.00	Fresh to mod weath. HTA Amy. basalt/ witih zeoletic cavities **(2.5m)**	11-23	DR2	2.5	4	89	59	GWT
		24-27	DR3	4	5	72	72	
	The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run CR : Core Recovery
GWT : Ground Water Table RQD : Rock Quality Designation

Fig. 48. %RQD of layer I-IV with depth in non-vesicular-vesicular flow of bore hole no.1 7

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Type 5 Quarters
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL 4.50 M

Bore Hole No. : **9**
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
	0.15		Silty sand (SM) **(0.15m)**							
1	1.50		silty sandy gravel (hard murum) mixed with boulders (GP) **(1.35m)**							
2	2.50		Highly to mod. weath. HTA basalt with zeolitic cavities **(1.00m)**	1-13	DR1	1.5	2.5	64	0	
3, 4	4.00		Fresh to mod weath. HTA fine grained compact basalt **(1.5m)**	14-17	DR2	2.5	4	95	95	
5	5.00		Fresh to mod weath. HTA Amy. basalt/ witih zeoletic cavities **(1m)**	18	DR3	4	4.5	88	88	
				19-24	DR4	4.5	5	68	32	
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 49. %RQD of layer I-IV with depth in vesicular – non-vesicular- vesicular flow of bore hole no. 9

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Type 3 Quarters
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL4m

Bore Hole No. : **12**
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
	0.15		Silty sand (SM) **(0.15m)**							
1	1.00		silty sandy gravel (hard murum) mixed with boulders (GP) **(0.85m)**							
2, 3			Fresh to mod weath. HTA fine grained compact basalt	1-11	DR1	1	2.5	76	61	
4	4.00		**(3m)**	12-19	DR2	2.5	4	79	70	
5	5.00		Fresh to mod weath. HTA Amy. basalt/ witih zeoletic cavities **(1m)**	20-23	DR3	4	5	53	46	
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 50. %RQD of layer I - IV with depth in vesicular – non-vesicular- vesicular flow of bore hole no. 12

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Type 2 Quarters
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL4M

Bore Hole No. : **13**
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
1	1.00		Fresh to mod weath. HTA Amy. basalt/ witih zeoletic cavities **(1.00m)**	1-7	DR1	0	1	86	48	
2			Fresh to mod weath. HTA fine grained compact basalt	8-12	DR2	1	1.5	67	39	
3	3.00		**(2.00m)**	13-24	DR3	1.5	3	78	43	
4			Fresh to mod weath. HTA Amy. basalt/ witih zeoletic cavities	25-29	DR4	3	4	65	58	
5	5.00		**(2.00m)**	30-35	DR5	4	5	63	50	
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 51 %RQD of layer I-IV with depth in vesicular – non-vesicular-vesicular flow of bore hole no. 13

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Location : Married Hostel
Dia. of Borehole : 100 / Nx m
Depth of GWT : WL5M

Bore Hole No. : **15**
Depth of Bore Hole : 5 m

Scale m	Depth m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	CR %	RQD %	Remarks/ Other Tests
1	1.00		Highly to mod. weath (HTA)Fine grained, Amygdaloidal basalt **(1.00m)**							
2	2.00		Highly to mod. weath. HTA basalt with zeolitic cavities **(1m)**	1-10	DR1	1	2	58	23	
3	3.50		Fresh to mod. weath. with fine grained compact basalt **(1.5m)**	11-15	DR2	2	3.5	87	87	
4, 5	5.00		Fresh to mod weath. HTA fine grained compact basalt **(1.5m)**	16-31	DR3	3.5	5	77	45	
6			The Bore Hole is Terminated at 5.00 m depth							

DR : Drill Run
GWT : Ground Water Table
CR : Core Recovery
RQD : Rock Quality Designation

Fig. 52. %RQD of layer I - IV with depth in vesicular – non-vesicular-vesicular flow of bore hole no. 15

NIASM Publications

NIAM : First Annual Report: 2009-2010 (2010). National Institute of Abiotic Stress management, Malegaon, Baramati 413115, Pune, Maharashtra. 69 pp.

NIAM : A Profile (2010). National Institute of Abiotic Stress management, Malegaon, Baramati 413115, Pune, Maharashtra. 17 pp.

Maurya, UK and Vittal, KPR (2010). Geology of the NIAM Site, Malegaon. NIAM Technical Bulletin-1, National Institute of Abiotic Stress Management (ICAR), Baramati, 13 pp.

Maurya, UK and Vittal KPR (2011). Identification of Abiotic Edaphic Stressors of Deccan Trap at NIASM Site, Malegaon: A Geotechnical & Geological Study, NIASM Technical Bulletin-2, National Institute of Abiotic Stress Management (ICAR), Baramati, 40 p.

NIASM : Second Annual Report: 2010-11 (2011). National Institute of Abiotic Stress Management, Malegaon, Baramati. 413115. Pune, Maharashtra, India, 64 pp.

NIASM : Vision 2030 (2011) National Institute of Abiotic Stress Management, Malegaon, Baramati. 413 115. Pune, Maharashtra, India, 40 pp.

NIASM Technical Bulletin -2

भाकृअनुप
ICAR

Identification of Abiotic Edaphic Stressors of Deccan Trap at NIASM Site, Malegaon

A Geotechnical and Geological Study

राअप्रस
NIASM

National Institute of Abiotic Stress Management

Indian Council of Agricultural Research

Malegaon, Baramati - 413115 (Pune) Maharashtra

About the NIASM

Recognizing the importance of influence of climatic change on the already mounting adverse effects of abiotic stresses of climate, water, edaphic factors, etc. on various sectors of agriculture, horticulture, livestock, fisheries, birds, etc., on 19th January 2009, the Union Cabinet approved in XI plan establishment of National Institute of Abiotic Stress Management (NIASM), with a status of Deemed-to-be University. Its foundation stone was laid by Shri. Sharadchandraji Pawar, Hon' Minister of Agriculture & Consumer Affairs, Food & Public Distribution, GOI on 21st February 2009, at Malegaon Khurd, Baramati, Pune District, Maharashtra. This is a 'Dream Project' of the Council. Wisely the Council vested the responsibility with Natural Resource Management Division to define the target areas to bio and other technologists to meet the mandate. The mandate of the institute is -

- To undertake basic and strategic research on management of abiotic stresses of crop plants, animals, fishes and micro-organisms through genetic, biotechnological and nano technological tools and agronomic methods for enhanced sustainable productivity, food/feed quality and farm profitability adopting integrated interdisciplinary approaches
- To develop a Global Center of Excellence by establishing linkages and networking with national and international Institutes/agencies, and
- To act as repository of information on abiotic stress and management

The primary objective is to develop agricultural commodities neutral or adoptable to mounting abiotic stresses under climate change using bio-nano-technologies and other scientific frontier tools without any reduction in productivity.

Presently the science is progressing from the functions of individual genes to behaviours of complicated systems that emerge from the interactions of a multitude of factors. These recent developments necessitate the promotion of a combination of approaches collectively called "Systems Biology." The final goal is to develop an insight into background, hypotheses to mitigate, strategies to incorporate with a foresight to practice climatically adaptable farming systems for building sustainable and profitable livelihood in stressed environments and constitutionally acceptable policy issues.

About NIASM Logo

A logo is founded on the pedestal of background of the National Institute of Abiotic Stress Management (NIAM) on which it is created and envisaged mandate alerting concerns and issues ranging from current to future in agriculture, livestock and fisheries justifying the formulation of a dedicated management institute for abiotic stresses. At this Institute, the four schools of Drought Stress Management, Atmospheric Stress Management and Edaphic Stress Management and Policy Support Research interact to improve the life ameliorating the impinged stresses and others invading in various related cycles sustaining the human life. This philosophy is conceptualized in the logo in succinct manner.

The symbols embody are the elements of

The three symbolically interlocking radial hands represent (a) the cyclic anthropogenic pressures of livestock (blue), agriculture (green) and fisheries and other water related activities (aquamarine blue) and (b) humans of various creeds and colors, under taking for livelihoods on the landscape which needs consideration not in a sectional approach but a holistic way to provide customized technologies and (c) asking for forging unrelenting extensive linkages of peers through global co-operation to pact against our surmountable problem by collective action, thus generating new material represented by emerging seedling in the center. This will receive a combined attention of all the four Schools of Edaphic, Drought and Atmospheric Stress Management including Policy Support Research along with others working objectively.

Raindrop in center is the driving force of life but is threatened by (a) stresses of climate change and (b) associated various anthropogenic actions reflected by symbolic hands around needing utmost attention for in-toto conservation. This will be the hub of actions around which the Institute revolves.

The clouds crossing raindrop are (a) like Asian Brown Clouds indicative of looming climate change (b) from green house effects or pollution which needs undeviating attention. This will be the core issue for Schools of Atmospheric Stress Management and Policy Support Research

The seedling in green color connecting earth with raindrop expresses (a) efforts of the scientists to tackle all the pressures through screening and developing through biotechnology or other futuristic tools to evolve abiotic stress tolerant and or adoptable plants, animals, fishes etc. and (b) the undying optimism towards ever regenerating life regardless of forever mounting pressures of human beings. These will have a foundation consideration of School of Drought Stress Management.

The central triangular open space created by hands around the raindrop institutionalizes creation of unique facility under single umbrella with growth for (a) especially focused high quality research facilities embedding frontier sciences, and (b) choicest capacity building through a cutting-edge education. The former will be a not only a shared facility of Drought, Atmospheric, and Edaphic Schools but also with their endeavoring peers in national and international agricultural research systems in the; while later is a collective responsibility of all the schools.

The earth surface is the endangered 'nature' consequential to (a) unabated land degradation resulting in edaphic stresses like drought, floods, salinity, soil acidity, pollution etc. due to the forces of varying rainfall confounded by the plaguing climate change and (b) a shrinking greenery by deforestation related activities needing attention of all dwellers of 'spaceship earth' on resource conservation. These will have the core attention of the two Schools of Drought & Edaphic Stress Management.

The set goal, thus of the NIAM, is to develop an invincible theory to model using frontier sciences and techniques for building flexible forming systems encompassing agriculture, livestock and fisheries sustaining most of the resources matching several aspirations, to practice and refine the system on a participatory mode, and finally to accomplish profitability from adopted livelihoods on the system by the farming communities on an abiotically stressed landscape under changing climate scenario.

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SAKALP, BARAMATI