

An Appraisal of Hydrogeological and Other Characteristics of the Barsingsar Lignite Deposit, Bikaner District, Rajasthan, India

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Abstract: Barsingsar village is located at the south-western corner of the lignite seam in the area. Mine Boundary is based on the cut of limiting ratio of 1:15 (lignite: OB in m³). The geological reserve reported within the mine boundary is 58.89 MT. The mineable reserves of 53 MT are to be excavated by removing 255.18 Mm³ of overburden. The average stripping ratio is 1:4.81 (lignite in T: OB in M³).

Key words: Lignite, geology and hydrogeology etc.

I. Introduction

The Barsingsar block is located about 25Kms in south-west direction from Bikaner city in State of Rajasthan and falls on the toposheet No.45E/1 of Survey of India having latitude 27° 48' 59'' -27° 51' 02''N and longitude 73° 11' 20''-73° 11' 58''E. The climate of the area is typical of dry and arid regions with variation in temperature between day and night. Maximum temperature rises up to 48°C in summer season and minimum to 2°C in the cold winter weather having an average annual rainfall of 250mm. The Barsingsar block is located in an arid region and therefore, precipitation is meagre and sporadic in nature and source of water is mainly ground water. The average annual rainfall in the area is 250mm and the highest rainfall recorded during recent years was 493.90mm in the year 1997.

Regional Geology

The regional generalised stratigraphy is shown in following table no.-1.

Age		Barmer basin	Jaisalmer basin	Bikaner-Nagaur basin	
Cenozoic	Holocene	Dune sands, alluvium	Shumar Formation	Sand dunes	
	Pleistocene	gravels		Mar Formation	
	Pliocene	Utarlai Formation			
	Miocene				
	Oligocene				
	Eocene	Priabonian			
		Bartonian		Bandah Formation	Jogira Formation
		Lutonian			
		Ypresian	Kapardi Formation Mataji ka Dungar Formation Akli Formation	Khuiala Formation	
	Palaeocene	Thanetian	Barmer Formation	Samu Formation	Marh Formation
Mountain		Fatehgarh Formation			
Danian				Palana Formation	
Mesozoic	Cretaceous	Santonian			
		Coniacian			
		Turonian			
		Cenomanian			
		Albian			
		Aptian		Harbur Formation	
	Neocomian	Sarnu Formation	Pariwar Formation		
	Jurassic	Tithonian		Bhadasar Formation	
		Kimmeridgian		Baisakhi Formation	
		Oxfordian			
Callovian		Jaisalmer Formation	Jaisalmer Formation		
Bathonian		Lathi Formation			
	Lias		Lathi Formation		
Triassic					
Paleozoic	Permian			Badhaura Formation	
	Carboniferous			Bap boulder bed	
	Devonian to Ordovician				
	Cambrian	Birmania Formation	Birmania Formation	Nagaur Formation Bilara limestone	
Neoproterozoic		Randha Formation	Randha Formation	Jodhpur sandstone	
		Malani rocks/ basement complex	Malani rocks/ basement complex	Malani rocks	

Table.1 Phanerozoic Stratigraphy Of Rajasthan (After Bhandari)

Geology Of Block

The Barsingsar block is covered by aeolian sand and having undulating topography with maximum and minimum altitudes of 288m and 262m respectively. The general slope of the region is towards west and northwest. The stratigraphic horizon of Barsingsar block consists of aeolian sand, kankar, friable medium grained to coarse grained sandstone with bands of clay & marcasite, variegated clay, lignite, intercalation and carbonaceous clay, clayey silt and fine grained sandstone towards bottom. The various formations have a gentle rolling dip due to uneven floor of deposition. The main lignite deposit in Barsingsar block is located in Palana formation which is about 200 m in thickness.

The lignite seam along with other litho units shows pinching and swelling nature at places. In general the dip of formations varies from 2 to 6°. The borehole data indicates mainly one lignite horizon from depth of 45.0m to 135.0m in this area which splits into two or more bands towards periphery of the block. The stratigraphic succession of the Barsingsar block is given below in tabular form.

Period	Formation	Litho Units	Thickness(m)
Recent to Sub-recent Eocene	Aeolian sand and Kankar	Aeolian sand and Kankar	1.50 to 6.50
	Palana Formation	Friable medium grained to coarse grained sandstone with bands of clay & marcasite	6.10 to 120.80
		Variegated Clay	0.00 to 63.20
		Lignite, intercalation and carbonaceous clay	0.00 to 61.60
		Clayey silt	0.70 to 57.00
		Fine grained sandstone	(Continuing to wards bottom)

Description Of Lignite Horizon

The drill data furnishes information that one lignite horizon is present in the Barsingsar block which splits into two or more sections and the depth of this horizon varies from 45 to 135 m. The workable lignite deposit is divisible in two parts viz. eastern part and western part separated by a linear tract which is devoid of lignite. The upper horizon above the main lignite horizon is dominated by variegated clay with occasional carbonaceous clay band and it is underlain by silty clay.

Lignite Quality

Units	Range of in situ Moisture%	Range of ASH%	Range of V. M.%	Range of F.C.%	Range of calorific value Kcal/kg.
Lignite	42.0 -47.0	10.0 -24.0	20.0-23.0	6.0 -20.0	2400-3500

Mining Operation

In Barsingsar Lignite Mine project, the method of working is opencast mining utilizing shovel- dumper combination. The average quantity of overburden to be removed per annum is about more than 9.1 million cubic metres and average lignite mining operation per annum is more than 2.1MT.

Production details

Over Burden		
S.No.	Year	Production in LCum
1	2006-07	64.18
2	2007-08	114.88
3	2008-09	102.07
4	2009-10	99.20
5	2010-11 (up to Nov10)	64.16
Lignite (in tonnes)		
1	2007-08	40,000.
2	2008-09	1,16,018.
3	2009-10	24,541.
4	2010-11 (up to Nov10)	1,57,256

Waste Disposal

The waste removal has been classified into categories as given below.

1) Top overburden

The top overburden comprises of aeolian sand and kankar. The excavation is carried out by forming 2 to 3 benches. The bench height is kept as 3m which is less than the digging height of the 3.5 m³ shovel. The sandy soil is kept separately to enable subsequent reclamation of dump sites.

2) Main Overburden After excavation, the main overburden of clay and friable sandstone is carried out by forming 6m. height benches which are less than the digging height of the 3.5m³ shovel. The overburden excavated from the faces is dropped to external dump sites.

The overburden up to main seam in Barsingsar block is composed of different litho units as shown in following table.

Litho unit	Thickness (m)
Aeolian sand	1.50 to 6.50
Kankar	0 to 20.50
Medium to coarse grained friable sand stone with clay and marcasite bands	6.10 to 120.80
Variegated clay, sandy clay, silty clay etc.	0 to 63.20

The inter-burden rocks in main seam are clay bands and overburden in the Barsingsar block composed of aeolian sand, kankar, medium to coarse grained friable sandstone, variegated clay, sandy clay and silty clay etc. The sandstone percentage in the overburden rock strata varies from 30% to 50% in the central part of the block and it increases up to 80% towards peripheral part.

Hydrogeological condition

The aquifers in the Bikaner District as a whole are comprised of mainly of quaternary and tertiary sediments alongwith the vindhyan formation at some places. The quaternary sediments are predominated by clay, silt, sand, gravel, pebbles and calcareous concretions. The general depth to water table lies from 12 - 70 meters and reported yield of tube wells varies from 10,000 to 70,000 LPH. The pre and post monsoon water table fluctuation is reported in the order of 0.1 – 0.7m

Groundwater Condition In The Mining Area

In the Barsingsar lignite deposit area the overburden consist of quaternary and tertiary coarse sands and gritty sandstone intercalated with clays and gravel having thickness of 60-80m. The upper blown sand and kankar zones are devoid of ground water. In the west part of the open pit water level in the aquifer zone above the top of the seam lies within thickness of 10-15 m. The lignite is underlain by clays and silty clays which in turn followed by fine grained tertiary sandstone. This sandstone which is slightly glauconitic in nature constitutes the main water-bearing horizon in the Barsingsar area. According to Groundwater Assessment Report prepared by Ground Water Department (GWD) of Govt. of Rajasthan in 1989, the general thickness of this aquifer was assumed as 60 m.

Behaviour Of The Aquifer

In 1989 the Ground Water Department of Govt. of Rajasthan has conducted pumping tests in the tertiary aquifer composed of coarse and gritty sandstone at depth of 201 meters which is located west of Barsingsar mine area. After continuous and constant pumpage for 2600 minutes with capacity of 437.4 m³/day (4050 gph)- and drawdown were recorded in tube well at 26.15m and observation well at 0.61 m respectively. The following results were obtained:

Transmissivity of the aquifer	396.695 m²/d
Storativity of the aquifer	0, 00044
General thickness of aquifer	60 meters

The results of some important chemical parameters of water sample collected from mine site are shown in tabular form given below.

Ground Water Chemistry

s.no.	Parameters	Bore well inside Mine
1	PH	7.1
2	Turbidity (NTU)	clear
3	Colour(Hazen units)	None
4	Odour	Agreeable
5	Total Alkalinity (as CaCo3)	340 mg/Ls
6	Total Hardness (as CaCO3)	220 mg/Ls
7	Calcium Hardness	105 mg/Ls
8	Magnesium Hardness	115 mg/Ls
9	Carbonate Hardness (as CaCo3.)	225 mg/Ls
10	Chloride (as CL-)	288 mg/Ls
11	Sulphate (as SO4-2)	80 mg/Ls
12	Nitrites (as No3)	6 mg/Ls
13	Fluoride (as F)	0.4 mg/Ls
14	Total Dissolved Solids	925 mg/Ls

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