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EVALUATION OF SOIL LAYERS AROUND BAR, PALI DISTRICT, RAJASTHAN

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ABSTRACT

The present study is concerned with South Delhi Fold Belt (SDFB) around Bar, Pali district, Rajasthan, type food with a mixture of hilly and peneplained topography. This study was an embodiment with an objective of distribution of physico-chemical properties, available nutrients in grey brown loams, sandy plain soil and younger alluvial soils of arid region of Pali district. Based on the morphological characteristics and land elevation, seven representative geo-referenced soil types were selected and horizon wise soil samples were collected during 2016.

The results of soil sediment surveys carried out at Bar, Birantiya Khurd, Dipawas, Kalab Khurd, Kalab Kalan and Raira Khurd villages in Pali district of Rajasthan andexamined by analysis for positioning of hills, rocky outcropsand inclination of hill slopes, the thickness of humus and rock types of the investigated area, located about 25 km SSE of Bar village. Considering different factors of scanty outcrops, widespread sandy soil cover, hilly terrain and active drainage, the area has been considered suitable for target selection using sandy and soil samples as for geochemical and geophysical analysis. To achieving desired results of regional and detailed soil sediment surveys as a tool for different clay minerals with different particle size and has been established in the SDFB which can be applied in other fold belts of the country. This study aims to important in the management of soil, very important for the farmers/agriculture and geology of the study area. This study focuses on the geology and physico-chemical analysis of soil around the Bar.

(Key words: South Delhi Fold Belt (SDFB), peneplained area,sandy soil cover, geophysical analysis, Bar, Pali district)

INTRODUCTION

India is an agrarian society and therefore soil is the precious and most important natural non-renewable resource for human society, especially inrelation to agricultural extension, land evaluation and protection of environment. Soil depth, fertility, texture, etc., and its interaction with climatic conditions result in productivity and thereby prosperity of the society. The soils of investigated area include initial investigations of eleven sites including mineralogy, soil depth and soil nutrients from Bar, Dipawas, Kalab Khurd, Kalab Kalan and Raira Khurd of Pali district, Rajasthan. The study deals with mostly conglomeratic (Bar conglomerate horizon) folded rocks which are metamorphosed. The soil of Bar area is complex, highly variable in composition and is required to estimate spatial and temporal variability in soils within short distance. On the basis of soils fabric, the soils are put into five major groups: (1) sandy soils or light soils (2) sandy loam or light medium soils (3) loam and medium soils (4) clay loam to clay and (5) hilly soils or skeletal and shallow rocky. Grey-brown (desert soil), ferruginous red soil, mixed red, black soil, medium black soil and alluvial soils belong to all groups.

The soil of Pali district has been classified as grey-brown alluvial soil. It contains good nitrate, which is good for vegetation. The soil depth in the study area varies from almost nil on hilltops to a few meters on the foothill with obstacle dunes. At places, particularly adjoining areas of water bodies, the soil is more fertile and supportive of crops, vegetables and tasteful fruits that may be due to water quality and trace minerals (Malvi *et al.,*2021 and Khandagle *et al.,*2019).Thus, the soil available in the study area may indicate the degradation of rock and the formation of soil supporting particular types of vegetation.

Geology Setting

The rocks of south-western side of the study area include scattered outcrops of granitic gneisses which are mostly concealed under thick pile of loose sand layer of alluvium. The posts-tectonic dikes, sills of pegmatite and granite and quartz-veins are quite common in this area, particularly widespread in Bar, Birantiya,Lawacha and Haripur and its immediate vicinity. Quartz veins, indicating the presence of intrusive activity in the region, also referred

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to by Naha *etal.* (1984), show presence of tourmaline, garnet, beryl, etc. The study area included three main tectonic divisions of Delhi supergroup from southwest to northeast, *viz*., Banded Gneiss Complex (BGC) of Heron, 1953, Barotia Formation (Alwar Group) and Sendra Formation (Ajabgarh). All the three tectonic divisions are well displaced in the area. The BGC is made up of Precambrian basement in the southwestern side, the lower most tectonic unit of the area (Roy *et al.,* 1985). It is separated from the overlying rocks of the Barotia Formation with an unconformity (Gangopadhyay and Lahiri, 1983). The Barotia Formation consists of Bar conglomerate horizon, calc amphibolite schist, quartzite schist and calc-schist with intercalated quartzite schist. Bar conglomerate horizon is further divided into quartzofeldspathic mica schist, Bar conglomerate schist, garnetiferous mica schist, staurolite schist and kyanite schist. The overlying Sendra Formation constitutes the northeastern part of the study area. Dolomite (equivalent to Nandana crystalline limestone of Heron, 1953) separates the Sendra Formation from the underlying Barotia Formation conformably (Table 1).

MATERIALS AND METHODS

The soils of Rajasthan includes preliminary geophysical investigations of 11 sites including mineralogy, soil intensity and soil nutrients from Bar, Dipawas, Kalab Khurd, Kalab Kalan and Raira Khurd of Pali district, Rajasthan (Table 3 and 4). The soil samples representing different type of soils were characterized for physico-chemical properties and chemical properties determine with the help of UV-VIS spectrophotometer-Model Shimadzu-1650PC and determine of soil texture was used the particulate organic matter (POM) method. The analysis of available nitrate nitrogen (NO_3-N), the extraction procedure was performed using Cataldo *et al*. (1975) method. Olsen's method (1954) was adopted for extraction and estimation of available phosphorus (PO_4-P). Titrimetric and DTPA method were used for other soil nutrients. Observation of the rock samples used for lithostratigraphic classification and data regarding mineralography are given in Table 1 and 2.

RESULTS AND DISCUSSION

The relationship between the parent rock mineralogy and nutrients available in soils is very strong. High magnesium availability in soils is related to the alteration products of the ultramafic rocks (Table 4). The potassium content of the soils showed no relation with the geology of the area. Micronutrients, iron and manganese, showed strong genetic relationship to the bulk chemistry and mineralogy of the parent rock material. According to the study of Moraetis *et al.* (2006), the parent rock bulk chemistry and mineralogy affects the Mg^{2+} availability in the soils. An oversupply of Mg^{2+} in soil solution appeared in areas underlain by ultramafic parent rock. Potassium availability did not exhibit any correlation with the bulk chemical analysis and the mineralogy of soil (Table 4). In contrast, it showed good correlation with the particle size distribution and specifically with soil clay content (Table 3). The input and output of magnesium and potassium were strongly related with the availability of these elements in vegetation. Also, the availability of important micronutrients such as manganese and iron followed the bulk chemical analysis and the mineralogy of the soil zinc and copper showed no correlation with the chemistry and mineralogy of the various types of soils (Pandurang, 2022). There is, however, a direct relationship in nutrients concentration present in plants which are affected with nutrient availability in soil. Nutrient concentrations in plants are usually correlated with nutrient availability in the soil. Nutrient concentrations are predicted to be higher at root level than open-grassland plants. Garcia-Moya and McKell (1970) found that shrubs helped maintaining the pool of soil nutrients in desert ecosystem by creating islands of accumulation of organic matter. Tiedmann and Klemmedson (1973) studied soil profiles under the canopy zone soil of Mesquite tree (*Prosopis juliflora* (Swartz) DC), and compared it with the soil from adjacent openings at three depths near Tuscon, Ariz. Bulk density was lower in soil under Mesquite but increased with the gravity in that location. Total potassium was higher under mesquite but increased with the gravity. Total phosphorus and hydrogen ion concentration were the same as in soil from open areas of past results suggested that mesquite trees function to improve soil condition under their canopies by redistribution of nutrients from areas beyond the canopy to areas beneath the canopy. Bernhard-Reversat (1982) observed good correlation between soil and vegetation study area belongs to BGC and Barotia and Sendra formations of Delhi supergroup. Out of 11 sites, two sample sites, *viz.,* Dipawas II and Kalab Khurd II cover BGC, two sites, *viz*., Birantiya Khurd I and II cover Sendra formation and rest seven sample covered different members of Barotia formation. The Birantiya Khurd I and II site is located in hilly terrain consisting of calc amphibole schist. Metamorphosed limestone formation is located on eastern side of this site. Dipawas is very close to Bar market located on Garnetiferous mica schist. The site is eroded patch adjacent to Bar conglomerate bed. At Dipawas II site there is small hillock of granitic gneiss (Fig.2a). There is thick pile of soil and rock formations are deposited and are concealed over a vast stretch. Kalab Khurd I and II are located on partially eroded hill where granitic gneiss is in gradual contact with feldspathic schist (Fig.2b). The sample sites at Kalab Kalan I and II located on calc schist rock which is situated in between garnetiferous mica schist and quartzitic schist. The hill is steeply sloping. The sample site of Kalab Kalan III is located in highly eroded garnetiferous mica schist rocks (Fig.2c).Raira Khurd I and II are located on Bar conglomerate bed. The western side of the location is highly eroded. The rocks have suffered low to medium grade of metamorphism ranging from biotite to kyanite grade.

The Aravalli range, the oldest mountain range, runs across the Rajasthan state from Mount Abu (Southeast) to

Table 1. Lithostratigraphy of the the Bar, Birantiya Khurd, Dipawas, Kalab Khurd, Kalab Kalan and Raira Khurd

<table>
<tr><th>Heron (1953)</th><th colspan="3">Under Present Study</th></tr>
<tr><td>Intrusive granite</td><td colspan="3">Intrusive granite is not exposed in the investigated area</td></tr>
<tr><td>Sendra Complex</td><td>Sendra Formation</td><td colspan="2">Calc amphibolite gneiss with alternate bands of mica schist and foliated quartzite</td></tr>
<tr><td>Nandana Crystalline Limestone</td><td colspan="3">Dolomite</td></tr>
<tr><td rowspan="8">Barotia Sequence</td><td rowspan="8">Barotia Formation</td><td colspan="2">Calc-schist with intercalated quartzite schist</td></tr>
<tr><td colspan="2">Quartzite schist</td></tr>
<tr><td colspan="2">Calc amphibolites schist</td></tr>
<tr><td rowspan="5">Bar conglomerate horizon</td><td>Kyanite schist</td></tr>
<tr><td>Staurolite schist</td></tr>
<tr><td>Garnetiferous mica schist</td></tr>
<tr><td>Bar conglomerate schist</td></tr>
<tr><td>Quartzofeldspathic mica schist</td></tr>
<tr><td>Unconformity</td><td colspan="3">Unconformity</td></tr>
<tr><td>Banded Gneissic Complex</td><td colspan="3">(B.G.C) Granitic gneiss</td></tr>
</table>

Table 2. Clay mineralogy of soils of Rajasthan

Name of Soil	Clay Minerals (in order of dominance)
Dune Soil	Illite (Mica), Smectite, Vermiculite, Kaolinite
Sandy plain soil	Illite (Mica), Smectite, Vermiculite, Kaolinite
Grey brown loams	Illite (Mica), Smectite, Vermiculite, Kaolinite, Attapulgite (fuller's earth),Kaolinite (in traces)
Grey Brown loams	Illite (Mica), Smectite, Vermiculite, Kaolinite,Attapulgite (fullers earth)
Brown soil	Smectite, Illite (Mica), Vermiculite, Chlorite,Kaolinite
Younger alluvial plain soil	Illite (Mica), Vermiculite, Chlorite and Kaolinite
Medium black soil	Smectite, Illite, Kaolinite

Table 3. Distribution of particle size of sand, silt and clay with Soil depth

Sampling site	Soil Depth (cm)	Gravel content (%)	Sand (%)	Silt (%)	Clay (%)	Texture
Bar I	80	54.53	40.53	2.48	2.48	Sand
Bar II	100	57.54	39.24	1.40	1.82	Sand
Dipawas I	80	54.83	41.93	1.46	1.78	Sand
Dipawas II	110	8.18	82.90	3.66	5.28	Sand
KalabKhurd I	70	52.30	45.66	0.88	1.15	Sand
KalabKhurd II	180	11.23	88.78	0.00	0.00	Sand
KalabKalan I	60	43.12	44.94	6.83	5.12	Loam sand
KalabKalan II	70	46.02	45.74	4.52	3.73	Loam sand
KalabKalan III	180	36.81	61.69	0.56	0.95	Sand
RairaKhurd I	50	71.51	27.07	0.71	0.72	Sand
RairaKhurd II	140	44.60	49.69	3.24	2.67	Loam sand

Table 4. Soil content for vegetation study around Bar area of Pali District

Sampling site	Soil depth (cm)	Soil nutrients (mg kg^{-1})				
		$PO_4 – P$	$NH_4 – N$	$NO_3 – N$	K	Mg
Bar I	0-15	17.88	2.15	1.16	160	105
	15-80	19.77	2.05	0.99		
Bar II	0-30	8.98	5.29	1.99	140	95
	30-75	12.66	5.15	1.66		
	75-100	17.38	4.80	1.10		
Dipawas I	0-10	11.08	4.35	3.35	135	91
	10-30	8.96	3.88	1.97		
	30-80	15.77	3.23	2.05		
Dipawas II	0-25	20.46	4.80	2.45	142	94
	25-80	10.65	4.10	1.85		
	80-100	13.16	3.62	1.94		
	100-110	11.35	3.38	1.82		
KalabKhurd I	0-10	19.45	4.95	3.95	130	80
	10 -50	11.92	4.36	1.55		
	50-70	8.60	2.55	2.45		
KalabKhurd II	0-10	13.16	3.62	1.45	155	75
	10-180	12.02	2.98	1.32		
KalabKalan I	0-60	10.55	3.42	2.30	134	77
KalabKalan II	0-20	21.18	4.50	3.28	120	98
	20-40	13.55	3.02	2.04		
	40-70	14.92	1.85	0.69		
KalabKalan III	0-30	18.15	2.32	3.10	155	105
	30-60	19.12	2.74	2.87		
	60-90	14.24	2.14	1.82		
	90-180	12.35	2.15	1.95		
RairaKhurd I	0-10	17.06	5.02	4.06	147	102
	10-50	16.62	4.84	2.05		
RairaKhurd II	0-10	17.05	3.83	2.52	131	95
	10-100	16.23	3.43	1.63		
	100-140	13.24	2.42	1.30		

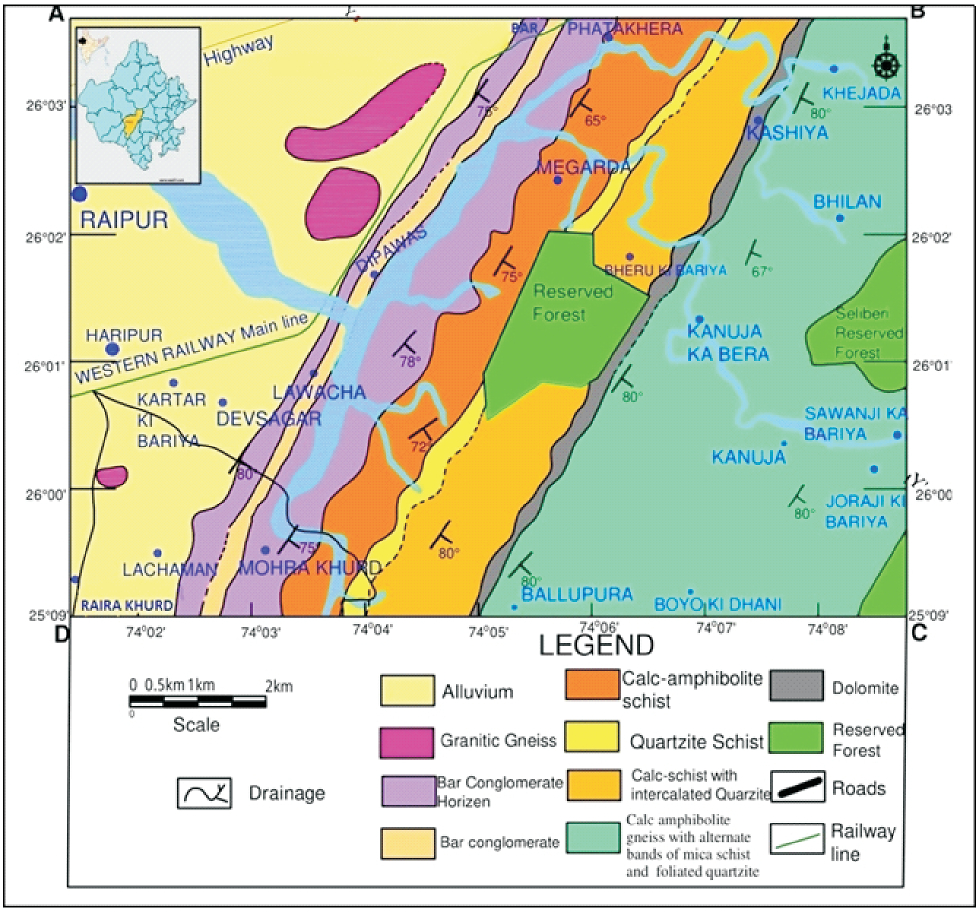

Figure 1. Geological map of Bar-Dipawash-MohraKhurd section of Pali district (Rajsthan)

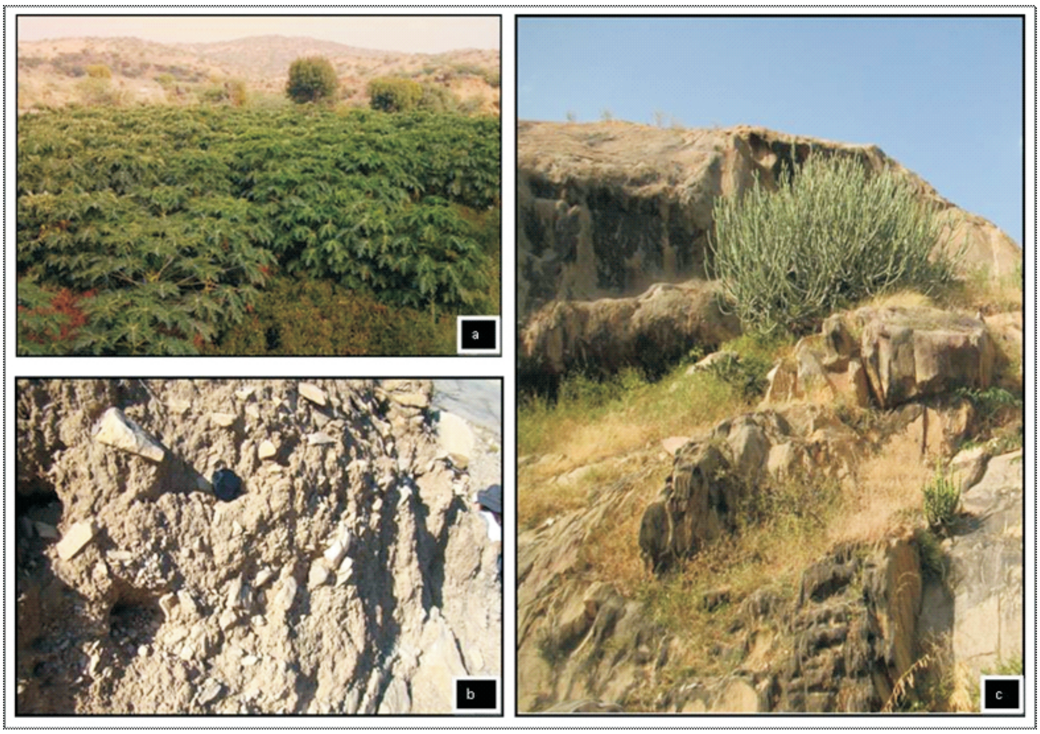

Figure 2.(a) Hills of granitic gneiss along with thick vegetation at Dipawas II. (b) Fractured and weathered hill of granitic gneiss of feldspathic schist at KalabKhurd II. (c) Weathered (Mechanical or / Chemical) garnetiferous mica schist at KalabKalan II

Khetri in Jhunjhunu district (Northeast) and divides the state into 60% in the northwest and 40% in total southeast. The northwest trace is sandy and un-productive with little rain fall whereas southeastern side is improved and fertile due to good climatic conditions.Bernhard-Reversat (1982) observed good correlation between carbon and nitrogen in soil under *Acacia senegal* and *Balanitesa egyptiaca* tree canopies and tree girth and growth. Soil nutrients changed with time of woody plant occupancy of a patch.Soil nutrients concentrations tend to diminish with increasing soil depth but there is increased evidence of a large reserve of nitrate-nitrogen at depth in groundwater in arid zone.

Soil of the area

The soil samples contain 15.27 mg kg^{-1}, 3.09 mg kg^{-1} and 2.18 mg $kg^{-1}$of PO_4-P, NH_4-N and NO_3-N respectively across the sampling sites and soil layers (Table 4). Irrespective of soil layers, available PO_4-P ranged from 10.59 mg kg^{-1} at Kalab Kalan I to 18.78 mg kg^{-1}at BarI, whereas available NH_4-N ranged from 2.15 to 2.05 mg kg^{-1} at Bar I and 5.02 to 4.84 mg kg^{-1} at Raira Khurd I. While averaging site for soil layers, all these soil nutrients showed their higher concentrations in top soil layer as compared to the deeper soil layers and showed a decreasing trend towards deeper soil layers except at Kalab Kalan III and at Dipawas I. However, in Kalab Kalan III the PO_4-P and NH_4-N availabilities was relatively greater in deeper soil layers as compared to the top soil layer. Dipawas I also showed their higher concentrations in deeper soil layers.

In India, arid soils cover about 20 million ha area covering Rajasthan, Gujarat, Punjab and Haryana and most of the soils are arid soils (Dregne, 1976).The process of soil formation by breaking up the rock particles and enriching the soil with organic matter from aerial and subterranean parts are influenced by biological activities. Minerals and organic matters are the main constituents of soils. River sands, gravels, cobbles, pebbles, and boulders are the main sources of soil. The ever increasing population, urbanization and industrialization have led to generation and indiscriminate mining of large amount of ores, rocks, minerals**,** placer deposits and soil for domestic, commercial and industrial purposes.It is not only an ecological risk, but simultaneously it is also a socio-economic issue. Such contaminated soil become poor in physicochemical properties, susceptible to erosion, loss of productivity, sustainability and diminished food chain quality, which are mandatory for human society.

The investigated area is located in the great Indian Thar Desert of Rajasthan, where soil of the Raipur- Pali area is of sandy and loam type with medium grained texture. This type of soil that may be utilized for making tiles, slabs and pillars, are in demand in rural and urban areas. In addition, soil, sand, concrete, cobble, pebble and boulders are already being utilized for masonry works and giving a good revenue, now the time has come to prevent the natural resources and control the unnecessary on modern comforts and luxuries for the sake of economic development of our country. The present paper, therefore, highlights by the fact that the mineral contents vary from soil to soil and depending upon different depth levels present in soil and these minerals are derived from the parent rock materials.

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