Characteristics of Termite Soils from Different Geological Formations in and Around Asbestos Mining Area, Andhra Pradesh

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ABSTRACT

Physical, physico-chemical and textural characteristics of soils of termite mounds from two different geological formations in around asbestos mining area of Brahmanapalli, Andhra Pradesh were studied and compared with corresponding adjacent termite free surface soils. Termite mounds soil contain significantly lower bulk density, higher amount of organic matter, pH, and electrical conductivity (EC) than that of their corresponding adjacent surface soils. Generally in the study area irrespective of the type of the mound termite soils contain higher content of sand and clay and lower content of silt than that of their adjoining surface soils. Grain-size parameters, viz., mean, median, sorting, skewness and kurtosis reveal that the mean and median behave in a similar way in all the termite soils and surface soils in two geological formations. The monophytic termite soils developed on limestones show positive skewness, whereas their surface soils show negative skewness. Kurtosis is high in barren termite soils developed on limestones than those of their surface soils. Scatter plots consisting of different combinations of the grain-size parameters are sensitive enough to differentiate the two geological formations and also the termite soils and surface soils.

Key words: Termite mound soils, Organic matter, Bulk density, Grain-size parameters, Asbestos mine

1. INTRODUCTION

Termite popularly known as white ants, commonly build earthen mounds or various sizes and shapes forming an important feature of the tropical landscape. Termites always live in communities. Their main function primarily is to maintain a constant high humidity, which is an essential requirement for the very survival of the termites especially for those that live in arid and semi-arid regions (Lee and Wood, 1971; Sen-Sarma, 1974). Termites penetrate through fissures and fractures or the sub-surface geological formation and sample them for their construction material carried in the jaws to the site and cemented with a mixture of clay and saliva. Biogeochemical studies have demonstrated that in tropical part of India these termite mounds have been used as important tool in explorations for copper (Prasad and Vijayasaradhi, 1984), chromium (Prasad and Vijayasaradhi, 1986), tin (Suryaprakash Rao and Raju, 1984), gold (Prasad *et al.*, 1987), and barite (Raghu, 2007). Earlier workers studied ecological (Lee and Wood, 1971), biological (Sen Sarma, 1974), geological (Arshad, 1981) and biogeochemical (Raghu and Prasad, 1996) aspects of termite mounds have been discussed.

2. STUDY AREA

Chrysotile asbestos deposit of Brahamanapalli area is located in Pulivendla mandal of Cuddapah District, Andhra Pradesh, and is included in the Survey of India toposheet No. 57J/3. The NW-SE trending Pulivendla asbestos belt forms a small segment in the S-W part of the Cuddapah Basin. This area is primarily consists of quartzites, shales, limestones and dolomites. The mineralized zone comprising yellow, green, black serpentine and talc. Chrysotile fibers are found as veins in serpentines, in serpentinized ultramafic rocks. Earlier workers have carried out geological (Prasad and Prasannan, 1976), mineralogical (Vyasa Rao, 1980; Prasad and Prasannan, 1976), economical (Krishnan and Venkataram, 1942), biogeochemical and trace elements interaction in grazing cattle products**(**Chandra Sekhar Reddy, 2015) from asbestos mineralization of Brahmanapalli, Andhra Pradesh have been studied.

In the study area, the mounds occurring on limestones are pale brown and those occurring on dolomites are dark brown. The size of the termite mounds vary from 0.5m to 2.45m in height and 0.75m to 2.62m in base diameter with different shapes. The present work deals with physical, physico-chemical, textural characteristics of the termite mound soils and of their adjoining ground surface sols on two different geological formations in and around asbestos mining area of Brahmanapali, Kadapa District, Andhra Pradesh. The present work has taken to study their relationship and on various characteristics viz., physical, physico-chemical and textural properties of soils.

3. SAMPLE PREPARATION AND METHODOLOGY

Nine soils samples were collected from different parts of the exterior of the mound and to represent a composite sample all these soils samples were thoroughly mixed. The surface soil adjacent to the termite mound in the vicinity in a radius of 6-10 m with reference to the mound was collected from six to eight pits, each measuring 15x15x15cm and combined to represent composite sample. Thus for each mound sample, its adjacent ground surface soil was collected for the purpose of comparison. In this way, a total thirty six pairs were collected in and around asbestos mining area of Brahmanapalli on two different geological formations. These sample mounds include barren, monophytic and polyphytic types. Based on the associated vegetation, termite mounds are categorized as barren mound devoid of vegetation; monophytic mound colonized by single taxonomic plant specie and polyphytic mound colonized by two are more taxonomic plant species. Samples of soils and termite soils were oven dried at 110^{o}C to expel moisture. These dry soils were lightly disintegrated with porcelain mortar and pestle to break lumps if any, with care to avoid the breaking of individual and were then sieved to pass through 2mm sieve mesh. From this material, required quantity of each representative sample was obtained by coning and quartering. The bulk density was determined adopting the Wax coating method of Blake (1965), organic matter was estimated by loss on ignition method (Davies, 1974). From the particle size distribution data cumulative frequency curves were drawn and the standard statistical parameters, comprising mean, median, sorting, skewness and kurtosis determined employing the formulae of Folk and Ward (1957).

4. RESULTS AND DISCUSSIONS

4.1 Physical properties

In the present study physical properties viz., bulk density and organic matter were estimated for termite sols and of their adjoining surface soils. During the time of construction of termite mounds, the soil particles will be rearranged, repacked and cemented together so that pore space may also be minimized (Mermut *et al*., 1984). Therefore, these biologically reworked soils may show wide variations in physical and physico-chemical properties with those of surrounding surface soils. Earlier studies have also shown that mould building termites have a considerable influence on many soil properties (Lee and Wood, 1971; Arshad, 1981)

Bulk Density

The bulk density of termite soils varies from 1.10- 1.45 gm/cc, 1.05-1.68 gm/cc, and 1.15-1.60 gm/cc for barren, monophytic and polyphytic mounds respectively. From the data (Table. 1), it is observed that the bulk density of termite soils is generally lower than that of their adjoining surface soils. This may be attributed to the termite activity (Ghilarov, 1962; Maldague, 1964) resulting in increased porosity (Lee and Wood, 1971; Nagaraju et al, 2004).

Organic Matter

The organic matter of termite soils vary from 3.70-6.90%, 1.70-7.80%, and 1.80-7.40% for barren, monophytic and polyphytic mounds respectively. The termite soils on limestone rock formation show maximum value (7.8%) of organic matter and a minimum value (1.7%) in the termite soils on dolomite. From the data (Table. 1) it is observed that the termite soils have invariably higher organic matter than their surface soils. It may be attributed to the vegetative diet of termites (Bouillon, 1970) and the presence of organic materials which are used in mound construction (Arshad, 1981; Sheikh and Kayani, 1982).

4.2 Physico-chemical properties

The Physico-chemical characteristics discussed in this study include hydrogen ion-concentration in terms of pH and electrical conductivity (EC) for termite soils and termite soils.

pH

pH was determined for termite soils and surface soils. pH values varies from 6.5 to 7.6 , 6.4 to 7.4, and 6.8 to 7.3 for barren, monophytic and polyphytic mounds respectively. From the data (Table. 1), it is observed that most of the termite soils have higher pH than that of their adjoining soils, as reported by earlier workers (Watson, 1975; Omo Malaka, 1977; and Mermut et al., 1984). The termite soils on limestone formation show maximum value (7.6) of pH and a minimum value (6.4) of pH is also noticed in the termite soils on limestone.

Electrical Conductivity (EC)

In soils, salts may arise from several sources such as weathering of minerals, mineralization of organic matter, nature of weathering process and the subsequent reactions that occur as the salts are moved from the site of weathering to the place of deposition. The electrical conductivity (EC) was determined for termite souls and soils. EC of termite soils is consistently higher than the surface soils. Watson (1975) has also reported higher EC in termite soils than the surface soils. The range of EC is 35-115 micromhos/cm, 40-95micromhos/cm, and 50-160 micromhos/cm for monophytic, polyphytic and barren termite mound soils respectively. Maximum EC (160 micromhos/cm) value is recorded in termite soils developed on limestones, and minimum (35 micromhos/cm) is in termite soils on both dolomites and limestones. During the time of construction of termite mounds, the soil particles will be rearranged, repacked, and cemented together so that pore space may also be minimized (Mermut et al., 1984). Therefore, these biologically reworked soils may show wide variations in physical and physico-chemical properties with those of surrounding surface soils. Earlier studies have also shown that mould building termites have a considerable influence on many soil properties (Lee and Wood, 1971; Arshad, 1981).

Table.1 Physical and Physico-chemical characteristics of Soils of Termites (TS) and Surface soils (SS) from Brahmanapalli Asbestos Mining Area

Type of the mound	Bulk density (gm/cc)		Organic matter %		pH		Electricity conductivity (micromhos/cm)	
	Ts	SS	Ts	SS	Ts	SS	Ts	SS
Barren (on limestones)	1.10-1.35	1.22-1.44	5.10-6.90	1.15-2.70	6.8-7.6	6.3-7.3	50-160	35-100
Barren (on dolomites)	1.18-1.45	1.25-1.70	3.70-4.50	2.00-4.00	6.5-7.5	6.3-7.1	65-105	25-75
monophytic (on limestones)	1.05-1.40	1.35-1.50	6.30-7.89	4.00-6.00	6.4-7.2	6.3-6.9	35-115	20-90
Monophytic (on dolomites)	1.30-1.68	1.40-1.70	1.70-4.70	1.00-4.00	6.5-7.4	6.2-7.1	35-90	30-75
Polyphytic (on limestones)	1.15-1.29	1.20-1.41	6.45-7.40	4.50-6.30	7.0-7.3	6.6-6.8	68-95	15-70
Polyphytic (on dolomites)	1.19-1.60	1.30-1.65	1.80-4.00	1.30-3.50	6.8-7.1	6.2-6.7	40-95	32-80

Table. 2 Textural characteristics of Soils of Termite soils (TS) and Surface soils (SS) from Brahmanapalli Asbestos Mining Area

Type of the mound	Sand %		Silt %		Clay %	
	Ts	SS	Ts	SS	Ts	SS
Barren (on limestones)	75.60-88.24	70.40-85.20	5.70-15.30	11.10-22.85	4.45-9.10	4.10-6.75
Barren (on dolomites)	78.95-87.50	75.45-83.76	8.25-15.60	12.14-20.40	4.25-9.55	2.90-6.20
Monophytic (on limestones)	78.65-92.70	75.30-89.70	4.25-15.60	7.35-19.94	3.05-6.15	2.90-6.00
Monophytic (on dolomites)	74.50-83.92	70.35-80.20	10.44-15.50	16.55-22.77	3.48-13.91	2.35-10.25
Polyphytic (on limestones)	84.62-92.30	79.70-89.10	5.15-10.15	8.80-15.65	2.55-6.18	2.10-4.65
Polyphytic (on dolomites)	78.20-86.75	73.65-84.25	9.34-16.84	13.11-21.40	2.46-7.30	2.15-6.24

4.3 Textural properties

Texture refers to the relative percentage of sand, silt, and clay in a soil. The textural properties, consisting of sand-silt-clay proportions and grain-size parameters viz., mean, median, sorting, skewness and kurtosis were estimated for the termite soils and surface soils.

From the data (Table. 2), it is revealed that minimum percentage of sand, silt and clay is 74.50, 4.25, and 2.46 on monophytic termite soils of dolomites, limestones and polyphytic termite soils of dolomites respectively; while the maximum is recorded as 92.70, 16.84, and 13.91 on monophytic termite soils of limestones, polyphytic and monophytic termite soils of dolomites respectively.

The maximum (89.70%) and minimum (70.35%) value of sand is found in surface soils of limestones and dolomites respectively; the maximum (22.85%) and minimum (7.35%) value of silt is found in surface soils on limestones; and the maximum (10.25%) and minimum (2.10%) value of clay is found in surface soils on dolomites and limestones respectively.

In the study area it is seen that all termite soils show higher content of sand and clay; and lower content of silt than that of their adjoining surface soils. This is the case observed irrespective of the type of the mound. In this study, generally termite mound soils fall under sand field in the classification of Shepard (1954). Earlier studies revealed that the role of termites on soil texture (Wood et al., 1983). The termite modified soil contains considerably higher amounts of smaller particles, which results from preferential selection of fine sand, silt and clay particles by the termites during the mound building process (Arshad, 1981). For many species of termite there is no precise selection of size particles (Lee and Wood, 1971).

Table. 3 Grain-Size Parameters of Termite soils (TS) and Surface Soils (SS) from Brahmanapalli Asbestos Mining Area

S.No	Type of the mound	Mean		Median		Sorting		Skewness		Kurtosis	
		TS	SS	TS	SS	TS	SS	TS	SS	TS	SS
On Limestones											
1	Barren	1.40	1.34	1.62	1.30	2.40	2.10	-0.25	-0.30	1.50	1.14
2	-Do-	1.90	2.50	1.86	2.10	2.50	2.30	-0.20	0.10	1.70	1.00
3	-Do-	2.50	1.90	2.20	1.65	2.60	2.00	0.15	-0.10	1.40	1.30
4	-Do-	2.00	2.30	1.96	2.10	2.30	2.40	-0.05	-0.05	1.60	1.10
5	-Do-	1.20	1.60	1.44	1.76	2.40	2.20	-0.35	-0.20	1.66	1.20
6	-Do-	1.74	1.70	2.00	1.50	2.56	2.10	-0.15	-0.25	1.54	1.06
7	Monophytic	1.40	1.34	1.30	1.44	1.30	1.90	0.15	-0.23	1.40	0.80
8	-Do-	1.00	1.14	1.20	1.10	1.10	1.20	0.05	-0.34	0.40	1.30
9	-Do-	1.24	1.54	1.14	1.60	1.60	1.70	0.12	-0.18	0.30	0.40
10	-Do-	1.10	1.20	1.06	1.50	1.20	1.10	0.10	-0.20	0.70	0.80
11	-Do-	1.20	1.34	1.10	1.50	2.00	1.50	0.20	-0.27	1.36	0.90
12	-Do-	1.30	1.50	1.50	1.70	1.60	2.20	0.05	-0.33	1.10	0.60

13	Polyphytic	1.04	1.40	1.00	1.44	0.80	0.08	0.15	0.00	0.90	1.74
14	-Do-	1.10	1.44	1.20	1.60	1.20	1.14	-0.10	-0.23	0.80	1.10
15	-Do-	1.00	1.60	1.14	1.90	1.00	1.04	0.10	0.13	0.30	1.26
16	-Do-	1.20	1.00	1.34	1.20	1.56	1.68	-0.23	-0.28	1.10	1.70
17	-Do-	1.10	1.70	1.28	1.56	0.50	1.86	0.30	-0.44	1.24	0.60
18	-Do-	1.00	1.60	1.40	1.68	1.70	1.30	-0.40	-0.38	1.70	0.40
On Dolomites											
19	Barren	1.70	1.40	1.60	1.50	1.10	1.60	-0.10	-0.10	1.22	1.60
20	-Do-	1.40	2.50	1.56	2.00	1.20	1.10	0.35	0.35	1.34	1.00
21	-Do-	1.90	2.20	1.80	2.14	1.10	1.30	0.30	0.30	1.50	2.40
22	-Do-	1.30	1.50	1.26	1.36	1.30	1.80	0.05	0.05	1.28	0.60
23	-Do-	1.60	1.00	1.50	1.20	1.00	1.20	-0.20	-0.20	1.10	0.40
24	-Do-	1.20	1.80	1.06	1.70	1.30	1.50	0.10	0.10	1.10	0.80
25	Monophytic	1.80	1.90	1.60	2.00	1.84	1.30	0.15	0.15	0.30	0.90
26	-Do-	2.10	2.30	2.00	2.00	1.34	1.50	-0.25	-0.25	0.50	0.64
27	-Do-	1.90	1.82	1.70	1.70	1.20	1.00	-0.40	-0.40	1.00	0.20
28	-Do-	2.60	2.30	2.16	1.70	1.70	2.40	0.35	0.35	0.80	0.20
29	-Do-	2.30	2.04	1.90	2.10	2.00	1.40	0.07	0.07	1.20	1.26
30	-Do-	1.90	2.00	1.40	1.70	2.50	2.10	-0.15	-0.15	1.20	0.94
31	Polyphytic	1.70	2.18	1.90	1.70	1.14	1.30	0.10	0.10	1.10	1.30
32	-Do-	2.30	1.80	2.10	1.75	1.44	1.70	-0.20	-0.20	1.66	1.20
33	-Do-	1.90	2.40	1.60	1.50	1.62	2.14	-0.30	-0.30	1.50	0.30
34	-Do-	1.50	1.80	1.64	1.74	1.82	2.54	-0.40	-0.40	0.60	0.40
35	-Do-	2.10	2.30	2.00	1.90	1.40	1.00	0.35	0.35	0.99	0.90
36	-Do-	2.20	1.96	1.84	2.00	2.10	1.70	0.05	0.05	0.50	0.34

Grain-Size Parameter

Grain-Size Parameters are used to bring out the differentiation between soils and termite soils. In this study, particle size analysis of the sand sized fraction of the soil material (devoid of organic matter) consisting of thirty six pairs of soils and termite soils developed on two geological formations was carried out by sieving for 10 minutes in Ro-tap shaker (Carver, 1971). From the sieve analysis data, cumulative frequency curves were drawn and the standard statistical grain-size parameters consisting of mean, median, sorting, skewness and kurtosis are determined (Folk and Ward, 1957). From the data (Table) the following observations are made:

1. Generally the mean median behave in a similar way in all the termite soils and surface soils of the two geological formations
2. The monophytic termite soils developed on limestones show positive skewness, whereas their surface soils show negative skewness.
3. Kurtosis is high in barren termite soils developed on limestones than their surface soils.
4. The barren termite soils developed on limestones show higher values of sorting
5. About 29% of the termite soils and 19% of the surface soils show negative skewness.

Scatter Plots of Grain-Size Parameters

Various combinations of scatter plots were prepared among five grain size parameters of termite soils and surface soils to see if any combination between two parameters would differentiate the termite soils and surface soils. From the scatter plots the following observations are made. The graphical scatter diagrams consisting of the plots of different combination of the textural parameters are found to be sensitive enough to differentiate the termite mounds and surface soils of two geological formations are recorded below:

1. High degree of positive correlation exists between mean Vs. median for both termite soils and surface soils
2. Mean Vs. skewness and also mean Vs. sorting is sensitive enough to differentiates the barren and monophytic mounds and soils developed on limestones from those developed on dolomites
3. Mean Vs. kurtosis differentiates the monophytic mounds and surface soils developed on limestones from those developed on dolomites
4. Sorting Vs. kurtosis differentiate the barren mounds and oils developed on limestones and dlomites
5. Sorting Vs. skewness differentiate the barren and polyphytic mounds and soils developed on limestones and dolomites
6. Kurtosis Vs. skewness is not of any utility in differentiating soils and termite soils

5. SUMMARY AND CONCLUSIONS

In this work physical properties in terms of bulk density and organic matter; textural properties (sand-silt-clay ratios); physico-chemical properties (pH and EC), and grain-size parameters consisting of mean, median, sorting, skewness and kurtosis of termite mound soils and soils have been studied. Bulk density of termite soil is lower than that of its adjoining surface soil. This may be attributed to increased porosity due to termite activity. Termite soils show higher amount of organic matter than that of their adjoining surface soil. This may be attributed to the vegetative diet of termite and the presence of organic materials which were used in mound construction. pH and electrical conductivity (EC) are higher in termite soils that that of surface soils. The variations in physical and physico-chemical properties of soils and termite sols are attributed to the variations in associated vegetation types and the microbial activity of the mounds. In the study area generally termite mounds are built by sand sized particles. Termite soils show higher content of sand and clay and lower content of silt than surface soils. The scatter diagrams consisting of different combinations of the grain-size parameters are sensitive enough to differentiate the two geological formations and also the termite soils and soils. The physical, physico-chemical, and textural data of soils and termite soils reveal that termites control and continuously modify all these properties within their habitat in order to maintain homeostatic equilibrium.

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