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Elemental composition and molar ratios of coastal soils of Guntur district, Andhra Pradesh

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Abstract
Horizon-wise soil samples collected from eight pedons from Khajipalem revenue village, Guntur district, A.P. were analysed for their chemical composition. The study revealed that high silica content was observed in coarse textured soils than in fine textured soils whereas sesquioxides followed a reverse trend. The molar ratios and concentrations exhibited the dominance of silica over sesquioxides in all the soils. The order of other elements was found to be CaO> MgO_2>NaO_2> K_2O>N>P_2O_5>MnO_2>CuO>ZnO in soils represented by majority of the pedons. The coarse textured soils registered higher SiO_2 / R_2O_3, SiO_2 / Al_2O_3 and SiO_2 / Fe_2O_3 ratios than fine textured soils.

Keywords: Silica, sesquioxides, molar concentrations, molar ratios

Introduction
The elemental composition of soils can be used to classify soils in a way that is related to soil-forming factors and inherent soil functional qualities. Furthermore, soil-forming factors (e.g., parent material, climate, terrain, vegetation, and time) influence overall elemental concentrations in the soil (Jenny, 1941) [7]. Fluctuations in the concentrations of soil chemical components are caused by differences in the parent material's composition as well as fluxes of matter and energy into and out of soils over time (Rawlins *et al.*, 2012) [15]. The nature of the parent material and the degree to which it has been weathered affect the mineralogy and elemental composition of soil (Towett *et al.*, 2015) [19]. Chemical weathering is a key process that alters the chemical composition of soils and the distribution of elements. The earth's crust contains about 47 percent oxygen, most of which is in the form of oxides (e.g., silica, alumina, and iron oxides).
The silica to sesquioxide and silica-alumina ratios have been considered important parameters in the chemistry of soil minerals and are also used for expressing the nature of clays (Tan and Troth, 1982) [18]. The changes down a profile in the silica-alumina and silica-sesquioxide ratios assist in explaining the development of that profile (Nandy *et al.*, 2013) [12]. The migration of silica and sesquioxide down the profile in comparison to parent material, as well as their ratios computed from the total composition of soils, offer a foundation for understanding profile evolution in relation to parent material. The Fe and Al released during the weathering of parent materials are re-precipitated in soils as iron and aluminium oxides, hydroxides, and oxyhydroxides. These alternation products often increase in quantity with soil age and their distribution in soil profiles indicates the stage and degree of soil development (Bera *et al.*, 2015) [1]. The elemental composition of soil also reveals the constituent minerals and nutrient supplying capacity of soils. However, very meagre information is available related to elemental composition in the soils of Khajipalem revenue village, hence the present study was carried out.

Material and Methods
Eight representative pedons from Khajipalem revenue village which is geographically located between 15.9497 to 15.9727°N latitude and 80.5738 to 80.6205°E longitude were studied. Horizon-wise soil samples were collected, processed and analysed for their elemental composition. Methodology given by (Hesse, 1971) [4] was adopted for acid extract preparation with a mixture of nitric acid and perchloric acid followed by filtering through Whatman no. 41 filter paper and the residue was washed with 0.5M HCl and finally the filtrate volume was made up to 250 mL with distilled water. The residue left over on the filter paper was washed

with warm distilled water until it was free from chlorides. Then the residue along with filter paper was ignited in a muffle furnace, cooled and percentage of silica was calculated from constant weight. The sesquioxides were determined by taking 100 mL of acid extract and the iron and aluminium were precipitated by adding ammonium chloride followed by ammonium hydroxide in the presence of methyl red indicator. The precipitate was filtered using Whatman No. 41 and washed with warm distilled water until it was free of chlorides. The residue along with the filter paper was dried, ignited at 800ºC for 4 hours, cooled and weighed to a constant weight. The results are expressed as per cent sesquioxides. Atomic absorption spectrophotometer was used for the estimation of iron in the silica free acid extract and results are expressed as per cent iron oxide. Alumina content was obtained deducting iron oxide from total sesquioxide content (Hesse, 1971) [4]. Total nitrogen was estimated by modified Kjeldahl's method using sulphuric – salicylic acid mixture (Hesse, 1971) [4]. Remaining all other nutrients were estimated in acid extract obtained by perchloric and nitric acid digestion method. The total phosphorus and total potassium content in the soils was estimated by ascorbic acid blue colour method and aspirating silica free acid extract into the flame photometer, respectively as described by Jackson (1973) [6]. The acid extract was aspirated into the flame photometer with K and Na filters, respectively and the results are expressed as per cent potassium oxide and sodium oxide (Jackson, 1973) [6]. Determination of total cationic micronutrients *viz*., iron, manganese, zinc and copper was done by aspirating acid extract was directly into atomic absorption spectrophotometer. The results are expressed as percent for iron and $\mu g\ g^{-1}$ for other micro nutrients (Hesse, 1971) [4]. Calcium was estimated by Versenate titration method by taking a suitable aliquot of sesquioxide free acid extract using Patton and Reeder's indicator (Kanwar and Chopra, 1976) [8]. A combined estimation of calcium and magnesium was also carried out in the sesquioxide free acid extract by using ammonium hydroxide-ammonium chloride buffer and Eriochrome black T. Magnesium titre value was obtained by subtracting calcium titre value from calcium and magnesium. The results are expressed as per cent magnesium oxide (Kanwar and Chopra, 1976) [8]. The molar concentrations of silica, Al_2O_3 and Fe_2O_3 were calculated by dividing content in per cent with their respective molecular weights.

Results and discussion

Silica (SiO_2)

The silica content ranged from 43.3 to 92.2 per cent in all pedons (Table 1). In P2 and P7 (fine textured throughout) the silica content varied from 49.5 to 65.6 per cent. In coarse textured pedons throughout, it ranged from 70.4 to 91.6 per cent whereas, other pedons recorded 43.3 to 92.2 per cent. The pedons P5 and P8 recorded higher silica content when compared to pedons P2 and P7. There was an irregular trend in distribution of silica in all pedons except in pedons P5 and P8 where, it increased with depth. The variations in silica content could be due to parent material and topographical variability. The parent materials with high coarse fraction might have contributed to high silica content in coarse textured horizons. The lower silica content in fine textured horizons compared to coarse textured might be due to high clay content and low sand content. According to Ratnam *et al.* (2000) [14] the variation in silica content in different pedons was due to the variations in chemical composition of the parent material and also relative amount of sand fraction. The chemical weathering of silicate minerals was predominantly by hydrolysis, when silicic acid and its associated bases are liberated. The semiarid climate might have resulted in mobilization of released silica, which could have moved upward with salt (Nandy *et al.*, 2013) [12]. Similar results were Sivajyothi *et al.* (2017) [16] in soils of Krishna delta region.

Sesquioxides (R_2O_3)

The sesquioxide content content varied from 4.75 to 33.00 per cent in all pedons. The pedons P2 and P7 (fine textured throughout) recorded 18.75 (Ap horizon in P2) to 30.25 (Bw2 horizon in P7) per cent, whereas, pedons P5 and P8 (coarse textured throughout) recorded 6.25 (C4 horizon of P8) to 17.50 (C1 horizon of P5) per cent. Other pedons with variable textures (P1, P3, P4 and P6) reported sesquioxide content varying from 4.75 (A1 horizon of P6) to 33.00 (3Bw3 horizon of P1) per cent. There was an irregular trend observed in all pedons except in pedon 8 where sesquioxide content decreased with depth. The pedons/ horizons with high amounts of clay recorded more amount of sesquioxides which might be due to the structural bonding of iron and alumina in phyllosilicate clay minerals. The variations in sesquioxide content might be due to the kind of parent material, physiography, soil drainage and overall pedo-chemical environment (Somasundarum *et al*., 2010). Previous research findings by (Manjulatha *et al.*, 2001) [10] reported that the sesquioxide content varied from 26.7 to 36.2 per cent in black soils of Guntur district derived from deltaic alluvium.

Iron oxide (Fe_2O_3) and Alumina (Al_2O_3)

The Fe_2O_3 and Al_2O_3 content varied from 0.81 to 14.42 and 1.58 to 22.93 per cent respectively, in all pedons (Table 1). Pedons P2 and P7 (fine textured throughout) recorded the Fe_2O_3 and Al_2O_3 content ranging from 6.17 to 14.35 and 7.15 to 17.13 per cent respectively, whereas in P5 and P8 (coarse textured throughout) the Fe_2O_3 and Al_2O_3 content ranged from 0.81 to 12.15 and 1.94 to 12.65 per cent respectively. Remaining pedons with variable texture recorded the Fe_2O_3 and Al_2O_3 content varying from 1.00 to 14.42 and 1.58 to 22.93, respectively. An irregular trend was observed in all pedons in Fe_2O_3 whereas, Al_2O_3 content decreased with depth in P8. The variable accumulation of Fe_2O_3 and Al_2O_3 in different horizons suggests that the elements are mobilized within the soil pedon due to active soil forming processes (Bera *et al*., 2015) [1]. The results are in conformity with (Nandy *et al.*, 2013) [12] where, the total alumina and iron oxide content in soils of Pedapuluguvaripalem village, Guntur district, Andhra Pradesh varied from 2.93 to 23.55 and 1.72 to 9.88 per cent, respectively.

Total Nitrogen

Total nitrogen content in soils varied from 0.014 to 0.112 per cent (Table 2). The total nitrogen content in pedons P2 and P7 (fine textured throughout) varied from 0.056 to 0.098 and in pedons P5 and P8 (coarse textured throughout) varied from 0.028 to 0.070. In other pedons with different textural combinations, the total nitrogen content ranged from 0.014 to 0.112. The total nitrogen content of coarse textured soils was less when compared to fine textured soils may be due to the relatively higher organic pool in soils with fine texture. The nitrogen percentage of soils of Digha coastal region of West Bengal varied from 0.10 to 0.125 per cent (Biswas and Das, 2014) [2].

Phosphorus Pentoxide (P_2O_5)

The P_2O_5 content varied from 0.014 to 0.090 per cent in all pedons. Pedons P2 and P7 (fine textured throughout) recorded the total P_2O_5 content ranging from 0.020 to 0.090 per cent. Pedons that are coarse textured throughout (P5 and P8) reported 0.014 to 0.060 per cent whereas, remaining pedons (P1, P3, P4 and P6) reported the P_2O_5 content ranging from 0.026 in 2B2 of P1 to 0.083 in 3Bw2, Ap, Bss1 of P1, P3, P4 respectively. The highest P_2O_5 was observed in Ap horizon of P7 and the lowest in C4 horizon of P8. It followed an increasing trend in P2 and decreasing trend in P7 with depth, while the remaining pedons did not show any trend. Total phosphorus was high in surface layers of pedons P1, P3, P4, P7 and P8, which might be due to higher dose of P fertilizers and also incorporation of organic materials. Similar observations were reported in soils of Digha and Sankarpur coast of West Bengal (Biswas and Das, 2014) [2] and coastal soils of Tamil Nadu by Mohanty *et al.* (2018) [11] with total P_2O_5 content ranging 0.025 to 0.050 and 0.046 to 0.121 per cent, respectively.

Potassium oxide (K_2O)

The K_2O content of different pedons in the study area varied from 0.045 to 0.855 per cent. There was a decrease in K_2O content with depth in pedons P5 and P7 vice-versa in P2. Fine textured throughout (P2 and P7) recorded the total K_2O content ranging from 0.045 to 0.855 per cent while, in coarse textured pedons throughout (P5 and P8) it ranged from 0.045 (C2, C4 horizon of P8) to 0.255 per cent (Ap horizon in P5). In the remaining pedons, the potassium oxide content varied from 0.120 in 2Bw3 of P3, Bw3 of P6 to 0.810 in 3Bw2 horizon of P1. High content of potassium oxide was recorded in fine texture soils which might be due to irregular distribution of clay in pedons. The low K_2O in soils might be due to fewer amounts of micaceous minerals. Similar results were reported by Nandy *et al.* (2013) [12] in coastal soils of Guntur district, Andhra Pradesh (0.09 to 0.75% K_2O).

Calcium oxide, Sodium oxide and Magnesium oxide (%)

The CaO, MgO and Na_2O content varied from 0.63 to 3.64, 0.13 to 1.43 and 0.07 to 0.88 per cent respectively, in all pedons (Table 2). The CaO, MgO and Na_2O content n pedons P2 and P7 (fine textured throughout) varied from 2.17 to 3.36, 0.84 to 1.43 and 0.20 to 0.88 per cent, respectively. In coarse textured pedons (P5 and P8) the CaO, MgO and Na_2O content varied from 0.63 to 1.75, 0.13 to 0.84 and 0.07 to 0.47 per cent, respectively. Whereas, the remaining pedons (P1, P3, P4 and P6) with variable texture reported 1.05 to 3.64, 0.13 to 1.09 and 0.11 to 0.88 per cent in CaO, MgO and Na_2O content, respectively. There was a decrease in CaO with depth in P2, P8 whereas, MgO content decreased with depth in pedon P8. Similar results were observed in soils of Andhra Pradesh developed from alluvium (Varaprasad *et al.*, 2012) [20].

Manganese dioxide, Cupric Oxide and Zinc oxide (μg g^{-1})

The MnO_2, CuO and ZnO content varied from 9.49 to 834.90, 4.07 to 94.45 and 1.24 to 73.40 μg g^{-1} respectively, in all pedons (Table 2). The MnO_2, CuO and ZnO content of fine textured throughout pedons (P2 and P7) varied from 9.49 to 592.06, 10.01 to 94.45 and 4.35 to 73.40 μg g^{-1}, respectively while, coarse textured throughout pedons (P5 and P8) reported 11.87 to 779.93, 4.07 to 30.65 and 1.24 to 23.01 μg g^{-1} MnO_2, CuO and ZnO content, respectively. In the remaining pedons (P1, P3, P4 and P6) with variable texture the MnO_2, CuO and ZnO content varied from 151.87 to 834.90, 16.58 to 58.48 and 10.26 to 49.45 μg g^{-1}, respectively. There was a decrease in MnO_2 and ZnO content with depth in case of P8 while, CuO content decreased with depth in P4. The presence of MgO indicated the presence of smectite minerals as reported by Varaprasad *et al.* (2012) [20]. In pedogenic study, the movement of manganese oxide and its distribution in soil pedons is important criteria, as it behaves more or less like free iron oxides. The fine textured pedons recorded higher cupric and zinc oxide content than the coarse textured pedons and low values of zinc which could be due to low zinc mineral content. Ramalakshmi *et al.* (2001) [13] reported similar views in the soils of Bapatla – Karlapalem.

Molar concentrations

Molar concentration is defined as the amount of a substance of solute per unit volume of solution and it indicates the actual concentration of all ionic species of a particular ion. The molar concentrations of SiO_2, R_2O_3, Fe_2O_3 and Al_2O_3 in all pedons were in the range of 0.722 to 1.537, 0.046 to 0.320, 0.008 to 0.135 and 0.015 to 0.225, respectively (Table 3). Molar concentrations of SiO_2, R_2O_3, Fe_2O_3 and Al_2O_3 of fine textured pedons (P2 and P7) were in the range of 0.825 to 1.093, 0.180 to 0.292, 0.058 to 0.135 and 0.070 to 0.168 per cent respectively, while in coarse textured pedons (P5 and P8) varied from 1.173 to 1.527, 0.061 to 0.168, 0.008 to 0.115 and 0.019 to 0.124 per cent respectively. Pedons P1, P3, P4 and P6 reported the molar concentrations ranging from 0.722 to 1.537 (SiO_2), 0.046 to 0.320 (R_2O_3), 0.009 to 0.136 (Fe_2O_3) and 0.015 to 0.225 (Al_2O_3) per cent. Similar results were reported by Himabindu *et al.* (2018) [5] in the soils of north coastal Andhra Pradesh where, the molar concentration of SiO_2, R_2O_3, Fe_2O_3 and Al_2O_3 were in the range of 0.173 to 1.190, 0.173 to 0.275, 0.022 to 0.080 and 0.149 to 0.225, respectively.

Molar ratios

The molar ratios were determined to evaluate most comprehensively the extent of chemical changes occurring in the soils. The molar ratios SiO_2/R_2O_3, SiO_2/Al_2O_3, SiO_2/Fe_2O_3 and Al_2O_3 / Fe_2O_3 varied from 2.49 to 33.31, 3.42 to 87.72, 6.50 to 196.25 and 0.15 to 11.96, respectively (Table 3). The ratios were relatively less in heavy textured soils than light textured soils. Presence of more silica led to high ratios in light textured soils due to the process of silication operating in the soils. The higher SiO_2/R_2O_3 also indicate lesser weathering of soils and the dominance of montmorillonite type of clay (Nandy *et al.*, 2013) [12]. Similar results were reported by Ramalakshmi *et al.* (2001) [13] in Psamments of Bapatla–Karlapalem region. Low values of SiO_2/Al_2O_3 and SiO_2/R_2O_3 molar ratios in West Bengal indicated that weathering process was at a more advanced stage when compared to high values (Bera *et al.*, 2015) [1]. Gidisagu and Gawu (2016) reported that silica-sesquioxide ratio was more than 2.50 indicating that they are non-lateritic soils. High SiO_2 and SiO_2/Al_2O_3 and SiO_2/R_2O_3 molar ratio indicated more siliceous nature horizons and advanced stage of pedogenic development. Sivajyothi *et al.* (2017) [16] reported that the coarse textured pedons were higher in SiO_2/R_2O_3, SiO_2/Al_2O_3 and SiO_2/Fe_2O_3 ratios and the wider ratios of SiO_2/R_2O_3 and SiO_2/Al_2O_3 were observed in the black soils of semi-arid tropical region of Tamil Nadu (Malavath and Mani, 2018) [9].

Table 1: Chemical composition of soils of Khajipalem Revenue Village

Pedon No. and Horizon	Depth (m)	Texture	SiO_2 %	R_2O_3 %	Fe_2O_3 %	Al_2O_3 %
Pedon 1						
Ap	0.00 -0.20	c	53.1	29.75	14.42	15.33
B1	0.21 - 0.32	c	51.8	28.00	12.77	15.23
^2B2	0.33 - 0.52	ls	77.3	16.25	9.70	6.55
3Bw1	0.53 - 0.73	c	69.1	29.75	13.58	16.17
3Bw2	0.74 - 1.00	c	64.4	26.00	11.26	14.74
3Bw3	1.01 - 1.20	c	52.1	33.00	10.18	22.82
3Bw4	1.20 - 1.50	c	61.7	26.25	9.88	16.37
Pedon 2						
Ap	0.00 - 0.23	c	61.8	18.75	11.50	7.25
Bw	0.24 - 0.41	c	65.6	20.25	10.86	9.39
Bss1	0.42 - 0.62	c	56.5	28.50	12.14	16.36
Bss2	0.63 - 0.86	c	54.4	26.75	13.63	13.12
Bss3	0.87 - 1.20	c	56.7	21.50	14.35	7.15
Pedon 3						
Ap	0.00 - 0.21	c	45.1	28.75	10.31	18.44
AB	0.22 - 0.38	c	54.3	20.75	10.18	10.57
Bw	0.39 - 0.52	c	44.4	23.50	11.33	12.17
2Bw1	0.53 0.70	scl	81.3	11.25	10.92	1.58
2Bw2	0.70 - 0.90	cl	70.1	18.00	12.03	5.97
2Bw3	0.90 - 1.20	cl	71.9	15.00	7.82	7.18
Pedon 4						
Ap	0.00 - 0.22	c	48.6	25.25	11.35	13.90
Bw1	0.23 - 0.34	c	52.3	20.00	10.35	9.65
Bss1	0.34 - 0.50	c	49.0	32.25	12.30	19.95
Bss2	0.51 - 0.80	c	53.0	27.00	11.84	15.16
2C1	0.81 - 0.95	s	76.3	10.00	1.08	8.92
2C2	0.96 - 1.10	s	84.4	14.75	1.25	13.50
Pedon 5						
Ap	0.00 - 0.17	ls	70.4	15.75	12.15	3.60
C1	0.18 - 0.32	ls	70.6	17.50	10.52	6.98
C2	0.33 - 0.58	ls	71.2	13.00	9.71	3.29
C3	0.58 - 0.92	ls	74.6	11.00	9.06	1.94
C4	0.93 - 1.20	ls	76.2	12.75	8.39	4.36
Pedon 6						
^Ap	0.00 - 0.24	s	87.6	9.50	1.00	8.50
^A1	0.25 - 0.39	s	92.2	4.75	1.16	3.59
Bw1	0.40 - 0.65	c	46.1	31.75	8.82	22.93
Bw2	0.66 - 0.82	c	43.3	27.00	10.06	16.94
Bw3	0.83 – 1.10	c	44.6	26.25	9.06	17.19
Pedon 7						
Ap	0.00 - 0.25	c	49.5	24.25	8.02	16.23
Bw1	0.26 - 0.42	c	50.0	23.25	6.17	17.08
Bw2	0.43 - 0.68	c	55.0	30.25	13.12	17.13
Bss1	0.69 - 0.92	c	51.1	28.00	12.38	15.62
Bss2	0.93 - 1.20	c	53.7	25.25	9.70	15.55
Bss3	120+	c	53.6	23.25	6.90	16.35
Pedon 8						
Ap	0.00 - 0.23	s	76.9	14.00	1.35	12.65
C1	0.24 - 0.45	s	87.4	11.50	0.92	10.58
C2	0.46 - 0.80	s	90.3	9.25	0.81	8.44
C3	0.81 - 1.10	s	91.1	7.50	0.98	6.52
C4	1.10+	s	91.6	6.25	0.83	5.42

Table 4.2: Elemental composition of the soils of Khajipalem Revenue Village

Pedon No. and Horizon	Depth (m)	Texture	N	P_2O_5	K_2O	CaO	MgO	Na_2O	MnO_2	CuO	ZnO
			%							µg/g	
Pedon 1											
Ap	0.00 -0.20	c	0.084	0.060	0.480	2.24	0.84	0.67	682.24	44.41	32.34
B1	0.21 - 0.32	c	0.098	0.054	0.450	2.03	0.67	0.61	649.41	40.03	29.55
^2B2	0.33 - 0.52	ls	0.028	0.026	0.255	1.47	0.76	0.27	492.40	16.89	14.62
3Bw1	0.53 - 0.73	c	0.063	0.069	0.615	2.94	0.97	0.72	671.16	32.53	27.06
3Bw2	0.74 - 1.00	c	0.070	0.083	0.810	3.29	1.09	0.79	413.30	46.29	38.56
3Bw3	1.01 - 1.20	c	0.084	0.063	0.525	3.22	0.71	0.57	400.64	39.41	25.81
3Bw4	1.20 - 1.50	c	0.042	0.052	0.453	2.52	0.63	0.51	382.45	32.84	20.22

Pedon 2										
Ap	0.00 - 0.23	c	0.077	0.066	0.240	3.22	1.18	0.84	202.89	51.29	32.66
Bw	0.24 - 0.41	c	0.056	0.072	0.420	3.08	1.01	0.71	196.56	47.23	31.72
Bss1	0.42 - 0.62	c	0.070	0.080	0.453	2.66	1.30	0.64	190.24	42.53	51.00
Bss2	0.63 - 0.86	c	0.063	0.086	0.810	2.38	1.22	0.67	258.66	44.41	61.58
Bss3	0.87 - 1.20	c	0.056	0.089	0.855	2.17	1.43	0.57	333.41	52.54	73.40
Pedon 3											
Ap	0.00 - 0.21	c	0.098	0.083	0.240	2.73	0.42	0.37	330.24	58.48	49.45
AB	0.22 - 0.38	c	0.084	0.046	0.210	3.01	0.67	0.35	312.05	43.16	37.01
Bw	0.39 - 0.52	c	0.042	0.060	0.180	2.59	0.63	0.31	272.50	40.03	33.59
2Bw1	0.53 0.70	scl	0.049	0.060	0.225	1.96	0.29	0.23	347.64	21.58	16.79
2Bw2	0.70 - 0.90	cl	0.070	0.052	0.225	2.52	1.05	0.26	216.34	27.21	25.81
2Bw3	0.90 - 1.20	cl	0.063	0.031	0.120	2.03	1.01	0.19	181.14	23.14	14.00
Pedon 4											
Ap	0.00 - 0.22	c	0.109	0.080	0.645	3.50	0.80	0.72	707.55	55.67	44.47
Bw1	0.23 - 0.34	c	0.112	0.074	0.555	3.64	0.67	0.59	588.11	51.29	43.23
Bss1	0.34 - 0.50	c	0.070	0.083	0.645	2.87	1.01	0.88	764.11	47.23	37.94
Bss2	0.51 - 0.80	c	0.042	0.052	0.450	3.01	0.88	0.69	655.74	39.09	43.85
2C1	0.81 - 0.95	s	0.028	0.050	0.225	1.54	0.29	0.23	584.94	20.02	10.26
2C2	0.96 - 1.10	s	0.014	0.054	0.405	1.12	0.38	0.20	834.90	16.58	14.00
Pedon 5											
Ap	0.00 - 0.17	ls	0.056	0.046	0.255	1.26	0.84	0.40	779.93	30.65	23.01
C1	0.18 - 0.32	ls	0.042	0.030	0.180	0.98	0.50	0.38	488.84	23.14	20.22
C2	0.33 - 0.58	ls	0.035	0.047	0.165	1.12	0.55	0.47	750.26	16.26	14.93
C3	0.58 - 0.92	ls	0.042	0.039	0.120	1.15	0.67	0.45	566.36	16.89	12.44
C4	0.93 - 1.20	ls	0.028	0.048	0.090	1.05	0.59	0.39	488.05	7.51	9.33
Pedon 6											
^Ap	0.00 - 0.24	s	0.069	0.052	0.270	1.12	0.25	0.20	584.55	23.46	27.68
^A1	0.25 - 0.39	s	0.042	0.031	0.285	1.05	0.13	0.11	151.87	20.33	14.62
Bw1	0.40 - 0.65	c	0.070	0.046	0.255	2.10	0.76	0.51	576.64	51.60	38.88
Bw2	0.66 - 0.82	c	0.070	0.041	0.225	2.59	0.59	0.48	435.84	44.41	30.79
Bw3	0.83 – 1.10	c	0.084	0.038	0.120	2.03	0.50	0.36	189.05	40.97	19.90
Pedon 7											
Ap	0.00 - 0.25	c	0.098	0.090	0.780	3.36	1.34	0.88	584.55	94.45	38.56
Bw1	0.26 - 0.42	c	0.084	0.084	0.750	3.29	0.97	0.81	492.40	67.87	52.25
Bw2	0.43 - 0.68	c	0.084	0.077	0.480	2.73	0.84	0.63	592.06	77.25	35.45
Bss1	0.69 - 0.92	c	0.090	0.069	0.390	2.87	1.09	0.59	501.10	32.84	29.23
Bss2	0.93 - 1.20	c	0.056	0.039	0.075	3.01	1.18	0.51	32.83	20.64	14.62
Bss3	1.20+	c	0.059	0.020	0.045	3.22	1.13	0.20	9.49	10.01	4.35
Pedon 8											
Ap	0.00 - 0.23	s	0.070	0.060	0.180	1.75	0.59	0.25	43.51	26.27	14.62
C1	0.24 - 0.45	s	0.042	0.022	0.060	1.19	0.34	0.27	38.76	16.89	10.26
C2	0.46 - 0.80	s	0.035	0.018	0.045	1.05	0.25	0.17	34.41	14.07	4.35
C3	0.81 - 1.10	s	0.028	0.021	0.060	0.91	0.21	0.10	17.80	9.70	2.80
C4	1.10+	s	0.038	0.014	0.045	0.63	0.13	0.07	11.87	4.07	1.24

Table 3: Molar concentration and ratios of soils of Khajipalem Revenue Village

Pedon No. and Horizon	Depth (m)	Texture	Molar Concentrations				Molar Ratios			
			SiO_2	R_2O_3	Fe_2O_3	Al_2O_3	SiO_2 / R_2O_3	SiO_2 / Al_2O_3	SiO_2 / Fe_2O_3	Al_2O_3/ Fe_2O_3
Pedon 1										
Ap	0.00 -0.20	c	0.885	0.286	0.136	0.150	3.09	5.89	6.50	1.10
B1	0.21 - 0.32	c	0.863	0.270	0.121	0.149	3.20	5.78	7.16	1.24
^2B2	0.33 - 0.52	ls	1.288	0.156	0.091	0.064	8.27	20.06	14.08	0.70
3Bw1	0.53 - 0.73	c	1.152	0.287	0.128	0.159	4.02	7.27	8.99	1.24
3Bw2	0.74 - 1.00	c	1.073	0.251	0.106	0.144	4.28	7.43	10.10	1.36
3Bw3	1.01 - 1.20	c	0.868	0.320	0.096	0.224	2.72	3.88	9.04	2.33
3Bw4	1.20 - 1.50	c	1.028	0.254	0.093	0.160	4.05	6.41	11.03	1.72
Pedon 2										
Ap	0.00 - 0.23	c	1.030	0.180	0.108	0.071	5.74	14.48	9.50	0.66
Bw	0.24 - 0.41	c	1.093	0.195	0.102	0.092	5.62	11.88	10.67	0.90
Bss1	0.42 - 0.62	c	0.942	0.275	0.115	0.160	3.43	5.87	8.22	1.40
Bss2	0.63 - 0.86	c	0.907	0.257	0.129	0.129	3.52	7.05	7.05	1.00
Bss3	0.87 - 1.20	c	0.945	0.205	0.135	0.070	4.60	13.47	6.98	0.52
Pedon 3										
Ap	0.00 - 0.21	c	0.752	0.278	0.097	0.181	2.70	4.16	7.73	1.86
AB	0.22 - 0.38	c	0.905	0.200	0.096	0.104	4.53	8.74	9.42	1.08
Bw1	0.39 - 0.52	c	0.740	0.226	0.107	0.119	3.27	6.20	6.93	1.12

Bw2	0.53 0.70	scl	1.355	0.119	0.103	0.015	11.43	87.72	13.15	0.15
Bw3	0.70 - 0.90	cl	1.168	0.172	0.113	0.059	6.79	19.95	10.30	0.52
Bw4	0.90 - 1.20	cl	1.198	0.144	0.074	0.070	8.31	17.01	16.25	0.96
Pedon 4										
Ap	0.00 - 0.22	c	0.810	0.243	0.107	0.136	3.33	5.94	7.56	1.27
Bw1	0.23 - 0.34	c	0.872	0.192	0.098	0.095	4.53	9.21	8.93	0.97
Bss1	0.34 - 0.50	c	0.817	0.312	0.116	0.196	2.62	4.18	7.04	1.68
Bss2	0.51 - 0.80	c	0.883	0.260	0.112	0.149	3.39	5.94	7.91	1.33
2C1	0.81 - 0.95	s	1.272	0.098	0.010	0.087	13.02	14.55	124.25	8.54
2C2	0.96 - 1.10	s	1.407	0.144	0.012	0.132	9.76	10.63	119.29	11.22
Pedon 5										
Ap	0.00 - 0.17	ls	1.173	0.150	0.115	0.035	7.83	33.28	10.23	0.31
C1	0.18 - 0.32	ls	1.177	0.168	0.099	0.068	7.02	17.20	11.85	0.69
C2	0.33 - 0.58	ls	1.187	0.124	0.092	0.032	9.58	36.77	12.96	0.35
C3	0.58 - 0.92	ls	1.243	0.104	0.085	0.019	11.90	65.26	14.55	0.22
C4	0.93 - 1.20	ls	1.270	0.122	0.079	0.043	10.42	29.69	16.05	0.54
Pedon 6										
^Ap	0.00 - 0.24	s	1.460	0.093	0.009	0.083	15.74	17.52	154.42	8.81
^A1	0.25 - 0.39	s	1.537	0.046	0.011	0.035	33.31	43.69	140.16	3.21
Bw1	0.40 - 0.65	c	0.768	0.308	0.083	0.225	2.49	3.42	9.23	2.70
Bw2	0.66 - 0.82	c	0.722	0.261	0.095	0.166	2.77	4.34	7.61	1.75
Bw3	0.83 – 1.10	c	0.743	0.254	0.085	0.169	2.93	4.41	8.70	1.97
Pedon 7										
Ap	0.00 - 0.25	c	0.825	0.235	0.076	0.159	3.51	5.19	10.90	2.10
Bw1	0.26 - 0.42	c	0.833	0.226	0.058	0.167	3.69	4.98	14.32	2.88
Bw2	0.43 - 0.68	c	0.917	0.292	0.124	0.168	3.14	5.46	7.41	1.36
Bss1	0.69 - 0.92	c	0.852	0.270	0.117	0.153	3.16	5.56	7.29	1.31
Bss2	0.93 - 1.20	c	0.895	0.244	0.091	0.152	3.67	5.87	9.78	1.67
Bss3	120+	c	0.893	0.225	0.065	0.160	3.96	5.57	13.71	2.46
Pedon 8										
Ap	0.00 - 0.23	s	1.282	0.137	0.013	0.124	9.37	10.33	100.59	9.73
C1	0.24 - 0.45	s	1.457	0.112	0.009	0.104	12.96	14.04	167.93	11.96
C2	0.46 - 0.80	s	1.505	0.090	0.008	0.083	16.65	18.19	196.25	10.79
C3	0.81 - 1.10	s	1.518	0.073	0.009	0.064	20.75	23.74	164.92	6.95
C4	1.10+	s	1.527	0.061	0.008	0.053	25.04	28.72	195.64	6.81

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