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Characterization and classification of litho sequence soils in selected area of Budhihal micro-watershed (4D7A312F) in Yadgir district, Karnataka, India

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Abstract
Remarkable differences in both particle size classes and chemical properties of soils was attributed to the underlying diversified geological materials which were the parent materials of the soils as it was confirmed by the total elemental analysis of soils, molar ratio and CEC/Clay ratio. Low siliceous basalt derived pedon-1 registered deeper solum depth, finer texture and well developed soil structure as compared to the high siliceous granite derived pedon-6. The above said physical properties were moderate in the intermediately siliceous schist derived pedon-5. Soil reaction, CEC, total exchangeable basic cations as well as percent base saturation were comparatively low in highly siliceous granite derived pedon-6 as compared to the rest of the two pedons. Positive correlation of SiO_2 with sand (0.015), coarse fragments (0.045) and negative correlation with clay (-0.134) suggested the influence of parent materials on soil properties. Soils under study were keyed out at subgroup level as Typic Haplusterts (Pedon-1), Typic Haplustalfs (Pedon-6) and Typic Haplustepts (Pedon-5).

Keywords: Parent materials, soil properties, genesis, taxonomy

1. Introduction

Mother Nature is blessed with more of diversity, complexity and heterogeneity rather than uniqueness, simplicity and homogeneity respectively and even soils are also not exceptional as they are the integral part of nature. Existence of diversified soils developed on diversified lithology at a shorter interval is also not uncommon. Genetic blood of the parent materials is very much depicted in the properties of soils which are overlying them, where the litho function, the formation of soil is a function of variation in lithology while rest of the soil forming factors remains constant.

Parent material is often related to the soil properties namely depth, texture, structure, shrink and swell potential, clay mineralogy, CEC, nutrient status, sodicity, salinity, acidity *etc*., (Gray and Murphy, 2002) [3].

The influence of parent material on soil properties has been recognized long back and is very conspicuous at the initial stage of soil development as the parent material provides matter for soil formation and however its influence on properties of soil becomes obscure and later diminishes gradually with the advancement in the soil development as other soil forming factors take upper hand in influencing soil formation as the pedogenic processes are dynamic in nature and thus the resultant product, soil is due to the interaction of rest of the soil forming factors on parent material.

Properties, genesis and taxonomy of soils developed on diversified lithology existing in a close proximity is the prerequisite for the proper utilization, conservation and either to improve or to maintain the health of diversified soils in good condition for sustainable soil productivity. Studies on litho sequence soils derived from diversified geological materials under the same climate and vegetation in addition to almost the same topography is meager in northern parts of the Karnataka and thus present investigation was taken up to know the influence of the parent materials on genesis, properties as well as taxonomic category of the soils.

2. Materials and methods

Study area is a part of budhihal micro-watershed (4D7A312F) which is situated between 16^{0}23'9.52" N and 16^{0}21'46.286" N latitude and 76^{0}23'46.086" E and 76^{0}24'18.432" E longitude in Yadgir district of Karnataka. As per the geological map of scale 1:50000, budhihal micro watershed is characterized by the predominant geological materials limestone, shale and granite and however diversified geological materials namely low siliceous mafic basalt, intermediately siliceous schist, grey shale and pink shale in addition to highly siliceous felsic granite and sandstones were observed in a small patch (Fig. 1) when the said micro water shed area was traversed. The small patch of area characterized by diversified geology in budhihal micro watershed was selected for the present study and is situated in between 16^{0}21'49.898 N and 16^{0}23'07.242 N latitude and 76^{0}24'04.876 E and 76^{0}23'55.015 E longitude and is characterized by semi arid climate. Seven soil profile sampling sites, one from each geology were selected and geomorphological features of the same were recorded (Anonymous, 1951) [1]. Geographical locations of the representative soil profiles one from each geology and elevations above mean sea level were recorded using GPS. Only three representative soil profiles one from each geology basalt, granite and schist are presented here. Based on morphological features, soil horizons were demarcated in these pedons and horizon wise these pedons were examined for morphological features (Table 1) and the terminologies used to describe the pedons were as per Anonymous (1951) [1]. Horizon-wise collected soil samples were processed and analyzed for particle size analysis by International pipette method (Piper, 1966) [7], soil reaction by potentiometric method, organic carbon content by Walkely and Black's Wet Oxidation method (Jackson, 1967) [5], free calcium carbonate content by rapid titration method (Piper, 1966) [7]. Exchangeable cations of soil samples were extracted by 1 N ammonium acetate (Thomas, 1982) [13] and exchangeable sodium and potassium were determined flame photometrically and exchangeable calcium and magnesium were determined by standard EDTA titration (Jackson, 1967) [5]. Cation exchange capacity of soils was determined, using 1 *N* sodium acetate (pH 8.2) as described by Richards (1954). Total elements of fine earth were extracted by $HF\text{-}HClO_4$ decomposition (Jackson, 1967) [5]. Total sodium and potassium contents in the extract was estimated flame photometrically, Ca and Mg contents were estimated by versanate titration method (Jackson, 1967) [5] and total silicon, aluminum, iron concentrations were measured by atomic absorption spectrophotometer using appropriate hallow cathode lamps and these elements were expressed as their respective oxides to predict the dominant primary mineralogical composition of soils for the confirmation of the parent materials of the soils.

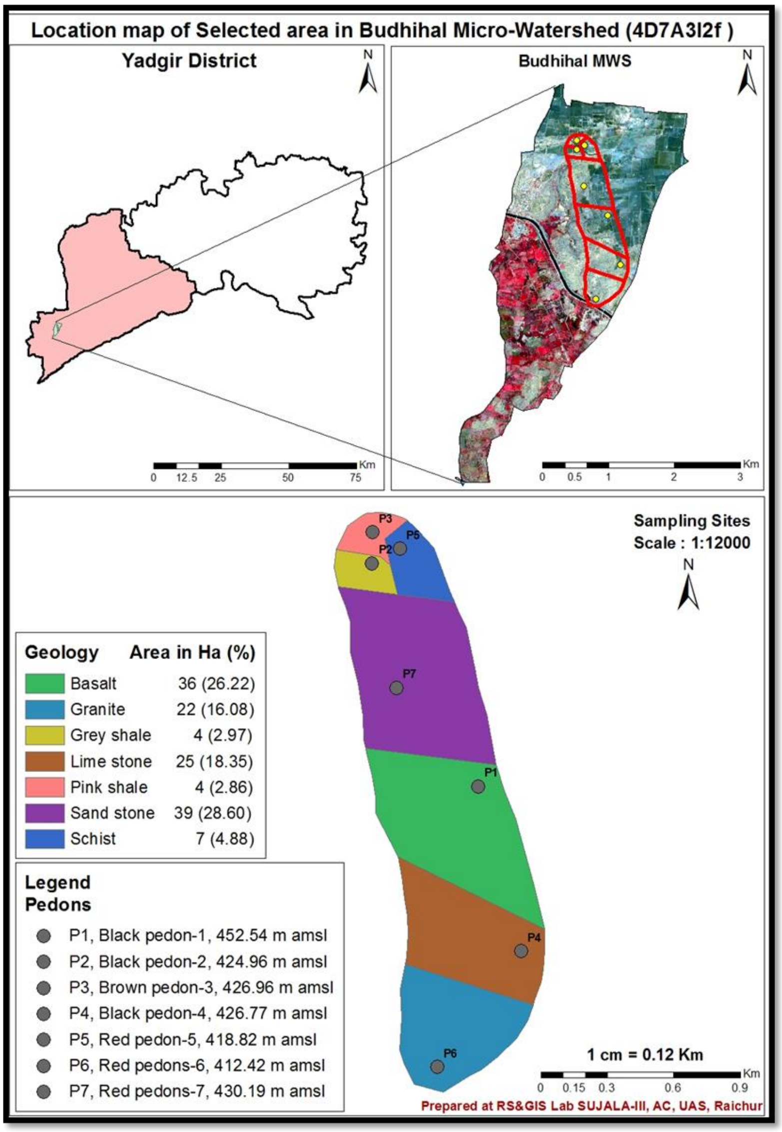

Fig. 1: Diversified geology and profile sampling spots in a selected area of Budihal MWS (4D7A312F)

3. Results and discussion
3.1 Morphological features
3.1.1 Solum depth
Solum depth decreased from more yellower (10YR) black pedon-1 to less yellower (5YR) red pedons-6 and 5 and this could be attributed to the more of chemical weathering than physical weathering in the former pedon than in the later pedons (Krishnamoorthy and Govinda Rajan, 1977) [6] deep, moderate deep and moderate shallow depth of the pedons-1, 6 and 5 could also be attributed to the sand/silt ratio which indicates intensity of soil erosion. As the ratio of rate of weatherability of parent materials to the rate of soil erodability was more in low and intermediately siliceous basalt and schist derived pedons-1 and 5 as compared to the pedon-6 derived from highly siliceous felsic granite as indicated by lower sand/silt ratio in former pedons than in the later pedon solum depth was more in former pedons than in later pedon. Gray and Murphy (2002) [3] and Sidhu *et al*., (2000) [10] also observed. Thicker soil profile in soils where ratio of rate of weatherability of parent materials to the rate of soil erodability was more. Soils were the evident for it and it was further supported by the Pearson correlation where SiO_2 content (Table 3) and negatively with clay and however it was non significant

3.1.2 Pedogenic horizons
Soil horizonation was better in granite derived red pedon-6 (A-Bt-BC-C) and was followed by schist derived red pedon-5 (A-Bw-BC) and basalt derived black pedon-1 (A-AC) and this could be attributed to the more well drained condition which facilitated downward movement of soil constituents in the former pedon than in the later pedon as the former pedon is rich in more resistant primary mineral quartz produced coarser textured soil unlike later pedon which is rich in clay forming primary minerals as indicated by the total elemental composition of fine earth and it was further supported by positive significant correlation between SiO_2 and both coarse fragments and sand while clay was negatively but significantly correlated with SiO_2.

3.1.3 Soil color
More of yellower hue (10YR) in the black pedons-1 as compared to less of yellower hue (5YR) in the red pedons-6 and 5 (Table 1) could be attributed to the more of free calcium carbonate, clay-humus complex with lime and less of iron oxides in the former pedon than in the later pedons. (Singh, 1956: Rudramurthy and Dasog, 2001) [11, 9].

3.1.4 Soil structure
Irrespective of the parent materials, stronger soil structure grade in sub surface than in surface horizons of the pedons-1, 6 and 5 could be attributed to the illuviation of clay with or without iron oxides in subsurface horizons and eluviation of the same in surface horizons and these findings are in agreement with Sitanggang *et al*. (2006) [12]. Stronger soil structure grade throughout the solum of the pedon-1 (Table 1) could be attributed to both the quantity and quality of clay as the parent material was clay forming basalt. The soil structure grade was comparatively weaker in pedon-6 and this could be attributed to low clay forming felsic granite as well as presence of low active clays illite and or kaolinite as indicated by the CEC/Clay ratio. Soil structure grade was moderate in pedon-5 as it is derived from intermediately siliceous schist and it was further supported significant negative correlation between SiO_2 and CEC/Clay ratio.

Slickensides were observed in pedon-1 and this could be attributed to the high active clay forming low siliceous mafic basaltic parent material of pedon-1 and presence of clay skins in the pedons-6 derived from felsic high siliceous granite could be attributed to the coarse textured nature of the soil as its parent material is of low clay forming type as it is rich in quartz, the more resistant mineral to weather which imparted coarse texture to pedon-6 which favored clay illuviation and was indicated by the presence of clay skins.

3.2 Particle size class of whole soil and fine earth
The content of coarser fractions (coarse fragments and sand) of soil was comparatively more in red pedons-6 and 5 as compared to the black pedon-1 and this could be attributed to more of chemical than physical weathering in the later pedon than in former pedons and it could also be attributed to their parent materials as well as internal drainage condition of the soils. The former pedons were derived from either highly or intermediately siliceous parent materials which were of coarser fractions forming type unlike low siliceous finer fractions forming type of later pedon. These findings are in agreement with Desai (1942) [2] and Krishnamoorthy and Govinda Rajan (1977) [6].

Comparatively higher sand to silt ratio (Table 1) in the pedons-6 than in the pedons-1 and 5 could be attributed to their parent materials. The parent material of the pedon-6 is highly siliceous granite as it consists of more of highly resistant mineral quartz as indicated by the total elemental analysis of fine earth (Table 3) which suggested the presence of more of coarser fraction than finer fraction in it and obviously pedon-6 registered the highest sand/silt ratio. Lowest sand/silt ratio in the pedons-1 and 5 could be attributed (Table 1) to their low siliceous mafic basalt, intermediately siliceous schist respectively which consist of either low or moderate content of more resistant quartz mineral and was evident from the lower SiO_2 (Table 3) content in fine earth fraction of these soils.

Pedon-1 registered higher clay content (Table 1) as compared to the pedon-6 and this could be attributed to their parent materials as the former pedon was derived from clay forming basalt, while the later pedon was derived from coarser soil fractions forming granite. Clay content was intermediate in the pedon-5 as the mineralogical composition of its parent material schist was intermediate especially with respect to quartz and was supported by the data on total elemental composition of soil (Table 3).

3.3 Soil reaction (pH)
Irrespective of the parent materials increasing trend of soil reaction down the solum could be attributed to leaching of bases from upper solum and accumulation of the same in the lower solum. Alkaline nature of all the pedons could be attributed to both the mineralogical composition of the parent materials as indicated by elemental composition of fine earth (Table 3) as well as internal drainage of the soils. The low siliceous mafic basalt, the parent material of black pedon-1 was composed of bases supplying minerals such as olivine, anorthite, albite, pyroxenes and amphiboles while intermediately siliceous schist the parent material of pedon-5 was composed of calcium, magnesium, potassium and sodium supplying minerals biotite mica, muscovite mica and plagioclase feldspars. Highly siliceous felsic granite the parent material of the pedon-6 is composed of both quartz and feldspars which are the poor suppliers of bases and thus these basic cations could be attributed for the alkalinity of all the

pedons and it was further confirmed by strong significant correlation between pH and oxides of total elements which were the indices of the dominant primary minerals of the parent materials. Correlation coefficient of soil reaction with SiO_2, Na_2O, K_2O, CaO and MgO were -0.350*, -0.279, -0.408**, 0.095 and 0.509** respectively which suggested that the soils derived from highly siliceous parent materials were rich in sodium and potassium bearing minerals while the soils derived from low and intermediately siliceous parent materials were rich in calcium and magnesium bearing minerals.

3.4 Free $CaCO_3$

Free $CaCO_3$ content was comparatively more in low siliceous basalt derived pedon-1, moderate in intermediately siliceous schist derived pedon-5 and low in the highly siliceous granite derived pedon-6 as the soils derived from more siliceous parent materials were low in bases unlike the soils derived from low and intermediately siliceous parent materials as the bases supplying capacity of parent material is inversely related with siliceous content (Gray and Murphy, 2002) [3]. These soils were non calcareous as they failed to fulfill the definition of calcic horizon though appreciable amount of free $CaCO_3$ content was present and it indicated the tendency of soils towards calcareousness. Attribution of free $CaCO_3$ content of soils to the parent materials was further supported by significant positive correlation of free $CaCO_3$ with the oxides of calcium (0.750**) and magnesium (0.559**) and significant negative correlation with the oxides of silicon (-0.904**), sodium (-0.660**) and potassium (-0.659**).

3.5 Soil organic carbon (OC)

Irrespective of the parent materials, decreasing trend of OC down the solum (Table 1) in all the pedons could be attributed to the fact that amount of biomass added to the sub soil was very less as the crop residues after the harvest of crop were uprooted and either removed from the field and used as fuel or burnt in the field and however soil organic carbon content was low ($<5g\ kg^{-1}$) in all the pedons as indicated by solum weighted average. Comparatively higher OC content in the upper solum of pedons-1 and 5 than in the pedon-6 could be attributed to nature of parent materials as the former pedons were derived from more of clay forming type of parent materials while the later pedon was derived from the more of coarser fraction forming type of parent material the impeded drainage in former pedons retarded the rate of oxidation of organic matter and conserved the same.

3.6 Cation exchange capacity (CEC)

Increasing trend of cation exchange capacity of soils down the solum could be attributed to the increasing trend of clay down the solum (Table 1). Pedons-1, 6 and 5 derived from low siliceous basalt, highly siliceous felsic granite and intermediately siliceous schist respectively could be attributed to the mineralogical composition of the parent materials as the low and intermediately siliceous parent materials are rich in bases supplying minerals while highly siliceous parent material- is poor in bases supplying minerals and it was very much evident from the total elemental analysis of fine earth (Table 3) fraction of the soils.

Irrespective of parent materials, the exchangeable site of soils, was dominated by calcium and was followed by magnesium, sodium and potassium. Among the soils studied low and intermediately siliceous parent materials derived pedons-1 and 5 witnessed higher saturation of Ca and Mg (Table 2) while highly siliceous parent material derived pedon-6 registered higher sodium (Table 2) and potassium saturation and this could be attributed to the mineralogical makeup of the parent materials as the pedon-6 is rich in sodium plagioclase and potassium orthoclase feldspars and it was very much evident from the total elemental analysis of fine earth (Table 3) fraction of the soils as well as significant negative correlation coefficient value (-0.298*) between SiO_2 and CEC which has confirmed the influence of parent materials on CEC of soils. Similar kind of observation were reported by Hallsworth and warring (1964) [4].

3.7 Soil genesis

Both pedogenic factors and pedogenic process influenced the genesis of diversified soils under study. Pedons-1, 6 and 5 were overlying the diversified geological materials such as basalt, granite and schist respectively. Higher amount of sharp edged coarse fragments in whole soil of the pedons-6 and 5 with exception to the pedon-1 where the coarse fragments content in whole soil was low unlike other pedons but total sand content was more like other pedons which confirmed that these soils have been developed insitu and were sedentary in nature.

Lower coarse fragments content in whole soil of pedon-1 could be attributed to the mineralogical composition of the underlying parent material basalt which composed of easily weatherable minerals and it was evident from the higher content of oxides of Ca and Mg with appreciable amount of iron oxides in fine earth as indicated by the total elemental analysis. Moderate amount of silicon, calcium, magnesium, potassium and sodium oxides in fine earth (Table 3) of pedon-5 suggested that the geological material underlying pedon-5 is composed of biotite mica, muscovite mica and plagioclase feldspars which confirmed that the schist is the parent material of pedon-5. Higher amount of silicon, iron, sodium and potassium oxides and lower amount of Ca and Mg oxides in addition to higher Na_2O/CaO ratio in fine earth of the pedon-6 indicated that the dominant mineralogical composition of underlying geological material is both quartz and feldspar that too plagioclase as Na_2O/CaO ratio was comparatively more.

Prevailing data is not enough to predict the specific clay mineralogy of the soils and however dominant clay mineralogy can be predicted based on CEC/Clay (Table 2) and SiO_2/R_2O_3 (Table 3) ratios (Rudramurthy and Dasog, 2001[9] and Higher, moderate and lower CEC/Clay as well as SiO_2/R_2O_3 ratios in the pedons-1, 5 and 6 derived from low siliceous mafic basalt, intermediately siliceous schist and highly siliceous felsic granite respectively suggested the dominance of more active smectite group of clay in pedon-1, presence of more active smectite group of clay in appreciable amount along with dominant low active illite clay in pedon-5 and the dominance of low active illite group of clay rather than kaolinite as the ratio was not low enough to qualify for kaolinite clay in pedon-6. Low base saturation (Table 2), low molar ratio (Table 3), lower yellower hue (Table 1) and low CEC/Clay ratio (Table 2) in the pedon-6 derived from highly siliceous felsic granite as compared to that of pedon-1 suggested leaching, decalcification, desilicification and kaolinization were the dominant pedogenic processes in the pedon-6. The pedogenic processes calcification and silicification were at moderate rate in the pedons-5 derived from intermediately siliceous schist as it witnessed moderate base saturation, molar ratio and CEC/Clay ratio and thus the genetic blood of the parent materials was observed in these sedentary soils.

Table 1: Morphological, physical and chemical properties of soils

Depth (cm)	Horizon	Moist soil color	Soil structure	Soil consistency	Effervescence	Coarse fragments %	Sand %	Silt %	Clay %	Sand/ silt Ratio	Textural class	pH 1:2.5	OC (g kg^{-1})	Free $CaCO_3$ %
Pedon-1 (Basalt)														
0-15	Ap	10YR3/1.5	3msbk	sh,fi,ms,mp	Slight	2.90	42.64	19.12	38.24	2.23	cl	7.20	6.70	10.70
15-28	A2	10YR4/1.5	3msbk	sh,fi,ms,mp	Slight	2.71	39.10	18.40	42.50	2.13	c	7.88	2.80	10.90
28-38	A3	10YR4/1.5	3mabk	h,vfi,vs,vp	Strong	2.65	39.10	18.24	42.66	2.14	c	8.01	2.50	11.50
38-58	A4	10YR3/1	3mabk	h,vfi,vs,vp	Slight	2.67	36.55	17.82	45.63	2.05	c	8.05	2.10	12.55
58-68	A5	10YR3/1	3mabk	h,vfi,vs,vp	Slight	1.79	39.07	16.25	44.68	2.40	c	8.47	1.80	11.80
68-80	A6	10YR3/1	3mabk	h,vfi,vs,vp	Slight	1.61	37.77	16.03	46.20	2.36	c	8.88	1.60	11.85
80-110	A7	10YR3/1	3mabk	h,vfi,vs,vp	Slight	1.54	41.30	16.19	42.51	2.55	c	8.94	1.40	12.05
110-120	A8	10YR3/1	3mabk	h,vfi,vs,vp	Slight	2.60	40.94	16.95	42.11	2.42	c	8.94	1.30	11.95
120-135	AC	10YR4/2	3msbk	sh,fi,ms,mp	Slight	2.34	37.80	18.00	44.20	2.10	c	9.23	1.00	11.95
SWA						2.23	39.68	17.29	43.02	2.30	c	8.34	2.46	11.74
Pedon-6 (Granite)														
0-11	Ap	5YR4/5	1msbk	sh,vfr,ss,sp	Slight	25.95	64.30	15.15	20.55	4.24	g1 scl	7.86	3.80	6.85
11-25	B1t	5YR5/5	1msbk	sh,vfr,ss,sp	Slight	22.95	60.46	13.10	26.44	4.62	g1 scl	7.96	3.60	7.53
25-35	B2	5YR5/5.5	2msbk	sh,fr,ss,sp	Slight	18.11	58.17	13.02	28.83	4.47	g1 scl	8.12	2.50	8.18
35-50	B3	5YR6/5	2msbk	sh,fr,ss,sp	Slight	17.86	56.27	12.86	30.87	4.38	g1 scl	8.14	1.40	7.78
50-65	BC	5YR6/5	2msbk	sh,fr,ss,sp	Slight	36.31	67.45	11.12	21.43	6.07	g2 scl	8.20	1.00	8.12
65-80	C	5YR6/5	1msbk	sh,fr,ss,sp	Slight	51.79	81.79	10.05	8.16	8.14	g2 lfs	8.20	1.00	8.05
SWA						21.11	59.59	13.46	26.96	4.4	g1 scl	8.02	2.76	7.58
Pedon-5 (Schist)														
0-15	Ap	5YR5/3	1msbk	s,vfr,ss,sp	Strong	38.86	46.99	20.82	32.19	2.26	g2 scl	8.05	4.60	10.65
15-25	B1	5YR5/3.5	2msbk	sh,fr,ss,sp	Strong	26.82	44.74	20.02	35.24	2.24	g1 cl	8.27	4.10	11.16
25-48	B2w	5YR5/3.5	2msbk	sh,fr,ss,sp	Violent	27.64	44.11	20.07	35.82	2.20	g1 cl	8.31	2.50	10.60
48-58	B3	5YR5/3	2msbk	sh,fr,ss,sp	Violent	26.67	44.18	20.10	35.72	2.20	g1 cl	8.42	2.00	10.75
58-70	B4	5YR5/3	2msbk	sh,fr,ss,sp	Violent	25.81	42.74	20.13	37.13	2.12	g1 cl	8.55	1.80	10.70
70-90	B5	5YR5/4	2msbk	sh,fr,ss,sp	Violent	24.44	42.87	19.22	37.91	2.23	g1 cl	8.68	1.80	10.75
90-110	BC	5YR5/5	1msbk	sh,vfr,ss,sp	Violent	16.77	46.91	16.22	36.87	2.89	g1 sc	8.60	1.60	10.75
SWA						28.35	44.21	20.01	35.78	2.20	g1 sc	8.39	2.72	10.73

Table 2: Cation exchange properties of soils

Dept (cm)	Horizon	Ca	Mg	K	Na	CEC	Base	Ca	Mg	K	Na	CEC/Clay ratio
			cmol(p$^+$)kg^{-1}				Saturation %					
Pedon-1 (Basalt)												
0-15	Ap	25.77	3.6	0.56	1.00	33.78	91.58	76.30	10.66	1.66	2.96	0.88
15-28	A2	26.2	5.0	0.44	2.01	36.39	92.46	71.98	13.74	1.21	5.52	0.86
28-38	A3	27.98	6.6	0.31	2.88	40.46	93.35	69.16	16.31	0.77	7.12	0.95
38-58	A4	28.35	8.2	0.28	3.45	42.73	94.27	66.35	19.19	0.66	8.07	0.94
58-68	A5	28.76	8.41	0.27	3.73	44.3	92.94	64.93	18.99	0.61	8.42	0.99
68-80	A6	28.84	8.56	0.23	3.95	45.17	94.27	63.85	18.95	0.51	8.74	0.98
80-110	A7	25.29	8.75	0.25	4.31	41.6	92.8	60.80	21.04	0.60	10.36	0.98
110-120	A8	24.85	8.96	0.28	4.30	41.78	91.88	59.47	21.44	0.67	10.29	0.99
120-135	AC	24.36	9.15	0.28	5.58	43.24	91.04	56.33	21.16	0.65	12.9	0.98
SWA		26.79	7.4	0.32	3.29	40.75	92.98	66.10	17.9	0.81	7.93	0.95
Pedon-6 (Granite)												
0-11	Ap	5.12	1.0	0.4	1.4	11.31	70.00	45.25	8.84	3.54	12.37	0.44
11-25	B1t	6.96	1.2	0.24	1.54	13.81	72.00	50.41	8.69	1.74	11.15	0.44
25-35	B2	7.58	1.43	0.22	1.68	14.95	73.00	50.72	9.57	1.47	11.24	0.44
35-50	B3	8.56	1.56	0.16	1.88	16.21	75.00	52.80	9.62	0.99	11.6	0.45
50-65	BC	4.68	1.57	0.17	2.41	12.80	69.00	36.57	12.27	1.33	18.83	0.48
65-80	C	1.35	0.86	0.04	2.7	7.62	65.00	17.73	11.29	0.53	35.45	0.64
SWA		7.16	1.31	0.25	1.64	14.21	72.66	50.05	9.18	1.85	11.57	0.44
Pedon-5 (Schist)												
0-15	Ap	11.61	1.56	0.48	1.20	17.89	83.00	64.89	8.72	2.68	6.71	0.56
15-25	B1	11.86	2.95	0.29	1.36	19.95	82.50	59.44	14.79	1.45	6.82	0.57
25-48	B2w	12.56	3.36	0.3	1.53	22.11	80.29	56.81	15.20	1.36	6.92	0.62
48-58	B3	13.12	3.49	0.2	2.68	22.66	86.00	57.89	15.40	0.88	11.83	0.63
58-70	B4	13.52	3.80	0.16	1.96	24.05	80.84	56.22	15.80	0.67	8.15	0.65
70-90	B5	13.75	4.10	0.21	2.32	24.57	82.93	55.95	16.68	0.85	9.44	0.65
90-110	BC	14.20	4.21	0.23	2.42	25.36	83.06	56.00	16.60	0.91	9.54	0.69
SWA		12.78	3.25	0.28	1.81	22.03	82.28	58.30	14.5	1.33	8.14	0.61

Table 3: Total elemental composition of fine earth

Depth cm	Horizon	SiO_2 %	Al_2O_3 %	CaO %	MgO %	Na_2O %	K_2O %	Fe_2O_3 %	SiO_2/R_2O_3 ratio	Na_2O/CaO ratio
Pedon-1 (Basalt)										
0-15	Ap	51.50	6.80	8.40	2.99	0.12	0.98	0.89	6.70	0.014
15-28	A2	51.20	6.70	9.80	3.99	0.15	0.35	1.85	5.99	0.015
28-38	A3	48.60	7.20	23.80	4.98	0.28	0.39	1.53	5.57	0.012
38-58	A4	47.80	6.90	11.20	3.99	0.25	0.47	1.78	5.51	0.022
58-68	A5	48.20	6.80	7.00	3.99	0.30	0.38	0.90	6.26	0.043
68-80	A6	47.40	6.60	5.60	3.99	0.38	0.52	0.70	6.49	0.068
80-110	A7	48.50	6.50	5.60	4.99	0.37	0.56	1.64	5.96	0.066
110-120	A8	49.00	7.00	8.40	4.98	0.35	0.60	1.10	6.05	0.042
120-135	AC	49.80	7.30	12.50	6.00	0.38	0.58	1.24	5.83	0.030
SWA		48.96	6.76	9.20	4.27	0.28	0.54	1.38	6.03	0.030
Pedon-6 (Granite)										
0-11	Ap	68.40	19.20	5.20	1.99	1.17	1.32	1.59	3.29	0.225
11-25	B1t	68.90	19.00	6.60	2.35	1.36	1.75	1.52	3.36	0.206
25-35	B2	67.30	17.50	5.60	2.30	1.52	1.32	1.58	3.53	0.271
35-50	B3	67.10	17.80	5.60	2.32	0.90	1.91	1.01	3.57	0.161
50-65	BC	68.20	17.70	6.20	2.40	1.10	1.96	1.47	3.56	0.177
65-80	C	66.50	17.00	7.00	2.99	1.86	2.82	1.97	3.51	0.266
SWA		67.93	18.38	5.79	2.25	1.21	1.61	1.39	3.44	0.209
Pedon-5 (Schist)										
0-15	Ap	57.70	13.50	5.00	2.98	0.48	0.88	1.78	3.78	0.096
15-25	B1	57.20	13.80	6.20	4.98	0.56	0.60	1.48	3.74	0.090
25-48	B2w	55.40	12.40	7.00	1.99	0.59	0.75	1.65	3.94	0.084
48-58	B3	56.20	12.80	8.40	1.00	0.61	0.82	1.51	3.93	0.073
58-70	B4	56.00	11.70	8.20	2.99	0.50	0.95	1.74	4.17	0.061
70-90	B5	56.10	12.00	8.40	1.99	0.46	0.71	1.25	4.23	0.055
90-110	BC	56.00	11.80	8.50	2.99	0.55	0.90	1.32	4.27	0.065
SWA		56.31	12.60	7.20	2.51	0.52	0.78	1.56	3.99	0.072

3.8 Soil taxonomy
Black pedon-1 derived from basalt was classified as Vertisols at order level as it possessed slickensides in subsurface horizons, more than 30% clay in all the horizons to a depth of 80cm and open cracks at a depth of 50cm and that were one cm wide and extended upward to the surface and these cracks remain open for more than 90 cumulative days during the year but not throughout the year. As it exhibited the cracks that open and close more than once during the year in most years and mean annual soil temperature was more than 22 °C black pedon-1 was classified as Ustert at sub order level. At great group level black pedon-1 was classified as Haplusterts as it did not possess calcic, gypsic or salic horizons. At subgroup level, it was classified as Typic Haplusterts as it conveyed the central concept of Haplusterts.

Red pedon-6 derived from granite was qualified for Alfisols at order level as it possessed argillic horizon where clay content was 1.2 times higher than that of overlying horizon. At sub order level it was classified as Ustalfs as it possessed ustic moisture regime and at great group level it was classified as Haplustalf as it did not have duripan, plinthite, natric, oxic, kandic and cambic horizons. At sub group level it was qualified for Typic Haplustalfs as it possessed the central concept of Haplustalf.

In spite of high clay content and clay illuviation, illuvial horizon did not fulfill the requirements of argillic horizon and thus red pedon-5 derived from schist was qualified for Inceptisols at order level and at sub order level it was qualified for Ustepts as it possessed Ustic moisture regime. At great group level it was classified as Haplustepts as it possessed appreciable amount of free calcium carbonate but did not posses calcic, umbric or mollic horizons. At subgroup level it was classified as Typic Haplustept as it possessed central concept of Haplustept.

4. Conclusion
In general the genetic blood of the parent materials was observed in the soils overlying them as the remarkable differences in both particle size classes and chemical properties of soils of selected area in Budhihal micro watershed was observed and it was attributed to the underlying diversified geological materials which were the parent materials of the soils as it was confirmed by the total elemental analysis of soils, molar ratio and CEC/Clay ratio. Low siliceous basalt derived pedon-1 registered deeper solum depth, finer texture and well developed soil structure as compared to the high siliceous granite derived pedon-6 and intermediately siliceous schist derived pedon-5. Soil reaction, CEC, total exchangeable basic cations as well as percent base saturation were comparatively low in highly siliceous granite derived pedon-6 as compared to the rest of the two pedons. Soils under study were keyed out at subgroup level as Typic Haplusterts (Pedon-1), Typic Haplustalf (Pedon-6) and Typic Haplustepts (Pedon-5).

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