ORIGINAL ARTICLE

GENESIS AND CLASSIFICATION OF INCEPTISOLS FORMED ON THE SLATE PARENT MATERIAL UNDER FOREST VEGETATION

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ABSTRACT

Inceptisols are most extensive soils in this region. These soils are under forest vegetation. Ten soil profiles were selected in this research. The some important physical, chemical and morphological properties were investigated and classified according to USDA Soil Taxonomy.

KEYWORDS: Inceptisol, genesis, classification and slate

DETAILED ABSTRACT

In this study, ten soil profiles formed on slate in the northern part of the Uludag Mountain elevated from 250 to 500 m have been studied in order to investigate their important physical, chemical, morphological properties and formation. The investigated soils are deep and have A-Bw-C horizons. Texture of the soils varies from sandy clay loam to clay loam. The soil pH is slightly acidic in all soil profiles. According to results, the soil formation is characterized by downward movement of clay, iron, formation of a cambic horizon and leaching of bases. The investigated soils were classified as Typic Xerochrepts according to USDA Soil Taxonomy.

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INTRODUCTION

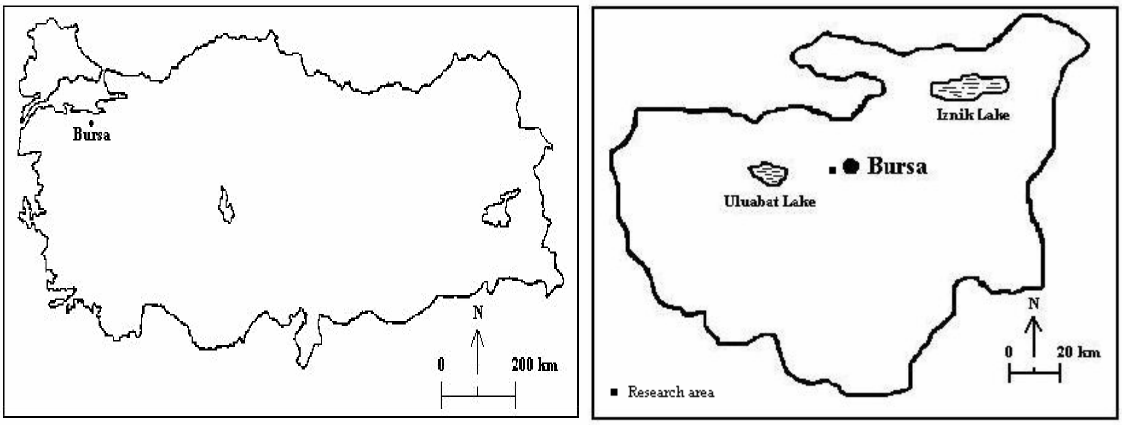
The investigated soils are ‘non calcic brown soils’ according to Thorp et all., [13]. These correspond to the Inceptisols of the USDA Soil Taxonomy [15]. Inceptisols, as contrasted to many of the other orders, include soils from a wide range of environments. These are found from the arctic to the tropics. However, the central concept of Inceptisols includes those soils from ustic and udic regions that have altered horizons resulting from translocation of loss of iron, aluminum, or bases [10]. In general, Inceptisols are soils that have undergone modifications of the parent material by soil-forming processes that are sufficiently great to distinguish the soils from Entisols, but not intense enough to form the kinds of horizons that are required for classification into other soil orders. Most Inceptisols have cambic horizons and most are eluvial soils [12] in that they have lost constituents by leaching and have no horizons in which significant amounts of these constituents have accumulated, but these are not necessary conditions for their recognition. For example, soils in which the only significant change is a fairly thick accumulation of organic matter with low base saturation at the surface and soils in which calcium carbonate has accumulated below a cambic horizon are recognized as Inceptisols. Poorly drained soils with permafrost are included with Inceptisols even though the soil is too sandy to satisfy the criteria for a cambic horizon. Soils with mollic epipedons are Inceptisols if the epipedon is formed in pyroclastic materials or if a cambic horizon below the epipedon has a low base saturation to great depth. Inceptisols are the most extensive soils covering 516.272 ha of the Bursa province in Turkey [1]. These are widespread in the southern part of the province, occurring over a large latitudinal range, but in the north, such soils are found only at the highest altitudes.

This research was conducted to investigate some important properties of the Inceptisols developed on slate under forest vegetation and same climate. This would help to classify these soils according to USDA Soil Taxonomy [15] to enhance our understanding of these soils how these are formed.

MATERIALS AND METHODS

The research area is located on northern side of the Uludag Mountain in the Bursa province, Turkey. Ten soil profiles were examined in this research. The investigated soil profiles were described and sampled in forest area of the mountain on the transects which lie between 40° 10′ - 40° 07′ N and 28° 53′ - 28° 56′ E and comprise lands an altitude ranging from 250 to 500 m above mean sea level. These soils are formed under the Mediterranean climate characterized by the mild and rainy winter, hot and dry summer. The mean annual precipitation is 713.1 mm and temperature is 14.4 °C in the province. The soil temperature and moisture regimes are thermic and xeric respectively.

Figure 1. The location of research area in the Bursa province of Turkey



Representative bulk samples of the recognized horizons in each profile were taken for laboratory analysis. Morphological properties of the soil profiles were described according to Soil Survey Manual [11]. Soil samples were analyzed for particle size distribution [4], pH in a 1:2 soil:water ratio [5], organic carbon [7], total nitrogen [3], calcium carbonate [6], EC [9], CEC [8], exchangeable cations [14], and acid-oxalate extractable Al, Fe, and Si [2].

RESULTS AND DISCUSSION

The morphological properties of the profiles were given in Table 1.

The color of all profiles was 7.5 YR hue. The values ranged from 5 to 6 and chromas from 3 to 4. The profiles were situated on north aspect with slope of 2% and formed on concave landforms and well drained and such devoid of any aquic features. All the profiles were deep and had clay enriched in the Bw horizons. The width of cambic horizons varied from 15 to 35 cm. In general, the width of cambic horizons was lower in the profiles of 4 and 5 as compared with other profiles. Structurally, Bw horizons were stronger than A horizons and the structures were granular and subangular blocky in the investigated profiles. The granular structure in the A horizons is probably due to earthworm activity. The stronger structure was also occurred in the lower horizons of the profiles due to the high clay content.

The physical and chemical properties of the soils are presented in Table 2. The profiles contain clay between 21.4 to 39.4% and increase slightly in the Bw horizons. Then, it decreases in the C horizons. There is more sand than silt throughout all the studied profiles. The values of sand, silt and clay fractions were varied in each profile due to physical and chemical weathering conducted by soil forming process. These soils have developed on noncalcareous parent material under conditions of moderate rainfall and good drainage. The soil pH is slightly acidic. pH values range from 6.0 to 6.8 and increase with depth, suggesting some leaching of base cations or probably an organic matter effect. Electrical conductivity values were low in all the profiles due to good drainage. The organic carbon, total nitrogen and C/N values are generally in moderate to high. $CaCO_3$ is absent throughout all the profiles due to the nature of the acid parent material. The cation exchange capacity of the profiles ranges between 19.7 to 37.6 cmol (+) kg^{-1} and increase with depth in the Bw horizons. The higher CEC values in the Bw horizons related with the clay content of the profiles. Exchangeable Ca and Mg are dominant cations in all the soils. Base saturation values of the profiles vary from 92.7 to 98.5%. Increase of the acid oxalate extractable Al and Fe values have been suggested that Al and Fe accumulated in the C horizon of the profiles due to weathering of the soils. The acid oxalate extractable Si values are almost in similar amounts in all the profiles. The physical and chemical properties of the all profiles indicated that differences have occurred due to location of the profiles and degree of pedogenic process in the research area.

Table 1. Morphological characteristics of the profiles

Horizon	Depth (cm)	Munsell Color, (moist)	Texture	Structure	Consistence (moist)	Roots	Boundary
Profile 1							
A	0-25	7.5 YR 6/3	CL	1f, gr	fi	c, c	w
Bw	25-60	7.5 YR 5/3	CL	1f, sbk	fi	c, m	g
C	60-90	7.5 YR 4/4	SCL	1f, gr	fr	---	g
Profile 2							
A	0-30	7.5 YR 6/3	L	1f, gr	fi	c, c	g
Bw	30-55	7.5 YR 5/4	CL	2f, sbk	fi	c, f	g
C	55-80	7.5 YR 4/3	SCL	1f, sbk	fr	---	g
Profile 3							
A	0-20	7.5 YR 6/4	CL	1f, gr	fi	c, m	g
Bw	20-50	7.5 YR 5/4	CL	2m, sbk	fi	f, m	w
C	50-85	7.5 YR 5/3	SCL	1f, gr	fr	---	g
Profile 4							
A	0-10	7.5 YR 6/3	CL	1f, sbk	fi	c, c	w
Bw	10-45	7.5 YR 5/3	SCL	2m, sbk	fi	c, m	w
C	45-75	7.5 YR 5/3	SCL	1f, sbk	fr	---	g
Profile 5							
A	0-23	7.5 YR 6/4	L	1f, gr	fi	c, c	g
Bw	23-48	7.5 YR 5/4	SCL	1f, sbk	fi	c, m	w
C	48-83	7.5 YR 5/4	SCL	1f,gr	fr	---	w
Profile 6							
A	0-15	7.5 YR 6/3	CL	1f, gr	fi	c, m	w
Bw	15-30	7.5 YR 5/4	CL	2m, sbk	fi	f, f	g
C	30-70	7.5 YR 5/4	SCL	1f, gr	fr	---	i
Profile 7							
A	0-20	7.5 YR 6/3	CL	1f, sbk	fi	c, m	g
Bw	20-40	7.5 YR 5/4	CL	2m, sbk	fi	c, f	w
C	40-80	7.5 YR 5/3	SCL	1f, sbk	fr	---	i
Profile 8							
A	0-25	7.5 YR 6/4	CL	2f, gr	fi	c, m	g
Bw	25-43	7.5 YR 5/3	C	2m, sbk	fi	c, m	w
C	43-72	7.5 YR 5/3	SCL	1f, gr	fr	---	i
Profile 9							
A	0-14	7.5 YR 6/4	CL	2f, gr	fi	c, c	w
Bw	14-28	7.5 YR 5/4	CL	2m, sbk	fi	c, m	w
C	28-55	7.5 YR 5/3	SCL	1f, gr	fr	---	i
Profile 10							
A	0-18	7.5 YR 6/4	CL	2f, gr	fi	c, m	g
Bw	18-36	7.5 YR 5/3	CL	2m, sbk	fi	c, m	w
C	36-62	7.5 YR 5/3	SCL	1f, gr	fr	---	i

Structure: 1 = weak, 2 = moderate. Type: f = fine, m = medium. Class: gr = granular, sbk = subangular blocky.
Consistency: fi = firm, fr = friable Roots: abundance: f = few, c = common; size: f = fine, m = medium c = coarse.
Boundary: g = gradual, w = wavy, i = irregular. Topography = concave

Table 2. Some physical and chemical properties of Inceptisols.

Horizon	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Texture	pH 1:2 soil: water	EC (dS m^{-1})	Org. C (%)	Total N (%)	C/N	$CaCO_3$ (%)	CEC	Exchangeable cations cmol (+) kg^{-1}					BS (%)	Acid oxalate extractable (%)		
													Ca	Mg	K	Na	H		Al	Fe	Si
Profile 1																					
A	0-25	41.8	28.5	29.0	CL	6.5	0.46	1.82	0.16	11.4	-	26.8	19.5	3.8	1.0	0.7	0.9	96.6	1.42	0.73	0.08
Bw	25-60	46.3	22.1	31.2	CL	6.8	0.38	0.85	0.09	9.4	-	28.9	21.2	4.7	0.8	0.6	0.0	94.5	1.48	0.79	0.07
C	60-90	50.4	23.9	24.7	SCL	6.8	0.30	---	---	---	-	25.7	18.3	4.6	0.6	0.6	0.0	93.8	1.55	0.86	0.07
Profile 2																					
A	0-30	40.2	31.3	27.4	L	6.1	0.52	1.95	0.19	10.3	-	30.9	21.8	4.0	1.2	0.9	1.2	94.2	1.31	0.58	0.07
Bw	30-55	45.8	25.6	28.0	CL	6.4	0.34	0.63	0.07	9.0	-	31.8	23.1	4.9	0.9	0.7	1.0	96.2	1.44	0.65	0.06
C	55-80	52.3	21.1	25.8	SCL	6.5	0.20	---	---	---	-	28.5	20.0	4.8	0.8	0.7	0.8	95.1	1.49	0.68	0.07
Profile 3																					
A	0-20	38.1	29.5	31.2	CL	6.0	0.42	1.42	0.15	9.5	-	27.4	18.2	3.7	0.9	1.3	1.8	94.5	1.54	0.62	0.06
Bw	20-50	40.7	24.7	32.5	CL	6.2	0.32	0.48	0.06	8.0	-	28.8	20.4	3.9	0.7	1.0	1.1	94.1	1.60	0.69	0.07
C	50-85	48.8	21.9	28.7	SCL	6.3	0.28	---	---	---	-	25.2	17.7	3.9	0.5	0.8	1.0	94.8	1.67	0.73	0.07
Profile 4																					
A	0-10	39.2	30.7	28.8	CL	6.5	0.38	1.63	0.17	9.6	-	28.4	19.8	3.8	1.0	1.1	1.1	94.4	1.34	0.70	0.07
Bw	10-45	42.6	24.5	30.1	SCL	6.6	0.23	0.71	0.08	8.9	-	30.3	22.1	4.3	0.8	0.7	0.8	94.7	1.37	0.75	0.08
C	45-75	55.0	20.8	23.2	SCL	6.7	0.15	---	---	---	-	24.8	17.3	4.0	0.7	0.5	0.5	92.7	1.43	0.78	0.08
Profile 5																					
A	0-23	43.4	28.9	26.3	L	6.6	0.50	1.41	0.14	10.1	-	24.2	16.4	3.6	1.1	1.0	1.1	95.9	1.30	0.60	0.07
Bw	23-48	48.3	21.5	27.8	SCL	6.7	0.44	0.47	0.05	9.4	-	27.4	20.2	3.9	0.9	0.8	0.6	96.3	1.33	0.64	0.07
C	48-83	51.2	26.7	21.4	SCL	6.7	0.38	---	---	---	-	19.7	19.0	3.8	0.8	0.6	0.5	96.4	1.40	0.68	0.08
Profile 6																					
A	0-15	36.0	27.4	35.1	CL	6.3	0.58	1.90	0.16	11.9	-	30.5	21.5	4.0	1.1	1.0	1.1	94.1	1.37	0.50	0.07
Bw	15-30	36.9	26.2	36.3	CL	6.5	0.40	0.95	0.09	10.5	-	31.8	23.2	4.2	0.8	0.7	0.9	93.7	1.43	0.57	0.08
C	30-70	50.6	18.3	30.4	SCL	6.6	0.18	---	---	---	-	26.1	18.7	3.9	0.4	0.6	0.6	92.7	1.50	0.65	0.07
Profile 7																					
A	0-20	34.6	28.7	34.7	CL	6.1	0.55	1.92	0.17	11.3	-	31.9	22.0	4.5	1.2	1.2	1.3	94.7	1.40	0.55	0.06
Bw	20-40	35.8	25.5	35.8	CL	6.3	0.37	0.84	0.08	10.5	-	33.5	24.3	4.9	0.7	0.9	1.2	95.5	1.48	0.60	0.07
C	40-80	52.1	19.9	27.1	SCL	6.4	0.25	---	---	---	-	28.1	20.5	4.5	0.6	0.7	1.0	97.1	1.54	0.67	0.08
Profile 8																					
A	0-25	32.1	28.5	37.8	CL	6.4	0.60	1.86	0.15	12.4	-	34.8	26.0	3.9	1.3	1.1	1.2	96.3	1.42	0.47	0.07
Bw	25-43	33.9	26.2	39.4	C	6.5	0.52	0.73	0.06	12.2	-	37.6	29.3	4.0	1.1	1.0	1.0	96.8	1.45	0.53	0.07
C	43-72	49.5	17.0	32.8	SCL	6.7	0.32	---	---	---	-	27.5	27.0	3.8	0.5	0.8	0.6	98.2	1.52	0.63	0.08
Profile 9																					
A	0-14	37.4	28.5	32.4	CL	6.5	0.53	1.80	0.16	11.2	-	29.7	21.3	4.2	1.2	1.3	1.0	97.6	1.44	0.50	0.07
Bw	14-28	39.3	24.2	33.8	CL	6.6	0.37	0.62	0.06	10.3	-	34.1	26.1	4.5	0.9	1.1	0.8	97.9	1.49	0.55	0.07
C	28-55	51.9	18.4	28.9	SCL	6.7	0.24	---	---	---	-	25.2	19.0	4.1	0.6	0.5	0.6	98.4	1.58	0.64	0.08
Profile 10																					
A	0-18	35.6	26.4	36.5	CL	6.5	0.45	1.88	0.17	11.0	-	33.5	24.7	4.4	1.3	1.2	0.9	97.0	1.38	0.52	0.06
Bw	18-36	38.0	22.1	37.8	CL	6.6	0.37	0.79	0.08	9.9	-	37.4	28.9	4.7	1.1	1.0	0.7	97.5	1.44	0.56	0.07
C	36-62	50.0	17.7	31.7	SCL	6.7	0.19	---	---	---	-	27.0	20.7	4.2	0.5	0.7	0.5	98.5	1.53	0.66	0.08

Soils are classified according to the type and sequence of horizons present, therefore the first step in soil classification is horizon recognition. The cambic B (Bw) horizon was defined in the profiles. These soils were classified as Typic Xerochrepts [15] according to obtained results.

CONCLUSIONS

Conclusion to be derived from this research as follows;

The formation of the soils was conducted by the addition and accumulation of organic matter and translocation of clay and sequioxides under control of their climatic conditions, vegetation and composition of parent material. Much of the variation among the soils can be related to location of the profiles and the geomorphological history of the region. According to overall soil properties, it is concluded that all soil profiles are still in developing stage.

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