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Soil-Landscape Relationship as Indicated by Micromorphological Data on Selected Soils from Karaj Basin, Iran

Sh. Mahmoodi[1]*, A. Heidari[1], M. H. Masihabadi[2] and G. Stoops[3]

ABSTRACT

Soils of the arid–semiarid Karaj Basin in north-central Iran have formed on alluvium-colluvium derived from mixed calcareous-gypsiferous marls of Miocene and basic igneous rocks of Holocene age. In order to characterize and classify the soils and to determine the soil-landscape relationship in the area, sixteen pedons located on different physiographic positions have been described, sampled and analysed. According to field descriptions these soils all show evidences of carbonate accumulation to be classified as Calcids or Cambids. However, soils with well developed argillic and calcic horizons have been observed on apparently younger colluvial fans, whereas the less developed soils with calcic and cambic horizons occur on older upper alluvial plains. Due to the calcareous gravelly soil parent materials, clay films are mainly masked by carbonates and their identification in the field is mostly impossible. Also due to the adherence of these clay films to coarse gravels and their separation from the fine earth materials through sieving, they may not sometimes appear on the particle size distribution analysis. Yet under the microscope the soils show enough indicators to be characterized as argillic horizon and to classify the soils properly according to Soil Taxonomy as Argids instead of Calcids. Also, these findings point out the relatively older ages of these physiographic surfaces now they are covered by younger colluvial materials.

Keywords: Carbonates, Clay film, Landform, Micromorphology, Plaeoclimate.

INTRODUCTION

There have been many attempts to correlate soil properties with various factors, such as parent material and topography (Wilding *et al*. 1994; Cook *et al*. 1996; McBratney *et al*. 2000). This approach, frequently cited as soil-landscape analysis, was initiated for more accurate and easily obtainable information on the spatial distribution of soils for detailed environmental modeling and site specific land management (McBratney *et al*., 2000). This emphasis on using geomorphological variables to predict spatial variations in soil properties can be linked to both theoretical and practical considerations. Theoretically, landforms may be the best indicators of soil attributes in places where the impact of other environmental factors is relatively small (Moore *et al*., 1993). In terms of practical considerations, a topographic map is still the most easily available source of information in many parts of the world, particularly in developing countries where relatively expensive soil surveys have not yet been carried out, and such soil-landscape analysis is considered as a technique in natural resource surveys (Gessler *et al*., 1995).

1. Department of Soil Science, College of Agriculture, University of Tehran, Karaj, Islamic Republic of Iran.
2. Soil and Water Research Institute, Amirabad Shomali, Tehran, Islamic Republic of Iran.
3. Laboratory of Mineralogy, Petrography and Micromorphology, Ghent State University, Belgium.
* Corresponding author, email: smahmodi@ut.ac.ir

Despite the recent developments in analytical methodologies, some theoretical questions of systematic correlation between soil properties and landform geometry have not been fully investigated (Park and Burt, 2002). For example, it is well known that soils are anisotropic in both vertical and horizontal vectors and, in most places, vertical heterogeneity is more pronounced than the lateral one (Wilding *et al*., 1994), whereas most previous research has only dealt with lateral variation at one or two depths, because of either the difficulty of sampling or added complexities in statistical analysis (Park and Burt, 2002). However, considering the strong vertical variations of cumulative soils (Grossman, 1983) and also taking into account the possible paleoclimatic effects and polygenesis on soils of arid regions (Gile and Grossman, 1968; Eghbal and Southard, 1993; Khormali *et al*., 2003; Khademi and Mermut, 2003), the establishment of such soil-landscape relationships may not be always correct and in many cases without detailed analysis the misleading soil attributes may cause the failure of developmental projects.

The aim of the present study is generally, to characterize more precisely and more easily the soils of the arid to semi-arid area in Karaj Basin (Iran) using soil-landscape relationship and, more specifically, to illustrate the role of micromorphological study in this research.

MATERIALS AND METHODS

Karaj Basin is located 40 km west of Tehran, the capital of Iran, at the southern foot of the Alborz Mountain range (Figure 1). The Central Alborz belongs to the Lower and Middle Jurassic and is typically a formation of carbonaceous shales, sandstones and conglomerates. The southern boundary of the plain is bordered by an andesitic chain of the Holocene age (Eshghi, 1976). In the western part of the basin, between the foothills of the Alborz Mountains and the western boundary of the plain, Miocene formations appear, consisting of the relicts of playas in depressions and composed of green marls, alternating salts, gypsum, calcareous marls, limestone and red shale sequences.

The area is characterized by an arid to semi-arid climate. The mean annual rainfall is about 245 mm and the temperature is 13.7 °C, with a dry and hot summer and a relatively cold winter.

Sixteen pedons on three north-south transects at different physiographic positions of the lower and upper alluvial plains, colluvial and alluvial fans and lowlands were studied in the field (Mahmoodi, 1979, Figure 1). The results of four pedons are presented in this paper (Table 1). Pedons 1 and 2 have formed on alluvial-colluvial materials derived from the southern andesite chains; mainly composed of basic igneous rocks, whereas the other two pedons (3 and 4) have formed on the alluvial plain and colluvial fan, respectively. Soil samples for physico-chemical, mineralogical and microscopic studies were taken from each horizon. The physico-chemical and mineralogical analyses were carried out according to USDA standards (USDA, 2004). The results are presented in Table 2. In some gravelly horizons the adhered materials were carefully scraped off from the gravels and added to the fine earth material for further analysis. In some samples the soil texture was determined before and after removal of carbonates using dilute hydrochloric acid (Jackson, 1975). Pedogenic carbonates were calculated according to Gile (1995). Based on his formula, secondary calcium carbonates can be calculated as;

$CaCO3$ (kg/m^2) = L.Ds (1->2 mm vol %/100) $CaCO_3$/100/10.

Where L is the thickness of the horizon, Ds is the bulk density of the fine earth. (1->2 mm vol %) is a correction factor for the volume occupied by the >2 mm material and $CaCO_3$ is the carbonate content of the horizon minus the carbonate content of the parent materials. Soil thin sections were prepared following the method used at the Laboratory for Mineralogy, Petrology and Micropedology of the Ghent University (Stoops, 1974). SEM was also used to study the morphology of some of the cutanic features.

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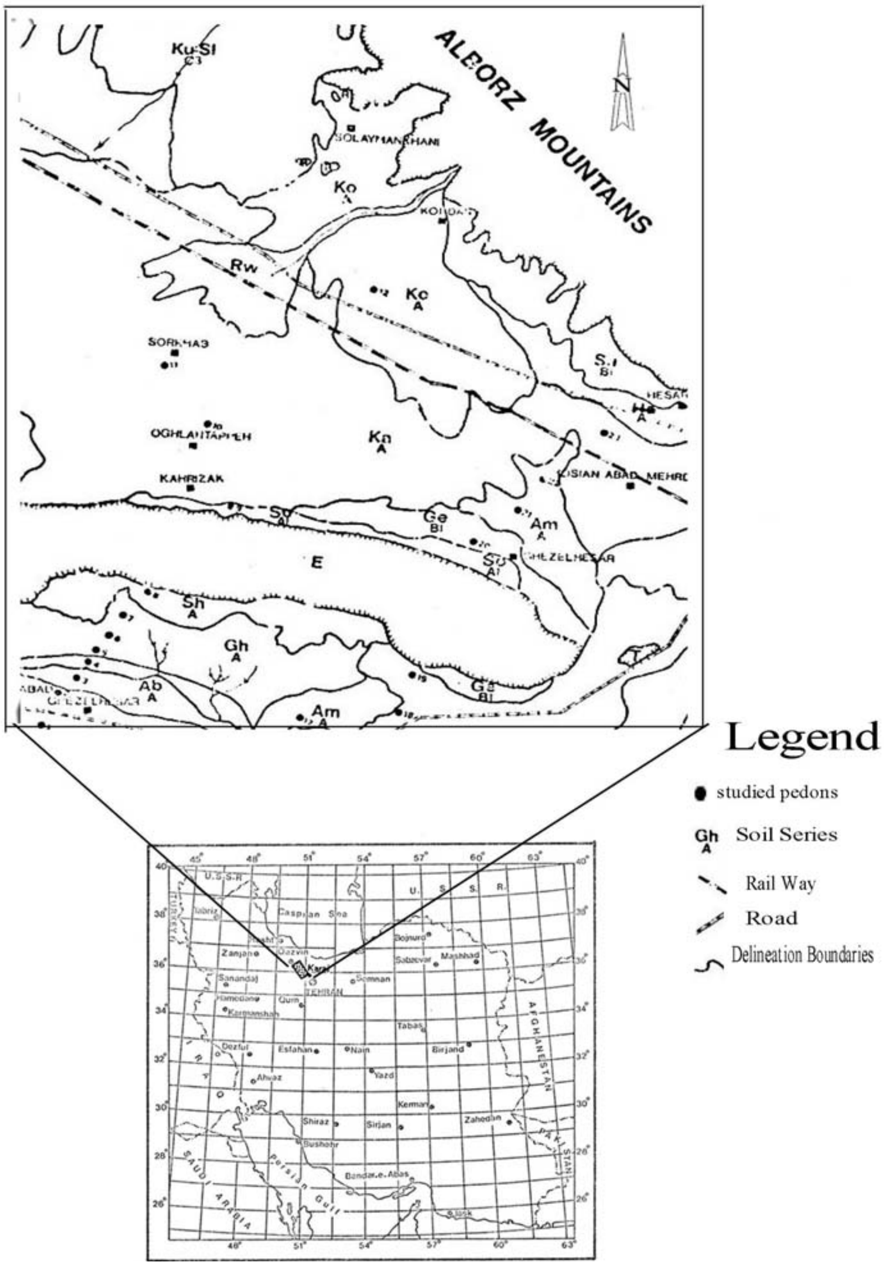

Figure 1. Map showing approximate delineation of geographic area selected for study. Solid cycles in the upper map indicate the location of the studied pedons.

Table 1. Morphology and classification of the studied soils.

Horizon	Depth cm	Munsell colors moist	Texture	Structure	Consistence	Boundary	Carbonate concentration and stage
Pedon 1-Typic Calciargids, loamy skeletal, mixed, superactive, mesic (Alluvial-colluvial fan)							
A	0-10	10YR 3/3	-	1fpl [a]	dl	cs	esd
2 C	10-32	5YR 3/4	gl	1vfgr &sg	ds	as	esfCp & I
3 $Btkb_1$	32-50	5YR 3/3	gsl	1vfabk &sg	-	as	esmCp & sm & II
4 $Btkb_2$	50-85	2.5YR 3/4	gscl	1mabk & sg	mfi &fr	gs	esmCp & sm & II
4 $Btkb_3$	85-115	5YR 3/3	gsc	sg	mfi &fr	gs	esmCp& no & II
Pedon 2-Typic Calciagids, loamy skeletal, mixed, superactive, mesic (Colluvial fan)							
A	0-15	10YR 3/3.5	gsl	1fpl	dl	aw	esd
2 Btkb1	15-50	5YR 3/3	-	2fmabk	dsh	cw	escCp&sm &I
2 $Btkb_2$	50-80	5YR 3/4	gscl	2mabk	dh	cw	esmCp&sm &II
2 $Btkb_3$	80-120	5YR 3/3	gscl	sg-m	dh	gs	escCp&sm &II
Pedon 3-Typic Haplocalcids , Fine ,mixed, active, mesic (Upper alluvial plain)							
Ap	0-12	10YR 4/3	sil	1fpl-2fgs	ds	as	evd
2 Bk_1	12-21	10YK 4/3	sil	1abk	dsh	as	evm3rsm &II
3 Bk_2	21-46	10YK 4/2	sil	1mabk-1mcpr	dh	gi	evm3rsm&II
4 Ck_1	46-90	10YR 6/2	scl	m	dvh	as	evfsm
5 Ck_2	90-108	10YR 5/2	cl	m	dsh	as	evfsm
6 Ck_3	108^+	10YR 6/3	sic	m	mvfi	g	evfsm
Pedon4-Typic Haplocambids , loamy skeletal , active, mesic (Colluvial fan)							
A	0-34	10YR 6/3	gl	1fpl-fgr	ds	as	esd
2 Bk	34-79	10YR 6/3	gl	2mabk	dsh-dh	aw	esfsf&sm &I
3 Ck	79-120	7.5YR 6/4	gc	sg	dh	g	esfsf&sm &I

[a] Abbreviations from Soil Survey Manual (1993)

RESULTS AND DISCUSSION

Field morphology (USDA, 1993) of the pedons studied is presented in Table 1. According to their classification (USDA-NRCS, 1999) soils, occurring on apparently younger alluvial-colluvial fans (Pedons 1 and 2) are classified as loamy skeletal Typic Calciargids, whereas the one on the upper alluvial plain (Pedon 3) is classified as a fine Typic Haplocalcid and the last one on the colluvial fan (Pedon 4) as a loamy skeletal Typic Haplocambid.

The redder (5YR3/4 and 5YR3/3) subsurface horizons of Pedons 1 and 2 compared with the pale brown (10YR4/2-10YR6/3) colour of Pedons 3 and 4 (Table 1) were field indicators of more developed soils in these landscape positions, even as the presence of patchy clay coatings, although they seemed doubtful in the field. Yet due to the gravelly parent materials and frequent lithologic discontinuities of these soils (Table 1) recognition of argillic horizons in terms of clay increase with depth, which is the most common and evident field test, is often impossible, even the conventional physical methods (granulometric analysis) do not show the required clay increase with depth. This is because most of the illuviated clays are either attached to the coarse frag-

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Table 2. Some selected physico-chemical data and calculated pedogenic carbonates on studied soils.

Hori-zon	Depth cm	Particle Size Distribution %				CEC $cmol^{+}kg^{-1}$		EC_{sae} dSm^{-1}	$CaCO_3$ %	Pedogenic $CaCO_3$ kgm^{-2} [a]	Bulk-density gcm^{-3}
		Sand	Silt	Clay	>2 mm	Soil	Clay				
						Pedon 1					
A	0-10	-	-	-	20	9.4	40.0	1.01	10.5	6.6	1.4
2 C	10-32	58.2	29.8	12.0	30	10.0	-	0.76	8.0	15.1	1.4
3 $Btkb_1$	32-50	73.0	13.4	13.6	40	7.0	38.3	0.64	7.5	10.5	1.5
4 $Btkb_2$	50-85	53.0	11.0	36.0	40	18.7	44.4	1.50	11.4	32.8	1.5
4 $Btkb_3$	85-115	54.0	12.0	34.0	50	-	-	0.83	12.2	26.9	1.6
						Pedon 2					
A	0-15	68.0	20.0	12.0	50	8.9	38.4	0.72	8.3	8.2	1.5
2 Btkb1	15-50	-	-	-	35	11.8	-	1.56	11.4	37.9	1.6
2 $Btkb_2$	50-80	58.0	8.5	33.5	35	13.7	35.2	1.00	11.7	33.4	1.6
2 $Btkb_3$	80-120	59.5	10.5	30.0	35	12.8	-	0.84	11.5	43.7	1.6
						Pedon 3					
Ap	0-12	21.8	36.0	42.2	0	19.2	-	0.95	23.5		1.4
2 Bk_1	12-21	21.8	33.8	44.4	0	19.5	48.8	0.83	24.6		1.5
3 Bk_2	21-46	20.0	22.0	58.0	0	17.9	52.8	1.17	36.6		1.6
4 Ck_1	46-90	51.5	14.0	34.5	8	9.5	-	1.89	29.8		1.6
5 Ck_2	90-108	35.9	22.1	42.0	0	11.0	38.4	1.67	42.6		1.7
6 Ck_3	108^{+}	12.6	24.0	63.4	0	9.5	-	1.56	55.0		1.7
						Pedon4					
A	0-34	50.4	33.6	16.0	30	13.24	45.6	0.65	10.7		1.4
2 Bk	34-79	40.4	33.3	26.3	50	16.08	40.8	0.32	11.5		1.5
3 Ck	79-120	31.4	28.3	40.3	45	15.59	37.6	0.44	19.2		1.6

[a] Calculated according to Gile (1995)

ments or are flocculated by high contents of carbonates and, therefore, remain on the sieve during the sieving processes. So these clays are either not included in the fine earth fraction or appear as pseudo-sand or pseudo-silt when flocculated by carbonates. Scratching the fine materials from the pebbles and including them into the fine earth materials and determination of soil texture after removal of carbonates (Jackson, 1975) might be helpful in these cases. However, although this procedure has resulted in more clays for the argillic horizons compared with the routine method, the problem of argillic horizon recognition remains unsolved due to several discontinuities of these pedon.

The mechanism of argillic horizon formation and its recognition in calcareous soils of arid region have been discussed by many authors (Gile and Grossman, 1968; Nettleton *et al.*, 1969; Nettleton and Peterson, 1983; Mahmoodi, 1979; Khormali *et al.*, 2003; Khademi and Mermut, 2003). The absence of the key requirement of clay skin for argillic horizon in many carbonate-rich Argids is either tied to high shrink-swell potential, caused by the considerable amount of expandable clays (Nettleton *et al.*, 1969; Nettleton and Peterson, 1983) or to the disruption force of growing crystals, such as gypsum or calcite (Khademi and Mermut, 2003) or to engulfment with carbonates (Gile and

Grossman, 1968; Mahmoodi, 1979).

Considering the micromorphological results of the present study (Table 3, Pedon 2) one can see clearly the indicators of illuviated clay mostly as typical free grain and embedded grain argillans and also as illuviated clay around the carbonate accretions.In fact, the micromorphological results clearly show the presence of two generations of illuviated clay. The rather thick reddish brown ferri-argillans, mostly invaded by carbonates, which are composed mainly of coarse clays and, therefore, are dusty and have a diffuse extinction line with orientation parallel to the grain surface (Table 3, Pedon 2) occurring on the higher Bt, whereas the thinner more yellowish continuous argillans with sharp extinction lines and white color of the first order, have been observed around the calcitic nodules, and some needle shaped calcitans around the voids and pendants of the lower Bt (Figures 2, 3 and 4). Perhaps the depth and stage of evolution suggest more humid conditions of formation (pluvial period) than today. Based on the macro- and micromorphological characteristics (i.e. fabric, external boundary, etc.) there is no doubt that, at least, most of the microcalcite inter-pebble fillings and carbonate soft masses of Bt horizons are orthic features. The calcite nodules of 3Btkb3 horizon (Table 3) usually have a brown rim of illuviated clay (Figure 2). Consequently, these carbonate accretions have been formed before the clay illuviation and/or were transported. Most of the microcalcite nodules and carbonate pendants of the deepest horizons also have this brown rim, whereas this is seldom the case for these kinds of nodules in the upper Bt horizon. Probably an evidence of two chronologically different nodules, one has been formed before the clay illuviation and the other one after. Carbonate pendants on the surface layers are mostly considered to be inherited, as there is mainly no orientation with respect to the soil surface.

The physico-chemical results (Table 2) show that the calcium carbonate equivalent content ($CaCO_3$ %) is much higher throughout Pedons 3 and 4 (19.2-55.0 %) compared to Pedons 1 and 2 (7.5-11.7 %), probably partly due to calcareous parent materials of the first two pedons (Pedons 3 and 4) as compared with pedons 1 and 2 which have been formed mainly on basic igneous rocks. Taking into account the calculated amount of pedogenic carbonates (Gile, 1995) of pedons 1 and 2 (Table 2) and considering Gile's (1995) average rate of carbonate accumulation (5.1 Kg m^{-2}), the tentative age of the sediments and soils in Pedon 1 location with a total 91.9 Kg m^{-2} pedogenic carbonates is about 18,000 years and for Pedon 2 with a total 123.2 Kg m^{-2} pedogenic carbonates about 24,000 years. The average age of the alluvia-colluvial materials is therefore about 21,000 years which is about the late Pleistocene era. Although no early Pleistocene glacial deposits have been mapped in Iranian mountains (Krinsly, 1970), Allenbach (1966) attributes the absence of early Pleistocene deposits in the Alborz Mountains to volcanism. However, according to these authors, the last major glacial advance in the mountains of Iran was approximately 20,000 years B.P. and further researches indicate that the period immediately after the last glacial advance was characterized by slightly increased precipitation and lower temperature within the Iranian Plateau. Therefore, the Pleistocene epoch within the Iranian Plateau emerges as a colder and somewhat moister period which remained, however, essentially semi-arid (Krinsly, 1970). Therefore, a post pluvial period of more humid climate which is chronologically almost relevant (21,000 years) may justify the leaching of high amounts of carbonates occurring in the deeper horizons (32-115 cm, and 15-120 cm) in Pedons 1 and 2 and subsequently clay illuviation and formation of illuviated clays now is juxtaposed on carbonate nodules and pendants, mostly preserved in the deepest horizons (USDA, 1999). The microscopic characteristics of these illuviated clays (more yellowish

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Table 3. Some micromorphological data of studied soils.

Pedon Horizon Depth (cm)	Microstructure	Ground mass		Micromass	Pedofeatures
		$c/f_{2\mu m}$	c/f (RDP)*		
Pedon 1					
A_1 0-10	Pelicular grain st & intergrain microaggregates	7/3	Gefuric to coarse monic	Crystallitic (90%) and stipple- speckled b-fabric	Thick micritic carbonate clay pendants
$4Btkb_3$ 85-115	Spongy to weakly sub- angular blocky with inter pedal plannar voids	6/4	Close prophyric to single spaced porphyric	Crystallitic (90%) and grano striated b-fabric	Thick free & embedded grain clay coatings mostly engulfed by micritic calcite (vc) with continuous striated extinction pattern. Also continuous thin argillans Jaxtaposed on calcitans (c)
Pedon 3					
Ap 0-12	Crumb microstructure with compact crumbs (f) orthovughs	2/8	Open prophyric	Crystallitic (80%) and stiple spickled b-fabric	—
Bk_2 21-46	Channel microstructure with channels (f)	1/9	Open prophyric	Crystallitic with grano and porostriated b-fabrics	Irregular microcalcite nodules Interstice fillings (f) and neo mangans and different manganese nodules (c-r).patchy embeded grain asgillans(r).
Pedon 4					
A 0-34	Crumb microstructure with packing voids(c)	3/7	Porphyric type	Crystallitic	Highly humified organic matter mostly occur in channels (vc) Pellets (c).
2Bk 34-79	Subangular blocky microstructure with intrapedal channels(c)	5/5	Porphyric type	Crystallitic locally grano-porostriated b- fabrics	Many micritic and sparitic neocalcitans associated with channels and planner voids mostly jaxtaposed by needle shape calcite many of them are surrounded by a decalcified zone.

to whitish of first order, continuous orientation and limpid extinction lines) may also point to the finer clay fraction that could move deeper in the profile compared with the reddish brown dusty free grain and embedded grain argillans of the higher Bt which are mainly composed of coarse clay. However, when the climate changed to a more arid one, the subsequent added carbonates could only be leached to the upper depths and could engulf the closer argillans to the surface, which has been frequently observed in the upper Bt horizons (Table 3 and Figures 2, 3, 4 and 5). Soil studies conducted by Khormali *et al*. (2003), in southern Iran, and Khademi and Mermut (2003), in central Iran also revealed the presence of a more humid paleoargillic climate in Iran. Their studies were also documented mainly by micromorphological evidence. The pedogenic carbonate calculations were not performed for Pedons 3 and 4 due to their calcareous parent materials. However, the much higher carbonate contents of Pedon 3, together with its much finer texture (Table 2) could be responsible for a less advanced pedogenesis in this pedon. This is also indicated by its thinner solum (46 cm) compared to the much thicker solum of Pedons 1 and 2 (115-120 cm) and intermediate solum thickness of Pedon 4 (79 cm). However, the stage II morphogenetic carbonates (Gile *et al*., 1966) which are characterized in the field by many carbonate pendants and soft masses (Table 1) occur at variable depths in different pedons. On the gravelly materials of Pedons 1 and 2, the stage II morphogenetic carbonates start at lower depths (32-50 cm) while, on the non-gravelly finer materials of Pedon 3, the stage starts at a shallower depth of 15 cm from the soil surface. The different depths of pedogenic carbonates are clearly related to the particle size. The less developed soil (Pedon 4 and upper horizon of Pedon 2) are characterized by stage I morphogenetic carbonates. According to their field descriptions, they have few carbonate pendants, soft filaments and soft masses of carbonates (Table 1). However, not only the depth to the upper boundary of horizons including the stage II carbonates are different in these soils but also their lower depths show a big difference; it is much deeper in the loamy skeletal soils of alluvial-colluvial soils (Pedons 1 and 2, Table 1) which is about 115-120 cm from the soil surface whereas, on the fine soils of the alluvial plains (Pedon 3), the stage II carbonates end up at a depth of 46 cm. Gile (1995) attributed the big differences both in the amount of pedogenic carbonates and the depth that different stages of pedogenic carbonates occur in arid region soils of New Mexico to different soil textures and landscapes. He has concluded that in the fine materials of lower laying soils, due to the shallower wetting fronts, more water is available for carbonate movement into the soil while, in coarser materials of higher positions, the soils are wetted deeper and therefore there might be some loss of carbonates either laterally or vertically.

Regarding the soil-landscape relationship in this area, one may conclude that the geomorphic surfaces have probably gone through an evolution. Therefore, the soils which have been developed on more stable landscape positions than present (Pedons 1 and 2) probably had a decalcified surface horizon which was underlain by an argillic horizon and a well developed calcic horizon below and within the argillic horizon. Later on, due to truncation of the decalcified surface layer and deposition of rather thick alluvial-colluvial calcareous material and /or eolian carbonatic sediments and subsequent leaching and accumulation of carbonates, the second generation of carbonates recognized in the upper Bt horizon has developed. However, based on different results, these soils are the most developed soils of the area, whereas they occur on relatively young alluvial-colluvial fans and there are no similarities between these soils and other soils on more or less similar geomorphic surfaces (Pedon 4) in which the least developed soils

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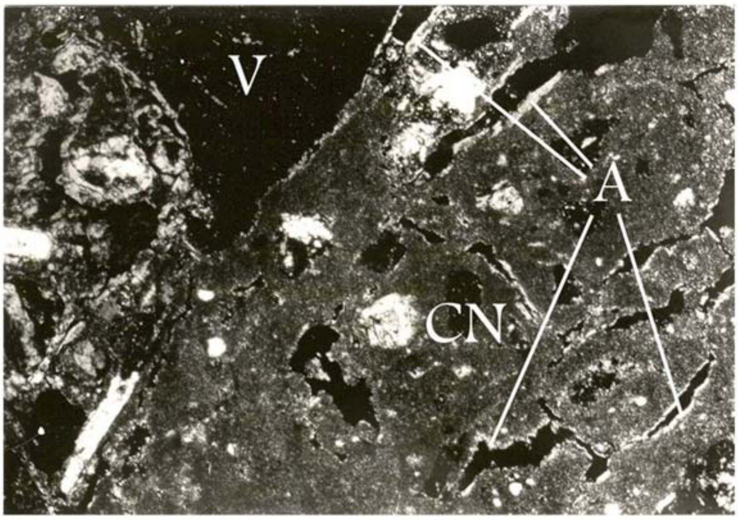

Figure 2. Micrograph of carbonate nodules with thin-continuous argillans on rims. Pedon-1, 3Btkb1 (32-50cm.). XPL 12.5X.
V=Void, A= Argillans, CN= Carbonate nodules

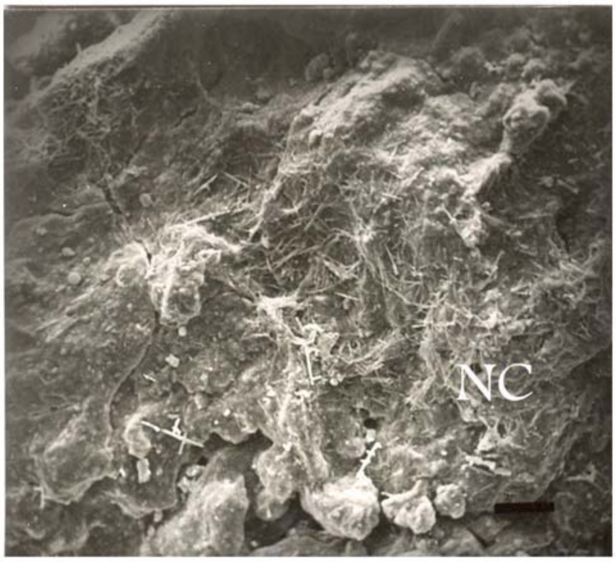

Figure 3. SEM micrograph of needle shaped calcite (NC) Mag.115X Pedon-1, 3Btkb1 (32.50 cm.).

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have been observed. Indeed, further analytical results confirming the age of these sediments (carbon dating) is needed to confirm this conclusion.

CONCLUSION

Although using geomorphological variables to predict spatial variations in soil properties is very helpful and easily performable and gives reasonable results in places where the impact of other environmental factors is small, it can not be applied everywhere. In many cumulative soils of

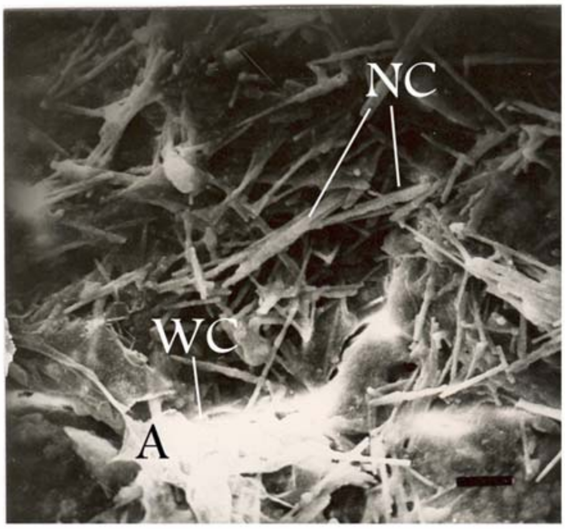

Figure 4. SEM micrograh of needle calcitans and argillans. Pedon-1,3Btkb1 (32-50cm). Mag. 575X. Note that calcite needles on the void are welded by argillans. In fact formation of argillans is a post process after calcification. A= Argillans, NC= Needle carbonate, WC= Welded carbonate.

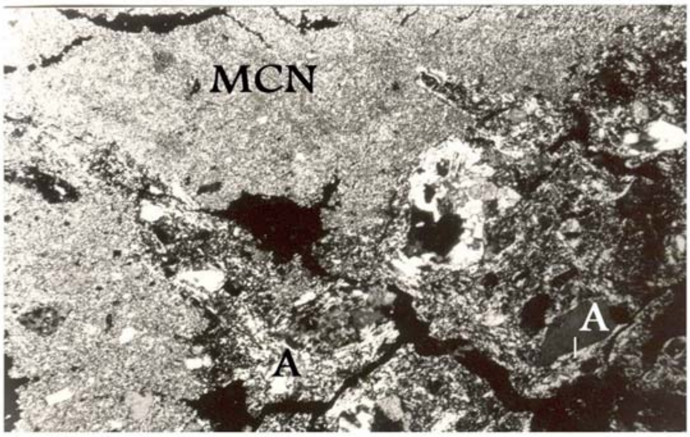

Figure 5. Photomicrograph of pedon- 2,2Btkb3 (80-120cm). XPL12.5X Notice the engulfed argillans by carbonate nodules. Upper right preserved argillans, lower left micritic calcite nodules. A= Argillans, MCN= Micritic calcite nodules.

arid regions due to the temporary or permanently uncovered soils, the geomorphic surfaces expose frequently upon the action of erosion and deposition, particularly if the area experiences alternative changes in climate. Many soils in today's arid region had a more humid past paleo-climate (pluvial period) when plenty of water was available both for leaching the materials through the soil profile or removal and deposition of variable thickness of sediments and, therefore, have influenced the chronology of the geomorphic surfaces.

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رابطه خاک ـ زمین نما براساس نتایج میکرومرفولوژیکی در خاکهای انتخابی دشت کرج (ایران)

ش. محمودی، ا. حیدری ، م.ح. مسیح آبادی و ج. استوپس

چکیده

خاکهای مناطق خشک و نیمه خشک دشت کرج (شمال مرکزی ایران) بر روی مواد آبرفتی ـ واریزه‌ای که مخلوطی از مارن‌های آهکی- گچی دوره میوسن و سنگهای آذرین دوره هولوسن می‌باشند تشکیل یافته‌اند. در این مطالعه به منظور شناسایی دقیق‌تر و سریع‌تر خاکها و اطلاع از توزیع جغرافیایی آنها با استفاده از رابطه خاک- زمین نما تعداد ۱۶پروفیل برروی واحدهای فیزیوگرافی مختلف حفر و مورد مطالعه قرار گرفت. با توجه به مطالعات صحرائی این خاکها همگی علائم تجمع کربناتها را نشان داده و در نتیجه می‌توانند به عنوان خاکهای کلسید یا کمبید رده‌بندی شوند. به هرحال مطالعات کامل نشان داده است که خاکهای با تحول زیاد و دارای افق آرجیلیک بر روی واحدهای ظاهراً جوان‌تر واریزه‌ای و خاکهای با تحول کمتر و دارای افق‌های کلسیک و کمبیک بر روی واحدهای قدیمی‌تر دشتهای آبرفتی فوقانی تشکیل یافته‌اند. وجود مواد مادری سنگریزه دار و آهکی در این خاکها ، اغلب منجر به پوشیده شدن پوسته‌های رسی و مخفی ماندن آنها در زیر پوشش های آهکی و در نتیجه مشکل شدن تشخیص اینگونه پوسته‌های رسی در صحرا گردیده است. هم چنین چسبیدن بخشی از ذرات رس به صورت پوسته در اطراف سنگریزه‌ها و جدا شدن آنها از بقیه خاک نرم (Fine earth) به هنگام الک نمودن ذرات درشت‌تر از دو میلی متر منجر به کاهش درصد رس تجزیه بافت در اینگونه افقها گردیده است. به هر حال مشاهدهٔ علائم واضح تجمع رس در زیر میکرسکوپ، اطمینان کافی از وجود اینگونه عوارض را حاصل نموده و در نتیجه به تشخیص قطعی افق آرجیلیک کمک نموده است. بنابراین از نظر رده‌بندی (سیستم رده‌بندی جامع آمریکائی) این خاکها به جای قرارگرفتن در زیر ردهٔ کلسید در زیر ردهٔ آرجید قرار می‌گیرند. این نتایج مؤید قدمت بیشتر واحدهای اراضی آبرفتی ـ واریزه‌ای است که در حال حاضر توسط مواد جوان‌تر پوشیده شده‌اند.

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