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SOIL CHARACTERISTICS, AMORPHOUS ALUMINOSILICATES AND FREE IRON OXIDES AS AFFECTED BY DIFFERENT SOIL PARENT MATERIALS IN SOUTH-WESTERN REGION, SAUDI ARABIA

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ABSTRACT

The southwestern region in Saudi Arabia is located within Al-Sarrawat high elevation mountains. In these mountains the dominant igneous and metamorphic rocks (granite, basalt, diorite, gabro, mica-schist and others) was relatively high leading to the formation of weathering products rich in amorphous materials, particularly in the residual soil profiles. The main types of parent materials in the study area are residuum in the soils formed in-situ from the source rock particularly at mountains, alluvium and colluvium particularly in slopes. The present study aimed to evaluate soil characteristics, the content and distribution of amorphous silica and alumina and free iron oxides of soils developed on different parent materials (i.e. igneous and metamorphic rocks) in the southwestern region, Saudi Arabia. This investigation also aims to test the impact of amorphous materials on some soil characteristics.

Results showed that the studied soils are differing considerably in their characteristics and morphological features, these differences are mainly related to variation in parent materials, elevation, climatic conditions and vegetation cover. The free iron oxides (Fe_d) (9.8 – 14.6 %) is the largest components forming the amorphous materials in all the studied soils followed by amorphous Si_{am} (0.1 – 8.4%) and Al (Al_{am}) (0.1 – 9.2%) in some soils or in the others. Distribution of these components with depth indicated no specific depth wise distribution trend in most cases. Contents of amorphous inorganic materials in soils are mainly associated with the parent rock from which these soils are derived. Thus, soils derived from metamorphic rocks (schist) have amorphous inorganic materials more than these derived from igneous rocks (granite and basalt). There is no direct correlation between some soils characteristics and the amorphous inorganic materials. This may be attributed to the effect of environmental conditions in the studied area on these relationships.

\Keywords: Soil characteristics, amorphous materials, southwestern mountainous region, Saudi Arabia

INTRODUCTION

Parent material exerts the greatest influence in arid region and during the early stages of soil formation. They also influence development of many soil properties but with varying degrees. Soil constituents such as sand and silt sized particles may be inherited directly from the parent material with little if any change. Other constituents such as clay minerals evolve through chemical changes in material components. Parent materials influences may or may not be obvious. For example, coarse-grained parent materials often produce coarse-textured soils. Coarse-grained parent materials that weather easily from clay, on the other hand, tend to produce fine-textured soils. Thus, coarse-grained granitic rocks composed mostly of minerals not susceptible to chemical weathering generally produce coarse-textured soils high in sand. Basaltic rocks that contain mostly minerals quite susceptible to chemical weathering yield fine-textured soils high in clay content. Soils formed on granitic rocks also generally are deeper than soils formed from basalt because granitic parent materials are more susceptible to physical disintegration than basaltic parent materials in which smaller mineral grains are tightly interlocked (Jenny, 1980). Weathering products of basaltic parent material, and transported materials greatly affect both physical and chemical soil properties as well as management practices and land use decisions as reported by Isotok (1981).

In addition, the amorphous content in soils also affects many soil characteristics. The amorphous fraction of soils relates to management problems such as dispersion, flocculation aggregation, infiltration, erosion and landscape stability. Nonetheless, their function in soil in terms of their influence on soil properties; has been received little attention. (Wada and Harward, 1974 and Jones et al., 2000).

Free oxides and hydroxides of soils include crystalline and amorphous compounds of silica, alumina, iron and manganese (Jackson, 1975). The term free and hydrous oxides refer to compounds having mainly a single and two or more co-ordinating cation species, respectively; the most abundant kinds in soil being the aluminosilicates. The amorphous aluminosilicates of soils, non-crystalline gel-like compounds, contain mainly Al, Si, O and H_2O, but less Fe, Mg, OH and occasionally phosphate or other ions. Some of the amorphous aluminosilicates have been designated as allophan. Furkert and Fieldes (1968) proposed the use of the name allophan for any clay size material characterized by structure randomness. Van Olphen (1971) defined allophan as a member of the series of naturally occurring hydrous aluminosilicates having widely varying chemical composition and characterized by short range order due to the presence of Si-O-Al bonds, and usually its DTA curve displays a low temperature endotherm.

Van der Marel (1966) and Beutelspacher and Van der Marel (1966) concluded that allophan occurs as a coating on crystalline constituents and it is widely spread in many soils. Moreover, it may be present as a sheet structure related to kaolinite.

Many soil morphological and micromorphological features, (such as duripan, petrocalcic, petrogypsic horizons), are directly related to the presence of amorphous and poorly crystalline materials. It reacts with other soil components to certain extent and forms hard cemented features, which affect most of soil properties. In arid and semiarid climates, silica cementation in some soils results in hard aggregates (durinodes) or horizons (duripans) that do not slake in water. In arid regions, silica cementation in soils is generally accompanied by calcite (Chadwick et al., 1987; Boettinger and Southard, 1995), whereas in semiarid climates, silica cementation is often associated with iron oxides (Torrent et al., 1980). Duripans are found in very old soils on intrusive igneous rocks and the sediments derived from them, or in young soils that contain rapidly weathering siliceous volcanic ash

(Flach et al., 1969) or siliceous loess (Blank and Fosberg, 1991). Silcretes are similar to duripans in that they are cemented with silica as a result of low-temperature, surface or near surface processes. Silcretes also include silica-cemented geologic material, similar to soils, and are not associated with either calcite or Fe oxides (Oilier, 1991). Once formed, both silcretes and duripans influence water movement through regolith (Torrent et al., 1980; Oilier, 1991).

Saudi Arabia could be geologically divided into four distinct and extensive terrains as described by Laurent (1993). These are the Proterozoic Arabian Shield, comprising metamorphosed volcano-sedimentary successions intruded by granite and gabbro; Arabian platform dipping gently eastward; the Teriary 'harrats' mainly overlying the Shield; and the narrow Red Sea coastal plain of Teriary and Quaternary sedimentary rocks and coral reefs. Igneous and metamorphic rocks are dominant in mountainous area and consisted mainly of granite, basalt, diorite, gabro, mica-schist and others (Al-Sayari and Zotl, 1978).

The present investigation attempts to evaluate some soil characteristics, the content and distribution of amorphous silica and alumina and free iron oxides of soils developed on different parent materials (i. e. igneous and metamorphic rocks) in the southwestern region of Saudi Arabia. This investigation also aims to test the impact of amorphous materials on some soil characteristics.

MATERIALS AND METHODS

Study area

Climatologically conditions in the southwestern region of Saudi Arabia are variable according to the location and elevation. Data of climatic elements for Abha stations in the period from 1982 and 1998 are illustrated in Figure 1 (Ministry of Agriculture and Water, 1995).

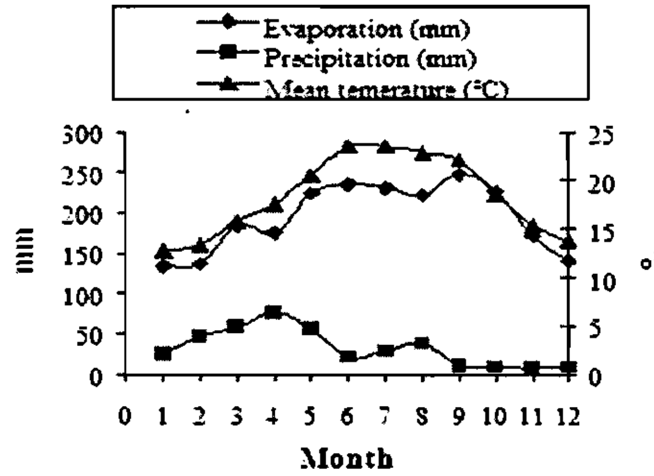


Fig. 1. Climatologically data, Evaporation (mm), Precipitation (mm) and mean temperature (°C) of Abha station.

The mean annual air temperature, rainfall (mm) and evaporation values are 18.3 C, 383.2 and 2330.7 mm respectively. These data clearly show the existence of high variations in the climate of this region. Relatively high mean annual rainfall and low mean annual temperature and evaporation follow the variations in topography and gradient in elevations.

Natural vegetation in the southwestern region is variable and followed the variations in topography, elevation, parent rocks and climate. Stocked forests, mostly of Junipers occupy high elevation slopes and deep inaccessible gorges (Ministry of Agriculture and Water, 1995). At elevations between 1000-1500 above sea level (masl) *Acacia glaucophylla Commiphora* association prevails. Differences in soil characteristics with elevation were studied by Al-Barrak (1985). He reported that soils developed on stable landscapes at elevation higher than 2000 m have well developed soil profiles and near neutral pH values. Much less research has been conducted on the southwestern region despite its relative importance as land resources for irrigated agriculture.

The main types of parent materials in the studied area are residuum in the soils formed in-situ from the source rock particularly at mountains, alluvium and colluvium particularly in slopes (Al-Barrak, 1985).

Field and laboratory work

Six soil profiles developed from residuum, alluvium and/or colluvium parent materials were selected. The studied soils are derived from granite (profile 1 & 2), schist (profile 3 & 4) and basalt rocks (profile 5 & 6). These profiles were selected to represent the variations in the soil characteristics of South-western region (Fig. 2). These variations included different types of parent materials. The morphological features of each soil profile as well as its surrounding environment were described in the field following the terminologies outlined in the Soil Survey Staff (1993) and FAO (1977). Soil samples (24 samples) were collected from the subsequent layers of each profile, air dried, ground and passed through a 2 mm sieve, and kept for analysis. Particle size distribution was carried out according to Day (1965). Soil pH, total soluble salts were determined in the saturation paste extracts according to Rhoades (1996) and Thomas (1996), respectively. Organic matter content was determined following the method of Nelson and Sommers (1982). Calcium carbonate was determined using Collin's calcimeter (Loeppert and Suarez, 1996).

Amorphous Si and Al and free iron oxides, were extracted using selected dissolution chemical techniques from clay particles size. Free iron oxides (Fed) were extracted using sodium citrate bicarbonate- dithionate method according to Jackson, (1975). Amorphous silica and alumina (Si_{am} & Al_{am}) were dissolved using boiled 1 N NaOH for 2.5 min. according to the method outlined by Alexiades and Jackson (1967). Fe, Al and Si were dissolved in the different extracts following the procedure described in Page et al (1982). These elements were detected using an atomic absorption spectrophotometer equipped with graphite furnace (Perkin Elmer model A Analyst 300).

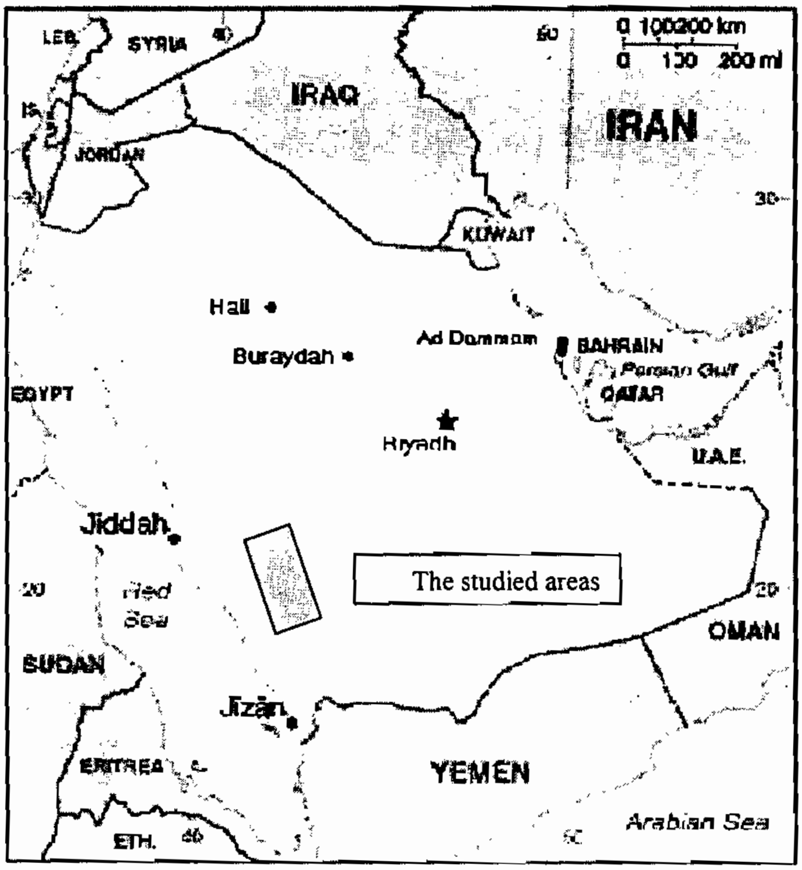


Fig. 2. Location map of the studied areas

RESULTS AND DISCUSSIONS

The results showed that the studied profiles derived from granite rocks differed substantially in their characteristics and morphological features. The parent materials of the profiles were quite different i.e., alluvium, colluvial and materials weathered residually from country rocks predominate. Table (1) showed that the soil profiles were deep with no sign of diagnostic horizon except the surface layer that has relatively dark colour as a result of high organic matter content (6.2 - 48 g Kg^{-1}) . EC_e values and $CaCO_3$ content were less than 0.61 dS m^{-1} and 15.3 g Kg^{-1}, respectively. It appears that there was no clear variation in texture between the studied profiles (Profile 1 and 2), except that of 4th layer 45-115cm (Profile 1).

Moreover, the vertical distribution of total clay content decreased with depth. CEC values were relatively low and more or less varied with clay contents with few exceptions.

Table 1. Some Physical and chemical characteristics of the studied soil profiles

Profile	Horizon	Depth	Particle size distribution			Texture	pH	EC	O.M.	$CaCO_3$	CEC
No.		cm	Sand	Silt	Clay	class		dS m^{-1}	g Kg^{-1}		cmol kg^{-1}
				Granite parent material							
1	A_1	0-10	75.1	11.4	13.5	SL	7.6	0.61	48	11	13.4
	A_2	10-45	77.2	14.9	7.9	SL	7.6	0.45	6.2	9	10.1
	C_1	45-115	90.3	8.3	1.4	S	7.5	0.51	6.8	13	3.8
2	A_1	0-15	62.9	23	14.1	SL	7.8	0.49	21.5	6.3	10.1
	A_2	15-35	61.1	24	14.9	SL	7.5	0.41	11.1	10.2	9.8
	B	35-75	71.9	16	12.1	SL	7.4	0.21	11.2	15.3	9.3
	C_1	75-115	72.5	15	9.5	SL	7.7	0.19	6.2	11	8.3
				Schist parent material							
3	A	0-30	23.8	45.1	31.1	CL	7.2	0.8	48	11	24.1
	B_{t1}	30-73	18.5	28.2	53.3	C	7.4	0.3	17	18	58.2
	B_{t2}	73-110	38.9	28.9	32.2	CL	7.7	0.4	2	44	29.4
	C	110-135	53.9	30.7	15.4	L	7.9	0.3	3	82	16.5
4	A	0-35	37.1	35	27.9	CL	7.4	0.3	14.7	4.5	25.2
	B_t	35-85	30.6	36	32.8	CL	7.3	0.3	22	6.1	30.2
	C	85-135	32.4	28	38.8	CL	7.3	0.4	13.8	8.8	28.4
				Basalt parent material							
5	A_1	0-10	74.1	12.1	13.8	SL	8.2	0.5	11	29	10.6
	A_2	10-40	64.2	20.1	15.7	SL	7.9	0.5	3	41	9.5
	B_k	40-90	83.3	10.9	5.8	LS	7.7	0.7	3	202	7.9
	C_1	90-120	84.9	11.1	4.0	LS	8.2	0.6	2	98	8.5
	C_1	120-150	81.1	13.1	5.8	LS	7.9	0.4	1	111	8.1
6	A	0-20	31	30	39	CL	7.9	0.5	10.1	83	27.2
	B_t	20-45	8.2	25	66.8	C	8	2.9	12.6	117	59.8
	B_{tk}	45-75	9.9	25	65.1	C	8.1	0.1	6.6	256	78.1
	B_k	75-150	38.8	22	39.2	CL	8	0.2	2.5	235	38.4
	C	150-180	51.6	33.8	14.6	L	8	0.2	3	82	19.3

The amounts and distributions of free iron oxides (Fe_d), and amorphous aluminosilicates extracted by sodium hydroxides (Si_{am} & Al_{am}) from the soils developed on granite rocks are presented in Table 2 and Fig. 3. Data showed that free iron oxides (Fe_d) represented generally larger components forming the amorphous materials in all the studied soil samples. Nevertheless, amorphous Al (Al_{am}) and amorphous (Si_{am}) were more or less similar. Distribution of these components with depth indicated that in most cases they have no specific trend. This behavior may be attributed to non-homogeneity of the parent material from which the soil was derived (Al-Barrak, 1985 and Sheta et. at., 2002). The formation of weathering products rich in amorphous materials particularly in the residual soil profiles could be attributed to the high intensity of chemical weathering on the dominant igneous and metamorphic rocks in the studied area (Al-Sayari and ZÖtl, 1978). Boettinger and Southard (1995) studied the distribution of minerals and amorphous materials in soils formed from granite rocks. They concluded that the lack of amorphous alumina in soils may be related to the composition of parent materials itself; being poor in these components or due to stabilize of amorphous Al_2O_3 by silica in the allophon.

Table (2): Amounts of amorphous aluminosilicates, and free iron oxides in the studied clay samples.

Profile	Horizon	Depth/cm	SiO_2am*	Al_2O_3am*	Fe_2O_3d**
				%	
Granite parent material					
1	A_1	0-10	0.1	1.5	3.1
	A_2	10-45	2.8	3.1	2.9
	C_1	45-115	1.5	2.3	1.8
2	A_1	0-15	0.4	1.1	3.6
	A_2	15-35	0.8	2.9	3.5
	B	35-75	3.6	2.8	1.4
	C_1	75-115	2.1	1.9	1.4
Schist parent material					
3	A	0-30	6.2	5.4	12.3
	B_{t1}	30-73	4.1	4.1	14.1
	B_{t2}	73-110	5.1	9.2	10.1
	C	110-135	1.9	5.2	10.6
4	A	0-35	8.4	4.6	14.6
	B_t	35-85	6.2	3.6	9.8
	C	85-135	7.1	4.1	12.4
Basalt parent material					
5	A_1	0-10	1.5	5.1	3.5
	A_2	10-40	0.1	3.5	2.9
	B_k	40-90	2.9	4.8	4.2
	C_1	90-120	3.8	0.1	3.9
	C_1	120-150	3.2	0.1	3.1
6	A	0-20	0.9	4.2	5.7
	B_t	20-45	0.4	3.5	3.9
	B_{tk}	45-75	4.5	2.9	4.7
	B_k	75-150	3.8	0.4	2.8
	C	150-180	3.8	0.4	3.6

***am: amorphous, **d: Na- Citrate, bicarbonate, dithionate**

Both representative profiles (3 and 4); developed from schist parent material were generally characterized with lower ECe (0.3 – 0.8 dS m^{-1}) but higher organic matter content (2.0 – 48 g Kg^{-1}) (Table 1). Soil texture ranges from loam to clay texture. Horizon below the surface particularly B_{t1} (Profile 3; 30 - 73) are more reddish and contain relatively high total clay content.

Data in Table 2 and Fig. 3 indicated that the soils derived from schist rocks had relatively very high free iron oxides (Fe_d) values. They range from 9.8 – 14.6 %. with no specific distribution with depth, and reaches very high contents (14.6% clay) in the surface layer at (0 - 35cm Profile 4 and 30 – 73cm Profile 3). This distribution was related to the presence of some morphological features in the deep layers related to the accumulation of iron oxides and the presence of iron oxide coatings on soil clods and around the cracks. The relatively high contents of free Fe oxides in the Bt horizon may result from the accumulation of Fe oxides as in situ weathering products or it may translocate with other soil materials such as clays and organic matter during soil formation. The amounts and distributions of free iron oxides (Fe_d), and amorphous aluminosilicates extracted by sodium hydroxides (Si_{am} & Al_{am}) for the soils developed on schist rocks are presented in Table 2. Data showed that free iron oxides (Fe_d) was the largest component forming the amorphous materials in all representative soil samples followed generally by amorphous Al (Al_{am}) in some samples or amorphous (Si_{am}) in the other samples like the same trend in soils developed on granite rocks. Distribution of these components with depth indicated that no marked trend could be noticed in all cases.

Data indicated also that, relatively high values of such materials appeared in the surface horizons compared with the subsurface layers. This finding may be attributed to the effect of cultivation on the formation of poorly crystalline and complexed iron materials. This explanation could be supported by the presence of relatively high contents of organic matter in the surface layers. Al- Barrak (1985) found that free iron oxides range from 0.61 – 13.44% in four soil profiles in the southwestern mountainous region, Saudi Arabia. He referred the high contents of free iron oxides in residuum parent material to the intensive weathering that might take place during the Eocene time. He found geothite mineral in some Bt horizons in the area. Soils formed under weathered basaltic rock and active weathering conditions that lead to the release and oxidation of Fe and Mn forming the relatively high quantities particularly in the Bt horizon.

The soils developed on basalt rocks represented by two profiles (5 and 6), the results elucidated that these profiles were deep with few of horizonation except the surface layer that have relatively dark colour in some areas as a results of relatively higher content of organic matter. Soil texture ranges from clay to loamy sand. The ECe values are quite different between the profiles layers and ranges from 0.1 – 0.7 dS m^{-1}, except the second layer of profile (6; 20-45cm), which reach 2.9 dS m^{-1}. While the soil pH ranges from 7.7 to 8.2. The organic matter content and CEC values are less than the other soils. These soils had high $CaCO_3$ content (29 – 256 g Kg^{-1}) compared with the other soils developed on granite or schist. Secondary $CaCO_3$ was identified in Profiles 5 (B_k; 40-90cm) and 6 (B_{tk}; 45-75 and B_k; 75-150cm) as soft lime spots.

The amounts of amorphous iron in these soils were comparatively low and showed tendency to decrease. Again the data showed that in general free iron oxides (Fe_d) represented the major components of these materials. Nevertheless, the values of Al (Al_{am}) exceeded those of (Si_{am}) in particularly at the upper layers (Table 2 and Fig. 3).

Correlation coefficients between amorphous materials and some soil characteristics are presented in Table 3. Data indicated that there are positive significant correlations (at 5%) between Fe_d and silt (r=0.729) and silt + clay (r=0.597). Also positive significant correlations (at 1%) between Fe_d and clay (r=0.429). Nevertheless, negative significant correlations were found between Fe_d and sand (at 5%, r=-0.597) and pH values (at 1%, r=-0.501). On the other hand, positive significant correlations (at 5%) were found between Si_{am} and silt content (r=0.527) and negative significant correlation (at 1%) with pH (r=-453). No significant correlation was obtained between Al_{am} and the studied soil characteristics. It seems that free iron oxides, amorphous Si and Al have little or no effects on some soil characteristics under the prevailing soils conditions.

Amorphous SiO_2

Multiple regression analyses were computed to determine the combined role of the studied variables. The multiple correlation coefficients were highly significant in soil derived from granite rocks (R^2=0.678) and the relation could be represented by the following equations:

Amorphous SiO_2 (in granite soils) =2.48 silt (%) +2.48 clay (%) +0.387 Fe_2O_3 (%) + 0.05 CEC (cmol l^{-1}) +0.01 $CaCO_3$ (g Kg^{-1}) – 0.02 O.M. (g Kg^{-1}) -0.181 Al_2O_3 (%) - 0.41 sand (%) -0.45 EC (dS m^{-1}) - 2.48 silt+clay – 2.7 pH + 62.28

From this equation it may be concluded that, amorphous silica is highly associated with increases of silt, clay, $CaCO_3$, CEC and decreases of sand, silt+clay, pH, EC, and O.M. These may be attributed to the abundance of mixed gels of hydrated silica with alumina in the igneous soils than free amorphous silica. This silica is released from silica complexes under reducing conditions

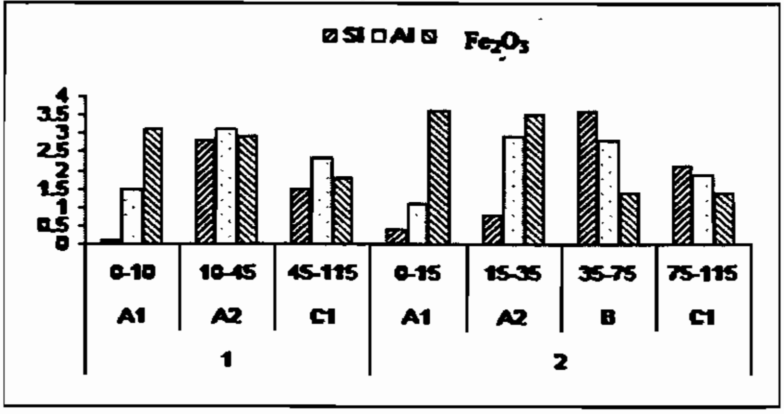
Amorphous Al_2O_3

Table (2) show that, soils of the studied areas have relatively high amorphous - alumina contents in the soils derived from schist rocks compared with the other soils derived from granite or basalt. With regard to the statistical analyses, the obtained correlation coefficients (Table 3) indicated a positive significant correlation with silt %. However, there are positive and negative insignificant correlations with other variables. Results of the multiple regression analyses indicate that, the different soil components associated with amorphous - Al_2O_3 in the mixed soils can be arranged in a descending order as follows: Fe_2O_3> sand %> EC dS m^{-1}> pH and the equation reads:

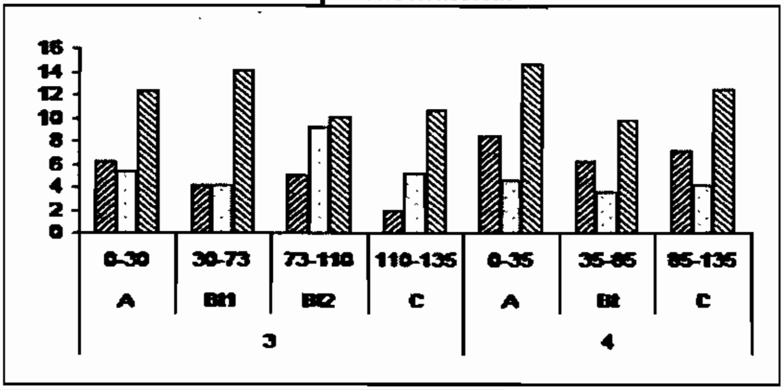
Al_2O_3 = 0.355 Fe_2O_3 (%) + 0.194 sand (%) + 0.138 pH + 0.17 EC (dS m^{-1}) +0.001 silt (%) +0.001 clay (%)- 0.001 silt+clay - 0.003 $CaCO_3$ (g Kg^{-1})– 0.018 O.M. (g Kg^{-1}) - 0.093 CEC (cmol l^{-1}) -19.638

The multiple correlation coefficient is significant (R^2=0.463), therefore all the equation regression coefficients are highly significant in their effect on amorphous - Al_2O_3. Thus, most of the amorphous - Al_2O_3 in the igneous and metamorphic soils is occurred as silica - alumina complexes, which are mainly coated the negatively charged of clay fractions.

Granite parent material



Schist parent material



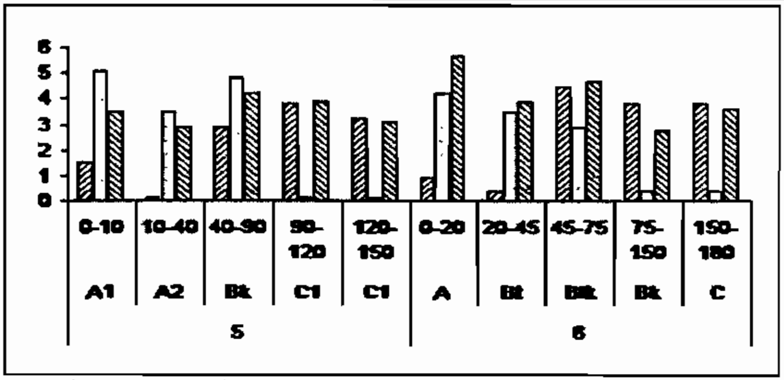


Fig. 3. Content and distribution of amorphous Si, Al and free iron oxides in the studied profiles

Free iron oxides

Data in Tables(2) show that amounts of amorphous iron are very high in soils derived from schist rocks compared with the soils derived from granite and basalt rocks, and don't show any specific depth trend. The highest values are detected.

With regard to the statistical analyses, results of the correlation matrix Table (3), indicate positive significant correlation with silt %, clay % and (clay + silt), but there is a negative significant correlation with pH and sand. However, there are positive and negative insignificant correlations with other variables.

Table 3. Correlation coefficients between amorphous Si and Al and free iron oxides and some soil characteristics.

soil characteristics	SiO_2am	Al_2O_3am	Fe_2O_3d
Sand	-0.395	-0.354	-0.597**
Silt	0.527**	0.392	0.729**
Clay	0.258	0.277	0.429*
silt +clay	0.393	0.356	0.597**
pH	-0.453*	-0.297	-0.501*
EC	-0.305	0.087	-0.085
O.M.	0.072	0.074	0.291
CaCO3	-0.020	-0.190	-0.242
CEC	0.276	0.180	0.371

** at 5% and * at 1%

Results of the multiple regression analyses indicate highly significant multiple correlation coefficient ($R^2=0.684$) and the equation read:

Fe_2O_3 = 0.926 sand (%) + 0.080 CEC (cmol l^{-1}) + 0.001 silt+clay - 0.001 silt (%)-0.001 clay (%) - 0.011 $CaCO_3$ (g Kg^{-1}) – 0.064 O.M. (g Kg^{-1}) -0.509 EC (dS m^{-1}) - 4.932 pH -52.053

From this equation it is indicated that higher values of Fe_2O_3 are mainly associated with the increase of sand, and the decrease of pH. This may be attributed to the precipitation of Fe_2O_3 as "Ferri-Silica" complexes under conditions of high pH. Thus the Ferri-Silica complexes are considered the abundance form of amorphous Fe and are dominated either as surface coating or as discrete particles of clay and fine fractions.

Appraisal of soil properties of the studied profiles (Table 1) show that the higher clay content was recorded for soils derived from basalt parent material (Profile 6). The results also showed that the clay content of soils developed from schist parent material (Profiles 3 and 4) was much higher compared with that recorded for Profiles 1 and 2; which represents soils developed from granite parent material. As expected, CEC values followed the texture classes of the soil, i.e. the more fine texture is the higher CEC (58.2- 78.1 cmol Kg^{-1}). The higher values of $CaCO_3$ were displayed by the profiles (5 and 6) assigned to basalt parent material (29- 256 g Kg^{-1}) followed by those of profile (3) developed from schist parent material (11- 82 g Kg^{-1}). But other profiles contained more or less $CaCO_3$ content. Soils of profiles derived from both granite and schist parent materials were slightly alkaline (7.2- 7.9), while, those of basalt parent material were alkaline (7.7 – 8.2).

Generally, the southwestern region was ~~located~~ within Al-Sarrawat high elevation mountains. Under this condition the intensity of chemical weathering on the dominant igneous and metamorphic rocks was relatively high leading to the formation of weathering products rich in amorphous materials particularly in the residual soil profiles. The obtained variations of the content and distribution of amorphous-silica, alumina and iron of soils developed on different parent materials in the southwestern region of Saudi Arabia could be attributed to the sedimentation pattern as well as to the intensity of chemical weathering of the parent rock from which these materials were formed. Moreover, the results indicated also that the residual soils have the highest free iron oxides, the distribution of these components indicated that free Fe oxides increased dramatically in the Bt horizon of the residual soils while other profiles showed no clear distribution trend with depth. The amounts and distributions of free Fe oxides in the residual soils are true reflection of both parent material type and the intensity of soil forming processes encountered during soil formation.

From the above mentioned discussion, it is found that:

- Contents of amorphous inorganic materials in soils are mainly associated with the parent rock from which these soils are derived. Thus, soils derived from metamorphic rocks have amorphous inorganic materials more than these derived from igneous rocks.
- There is no direct correlation between some soils characteristics and the amorphous inorganic materials. This may be attributed to the effect of environmental conditions in the studied area on the relationships.

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تأثير مواد أصل التربة المختلفة على خصائص التربة، سليكات الألومنيوم غير المتبلورة وأكاسيد الحديد الحرة في المنطقة الجنوبية الغربية (المملكة العربية السعودية)

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يقع الإقليم الجنوبى الغربي فى المملكة العربية السعودية بجبال السروات المرتفعة. يسود هذه الجبال الصخور النارية والمتحولة (الجرانيت، البازلت، الديوريت، الجابرو، الشست وغيرها)، والتي ينتج عن تجويتها تكوينات مرتفعة في محتواها من المواد غير المتبلورة وخاصة في قطاعات التربة ذات مادة الأصل المحلية، والتي تغطي معظم منطقة الدراسة وهى ترب تكونت في مواقعها من الصخر الأصلى وخاصة في مناطق الجبال، في حين تتواجد الترب المنقولة بالمياة والجاذبية في المنحدرات. تهدف الدراسة الحالية إلى تقييم بعض خصائص التربة، محتوى وتوزيع الترب من السليكا والألومينا غير المتبلورة وأكاسيد الديد الحرة في الترب التي نشأت على مواد أصل مختلفة (صخور نارية ومتحولة)، في المملكة العربية السعودية. كما تهدف الدراسة أيضا إلى أختبار تأثير تلك المواد غير المتبلورة على بعض خصائص التربة.

أوضحت النتائج أن ترب منطقة الدراسة إختلفت فيما بينها فى خصائصها والملامح المورفولوجية، ويرجع ذلك إلى الإختلافات في مواد الأصل والإرتفاعات والمناخ والغطاء النباتي. كذلك أظهرت النتائج أن أكاسيد الحرة هى السائدة في منطقة الدراسة بصفة عامة (٩,٨-١٤,٦%) يليها السليكا (٠,١-٨,٤%) والألومنيا (٠,١-٩,٢%) غير المتبلورة في بعض الترب أو غيرها.ولم تظهر هذه المركبات أى توزيع محدد مع العمق في معظم الحالات. يصاحب محتوى الترب المدروسة من المواد غير المتبلوة وأكاسيد الحديد الحرة مواد أصل التربة التي نشأت منها، ولذا فإن محتوى الترب التي نشأت على صخور متحولة (الشست) من تلك المواد كانت أعلى من الترب التي نشأت على الصخور النارية (الجرانيت والبازلت). أوضحت بيانات معاملات الإرتباط إلى أنه ليس هناك إرتباط مباشر بين المواد غير المتبلورة وبعض خصائص التربة وربما يعزى ذلك إلى تأثير بعض الظروف البيئية السائدة في منطقة الدراسة على تلك العلاقات.