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PROPERTIES OF THE DESERT SOILS OF THE MHAMID AREA

Abstract: Research has been carried out in the area situated on the border of the Antiatlas Mountains on vast and geologically and geomorphologically differentiated region of the Sahara Desert. Typical soil profiles of the investigated desert soils (Gypsisols, Arenosols, Solonchaks) have been shown and described. For the chosen soils and dunes a mineral composition analysis has been made. In the mineral composition quartz together with calcium minerals (gypsum, calcite) prevail. In the soils and dunes of the Iriqui Lake area also feldspars and micas can be found as well as ferruginous lithoclasts.

Key words: Antiatlas, Desert soils.

1. Introduction

Soil – the surface (external) part of the lithosphere – shows properties of the regolith (parent rock) transformed by external conditions (climatic and hydrological conditions; geomorphological processes, time and organic environment) – the so-called soil forming processes.

Soil, being a link between the abiotic and organic worlds, plays various different roles in the natural environment. Those roles are crucial for both abiotic and biotic parts of the environment.

Within land ecosystems soil is a natural environment for the vegetation (flora) and indirectly also for the animal world (fauna). The basic and the most obvious function of the soil is the production of the biomass and that is why, for man, soil is the most important base of the food production.

Soil plays also a sanitary role in the environment. The system of organisms and micro-organisms living in the soil, called the soil edaphone, takes part in the processes of decomposition, humification and mineralisation of the plant and animal remains. This process leads to the formation and accumulation of the soil humus in the surface

soil horizons. Present in the soil humus together with clay minerals form a specific complex of the soil elements with sorption and cation exchange capacities. Those elements are responsible for the water accumulation and retention (hydrological function) and for the retention of nutrients contained in water and also those easily accessible for the vegetation. This natural property of the soil cover (the retention and accumulation of water and nutrients, but also toxic substances) allows the soil to play a role of a natural filter retaining elements toxic for the organic world.

The morphology of the soil profile, its differentiation into colour diagnostic horizons, allows the description of the soil genesis. In the case of its destruction or burial, it is a record of the changes in the natural environment within a geologic time [scale].

The above described role of the soil in the functioning of the natural environment (Skiba 2003) makes the soil one of the most important elements of the environment. The detailed characteristics of the soil cover allows the description of the environment's evolution what is especially important for the desert areas as the contemporary desert climate provides excellent conditions for the conservation of various relic forms (Bednarek, Prusinkiewicz 1997, Brady, Weil 1999, Birkeland 1999, Skiba 2003).

Arid regions cover considerably big areas of Morocco and the soils formed in those areas show properties of the climate where evaporation dominates over precipitation. That is why the products of mineral weathering are transported upwards within the soil profile (to the surface horizons) sometimes forming crust (desert pavement).

2. Research area

Observations and field research were carried out in the region on the border of Antiatlas, on vast and geologically differentiated areas of the Sahara Desert (Dłużewski, Krzemień 2003). The area is built of weathering clay-gravel and sand--grain formations, which form various different types of desert (serir, hamada, erg). In the discussed region vast areas are covered by layered sandy, silty and loam sediments of the Dra river or by clay-loam bottom sediments of the dry Iriqui lake.

Vegetation in the discussed area forms scattered patches of desert formations or bigger groups of tamarisk trees typical for arid regions . Within the oasis where the water conditions are considerably better (as a result of irrigation) palm trees and agricultural plants (small fields) occur.

3. Soil properties

In the area of rock outcrops, on the southern slopes of Jebel Bani, desert rock initial soils dominate (Yermo-Lithic Leptosols), covered at places with tufts of xerothermal vegetation.

Within the wide valleys and on dune areas loose Aridic Arenosols occur. Layered loamy-clay formations of the Dra river and Iriqui lake sediments provide a base for the carbonate or sulfate enriched Fluvisols. Those soils have well formed diagnostic horizons gypsic or calcic. There are also patches of Solonchaks with crust of soluble

salts. In the valley bottom, especially on loamy-clay formations polygonal cracks are formed, typical for Takyric or Vertic Aridisols (takyric desert soils).

It seems that fluvial processes that formed the regolith of these soils, have no further influence on the functioning of these soils as Fluvisols because of the fact that both the river and the lake are dry. Soils occurring in this area had lost their alluvial soil properties as they had been deprived of the river sediment supply. They show properties of evolutionary transformation into typical desert soils (Aridisols) enriched by oozing with calcium sulphate, calcium carbonate or easily soluble chlorite-carbonate salts (Gypsisols, Calcisols, Solonchaks).

In the northern and eastern part of the discussed area on the slopes of Antiatlas initial rock soils (Yermo-Lithic Leptosols) dominate.

These soils have well cemented weathering horizon of a few centimetres and they occur on gentle slopes, in cracks or on rock shelves. They are covered by tufts of xerothermal vegetation. Remains of the vegetation are transformed into humus. In general these soils contain very little humus, usually around 0.5%. The reaction of the weathering horizons is between pH 7.5-8.0. Weathering stony rock fragments (e.g. sandstone) are covered, in the surface area, by iron-manganese evaporation crust (lack). Initial soils form a mosaic with the non-soil outcrops of massive rock.

Soil formations of the dune areas belong to the initial sandy desert soils (Aridic Arenosols). Those formations consist mainly of sand fraction (2-0.05 mm) and the sand fraction content is usually bigger than 70-90%. Remaining part consists mainly of silt (0.05-0.002 mm) and the clay fraction (below 0.002 mm) constitutes approximately 1% or below of the whole soil profile. In the mineral composition of the sand (dune) formations usually quartz dominates (Figures 1-3) but also small amounts of carbonates (calcite) or sulphates (gypsum) occur as well as lithoclasts and ferruginous-clayey aggregates. The presence of calcite or gypsum in the aeolic sand formations should be associated with the transport of this material from the nearby in-dune crystalline carbonate and sulphate salt crust. Desert arenosols form an unstable initial soil cover in the investigated area. Those formations are deprived of vegetation or can be covered by single and scattered patches of xerothermal plants. In the small depressions also nebkhas occur, forming unstable (only periodically stable) sand fans. Bigger fan forms occur under the tamarisk trees.

In the stony and gravely areas (hamada, serir) typical reddish clay desert formations (Aridisols) occur. The profile of these soils starts with the surface gravel layer covered with black or black-reddish iron-manganese desert pavement. Below that brown or red (2.5YR 4/3-2.5YR 5/6) sandy clay loam formations occur and they are usually hard and well cemented by calcite or gypsum (Yermoduric or Takyric Calcisol, Gypsisol). The reaction of these soils is weakly alcaline (pH 7.5-8.0). Those formations are covered by small patches of dry desert vegetation, also single acacia trees occur there.

Alluvial sediments of the Dra river and the Iriqui lake sediments provide a silty clay loam parent material for the secondarily saturated with salt Calcic, Gypsic, Takyric Fluvisols.

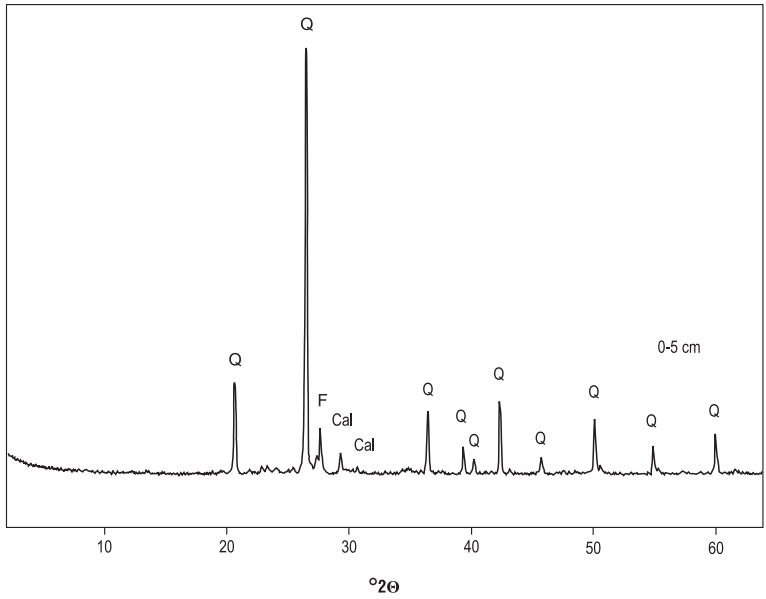

Figure1. Mineral composition of the surface layer of a dune – initial sandy soil (Aridic Arenosol): Q – Quartz, Cal – Calcite, M – Mica, F – Feldspar

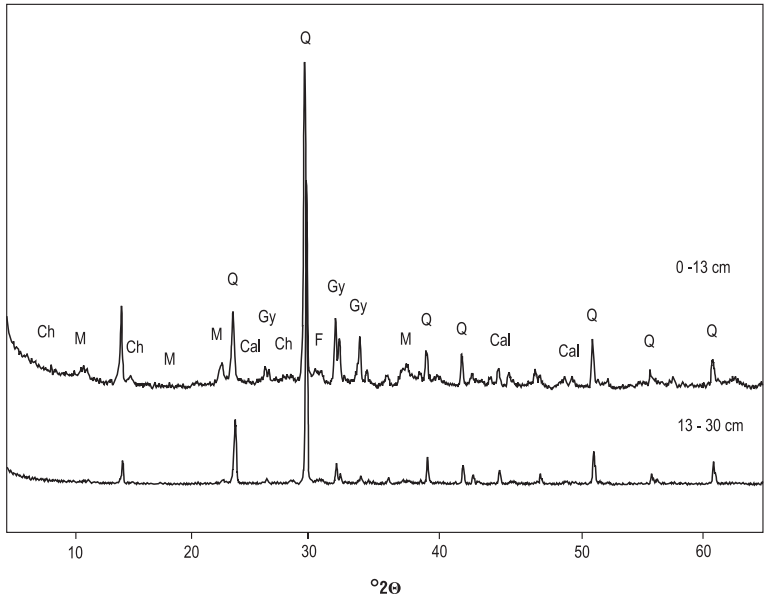

Figure 2. Mineral composition of the soil profile no. 1: Q – Quartz, Cal – Calcite, M – Mica, F – Feldspar, Gy – Gypsum, Ch – Chlorite

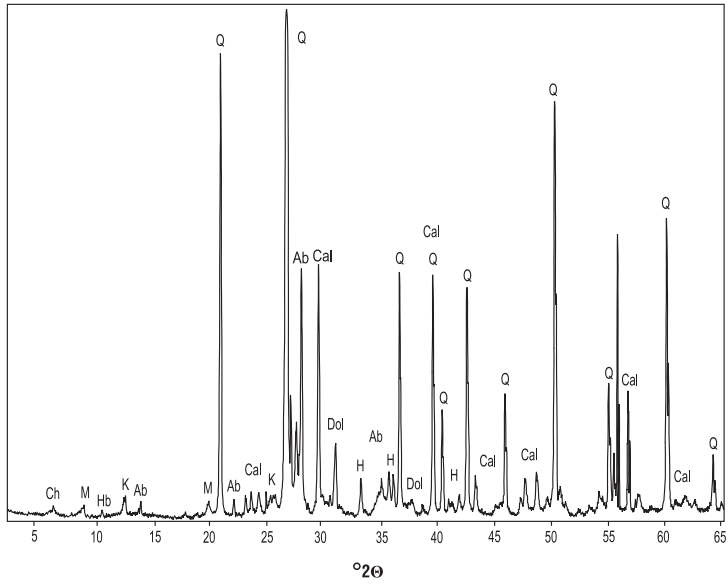

Figure 3. Mineral composition of the surface layer (0-5 cm) sediments of the Iriqui Lake: Q – Quartz, Cal – Calcite, M – Mica, F – Feldspar, Ch – Chlorite, Ab – Albite, K – Kaolinite, Dol – Dolomite, H – Hematite, Hb – Hornblende

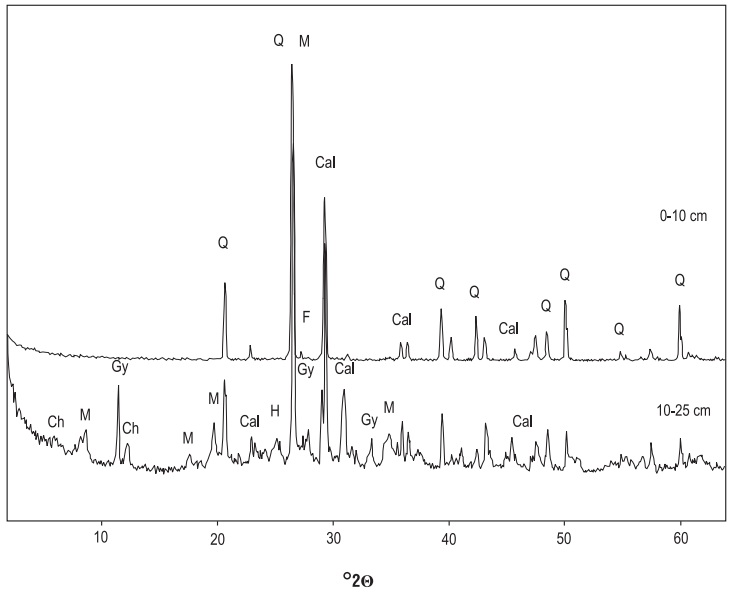

Figure 4. Mineral composition of the soil profile No. 2: Q – Quartz, Cal – Calcite, M – Mica, F – Feldspar, Gy – Gypsum, Ch – Chlorite

The soil profile of these formations starts with fragile and cracked, few centimetre layer (usually – 2 cm) of light grey (5YR 7/1-7/2) carbonate-sulphate crust. Also typical clay takyric cracks occur. Below that dry and hard (cemented) brown-red (5YR 5/4-6/4) clay horizon rich in calcite and gypsum occurs (Figure 2). Profile No 1 is a good example of such soil. It is formed of dried and polygonally cracked bottom sediments of the Iriqui lake covered with white salt pan (Figures 2-3).

Profile No 1.

Acacs 0-13 cm, light grey-brownish crust (7.5YR 7/2), texture – loamy sand, fragile, easily cracked patches covered (encrusted) by gypsum and calcite salts, pH 8.4, $CaCO_3$ content – 10.9%,

1Bcsca 13-30 cm, reddish-brown (5YR 3/4) silt loam, encrusted with gypsum and calcite, pH 8.0, $CaCO_3$ content – 7.9%,

2Bcsca from 30 cm.

Sample No. 2 is an example of desert soil, weakly crusted and formed on the Dra river alluvial sediments.

Profile No 2. (Figure 4)

Acacs 0-13 cm, grey-brownish (7.5YR7/2), texture – silty loam, shaly structure, weakly cemented by gypsum and calcite salts, pH 7.5, $CaCO_3$ content – 7.5%,

1Bcsca 13-25 cm, reddish-brown (5YR 3/4) silty loam, hard, cemented by gypsum and calcite, pH 7.6, $CaCO_3$ content – 17.6%,

2Bcsca from 25 cm.

4. Conclusions

1. Investigated soils show typical properties of the arid regions soils – Aridisols.
2. Mineral composition of these soils shows a strong connection to the rock material of the Anti-Atlas and Jebel Bani Mountain range (considerable amount of feldspars and micas together with ferruginous lithoclasts).
3. Mineral composition of the sand dunes (ergs) in the Iriqui Lake area is connected to the mineral composition of the lacustrine bottom sediments of the lake.

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