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GEOLOGICAL STUDIES OF THE PLIO-PLEISTOCENE PALEOSOL SEDIMENTS OF 6TH OCTOBER CITY, GIZA, EGYPT

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ABSTRACT

Eight sections were measured and described from the 6th of October City. These sections are I, II, III, IV, V, VI, VII and VIII. Lithostratigraphic sections I to III belong to the post- Miocene (Plio-Pleistocene) paleosols, whereas section V and VI belong to late Pleistocene (most –recent paleosol) and section VIII belong to Miocene clastic. The sequence of the previously diagenetic processes may be accepted because the studied paleosols constitute the upper most parts of the stratigraphic sections. So, they did not subjected to burial compaction and then the cementation played the main role of lithification. Also, the abundance of iron oxides in the studied paleosol samples may be referred to the Oligocene iron rich sediments which supply the solutions with more iron oxides. The studied sediments were transported and deposited mainly by fluviatile processes. These paleosols are resulted from the karstifications processes in which the dissolution of the Eocene, Miocene and Pliocene carbonates during the pluvial period in an oxidizing wet phase environments.

Keywords: Geological, Studies, Plio-Pleistocene, Paleosol, Sediments, 6th October City and Giza

INTRODUCTION

Soil is a product of the influence of climate, relief (elevation, orientation, and slope of terrain), organisms, and its parent materials (original minerals) interacting over time (Gilluly, et al. 1975). A soil is considered to be a buried soil if there is a surface mantle of new material that is 50cm or more thick or if there is a surface mantle between 30 to 50cm thick and the thickness of the mantle is at least half that of the named diagnostic horizons that are preserved in the buried soil (Soil Survey Staff, 1987).

The term pedolith, used commonly to refer to the soil, literally translates ground stone. Soil consists of a solid phase of minerals and organic matter (the soil matrix), as well as a porous phase that holds gases (the soil atmosphere) and water (the soil solution). (E.g.: Voroney & Heck, 2007; Danoff-Burg, 2011and Taylor and Ashcroft, 1972).

Little of the soil of planet Earth is older than the Pleistocene and none is older than the Cenozoic (Buol, et al. 2011), although fossilized soils are preserved from as far back as the Archean (Retallack, 2008).

In the geosciences, paleosol (palaeosol in Great Britain and Australia) can have two meanings. The first meaning, common in geology and paleontology, refers to a former soil preserved by burial underneath either sediments (alluvium or loess) or volcanic deposits (volcanic ash), which in the case of older deposits have lithified into rock. In Quaternary geology, sedimentology, paleoclimatology and geology in general, it is the typical and accepted practice to use the term "paleosol" to designate such "fossil soils" found buried within either sedimentary or volcanic deposits exposed in all continents as illustrated by Retallack (2001)and Kraus (1999).

Paleosols in this sense are always exceedingly infertile soils, containing available phosphorus levels orders of magnitude lower than in temperate regions with younger soils. Ecological studies have shown that this has forced highly specialised evolution amongst Australian flora to obtain minimal nutrient supplies (Tim, 1994).

Location of the Study Area

Egypt is a desert nation; only four percent of the country's total land area of 1 million km2 is arable with over 100 million inhabitants. The area of the 6th of October is largely deserted but contains the left bank of the Nile valley to both the north and south of Giza. It is 17 km from the great pyramids of Giza and 32 km from downtown Cairo (Fig.1).

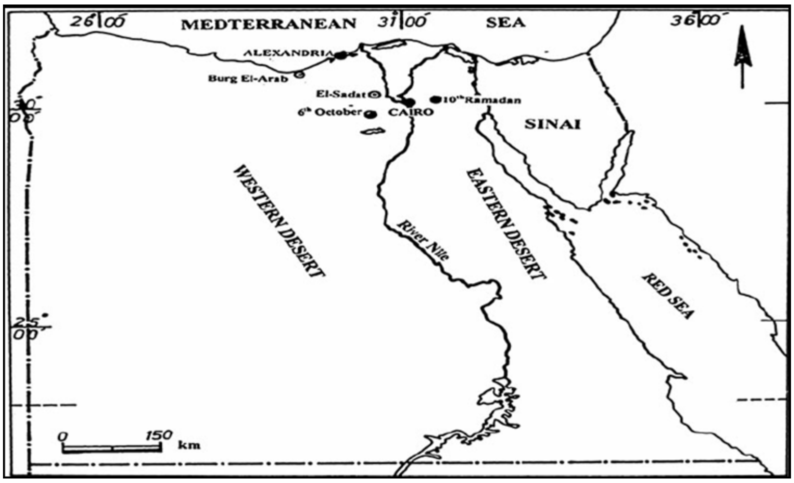

Fig. 1: Location map of the study area.

Bedrock Geology

The rocks that are exposed in 6th October City can be subdivided into the following units, from bottom to top (Fig. 2):

1-Eocene Limestone Thebes: Upper Eocene rocks follow the khoman chalk with an angular unconformity. Middle Eocene rocks follow immediately upon the chalk. The lower middle Eocene follows unconformably over the Chalk. The Eocene rocks are not different from the rocks described from the Giza Pyramids plateau. They are considerably thinner towards the structure (Said, 1962).

2-Oligocene Basalt flow: On the top of the upper Eocene rocks a conspicuous basalt flow which is followed by gravel and sand deposits that make the enormous plain stretching around the entire structure. The sands and gravels include abundant fossil wood. Hydrothermal effects of this Tertiary volcanicity can be seen in the silicification of some Eocene limestones and in the dolomitization of some beds of the limestone series (Said, 1962).

3- Miocene: The larger part of the northern Western Desert as 6th of October City is covered by a thin blanket deposit of Miocene rocks that unconformably overlap older strata. In the east of lower Miocene, sediments rest over the weathered basalt flows or Oligocene sediments, thus marking a major period of non-deposition and erosion. The top of Miocene interval is marked by the unconformity upon which the coastal gently-dipping Pliocene sandstone and shales rest. The middle Miocene is unconformably overlaid by a section of alternating sands and shales of Pliocene age. The gently north-dipping strata of the Miocene are followed by a Pliocene limestone section (Said, 1962).

LITHOSTRATIGRAPHY

Compiled Lithostratigrghic Sections

The geologic sections I, II and III represented for post-Miocene Plio-Pleistocene Paleosol sediments, these units are overlying Basalts IV. The basaltic unit overlies the Miocene non-clastics VII. The Miocene clastics underlie the Miocene non-clastics which represented her by geologic section VII.

The most recent paleosol sediments V and VI are concentrated at the slope-wash of the older paleosol sediments (post Miocene) (Fig. 3).

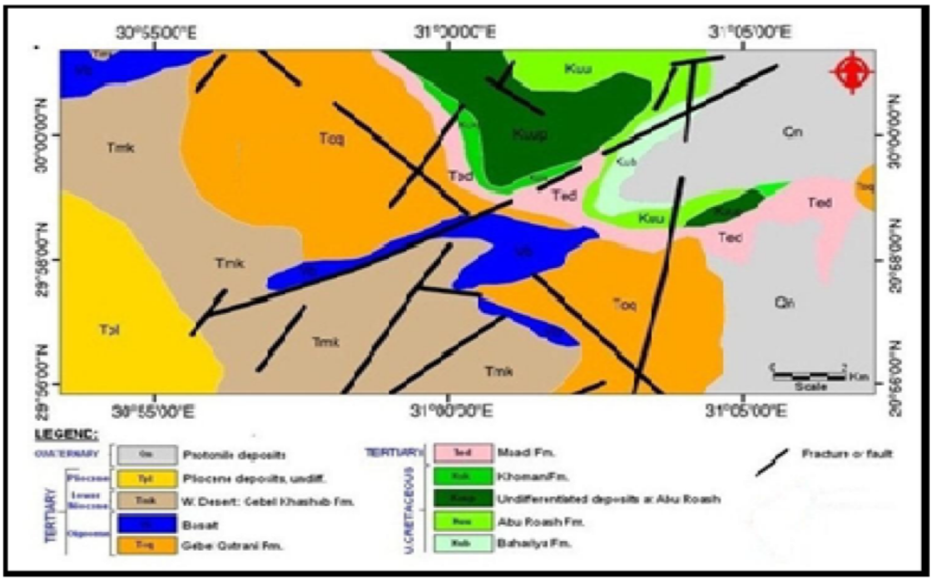

Fig. 2: Geological map of 6th October City (after Conco Coral, 1987).

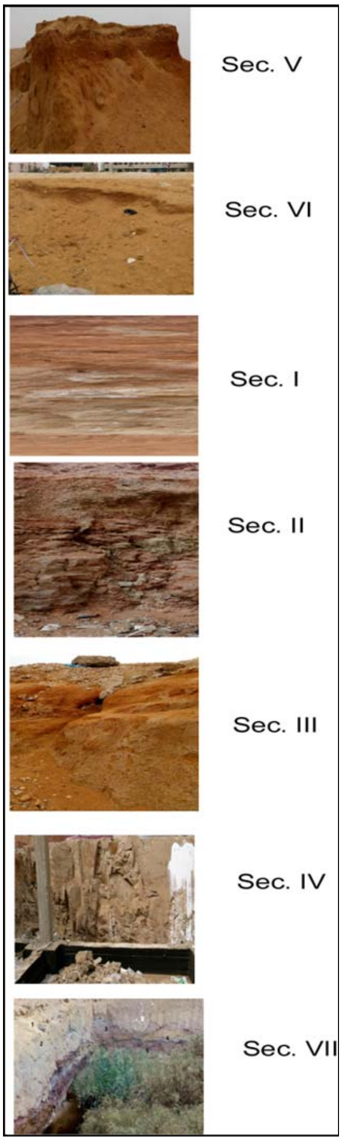

Fig. 3: Compiled Lithostratigrghic Sections.

METHODOLOGY

To achieve this study, we accompalished first field studies. Thes are followed by using particular techniques which include geochemical analyses, XRD technique and Polarizing microscope.

GEOCHEMISTRY

The soil sample was crushed, hard ground and sieved through 2 mm sieve before chemical analysis. The concentrations of major oxides were measured using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) with ultrasonic Nebulizer (USN) (Perkin Elmer Optima 3000, USA).

Chemical Composition

The concentrations of major oxides recorded in the studied paleosols is represent in Table 1. This table clarify that SiO2 is the most abundant oxide (68.698-79.7839 %, with an average of 74.45%). This fact may be related to the abundance of quartz and chert fragments in the studied samples as revealed from petrographical characteristics. The low percentages of Al_2O_3 (8.3285-18.2262%, with an average of 12.0452%), Fe_2O_3 (2.9491-4.0276%, with an average of 3.3339%) and CaO (0.8221-3.1114%, with an average of 2.1519%) may be related to the presence of clay minerals matrix, iron oxides cement and pigments, and calcite cement in the studied samples; respectively. The other oxides are rare to very rare (average 0.1011-0.7159%) and may be related to alteration of the mineral constituents.

Table 1: Percentage of major oxides in the studied paleosols.

Major Oxides	%	
	Range	Average
Al_2O_3	8.3285-18.2262	12.0452
CaO	0.8221-3.1114	2.1519
Fe_2O_3	2.9491-4.0276	3.3339
K_2O	0.0918-0.1415	0.1111
MgO	0.4163-0.8115	0.6217
MnO_2	0.0888-0.1191	0.1011
Na_2O	0.6355-0.7801	0.7159
P_2O_5	0.5444-0.7311	0.6323
SiO_2	68.6987-79.7839	74.4570
TiO_2	0.1025-0.1608	0.1286
L.O.I	4.1861-7.8790	5.4313

XRD DIFFRACTION TECHNIQUE

X-ray diffractometry was used to identify the clay mineral components of the studied paleosols. Oriented-particle mounts were prepared from the clay fractions. These mounts were prepared by pipetting the suspended clay fractions obtained by mechanical analysis onto glass slides which were left overnight for drying. For each sample, three oriented-particle mounts were prepared: untreated, glycolated and heated at 550°C for two hours.

The X-ray diffraction runs were obtained using a Philips Diffractometer (Model PW/1840) with a Ni-filtered, Cu, K□□ radiation (□ = 1.542 Å) run at 40 Kv and 30 mA potential. The scanning speed was 0.05°/s. The 2□□ranged from 2° to 35° and identification of minerals is based on data of ASTM and those published by the International Centre for Diffraction Data (1995).

X-ray diffractograms (Fig.5) of the clay size fractions in the studied paleosols reveals the presence of montmorillonite and kaolinite.

Montmorillionite

Montmorillonite is a product of intermediate leaching and moderate weathering conditions, being common in temperate soils with good drainage and neutral pH, in poorly drained soils and in arid-zone soils that are highly alkaline. The distribution of smectites, derived largely from alteration of volcanic material.

Kaolinite

In the studied paleosols, kaolinite follows montmorillonite in abundance. It belongs to Kandite group and consists of two layers structure of aluminum and silicon. Kaolinite is generally formed in warm moist regions as a residual weathering product or sometimes by hydrothermal alteration of other aluminosilicates. Kaolinite is characteristic of acid tropical soils where leaching is intensive in low-latitude areas.

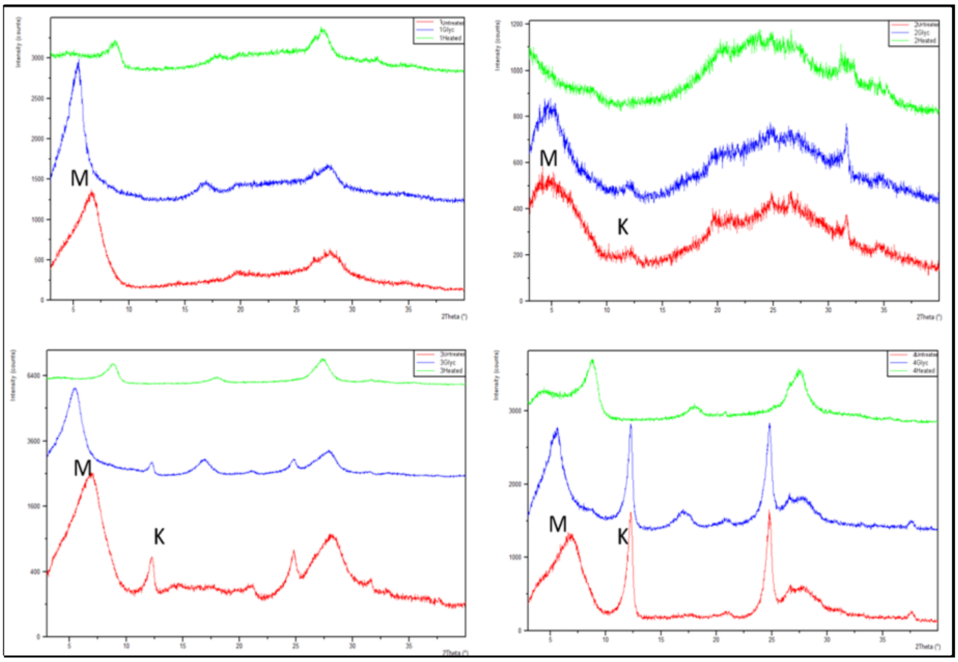

Fig. 5: X ray diffractograms of representative paleosol samples.

M: main peak of montmorillonite,   K: main peak of kaolinite

PETROGRAPHY

Eleven representative samples were collected from the studied sections. The collected samples were described megascopically and their thin sections were examined microscopically .These investigations revealed that the studied paleosols are essentially made up of sandstone with some conglomerate and limestone. The results of microscopic examination were used to classify the sandstone according to Pettijohn et al., (1987) and limestone according to Folk (1959).

Quartz arenite (unite 1)

The detrital fraction of this rock type consists mainly of quartz with very rare chert fragments and feldspar (Figs. 6 & 7). The grains size is represented mainly by fine to very fine sand size. Some pebbles to granule gravel-sized and coarse to medium sand-sized grains are observed. These grains are poorly sorted and subangular to subrounded. The quartz grains are mainly monocrystalline displaying unit extinction. Most of the gravelly–sized grains are polycrystalline. The rarely observed feldspars are represented by plagioclase and microcline. These grains float in silica and iron oxides cement with little matrix. The grain floating revealed that cementation precedes the compaction process. Paragenetically, the iron oxides followed the silica cementation. Also, iron oxides are represented by nodules and grain coating.

Quartz arenite (Unite 2)

This rock type made up of abundant quartz, some chert fragments and very rare feldspar (plagioclase and microcline) grains embedded in silica and iron oxides cement with little matrix **(Figs. 8 & 9)**. The recorded grains are mainly fine to very fine sand-sized. Some pebble and coarse to medium sand size are observed. This rock type is poorly sorted with subrounded to subangular grains. Most of the quartz grains are monocrystalline showing unit extinction. Some coarse quartz grains are polycrystalline or monocrystalline displaying undulose extinction. Diagenetically, compaction of the grain is evidenced by the point and straight grain contacts. The compaction followed by cementation by silica and iron oxides. Iron oxides are coating the grains and rock groundmass. Some quartz grains show inclusions of opaques which may be observed in the rock groundmass.

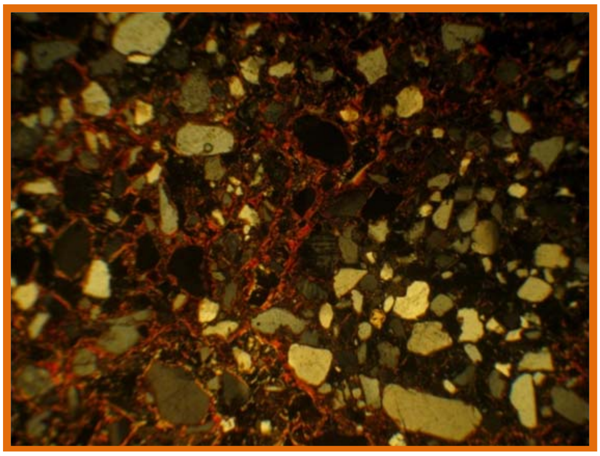

Fig. 6: Poorly sorted, subangular to subrounded quartz grains. Note the plagioclase grains in the center of photo (Sample I4, CN, 4X).

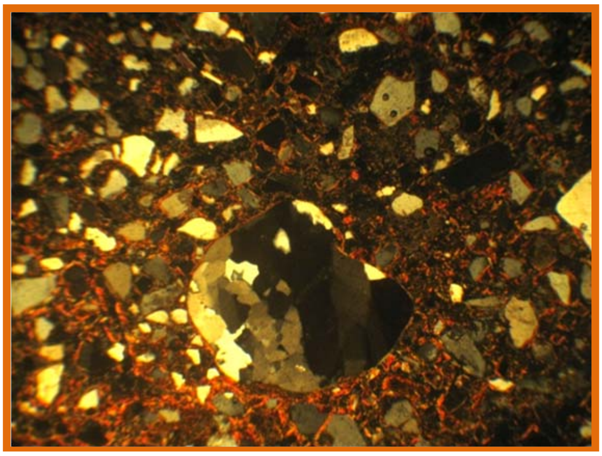

Fig. 7: Monocrystalline, fine to very fine sand sized quartz grains float in iron cement. Note the polycrystalline, pebbly sized quartz grain (Sample I4, CN, 4X).

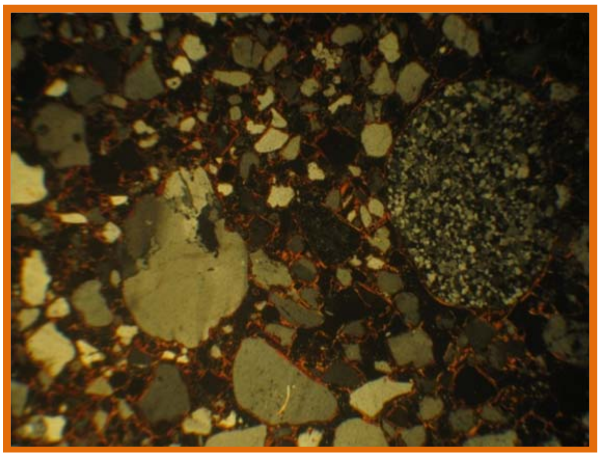

Fig. 8: Some pebbly quartz and chert grains associated with sand sized quartz grains (Sample III 1, CN, 4 X).

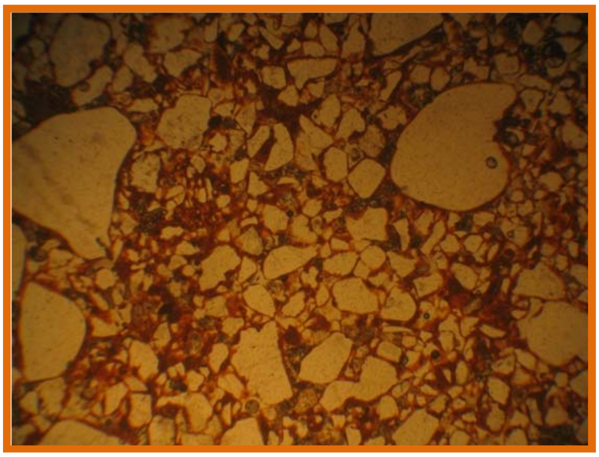

Fig. 9: Quartz grains show point and straight contacts. Note the abundant iron oxides cement, nodules and coatings (Sample III 1, PPL, 4X).

Intrasparite

Intrasparite represents an intercalation within the studied paleosols. The allochems of this rock type are composed of terrigenous grains which represented mainly by quartz, very rare chert and feldspars (Figs. 10 & 11**)**. The quartz grains are mainly monocrystalline displaying unit extinction. The orthochems are dominated by micro to pseudo-sparite and rare micrite. Calcite cement is filling the intergranular pores or surrounded the grains in the form of isopacheous cement. This isopacheous cement witnessed the fresh water diagenesis. The main process of diagenesis is the aggrading neomorphism. This evidenced by the abundance of micro-and pseudosparite with relics of micrite this diagenetic process is commonly occurred in fresh water diagenetic environment

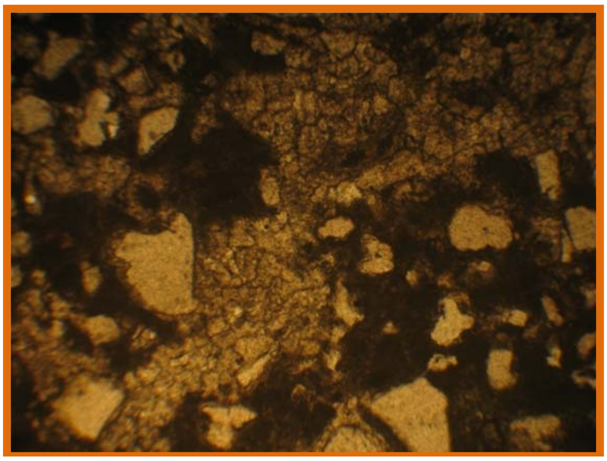

Fig. 10: Pseudosparite filling the intergranular pores with relics of micrite (limestone sample, PPL, X4).

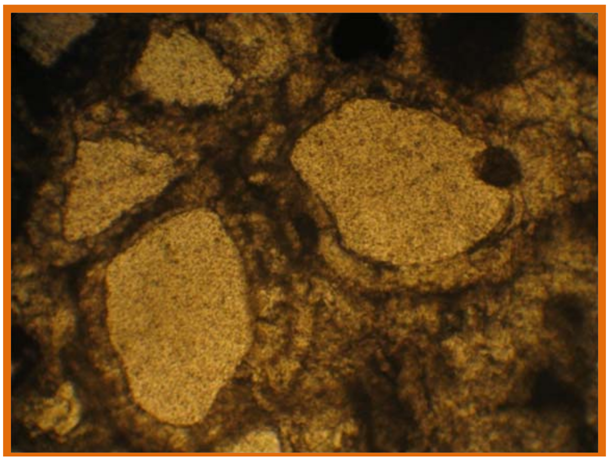

Fig. 11: Intrasparite composed of quartz allochems cemented by intergranular pseudosparite and isopacheous calcite (limestone sample, PPL, X10).

These observations indicate the great similarity between the mineral composition of the studied paleosols and those of the nearby fluviatile sands and gravels. So, these sands and gravels constitute the provenance of the studied paleosols. This provenance may be passed through more than one cycle of sedimentation (i.e. high maturity); hence, the sediments (paleosols) are highly mature. On the other side, the studied samples show low matrix content and nearly high roundness (high maturity) which again confirm the results obtained from the compositional characteristics of the studied samples. The intrasparite intercalation may be considered as a duricrust of calcaarete type formed by the effect of raised water table of groundwater. This fact is evidenced by the occurrence of fresh water isopacheous calcite cement, absence of marine skeletal grains and abundance of terrigenous allochems similar to those recorded in the studied quartz arenite. The recorded abundant montmorillonite may be referred to alteration of basalt outcrop in the study area. The unstable minerals (olivine and pyroxene) of basalt are easily altered to montmorillonite under neutral to alkaline pH by the effect of moderate weathering. Kaolinite may be produced by the hydrothermal alteration of other aluminosilicates.

SUMMARY AND CONCLUSION

The foregoing discussion revealed that the studied paleosols are represented mainly by quartz arenite and rarely by polymictic conglomerate with intercalation of intrasparite. The detrital fractions of these rock types are dominated by quartz with rare chert and very rare feldspars and clay minerals. Most of the quartz grains are monocrystalline displaying unit extinction. Some quartz grains are polycrystalline or monocrystalline with undulose extinction. Clay minerals are dominated by montmorillonite with subordinate amounts of kaolinite.

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دراسة جيولوجية لرواسب التربة القديمة فى عصر البليو– بليستوسين – منطقة السادس من اكتوبر، الجيزة ، مصر

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الخلاصة

تم قياس ثمانية قطاعات ووصفها في مدينة السادس من أكتوبر . هذه القطاعات هي الأول والثاني والثالث والرابع والخامس والسادس والسابع والثامن ، السمات الصخرية للقطاعات من الأول إلي الثالث تنتمي إلى فترة الميوسين العلوي (بلايوبليستوسين) ، حيث ينتمي القطاعان الخامس والسادس البليستوسين المتاخر(التربة القديمة الحديثة) و القطاع الثامن ينتمى الى الميوسين الكربوناتى. قد يتم قبول تسلسل العمليات التي تم تحديدها في السابق لأن الباليوسولس المدروسة تشكل الجزء العلوي لمعظم الأجزاء الستراتجرافية. لذا ، فإنهم لم يتعرضوا لضغط الدفن ، ومن ثم لعب الاسمنت دورًا رئيسيًا للتثبيط .

يمكن الاشارة الى وفرة اكاسيد الحديد فى عينات التربة القديمة المدروسة الى رواسب الأوليجوسين الغنية بالحديد والتي تزود المحاليل بأكاسيد الحديد. تم نقل الرواسب المدروسة وترسبت بشكل رئيسي عن طريق عمليات إنسانية. وتنتج هذه التربة القديمة عن عمليات الكارستاتيات التي حل فيها كربونات الإيوسين والموسين والبليوسين خلال فترة الدورات النهرية في بيئات طورية رطبة مؤكسدة .