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Mineralogy of Nile Valley sediments as an indicator of changes of climate: the Armant–Luxor area, Upper Egypt

Investigations were carried out at the left bank of the Nile, between Qurna and Armant during four years of intensive field work; more than 20 Neolithic and Palaeolithic sites were discovered.

One of these sites, Ma 21/83 was investigated in detail. The site is located just behind small village called Hagar Dabija between low hills elevated about 7 - 8 metres above the cultivated zone. All regions between Qurna and Armant were tested geologically by more than 30 trenches and pits. Each separated sediment was sampled and tested mineralogically using X-ray, infrared, microscopic and chemical methods. Field and mineralogical investigations showed that the sediments of the Nile Valley were deposited here in five morphological zones as following: zone I, II, high mountains; zone III, hills; zone IV, small hills, level of Neolithic period sites; zone V, flood plain.

The Neolithic sites were localised between two very different zones of sedimentation; at the rapid sedimentation of hill streams and the slow sedimentation of the Nile. In this situation the main problem of interpretation was the identification of the Nile and the hill stream sediments as well as determination of eolian sediments; this was possible with the use of grain and mineral analysis.

Nile sediments

They are represented by different types of fine grained sediments *i.e.* silts, composed of quartz, feldspars, clay minerals, organic substance and heavy minerals. All of the investigated silts of the Nile contain them, but the proportions between them vary.

The material transported from the gebels

This is represented mainly by river gravels composed of well rounded rocks present in the gebels. At Armant–Qurna they are represented by Theban Limestones, which sometimes contains varying admixtures of sand.

Eolian sediments

These are fine grained and are represented by eolian quartz or calcareous sands containing admixtures of small grains of limestones or other rocks.

Residual rocks

These are from red soils developed in the past on the surface of limestone. Relics of these soils are preserved in some regions of the Theban Gebel.

Slope sediments

These are poorly rounded or sharp patinated fragments of Theban Limestones.

Taking into consideration all the sediments, one can determine the general profile of the V zone, in which the archaeological sites are located. At the base of the analysed geological profiles are Sahaba silts which represent one or more layers of Nile mud; the number of layers depends on the locality of the outcrop. Near the gebel, where gebel streams were active, Sahaba silts are interlocated with stream gravels; similar situations can be observed in the old wadis which were transporting material from the gebels during the laying down of Sahaba silts.

The colour of Sahaba silts depends on the admixture of red soils eroded from the gebel during their formation; if the admixture was high, silts were brown or reddish, if low, grey. The Sahaba Formation documents a high level Nile as well as a wetter climate in the region investigated.

The next stage of the sedimentation is represented by sandy silts containing calcified roots of reeds and sometimes mud cracks, contemporary with these sediments, but at other localities there are lake sediments represented by sands, laminated sands and other sediments containing fish bones, mollusca, wood, *etc.* All these document the lowering of the Nile level and the presence of local small relic lakes.

Sahaba silts as well as lake sediments are covered by a pediment deposit of gravels transported from the gebels. This old pediment shows high activity in streams flowing from the gebel and indicates high rainfall. The thickness of this old pediment is much greater in the stream beds than at other places.

The next sediment is represented by river sands which fill the old wadis and show less activity in the streams flowing from the gebels; thin intercalated sedi-

ments were also observed. On the sediments described above, mostly Neolithic sites were found.

The morphological phase is documented by the formation of new wadis, which cut earlier strata and destroyed parts of archaeological sites. The banks of the wadis show three phases of terraces, in which the grain size of the gravels showed changes in the transporting abilities of the streams flowing from the gebels. These changes can be linked to local changes in rainfall. During the formation of the wadis another generation of river gravels (*i.e.* young pediment) was laid down; between the activity phases of the wadis eolian sediments were continuously deposited.

At the end of the Neolithic and in the Early Dynastic periods, climate was very dry and the level of the Nile was very low; this is confirmed by the El Tarif mastabas, which are practically on the Nile flood plain. This very dry climate and low level of the Nile continued in Middle Kingdom times, when probably heavy torrential rains destroyed Amenophis III's temple as well as other mud brick structures situated near the flood plain. It is impossible to determine precisely the date but it must have been after 3,350 B.P.

The geological and morphological pattern is complicated by wind activity eroding the sediments and leading to the formation of surfaces covered by coarse pebbles. The data show that the Neolithic site Ma 21/83 was located on sediments older than the top of the younger pediment.