SAQQARA

ANALYSIS OF MINERAL DEPOSITS IN THE NORTHERN WALL OF PIT I

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The archaeological site at Saqqara is situated on a slope with a variable surface inclination of 6-160, inclined towards the west, southwest and northwest. The examined trench wall constitutes the northern limit of the excavated site (Pit I); it is 15m long and about 2 m high.[1]

At the eastern end, a layer of distinctly segregated deposits connected with water flow appears at the bottom of the wall (Fig. 1: layer 1). This series as a whole is slightly inclined westwards (1-2°). It is composed of limestone fragments (up to several cm in diameter) with occasional gravel and pebbles of granite, quartz and flint, which are lacking in the overlying layers. Fragments of pottery are also encountered sporadically.

Limestone debris (Fig. 1: layer 2) overlies these deposits; it comes most probably from the excavation of a shaft situated in the northeastern corner of the archaeological site. On the ground of archaeological data on the shaft age, it can be concluded that the heap of debris accumulated undoubtedly earlier than 4000 years BP (i.e., 2050 BC), but it is still difficult to say whether it was 4300 or 4500 years BP (2350 and 2550 BC respectively). The no. 1 series underlying the heap is obviously older. A thin layer of clay coating covers the heap (Fig. 1: layer 3); it is spread over the slope and forms part of the slope deposits (Fig. 1: layers 3a, 3b), which in turn are composed of very poorly sorted limestone debris with an occasional accidental

[1] K. Myśliwiec and T. Herbich, with contribution by A. Niwiński, Polish Research at Saqqara in 1987, in: *EtTrav* XVII, Warsaw 1995, pp. 186-195; K. Myśliwiec, Saqqara, Excavations 1996, in: *PAM* VIII, 1996 (1997), p. 109.

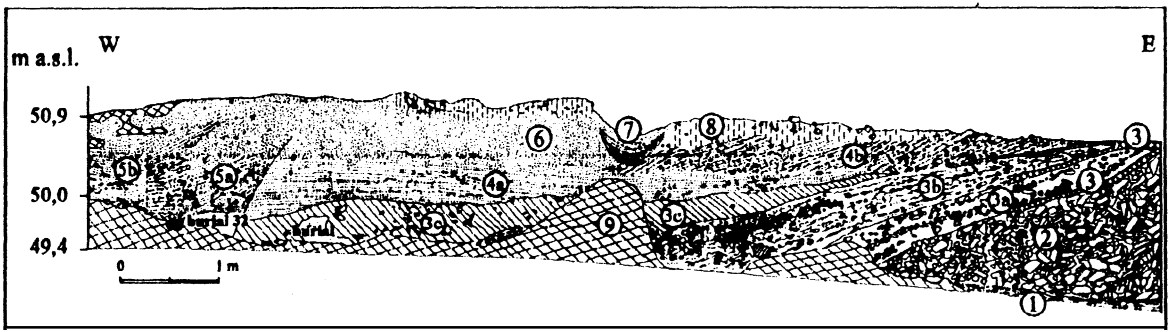

Fig. 1. Northern outcrop of Pit I (1997) 1. Sand and gravel horizontally stratified, with limestone breccia and granite, quartz and flint gravels; 2. Heap of limestone breccia of angular rock fragments; 3. Clay coating layer spread over the slope; 3a-3b. Slope deposits with large angular rock fragments, poorly sorted, stratified parallel to the slope, containing individual fragments of mud bricks; 3c. Weathering-soil horizon; 4a. Sandy-gravel deposits horizontally stratified. Flood series. 5a. Sandy-gravel deposits of the talus; 5b. Stratified deposits filling the excavations; 6. Structureless sand with strong aeolian quartz grain rounding; 7. Medium and coarse grain sands with gravels, cross-stratified in rill, formed during episodic heavy rains; 8. Stone-sandy layer, anthropogenically transformed; 9. Embankment.

piece of mud brick. These deposits clearly follow the fossil slope inclination. The ceiling of this series exhibits the presence of a weathering-soil horizon, consisting of clay debris of gray color (Fig. 1: layer 3c); remnants of a human skull were found in this layer at the western end of the trench wall.

The series as a whole (Fig. 1: layers 3, 3a, 3b, 3c) is indicative of deep erosion inside a valley under formation (westward of the pit) running N-S and sloping toward the south. It also testifies to a slope being formed, dissecting an earlier, barely inclined surface, represented by layer no. 1. The formation of the weathering-soil horizon, as of the heap of limestone debris, should be referred to a period older than 4000 years BP (2050 BC).

Above the no. 3 series (Fig. 1, layers 3, 3a, 3b, 3c) there is a sandy layer, 0.50 m thick, mixed with some horizontally laminated gravel, slightly inclined southwards (Fig. 1: layer 4a). The stratification is of a type that suggests accumulation by flood water from a dynamic episodic river, which while flowing in the N-S valley (known to have developed in the area west of the excavation trench), at a level of c. 49 m a.s.l., may have encroached during flooding onto upper levels, reaching 51-52 m a.s.l. The laminae inclination in the deposit points to a southward run-off. A number of such flood episodes are recorded in layer 4a, beginning each time with a layer of thin gravel and ending with sand. Toward the east, the layer thins out and partly overlaps with slope deposits (Fig. 1: layer 4b). Several facts lead to conclusions on the period of its formation. A low stone wall runs parallel to the pit wall in its immediate vicinity, its height reaching the ceiling of the weathering-soil horizon (Fig. 1: layer 3c). Its date has been established on the ground of archaeological data as 2050 BC. No weathering-soil horizon was discovered when excavating this wall, indicating that the layer was older than the stone wall and had been removed from the building area. On the other hand, flood waters entering the building area from the north found no transversal obstacle in the form of a high stone wall. Hence, the construction of the stone wall must have been interrupted at the present height, which corresponds to the ceiling of the weathering-soil horizon. Above this horizon, as well as above the stone wall, sand carried with the flood waters had accumulated freely, forming a horizontal stratification (Fig. 1: layer 4a). The chronology of this series (Fig. 1: 4a) is confirmed additionally by massive Nile flooding dated to 1850-1550 BC (personal communication of Z. Szafrański). It must have been a period of heavy rains leading to floods not only in the main river valley, but also in the tributaries. Therefore, it cannot be excluded that the building works at the stone wall were interrupted by flood sands accumulating in the area, and were never resumed.

A deep pit cuts through layer 4a, with a talus visible at the bottom (Fig. 1: layer 5a). The pit of a mummy burial (no. 32; Fig. 1: layer 5c) was excavated in the talus deposits, thus it must be somewhat younger than the talus itself, probably of Ptolemaic age. It indicates all the series described up to this point were formed between 4500 (or 4300) and 2000 years BP (2550 or 2350-50 BC).

The remains of a human skull were discovered at the same level as the mummy burial, but in a neighboring weathering-soil horizon. In neither case were there any traces of excavation from above visible. This allows the inference that the burial pits were excavated horizontally from trench walls that no longer exist. Part of such a trench seems to be visible in the western wall of Pit I. (Fig. 1: layer 5b). During heavy episodic precipitation, these trenches could have been filled with sandy-gravel deposits washed down the slope (layer 5b). Hence, the repeated digging up of these deposits on the occasion of subsequent burials.

The next deposit series is a layer of structureless sand, poorly sorted, covering the whole slope (Fig. 1: layer 6). To judge by its character, this is a slope deposit, heavily changed due to aeolian processes. At the time of its formation, the area of the archaeological site must have been completely and evenly covered with sandy deposits.

Within the upper part of the structureless sandy series (Fig. l: layer 6) two rill erosion forms are strongly marked. They originate in episodic concentrated water flow running down the slope (Fig. 1: layer?) toward the northwest, that is, in accordance with the present slope inclination. Both grain-size and diagonal stratification of these rill deposits indicate that the water flow was brief and violent, connected with episodic downpours.

To complete the description of the northern wall of pit I, it is to be noted that the investigations comprised also a pale-yellow, well-sorted sandy deposit inside a rock-cut shaft, sampled from a depth of 7 m below the surface. A macroscopic examination of the sand is sufficient to reveal that it differs from all other sand deposits identified in the trench wall. Neither does similar sand occur anywhere in the vicinity.

For a detailed textural deposit analysis, sand was sampled from: the shaft (depth of 7 m), the weathering-soil horizon (Fig. 1: layer 3c), alluvial sand series (Fig. 1: layer 4a) and the rill erosion form deposit (Fig. 1: layer 7). The rounding and frosting of quartz grains of the sand fraction (0.5-0.8 mm) were studied under an optical microscope, and a surface micromorphology of quartz grains of the same diameter was done under a scanning electron microscope (SEM); a heavy-mineral

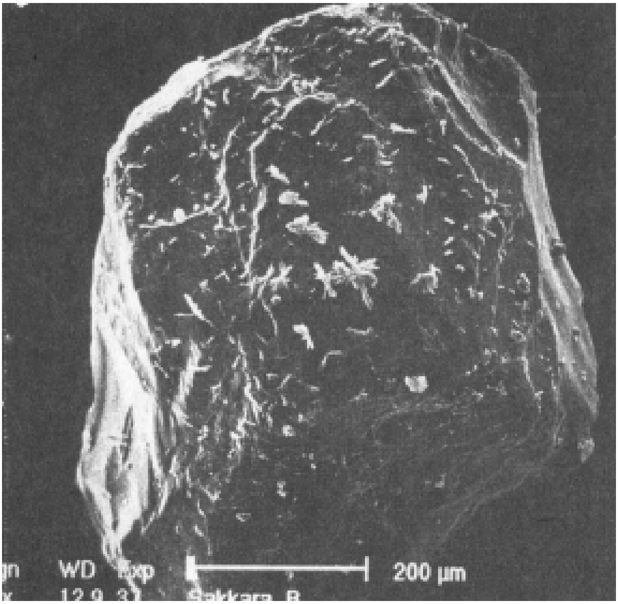

Fig. 2. Quartz grain weakly rounded, with secondary crystals on the surface.

analysis and an X-Ray-structural analysis were also carried out (on samples from the weathering-soil deposits).[2]

The analyses results permit conclusions concerning both the changes in the natural environment as well as human activity in the area during the last 4500 years.

The presence of fragments of granite, quartz and flint in layer no. 1 seems to indicate that the reach of episodic rivers in this area was much more extensive at the time than nowa-

[2] The authors wish to thank Dr. A. Barczuk for having carried out the heavy mineral analysis and the X-ray-structural analysis and for his generous help in interpreting the results.

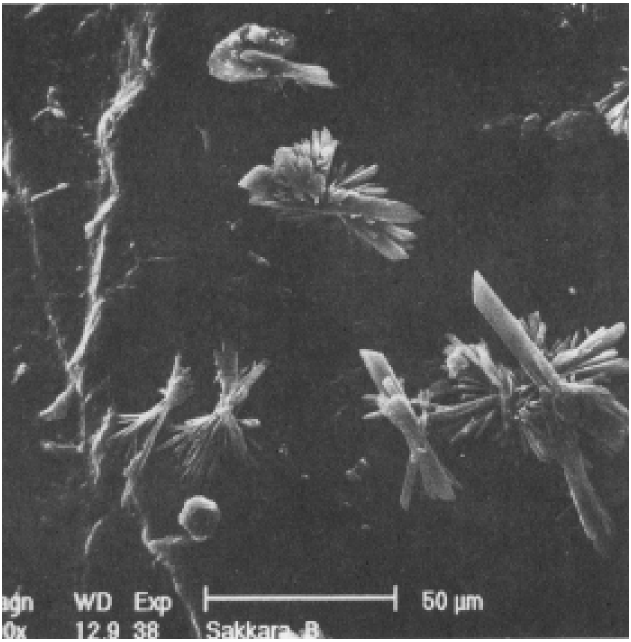

Fig. 3. Fragment of quartz grain surface with gypsum aggregates.

days. The relief of the examined terrain must have been also less diversified than now. The erosion episode recorded in slope deposits (Fig. 1: layers 3a, 3b) indicates the possible high intensity of episodic rainfall. Analogously, the analysis of rounding and frosting of quartz grains from the same series and from the weathering-soil horizon (Fig. 1: layer 3c), as well as the micromorphology of the quartz grain surface, proves the share of grains evidencing aeolian abrasion to be low (the lowest in the whole profile under examination). This may also be proof of seasonally increasing amounts of rainfall.

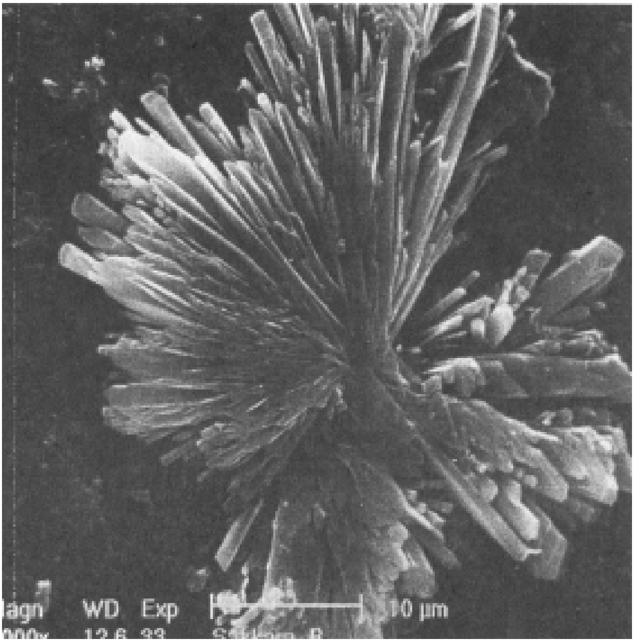

Fig. 4. Gypsum aggregate crystallized on quartz grain surface.

The analysis of heavy mineral composition from the weathering-soil horizon (Fig. 1: layer 3c) shows the highest share of minerals resistant to chemical weathering as compared to all the other deposits. This feature is typical of soil levels undergoing intensive weathering processes. The X-Ray-structural analysis of this deposit allowed crystals of gypsum, quartz, ardealite, calcite and smectite to be distinguished. Gypsum, ardealite (hydrated sulphate and phosphate of calcium) and calcite are evaporites, formed in near-surface horizons in a dry or semi-dry climate, whereas smectite (a clay mineral from the montmorillonite group) forms in strongly alkaline (pH 8) and saline soils. A micromorphological analysis of quartz grains

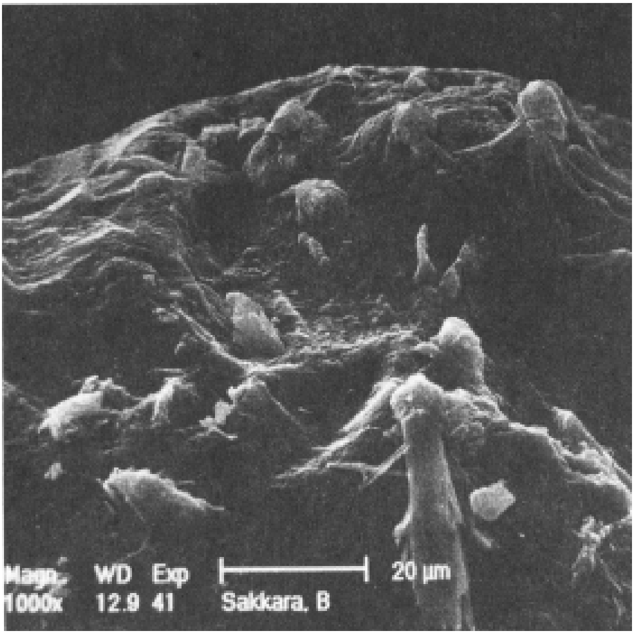

Fig. 5. Fragment of quartz grain surface with secondary minerals (probably ardealite).

from the weathering-soil horizon revealed the presence of crystal aggregates of gypsum on the quartz-grain surface and probably crystals of ardealite (Figs 2-5). All the textural features of the weathering-soil horizon indicate that it took several hundred years at least for this horizon to form (well grown crystals), in climatic conditions characterized by a seasonal variability, with dry and wet seasons.

As follows from the stratigraphy, the sand filling of the shaft corresponds in age to the weathering-soil horizon. But a comparison of the features of both deposits led to some surprising results: They turned out to be completely different.

The micromorphological and heavy-mineral analyses of the sand filling the shaft points to its aeolian character and to its origin from a region with a much drier climate in comparison to that of the area of Saqqara in the same period. This character is, moreover, confirmed by considerable amorphous silica encrustation of the grains. Quartz grains of this kind are nowadays characteristic of the middle Sahara. Such encrusting was not observed on quartz grains with aeolian abrasion, found in layers 3a, 3b and the horizon 3c, as well as in overlying deposit layers (Fig. 1: layer 4,7) where the total percentage share of grains with aeolian abrasion increases considerably. Aeolian abrasion predominates over encrusting on these grains. It seems then that the sand filling the shaft could have been brought even from rather distant regions to the south.

The weathering-soil horizon (Fig. 1: layer 3c) dated to about 4000 years BP (2050 BC) is the last one to be formed in a period of relatively moist and stable climatic conditions prevalent in the region. Ever since there has been an increasing dryness, which is recorded in the deposits, characterized by episodic intensive rainfalls during the first 500 years, causing heavy flooding. During the next 3500 years, the progressing climate dryness is reflected in changes of the ground relief toward deflation forms. The former valley bottom on the western side of Pit I is lowered by about 3 m (to 46 m a.s.l.) and transformed into a deflation pan with a longer N-S axis. The wind-blown sand is accumulated on the slopes, covering the formerly deposited series with a structureless layer. In this period, heavy rains still occur sporadically, generating occasional concentrated flow on the slope, but these rains are no longer as abundant as before and do not cause flooding in the valley.

