GENETIC-CLIMATIC INTERPRETATION

of Mineral Deposits Uncovered in Section N and Sections Perpendicular to It

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SECTION N - AREA I/E-F

Further work carried out in Area I in 1998 uncovered layers lying below those analyzed in the previous season.[1] Two other cross-sections were cut through the deposits, situated at right angles to Section N and hence of N-S orientation [*Fig. 1*]. Of these cross-sections one adjoins the rock shelf with Shaft 1 [*Fig. 2*], while the other is situated in line with the entrance to the vizier's tomb [*Fig. 3*].

Further excavation eastward (uphill) enabled the authors to examine the lay-

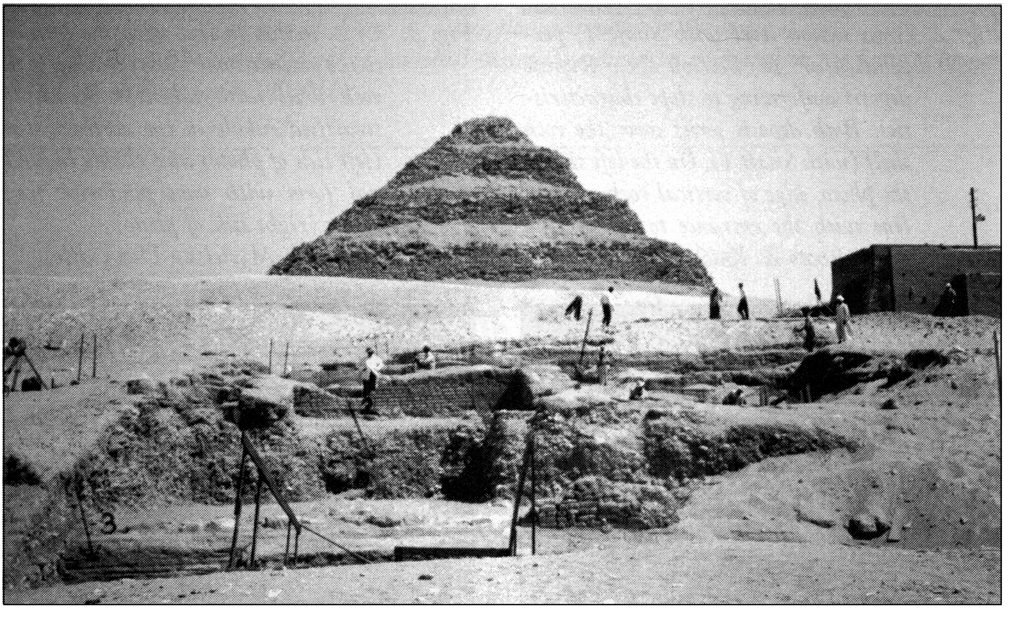

Fig. 1. General view of the archaeological site at West Saqqara: 1 - upper level, point of measurement of the pebble longer axis (Shaft 16, Fig. 6); 2 - section adjacent to rock shelf inside Shaft 1 [Fig. 7]; 3 - section in line with the entrance to the tomb of Meref-nebef [Fig. 8] (Photo B. Woronko)

[1] E. Mycielska-Dowgiałło, B. Woronko, Analysis of mineral deposits in the northern wall of pit 1, *PAM IX, Reports 1997* (1998), pp. 106-115.

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ers superimposed directly on the rock. A fossil slope found there had an average inclination of 7 degrees.

The gravel layer makes for the oldest deposit series lying directly on the rock terrace; apart from calcareous rubble, it contains numerous flint and chert pebbles along with quartzite and quartz [*Fig. 4*].

This layer also contains abundant organic remains and pottery fragments dating back presumably to the 3rd dynasty of the Old Kingdom. The gravel layer conforms to the fossil rock terrace surface. Measurement of pebble longer axes indicates an orientation in conformity with the slope inclination [*Fig. 6*].

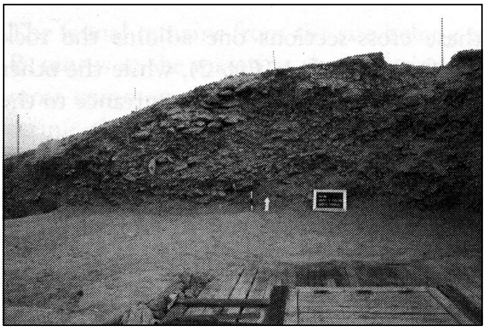

Fig. 2. Cross-section level with Shaft 1, perpendicular to Section N. Rubble deposit conforming to slope characteristics. Both deposit series cover the rock shelf (with Shaft 1). On the left side of the photo, edge of vertical rock wall in line with the entrance to the vizier's tomb (Photo Z. Kość)

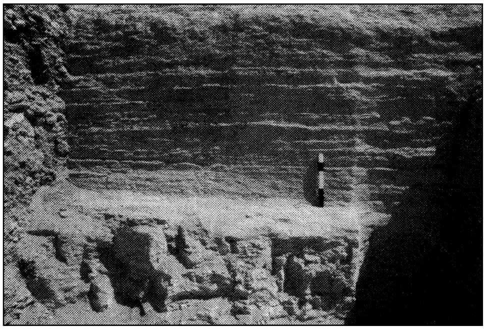

Fig. 3. Cross-section in line with the entrance to the vizier's tomb. One can observe the rock wall with adjacent deposits of stratified rubble in the northern wall (left side of photo) and rubble in residual form with some mud-brick fragments (right side of photo) (Photo E. Mycielska-Dowgiałło)

Fig. 4. Gravel deposit intercalated with stratified sand from upper levels of the archaeological site. Point of measurement of pebble longer axes [Fig. 6] (Photo E. Mycielska-Dowgiałło)

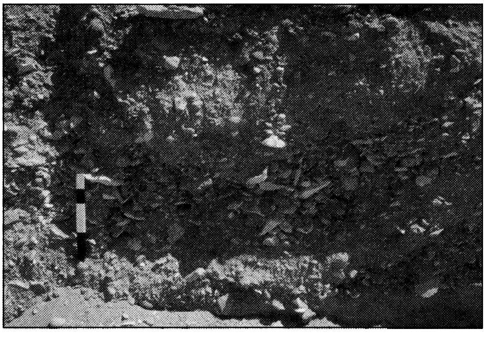

Fig. 5. Gravel and rubble deposits [Fig. 7] in the longitudinal cross-section adjacent to the rock shelf with Shaft 1. Below (lower right corner), a lenticle of fine-grain stratified sand with westward laminae inclination (Photo Z. Kość)

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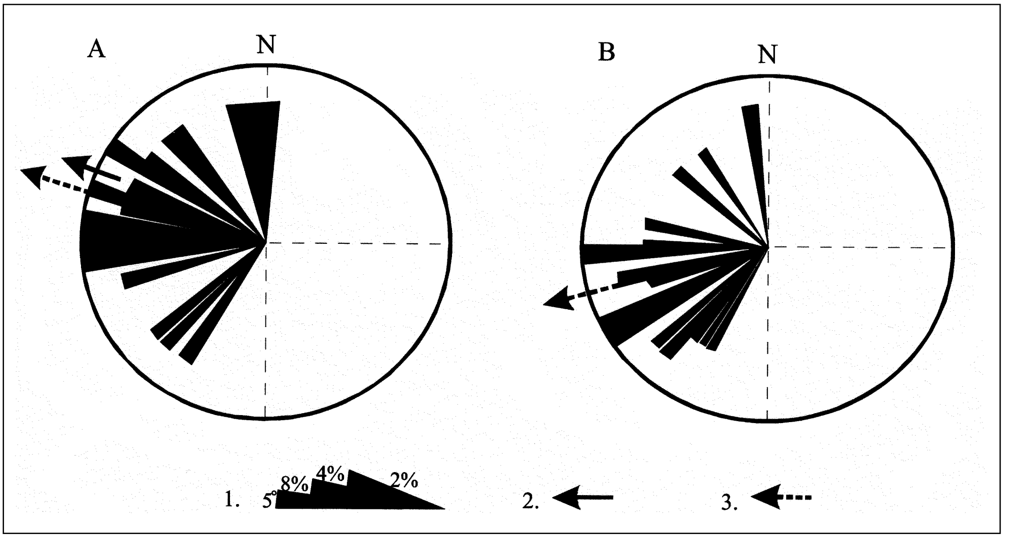

Fig. 6. Distribution of the longer axis orientation in pebbles 0/5-9.5 cm fraction, from the upper level of the site (Shaft 16, Figs 1,4) presented as a circle diagram: A - NW part of the downhill flow; B - SW part of the downhill flow; 1 -percentage share of pebbles in 5o angle sectors; 2 - direction of downhill water flow estimated on the basis of inclination of sandy layers; 3 - average vector of downhill water flow direction estimated on the basis of longer-axis orientation of pebbles

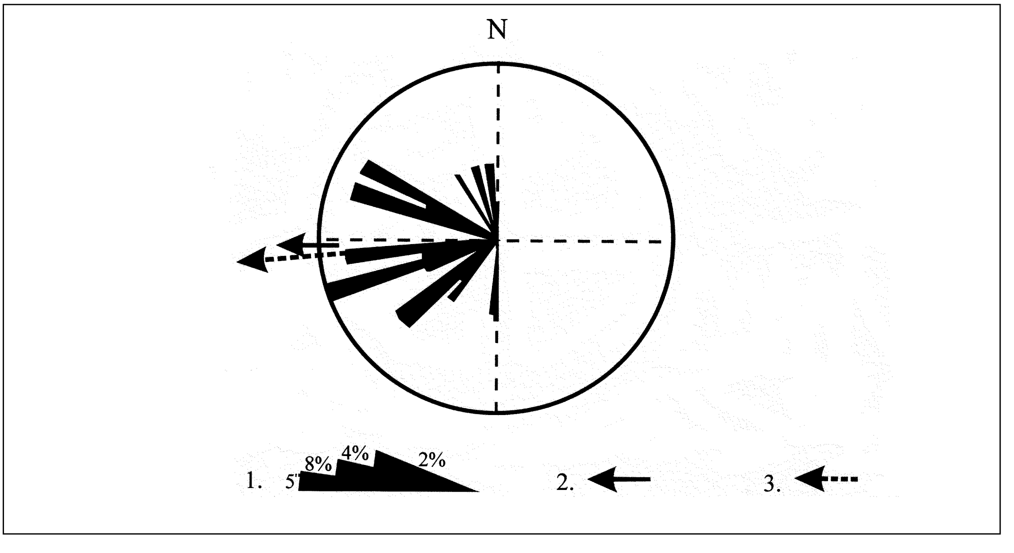

Fig. 7. Distribution of the longer axis orientation in pebbles of 5.5-11 cm fraction from the section in line with Shaft 1 [Figs. 1, 5]: 1 - percentage share of pebbles in 5o angle sectors; 2 -direction of downhill water flow estimated on the basis of inclination of sandy-gravel layers; 3 - average vector of downhill water flow direction estimated on the basis of longer axis orientation of pebbles

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The extension of this gravel layer visible also in the cross-section in line with Shaft 1 [*Figs. 2, 6*], refers to layer No. 1 spread horizontally over the rock surface and identified in 1997 as the oldest deposit series on the examined slope.[2] Beside calcareous debris, this layer also yielded flint and quartz pebbles, as well as single granite grains. The data on the size and the longer-axis orientation of pebbles indicates that the gravel was transported by episodic rain water characterized by high dynamics, flowing downhill, and concentrating in a stream on the rock shelf (of Shaft 1). The origin of the well-rounded gravel is unclear [*Fig. 7*].

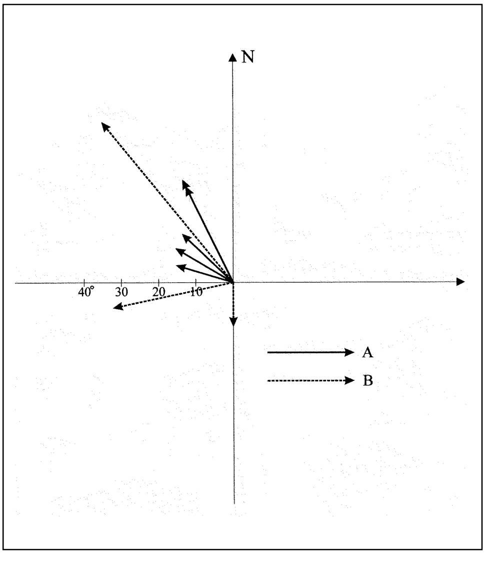

Fig. 8. Diagram of laminae inclination in deposits adjacent to the rock wall in line with the entrance to the viziers tomb [Fig. 1,3]: A - of debris deposits in Section N; B - of debris deposits with single pieces of mud-brick in residual form

It is currently difficult to say whether it had been brought to the site intentionally, at the time that the Djeser pyramid was under construction, and was later spread out all over the terrace by rains or whether it had had a natural source which it is impossible to identify today.

The rock shelf with its thin gravel and pebbles layer is situated at 50.4 m above the sea level, that is, about 4 m above the modern bottom level of the vast depression extending west of the site. It cannot be excluded that it is a surviving fragment of an erosion-accumulation terrace of a valley that followed the same line as the modern depression. At one point below the gravel layer, a lenticle of strongly limy yellow sand was found well preserved [*Fig. 5*]. Examination of quartz grains under an optical microscope revealed the predominance of shiny grains, with slight encrusting and poor frosting, visible only on the ridges and corners. The quartz grain analysis in the electron microscope (SEM) confirmed these findings. A great part of the grains (43%) shows a microrelief typical of an aquatic environment characterized by high energy, an environment of the beach type[3] with traces of secondary encrusting. Only on 2% of the grains a distinct aeolian relief was observed. On 55% of the grains aeolian processes were marked as a delicate touch-up on the ridges and corners of grains bearing an earlier relief typical of a high-energy aquatic environment. The character of the grain surface points to the absence of intensive and long-lasting aeolian processes. It may be concluded that the examined sandy deposit originates from the re-deposition of Tertiary marine deposits, insignifi-

[2] Ibid., fig. 1.

[3] Id., Analiza obtoczenia i zmatowienia powierzchni ziaren kwarcowych frakcji piaszczystej i jej wartość interpretacyjna, *Przegląd Geologiczny* 46 (1998), p. 12.

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cantly transformed in the Holocene aeolian environment.

Shaft 1 was sunk in the rock terrace covered with a layer of gravel and a high mound of calcareous rubble from the excavation was piled up nearby. This resulted in the formation of a new slope which was inclined 13° westward [*Fig. 6*].[4] The next step in the evolution of the examined slope was the cutting of a vertical rock wall [*Fig. 3*] which served as the entrance facade to the tomb of the vizier Meref-nebef.[5] This rock face has been strongly modified by natural processes, chiefly by water flowing downhill, which led to the accumulation of a detrital fan with laminae inclined to suggest water flow toward the SW and NW [*Fig. 8*].

The detrital fan consists almost exclusively of calcareous rubble with some pieces of mud brick. The lithologic composition of the detrital fan and the size of the stone material prove that it was formed only after the mound of rubble excavated from Shaft 1 had come into existence. The mound was the source of material for the detrital fan, as well as a factor in its appearance, generating as it did greater energy of the flowing waters due to a steeper slope inclination. The laminae inclination toward the NW (visible in Section N) seems to indicate a further spreading of the layer toward the north.

Further stages in the evolution of the slope have already been discussed.[6] Generally, it may be said that prior to the formation of a weathering-soil horizon (initial fossil soil about 4000 years BP = 2050 BC) alluvial rainwater processes prevailed on the slope, their dynamics diminishing over time. After a weathering-soil horizon was formed, the share of aeolian processes, both deflation and accumulation, grew distinctly as indicated by the character of the deposits.

CONCLUSIONS

A structural and textural analysis of mineral deposits at West Saqqara permitted a reconstruction of both the natural and anthropogenic processes occurring during the last 4700 years and, indirectly, the prevailing climatic conditions in this time.

During the first 400 years (4700-4300 years BP - 2750-2350 BC), as indicated by the pottery finds, the slope was subject to dynamic water flow, carrying and accumulating coarse gravel mixed with considerable quantities of organic remains. The presence of these remains indicates that the climate at this time was more humid than today.

Rainwater deposits also prevail in the overlying deposit series, accumulated during the period 4300-4000 years BP (= 2350-2050 BC) and partly intercalated with mounds being the effect of human activity. These water flows were, however, much less dynamic and organic remains here are encountered only sporadically.

A period of relative slope stability is evidenced by a weathering-soil horizon formed around 4000 years BP (= 2050 BC). An analysis of the heavy and clay minerals seems to indicate that this horizon reflects the conditions of a seasonally variable climate, with alternating wet and dry periods.

4 See n. 2 above.
5 Area I/E-F. See report by Z.E. Szafrański in this volume.
6 See n. 2 above.

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The rounding and frosting of quartz grains, as well as their surface micromorphology as seen under an electron microscope (SEM) indicate that this was a time of low-intensity aeolian processes.

The formation of the weathering-soil horizon corresponds to a disappearing relatively humid climate. The overlying deposit series reveals a growing share of grains featuring aeolian abrasion, inversely proportionate to layer age. Deflation processes lowered the former wadi west of the investigated site by about 3 m by deflation processes and the wind-blown material spread out on the rock terrace slope in a continuous layer.

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