# Sedimentological Evidences to Archaeological Problems on Tall Munbāqa, Northsyria

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## Abstract

The aim of this study is to offer explanation aids for archaeological questions in Tall Munbāqa[1], Northsyria, by sedimentological approaches. At first all sediments found were classified into four categories serving as a basis of comparison for the further investigations: 1. typical aeolian loess-like deposits of the surroundings of Tall Munbāqa, 2. sediments of initially aeolian origin on the mound, 3. ashes with different sediment portions, and 4. sediments of the occupation floors. The analyses of the sediments directly above the oldest Late Bronze Age road level (H2) point to a fire in that city district. After that the area was exposed for estimated 50 to 75 years and covered by wind blown sediments. Due to a relatively fast burying by broken down wall remainders the aeolian sediment character was preserved. In 1989, the year of the investigation, the excavators discussed an occupation gap between the Early and the Late Bronze Age. However, no sedimentological indications for a Middle Bronze Age occupation gap were discovered.


## 1. Introduction[2]

Tall Munbāqa is one of the numerous sites on the banks of the Euphrates, which has been investigated since the end of the sixties due to rescue operations becoming necessary because of the Syrian Euphrates dam project. The excavated fortifications, temples and houses of the antique city – the ancient name is Ekalte (D. Machule, written communication) – as well as the exposed position facing the Jebel Arūda suggest an important regional centre of the third and second millennium BC (Machule 1984, 160). The oldest cultural levels of the site are dated to the Early Bronze Age (about 3000–2100 y BC). Even though an exact chronological determination is not yet possible (D. Machule, written communication), three Late Bronze Age main periods or settlement periods could be distinguished in the light of archaeological findings hitherto excavated both in the 'Innenstadt' and in 'Ibrahims Garten' (Machule 1987, 75 u. 101). Their separation within the succession of cultural levels is defined by roads or occupation floors[3]: the first two of these periods between level H2 and H1 (Ibrahims Garten 1 and Ibrahims Garten 2) are dated to the beginning and the youngest one, between H1 and H0 (Ibrahims Garten 3), to the third quarter of the second millenium BC (D. Machule, personal communication).

[1] Spelling of the archaeological names corresponds to the cited excavation reports.

[2] All statements concerning the archaeological results of Tall Munbāqa and their chronology are based on written or personal communications by Professor Dr. D. Machule and W. Pape.

[3] Archaeologists use the term occupation floor ('walked on horizon' in Fig. 4 and 6) for a former surface, i.e. a linear boundary in between a succession of cultural levels. But as in this study emphasis was laid on the sediments, the term is – corresponding to the pedological application – referred to the whole sediment body having been influenced by walking on.

Evaluating the findings of the excavation some sedimentological questions appear, which are important for the reconstruction of the occupation history of Tall Munbāqua – and not only for Tall Munbāqa:

The first problem area refers to the sediments themselves. How is the sedimentological composition of the cultural layers as compared with those of the vicinity and which conclusions can be drawn in regard to their genesis? Additionally it refers to an ash-like layer of approximately 5–10 cm appearing only above the Late Bronze Age road level (H2). Is that a matter of fire born deposit or does the substratum bear any evidences for a volcanic eruption in this time period? Both possibilities would have had respective consequences for the further occupation.

The second complex of problems in 1989, the year of the investigations, referred to the question, if there was a Middle Bronze Age occupation on Tall Munbāqa at all and if it was so, what could it have been like. 'The Middle Bronze Age left a specific kind of pottery, which is distinctly proven by architecture on other ruins, but which is only sparse in Munbāqa and occurs only at certain locations. The problem is . . . that levels with definite Early Bronze Age ceramics are followed directly by levels with definite Late Bronze Age ceramics' (D. Machule, written, translated communication). The question was asked whether there was a hiatus, i.e. a longer lasting interruption of the occupation.

Coming from a pure sedimentological approach the investigations try to support clarification of these questions.

## 2. Morphology and Climate

Tall Munbāqa (322 m) is situated on the northeastern shore of the Al Assad reservoir (see Fig. 1) above the highest expectable watertable (maximum storage level 300 m above sea level). The landscape is formed by the monotonous, gently rolling plains of the northsyrian steppe region only loosened up by some precipitous rising buttes with pediments softly inclining to the west – outliers of a former cuesta. Such a mountain range with heights between 360 and 434 m extends in a north-south direction 2 km

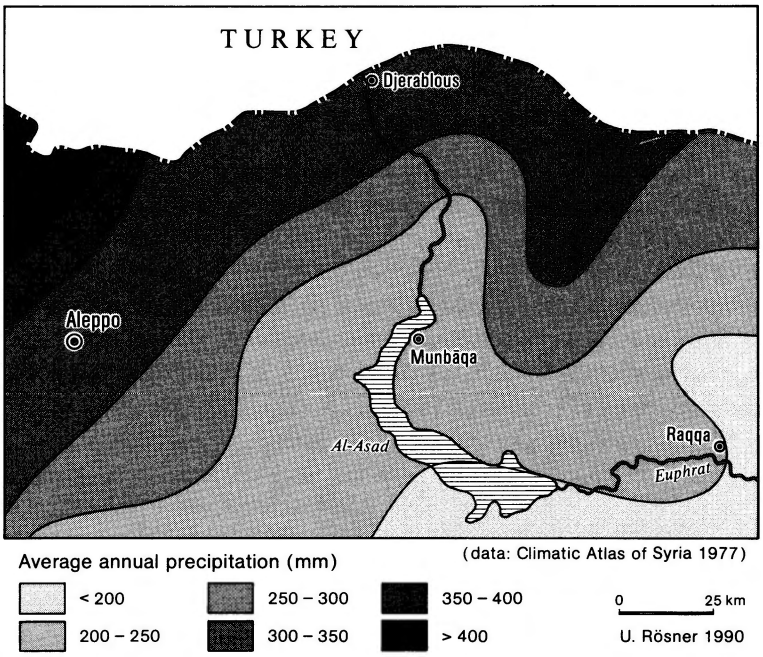


Fig. 1. Location of Tall Munbāqa and average annual precepitation of this region.

east of the lake shore. Plains, buttes and pediments are covered by a thin silty-fine sandy veil of sediments whose main provenance area must have been the pleistocene and recent river deposits of the Euphrates valley. The site itself is situated on a isle-like elevation near to the shore, being composed of old fluvial pebbles.

Between this embankment and the outlier chain a former lateral valley of the Euphrates river is depressed, which was always reactivated in former times of high flooding. Still for the beginning of the settlement in the Euphrates river valley – under already semiarid conditions – one has to visualize it as an extensive marshland with reed belts, meadow woods, abandoned stream channels, and some green spots (see Hahn 1987). Today nothing of it is left.

From a climatological perspective the region belongs to the area between the North-East Syrian steppe climate and the desert steppe climate (see Wirth 1971, 100). The average annual precipitation ranges from 200 to 250 mm (see Fig. 1); the average annual air temperature amounts to 18° C, the average air temperature in July lies at 29°–30° C and in January at 6°–7° C (Climatic Atlas of Syria, 1977). Westerly to northwesterly winds (Etesien) are predominant.

## 3. Methods

During the excavation work in the falls of 1988 and 1989 samples were taken of three profiles (no. 15, 101, and 102) on the mound of Tall Munbāqa (see Fig. 3, 4, and 6) as well as one single sample (no. 46, see Fig. 5) in 'Ibrahims Garten' (grid square 17/16). Several surface samples of the surroundings served as a basis of comparison from which only no. 100/1, taken on the plateau of the middle butte 2 km east of Munbāqa, is shown here representatively (see Fig. 2, Table 1 and 2).

In order to typify the sediment characteristics particle size distribution, carbonate content, content of organic matter, electrical conductivity, and pH-value were determined[4]. For an overview over the total mineralogical spectrum the samples of profile 15 and 102 were analysed by X-ray diffractometry of random powder specimens of the fine earth (2 mm Instrument: Phillips – PM 1040 with silicium detector by CuK$\alpha$-radiation). On seven selected samples containing all sediment types the heavy minerals of the fraction 0.063–0.2 mm were determined. At least optical investigations of the sand fractions with the binocular microscope aimed to give information about the compound of the ashes and their portions at the sediments.

## 4. The Sediment Types of Tall Munbāqa

In order to be able to make some statements about the genetic processes being responsible for the deposits of Tall Munbāqa, one has to find out first, what kind of sediments occur and what they look like compared with those of the surrounding areas (see Fig. 2). From this point of view four types of sediments can be differentiated:

[4] Particle size analysis by wet sieving followed by pipet analysis after Köhn (generally it was done without removal of carbonates because one has to count on a high amount of clastic carbonates due to the carbonate-rich geologic surroundings); carbonate content gas-volumetric with Scheibler-apparatus; organic matter by wet combustion with potassium dichromate; electrical conductivity in 1:5 extract; pH-value in 1:2.5 $H_2O$ suspension.

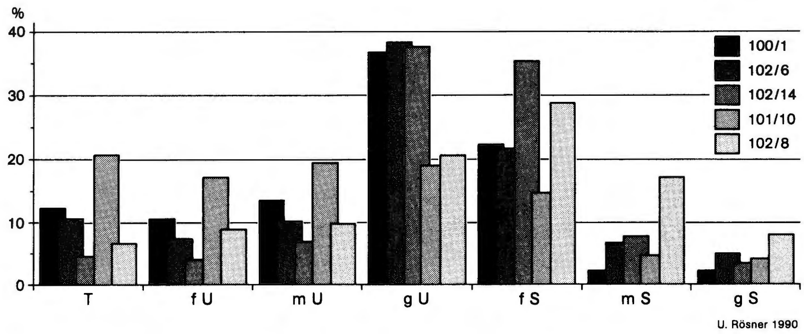


Fig. 2. Examples for the particle size distribution of different types of sediments of Tall Munbāqa and the surrounding area (for further comments see text).

## 1. Typical aeolian loess-like deposits of the surroundings of Tall Munbāqa

Sample 100/1 from the thin aeolian cover on the plateau of the middle outlier east of Tall Munbāqa shows a particle size distribution, which is characteristic for loess (see Fig. 2): the percentages increase distinctly starting from clay over fine and medium silt culminating in a pronounced coarse silt maximum. The secondary fine sand maximum can be explained by the little distance of the mound (3 km) to the Euphrates terraces, still allowing a wind transport of a considerable amount of fine sand up onto the plateau. The carbonate content of 33,1 % and the content of organic matter of 1.75 % represent a good average for the topsoils in the vicinity of Munbāqa. The electrical conductivity as a measure for the total content of water soluble salts is very low (0.3 mS) in this natural sediment. The pH-value lies within a – for arid regions – normal alkaline range (see Vogg 1981). The optical check of the sand fraction under the binocular microscope yielded no evidences on ash residues, small charcoal fragments or fusion particles.

## 2. Sediments of initially aeolian origin on the mound

They are most clearly represented in the upper part (0–108 cm) of the profile Munbāqa (102) – 'Sondage östlicher Steinbau 2' by the samples 102/1 to 102/6 (see Fig. 6). Sample 102/6 is presented in Figure 2, exemplifying the same typical loess particle size distribution as 100/1 though its fine platy fabric points to slope wash processes. The only existing granulometric difference is the higher amount of medium and coarse sand on account of the relative portion of silt and clay indicating the shorter distance to the Euphrates terraces. Both samples, 100/1 and 102/6, are therefore good examples for the facies change from the coarser grain size to the finer one with increasing distance to the provenance area. In all samples of this category the content of clay (approx. 10 %), of fine silt (6.4–8.9 %) and of medium silt (9.6–11.3 %) is relatively uniform, whereas the amount of coarse silt and fine sand varies strongly due to the occupation floors: sediments above these horizons show a higher portion of coarse silt than those just beneath the overlying occupation floor. The latter seem to be already much more changed in their original compound by the walking on: the material became denser, it was therefore more washed out and the particle size distribution was modified. The carbonate content (28–30.2 %) is a little lower than in the youngest sample 100/1. Though no soil development took place yet except in the topsoil, the distinct carbonate enrichment in that part of the profile below the aeolian sediments (108–140 cm) suggests a descending carbonate translocation. The very low EC-values (0.28–0,69 mS/cm) in the uppermost 55 cm of the profile point to a hardly man influenced substratum. But then they increase uniformly below the second, more distinct occupation floor and thereby document a stronger anthropogenous effect in this period.

### 3. Ashes with different sediment portions

In Figure 2 an example is given for each one of the profiles Munbāqa (102) — 'Sondage östlicher Steinbau 2' (102/14) and Munbāqa (101) – 'Ibrahims Garten' (101/10). The particle size spectrum of sample 102/14 indeed resembles that of the aeolian sediments, but some facts not obvious in the diagram contradict to a wind transport: there is no logical reason for such a fundamental change in the conditions of transportation and sedimentation at the same place with the result that all of a sudden mainly coarse silt and fine sand would have been blown out and transported by wind. Besides that other ash layers (102/25, 48[5]) show very high sand percentages as well. The microscopic observation could clarify this phenomenon: most ash particles are conglomerated to fine, medium and coarse sand sizes; hence the dark sediment colour. Genuine mineral components occur only subordinately. In addition tiny charcoal fragments and small carbonate concretions are found in isolation.

An aeolian genesis can be excluded in the case of sample 101/10: it has an absolutely unsorted pattern of particle size distribution, the ash admixture is expressed in coulour and content of organic matter (2.08%[6]) and the EC-value (5.8 mS/cm) is too high for an unchanged, natural sediment. Under the microscope it can be seen that the basic mineral substance derives from the often bleached terrace material of the vicinity of Munbāqa. Altogether ash aggregates as well as small charcoal fragments are fewer than in typical hearth fire ashes (e.g. sample 48). Additionally there are black, shiny particles of totally irregular shape with tiny fusion channels and shrinking cracks at the surface and with a straight to mussel-shaped fracture. According to their X-ray diffraction pattern they seem to be amorphous. They look like volcanic glass particles, but they have apparently nothing to do with them, because they occur exclusively in ash layers or in ash-containing horizons regardless of age.

### 4. Sediments of the occupation floors

Sample 102/8 out of profile 102 was chosen as an example for an occupation floor in Figure 2. The increase of the fractions fine sand, medium sand, and coarse sand at the expense of the silt fraction points to stronger erosional processes on the occupation floor. That is explainable by the constant walking on the soil surface over a long period of time resulting in a higher density and a complete absence of a protecting vegetation cover and so forcing the surface runoff. That means a remaining of coarse particles after fine materials have been dislodged by raindrop erosion and removed by running water. Additionally all samples of the occupation floors show a higher EC-value (for instance between 3.98 and 12.78 mS/cm in Profile 101) in comparison with the overlying sediment body and simultaneously a lower content of organic matter.

## 5. The Sediments above the Late Bronze Age Road Level

### 5.1 Results

Both profiles Munbāqa 15 and 101 – 'Ibrahims Garten' (see Fig. 3 and 4), lying in a distance of 17.5 m to each other, represent a succession of cultural levels in the area of a single road not having been built over. Sample no. 46 (see Fig. 5) was also taken from above the road level H2 (0–5 cm). 'H2 is the

[5] Sample 48 was taken from a pure hearth fire ash on Tall Chuera, some 100 km NE of Tall Munbāqa.

[6] Characteristically the ash horizons and the horizons of ash-sediment-mixtures contain a high content of organic matter, e.g. 102/14: 1.41%, 102/25: 2.46%, 15/3: 1.79%, and 48: 5.57%.

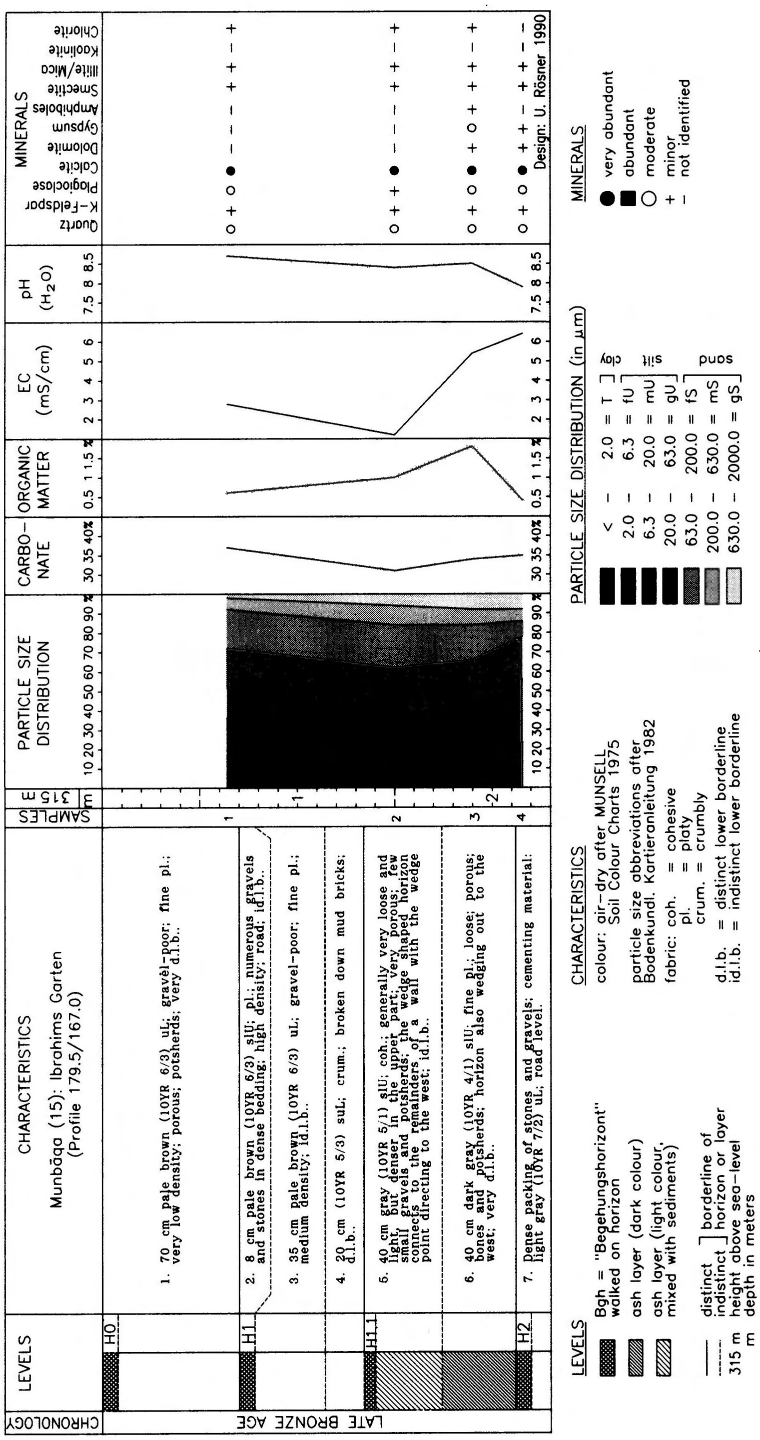


Fig. 3. Profile Munbāqa (15) – „Ibrahims Garten" (profile 179.5/167.0). Characteristics and analyses data.

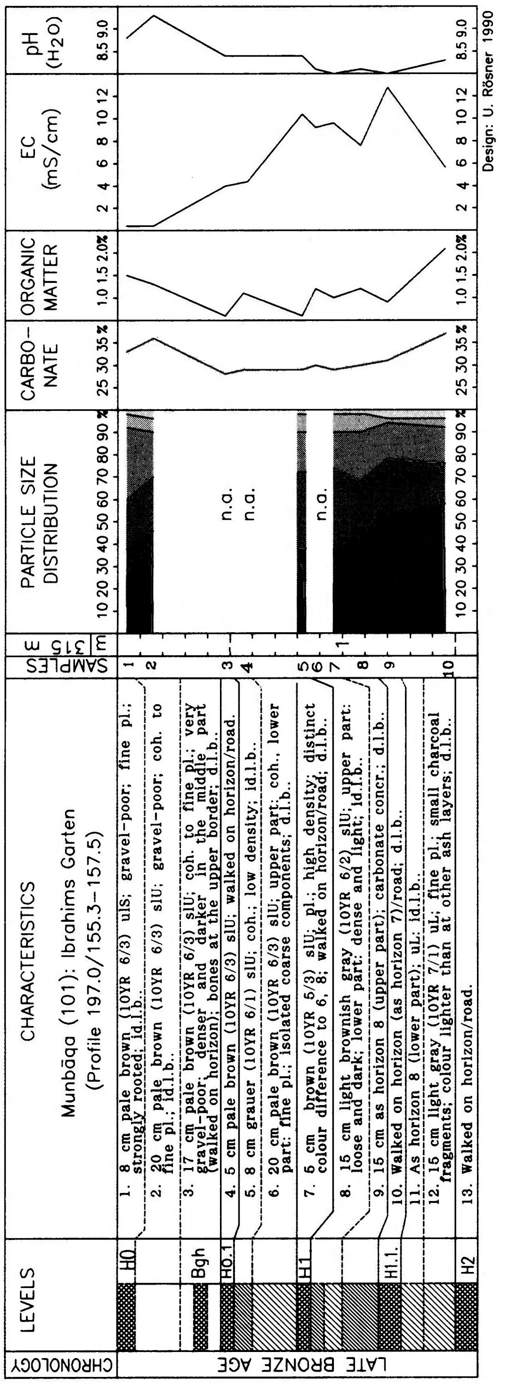


Fig. 4. Profile Munbāqa (101) – „Ibrahims Garten“ (profile 197.0/155.3-157.5). Characteristics and analyses data (legend see Fig. 3).

| Sample | Fraction in µm (%) <2 | 2–6,3 | 6,3–20 | 20–63 | 63–200 | 200–630 | 630–2000 | Carbonate (%) | Organic Matter (%) | EC (mS/cm) | pH ($H_2O$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15/3 | 8,5 | 8,1 | 22,5 | 27,3 | 16,8 | 9,5 | 7,3 | 33,7 | 1,79 | 5,47 | 8,46 |
| 101/10 | 20,7 | 17,2 | 19,4 | 19,0 | 14,8 | 4,8 | 4,1 | 36,9 | 2,08 | 5,81 | 8,29 |
| 46 | 6,0 | 9,6 | 14,4 | 30,3 | 23,9 | 10,3 | 5,5 | 28,9 | 0,72 | 3,39 | 8,21 |

Table 1. Sediments directly above the Late Bronze Age road level.

surface of a first Late Bronze Age road built there, whose formation we date at present to about 1500 years BC. The upward succeeding occupation floors are then the additional Late Bronze Age road levels having been formed after destructions or by a long period of use. At present we can reckon with about 150 years but that is uncertain.' (D. Machule, written, translated communication).

First it is to notice, that the samples (15/3, 101/10, 46) collected directly above the Late Bronze Age level are apparently not identical in their coumpound (see Table 1):

The samples 15/3 and 101/10 show a relatively unsorted particle size spectrum, whereas sample 46 (see also Fig. 5) indicates a clear aeolian component (see above). Especially in the overlaying sediment body – wedge shaped blown against the remainders of a wall – an increasing aeolian component can be identified. The data of the other analyses allow as well to classify sample 46 as sediment type 2 (sediments of initially aeolian origin on the mound) and the two other samples as type 3 (ashes with different sediment portions; see above).

This classification is confirmed by the microscopic examination: sample 46 has a mineral spectrum with many quartz and feldspars causing the light colour. Gray, compact ash aggregates and small charcoal fragments are scarce. The basic substance of sample 101/10 consists of grains also deriving from the terrace material of the surroundings. In contrast to sample 46 it contains more ash aggregates – crusted outside with white powdery ash inside, easy to crush – as well as charcoal pieces and more of the small, black and glass-like fusion particles. In sample 15/3 the mass of the sand sized grains are some ash aggregates and some hardened ('burned') mineral conglomerates. Charcoal does not appear but lots of the black and shiny fusion products as described above. Their well preserved condition points to an autochthonous or parautochthonous formation.

The heavy mineral analyses show considerable quantities of volcanic heavy minerals, mostly hornblende and pyroxenes, but not concentrated at all in the questionable layers. They occur in all sediments of the mound and there is not even a significant difference to the heavy mineral spectrum of sample 48 from Tall Chuēra, about 100 km to the NE (see Table 2). Other minerals, which could be characteristic for these sediments, can not be discovered either.

## 5.2 Discussion

A comparison of the results of profiles 15 and 101 and of sample 46 from a sedimentological perspective allows the following interpretation: first of all the layer under consideration was found nearly everywhere on the Late Bronze Age road level H2 but not on the younger ones. That points to an event within a limited time period. But the fact that the samples are not completely identical opposes a morphodynamic process with a uniform effect such as covering by volcanic ashes. A unique deposition of the substratum by a volcanic eruption can be excluded because the concerned samples show no difference

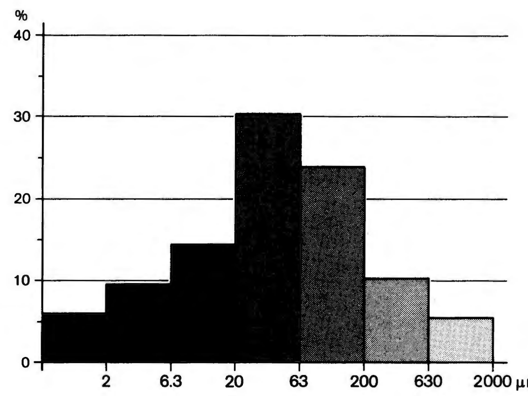


Fig. 5. Particle size distribution of sample 46 – „Ibrahims Garten" (grid square 17/16), (legend see Fig. 3).

| Sample-No. | Heavy minerals (in %) | | | | | | | | | Other particles (per 100 grains) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Green hornblende | Brown hornblende | Pyroxene | Mica | Garnet | Epidote | Zircon | Rutile | Sillimanite | Opaque | Aggregates | Carbonate |
| 46 | 62 | 4 | 26 | 4 | 4 | - | - | - | - | 23 | 23 | - |
| 48 | 41 | 4 | 51 | 2 | 2 | - | - | - | - | 35 | 12 | - |
| 15/03 | 41 | 6 | 44 | 9 | - | - | - | - | - | 21 | 11 | - |
| 100/01 | 61 | 9 | 21 | 4 | 3 | - | 1 | 1 | - | 23 | 1 | - |
| 101/07 | 45 | - | 20 | 27 | 8 | - | - | - | - | 37 | 11 | 3 |
| 101/10 | 58 | 11 | 24 | 5 | - | - | - | - | 2 | 21 | 17 | - |
| 102/06 | 51 | - | 27 | 9 | 9 | 2 | - | 2 | - | 37 | 9 | 1 |
| 102/25 | 56 | - | 28 | - | 7 | 9 | - | - | - | 39 | 5 | 2 |

Table 2. Heavy mineral analyses of some samples from Munbāqa and surroundings.

with regard to species and quantity of the volcanic heavy minerals compared to the reference samples. Even the youngest sample 100/1, a natural aeolian sediment, has the same compound. That points rather to a permanent deflation out of older volcanic depositions distributed in the nearer and further surroundings (see Ponikarov 1963).

The absence or scarcety of charcoal normally occuring in hearth fire ashes, though many ash aggregates and 'burned' sediment conglomerates testify to a fire, suggest burning residues having been formed by the burning of houses. After that the area was abandoned, so that the wind could drift ashes, dust and sand against wall remainders (sample 15/2) or spread them across the bare lying roads (sample 46) as a sandy dust layer selecting the light ash particles.

Now it is an interesting attempt estimating the period of time during which the area (above H2) was lying bare. If the road level H2 dates back to 1550 y BC and if the road H1 is ascribed to the last part of

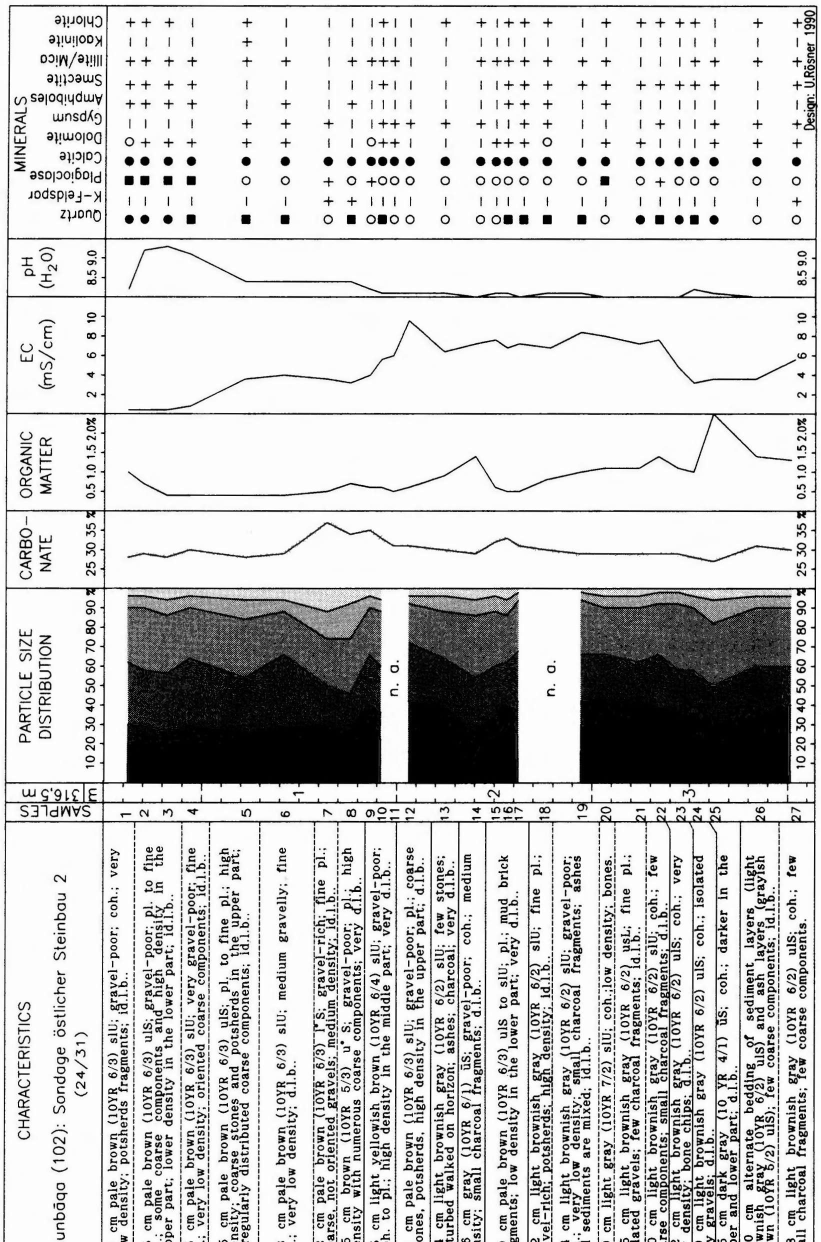


Fig. 6. Profile Munbāqa (102) – „Sondage östlicher Steinbau 2" (grid square 24/31). Characteristics and analyses data (legend see Fig. 3).

the third quarter of the second millenium (up to 1300 y BC), then there are about 150 years left between the use of H2 and the initial formation of H1 (D. Machule, personal communication). These 150 years are interrupted by a weaker developed occupation floor ( H1.1) already formed above the aeolian sediments as can be seen most clearly in profile (15). That means the surface was certainly not exposed for 100 years, assumingly for even a considerably shorter time, approximately 50 to 75 years.

Collapsing wall remainders (profile 15) have then burried the cultural levels, preserving the aeolian sediment appearance. Without this covering up, assumingly the same would have happened as to the sediments on the young basalt lava field (4000 years) in Southsyria, the Leja: lying unprotected and not held by vegetation an aeolian remobilization of the coarser silt and the sand grains took place. As time went by the particle size distribution was so much changed that the aeolian genesis is not to be assumed at first sight. But a typical aeolian sediment deposited in a protected position at the entrance to a subterranean tunnel proves the opposite (see Rösner 1989).

## 6. The Question of the Middle Bronze Age Occupation Hiatus

### 6.1 Results

The sediments of profile Munbāqa – 'Sondage östlicher Steinbau 2' (102; see Fig. 6) mainly consist of silt partly with high portions of fine sand. Coarse components like gravel and potsherds in variable quantities appear everywhere. Fossil soil horizons can not be identified in the whole sequence of cultural levels. But the sequence itself is characterized by an alternate bedding of different types of sediments as described earlier. Between 108 cm and 365 cm there is a frequent alteration of ash respectively ash-mixed horizons and occupation floors. Initial aeolian sediments (type 2) can only be assumed in horizon 21 and 19 and in a very low thickness in special parts of the occupation floors 3, 4, 5, and 8. In the uppermost third of the profile the substratum is of definite aeolian origin. Under those sedimentological aspects, the period of absence of occupation alone enabled an undisturbed sedimentation above the occupation floor 3. Otherwise changing in the particle size distribution and higher compressing would have been the consequence as it was the case at the underlying occupation floors (see above).

The upper part of the profile shows very well what kind of processes would take place in a period of absence of occupation in this region: mainly aeolian deposition with slight syn- and postsedimentary erosion by surface runoff during the rainy season of the year but never strong enough for complete denudation.

### 6.2 Discussion

The part of the profile concerning the question of the Middle Bronze Age occupation is horizon 11 (sample 102/14). Up to here the ceramic finds can definitely be dated back to the Early Bronze Age (approx. 3000–2100 y BC). Above that the ceramic finds prove a Late Bronze Age occupation (approx. 1500–1200 y BC). However, the zone in question inbetween the Early and the Late Bronze Age sediment complexes did not contain any definite archaeological proof for a Middle Bronze Age occupation at the time when the investigations were carried out. The excavation in 'Sondage östlicher Steinbau 2' '. . . also yielded some scattered Middle Bronze Age ceramics, which on the other hand could as well be defined by some archaeologists as ending (still in use) Early Bronze Age ceramic or as early (already in use) Late Bronze Age ceramic' (D. Machule, written, translated communication).

The time period under question (approx. 2100–1500 y BC) is climatically coinciding with the one in which – after palynological results – the present semiarid conditions in the Near East had already been reached (see Bottema 1989, 6) and in which the requirements for an aeolian dynamic had already been given. Even though the dimensions of the wind erosion and transport in the steppe regions are strongly depending on the intensity of the land use (ploughing, herding) in the surroundings (see Rösner 1989; Rösner and Schäbitz 1991), there should be at least some evidence for aeolian activity in the referred horizon, considering the time range of about 600 years of possible absence of occupation on the mound. In any case the fluvial deposits are available as provenance areas of fine material during the dry seasons of the year at a low watertable.

But the sample 102/14 does not bear signs of aeolian dynamic. The high silt and fine sand portions normally indicating such are due to aggregated ash particles (see above). A distinct mineral component as it is clearly detectable in aeolian effected sediments under the microscope (e.g. sample 46) appears only subordinately. The relative high content of organic matter (1.41 %) corresponds with the general high percentages of ash horizons; an EC-value as high as the one of sample 102/14 (7.25 mS/cm) was not found in any natural sediment. And the mineral compositions of the overlaying and underlaying levels analysed by X-ray diffractometry show no significant changes either.

Furthermore some calculations concerning the sediment thickness seem to be informative: within the time period between the beginning of the Late Bronze Age (approx. 1500 y BC) and today 180 cm of sediment grew up. This is an average rate of 0,05 cm a year. At a duration of the possible occupation gap of 600 years a sediment body of 30 cm were to be expected. But the horizon 11 has only a thickness of 15 cm. It is surely a risk to use rates of sedimentation on settlement places. But the difference between the actual thickness and the one to be expected is very considerable especially taking into account the results of the sediment examination above the Late Bronze Age road level: an aeolian component is here already proved for a shorter time period of absence of occupation, estimated 50 to 75 years.

Summarizing all these considerations, there is no evidence at all from a sedimentological point of view for an occupation gap during the Middle Bronze Age.

## 7. Conclusion

Detailed study of the sediments from Tall Munbāqa along with evaluation of archaeological findings yielded evidence to events having taken place during the occupation as well as to chronological problems.

Indications of a fire followed by aeolian covering were found in the sediments above a road level of the first Late Bronze Age period. The range of time during which the devasted area was lying bare can roughly be assumed with 50 to 75 years.

The accurate investigation of a cultural level, which should theoretically represent a Middle Bronze Age occupation gap, could not prove an aeolian component. But to be certain it would have to be expected at an actual interruption of the occupation of about 600 years. This statement is sustained by the results of the sediment analyses above the oldest Late Bronze Age road. Therefore, including the first archaeological results, it is more likely that a continuous occupation has existed. Later on, these sedimentological interpretations were confirmed by new archaeological findings on Tall Munbāqa made during the excavations of the early nineties (see D. Machule 1995).

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