immense Gewicht dieses Eiskörpers wurde die kontinentale Kruste einige 100 Meter in den Erdmantel gedrückt. Vor ca. 14000 Jahren begann in Skandinavien das Eis zu schmelzen und die Erdkruste fing langsam an sich wieder zu heben. Zu Beginn der Abschmelzvorgänge fielen riesige Mengen an Schmelzwasser an, so dass große Gebiete von Skandinavien lange Zeit überflutet waren. Erst als die isostatische Landhebung größer war als der Meeresspiegelanstieg, wurden vormals untermeerische Gebiete zu Land (Cato & Kjellin, 1992). Der Prozess der Landhebung ist bis heute noch nicht abgeschlossen. Da die Hebungsraten genau bekannt sind, kann man den Zeitpunkt des Auftauchens küstennaher Gebiete – wie z. B. Alnö - aus dem Meer exakt datieren. Ab dem Zeitpunkt der Landwerdung setzen terrestrische Bodenbildungsprozesse ein. Die derzeitige Hebungsrate im Untersuchungsgebiet beträgt 7 mm/Jahr (Eriksson & Henkel, 1994; Donner, 1995).

Ziel der Arbeit ist es, den zeitlichen Ablauf von tonmineralogischen Umwandlungsprozessen in zwei Gebieten mit unterschiedlichem Ausgangsgestein zu untersuchen.

Die Probennahme wurde im August 2001 entlang von zwei Transekten (Ausgangsgestein Granit/Gneis bzw. Alkalinkomplex) von Meeresniveau bis zur höchsten Erhebung (128 m) – die sich im Granit/Gneis-Gebiet befindet - durchgeführt. Dabei wurden die Böden klassifiziert und die einzelnen Horizonte beprobt.

Die Proben wurden (ton)mineralogisch, geochemisch und mikromorphologisch analysiert und die zeitliche Abfolge der Umwandlungsprozesse ermittelt.

Folgende Analysen wurden angewendet:

*Mineralogie:* Gesamt- und Tonmineralogie (XRD, FTIR, DTA, TG), Korngrößen, Schwerminerale, pedogene Oxide (Dithionit- und Oxalat-Extraktion; ICP-OES)

*Geochemie:* Hauptelemente (XRF), pH, elektrische Leitfähigkeit, C/N/S, KAK, Spurenelemente und Seltene Erden, Kationen (ICP-MS) und Anionen (IC)

*Sonstige Analysen:* Mikromorphologische Untersuchungen, Magnetismusmessungen im Boden und Bodenklassifikation nach der World Reference Base for Soil Resources (WRB)

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# TEMPORAL AND SPATIAL TRENDS OF MINERAL ASSOCIATIONS IN SOILS FROM THE SAHARA (N-CHAD) TO THE SAHEL (SW-NIGER)


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## 1. Abstract


During the Holocene, the climate in the Central Sahara south of the Tibesti changed from subhumid to arid. Accordingly, the desert margins shifted to the south. Today, at the southern boundaries of the Tibesti mountains, rainfall as an average is less than 50 mm $yr^{-1}$ and increases towards the south, reaching more than 500 mm $yr^{-1}$ in the southern Sahel. This is an ideal situation to study the behaviour of soils under changing climate conditions.

We used three soil profiles which developed in different time spans in order to study the temporal trends in weathering, and additional soil surface samples from all over Niger in order to represent the spatial trends of clay mineral associations.

The northernmost soil profile south of the Tibesti mountains shows at least three development stages. A first one under shallow water conditions near a river delta, reflected by Mg-smectites, formed under a climate with distinct dry phases. In the next stage the river incised under a more distinct seasonal (drier) climate. This led to the accumulation of Mn-oxides in the sub-soil horizon under groundwater conditions. At the same time the topsoil experienced more intense weathering (hematite/kaolinite formation). As a pedogenic process, clay illuviation can be identified. Finally, the climate became arid and the soil profile was influenced by surface erosion processes (wind and water). The modern clay fraction of the topsoil consists mainly of aeolian material which is deposited as (local and long -range transported) mineral dust. The clay mineral fraction consists of smectite and kaolinite, a small amount of illite and some intergrades. The mineralogy of the dust is dominated by quartz, feldspars and small amounts of calcite and salts. Salts and calcite are washed into the soil profile by the erratic but heavy rains.

The Bodele depression south of the Tibesti mountains is identified as the biggest source of mineral dust for eastern West Africa. In the dry season the dust is blown out of the former lake deposits and transported along the major wind direction. On the trajectory, which represents a climate gradient, the dust is deposited onto the soil surface. Analysing the clay fractions of soil surface samples on a NE/SW transect, reveals a distinct decrease of smectite in relation to kaolinite. At the southern end (ca. 560 mm $yr^{-1}$ precipitation) beside kaolinite only weak reflexes of intergrades can be detected. This is an effect of smectite dissolution in the sandy Sahelian soils, which experience a seepage of approximately 200 mm $yr^{-1}$. On the other hand the sandy soils experience a potassium enrichment due to deposition of feldspars and micas/illites with the dust. But with the constant expansion of agriculture, the accumulated fine dusts are blown out of the topsoil again.

The study shows, that with increasing aridity, pedogenic processes and weathering are increasingly influenced by allochthonous material, which can be of local but also of distant origin. Soil mineralogical studies should take these factors into account in order to avoid misinterpretations.


**Keywords**: weathering, Holocene, mineral dust, climate gradient, geo-chemistry

## 2. Introduction

One of the most urgent question addressed to soil scientists is, how soil characteristics will change with changing climate. Another demand of atmospheric scientists with respect to climate is to predict the source potential of soils and sediments and the particle characteristics of mineral dust which is entrained from the earth surface and then transported in the atmosphere, thus influencing the radiation budget.

The answer to both questions can best be studied in Saharan and Sahelian environments, since they were subject to intense climate change in the Holocene, as lake level fluctuations (e.g. Lake Chad, Gac 1980) indicate, and are the most important source for mineral dust in the atmosphere on the globe (Pye 1984). Even at present, the sub-Saharan areas are subject to climate change as recorded by southward shifting rainfall isohyetes in the last decades (Wezel et al. 2000).

In order to study the potential effects of changing climate on soil pedogenic processes, properties and mineral assemblages, we analysed three soil profiles (Table 1) and a number of soil surface and mineral dust samples all on a NE-SW transect, representing a rainfall gradient of 50-600 mm $yr^{-1}$.

## 3. Methods and sampling sites

The soils, surface and dust samples in Niger were collected in 1992. For further information please refer to Herrmann (1996). The soil profile in Chad was sampled in 1997 during an interdisciplinary expedition of the Universities Trier, Würzburg, Giessen and Hohenheim. The soil description followed the FAO guidelines (1990). Soil type classification is according to the World Reference Base for Soil Resources (FAO 1998).

**Table 1**: Geographical position, estimated age and recent annual precipitation of three investigated soil profiles in Chad and Niger

| Profile | Latitude | Longitude | Assumed age [yr] | Recent annual rainfall [mm $yr^{-1}$] |
|---|---|---|---|---|
| Aridi-Gleyic Luvisol | 17°48'N | 17°44'E | 7000 | 50 |
| Aridic Arenosol | 14°18'N | 1°57'E | 200 | 400 |
| Luvic Arenosol | 13°14'N | 2°17'E | 2000 | 560 |



**Table 2**: Applied physical, chemical and mineralogical methods

| Method | Citation | Remarks |
|---|---|---|
| Granulometry | Schlichting et al. 1995 | Combined sieve and pipette method |
| pH | Schlichting et al. 1995 | 1:2,5 ($H_2O$) |
| Electrical conductivity | | 1:20 |
| Carbonate | | Wösthoff (Carmhograph C12S) |
| Total carbon | | Carlo Erba N1500 |
| CECpot | Bower et al. 1952 | Shaking instead of percolation |
| Weatherable elements | Schlichting et al. 1995 | HCl |
| Water soluble elements | | 1:20 with deionized water |
| Total elements | | XRF, Siemens SRS 200 |
| Bulk mineralogy | | Powder, Siemens RBA 500, Cu-Kα |
| Clay mineralogy | | Oriented, Siemens RBA 500, Cu-Kα, Mg, K-saturated, glycol and heating |

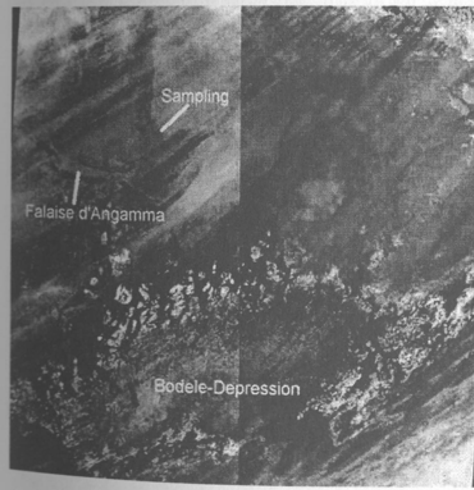


**Figure 1**: Sampling point of the (paleo-)soil in N-Chad (Landsat TM image, RGB 7-4-3)

## 4. The Aridi-Gleyic Arenosol in Chad

The profile is situated on the banks of a paleo-riverbed. The river drained the Tibesti mountains into the paleo-lake "Mega-Chad". The profile lies several km north of the "Falaise d'Angamma" which marks the point where the river delta met the lake shore (Figure 1). The lake sediments of this Bodele Depression are subject to strong wind erosion as frequent yardangs indicate. The Bodele Depression is believed to be the major source for mineral dust transported with "Harmattan" winds towards sub-Saharan eastern West Africa (e.g. Herrmann et al. 1999).

From the morphological point of view the profile can be separated into three parts. The uppermost part is characterised by a serir surface and a yermic phase. The central part contains coarse components and has a reddish colour. Finally, the finer textured subsoil is characterised by brown to greenish colours, impregnated along coarse pores with material from the reddish overlying horizons.

The granulometry data (Table 3) indicate - with exception of the two lowermost horizons - strong layering with an increase of the skeleton content towards the topsoil. A distinct increase of the clay content between 40-70 cm depth indicates beside clay cutans, clay illuviation, though the whole profile contains small amounts of carbonates.

Organic matter content is extremely low for all horizons. The potential cation exchange capacity is over proportion increasing in relation to the clay content towards the subsoil, indicating a shift in clay mineral assemblage. The base saturation lower than 100 % instead of low carbonate concentrations indicates that i. the profile had been decalcified and that ii. recalcification of the subsoil is associated with morphological organisation (coarse pores). The exchange complex is dominated by calcium with an increasing share of magnesium towards greater depths. With respect to the weatherable stock, calcium and magnesium is balanced. Whereas weatherable calcium is - within analytical errors - equivalent to the exchangeable fraction, weatherable magnesium reserves indicate stronger binding in silicate structures.

The very low ratio of pedogenic iron fractions ($Fe_{o/d}$, Table 3) shows low activity with respect to i. silicate transformation and ii. redox processes. Electrical conductivity is relatively elevated (please remark the high sample/extractant ratio of 1 : 20). This suggests soluble salts, which also should be responsible for the high pH-values. Calcium and sulphate concentration in the E and Btg horizons might indicate the presence of small concentrations of gypsum. A maximum of water soluble sodium and calcium in the central profile part indicates accumulation under downward percolation to medium depth even under the present arid climate with erratic heavy rains.



Table 3: Basic analytical data of the Aridi-Gleyic Luvisol in N-Chad

| Horizon | Depth cm | Skeleton wt.% | cS % | mS % | fS % | Sand % | Silt % | Clay % | C org % | pH ($H_2O$) |
|---|---|---|---|---|---|---|---|---|---|---|
| Serir | 0-3 | 100 | | | | | | | | |
| C | -7 | 63 | 10 | 18 | 24 | 53 | 24 | 23 | 0,10 | 9,1 |
| E | -40 | 61 | 35 | 20 | 7 | 62 | 12 | 26 | 0,02 | 8,1 |
| Btg | -70 | 3 | 12 | 23 | 13 | 47 | 21 | 32 | 0,03 | 7,9 |
| B(t)kg | -120 | 2 | 5 | 17 | 16 | 38 | 33 | 30 | 0,02 | 8,1 |
| B(t)gr | -140 | 2 | 6 | 25 | 18 | 48 | 27 | 25 | 0,02 | 8,1 |

| | KAKpot | ----Exchangeable cations---- Ca | Mg | K | Na | BS | -Weatherable elements (HCl)- Ca | Mg | K | P |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ----mmol (c+) $kg^{-1}$---- | | | | | ----mmol $kg^{-1}$---- | | | |
| Serir | | | | | | | | | | |
| C | 256 | 222 | 18 | 12 | 3 | 100 | 161 | 115 | 96 | 11 |
| E | 207 | 148 | 25 | 6 | 3 | 88 | 74 | 91 | 71 | 4 |
| Btg | 343 | 192 | 58 | 4 | 3 | 75 | 90 | 129 | 57 | 2 |
| B(t)kg | 470 | 329 | 75 | 4 | 5 | 88 | 208 | 166 | 55 | 2 |
| B(t)gr | 407 | 265 | 65 | 3 | 2 | 82 | 133 | 146 | 49 | 2 |

| | EC 1/20 µS/cm | -----Water soluble cations----- Na | K | Ca | Mg | -----Water soluble anions----- $NO_3$ | $SO_4$ | Cl | $PO_4$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | mmol $kg^{-1}$ | | | | |
| Serir | | | | | | | | | |
| C | 79 | 7 | 3 | 5 | 1 | 0 | 0 | <0,2 | <0,6 |
| E | 259 | 20 | 3 | 18 | 3 | 1 | 19 | 1 | <0,6 |
| Btg | 272 | 22 | 2 | 17 | 6 | 9 | 12 | 8 | <0,6 |
| B(t)kg | 274 | 21 | 2 | 19 | 5 | 12 | 3 | 16 | <0,6 |
| B(t)gr | 243 | 17 | 2 | 18 | 5 | 10 | 4 | 12 | <0,6 |

| | $CaCO_3$ % | $Fe_{o/d}$ | $Fe_d$ | $Mn_d$ | Kaolinite | Illite | Smectite |
|---|---|---|---|---|---|---|---|
| | | ----mg $kg^{-1}$---- | | | ----%---- | | |
| Serir | | | | | | | |
| C | 0,8 | 0,03 | 11216 | 429 | 30 | 2 | 68 |
| E | 0,2 | 0,02 | 10351 | 115 | 34 | 3 | 63 |
| Btg | 0,3 | 0,01 | 11514 | 361 | 10 | 3 | 87 |
| B(t)kg | 1,3 | 0,02 | 8308 | 339 | 6 | 2 | 92 |
| B(t)gr | 0,4 | 0,02 | 8694 | 640 | 6 | 2 | 92 |

| | K $H_2O$ | K exch. | K weath. | K $clay_t$ | K total | Mg $H_2O$ | Mg exch. | Mg weath. | Mg $clay_t$ | Mg total | Ca $H_2O$ | Ca exch. | Ca weath. | Ca $clay_t$ | Ca total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mmol $kg^{-1}$ | | | % | | mmol $kg^{-1}$ | | | % | | mmol $kg^{-1}$ | | | % | |
| Serir | | | | | | | | | | | | | | | |
| C | 3 | 12 | 96 | 1,17 | 0,76 | 1 | 18 | 115 | 1,21 | 0,50 | 5 | 222 | 161 | 1,57 | 0,95 |
| E | 3 | 6 | 71 | 0,85 | 0,59 | 3 | 25 | 91 | 0,86 | 0,39 | 18 | 148 | 74 | 1,01 | 0,49 |
| Btg | 2 | 4 | 57 | 0,66 | 0,84 | 6 | 58 | 129 | 1,23 | 0,74 | 17 | 192 | 90 | 1,18 | 0,91 |
| B(t)kg | 2 | 4 | 55 | 0,61 | 0,77 | 5 | 75 | 166 | 1,48 | 0,62 | 19 | 329 | 208 | 1,51 | 0,61 |
| B(t)gr | 2 | 3 | 49 | 0,65 | 0,87 | 5 | 65 | 146 | 1,51 | 0,85 | 18 | 265 | 133 | 1,54 | 1,28 |

The silt fraction of all samples is dominated by quartz (Figure 2). Feldspars occur as a secondary component in all samples. Calcite can be detected in the uppermost horizon, as already indicated by the carbonate measurements. Striking are the differences at low 2-Theta angles of the XRD-diffractogram. Therefore, also clay mineralogy was investigated.

Clay mineral composition shows a clear gradient with downward decreasing kaolinite and increasing smectite (Figure 3). Illite could only be detected in traces. With respect to both mineral fractions the two uppermost and lowermost horizons are nearly identical, whereas the Btg represents a transition.

The peaks at 14.8, 4.9 and 4.5 Å indicate with high probability saponite (a Mg-smectite). This is supported by the downward increasing concentration of different Mg-fractions ($H_2O$, exchangeable, weatherable, total elements in clay fraction; Table 3). The high intensity and the symmetrical form of the peak at 14.8 Å are arguments for in situ neo-formation. Saponite is known to occur in soils of arid climates in the surroundings of salt lakes and salt pans (Jasmund and Lagaly 1993).

What do all these findings tell us? Most of the material building up the soil profile has been fluvially transported. The subsoil material should have been deposited under river delta or even shallow lake conditions during a period with at least sub-humid climate conditions in order to feed the paleo-lake "Mega-Chad". During the existence of this lake the subsoil material was under prolonged groundwater influence. During distinct dry seasons the soil solution was concentrated and saponite neoformation occurred under alkaline conditions. Similar processes are described in the nowadays northern Lake Chad area (Carmouze 1976, Gac 1980). There, the chemical structure of the "montmorillonite magnésienne" is given with: $Ca_{0.145}(Si_{4.0})\,(Al_{1.32}Fe_{0.46}Mg_{0.18})\,O_{10}\,(OH)_2$.

The overlying gravel rich material was deposited during catastrophic events, probably when climate began to become drier and prolonged dry seasons occurred. However, rainfall was still high and intensive enough for leaching of carbonate (and potentially present salts) so that clay illuviation could occur. With increasing aridity the groundwater level dropped, and cracks and plant roots could reach the lowermost horizons. Along these coarse pores topsoil material was illuviated with high intensity rains. The river became ephemeral. Finally, the climate became arid. The topsoil was eroded by wind and sheet wash and the serir surface with a yermic phase developed.

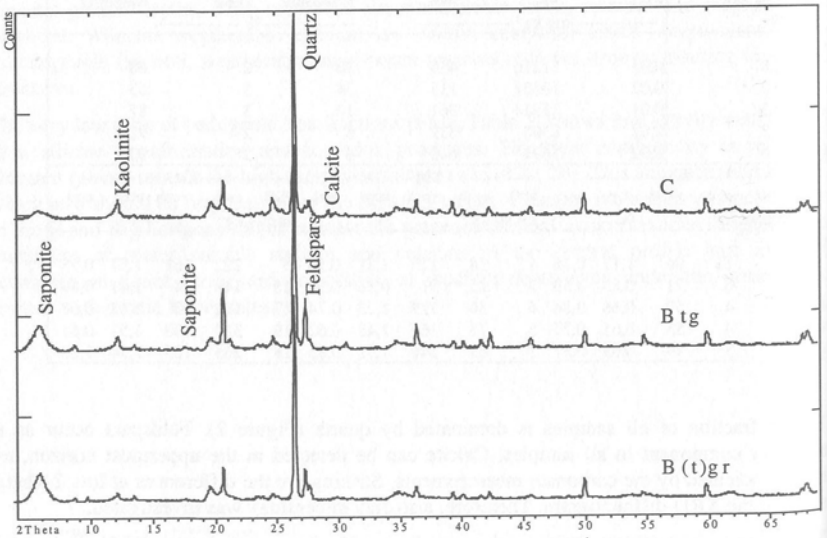


**Figure 2**: XRD-diffractogram (Cu-Kα, normalised for the quartz peak at 3.35Å) of the silt fraction (2-63 µm) of three horizons in the paleo-soil profile in N-Chad



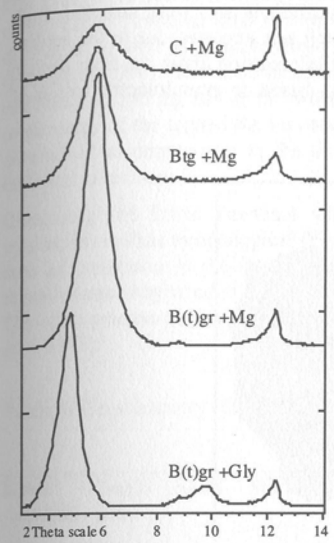


**Figure 3**: XRD-diffractogram (Cu-Kα, background corrected) of the clay fraction (<2 µm, Mg and glycerine treated) of three horizons in the paleo-soil profile in N-Chad

The fine earth fraction of the uppermost horizon is now built up by aeolian deposits with short- and long-range transport components. The dominant influence of aeolian processes is visible by elongated lines and features stretching from the Northeast to the Southwest in Figure 1. The wind erosion leads to a regional sediment loss. Most of the material is deflated from lake sediments by moving sand dunes. The fines are lifted into the atmosphere and are subject to long-range transport in south-westerly direction by the local wind called "Harmattan".

## 5. The climate gradient on a NE-SW-transect in Niger

During the transport particles fall out due to gravitational settling and are deposited onto the soil surface where they accumulate. In order to detect this fraction, topsoil material was collected on an ENE-WSW transect in Niger connecting the soil profile sampling sites in N-Chad and SW-Niger.

Figure 4 shows the clay mineral composition of these samples and a representative "Harmattan" dust sample. The qualitative similarity of the clay mineral composition at the northern Chad site and the mineral dust is striking (Figure 3 and 4). Once deposited onto and incorporated into the soils, the material is decomposed when rainfall increases above approx. 200 mm $yr^{-1}$. Already at the site Tanout with 300 mm $yr^{-1}$, the smectite-kaolinite ratio is decreasing. At 400 mm $yr^{-1}$ rainfall the smectite component is nearly completely transformed.

In order to identify the cumulative effect of mineral dust additions to soils in SW-Niger two profiles of the same soil group (Arenosol) but assumed different age, were sampled. Bulk mineralogy is dominated by quartz (Herrmann 1996), which was expected due to the aeolian origin (sand dunes) of the parent material. In order to get information about the finer aeolian fractions the so called "potential dust fraction" (<63 µm) - based on granulometric results of collected dust samples - was analysed (Figure 5).

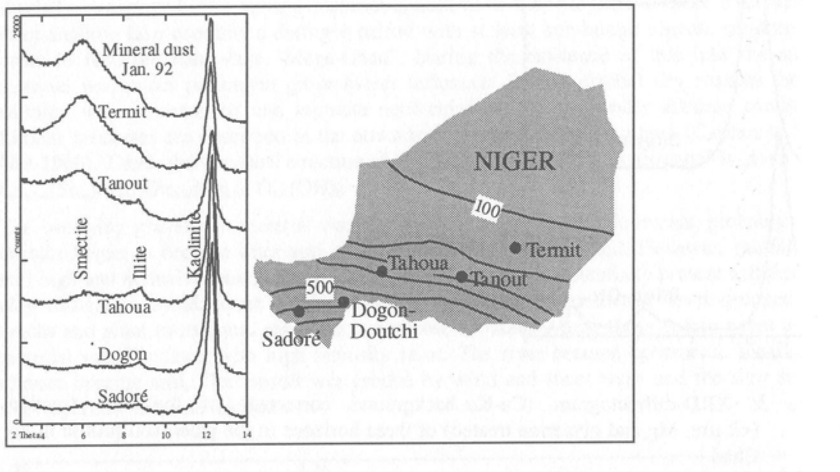


**Figure 4**: Rainfall isohyetes, sampling points and XRD-diffractograms of the clay mineral fraction (<2 µm, Cu-Kα) of surface samples and aeolian dust in Niger

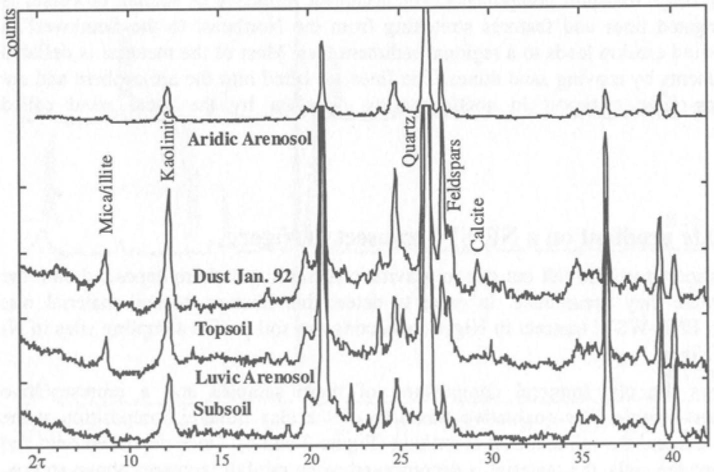


**Figure 5**: XRD-diffractograms (Cu-Kα) of the potential dust fraction (<63 µm) from soil profiles and a dust sample collected in SW-Niger



Due to high resolution sampling, the dust component can be identified in the first centimetres of the Luvic Arenosol (560 mm $yr^{-1}$ rainfall, fallow vegetation including bushes) by x-ray diffraction as well as granulometry (Table 4) and micromorphological investigations directly (Herrmann 1996). The dust accumulation calculated on the basis of granulometric data is estimated at 165 kg $m^{-2}$ in the whole profile (Herrmann et al. 1996). Already in the first centimetres of the topsoil the less stable minerals (calcite, smectite, intergrades) are strongly diminished in comparison to the dust sample. In the subsoil also the share of micas and feldspars is reduced.

Comparing the Luvic Arenosol with the Aridic Arenosol (400 mm $yr^{-1}$ rainfall, grass vegetation) neither mineralogical (Figure 5) nor granulometric data (Table 4) suggest mineral dust accumulation in the latter. This is simply caused by regularly re-entrainment of the topsoil material by wind in dry years with sparse vegetation cover, leading to loss of the fines. The same process occurs at the more humid sites with expanding agricultural activities (Jahn et al. 1995)

**Table 4:** Granulometry (%) of two soil profiles in SW-Niger

| Luvic Arenosol | Depth (cm) | Sand | Silt | Clay | Aridic Arenosol | Depth (cm) | Sand | Silt | Clay |
|---|---|---|---|---|---|---|---|---|---|
| Ah1 | 0-0.2 | 88.8 | 8.1 | 3.1 | AC1 | 0-4 | 93.1 | 4.5 | 2.4 |
| Ah2 | -1 | 82.8 | **12.4** | 4.8 | AC2 | -8 | 93.4 | 3.9 | 2.7 |
| Ah3 | -3 | 83.4 | **11.7** | 4.9 | AC3 | -12 | 93.2 | 4.0 | 2.8 |
| Ah4 | -8 | 85.0 | 8.9 | 6.1 | AC4 | -24 | 93.5 | 4.1 | 2.4 |
| Ah5 | -16 | 85.1 | 6.8 | 8.1 | AC5 | -40 | 94.6 | 2.9 | 2.5 |
| Btw1 | -29 | 85.1 | 6.1 | 8.8 | Ahb1 | -60 | 91.8 | 4.3 | 3.9 |
| Btw2 | -37 | 84.2 | 6.4 | 9.4 | | | | | |
| Btw3 | -60 | 83.3 | 7.6 | 8.6 | | | | | |
| Btw4 | -110 | 83.8 | 7.6 | 8.6 | | | | | |

## 6. Conclusions

In arid and semi-arid areas water and wind erosion processes lead to a steady redistribution of materials. Steady import of allochthonous material, especially by wind transport processes, is the rule for all soil profiles, rather than the exception. Whether this material is retained, is a question of the soil surface organisation (non-erodible elements, vegetation).

Ease of detection of the aeolian long-range transport component depends on climate factors, mainly rainfall, and deposition rate. Already with rainfall amounts of >200 mm $yr^{-1}$ silicate decomposition has to be considered. In sandy profiles, the total fine fraction (approx. <60µm) may consist of allochthonous aeolian dust material.

Soil mineralogical studies should take these factors into account in order to avoid misinterpretations.

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# SCHMALWANDMATERIALIEN UNTER DEM EINFLUSS KONTAMINIERTER WÄSSER


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## Abstract:

For environmental applications, slurry walls are commonly used as vertical barrier in remediation schemes at contaminated sites. In many cases site remediation means to construct slurry walls through soils having high levels of contamination. Referring to the problem of present contamination during the construction, vibrating beam slurries were mixed in the laboratory by using contaminated gauging waters. The effect of contamination on the rheological characteristics and the setting behaviour was tested. The hardening process of contaminated slurry mixtures was examined by laboratory miniature vane shear tests and penetration tests. Further the hardened sealing masses were tested on unconfined compressive strength, hydraulic conductivity and erosion stability. The influence of contamination on morphology was observed by environmental scanning electron microscope and possible mineralogical changes were checked by X-ray diffraction analyses. Different synthetic percolating waters containing chloride, sulphate, acetic acid and heavy metals (lead and zinc) were used for mixing liquid. Furthermore investigations to determinate the specification of heavy metals in the sealing masses were carried out.

In this study the negative effect of contaminated gauging water on the setting behaviour, unconfined compressive strength and hydraulic conductivity could be documented. Environmental scanning electron microscope photographs and X-ray diffractograms did not show any changes in mineralogy and morphology of contaminated sealing masses. Chemical analyses have shown that most of the heavy metal contamination is immobilized by the solid components of the vibrating beam slurry.


## 1. Einleitung

In der Umwelttechnik werden immer häufiger Dichtwandsysteme, wie Schlitz- oder Schmalwände, zur Sicherung von Deponien und Altlasten angewandt. Dichtwände bei Deponieumschließungen sind, anders als im Wasserbau, häufig einem chemischen Angriff durch verunreinigte Wässer im Untergrund ausgesetzt.

Im Rahmen von Forschungsprojekten des Institutes für Angewandte Geologie wurden von KNAAK (1995) und SCHWAIGHOFER et al. (1996) die Beständigkeit von Schmalwandmaterialien unter dem Einfluss von kontaminierten Wässern am Beispiel der Deponieumschließung am Rautenweg und der Altlastumschließung Lackenjöchelgasse in Wien untersucht. Durch Beprobung der seit 1986 bzw. 1990 bestehenden Bauwerke wurden für die durchge-