Stratigraphy, Palaeontology and Archaeology of Klinghardtfelder, Sperrgebiet, Namibia

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Abstract: The Southeast-Northwest oriented ridge between Buntfeldschuh and the coast of Namibia was called Klinghardtfelder by early 20th Century diamond prospectors. It is the site of extensive travertine deposition and there are still active saline springs along the northern and southern margins of the ridge. Surveys of the area by the Namibia Palaeontology Expedition in 2019 led to the discovery of fossils and stone tools at several localities. These occurrences throw some light on the timing of geological and geomorphological events in the sector, and are thus of interest for understanding the Neogene to Recent evolution of the region.

Key words: Travertine, Oysters, Phragmites, Oligo-Miocene, Pleistocene, Biochronology, Stone tools

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Introduction

At the beginning of the 20th Century, diamond prospectors were active in the coastal region of Namibia, known since 1908 as the Sperrgebiet (Forbidden Zone) (Kaiser & Beetz, 1926) (Fig. 1, 2). On account of the abundant presence of agates in the broad area between the Buntfeldschuh Cliffs and the coast the region was intensively prospected and there are still visible signs of trenches and several claim markers along the Klighardtfelder Ridge (Fig. 3). The aim of this contribution is to provide succinct descriptions and interpretations of the post-Cretaceous deposits at Klinghardtfelder and to point out their interest for understanding local geomorphological history. The fact that there are ancient human artefacts and middens in the rock sequence adds interest to the region and provides constraints on the ages of the travertines.

Materials and Methods

The field surveys consisted of tramping over the outcrops looking for evidence of fossils, stone tools and noting the rock types in which they occurred. Co-ordinates of localities were obtained using a Garmin GPS unit set to WGS 84 (Table 1).

Abbreviations

GPS - Geographic Positioning System
msl - mean sea level
KF - Klinghardtfelder
NPE - Namibia Palaeontology Expedition
WGS - World Grid System

Geological context and Stratigraphy

Much of the region known as Klinghardtfelder, west of Buntfeldschuh and Kakaoberg, is covered in travertine, but, as was recognised by Kaiser & Beetz (1926) there are diverse layers of other rock types in the area, most of which were mapped by them as Pomona Schichten (Fig. 1). Three brief visits to the region by the NPE resulted in the discovery of abundant fossils and stone tools at diverse sites and in various layers of sediment (Tables 1, 2). Commonest are plant remains (*Phragmites*, *Cyperus*) in red sand/silt and grey sand, and algae in limestone.

Table 1. Fossiliferous and implementiferous localities at Klinghardtfelder, Sperrgebiet, Namibia.

Locality	Latitude	Longitude	Altitude	Content
KF 1	27°35'32.2''S	15°32'56.3''E	112 m	Filamentous algae in limestone
KF 2	27°35'10.4''S	15°32'54.4''E	111 m	Stone tools
KF 3	27°35'52.1''S	15°32'49.3''E	100 m	Oysters *in situ*
KF 4	27°35'53.2''S	15°32'34.7''E	108 m	Silcrete boulders on wave-cut platform
KF 5	27°35'55.5''S	15°33'23.3''E	118 m	*Phragmites* in red sandstone
KF 6	27°35'54.9''S	15°33'23.4''E	121 m	*Phragmites* in grey sandstone
KF 7	27°35'52.6''S	15°33'33.2''E	125 m	Agates *in situ*
KF 8	27°35'59.2''S	15°33'17.8''E	108 m	Stone tools *in situ* with *Patella*, oysters, mussels, ostrich eggshells

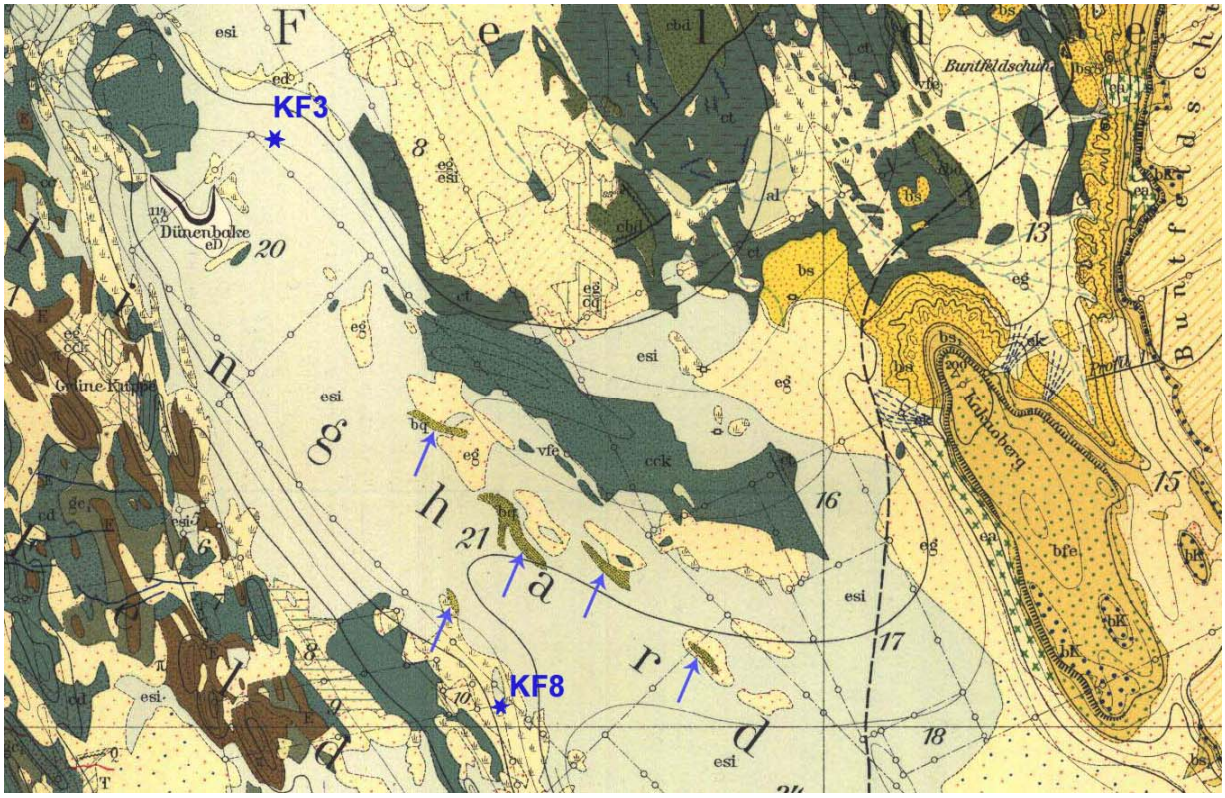

Figure 1. Geological map of the Klinghardtfelder area showing the positions of the Oyster site (KF 3) and the richest of the stone tool sites (KF 8). Blue arrows depict outcrops correlated by Kaiser & Beetz (1926) to the Pomona Schichten (light green tones, esi - travertine).

Table 2. Stratigraphic succession at Klinghardtfelder, Sperrgebiet, Namibia.

Rock unit	Age
Loose sand (Aeolian) and deflation lag (agates, quartz)	Recent
Indurated grey sand (Aeolian, cemented by limestone) with stone tools, fauna	Pleistocene
Travertine terraces and veins	Plio-Pleistocene
Limestone with plant remains (yellowish to white)	Oligo-Miocene
Marls and sand with agates, rounded quartz clasts, oysters, and locally derived silcrete boulders	Oligo-Miocene
Ferruginised marl, sand	Oligo-Miocene
Kätchen Plateau Silcrete (all reworked)	Ypresian/Lutetian
Bo Alterite	Ypresian-Lutetian
Basement rocks (Dolomite)	Proterozoic

Figure 2. Saline spring at Klinghardtfelder Travertine Plateau close to an *in situ* occurrence of fossil oysters and marine gravel at 100 m altitude (view eastwards towards Kakaoberg and Buntfeldschuh in the background).

Figure 3. Diamond claim markers at Klinghardtfelder constructed on top of a travertine terrace which itself reposes on ferruginised Basement complex rocks (Gariep Group).

The post-Cretaceous stratigraphic record of the Klinghardtfelder area is incomplete and patchy, as was recognised by Kaiser & Beetz (1926). The oldest such rocks recognised by the NPE comprise alterite (weathered basement rocks, generally of deep red and brown tones) attributed to the Bo Alterite which is most likely of pre-Lutetian age (Pickford, 2016). There are a few loose blocks of silicified conglomerate along the top of the ridge which are interpreted to be locally derived blocks of Kätchen Plateau Silcrete, also of Palaeogene age (Pickford, 2015). There are discontinuous patches of ferruginous crusts which are correlated to the Oligo-Miocene. Similar ferricretes occur at Buntfeldschuh a few km to the east and northeast, as well as more widely in the Sperrgebiet (Pickford, 2016). There are discontinuous patches of agate-rich silts and gravels overlying the ferricrete and older rocks and underlying widespread travertine terraces. At one outcrop, these agate-bearing deposits contain *in situ* oysters at an altitude of ca 100 metres above msl.

There then follows a widespread but thin and discontinuous deposit of travertine, often cementing reddish and greyish sand of aeolian origin. In detail, these travertine deposits reveal a complex pattern of cross-cutting relationships, indicative of shifting centres of spring activity and local superficial neo-tectonic activity, producing veins and terraces of more-or-less pure travertine as well as cementing surface deposits such as wind-blown sand and silt. The presence of stone tools and fossils in the grey cemented sands indicate a Late Pleistocene age for some of the travertine activity, which is still continuing today at active saline water seepages (albeit at reduced discharge rates) (Fig. 2). Some of the travertine, however, could be older than the Pleistocene, but no indicative fossils have been found in them, although a few outcrops contain abundant plant remains (sedges, filamentous algae).

Finally the area is covered in a discontinuous but thin layer of loose aeolian sand and locally deflated concentrations of agate clasts and well-rounded quartz pebbles.

Bo Alterite, Kätchen Plateau Silcrete and agate-rich beds

The oldest post-Proterozoic sediments in the Klinghardtfelder area comprise weathered basement rocks (Bo Alterite, Fig. 4, 5) ferruginised alterite and sand (Fig. 7) and locally derived blocks of silcrete (Fig. 8) similar in composition, colour and clast content to outcrops of Kätchen Plateau Silcrete in the Pomona area (Pickford, 2015). Comparable outcrops of Bo Alterite and silcrete occur *in situ* in the northern part of the Buntfeldschuh, 3.8 km to the northeast, where they underlie the marine silts, sands and gravels of the Buntfeldschuh Formation (Corbett, 1989). Agate-rich layers overlying ferruginised alterite are probably correlative with the basal marine layers at Buntfeldschuh (Fig. 9, 10).

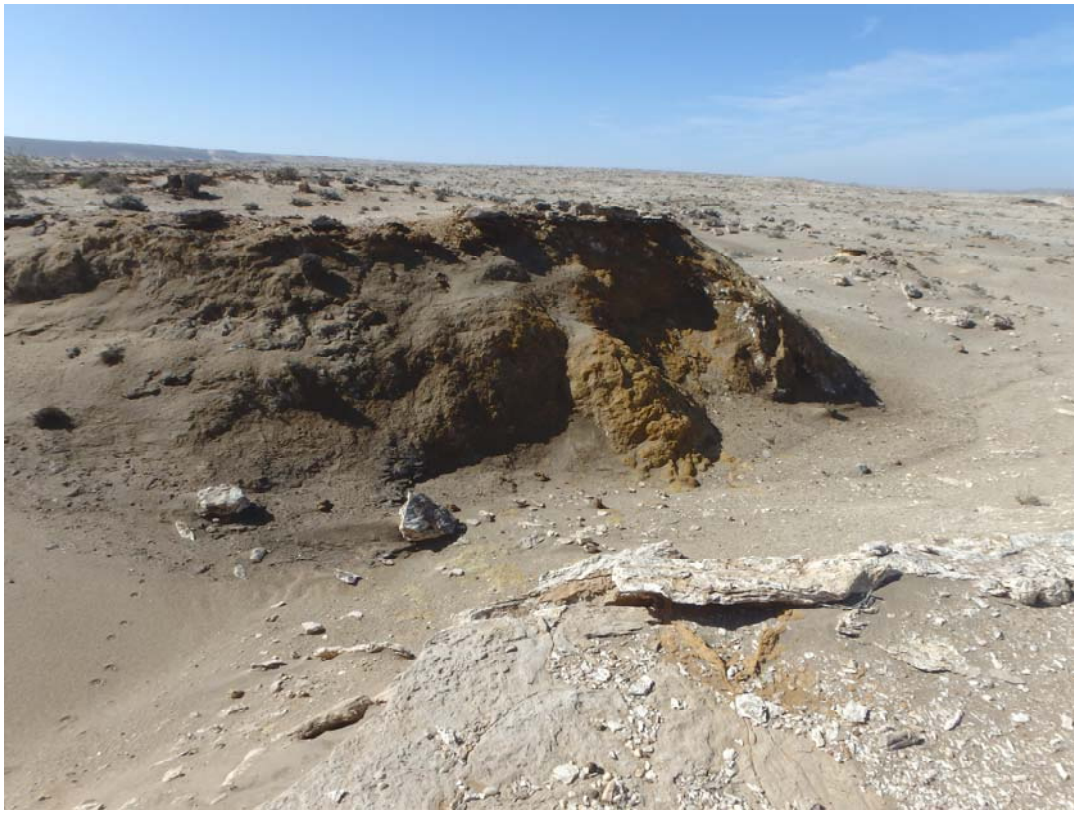

Figure 4. A 3+ metre thick layer of Bo Alterite exposed in the Klinghardtfelder Ridge, capped by a terrace of white travertine (view eastwards towards Kakaoberg).

Figure 5. *Phragmites* root systems and stalks *in situ* in orange Bo Alterite in the Klinghardtfelder. There are many places in the region with remains of this plant preserved, attesting to the former presence of open water at the surface.

Figure 6. Well-preserved *in situ* stems and roots of *Phragmites* in grey calcified sand at Klinghardtfelder, Namibia.

Figure 7. Ferruginised sand and silt layer at Klinghardtfelder overlain by limestone and travertine. The ironstone level probably correlates to the Oligo-Miocene.

Figure 8. Locally derived boulders of silcrete atop the Klinghardtfelder Ridge, correlated to the Kätchen Plateau Silcrete, overlying Gariep Group dolomite, with the bases of some of the boulders cemented by travertine. A) Boulders lying on a wave-cut platform at ca 108 m above msl; B) Intensely silicified conglomerate boulders overlying Basement rocks.

Figure 9. Well-rounded fist-sized quartz pebbles and other clasts in partly ferruginised marls derived from Bo Alterite at Klinghardtfelder, Namibia, at an altitude of ca 125 metres above msl. These pebbles attest to a marine transgression considered to pre-date the 90 metre marine package of Pether (1986). The ferruginisation likely occurred during the Oligo-Miocene transition.

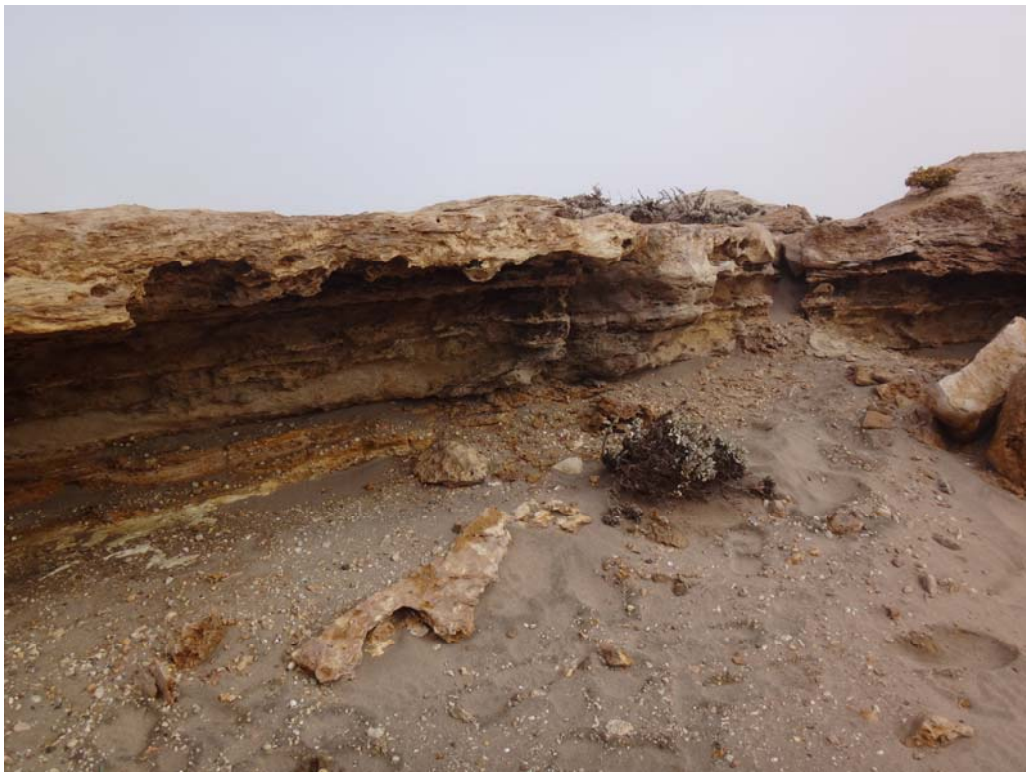

Figure 10. Thin layers of well-rounded agate and quartz pebbles intercalated with marly silt layers overlain by limestone beds and travertine and loose sand at Klinghardtfelder, Sperrgebiet, Namibia. These deposits are at an altitude of ca 125 metres above msl.

The Klinghardtfelder Oyster Site

A layer of silt and conglomerate containing fossil oysters mixed with marine pebbles was recognised in a bed of red sand overlying Bo Alterite and underlying travertine (Fig. 11, 12). The precise stratigraphic position and age of this occurrence of oysters needs to be examined further, but our preliminary assessment is that it postdates the Oligo-Miocene ferricrete which is widespread but sporadic in the Buntfeldschuh depression, as at Klinghardtfelder itself, and it pre-dates the travertine deposits. As such it is probably early Miocene, but older than the 90 metre marine package. These fossil oysters crop out at an altitude of 100 metres above msl. Most of the shells are oriented vertically in the sediment, probably in their life positions.

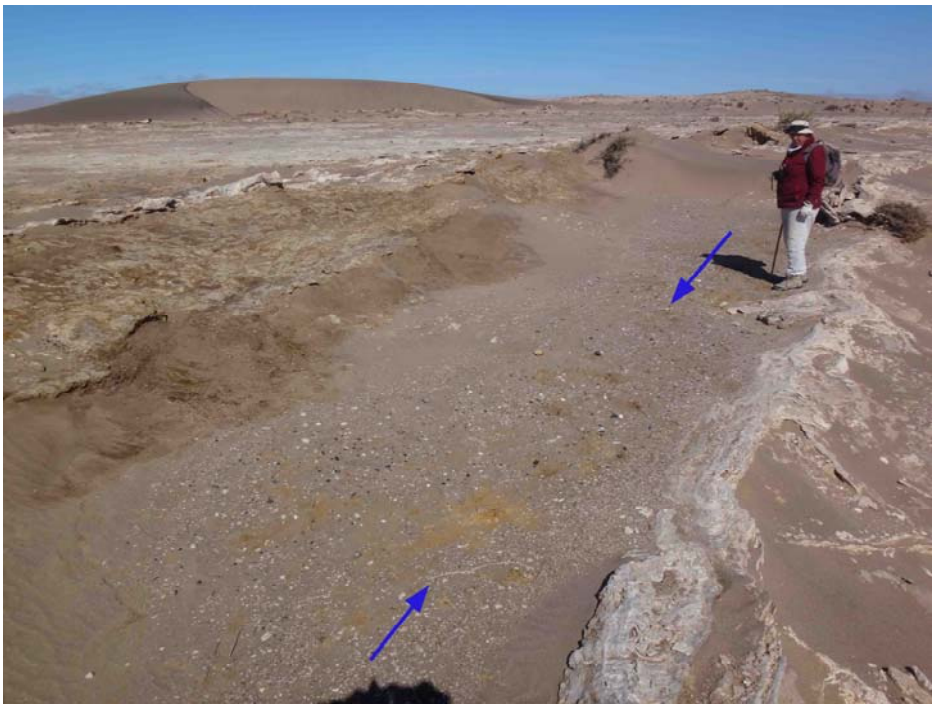

Figure 11. Fossil oyster site (KF 3) at Klinghardtfelder at an altitude of 100 metres above msl. The oysters are in the orange pebbly marl (blue arrows) interbedded between Bo Alterite to the left (brown marly deposit) and white travertine sloping to the right (northwards). Note the recently deflated lag of agates, quartz and other well-rounded pebbles.

Figure 12. Close-up view of *in situ* oyster shells locality KF 3, Klinghardtfelder, west of Buntfeldschuh, Sperrgebiet, Namibia (inset - stereo view of oyster shells associated with well-rounded quartz pebbles).

The Klinghardtfelder travertine deposits

The Klinghardtfelder Ridge is largely blanketed by a thin layer of travertine, mostly white, but often mixed with sand of various hues, grey and brown predominating (Fig. 13-17).

At present the ridge is the site of several seepages of highly saline water (Fig. 2, 18) and it is likely that during the past the springs were more abundant, more active and possibly somewhat fresher.

The ridge possibly owes its presence to the fact that it was a focus for long-term groundwater leakage to the surface, which dampened the surface and retarded the deflation processes that removed rock mass from the drier areas north and south of the ridge to a depth of more than 50 metres. The summit of the ridge is ca 125 metres above msl, whereas the depressions north and south of it lie at an altitude of ca 65 - 70 metres above msl.

There are vast numbers of travertine-filled veins in the region, which attest to the presence of minor neo-tectonic activity localised to the ridge and possibly related to water pressure fracturing semi-consolidated superficial sediments through which the water was flowing towards the surface.

As such an extremely complex series of veins and terrace deposits cross-cut each other in an amazing fashion. The terraces are seldom more than a metre thick, often only a dozen or so centimetres, but can cover areas of tens to hundreds of square metres.

The abundant presence of root systems of *Phragmites* (Fig. 5) and of stem fossils of *Cyperus* (Fig. 17) indicate that the water seeping to the surface probably formed pools and swampy areas. However, no gastropods or fish remains were found, suggesting that the waters may have been saline, as they are today.

Figure 13. General view of the travertine sheets and veins blanketing the Klinghardtfelder Ridge, with Kakaoberg in the distance. Note the sand dune, and the thin layer of loose sand cover in local depressions and forming sand shadows in the lee of plants.

Figure 14. Vertical veins and inclined layers of travertine in the northern margin of the Klinghardtfelder. The inclined travertine layers were deposited along the north-facing slope of the ridge as water flowed downhill from the seepage. The veins of travertine infill fissures in the sand and underlying rocks.

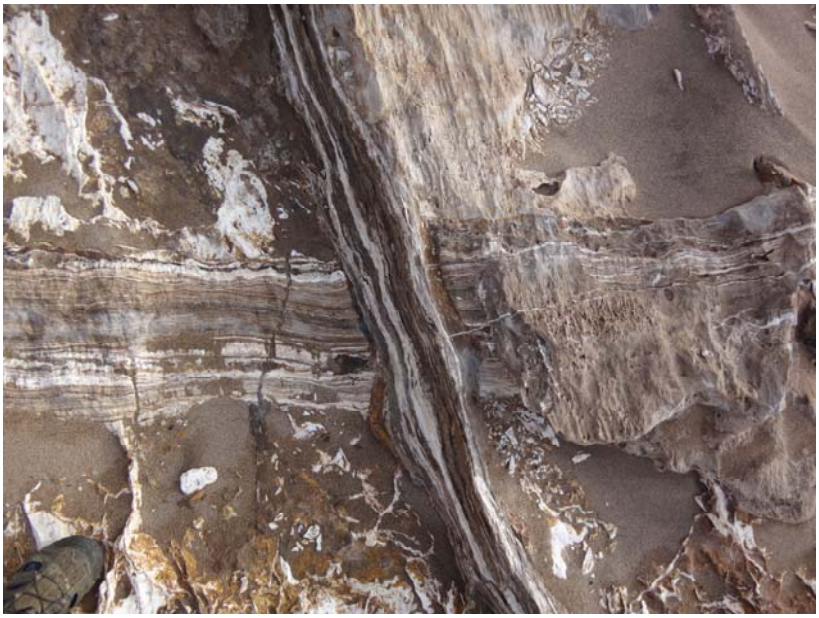

Figure 15. Cross-cutting veins of travertine and grey/brown sand deposited in fissures in Bo Alterite at Klinghardtfelder, Namibia.

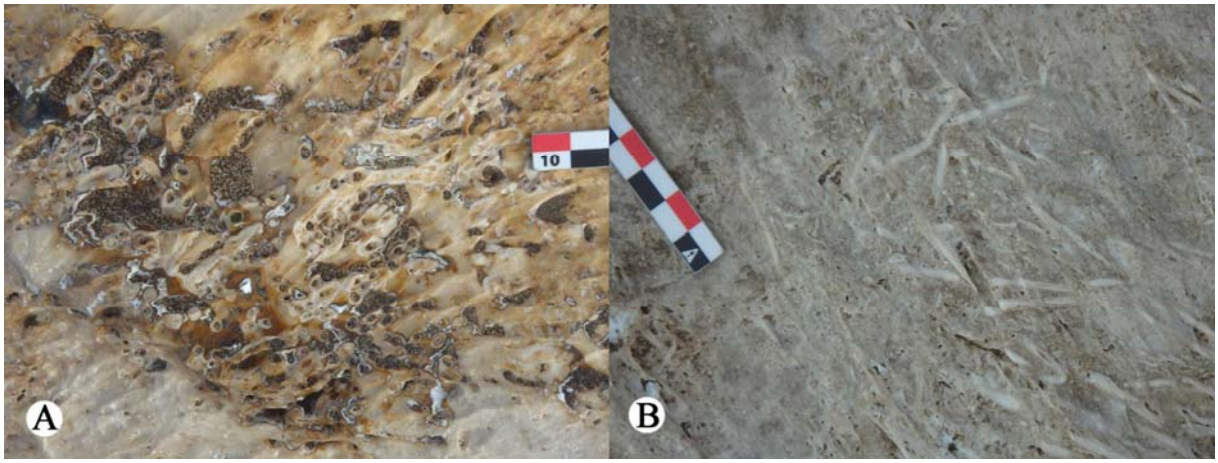

Figure 16. Yellow (A) and grey (B) limestone containing plant remains (algae, *Cyperus*) overlying agate-bearing marls at locality KF 1, Klinghardtfelder, Namibia.

Figure 17. *Cyperus* in the Klinghardtfelder. A) Fossil stem imprints in calcareous grey sand. B) Living plants growing in damp grey sand.

Archaeological remains

In the Klinghardtfelder area there are lithic implements scattered over the surface, often close to water seepages (Fig. 18). At locality KF 8, a rich assemblage of stone tools, oysters, *Patella* shells and ostrich eggshell fragments is present, many of which are *in situ* in indurated grey sandstone (lime-cemented aeolian sand) (Fig. 19-23). There is a diverse fauna scattered on the surface, including a variety of marine gastropods and bivalves, as well as poorly preserved mammalian bones. This site is 5.1 km inland from the nearest point of the coastline.

The occurrence shows resemblances to that at Hexen Kessel described in previous reports (Pickford & Senut, 2016; Pickford *et al*. 2018). No signs of fire (charcoal or burnt bones) were observed and no pottery sherds were seen.

Figure 18. Locality KF 8, Klinghardtfelder, the site of a water seepage (dark tones in the middle of the image with saline water seeping downwards into the foreground). The surrounding area contains a rich assemblage of stone tools, marine mollusc shells and ostrich eggshells.

Figure 19. Surface scatter of lithic implements and faunal remains at locality KF 8, Klinghardtfelder, Namibia.

Figure 20. « Oldowan-style » stone chopper tool from surface context at Site KF 8, Klinghardtfelder, Namibia.

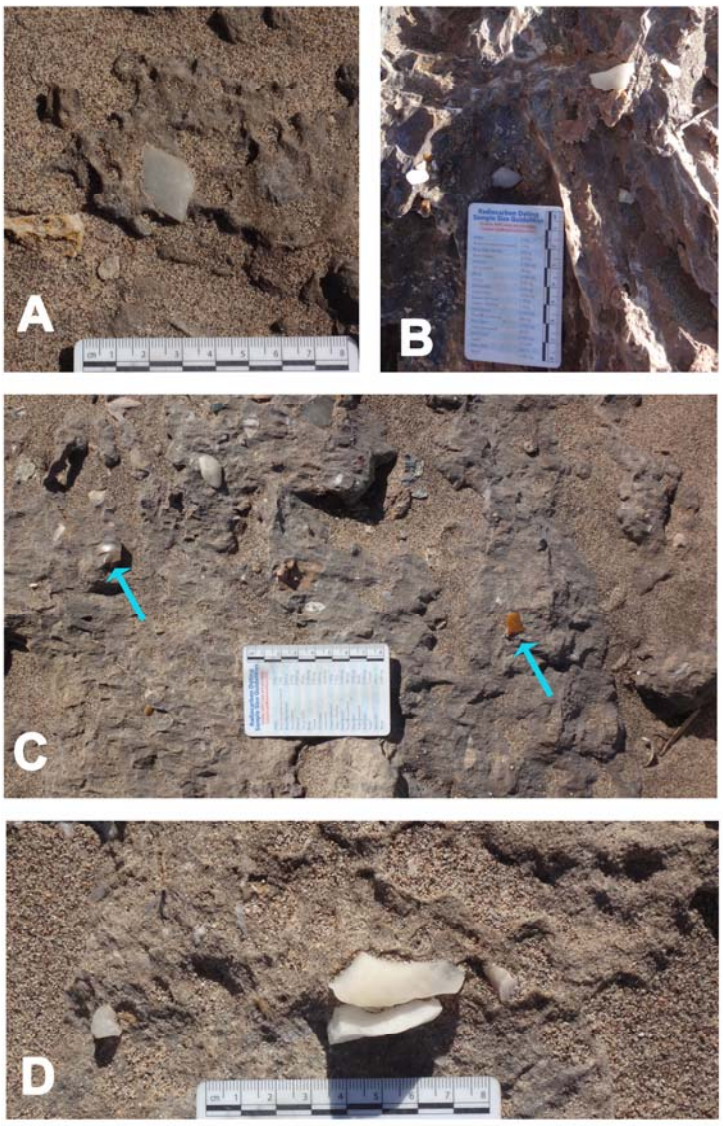

Figure 21. Stone flakes (chert, quartz, quartzite) *in situ* in lime-cemented grey sand at Site KF 8, Klinghardtfelder, Namibia. The blue arrows in (C) show two *in situ* flakes (scale : 8 cm).

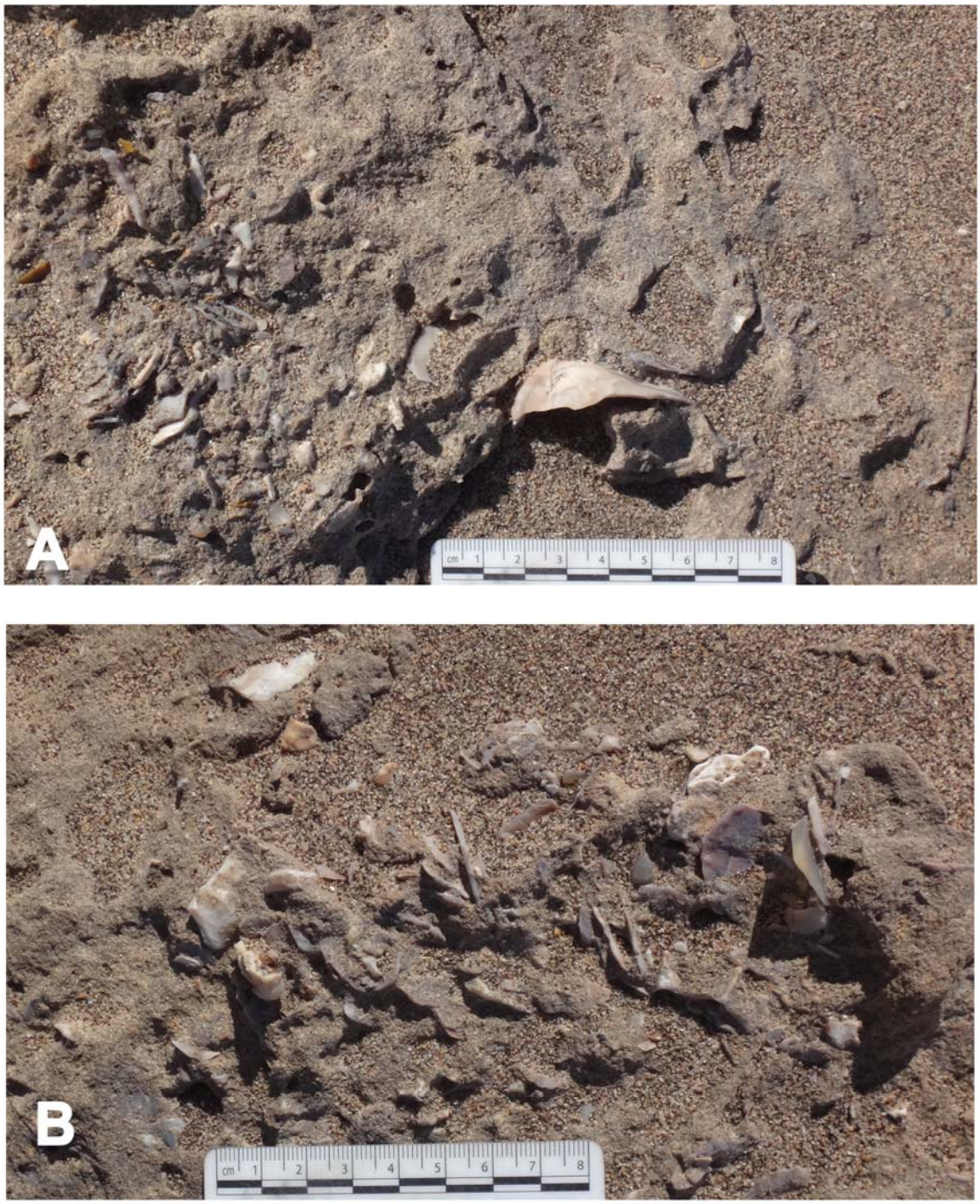

Figure 22. A mass of marine shell fragments including oysters and *Patella* as well as lithics *in situ* in indurated grey sandstone at locality KF 8, Klinghardtfelder, Namibia.

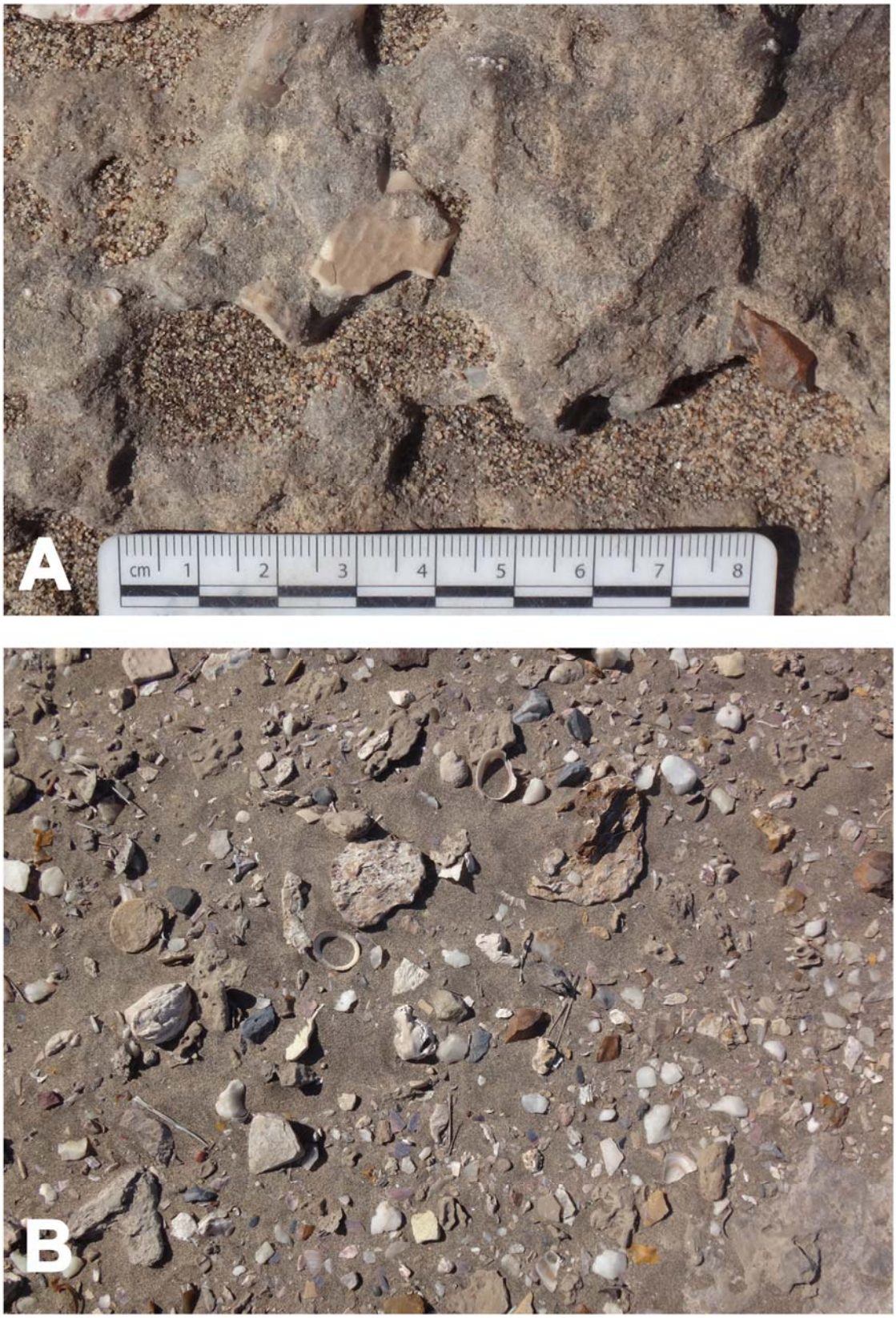

Figure 23. A) Ostrich eggshell fragment (left) and chert flake (right) *in situ* in grey sandstone at Klinghardtfelder, Site KF 8. B) Rich surface scatter of lithic implements and marine mollusc shells, Klinghardtfelder, KF 8, Namibia. Note reworked fragments of travertine.

At present the water seeping to the surface at Klinghardtfelder is too saline for human consumption, being even more saline than sea-water. However, wild animals such as *Oryx*, ostrich and jackals regularly imbibe the water, so it is possible that ancient humans were attracted to the area because of the presence of game animals around the springs. However, with greater rates of flow during the past the springs may have been fresher than they are at present. There may also have been seasonal fluctuations in salinity related to local rain showers. Whatever the case, judging from the quantity of seashells preserved in the deposits, it seems that the ancient humans were largely dependant upon marine food resources for survival, with addition of ostrich eggs and occasional mammals to the diet.

Discussion and Conclusion

Survey of the Klinghardtfelder Ridge in the Sperrgebiet, Namibia, has revealed the presence of a patchy, discontinuous succession of post-Cretaceous deposits, capped by widespread travertine deposits and recent aeolian sands. There are outcrops of weathered Basement rock (dolomite) which are attributed to the Bo Alterite of pre-Lutetian age, although it is likely that weathering continued for a long time after the Lutetian, depending on the topographic position of the weathered rocks. In several places at Klinghardtfelder, there are *in situ* fossilised root systems of *Phragmites* which grew in near-surface occurrences of these alterites as well as in grey sands overlying the alterite. Younger than the Bo Alterite is a scatter of locally derived large to huge silcrete boulders which attests to the former presence of a layer of silcrete in the area, now broken up into boulders which are strewn over the top of a wave cut platform ca 100 - 125 metres above msl.

Before the silcrete bed was broken up, however, there was a phase of ferruginisation, during which ferricrete of Oligo-Miocene age was deposited, cementing silt, sand and gravels.

There then followed a period of marine activity which brought in a great deal of agates and quartz pebbles which occur in silts and gravels underlying the travertine terraces. This is likely the period during which the silcrete bed was eroded and broken up by wave activity. In one place, agates and quartz pebbles are associated with *in situ* oyster remains (locality KF 3) at an altitude of 100 metres above msl. It is estimated that these oysters are of Oligo-Miocene age and that they appear to predate the 90 metre marine package of Pether (1986) (Pickford, 1998). However, further study is advised.

During Plio-Pleistocene times the Klinghardtfelder was the site of intensive travertine deposition. Veins and sheets of travertine are widespread, and are often mixed with grey or reddish sand, much of which is of aeolian origin.

Because of the presence of water seepages, even though the water is highly saline, the area was apparently attractive to early humans, as suggested by the abundant presence of stone tools and faunal remains in several discrete locales along the top and margins of the ridge. At locality KF 8, grey sand which has been cemented by travertine is rich in lithic remains and fossils, in particular marine gastropods and ostrich eggshell fragments. The lithic assemblage suggests a Late Stone Age or, less likely, a Neolithic correlation.

As such, even though the stratigraphic record at Klinghardtfelder is incomplete, it provides evidence concerning the geomorphological evolution of the immediate area, and indicates that during the Oligo-Miocene, sea-level was at least 125 metres above its present day level. Either that, or there has been localised uplift of geomorphological features related to the well-known early Miocene 90 metre package. Further studies are indicated.

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