Kaokoland Cascade Tufa Survey : Interim Report

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Abstract: Kaokoland is a semi-arid to desert region in northwestern Namibia. The presence of numerous cascade tufa deposits in the area attests to a more humid, cooler climate during the past. A preliminary palaeontological survey of the tufas in 2017 resulted in the discovery of rich and diverse fossil faunas which indicate that the tufas accumulated during the late Pliocene and early Pleistocene. Some of the tufa deposits contain stone tools and burnt bones yielding evidence concerning ancient human activities. This paper provides a preliminary report on the Kaokoland Tufa Survey.

Key words: Cascade Tufas, Fossil fauna, Palaeoclimate, Pliocene, Pleistocene, Namibia

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Introduction

A brief survey of Cascade Tufas in Kaokoland was undertaken in 2017 in order to assess the palaeontological and archaeological potential of the deposits (Pickford *et al*. 2016) and to refine the age of tufa deposition. This paper provides a preliminary assessment of some of the faunal and archaeological remains encountered.

This preliminary report does not pretend to present an exhaustive description of the fossils or stone tools, but is intended to give a reliable impression of the potential of the region for further studies in palaeontology and archaeology, as well as of the timing and mode of development of cascade tufas in this arid environment. The palaeontological potential of the Kaokoland tufas is vast, and it will take several years of concerted effort to describe the fossils already obtained from the breccias associated with the tufas.

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Geological context

The geological setting of the Kaokoland tufas was described by Pickford *et al*. (2016). In brief, the tufa deposits form barrages in valleys incised into the edges of dolomite plateaux (Fig. 1). Most of them are still the sites of freshwater springs but active tufa deposition is much reduced compared with the rates of precipitation that prevailed during the late Pliocene and early Pleistocene.

During tufa deposition, tufa curtains formed, behind which there were cavities, some large enough to be called caves. Some of these cavities subsequently filled with carbonates but because they were not accessible to surface water flow, the breccias contain almost no clastic deposits, being almost pure calcium carbonate with fine dust residues. Many of the cavities acted as refuges for animals such as lizards, birds such as owls, and small mammals. Animal remains that accumulated on the floors of the cavities represent regurgitated owl pellets and skeletons of animals that died in the cavities or were brought into them by small predators. There are few large mammal remains in the deposits.

Figure 1. Okongwe tufa lobes near the village of Okozonduno, Kaokoland, Namibia. These lobes formed during the Pliocene and Pleistocene, blocking the valley eroded into the dolomite plateau behind.

Table 1. Location and age estimates of Kaokoland fossiliferous breccia samples.

Locality	Latitude	Longitude	Altitude	Age
Okongwe 2015 Site	18°53'54.6''S	14°04'10.9''E	1191 m	Pleistocene
Okongwe 2017 Site	18°53'53.9''S	14°04'12.4''E	1202 m	Pliocene
Okongwe Lower Site	18°53'54.6''S	14°04'11.3''E	1234 m	Pliocene
Okongwe Up Site	18°53'42.9''S	14°04'20.3''E	1272 m	Pliocene
Omatapati	18°53'38.5''S	14°08'50.7''E	1199 m	Pleistocene
Otjitaime	18°51'54.9''S	13°44'55.0''E	1312 m	Pleistocene

Material and Methods

200 kg of fossiliferous breccia was delivered to Paris for laboratory treatment in order to extract the fossils from the rock. Breccias were treated in a 7% solution of formic acid buffered by calcium triphosphate.

The laboratory process is relatively slow, each batch of 25 kg taking about two weeks to digest, after which the insoluble residue was dried, sorted and then examined under a microscope to pick out the fossils.

Once sorted, the fossils have to be consolidated one by one with a dilute solution of glyptol dissolved in acetone. The Kaokoland tufas need to be consolidated, otherwise the specimens crumble to powder after a few weeks. In blocks that have more complete specimens such as skulls, the fossil specimens are consolidated before extraction from the block, which means that the blocks have to be dried and the specimens consolidated as they are exposed by the acid attack. This procedure is slow, as it requires repeated episodes of drying, consolidating and reimmersion in acid, but it is essential to preserve the more complete specimens intact. Such complete specimens are relatively rare in the fossil record, which is why they deserve special attention and treatment, even if it results in delays in extracting other fossils from the breccia.

The cleaned and consolidated fossils were then sorted into taxonomic groups and labelled with the locality data and other information, after which selected specimens were photographed and measured. Scientific study of the specimens will be carried out as and when experts agree to do the research.

Results

Rich and diverse faunas have been recovered from breccia at all tufa localities in Kaokoland examined so far (Okongwe, Omatapati and Otjitaime). Most of the faunal remains comprise Pleistocene taxa, but Okongwe is somewhat different from the others in that it has yielded breccias of two different ages, one of which is Pliocene (with extinct rodent taxa) the other Pleistocene (with extant genera) (Fig. 2-20).

The faunas from the breccias comprise a rich assemblage of frogs, snakes, lizards, chamaeleons, birds and small mammals (bats, rodents, soricids, macroscelidids) medium-sized mammals (lagomorphs, hyracoids, small carnivores, small bovids) and a few large mammals (medium-to-large equids, suids, bovids and giraffids). When combined with the gastropods and fossil plant remains, these tufa-related biological remains will permit reliable reconstructions of the palaeoenvironments.

Several of the Pleistocene breccias have yielded stone tools (Omatapati, Okongwe 2015 Site). The Pliocene sites at Okongwe (Okongwe 2017 Site, Okongwe Up Site) also yield stone tools, possibly the oldest known from sub-equatorial Africa.

The stone tools at Omatapati are associated with burnt bones and teeth, indicating that hominids were probably cooking food at the site. In contrast, the Pliocene breccias from Okongwe which yield stone tools, show no signs of burnt bones.

The majority of fossils in the Kaokoland breccias comprise microfauna. It is likely that these remains represent owl pellets which accumulated in cavities in the tufa lobes as they grew. It is also likely that some of the remains, especially those of the lizards, small birds and bats, represent the remains of animals that lived in, or sheltered in the cavities, and that some of them died therein. A few of the cavities were large enough to admit larger animals, including hominids, and this accounts for the occasional presence of large mammal remains (equids, bovids, giraffids) in the breccias. The bones and teeth of large mammals were likely introduced into the cavities by hominids or predators, rather than from the animals themselves climbing into the caves and dying inside. The hyracoids, lagomorphs and small bovids (Klipspringer) in contrast could themselves access some of the cavities, as they still do today.

Some of the breccias comprise immense concentrations of post-cranial bones and jaws, often showing preferred alignment of the specimens. These concentrations are likely to be locally reworked remains of disaggregated owl pellets, gently transported a few cm by water flowing inside the cavities and concentrated at the point where the water percolated out of the cavity. The bones are not rolled or abraded, meaning that transport was minimal and gentle.

In a few cases, it is clear that there were two phases of accumulation of fossils, shown by the presence of fossils of two different colours, an older assemblage comprising rare bones and teeth with brownish/blackish coloration (often isolated teeth or broken bones and jaws) intermixed with abundant pale yellow/cream fossils in excellent condition.

Apart from their fossil content the Kaokoland breccias are composed of almost pure limestone. All the breccias yield rare sand grains, but only a few contain the occasional stone larger than 1 cm. The Okongwe Pliocene breccia at the 2017 Site yielded two large stones (larger than a fist) which show signs of percussion damage at one pole. These stones are interpreted to have been introduced into the cavity by early hominids and employed as hammer stones. The presence of small waste flakes in the breccia from the same site (and at Okongwe Up Site) suggest that hominids were making stone tools inside the cavities, but were carrying the completed tools out when they left, leaving behind the waste flakes and hammer stones.

In contrast, the Pleistocene breccia at Omatapati is rich in stone tools, waste flakes, cores and hammer stones, along with burnt bones of large mammals (equids, bovids). The assemblage indicates more frequent occupation of the cavity by early hominids.

Okongwe 2017 Site

Figure 2. Stereo lateral view of the spur from the leg of a spurfowl from Okongwe 2017 Site.

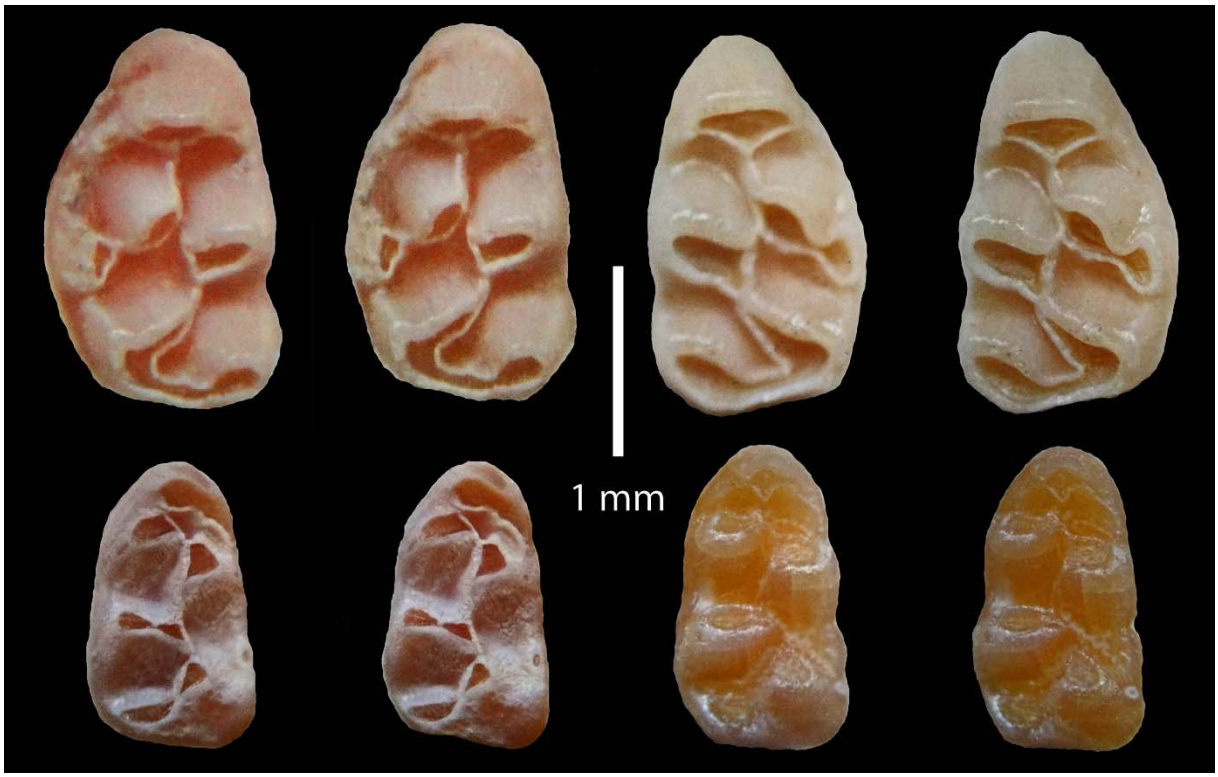

Figure 3. Stereo occlusal views of upper (top row) and lower (bottom row) first molars of the rodent *Petromyscus collinus* from Okongwe, 2017 Site.

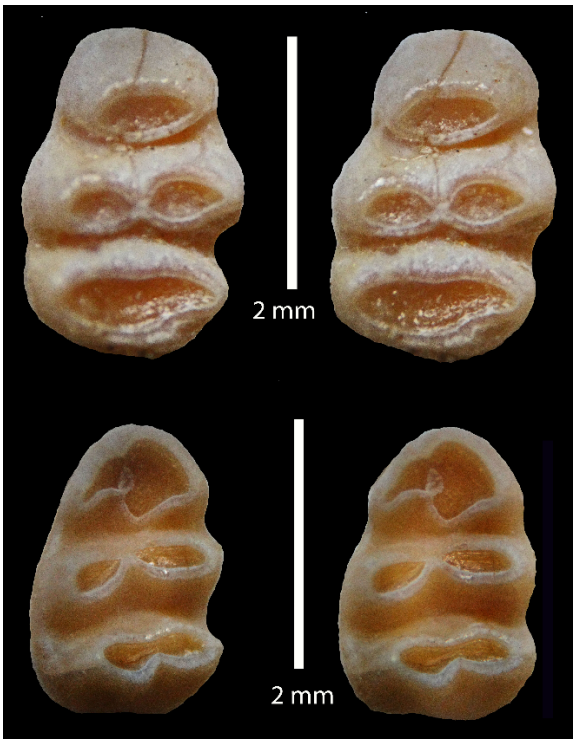

Figure 4. Stereo occlusal views of first upper and lower molars of *Desmodillus* sp. from Okongwe, 2017 Site, Kaokoland, Namibia.

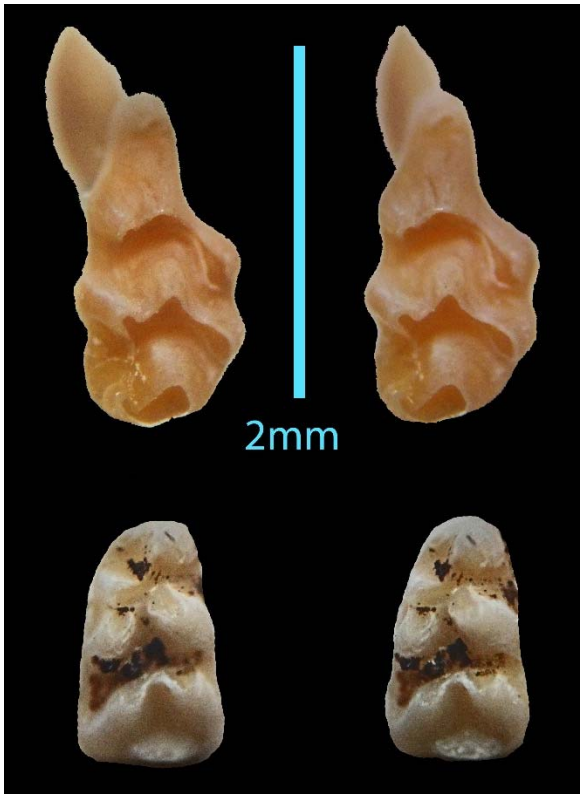

Figure 5. Stereo occlusal views of upper and lower first molars of *Acomys* / *Mus* sp. from Okongwe 2017 Site.

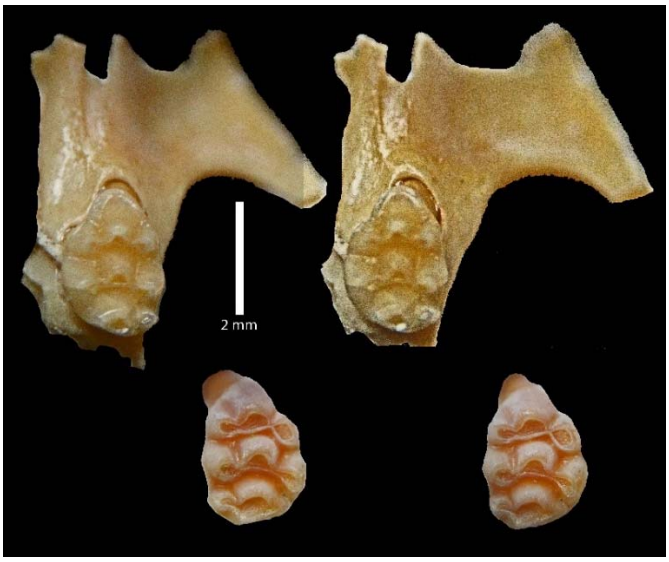

Figure 6. Stereo occlusal views of upper first molars of *Aethomys* sp. from Okongwe, 2017 Site.

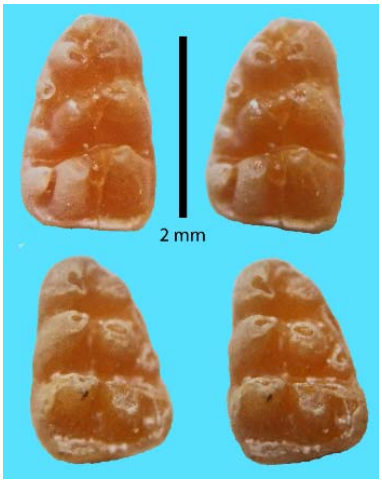

Figure 7. Stereo occlusal views of lower first molars of *Aethomys* sp. from Okongwe 2017 Site.

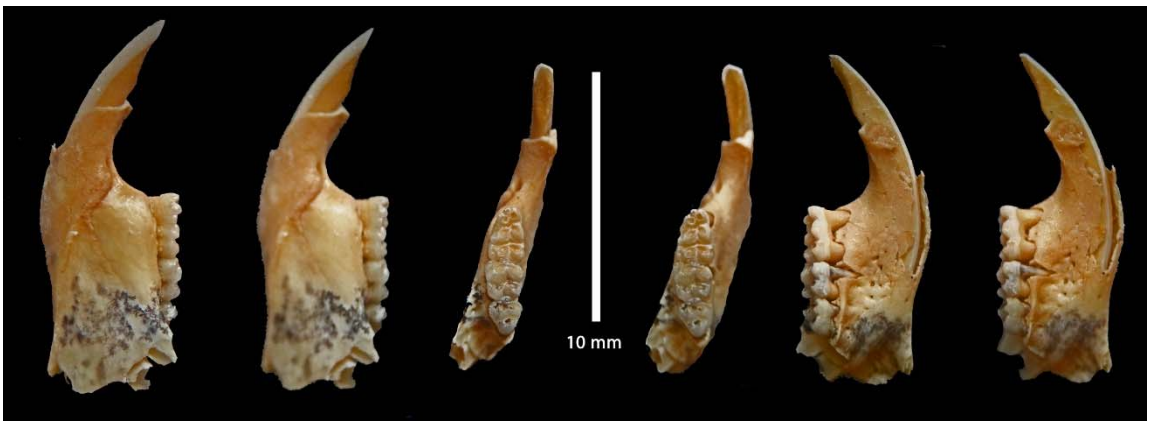

Figure 8. Stereo views of left mandible of *Aethomys* sp. from Okongwe 2017 Site, buccal, occlusal, lingual views.

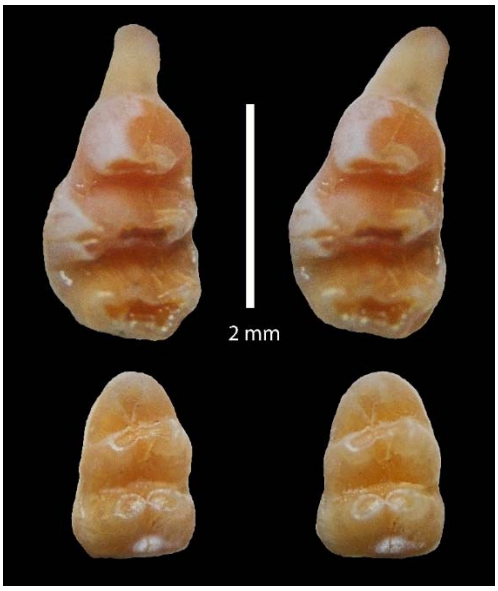

Figure 9. Stereo occlusal views of upper and lower first molars of *Steatomys* sp. from Okongwe 2017 Site.

Figure 10. Stereo views of teeth and a mandible of a small bat (Chiroptera) from Okongwe 2017 Site.

Figure 11. Stereo views of a left lower premolar of a dassie (*Procavia* sp.) from Okongwe, 2017 Site.

Figure 12. Ventral view of a right maxilla of *Procavia* sp. from Okongwe, 2017 Site. The length of the specimen as preserved is 3.5 cm.

Figure 13. Leporidae from Okongwe 2017 Site. Upper molar stereo occlusal view and lower premolar stereo occlusal and lateral views.

Figure 14. Stone (black quartzite) in fossiliferous breccia from Okongwe 2017 site, Kaokoland, Namibia. This stone was likely introduced into the cavity by early hominids and employed as a hammer stone. Note the percussion damage at the pole (pale patches at the top of the black stone).

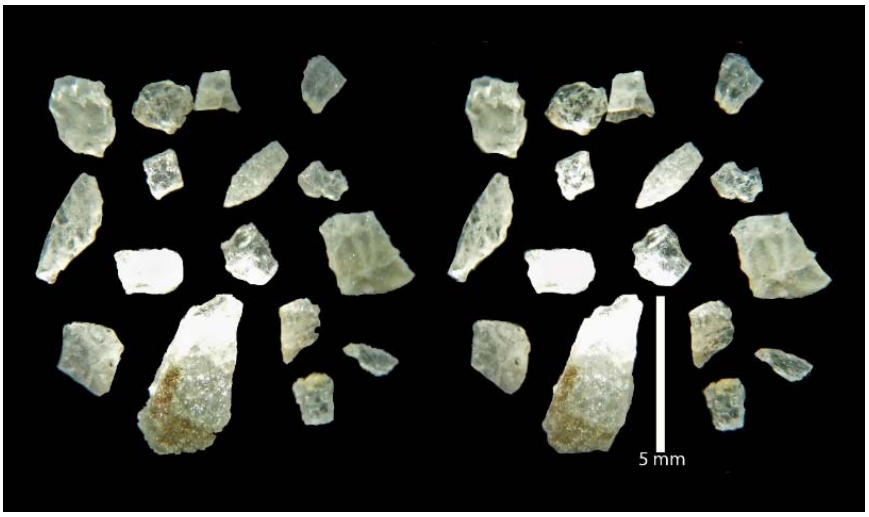

Figure 15. Stereo views of quartz waste flakes recovered from late Pliocene fossiliferous breccia at Okongwe 2017 Site.

Otjitaime

Figure 16. Fossiliferous breccia from Otjitaime, Kaokoland, Namibia. The long bones in this immensely rich concentration of fossils show a preferential alignment indicating transport and deposition by flowing water. These remains are probably locally reworked from disaggregated owl pellets. The fauna indicates a Pleistocene age.

Figure 17. Stereo views of a molar of *Otomys* sp. from Otjitaime, Kaokoland, Namibia. The associated fauna suggests a Pleistocene correlation.

Omatapati

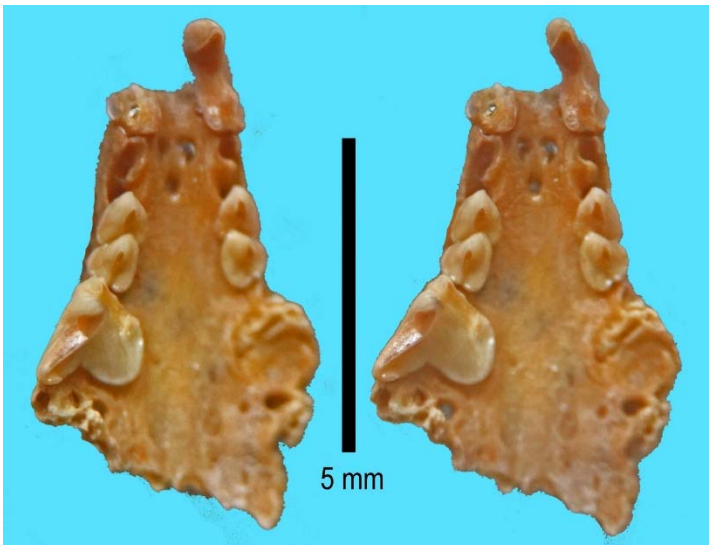

Figure 18. Stereo palatal view of a well-preserved snout of *Crocidura* from Omatapati, Kaokoland, Namibia. The associated fauna is Pleistocene.

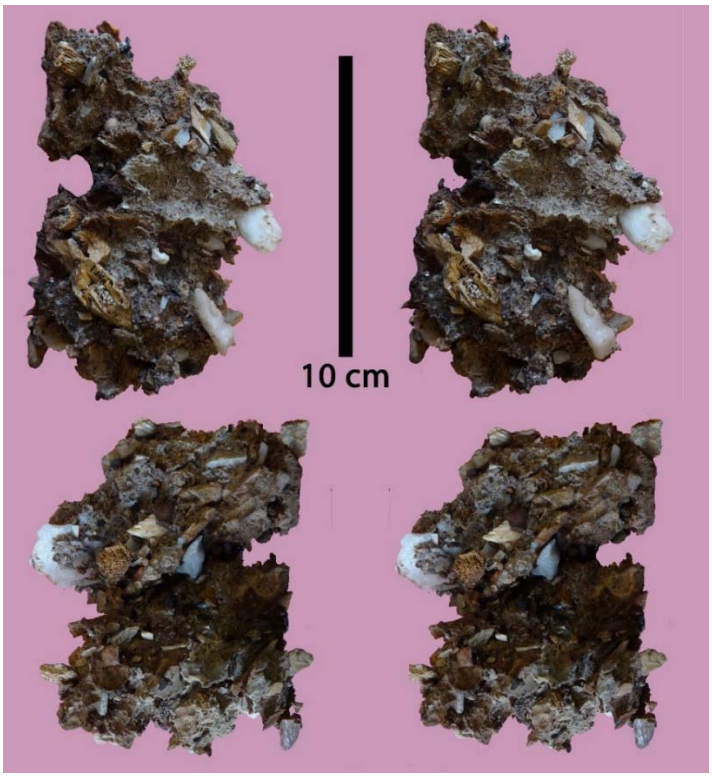

Figure 19. Stereo images of stone tools and bones (some burnt) in breccia from Omatapati, Kaokoland, Namibia – upper and lower views of the same block.

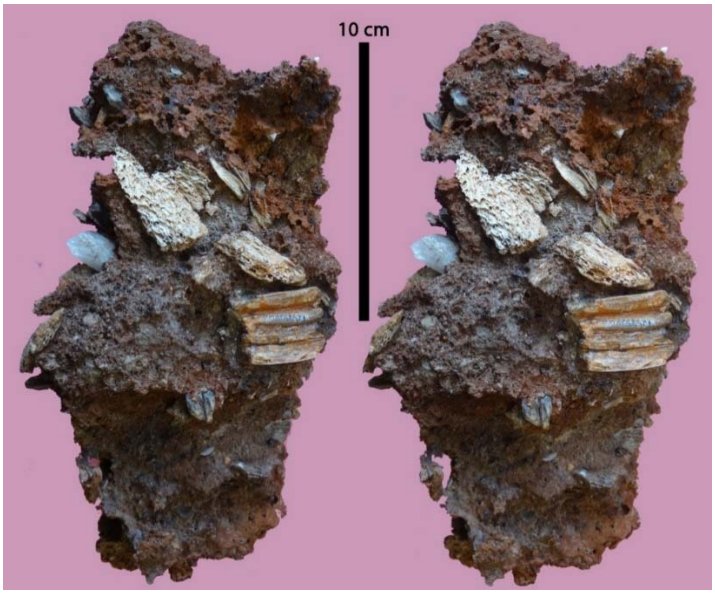

Figure 20. Stereo images a block of breccia from Omatapati, Kaokoland, Namibia, containing an equid tooth, several bones (some burnt) and stone tools.

Discussion and conclusion

The cascade tufas of Kaokoland represent a rich source of information about the faunas that lived in the region during the Plio-Pleistocene. Some of the deposits contain evidence of ancient human activities in the form of lithic implements and burnt animal remains.

The faunal remains indicate that the tufas are latest Pliocene to early Pleistocene, but there is evidence of older tufas beneath or to one side or other of the surveyed examples. Future surveys should examine these potentially older deposits

in detail because they may yield evidence of interest to palaeoclimatology.

The discovery of tiny quartz waste flakes in some of the breccias such as Okongwe 2017 Site while picking through the residues for microfauna was a surprise because the deposits contain no obvious signs of human activities such as stone tools or burnt bones. It is hypothesised that early humans used the cavities in which the breccia accumulated as temporary shelters and while therein manufactured stone tools, leaving behind the waste flakes, but taking the finished tools with them when they left. On occasion, they would also leave behind the hammer stones.

One implication of the serendipitous discovery of waste flakes in the Okongwe breccias, is that researchers working on other Plio-Pleistocene breccias in Africa should be encouraged to keep an eye open for similar occurrences in the samples on which they are working. This may help fill out the map of early hominid occurrences in the continent.

Other Kaokoland Tufas such as the one at Omatapati contain abundant evidence of stone tools and the use of fire, and these sites were likely places of more frequent habitation by early hominids.

It is stressed that many of the faunal remains found in the Kaokoland breccias remain to be identified, this report being in the nature of an interim report rather than a definitive statement about them. Skeletal remains of bats, macroscelidids, birds, frogs and small reptiles abound in the breccias, and there are a few large mammals such as bovids, suids, giraffids and equids.

The Kaokoland tufas are also richly endowed with plant remains (Mocke, 2014) but these were not studied in detail during the 2017 survey.

Finally, the huge volumes of tufa in these Kaokoland deposits suggest that the rates of tufa deposition were greater during the Plio-Pleistocene than they are today (minor deposition at some sites such as Okovanatje Tufa - front cover of this issue of the Communications of the Geological Survey of Namibia - none at all at others). This in turn implies the existence of a different climatic regime in the region during the Plio-Pleistocene, possibly more humid, cooler, or a combination of both.

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