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Article *in* Communications - Geological Survey of Namibia · January 2019

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Note on the fossil fauna and flora in tufa at Ongongo Springs, Damaraland, Namibia

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Knowledge of Quaternary fossils in Namibia is poor, although several sites were identified by Hermann Korn and Henno Martin (Korn and Martin, 1937). The Ongongo Springs in Western Namibia are associated with thick layers of tufa (freshwater carbonate) containing a rich collection of impressions of macroscopic fossil plant leaves, roots, branches and trunks. The leaf impressions show mostly primary venation, making their identification difficult. The absence of organic material within the preserved leaves, roots, stems and trunks renders C14 dating impossible. Dating of tufas has been attempted in the past, but the results are not reliable as contaminations easily occur, due to their porous nature.

At Ongongo a possible sedge leaf was noted as were impressions of the leaves of sycamore fig, *Ficus sycomorus* (Family Moraceae) and mopane, *Colophospermum mopane* (Family Fabaceae). However, no fruits or seeds were found. To date only a single vertebrate fossil has been reported by a visitor to the springs. It was suggested to be the impression of a frog skeleton. Land snails were observed in the tufas and surrounding calcretes and are comparable to the modern genus *Sculptaria*.

Introduction

Ongongo Springs is located at S 19° 08′25.3′′ E 13° 49′09.5′′ ca. 30 km south of the village of Sesfontein in Damaraland and close to another spring and small community settlement called Warmquelle (*German: Hot Spring*), which is located about 45 km south of the Ongongo Springs camp.

It is currently run as a communal camp site by the local inhabitants, and has become an attractive tourist destination.

Travertine is the most common spring deposit, with tufa being a porous variety of travertine. Both consist of $CaCO_3$ and tend to have a creamy to off-white colour. Such spring deposits form by the precipitation of mineral matter dissolved in waters of hot or cold springs which emerge from permeable rocks or from weak zones in the earth's crust, such as faults, fissures and fractures. At the Ongongo site the predominant component of the spring deposit is tufa (Fig. 1).

Upon closer inspection of the tufas at Ongongo, impressions of leaves, casts of twigs and branches, and moulds of molluscs and possibly the bone impressions of a frog could be seen. The organic matter is not preserved however. Due to the porous nature of tufa there are constant additions from the surrounding environment and hence much contamination, making dating unreliable. Dating has been attempted on tufa deposits in the Namib Naukluft without success (pers. comm. Dr A Stone). The tufa may be Quaternary in age, since the leaf impressions identified in the tufa are those of still resident plant species in the area, like the sycamore fig, *Ficus sycomorus* (Family Moraceae) and mopane, *Colophospermum mopane* (Family Fabaceae).

In Namibia there are several sites preserving tufa (Fig. 2), but our knowledge about them and the fossils they preserve is poor. Hermann Korn and Henno Martin (1937, 1955) recorded several sites in Namibia, including a 5m-high hill of fossil tufa on Farm Doornkom 173, 65km SSE of Otjiwarongo, with casts of reeds. They reported a similar deposit on Farm Sukses 133 West of Maltahöhe. Tufa from Farm Blässkranz, hosted calcified casts of the reed, *Phragmites australis*, as well as other plant varieties. Near Outjo, spring waters calcified a honeycomb, estimated to be 1 million years old and at Bushman Hill spring waters petrified filamentous algae, estimated to be 10 000 years old. Miller (2008) reported both ac-

tively forming and fossil tufas at the Nauk-luft Mountains, where calcified plant remains and fresh-water crabs, *Potamonautes perlatus*, have been found. Ward (1987) recorded 17 tufa deposits along the edge of the lower Kuiseb River canyon section, on tributary valley walls and areas where water seeps occur. Ward named these deposits the Hudaob Tufa Formation. Another tufa deposit has been noted at Ruacana (pers. comm. Dr M Pickford).

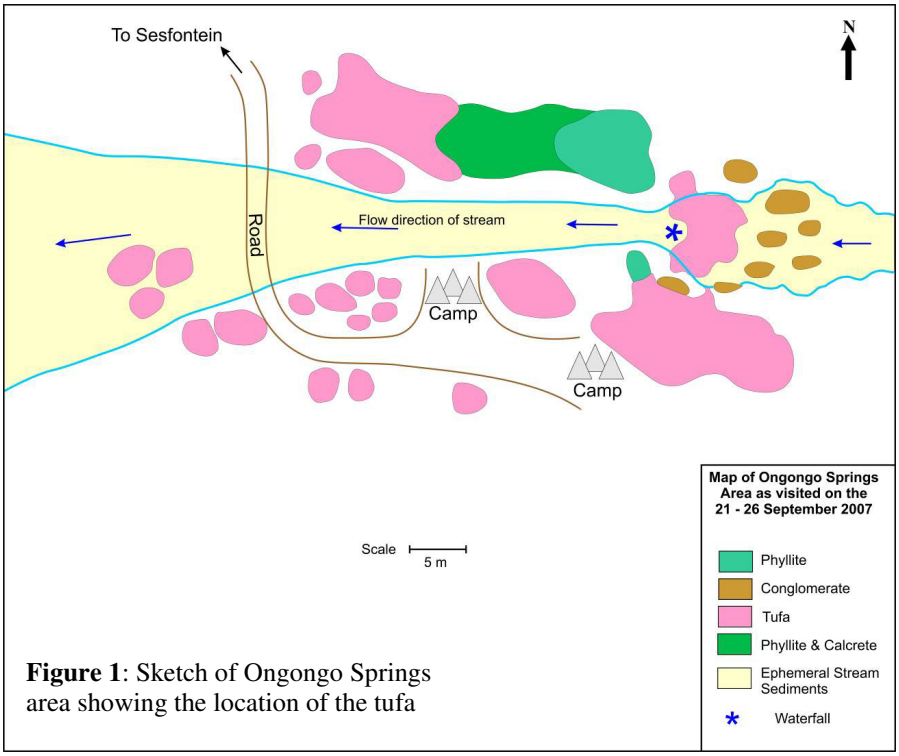

Figure 1: Sketch of Ongongo Springs area showing the location of the tufa

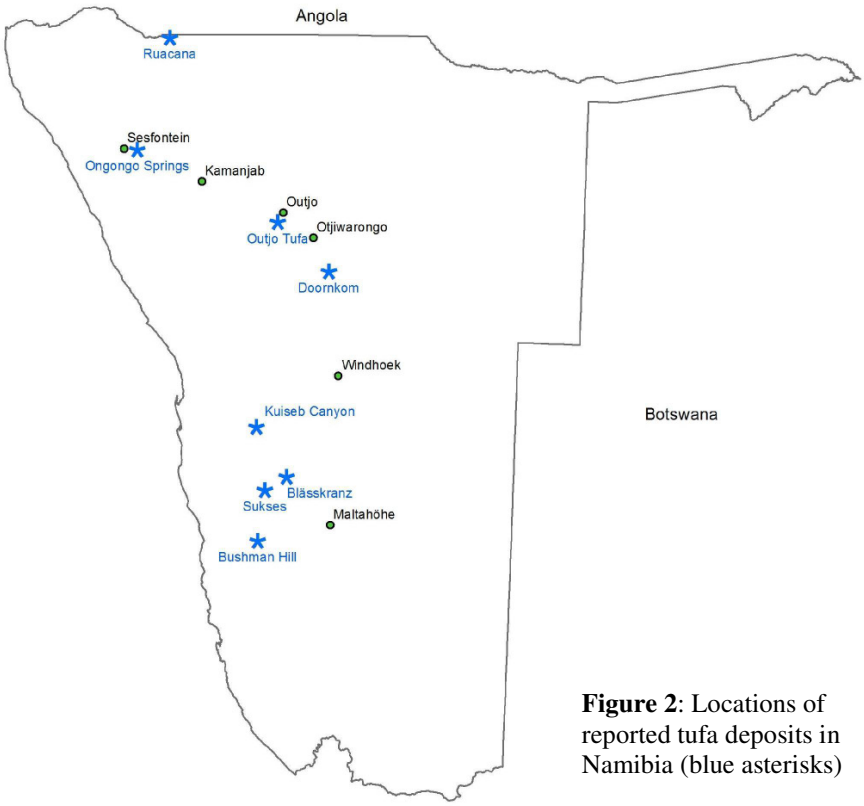

Figure 2: Locations of reported tufa deposits in Namibia (blue asterisks)

Geological setting

The geology of the Ongongo area consists of phyllites and conglomerates of the late Neoproterozoic Sesfontein Formation (Mulden Group, Damara Supergroup) overlain by surficial sediments. At the site of the springs huge boulders of tufa are present within a narrow river cut through the conglomerates of the Warmquelle Member and the grey, pearly phyllites of the Sesfontein Formation (Fig. 3).

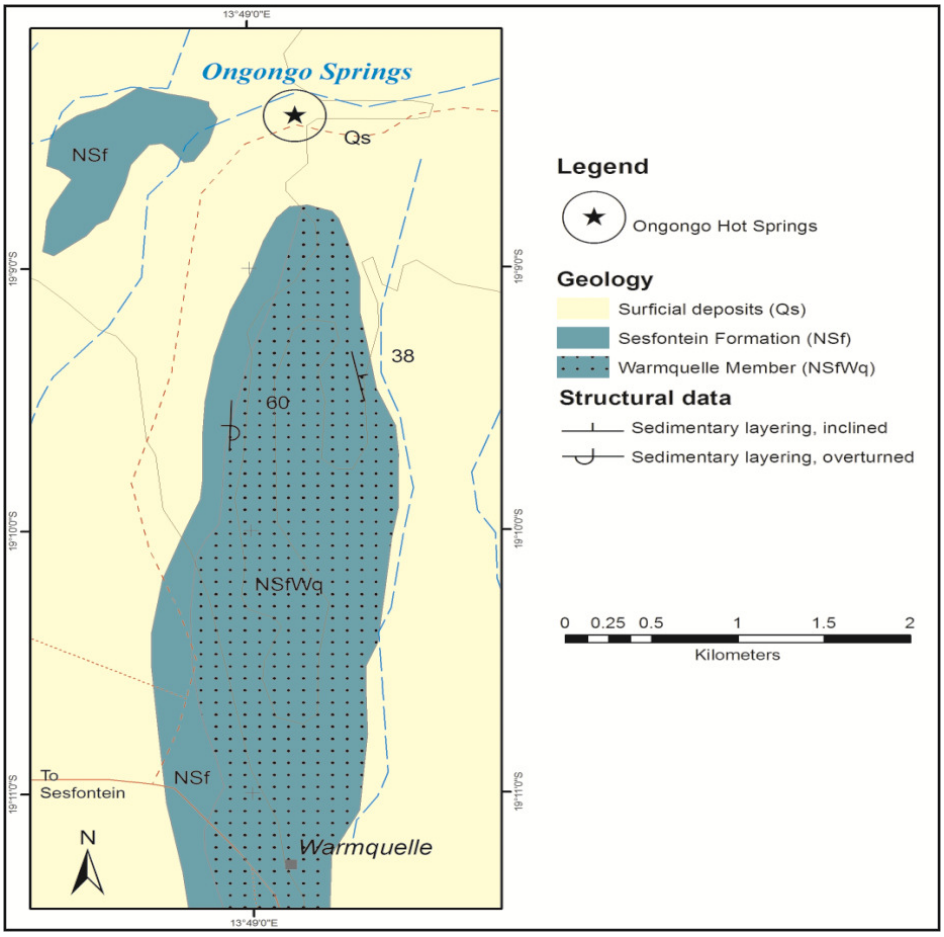

Figure 3: Regional Geology of the Ongongo Springs area

Preservation and description of material

Flora

Leaf impressions were noted within the Ongongo tufas. Roots, trunks and stems were infilled with tufa and form the predominant component of the preserved material.

Comparison of well-preserved leaf specimens with extant plant leaves growing in the area, indicate that the venation characters are particularly similar to sycamore fig and mopane trees. However, carbonaceous material was not preserved and all material was layered randomly with no indication of flow direction.

Ficus sycomorus (Family Moraceae)

Figure 4: Description of material

The apex of the leaf was not preserved. The mid rib and lateral veins are conspicuous with a deep depression where the petiole would have inserted into the base of the leaf blade. The preserved leaf margin is slightly lobate. The base of the leaf blade is slightly heart-shaped. The preserved specimen is comparable in dimensions to that of the extant sycamore fig leaf (Fig. 5), and is com-

Figure 4: Impression of leaf resembling wild fig (scale in cm)

Figure 5: Extant wild fig growing in the Ongongo area (scale in cm)

Colophospermum mopane
(Family Fabaceae)

Figure 6: Description of material

Only the central part of a single leaflet, part of a bi-foliate leaf is preserved. The radiating veins are well preserved and are comparable to those seen in extant species of mopane (Fig. 7) still growing in the vicinity. Other, better preserved specimen were noted during low light situations but were inaccessible for sampling.

Figure 6: Impression of part of a leaflet with radiating veins (scale in cm)

Figure 7: Extant mopane leaf (scale in cm)

?Sedge (Family Cyperaceae)

Figure 8: Description of material

Part of a sedge leaf was preserved with clearly visible parallel veins. Unfortunately no seeds were found, which would have helped with the definite identification of the species. Sedges, such as the one illustrated in figure 9, are growing profusely along the run-off of the spring's area.

Figure 8: Impression of sedge leaf with parallel veins (scale in cm)

Figure 9: Extant sedge living in river course (scale in cm)

Fauna

Sculptaria, terrestrial snail

Figures 10, 11, 12: Description of material

Small impression of snail with flattened whorls, about 8 mm in diameter, preserved in tufa and calcrete, but aperture not preserved, see figure 12. This impression can be ascribed to a terrestrial snail, similar in general morphology to the modern species *Sculptaria* (Pickford, pers. comm.). More recent specimens were observed in finely laminated sediments and calcretes in the immediate area surrounding the spring pool as seen in figures 10 and 11.

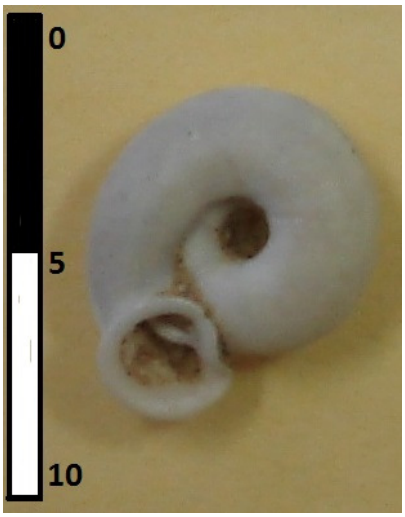

Figure 11: View of aperture opening of *Sculptaria* (scale in cm)

Figure 10: Dorsal view of modern Snail, *Sculptaria* in the area (scale in cm)

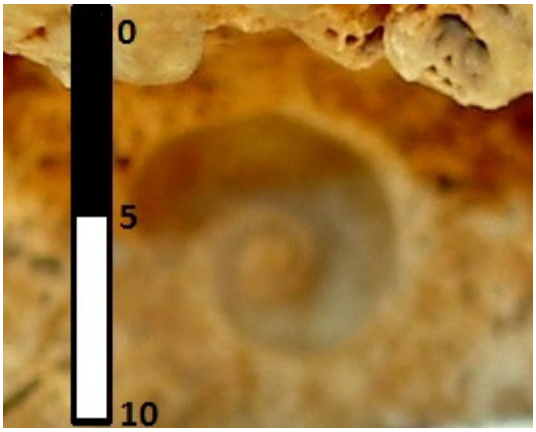

Figure 12: Impression of snail in tufa (scale in cm)

?Vertebrate

Figure 13: Description of material

Impressions of possibly ribs and vertebrae preserved within tufa at the edge of the spring run-off. The impressions were reported and photographed by a visitor to the springs. It has been suggested that the sample is the impression of a frog skeleton based on the interpretation of the shapes of the impressions, which are similar to ribs and vertebrae, as well as the scale of the material (pers. Comm. Dr M. Pickford). However, given the complexity of the specimen and the lack of bone material, this could not be confirmed.

Figure 13: Impression of a possible frog. Photo taken by Martin Prinsloo

Layered *Procavia capensis* dung

Figure 14: Description of material

Well layered *Procavia capensis* dung was observed within one of the hollows of the tufa boulders about 4.5 m above the spring pool. This is well compacted and not too granular in nature, though it would be younger in age than the tufa.

Figure 14: Layered *Procavia capensis* dung

Palaeoecology

According to the vegetation map of Giess (1998), the Ongongo area is located within the Mopane Savanna vegetation type. As the name suggests the dominant plant species of this vegetation type is *Colophospermum mopane*, or mopane tree. The Mopane Savanna vegetation type is closely related to the Mountain Savanna vegetation type, which includes the entire Karstveld and includes *Ficus sycomorus*, or wild fig trees. Both tree species occur in the Ongongo area today.

The mopane can occur either as a shrub or tree. Towards the western Namib, where the annual rainfall ranges from 50-100 mm, the mopane is often confined to depressions or dry riverbeds (Giess, 1998). In areas of higher annual rainfall ranging from 500-600 mm, towards Ovamboland and the Grootfontein District, the mopane usually grows as a tree.

The nearest rainfall monitoring station to the Ongongo area is located at Kamanjab which has an average annual rainfall of 303.5 mm (data from the Meteorological Division, Windhoek). The tufa outcrop area under observation is located in a river bed which receives more moisture compared to surrounding areas, due to the Ongongo spring and often contains standing water pools. According to the National Drought Task Force (1997) climate classification based on annual rainfall averages, the Ongongo area has an arid to semi-arid climate.

The average annual temperatures for the Ongongo area range from 20 ˚C to more than 22 ˚C (Mendelsohn *et al*., 2002). According to the same authors the average maximum temperatures during the hottest month of the year for the same area ranges from 30 ˚C to 34 ˚C. According to (Sweet, 1999) the annual potential evapotranspiration rate for Namibia exceeds annual precipitation by ratios of up to 30:1, excluding deserts, resulting in the aggravation of drought conditions throughout most of the country.

Conclusions

The fossiliferous tufa described here is located at S 19° 08′25.3′′ E 13° 49′09.5′′. In order to establish an age for the impressions, it is necessary to develop reliable dating techniques for spring deposits.

Fossils identified include

- *Ficus sycomorus* (Family Moraceae)
- *Colophospermum mopane* (Family Fabaceae)
- ?Sedge (Family Cyperaceae)
- *Sculptaria,* terrestrial snail (Invertebrata)
- ?Frog (Vertebrata)
- *Procavia capensis* dung (Vertebrata)

This biota indicates the presence of the Mopane Savanna vegetation type, an arid to semi-arid climate, an average annual rainfall of 50 mm to above 300 mm, and high rates of evapo-transpiration at the time of deposition, similar to today's climatic conditions in that area.

Acknowledgements

The author would like to thank Gunther Von Schumann of the Namibia Scientific Society for his help with collecting specimens and exploring the area of Ongongo Springs as well as Dr Ute Schreiber and Dr Martin Pickford for helpful suggestions. The cartography section in the Geological Survey of Namibia was kind enough to digitize figures one and two.

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