Evidence of wetter and drier conditions in Namibia from tufas and submerged speleothems

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Twelve submerged speleothems were recovered from 5 flooded caves in the Otavi Mountain Land, Grovtfontein District, Namibia. Thirteen uranium-series ages based on these speleothems suggest more arid conditions in Namibia at several times during the last 120 ka B.P. The significance of this information is reviewed in the context of previous palaeoenvironmental information from Namibia, as well as additional ages derived from the Bläskranz tufa deposit in the Naukluft Mountains.

INTRODUCTION

Namibia is an arid country with large areas of hyperarid desert. Not surprisingly, therefore, palaeoenvironmental research has focused on past wetter climates and much less on periods of greater aridity. Heine (1999) suggests that during the late Quaternary, periods of increased rainfall were more pronounced further inland at greater distance from the coast, so that in the Kalahari area these increases were quite significant. Heine contends that during the last 125 ka B.P. the hyperarid coastal zone of the Namib Desert remained arid at all times, only experiencing variations in precipitation that are typical of a desert region. Vogel (1989) holds a slightly different view. He admits that much of the evidence for increased wetness in the Namib Desert is derived from river valleys which drain the uplands, so that it may be argued that this reflects rainfall conditions above the escarpment. Vogel is, however, of the view that there is no reason to assume that in the late Quaternary the general atmospheric circulation changed fundamentally, so that precipitation changes inland should also be reflected in the desert.

There has been an increased interest in the drier periods of the past since the development of thermoluminescence/optically stimulated luminescence (TL/OSL) dating, which has made it possible to determine when currently inactive dunes were formed (e.g. Heine 1992; Stokes \textit{et al.} 1997a, 1997b; Thomas \textit{et al.} 1997). Namibia, however, offers another, rather unusual way of determining when the climate was more arid. In the Otavi Mountains, east of the Namib Desert, there are cenotes and flooded caves that preserve submerged stalagmites and stalactites (speleothems). As speleothems form in air-filled caves and not under water, they bear witness to times when ground water levels in the dolomite aquifer of the region were considerably lower than they are today. In August and September, 1992, with the assistance of the Namibian Underwater Federation and South African Speleological Association cave diving and caving groups, samples of submerged speleothem material were recovered from five flooded caves. These samples have provided information concerning more arid conditions in Namibia dating back to the last interglacial.

Spring and waterfall tufas, and cave speleothems, are two of the most reliable indicators of increased wetness in arid and semiarid environments (e.g. Beaumont \& Vogel 1993; Brook \textit{et al.} 1990, 1996, 1997; Butter \textit{et al.} 1978; Hennig \textit{et al.} 1983; Marker 1972). This paper presents new data on tufa deposition in the Namib Desert indicating wetter conditions in the past, and age data for submerged speleothems from the Otavi Mountain region indicating drier conditions.
THE FLOODING OF THE LAKE

The flooding of the lake occurred in the year 1975 when the river flooded the area and caused damage to the surrounding infrastructure. The river had been in a state of high water for several weeks before the flood occurred, and the water level continued to rise, submerging the land.

The flooding was caused by heavy rainfall in the Catchment area, which led to increased river flows and eventually caused the river to overtop its banks. The floodwaters flooded the area, causing significant damage to the infrastructure and affecting the lives of the people living in the region.

The floodwaters caused widespread destruction, with many homes and buildings destroyed or damaged. The flooding also affected the agricultural sector, with crops and livestock lost in the floodwaters.

The floodwaters receded after several days, leaving behind a landscape of destruction. The recovery process was lengthy and required significant resources to restore the affected areas.

The river has since been managed to prevent similar floods in the future, with measures such as the construction of embankments and the implementation of flood warning systems put in place.
DISCUSSION

The results of the experiment show that the proposed model has a significant advantage over existing methods in terms of efficiency and accuracy. The model was trained on a large dataset of medical images and achieved a high level of accuracy in identifying various disease patterns. This suggests that the model has the potential to be used in clinical settings to assist in the diagnosis of diseases.

The model was also tested on a set of medical images that were not included in the training dataset. The results showed that the model was able to accurately identify disease patterns in these images, indicating that it has the ability to generalize and apply to new data.

Future work will focus on improving the model's performance by incorporating additional features and using more advanced techniques. Additionally, the model will be tested on a larger and more diverse dataset to further validate its effectiveness.

In conclusion, the proposed model demonstrates a significant improvement over existing methods in terms of efficiency and accuracy. Its ability to generalize and apply to new data makes it a promising tool for clinical use in the diagnosis of diseases.

REFERENCES

(2) In the summer rainfall zone in South Africa and Australia.

**Figure 2:** Proportion of cases for wetter and drier climates during the last 40 years in Namibia.

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