Loan 872 - Palaeolithic mega-lakes and early human occupation of the Kalahari, Botswana, Southern Africa

Abstract

DGPS were employed in the field within a project to investigate archaeological artefact distributions, topography and landforms of the western Makgadikgadi basin, Kalahari Desert, Botswana. Logistical problems in both 2008 and 2009 reduced the intended survey activity in scope and geographic extent. Nonetheless, detailed data on the 3D spatial relationships of extensive MSA artefact scatters, barchan dune remnants and basin shorelines have been achieved. While data analysis continues, outputs to date include two papers in preparation and a major landscape archaeology grant application to AHRC.

Background

This loan relates to a preliminary geoarchaeological investigation that aimed to establish the potential to develop a major research project linking late Quaternary environmental change in central southern Africa, specifically the Makgadikgadi basin, Botswana, with the evolving but as yet systematically uninvestigated archaeological record of the region. The origins of this work lie in for example NERC initiatives such as the EFCHED project, which sought to understand relationships between human evolution and environmental change. The Makgadikgadi basin has been occupied during the late Quaternary on several occasions by a palaeolake that at its greatest extent covered over 60,000 km². A chronology for the lake phases has been developed using OSL dating and has resulted in 5 publications to date (research predating the application for the loan). The loan related specifically to understanding past conditions and the archaeological record in part of the basin itself.

The loan related to a two year (2008 and 2009) pump-priming project supported by the University of Oxford’s Boise Fund. The overall objectives of the project were:

1) The production of an OSL chronology for the pan floor barchan dune and lake-floor deposits;
2) Systematic DGPS mapping and recording of the occurrence of artefacts in the Ntweletwe Pan, western Makgadikgadi, (the region of the lake system with the greatest known concentration of lithic artefacts);
3) Establishment of the spatial (DGPS) and temporal (OSL dating) relationship between artefact distributions and (i) relict shorelines for which a chronology is now published, and (ii) basin floor landforms (which are to be investigated);
4) Contingent on the outcomes of objectives 1-3, to develop, with both regional and Oxford archaeologists, an informed and detailed proposal for a major archaeological investigation.

Thus the loan specifically related to objective 2), which feeds in, with other data, to objective 3). Objective 4) has now been met with an application made to AHRC (submitted March 2010) for a major landscape archaeology research project in the region. This project is entitled ‘Landscape archaeology of central Botswana: How did late Quaternary hydrological dynamics affect environmental use in the MSA?’
The general location of the study area is shown in Figure 1. Figure 2 shows Ntwetwe Pan.

**Figure 1.** Makgadikgadi basin. The black rectangle outlines the study area (Ntwetwe Pan).

**Figure 2.** Ntwetwe pan, showing an example of a major beach ridge and the Boteti river course, which traverses the ridge to enter the pan. Inset shows an example part of the pan floor, from a Google Earth Image. ‘Islands’ are barchan dune remnants. BPS588 and base stations are indicated.

**Survey procedure.**

Surveys were conducted in July 2008 (2 week loan) and July 2009 (three week loan). DGPS loan equipment was sent by DHL to Botswana: in 2008 delays at Customs during import led to the loss of 4 field days. DGPS was used to survey lake-floor and topographic landforms that lie within it
(figure 2) as well as associated palaeolithic artefact sites. Surveys were desired at the sub-metre scale due to the low relief of the basin floor, the topography varying by only a few metres. Surveys were carried out by mounting DGPS rover equipment on to quad bikes and for surveys conducted in 2009 to a 4-wheel drive truck. Surveys were referenced to a Botswana Government trig point within the field area. Two further trig points were considered for use as reference points. One however, could not be located in the field whilst the other was too distant from the areas surveyed in 2008/2009. Beacon 588 was used as the reference point to establish two ‘base-stations’ that were respectively used in each field season. Base station 1 (used in 2008) was located on a barchan feature on Ntwetwe Pan close to the cutline used to access field sites to the south and west. Base station 2 was located at the research camp in 2009 because flooding of Ntwetwe Pan denied access to base station 1. Base stations were each surveyed for a minimum of 19 hours. Elevation data in the Botswana survey system is rudimentary. Despite extensive inquiries and investigation at the Department of Surveys and Lands Headquarters, the only elevation data available for this area is that published on topographic maps dating to 1978. There is no historical database (height, longitude and latitude) of the pre and post independence survey data that was used to construct the 1:50000 orthophoto maps that cover our area of investigation. Therefore our referencing of base stations was to the published elevation data on these maps (912m asl). Latitude and longitude values from the DGPS were not constrained because the primary data of interest in this study was relative elevation in this flat landscape.

In 2008 the area outlined in Figure 2 was surveyed, including landforms suggested to be barchans dune forms artefact scatters previously believed to be associated with them. Plans for 2009 to complete and extend this survey to two other parts of the basin, were completely confounded by local environmental conditions. In the week preceding the scheduled survey, after equipment had been shipped, Botswana received precipitation equivalent to 50% of the mean annual total in two days (during the dry season). As a result the basin was flooded in most areas to depths up to 2 metres. Consequently a rescheduling of surveying was made, to focus primarily on the basin-peripheral ridge topography to the north and west of Ntwetwe.

**Processing and data quality**

Post processing was carried out in the field using the Leica Geo Office post processing system. Measurements were tied to the reference beacon 588 surveyed in 1978 (912m asl). The precision of this reference is unknown but since the overall aim of this survey was to investigate the relative elevation relationships between landforms and archaeology, the absolute error is less critical in this instance. Repeat measurements suggest a maximum latitudinal and longitudinal variation of 0.000015 (1.7m) and 0.0000924 degrees (0.96m) respectively. Average absolute deviations however were 0.34 m in the horizontal and 0.25m in the vertical. Measurement during times of poor satellite coverage exceeded these values with maximum vertical differences at these times up to 1.1m. These data were not included in the survey. The resulting uncertainty
of the presented measurements is therefore generally below +/-0.5m and adequate to address the questions being investigated in this study.

**Interpretation to date and preliminary findings**

*Landform morphology*

In Grove (1969) apparent concentric lines, visible from aerial photographs, on the flanks of the ‘barchan-like islands’ on the floor of Ntwetwe Pan was attributed to retreating water levels: i.e. these features were hypothesised to be shallow shoreline forms. In air photographs (Fig 3b) they also appear to be picked out by vegetation differences. DGPS survey to establish the elevation of these distinctive concentric features was carried out as a contribution to explaining their occurrence. This demonstrated that these concentric features do not have consistent elevation (Fig 3c) but do have significant topographic expression and are not merely expressions of vegetation differences. However the lack of consistent elevation of these features makes it less likely that they are shoreline beach ridges. Sedimentary analyses of material from these features could allow us to test hypotheses that these features relate to sedimentary structures associated with former barchans dune accretion.

*Figure 3:* Location (a) and detailed survey data of Ntwetwe landforms currently being analysed in ArcGIS (b) Vegetation differences noted on the landform surface from aerial photography (c) also have a topographic expression on the ground when measured using DGPS. The implication of the lack of consistent elevation of the arcuate feature (dashed white line) for formative processes is discussed in the text.

*Landform evolution*

In a systematic analysis of Kalahari landforms, Grove (1969) suggested the swarm of arc-shaped features that clustered on the western side of the Ntwetwe pans, the former lake bed of the mega-lake Makgadikgadi, were in fact degraded barchans dunes representing...
a period in Botswana’s past when the climate was drier and windier than present. Since then, it has also been suggested these landforms could be subaqueous in nature, similarly formed by dynamic fluid processes but during times when lake levels were high. Until now these hypotheses and the implications that they have for the associated archaeology have not been investigated. Optically Stimulated Luminescence (OSL) dating provides a reliable record of landform evolution in environments lacking organic material (and thus alternative proxy data and dating methods) (e.g. Burrough et al; 2007). Sample preparations and measurements for over half of the 65 samples taken from key geomorphological sites have now been measured at the Oxford Luminescence Dating Laboratory (OLDLab) and together with the DGPS elevation data and sedimentological analyses, form the basis of two papers in prep to be submitted to the journals *Palaeogeography, Palaeoclimatology, Palaeoecology* and *Geomorphology*. These papers will suggest that whilst some of the landforms of the Ntwetwe pan floor have a younger aeolian signature and morphology and which consistently and interestingly mark the end of an arid period in the late Holocene in Botswana, the more complex landforms in the west of the basin include much older units and encompass an admixture of aeolian and lacustrine landforms. The former of these conclusions has important consequences for anthropological and archaeological debates on the causes of cultural and demic diffusion during the Iron Age. Overall however, the findings of this survey have both spatially and temporally demonstrated that there is little association between the topographic landforms that lie in the basin and the much older archaeology that surrounds them on the pan floor.

**Archaeological Survey**

95 localities yielding artefacts were identified in the survey. All of these sites were located on the pan floor at elevations between 903.3 m asl and 904.3 m asl (Fig 5) with no sites being found on elevated landforms located within the Ntwetwe region. Preliminary identification suggests these artefact scatters are predominantly Middle Stone Age (MSA) in typology. Much of this material is debitage with only a few cores present. Surface artefacts are variably preserved with some evidence of chemical weathering at some sites.

**Figure 5:**

*Example of one of the large ‘handaxe-like’ artefacts found on the pan floor of Ntwetwe*

Optical dating of underlying lake bed material suggests sands were laid down during former lake phases up to 140ka ago. Archaeological material sits within and on an undated unit above this. Deflation of this surface and lake floor lowering is a significant possibility (Bryant et al; 2007). A small component of the archaeological material is of
global interest and possibly represents the largest hand-axes ever-found (Fig 5). On the basis of these preliminary findings, a major collaborative AHRC bid has been submitted that brings together 4 international institutions (the National Museum of Botswana, the human origins centre at Wits University and the University of Oxford). This project aims to fully characterise the Makgadikgadi artefacts within the Southern African record and to integrate them into the increasingly detailed environmental record.

Conclusions and recommendations

The two seasons of survey, intended to cover 6 weeks, instead generated less than two weeks field time due to delays in shipping equipment to Botswana in 2008 and the exceptional wet conditions in June-July 2009. Nonetheless, the surveys that were conducted are generating data that increase information of the relative height relationships between pan floor, barchan dune and shore features, the relationship between archaeological distributions and landforms, and the morphometry of the barchan features. When combined with other data, particularly from OSL dating and in the future from archaeological analyses, this will provide new and significant information on the palaeoenvironments/early human use of the Makgadikgadi basin.

Publications (including proposed, in preparation, submitted, in press and published)


Presentations on this research have been made at:
- The National Museum, Botswana, 2008;
- Geoarchaeology Conference, University of Sheffield, 2009;
- The Southern Connections Congress, Bariloche, Argentina, 2010.

Other:
- One undergraduate dissertation has benefited from the data.
- The findings are contributing to the landscape component of the Botswana government’s Makgadikgadi Management Plan.
- A major grant application, ‘entitled ‘Landscape archaeology of central Botswana: How did late Quaternary hydrological dynamics affect environmental use in the MSA?’ has been submitted to AHRC, March 2010, to which this loan contributed.

Publications refered to in text

