

Eurolanet TA Scientific Report

PROJECT LEADER

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Project Title: Investigation of geomorphic features in Ntwetwe pans, Makgadikgadi Basin, Botswana, using Ground Penetrating Radar: implications for Martian surface landforms

Scientific Report Summary.

(plain text, no figures, maximum 250 words, to be included in database and published)

The Makgadikgadi Basin in Botswana, covering an area of 16,000 sq.kms, is the largest salt pan in the world. Its formation is related to a tectonic episode in the Tertiary, possibly linked to the East African Rift System (EARS), which caused the subsidence and infilling with water and sediments. Changes in climate and tectonics eventually led to the drying up of the ancient lake, leaving behind the expansive salt pans we see today. The basin consists of two major pans, namely Sua and Ntwetwe, with a combined area of approximately 8400 sq.km. These pans are mostly flat but feature distinct geomorphic elements such as mounds and shoreline features that can be easily identified through satellite imagery. In the western part of the Ntwetwe pan, there are numerous mounds with an east-facing convex side and an average height of 5m. These mounds are primarily composed of fine-grained sands, calcareous sand, and occasionally contain bivalve shells. While several theories have been proposed regarding their origin, the internal sedimentary structure of these geomorphic features remains unknown.

On Mars, conical mounds are significant morphological features that have been observed and mapped in various regions. The Noachian-Hesperian climate change on Mars resulted in the deposition of crudely layered sediments in the equatorial region, where fluctuations in groundwater played a crucial role. These layered sediments, known as Equatorial Layered Deposits (ELDs), contain numerous mounds that were exposed due to impact craters. The objective of this study is to investigate the mounds in the Ntwetwe pan using geophysical methods, particularly Ground Penetrating Radar (GPR). By employing GPR, we aim to image the internal structure of these mounds and other geomorphic features, with the ultimate goal of understanding the formation and preservation of similar structures on the Martian surface.

Several sites within the Ntwetwe pan were selected for GPR survey, primarily along east-west and north-south profiles. These sites are located in the northwest, northeast, and central parts of the pan. Over a period of six days, approximately 23 kilometers of GPR data were collected. Most of the surveys utilized 50MHz antennas, while three lines were acquired using both 50MHz and 30MHz antennas to attain penetration depth as well as resolution. Preliminary results indicate clear imaging of the top 15 meters over the mounds and delta sites. However, reflections away from these structures appear to be weaker, possibly due to the high moisture content of clays on the pan floor, requiring further processing works to achieve better results.

Full Scientific Report on the outcome of your TNA visit

We encourage you to add figures to your report, which should be approx. 1 page of text plus figures.

A number of sites have been studied in Ntwetwe pan, Makgadikgadi basin with a goal of imaging the internal structure of surface geomorphic features in the basin. The study mainly focused on mounds in the western part of the study area and on a delta found close to center of the basin. In addition, 2D profiles were acquired over structures previously mapped using aeromagnetic and Electrical Resistivity Tomography (ERT) methods. The survey was done using Mala ProEx acquisition system (Figure 1). The system uses rough terrain antennae with an in-line configuration for 30 and 50MHz frequencies. The preliminary processing steps applied to data include correction applied to setup geometry, recover gain and suppress noise and adjust static shifts. The result from the survey has shown that the GPR data was effective in mapping up to a depth of ~15m in the study area. The imaging result shows better quality over the studied geomorphic features compared to over the pan floor.

Sites studied during the fieldwork

Site 1: this site is located close to center of the basin (Figure 2). It was selected based on a previous study that mapped faults using aeromagnetic and ERT methods. Two lines with a NW-SE trend were surveyed, with a separation of 2.7km between the lines. Both 30 and 50MHz antenna were used in this survey to increase depth of penetration and to get higher resolution along the same line. The total distance surveyed is 2.26kms. The results show poor to good reflections.

Site 2: the site is located in the western part of the basin (Figure 2). It was acquired over mound structures RM-4 and RM-5. These mounds were previously studied using cores drilled to the bottom of the mounds and geological log from this study will be used to correlate reflections with geological contacts. Two lines were acquired over RM-5 and three lines were acquired over RM-4 with a general E-W and N-S trend. Since the 50MHz antenna was providing better resolution and depths reaching much deeper than mound bottom, the antenna was used to acquire all the data at the site. The total distance surveyed is 3.63kms. The results show poor to good reflections.

Site 3: the site is located in the southern central part of the basin (Figure 2). It was acquired over an east- west trending delta system. The survey was designed to cross distributary channels at high angles over the delta plain. Previously this delta was inferred from a satellite image, and hence this survey is the first ground work to investigate the delta. A total of four lines were acquired over the delta with three lines trending N-S in different parts of the delta and one E-W line connecting cross lines. Similar to the other the surveys, a 50MHz antenna was used and the total distance surveyed is ~11kms. The results show good reflections.

Site 4: this site is located in the eastern part of the Ntwetwe pan (Figure 2). The line runs NW-SE and crosses a fault mapped previously using aeromagnetic and ERT methods. Only one line was surveyed, with a total length of 1.36km. Both 30 and 50MHz antenna were used in this survey to increase depth of penetration and to get higher resolution along the same line. The result shows poor to good reflections.

Site 5: this site is located in the northeastern part of the Ntwetwe pan (Figure 2). It was acquired over mound structures (NT-1 to NT-5), relatively small in dimensions compared to RM mounds in site 2. The survey was acquired using a grid of east-west and north-south lines to image the mounds and to investigate relationship if any between the mounds. These mounds were previously studied using cores drilled to the bottom of the mounds and geological log from this study will be used to correlate reflections with geological contacts. The 50MHz antenna was used to acquire all the data at the site. A

total of seven lines were surveyed in this site and the total surveyed distance is 4.7kms. The results show good reflections.



Figure 1 Mala ProEx GPR acquisition system in use during site 1 survey. (Image: N Shaw, 2023)

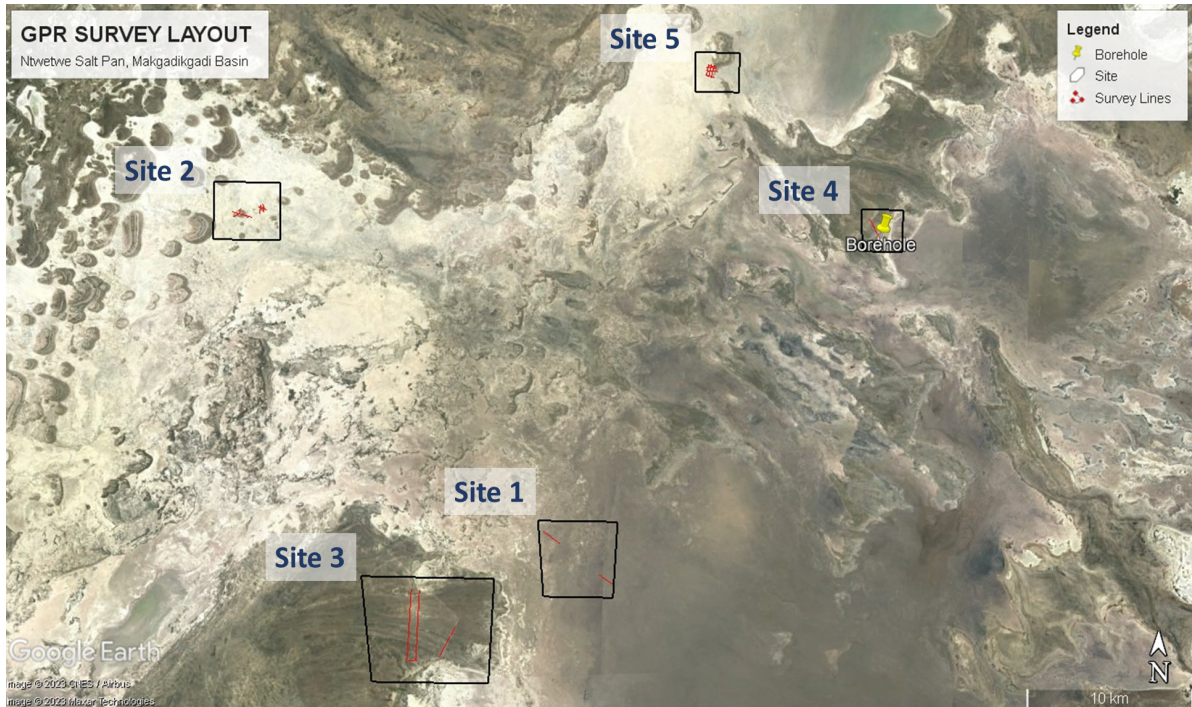


Figure 2 GPR survey sites and profiles.

- Give details of any publications arising/planned (include conference abstracts etc)


The results of this work will be presented in conferences such as the Europlanet Science Congress. The results are also expected to be published in two renowned peer-reviewed journals.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 05-07-23 Arrived: 05-07-23	06-07-23	1	6	2	13-07-23	Departed: 14-07-23 Arrived: 14-07-23

The host is required to approve the report agreeing it is an accurate account of the research performed.

<u>Host Name</u>	Fulvio Franchi
<u>Host Signature</u>	
<u>Date</u>	24/07/23

- Project Leader confirmation

Do you give permission for the full version of this TA Scientific Report (in addition to the 250 word summary) to be published by Europlanet 2024 RI on its website and/or public reports? YES

<u>Project Leader Name</u>	Mebatseyon Shawel
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Project Leader Signature

A handwritten signature in blue ink, appearing to be 'M. Li', written in a cursive style.

Date

23/07/23