Europlanet TA Scientific Report

PROJECT LEADER

Project number: 22-EPN3-127
Name: MAXIME PINEAU
Home Institution: **Laboratoire d'Astrophysique de Marseille (UMR-CNRS-7326)** Pôle de l'Étoile Site de Château-Gombert 38, rue Frédéric Joliot-Curie 13388 Marseille Cedex 13 (FRANCE)
TA Facility visited: TA1-PFA.5 - Makgadikgadi Salt Pans, BOTSWANA

COLLABORATOR

Name: SIMON GOUZY
Home Institution: **Laboratoire de Planétologie et Géosciences (UMR-CNRS-6112)** Bâtiment 4, Faculté des Sciences et Techniques, Nantes Université 2 rue de la Houssinière – BP 92208 44322 Nantes Cedex 3 (FRANCE)

Project Title: SILCRETE DEPOSITS OF THE KALAHARI DESERT AS POTENTIAL ANALOGS FOR SILICA-RICH DEPOSITS ON MARS

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

Hydrated silica occurs in various forms depending on the geological context and as such are good tracers for paleoenvironmental reconstitutions on Earth and Mars, as well as a prime exobiological target. Observed on Mars since the early 2000's, hydrated silica minerals have been used to describe aqueous geological processes in diverse regions. However, geological origins of some deposits are still misunderstood because no satisfactory terrestrial analogues were found. Likewise, the exobiological potential of hydrated silica as a prime host of Mars organic matter remains to be fully ascertained. The Makgadikgadi Salt Pans show a very high potential to be considered as a terrestrial analogue site for Mars hydrated silica, especially in fluvio-lacustrine geological settings. Maxime Pineau (LAM), Simon Gouzy (LPG), plus 2 other colleagues (Vassilissa Vinogradoff (PIIM) & John Carter (LAM)), spent 9 days at the pans (15 different locations) and sampled numerous samples (over 80s) of silicified clastic sedimentary rocks (i.e., silcretes) and conducted preliminary visible-near infrared spectra with a portable spectrometer. Field observations and spectral analyses confirm the large amount of amorphous to (micro-)crystalline silica in the samples, along with different clays (e.g., glauconite, sepiolite) and salts (e.g., sulfates). This type of mineralogy, possibly indicating a formation in a fluvio-lacustrine context in semi-desert environments, is reminiscent of some silica-rich deposits on Mars in locations interpreted as potential paleo-lakes. These observations will be completed by further laboratory measurements (spectroscopy, microscopy, geochemical and organic analyses) in order to perform advanced studies in terrestrial geology, comparative planetology (e.g., Mars' geology) and astrobiological exploration.

Full Scientific Report on the outcome of your TNA visit

Between 20 and 27 August, 2023, we visited 15 locations in the Makgadikgadi Pans area (Nwetwe and Sua Pans), along the Nata, Old Boteti and Boteti rivers (Fig.1). We sampled ≈80 silica-rich rocks (i.e., silcretes) in context of fluvio-lacustrine geology. Some visible-near infrared spectra of the surface of the samples were acquired using an ASD FieldSpec portable spectrometer (0.35-2.5µm) to evaluate the mineralogy of the rocks. The samples were collected for further analysis in the laboratory; a total of ≈37kg of samples was labeled and packed for shipment to LPG, Nantes, France.

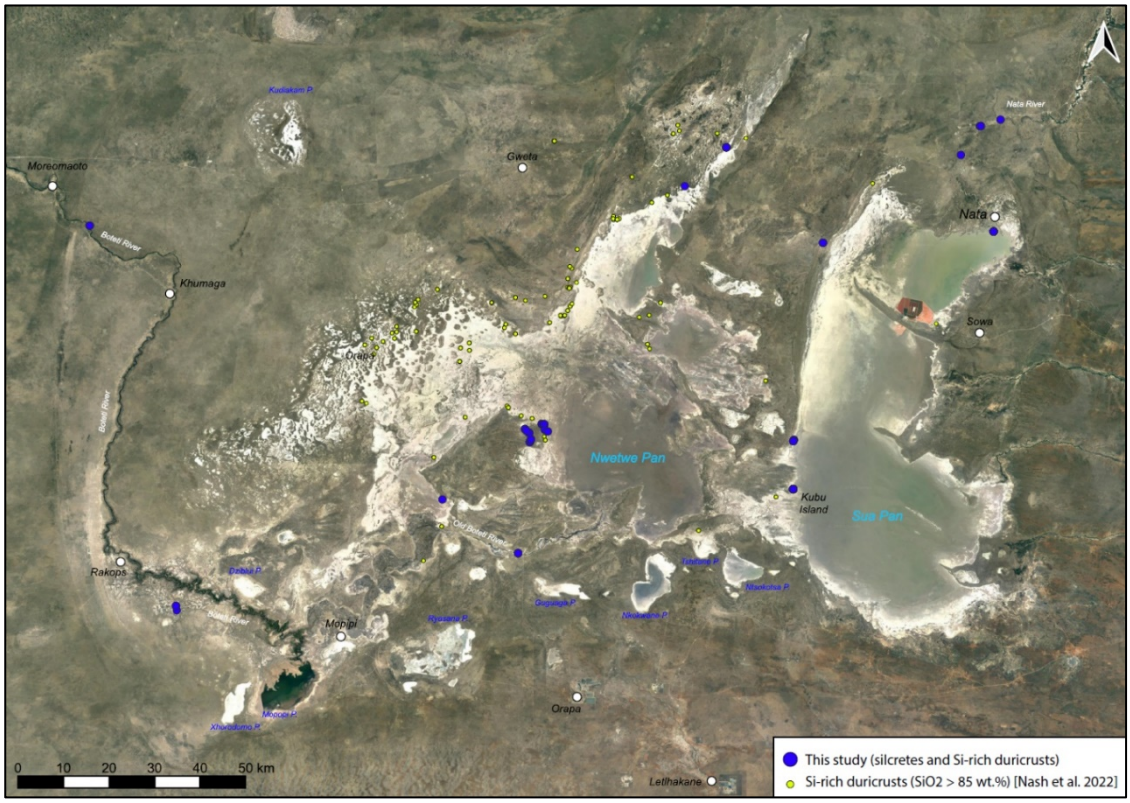


Fig.1 | Satellite view of the Makgadikgadi Salt Pans with sampling locations (blue circles). The yellow circles on the map represent silica-rich rocks (silcretes and duricrusts) locations from a publication by Nash et al. (2022).

Based on macroscopic observations on the field, most of the samples are silicified/indurated clastic sedimentary rocks and consist of coarse-grained quartz-rich sandstones and conglomerates with a fluvio-lacustrine origin (Fig. 2). Clasts in the sedimentary rocks can be of various types, fragments of quartz pebbles or sometimes opaline silica to detrital fragments of other silica-rich clastic sedimentary rocks (i.e., sandstones, conglomerates, etc.). Matrix between the clasts is of different nature from one sample to another; it can be either opaline or microcrystalline silica and sometimes consists of clay-rich cemented materials. Depending on the nature of the clasts and matrix, the samples exhibit different colours: from white to creamy-white shades, from dark-toned shades of green, brown, and black. Some samples also have light-brown laminae on their upper surface. Samples consisting of translucent opaline and/or microcrystalline silica plates were also taken.

First VNIR observations permit us to identify several mineral phases that are present in our samples. Hydrated opaline and/or microcrystalline silica is present in most of the samples along with various clays (e.g., sepiolites) and sulfates in mixtures with silica or as (clayey) salty crusts. The presence of the mineral glauconite, suggested in the literature for these silcretes, giving this pale green colour, is verified in our spectra and support the fluvio-lacustrine origin in a semi-desertic environment for these silica deposits. Petrographic observations of thin sections and laboratory measurements (Infrared and Raman spectroscopy, X-Ray Diffraction, Electron microscopy, Geochemical Analyses) will permit to give detailed investigation of the mineralogical compounds of the samples. With that information, we will be able to better understand the silicification of these clastic rocks. These observations will be compared to the observations of silica-rich deposits at the surface of Mars (OMEGA & CRISM imaging spectrometers), and possibly supported by remote sensing data from the Makgadikgadi area (e.g., EnMap data). We also aim to better understand the exobiological potential of this type of deposit by studying the sequestration of various organic compounds in these silicified rocks. To do so, microscopic observations will be associated with extraction procedures of the organics for further analysis by chromatography technics.

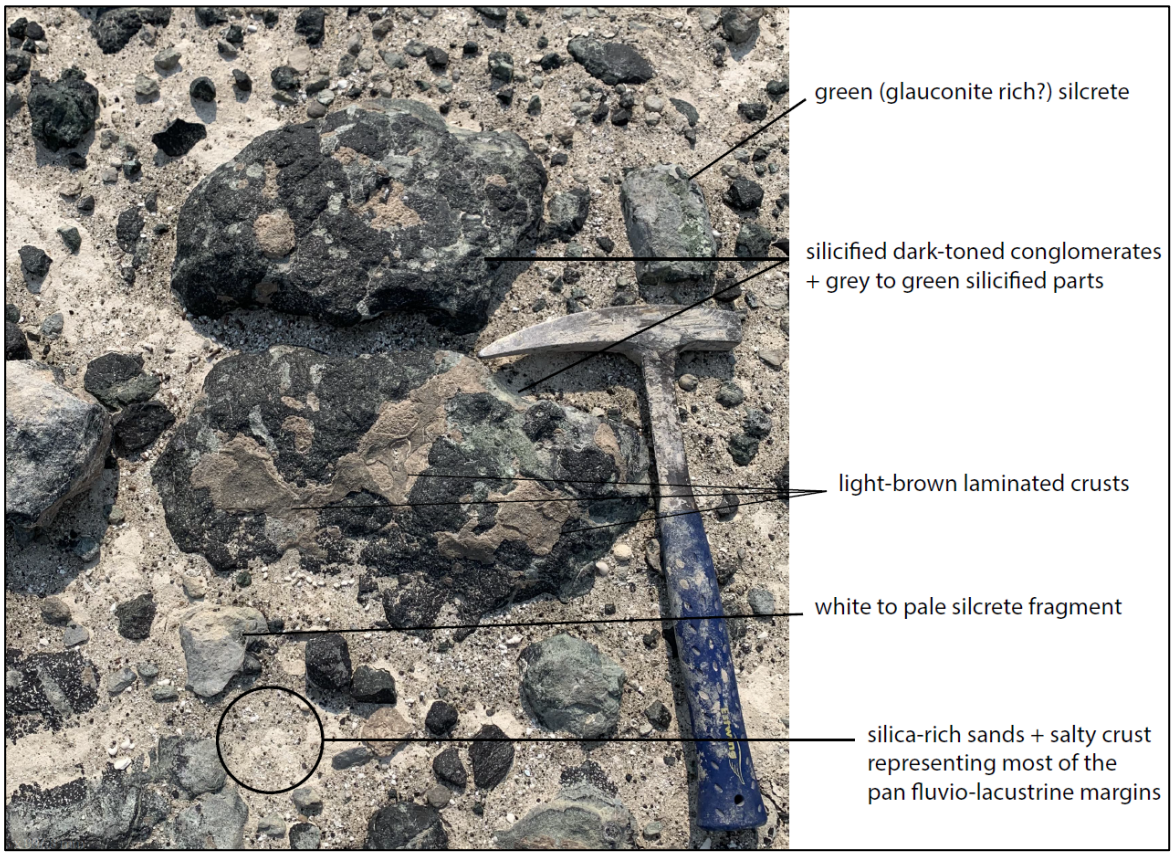


Fig.2 | Example of a silcrete boulder outcrop at the Old Boteti River Paleo-Delta on the western margin of the Nwetwe Pan. Various examples of coloured silcretes are indicated, topped in places by a light-brown laminated crust. The geological hammer gives the scale.

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

As we sampled large number of samples and expect numerous analyses from the laboratory, we are confident that we can carried out several peer-reviewed papers.

For example, our results could contribute to future publications focused on diverse objectives:

- the geology and mineralogy of the Makgadikgadi silcretes and interpretation of their possible fluvio-lacustrine origin and silicification processes involved in their induration (1 paper),
- the relevance of the silcretes from the Makgadikgadi basin as terrestrial analogues compared to silica-rich Martian deposits that could possibly linked to paleo-lakes (1 paper),
- the potential for sequestration of organic compounds in these silcretes and their possible biogenic characteristics (1 paper).

The sampled collected will also contribute to several consequent databases and catalogues of well-characterized rocks and minerals. These data would be available to the scientific community as terrestrial references in various fields of study, from terrestrial mineralogy and geology to planetology and exobiology perspectives.

We expect to present the first reliable results from field study and laboratory analyses in international conferences dealing with planetology and/or exobiology next years, from early-to-mid 2024.

- Host confirmation

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

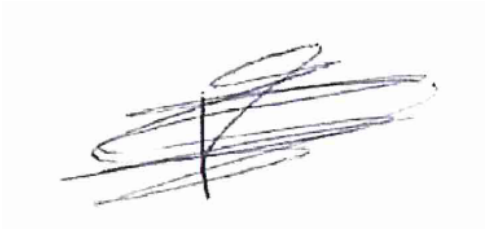
Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 19/08/2023 Arrived: 20/08/2023	21/08/2023	1	7	1	28/08/2023	Departed: 31/08/2023 Arrived: 01/09/2023

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

Host Name	**FULVIO FRANCHI**
Host Signature	
Date	**15/10/2023**

- 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 / ~~NO~~

Project Leader Name	**Maxime PINEAU**
Project Leader Signature	
Date	**10/10/2023**