Europlanet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN-061
Name: Ganna Portyankina
Home Institution: DLR Berlin Rutherfordstraße 2 Berlin 12489 Germany
TA Facility visited: Planetary Environment Facilities at Aarhus University

Project Title: CO2 ice crystals formation under conditions in the martian polar regions: influence of substrate properties and temperature gradient

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

The main goal of most recent tests conducted at the Planetary Environment Facilities at Aarhus University was to condense CO_2 from the chamber's atmosphere under Martian conditions onto a specially designed set of different surface materials (martian regolith simulant, glass beads of various sizes, dust). We investigated ranges of temperatures and pressures and observed the texture of the created CO_2 ice. Our goal was to determine if CO_2 deposits over regolith/glass beads/dust differently compared to brushed aluminium. We have observed that various properties of substrate did not considerably alter the deposition morphologies of CO_2 observed in our previous work. Most importantly, we find that under conditions usual for Martian polar areas in fall and winter, CO_2 ice always deposits as a translucent slab. Under deviating conditions, i.e. colder temperatures and lower pressures, CO_2 crystals assume different shapes including opaque slab and highly porous multi-crystalline. Such CO_2 crystalline morphologies require further investigations, because of their relevance to icy satellite surfaces as well as CO_2 cloud formation.

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.

In tests conducted at the Planetary Environment Facilities at Aarhus University in years from 2011 through 2018, we have observed that under Martian conditions the CO_2 ice preferably deposits in the form of slab ice while , under conditions slightly different from typical Martian CO_2 creates various crystalline structures. Morphologies of some of these structures are not clearly identified and the theoretical explanation of why CO_2 deposit take such shapes is still lacking. In these tests CO_2 ice was deposited directly on the top surface of the cooling plate, i.e. on the cooled brushed aluminium substrate.

In the most recent series of tests, our goal was to condense CO_2 from the chamber's atmosphere onto a specially designed set of different surface materials (martian regolith simulant, glass beads of various sizes, dust). We investigated ranges of temperatures and pressures and observed the texture of the created CO2 ice. Our goal was to determine if CO_2 deposits over regolith/glass beads/dust differently compared to brushed aluminium.

Fig. 1 shows a close up of the 4 different substrates that were used during the tests: coarse regolith, glass beads, fine regolith, and regolith covered by dust. Each of the 4 substrates were carefully deposited on the top of the cooling plate to the thickness of 2 particles (thus the coarser substrate resulted in a thicker layer). Fig. 2 shows same substrates during CO_2 ice deposition. CO_2 deposition started at the lower boundary of the substrates, i.e. on the cooling plate and spread through the substrates upwards.

We have observed CO_2 depositing as a transparent slab ice as well as different crystalline textures ranging from opaque slab to single crystals of various shapes. The environmental conditions for all these types of ice were the same independently if depositing over a substrate or brushed aluminum plate.

This leads us to the conclusion that substrate did not considerably alter the deposition morphologies of CO_2 observed in our previous work. Most importantly, we find that under conditions usual for Martian polar areas in fall and winter, CO_2 ice always deposits as a translucent slab while under colder temperatures and lower pressures, CO_2 crystals assume shapes that we best can describe as hollow triangular prisms. These CO_2 crystalline morphologies require further investigations, because of their relevance to icy satellite surfaces as well as CO_2 cloud formation.

Laboratory studies are often the only way to acquire empirical data on the physical state, properties, and behaviour of different types and species of ices under conditions found on other planetary bodies. Physical models can then be based on, refined and validated by the laboratory-results and used to understand remote- sensing data from planetary missions. Our results will advance the analysis of remote-sensing data and various models considering CO_2 ice condensation-sublimation related processes.

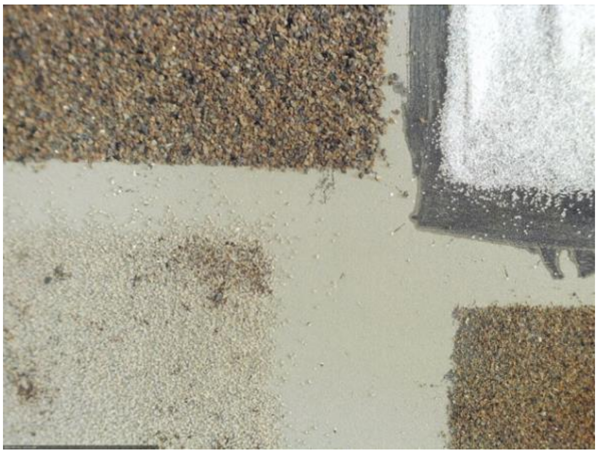

Fig. 1: Close up of the 4 different substrates. Clockwise from upper left: coarse regolith, glass beads, fine regolith, and regolith covered by dust.

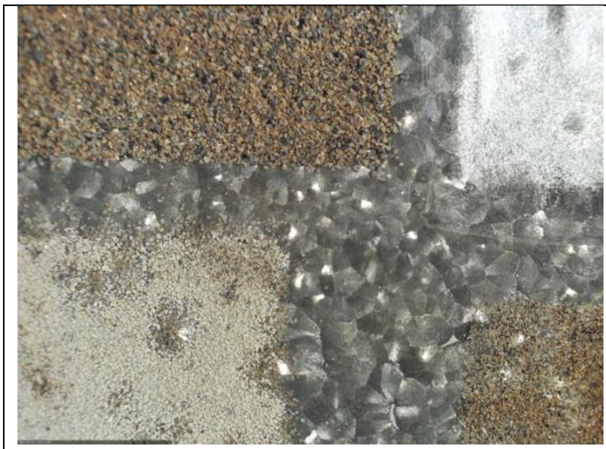

Fig. 2: Close up of different substrates during CO_2 deposition.

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

G. Portyankina, J. Merrison, J.J. Iversen, C.J. Hansen, 2023 “CO2 Ice Deposition on and Its Interaction with Regolith: Laboratory Studies”, 54th Lunar and Planetary Science Conference, LPI Contrib. No. 2806

Planned to be submitted to Planetary Science Journal or similar: G. Portyankina, J. Merrison, J.J. Iversen, C.J. Hansen, “Laboratory studies of CO_2 ice deposition under conditions of Martian polar regions and connection to CO_2 basal sublimation hypothesis”

- 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: 30-04-2022 Arrived: 1-05-2022	2-05-2022	[0-3]	5	[0-2]	6-05-2022	Departed: 7-05-2022 Arrived: 8-05-2022
Departed: 22-01-2023 Arrived: 22-01-2023	23-01-2023	[0-3]	4	[0-2]	27-01-2023	Departed: 27-01-2023 Arrived: 27-01-2023

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

Host Name	**Jonathan Merrison**
Host Signature	
Date	**7-10-2023**

- 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	Ganna Portyankina
Project Leader Signature	
Date	6.10.2023