Europlanet TA Report

Please see Annex 1 below

Infrastructure short name	Installation ID	Installation short name
Distributed Planetary Simulation Facility (DPSF)	TA2-4	CSS

PROJECT LEADER – APPLICANT 1

Project number: 17-EPN3-057		
Name: Zuriñe Yoldi		
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Legal Status* UNI		
***UNI** (University and other higher education organisations) **RES** (Public research organisation (including international research organisation as well as private research organisation controlled by a public authority) **SME** , **PRV** (Other Industrial and/or profit Private organisation) or **OTH**		
Tel: +41 31 631 32 33	**Fax:** ---	**E-mail:** zurine.yoldi@space.unibe.ch
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New user: N	**Number of visits:** 2	**Nationality:** Spanish
Affiliation: PlanetS-NCCR	**Researcher Status:** UND	**Activity Domain***: Physics

CO - APPLICANT – if applicable

Name: Romain Cerubini		
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New user: Y	**Number of visits:** 1	**Nationality:** French
Affiliation: PlanetS-NCCR	**Researcher Status:** UND	**Scientific background***: Physics

**Please select the most appropriate description from the list below:*

Physics	Chemistry	Life Sciences & Biotech	Earth Sciences & Environment

Mathematics	Energy	Material Sciences	Engineering & Technology
Social Sciences	Humanities	Information & Communication Technology	

How did you hear about us?

~~Website~~	~~Advertising email~~	Colleague	
Other:-			

HOST (TA Facility) **–** Please be accurate. This information is required for reporting.

Name:	**Host laboratory:**
	Institut de Planétologie et d'Astrophysique de Grenoble (IPAG) Bât. OSUG A 414, Rue de la Piscine - Domaine Universitaire 38400 St. Martin d'Hères France
Start Date of visit	11 June 2018
Finish Date of visit:	22 June 2018
No. of days: Please do not include travel days, this is lab/field access only	8
Applicant/Co-applicant reimbursed? Please indicate Yes or No	Yes

VISITORS TO LAB (If different from above applicant and co-applicant) **–**

Name:	**Affiliation:**	**Date**
Antoine Pommerol	University of Bern – NCCR PlanetS	11-13 and 20-22 June

<u>Project Title</u> – **Measurement of the infrared reflectance spectra of icy Solar System analogue material**

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

Ices are ubiquitously present at the surfaces of the bodies of the Solar System. Through sublimation and condensation cycles, ices act as active agents in the climate of the planets or the shaping of the surfaces. As a consequence, detecting, identifying and characterising these ices is a priority task in planetary sciences. We have used the *Cold Surfaces Spectroscopy Facility* (CSS) of the Institut de Planétologie et Astrophysique de Grenoble (IPAG) to study the evolution of the near-infrared reflectance of water-ice and dust mixtures as ice sublimed.
We have prepared analogues for icy soils on comets (using a dark basaltic powder as regolith analogue), Mars (regolith analogue: JSCM-1) and icy moons (refractories: sulphur, epsomite). First, we have condensed atmospheric water on the regolith analogues and measured the effect of the sublimation of the frost on the reflectance. Second, we have prepared intimate mixtures of the refractories with water ice and measured their reflectance as water ice sublimed.
A quantitative analysis of the changes in the reflectance of the samples will allow us assessing the presence of ice in different forms on the planetary surfaces from the study of their reflectance.

Full Scientific Report on the outcome of your TNA visit

Approx. 1 page

Back in 2017, we submitted a proposal to study the near-infrared reflectance of mixtures of ice and dust with a focus on the application of our data on small bodies and Mars. Since then, the need of the scientific community for laboratory data has not ceased to increase. Scientists studying the surface of the icy moons are now interested as well on boosting the quantity and quality of laboratory measurements of the reflectance of icy samples. This is why we have added mixtures relevant for the icy moons to our catalogue of samples during this TNA campaign.

Ice is known to be an active agent on the surface of the planetary bodies. Because of this, we have focused on the evolution of the reflectance of icy samples as they lose their ice by sublimation. We have considered two modalities of ice/dust mixtures: *i)* stratigraphic mixtures, i.e. frost-deposition on a substrate, and *ii)* intimate-mixtures, i.e. salt-and-pepper mixtures. Once prepared, we have forced the sublimation of the ice by modifying the temperature and/or pressure of the chamber. As ice sublimed, we measured the reflectance of the samples.

We have used a dark basalt as a **cometary** soil photometric analogue. Although this material is brighter than comets, it is useful to understand the effects of the sublimation of frost from dark and red-slopped materials. Hence, we condensed atmospheric water onto our basalt to achieve a millimetric layer of frost onto the sample and proceeded to measure its reflectance. At a fixed temperature of 200 K, we varied the pressure to force the sublimation of frost. Figure 1 shows the evolution of the reflectance of the sample as frost sublimed. We observe different effects of frost on the reflectance depending on the part of the spectrum, e.g., frost rises the reflectance of the powder at wavelengths shorter than 2.6 μm but reduces it at longer wavelengths. We complemented these data with the acquisition of a picture of the sample before each reflectance measurement, which will allow us to relate the changes of reflectance to the physical evolution of the sample. Furthermore, these data complement measurements on similar frost previously performed at the University of Bern.

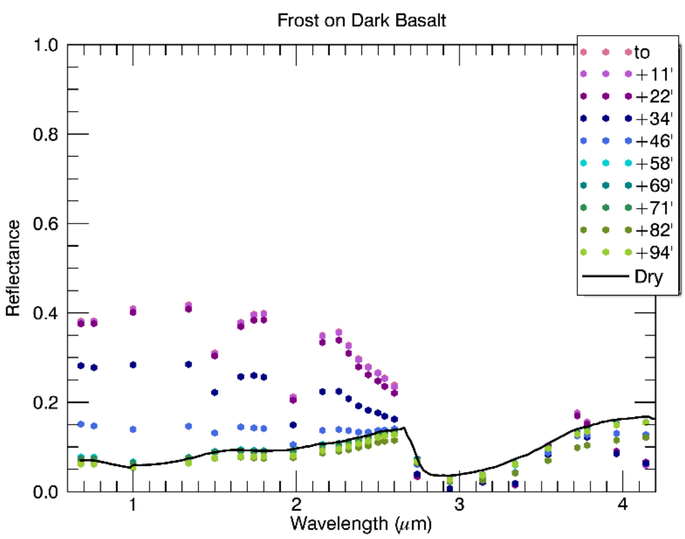

Figure 1 Reflectance evolution from the sublimation of a millimetric layer of water frost from a basaltic powder

As a **Martian** analogue, we used the JSCM-1 regolith simulant. We proceeded with frost-sublimation experiments (analogues to the ones shown in Figure 1), and we also condensed frost on intimate mixtures of SPIPA-B water ice (d ≈ 70 ± 30µm) with 20 wt% of JSCM-1. Figure 2 shows the sublimation of frost from the icy mixture. Because the calibration shown here is preliminary, we still see some calibration artefacts, e.g., a jump in reflectance at 1 µm. The quantification via spectral parameters (e.g., band depth or spectral slope) will allow us assessing the strategies to differentiate from remote, whether frost is covering our dry and icy soils.

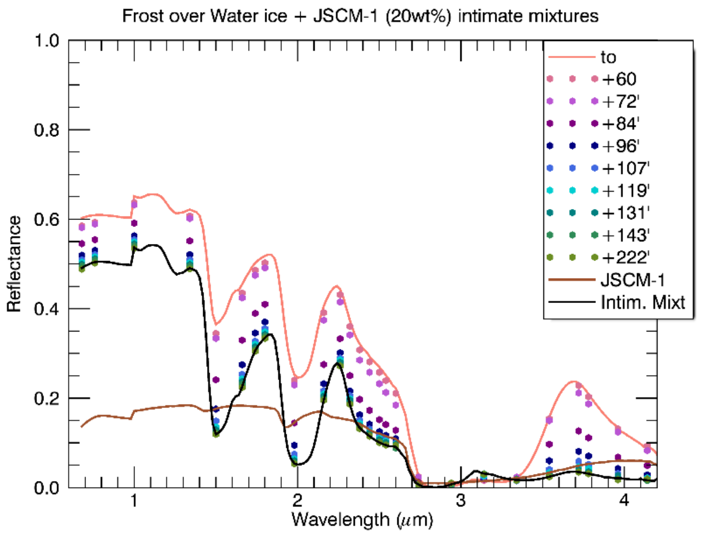

Figure 2 Reflectance evolution from the sublimation of a millimetric layer of water frost from a water ice and JSCM-1 intimate mixture.

Finally, we prepared an intimate mixture of SPIPA-B ice with sulphur (25wt%) and another one of SPIPA-B ice with epsomite ($MgSO_4.7H_2O$, 10wt%) as plausible analogues of the surface of the **icy moons**. In these two cases, we were interested to observe the effects of temperature on the reflectance of the mixtures; this is why we programmed changes of temperature of 20 K (from 170 to 80 K). Figure 3 shows the thermal evolution of the sulphur-bearing sample. The sublimation of ice changes the spectra from a highly hydrated state to an almost dry one. Moreover, the strong absorption complex of water at 3.0 µm is weakened and lets the absorption band of Sulphur at 3.4µm appear. At the end of the experiment, when we removed the sample from the instrument, we found a residue of sublimation consisting of a 1mm layer of sulphur.

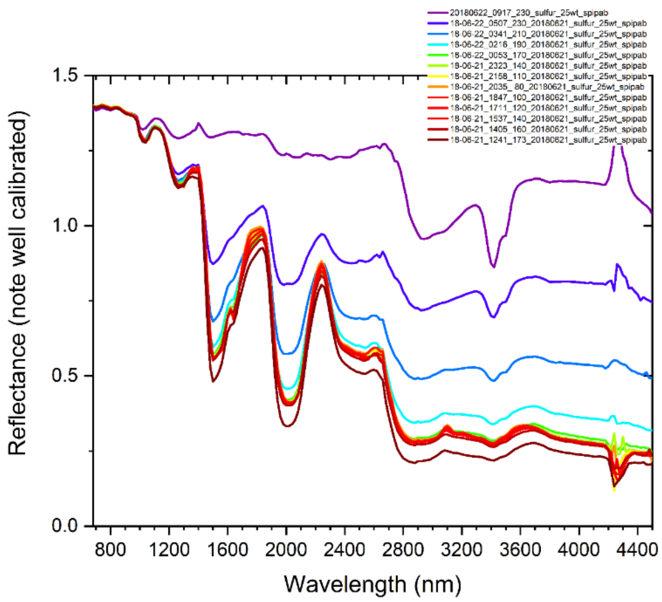

Figure 3 Reflectance evolution from the sublimation of ice from an intimate mixture of water ice and sulphur.

These frost and sublimation experiments will be extremelly useful for the community studying the activity of ices on the bodies of the solar system.

Please include:

- <u>Publications arising/planned</u> (include conference abstracts etc)

Talk at EPSC, 2018: *Reflectance of low-albedo dusts and water ice mixtures. Application to the surface of comet 67P. (Yoldi et al.)*
Talk at EPSC, 2018: *Experimental, spectral and colour analysis of H2O and CO2 ices and dust samples. Application to Martian, icy surfaces. (Yoldi et al.)*
Poster at EPSC, 2018: *Laboratory reflectance measurements of water ice/salt mixture irradiated by electrons. (Cerubini et al.)*

Some of the measurements presented here will also appear in a paper with provisional name "Laboratory reflectance studies of low-albedo dusts and water ice mixtures" that will be submitted to a high-impact journal.

Please add the Europlanet official Acknowledgement to each publication and dissemination activity

"Europlanet 2020 RI has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654208"

- Host approval

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

The two managers of the facility, Bernard Schmitt (CNRS/IPAG, Grenoble), and Pierre Beck (UJF/IPAG, Grenoble), approve the report and agree that it is an accurate account of the research performed during the visit of the Cold Surface Spectroscopy facility (DPSF/CSS/TA2-4).

Annex 1

Access provider short name	*Short name of infrastructure*	*Installation*		*Installation Country code*
		ID	*Short name*	
INTA	PFA	TA1-1	Rio Tinto	ES
IRSPS	PFA	TA1-2	Ibn Battuta	IT
Matis	PFA	TA1-3	Iceland	IS
INTA	PFA	TA1-4	Tirez Lake	ES
IRSPS	PFA	TA1-5	Danakil	IT
DLR	DPSF	TA2-1	PEL	DE
MUG	DPSF	TA2-2	IMRF	AT
AU	DPSF	TA2-3	PEF	DK
CNRS	DPSF	TA2-4	CSS	FR
UJF	DPSF	TA2-4(8)	CSS – 3rd party	FR
VUA	DPSF	TA2-5	HPHT	NL

OU	DPSF	TA2-6	LMC	GB
NHM	DPSF	TA2-7	PMCF	GB
VUA	DAFS	TA3-1	GGIF	NL
CNRS	DAFS	TA3-2	HNIF	FR
CNRS	DAFS	TA3-3	SRIF	FR
OU	DAFS	TA3-4	HS50L	GB
OU	DAFS	TA3-5	LFS	GB
OU	DAFS	TA3-6	CSSIA	GB
WWM	DAFS	TA3-7	RNTSI	DE
CNRS	DAFS	TA3-8	IPF	FR