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Executive Summary / Abstract:
The Planetary Science and broader scientific community demonstrated they were and remain highly motivated to undertake research at the TA laboratory facilities offered by Europlanet. All facilities bar one received applications and after peer review, funds were allocated to visits to all the TA2 labs bar one. The COVID pandemic initially curtailed travel and in many cases the number of people allowed to enter labs. In addition, travel restrictions limited travel. The number of visits completed is therefore lower than planned. Extensive work was undertaken to set up virtual visits. The feedback is that these can be highly effective at generating data but are not as effective at teaching and in generating longer term working relationships. Due to the lack of a physical presence of the visitor(s) in the lab, the work requires additional resources and generally is conducted over a significantly longer period of time. This means that multiple virtual visits have been started (e.g. 5 at GGIF VUA) but not completed as the work is carried out along with on-going work. A total of 16 visits have been completed with others part way through. New lab facilities were added to TA2, two high resolution microscopes with capabilities to study organic material, KBSI, South Korea.

The TA management recognised the requirement for access to TA facilities particularly by early-stage researchers (ESR) on fixed term contracts. A Fast Track TA Call was set up to allow ESR access to many of the TA facilities. Twenty-four applications were made in the Fast Track call TA2 facilities. Peer review of the proposals was completed in January 2022 and results of the Call will be published in February 2022. The period of time allocated for completion of TA visits awarded in Call 1 & 2. The period of time allocated for completion of TA visits awarded in Call 1 & 2 has been extended until the end of 2022.

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1 Explanation of WP3 Work & Overview of Progress

a. Objectives

Objective 3: to provide access to well-characterised terrestrial field sites and a unique set of laboratory facilities capable of simulating the wide range of environments encountered on planetary bodies.

b. Explanation of the work carried in WP

Task 3.1 – Management (VUA, UNIKENT, CNRS, AU, DLR, NHM, OU)

Task 3.1 has coordinated the provision of access to simulation and analytical laboratory facilities during Year 2 Management of the TA2 programme, along with TA1, is overseen by the Transnational Access Sub-Committee (TASC). For details of management implementation activities, see Task 2.1.
Work carried out in collaboration with NA1 in Year 1 of the project has scoped out a reciprocal agreement between Europlanet 2024 RI and the Korean Basic Science Institute (KBSI), which will allow European researchers access to 11 facilities in Korea and Korean researchers to access Europlanet 2024 RI facilities from Call 2 onwards.

Table 1: TA2 Distributed Planetary Laboratory Facilities (DPLF)

European TA2 Distributed Planetary Laboratory Facilities	Korea Basic Science Institute (KBSI) Facilities
1. Geology and Geochemistry radiogenic and non-traditional stable Isotope Facility (GGIF), VUA, NL	**High Precision Isotope Geochemistry / Cosmochemistry and Geochronology Lab**
2. High-Pressure, High-Temperature Laboratory, VUA, NL.	26. Sensitive High Resolution Ion MicroProbe / SHRIMP-IIe / MC
3. Petrology-Mineralogy Characterisation Facility (PMCF), NHM, UK	27. Isotope microscope with SCAPS imaging detector
4. Planetary Environment Facilities (PEF), AU, Denmark.	28 Laser Ablation-Multi Collector-Inductively Coupled Plasma Mass Spectrometer
5. Planetary Spectroscopy Laboratory (PSL), DLR, Germany	29. Nano Secondary Ion Mass Spectrometer
6. Planetary Simulation Laboratory (PASLAB), DLR, Germany	30. Thermal Ionization Mass Spectrometer
7. University of Kent Light Gas Gun Laboratory, UK	31. Multi-collector Static Vacuum Mass Spectrometer
8. Cold Surfaces spectroscopy (CSS), IPAG, France	32. Automated Optically Stimulated Luminescence system
9. Ion probe facility (IPF), CRPG, France	**High Resolution TEM Laboratory**
10. Stable Rare Gas and Radiogenic Isotope Facility (SGRIF), CRPG, France	33. High Voltage Electron Microscope
11. Atomki Ice Chamber for Astrophysics/Astrochemistry (ICA), Hungary	34. Atomic-level STEM and EDX/EELS analysis
12. Atomki ECRIS Laboratory, Hungary	35. Ultra-Corrected-Energy-Filtered TEM
13. Electron induced fluorescence laboratory (EIFL), Comenius University, Slovakia	36. Double Cs & monochromated TEM

14. ETH Zürich Geo- and Cosmochemistry Isotope Facility, Switzerland	
15. ETH Zürich Geo- and Cosmochemistry Noble Gas Laboratory, Switzerland	
16. Isotoptech Carbon-14 dating accelerator mass spectrometry laboratory, Hungary	
17. Isotoptech Stable/Clumped Isotopes Laboratory (ISIL), Hungary	
18. Isotoptech Noble Gas Isotope facility (INGIL), Hungary	
19. Center for Microbial Life Detection, MUG, Austria	
20. Mars Chamber Facility, OU, UK	
21. NanoSIMS 50L (NSIMS), OU, UK	
22. Laser Fluorination System, OU, UK	
23. Flow-Through Simulation Chambers, OU, UK	
25. Stirling / Swedish Planetary Ices Laboratory, SLTU, Sweden	

Task 3.2 Provision of Access to DPLF (VUA, UNIKENT, CNRS, AU, DLR, NHM, ATOMKI, COMENIUS, ETH-Zurich, ISOTOPTECH ZRT, MUG, OU, LTU)

A strategic collaboration was established with Korea Basic Science Institute (KBSI) to add a further 11 facilities to TA 2, and these were offered in Call 2.The second TA call offered access to all 24 European TA2 facilities and 11 Korean facilities. The call was opened on 10th November 2020 and closed on 6th January 2021. The peer review of applications by experts independent from the Europlanet 2024 RI project was managed by the ESF. The peer review and normalisation of the evaluations of the sub-panels was completed on 19th June 2020, discussed and approved by the PMC and published on 19th April 2021.

There were 75 applications for TA2 facilities in TA Call 2, of which 59 were funded (see Deliverable 1.6 for a list of successful applications). Covid-19 has also had a huge impact on the implementation of TA2 visits. Numerous visits were planned for 2020 but were postponed. A protocol for remote access was established and nine fully virtual TA visits were completed during Year 2, as well as one hybrid virtual/in-person visit and five in-person visits. The implementation period of TA visits approved under Calls 1 and 2 has been extended to the end of 2022.

c. Impact to date

Covid-19 has caused significant delays in Year 2 to the expected impacts for the TAs. Extensive discussions and planning have been conducted to develop remote access procedures to the TA2 facilities and several remote visits have now taken place. Remote access remains challenging for TA1 but the six field visits were undertaken in Year 2. A major development in respect of TA access has been the addition of 11 new TA2 facilities at KBSI to be included in TA Call 2, and addition of TA1 field sites in Argentina and China.

The visitors who have conducted TA visits to date have all committed to make presentations of their results at EPSC and also have plans for journal articles as well as conference papers and wider outreach/dissemination based on their visits.

In addition to publications from the Europlanet 2020 (and even 2012) RI that continue to come out, there have been multiple communications in popular media (e.g. interviews on television, radio and in national newspapers, particularly in the UK and the Netherlands). There have also been research collaborations that originated in TA visits, including participation in an interdisciplinary bid focused on art conservation (Davies), a UK Space Agency funded fellowship for a visitor to PMCF (bid supported by PMCF), and multiple co-authored papers between an NHM scientist and two-time visitor (Mohr-Westheide).

d. Summary of plans for Year 3

The outcome of the Fast Track TA call is due in February 2022. The peer review process was completed in January 2022 and a ranking list produced. Funding will be determined in February after consultation with the TA facilities to establish the number of visits that they are able to host and a check that sufficient finances are available. Some facilities received more successful applications than they are scheduled to host.

A review will be undertaken at Easter of the outcome of the Fast Track TA applications and progress on the implementation of TA visits of Call 1 & 2. At that stage a decision will be taken as to if a second Fast Track call is viable/required in the late spring. The current plan is to launch a full TA call immediately after EPSC (October 2022), by which time it is expected that all labs and field sites will have reduced the backlog of funded TA visits.

We specifically note the need to widen participation and will follow up on the successful workshop held in 2021 where advice was given on how to prepare and submit successful TA proposals. Based on the current Covid situation, this is most likely to be a virtual meeting.

2 Update of data management plan

An update of the Data Management Plan is due at the end of March 2022.

3 Follow-up of recommendations & comments from previous review(s)

Widening participation for URS was the main comment that came back from the Interim review. As noted above, a workshop was conducted in 2021 and follow up work is planned.

4 Access provisions to Research Infrastructures

Sixteen TA2 visits:

1. **TA project 20-EPN2-009: High-precision oxygen isotope composition of Martian meteorites and their components – insights into the accretion history of Mars. TA2.22 Laser Fluorination System, Open University Isotopes Facilities (UK). 17 May – 11 June 2021 (virtual Part 1/2).** Siw Egdalen, University of Copenhagen (Denmark) analysed the $\Delta^{17}O$ composition of meteorites that represent ancient (>4.5 Ga)

lithified portions of the surface Martian regolith. The outcome of this project may have major implications for understanding the accretion history of Mars and its kinship to other bodies in the Solar System. The second part of this virtual visit will take place in RP2.

2. **TA project 20-EPN-078: Abrasion test to understand aeolian grain surface evolution on Mars versus Earth – suggestions for ExoMars rover mission. TA2.4 AU Planetary Environment Facilities (Denmark). 30 July – 5 August 2021 (virtual).** Zsuzsanna Kapui, ELTE (Hungary), carried out an experiment that circulated and abraded particles inside the wind-tunnel under both Earth- and Mars-base pressures. Tests were made with quartz and basalt relevant olivine and the results will help to improve understanding the similarities and differences between sand abrasion on Earth and Mars, as well as between quartz and olivine or even basaltic grains too.
3. **TA project 20-EPN-005: Cosmic-ray-induced chemistry in pure ices. TA2.11 Atomki Ice Chamber for Astrophysics / Astrochemistry (ICA) (Hungary). 23 February – 5 July 2021 (virtual).** Alexei Ivlev, Max Planck Institute for Extraterrestrial Physics (Germany), conducted a virtual visit to study generic effects induced in pure astrophysical ice analogues due to their bombardment by cosmic rays with energies in the vicinity of the maximum of electronic stopping power. Read more.
4. **20-EPN-032: Radioresistance of aromatic complex organic molecules: nucleobases. TA2.11 Atomki Ice Chamber for Astrophysics / Astrochemistry (ICA) (Hungary). 17 May – 02 July 2021 (virtual).** Hermann Rothard, CIMAP/CNRS (France) studied the radiolysis and radio-resistance of the purine nucleobase (Adenine, two aromatic rings) in solid phase as a function of temperature (20-300 K) with H (0.8 MeV) and He (3.2 MeV) beams at ATOMKI. This first systematic study of the influence of the temperature revealed that Adenine is significantly (of the order of 50%) more radio-resistant at high temperatures. At low temperatures T < 50K, Adenine is more radiosensitive (higher cross sections). Read more.
5. **TA project 20-EPN2-012: Discovering the origin of dissolved gases in CO2-rich mineral groundwaters from Aquae Spadanae. TA2.10 Stable, Rare Gas and Radiogenic Isotope Facility at CRPG (France). 21 June – 02 July 2021 (in-person).** Agathe Defourny, University of Liège (Belgium) aimed to better assess the origin of dissolved CO_2 found in naturally sparkling groundwater springs from the east of Belgium. The results showed with a high confidence level that the gases dissolved in the naturally sparkling spring from eastern Belgium come from the degassing of the Eifel mantellic plume, at a distance of about 100 km. Read more.
6. **TA project 20-EPN-014: Constraining CO_2 uptake and release through chemical weathering pathways in a young, active orogen. TA2.10 Stable, Rare Gas and Radiogenic Isotope Facility at CRPG (France). 14-21 June 2021 (in-person).** Erica Erlanger, GFZ Potsdam (Germany) carried out a study to calculate the overall carbon budget for the Central Apennines, a young, active orogen (deformed belt of rock), and to understand the mechanisms for the release and drawdown of CO_2 in this landscape. Young, active orogens often retain an intact sedimentary cover that is composed of marine sequences, which can host large volumes of carbonate and sulfuric acid-producing minerals, such as pyrite. Unlike silicate weathering, which is responsible for CO_2 drawdown over geologic timescales, sulfuric acid weathering of carbonates has the potential to release CO_2 into the atmosphere that was previously trapped in rock. Read more.
7. **TA project 20-EPN-050: 26-Aluminium-26-Magnesium systematics of chondrules and clasts in unequilibrated ordinary chondrites. TA2.9 IPF (Ion Probe Facility) at CRPG (France). 07-11 June 2021 (in-person).** Audrey Bouvier, University Bayreuth (Germany), studied 26Al-26Mg ratios in chondrules (round grains) and inclusions in

six chondritic meteorites to evaluate two hypotheses for the timescale of formation of these features. Read more.

8. **TA project 20-EPN2-088: High spectral resolution / low-temperature IR study of carbonates. TA2.8 CSS (Cold Surfaces Spectroscopy) at IPAG (France). 11 May - 04 June 2021 (virtual).** Simone De Angelis and Cristian Carli, IAPS-INAF (Italy), acquired reflectance spectra of anhydrous carbonates in the infrared range (3.2-4.6 µm), at high spectral sampling/resolution and at different cryogenic temperatures in the range 60-270K. The analysed materials were calcite, dolomite, siderite, natrite, malachite and magnesite; all the minerals were prepared and measured at fine powders, d<50 µm. These measurements provide new spectral data in the IR that will be useful in the interpretation of remote-sensing spectroscopic observations of Solar System rocky bodies such as Mars, Jovian satellites and minor bodies by current and future missions (Mars 2020, ExoMars-2022, JUICE, Europa Clipper, OSIRIS-REx). Read more.
9. **TA project 20-EPN-029: VIS-NIR reflectance analysis of analogue mixture representative of young Haulani crater on Ceres. TA2.8 CSS (Cold Surfaces Spectroscopy) at IPAG (France). 15-26 March 2021 (virtual).** Fabrizio Dirri and Anna Galiano of IAPS-INAF (Italy) studied bright areas of Haulani crater (e.g. Southern floor, i.e. ROI3 and North-east crater wall, i.e. ROI4) on Ceres by arranging different analogue mixtures and comparing them with Dawn VIR data. Read more.
10. **TA project 20-EPN-043: A Systematic Study of Sulfur Ion Radiolysis of Simple Oxide Ices. TA2.11 Atomki Ice Chamber for Astrophysics / Astrochemistry (ICA) (Hungary). 30 November – 4 December 2020, 25-29 January 2021 (Virtual/In-Person).** Zuzana Kanuchova, Astronomical Institute of Slovak Academy of Sciences (Slovakia), and Duncan V. Mifsud, University of Kent (UK), implanted 290 keV S+ ions in a variety of simple oxide ices, including CO, CO_2, H_2O, N_2O, O_2, and CO:N_2O at 20 K, as well as CO_2 and H_2O at 70 K. The project's aim was to determine whether such implantations could result in the formation of sulfur-bearing product molecules, particularly SO_2 which has been detected at the surfaces of several icy Solar System moons. Mifsud was physically present at the facility and Kanuchova took part virtually. Initial findings were presented at the TA application workshop and covered on the website and through social media (see NA1 report). The results of the project are being submitted for publication and presented at EPSC2021. Read more.
11. **TA project 20-EPN-016: Formation and fate of methyl formate isomers in space. TA2.11 Atomki Ice Chamber for Astrophysics / Astrochemistry (ICA) (Hungary). 12-26 October 2020 (virtual).** Sergio Ioppolo and Alejandra Traspas Muina of Queen Mary University of London carried out an investigation of a large set of cosmic ray-induced surface formation and destruction routes for all the $C_2H_4O_2$ isomers to disentangle their chemical link in space and their observed distribution around star forming regions. The results will ultimately help understanding the presence of such species in comets in the Solar System. The dataset generated by the proposed research programme will be made public to support the ALMA, JWST and JUICE astronomy modelling and observational communities to interpret and guide observational data. Read more.
12. **TA project 20-EPN-042: Reflectance spectroscopy of ammonium-bearing minerals: a tool to improve the knowledge of the surface of icy planetary bodies. TA2.8 CSS (Cold Surfaces Spectroscopy) at IPAG (France). 9-27 November 2020 (virtual).** Maximiliano Fastelli, University of Perugia, collected reflectance VIS-NIR spectra at 10 different temperature steps. The collected data will help on the interpretation of VIR remote spectra from Europa, Pluto's moons, Enceladus and other icy celestial bodies surface where NH_4 minerals have been supposed to occur. Moreover, the study of ammonium bearing minerals and their behaviour at very low temperature

might give information on how the phase transition affects the bands position and shapes inside the reflectance spectra. Read more.

13. **TA project 20-EPN-034: Calibration of the Al-in-olivine thermometer: Insight into the thermal history of type II chondrules. TA2.9 IPF (Ion Probe Facility) at CRPG (France). 18-22 October (in person).** Olivier Namur from KU Leuven, Belgium analysed Al contents in co-existing olivine and spinel phases that had been equilibrated under variable temperature and oxygen fugacity. Add link:
14. **TA project 20-EPN-084: Converting one amino acid to the other containing sulphur via ion irradiation: Implication to chemical evolution on Europa surface ices. TA2.11 Atomki Ice Chamber for Astrophysics / Astrochemistry (ICA) (Hungary). 8-22 November 2021 (in person).** Rahul Kumar Kushwaha of the Physical Research Laboratory, Ahmedabad, India, studied the effect of S ion irradiation of Aspartic acid for a range of energies at different temperatures (20 & 100K). Irradiated residua were analysed using optical and scanning electron microscopes and liquid chromatography . add link Read more.
15. **TA project 20-EPN2-081: Vis-NIR reflection spectroscopy of ammonium-bearing minerals: a tool to improve the knowledge of the surface of icy planetary bodies. TA2.8 CSS (Cold Surfaces Spectroscopy) at IPAG (France). 5 October - 12 November 2021 (virtual).** Maximiliano Fastelli, University of Perugia, conducted a virtual visit (13 days) to collect reflectance Vis-NIR spectra of several ammonium salts at 10 different temperatures to assess if these phases potentially exist on icy moons. Read more.
16. **TA project 20-EPN2-073: Assessment of Aeolian dispersion and wind effects on cryptoendolithic microorganisms in the Martian environment. TA2.4 AU Planetary Environment Facilities (Denmark). 15-19 November (in person).** Lorenzo Aureli, University of Tuscia, (Italy), carried out experiments to examine the possibility of dispersal of hypothetical rock-dwelling microorganisms on the surface of Mars. Read more.