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D2.3 First Annual report of TA1 access

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Responsible WP Leader: INTA, Felipe Gómez

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Dissemination level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Service)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (excluding the Commission Services)	

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Abstract: Under Horizon 2020, the Europlanet 2020 Research Infrastructure (EPN2020-RI) is promoting the visit to already validated Earth Analogues to external users trough the Trans National Activity 1 (TA1). Several field sites are available to external users for developing their own research. The selected sites provide the most realistic terrestrial analogues of the surface and near surface geological-geomorphological environments of Mars, Europa and Titan.

Three planetary field analogues (rio Tinto (Spain), Ibbn Battura (Morocco) and cold and hot environments in Iceland) (PFA) have been selected to provide transnational access during the first two years of the project to a set of well-characterized planetary analogue field sites. The planetary analogues field sites from part of EPN2020-RI´s strategy to provide researchers from a board spectrum of disciplines the capability to undertake the comprehensive multi-disciplinary research strategies needed to support planetary missions. The main goals of proposals presented during the first year of the project are related with the quantification of the complex (bio) geo-chemical feed-back processes that control planetary evolution so that researchers can develop quantified models to explain observations made of planets in our Solar System. Other proposals presented focussed on the study of the processes that influence the survival of life under extreme conditions and the detection of records of past or present biological activity. In this context some of the characterized habitats are similar to where life is thought most likely to have evolved on Earth and consequently will be a valuable resource for Earth and life scientist and with important astrobiological implications. Finally, other proposals were interested on testing of instrumentation under development by industry for future planetary space missions, evaluating analyticial-operational-management concepts in fully operational settings. Those sites running during the first year of the project were Rio Tinto (Spain), Iceland and Morocco desert.

Contents

1. Publicity and selection process

For information regarding the publicity and selection procedure please refer to D4.3- First Annual report of TA3 access.

2. Explanation of the work carried out by the beneficiaries and Overview of the progress for TA1

All the extreme sites offered to external users on TAs activities had low number of applications due to the strict dates of the first open call. Final selection by an external independent panel of experts approved the visits described in this report.

2.1 Description of the Trans-national Access activity in Rio Tinto

1 Ta visit was approved for Rio Tinto. Proposal leader: Dr. Lisset Gavilan

Home Institution:

Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS)

Université de Versailles Saint-Quentin

11 boulevard d'Alembert

78280 Guyancourt

France

Project Title –

Constraining optical properties of Martian aerosols by using Rio Tinto regolith analogues at increasing oxidation state

Scientific Report Summary.

The central goal of this project was to use minerals from Mars analogue sites at increasing oxidation state to explore how oxidized aerosols could affect Mars climate. A visit to the Rio Tinto Transnational Access facility was scheduled in collaboration with Dr. Felipe Gómez of the Centro de Astrobiologia in Madrid. Mineral samples were collected from visits to different sites along Rio Tinto's banks ("Berrocal", "Minas", and "El Origen"). These included wet and dry samples of natural iron oxides (jarosite, pyrite) and sulfates, selected under the criteria that they should provide fine regolith and high-volatility.

Ten samples were selected from the field that seemed to be the most interesting candidates to study volatility. The color of the minerals ranges from bright yellow to dark brown, and is expected to provide oxides at increasing degree of oxidation. A collaboration with the Ecole Normale Superieure (ENS) de Geologie in Paris has been recently started. Centro de Astrobiología dried, grinded and filtered these samples. XRD measurements will be performed to identify the dominant minerals of sizes inferior to 40 microns. A fraction of the dry powder

samples will be studied in the Planetary Emissivity Laboratory in Berlin, in order to constrain the spectral properties of this regolith from the UV to the IR and to compare to current rover and orbiter data of Martian aerosols.

Full Scientific Report on the outcome of the TNA visit to río Tinto (June 2016)

The central goal of this visit was to collect minerals from Rio Tinto minerals at increasing oxidation state to explore how oxidized aerosols can affect Mars climate. This project involves a sequential program gathering tools from geochemistry, spectroscopy, and modeling taking advantage of the transnational access facilities of the Europlanet consortia.

The mineralogy of Martian dust is constrained by in-situ Mars Exploration rovers, showing the dominant presence of ferric oxides and perchlorate salts. The oxidation of basaltic dust is thought to be the result of chemical weathering in the atmosphere [Bibring et al. 2006, Chevrier et al. 2006], and this is why Martian dust has become a target of atmospheric studies [Smith 2008]. The effect of aerosol weathering via oxidation, nucleation, and/or UV irradiation in the atmosphere of Mars is less well constrained. Winds can suspend soil dust into aerosols, and aerosol surfaces can favour nucleation and oxidation by radicals. These can in turn modify the optical properties of aerosols, having a yet unknown impact on Mars climate. Thus, we searched for mineral samples that had the potential to provide very fine regolith and a high potential for volatilization: these minerals will be used as Martian aerosol analogues.

Under the guidance of Dr. Felipe Gómez (Centro de Astrobiologia) mineral samples were collected from different sites along Rio Tinto's banks ("Berrocal", "Minas", and "El Origen"). These included wet and dry samples of natural iron oxides (jarosite, pyrite) and sulfates, selected under the criteria that they should provide fine regolith and high-volatility. A few examples are shown in the figure below.

Ten samples were selected from the field that seemed to be the most interesting candidates to study volatility. The colour of the minerals ranges from bright yellow to dark brown, and is expected to provide oxides at increasing degree of oxidation.

Collaboration with the Ecole Normale Superieure (ENS) de Geologie in Paris has been recently started.

Rio Tinto facility staff analyses: regular studies on the physic-chemical parameters of the Rio Tinto water are carried out seasonally. At the same time, new sites of astrobiological interest are located in order to provide the external users new opportunities for their own science.

The accesses in preparation for for future external users visits are:

- (Number 10940) Master: Mars Analog Spectrescopic Technology For Exploration Research, proposed by Dr. Sobron from SETI Institute.

2.2 Description of the Trans-national Access activity in International Research School of Planetary Sciences (IRSPS)

The activity on the Ibn Battuta Centre field sites has been concentrated in three sub-activities: Fieldwork of host scientists, Fieldwork of IRSPS personnel, and implementation of the field facility.

One scientific access has been performed from 4th to 18th May 2016 for a total of 14 days. The project leader was Dr. Dennis Reiss from Institut für Planetologie**,,** Westfälische Wilhelms-Universität, Münster, Germany and co-applicant Jan Raack, Department of Physical Sciences, The Open University, Milton Keynes, UK.

The aim of the work was to describe and constrain the meteorological signatures of vertical convective vortices to be used as analogues to interpret the behaviour of the Martian dust devils. A report has been sent and filed in the Europlanet Project Office.

The team deployed a linear array of at least 5 stations, each station logging simultaneously horizontal wind speed, vertical wind speed, wind direction, pressure, temperature, solar irradiation, magnetic field, and sound level at a high sampling rate of 4 Hz combined with direct observations of the study area by 2 time lapse cameras with an imaging rate of 1 Hz.

This activity is also linked to the InSight mission operations. InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) is a NASA Discovery Program mission that will place a single geophysical lander on Mars to study its deep interior.

The accesses in preparation are at the moment:

- September 2016: Simulated drilling Martian operations and scientific return, Dr. Akos Kereszturi, Hungarian Academy of Sciences.

- October 2016: Flood basalts, lava tubes and collapsed structure in the Mid-Atlas, Dr. Titti Melis, Università di Cagliari, Italy and Dr. Jo De Waele, Univerità di Bologna, Italy

- February or March 2017: evaporitic deposits and carbonate interfingering in the Tah Sebkha and other locations nearby (Layounne), Prof. Roberto Barbieri, Università di Bologna

- May 2017: sand mobility and bedforms, Dr. Simone Sivestro, INAF, Italy

The IRSPS with a parallel effort has built along with the Hotel Chain Kasbah Xaluca a facility consisting of two large workshops, storage room, offices, recreational rooms and kitchen. A satellite connection provide internet through a WIFI system. An area of download and upload of trucks is next to a large parking area and they are connected with a cement pathway to the workshop and an helipad.

Fig. 1 – The Ibn Battuta Field Facility

The facility has been already used for large and complex operation for the simulation of the landing system for both 2016 and 2020 Exomars missions. The facility, created with a independent budget will be anyway available for Europlanet activities and will be particularly suitable for industrial applications.

In May 2016 the Ibn Battuta Centre has hosted and taken into the field a troupe shooting a 3D documentary for Pannon Observatory of the Balaton Uplands National Park.

2.3 Description of the Trans-national Access activity in Iceland

Three applications were made in response to the first call to access the TA1: Planetary Field Analogue Site "The glacial and volcanically active areas of Iceland, Iceland" (Table 1). During the second call, again three applications were submitted to visit the Icelandic Planetary Field Analogue Site, with two additional applications listing it as a secondary choice. Of those applications of the second open call, one (no. 11132) was selected by the external experts panel to be granted and the visit and research will be conducted in 2017. In total four visits were selected by the external experts panel for Iceland.

Table 1: Successful applications in the first and second call to access the Icelandic TA-RI site.

Appl. No.	**ESF Project No.**	**Title**	**Applicant organisation**	**Country**
10361	15-EPN-006	Complex eukaryote life in Mars analogue field sites on Iceland - environmental (meta)genomics	University of Kaiserslautern	Germany

		approaches in astrobiology		
10572	15-EPN-028	Microbes at mineral interfaces in sub-seafloor young volcanic rocks	University of Bremen	Germany
10597	15-EPN-039	Field Exploration and Life Detection Sampling for Planetary and Astrobiology Research (FELDSPAR)	Cranfield University	U.K.
11132	16-EPN-064	Analog studies on salt minerals assemblages for support of the MEDA instrument of the future Mars 2020 NASA mission	Centro de Astrobiología	Spain

ESF Project 15-EPN-006 (Complex eukaryote life in Mars analogue field sites on Iceland - environmental (meta)genomics approaches in astrobiology): The project will investigate eukaryote diversity in Mars-analogue field sites on Iceland through targeted isolation and cultivation of extremophile microbial eukaryotes for subsequent genome and transcriptome analyses. These analyses will allow the identification of physiological key mechanisms for survival of higher-life in the investigated Mars-analogue environments. The visit of the applicant is planned for the time period 01.09. - 10.09.16. Samples will be taken at the Krýsuvík area (Reykjanes peninsula, SW Iceland) that hosts a variety of extreme environments of volcanic origin and analysed partially at the laboratory of the Icelandic host organisation Matís and partially at the applicant´s home institution in Germany.

ESF Project 15-EPN-028 (Microbes at mineral interfaces in sub-seafloor young volcanic rocks): The main objective of the project is to study microbe-rock interaction and colonization of volcanic rocks in seawater at the volcanic island Surtsey in the eastern Icelandic Rift. Surtsey was formed in a volcanic eruption in 1963 and provides a unique pristine natural laboratory to a) study biosignatures in sub-seafloor volcanic rocks at a site where microbiology and fluid geochemistry will be well constrained, b) constrain the onset of biologically mediated alteration in young volcanic rocks, and c) assess the possibility of similar ecosystems on other planetary bodies. The planned work will be conducted in association with the SUSTAIN project of the International Continental Scientific Deep Drilling Program (ICDP) and will make use of the samples obtained from it. However, the SUSTAIN project could not be carried out in 2016 due to belated approval of its funding and will be undertaken in 2017 instead. As the sampling from the deep drilling is a prerequisite for the proposed research project 15-EPN-028, it was delayed as well and the site visit of the applicant will happen in conjunction with SUSTAIN during summer 2017.

ESF Project 15-EPN-039 (Field Exploration and Life Detection Sampling for Planetary and Astrobiology Research (FELDSPAR)): The main objective of the project was to contribute to

the development of Mars mission / rover / instrument payload operations in the context of the decision cascades concerning sample identification and selection for future Mars sample return missions. Based on an understanding of the distribution of life biomarkers in recent lava fields at a variety of size scales from 1000m, 100m, 10m, 1m and 0.1m scales and correlation to observable geological / geochemical features, the project aimed to demonstrate and evolve the ability to implement cascades of multiple life detection and characterisation techniques along with contextual analyses both in situ and in field laboratories at recent lava field sites.
The applicant visited Iceland during the period 06.07. – 15.07.16 and set his field laboratory up at the University of Akureyri (North Iceland). Funded through the EuroPlanet grant were Prof David Cullen, Cranfield University, UK, and Prof Wolf Geppert, Stockholm University, Sweden, while additional scientists from the Georgia Institute of Technology and the University of California, both USA, were involved in the project as well. Sampling and field surveys were performed in North East Iceland; in addition to the originally planned work at Holuhraun (Nornahraun), Krafla lava field, Dyngjusandur sand field, Hverfjall and Ludentarskali explosion craters were also sampled. These sites replaced the two originally proposed field sites in South West Iceland from the application. The research included surveys performed via drone visual imagery, in field mineralogy performed with a portable UV-visible spectrometer, systematic sample acquisition based upon methodology developed in previous Iceland field campaigns and ATP analysis performed at a "field" laboratory established at the University of Akureyri on a subset of collected samples. Further collected samples were returned to institutional laboratories (Georgia Institute of Technology) for genomic analysis. During the following post-field campaign activities, the various analytical datasets will be collated in the context of the original study hypothesis (i.e. ability to identify appropriate samples for bio-signature analysis).

Visits in preparation:
The application no. 11132 was selected by the external experts panel to be granted and the visit and research will be conducted in 2017

3. Annex. PFA participants

PFA participants are listed below.

Participant	Permanent personnel	Personnel hired by the project
5. INTA	Dr. Felipe Gómez Gómez Dr. José Antonio Rodriguez Manfredi Prof. Ricardo Amils Dr. Olga Prieto-Ballesteros Dr. Juan Angel Vaquerizo Nuria Rodríguez Fernando Camps	
9. IRSPS	Prof. Gian Gabriele Ori Professor Kamal Taj Eddine Dr Goro Komatsu Dr Monica Pondrelli Barbara Cavalazzi	
20. MATIS OHF	Dr. Viggo Thór Marteinsson René Groben	

PFA Structure – wp2 – TA 1: Planetary Field Analogues Coord.: INTA with partners INTA, IRSPS and MATIS OHF

PFA activities consist of one work package with three different sites managed by three partners. These activities consist of the following tasks:

- *Task 2.1. Rio Tinto field site: Managed by INTA*
- *Task 2.2. The Ibn Battuta Field Centre. Managed by IRSPS*
- *Task 2.3. Iceland Field Sites. Managed by MATIS OHF*
- *Task 2.4.Tirez Lake. Applicable as TA1 report after second year of the project. Managed by INTA.*
- *Task 2.5. Danakil Depression (Ethiopia). Applicable as TA1 report after second year of the project. Managed by INTA.*

4. JRA 1 Report – wp 7: Characterisation of Lake Tirez and Danakil planetary field analogues

4.1 Objectives

The main objective of JRA1 activity is to provide two more field sites for TA 1 external users visits during the last two years of EPN2020-RI infrastructure. The objective is to validate two extreme environments as Earth Analogues. Those sites are Tirez Lake (Spain) and Danakil depression (Ethiopia).

The preparation of those sites as field facilities for TA1 activity requires extensive groundwork to develop theories and models of the interior, surface and atmospheric conditions of the planetary analogues. This extensive field and laboratory work to prepare the PFAs will fully characterize the geology, hydrology and geomicrobiological environments, determine the feed-back mechanisms between the regional geology, soils, climate and biology and establish how these mechanisms vary throughout the year. As part of TA1 in years 3and 4, these two extreme and diverse environments will represent a tremendous new resource for the planetary science community, and will undoubtedly become sites on ongoing research for external users. In order to prepare the sites for those future activities we need to develop ground work as well as laboratory work in order to validate those sites as Earth Analogues.

4.2 Task 7.2. Characterisation of PFA 1 – Tirez Lake.

Three visits to Tirez lake field site during the first year of the project were organised. During these two visits groundwork was develop for regional geological studies as well as sampling for laboratory work.

Tirez lagoon together with Peña Hueca and Laguna Larga are members of the lacustrine Villacañas region, a group of small endorheic hypersaline lagoons of western La Mancha (known as Campo de Calatrava). It is included in one of the three areas of endorheic regions of the Iberian Peninsula: La Mancha, Aragón and Andalucía, rich in hypersaline lakes (Guerrero and de Wit, 1992). Tirez has a maximum extension of 0.8 km2 and a depth of 40 cm. It is located at 653 m altitude, N 39o32´695´´ and W 03o21´073´´ (UTM 50469821-4377309). With a continental climate, there are wide daily and seasonal thermal oscillations.

From a limnological point of view, Tirez is a rather peculiar lagoon, with a differential precipitation of various types of salts and crust formations during the summer. Due to the high sulfate and magnesium content in the water it can be classified as a Na-Mg-Cl-SO4 type of lagoon. The inner part of the lagoon is covered during the dry season by a saline crust made up of, from top down,: halite, epsomite, thenardite, bloedite and gypsum. From a lithological point of view, the dominant material is sand, which alternates with gypsum and limestone. The bottom is made of clay with a sopropel layer produced by decomposition of algae with epsomite crystals.

Several techniques and protocols were used in the groundwork as well as in the laboratory work.

Sampling and sample conservation. Sampling was done with a RingKit core-sampler for soft soils. An homogeneous mixture of the first centimetres of sediments with the water retained in the core-sampler, corresponding to a 1-2 cm of the water column, was taken. The samples

were kept refrigerated at 4oC during their transport to the lab and until further use for chemical and microbiological analysis. The sampling was done in January, the first days of April, which climatologically corresponds to the end of the wet season, with average temperature and rain values of 13oC and 45 mm, respectively, and in June 2016 (summer season). More visits are expected in near future for winter sampling in order to follow the evolution of the physic-chemical parameters of the water of the associated lagoons.

Physico-chemical characterization. Physico-chemical parameters were measured in situ: temperature and conductivity (Orion 120), pH and redox potential (Orion 420), and dissolved oxygen (Symplair Sylaud Ins.). Sulfate and carbonate were also determined in situ with Hanna Instruments kits (Hanna Sulfate LR-HR H1-38001A for sulfate and Hardness HR H1-3812 for carbonate). Other anions and cations (Cl-, Na+, K+, Mg2+, Ca2+, etc.) were determined in the laboratory by elemental TXRF analysis and NO3- by ionic chromatography.

Metabolic assays and isolation of pure cultures. Some particular cultures and isolates were of special interest. Sulfate-reducing and methanogenic activities were analyzed using the mixture of sediment in water as inocule. For sulfate-reducing bacteria (SRB) enrichment cultures the following media was used: 0.2% MgSO4. 7H2O, 0.35% Na-lactate, 0.1% Fe(NH4)2-6H2O, 1 ml/L of trace elements, in Tirez lagoon water. The sulfide production was qualitatively detected with the lead acetate-paper method. Acetate and formate were used as substrates. The methane produced was analyzed with a Shimadzu GC-8A gas chromatograph.

In order to isolate pure cultures, SRB enrichment cultures and methanogenic cultures were used as inoculum. Agar plates with specific media were inoculated and incubated in an anaerobic chamber with N2:H2 atmosphere at room temperature. Colonies were picked, diluted in 100 µl of water and 1µl was directly used, without cell disruption, for PCR amplification according with the protocol described below.

DNA extraction and PCR. Cells from the homogeneous sediment-water samples were disrupted and DNA was extracted using FastDNA kit for soils BIO101 according to the manufacturer's protocol. The 16S rRNA genes from mixed microbial DNA were amplified by PCR. To obtain 16S rRNA genes two oligonucleotide primer pairs were used: 27F and 1492R (annealing T: 56oC) for the Bacteria domain and 25F and 1492R (annealing T: 52oC) for the Archaea domain. The thermal profile for amplification included 30 cycles of denaturation at 94oC for one min, primer annealing for one min, and primer extension at 72oC for three min. The DNA concentration was 25-50 ng for each reaction.

Clone libraries and sequencing. The amplified 16S rRNA genes (length 1465-1467 bp for bacteria and archaea respectively) were cloned using TOPO Cloning Kit (Invitrogen Corporation, San Diego, California) and then transformed into competent *E. coli* cells. Plasmid DNA inserts were extracted by alkaline lysis method (Miniprep). The archaeal clones were grouped according to their restriction pattern obtained after digestion with Sau3AI. Plasmid

inserts were amplified by PCR using the M13 primer set (Invitrogen). Automated DNA sequencing was performed with an ABI model 377 sequencer (Applied Biosystems).

Sequence analysis. Sequences were compared with the NCBI database by using the basic local alignment search tool (BLAST, http://www.ncbi.nim.gov) to identify the closest sequence. After that, sequence data were aligned and analyzed with the ARB program package (available at http://www.mikro.biologie.tu-muenchen.de/). Parsimony was used to construct phylogenetic trees. Sequence alignments of the clones to determine their identities were made using the SeqLab program (http://www.accelrys.com/support/bio/fags_wis_html).

Nucleotide sequence accession numbers. The sequences obtained in this study have been deposited in the GenBank database.

Atmospheric measurements. Weather stations were settled on the site in order to follow atmospheric parameters during the duration of the field campaigns.

All these techniques rendered results ready to be published. A paper is under preparation to be submitted to Microbial Ecology journal.

This site will be open for external users visits in the period 2018-2019.

4.3 Task 7.3. Characterisation of PFA 2 – Danakil Depression (Ethiopia).

The Danakil Depression field area has been the object of two expeditions/visits in order to collect data and check logistical details.

The first mission has been executed by Barbara Cavalazzi from 18th to 29 January 2016. During this mission Dr Cavalazzi has collected samples for the time series reconstruction of the environmental changes of the Dallol system (started 3 years ago). Moreover, she has expanded the area of investigation with further observations, data collections and sample collections. Lab analysis related with this field campaign are in progress. The Europlanet project will take advantage of the data collected in the last year in reconstructing the environmental changes

A second mission, from 3rd to 9th April 2016, has been carried out by Drs Barbara Cavalazzi and Felipe Gomez with two main objectives: to set up some organisational contacts at the Mekelle University and to sample the Dallol area. Samples have been recovered and are under analysis at Cab and University of Bologna. The studies being carried on at the laboratories are as follows:

Physico-chemical characterization. As in others environments, physico-chemical parameters were measured in situ: temperature and conductivity (Orion 120), pH and redox potential (Orion 420), and dissolved oxygen (Symplair Sylaud Ins.). Sulfate and carbonate were also determined in situ with Hanna Instruments kits (Hanna Sulfate LR-HR H1-38001A for sulfate and Hardness HR H1-3812 for carbonate). Other anions and cations (Cl-, Na+, K+, Mg2+, Ca2+, etc.) were determined in the laboratory by elemental TXRF analysis and NO3- by ionic chromatography.

Metabolic assays and isolation of pure cultures. Inoculation of fresh media bottles was done on site. Several media was used in order to growth and isolate the most representative bacterial groups present on the samples.

DNA extraction and PCR. Cells from the homogeneous sediment-water samples were disrupted and DNA was extracted using FastDNA kit for soils BIO101 according to the manufacturer's protocol. The 16S rRNA genes from mixed microbial DNA were amplified by PCR.

Clone libraries and sequencing. The amplified 16S rRNA genes (length 1465-1467 bp for bacteria and archaea respectively) were cloned using TOPO Cloning Kit (Invitrogen Corporation, San Diego, California) and then transformed into competent E. coli cells. Plasmid DNA inserts were extracted by alkaline lysis method (Miniprep). The archaeal clones were grouped according to their restriction pattern obtained after digestion with Sau3AI. Plasmid inserts were amplified by PCR using the M13 primer set (Invitrogen). Automated DNA sequencing was performed with an ABI model 377 sequencer (Applied Biosystems).

Sequence analysis. Sequences were compared with the NCBI database by using the basic local alignment search tool (BLAST, http://www.ncbi.nim.gov) to identify the closest sequence.

Atmospheric measurements. Weather stations were settled on the site in order to follow atmospheric parameters during the duration of the field campaigns.

Currently, Gian Gabriele Ori and Hagos Miruts are working on overtaking administrative, importation and military problems in order to get the permission to perform a photogrammetric and spectral survey of the Dallol volcanic system. This will be the first high-resolution photomosaic, geological map and geomorphological/digital elevation model rendering of Dallol. This activity will provide a reference for future scientific activities, for the analysis of environmental changes and for the monitoring of the volcanic activity in the subsurface and magmatic chamber.