

Workshop Report

Volcano 2019 Workshop and Summer School: *A natural laboratory for marine, terrestrial and planetary science and technology*

11th – 20th June 2019

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Figure 1: Group photo of the Vulcano 2019 Summer School. Most of the 44 participants are present in this image.

1 Background

Vulcano is the third largest and southernmost island of the Aeolian archipelago. It is also one of the most closely monitored, heavily researched and studied active volcanoes in the world. It hosts the largest unique assemblage of high and low temperature volcanic and hydrothermal minerals. The larger part of the island consists of two main edifices built by strombolian to phreatomagmatic eruptions in the last 200,000 years. The latest volcanic eruption took place in 1888 and since then the volcano has exhibited two to three phases of enhanced activity.

From a planetary perspective, the surface morphology of parts of the Fossa Crater on Vulcano are similar to lunar and martian regions with extremely dry, arid conditions and little or no vegetation cover. Furthermore, fumeroles, hydrothermal CO₂ seepage and a broad range of associated mineralisations combined with easy access, make Vulcano an excellent location for a field-based summer school and workshop.

This is the reason why, for the fifth consecutive year, a two-week summer school was held at Vulcano, Sicily focussing on bringing together planetary scientists, researchers, students, technicians and policy makers, to provide enhanced field exposure and training on a variety of topics ranging from geology, volcanology, geophysics, oceanography to robotic environmental exploration and the study of planetary analogues.

2 Aims and Objectives

The Summer School aims to expose junior researchers and students to a broad theoretical background on planetary and terrestrial field-based analogue case studies. This is achieved through a combination of lectures and extensive fieldwork using oceanographic and geophysical sensor packages and robots. Teams are formed and to carry out experiments and sampling campaigns on the island and in the coastal waters around Vulcano. A small research boat, fully equipped with sensors, sampling devices, precise navigation and two remotely operated vehicles for teleoperations will be used in the ocean, while hybrid robots and rovers, as well as tetracopters (drones), are available for terrestrial operations. The visit to the island of Stromboli would provide a direct comparison of volcanic degassing processes with Vulcano.

3 Vulcano 2019 Summer School – themes

The Vulcano Summer School focused on Planetary and Terrestrial Analogues with an emphasis on magmatic and hydrothermal systems. This year a variety of spectral instruments ranging from visible and near-infrared (VNIR) reflectance and Raman spectroscopy to Laser-Induced Breakdown Spectroscopy (LIBS) were deployed at various sites for mineralogical, biological, and elemental analysis. The in-situ survey, and its comparison with laboratory standards and instruments, will provide an assessment of the usability these techniques to characterise extraterrestrial environments and guide our search for life in the Solar System (e.g. via assessing the detectability of biosignatures).

Drone photogrammetry surveys were performed on different areas of potential slope instability hazard, while an Integrated Positioning System (IPS) in combination with infrared thermal imagery was deployed for future mapping and thermal stability analysis of the fumarole fields in the Fossa Crater on Vulcano. New instrumentation such as a prototype thermal camera to be used on Venus and Mercury was tested. Preliminary analysis suggests good agreement of the infrared and in-situ temperature measurements. TEM and IP electric measurements of diffusive CO₂ fields were successfully acquired. Their processing, data analysis, inversion and modelling is ongoing. Last but not least, robotic missions for terrain analysis, locomotion and mapping were undertaken by the ASgard robot on various lunar and martian analog terrains.



Figure 2: (Left) LIPS instrument measuring spectra; (center) TEM measurements at diffusive CO₂ site; (right) field lecture on the geological evolution of the Fossa Crater.

Underwater AUV and ROV missions investigated diffusive CO₂ bubble field to map and quantify emissions. A variety of robotics systems were used, equipped with scientific payload to gather data. Small ROVs such as the BlueROV and Gnome, as well as more complex AUV systems such as FeelHippo and MARTA from University of Florence. Video images as well as acoustic data from side-scan sonar and forward-looking sonar have been gathered and classified to analyse the CO₂ flux. Oceanographic work such as depth profiles of conductivity and temperature (CTD), pH measurements and biological sampling suggest that ocean acidification occurs close to the marine CO₂ venting sites. Marine robotic AUV, ROVs and terrestrial robotic traverses highlighted the need for further testing concepts and finding innovative solutions for locomotion on diverse planetary terrains.

4 Vulcano 2019 - schedules

The participants develop a sense to work in international and multidisciplinary teams and to cope with challenges in terms of time management and reporting. Hands-on experience during the fieldwork helps better understand cross-disciplinary links between scientific objectives, measurement requirements, data analysis, interpretation and the final presentation of results (See Fig. 2 for some impressions).

The Vulcano Summer School had a busy schedule with morning session generally consisting of an early morning briefing, followed by a field campaign to collect data in the various teams. The afternoon session started with a lecture on a particular current theme and topic. This was followed by a field data collection campaign. On most days, the terrestrial and marine ocean teams switched, so that team members had a the opportunity to participate and try out all the various tools, techniques and data collection methods. The evening sessions were used for astronomy, poster sessions and discussion of results. See Table 1 for the daily plans and schedules adopted during the summer school.

5 Participants

The summer school provided a unique field experience and training to a broad group of undergraduate, graduate and PhD students and scientists from a variety of scientific fields, ranging from Geophysics to Marine Sciences, Robotics to Planetary Sciences. It also provides excellent training and outreach opportunities for administrators and policy makers.

In total 44 participants from more than 15 countries took part in the summer school (see Fig 1 for a group photo, Fig 3 for country distributions of participants). Most of the participants were early career scientists and researchers (see Fig 3.). Participants from non-inclusiveness states included Poland and Greece. International students included countries such as India, US and China.

Unfortunately, three participants could not make it to the summer school: Prof. Foing (ESA), Dr. Schnars (IFAM) and Jos van den Broek (Europlanet)

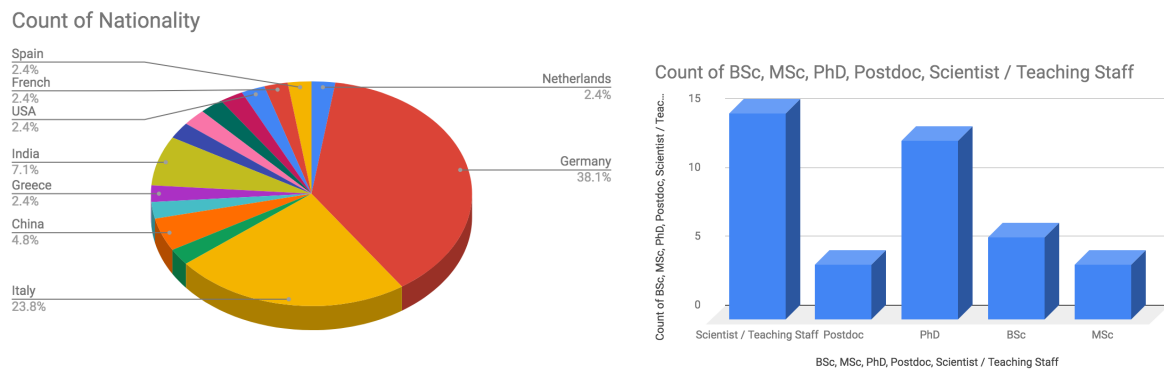


Figure 3: Pie chart (left) showing the distribution of the nationalities taking part in the Vulcano Summer School. Bar chart (right) highlights the greater number of PhD's and scientists / teaching staff participating in the Summer School

6 Feedback

Feedback from this and previous summer schools has been very positive with participants keen to return to future summer schools on Vulcano. Over 10% of the participants in the 2019 Vulcano Summer School have participated in one or more of the summer schools in the past! Over the past years, the summer schools on Vulcano have clearly highlighted the need for field-based experience and the necessity to mix students with experienced researchers, scientists with engineers and politicians and administrators with academics, in order to get the optimum learning experience and networking opportunities.

7 Budget / Expenses Overview

We received a very generous contribution of 10,000 euro from Europlanet to support the Vulcano Summerschool. Although some institutional funds were available, with the Europlanet financial support, the Vulcano 2019 Summer School would not have been possible. The funds received from Europlanet were primarily used for transportation, travel and accommodation support, with:

- **Transport and Equipment Logistics** - (3500 euro) - van hire, petrol, road toll and ferry charges to bring all the needed equipment (including small research vessel) from Jacobs University, Bremen and DLR Berlin
- **Student / Researcher participation support** – 10 participants with accommodation support only of up to 300 euro each, 2 participants with transport and accommodation support of up to 750 euro each, and 5 participants reduced accommodation support of 500 euro
- **Visit to Stromboli and associated Logistics** - (1000 euro) ~ 20 participants
- **Organisational Support** - ~ 250 euro

8 Links

Results from the 2019 Summer School will be presented at the 2019 EPSC Conference. The two posters are:

- EPSC-DPS2019-2062 - Multi-spectral investigation of volcanic deposits and their alteration processes on Vulcano/ Italy by Katrin Stephan et al. accepted in LP1 – Late posters Terrestrial Planets (TP)
- EPSC-DPS2019-2051 - Vulcano Summer School 2019: Field-based terrestrial, marine and planetary analogue studies by Vikram Unnithan et al. accepted in LP1 – Late posters Terrestrial Planets (TP)

Additional links to websites, previous conference presentations and promotional video:

- Vulcano Website - gisnix.jacobs-university.de and robexsummerschool.de
 - EPSC 2018 presentation - <https://meetingorganizer.copernicus.org/EPSC2018/EPSC2018-1112.pdf>
 - AOGS 2018 presentation - <https://www.meetmatt-svr3.net/aogs/aogs2018/mars2/pubView-Abs.asp?changeDate=&sMode=sTitle&txtTitle=Robex+Lunar+Analogue>
- YouTube video - <https://www.youtube.com/watch?v=HHhfoa1mxwg>

Table 1: Daily Schedule and Plans for the Vulcano 2019 Summer School

Day Nr	Date	Important Events	Field Plans Morning	Lecture	Field Plans Afternoon	Evening	Night
	Saturday	Departure van (Vikram + Florian)					
	Sunday	AUV team arrives					
	Monday	Van arrives - Vulcano pm					
1	Tuesday 11th June	Arrival Laurenz + Jacobs Students late pm; most participants					
2	Wednesday 12th June	Welcome and Introduction at 08:00; General Geology Excursion (Vikram /others); Deploy boat for AUV		Overview Lecture (Vikram, Frank, Laurenz);	more lectures,, Intro sessions for field work; OR AUV work	Data / QGIS / ArcGIS session	
3	Thursday 13th	Start Field Activities	Daily plans, Ocean team / Vulcano Team	AUV lecture/Summary, Laurenz (Oceans)	Fieldwork (Ocean/Vulcano)	Poster Session	Poster Session
4	Friday 14th	AUV Team leaves	Fieldwork (Ocean/Vulcano)	Mika (Astrobiology);	Fieldwork (Ocean/Vulcano)		Star Gazing with Frank ?
5	Saturday 15th		Fieldwork (Ocean/Vulcano)	LIPS (Susanne/Kristin) and Planetary Spectroscopy (Katrin/Indhu)	Fieldwork (Ocean/Vulcano)		Star Gazing with Frank ?
6	Sunday 16th	Geoelectrics Team arrives	Fieldwork (Ocean/Vulcano)	Geoelectrics (Klaus, Jana)	Fieldwork (Ocean/Vulcano)		Star Gazing with Frank ?
7	Monday 17th		Fieldwork (Ocean/Vulcano)	B. Foing (Moon, ESA)	Fieldwork (Ocean/Vulcano)		
8	Tuesday 18th		Fieldwork (Ocean/Vulcano)	Jos (Europlanets)	Fieldwork (Ocean/Vulcano)		
9	Wednesday 19th		Fieldwork (Ocean/Vulcano)	Summary results / overview of data gathered	Data backup	Packing Van	Packing Van
10	Thursday 20th	Most participants leave - Stromboli Visit					