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IGLUNA IGLUNA consists of the building of a habitat in a glacier in Zermatt, Switzerland as a simulation of building a similar habitat at the South pole of the Moon [1-4]. The experiments will be conducted in June 2019 in Zermatt with phases of testing beforehand. The team from VU Amsterdam (VUSE) is one of the 19 teams from 14 different universities participating in this project and will focus on the scientific research and exploration [6].

Application: The research planned by the VUSE team consists of two main parts: Ice core analysis and geological exploration of the glacier and surrounding area. A third component of the project is to improve the remote support and control. The ice core analysis will be performed to gather an understanding of the chemical composition of the glacial ice, since one would want to research this in a hypothetical situation on the Moon as well. By exploration of the surrounding area we want to get a better understanding of the glacier itself and the geology to complement our chemical analyses.

Using the instruments for the chemical research as well as the geological research, we hope to constrain the history of the glacier in Zermatt, as well as performing realistically comparable ice research to what will be conducted on the South Pole of the Moon. We hope to obtain this with the use of remote control of instruments on the glacier and in the habitat. To accomplish all this, extensive technological knowledgeis very important. Therefore, various devices will be used and tested beforehand.

Instruments: For this research, we will use the instruments as listed and described below (fig 1). One part of this equipment will be on our ILEWG ExoGeoLab [5], which will be stationed on the glacier, while the other part will be inside the SMART-ICE lab, also created by ILEWG [6-9]

Cameras: We will require two types of cameras: firstly, hand-held cameras for documentation of our processes and results and for public outreach and, secondly, remotely controlled cameras attached to the ExoGeoLab used to guide the astronauts during the exploration and collecting of samples.

Spectrometer: We have a vis-NIR spectrometer to recognize the ice's (micro)biological content and chemical composition.

Close up camera and microscope: Close up cameras will be used to connect microscopy data to larger samples. The microscopy data can be used to determine the origin of an ice or a rock sample. Microscopes can also be used to determine the pressure gradient in ice with thin sections.

Telescopes: The telescopes will be used for geological observations to remotely determine the location of promising samples that later can be picked up by astronauts during EVA-simulations.

IR vibration spectroscopy: This spectroscope can provide information about molecular vibrations and crystal structures. This can be helpful when determining the chemical and biological composition of the ice.

Drones: We will have multiple drones to explore the surrounding area, and possibly map them. The drones can be controlled remotely.

Additional ExoGeoLab equipment: Placed on our ExoGeoLab will be the computer toremotely control the instruments andenvironmental sensors. These include a seismometer to register minor geological activity and ice movement, and sensors for heavy weather protection.[8]

Fig 1: The ExoGeoLab lander (top) and instruments

on the top platform of the ExoGeoLab (bottom), including: a microscope (1), a solar H alpha telescope (2) and a vis-NIR spectrometer on SpectroLab cube (3)

Tests Before the experiment in Zermatt in June 2019, multiple tests will be conducted with the instruments and for validating the proper function of the remote control communications. So far, one major test phase has been conducted in October 2018 in the Eifel volcanic region in Germany (fig 2). Here, we tested the working of drones, the vis-NIR spectrometer and the telescopes, together with the remote indication of the location of potential samples and the following correspondence with the analogue-astronauts. Further (remote) testing is to take place during the HI-SEAS campaign in Hawaii in February 2019, during MDRS-205 in the Utah desert and on a small scale at the European Space Research & Technology Center (ESTEC). With the planned testing we want to ensure that all the instruments are functioning properly and that the communication with the astronauts will be smooth. This will require some training in the use of the instruments from the astronauts beforehand.

Fig 2: Pictures taking during the testing phase in Eifel, Germany, including the drone (top left), the drone being used (red circle, bottom left), a telescope and equipment in the background (top right) and samples taken during the tests (bottom right).

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References:

[1]Heemskerk, M.V. (2019) LPS50, Abstract #2416 , [2] Foing, B.H, (2018) EGU2018, 18534, [3], Foing, B.H (2018) LPS49, Abstract #1988, [4] Foing, B.H (2017) LPS49, Abstract #5073 [5] Lillo, A (2018), LPS49, Abstract #1242. [6] De Winter, B. et al , LPS 50 , Abstract #1588 [7] Sitnikova A. et al, LPS 50 , , Abstract #Y, [8] Bas, R.. et al, LPS 50 ,(2019) , Abstract # , [9] Clément, T. et al, LPS 50 , Abstract #2445