Geology and Astrobiology Research and Data Analysis for Igluna.

D. Beentjes[1], B. de Winter[2], M.V. Heemskerk[2], B. Foing[3,4,5], and VUSE Igluna Team (B. Albers, M. Daeter, A. Kruijver, S. van Bloois, T. Clement, M. Grosjean, I. Brouwer, M. Berg, R. Korthouwer, A. Dingemans, G. Vaessen) [1]VU Amsterdam (dieke.beentjes@gmail.com) [2]VU Amsterdam (dewinterbram@hotmail.com, marczijnmailadres@gmail.com), [3]VU Amsterdam, [4]ESA ESTEC, [5]ILEWG

Introduction: IGLUNA is a project organized by ESA_Lab and the Swiss Space Centre [1]. The main goal of the project is to build a habitat inside a glacier, as a simulation for a moon habitat [2]. We are a group of students from the VU in Amsterdam and as part of this project we present our progress so far.

Research Prospects: Our addition to IGLUNA is called VUSE and is focused on the science in and on a glacier: to construct the history of the glacier by observing ice cores and to conduct chemical and biological compound analysis in the habitat. Additionally, there will be a life science experiment; the goal is to inspect rock and ice samples for markers of (micro)biological life. A subsequent goal would be to characterize the microbes that are found in the samples [3]. The habitat will accommodate the SMART-ICE Lab, where the majority of the experiments will be conducted. Two of the techniques that we have implemented are close-up imaging and microscopy.

Sampling. Samples are acquired by small expeditions of analogue astronauts, employing the ExoGeoLab for guidance. The ExoGeoLab is equipped with telescopes and cameras that can be controlled from the ground station in Zermatt. Additionally, drones will be deployed to scout the area to mark locations of interest, where rocks and/or ice could be sampled [4].

Another team from IGLUNA plans to build a drill that can produce ice cores. If this is successful, our team can analyze these samples as well.

Depending on the measuring technique, the samples will be melted into water or sliced into thin sections.

Close-up imaging. Close-up images (fig. 1) can be made of rock debris found in ice samples to determine the mineralogy and general characteristics, such as roundness and smoothness. Close-up imaging of handheld samples will also be employed to document the samples before alteration occurs and to formulate a context for the microscopy data. This will allow us to compare sets of data and give more support behind our conclusions.

Microscopy. Thin sections of the ice will be made from ice samples, either by melting or slicing. Using a polorized microscope we can provide information about pressure gradients and the transition from densily compacted snow to glacier ice. Atmospheric snowcrystals are known for their intricate shapes, however, these shapes are highly unstable. Accumulation of snow causes an increase in pressure, which in turn causes rounding of the snowcrystals. How and at what depth this transition takes place is one of the research questions we will answer. The microscopes will also be used to document the progress of the life science experiments.

Additional research. A VIS-NIR spectrometer will be used to determine the chemical composition of the ice and its organic and microbial content. A pH-meter and an EC-meter are used to measure the acidity and the electrical conductivity, respectively, of molten glacier ice. Another team will provide us with ice cores that can be analysed for information about the ice deeper into the glacier. A portable sequencing device will be employed to sequence DNA or RNA of samples in real-time.

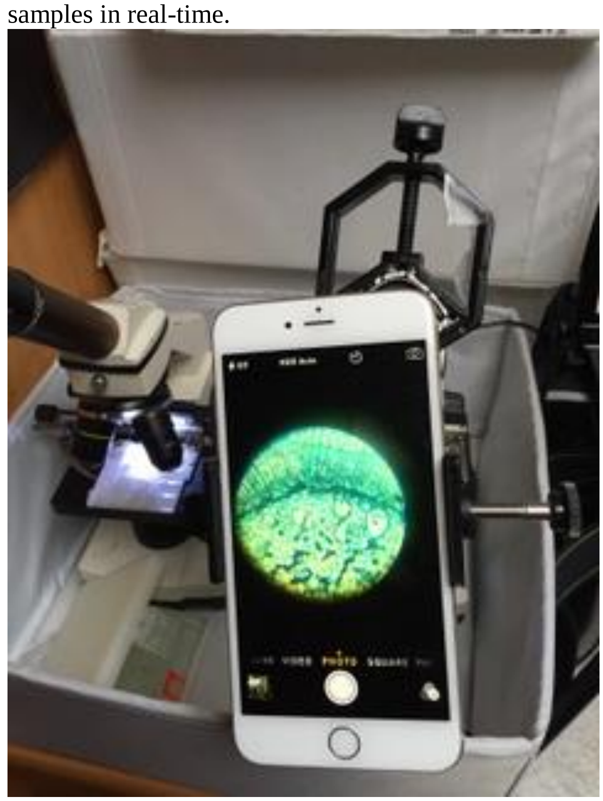

Figure 1. Part of the experimental setup for the microscopy, with polarized microscope (left) at the ExoHab, ESTEC.

Data analysis: Analysing and interpreting the data will be done in two sections: the field database, where the data from the ExoGeoLab is collected, and the database for the instruments from SMART-ICE Lab, which is inside the IGLUNA habitat. The data from both databases will be sent to the ground station in Zermatt and to the support team located in Amsterdam. There, the data can be analyzed and interpreted, results can be used to formulate feedback and/or additional research for the team back in the habitat.

Further Testing: Before the final field test in Zermatt (June 2019), additional testing is required to ensure the equipment is functional and all the experiments can be carried out as planned. A functional laboratory module (ExoHab, fig. 2) was built at the European Space Research and Technology Centre (ESTEC). This module is used to simulate the conditions of a small terrestrial analogue habitat. Furthermore, the VUSE team will partake in the Hi-Seas campaign in Hawaii and MDRS-205 in the Utah desert [4].

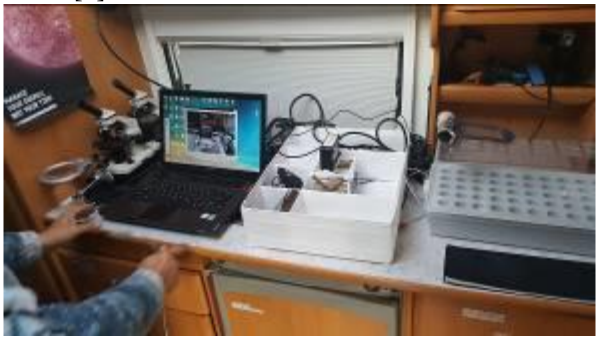

Figure 2. Prototype of the experiment setup at ExoHab, ESTEC. Containing (l to r): microscopes, control computer, spectrometer and a prototype astrobiology experiment.

Acknowledgements: We would like to thank the coordinators of the Igluna project and Swiss Space Centre (including T. Benevides, O. Kirchhoff, K. Kunstmann, D. Bass and Y. Delessert). We acknowledge the VUSE Igluna team (including A. Kruijver, S. van Bloois, M. Grosjean, M. Daeter, T. Clement, B. Albers, G. Vaessen, A. Dingemans, I. Brouwer, M. Berg and R. Korthouwer). We also thank ESA and the ILEWG teams for supporting the VUSE project. Lastly, we would like to thank Prof. Bernard Foing for his outstanding support and experience.

References:[1] https://www.spacecenter.ch/igluna/ [2] Heemskerk, M.V. (2019) LPS50, Abstract #2416 [3] Clement, T. (2019) LPS50, Abstract #2445 [4] De Winter, B. (2019) LPS50, Abstract #1588