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Callio Spacelab - An underground laboratory for future exploration and analogue missions in Finland

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An isolated but highly connected underground mine can be used as an analogue environment for the astronauts operating without sight to the home planet and with limited connectivity to the psychologically-important “home”. Similarly to the real-world space mission, the Earth-bound analogue mission can be run with limited resources, i.e., just enough for the duration of the mission. Such a location is available in Pyhäjärvi, Finland.

The conceptualisation of the use of the Pyhäsalmi mine as an analogue environment for space missions started in 2017 with an idea of a Marscape environment to be developed in the old part of the mine. The 1.4-km-deep base metal mine is ending its underground ore extraction (zinc, copper and pyrite as main products) in 2022. The concept is branded as Callio SpaceLab¹, and it has been developed by the University of Oulu, Finland, in cooperation with international partners. The Callio SpaceLab is part of the underground research centre Callio Lab², and it is one of the strategic research infrastructures of the University of Oulu.

The mine is located within a volcanogenic massive sulphide (VMS) deposit³, with known mineralisation reaching a depth of 1.4 km. Deep overpressured ancient water-conducting fracture zones have occasionally been intersected by drilling. Water of this kind is accessible through a high-pressure valve system, making further analyses possible, especially from the astrobiological point of view.

The vast tunnel network with more than 100 km of tunnels, old main levels and operational areas give room for any activities ranging from technological testing to having analogue astronauts in total isolation. With the optical baseline and copper and wireless access, personnel and monitoring activities are possible through a 1+GB on-site internet connection, from the surface or securely through a VPN access. Moreover, there are two underground, hydroponic greenhouses built at the 660 m level. These can be used for analogue missions. The well-known geology gives many possibilities for scientific drilling, on-site analysis, and possibly in-situ resource utilisation.

The multidisciplinary University of Oulu has turned its eye to the stars. Many earthbound research topics are being evaluated from the space exploration viewpoint. These include mining technologies and processes⁴, such as free crushing and comminution⁵, dry beneficiation, digital construction, and geophysical methodologies.

We will present the possibilities brought by the Callio SpaceLab environment to the selected earthbound research topics and applications of space exploration.

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3) Mäki, T. *et al* The Vihanti-Pyhäsalmi VMS Belt. in *Mineral Deposits of Finland* 507–530 (Elsevier Inc., 2015). doi:10.1016/B978-0-12-410438-9.00020-0.

4) Oulu Mining School University of Oulu. <https://www.oulu.fi/en/university/faculties-and-units/faculty-technology/oulu-mining-school>.

5) Hugger crusher. *University of Oulu* (2020).