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TESTING TECHNOLOGIES AND OPERATIONAL CONCEPTS FOR THE GEOLOGICAL EXPLORATION OF THE MOON: THE ESA PANGAEA-X CAMPAIGN

Abstract

Following the successful implementation of PANGAEA (Planetary ANalogue Geological and Astrobiological Exercise for Astronauts), ESA developed an analogue test campaign called PANGAEA-X (PANGAEA-eXtension) aimed at acquiring knowledge to develop exploration strategies for planetary missions, with a specific focus on lunar settings. Two implementations of PANGAEA-X were carried out in November 2017 and 2018, on the island of Lanzarote, Spain. Both campaigns were open to internal actors, partner agencies, and external investigators. Lanzarote was chosen because of its extensive volcanic environments that act as geological analogues to several environments on the Moon and Mars. The 2017 campaign focused on both testing technologies and operations for geological and geo-microbiological sampling, and examining exploration, mapping, navigation and communication methods in low lighting conditions and over rough terrain. The 2018 campaign concentrated on tele-robotic operations (in the frame of the Analog-1 experiment) and lunar surface EVA operations and tools. Between the two campaigns, 11 different research institutions and companies, involving four different space agencies, conducted a total of 18 experiments. This variety of experiments enabled PANGAEA-X campaigns to develop testing programmes with ambitious sets of inter-related goals related to both human and robotic exploration. Operational concepts for geological sampling during spacewalks were compared in tandem with testing new analytical and mechanical tools designed to support geological sample collection. A series of technological solutions, such as 3D LIDAR scanning and drone photogrammetry, were used to characterise several geological sites for the Analog-1 robotic teleoperation campaign, providing information on both navigability and geological setting. Other tests included examining the navigation of rovers in challenging rocky terrain and lava tubes using automated and tele-operated modes, conducting microbiological sampling and in-situ portable DNA sequencing of cave microbiota in a lava tube, and testing underground communication instruments, remote sensing and 3D mapping. Geophysical technologies were also used to identify and characterise underground voids in the testing area. All these tests and experiments were

performed with the participation of European astronauts and the assistance of ESA experts, with the aim of evaluating potential applications and developments for future missions and training programmes.