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PHASE-A DESIGN OF A MARS SOUTH POLE EXPLORATION MISSION: MARS PENGUIN

Abstract

During the last 60 years, several space missions have been designed and launched to explore our neighboring planet, Mars. Most of these expeditions had the goal of mapping the planet and evaluating some of its key characteristics, such as terrain configuration and composition. In this context, in 2018 the Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) instrument, on board the European Space Agency's (ESA) Mars Express Orbiter, led to the discovery of a subglacial lake located at the South Pole of Mars, in the same area where several geysers were first observed in the late '90s. This discovery suggested complex seasonal dynamics associated with both the Mars icy caps and led to the launch of some missions to inspect the main features in situ. However, none of the attempts was successful. This paper presents the phase-A design of a fully European rover mission, called MARS South Pole ExploratioN and Geysers in-sitU Investigation (MARS-PENGUIN), to sample the icy crust above the South Pole subglacial lake in different locations and characterize the aforementioned geysers' phenomena from a close distance. The mission, composed of a service module, a rover, and a martian helicopter, is designed to reach the subglacial lake region during the martian spring, in 2029, after a ten-month cruise, to spot the geysers during their activity period. This work reports the requirements, the feasibility analysis, and the preliminary technical development for each subsystem. Moreover, the operational phase is characterized, with an emphasis on the sampling strategies adopted to meet the mission objectives.