Paper ID: 59645
oral
student

18th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Space Resources, the Enabler of the Earth-Moon Econosphere (5)

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HYDRATION: MINING WATER ICE ON THE MOON AND MARS USING DOWNHOLE RADIATIVE HEATING

Abstract

NASA is interested in returning humans to the Moon and eventually to Mars, this time to stay. A critical enabler for sustainable human exploration is water, and water in various forms, including ice, is believed to exist on both worlds. Accordingly, NASA and industry partners have sponsored the National Institute of Aerospace's RASC-AL Moon to Mars Ice and Prospecting Challenge to elicit designs and proof-of-concept prototypes for ice mining and prospecting systems. One water mining design well-suited to thick ice sheets, used in Antarctica today, is the Rodwell, where hot water is circulated under feedback control to sustain a self-deepening, simple and reliable water well. However, the Rodwell is not optimized for the presence of overburden or for energy efficiency. Our proof-of-concept Earth-conditions-analog prototype described in this paper, HYDRATION (High-Yield Dihydrogen-monoxide Retrieval And Terrain Identification On New worlds), is a dry-hole variant of the Rodwell, but based on down-hole radiative heating with immediate extraction of cold water instead of recirculation of hot water. Compared to the classic Rodwell design, the constant collection of cold water reduces heat losses into the ice and cools the boom assembly above the heater cartridge, helping to maintain the frozen neck of the ice cavity which supports the overburden and the hole wall. A second use case for HYDRATION is prospecting on the moon to obtain a "digital core" of mineral deposits with minimal human intervention. HYDRATION competed at the RASC-AL Special Edition, NASA Langley in June 2019 where it received the 'Honorable Mention' and 'Best Technical Paper' awards and demonstrated the recovery of 5583ml of meltwater in 9 hours of operations. The gross water extraction rate of 620 ml/hr was the highest water rate per hour and the water produced had fine particulate turbidity measured 115-321 NTU, which was the third clearest. Development continues with analog field experiments at the RASC-AL Special Edition 2020 sponsored by NASA, and at the Swiss Space Center's IGLUNA 2020 which is sponsored by the European Space

Agency.