**MOBILE IN-SITU MARS/MOON WATER EXTRACTOR SYSTEM (MISMWE).** K. Zacny[1], G. Paulsen[1], A. Avanesyan[1], J. Craft[1], L. Oryshchyn[2], J. Sanders[2], [1]Honeybee Robotics, 398 W. Washington Ave, Suite 200, Pasadena, CA 91103, zacny@honeybeerobotics.com, [2]NASA Johnson Space Center,

**Introduction:** The mining and transportation of icy regolith faces key challenges. First, conventional excavators will not be able to penetrate soil having any substantial ice fraction (icy-soils are harder than concrete). Second, as seen during the Mars Phoenix mission, any exposed ice would sublime, leaving behind dry soil. Thus, even if the excavator manages to acquire some chunks of icy soil, some ice would sublime away during transport to the processing plant.

The solution to these problems is an integrated mobile mining and water extraction system that uses an auger based excavation approach and an integrated water-ice extraction plant – hence, if the water-ice does sublime, it will sublime straight into the extraction system. The proposed system is an auger with a reactor, and the weak link – the transfer system – is eliminated altogether.

**MISMWE:** The system, called the Mobile In-Situ Mars/Moon Water Extractor (MISMWE), consists of the Icy-Soil Acquisition and Delivery System (ISADS), and the Volatiles Extraction and Capture System (VECS). The operation steps are shown in Figure 2.

The ISADS is a deep fluted auger that drills into the ice or icy-soils and retains material on its flutes. Upon material acquisition, the ISADS is retraced into VECS and sealed. The VECS consists of a cylindrical heat exchanger and volatiles transfer system (a reactor). The material on the deep flutes is initially heated via for example conduction or microwave. However once some water sublimes and pressure inside the reactor increases, the further heat transfer could be accomplished via very efficient convection. The reactor pressure gage monitors the pressure at all times to prevent liquid forming. Vapor is bled into a water collection canister by a one way valve where it condenses. The heat is transferred back to the reactor. After water extraction the ISADS is lowered towards the ground and spun at high speed to eject the dry soil. At the same time, the collected water is pumped from the canister into a storage container within the rover's Warm Electronics Box. The MISMWE rover then moves to the next location and the operation is repeated. Once the water tanks on the rover are full, the rover drives back to the base while leaving dry soil and a "Swiss cheese"field of holes in the ground.

Since the regolith is not actually transferred, there is no need for a transfer system and associated dust tolerant valves. If the rover is powered using Radioisotope Thermal Generators (RTG) or the more efficient Advanced Stirling Radioisotope Generator (ASRG), the heat generated by the unit can be transferred to the reactor.

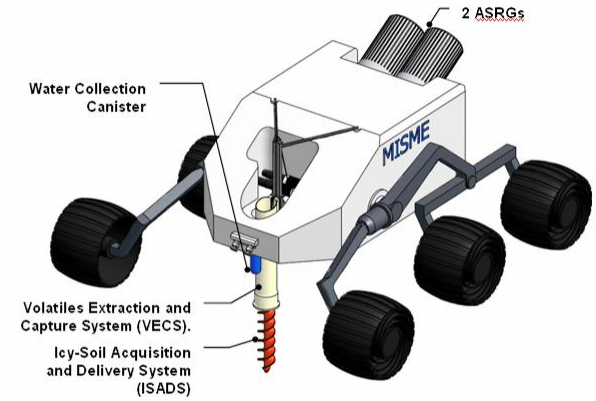
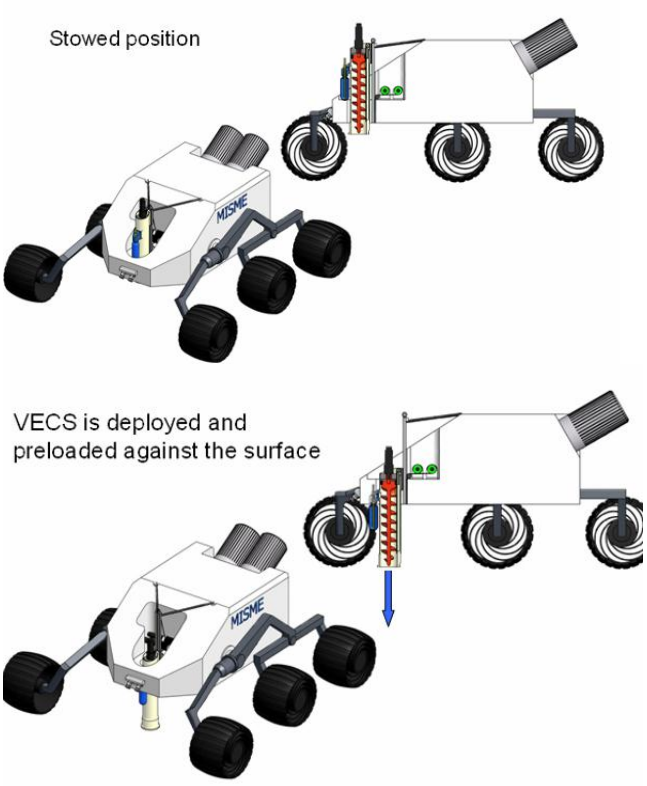
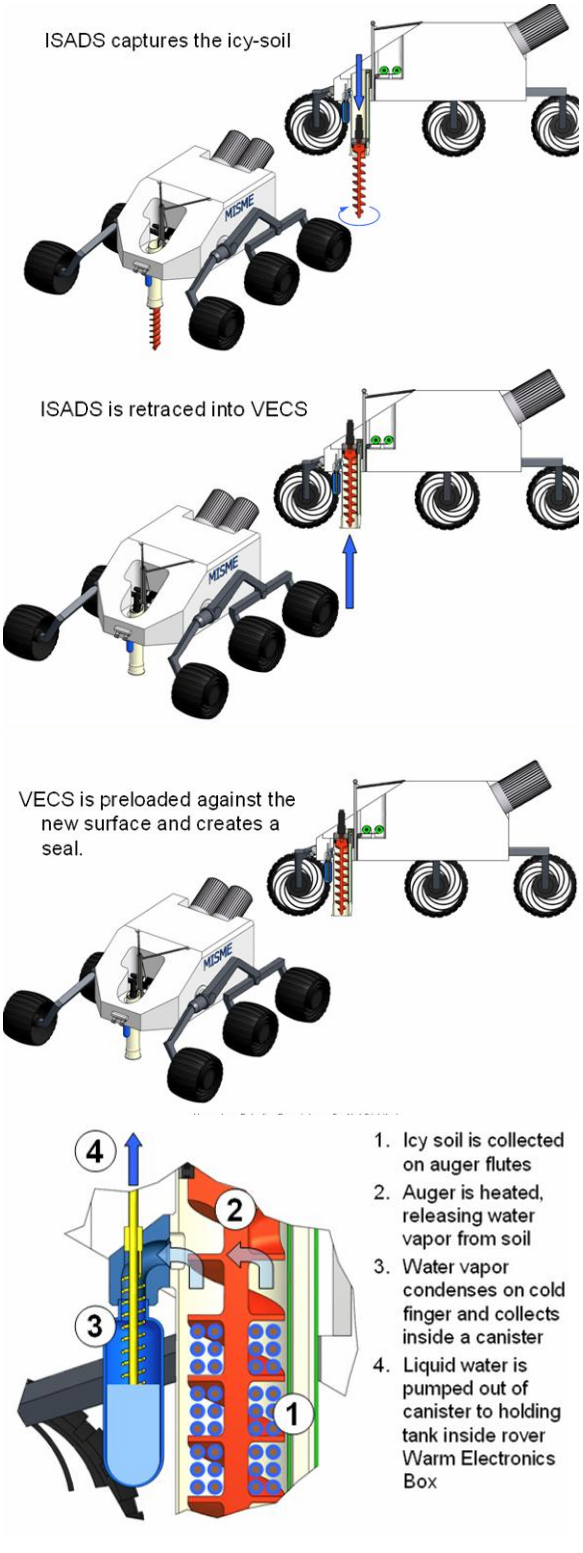



**Figure1. A concept of a Mobile In-Situ Mars Water Extractor (MISMWE).**





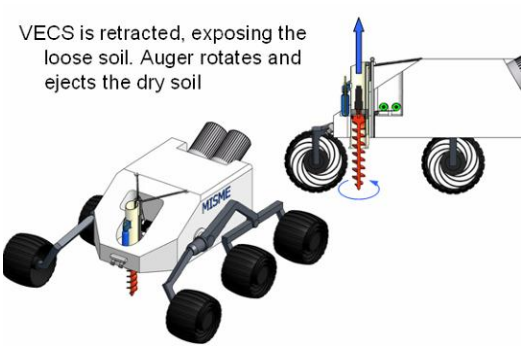




**Figure 2. MISMWE sequence of operations.**

**Proof of Concept:** We demonstrated drilling to 1 meter depth into ice and ice cemented ground under Mars conditions. The drilling power was 100 Watt and Penetration Rate was 1 m/hr [1, 2]. We also built a scaled model of the VECS subsystem to demonstrate feasibility of water extraction. The system shown in Figure 4 was tested in a Mars chamber. In preliminary tests we successfully recovered more than 60% of the water present (7 grams).

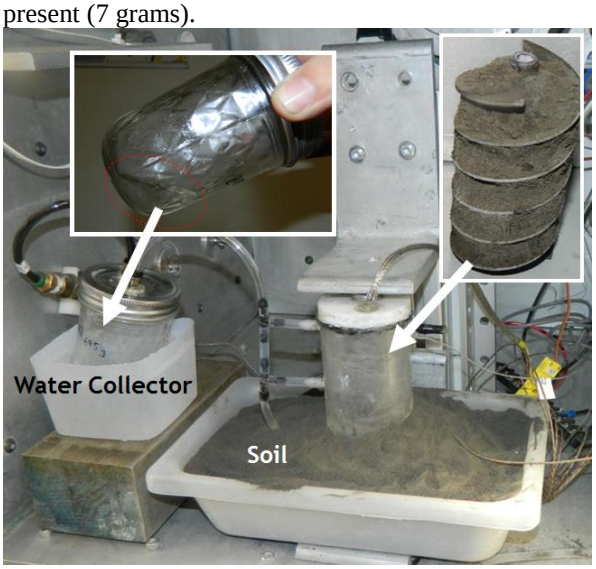



**Figure 4. MISMWE water extraction system being tested in Mars chamber.**

**References:** [1] Paulsen, et al., Testing of a 1 meter Mars IceBreaker Drill in a 3.5 meter Vacuum Chamber and in an Antarctic Mars Analog Site, AIAA SPACE 2011 Conference; [2] Zacny et al., The Icebreaker: Mars Drill and Sample Delivery System, Abstract 1153, LPSC 2012;