SHALLOW-BOREHOLE ARRAY FOR MEASURING GREENLAND EMISSION OF TRACE GASES AS AN ANALOGUE FOR METHANE ON MARS (GETGAMM). K. Zacny[1], G. Paulsen[1], J. White[2], [1]Honeybee Robotics, 398 W. Washington Ave, Suite 200, Pasadena, CA 91103, zacny@honeybeerobotics.com, [2]Indiana University

Introduction: We are developing a method for measuring seasonal and diurnal variation in concentration and isotopic composition of methane in the subsurface that can be applied to a Mars landed or rover mission. The purpose for taking these measurements is to provide ground truth data for reports of methane plumes in the Martian atmosphere.

Our task over the course of this ASTEP funded three year project is to develop a 'sniffer' drill string for sampling subsurface gas and to deploy it using the IceBreaker Mars prototype drilling system [1, 2] in Greenland.

This technology addresses Challenge Area 1: Instrumentation and Investigation Approaches: Near-term: Interrogating the shallow subsurface of Mars from the surface (drilling).

Drilling Technology: When designing a drill system there will always be a trade-off between mission complexity and risk (an engineering driver) and science payoff (science driver). In general, there are five different subsurface exploration approaches [3]: 1. Drill Embedded Sensor; 2. Sniffer (drill that enables sampling of gases from subsurface); 3. Sampling Auger (cuttings generated during drilling are transferred into an instrument on the surface); 4. Bit Sampler (sample is captured inside a drill and transferred into an instrument once the drill is pulled out of the hole); 5. Coring (acquisition of a core sample and transfer of core to an in-situ instrument and core processing system, e.g. crusher).

Although a drill-embedded sensor is the simplest method, it limits the science data that can be returned. The Sniffer system on the other hand, enables sampling of gases and transfer of the gases to a mass spectrometer or other instruments.

Note that it is also possible to combine 2 or 3 of the above drill based exploration approaches into one system. For example, a drill could have an embedded sensor (temperature, neutron spectrometer etc.), the capability to acquire and transfer subsurface gasses, and since the drill produces cuttings during drilling, these cuttings could be transferred to various science instruments. The major benefit of this approach is that the drill string will not have to be pulled out of the hole, unless more than one hole is required and there are no spare drill strings.

Sniffer System: The Sniffer drill consists of an Inlet Valve linked to a Capillary Tube and the Outlet Valve linked to a Mesh Drill section (Figure 1 and 2). The Mesh Drill section has numerous small holes that prevent soil particles from getting in, while allowing borehole gas to diffuse inside the drill cavity. Initially, inert/purge gas is injected downhole to displace the gas from inside the drill and also open up blocked holes. The purge gas returns to the surface via the Outlet Valve. After the purge operation, the Inlet Valve is closed and the Outlet Valve connecting the inside cavity of the drill string to the gas sensor is opened. The borehole gas then flows through the Mesh Drill section, around the Capillary Tube, up into an Outlet Valve and ultimately a gas sensor.

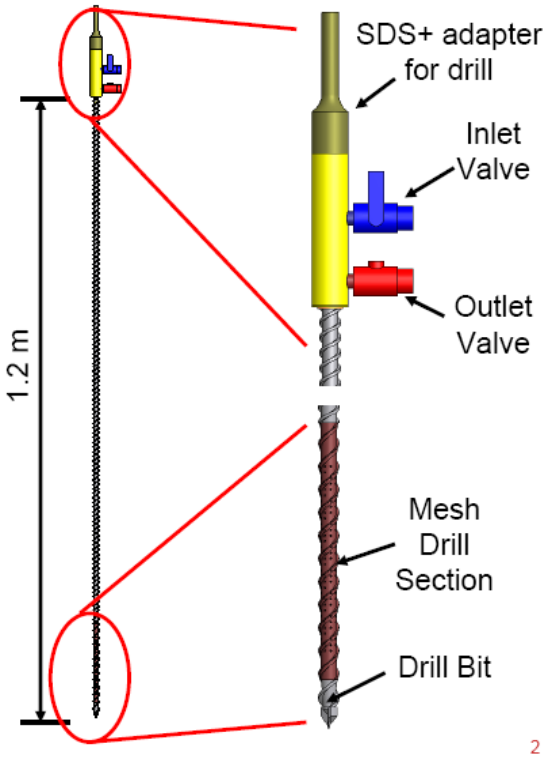

Figure 1. View of the Sniffer drill.

Ideally, the drill is deployed once and left in place. Since the drill does not have to be pulled out of the hole, it drastically reduces the mission risk and complexity. If the mission requires sampling more than one location (e.g. rover-based rather than lander based mission), additional drill strings could be brought in. Additional drill stings also add redundancy to the mission.

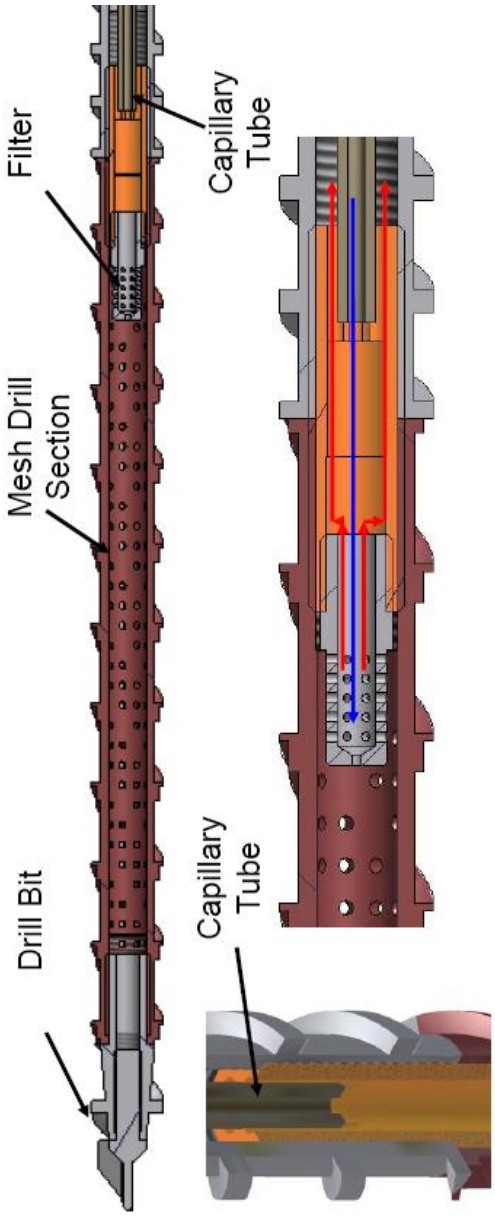

Figure 2. Details of the 'Sniffing' part of the drill string.

References: [1] Paulsen et al (2011), Testing of a 1 meter Mars IceBreaker Drill in a 3.5 meter Vacuum Chamber and in an Antarctic Mars Analog Site, AIAA Space. [2] Zacny et al. (2012) The Icebreaker: Mars Drill and Sample Delivery System, #1153, LPSC. [3] Zacny et al (2011). LunarVader: Development and Testing of a Lunar Drill in a Vacuum Chamber and in the Lunar Analog Site of the Antarctica. Accepted. J. Aero. Eng.