EVALUATING CORE CONTAMINATION DURING DRILLING UNDER MARS-LIKE CONDITIONS

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Synopsis

Goal: Determine the likelihood of microorganisms transfer from drilling surfaces (drill bit, core breakoff tube) onto core sample under Mars-like pressure conditions.

Methodology: Rotary-Percussive core drill mounted inside a Mars vacuum chamber. Mars conditions included 7 torr pressure with N2 purge and room temperature. Rock core was 1 cm diameter and 6 cm long. The rocks included: travertine, gypsum, and kaolinite (formed in the presence of water).

Microsphere application and analysis: Fluorescent microspheres 0.5 um and 0.05 um in diameter were used as microbial tracers. A solution of 250 ul of stock solution of microspheres and 500 ul of acetone was evenly applied to inside of the bit (total of 9.1 x 10^13 microspheres) and dried. Processing was performed by making a lateral cut across the core to create a clean face, and then sampling the core from the center in 2 mm increments outwards to avoid transfer. Outer and inner drill cuttings were collected and processed as well. Microsphere distribution was quantified using a fluorescent microscope. For each sample ten fields were counted.

Findings: Microbial load was less under Mars conditions. Microsphere distribution on the outside of core samples was ~1-2 orders of magnitude lower than the amount of tracer applied to the bit. Centers of cores and the bottom of cores had least tracers; these areas would be the best for life detection analyses. Surfaces of broken up cores have as much tracer as outside. Cuttings (chips) left on rock surface have as much tracer as cuttings (powder) inside the bit.

Core Drilling Test in Travertine

Drilling Results

- Drilling power & energy was higher at Mars Pressure, which can be attributed to higher bit-rock friction.
- Core quality was lower at Mars conditions (that is the core was more broken up). It is believed that this is due to changes in coefficient of friction between cuttings and drill and changes in cuttings’ friction angle. At Mars vacuum, friction between soil/rock and friction angle is lower. This caused the cuttings to flow into the bit (these cuttings we call “powder”) as opposed to being augured out (these we call “chips”). Additional cuttings between the core bit and the core caused the core to fracture.

Tracer Results:

- Microsphere load was highest:
  - near the top of the core and lessened with depth
  - on the outside surface of the core and lessened into the center of the core
  - break faces at the top of the core
- Cores drilled under Mars conditions had 1-2 orders of magnitude less tracer.
- Under both conditions, drill cuttings (“powder”) from inside the bit and from the outside of the drill bit (“chips”) contained spheres with a similar load to those found on the outside of sample cores.
- Cuttings left behind would be a concern for planetary protection of sampling sites

Results

Microsphere distribution in travertine

Fluorescent microsphere distribution visualization under UV light on a travertine core drilled under atmospheric conditions (top) and under vacuum (bottom). The top of the core is on the left hand side.

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