National Aeronautics and Space Administration

FY23 Topic Areas Research and Technology Development (TRTD)

# Sample Integrity Evaluation Methodology for Icy Worlds Applications

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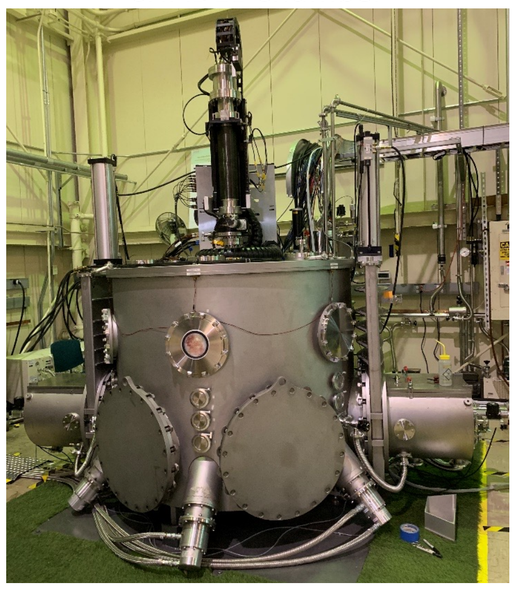
**Strategic Focus Area:** Manipulation and Sampling Systems

## Objective

To develop a method of evaluating the scientific integrity of a collected water ice sample as compared to its parent material. Sample acquisitions leverage the development of the Ice Cutting and Encapsulation via Centrifugal Acceleration and Pneumatics (ICECAP) tool for use in the existing stat of the art Cryogenic Ice Transfer, Acquisition Development, and Excavation Laboratory (CITADEL) vacuum chamber.

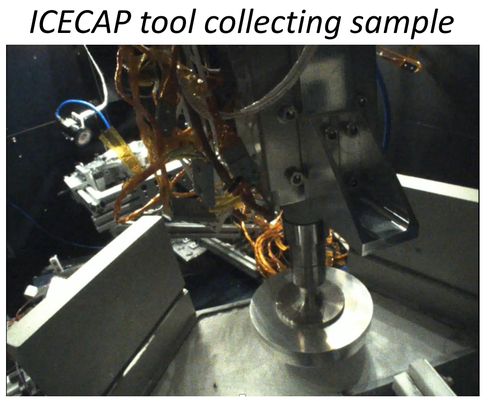
*CITADEL Chamber*



## Background

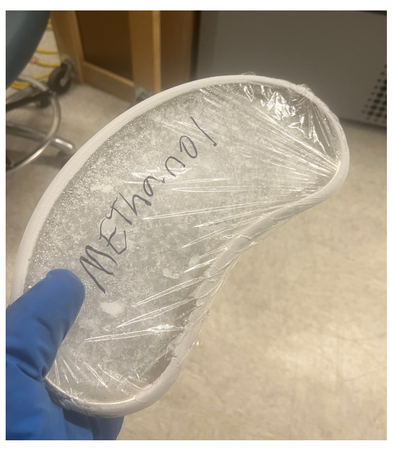
Icy Worlds are an ideal candidate to search for biologic indicators due to the existence of water. High sensitivity scientific instrument would be deployed to search for trace signs of past or present biology. To have confidence in these measurements, it is imperative for the science team to know that the collected samples have the same character and composition of the parent sample material, leading us to propose a sample integrity test campaign

*ICECAP tool collecting sample*



## Ice Sample Creation

Ice samples were mixed and frozen in sample troughs for use in the CITADEL Chamber. Samples were poured into the mold containers and set to freeze in a -80˚C Freezer


## Approach: Sample Candidates

Deionized water doped with 1% Alcohols were identified as candidate materials to evaluate the effects of heating and determine the volatile constituent losses due to sample collection.

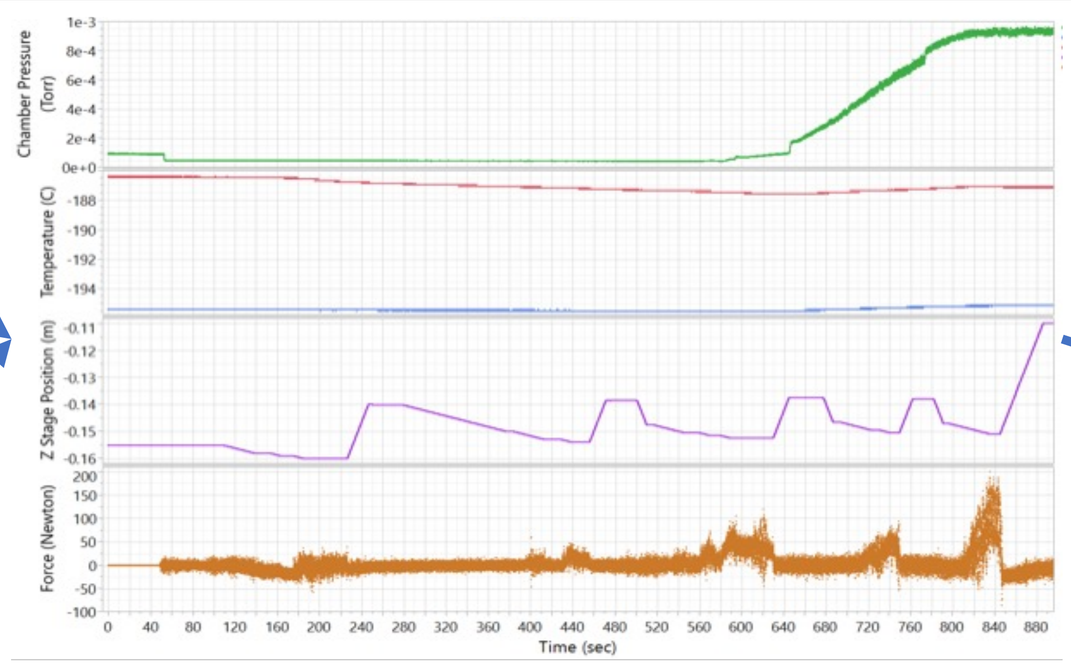
| # of Carbons | Alcohol | Boiling Point (˚ C) | Water Solubility at 20˚ C (g/100g $H_2O$) |
|---|---|---|---|
| **1** | **Methanol** | **65** | **Miscible** |
| **2** | **Ethanol** | **78** | **Miscible** |
| 3 | i-Propanol | 82.5 | Miscible |
| **3** | **n-Propanol** | **97** | **Miscible** |
| 4 | i-Butanol | 108 | 8.5 |
| **4** | **n-Butanol** | **118** | **7.3** |
| 5 | n-Pentanol | 138 | 2.2 |
| 8 | n-Octanol | 195 | 0.03 |
| **2** | **Ethylene Glycol** | **197** | **Miscible** |

## Results

- ICECAP tool worked as expected with visual confirmation of sample delivery into sample tubes.
- When opening sample tubes for analysis at the chemistry lab, no visible or quantifiable amount of liquid sample was present!

## Benefits to JPL and NASA

- Plans to use non-volatile organic molecules as ice dopant materials to prevent evaporation of collected samples.
- Modification to sample transfer and collection procedure to minimize the time the samples are exposed in air after being collected in-situ.
- Optimize sample tube design and in chamber monitoring for better visual confirmation of collected samples.




## Procedure

1. Sample Tubes (Top Left) and Ice Sample (Bottom Left) are inserted into chamber.
2. ICECAP Tool collects sample and delivers it to sample tubes
3. Sample tube is removed from chamber, visually inspected, and physically capped with an air-tight seal; then taken for chemical analysis

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