Titan’s Surface from Dragonfly: Bridging the Gap Between Composition and Environment

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Dragonfly will provide the first in situ characterization of Titan’s surface chemistry. (See Lorenz et al. 2018; Turtle et al. 2019 LPSC 50 #2889)

The Earth-like geological and atmospheric processes at work on Titan make understanding the geological context critical to evaluating the habitability potential of this ocean world.

Sample provenance

Dragonfly’s suite of cameras with nested fields of view provides context for where sampled material originates in the landscape.

(Below) Curiosity images from Ewing et al. (2017) are a good analog for the scales at which Dragonfly will interrogate the surface.

A landing site

In front of the lander

Below the lander

At the sampling site

A landing site

In front of the lander

Below the lander

At the sampling site

Extrapolating between these scales facilitates building hypotheses concerning the geological provenance of the samples and thus the processes responsible for distributing and reworking compounds for prebiotic (or potentially even bioitic, e.g. Nesbitt et al. 2018) chemistry.

Illuminating the surface with specific wavelengths in the visible-near-infrared enables Dragonfly to distinguish water-ice-rich and organic-rich materials at the microscale.

In this false-color image

- tholins made with 5% methane in nitrogen (yellow)
- tholins made with 10% methane in nitrogen (orange)
- Water ice (white)

are distinguishable with a 2% linear stretch.

See also Núñez et al. (2019) LPSC 50 #3004.

Material properties

Observations of the interactions between the rotorcraft and the surface can also provide evidence for deducing the physical properties of the regolith, much like the investigations by Viking and Phoenix [e.g. Moore et al. 1977; Shaw et al. 2009].

Observation

Property

Example Interpretation

Texture and morphology of drill cuttings and hole walls

cohesion

Liquid methane can increase soil cohesion and therefore reduce transportability (Lorenz 2014; Yu et al. 2017).

monitoring the drill current applied during drilling

bulk hardness

Simple organics (e.g. acetonitrile, a potential evaporite) have lower hardness than water ice. (Lorenz et al. 2018)

Water ice

Ammonia-water ice

Silica Sand

Paraffin Wax

(Right) Cryogenic lab tests with Titan analog materials with a range of material properties show that the drilling system is capable of generating and transporting sufficient volume of samples for sampling and analysis.

The Dragonfly Geophysics and Meteorology package includes several commercial, off-the-shelf sensors for measuring

- Dielectric constant
- Thermal properties
- Methane humidity

regolith dampness, porosity, and composition

Data from: Huygens PWA-MIFFHASI (Hamelin et al. 2016), Cassini RADAR (Le Gall et al. 2015), and lab measurements (Palou et al. 2008, 2016; Lethliullier et al. 2018).

Bridges, N. T. et al. (2017) JGR-E, 122(10), 2077-2110.
Núñez et al. (2018) LPSC 50 #3004
Turtle E. P. et al. (2019) LPSC 59 #2888.