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THE GEOMORPHOLOGY OF TITAN: A NEW APPROACH

Abstract

Titan, Saturn's largest moon and one of the most intriguing objects in the Solar System, has been visited only once in the history of space exploration. The Cassini-Huygens mission confirmed the presence of surface liquid, probed a chemically complex atmosphere, and returned a wide-ranging dataset which is still under analysis today. Launched more than 20 years ago, the mission allowed scientists to develop different theories regarding the moon's geomorphological activity and endogenous processes. This is of great interest to planetary scientists and is one of many reasons making Titan an important and promising celestial body for future exploration.

The multinational research group, Conex Research, is currently conducting a pre-Phase A study of a mission to Titan called *Astraeus*. We present in this work the science traceability matrix and proposed scientific payload and mission profile. This payload is distributed across multiple vehicles in the multi-component mission, with remote sensing and in-situ observations seeking answers to important questions about Titan's geomorphology, origin and evolution.

We also present the most promising surface sites for exploration by the mission, three of these being the hydrocarbon seas and lakes, and the fourth site being a potential area of cryovolcanic activity. We have calculated the expected levels of outgassing at this site and used this to determine the necessary altitudes at which CubeSats would be required to fly in order to satisfy the science requirements of this particular study.

To address the complete science traceability matrix of the *Astraeus* mission, we have designed orbital, atmospheric, and landing segments of the mission. A Main Orbital Spacecraft (MOS) is the central element that will carry the mission to Titan and continue to act as a platform of observation. It will support 2U CubeSats called Mites which, with a mass of no more than 2 kg, will be launched from an altitude of approximately 1,400 km into a low decay orbit around Titan to fly over the many regions of interest and perform measurements within the upper atmosphere. Also carried by the MOS will be a near-surface flying vehicle called Mayfly. Mayfly, which has fixed motors for vertical and horizontal flight, will provide information on Titan's atmosphere and surface. A submersible vehicle, Manta, is a deployable probe from Mayfly, which will explore Titan's lakes. Both science and engineering synergies with the upcoming NASA Dragonfly quadcopter mission have been considered, and the flight heritage this will provide has been leveraged.