FY23 Strategic Initiatives Research and Technology Development (SRTD)

The Uranian moons as possible active worlds

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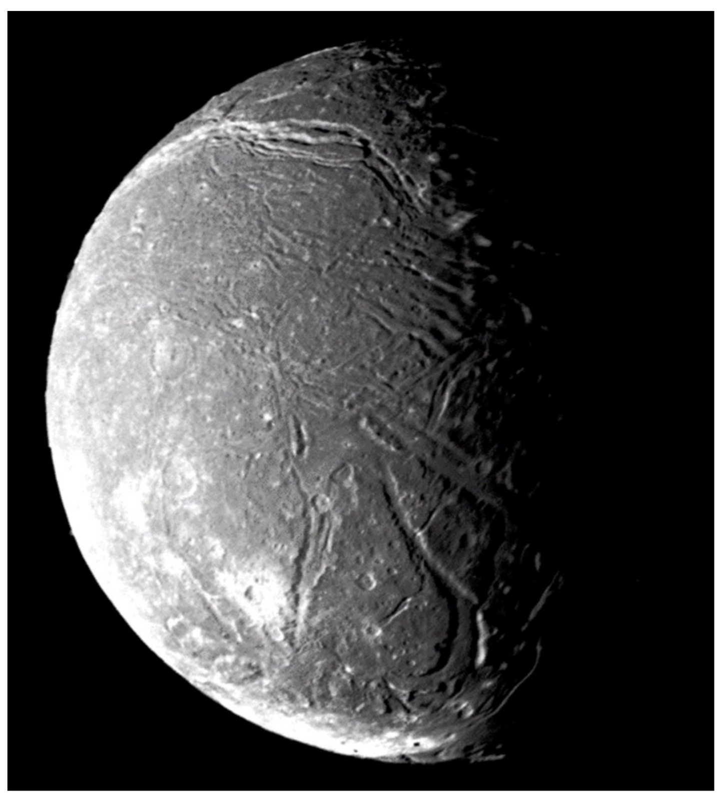
Strategic Focus Area: Ice Giant Science Leadership **| Strategic Initiative Leader:** David H Atkinson

Objectives:

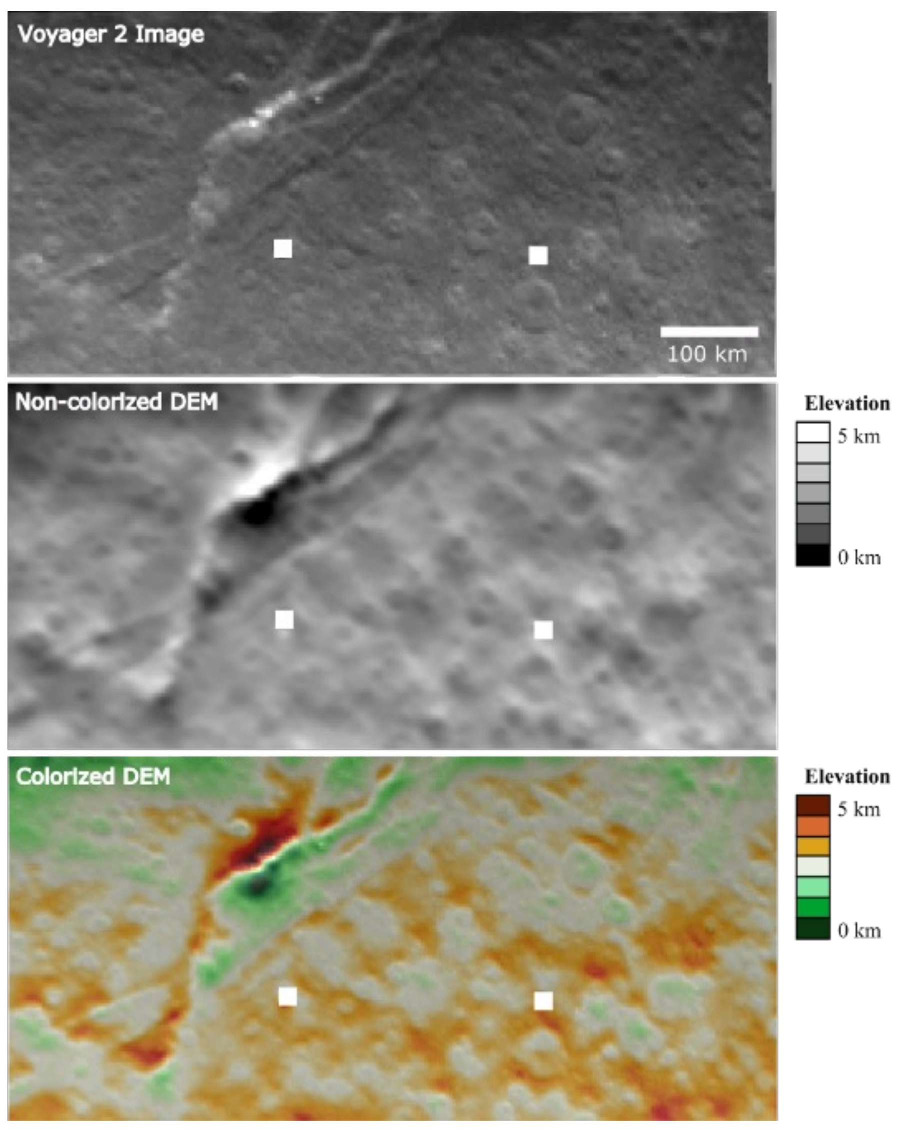
The purpose of this project is to determine if the surface geology and surface compositions of the Uranian moons indicate recent endogenic activity and possible subsurface oceans.

- Does the distribution of volatiles and the observed surface geology of the Uranian moons indicate recent activity?
- What are the key spectral features that an infrared spectrometer on a future Uranus mission will need to detect and characterize?
- Could a magnetometer be used to detect subsurface oceans on the Uranian moons?



Ariel

Titania



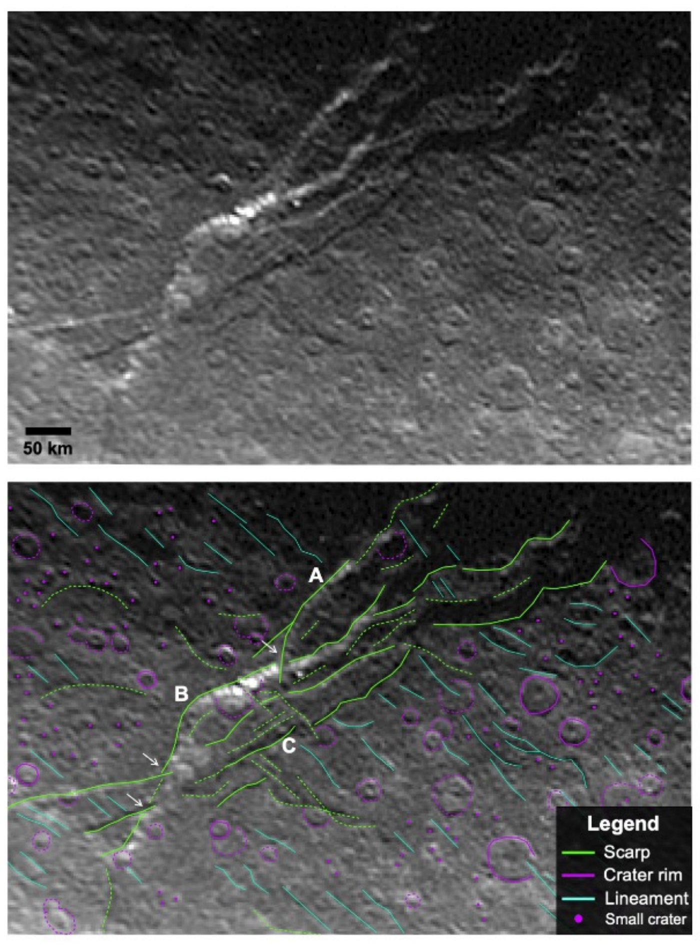
Approach and results: We have modeled the distribution and evolution of volatile deposits on the moon Ariel, and carried out the first ever observation-based assessment of tidal heating on the moon Titania.

We have carried out geologic mapping and flexure analysis to investigate the region around Messina Chasmata, the youngest known geologic feature on Titania. Our results indicate that the moon has experienced significant tidal heating in the recent geologic past, beyond what is expected from radiogenic decay alone. This additional tidal heating, while lower than what we have previously estimated at Miranda and Ariel, may have been the result of a mean motion resonance and contributed to maintaining a subsurface liquid water ocean to present day.

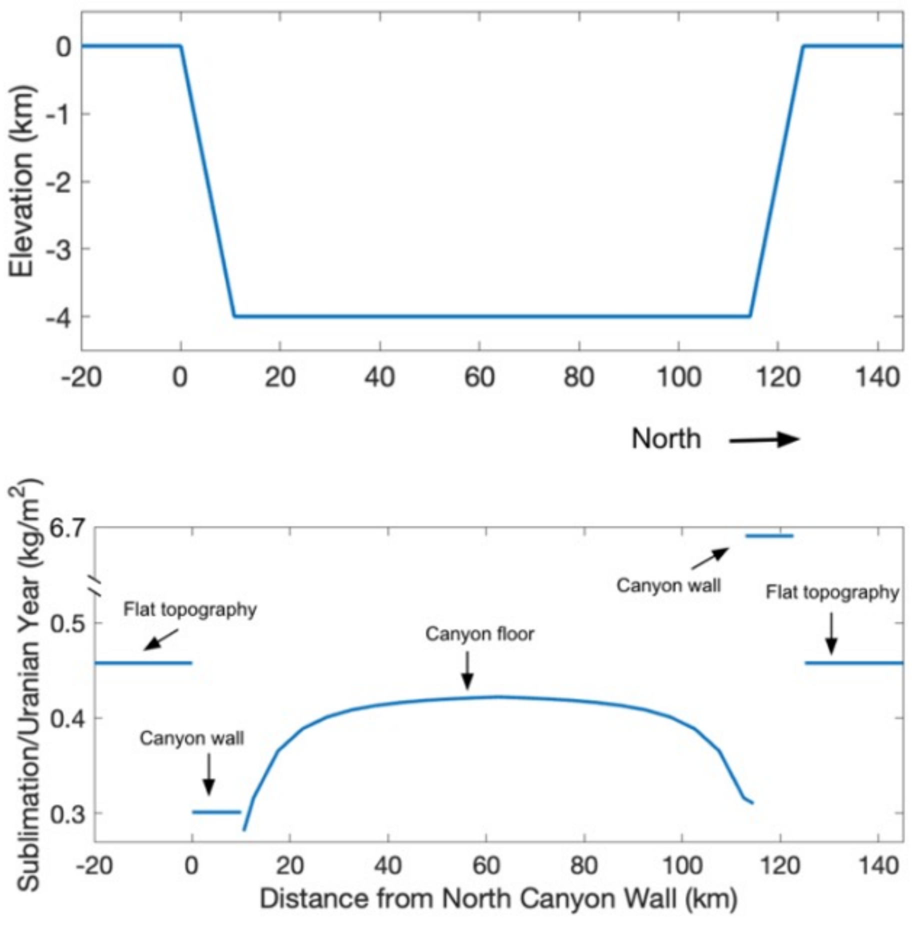
We have carried out thermal/sublimation modelling for CO_2 on the moon Ariel and investigated the resulting surface volatile distribution using a ballistic transport code. Our models included both a spherical Ariel with no topography, as well as the specific case of a large canyon (Chasma). These observations have allowed us to compare predicted CO_2 distributions with observations of CO2 from ground-based facilities and the James Webb Space Telescope.

Significance & benefits to JPL/NASA: Our work has attracted attention to Ice Giant moon science that is being conducted at JPL, and is contributing to establishing JPL as a leader in the field. Our work has over the course of this project (FY21-FY23) led to 17 conference presentations and 4 published journal articles, with an additional 2 manuscripts under review, and 2 more in preparation for submission.

We have investigated the surface geology and estimated past tidal heating on the moons Miranda and Titania. We have investigated the possibility of detecting present day sub-surface oceans at the Uranian moons using magnetic induction, finding that oceans should be readily detectable even from a single flyby with a spacecraft. This is **enabling for future missions to the Uranian system.**



Geologic map of Messina Chasmata, Titania



Modeled CO_2 sublimation rate in a chasmata (canyon) on Ariel

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Publications: Leonard, Beddingfield, Elder, and Nordheim: Unraveling Inverness: Geologic Mapping and Analysis of Miranda's Inverness Corona [Under review, Planetary Science Journal]

Beddingfield, Leonard, Nordheim, Cartwright, Elder: Estimating Heat Fluxes from Titania's Messina Chasmata [Under review, Planetary Science Journal]

Menten, Sori, Bramson, Nordheim, Cartwright: Volatile transport on Ariel and implications for the origin and distribution of carbon dioxide on Uranian moons [in preparation]

Nordheim et al: Nature and origin of CO2 on Ariel [in preparation]