Overarching questions related to the formation of units at Mawrth Vallis

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Orsay, France

5th MSL landing site workshop, May 16, 2011

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These questions can now be addressed scientifically, not only because the Curiosity instrumental suite is of utmost and unprecedented novelty and performances, but also because a site has been identified (after the AO was released…), where these and most related questions can get answers.

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1. Abundance

- Phyllosilicates grew as layers tens to hundreds of meters in thickness (see Mangold et al.,), not as a minor constituents (e.g. within veins) but as the major (bulk) one (Poulet et al.).
- Phyllosilicate formation occurred at a planetary scale, as demonstrated by the findings of Carter et al. of similar compositional suite in craters within the southern and the northern crust.
- The more abundant type is constituted by Mg/Fe smectites (low degree of leaching end-members).

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→ Explore the site with highest phyllosilicate abundance

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- The more we acquire and reduce hyperspectral (OMEGA and CRISM) data, the highest diversity of phyllosilicates and of other alteration phases we find.
- However, in emplacements where layering is preserved, the diversity appears sequential, as a translation of the planet environmental ("enabling") conditions. The trend in increased diversity seems to go from less to more leaching capability, from less to more acidic environment.

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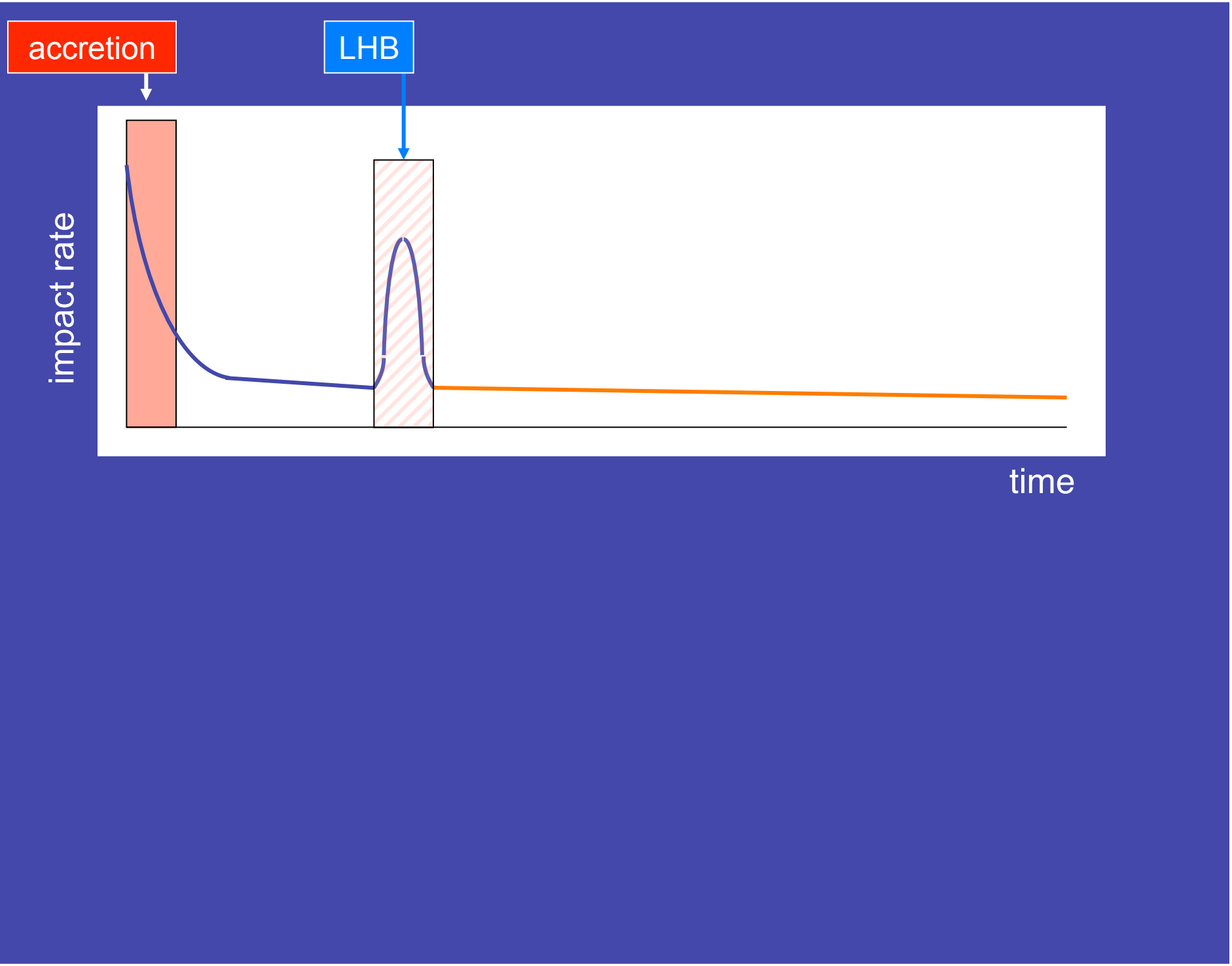
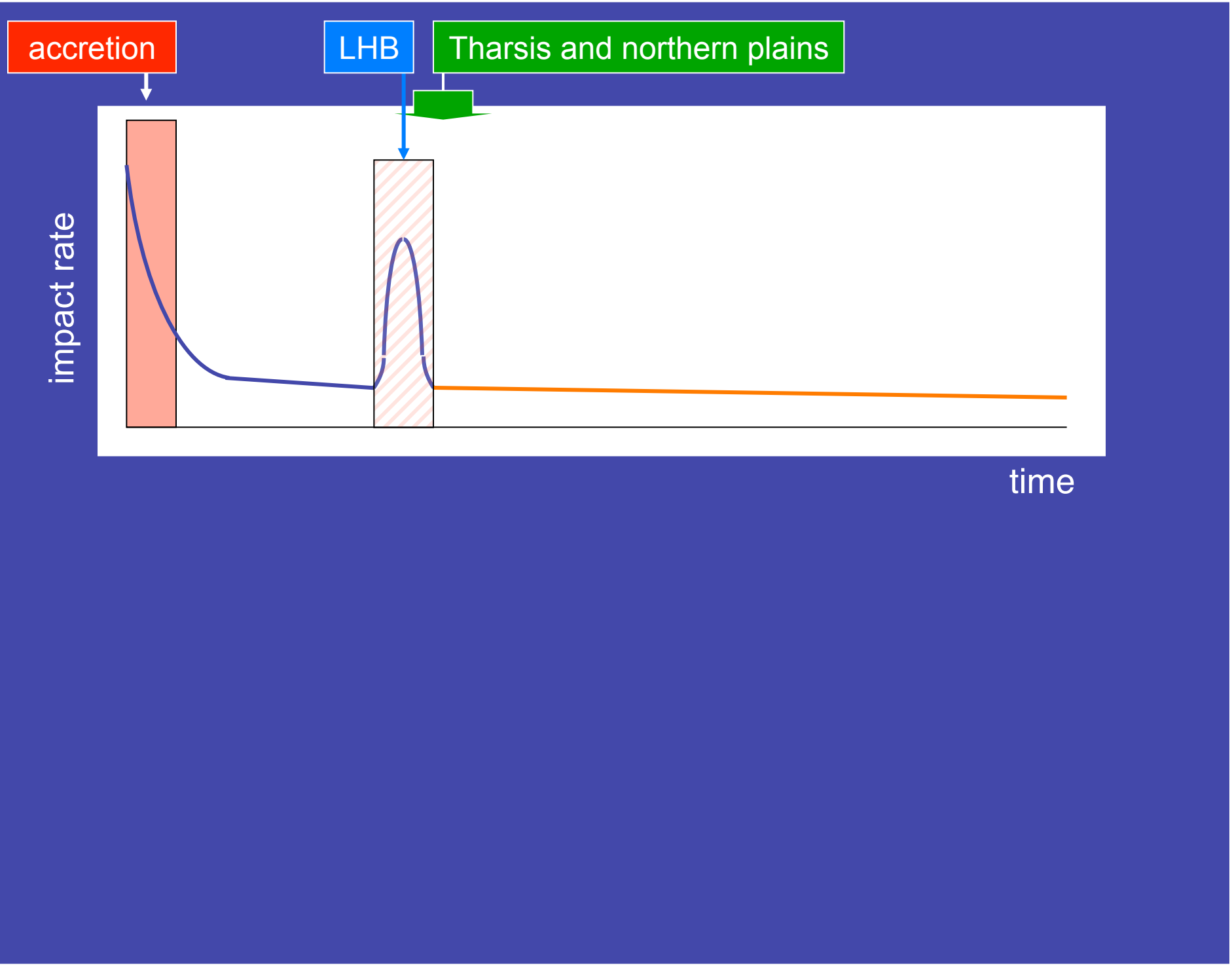

accretion
LHB
impact rate
time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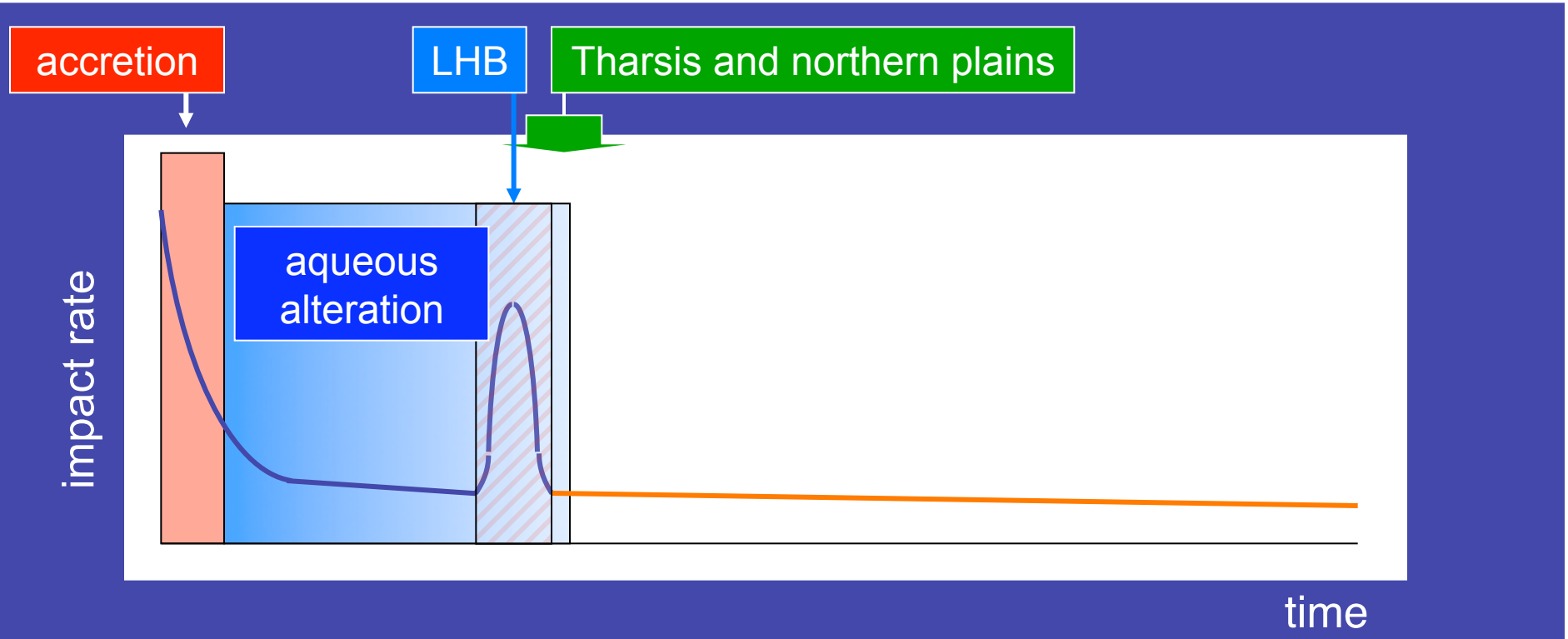
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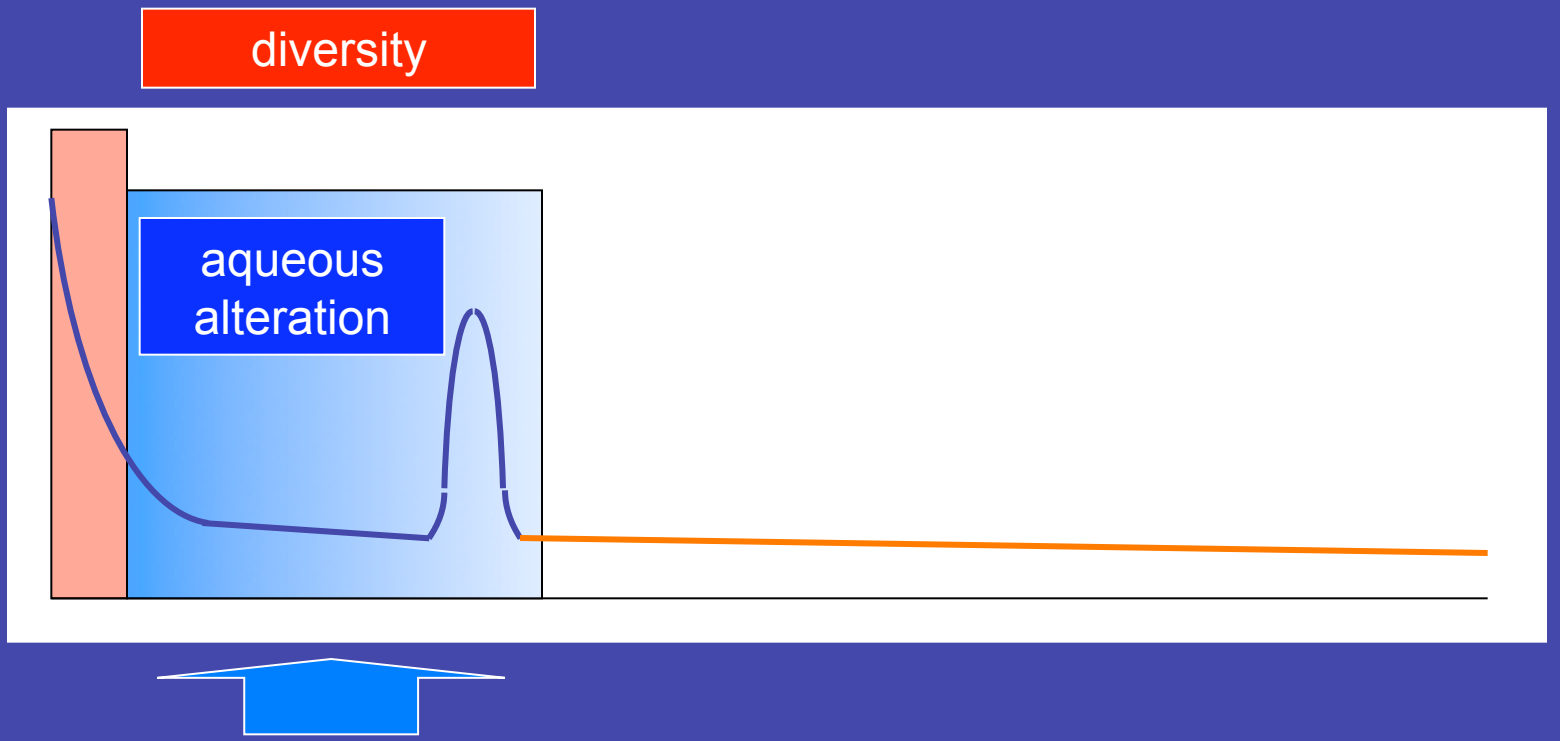
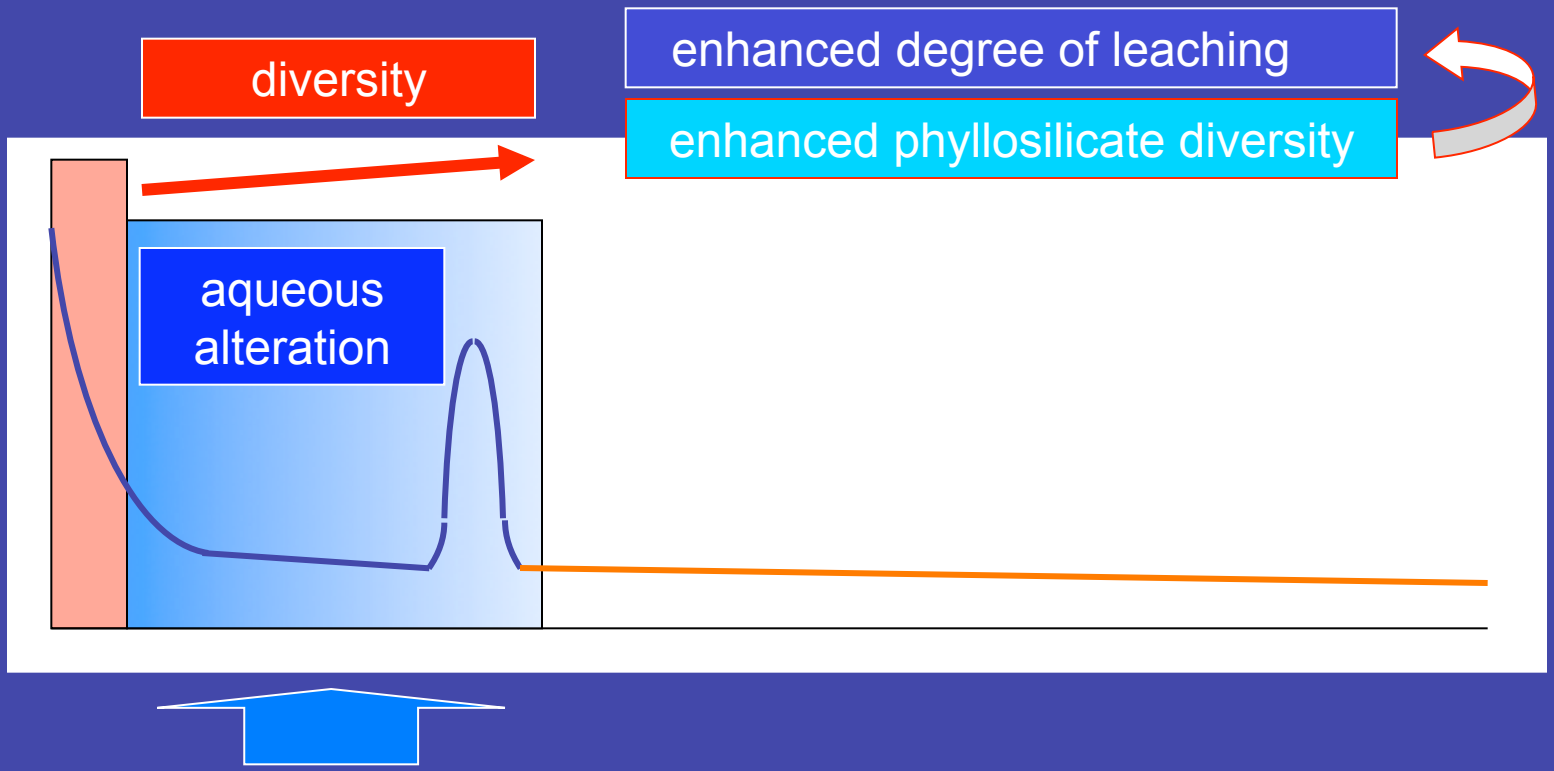


This is not a single (environment-wise) era: Mars evolution is translated in a wide diversity of aqueous altered phases formed.



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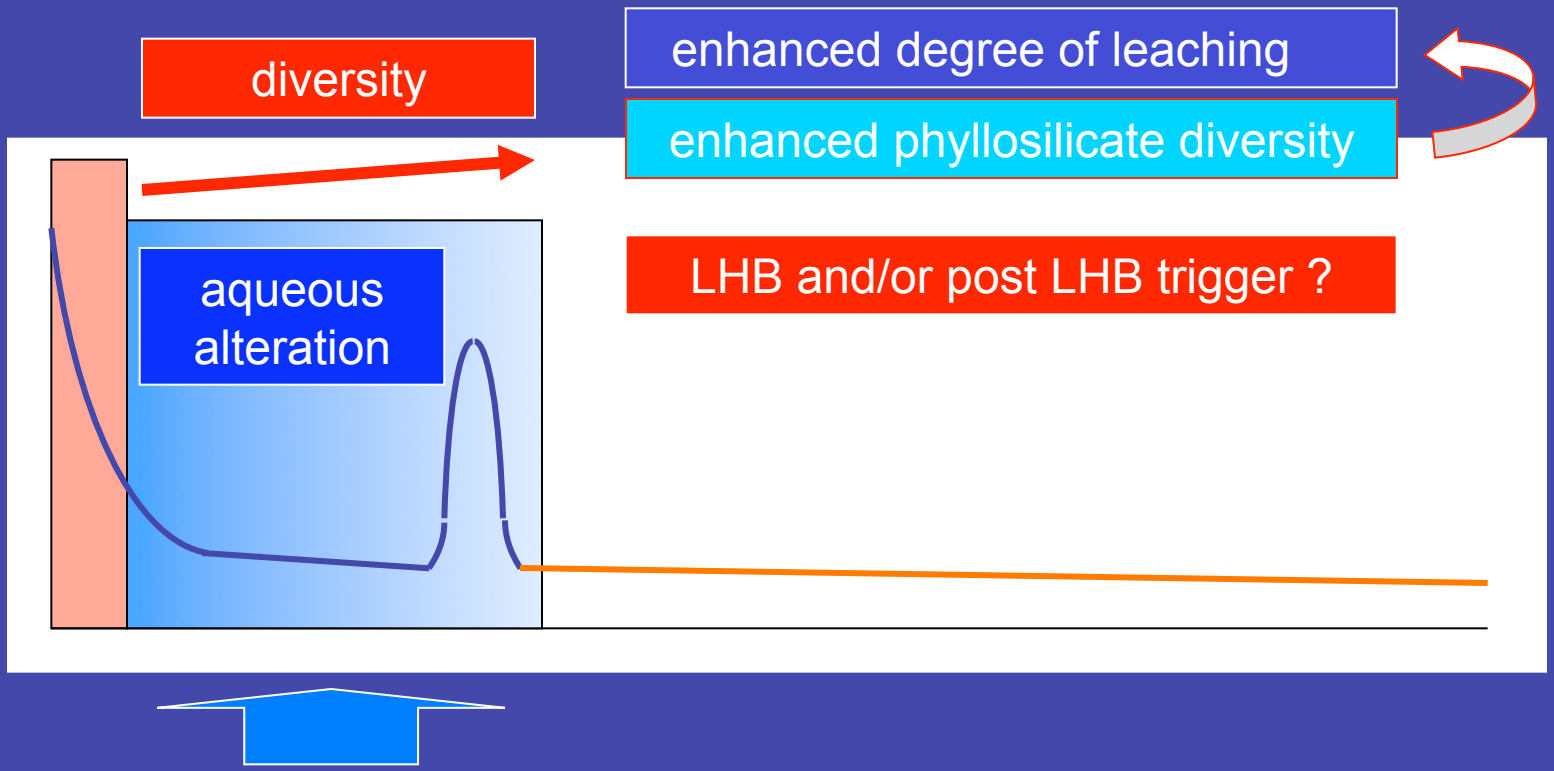

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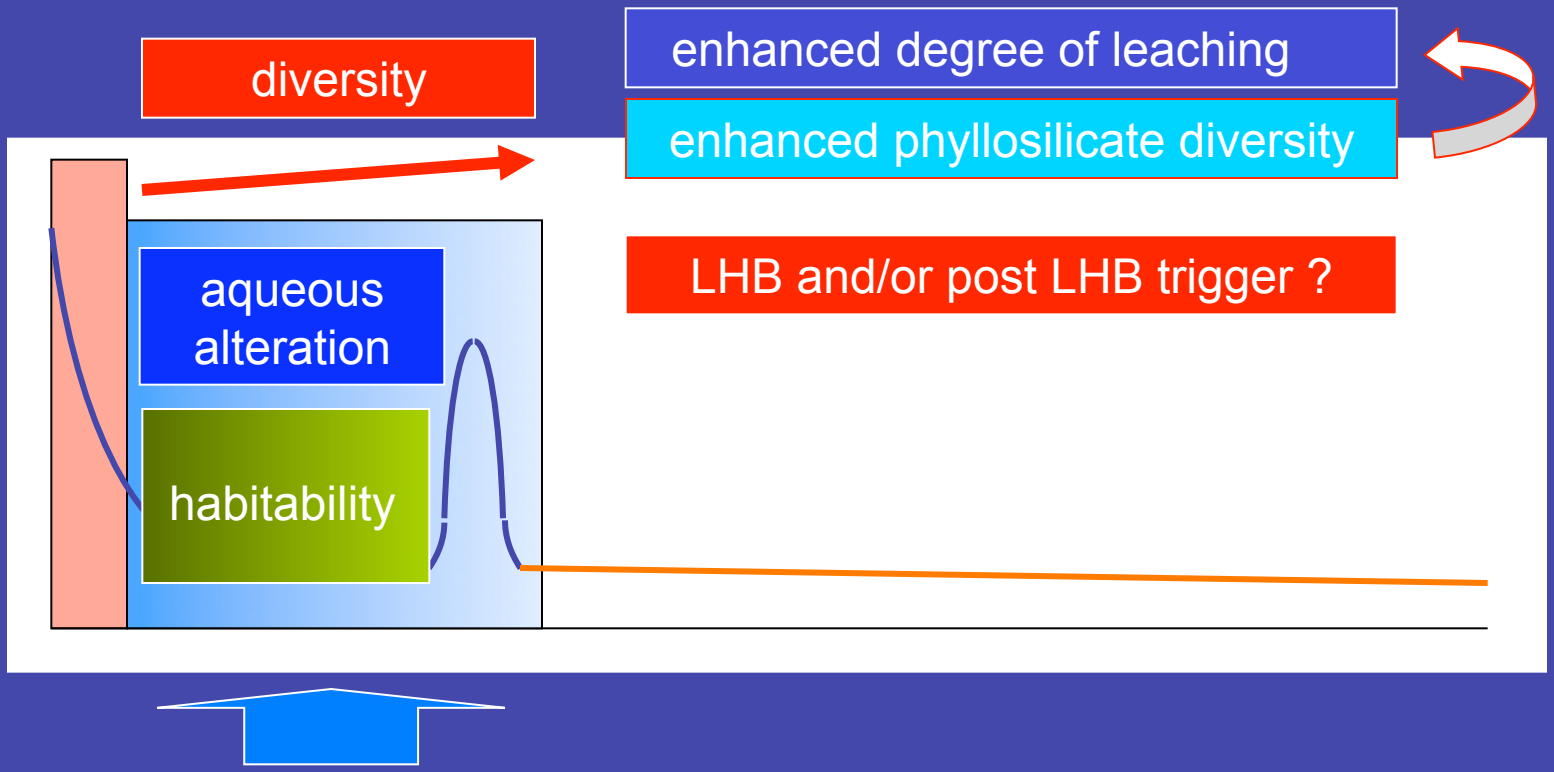

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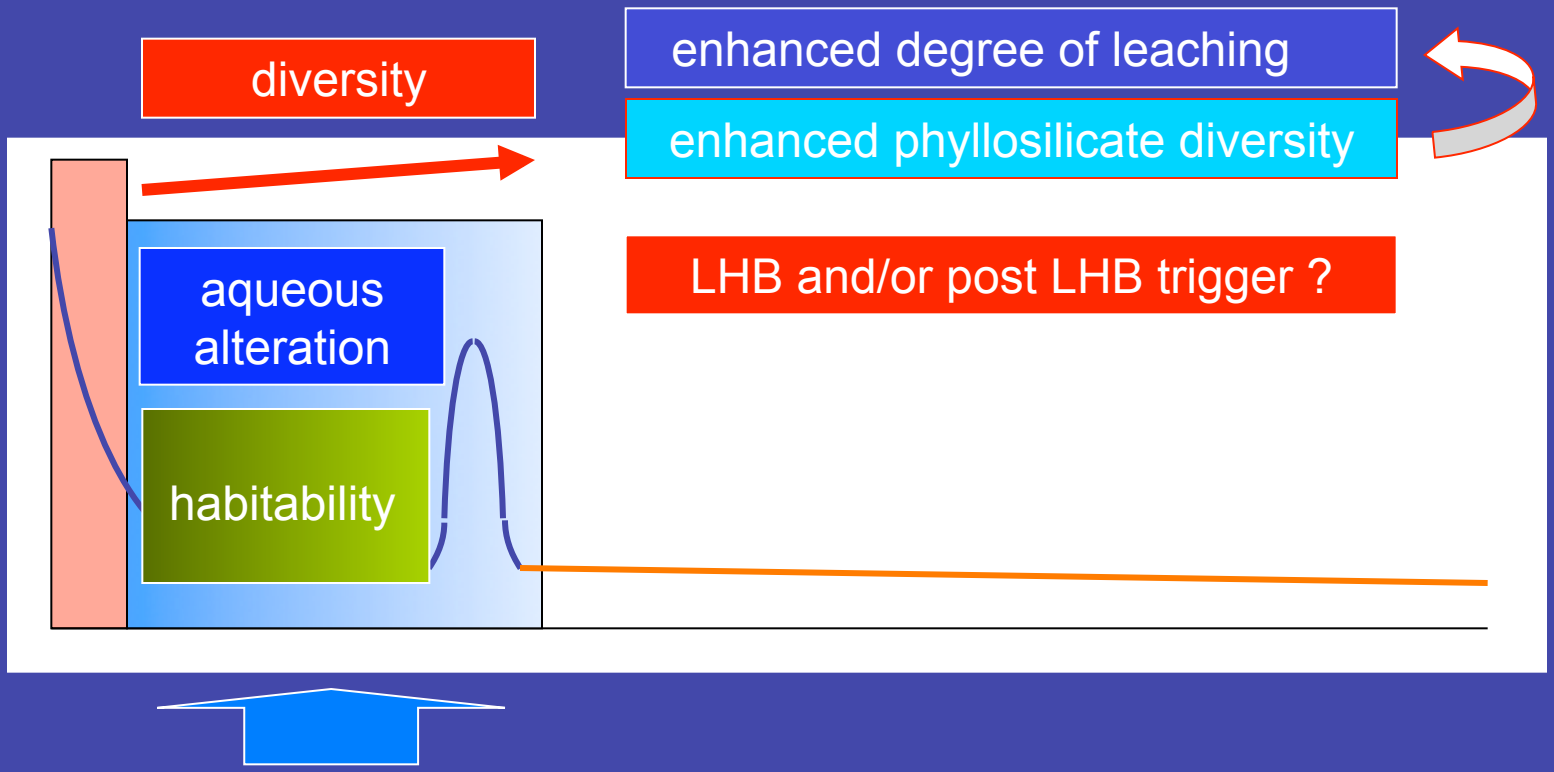

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habitability

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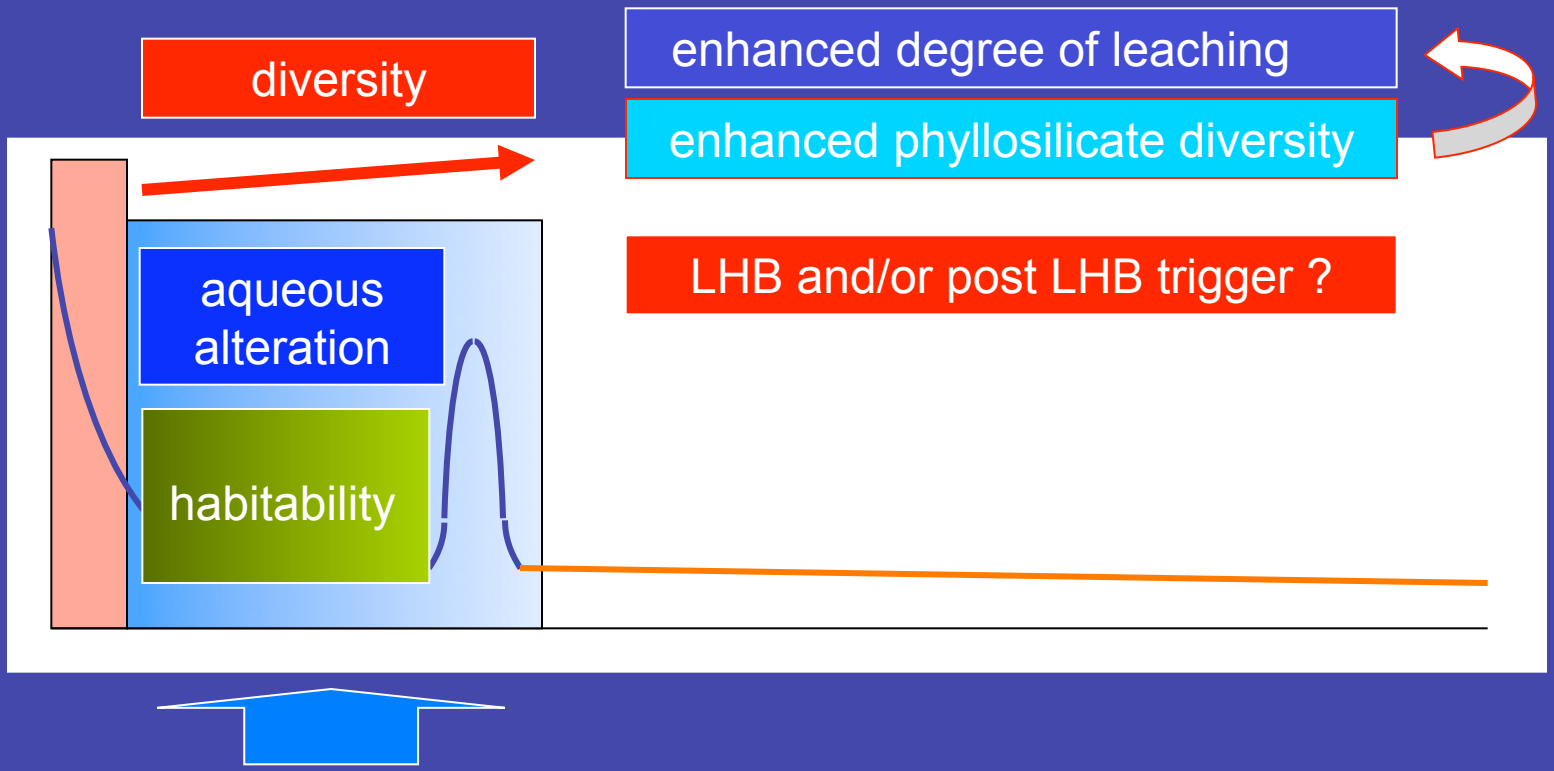

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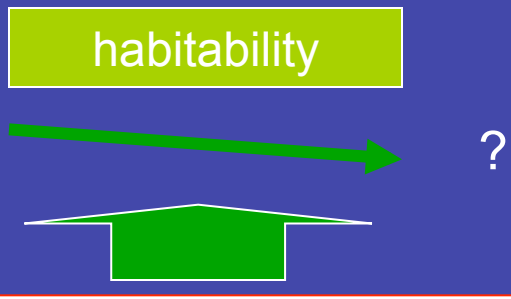
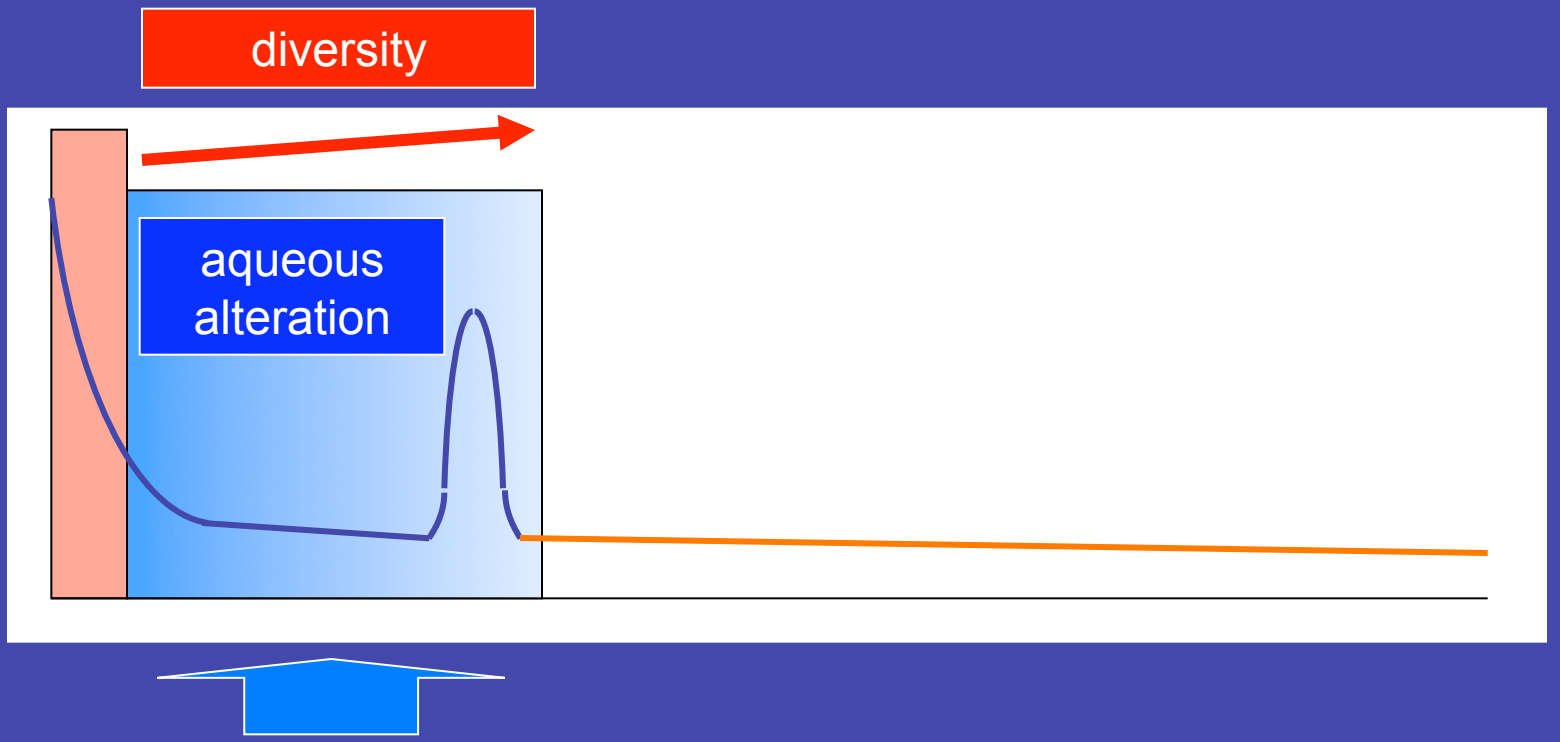


One must access a site preserving processes which paved this period



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Later processes (irrelevant to life emergence) have transported these minerals in distant sites where they are identified (but context is lost).

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- Our ignorance of what habitability (and life emergence) at Mars (and at Earth!) means and requires, is profound.
- As for today, the remote characterization of the mineralogical surface composition indicates the occurrence of one ingredient, liquid water, not of any other (C-rich or P-rich phases). It is Curiosity task to take over and scrutinize, at a sample scale, the potential coupling between host materials and bio-signatures (reduced C).

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- the site with the highest variance in age and materials;
- the site which the best preserves/witnesses the evolution of Mars over its first hundreds of millions years.

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Why has Mawrth Vallis not suffered from the LHB gardening?

Mawrth Vallis offers Curiosity

- to explore a range of times and materials produced and modified in aqueous environments that far exceeds what is exposed in the other three sites, starting with the most ancient ones;

- to traverse a well-defined stratigraphic section, translating the "traverse in space" into a unique "traverse in time" over the building and the alteration of the Noachian crust, through a period of highest water/rock ratios that ever happened on Mars.

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At each target of interest along the traverse, in particular by analyzing distinct layers and minerals in a wide diversity of composition, Curiosity will be able to *reconstruct the actual aqueous and environmental conditions*, along their evolution, from contextual and compositional, mineralogical, and isotopic measurements.

Curiosity will thus dive into Mars History providing an unprecedented deciphering of a totally unexplored time window, from planetary accretion towards the end of the heavy bombardment and the onset of surface activity (Tharsis building and plains filling), having possibly harbored an habitable phase.

- Most importantly, Mawrth Vallis offers Curiosity to identify and characterize the context and environment that provided the *most favorable harboring conditions for habitability and life*, through the potential identification and characterization of the minerals hosting reduced C-rich species or other bio-signatures.

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- Wherever Curiosity will land within the Mawrth Vallis error ellipse, it will immediately access to one of the key events that paved the early times of Mars potential habitability, with the highest load (abundance) of aqueous altered minerals.

- Given the diversity of aqueous mineral in Mawrth Vallis, the highest of all four sites, Curiosity will access the largest set of minerals / environments having paved Mars ancient History, optimizing the probability to find those during which life might have emerged, thus *maximizing the probability to meet the prime MSL objectives.*

- At Mawrth Vallis, if Curiosity discovers that reduced carbon chemistry took place at a given time and under given conditions, in given minerals, it will be able 1. to validate this key finding by exploring other spots with similar minetrals, and 2. to study how life could be preserved while Mars evolved, in searching for similar or derived compounds in samples having evolved from these host minerals.

MSL @ Mawrth Vallis:
roving towards the emergence of life

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Curiosity long roving capability, for the nominal duration then possibly its extension(s), will therefore be used to

- increase the probability to detect bio-signatures, in enlarging the frame for scrutinizing Mars History, with high time sampling;
- validate a potential key finding by exploring “similar” sites;
- follow life preservation over time, till it eventually disappeared or went to dormant mode.

MSL @ Mawrth Vallis:
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Our wish to see Mawrth Vallis selected for Curiosity is solely driven by the impressive merge of results that indicate that this site does provide by far the highest probability to meet MSL goals. Mars has been incredibly cooperative in protecting then exposing such an ancient and precious site to our exploration. It is now our responsibility to take the best profit of Mawrth Vallis existing, and ready to deliver its witness/testimony, kept over more than 4 Bys.

If we failed to detect bio-signatures at Mawrth Vallis, it will likely indicate that not all the ingredients were present at Mars to enable life to emerge. On the opposite, if we decided not to land in Mawrth Vallis, and failed to detect bio-signatures, we will regret for ever not to have explored Mawrth Vallis.

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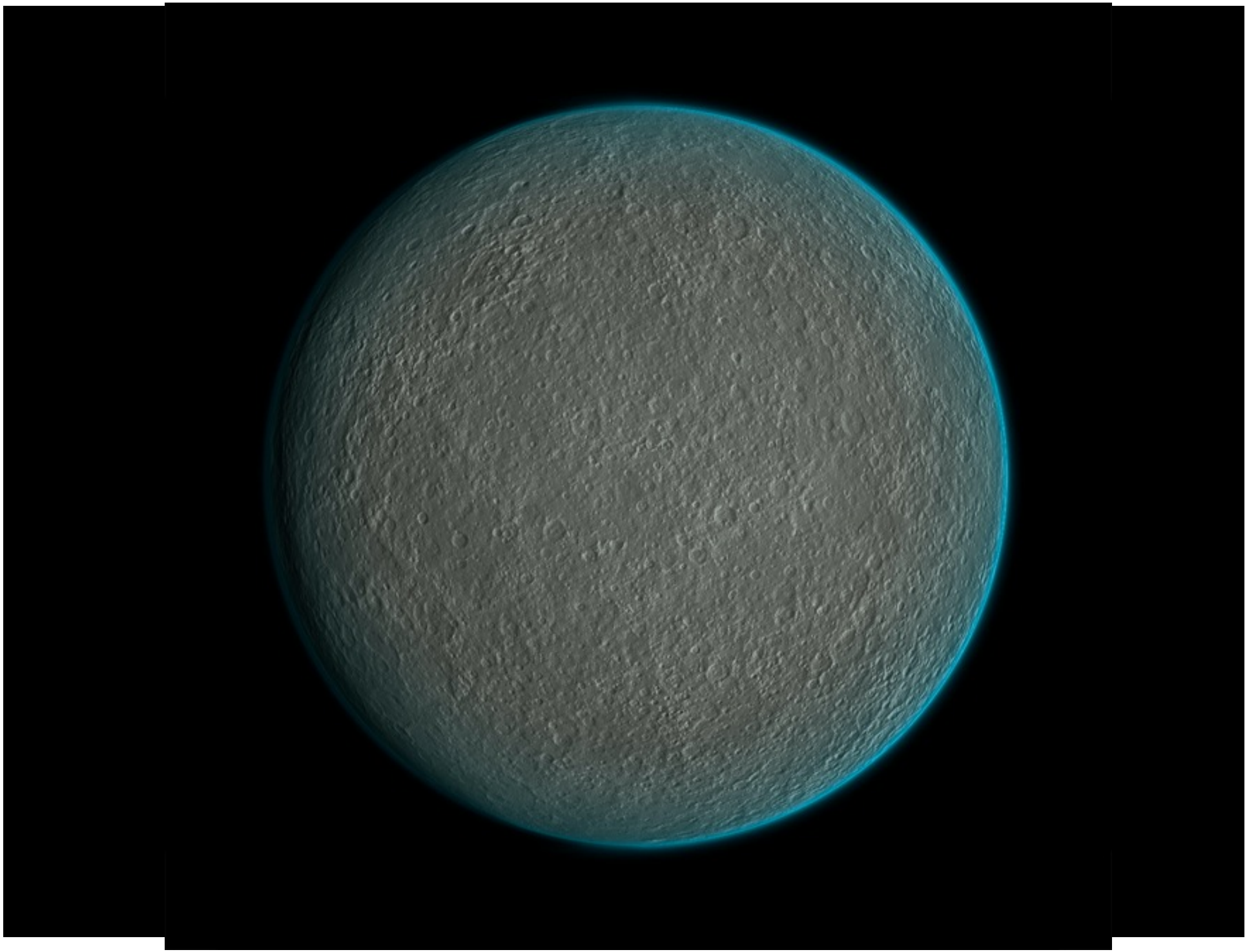
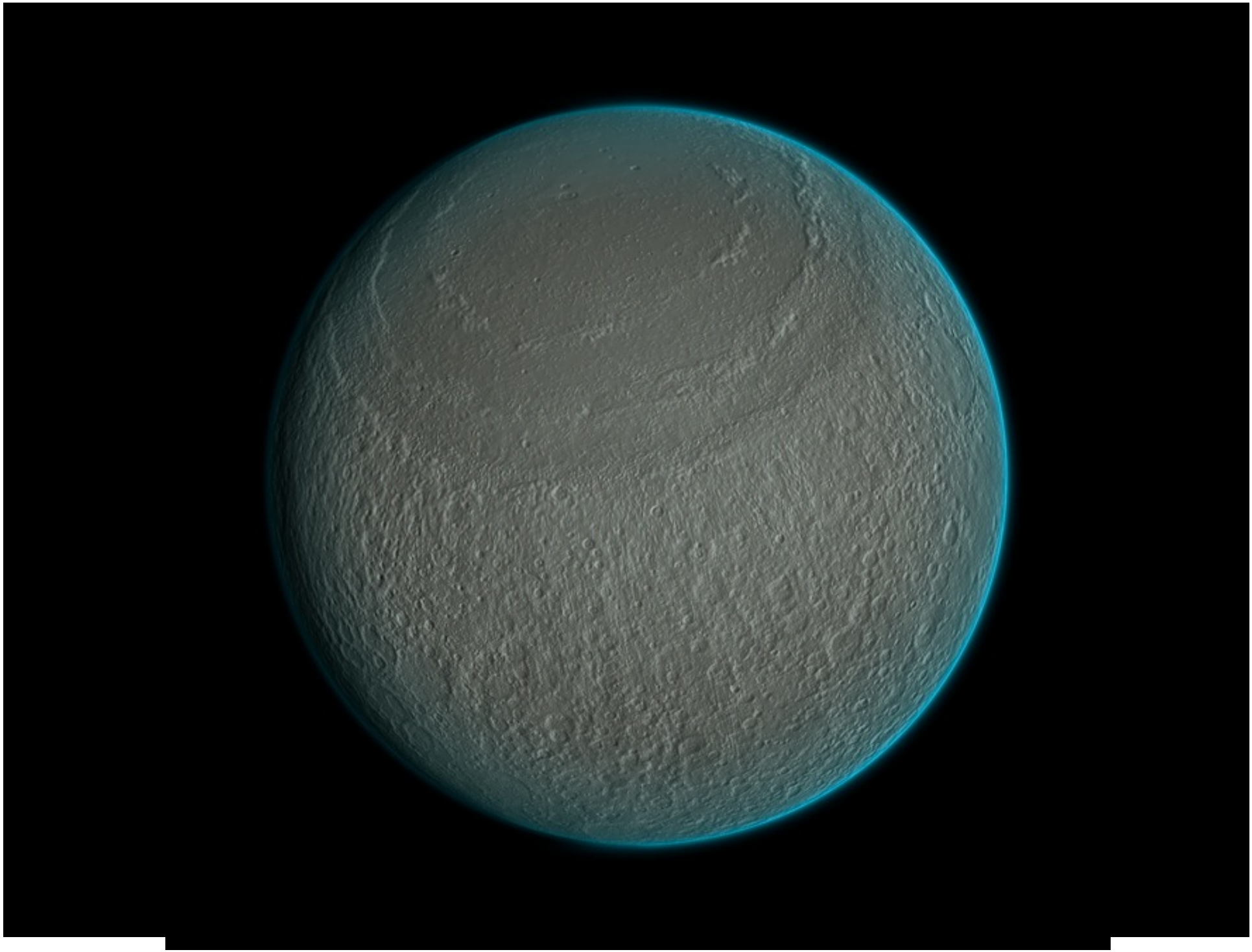
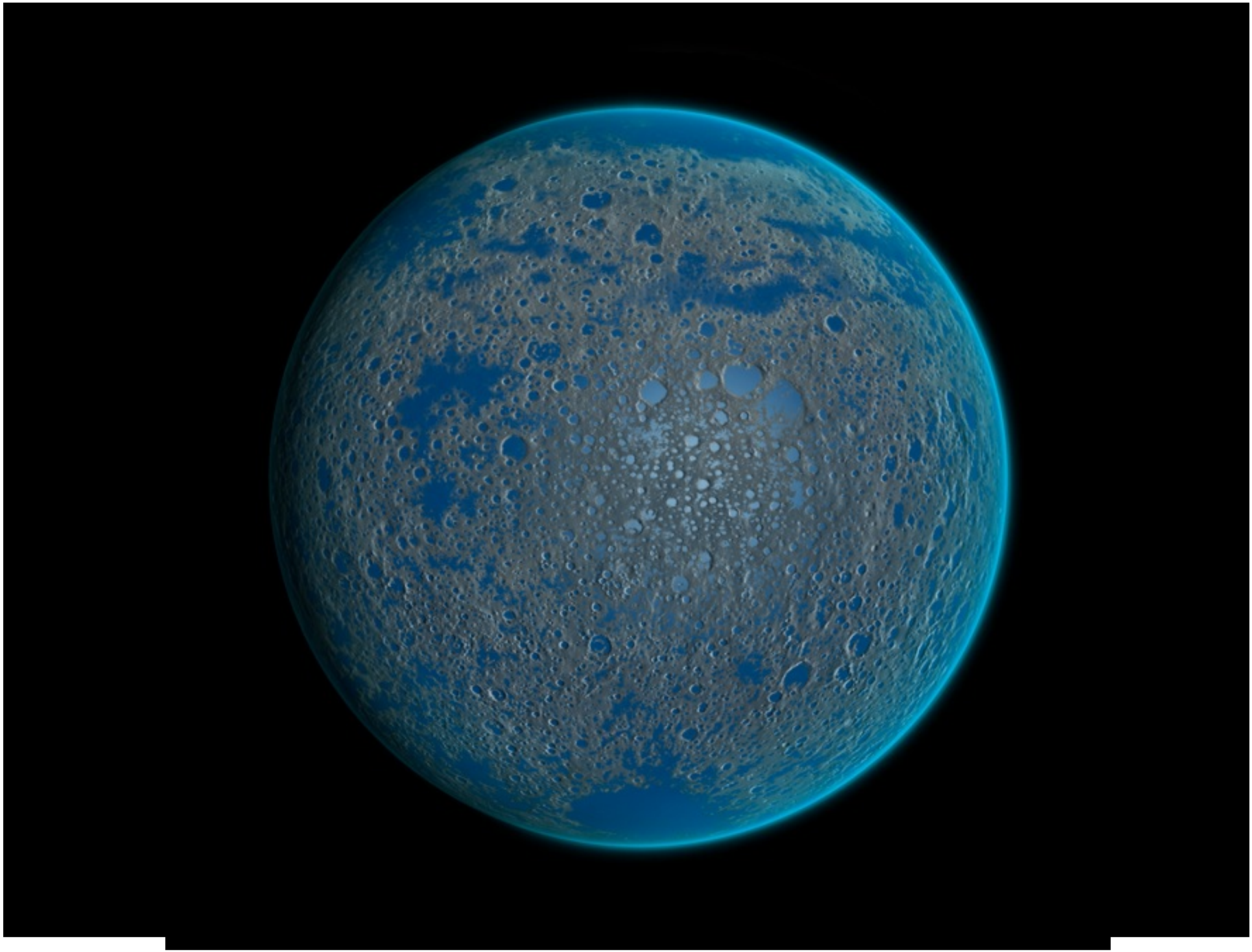
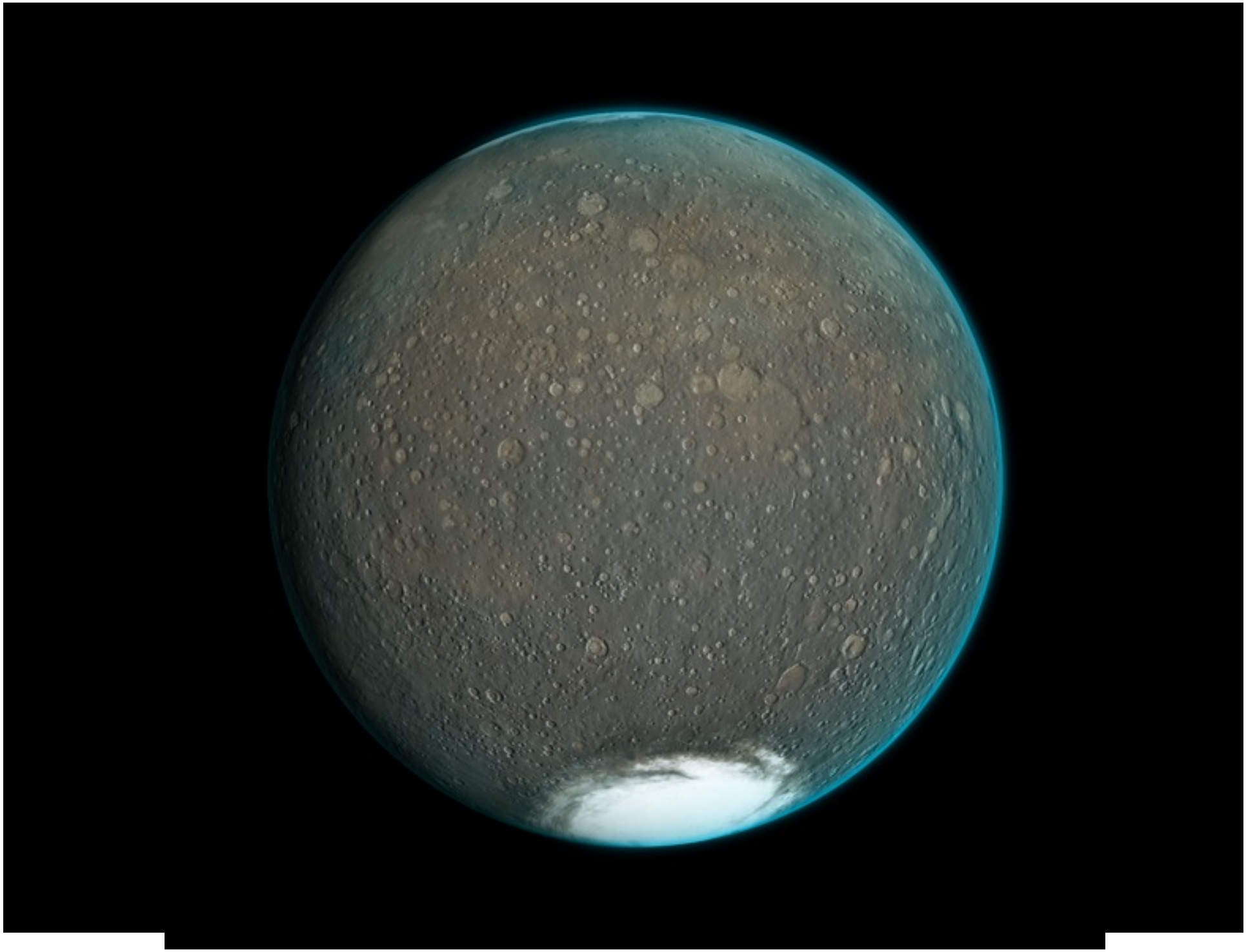
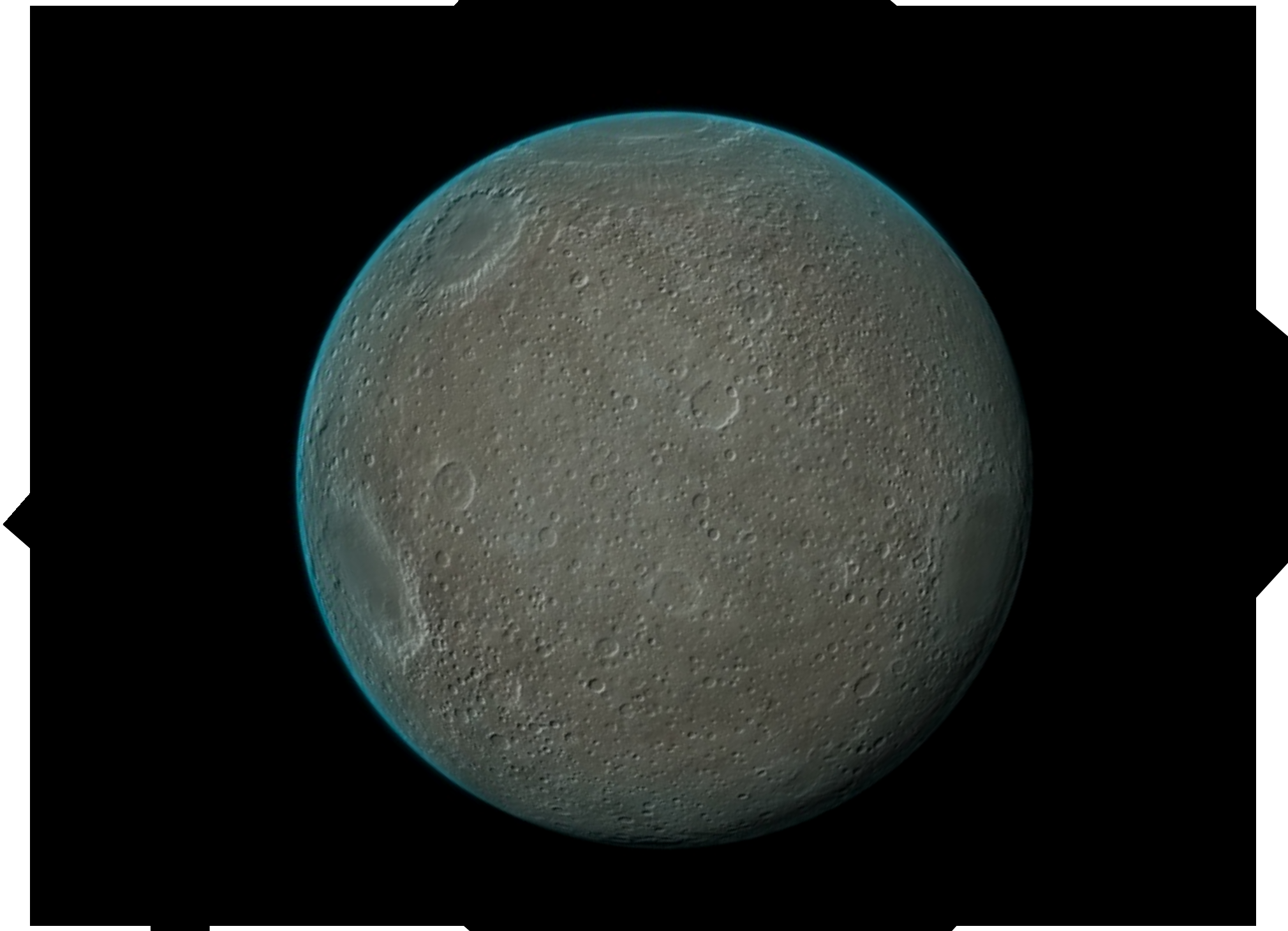
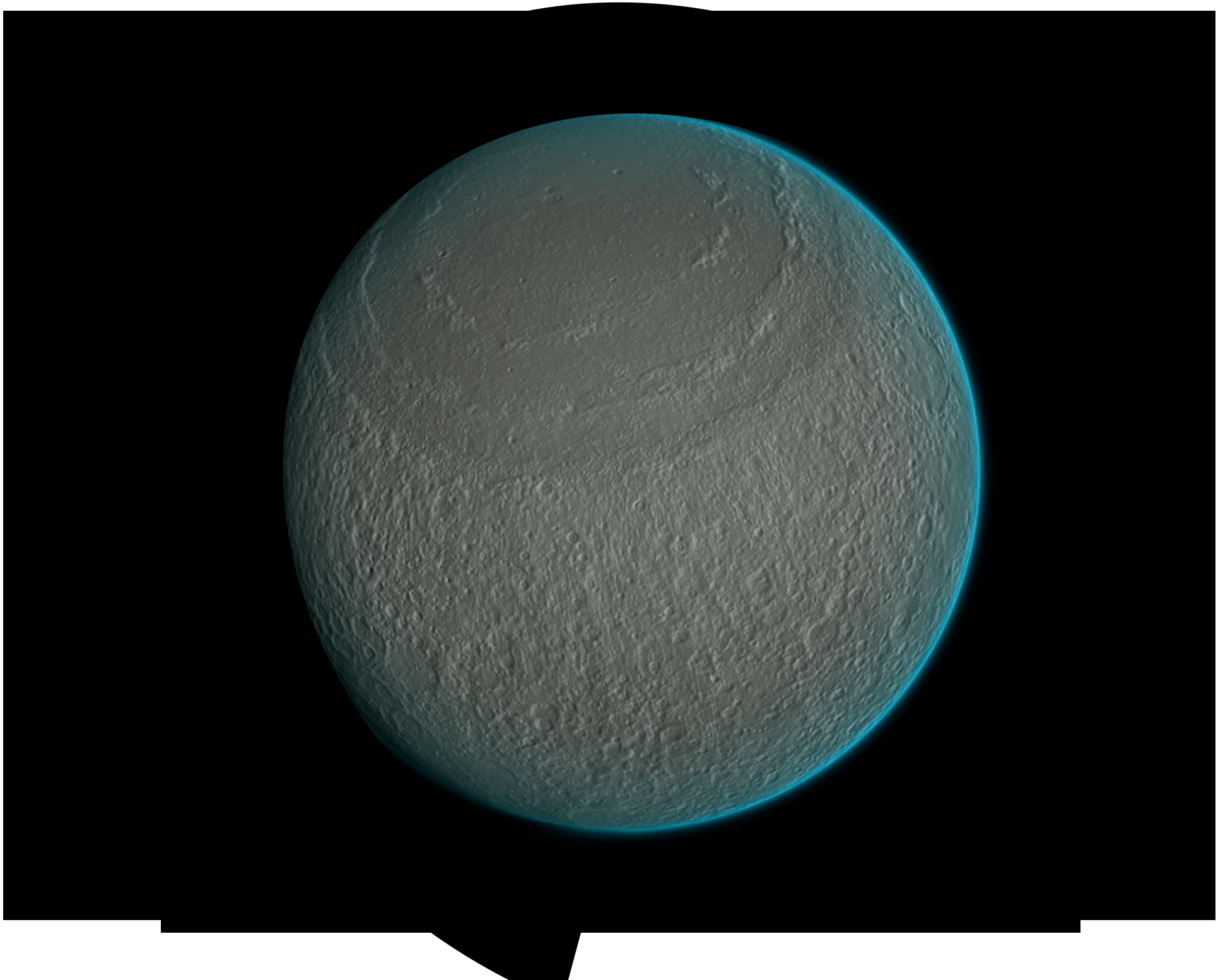


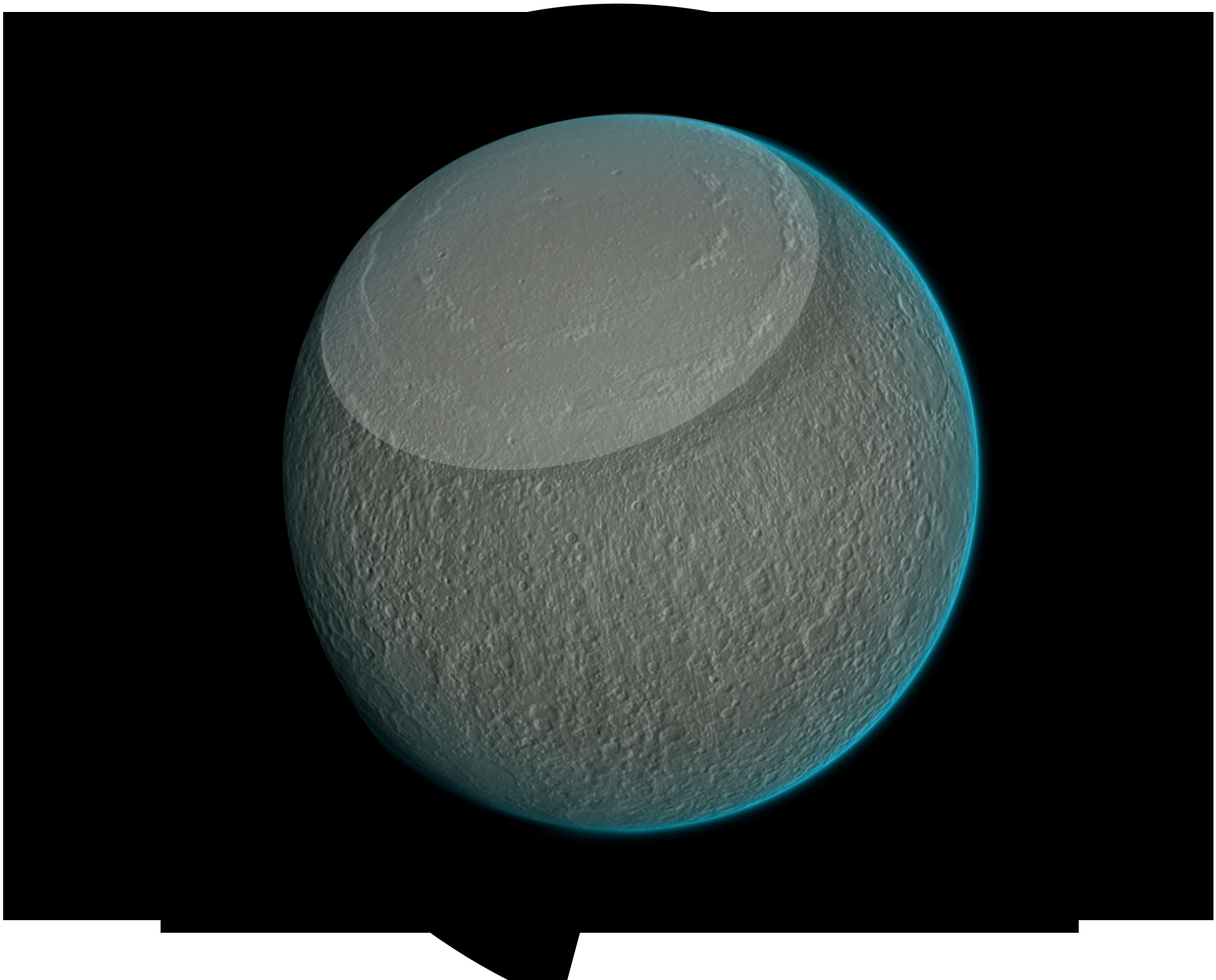


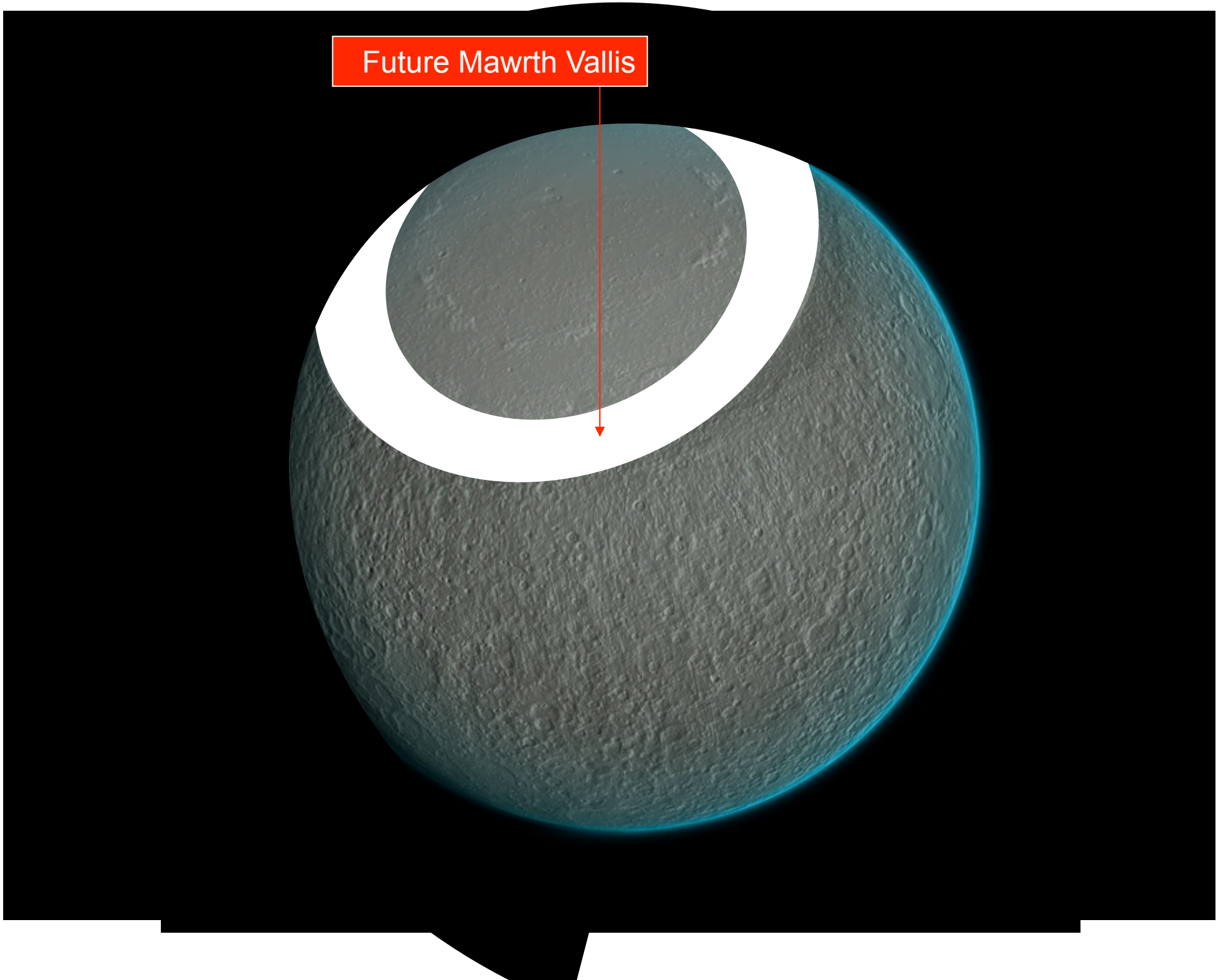


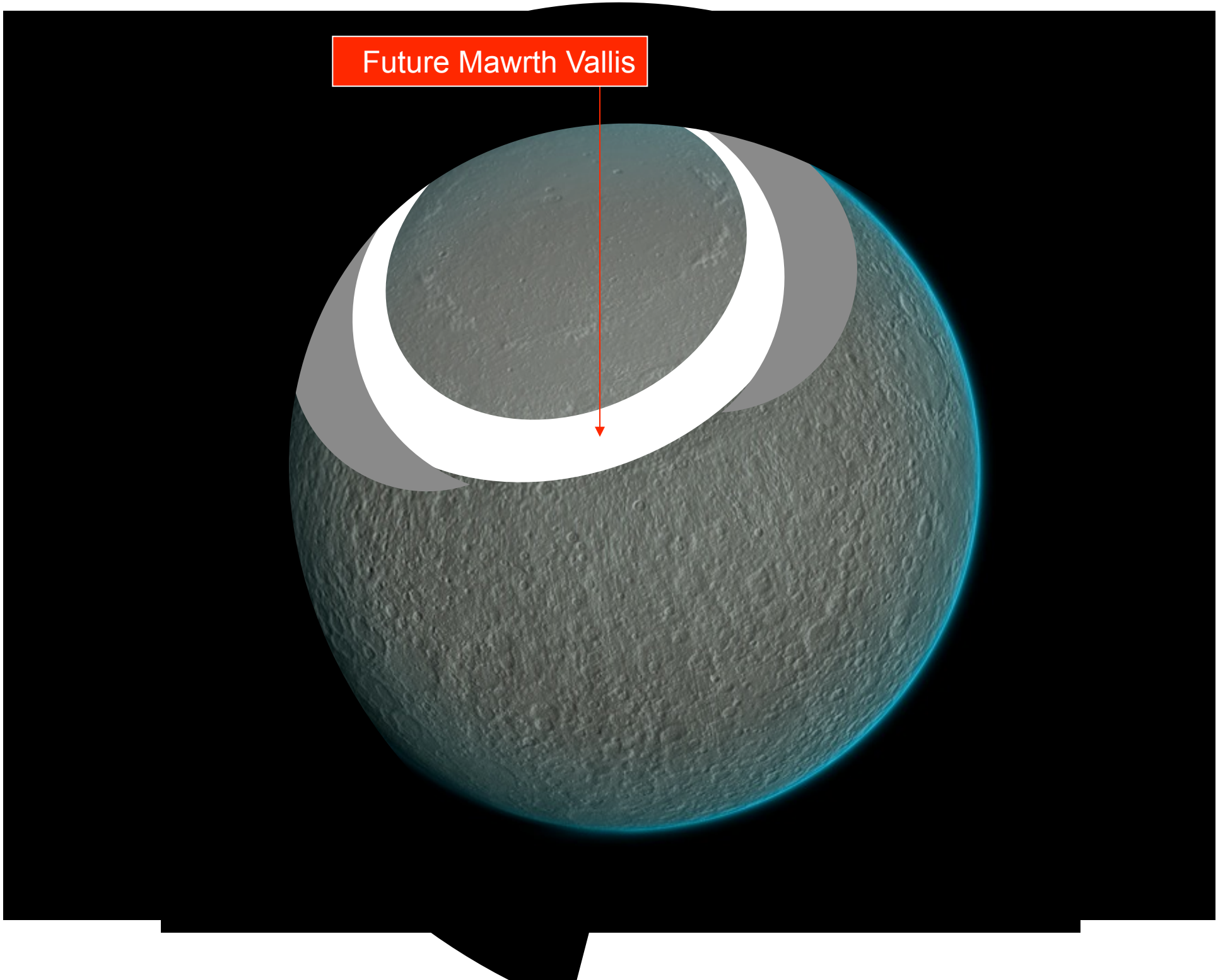









Future Mawrth Vallis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