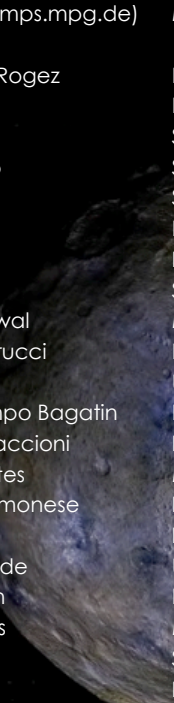




Genesis of Asteroids and evolution of the Solar System

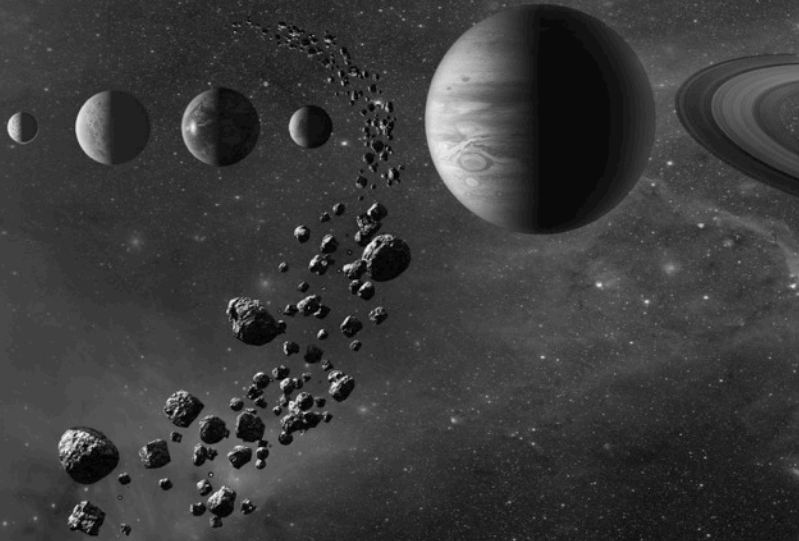
G A U S S



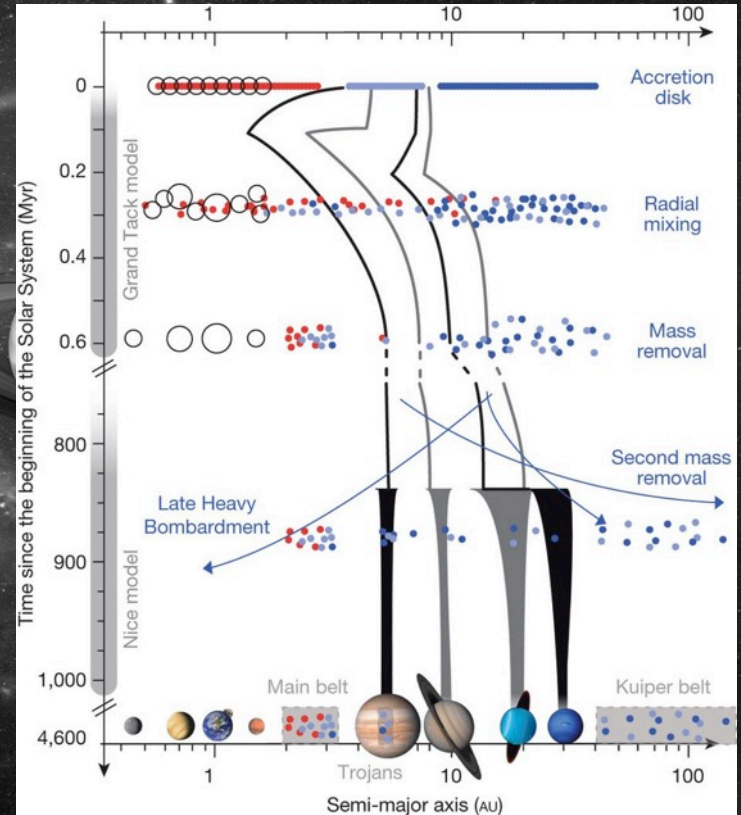
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Origin and evolution of Solar System and the like

Past and present-day habitability

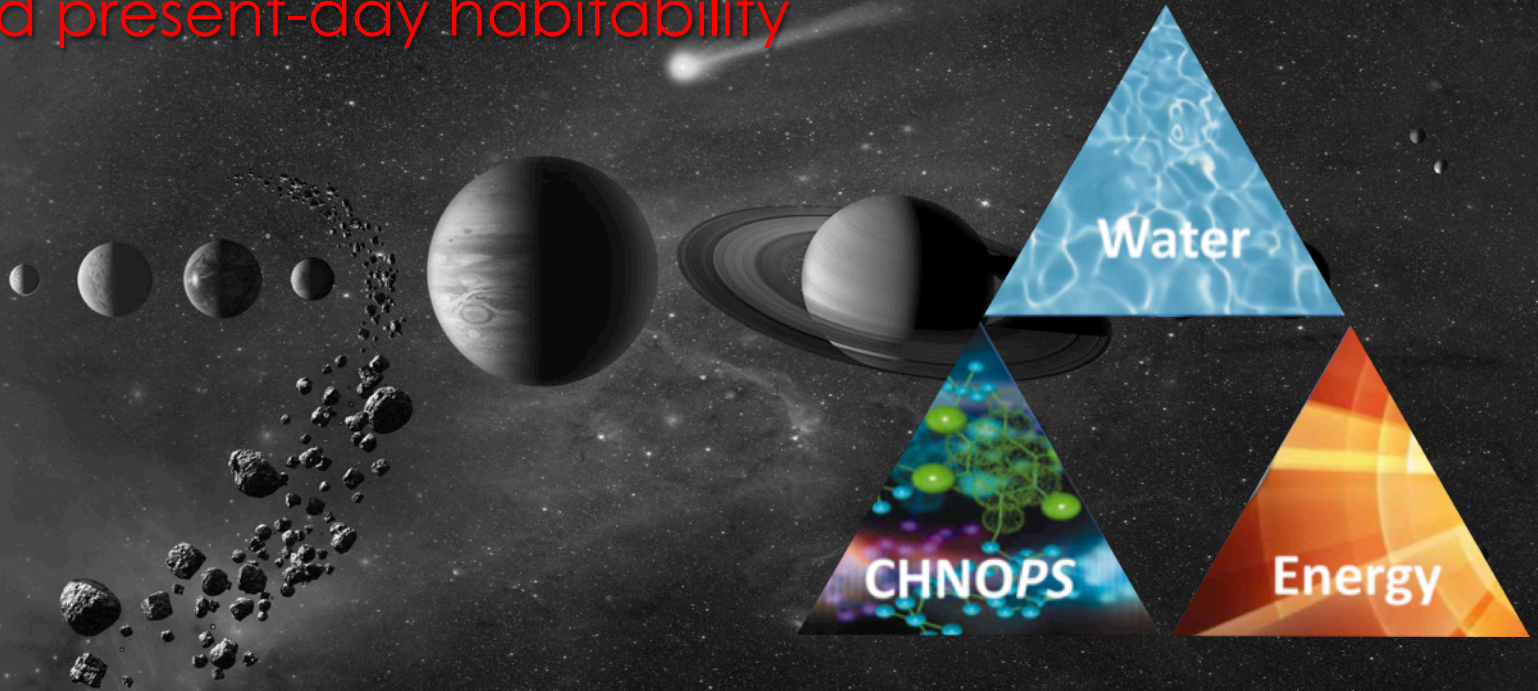


(DeMeo et al. 2014, Nature)

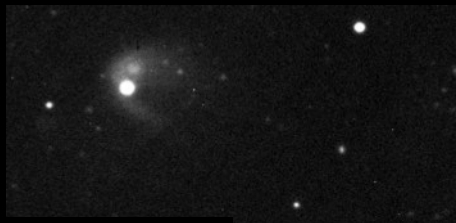


Origin and evolution of Solar System and the like

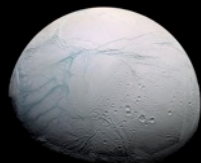
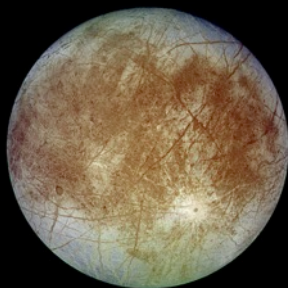
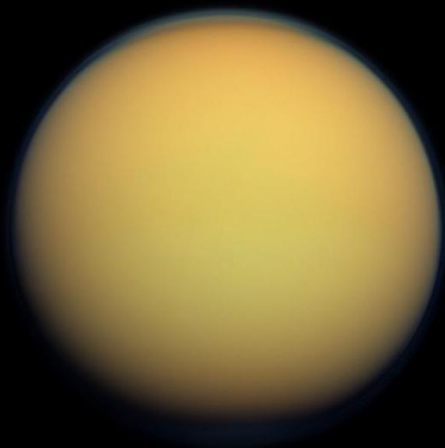
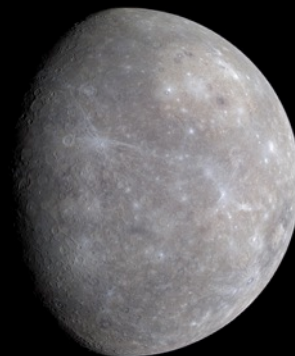
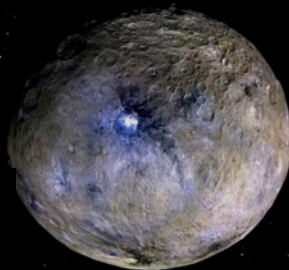
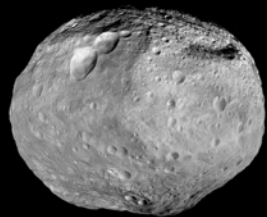
Past and present-day habitability



main belt inhabitant



hydrostatic body



possible ocean world

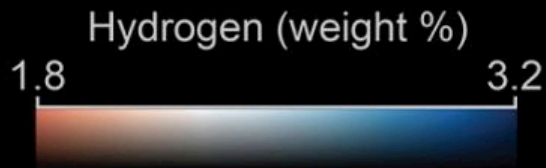
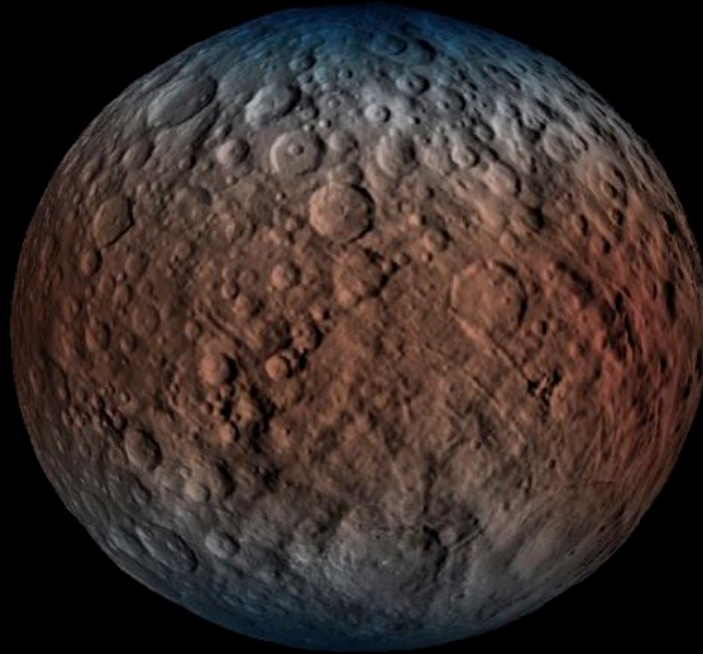
icy world

Ceres revealed by Dawn

Water-rich, carbon-rich, and organics!

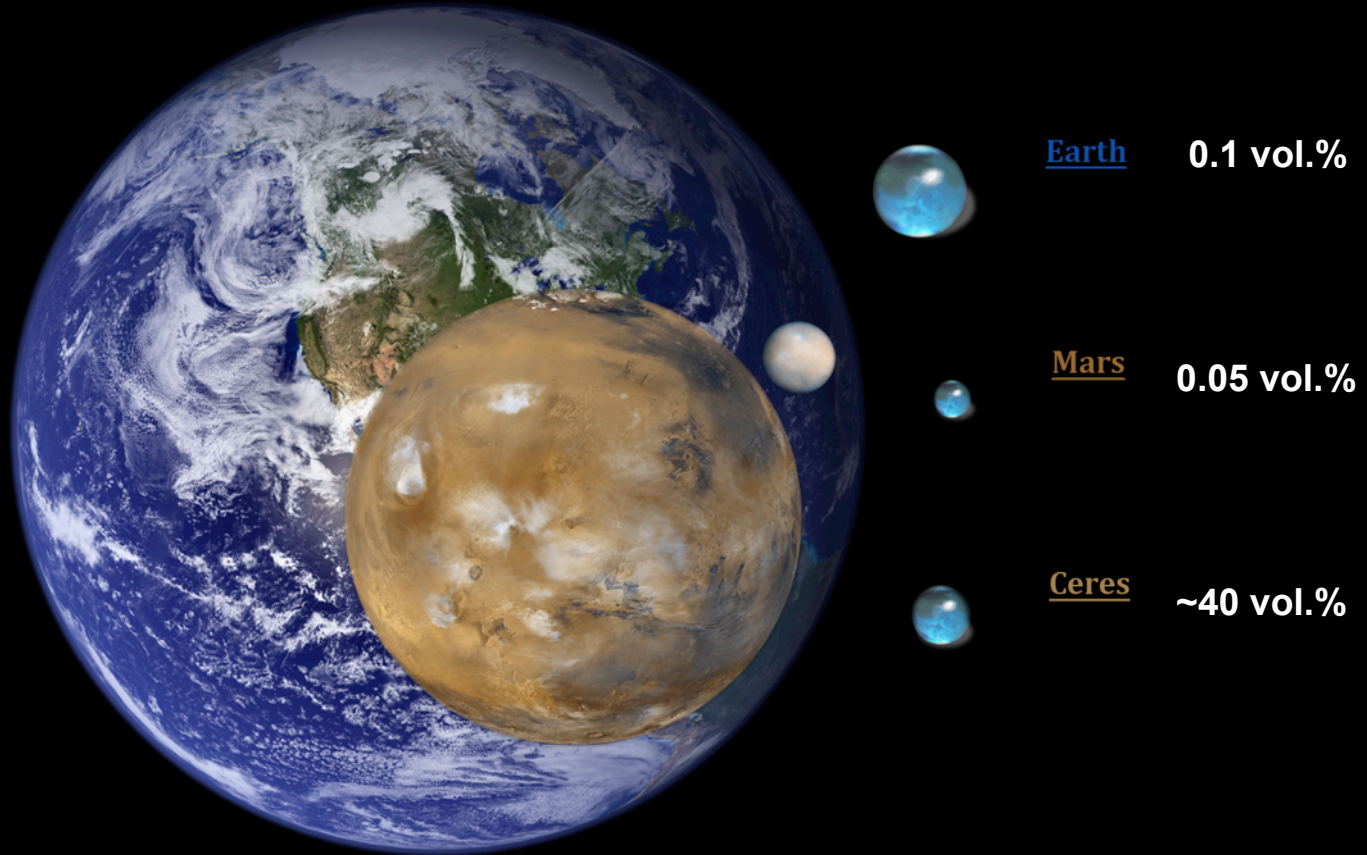


Ubiquitous water ice

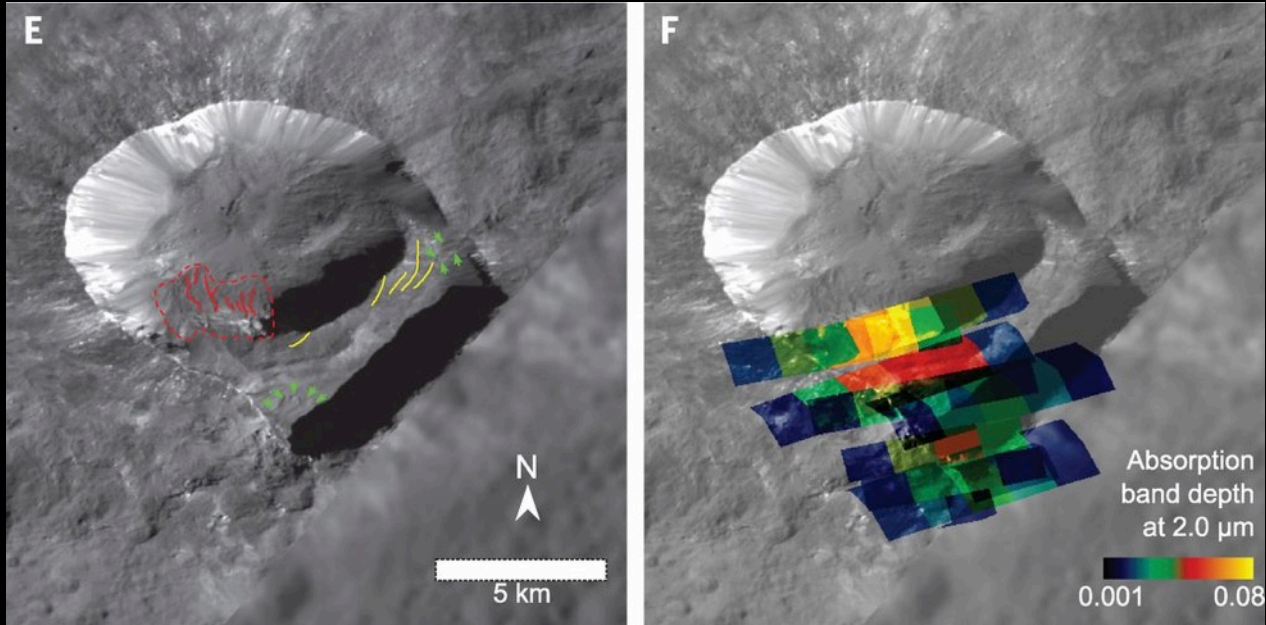


(Prettyman et al. 2017, Science)

Large abundance of water

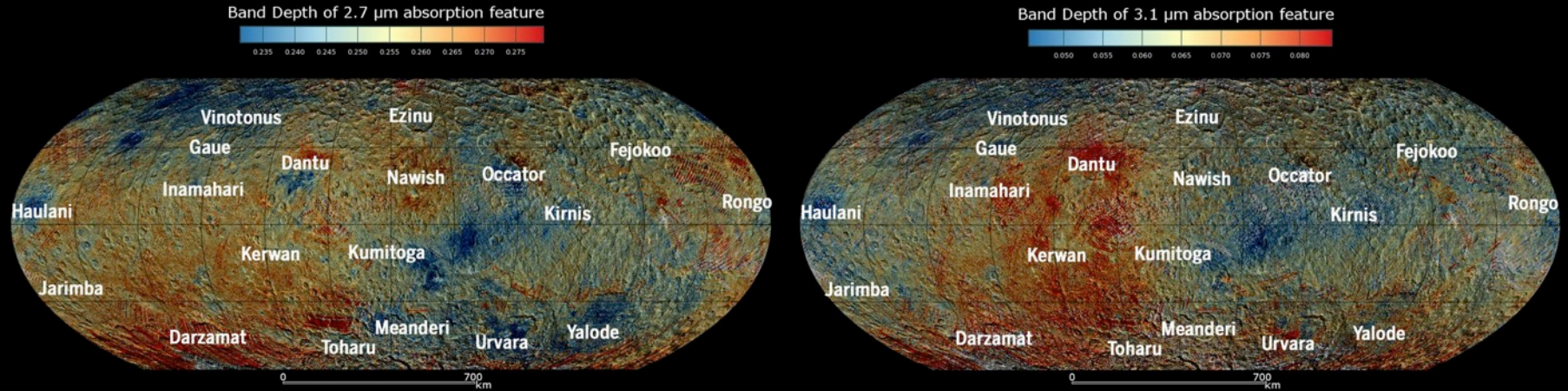


Exposed water ice on the surface



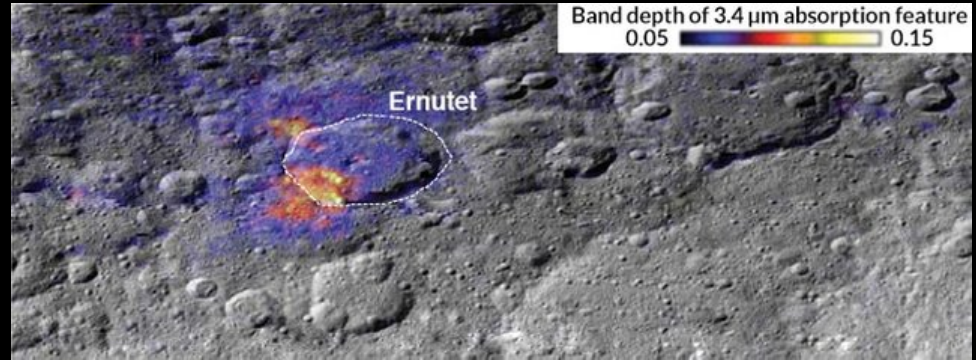
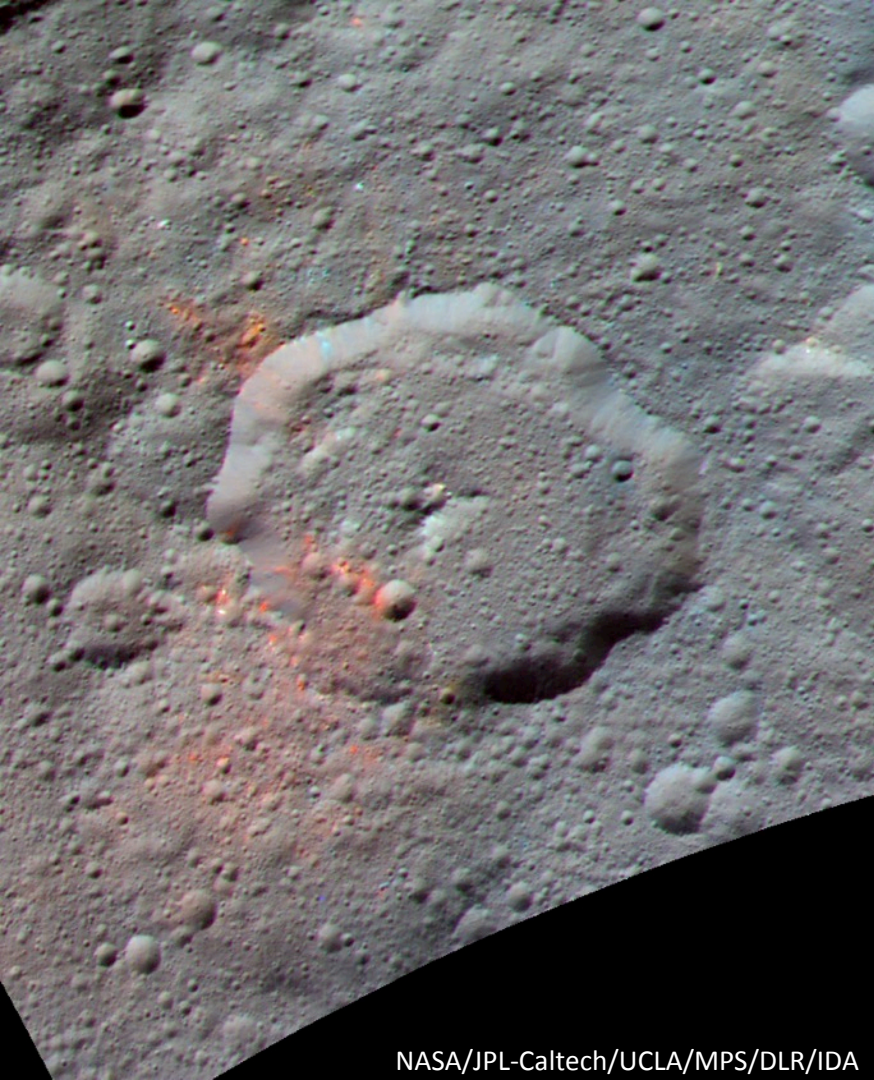
(Combe et al. 2016, 2018; Platz et al., 2017; Schorghofer et al. 2016)

Globally distributed ammoniated phyllosilicate

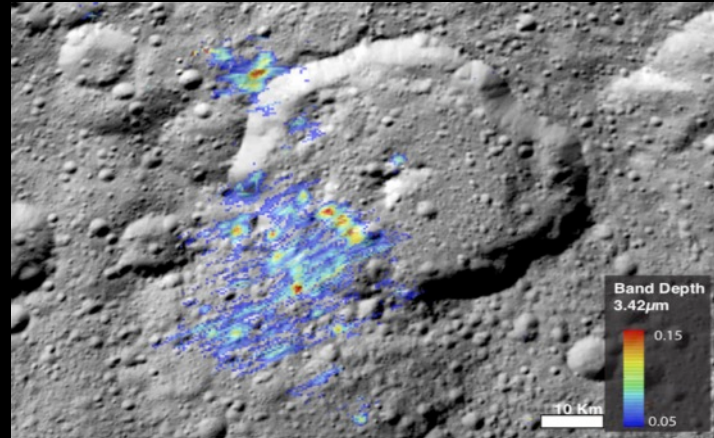


(De Sanctis et al. 2015, Nature; Ammannito et al. 2016, Science)

Organics



(De Sanctis et al. 2017, Science)



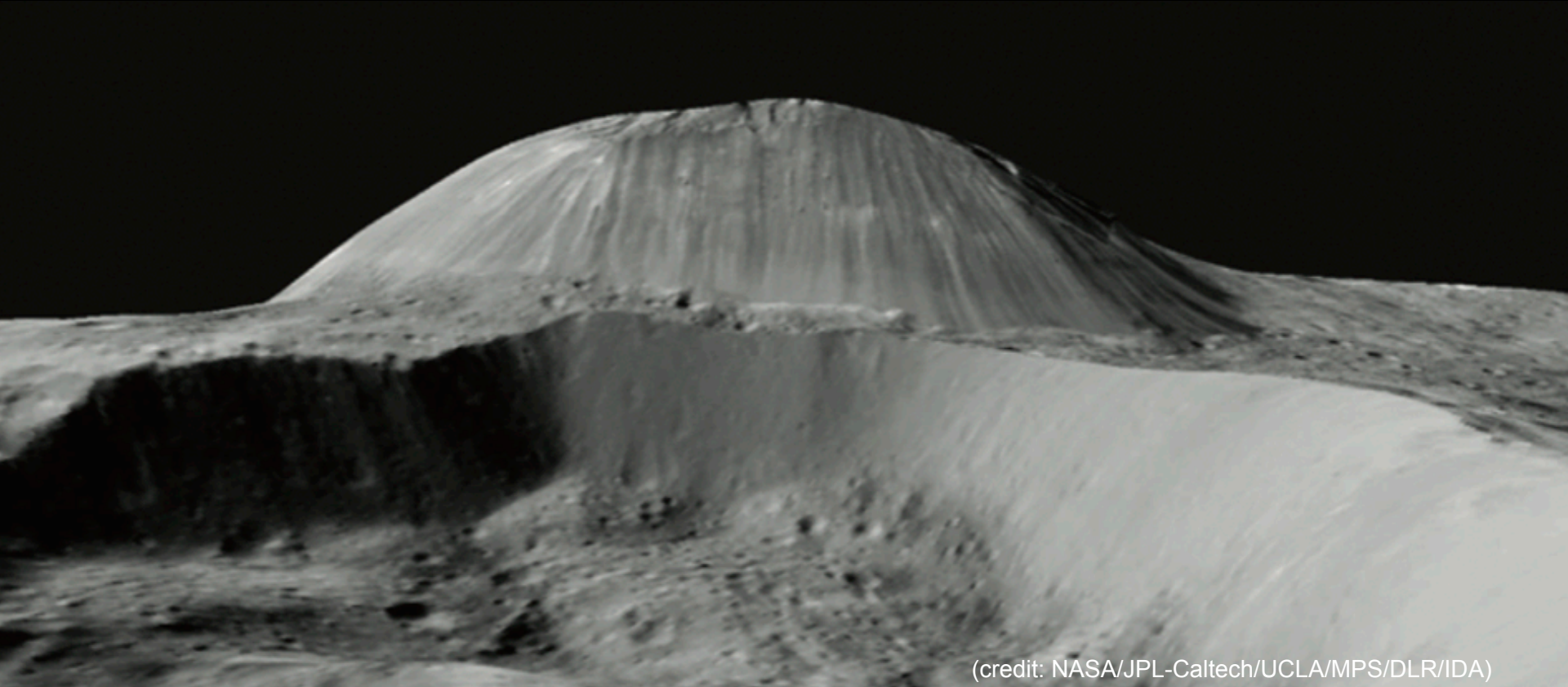
(Kaplan et al.
2018, GRL)

Ceres revealed by Dawn

Geologically active



Ahuna Mons – young cryovolcano



(credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA)

Ahuna Mons – young cryovolcano

- The emplacement of 4-km high Ahuna Mons requires a partially molten source – indicates subsurface brine pockets (Ruesch et al., 2016, 2019)
- Bright streaks are rich in Na-carbonate (Zambon et al., 2017)
- Emplacement is recent
- Brine mixture eutectic temperature is about 245K, possibly lower if ammonia remains



(credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA)

Occator crater – recent hydrothermal activity

Cerealia Facula

Vinalia Faculae

- Crater dating indicates Occator to be 10s My old (Nathues et al., 2017, Neesemann et al., 2019)
- Cerealia Facula (central deposit) appears to be even younger (Scully et al., 2018)
- Geology indicates that Cerealia Facula formed by a recurring, eruptive process
- Central dome similar to cryovolcanic features found on icy satellites

Occator crater – recent hydrothermal activity



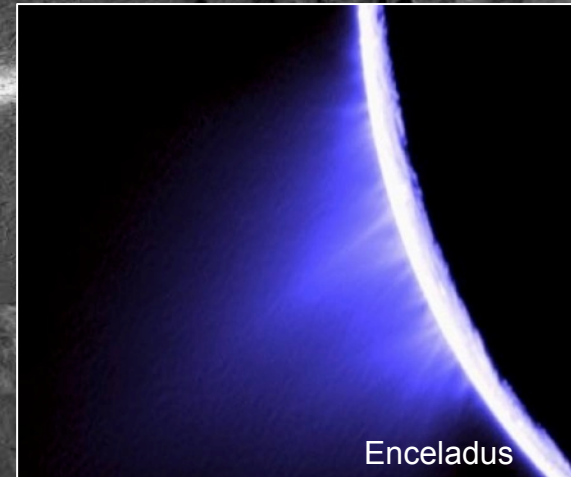
Lake Searles, CA

Cerealia Facula

Vinalia Faculae

Sodium carbonate
Ammonium salts

(De Sanctis et al. 2017, Science)



Enceladus

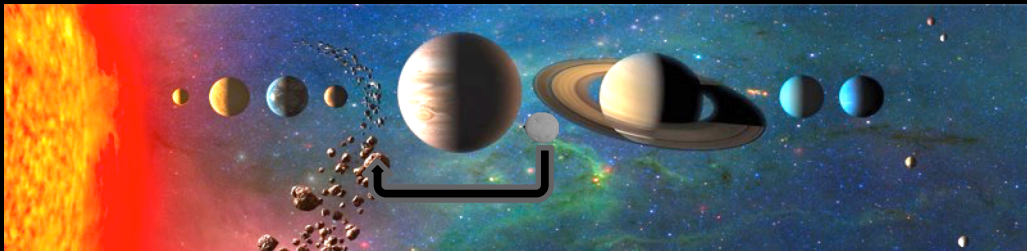
Origin and evolution of Solar System and the like



Ceres may have formed in the trans-Neptunian disk, before it was implanted into the main belt (e.g., McKinnon, 2012)

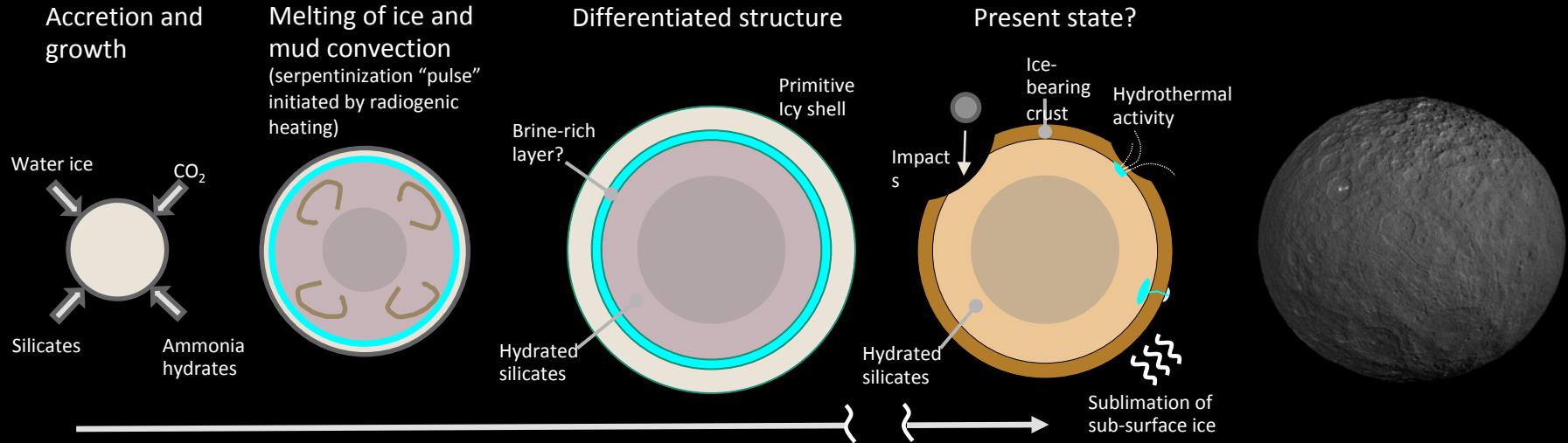


Ceres formed closer to its present position by accreting material that drifted inward from greater distances (e.g. Mousis +Alibert, 2005)



Ceres formed between the orbits of the giant planets and was scattered due to giant planet growth and migration (Raymond +Izodora, 2017)

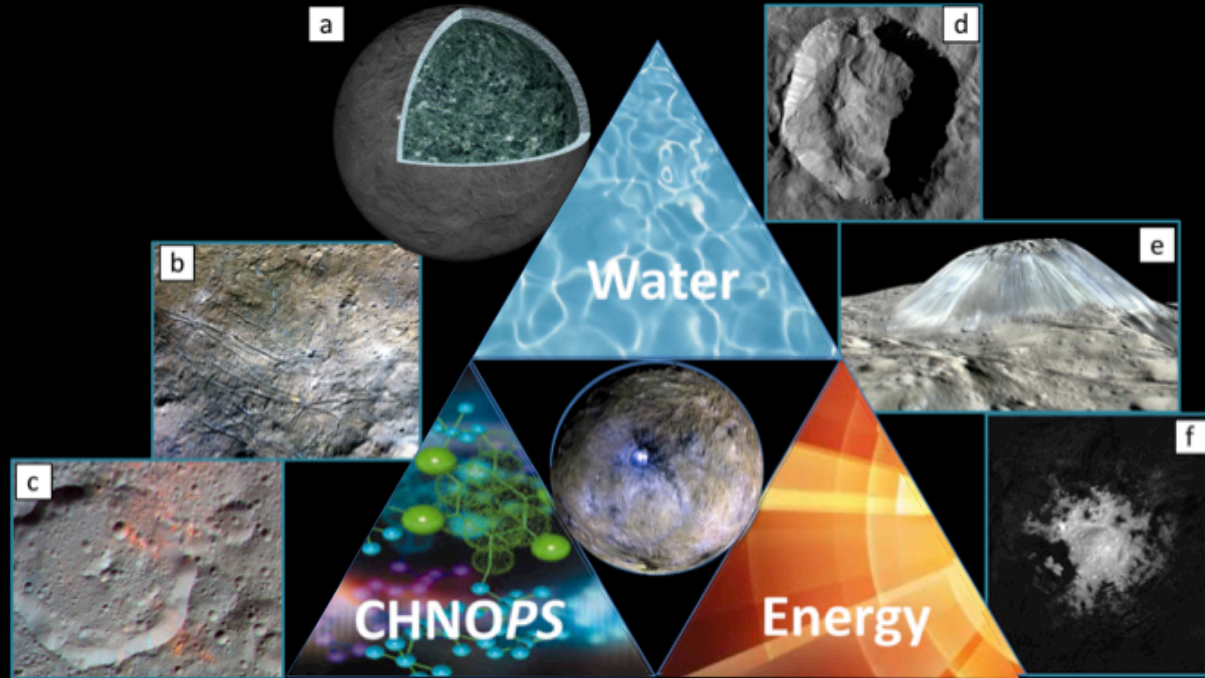
Origin and evolution of Solar System and the like



- Residue and brine separate, resulting in chemical fractionation
- Surface and bulk elemental composition differ

Castillo-Rogez & McCord, 2010, *Icarus*; Neveu et al., 2015, *GRL*; Rivkin et al. 2011, *SSR*; Castillo-Rogez et al., 2016, 2017

Past and present-day habitability





GAUSS

sample return from Ceres

mission scenario and international context

2020

2025

2030

2035

Tianwen-1

Mars2020

Hope

Chang'e-5

Lucy

ExoMars

JUICE

Psyche

MMX

CAEX

Europa clipper

Dragonfly

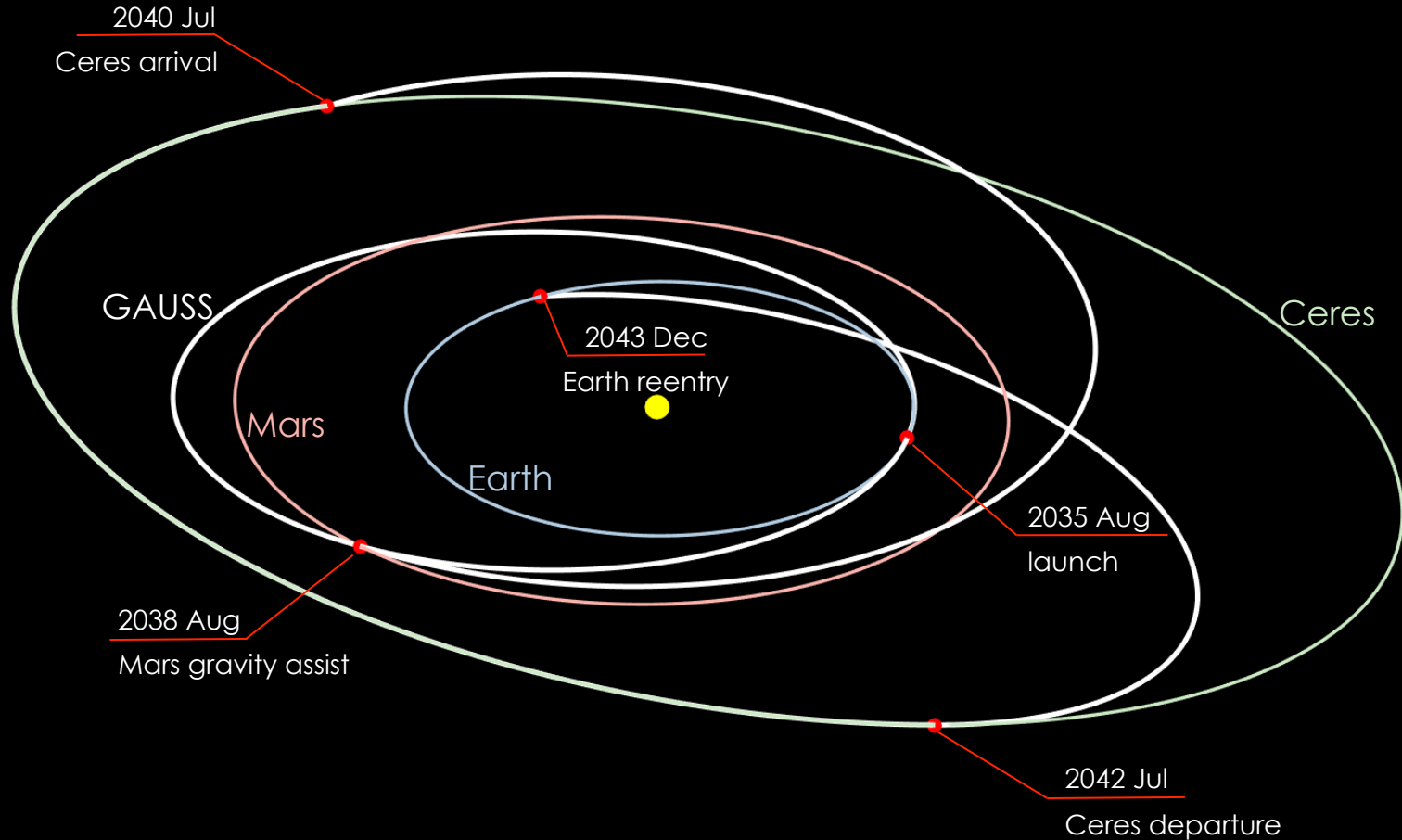
Comet Interceptor

GAUSS

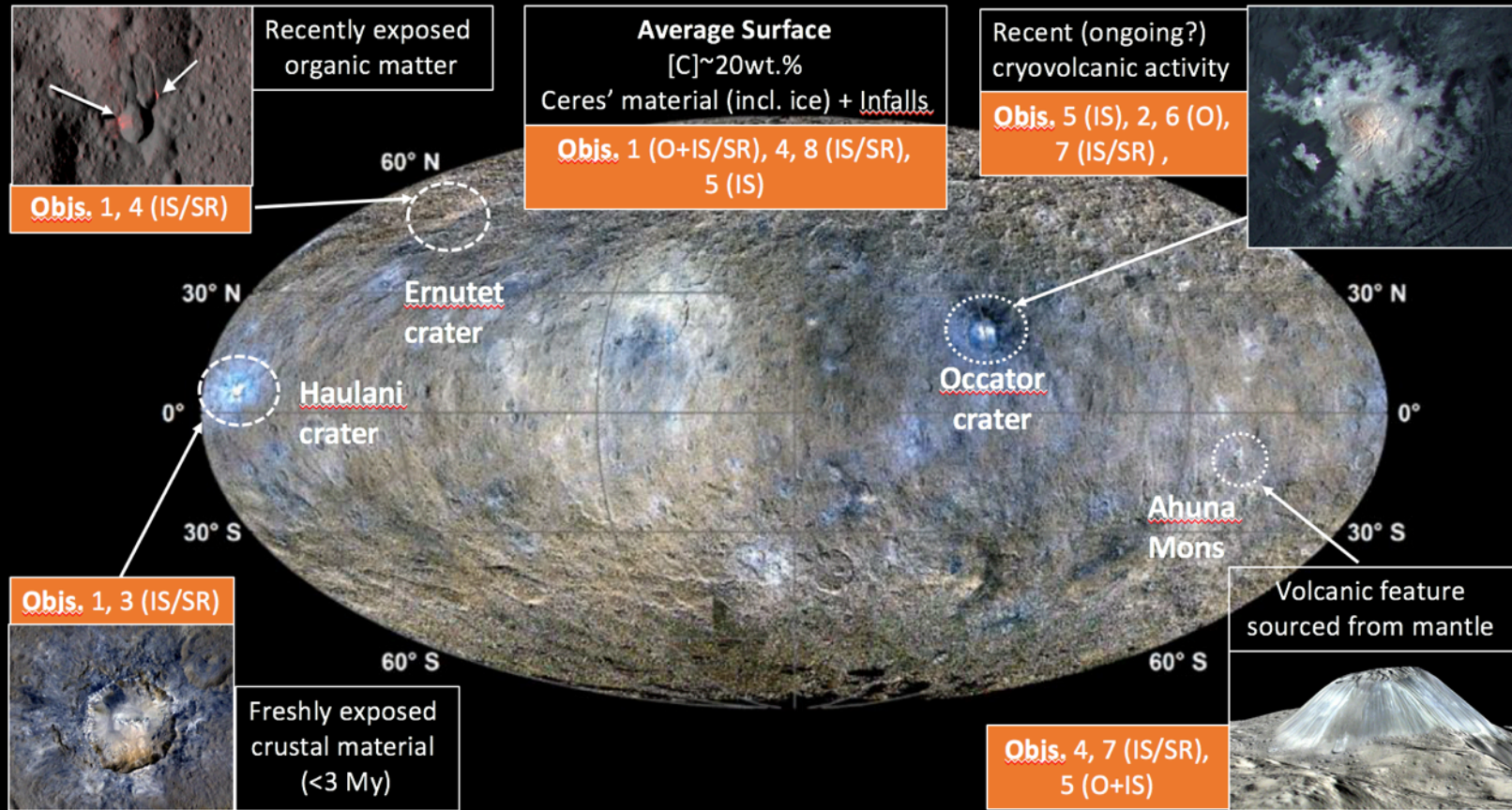
orbiter + lander + return capsule

L-class or M-class with significant
international contribution

Preliminary trajectory design



Sites of interest



latest version of the white paper on arXiv:

arxiv.org/abs/1908.07731

Extended proposing team

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