Solar System Moons – Inert or Active ?

Inert moons

-- Intense bombardment in early phase of solar system –impact craters / basins

- Molten interior during formation of moon– lava flows frozen on surface

- Lack of atmosphere – no weathering processes on surface

- Preserved geological record – impact craters / lava flows – unchanged / frozen

Active moons

-Geological processes – currently seen in some moons of outer solar system

-Surface changes – seen over short times scales

-Atmospheric processes-weathering – seen on one moon of outer solar system (Titan)

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Inert moon (1) : Callisto(Jupiter)

Mean radius
(2410 km)

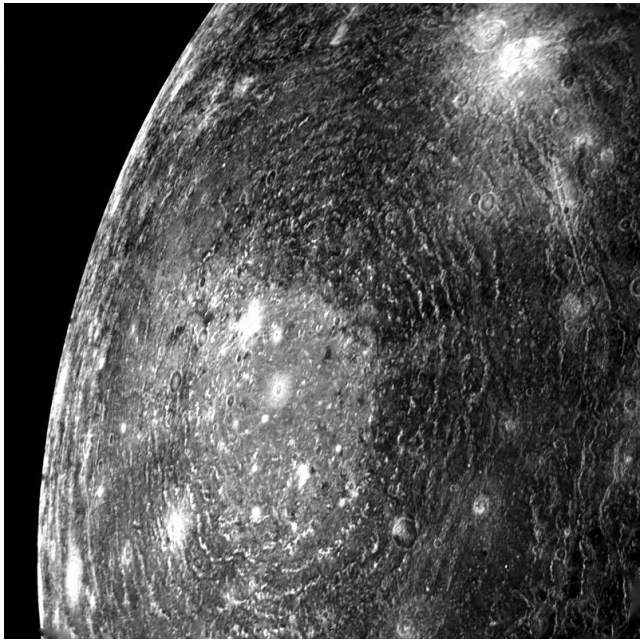
Mean temp
(134K)

Orbital period
(16.69 dys)

Mean density
(1.834g/cm3)

Mass
(0.015*Mearth)

Albedo
(0.22)



Valhalla - multi-ringed
Impact structure (3800km diameter)

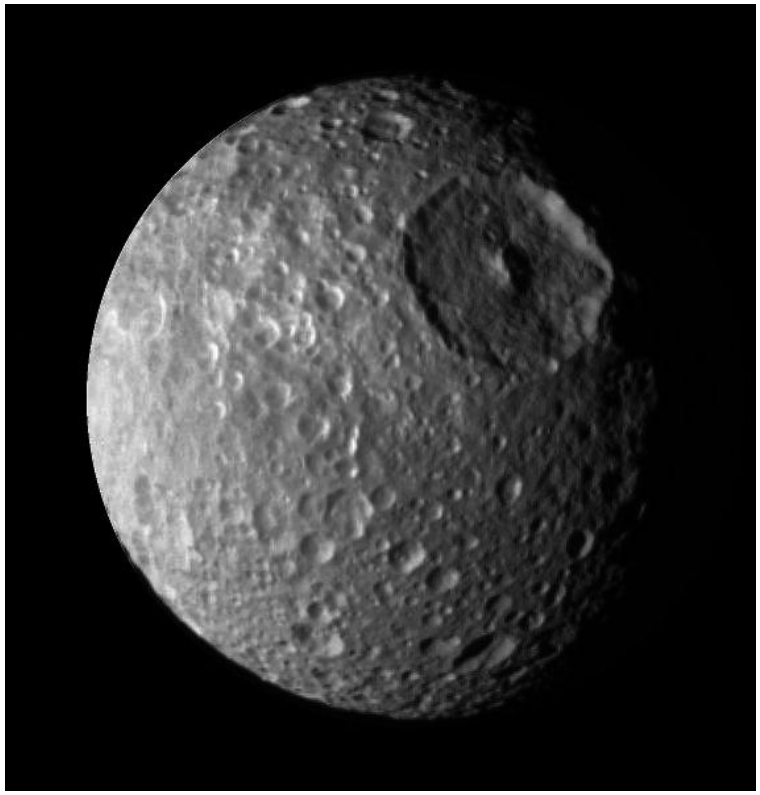
Characteristics:
Dark surface (except for exposed ices)
Impact crater size(0.1 – 100km)

Composition - water ice / rocky material & volatile ices (NH3)

Ancient surface- most cratered in solar system (+ multi-ring structures)

Age of surface features – up to 4 billion years old

Inert moon (2) : Mimas(Saturn)



Mean radius (198 km)

Mean temp (64K)

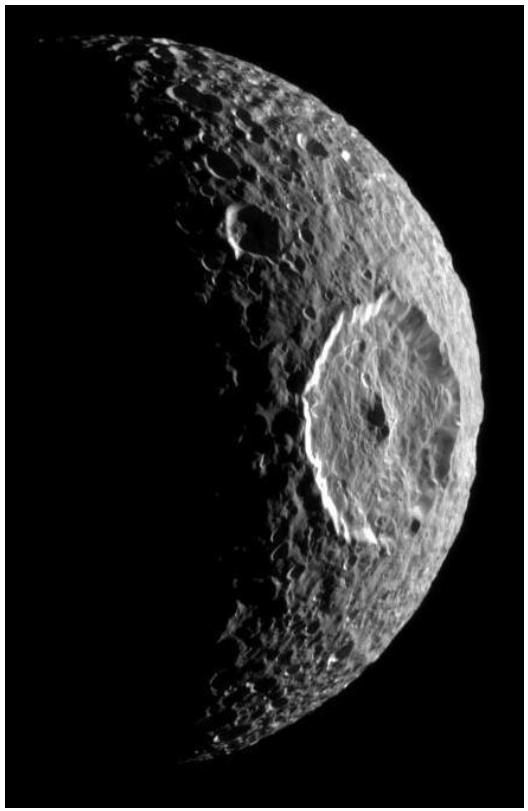
Orbital period(0.94 days)

Mean density (1.15g/cm3)

Surface gravity(0.65%g)

Escape velocity(0.16km/s)

Albedo (0.96)

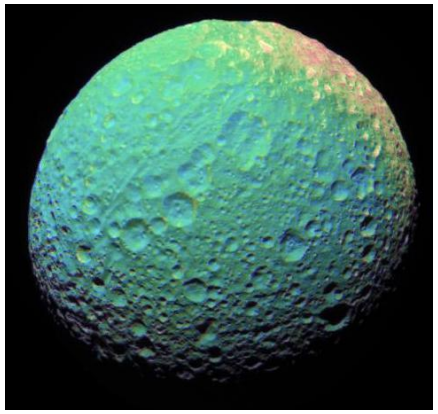


Composed mainly of water ice- small amount of rock

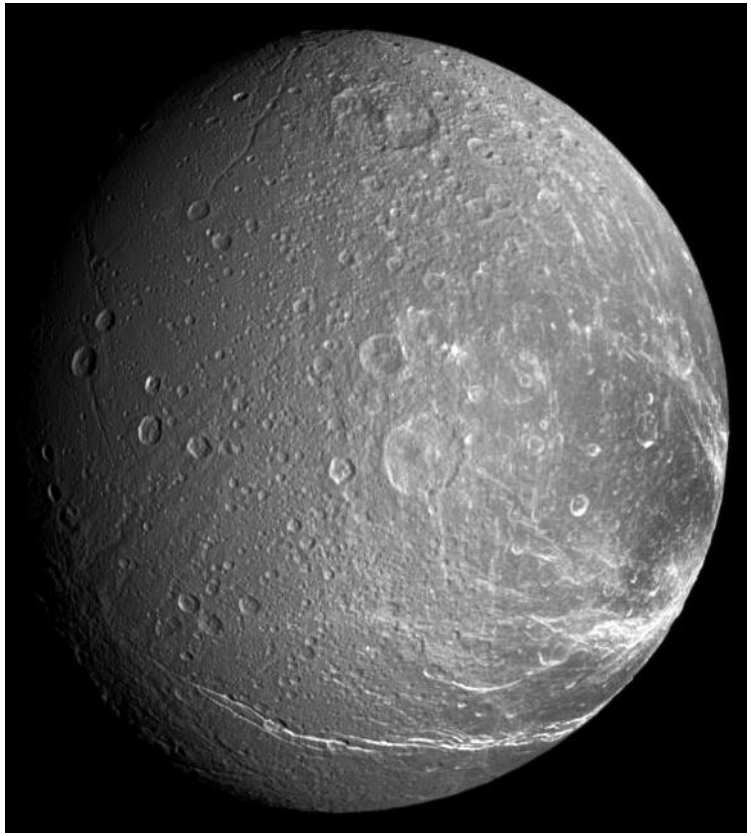
Large impact crater(Herschel 130km) – almost shattered moon

Fractures – other side of moon- due to shock waves from impact

Heavily cratered surface –greater than 40km



Inert moon (3) : Dione(Saturn)



Mean radius
(561 km)

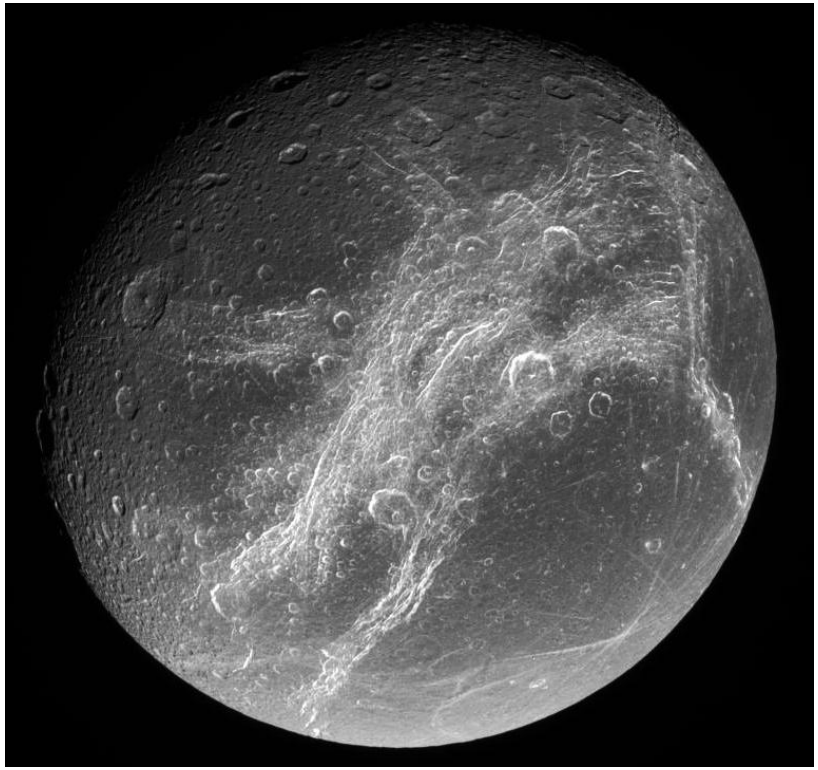
Mean temp
(87K)

Orbital period
(2.736 dys)

Mean density
(1.475g/cm3)

Escape velocity
(0.23km/s)

Albedo
(0.998)



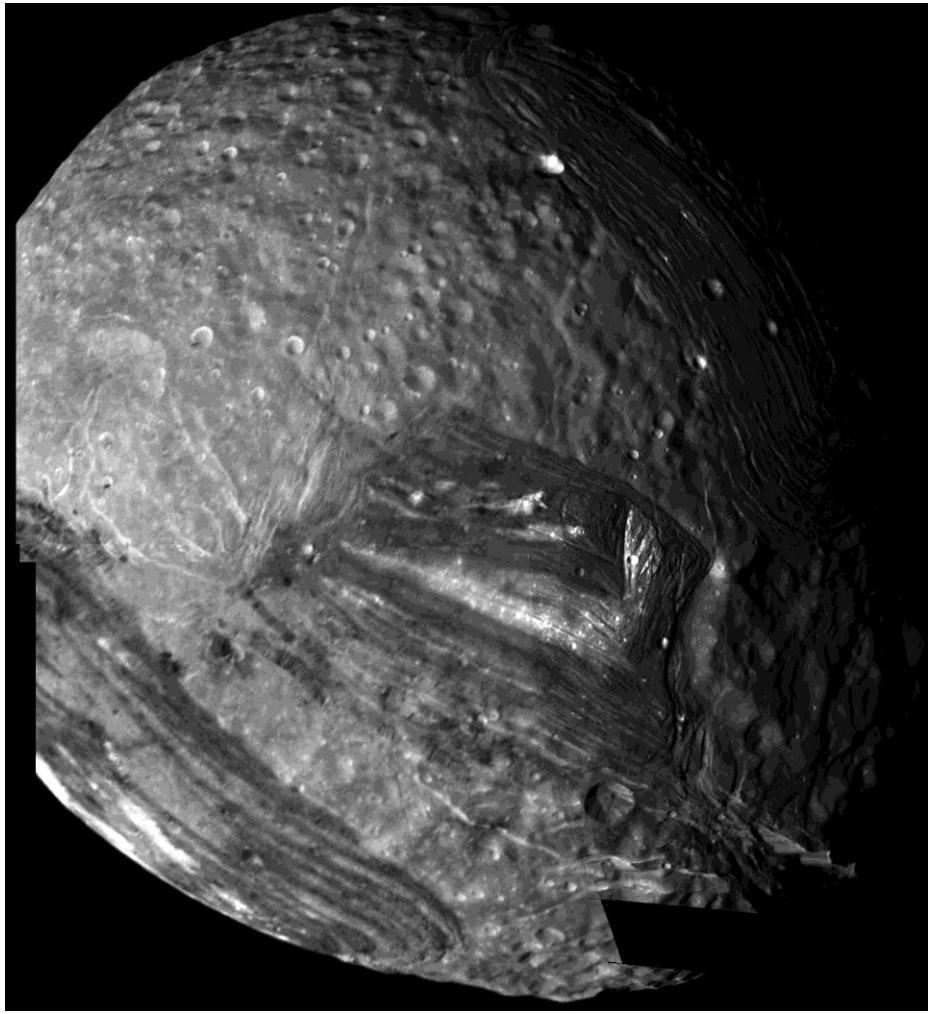
Composed mainly of water ice- large fraction of silicate rock in interior (46% fraction)

Leading hemisphere – heavily cratered (uniformly bright)

Trailing hemisphere - network of bright ice cliffs (high albedo)

Bright ice cliffs - created by tectonic fractures – several hundred meters high

Inert moon (4) : Miranda(Uranus)



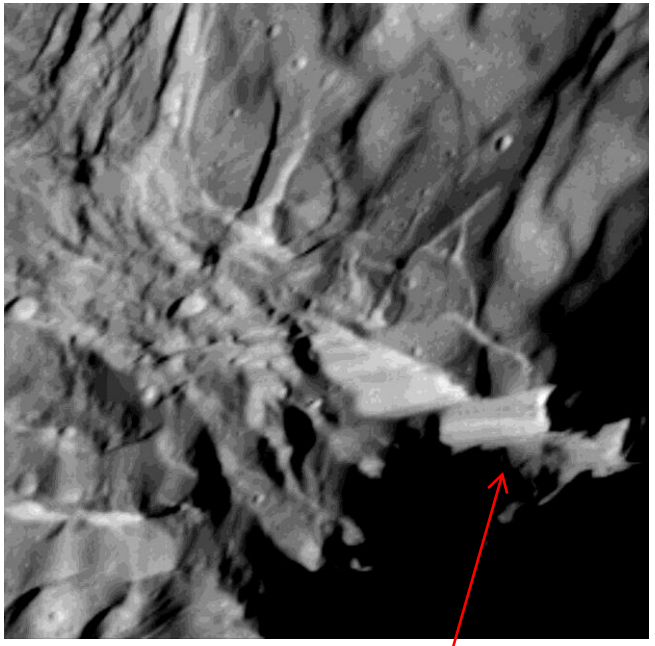
Mean radius (235.8 km)

Mean temp (60K)

Orbital period (1.40 days)

Mean density (1.20g/cm3)

Albedo (0.32)



Rupes Verona (5-10km high)

Surface Features :

Race track grooves (Coronae)

Scarps (Rupes) - surface faulting

Sulci - parallel grooves

craters

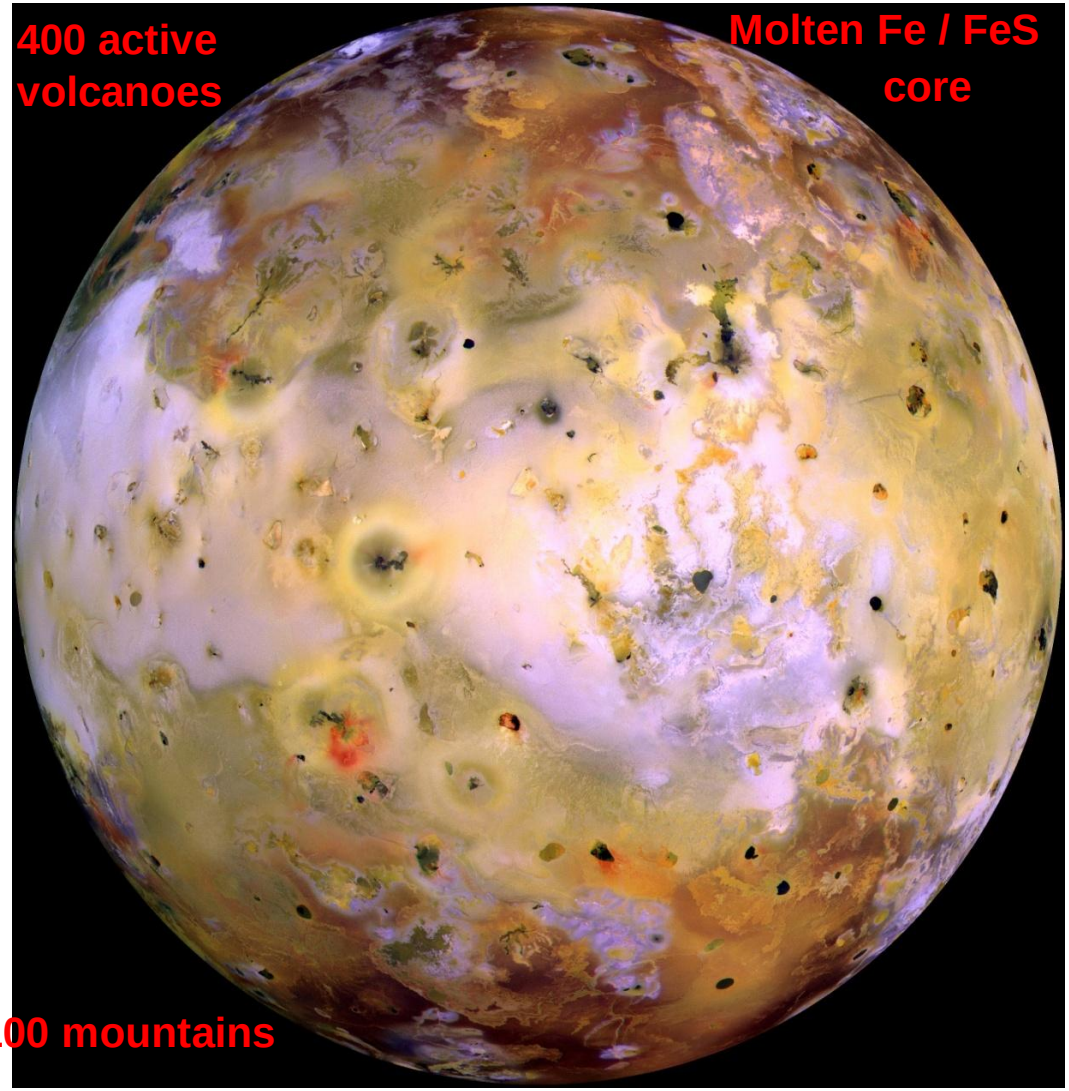
Composed mainly of water ice- silicate rock / organic compounds in interior

Canyon`s on Miranda`s surface – indicate intense geological activity in past

Currrent moon – may have re-formed from shattered fragments (previous impact)

Active Moons : Jupiter / Io

Innermost moon of Jupiter (diam 3640 km) – tidal heating by Jupiter / Galilean moons



Highest resolution mosaic of Io (July 1999)

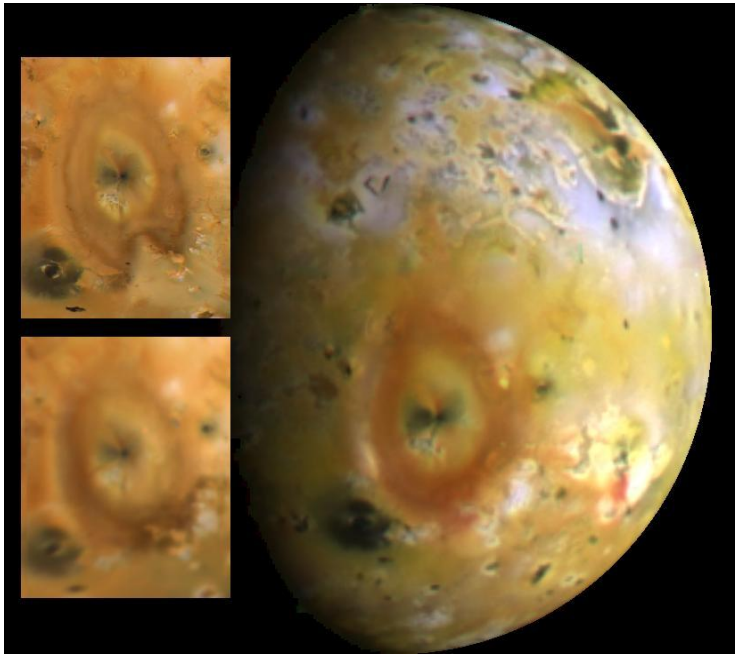
Sulphur Lava flows and deposits around volcanic centres

S / S02 volcanic plumes(500 km high)

Sulphurous lava flows(500km)

Molten Fe / FeS core – silicate crust

Voyager 1 image



Voyager 2 image

Galileo image

Volcanic eruption from Pele (red deposits are form of sulphur)

Active Moons : Jupiter / Io (cont)

plume from volcano Tvashtar (180 miles high)

Volcanic Plume (Pillan Patera 86miles High)

Volcanic Plume (Prometheus)

Volcanism on Io :

Most volcanically active body in solar system

Surface Lava flows – basaltic composition – similar to Hawaii – over 100km long

Lava Plumes – explosive eruptions of silicates/ S & S02 - high temperatures (1600K)
(plumes up to 300 miles high – coating surrounding terrain (red / black white)

Active Moons : Saturn / Titan

Mean radius (2576 km)

Mean temp (93K)

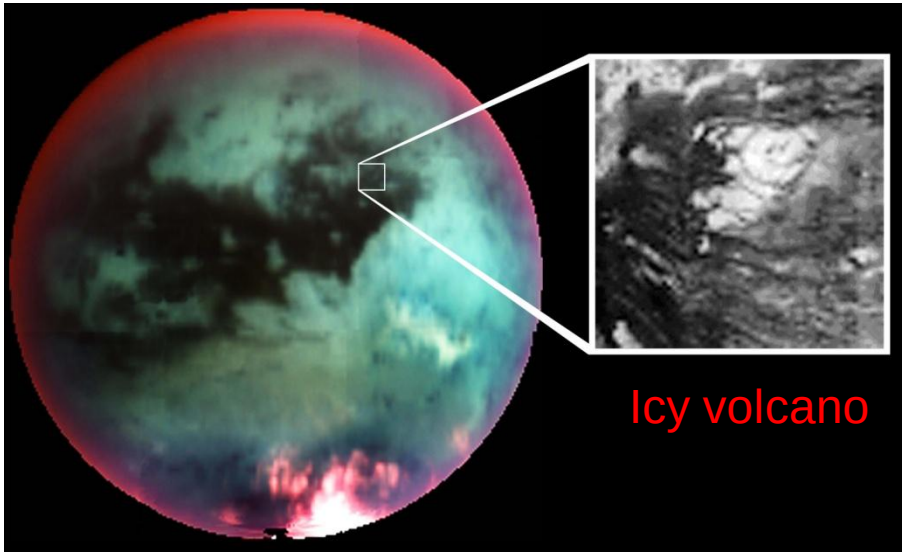
Orbital period (15.9 dys)

Mean density (1.88g/cm3)

Escape velocity (2.64m/s)

Albedo (0.22)

Infra-red view of Titan (Cassini 2004)



Atmospheric features(red)
Surface features(blue / green)

Titan – thick atmosphere
(surrounded by light scattering haze)

Atmosphere – nitrogen / methane and ethane clouds / organic smog

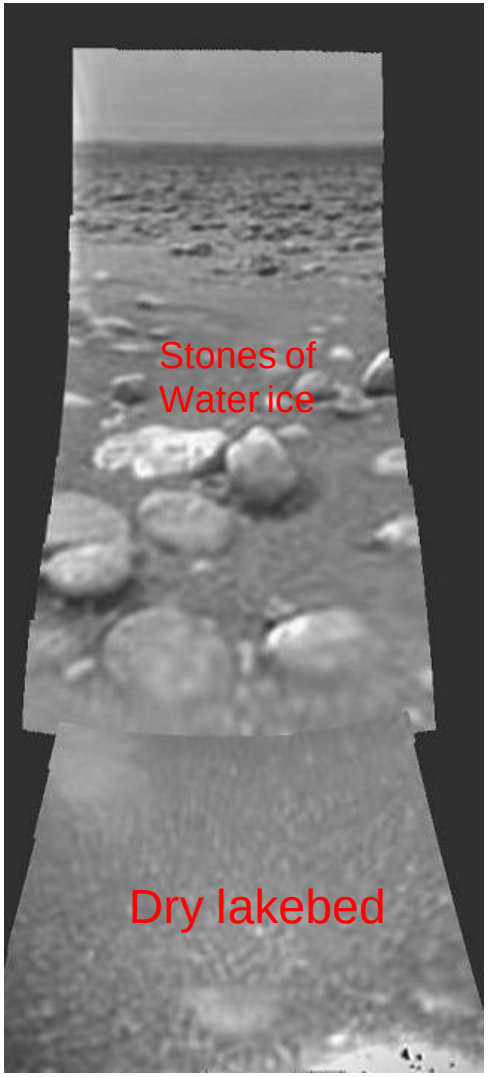
Climate (wind/ rain) – creates surface features (sand dunes/rivers/lakes/seas-liquid methane/ethane)

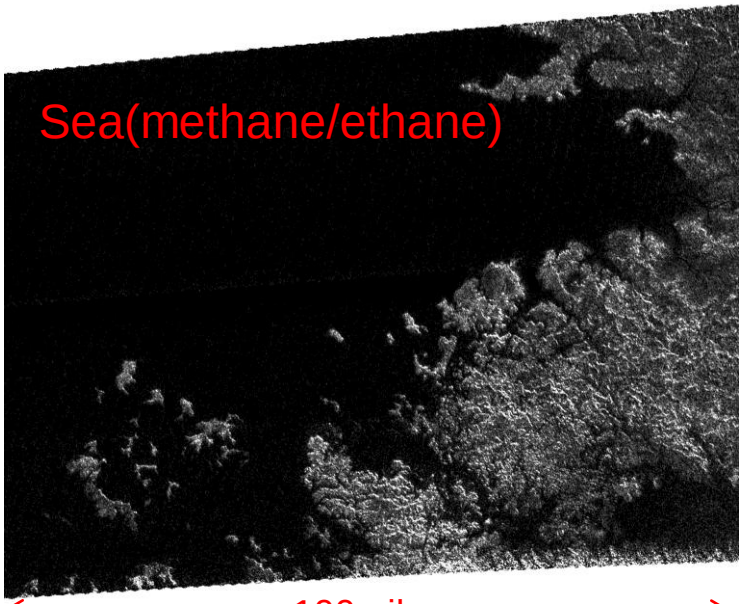
Transient white spots / features on surface –associated with volcanic activity

Active Moons : Saturn / Titan(cont)

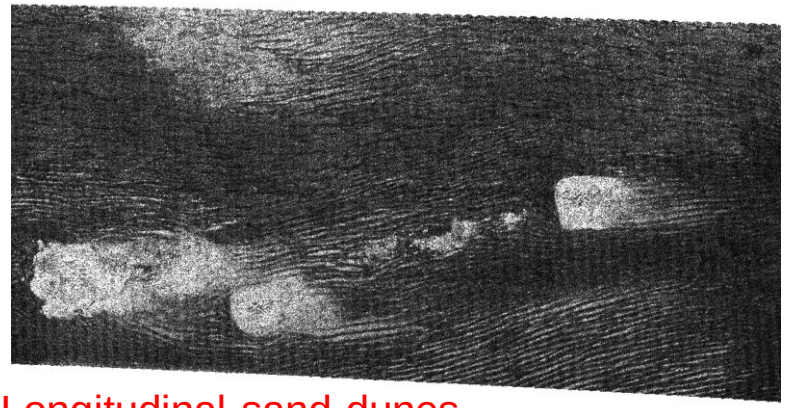
Images from Cassini`s radar instrument

View from surface
(Huygens lander)



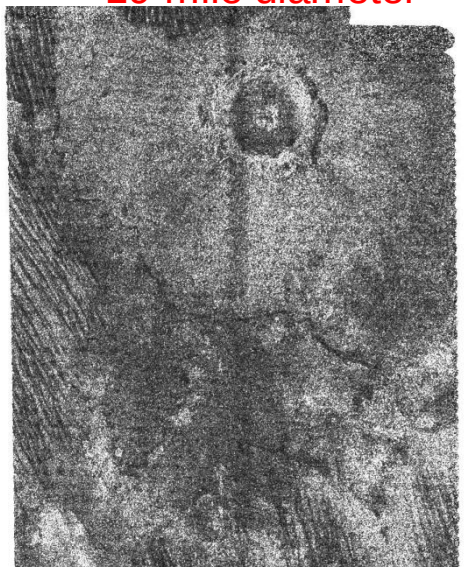


100miles
Isolated islands / coastline

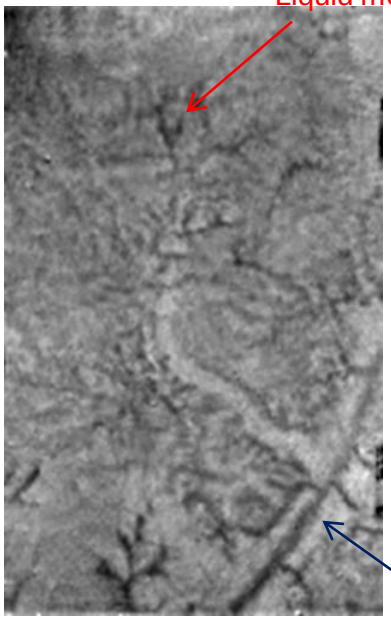


Longitudinal sand dunes
(ice coated with organic material)

Impact crater
19 mile diameter

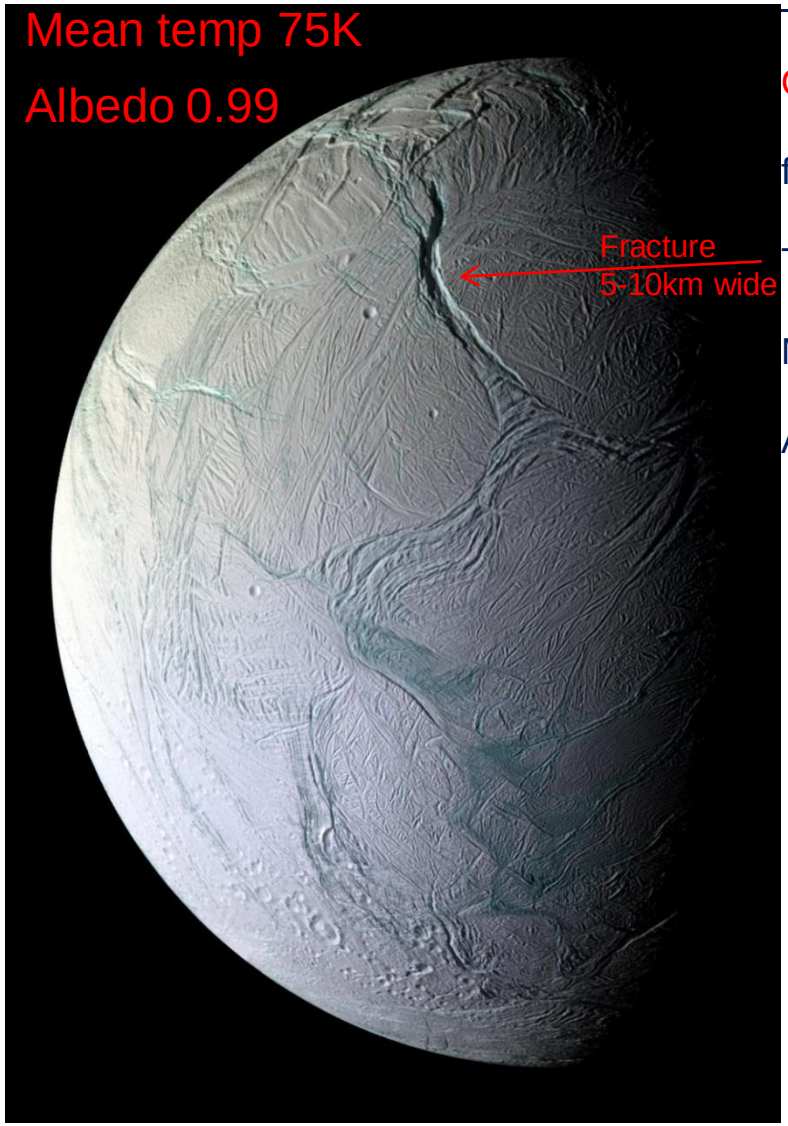


Springs of
Liquid methane



Water ice extruding on surface

Active Moons : Saturn / Enceladus



Surface :

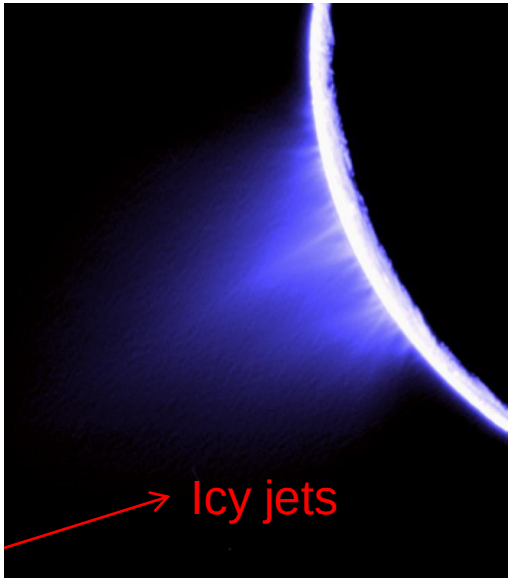
Only few million yrs old

fractures / folds / ridges

Tectonic features – rifts

Most reflective in solar system

Activity due to water volcanism



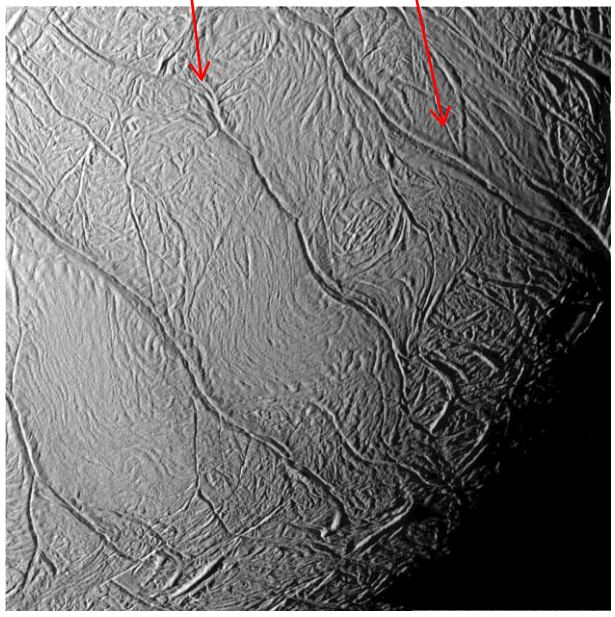
Tiger stripes(sulci) – ----------source of icy jets

--Pressurised
Water ocean

--Source of icy jets
Through tiger stripes

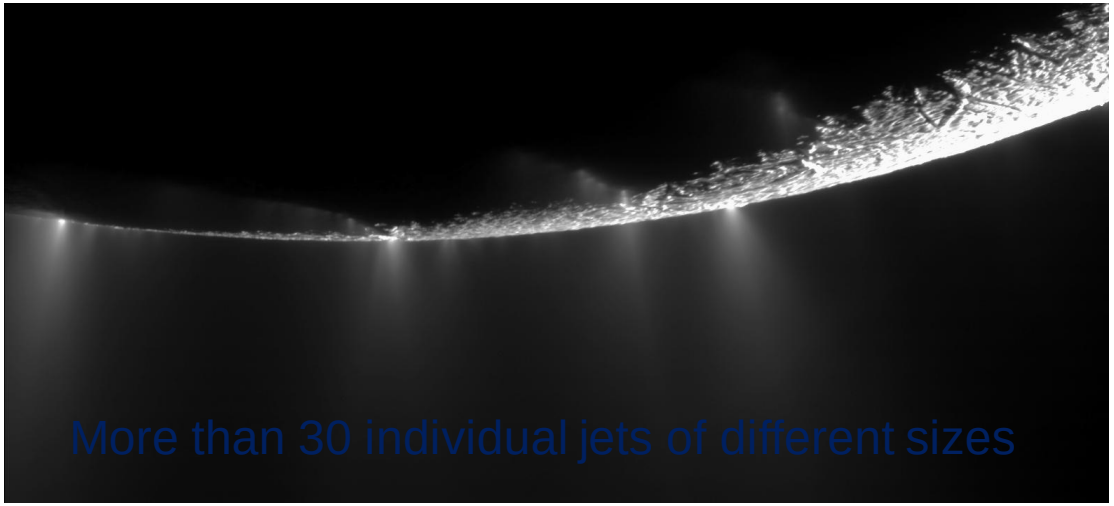
-Salt / organic compounds
Found in icy jets

Icy particles are source for
Saturn`s E ring

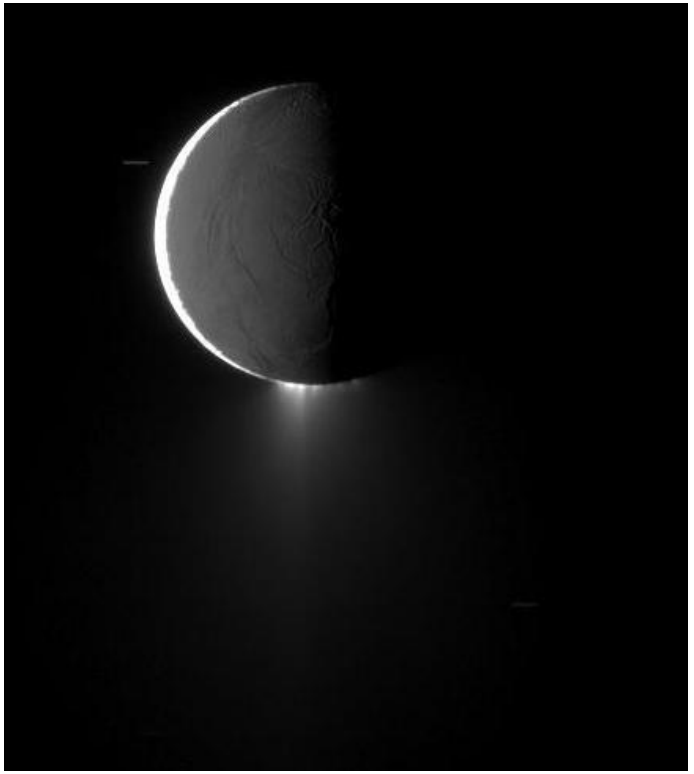


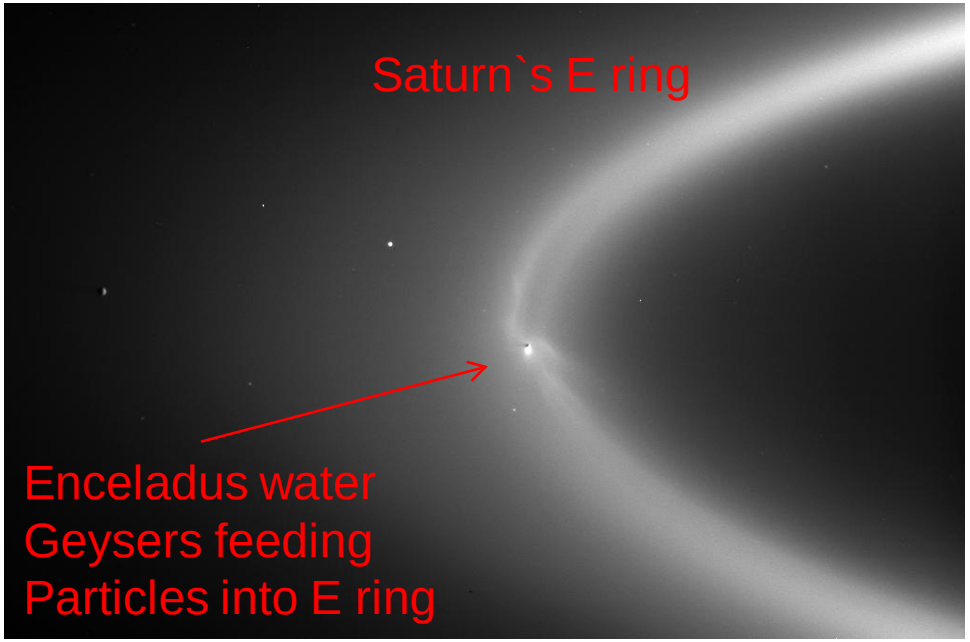
Mean density (1.61g/cm3) –
silicate/ iron core – icy mantle

Active Moons : Saturn / Enceladus(cont)

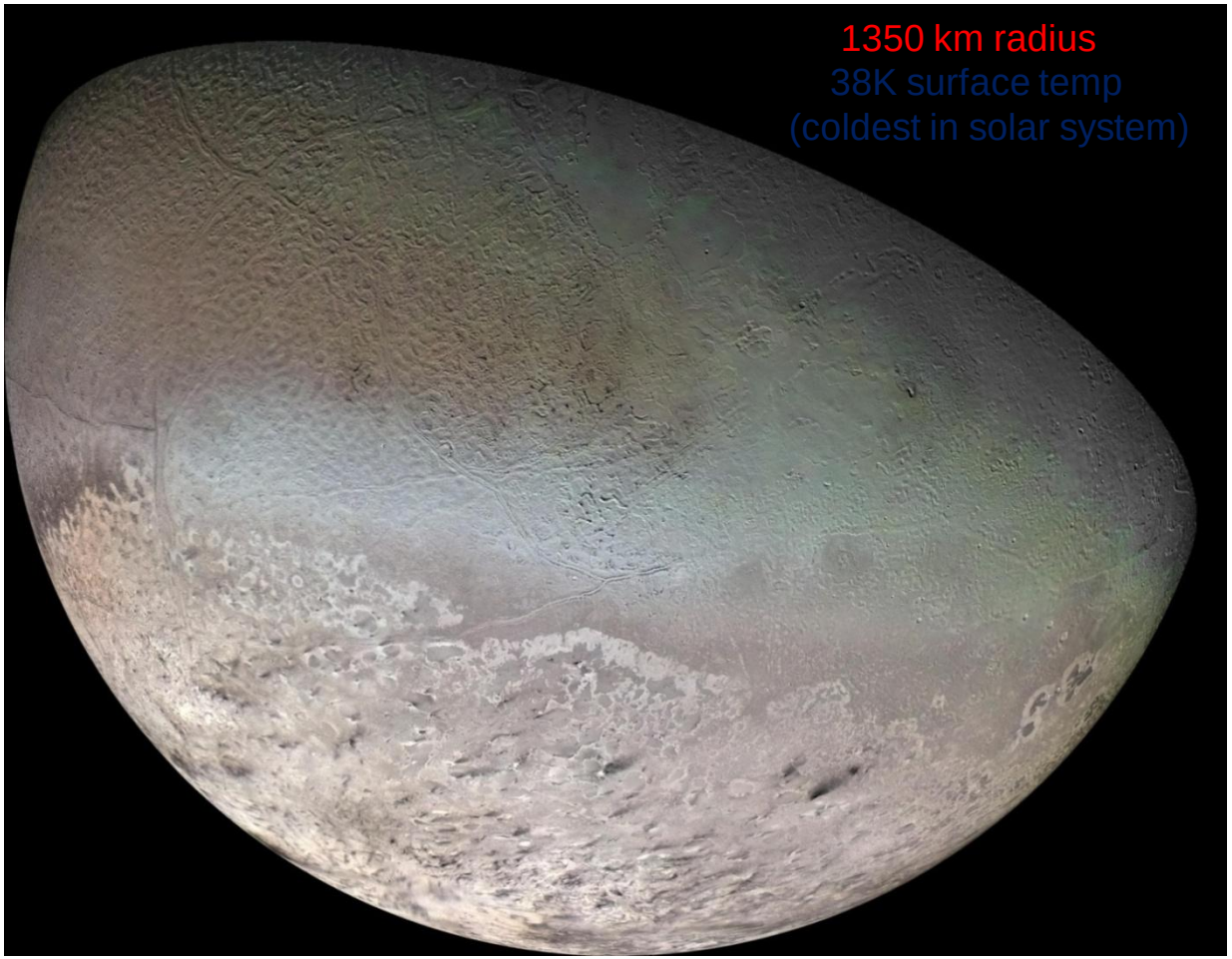


Dramatic plumes spraying water ice from tiger stripes

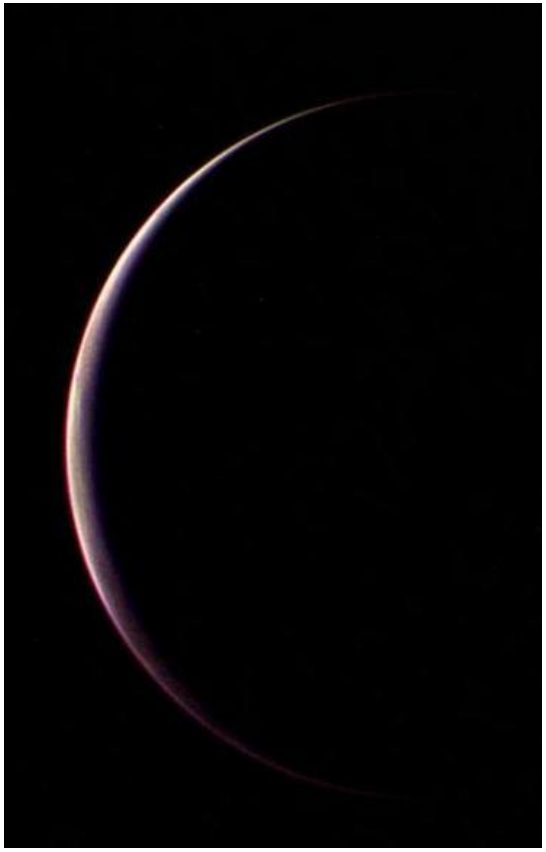




Potentially Active Moons : Neptune / Triton



Voyager 2 parting shot
Aug 1989 last (distance 56,000mile)



Nitrogen on surface of Triton is condensed as frost – bluish-green band near equator

Pinkish deposit is large south polar cap – methane ice – reactions forming red/pink deposits

Dark streaks – icy / carbonaceous deposits from geysers – active during Voyager2 flyby