Challenging Science Mission Scenarios

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Planetary Decadal Survey (2013-2022)

- Priority of flagship missions
  - Mars Sample Return
  - Jupiter Europa Orbiter
  - Uranus Orbiter and Probe
- New Frontiers should be selected from
  - Comet surface sample return
  - Lunar South Pole –Aitken basin sample return
  - Saturn probe
  - Trojan Tour and Rendezvous
  - Venus In Situ Explorer
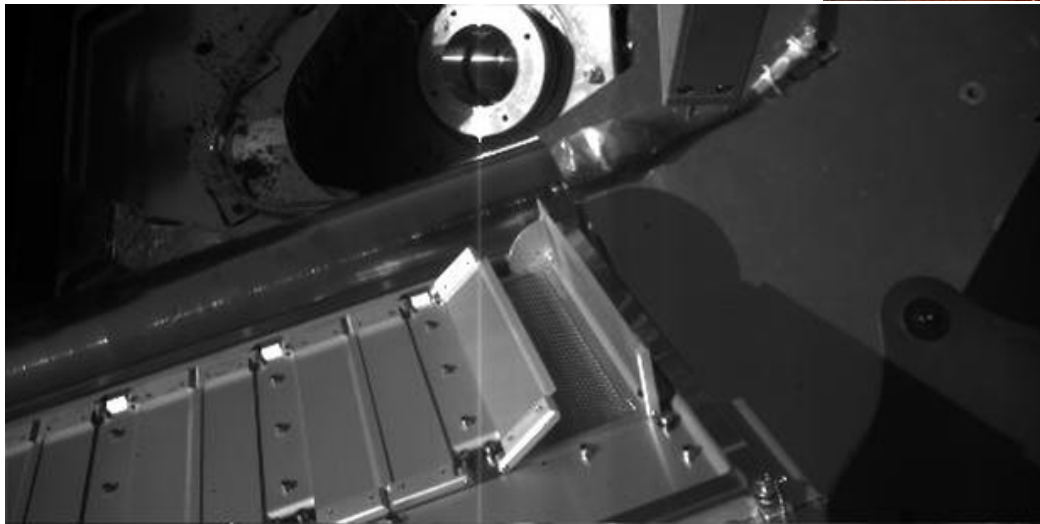 - But, Osiris-Rex was selected: Asteroid sample return
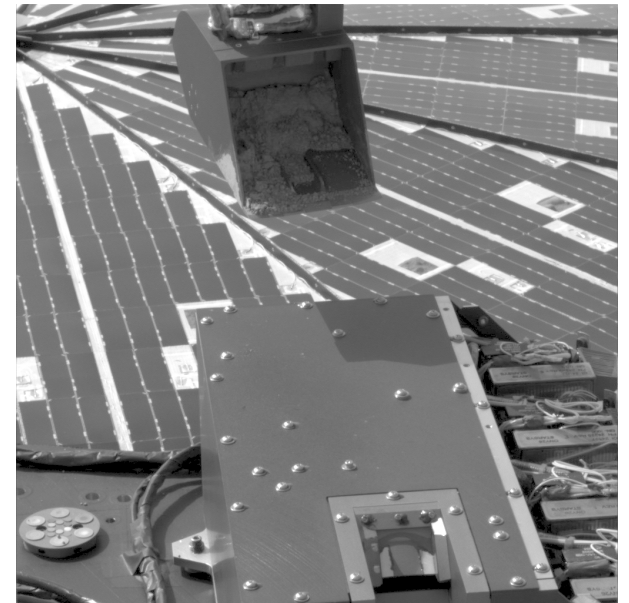
Nature of surface material

Unconsolidated material easily excavated by decent engines
(Decent engines also contaminate the surface)

Sample acquisition and delivery

- Unknown material properties
  - Cohesiveness
  - Stickiness
  - Water content

Took 1/3 of Phoenix prime mission to get ice sample; 5 of 8 TEGA cells filled

MSR Sample challenges

- Need to acquiring intact core samples that retain physical characteristics
- However, rock material properties are unknown
- How they affect the drilling system and how they behave under drilling conditions must be robust
  - Rock hardness (really a property of minerals; rocks are a compilation of minerals)
  - Abrasivity
  - Friability
  - All sandstones are not alike
  - The most common rocks on Mars are less common on earth
  - Mineral assemblages could be different on Mars
  - Cannot test all possibilities

Landing on Unknown Surfaces:
Europa Lander example

Cassini Enceladus 4 m/pixel

200 m

Galileo Europa 6 m/pixel

500 m
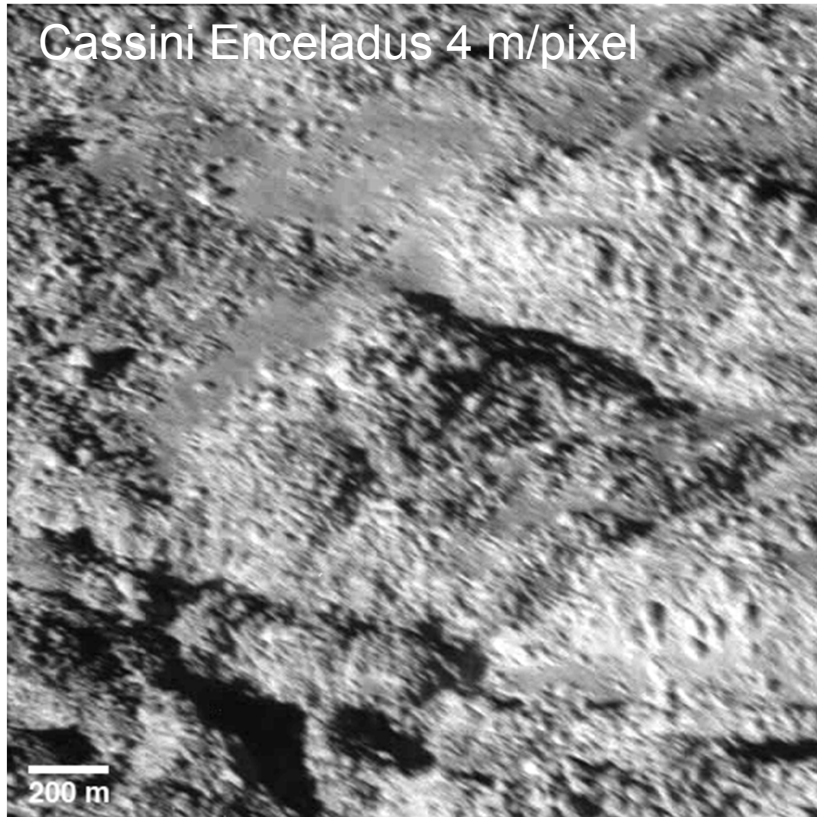
Surfaces can be very rough and sufficient imaging may not exist to find a known safe location
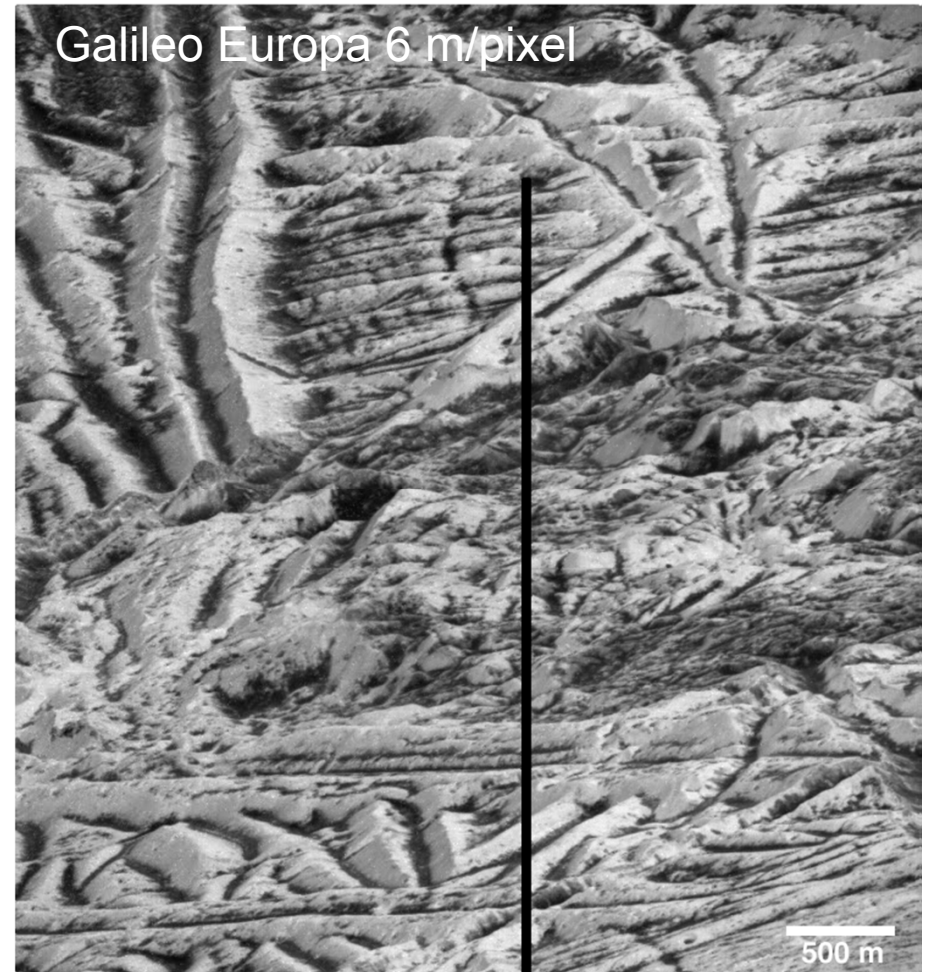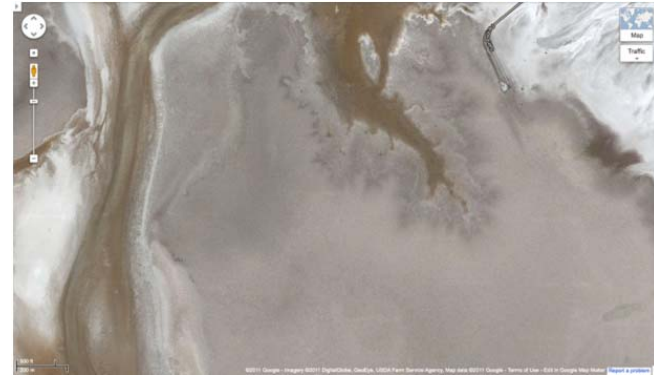
Courtesy: Europa Lander Study Team

Some "smooth" looking surfaces may not be smooth on the scale of the lander

Earth glacier surfaces

1 m/pixel

Devil's Golf Course – Death Valley

Courtesy: Europa Lander Study Team

Traversing, climbing, repelling

- Traversing: In limited duration mission, need to get somewhere fast (Venus, Europa); over/around obstacles
- Climbing, repelling: Geologists often want to examine layering.
  - Drive up mountain (e.g., MSL)
  - "Repel" down or climb up canyon wall

Atmospheric challenges

- Density profile and wind profile for landing/aerobraking/ sampling
  - E.g., dust storms on Mars
  - Saturn atmosphere below the clouds
  - Venus winds below the clouds
- Launching from surface of Mars
  - Reverse of 7-min of terror of MSL
  - Able to handle any conditions; possibly perform measurements to select the right time to launch
- Landing on comet
  - Unknown particles sizes, velocities, composition
- Venus
  - Don't know if clouds are particulate or gaseous

Orbiting challenges

- Unknown satellites orbiting body of interest
  - E.g., Ida's moon Dactyl
- Unknown gravity field
- Unknown atmosphere, atmospheric extent