



# **(Some) Key Questions in Planetary Volcanology**

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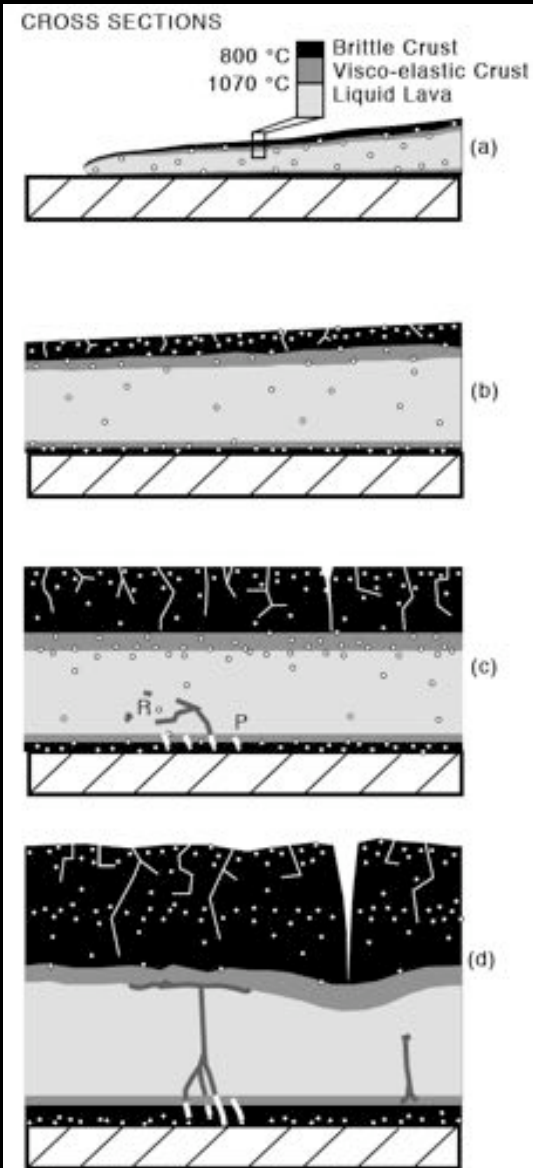
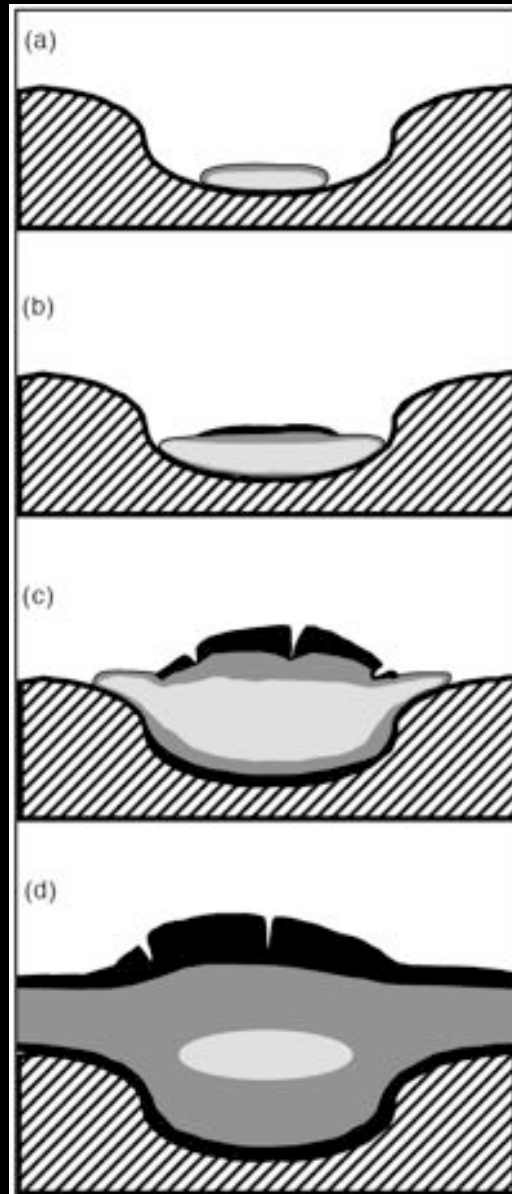
# Select Questions

- **How do large lava flows form?**
  - Humans have never seen these active on Earth
- **What does cryovolcanism look like?**
  - Definitive examples rare, at best
- **Habitability and life**
  - Many questions with few answers

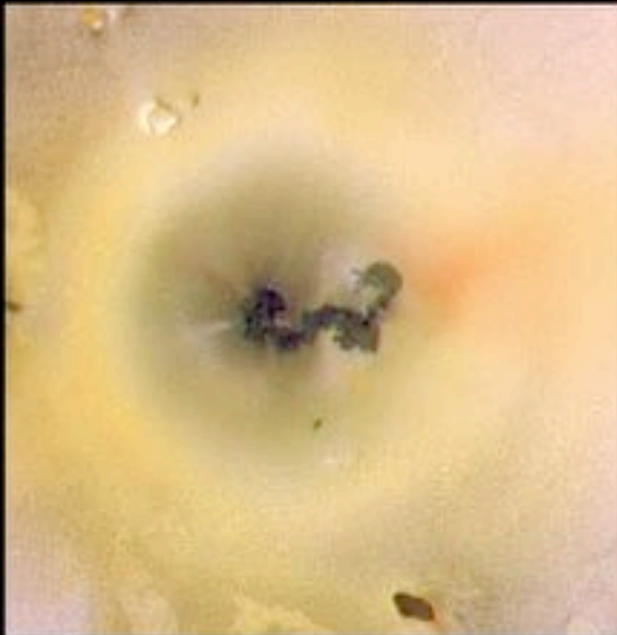
# How do large lava flows form?

- Terrestrial studies led to the “SWELL” hypothesis
- Then we looked at beyond Earth...

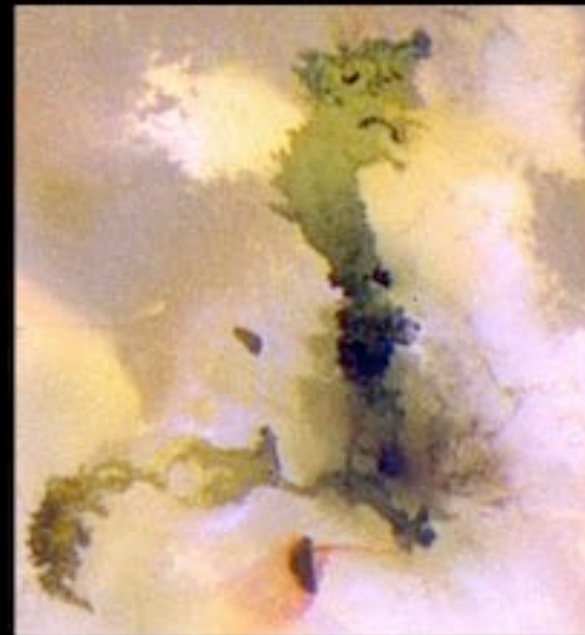
# SWELL = Lava Flow Inflation



**PROMETHEUS**



**AMIRANI**



← **Kilauea, Hawaii: Longest Active Lava Flow on Earth**

← **Laki, Iceland: Longest Lava Flow Witnessed on Earth**

← **Pomona Flow, Washington: Longest Lava Flow Mapped on Earth**

100 km (60 miles)

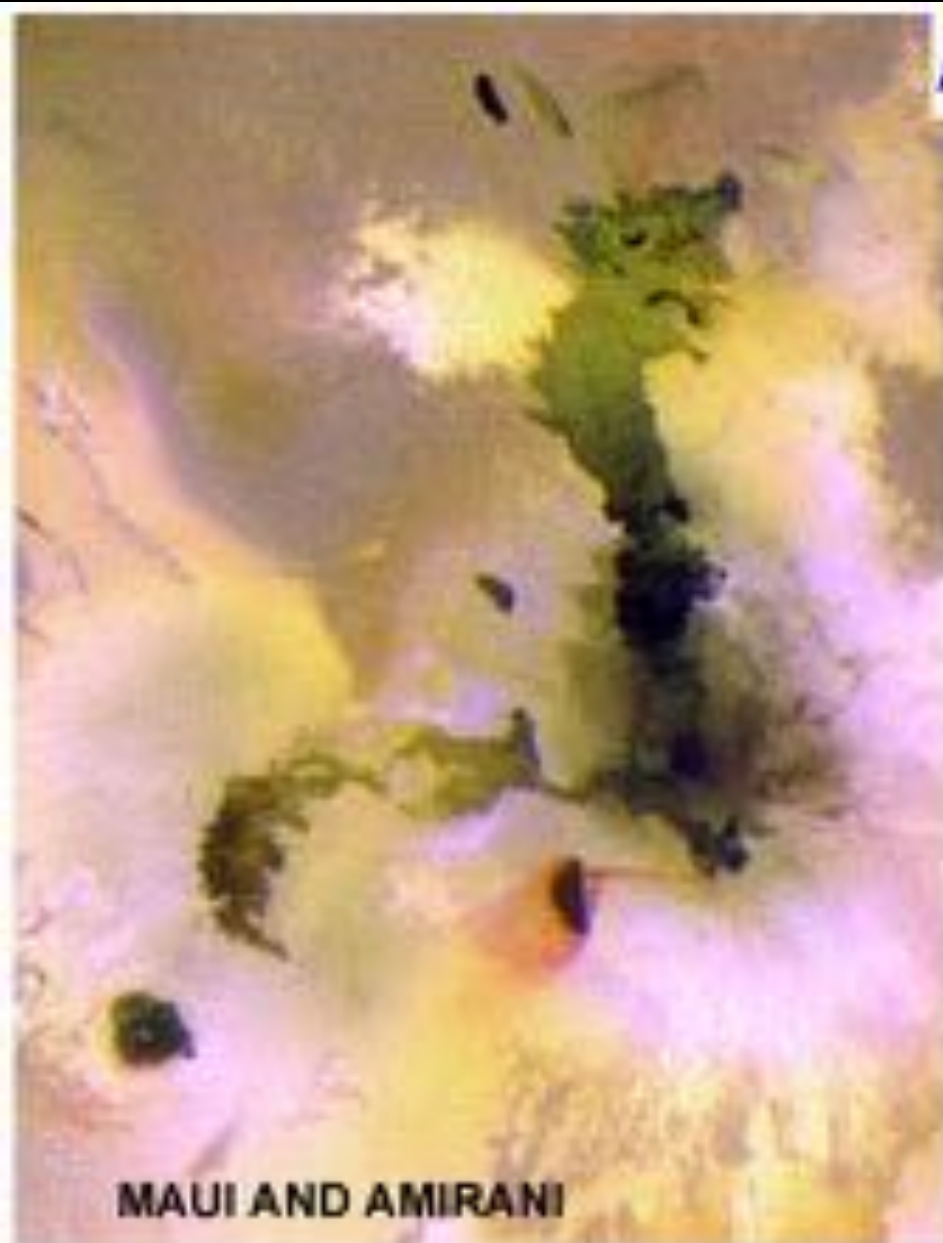




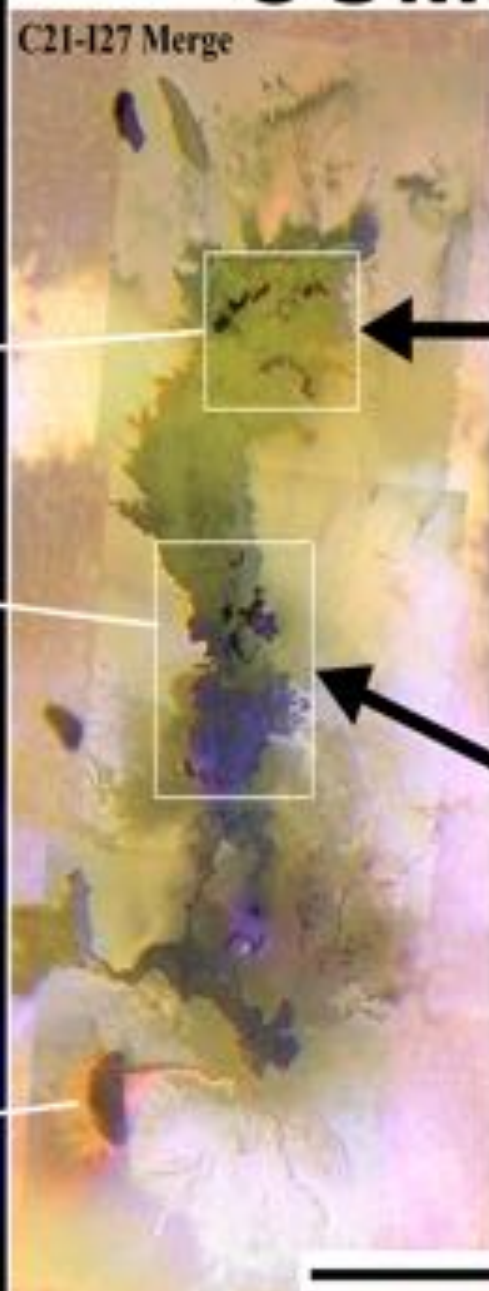
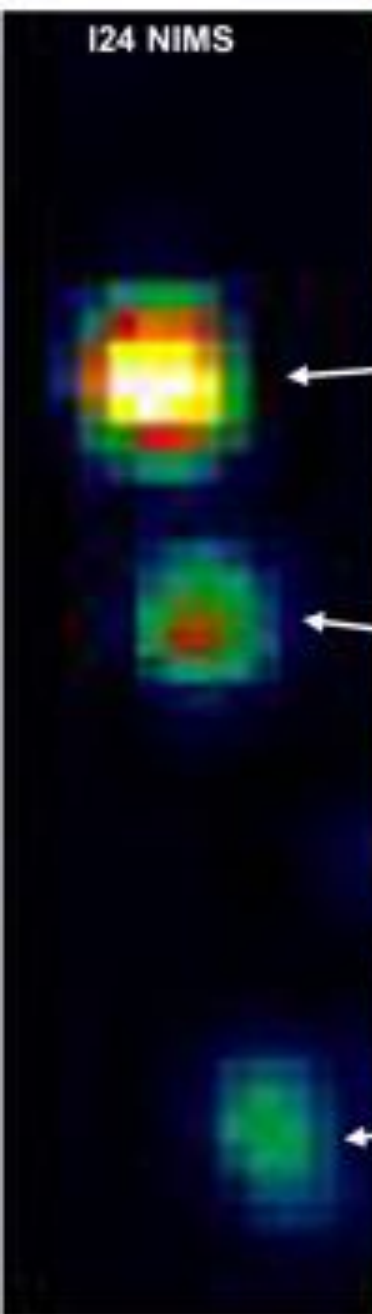
100 km



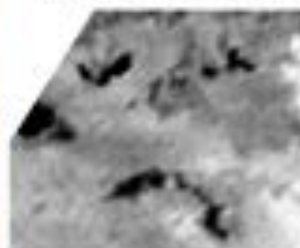
# Amirani-Maui Flowfield



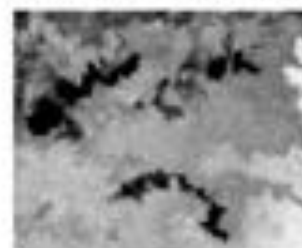
# COMPOUND FLOW FIELD (Amirani)



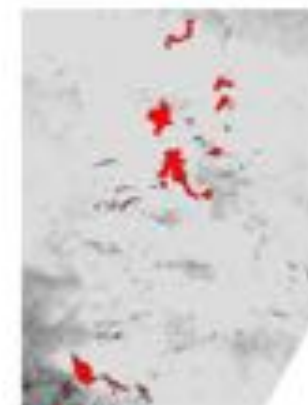
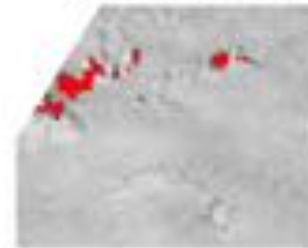
I24  
(October 11, 1999)



I27  
(February 22, 2000)



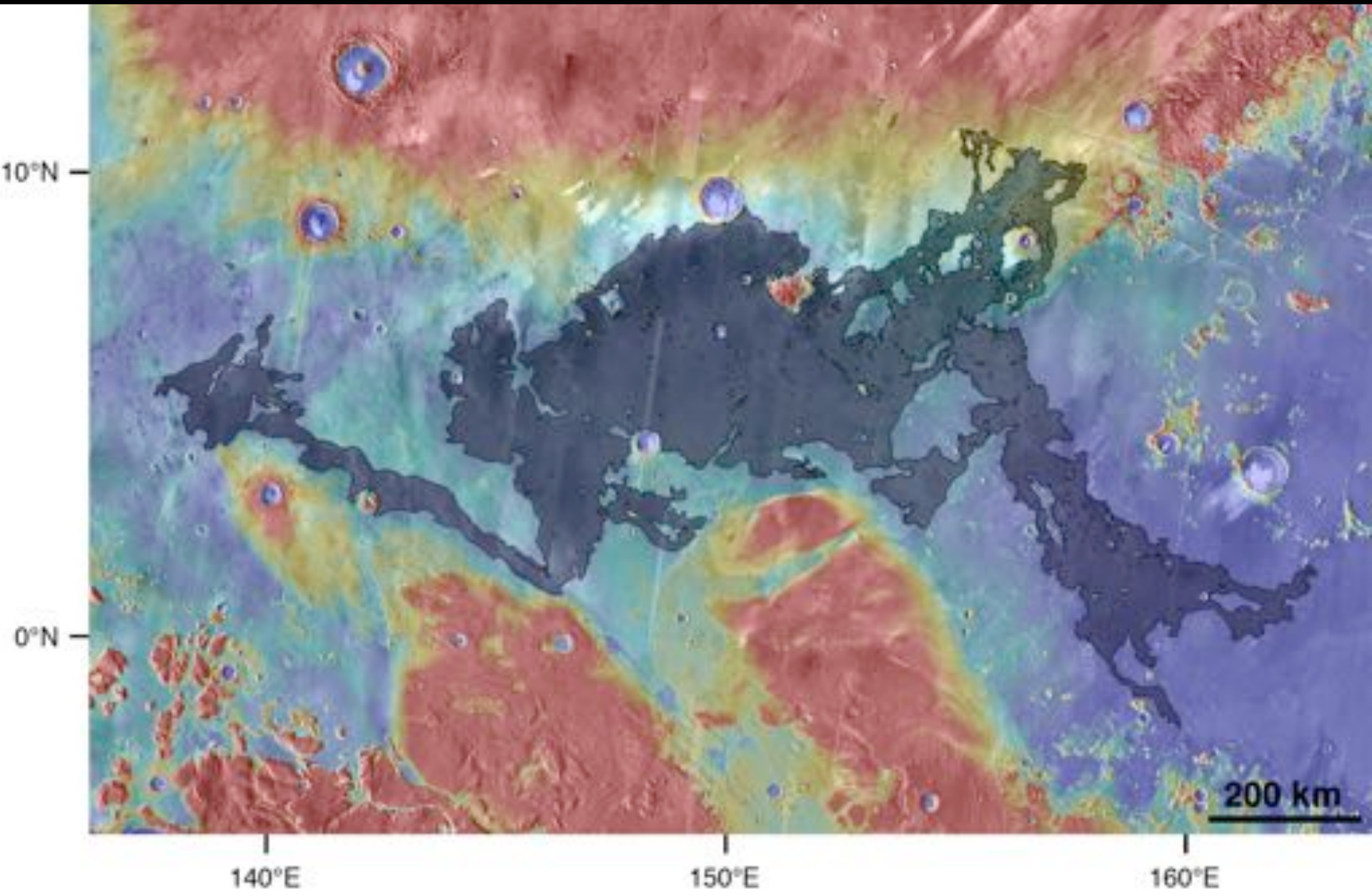
Ratio  
(New Lava Red)



100 km



# Athabasca Valles Flood Lava



# On Io too?

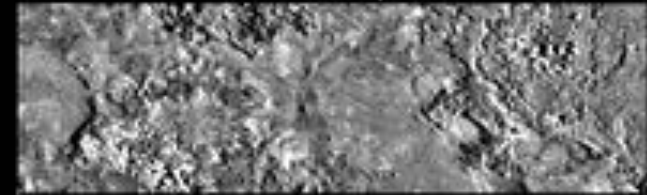
3100 km<sup>2</sup> of lava  
emplaced in 52-167  
days.

$10^3 - 10^4$  times larger  
flux than Kilauea

Isolated high resolution  
image(s) suggest some  
similar textures to Mars

Highest Resolution Image Ever Obtained From Io  
(9 m/pixel)

NASA's *Galileo* Spacecraft, Orbit I24  
October 11, 1999



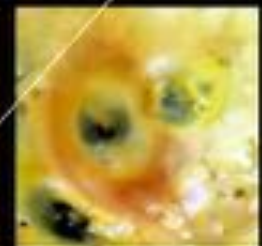
1 km



G7: April 1997



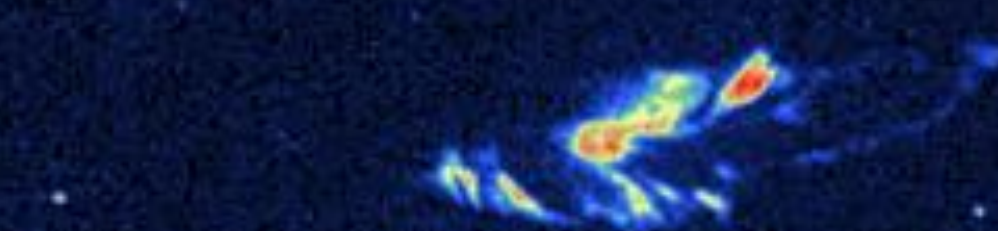
C10: September 1997



O21: July 1999

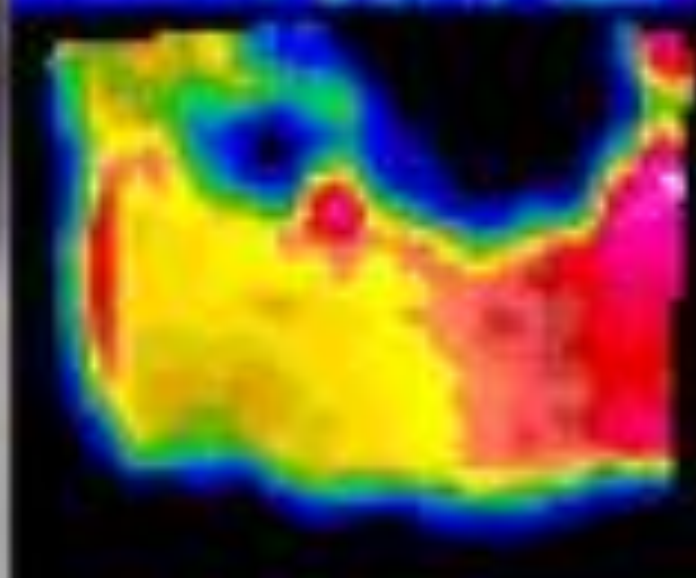
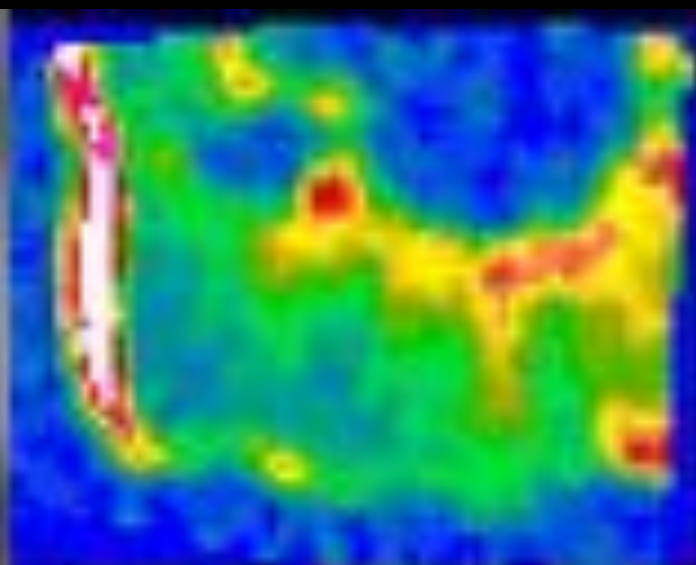
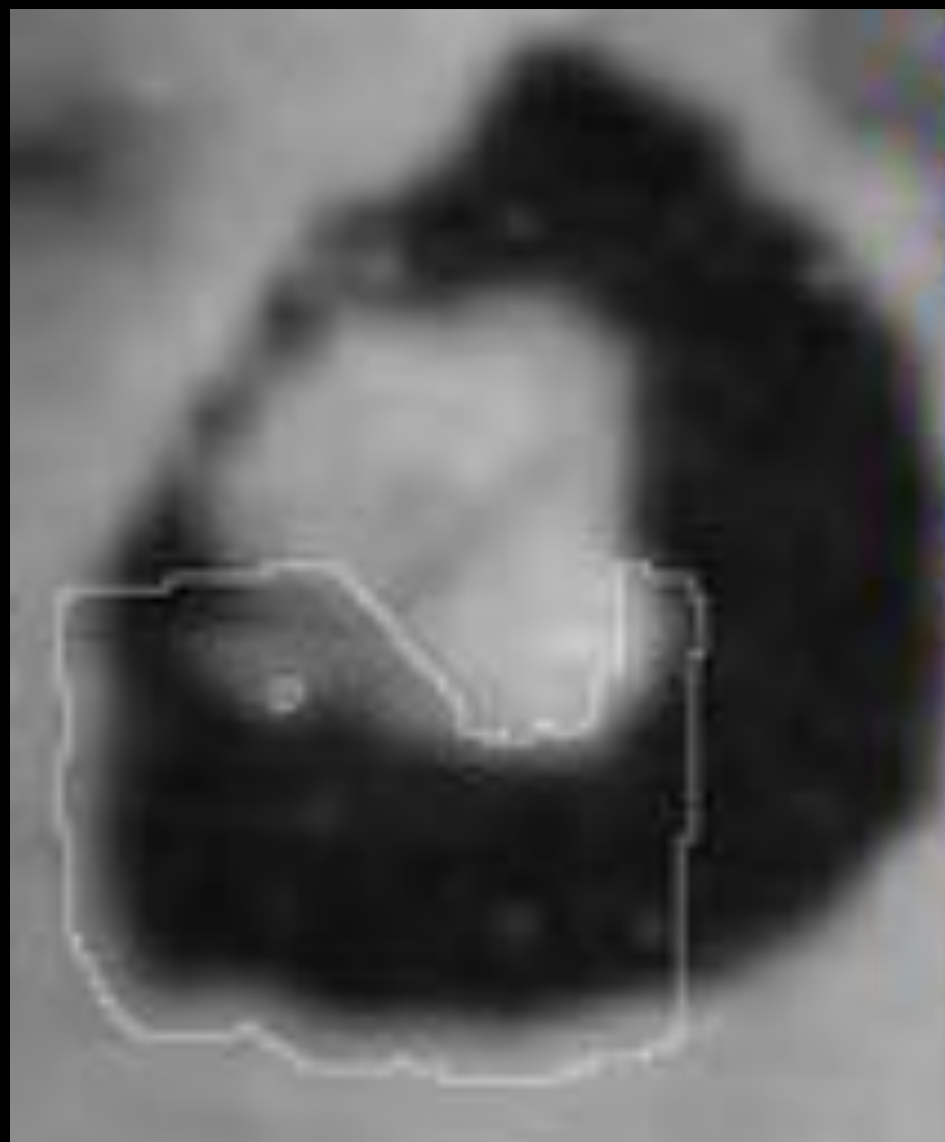


# I32 Pele



30 km

1mc filter brightness

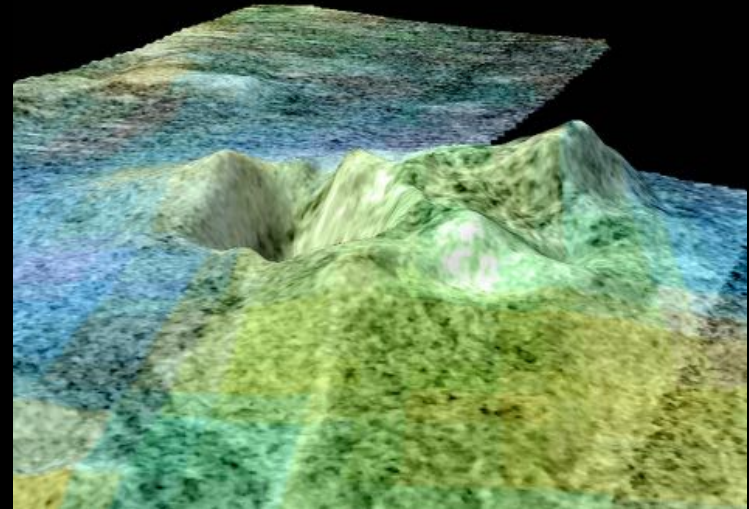
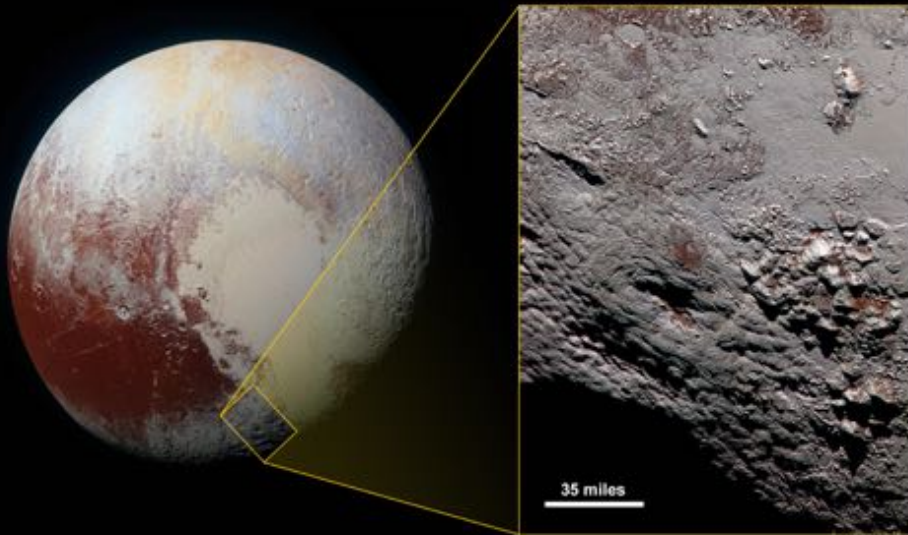
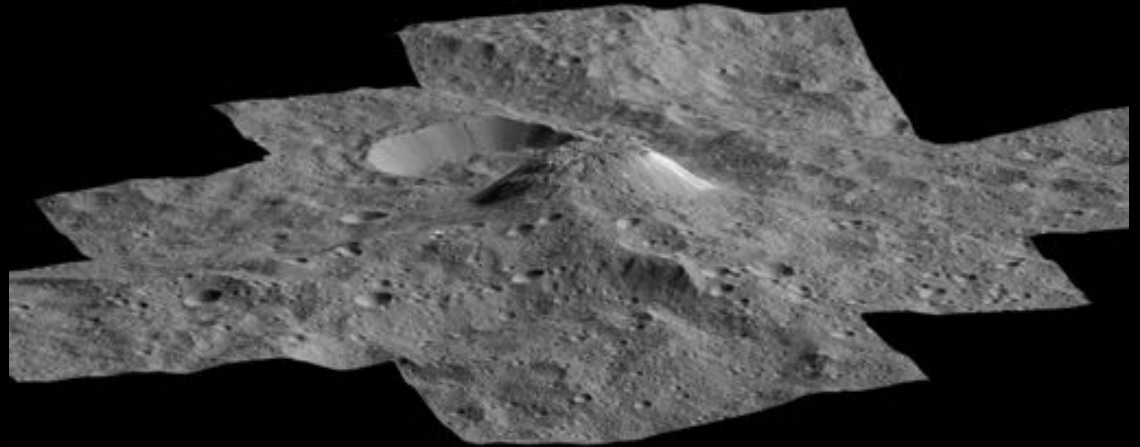




# How do large lava flows form?

- Detailed studies of different planets has led to critical breakthroughs
- Only active lavas provide unambiguous proof of how they were formed
- Io has forms of still poorly understood active volcanism that we have no other place to observe
- New observations of Io have great value

# Are these cryovolcanoes?



**This is cryovolcanism – active!**





**This is also active cryovolcanism**





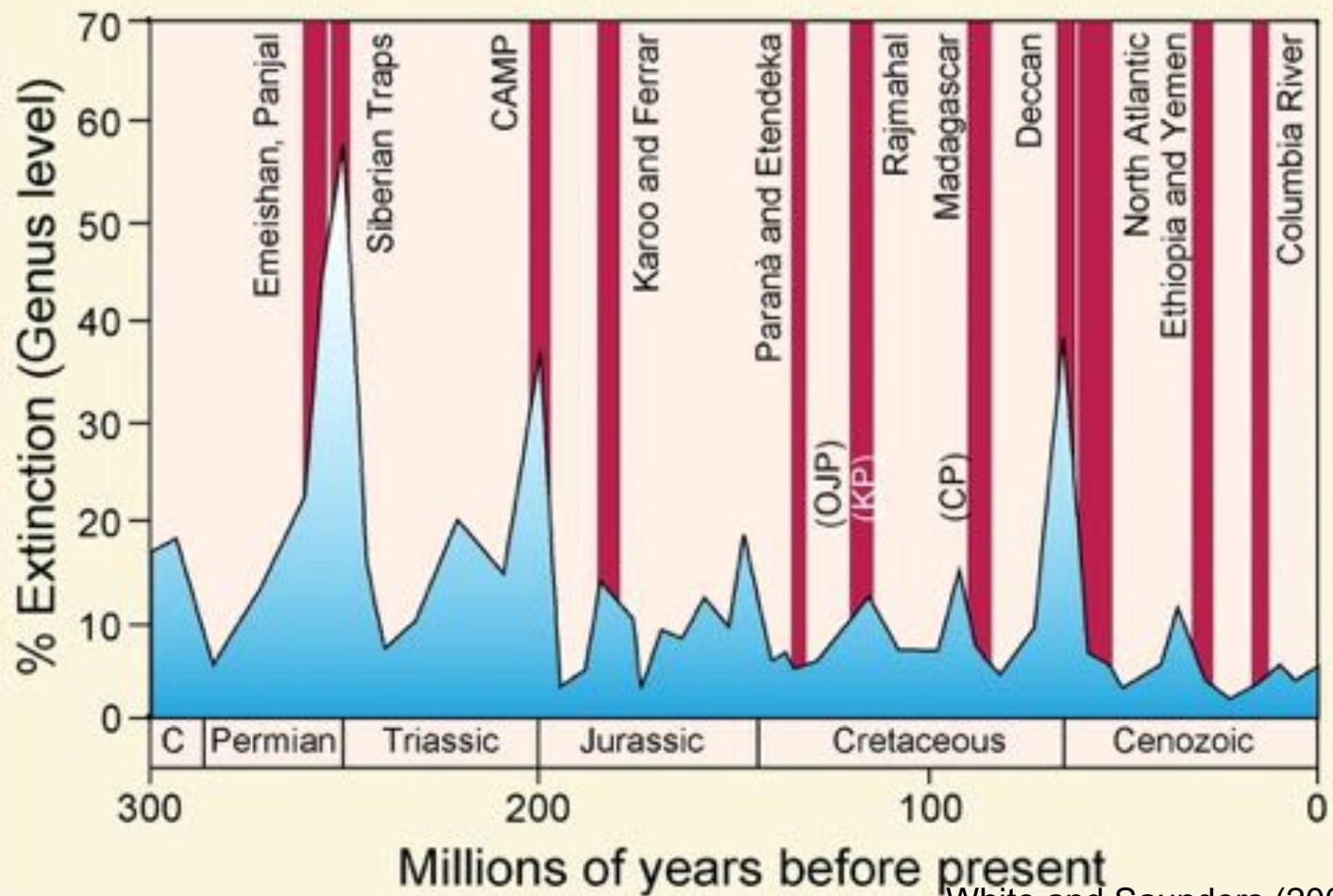
# What does cryovolcanism look like?

- Cryovolcanism is so alien that we need to see it active
- Io is the only certain place to see active effusive cryovolcanism (but its not water)

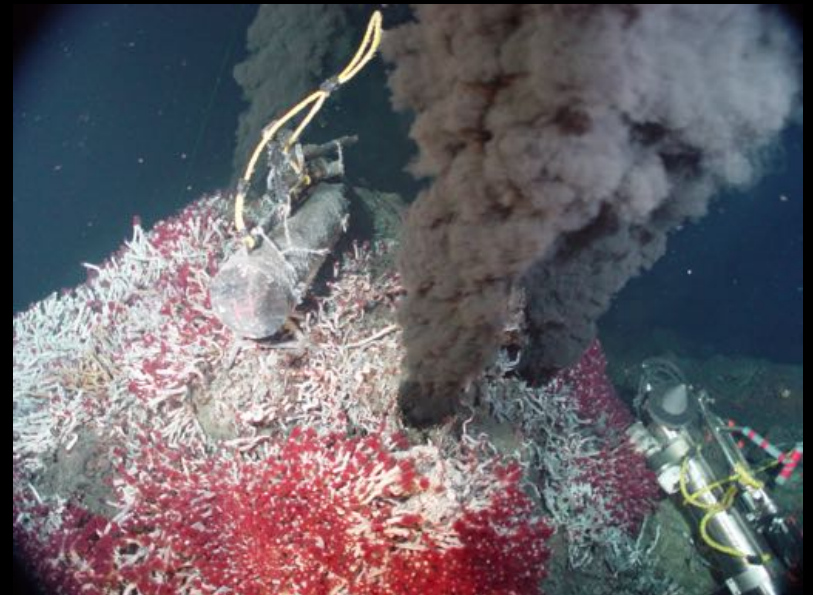
# Volcanism and Life

- Volcanism is associated with mass extinctions
- Volcanism creates habitable environments
- In the Galilean system, the history of volcanism is the history of tidal heating...

# Volcanism and Mass Extinctions



# Volcanism and Habitability



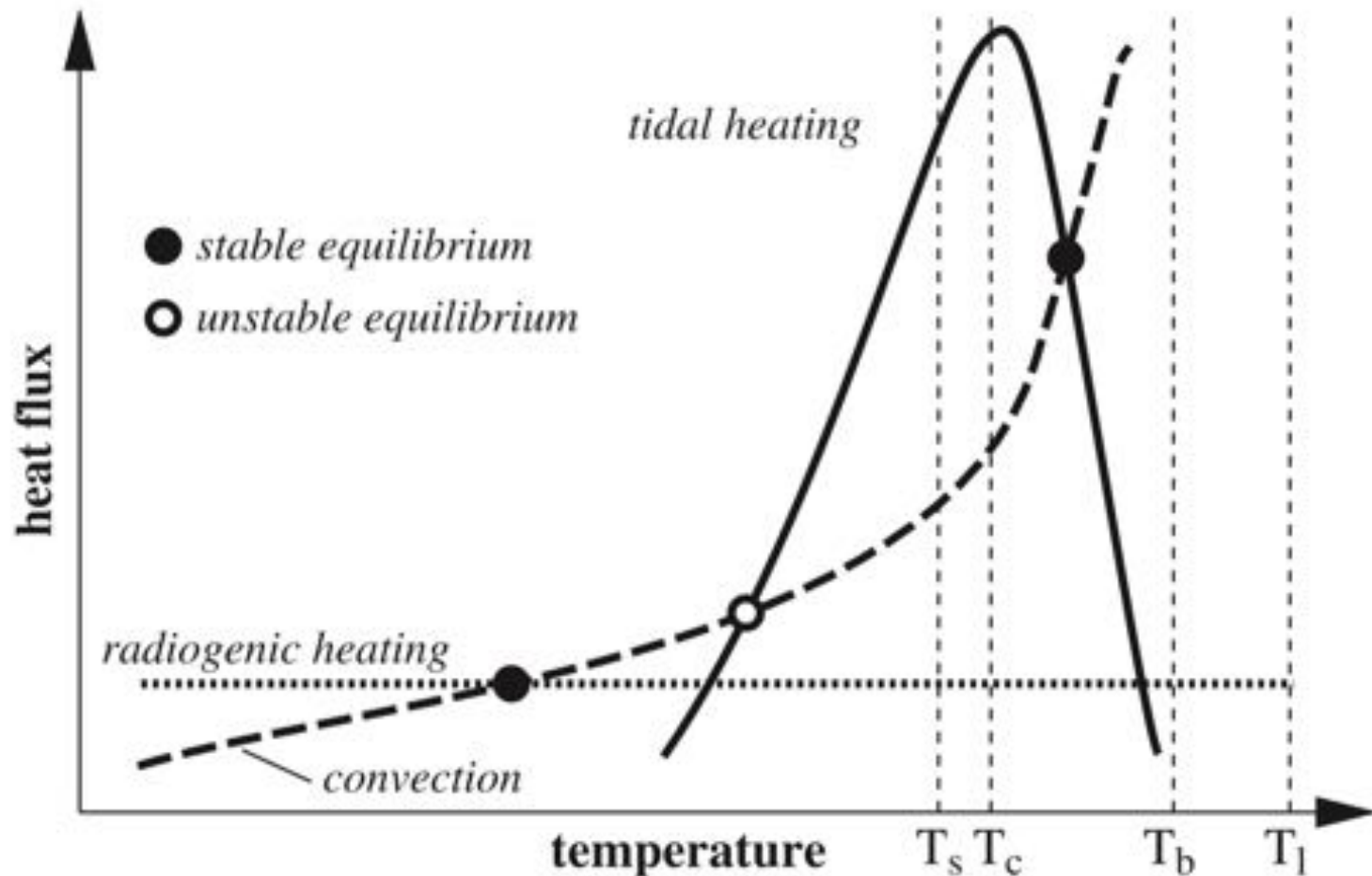


# Tidal Heating – Io's Story

- **Io's current heat flux can only have existed for a fraction of the age of the Solar System**
  - Galilean satellites entered resonance recently
  - Significant tidal heating only occurs episodically for geologically short periods (Ojakangas and Stevenson, 1986)

# Episodic Heating Does Not Work

Moore (2003)

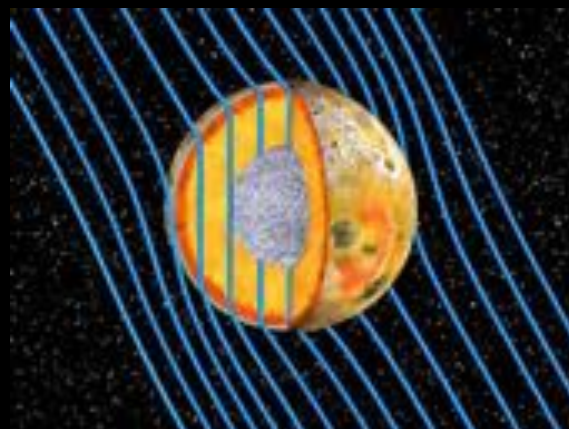


# Conclusion: Io Cannot Exist!



# Conclusion: We need to study Io more in order to understand

- Tidal heating
- Habitability in the Jovian system
- Volcanism across the Solar System



- Io is an “ocean” world too!

