Ménec Fossae and Thrace Macula on Europa: Hints for Shallow Water Pockets and Identification of the Youngest Terrains

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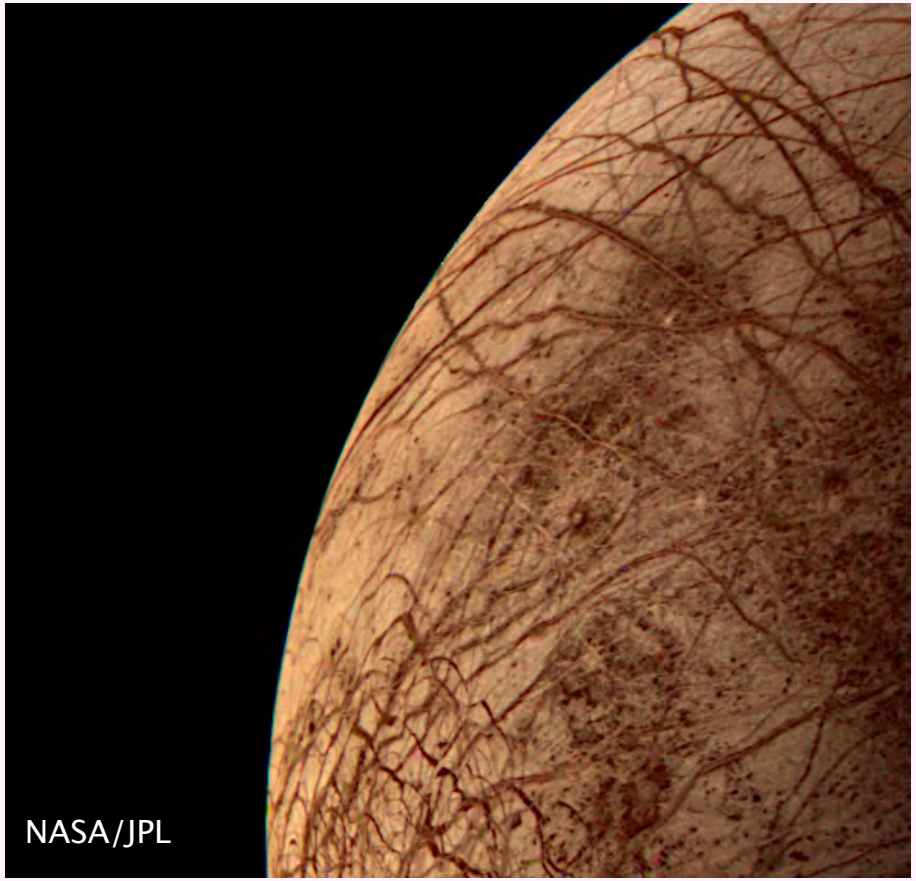
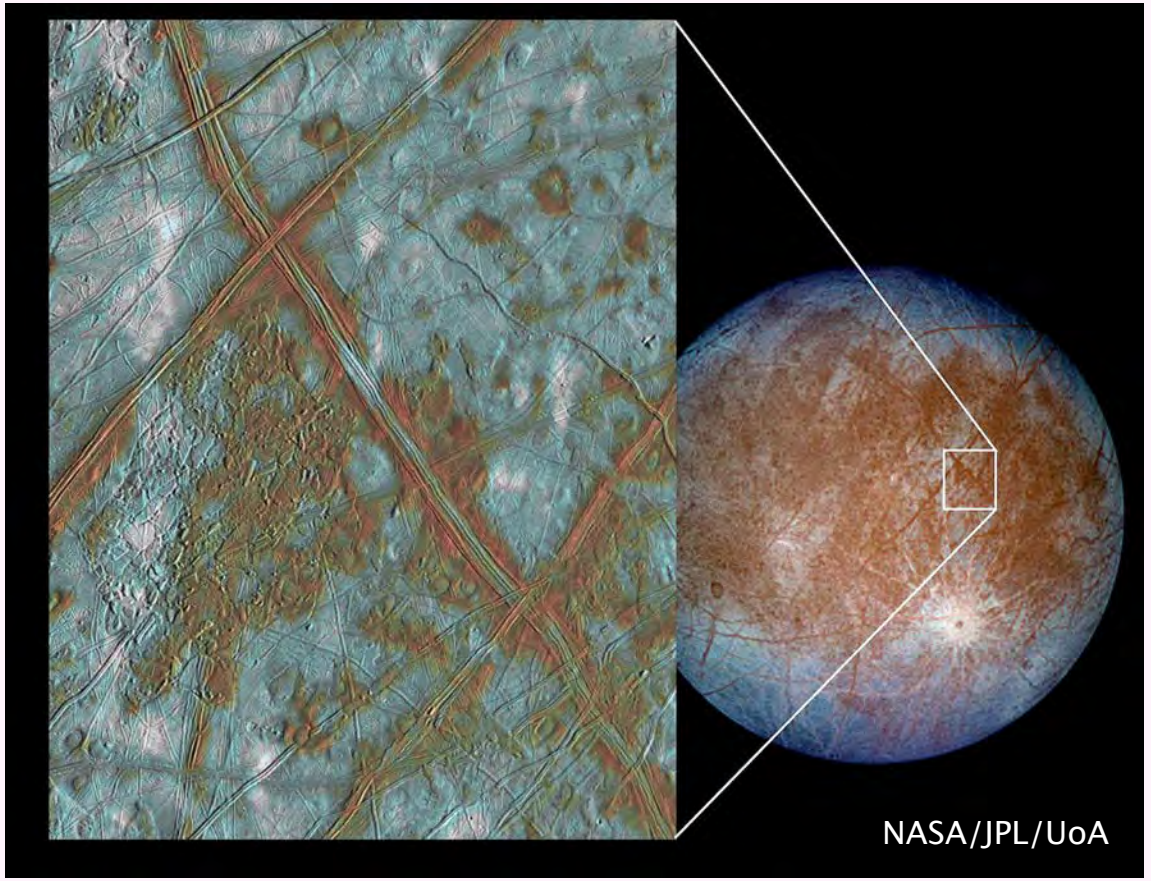
Europa – An Ocean World: Overview
Past Space Missions

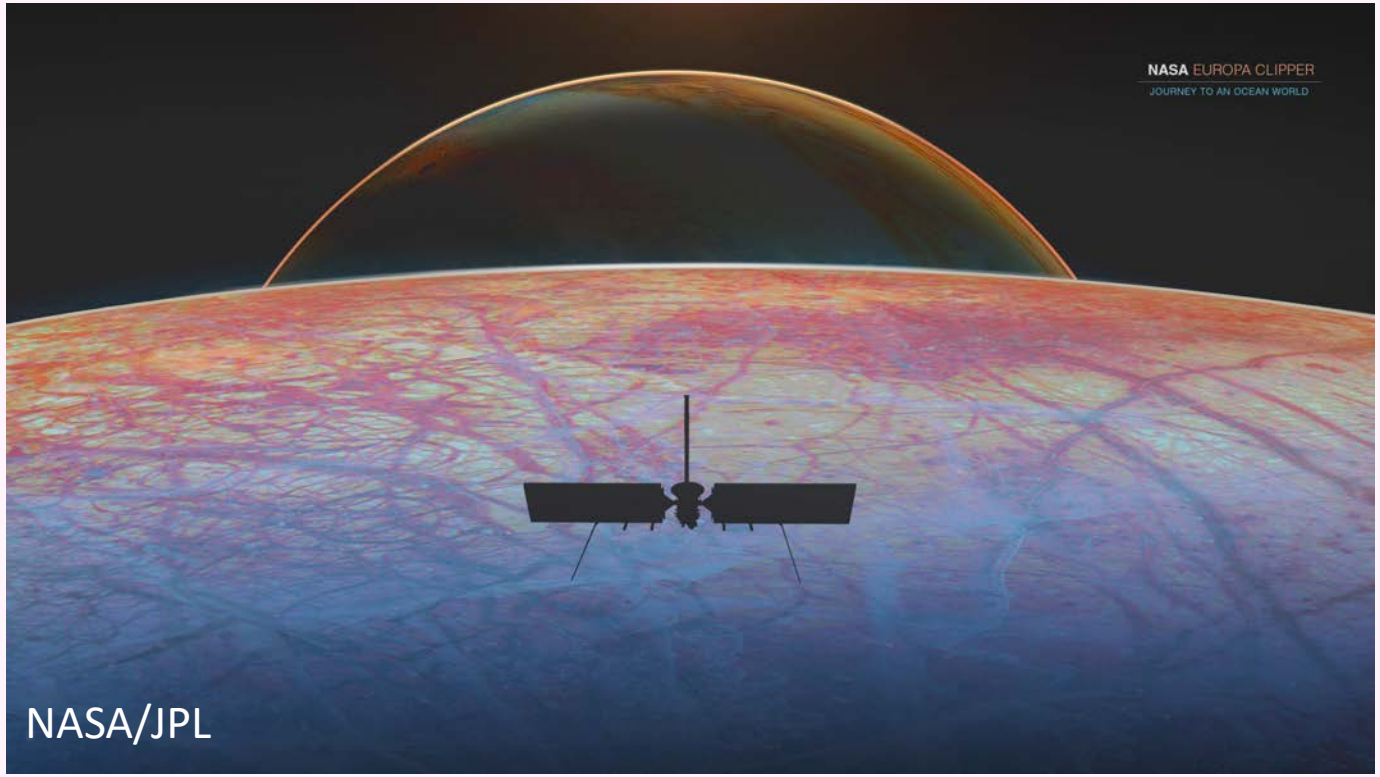


1979
Voyager missions
(NASA)



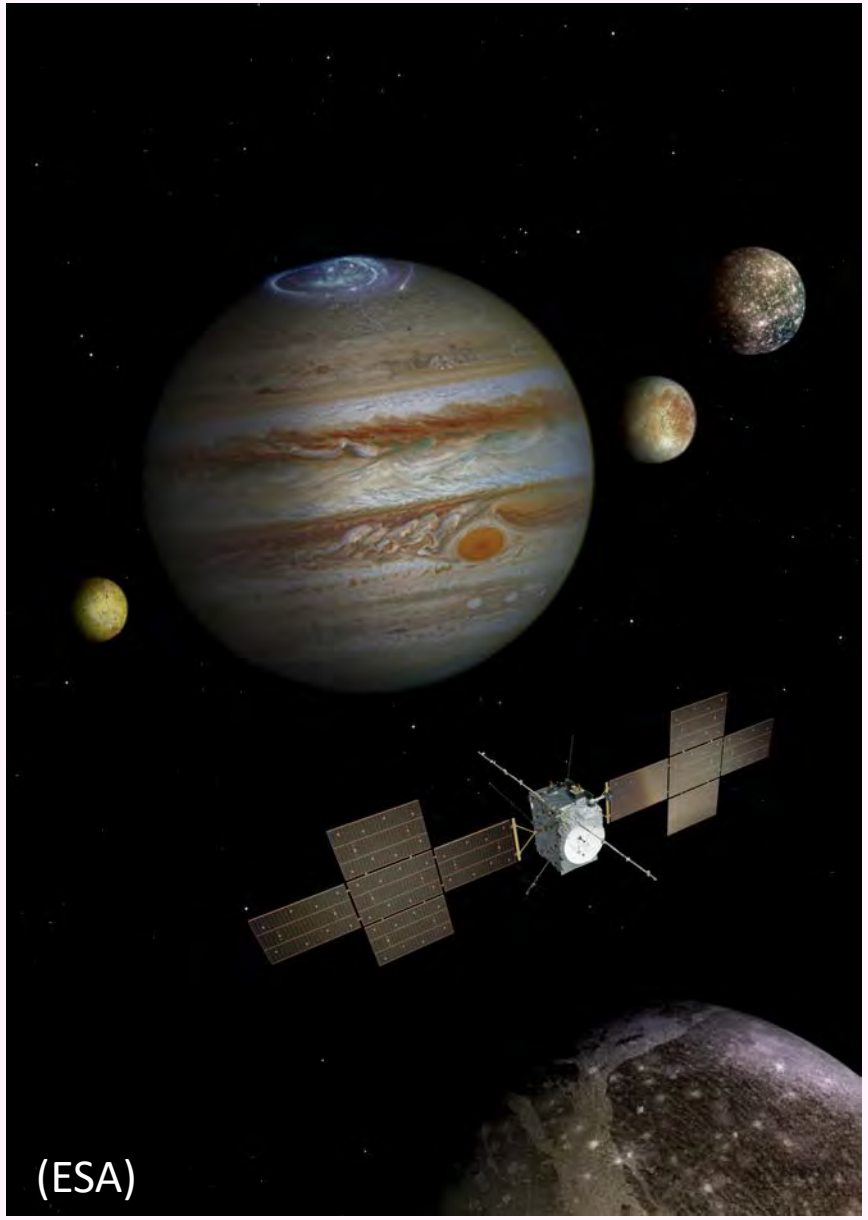
1995-2003
Galileo mission ⟶ Data we use!
(NASA)

Europa – An Ocean World: Overview
Upcoming Space Missions

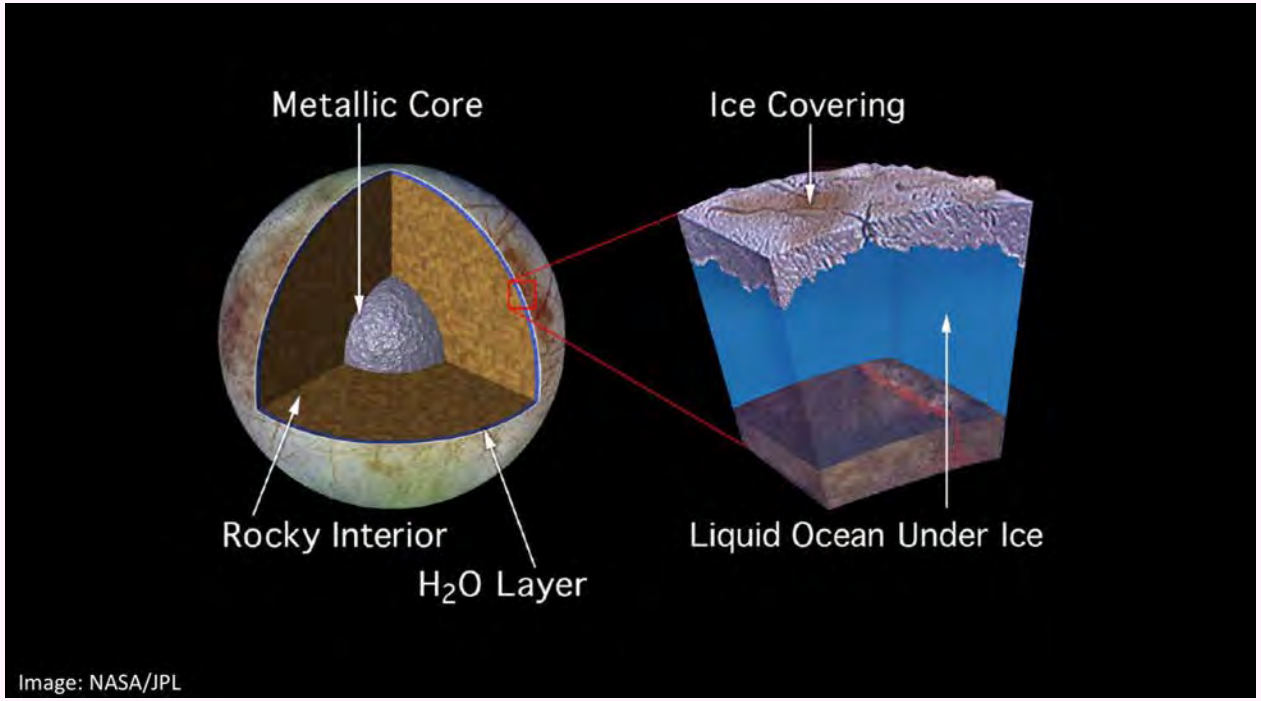


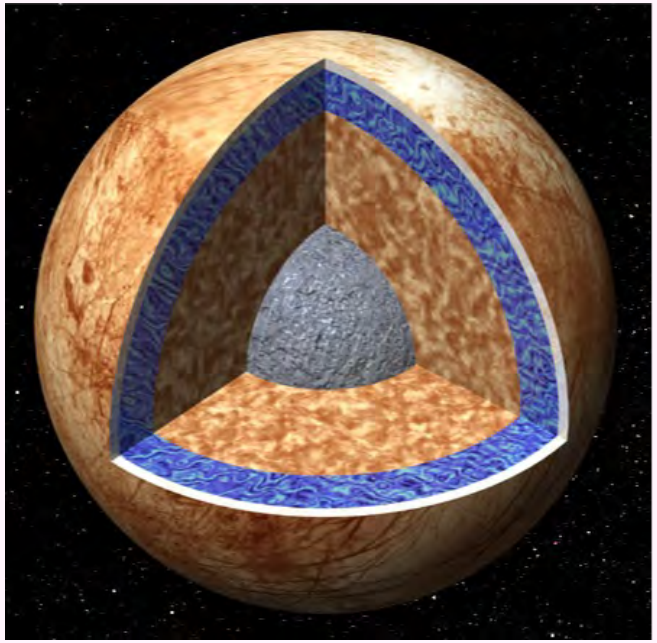
Launch: 2024
Arrival: 2030
Europa Clipper (NASA)

Launch: April 2023
Arrival: 2030
JUpiter ICy moons Explorer – JUICE (ESA)



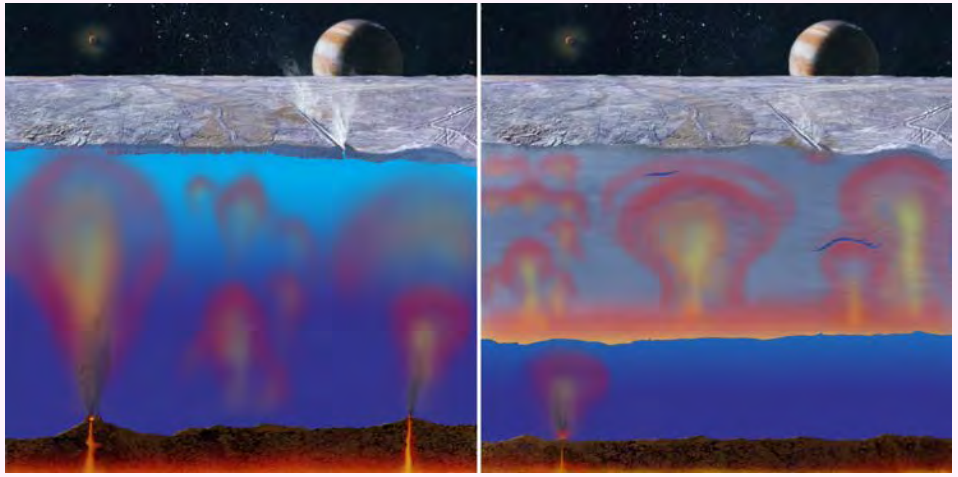
Europa – An Ocean World: Overview
Interior Structure



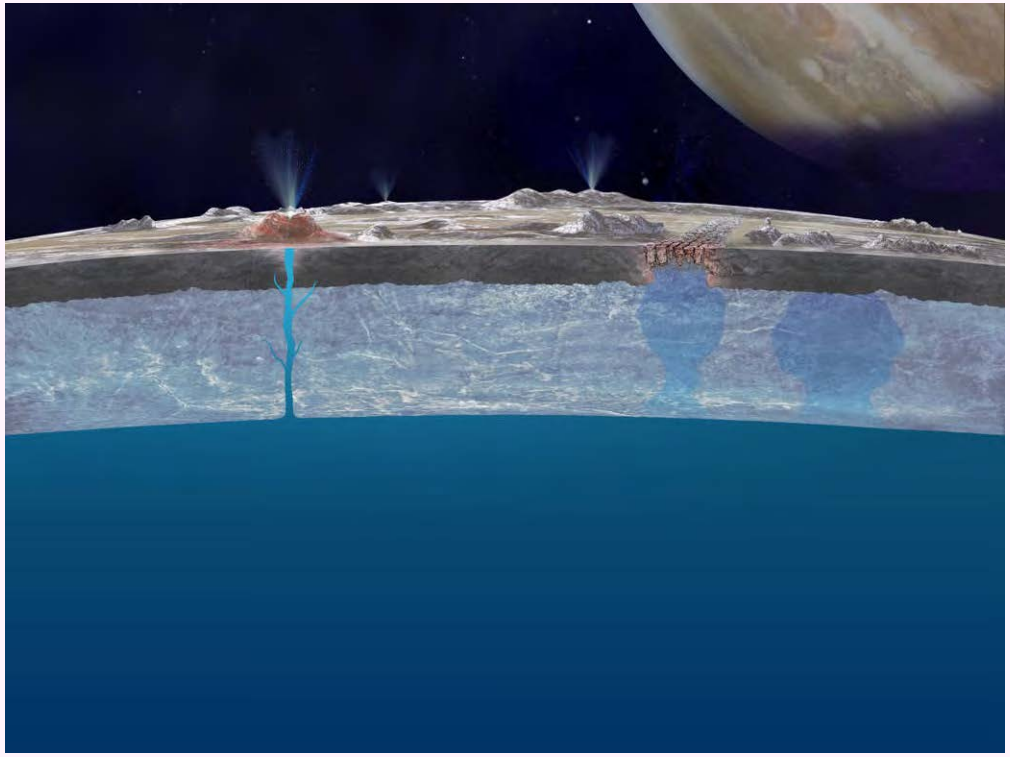


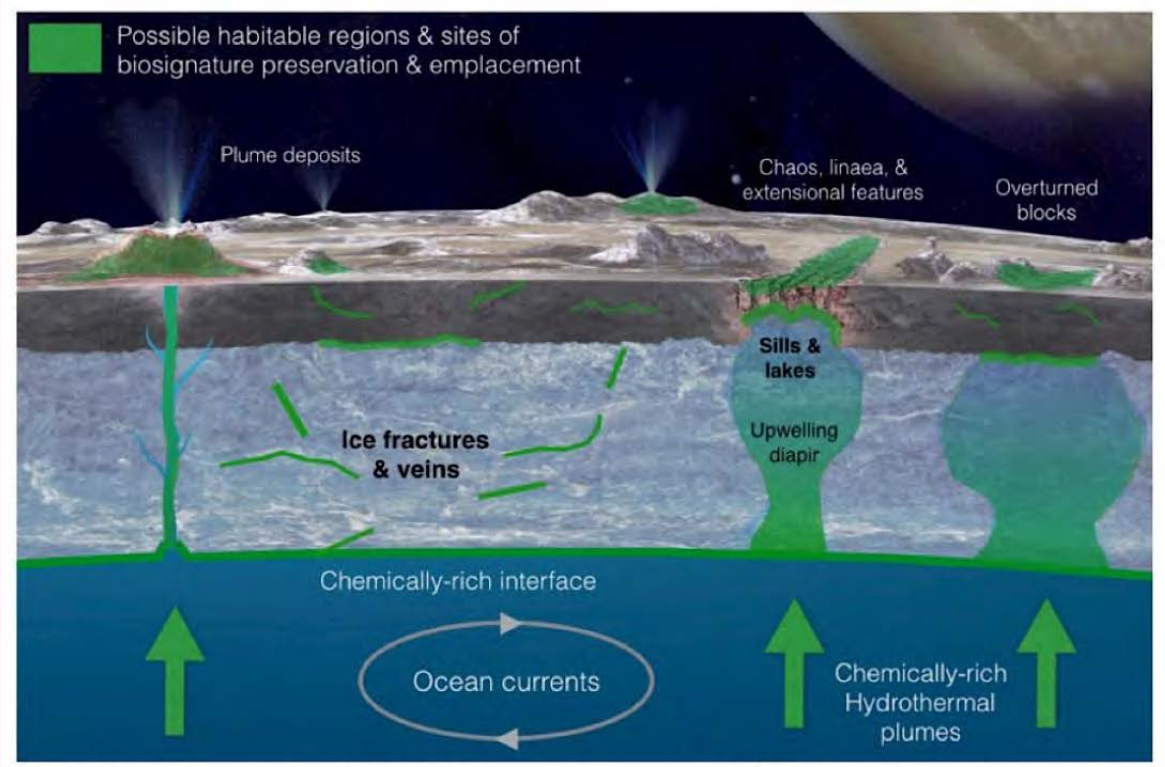
NASA/JPL

Thickness and **Structure** of **Ice Shell** is unclear



Possible Exchange Processes
Emplacement of biosignatures





Hand et al., 2017

If **biosignatures** are produced **within Europa's ocean**
they will need to **reach the surface** to be **detected by space missions**

Introduction and background – Shallow water pockets

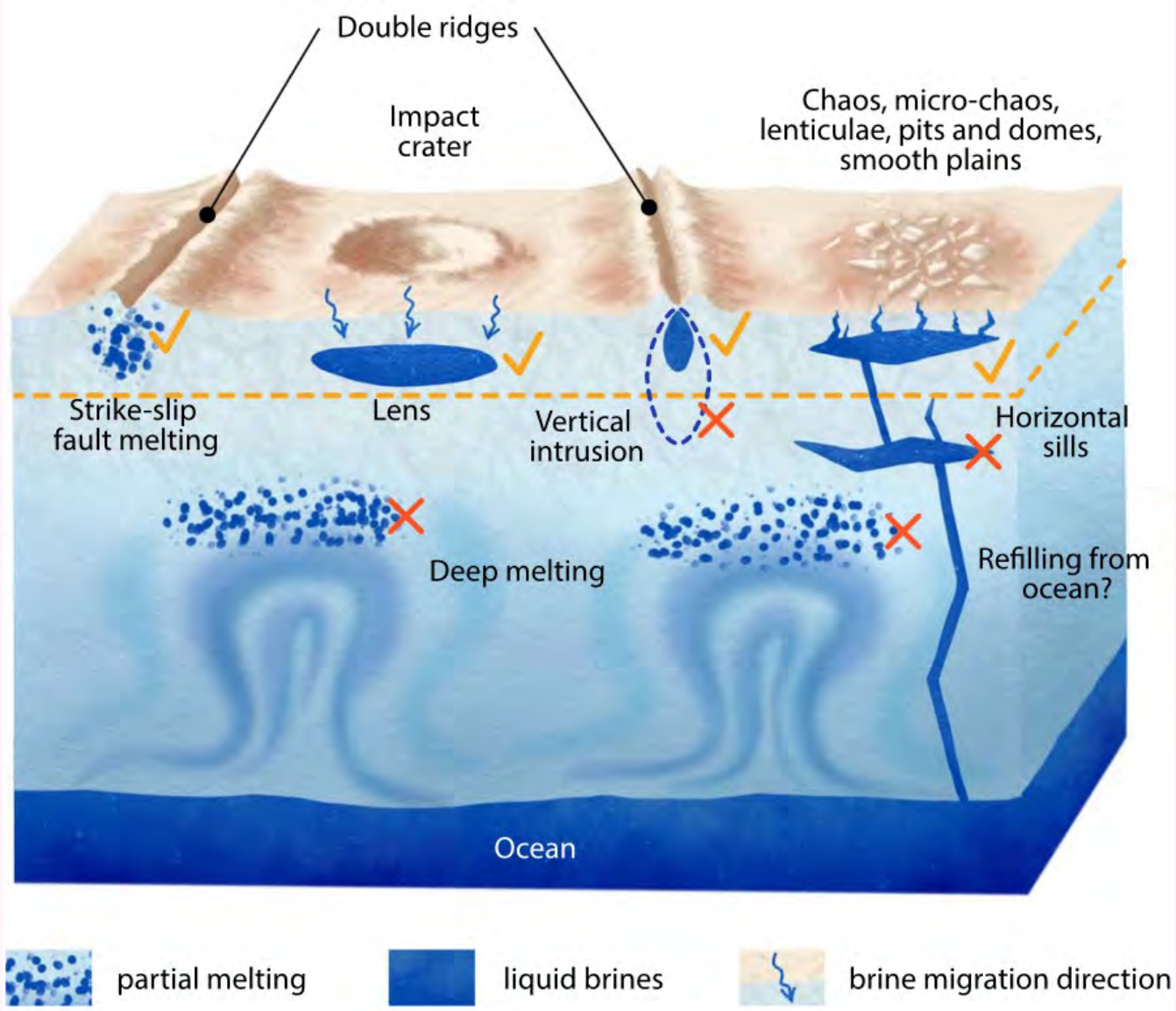
- **Fractures** directly **connecting ocean to surface** are <u>unlikely</u>

↓

- **Shallow water pockets:** critical for **habitability**
  - Have been **associated with** different **surface features**

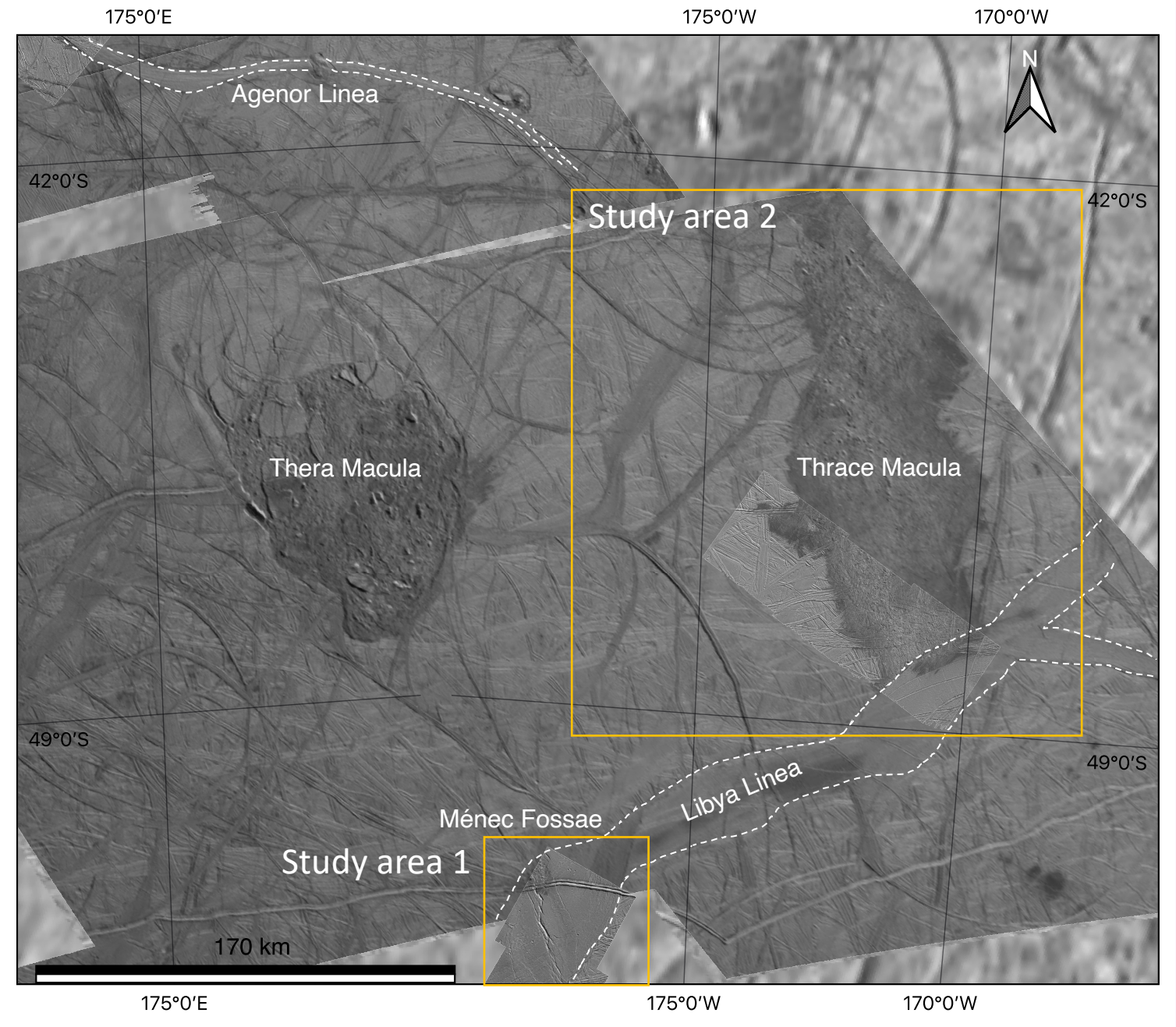
- **Material** from the **ocean** or from **shallow water pockets** can be emplaced on the surface

  → Through **tectonics cracks**



Lesage et al. (2022)

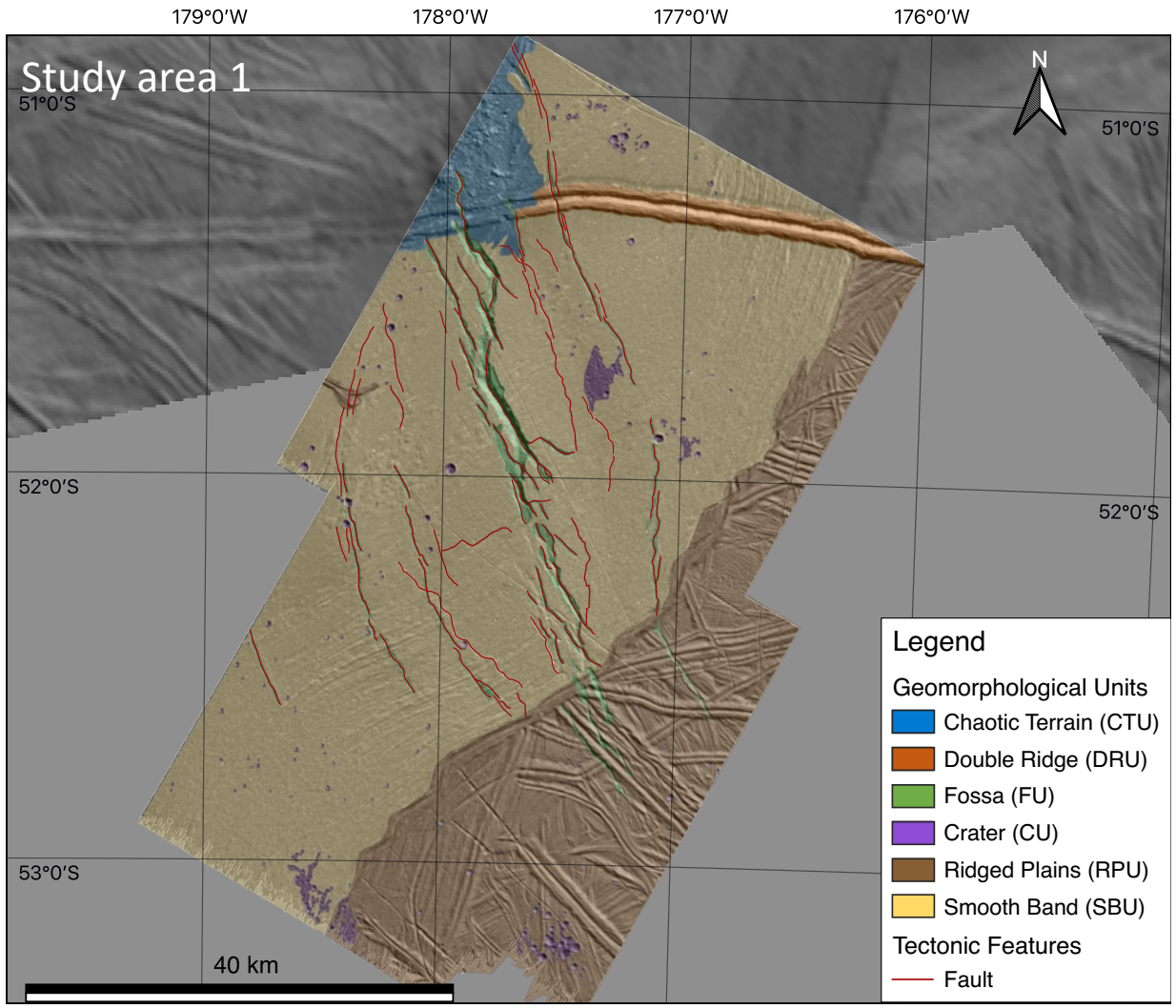
Ménec Fossae and Thrace Macula – Large scale view

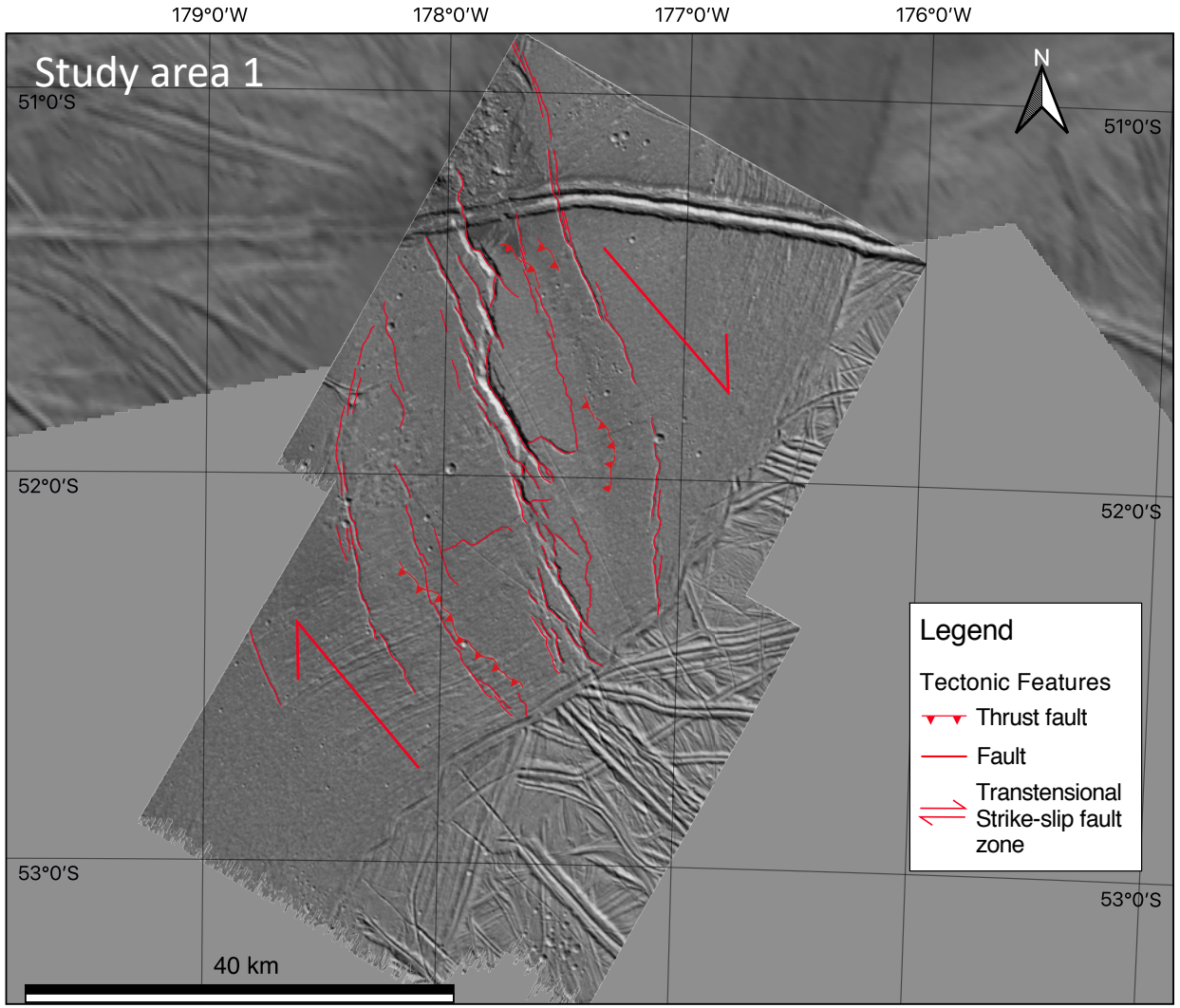


Ménec Fossae - General characteristics

Ménec Fossae displays in a small area **different features** likely related to the **subsurface**

We propose that **Ménec Fossae** has been shaped by **tectonic activity**

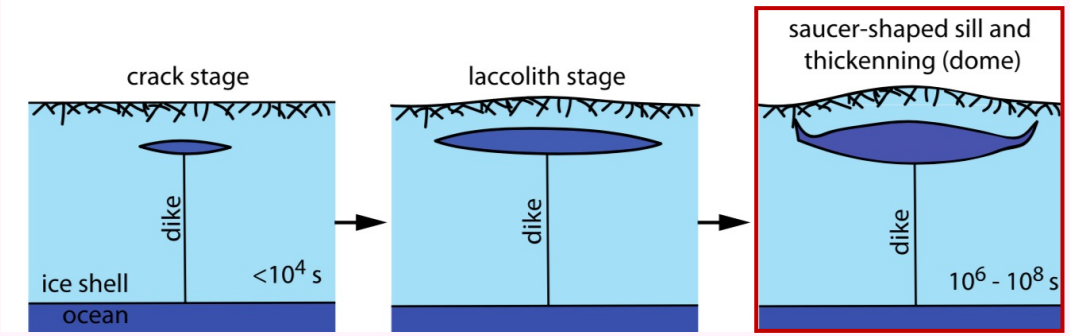




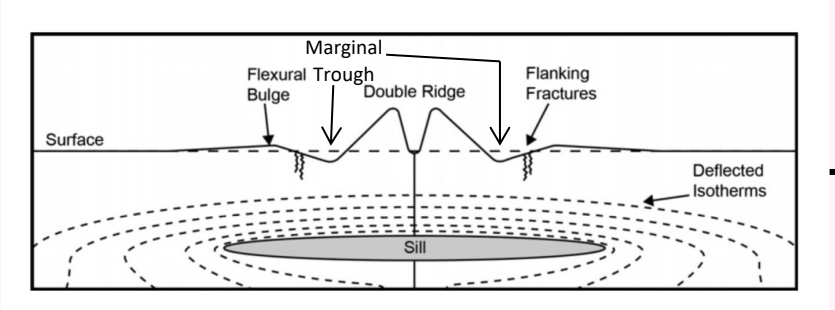
Matteoni et al. (2023a)

Implications for shallow water
Ménec Fossae

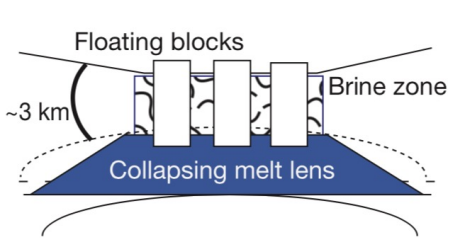
- **Tectonic activity** likely **associated with a shallow water pocket** in the ice shell



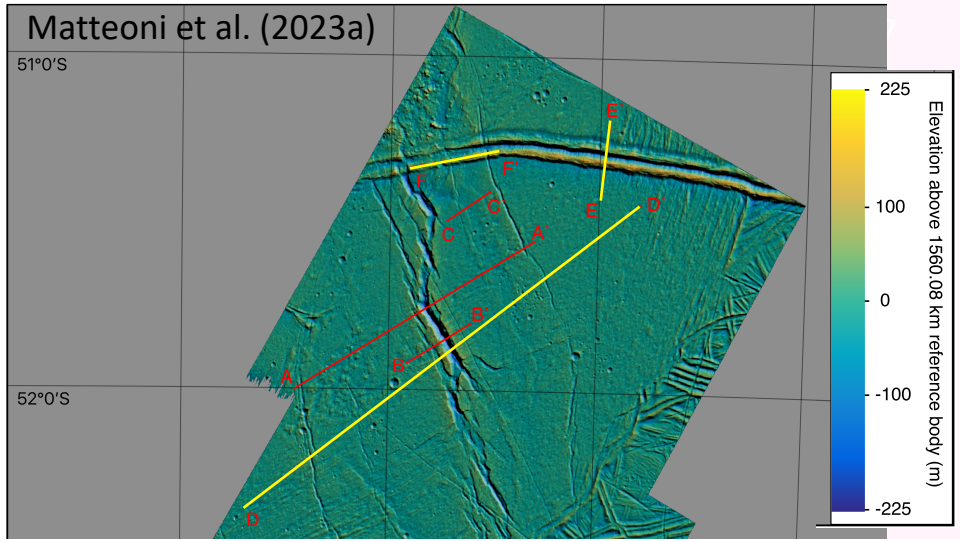
Manga & Michaut (2017)

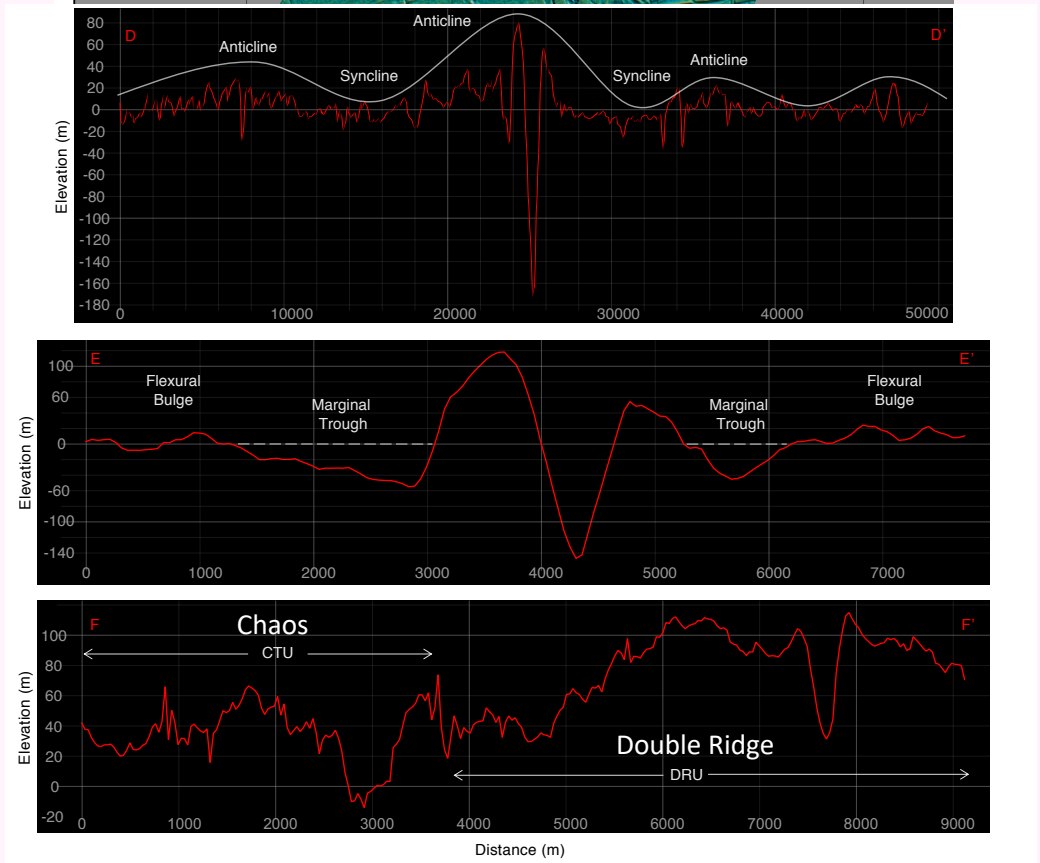


Dombard et al. (2013)



Schmidt et al. (2011)

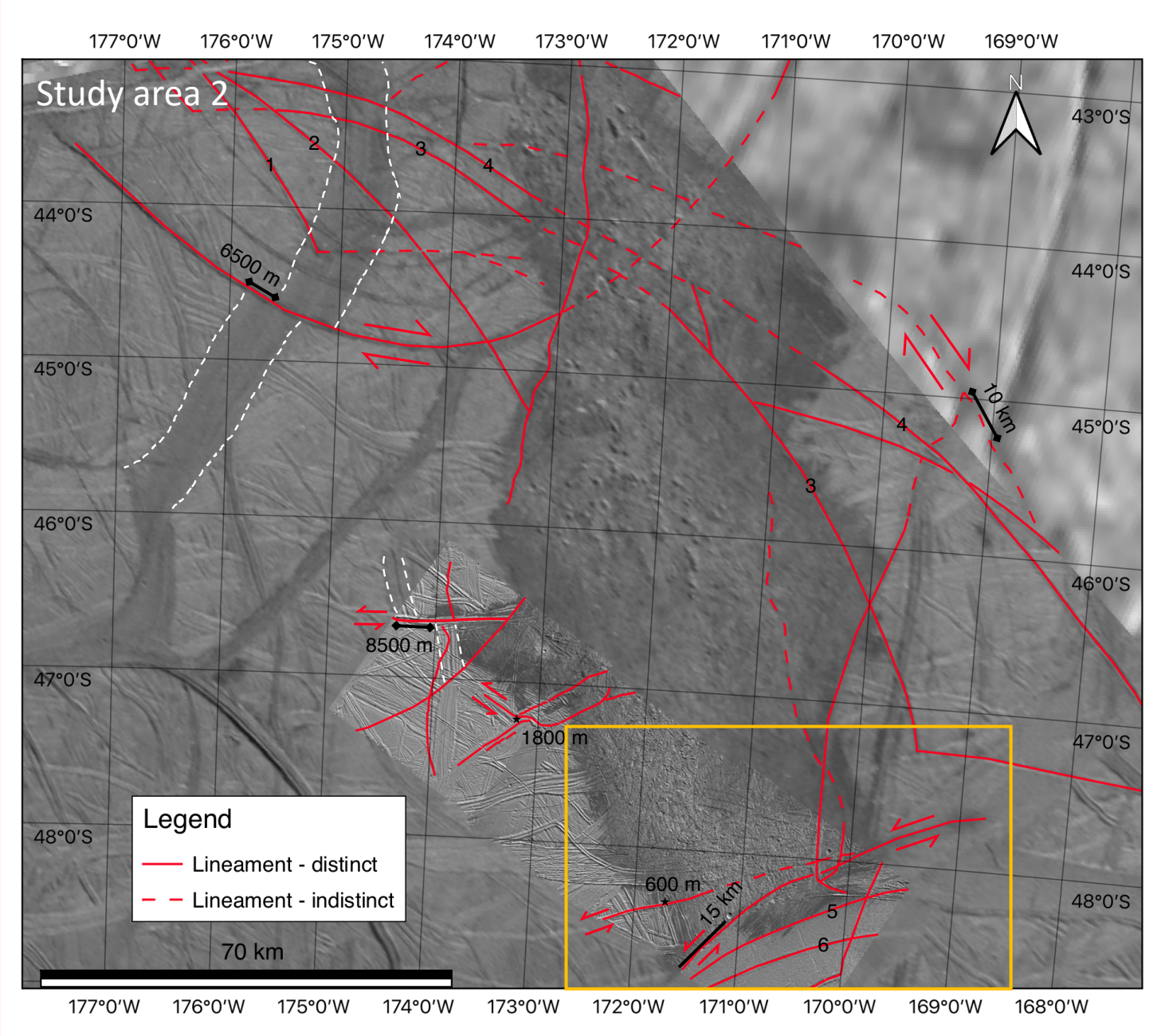




Thrace Macula – General characteristics

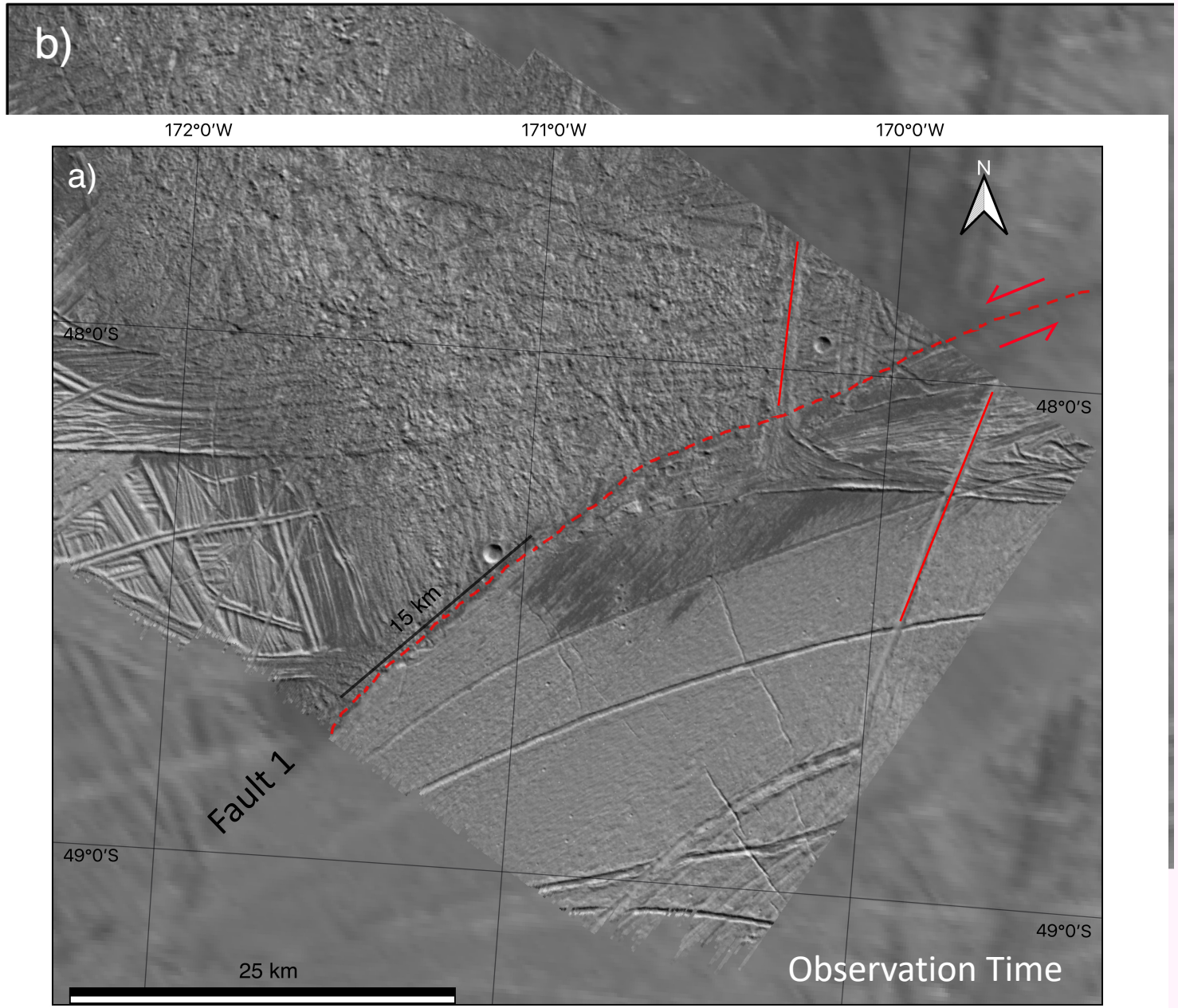
- Known to be a **young terrain**
- Known **presence** of **material** originating from **Europa's interior**
  - **Prime target** to investigate **astrobiological potential** of Europa

→ **One *JUICE* and two *Europa Clipper* fly-overs planned** over it



Thrace Macula Libya Linea contact - Reconstruction of geological setting

Tectonic fault
at the contact
(Fault 1)



Matteoni et al. (2023b)

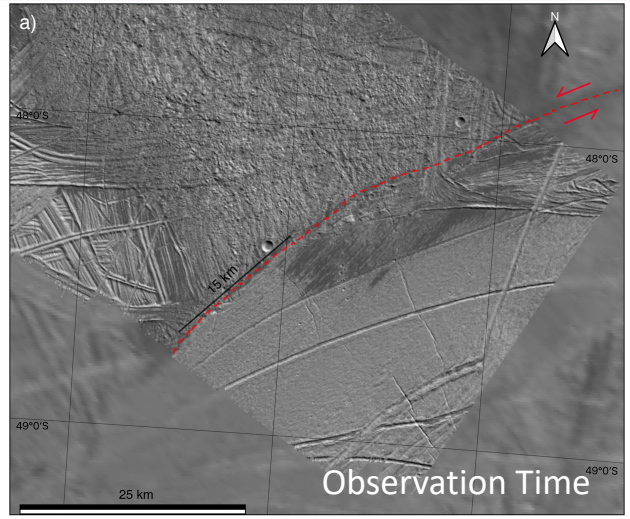
Thrace Macula - Identification of the youngest terrains

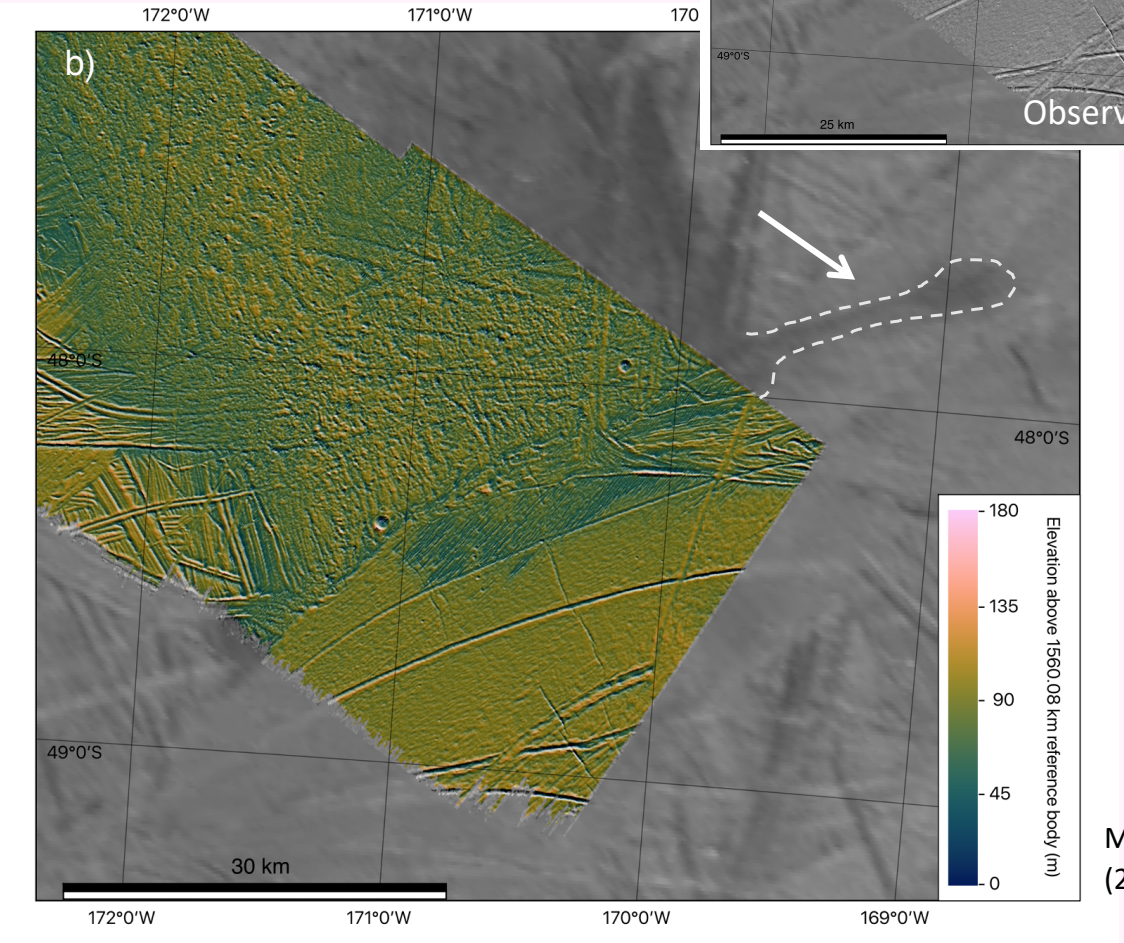
- **Faults formed after Thrace** (such as **Fault 1**)

  → **Conduits** for fluids

  - **Deep material** from **Thrace** can infiltrate along them and **emplace on the surface**
  - **Surface material** needs to be **young** to be **astrobiologically relevant** – rest is altered by radiations from Jupiter

→ **We identified Thrace's youngest material** to be **encountered and sampled** by *JUICE* and *Europa Clipper* in this area





Matteoni et al. (2023b)

Summary

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- Our findings on **Ménec Fossae** and **Thrace Macula:**

  1. Suggest the **presence of a shallow water pocket** and have implications for **Europa's ice shell structure** (for **Ménec Fossae**)
  2. Lead to identify the **youngest and most astrobiologically-relevant terrains in the area** (for **Thrace Macula**)

JGR Planets
RESEARCH ARTICLE
10.1029/2022JE007623
Key Points:

Ménec Fossae on Europa: A Strike-Slip Tectonics Origin Above a Possible Shallow Water Reservoir

Pietro Matteoni[1], Alicia Neesemann[1], Ralf Jaumann[1], Jon Hillier[1], and Frank Postberg[1]

Scan me to access this paper

JGR Planets
RESEARCH ARTICLE
10.1029/2023JE007905
Key Points:

Evolution of Thrace Macula on Europa: Strike-Slip Tectonic Control and Identification of the Youngest Terrains

Pietro Matteoni[1], Alicia Neesemann[1], Ralf Jaumann[1], Jon Hillier[1], and Frank Postberg[1]

...And me for this one