Accretionary complexes: Recorders on Earth and possibly Mars

James Dohm and S. Maruyama
ELSI, Titech, Japan

Contents

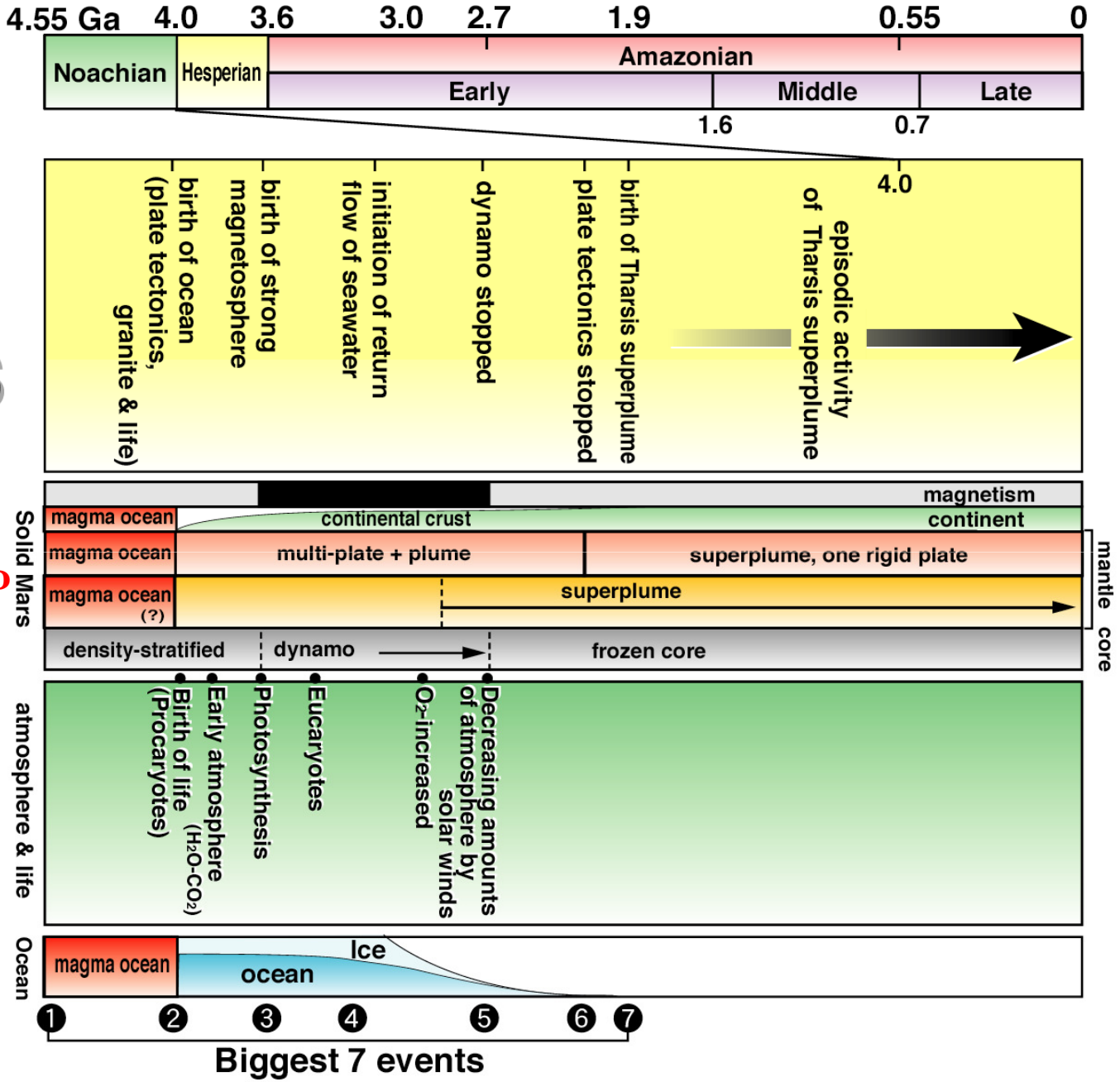
- 1 Debate on Mars; Plate Tectonics (PT) was present or not?
- 2 How to demonstrate PT on Mars.
  ANS: Accretionary complex (ACs) and Pacific-type orogen
- 3 Presence of ACs on Mars (cf. SW Japan)
- 4 Presence of olistostrome? (cf. Wales, UK)
- 5 Next step to demonstrate and conclusions

1. Debate on Mars

Plate Tectonics was present or not?

History of Mars

From multi-plates to one plate planet



2 How to demonstrate PT on Mars?

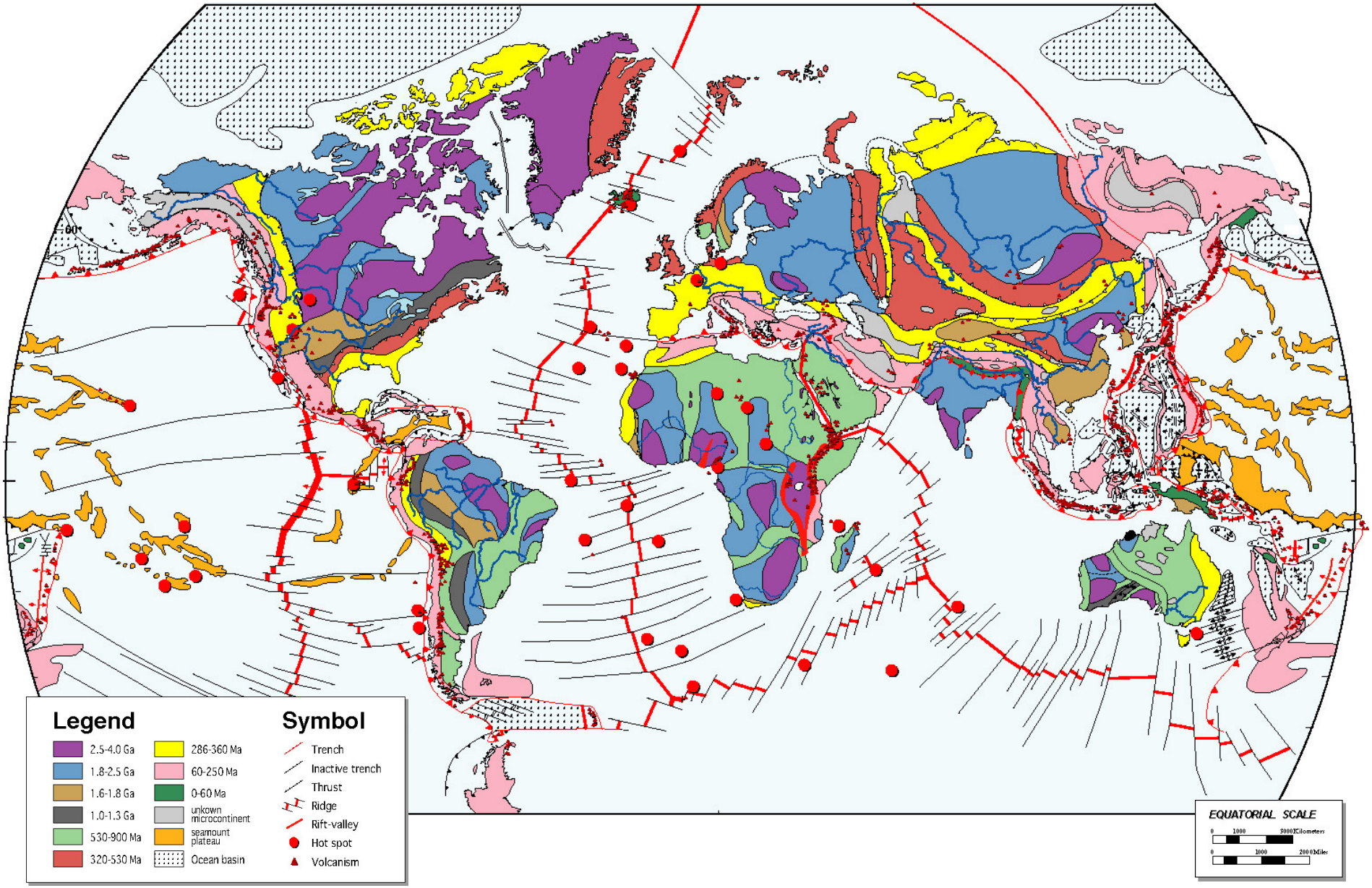
ANS:

Accretionary complex and

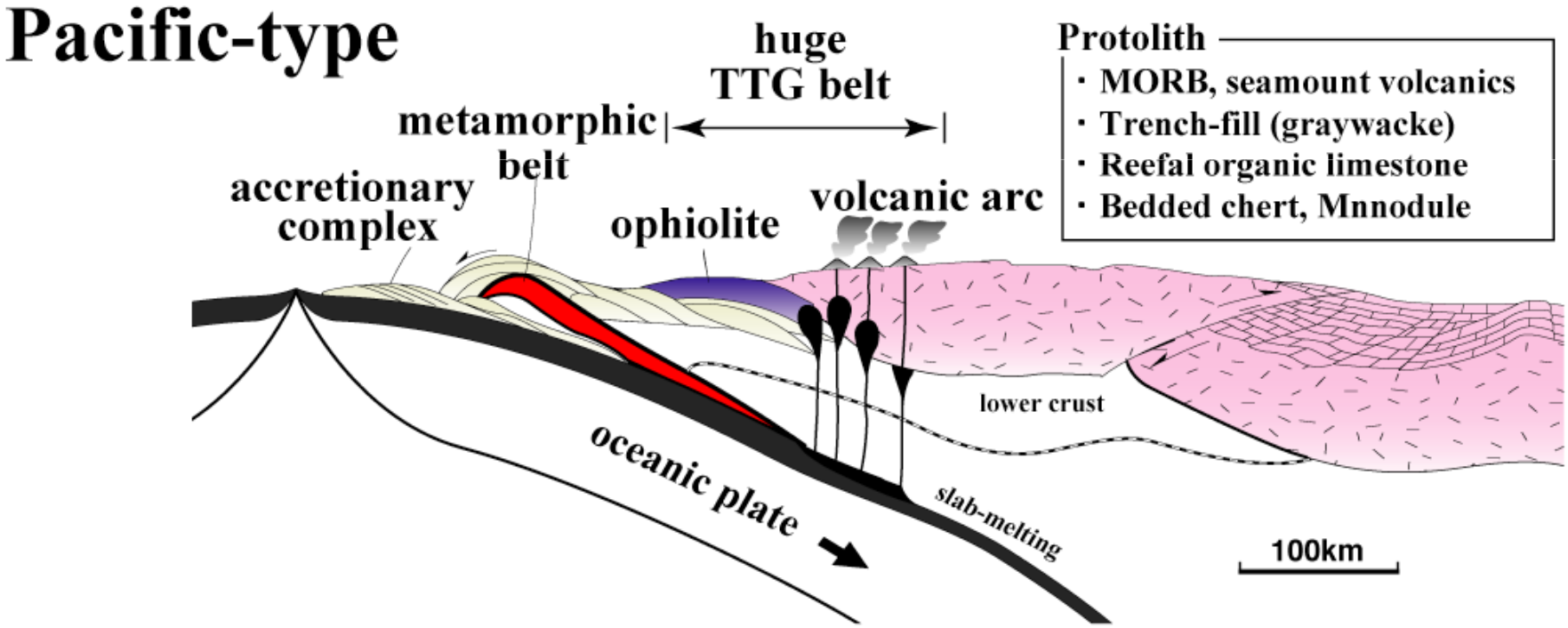
Pacific-type orogen

Orogenic belts of the world

How to demonstrate PT on the Earth before 200Ma



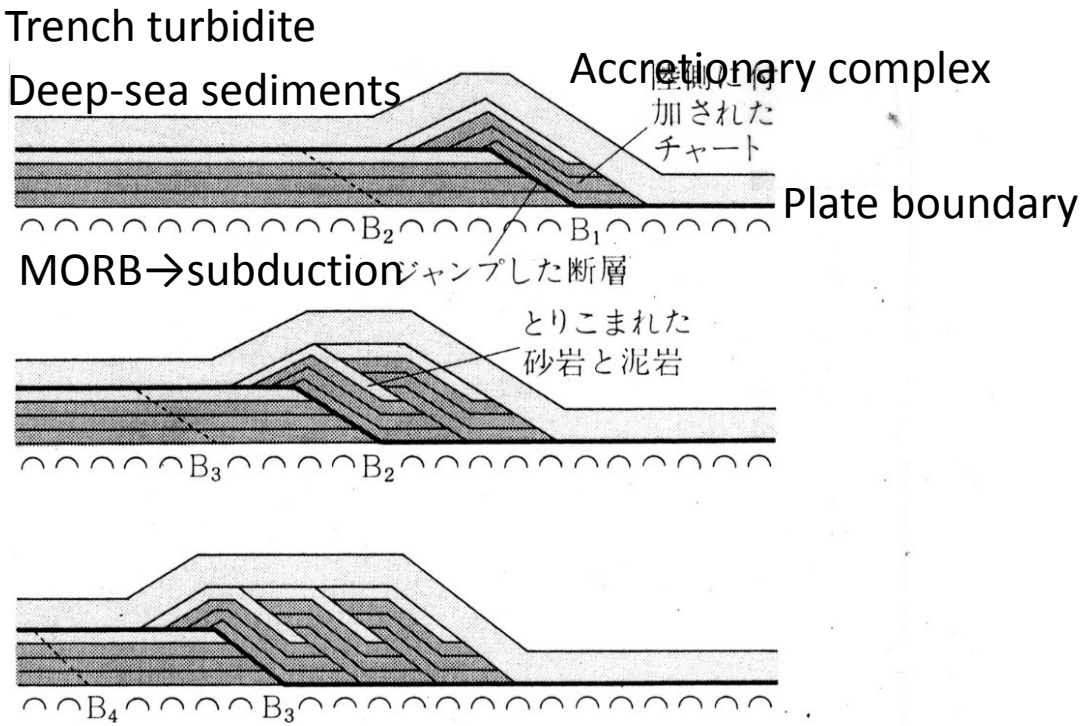
3. Key new evidence of plate tectonism on Mars: “candidate” accretionary complex



(Maruyama et al., 2002)

What is accretionary complex?

(1)Layer-parallel thrust
(2)Rock assemblages
(3)Ocean-plate stratigraphy

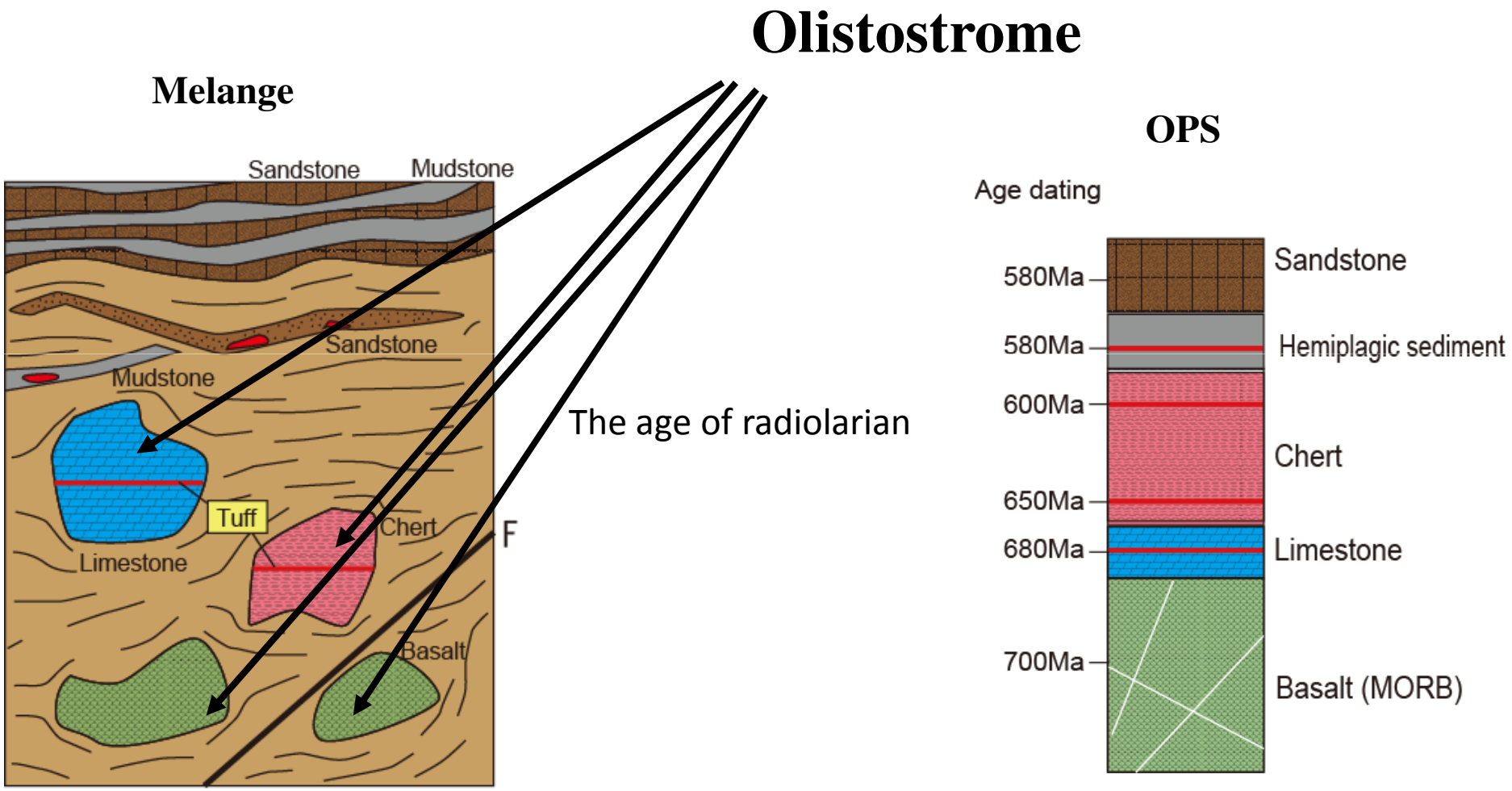


MOR

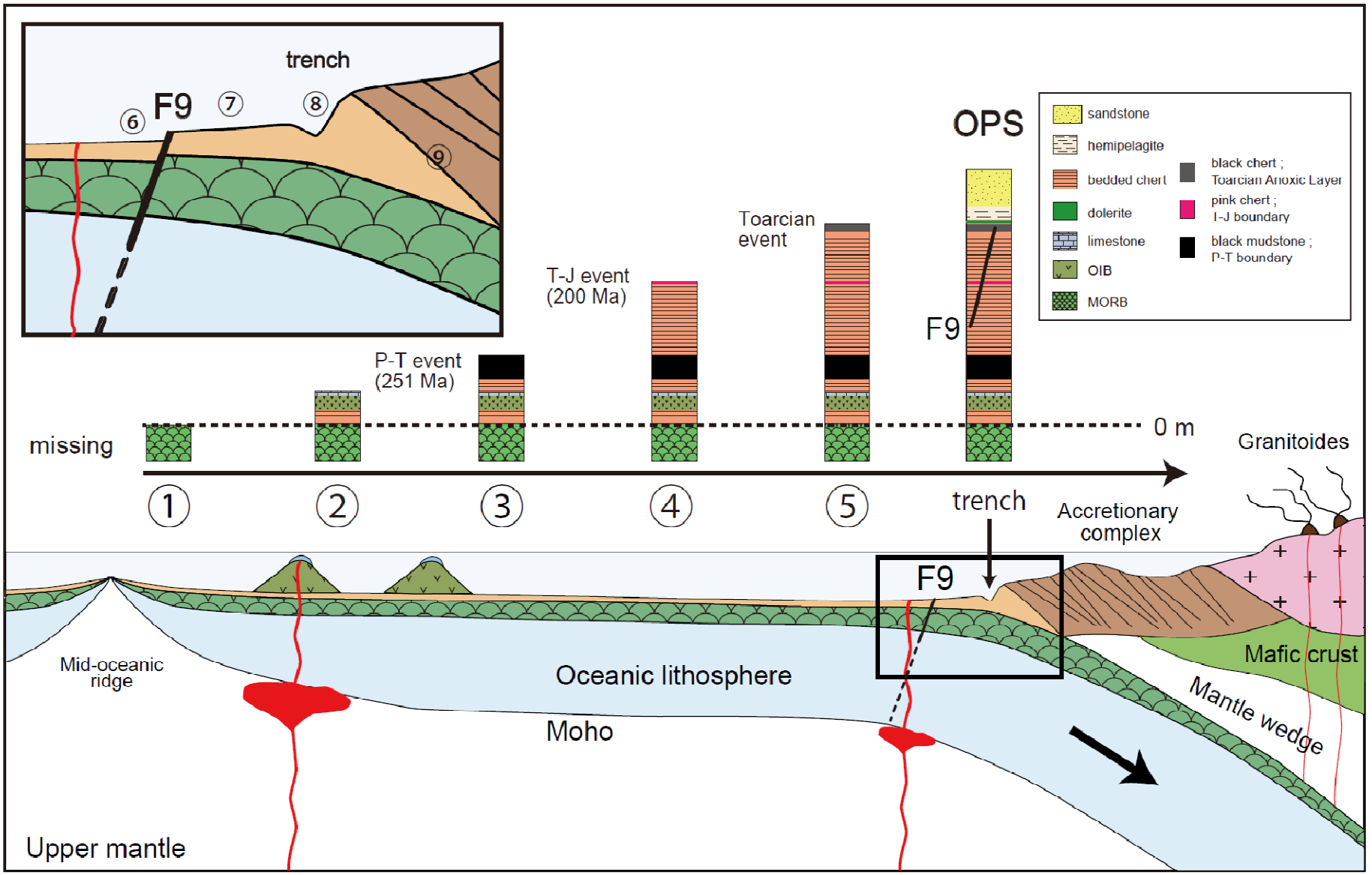
Major crustal shortening in places on Earth especially highlighted here associated with the development of orogenic belts here in the Japanese Islands, including accretionary complexes

Ocean Plate Stratigraphy (OPS)

Ocean Plate Stratigraphy, example from Wales, UK



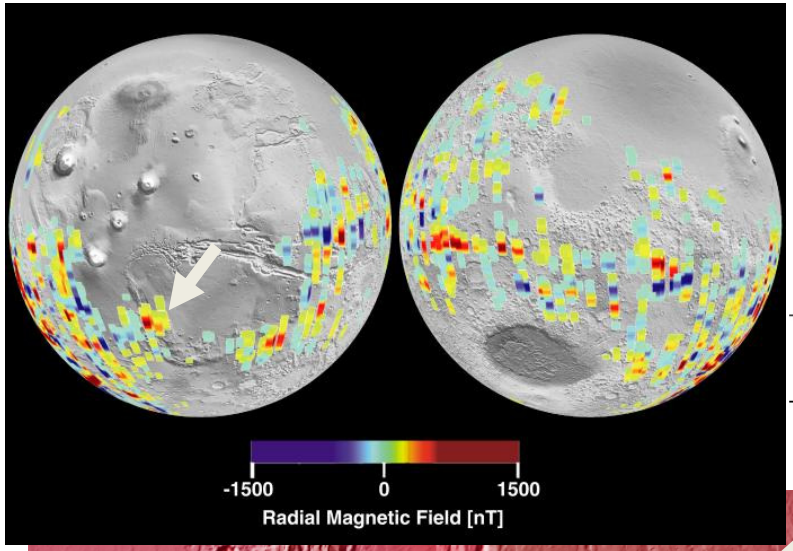
Travel history deduced from OPS, an example from SW Japan

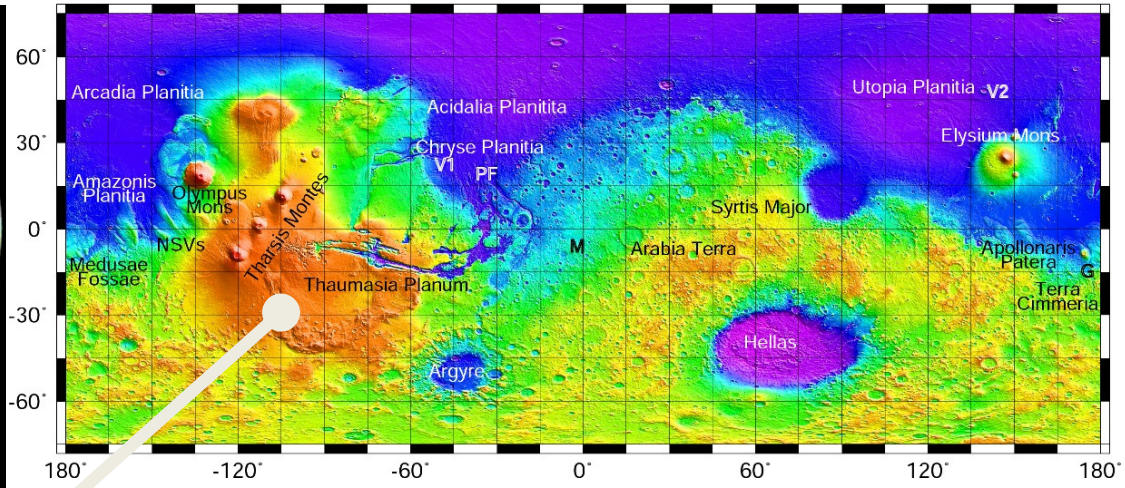


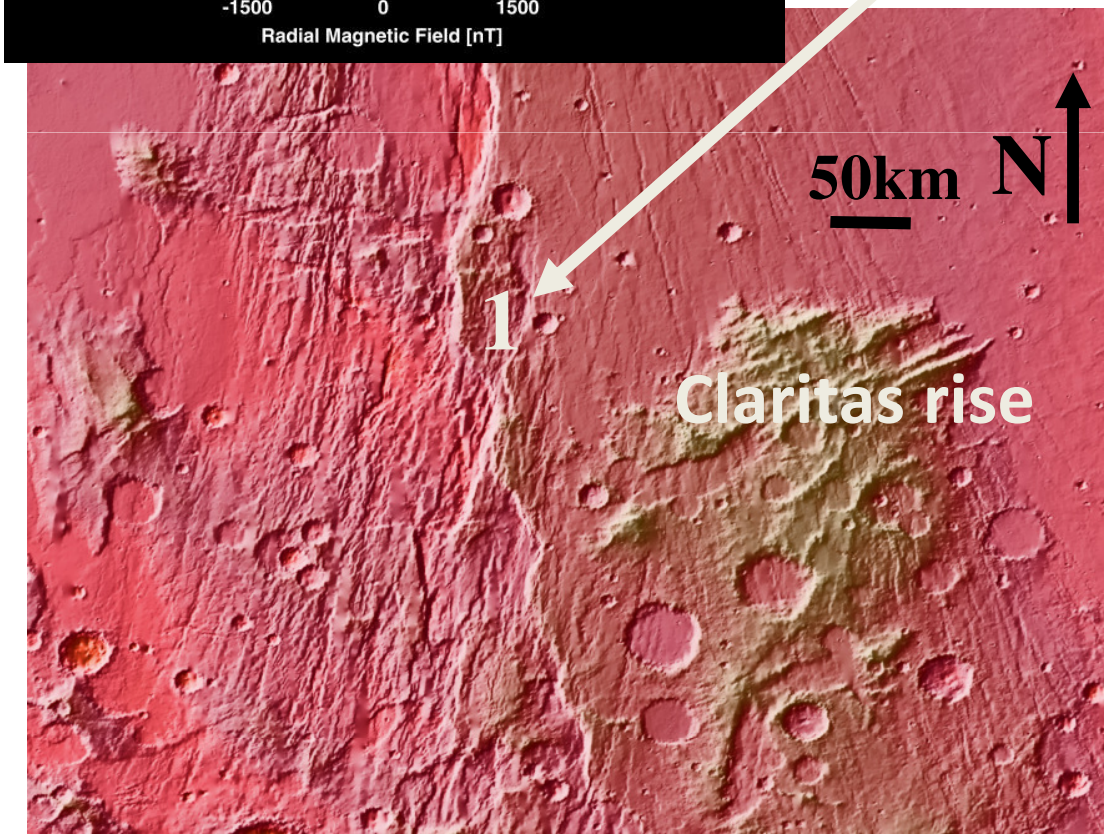
Fujisaki (2013)

Accretionary Complex on Mars

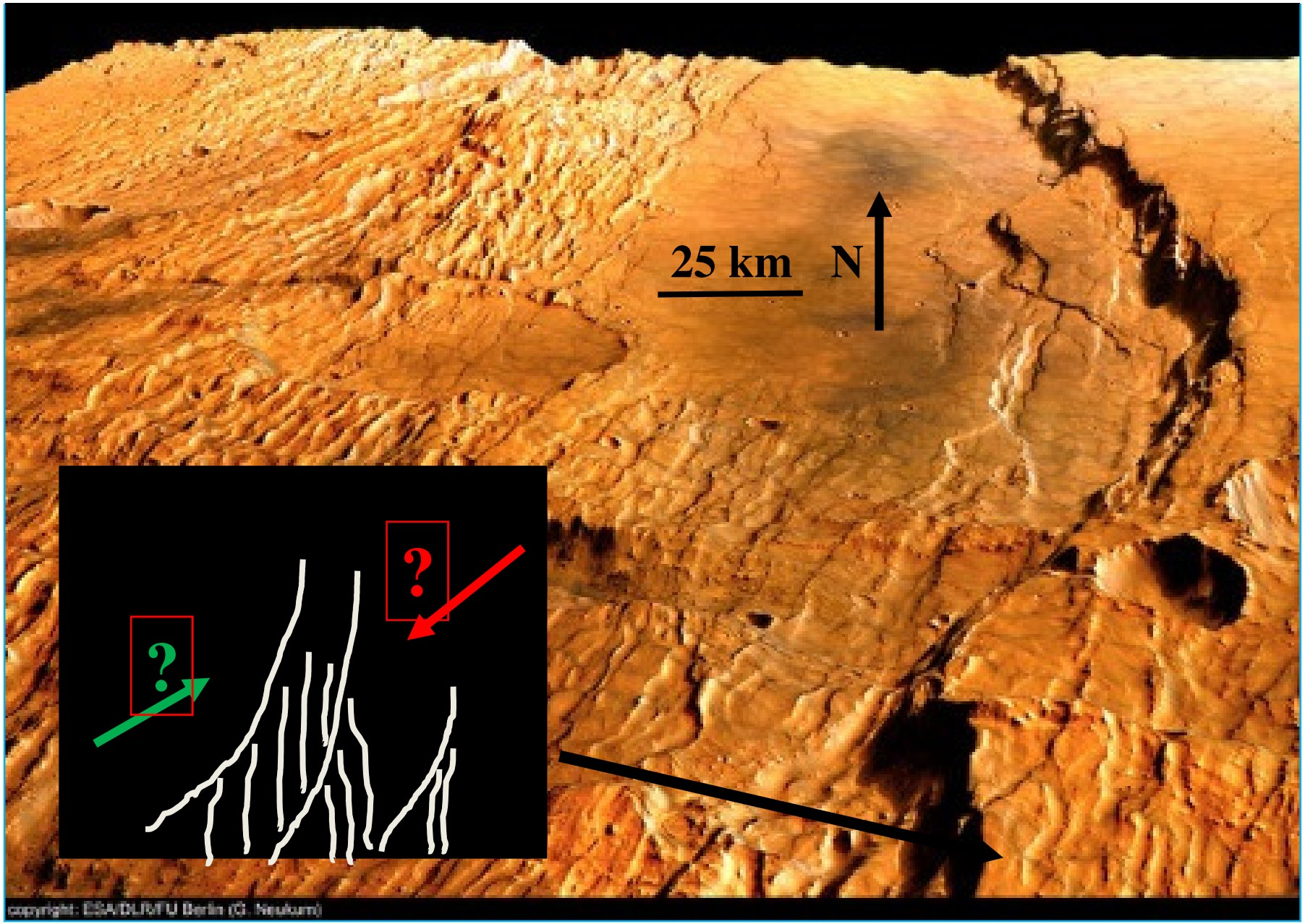
Example candidate 1 (Pacific-type accretionary complex)





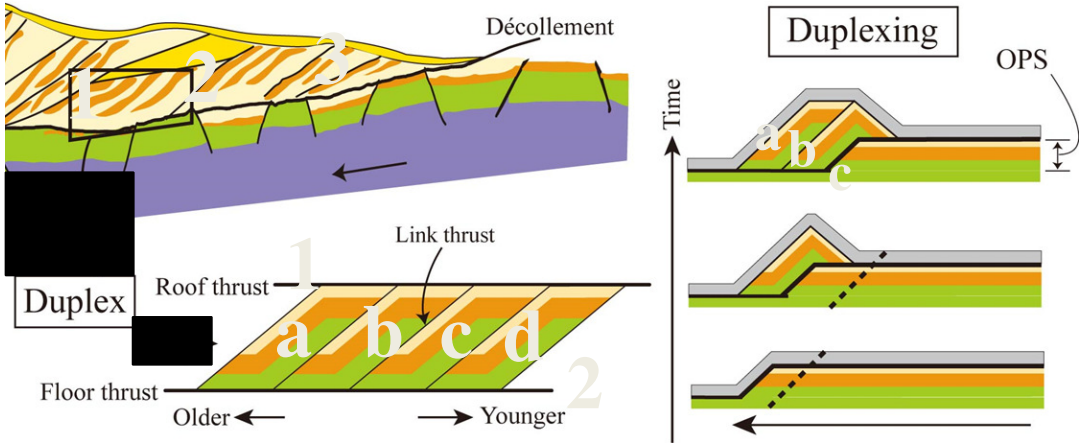


Target to assess the ancient rock record and plate tectonism, including plate boundaries and accretionary complexes



Possible duplex structures with link, roof, and floor thrusts (evidence of major crustal shortening)

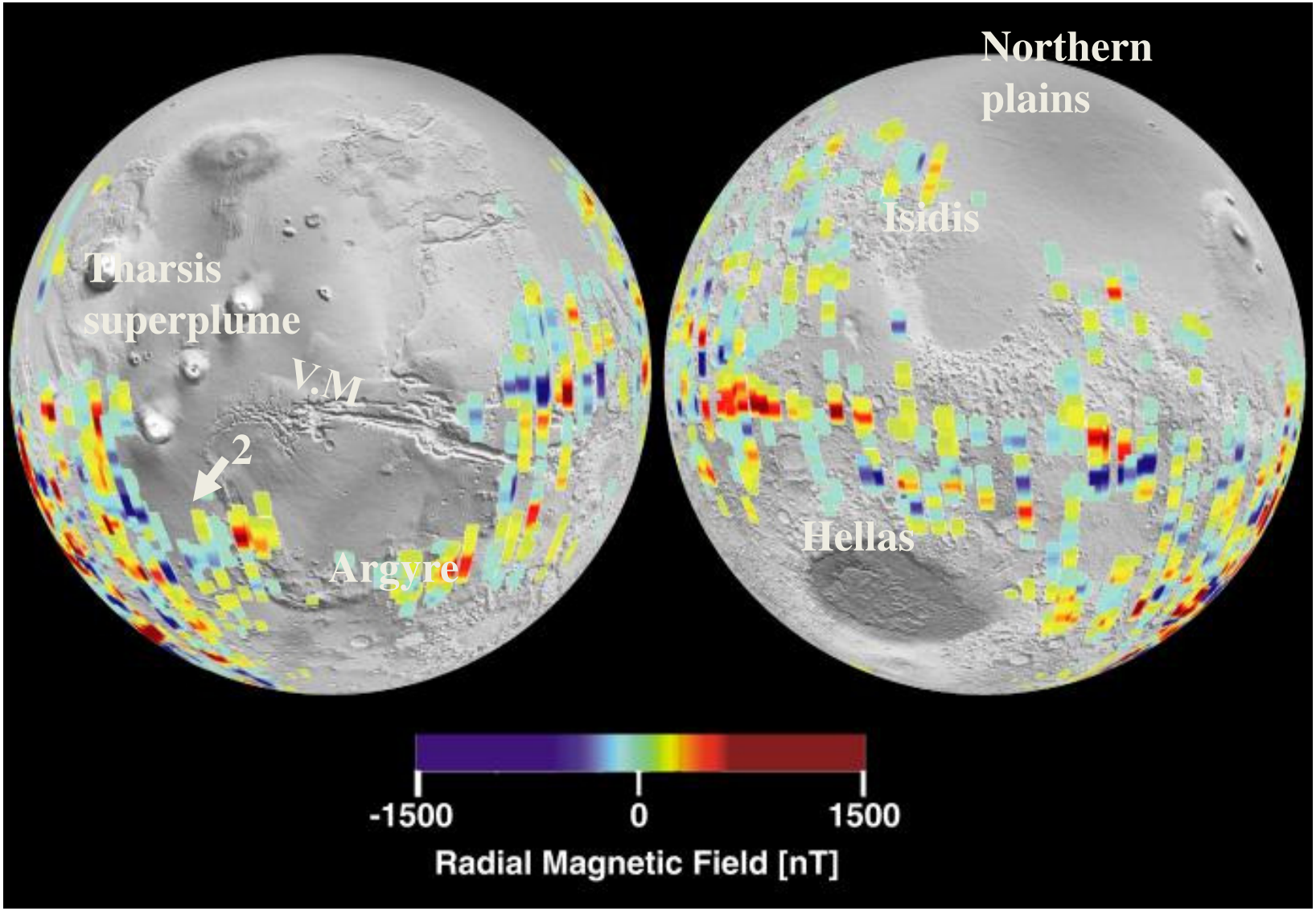
Reconstruction (sense of horizontal shortening, and underlying unit)



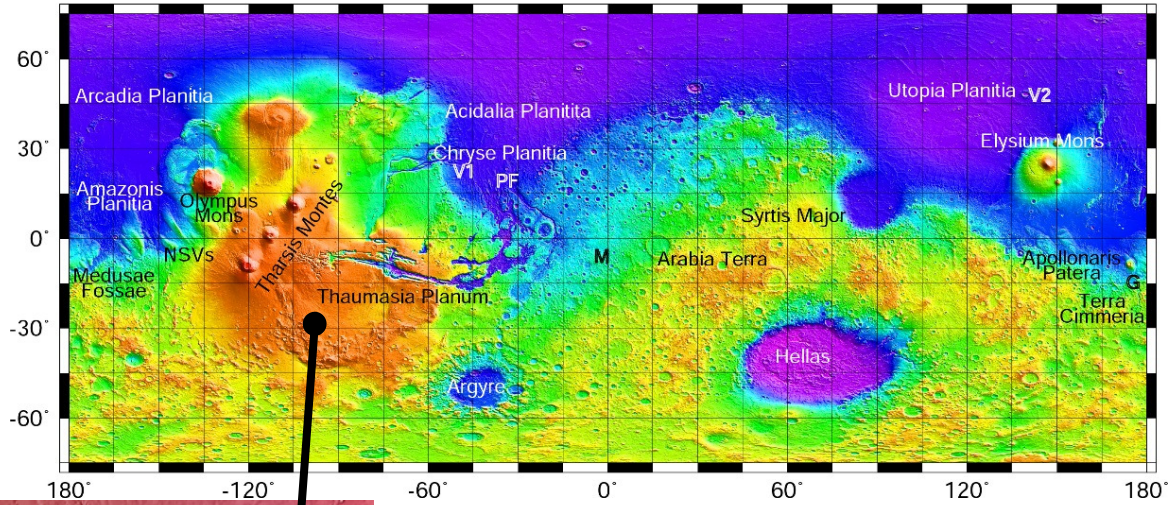


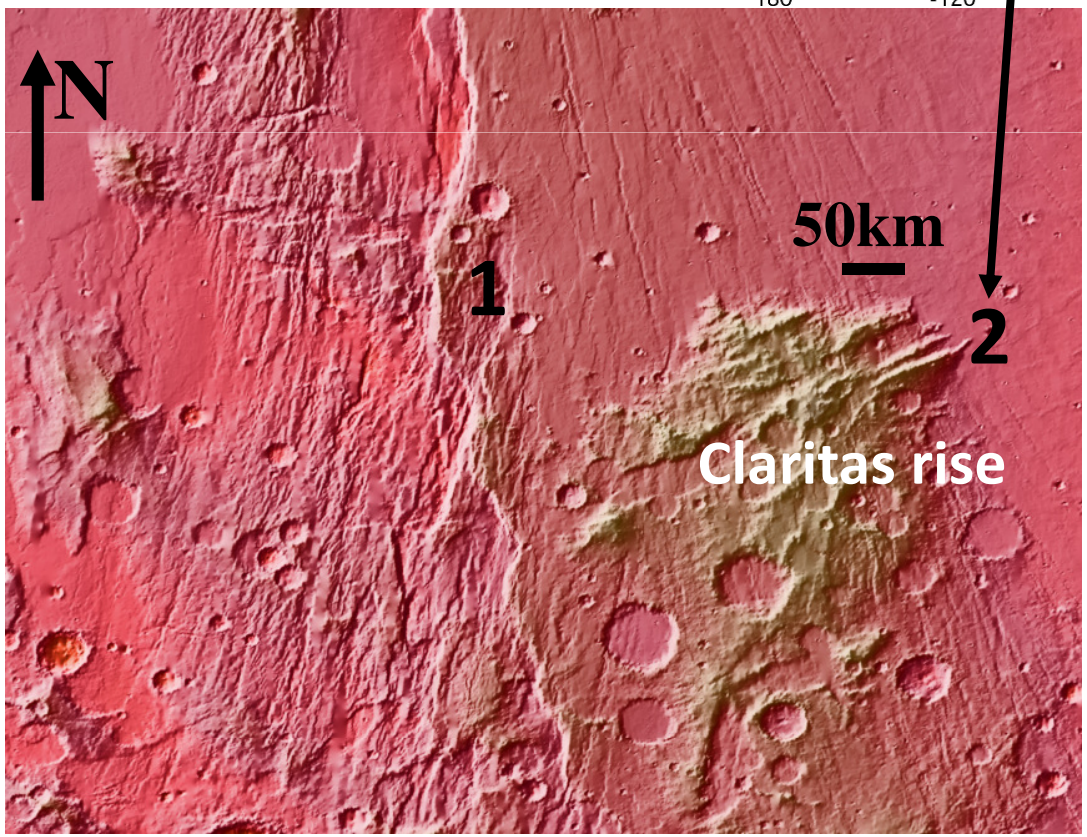
Need chemical mapping to test the hypothesis, which includes attempting to identify MORB and deep-sea sediments with trench turbidite (OPS)

Example candidate 2,
northwest part of a huge mountain range, Thaumasia highlands

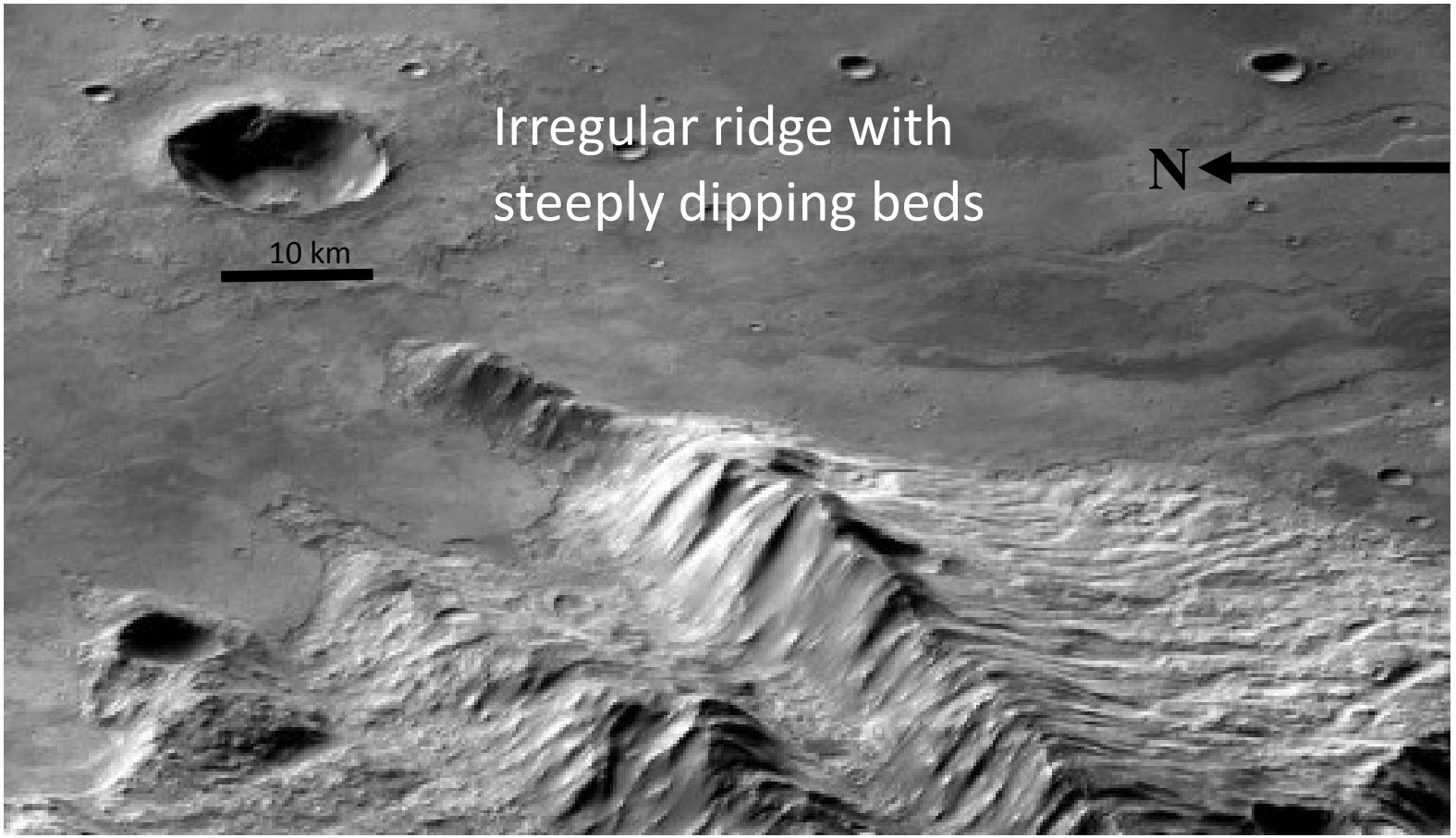


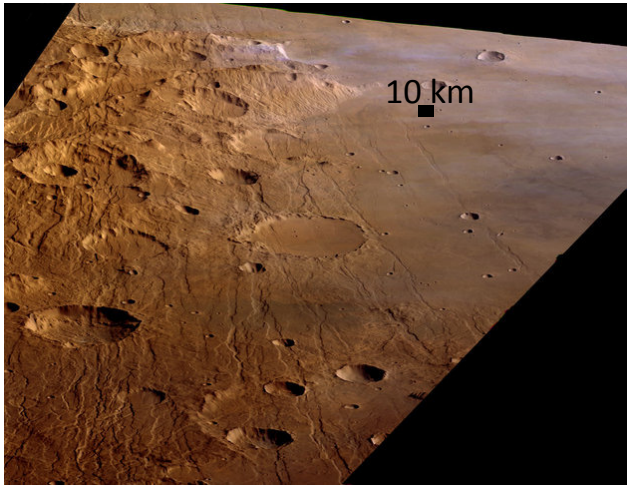
Example candidate 2



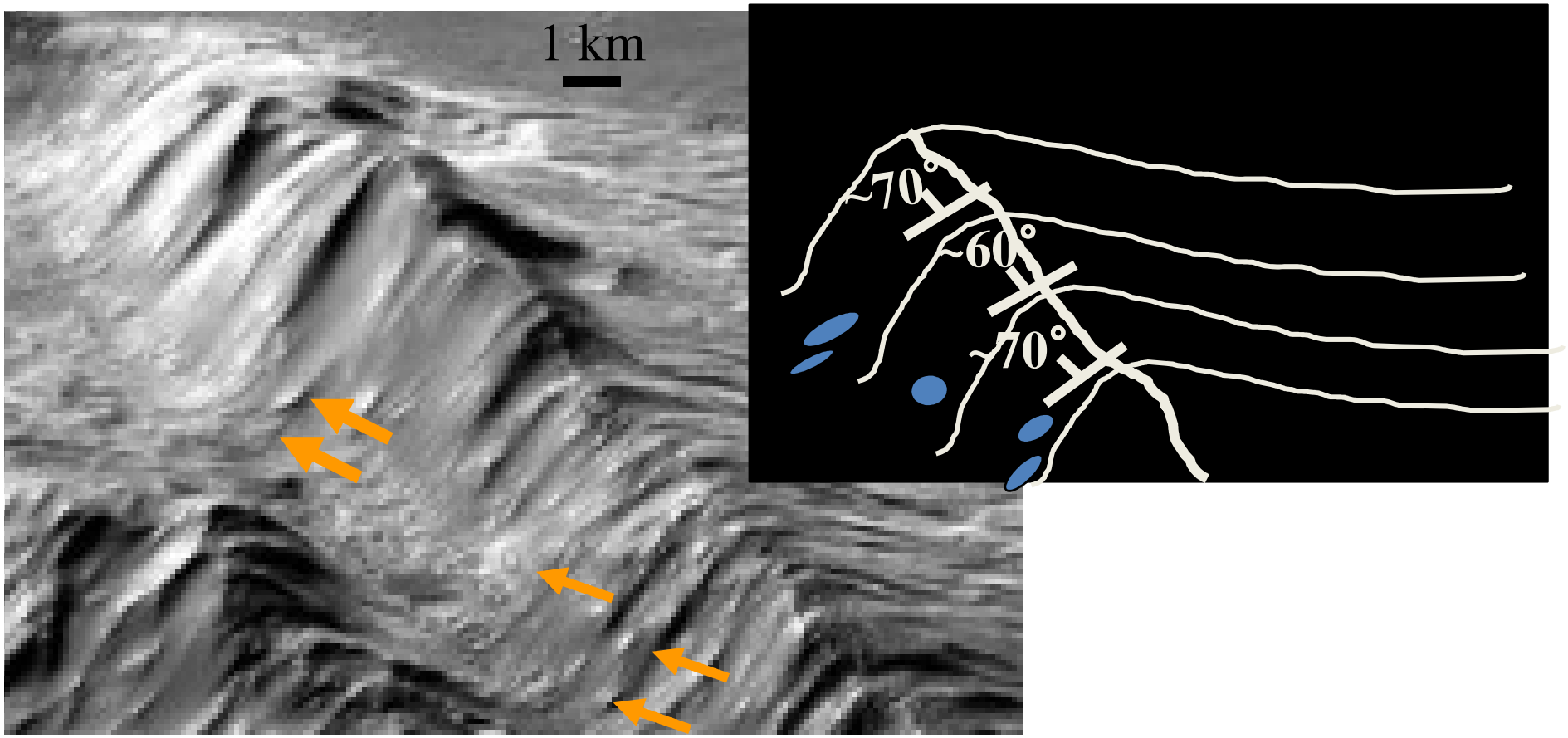


Claritas rise – Mountain where serpentine has been identified through the CRISM instrument onboard the Mars Reconnaissance Orbiter (Dohm et al., 2009)

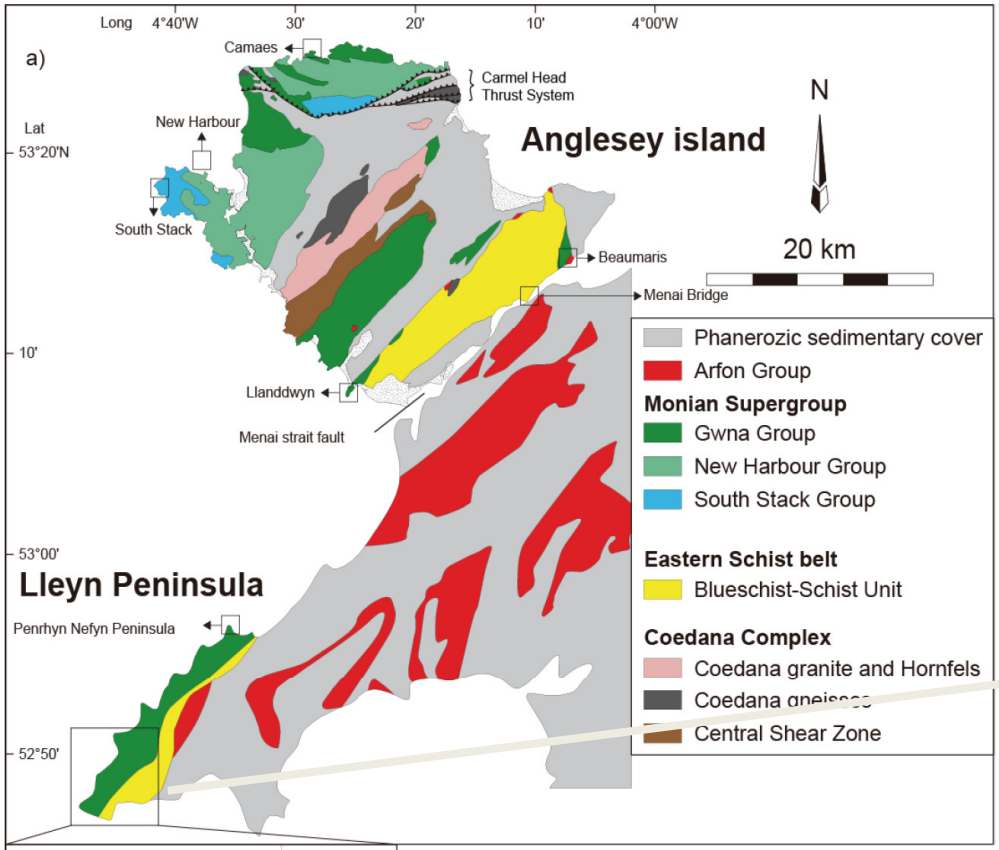


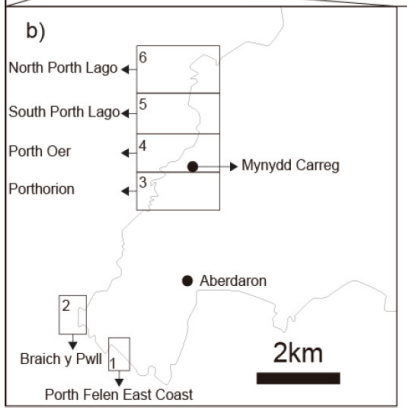


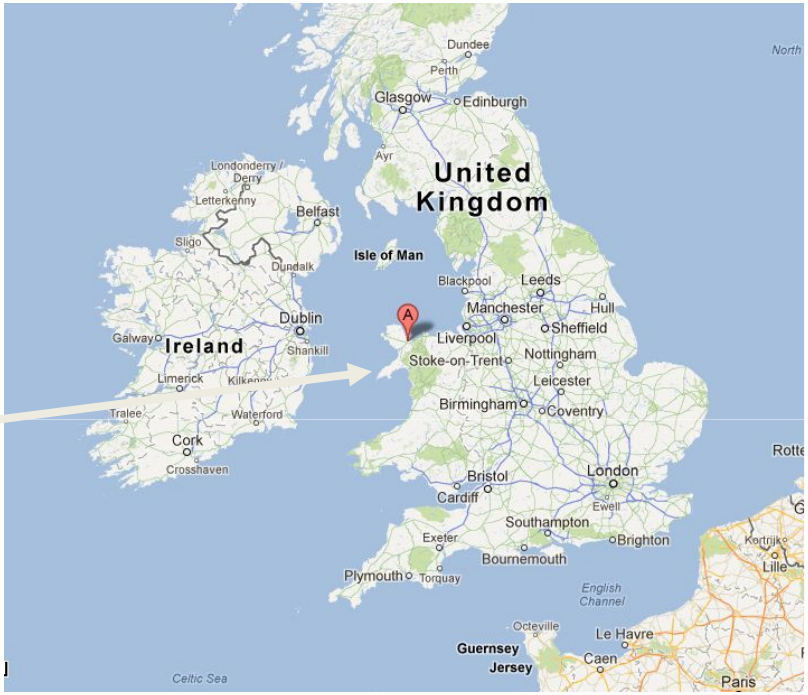
Credit: ESA

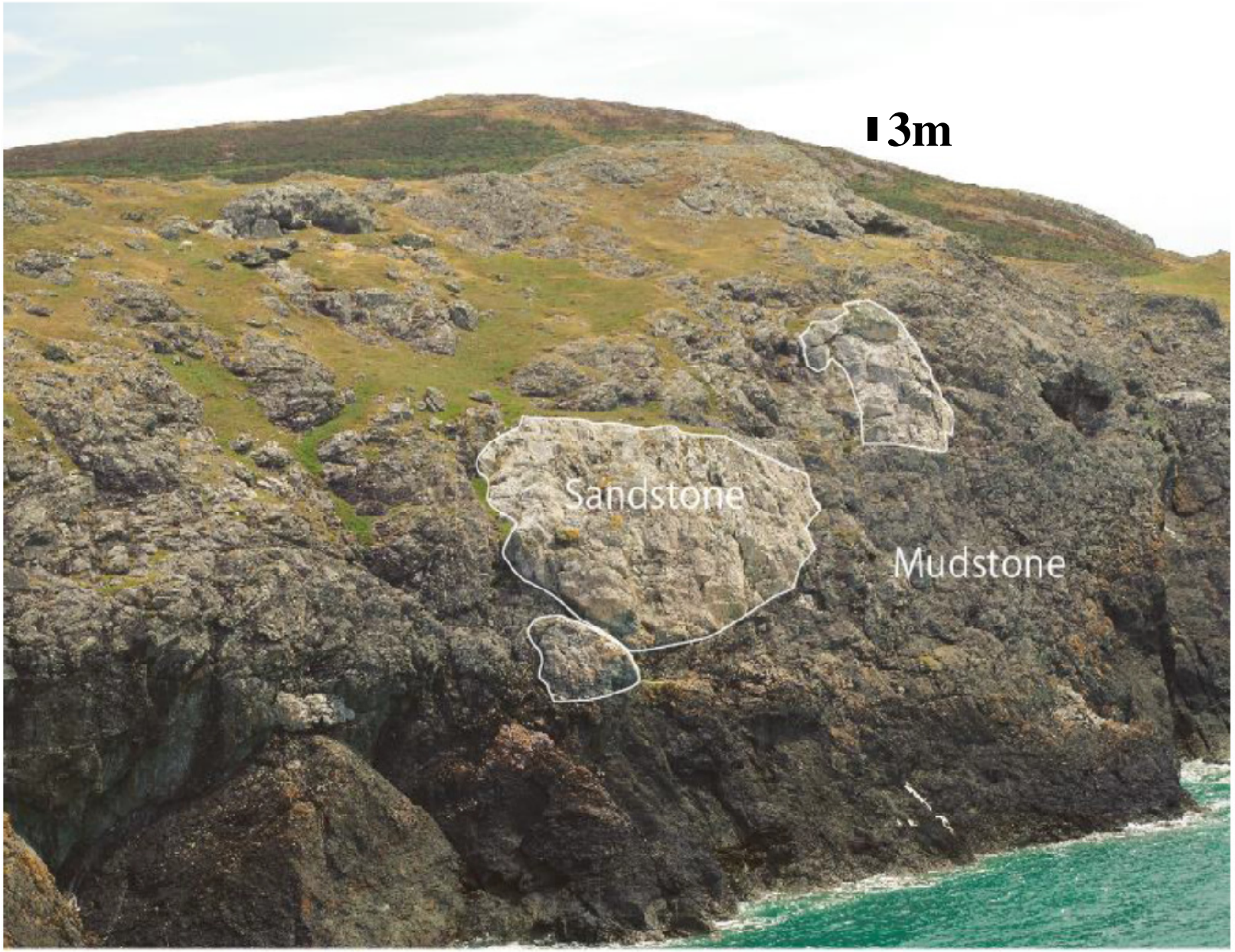


Steeply dipping beds which containing blocky masses


Long 4°40'W
30'
20'
10'
4°00'W
a)
Camaes
Carmel Head
Thrust System
New Harbour
Anglesey island
N
Lat
53°20'N
South Stack
Beaumaris
20 km
Menai Bridge
10'
Llanddwyn
Menai strait fault
Phanerozic sedimentary cover
Arfon Group
Monian Supergroup
Gwna Group
New Harbour Group
South Stack Group
53°00'
Lleyn Peninsula
Eastern Schist belt
Blueschist-Schist Unit
Penrhyn Nefyn Peninsula
Coedana Complex
Coedana granite and Hornfels
Coedana gneisses
Central Shear Zone
52°50'


b)
North Porth Lago
6
South Porth Lago
5
Porth Oer
4
Mynydd Carreg
Porthorion
3
Aberdaron
2
Braich y Pwll
1
2km
Porth Felen East Coast


Dundee
Perth
Glasgow
Edinburgh
United
Kingdom
Ayr
Londonderry / Derry
Letterkenny
Belfast
Sligo
Dundalk
Isle of Man
Blackpool
Leeds
Manchester
Hull
Sheffield
Dublin
Liverpool
Galway
Ireland
Shankill
Stoke-on-Trent
Nottingham
Limerick
Leicester
Birmingham
Coventry
Tralee
Waterford
Cork
Crosshaven
Bristol
London
Cardiff
Ewell
Southampton
Exeter
Brighton
Bournemouth
Plymouth
Torquay
English
Channel
Octeville
Le Havre
Guernsey
Jersey
Caen
Celtic Sea
Paris


3m
Sandstone
Mudstone



Conclusions

- 1 Possible candidates of accretionary complex and/or olistostrome were found on Mars.
- 2 If true, strong lateral shortening must have occurred on Mars presumably by plate tectonics.
- 3 If geochemical mapping is available, OPS (Ocean Plate Stratigraphy) can be demonstrated in future to demonstrate plate tectonics on Mars.