Accretionary complexes: Recorders on Earth and possibly Mars

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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

Pacific-type

metamorphic belt

accretionary complex

ophiolite

volcanic arc

huge TTG belt

Protolith
- MORB, seamount volcanics
- Trench-fill (graywacke)
- Reefal organic limestone
- Bedded chert, Mnodule

lower crust

slab-melting

oceanic plate

100km

(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.

MORB → subduction → Accretionary complex

Deep-sea sediments

Trench turbidite

Plate boundary
Ocean Plate Stratigraphy (OPS)
Ocean Plate Stratigraphy, example from Wales, UK

Melange

Olistostrome

The age of radiolarian

OPS

Sandstone
Hemplagic sediment
Chert
Limestone
Basalt (MORB)
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

- Tharsis superplume
- Argyre
- Isidis
- Northern plains
- Hellas

Radial Magnetic Field [nT]
Claritas rise – Mountain where serpentine has been identified through the CRISM instrument onboard the Mars Reconnaissance Orbiter (Dohm et al., 2009)
Irregular ridge with steeply dipping beds

Credit: ESA
Steeply dipping beds which containing blocky masses
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.