Tectonic Settings of UHPM

arc–continent collision
- active: Taiwan & Timor
- Cretaceous: Oman

intracontinental shortening
- active: Caspian & Tibet

continent–continent collision
- active: Hindu Kush, Tibet
- Cenozoic: Himalaya, Alps, Norway, Bohemia, Kokchetav

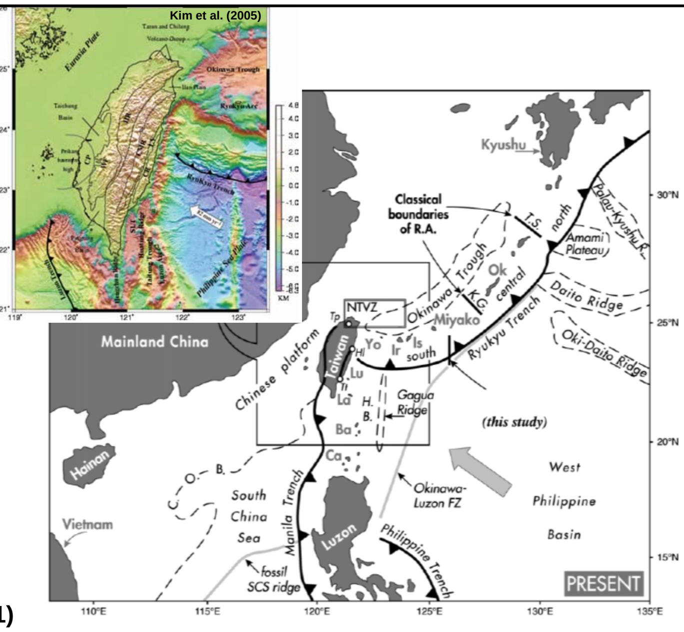
continental rift
- Papua New Guinea

subduction erosion
- active: Central America
- Cenozoic: Pamir

Arc–Continent Collisions

- active setting: Taiwan
- active setting: Timor
- Cretaceous: Oman

Arc–Continent Collision: Taiwan



Lallemand et al. (2001)

Fig. 1. Physiographic map of the Taiwan surroundings including the Ryukyu Arc and the northern Luzon Arc. T.S. = Tokara Strait, K.G. = Kerama Gap, Ok = Okinawa, Is = Ishigaki, Ir = Iri-Omote, Yo = Yonaguni, Lu = Lutao, La = Lanyu, Ba = Batan, Ca = Calayan, C.O.B. = continent–ocean boundary, Hl = Hualien, Tt = Taitung, Tp = Taipei. Insert: Geodynamic setting of the Taiwan region with the two active plate boundaries (longitudinal valley and deformation front) on both sides of the island and the surface projection of the tear fault that connects the deformation front with the Ryukyu Trench (this study).

Teng et al. (2000)

Taiwan

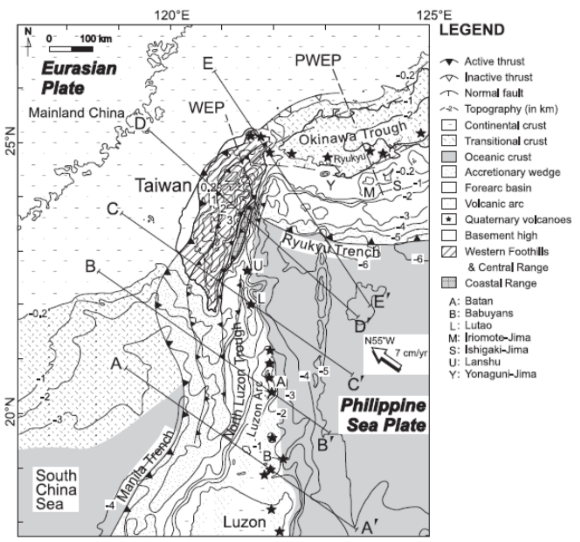
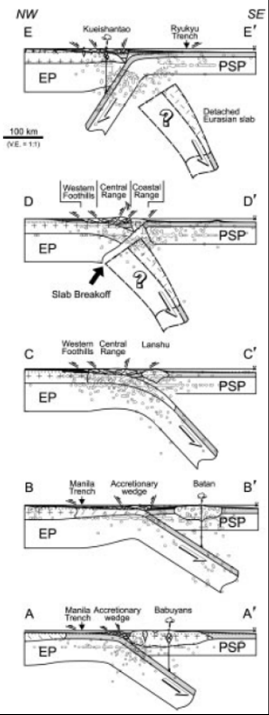
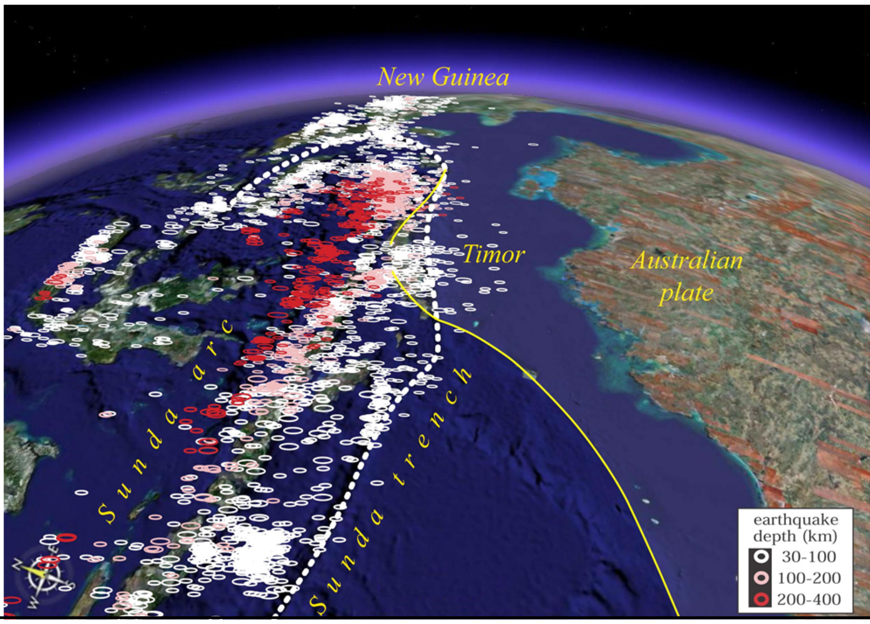


Figure 1. Plate tectonic setting of Taiwan. PWEP—precollision position of WEP; WEP—surface projection of western edge of north-dipping Philippine Sea plate. Summarized from Hayes and Lewis (1984), Lewis and Hayes (1989), Liu et al. (1997), Lundberg et al. (1997), Seno et al. (1993), Sibuet et al. (1998), Taylor and Hayes (1983), Teng (1990, 1996), Teng et al. (1992), and Yang et al. (1996).

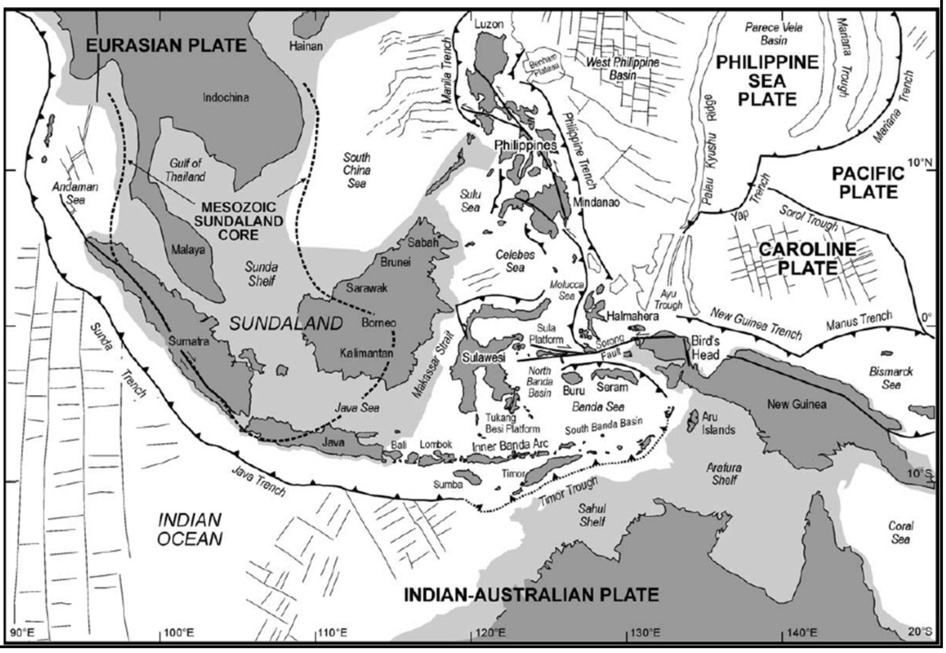


Arc–Continent Collision: Australia–Timor



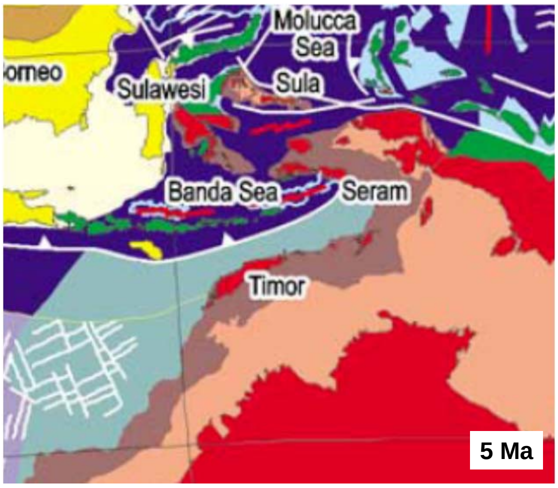
Australia–Timor

Hall (2002)



Australia–Timor

• See Hall N Oz movie

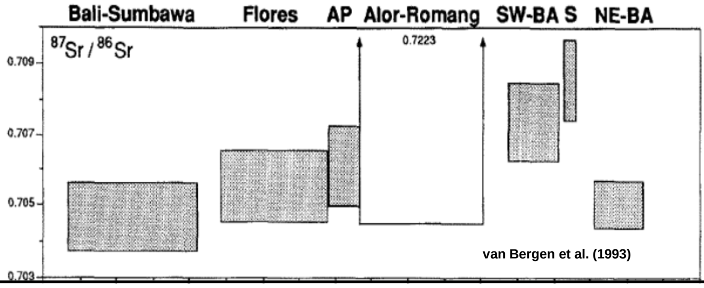


Hall (2002)

Australia–Timor

• He isotopes indicate crystalline Australia (Hilton et al., 1992)

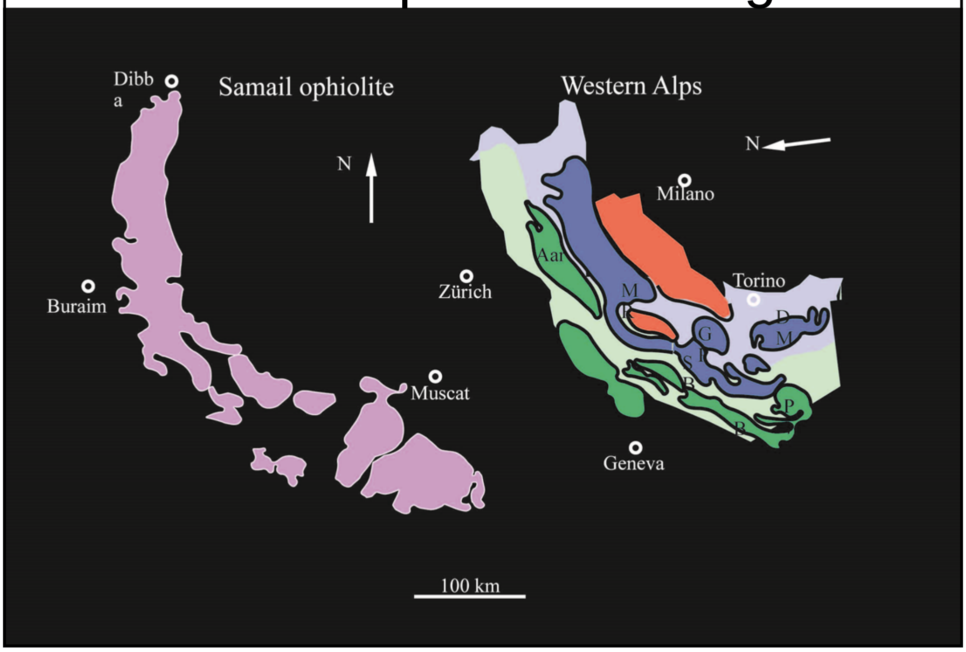
• rear-arc volcanoes show melting of MORB-type source in presence of mica, influenced by partial melt of continental material in presence of rutile & garnet that had undergone loss of fluid-mobile elements (e.g., Pb) (Elburg et al., 2002)



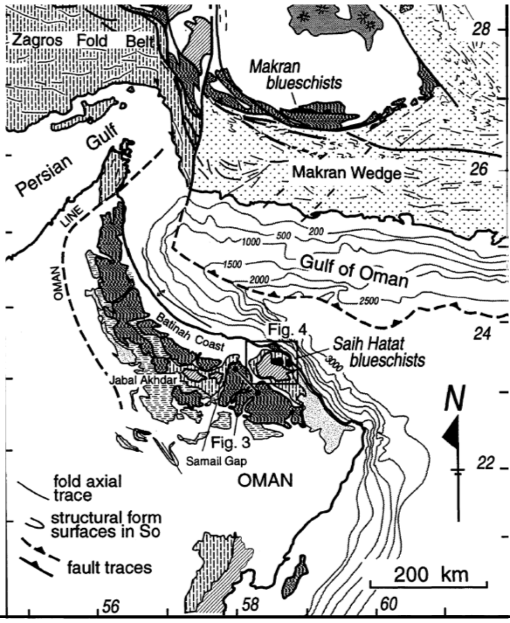
van Bergen et al. (1993)

Samail Ophiolite of Oman: Cretaceous Arc–Continent Collision

Samail Ophiolite is Large

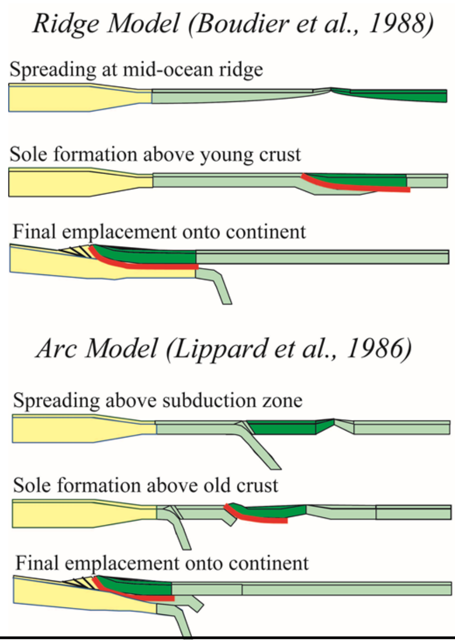


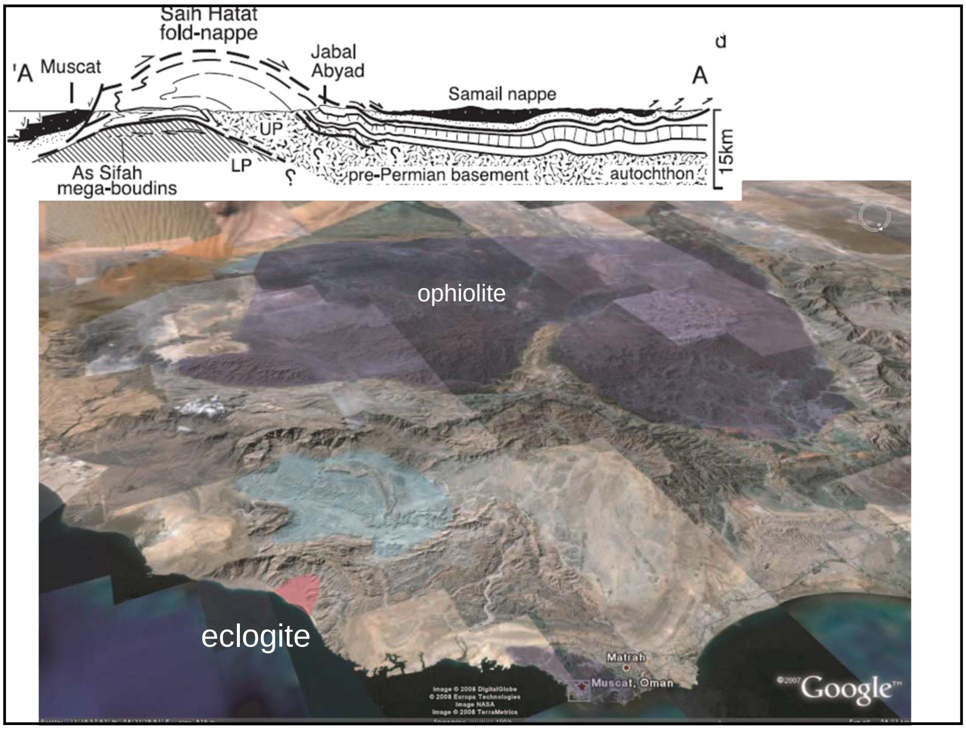
Tectonic Setting of Samail Ophiolite



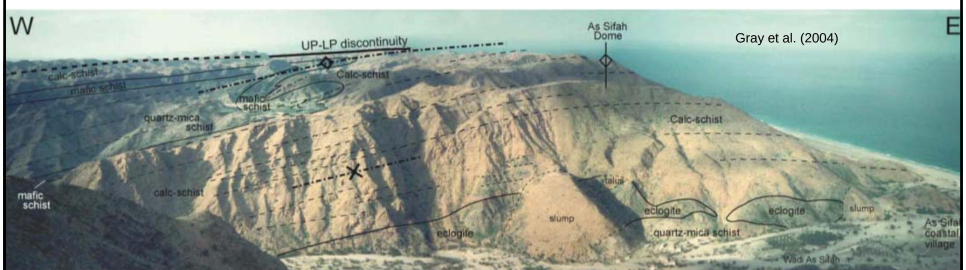
Gregory et al. (1998)

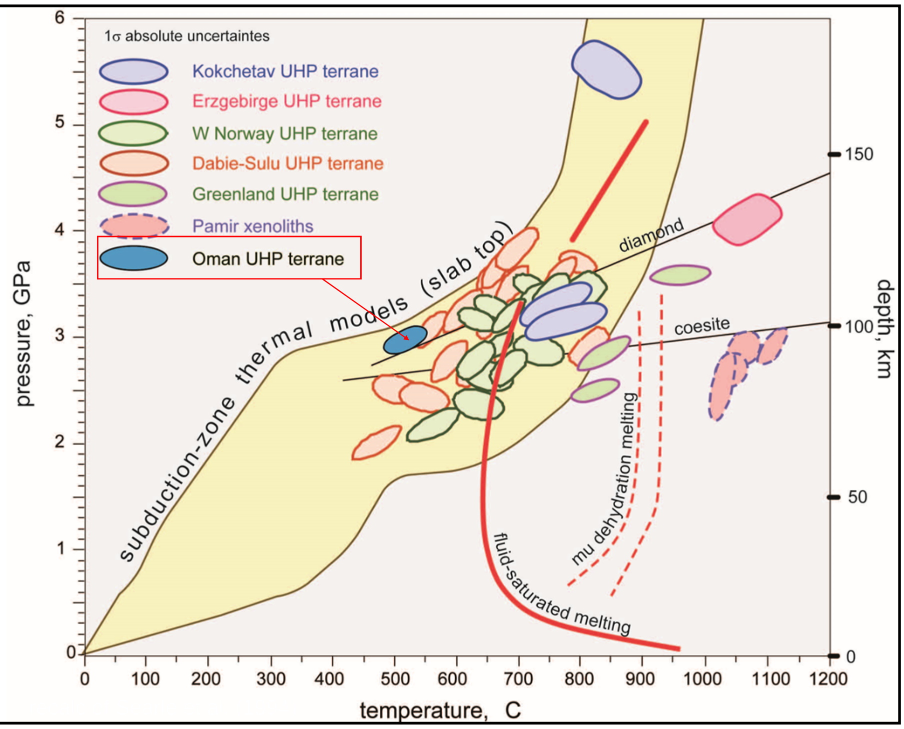
Samail Ophiolite Emplacement



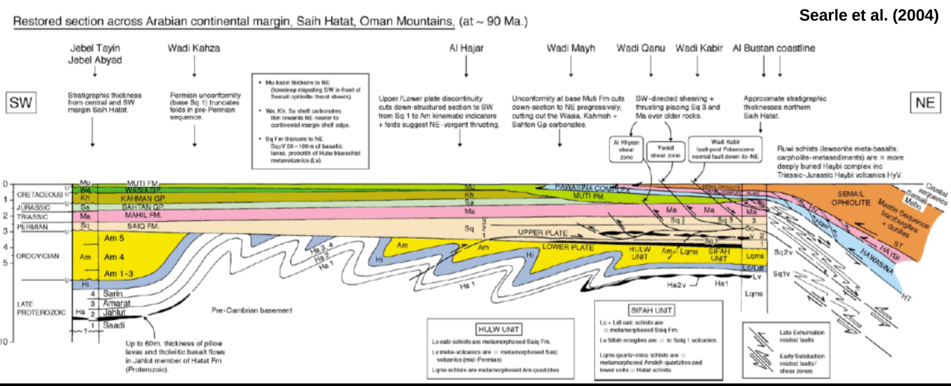


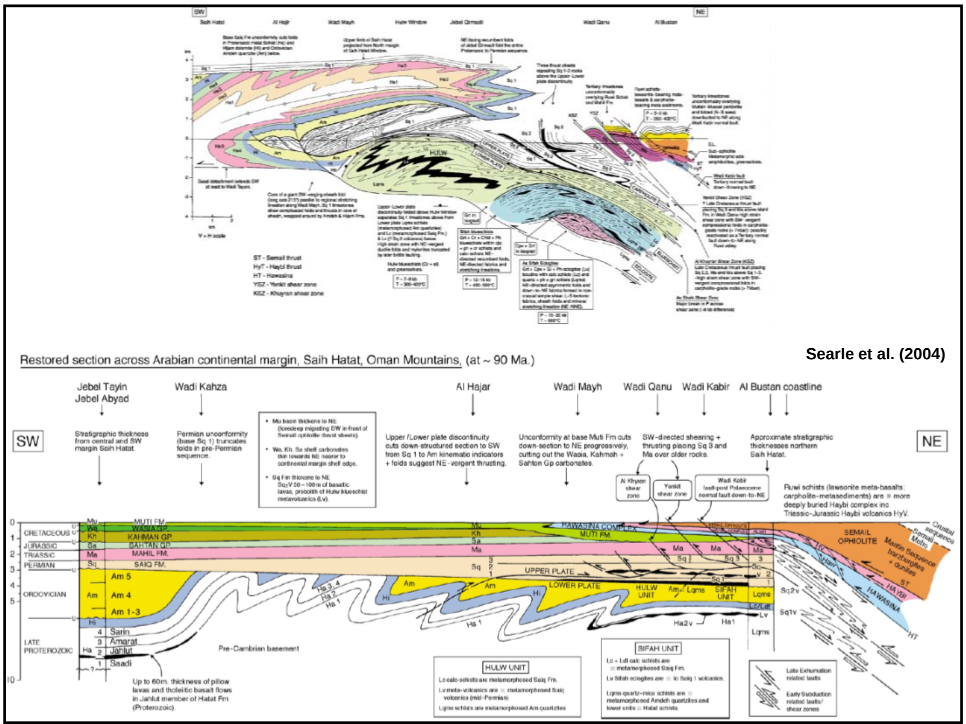
As Sifah Eclogite





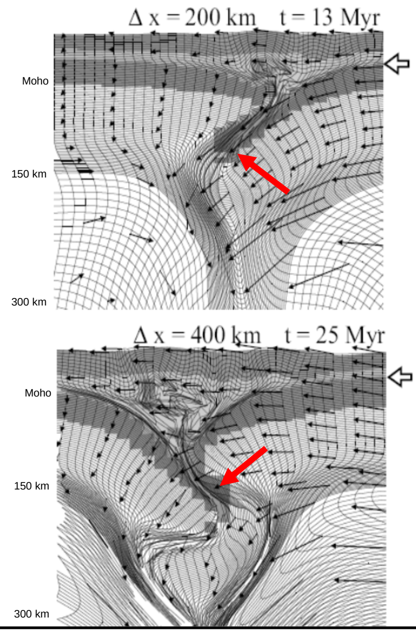
Inferred Shortening of Margin





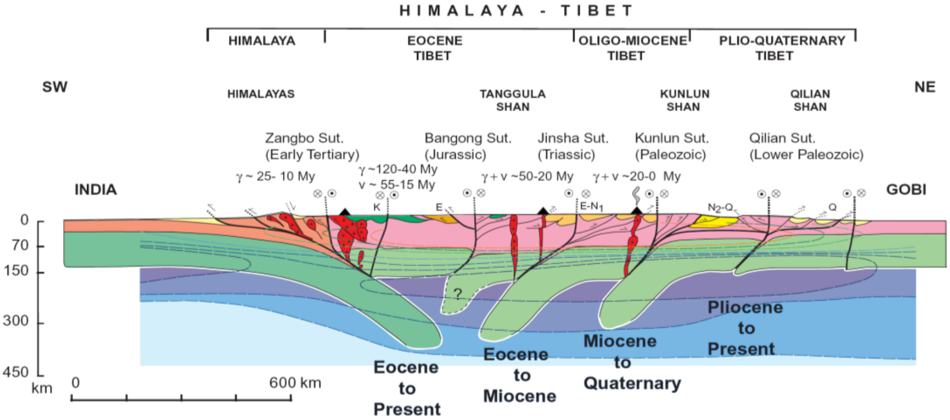
Searle et al. (2004)

Intracontinental Subduction: Models



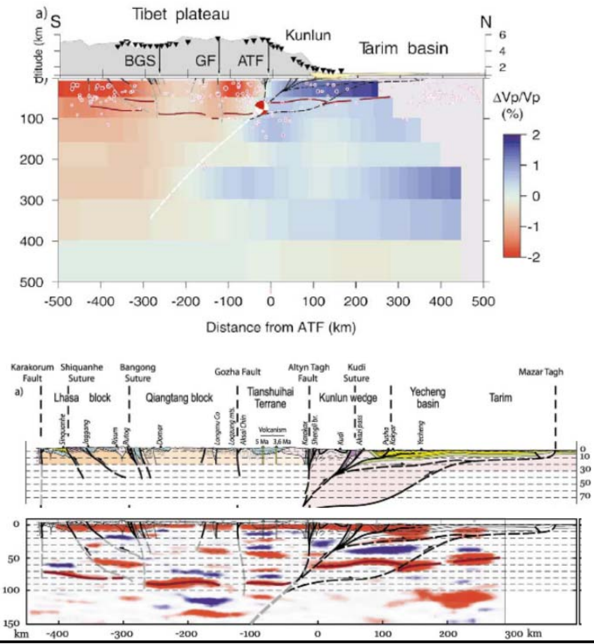
Pysklywec (2001)

Intracontinental Subduction: India–Asia



Tapponnier et al. (2001)

Intracontinental Shortening



Wittlinger et al. (2004)

Intracontinental Subduction

S Caspian basin sinking at 1.5–10X rate of foreland basins (2.4 km in 5.5 Myr)

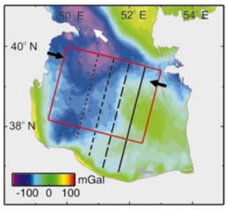
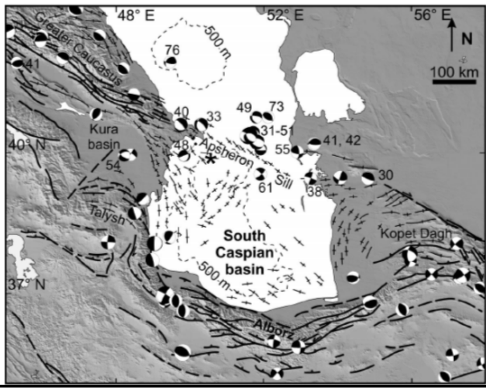


Figure 4. Free-air gravity field over South



Allen et al. (2002)

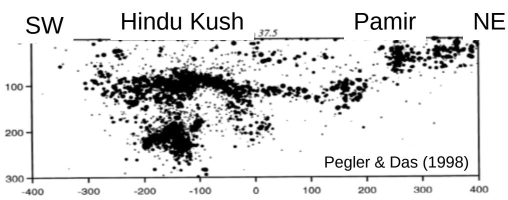
Continent–Continent Collision

- Active
  - Hindu Kush
  - India–Asia
- Ancient
  - Himalaya
  - Western Alps
  - Norway
  - Bohemian Massif
  - Kokchetav

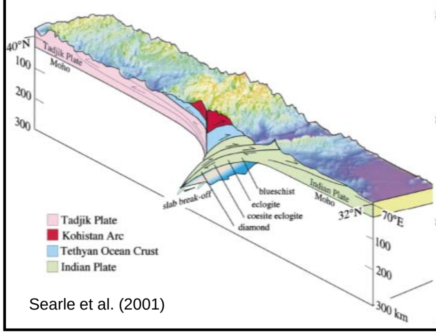
Hindu Kush–Pamir

- slow velocities beneath Pamir & Hindu Kush imply subduction of continental crust (Roecker et al., 1982)
- subhorizontal T axes in Pamir slab (implying bending) suggest it is not a normal P/T slab (subject to down-dip forces)
- Pamir is either a 2nd, S-dipping slab or an overturned segment of the Indian slab (Pavlis & Das, 1999)

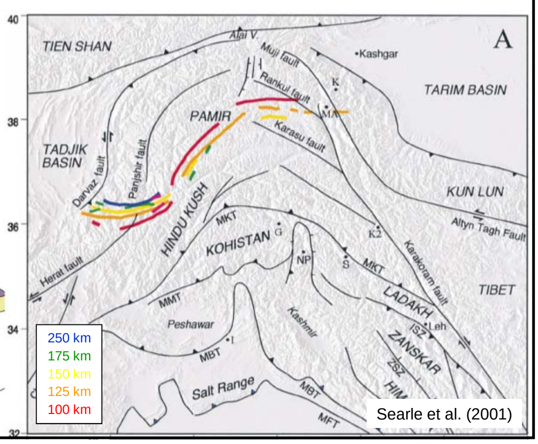
Continent Subduction Beneath Hindu Kush



Pegler & Das (1998)

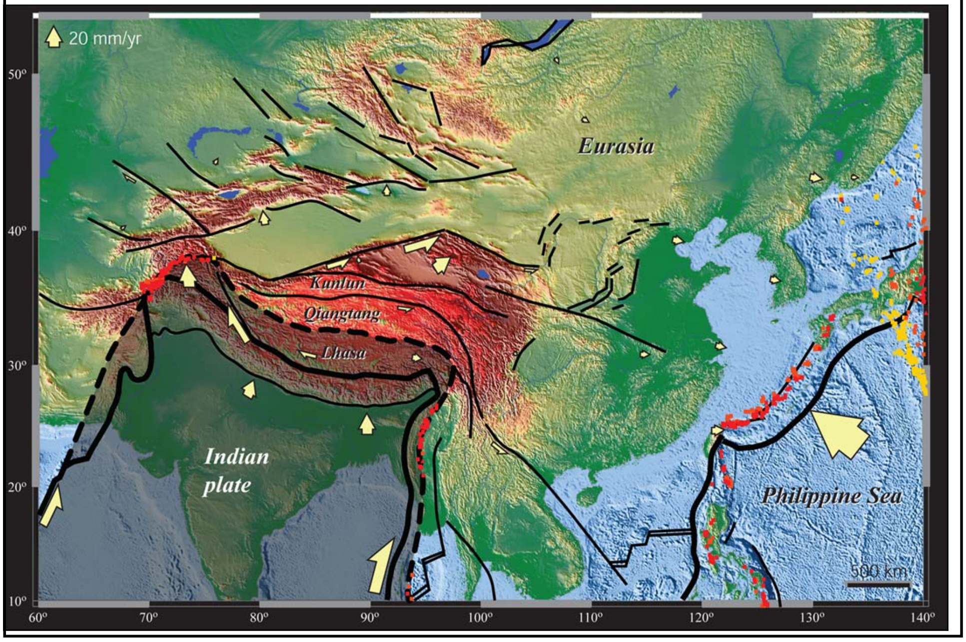


Searle et al. (2001)

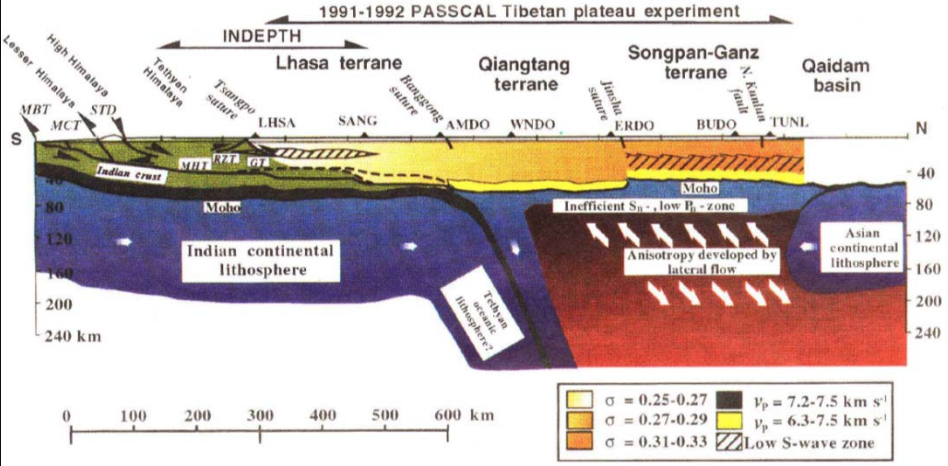


Searle et al. (2001)

India–Asia

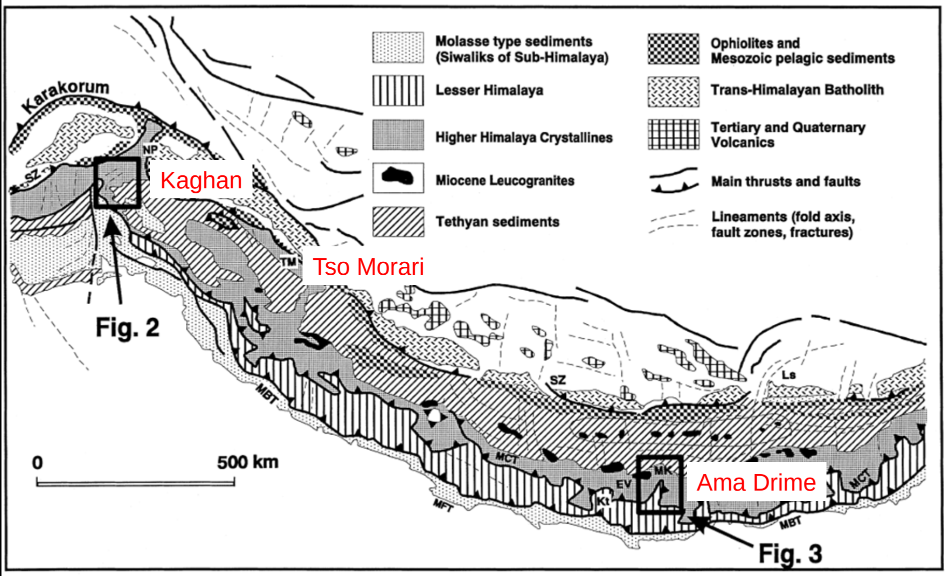


India–Asia

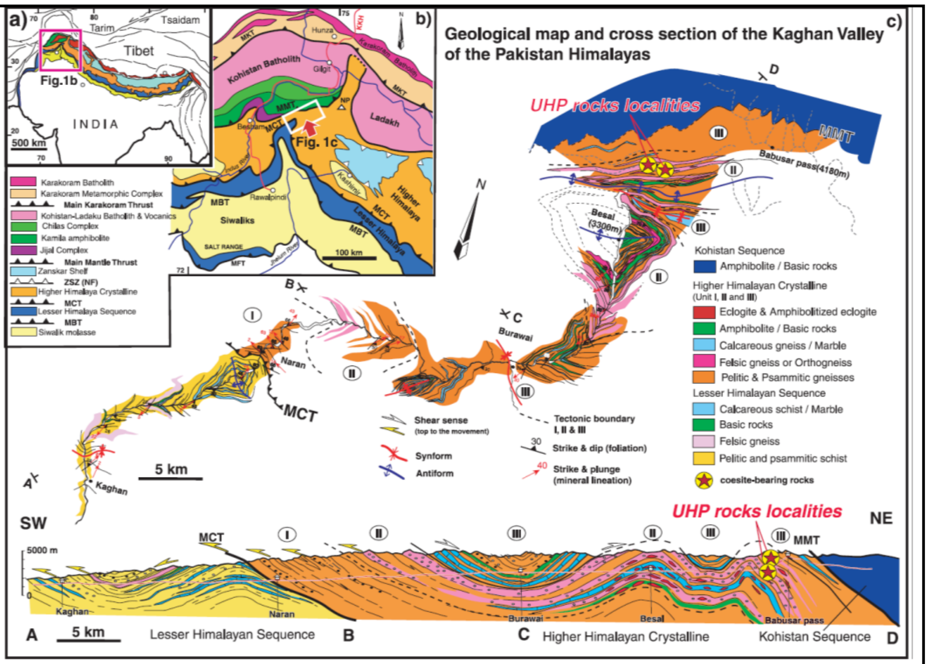


Owens and Zandt (1997)

Himalaya

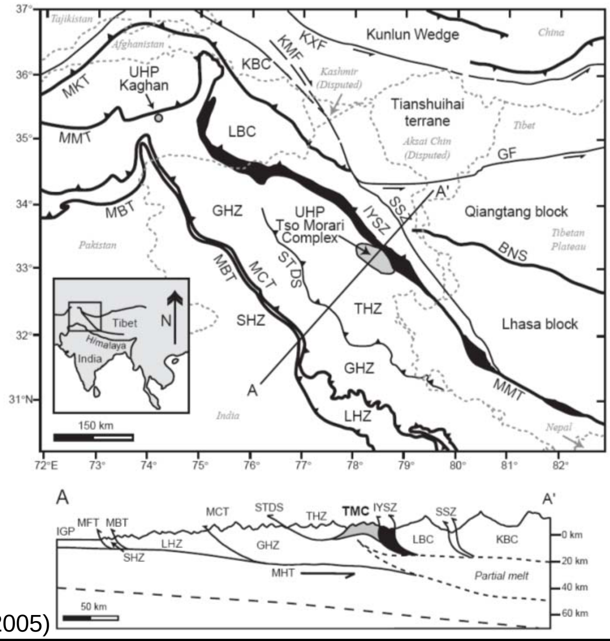


Lombardo & Rolfo (2000)



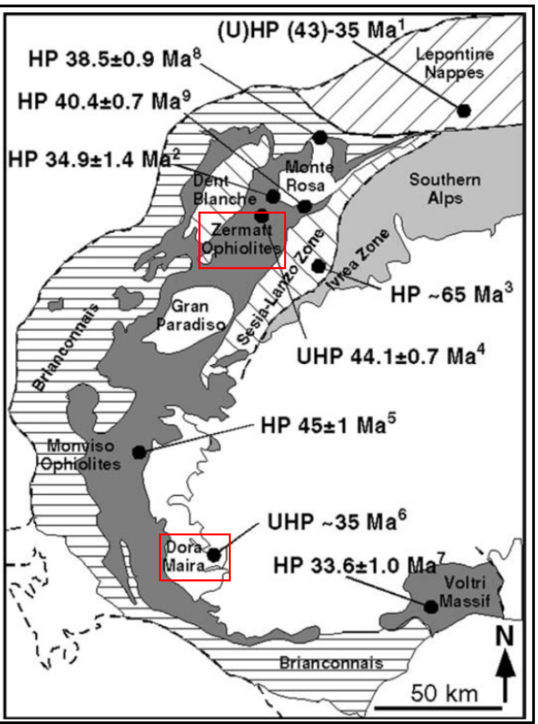
Kaneko et al. (2003)

Tso Morari



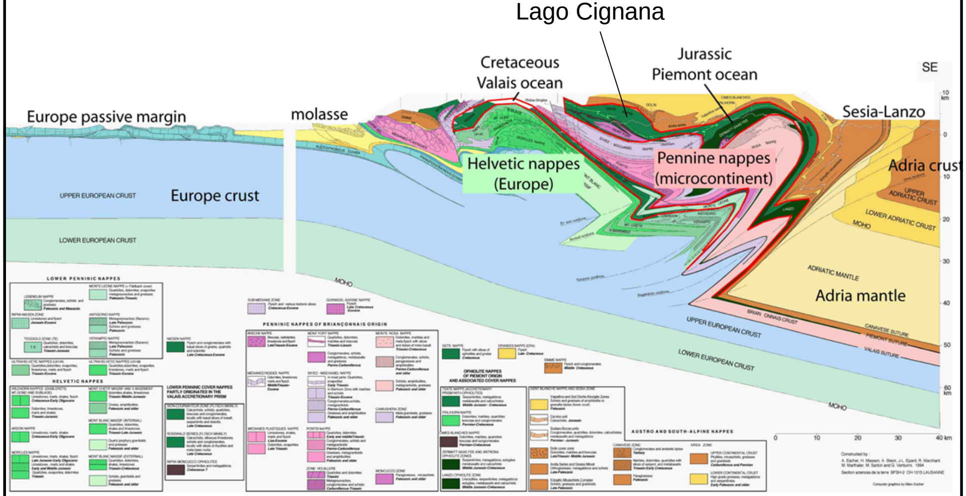
Leech et al. (2005)

Western Alps

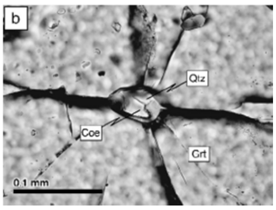


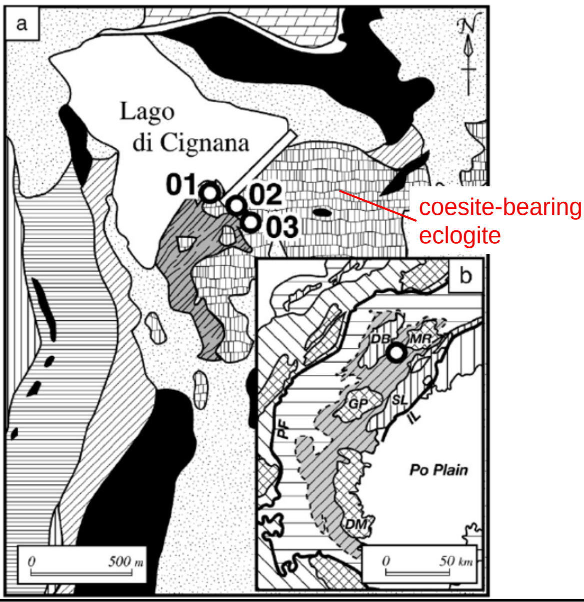
Rubatto et al. (2003)

Lago Cignana



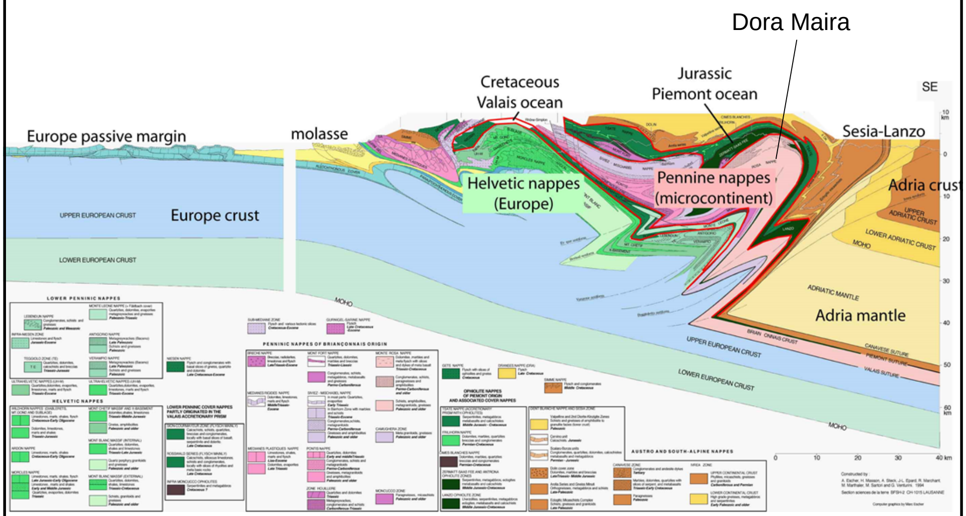
Lago Cignana



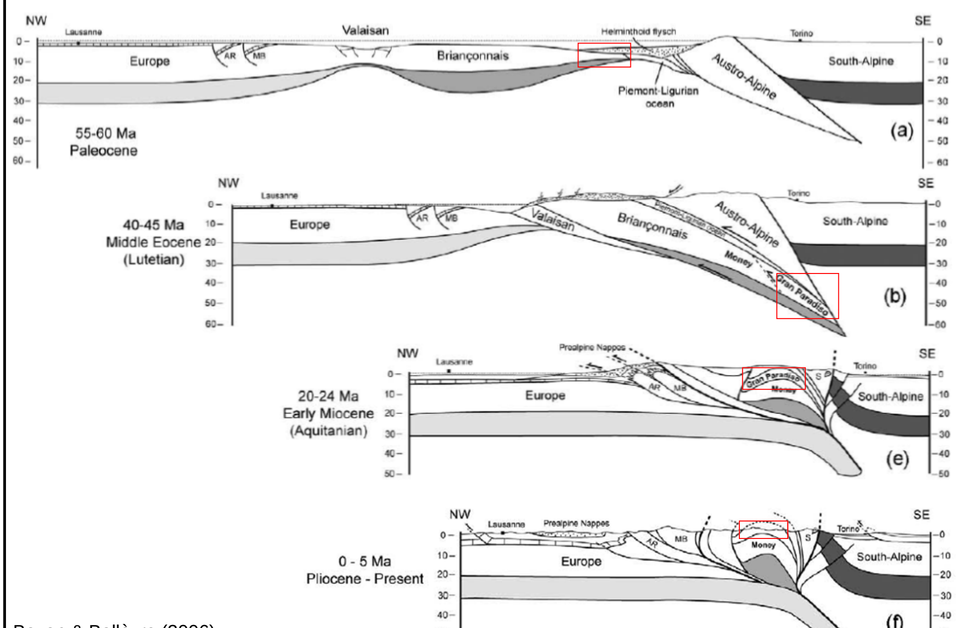


Gouzu et al. (2006)

Dora Maira

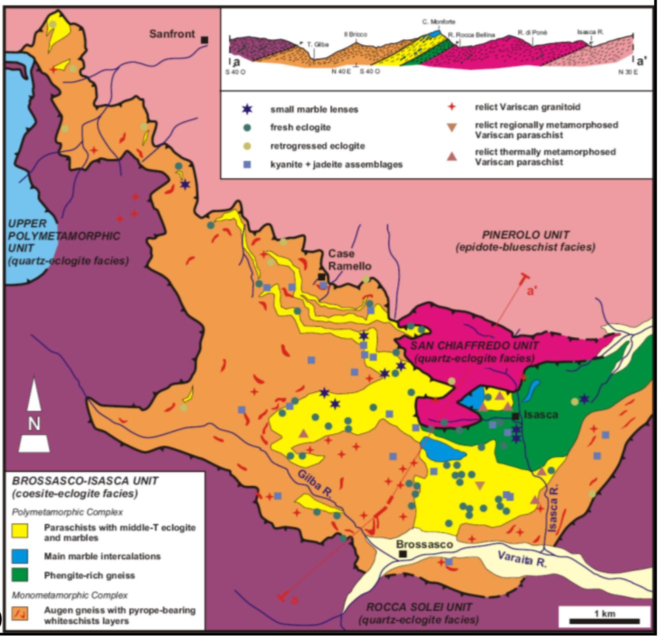


Dora Maira



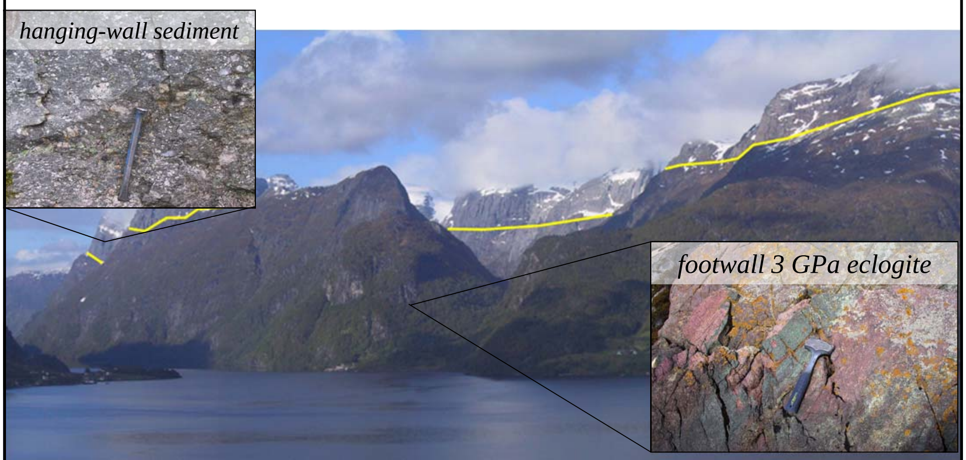
Bayon & Ballèvre (2006)

Dora Maira

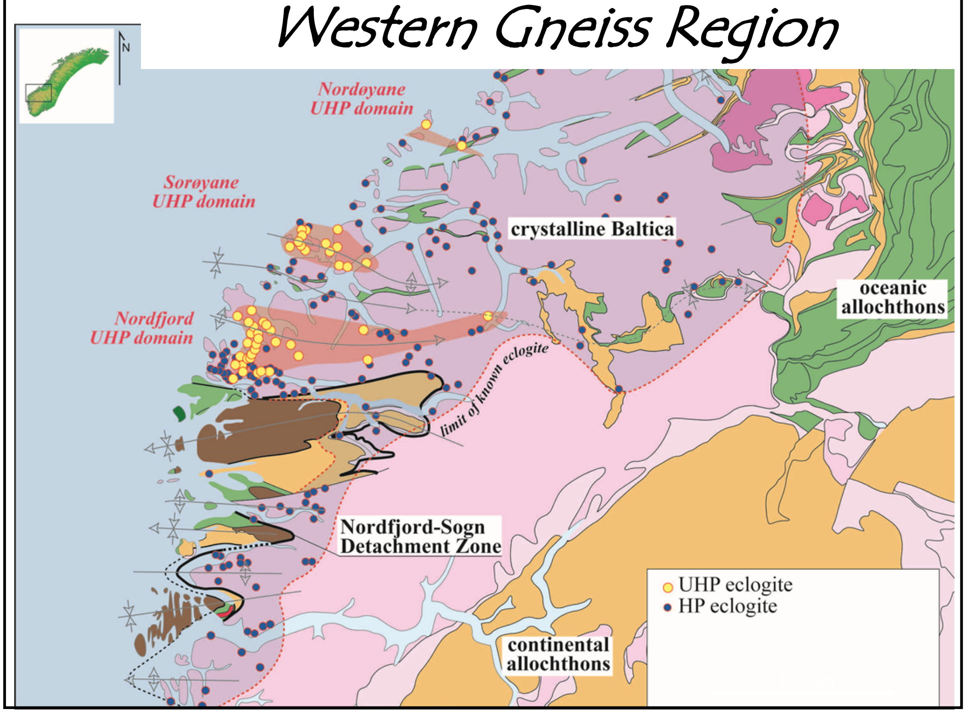


Compagnoni & Rolfo (2003)

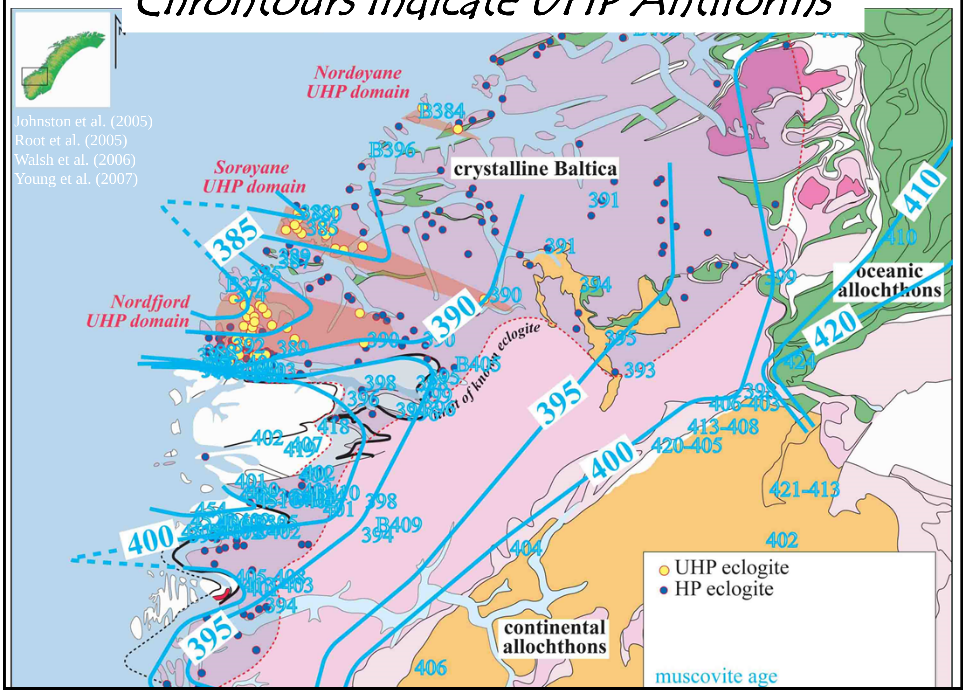
Giant Norwegian UHP Terrane



Western Gneiss Region

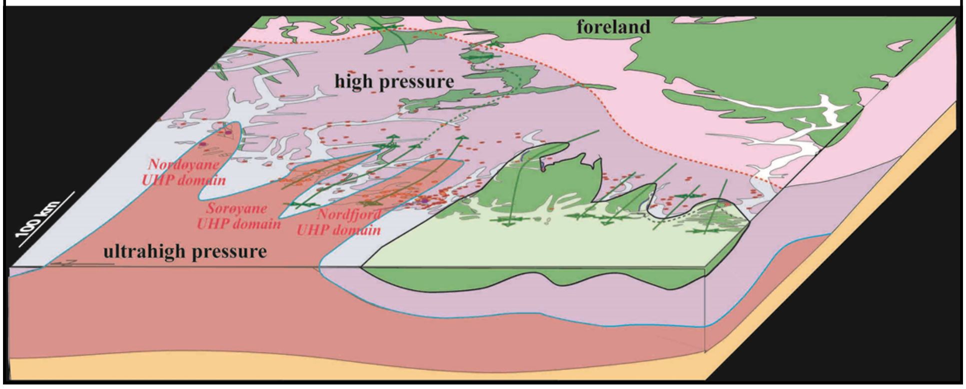


Chrontours Indicate UHP Antiforms



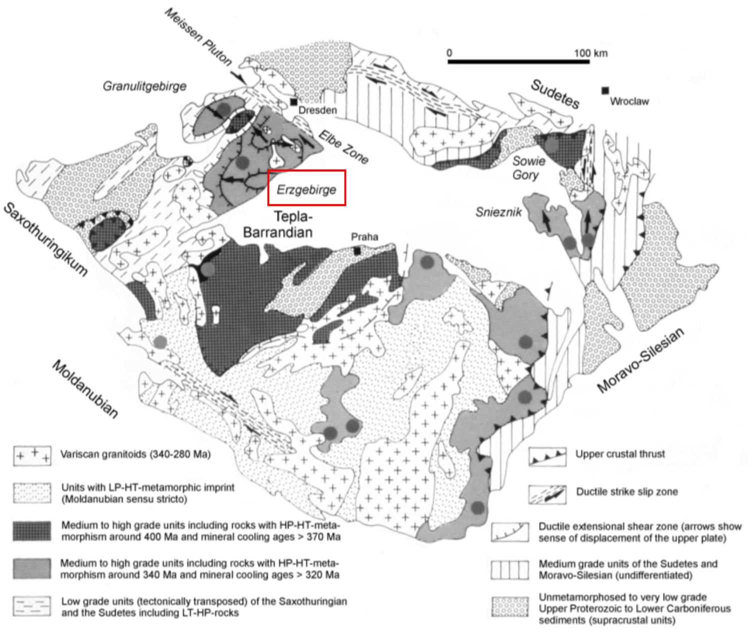
UHP Domains Underlie HP Region

- UHP antiforms are ~2500 km^2 to >100 km^2
- parallel those in allochthons to the south; <375 Ma
- if continuous at depth, >11,000 km^2 UHP overlain by HP veneer >60,000 km^2



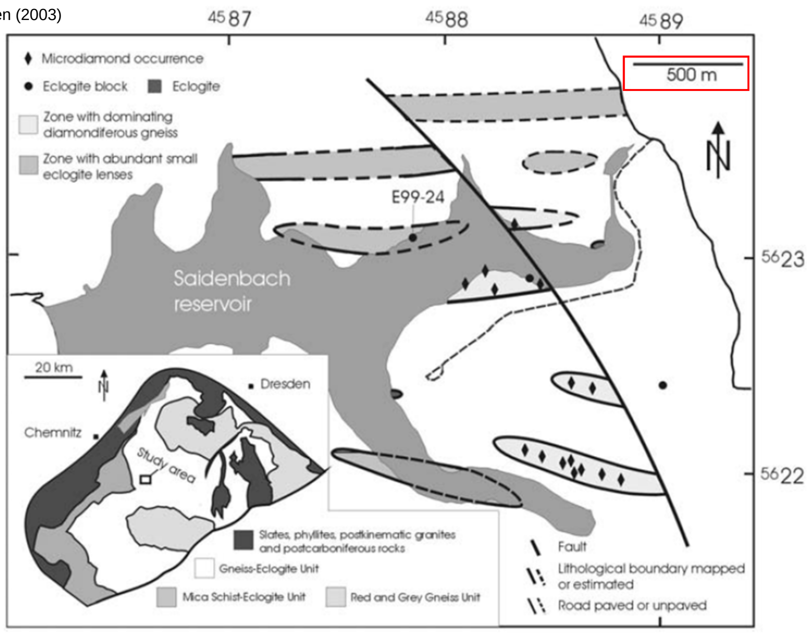
Bohemian Massif

Willner et al. (2000)

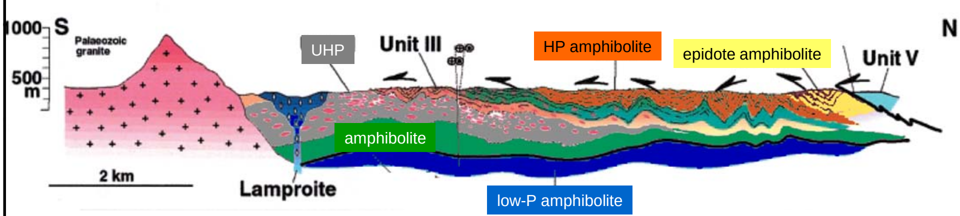


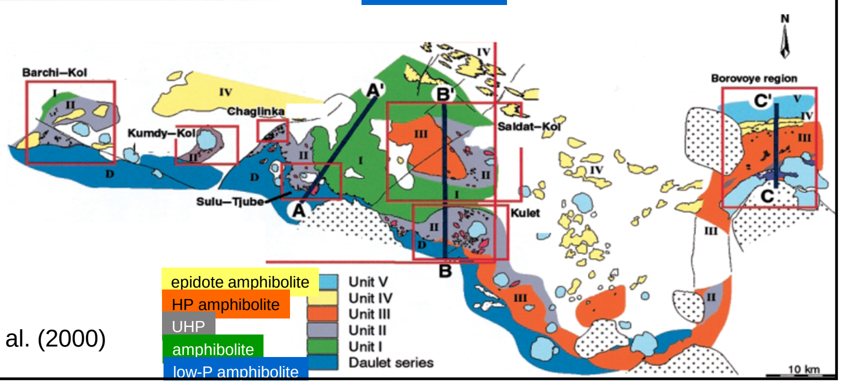
Diamondiferous quartzofeldspathic gneiss, Saidenbach Reservoir

Massonne & O'Brien (2003)



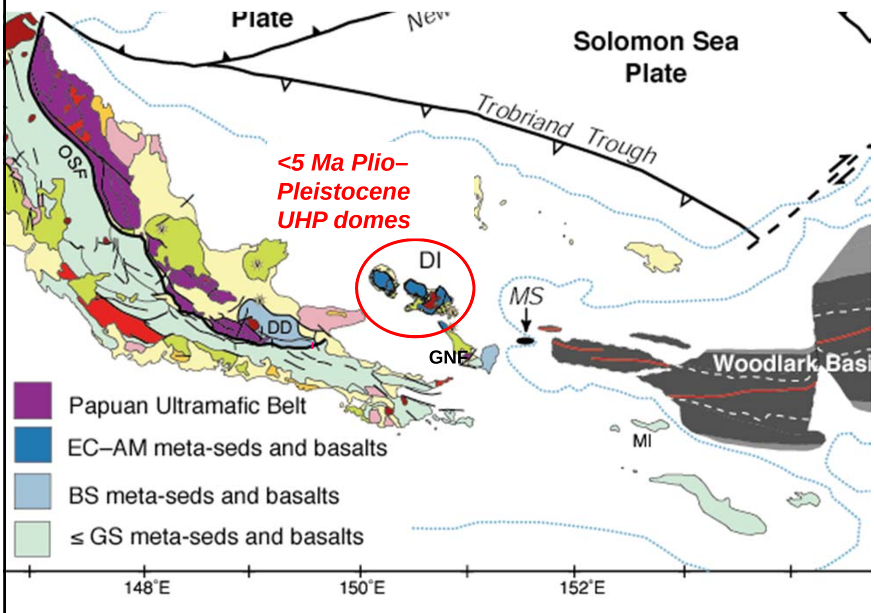
Kokchetav Massif, Kazakhstan



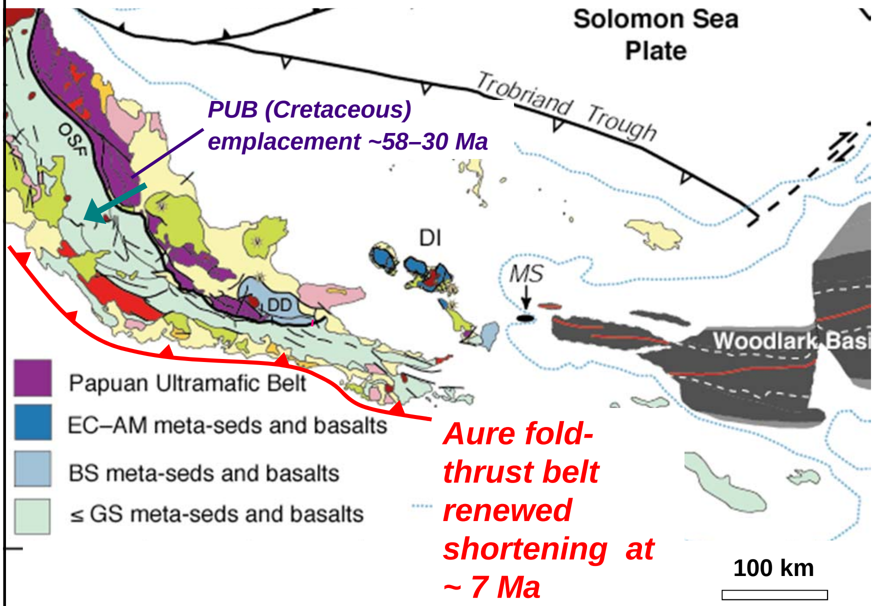


Kaneko et al. (2000)

Continental Rift: Papua New Guinea

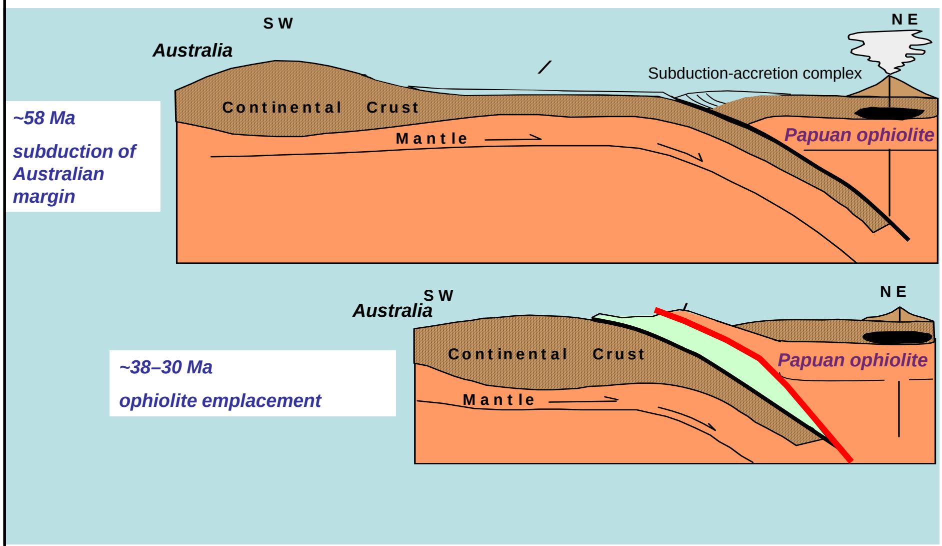


Emplacement of the Papuan Ultramafic Body (PUB)



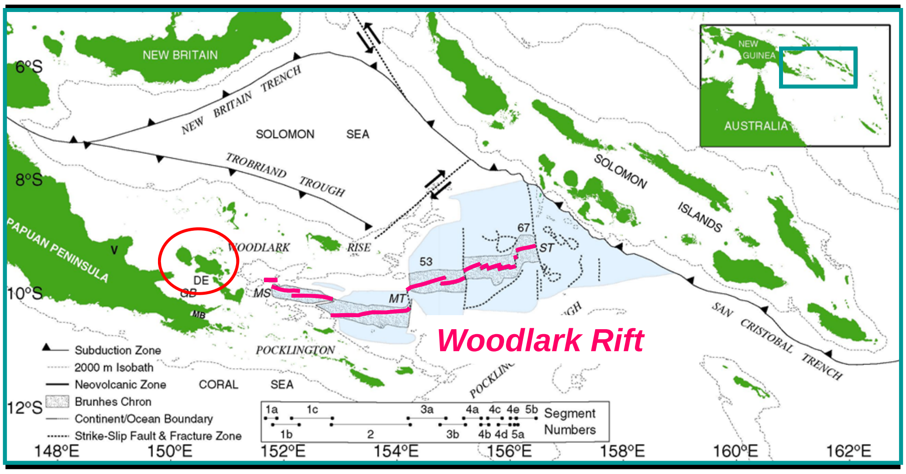
Davies, 1980; Lus et al., 2004; Cloos et al., 2005

Peninsular Collisional Orogen



Davies, 1992

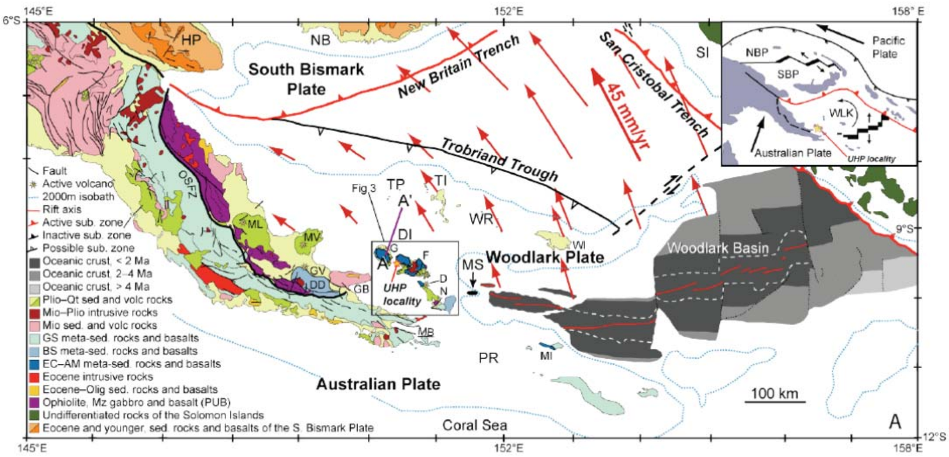
UHP Rocks at MOR Tip



6 Ma onset of seafloor spreading propagating westward

Taylor and Huchon, 2002

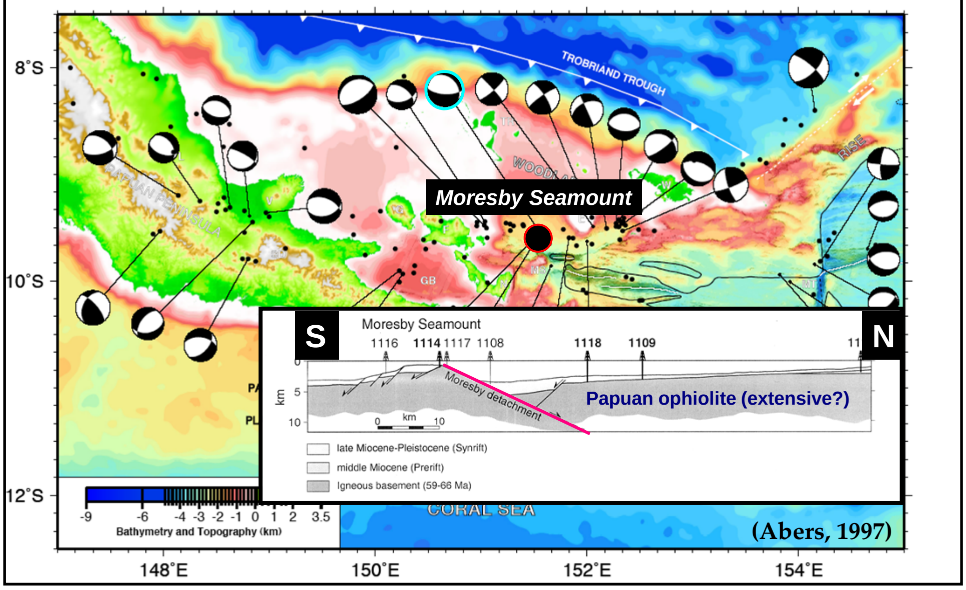
Plate Motion

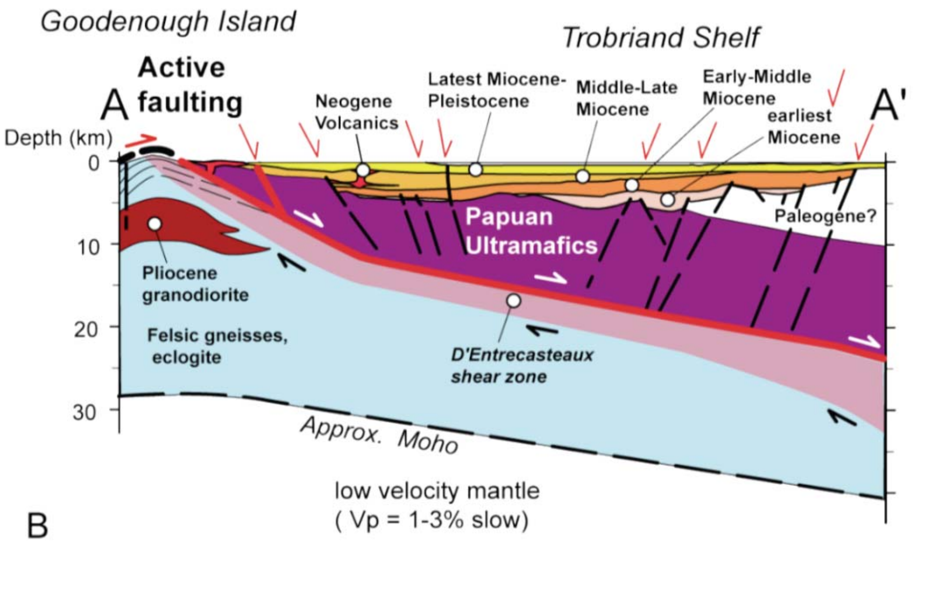


(Relative to Australian Plate)

Seismicity & Focal Mechanisms

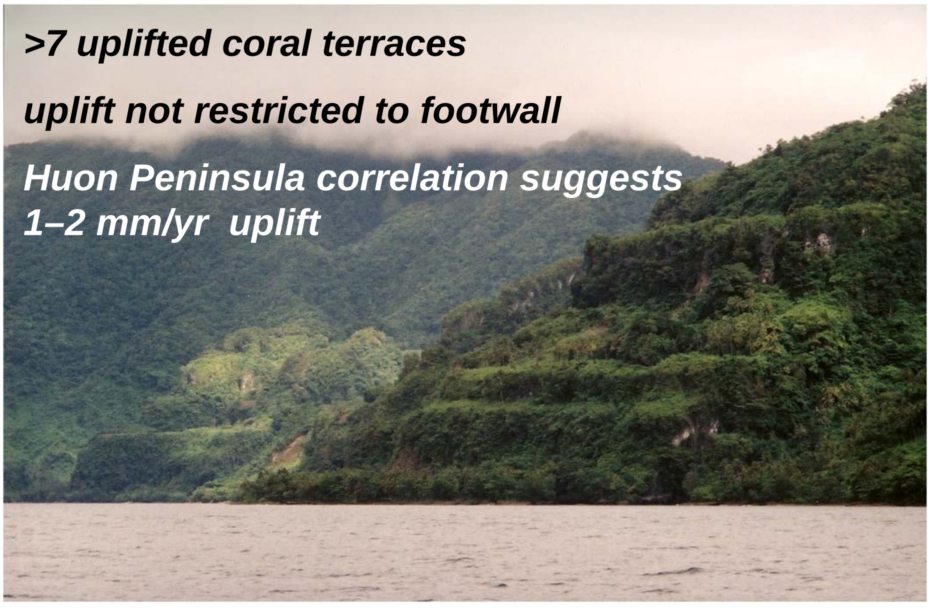
N–S extension on 23–35° normal faults near MOR tip





Goodenough Island active normal fault

Misima Island Uplift



Subduction Erosion

- Active
  - Central America
- Ancient
  - Pamir

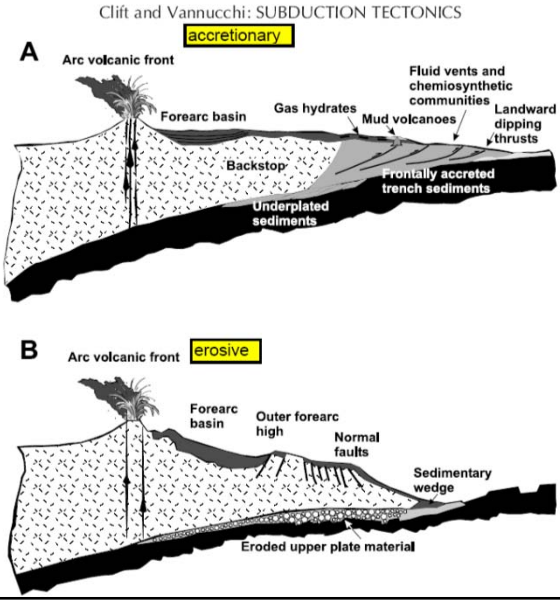
Subduction Erosion

half of arcs are erosional

favored where convergence rate >60 mm/a

favored where trench sediments <1 km

ridge-collision events are important controls on rate



(Clift & Vannucchi, 2004)

Subduction Erosion

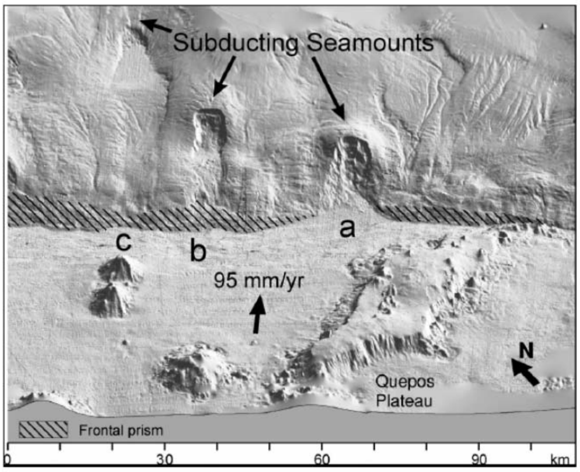
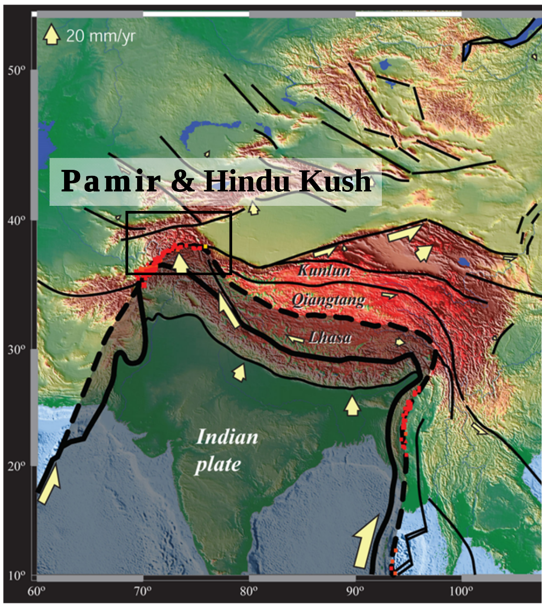
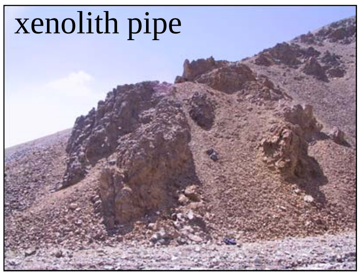


Figure 2. Perspective of multibeam bathymetry off central Costa Rica showing disruptive morphology from subducting seamounts: a—subducting seamount has breached prism; b—breach is healing; c—healed prism is modified by secondary seafloor features.

von Huene et al. (2004)

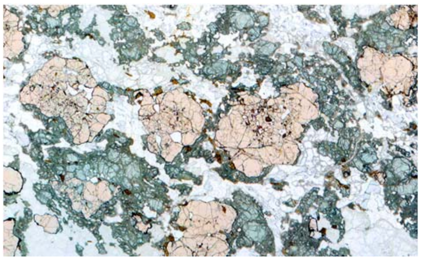
Subduction Erosion: Pamir Xenoliths



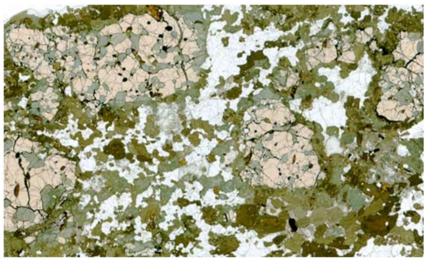


Eclogite-Facies Continental Crustal Xenoliths with Extreme Metasomatism & Devolatilization

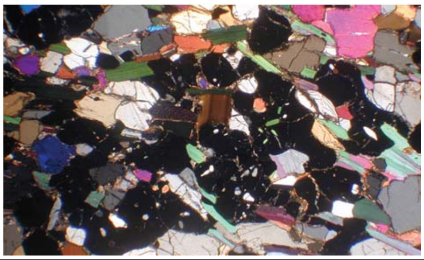
sanidine–kyanite ‘eclogite’



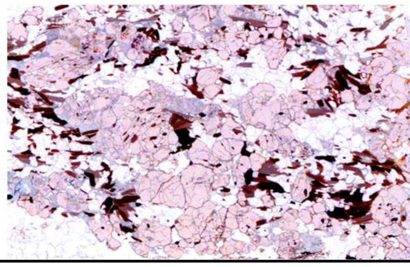
sanidine–phlogopite ‘eclogite’



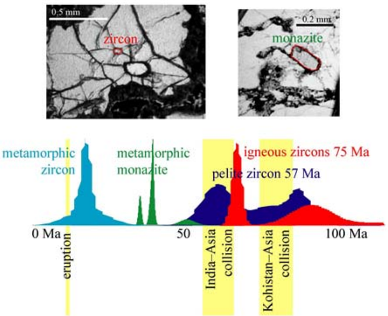
phlogopite–garnet orthopyroxenite



kyanite–garnet ‘eclogite’

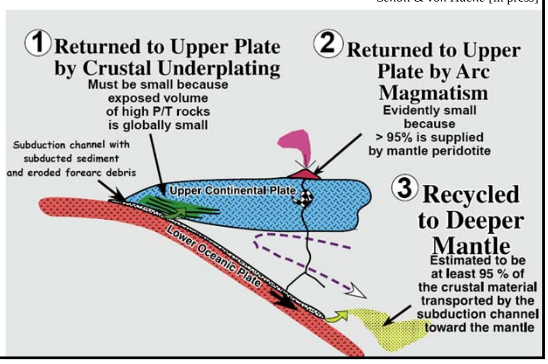


Subduction Erosion of Asian Margin



Ducea et al. [2003]

Scholl & von Huene [in press]



Extreme Sub-Moho Refining Conditions