Seisme du Japon
11 Mars, 2011

Main shock (9.1)
and after shocks
with tsunami
(port wave)

Geotectonic evolution of the Japanese Islands

significance not only for Japan but also for the whole mantle

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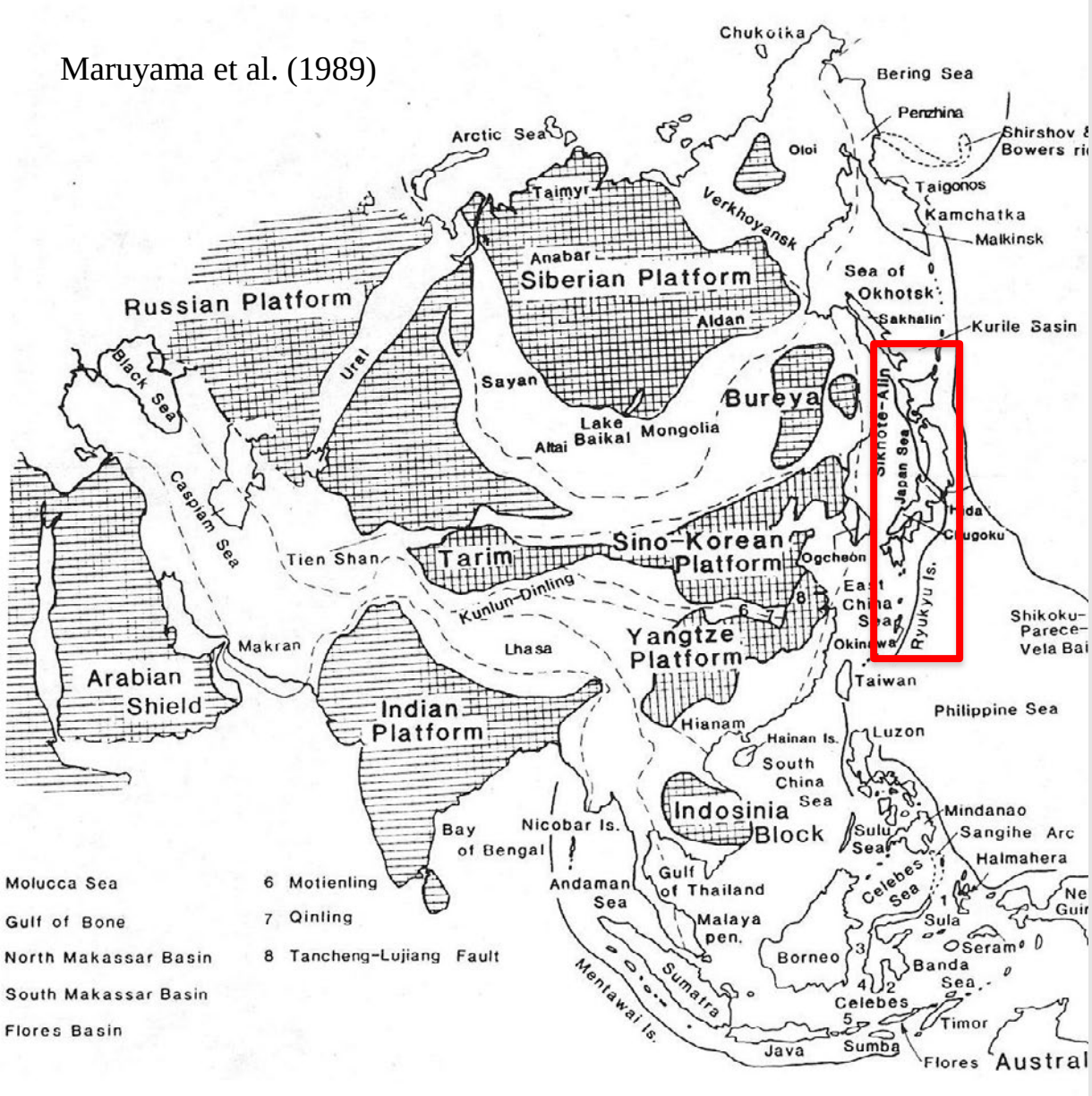
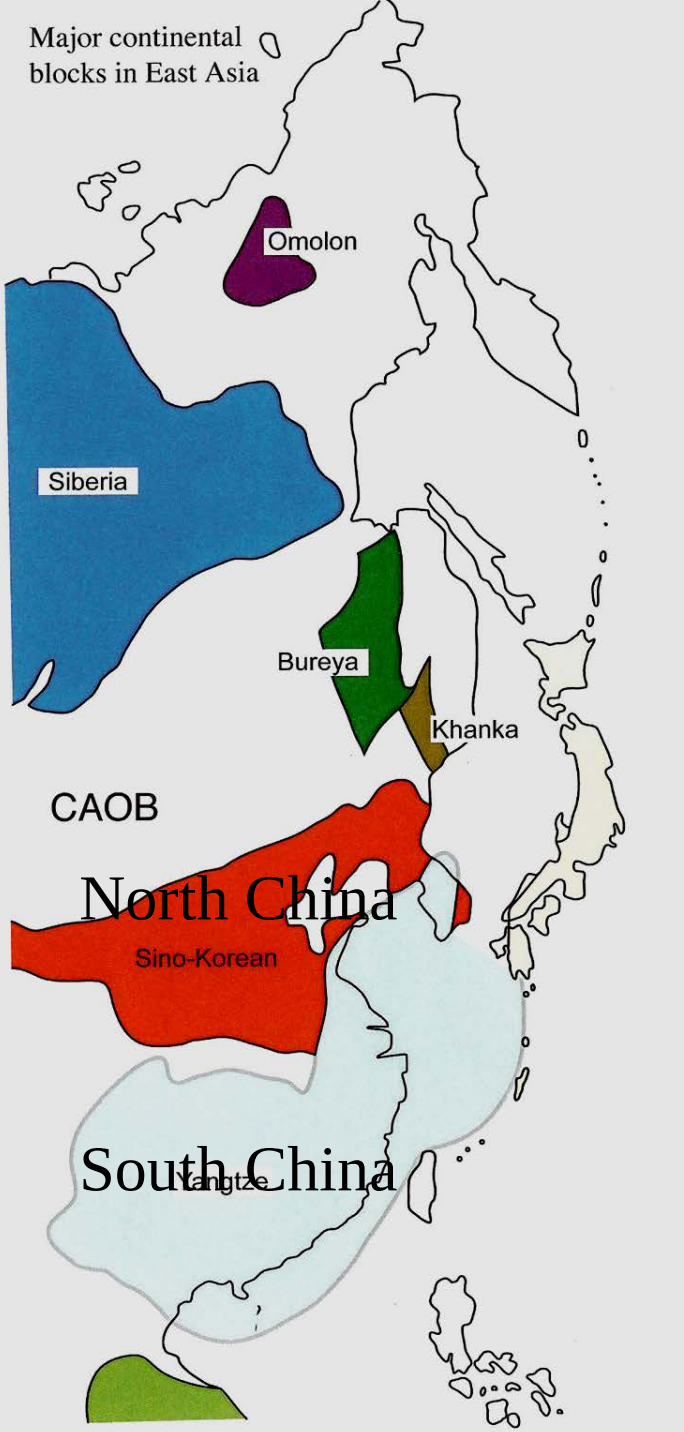
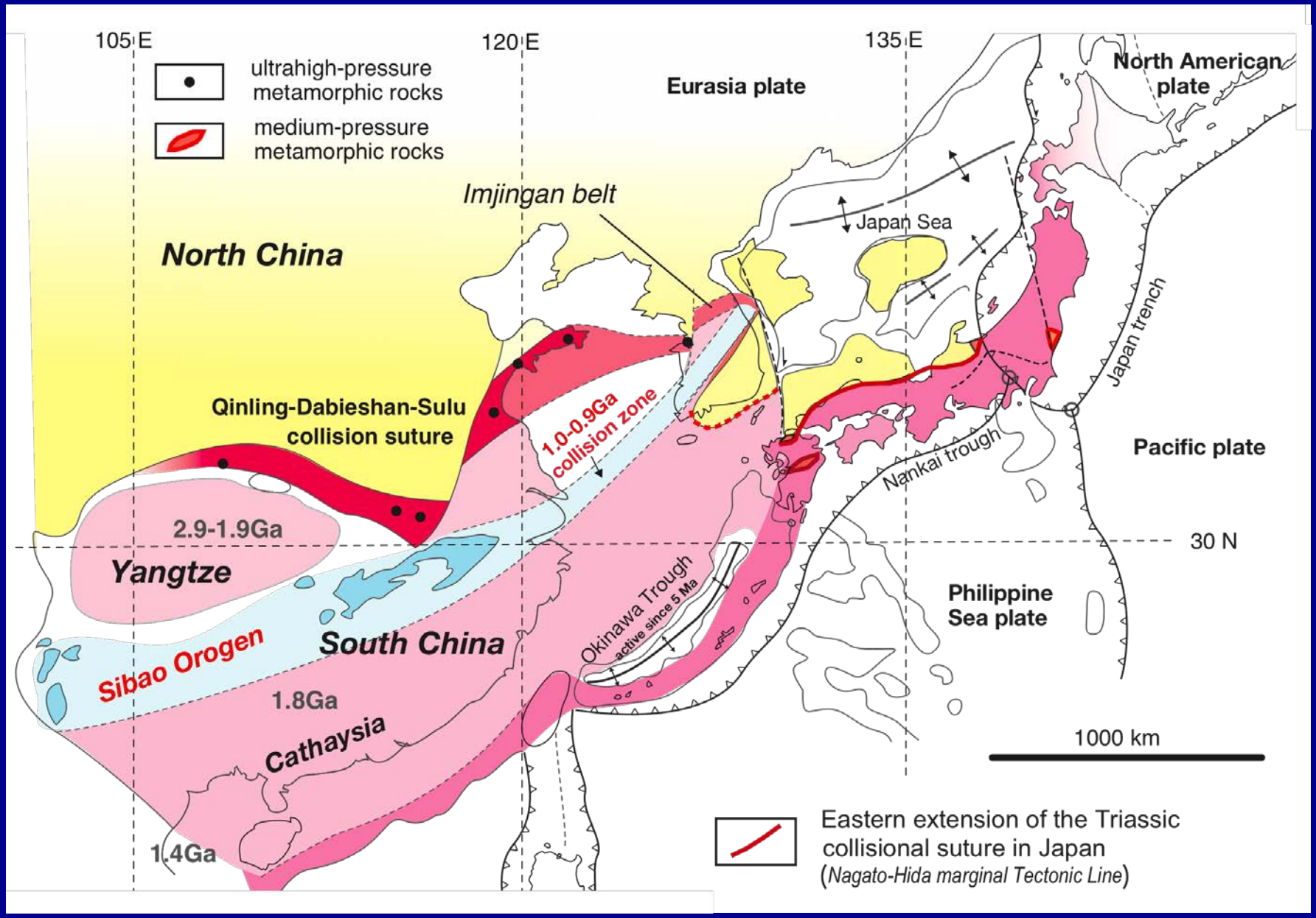
Maruyama et al. (1989)





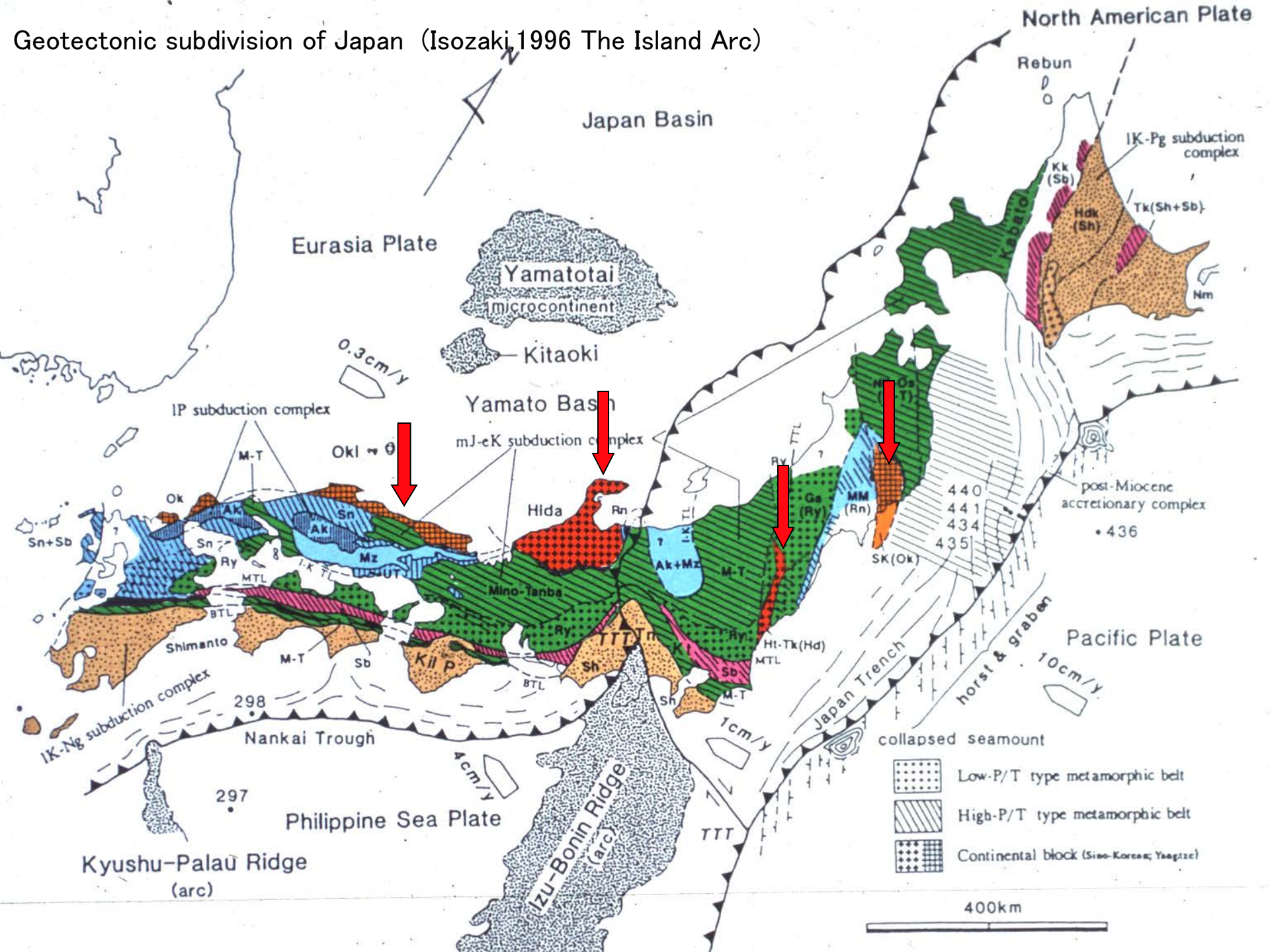
Asia is a composite continent
composed of 9-10 blocks

Old Japan along South China (Yangtze) block



(Isozaki et al., 2011)

Geotectonic subdivision of Japan (Isozaki,1996 The Island Arc)



ca. 900 million year-long history of the Japanese Islands in 1 minute

Ma: million years ago

birth @a rift: 700 Ma

early growth @passive margin: 700-500 Ma

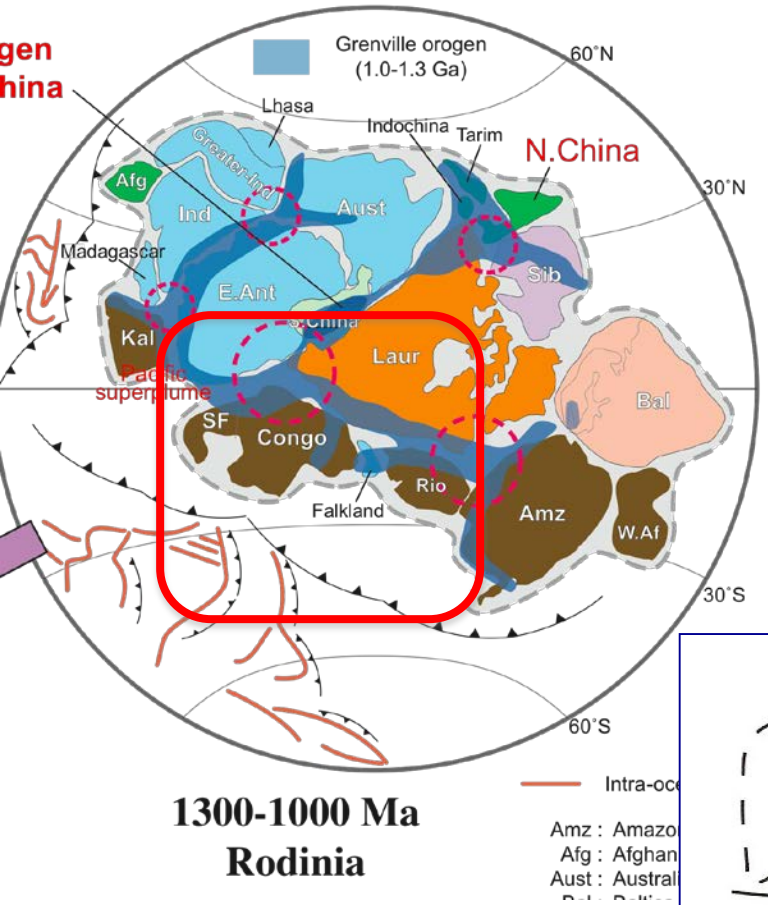
tectonic conversion: 500 Ma

accretionary growth: 500 Ma-50 MaAP

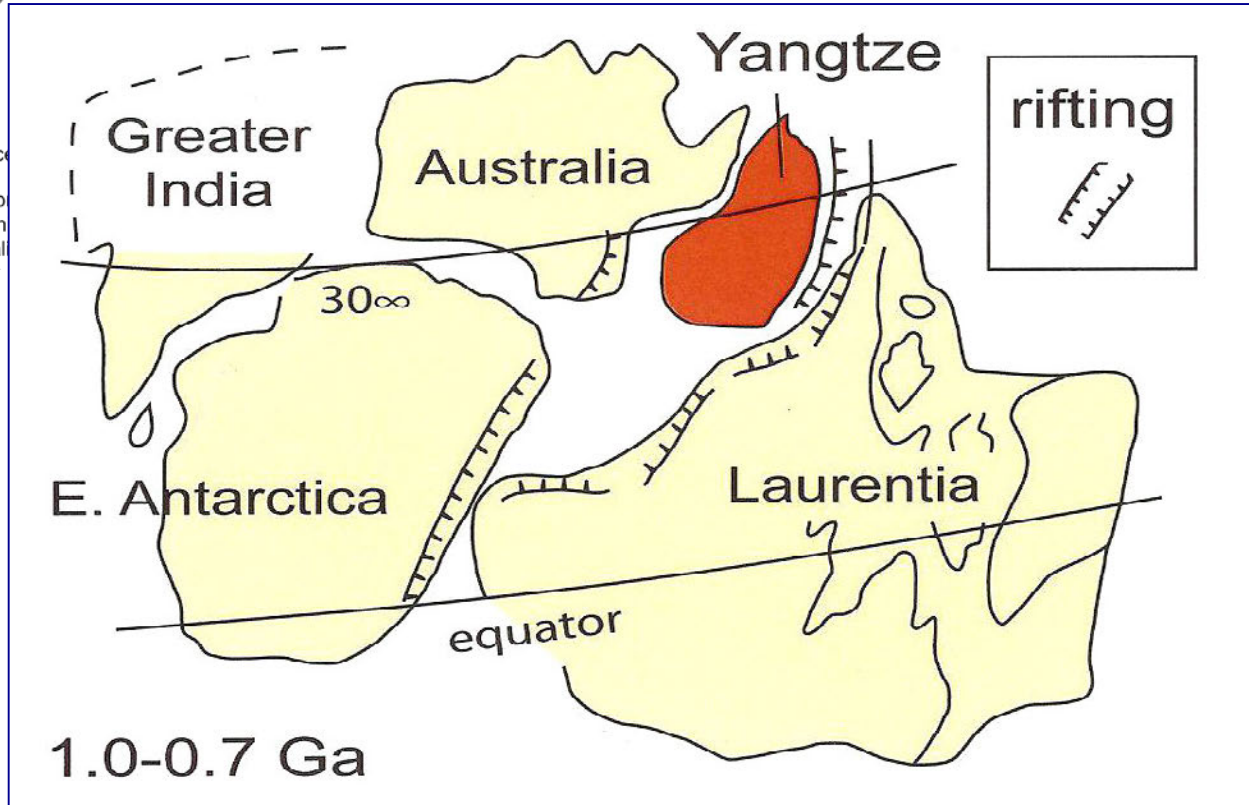
demise in collision: 50-200 MaAP

700 Ma breakup of the supercontinent Rodinia

(Rino et al., 2009)



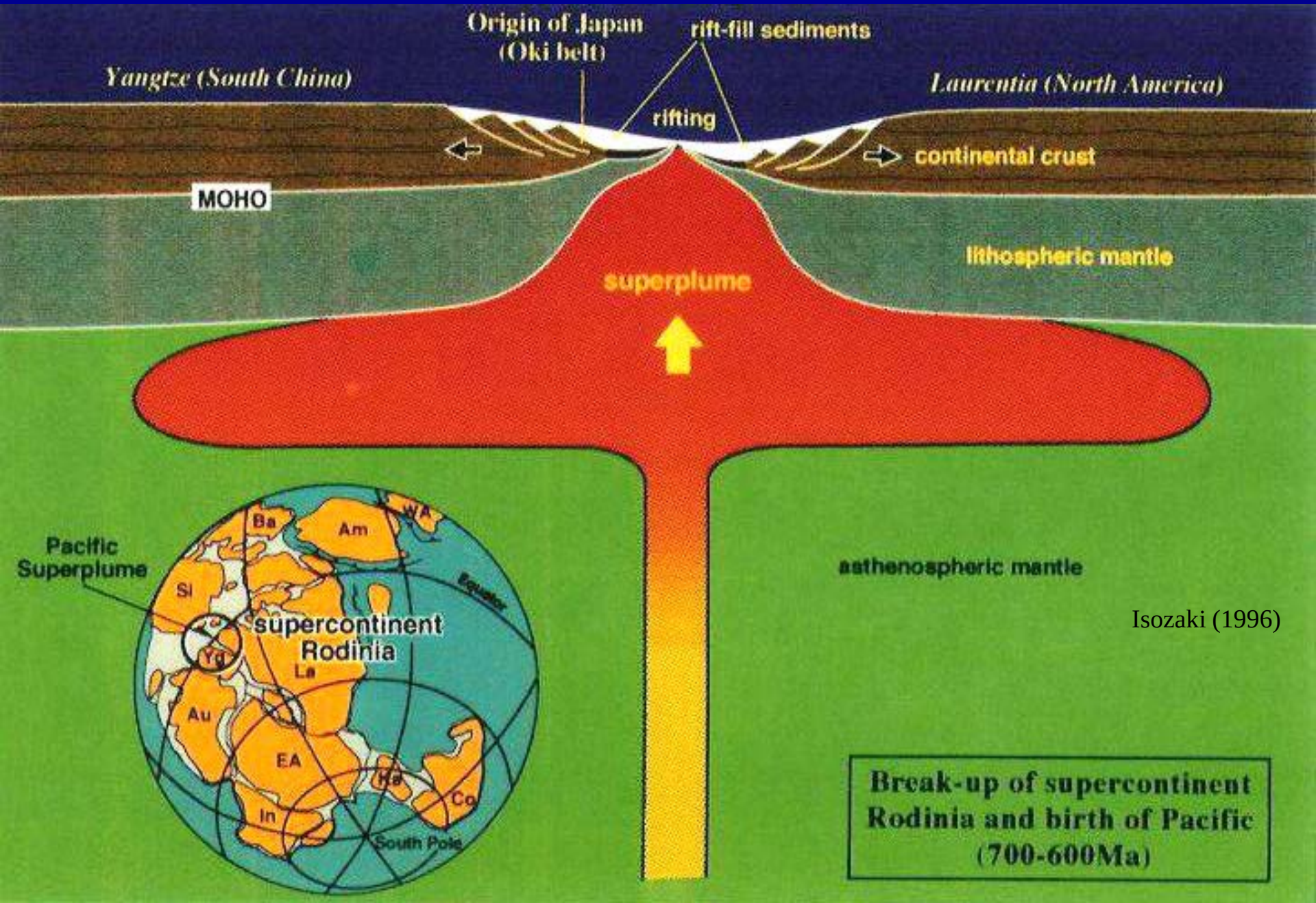
1300-1000 Ma Rodinia



birth @ S. China margin

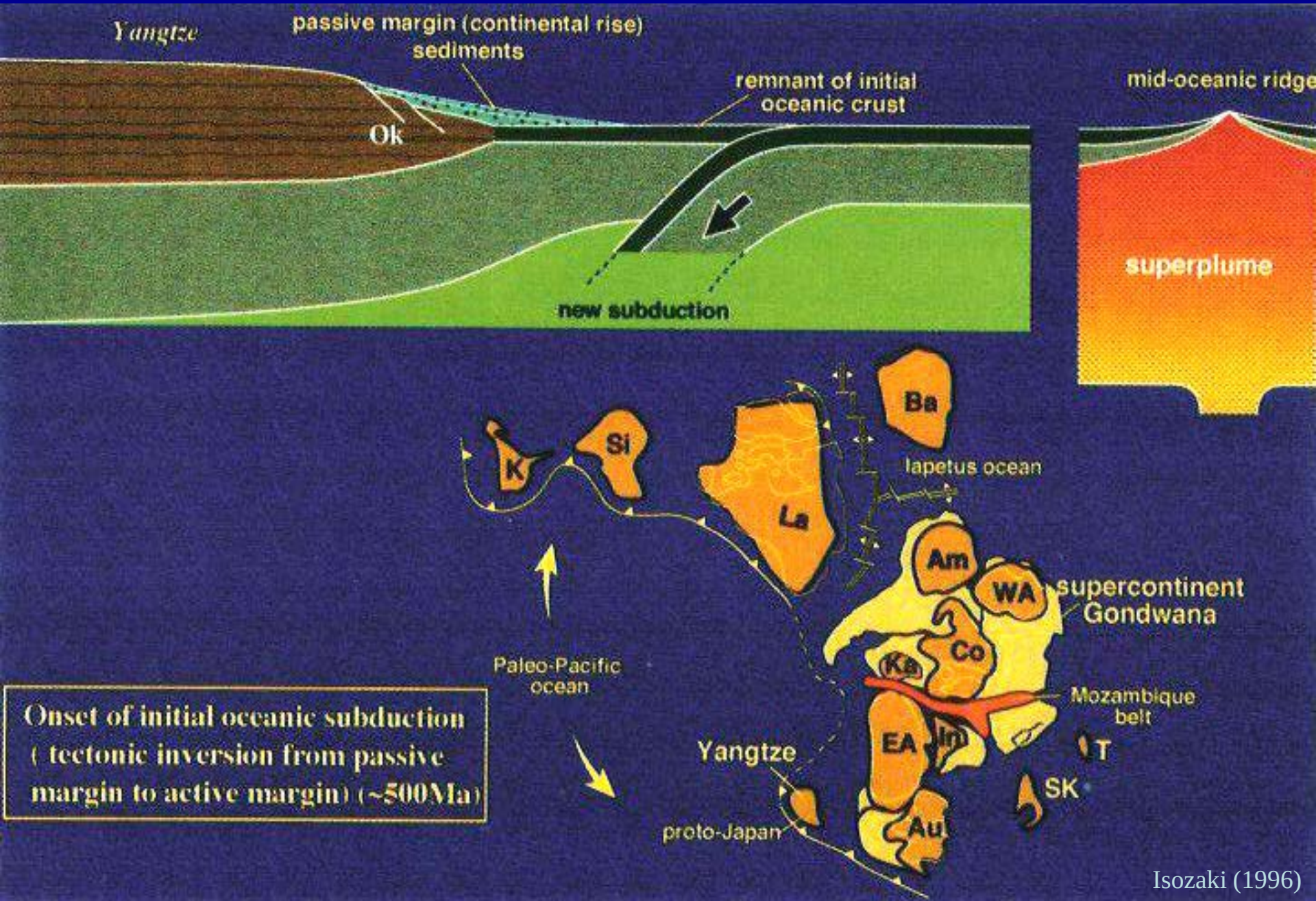
counterpart: western N. America (Laurentia)

“Say Good-bye to Hollywood!”

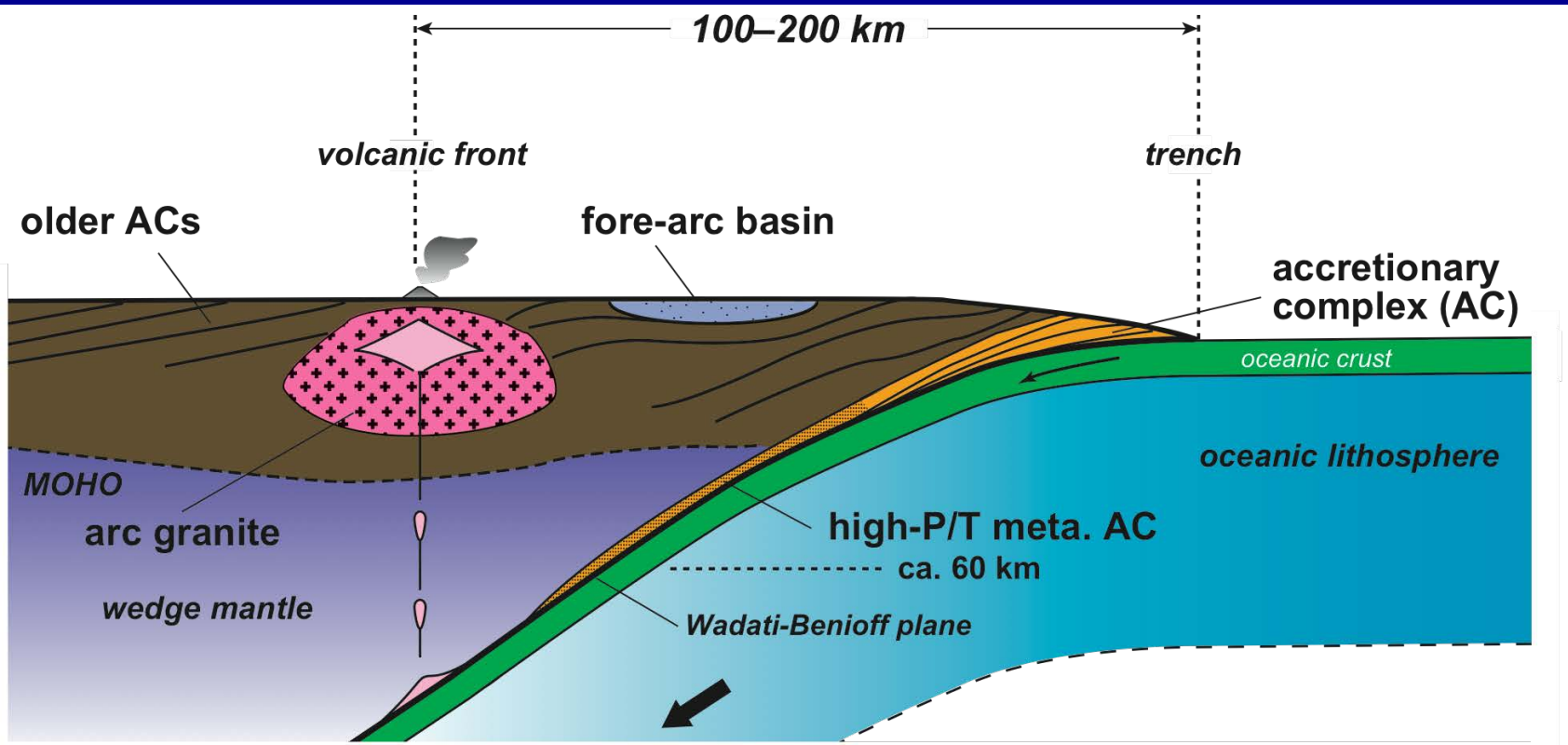


Isozaki (1996)

Initiation of oceanic subduction (500 Ma)



Isozaki (1996)

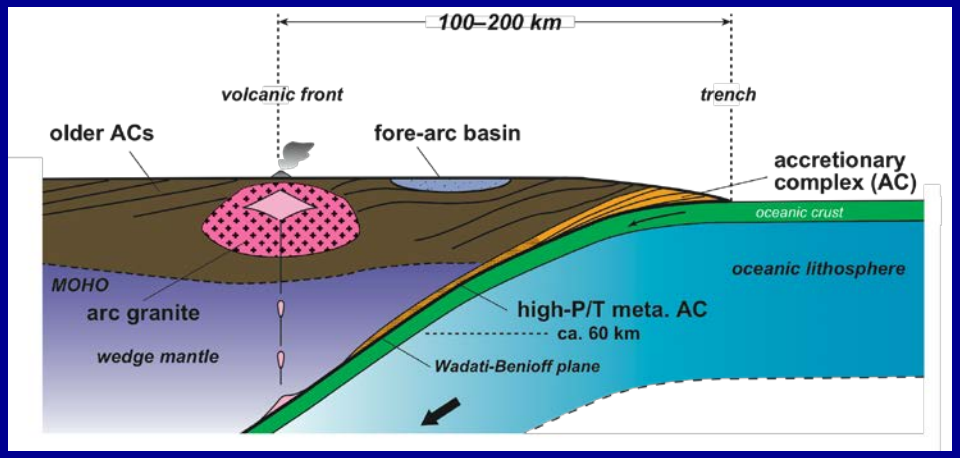


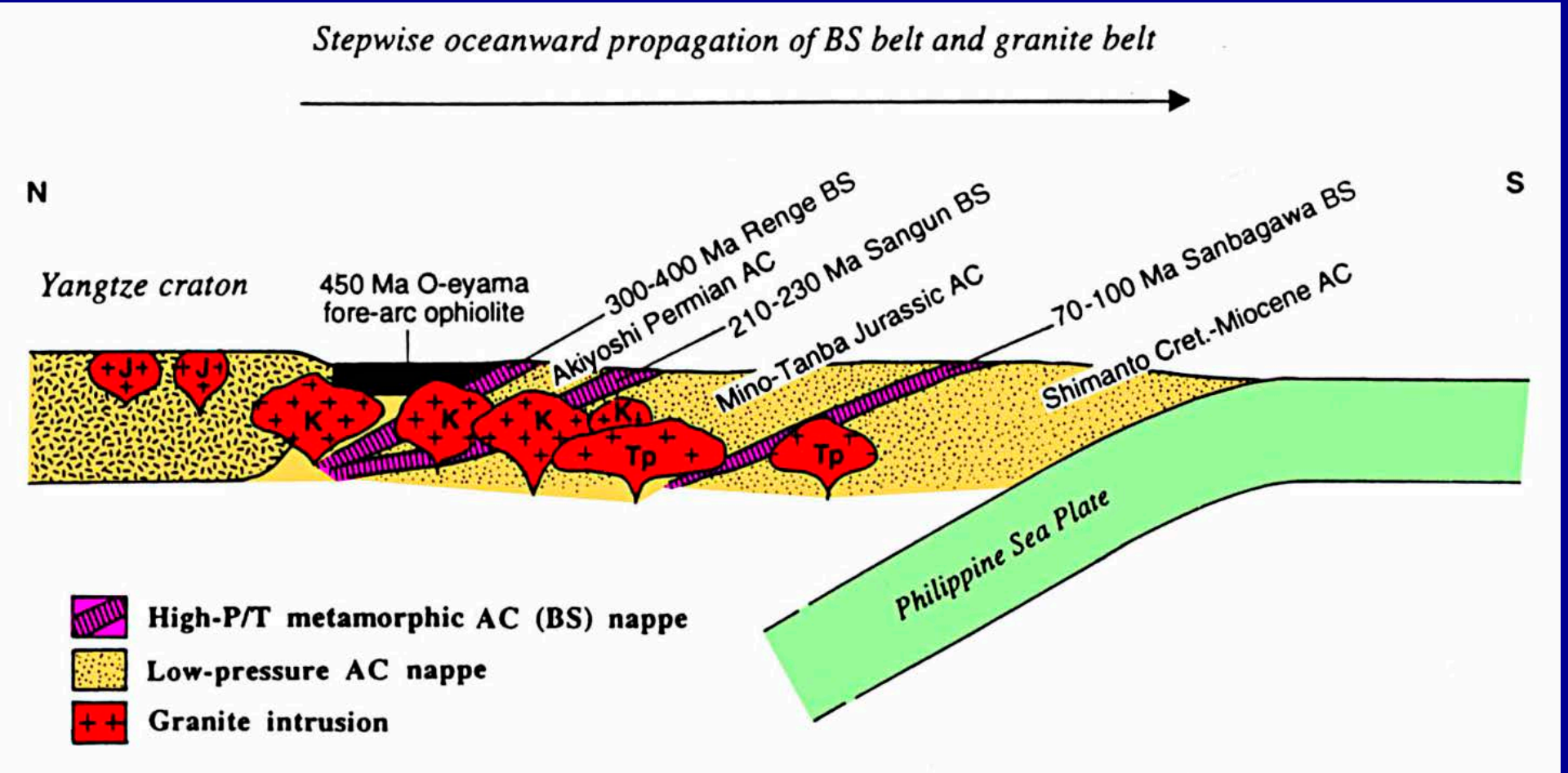
essential geologic elements formed along arc–trench system
(Isozaki et al., 2010, 2011)

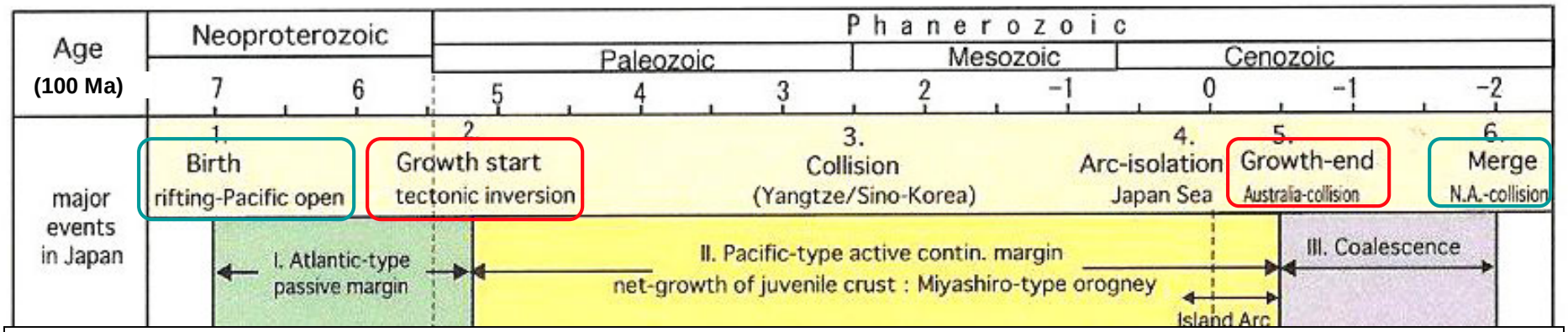
accretionary complex (AC)
blueschists (high-pressure meta-AC)
fore-arc +back-arc basin sediments
arc granite: factory of continental crust beneath volc. arc

oceanward growth
of continental crust
along active continental margin

net continental growth:
juvenile addition of arc granite

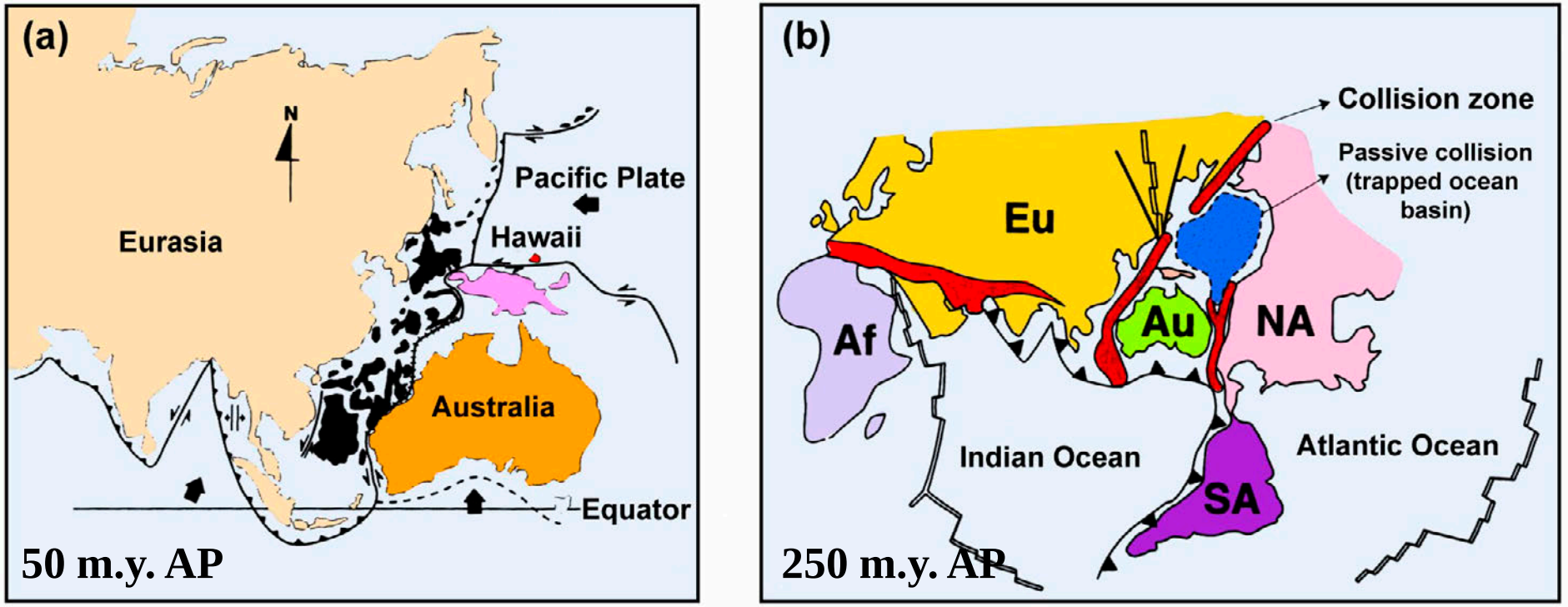






lifetime of Pacific Ocean

Grand finale @ ca. 200 m.y. after present



Geograpy of Asia at (a) 50 million years and (b) 250 million years after present

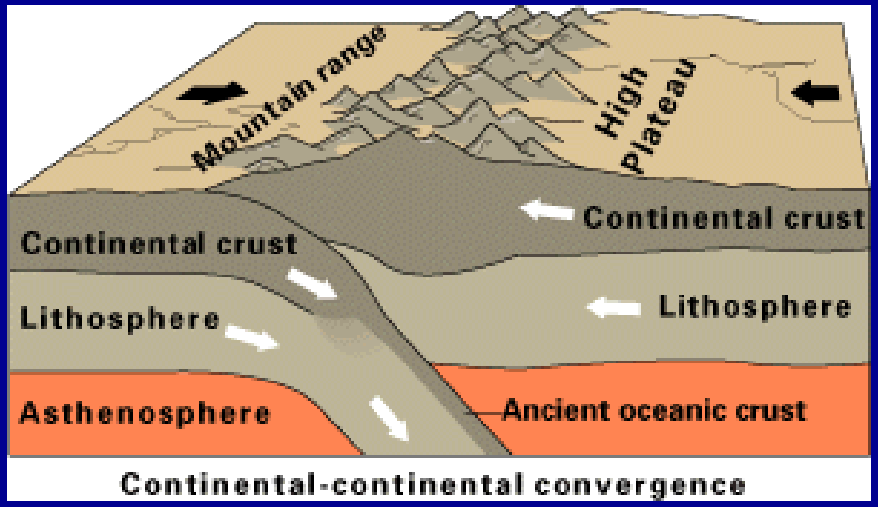
end of Japan = end of the Pacific Ocean
= formation of the next supercontinent

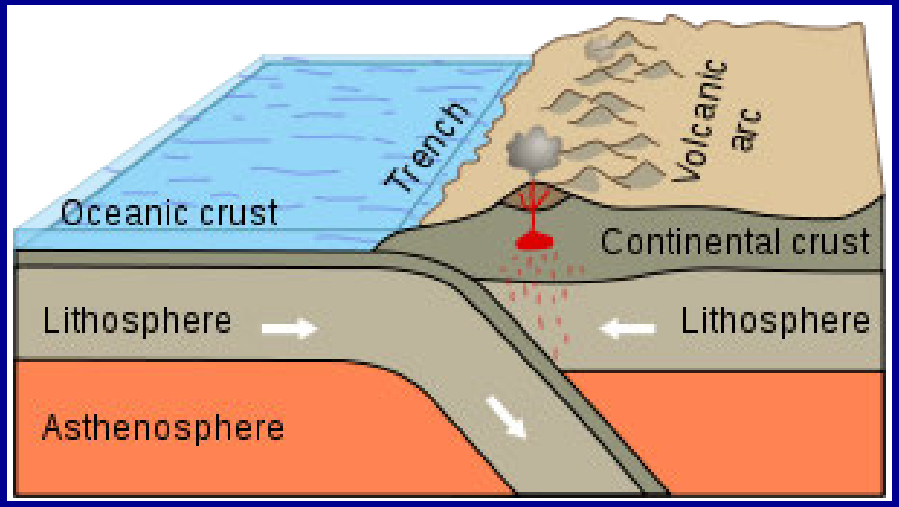
America + Asia = ***Amasia***

Dewey & Bird (1970) Jour. Geophys. Res.

highly cited classic paper on mountain building processes based on plate tectonics

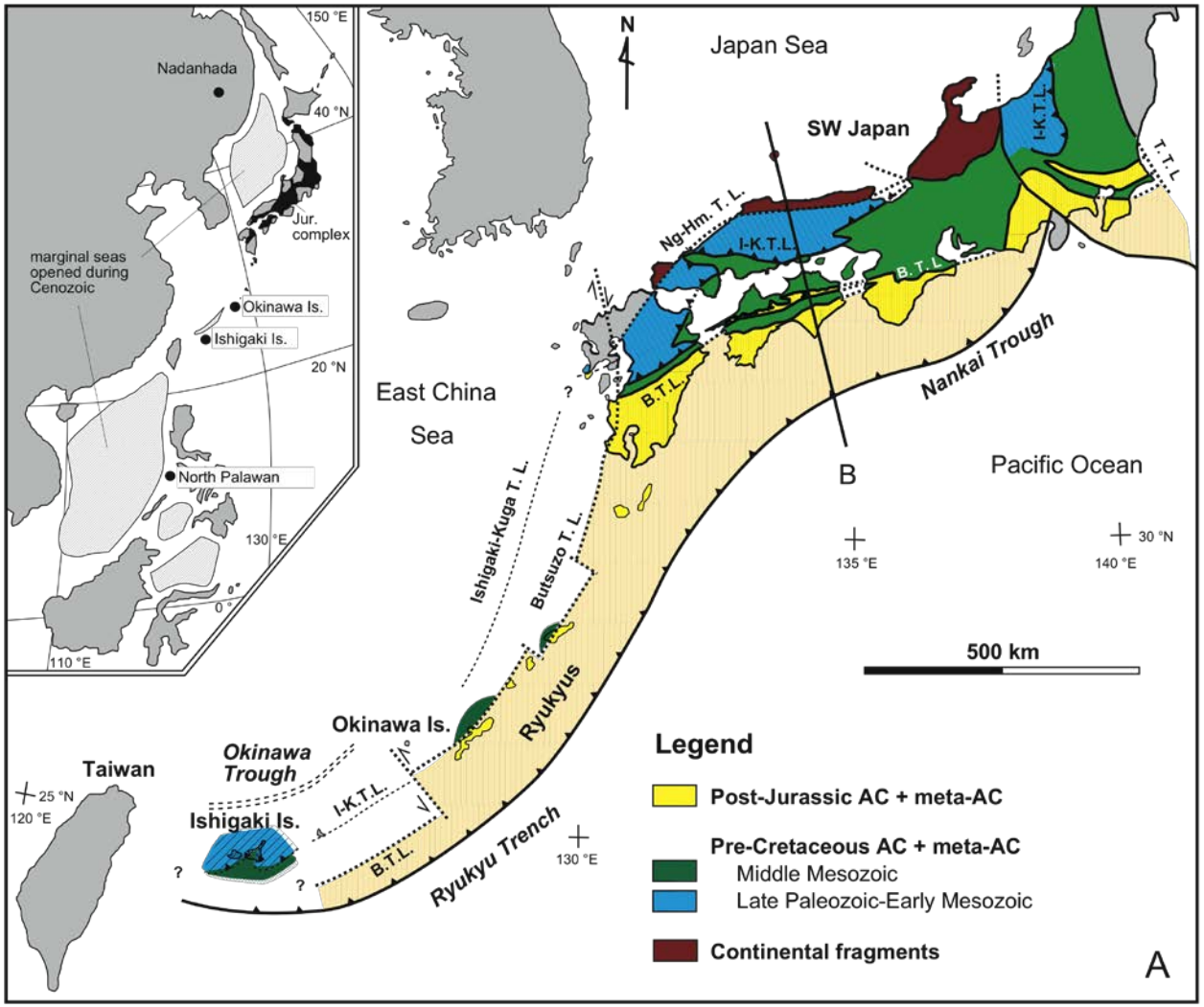
collision-type vs. Cordilleran-type

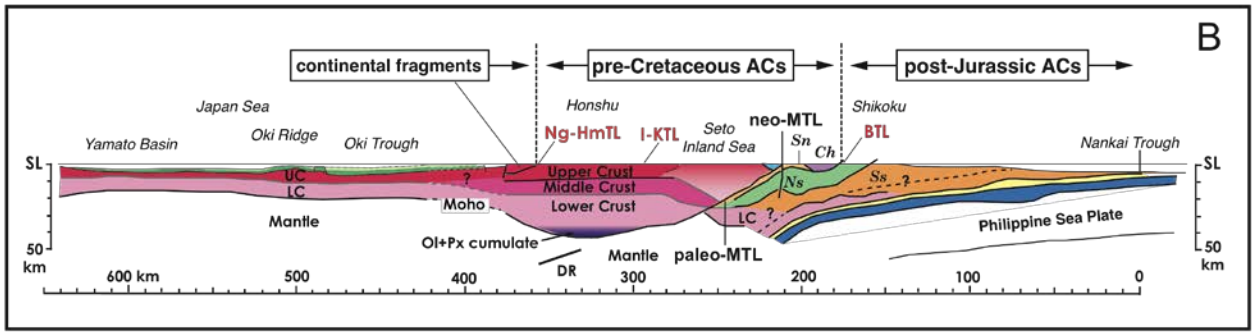




Alpine-Himalaya
Variscan/Hercynian
Caledonian

California, B.C.,
Japan
circum-Pacific

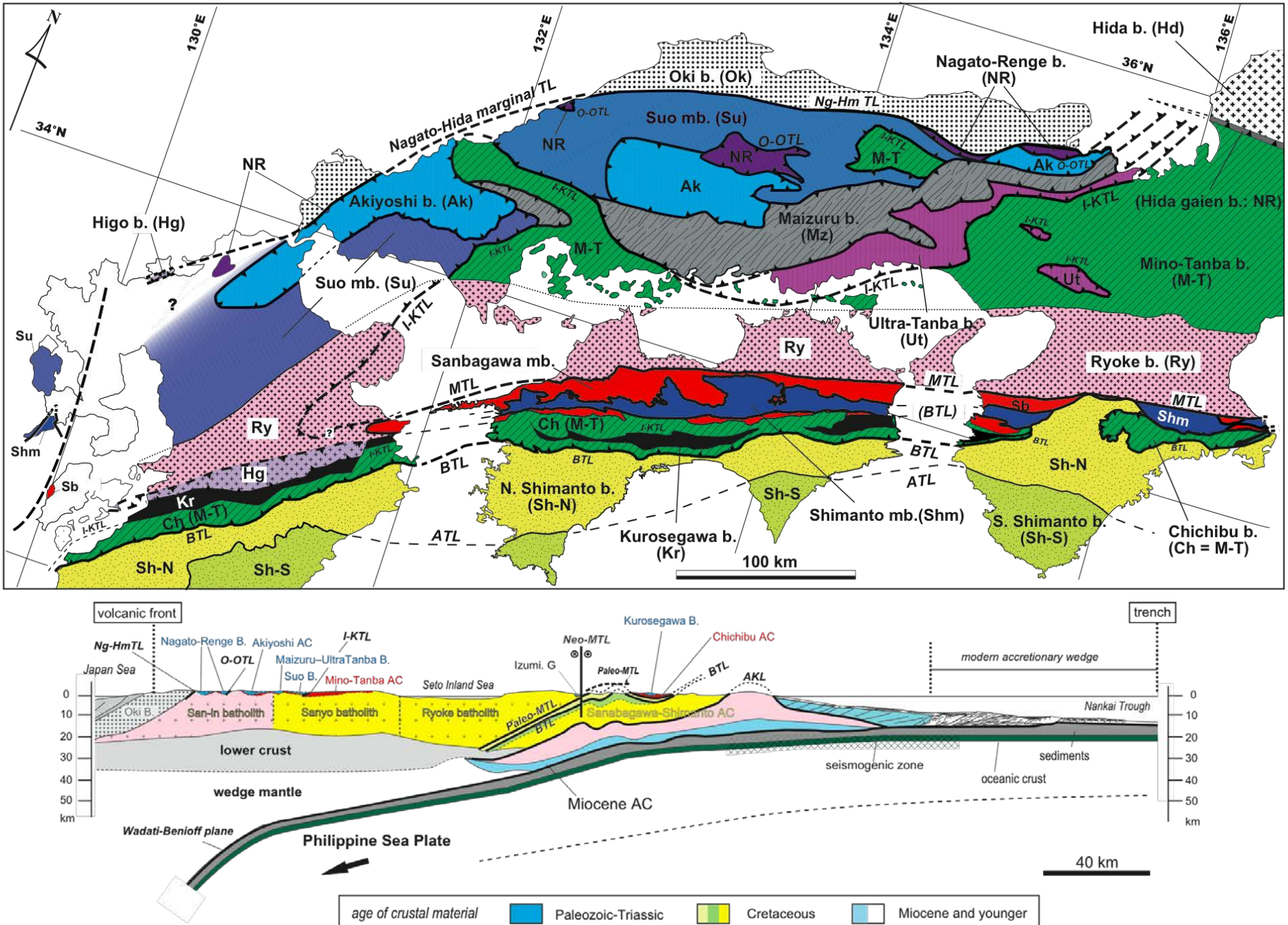




conundrum

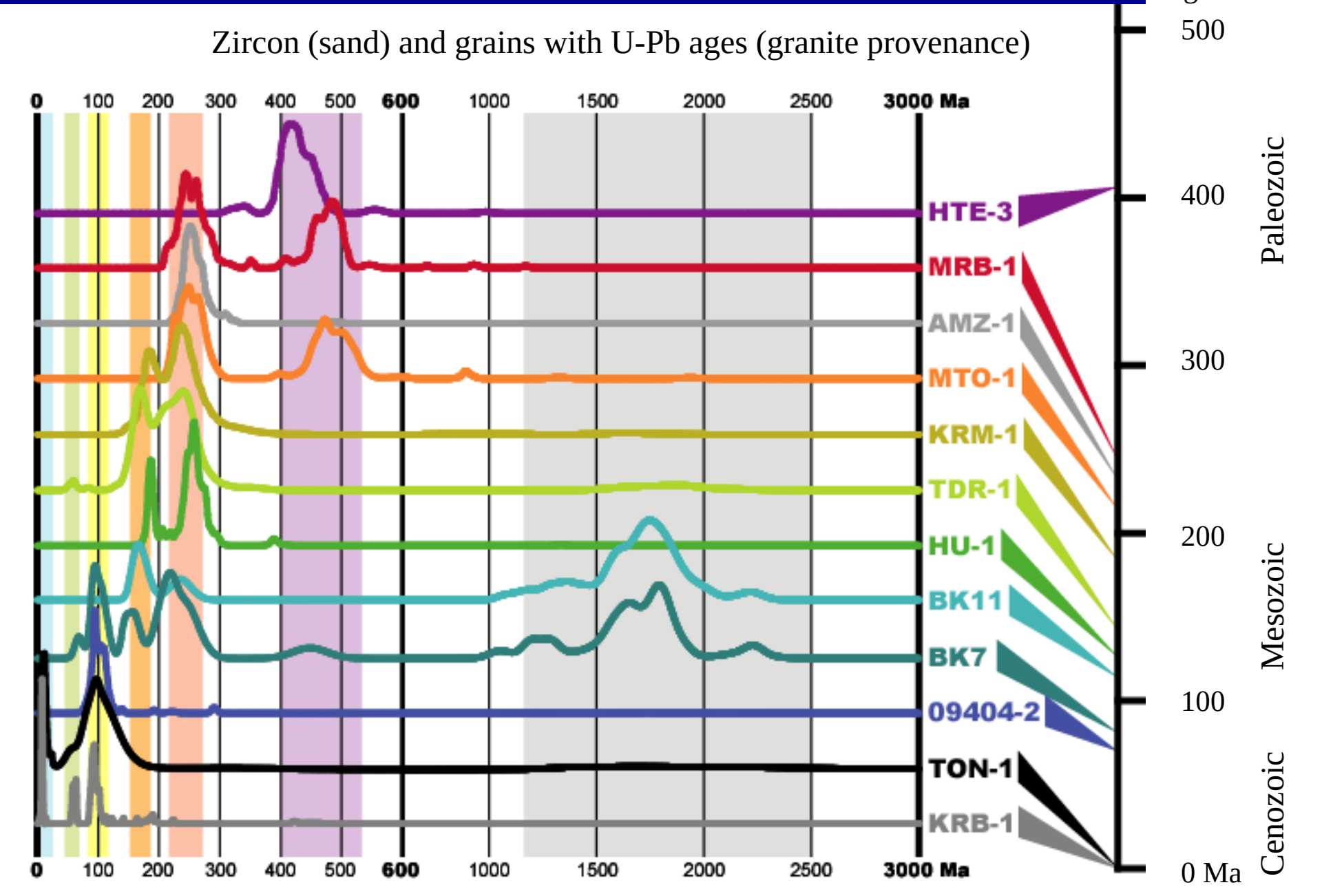
disagreement between elapsed time and remaining continental crust

Paleozoic: 290 m.y.
Mesozoic: 185 m.y.
Cenozoic: 65 m.y.


N
130°E
132°E
134°E
136°E
34°N
36°N
Hida b. (Hd)
Nagato-Renge b. (NR)
Oki b. (Ok)
Ng-Hm TL
Nagato-Hida marginal TL
O-OTL
NR
Suo mb. (Su)
Ak
M-T
I-KTL
Akiyoshi b. (Ak)
Higo b. (Hg)
Maizuru b. (Mz)
(Hida gaien b.: NR)
Mino-Tanba b. (M-T)
Ut
Ultra-Tanba b. (Ut)
Sanbagawa mb.
Ry
Ryoke b. (Ry)
MTL
(BTL)
Sb
Shm
Ch (M-T)
BTL
Hg
Kr
ATL
Sh-N
Sh-S
N. Shimanto b. (Sh-N)
Shimanto mb.(Shm)
S. Shimanto b. (Sh-S)
Kurosegawa b. (Kr)
Chichibu b. (Ch = M-T)
Su
100 km
volcanic front
trench
Ng-HmTL
Nagato-Renge B.
Akiyoshi AC
Maizuru–UltraTanba B.
Suo B.
Mino-Tanba AC
Japan Sea
Seto Inland Sea
Izumi. G
Neo-MTL
Paleo-MTL
Kurosegawa B.
Chichibu AC
AKL
modern accretionary wedge
Nankai Trough
Oki B.
San-in batholith
Sanyo batholith
Ryoke batholith
Sanbagawa-Shimanto AC
lower crust
wedge mantle
seismogenic zone
sediments
oceanic crust
Miocene AC
Wadati-Benioff plane
Philippine Sea Plate
km
40 km
age of crustal material
Paleozoic-Triassic
Jurassic
Cretaceous
Paleogene
Miocene and younger

Nakama et al. (2009)

mineral zirocn forms mostly in granite.



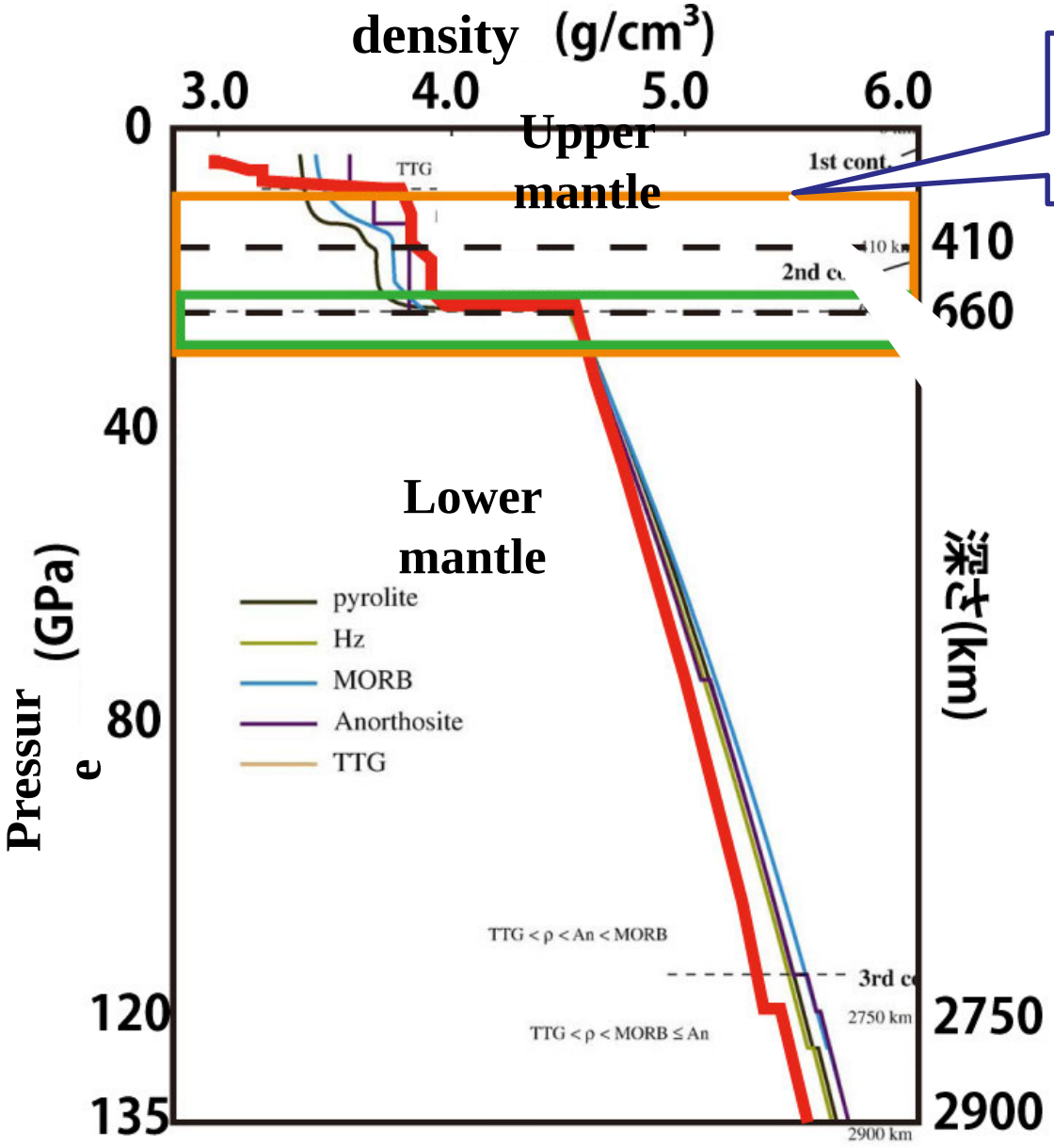
older arc granite belt:

exposed extensively, then gone….

Without vaporizing to the outer space,
to somewhere else?

Light-weighed continental (granitic) material
can subduct into mantle with heavy rocks??

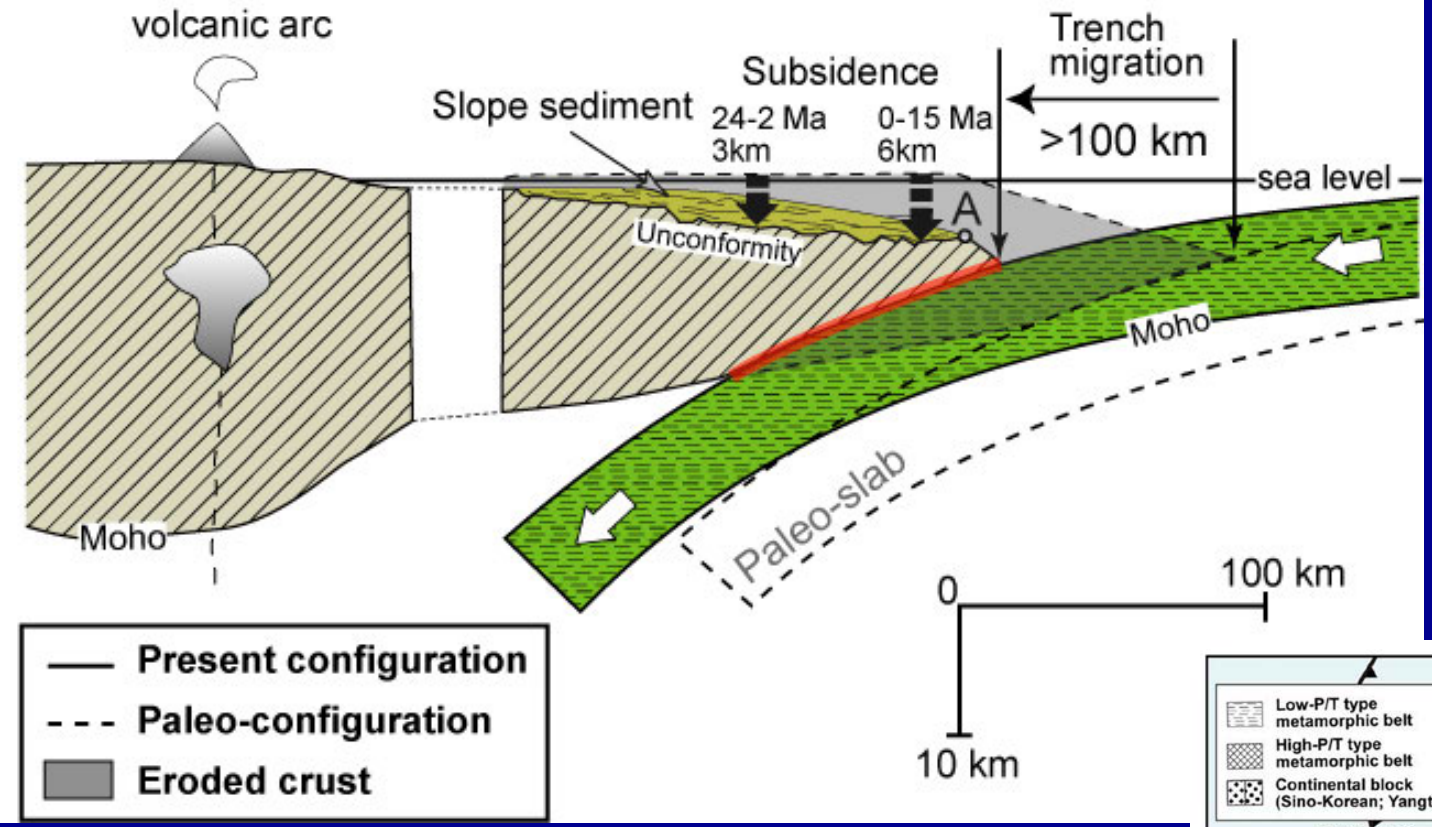
Indication of the existence of second continent



At 300-800km depth,
Granite becomes much denser than mantle peridotite

- **Across the lower transition zone, seismic velocity (Vp, Vs) becomes faster than PREM**
- **May indicate the presence of 6-7 times of granitic crustal material in mantle tansition zone.**

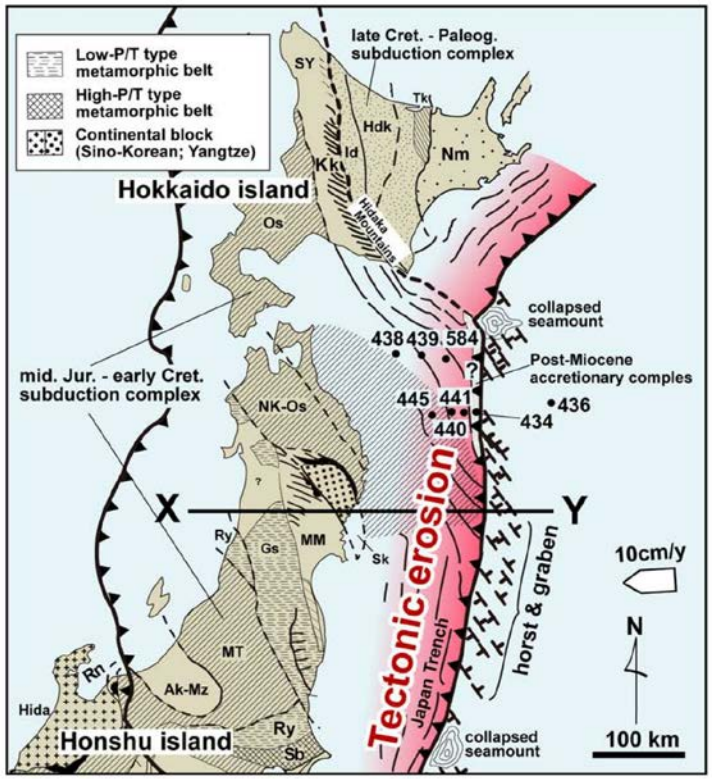
First principle calculation（Kawai et al., 2009; 2010）



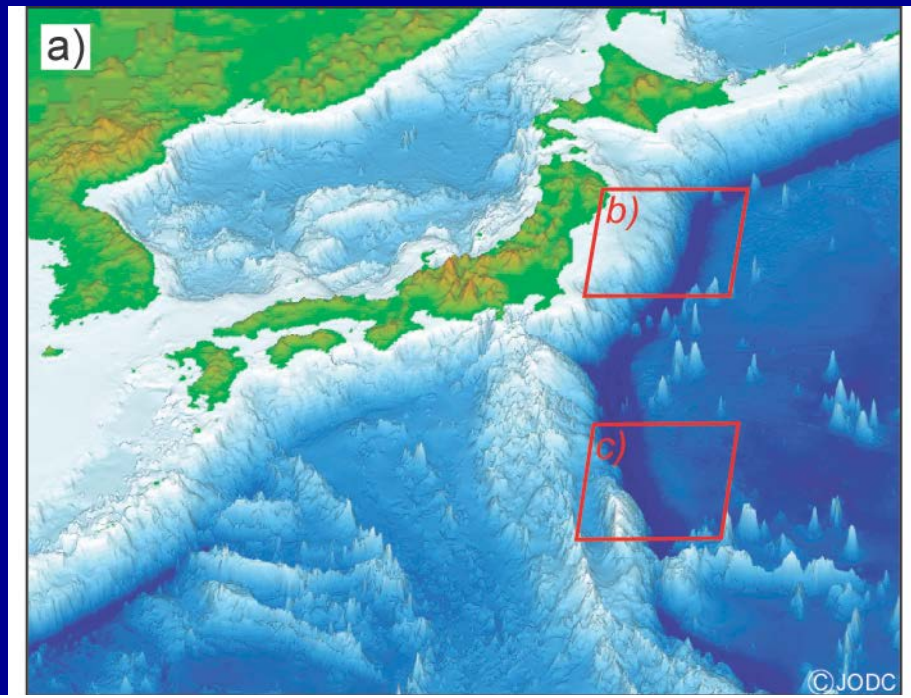
tectonic erosion
構造浸食

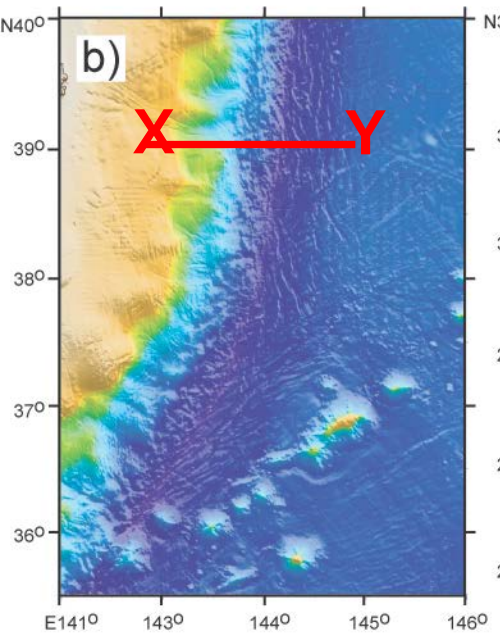
how to slim continents

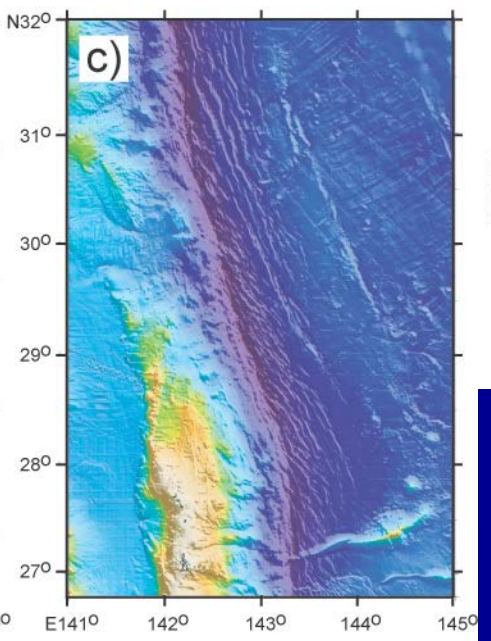
von Huene & Scholl (1990)

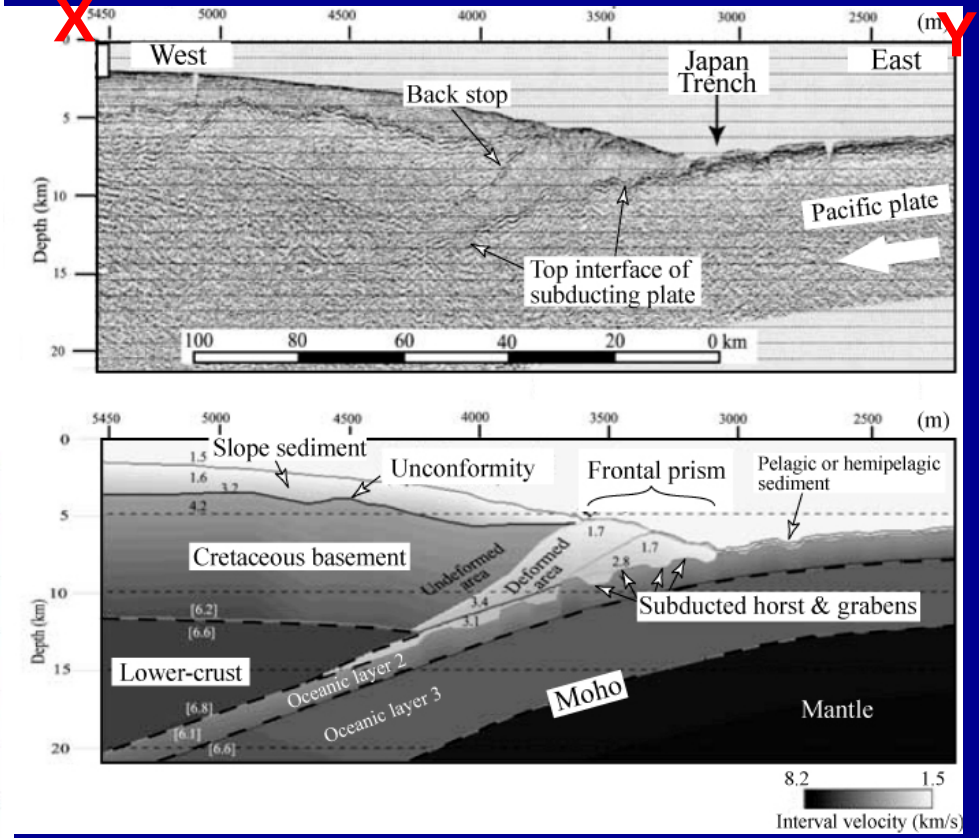


Seismic cross-section across the Japan Trench

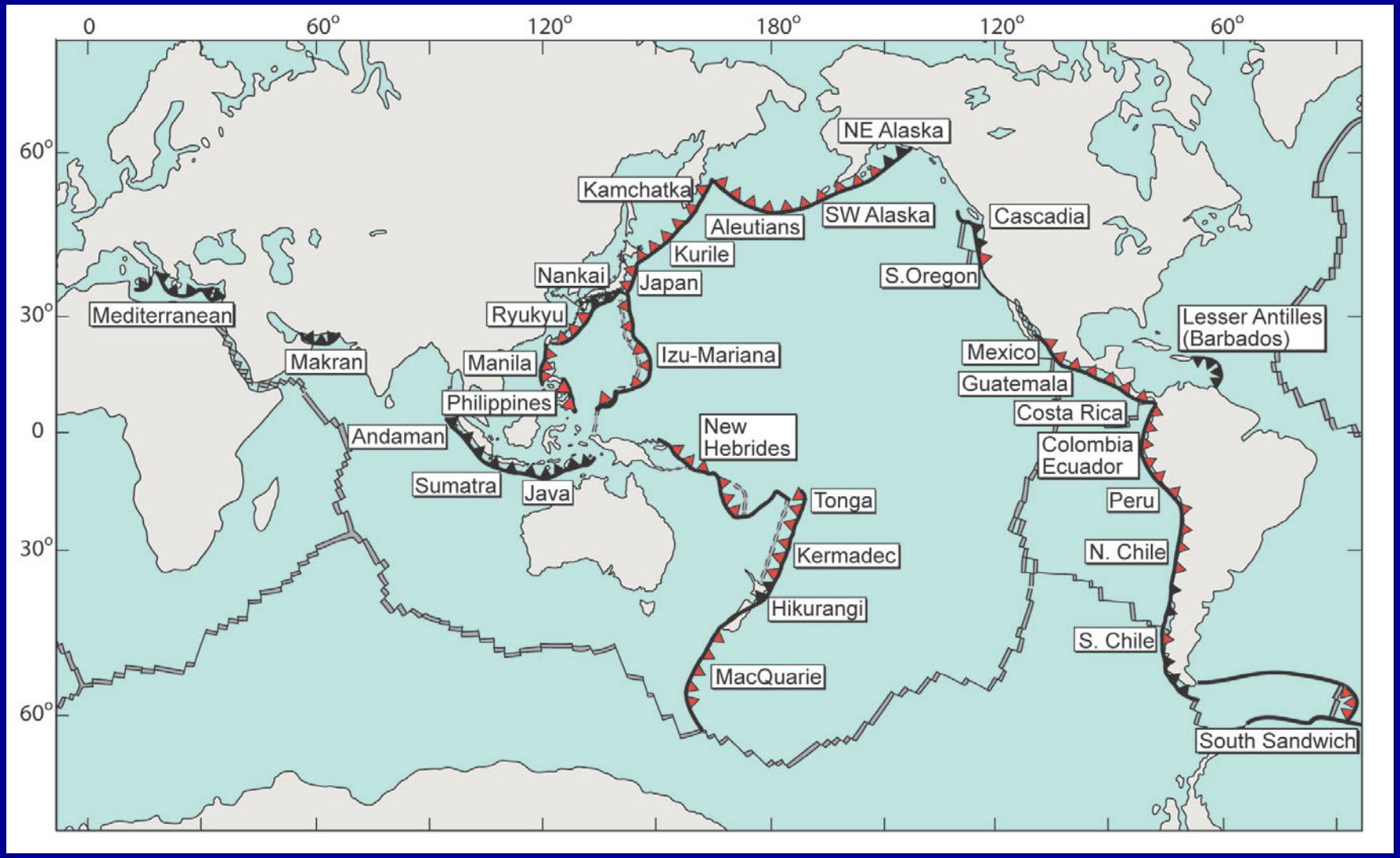








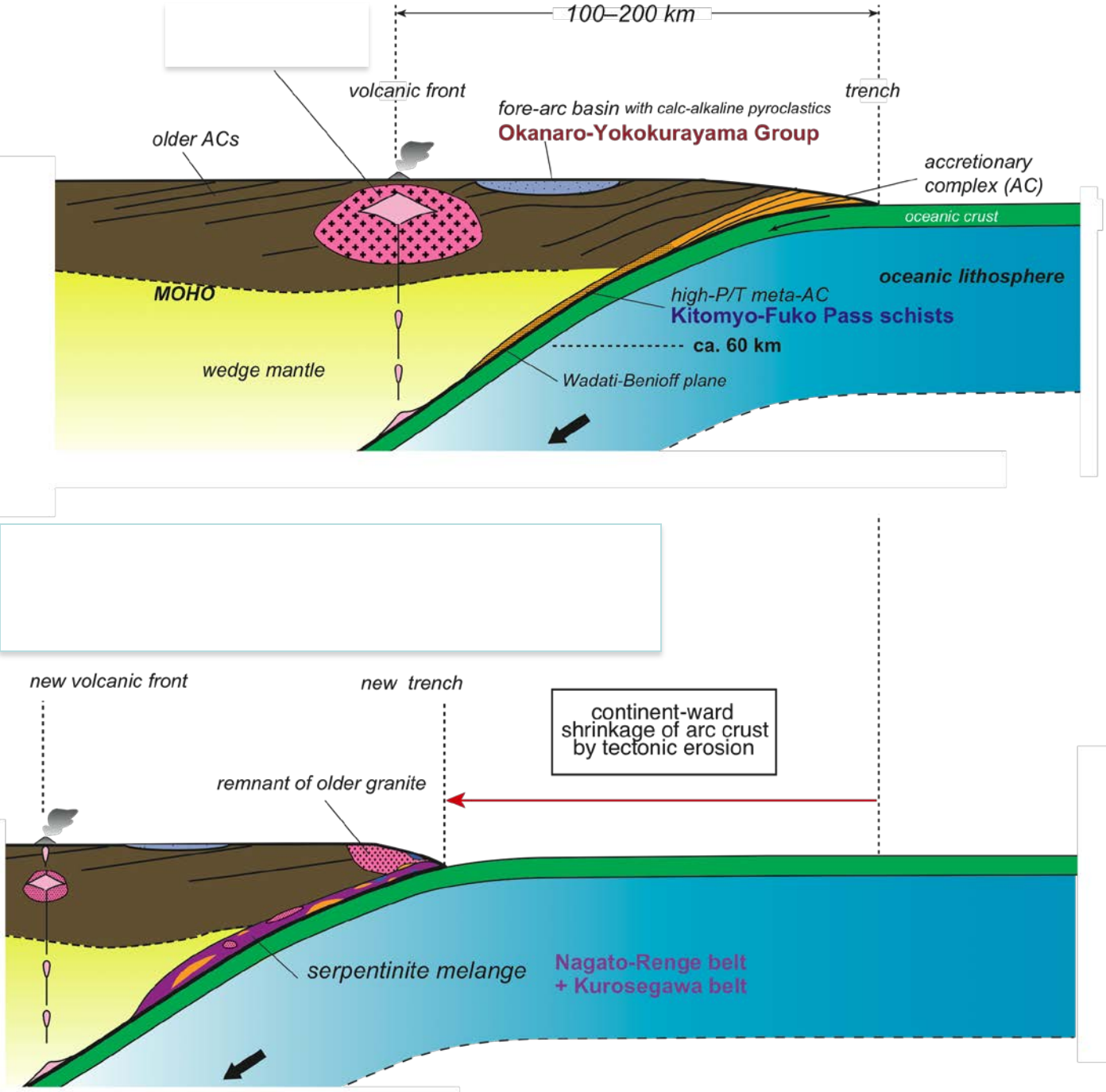
Modern subduction zones in the world



△: Erosive (non-accreting) margins（~75%）

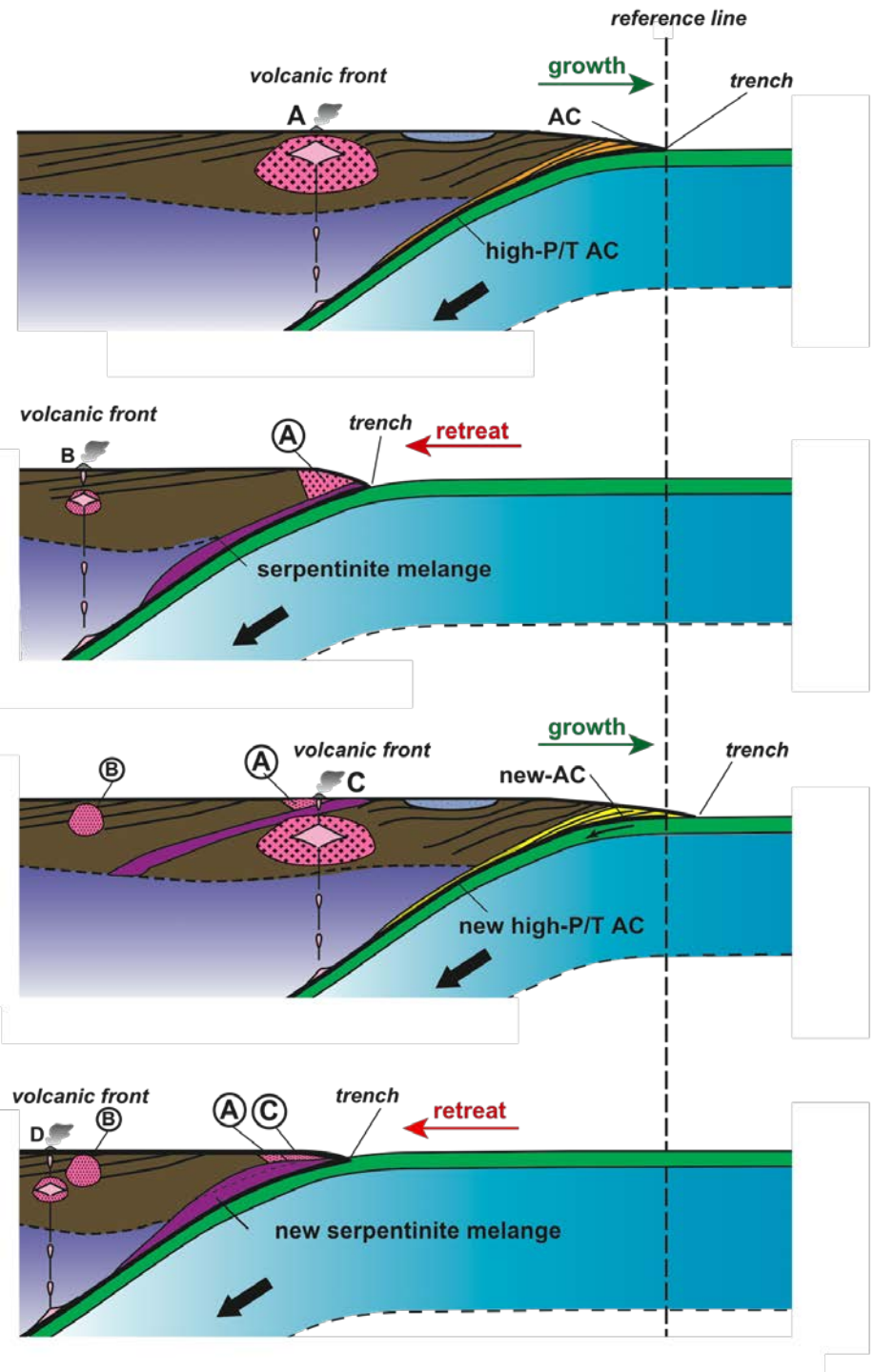
▲: Accreting margins （~25%）

(Scholl and von Huene, 2007; 2009)



tectonic erosion

Losing arc crust means disappearance of granitic continental crust……..



Where to dump the lightest rocks like granite in solid Earth?

No worries, we can bury continents into the mantle!

New view: another continent in mid-mantle (Maruyama, 2012)

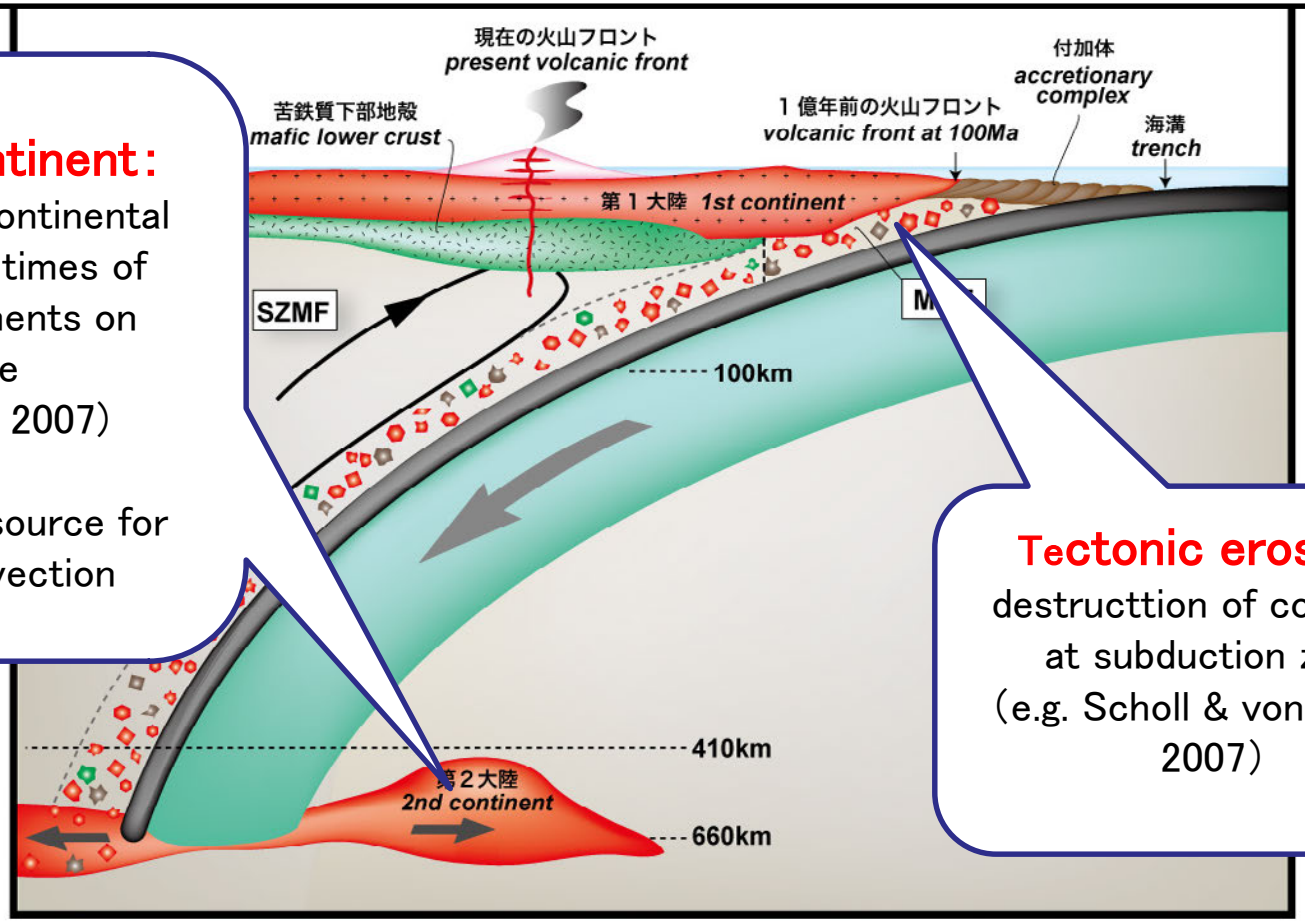
Lost Atlantis??

Previously we imagined without doubt ….

- **granitic continent. crust is more buoyant than mantle rocks**
- **low-density continents never subduct into mantle**

Second continent:
accumulated continental material is 6 times of extant continents on surface
(Rino et al., 2007)

Another heat source for mantle convection



Tectonic erosion:
destructtion of continent at subduction zone
(e.g. Scholl & von Huene, 2007)

Conclusions

1) Geology of Japan recorded the history of a Pacific continental margin that added continental crust, apparently for 400 km wide during the last 500 m.y.

2) Typical/general growth pattern of continental crust by active plate subsuction, with growth and retreat, was demonstrated.

3) The main implication is in the burial of a large amount of continental crust (with high content of U and Th) into the mantle, which was totally overlooked for years.

4) The claimed second continent in mid-mantle may provide a possible hunting target for geoneutrino researchers.