



Geotectonic Evolution of Thailand- a New Model

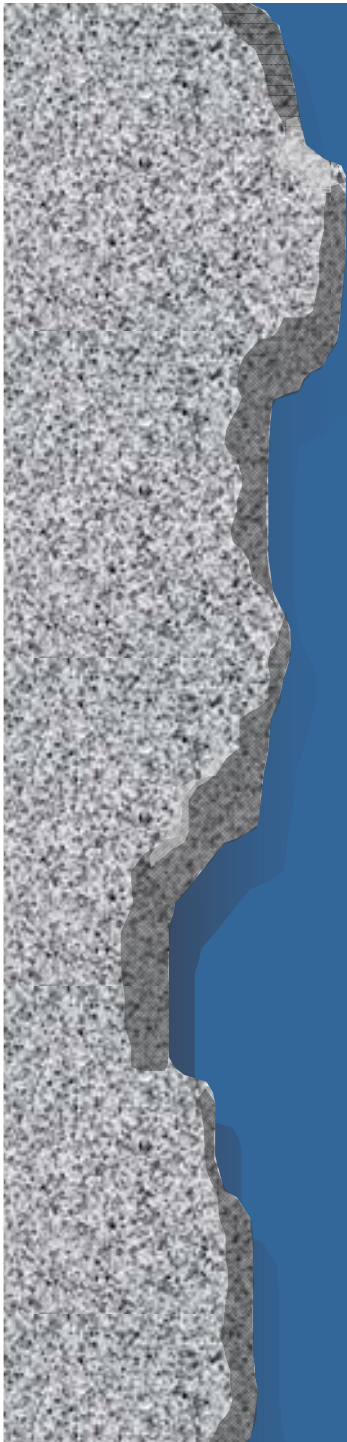
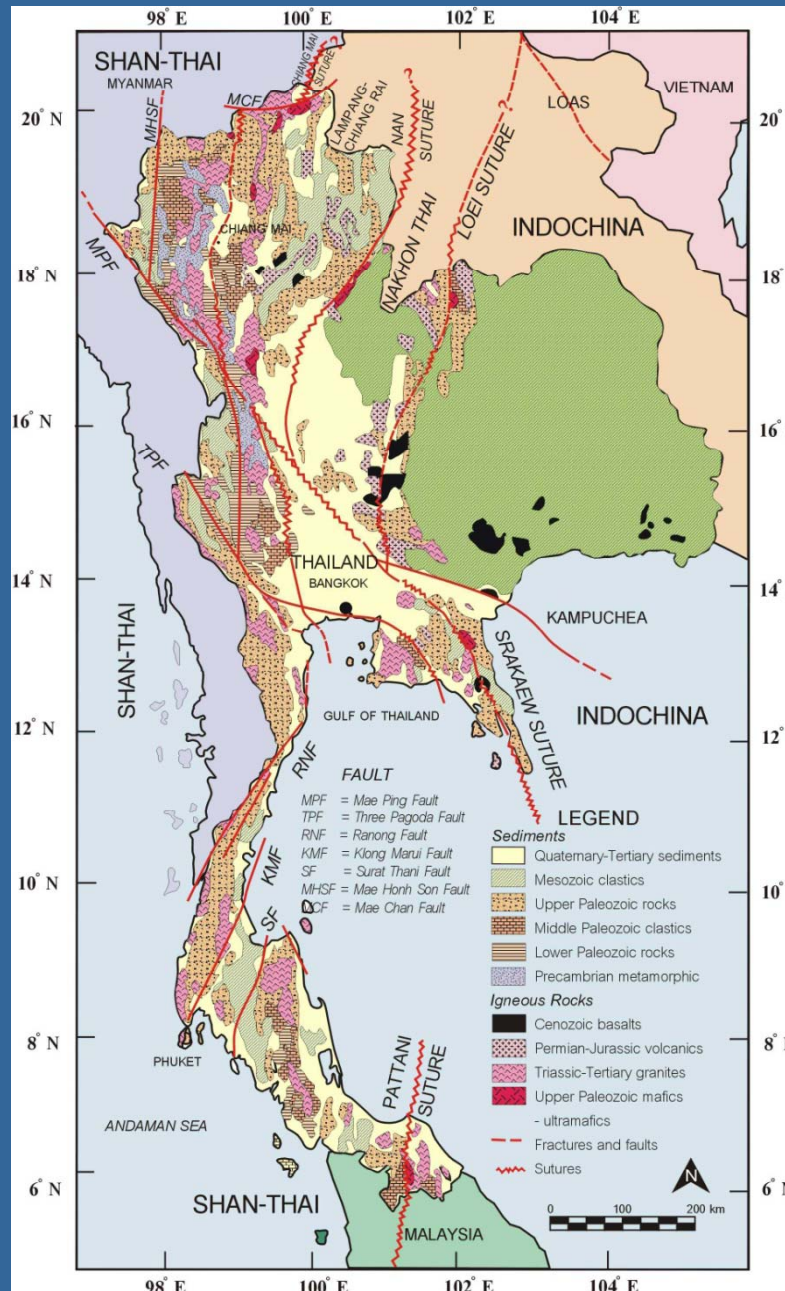
by Punya Charusiri (Chula Univ.)

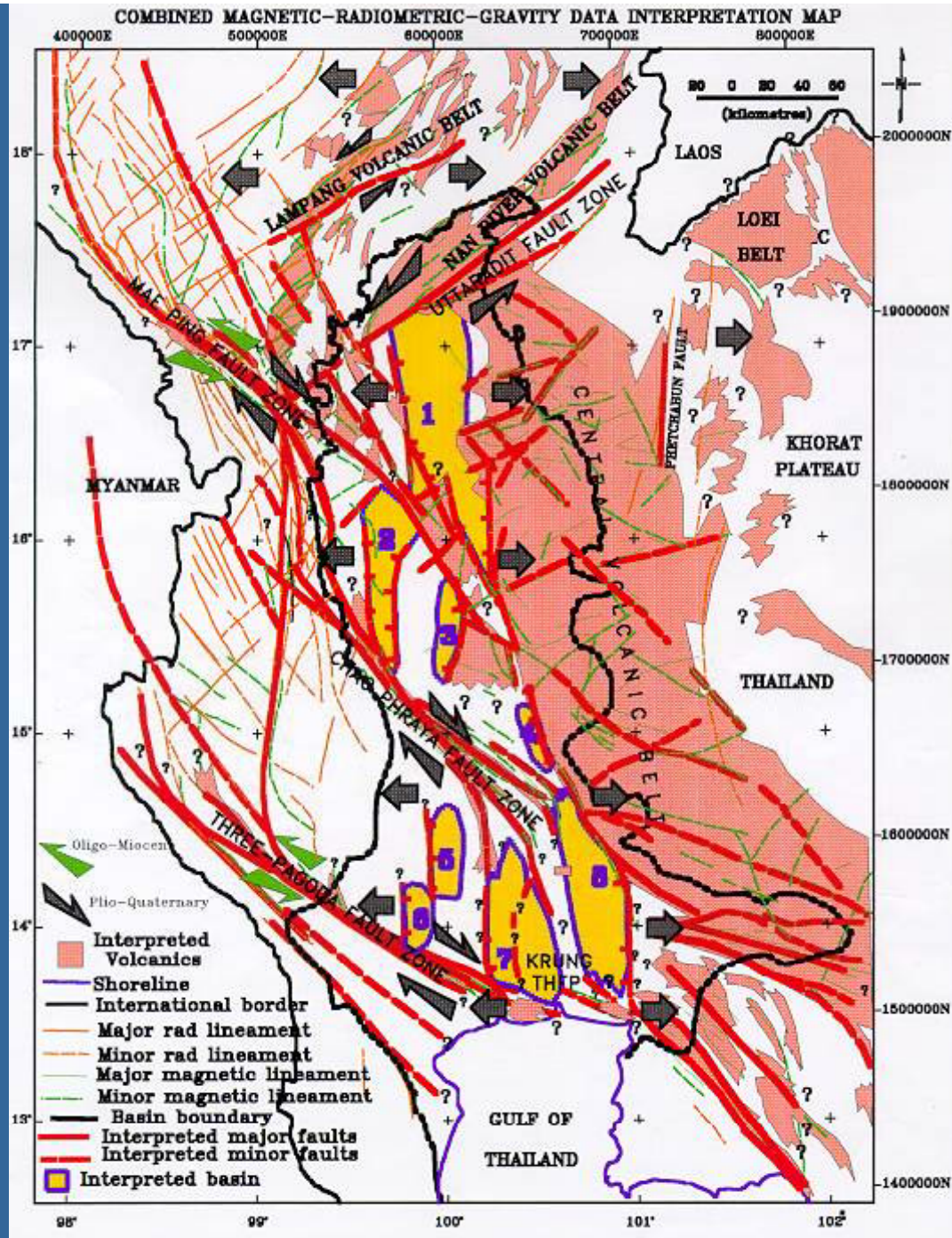


Co-research Institutes

- Earthquake and Tectonic Geology Research Unit (EATGRU), c/o Department of Geology, Chulalongkorn University, Bangkok, Thailand (Drs. Thasinee, Santi and Pisanupong)
- 1. Kyushu University, Fukuoka, Japan (Prof. Y. Osanai) +Ueno (Fuguoka U.)
- 2. Graduate School of Life and Environmental Science, University of Tsukuba, Tsukuba, Japan (Prof. K Hisada and Kamata)
- 3. Department of Mines, Vientiane, Lao PDR (Keo Kampawong, Chansorn)
- 4. Geological Survey of Japan, AIST, Japan (Dr. Hara)
- 5. PTT EP (Dr. C. Morley)
- 6. Adilade U. (A. Collin)
- 7. Academia Sinica (Taiwan and Beijing, China)
- 8. Akita U. (Takashia and Imai)

Geotectonic map of Thailand





Tulyatid
(1997)

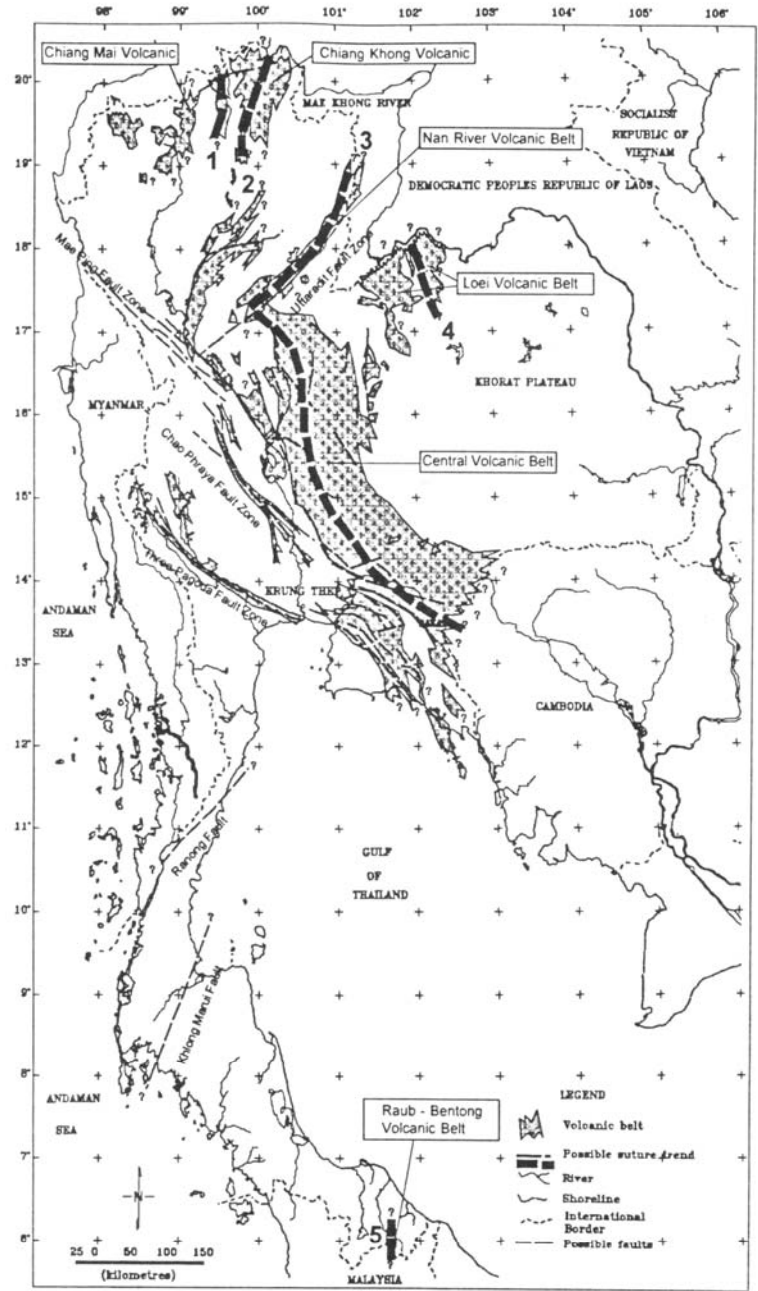
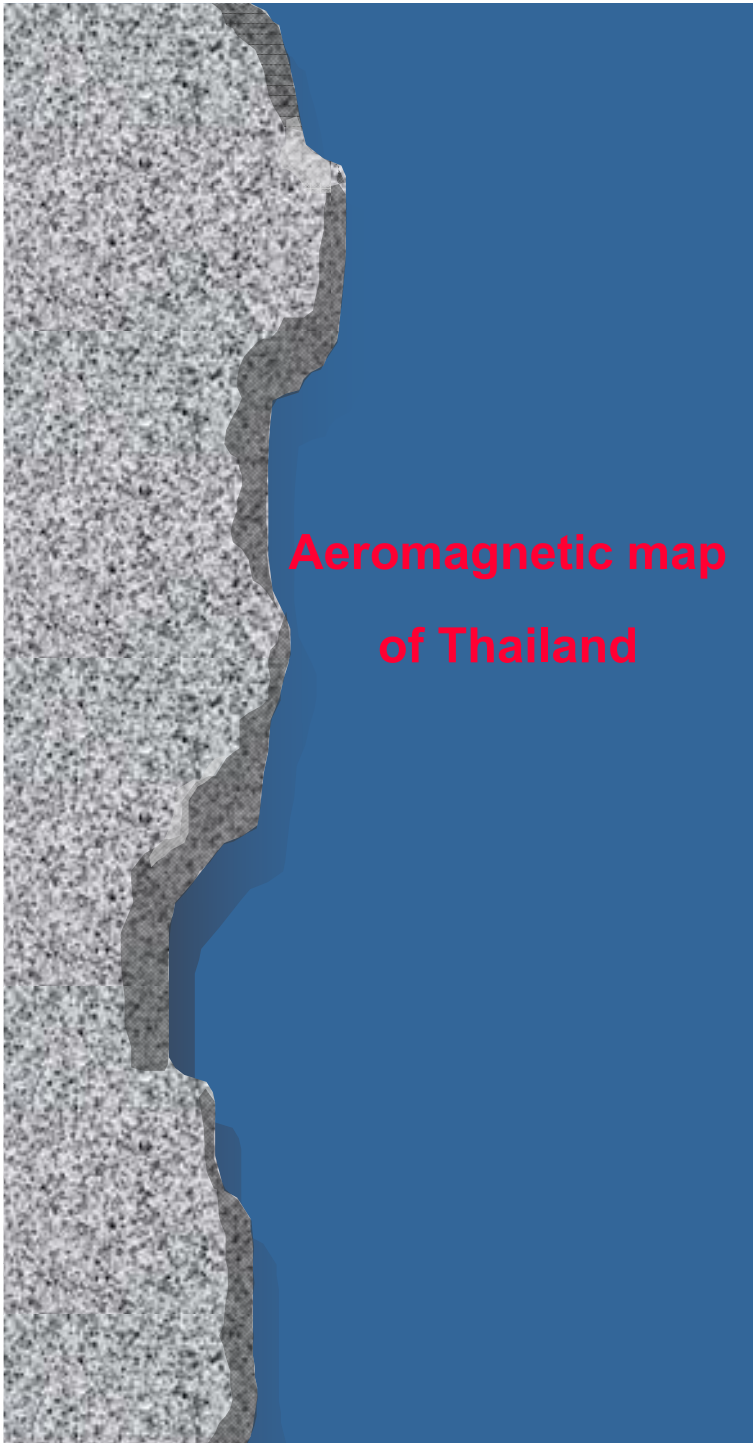
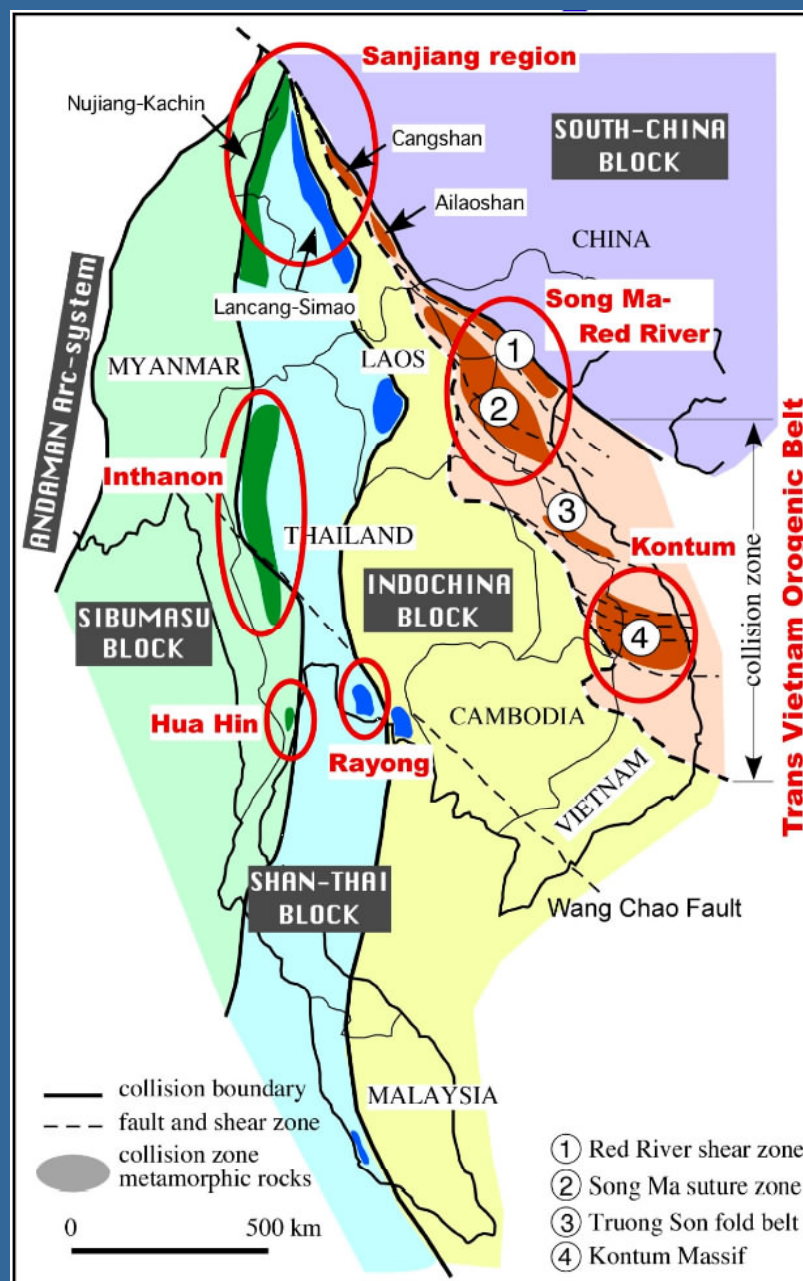


Figure 6 Sketched tectonic interpretation map of Thailand. The results of this study, in accordance with other geological evidence, suggest that there are four sutures in Thailand: (1) Chiang Mai (Charusiri and others, 1998); (2) Mae Chan, (3) Nan River-Central Thailand (-Sa Kaeo); (4) Loei and (5) the north extension of the Raub-Bentong sutures. These sutures may indicate different branches of the ancient Tethys Sea during Late Paleozoic - Early Mesozoic times.

Tectonic
framework of
SE Asia by
Osanai et al.
(2011)



2 minor blocks

Luang Namtha Block

Xam Nua block

(Geochem /dating granites
granites)

4 major tectonic units:

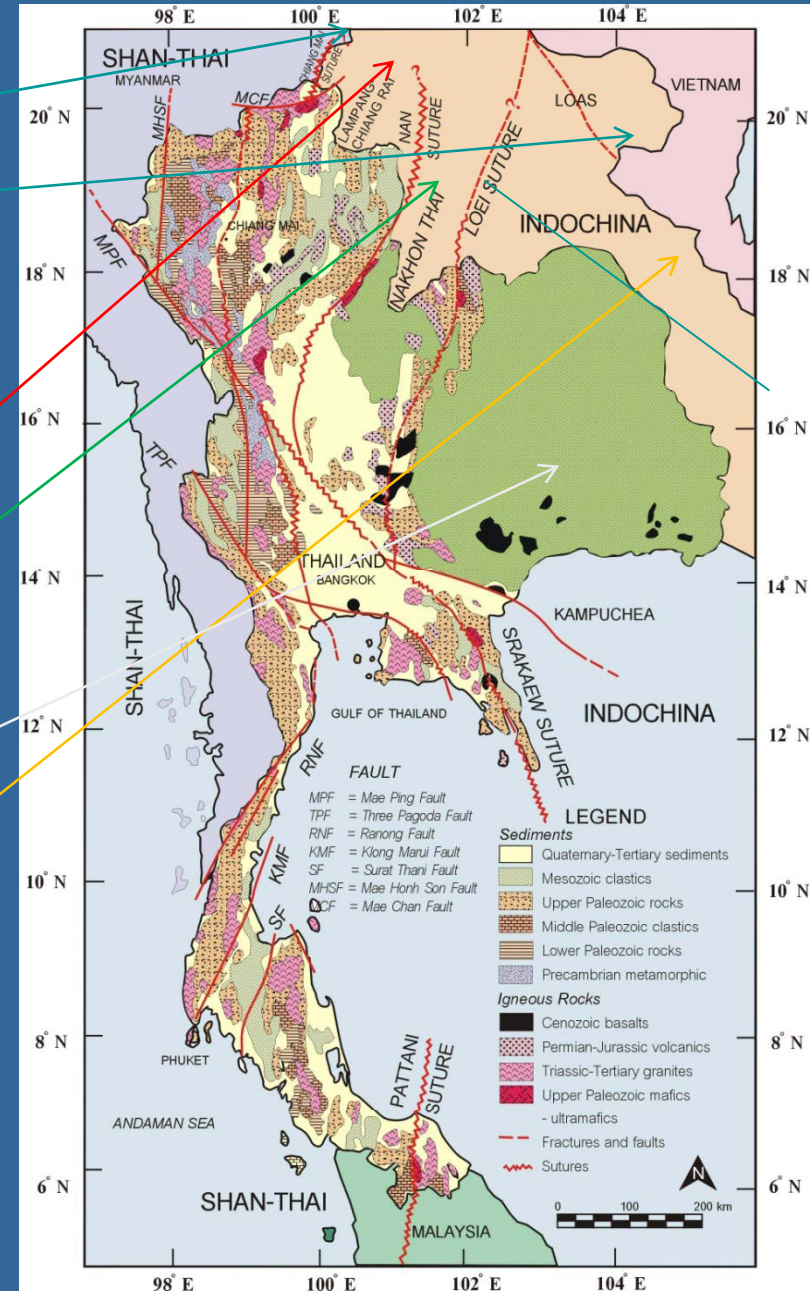
Oudomxai block -W,

Paklay block -C,

Xiangkhoang block -E

Indochina block-S

6 tectonic blocks in Lao



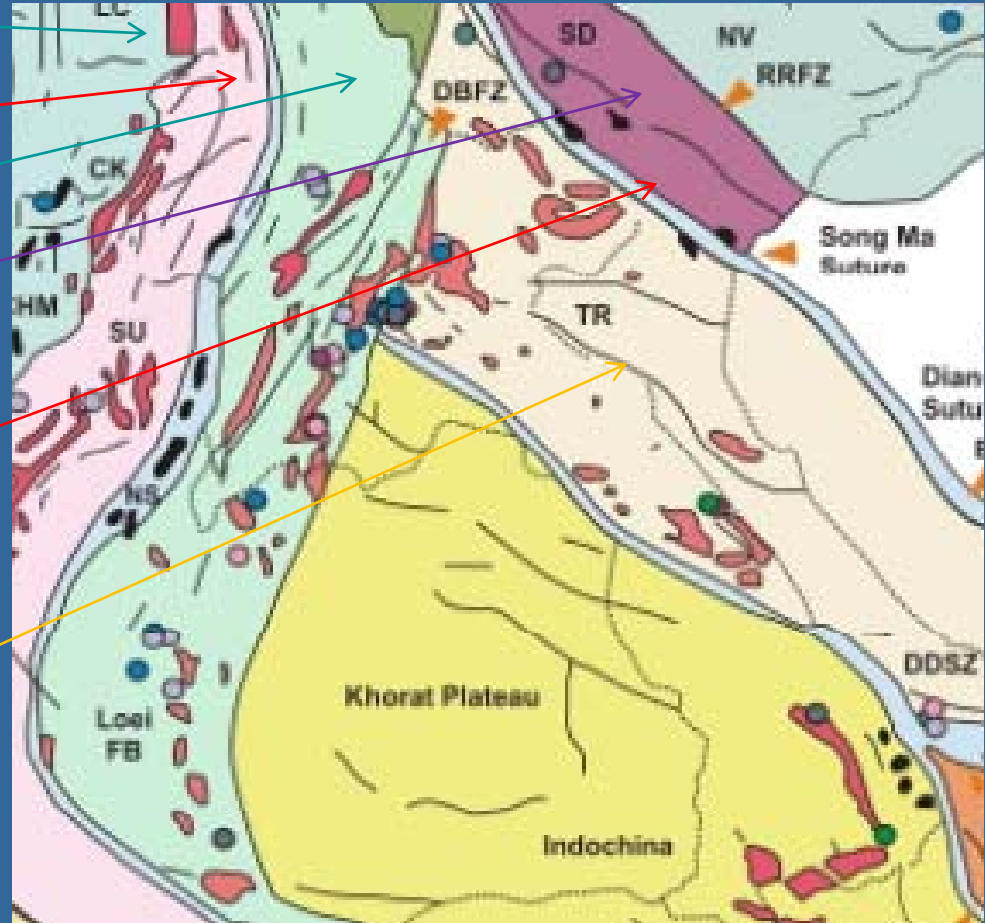
Luang Namtha Block

**Bo Kaeo S.
Oudomxai block**

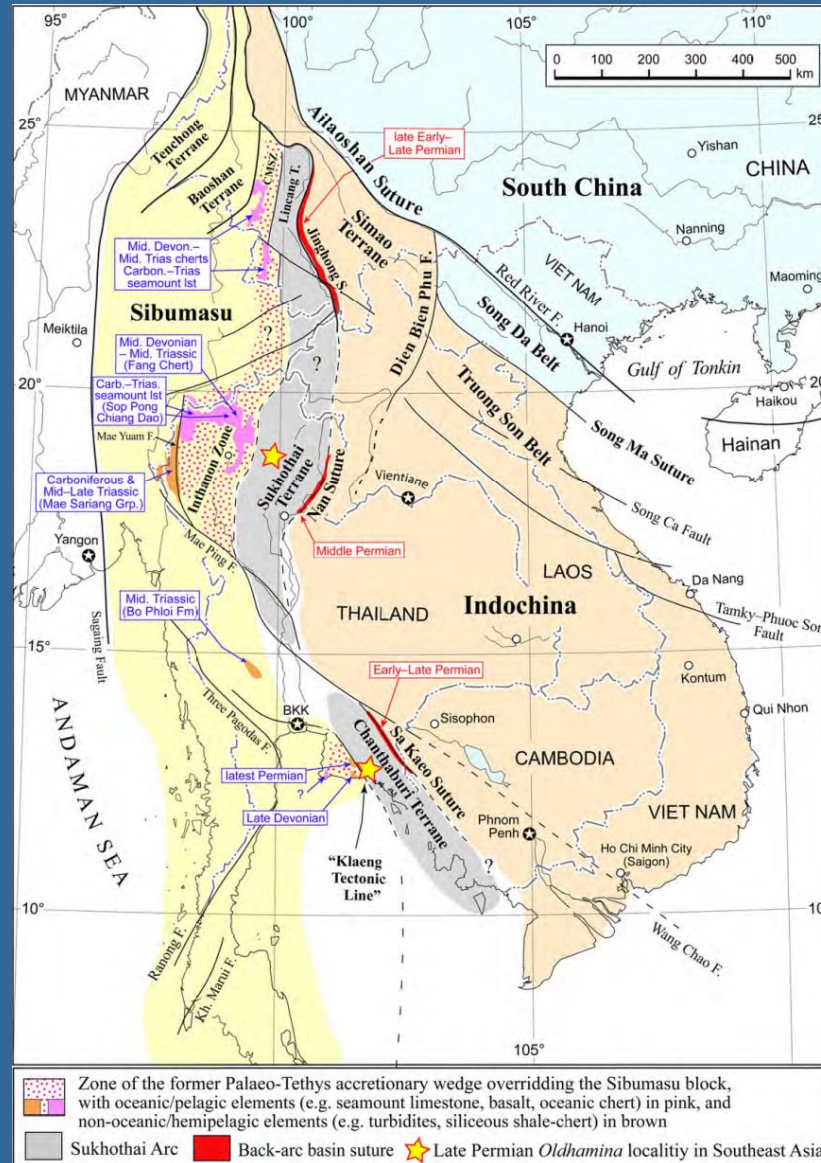
Xam Nua B.

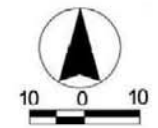
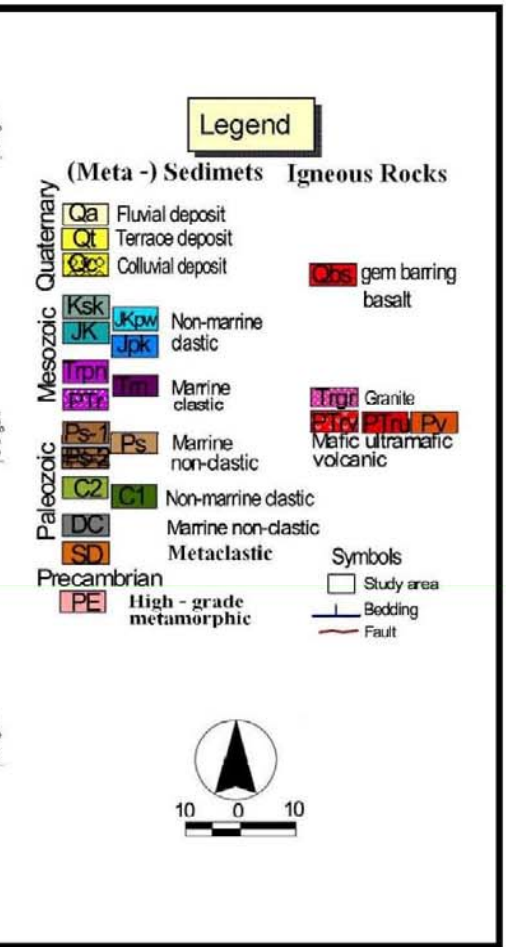
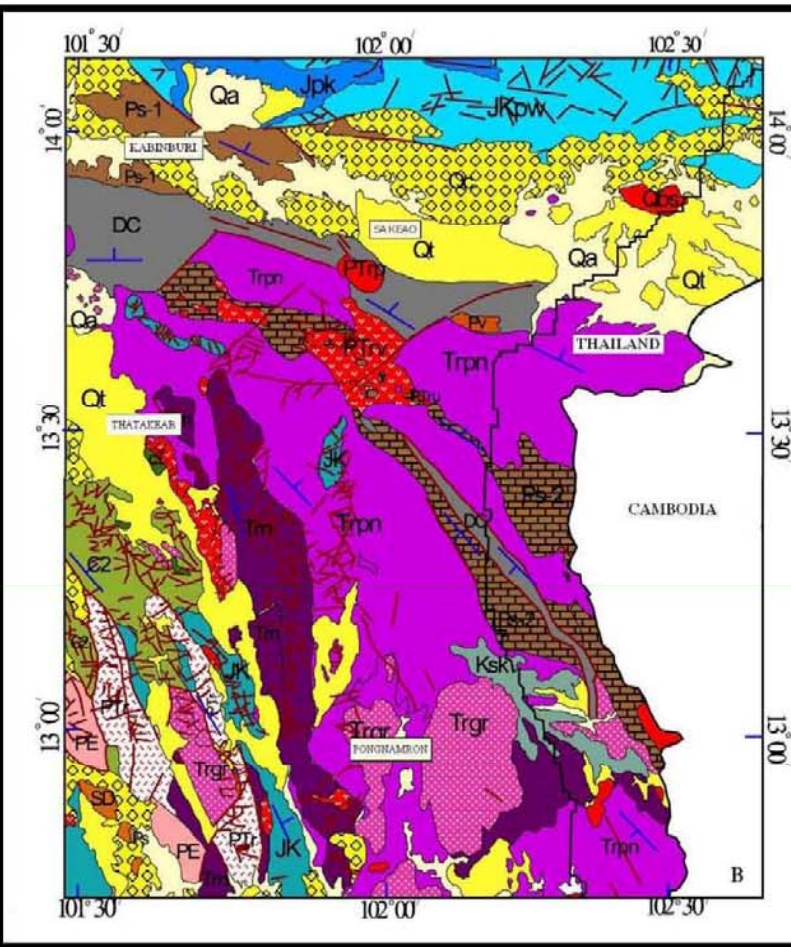
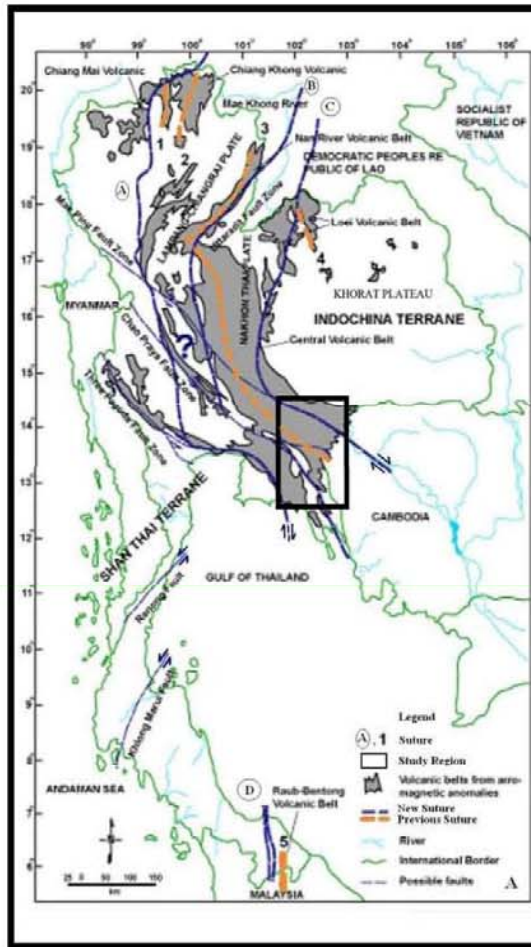
Nam Ma S.

**Phuluang B
(Trung Son B)**



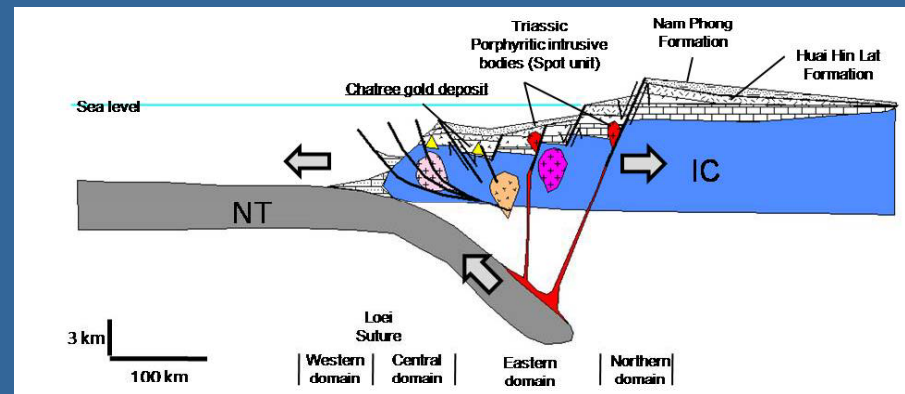
Sone et al. (2012)



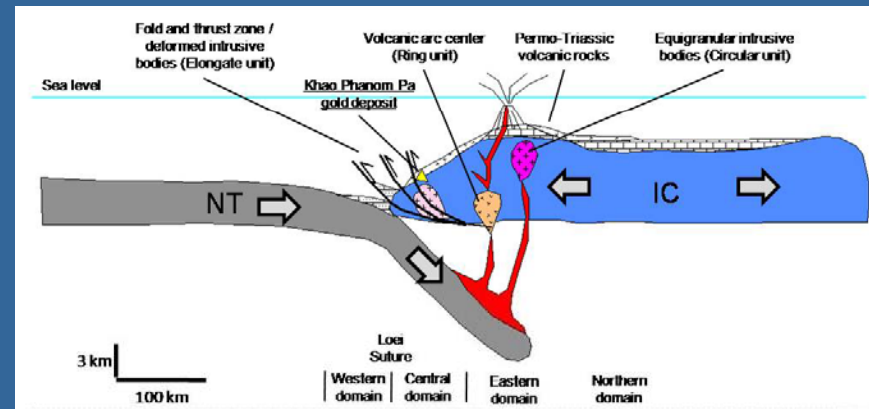


New interpretation of tectonic evolution between Nakornthai oceanic plate and Indochina Terrane (Sangsomphong et al., 2012)

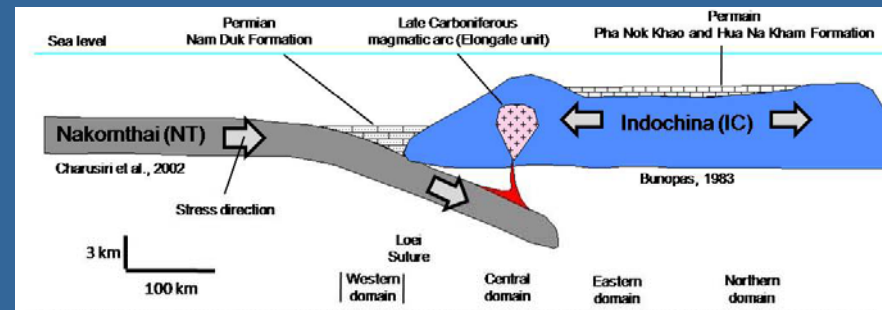
Mesozoic



Permo-Triassic

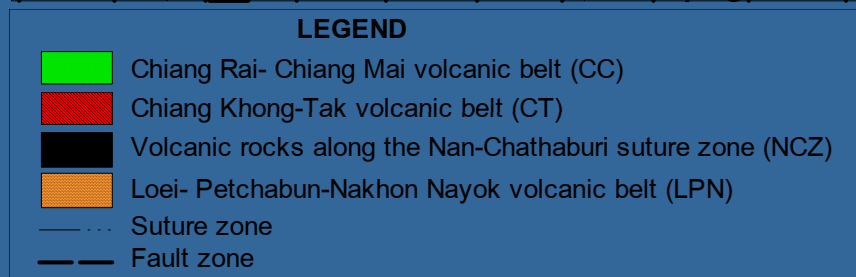
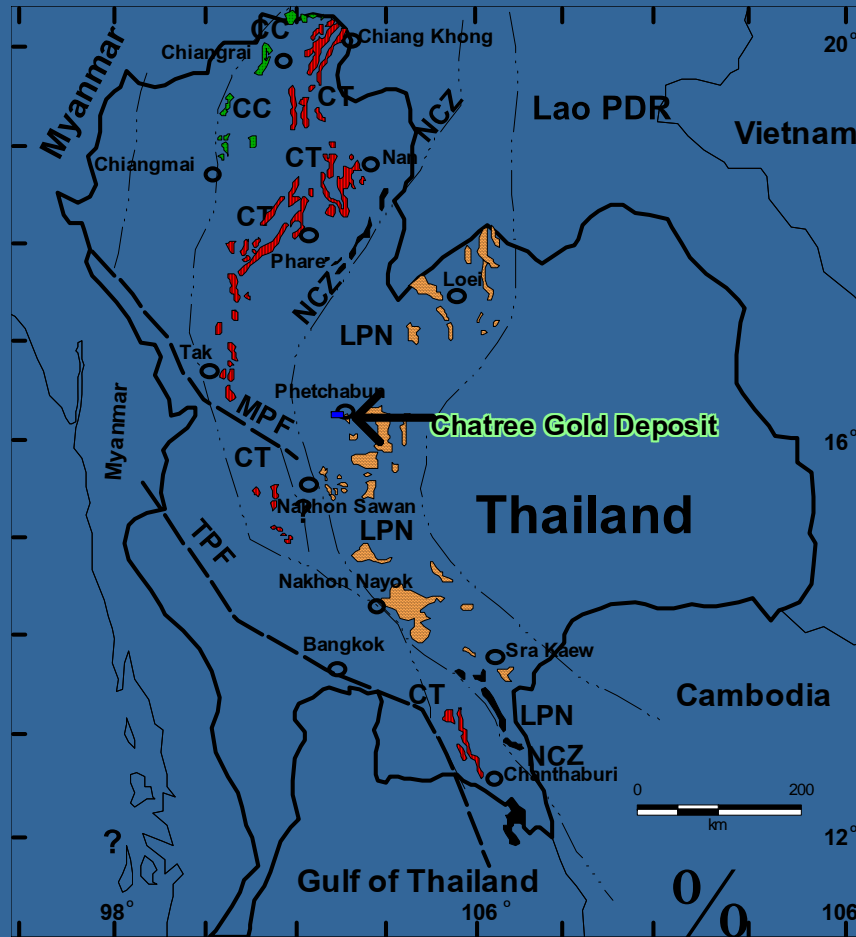


Permo-Carboniferous

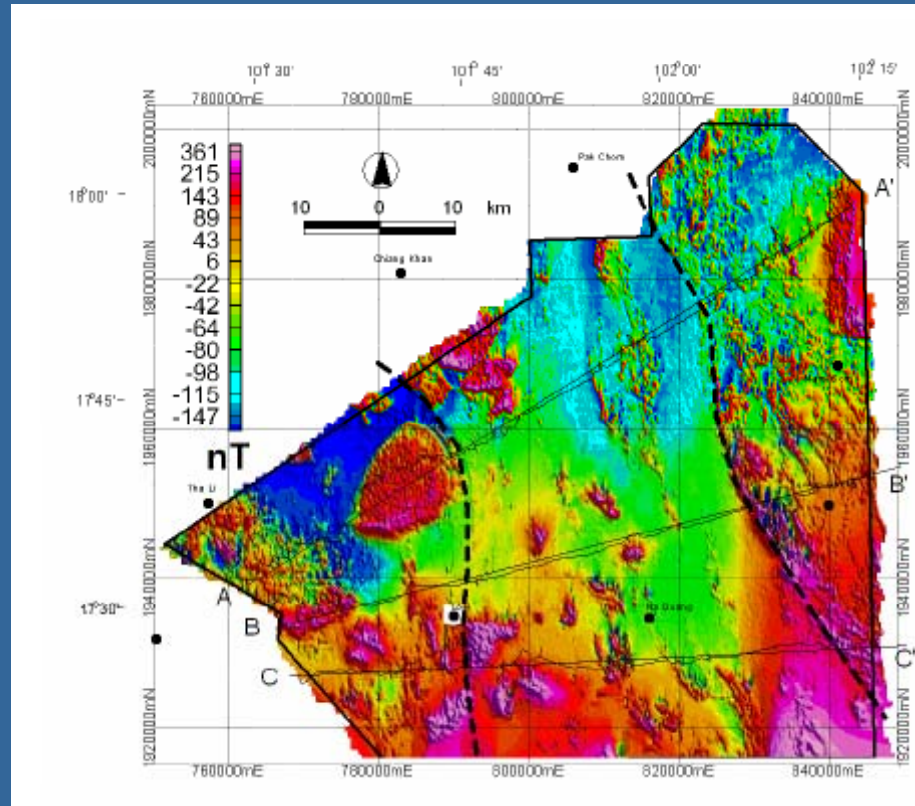


Volcanic rocks of Thailand (need to clarify eastern belt : calc-alkaline
volcanism = subduction-related, using REE geochemistry)

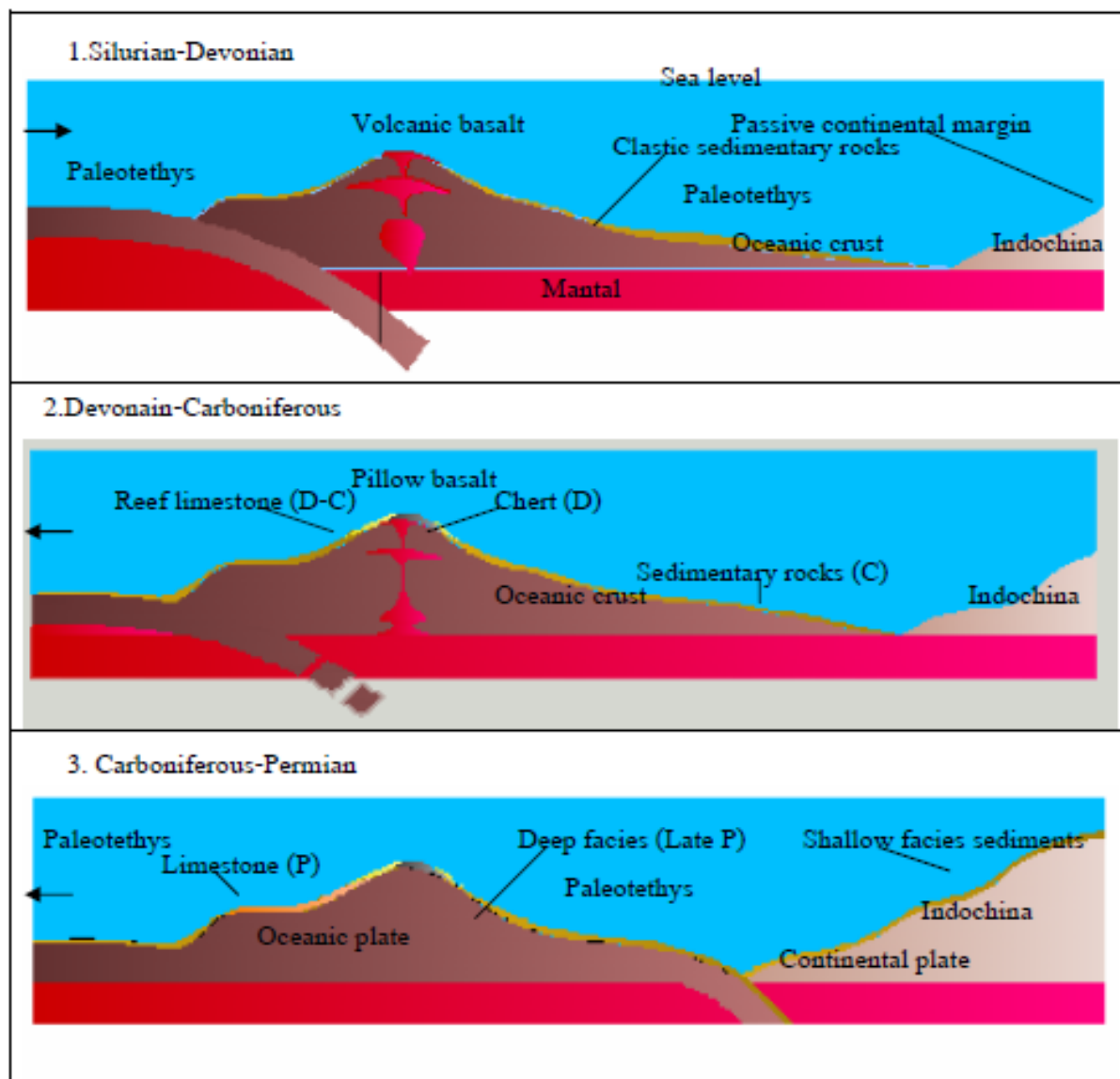
Vivatpinyou et al., 2010)



Nakhon Thai - Indochina



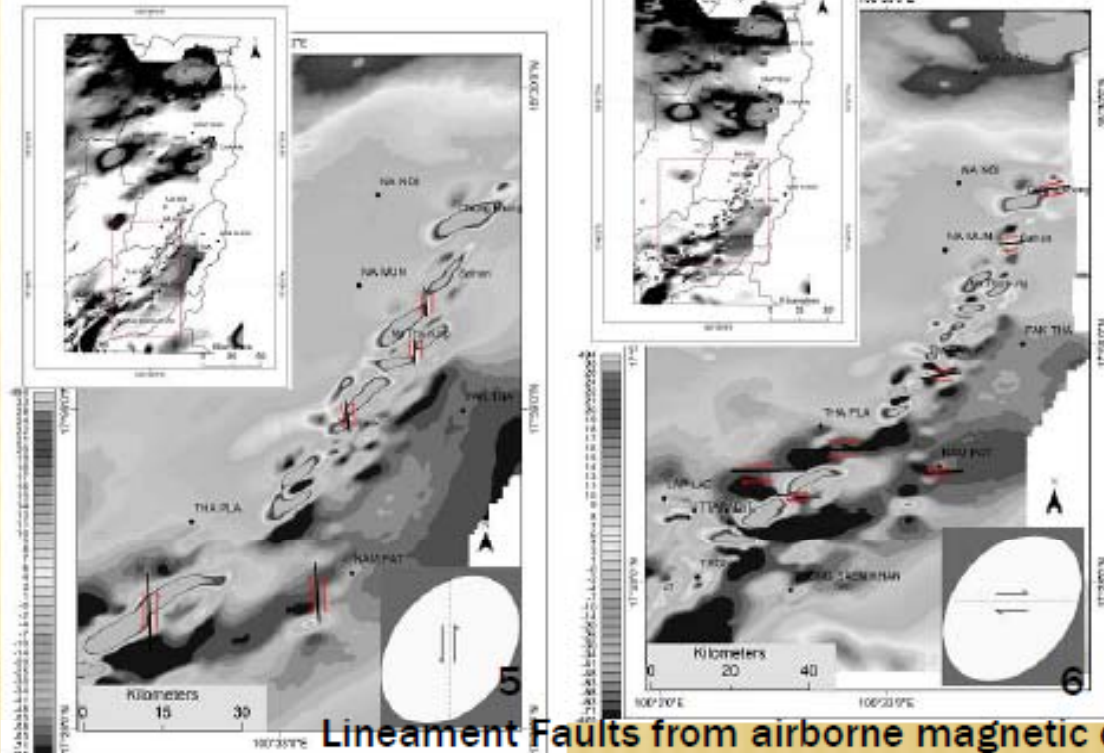
Neusuparp et al. (2006)



Rittisit et al. (2013) for the Nan suture

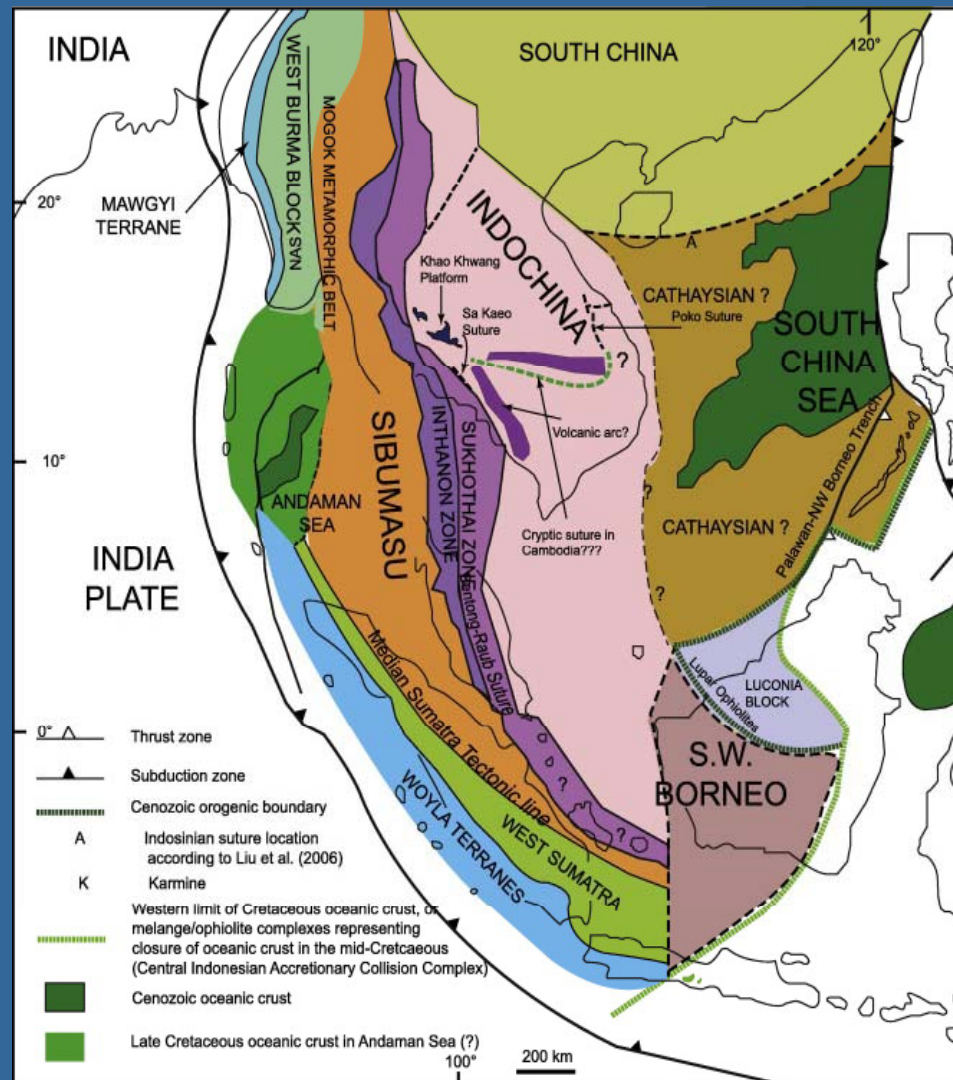
TYPES AND SEQUENCES OF LINEAMENT FAULTS

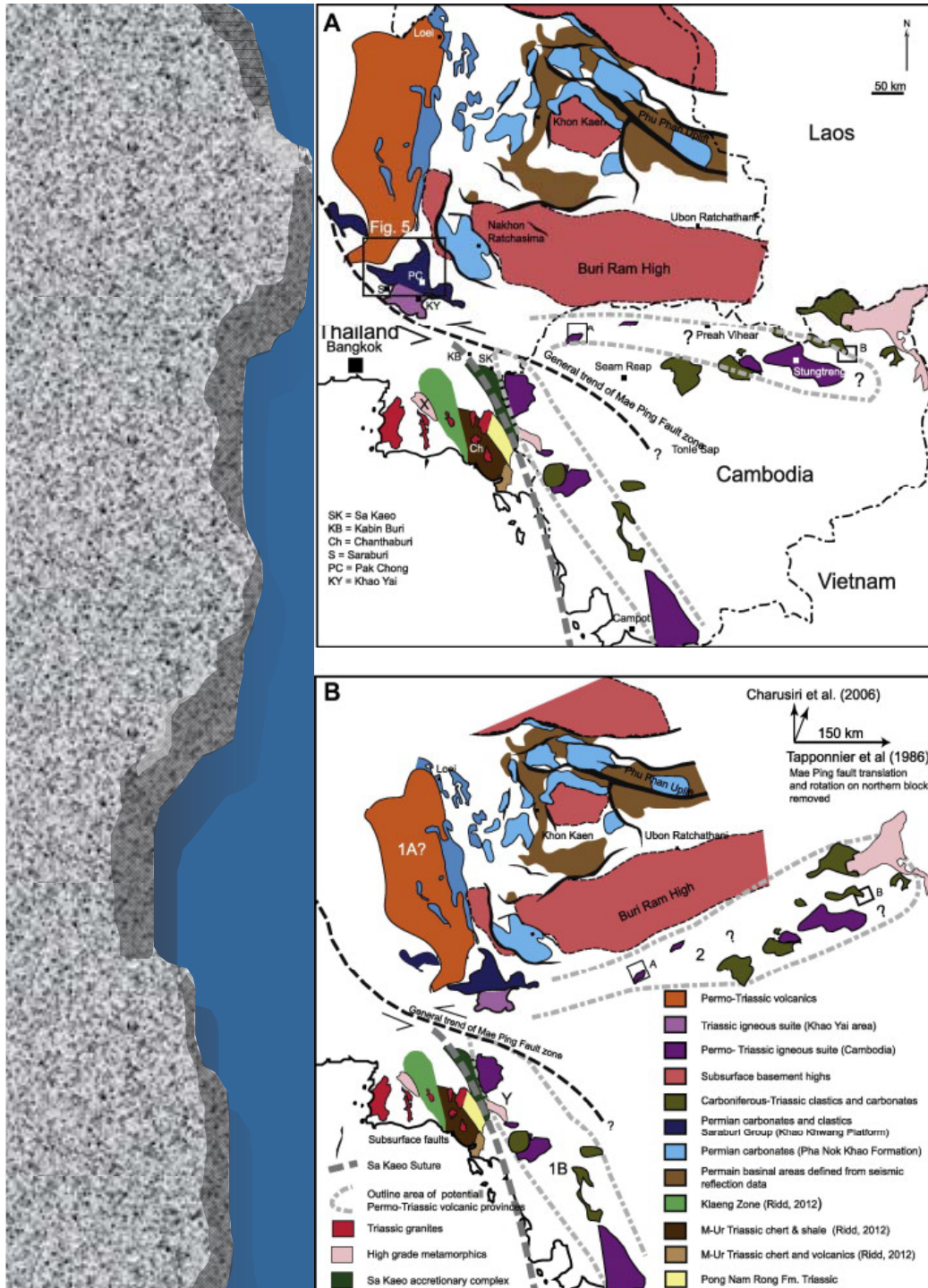
Directional Cosine Filter



Lineament Faults from airborne magnetic data

(Morley et al., 2012)





(A) Regional distribution of key Permo-Triassic tectono-stratigraphic units both from the surface and subsurface (compiled from Ueno and Charoentitirat, 2011; Barr and Charusiri, 2011). (B) Same map as A, but with 150 km Cenozoic sinistral translation of the block north of the Mae Ping Fault removed. The displacement amount is from Tapponnier et al. (1986) and the resulting rotation is consistent with the palaeomagnetic results obtained from the Khorat Group by Charusiri et al. (2006)

Morley et al. (2012)



Objectives

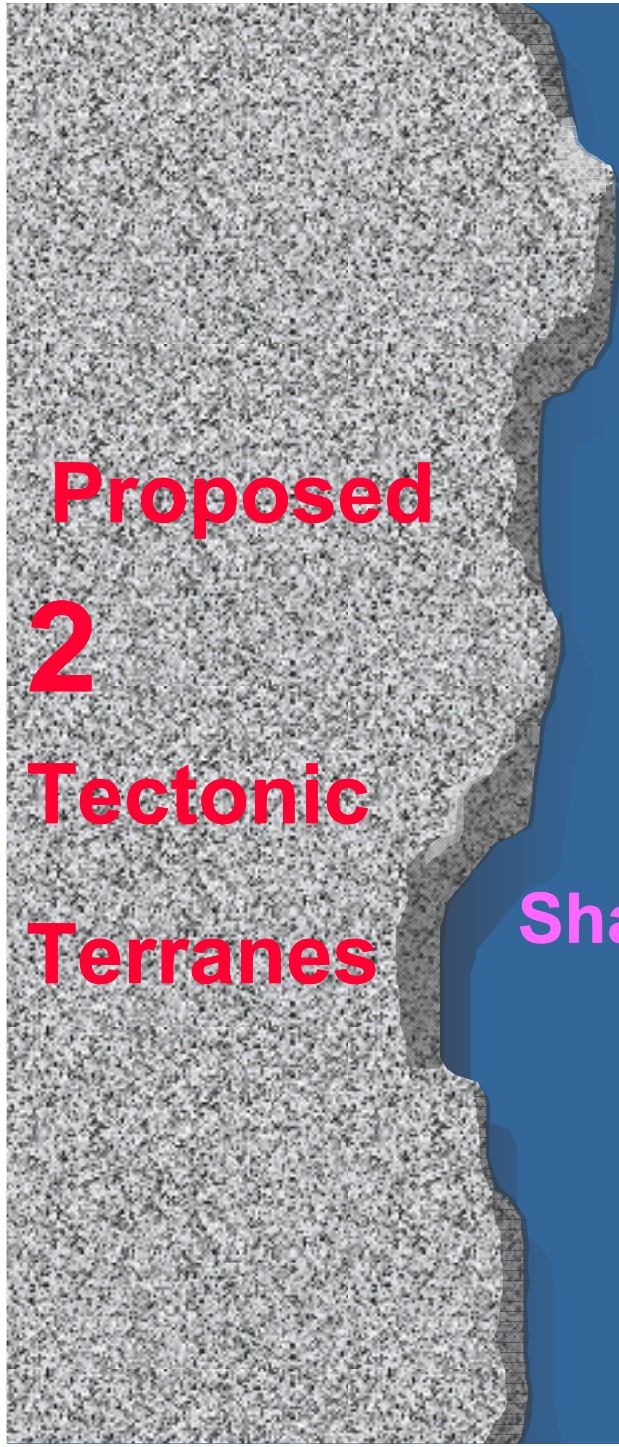
- ↪ make a critical review on tectonics of Thailand
- ↪ propose **2** new smaller tectonic terranes
- ↪ provide some cryptic evidence



**Tectonic
Stages
of Thailand**

**Geological, Tectonostratigraphic
& Geochronological Evidence**

- ☺ **Archaeotectonic**
(Pre Cambrian - Eocambrian)
- ☺ **Paleotectonic**
(Cambrian - L. Triassic)
- ☺ **Mesotectonic**
(M. Triassic - Cretaceous)
- ☺ **Neotectonic**
(E. Tertiary - Present - day)

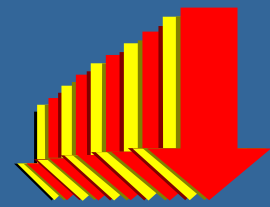


Proposed
2
Tectonic
Terranes

Shan - Thai (Sibumasu)

VS

Indochina

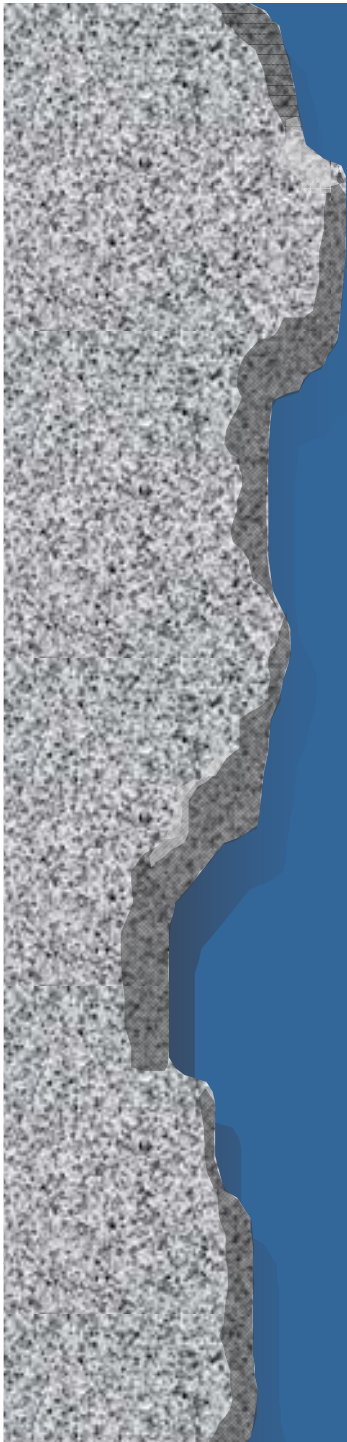
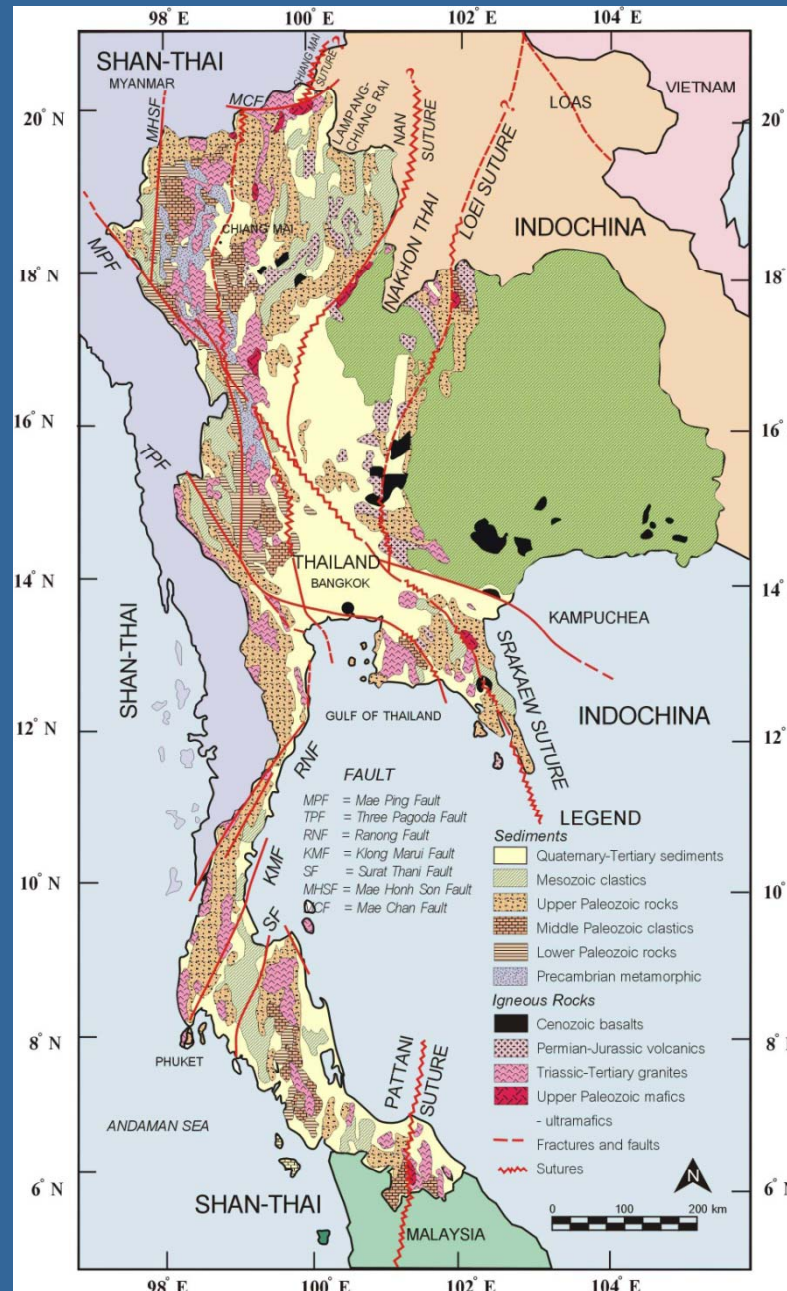


Shan - Thai + Lampang - Chiang Rai (LC)

VS

Indochina + Nakhon Thai (NT)

Geotectonic map of Thailand

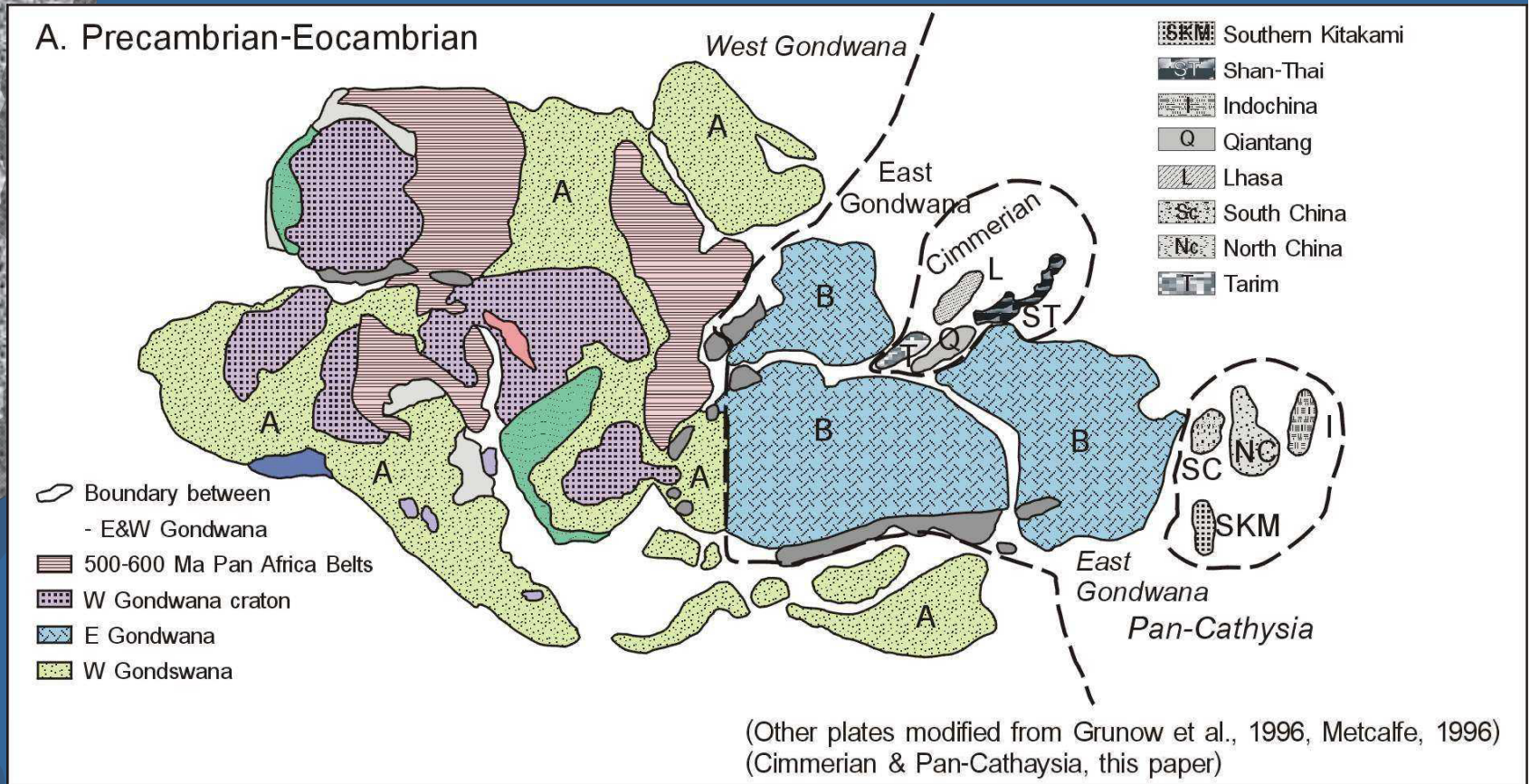


Archaeotectonic Stage (Block Formation)

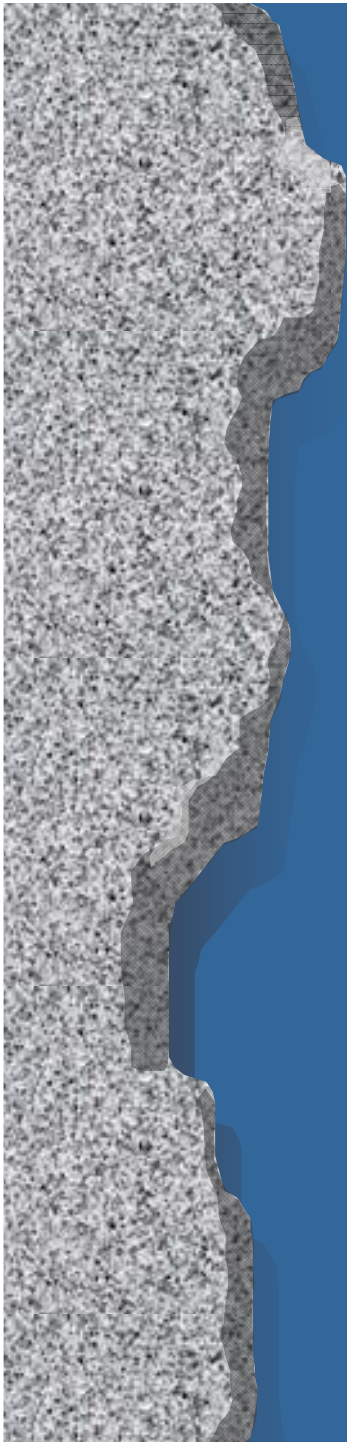
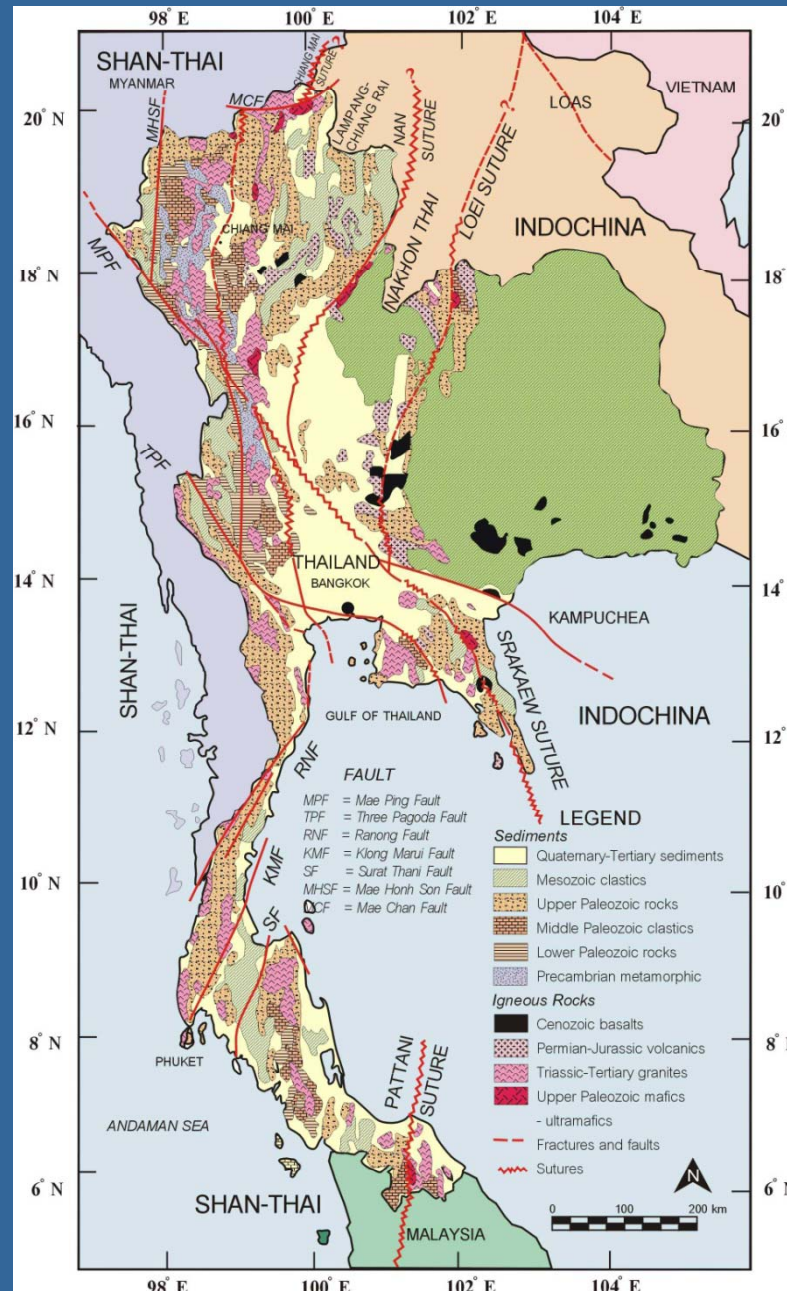
**Archaeo -
tectonic**

- ⌚ Detached cratonic fragments
(E. Gondwana, Pan - Cathaysia)
- ⌚ High grade metamorphic core
complexes
of inferred Pre Cambrian age
- ⌚ Intense folding, plastic to pygmatic,
isoclinal
- ⌚ Amphibolite (-Upper Greenschist)
during Eocambrian
- ⌚ No isotopic dates confirms the
Precambrian
- ⌚ Ages of gneiss from U - Pb Zircon dates

Lan et al. (2009)



Geotectonic map of Thailand



**Paleotectonic Stage
(Accretion - Rifting - Suturing)**

**Paleo -
tectonic**

Cambrian

Ordovician

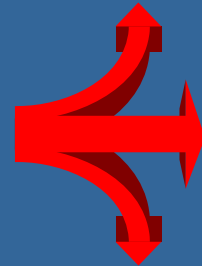
Silurian

Devonian

Carboniferous

Permian

Triassic



Stratigraphy

Tectonics

Plate

Mineralization

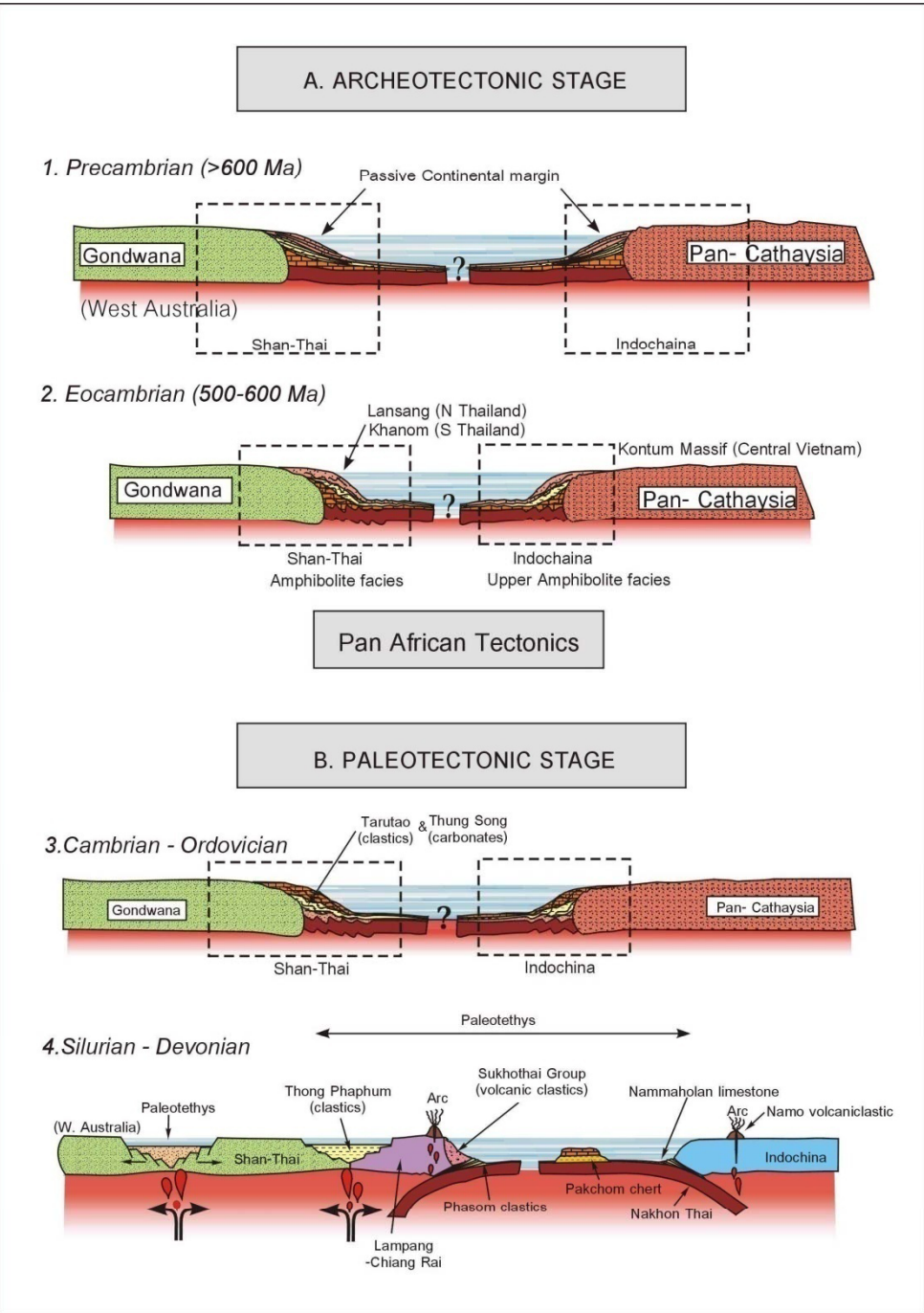
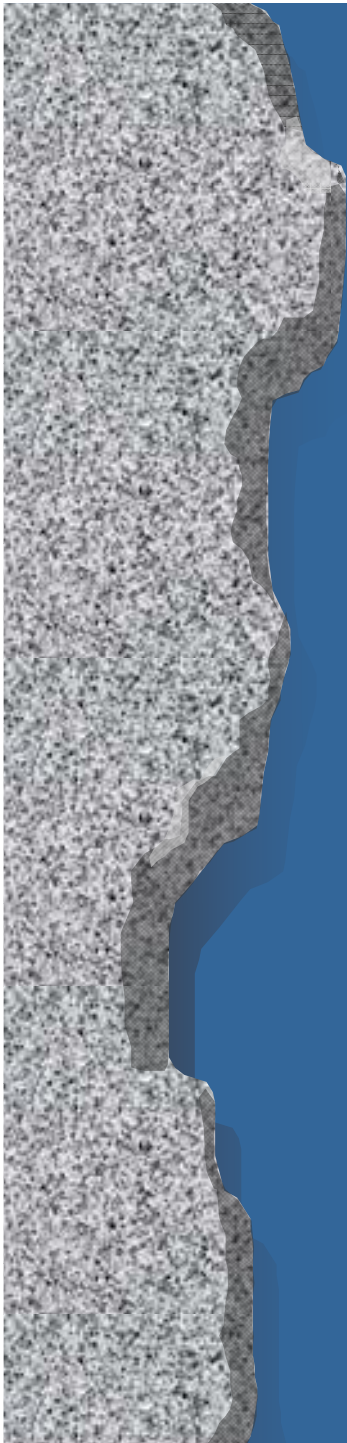
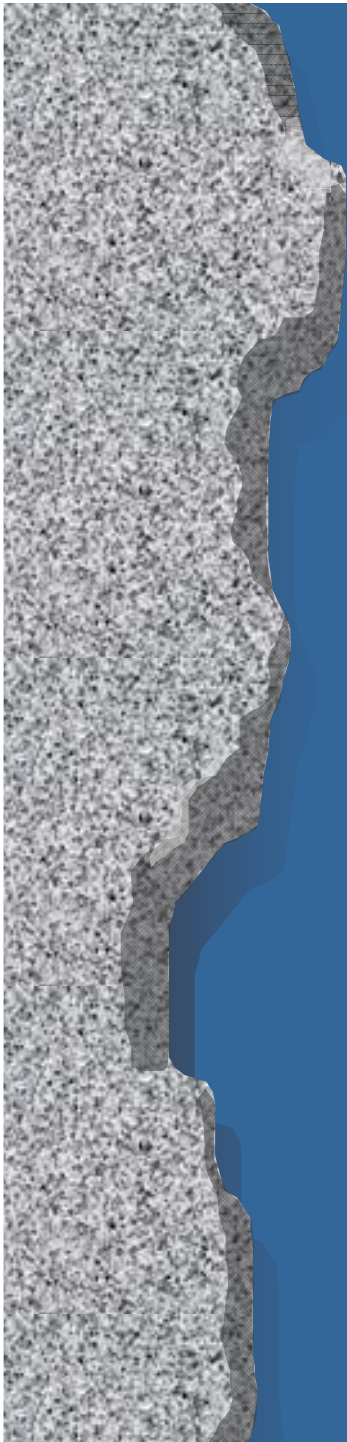
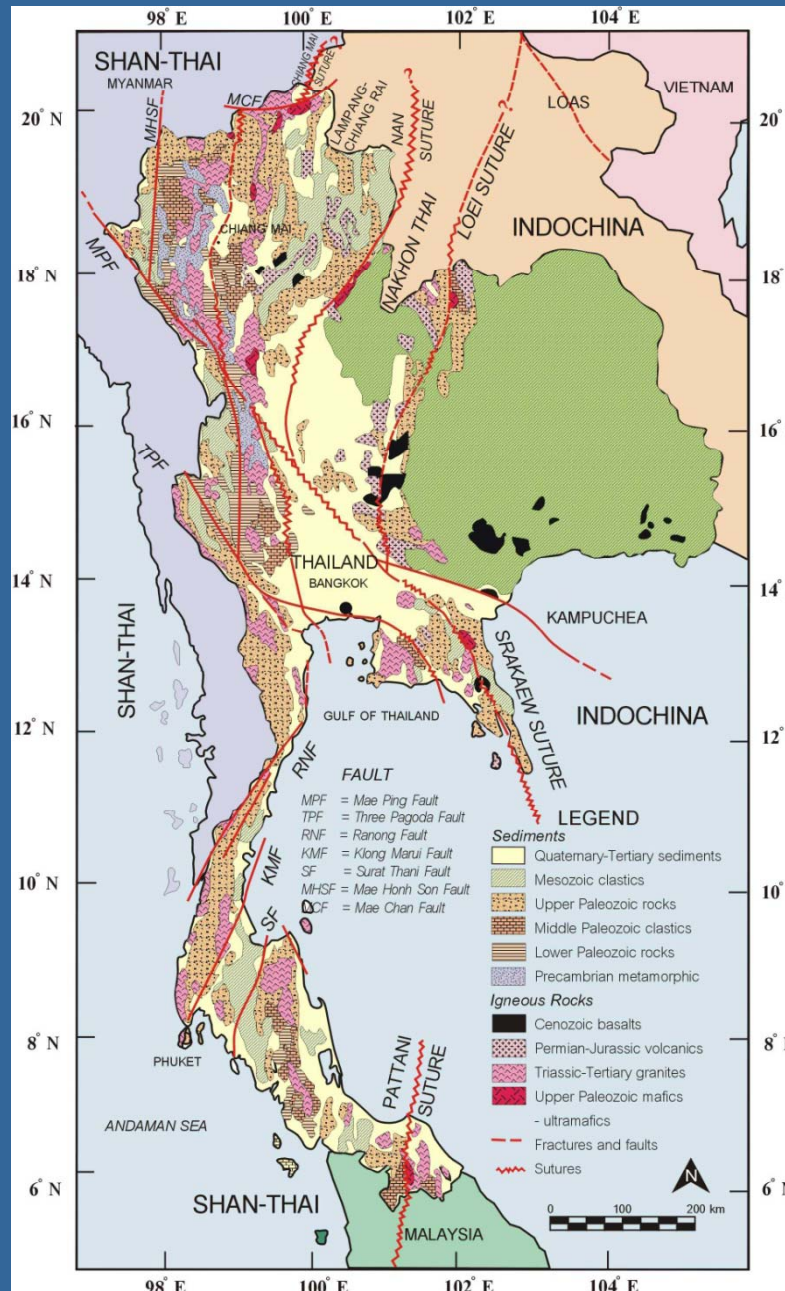


Fig. 5.1

Geotectonic map of Thailand



Stratigraphy

- Camb. → Shallow marine, siliciclastics
- Ord. → Open marine, carbonates
- Sil - Dev → Deep, (volcani-) clastics

Plate

Paleotethys betw. ST & IC

Both - S. Hemisphere & low Lat.

Cam - Ord : ST → counter clockwise

: IC → ??????

Tectonics

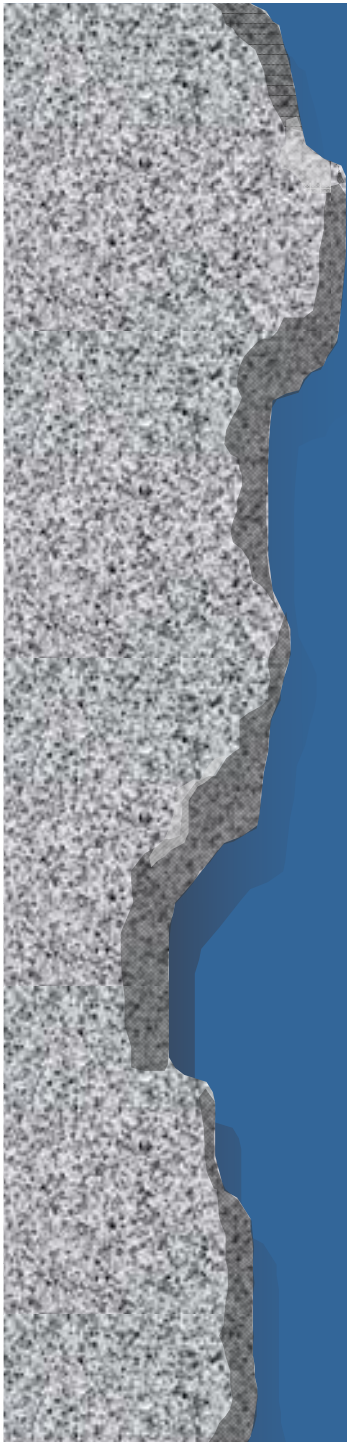
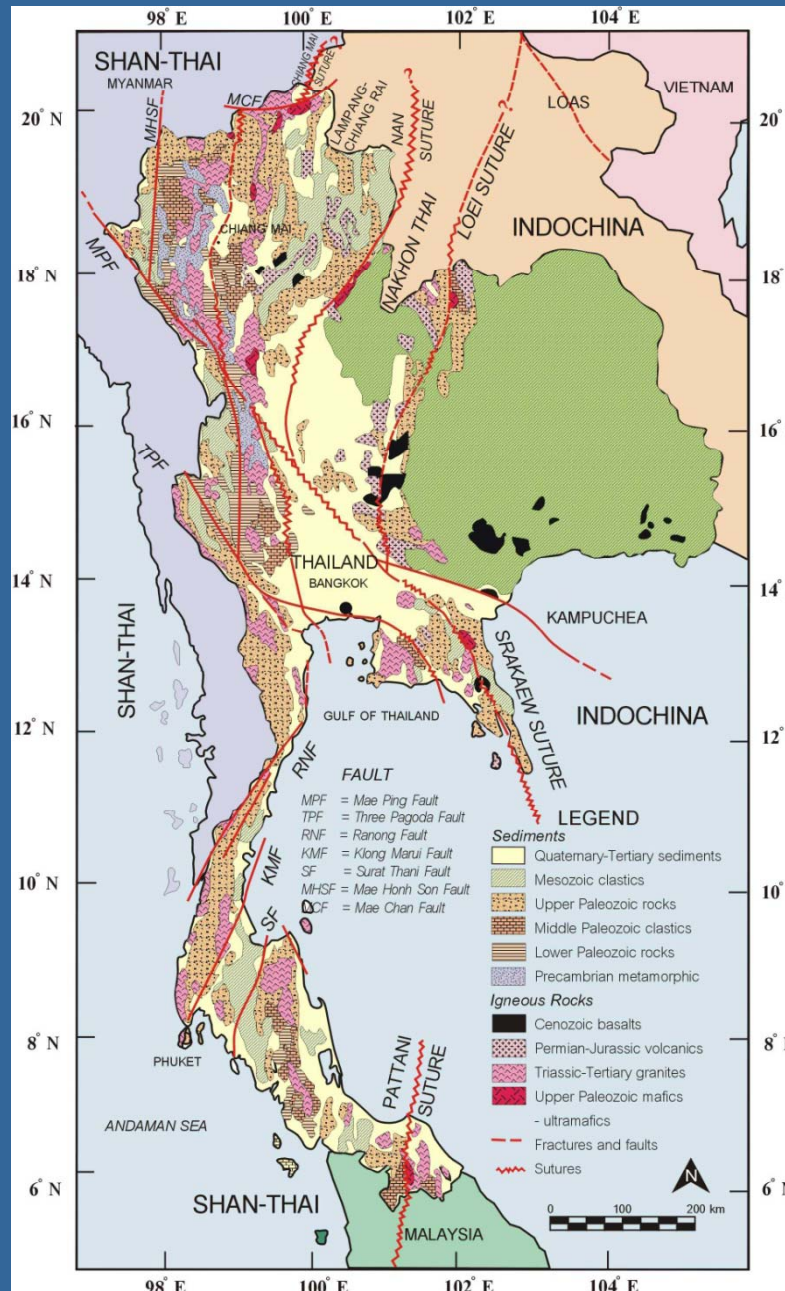
Accretional wedges // passive cont.

Mild rifting

Subduction + calc alk. volcanism

+ Caledonian Time

Geotectonic map of Thailand



Stratigraphy

Carb. - Perm.

- Diamictite (deep water)
Pebbly mudstone

Perm.

- Carbonate (shelf to platform)
± chert, tuff, clastic

Plate

- LC & NT Ocean Floor
- Ord - E. Perm.
: ST → clockwise & mid Lat. (cold)
- E. - L. Perm.
: ST → mid to low Lat., southern
: IC → ?????

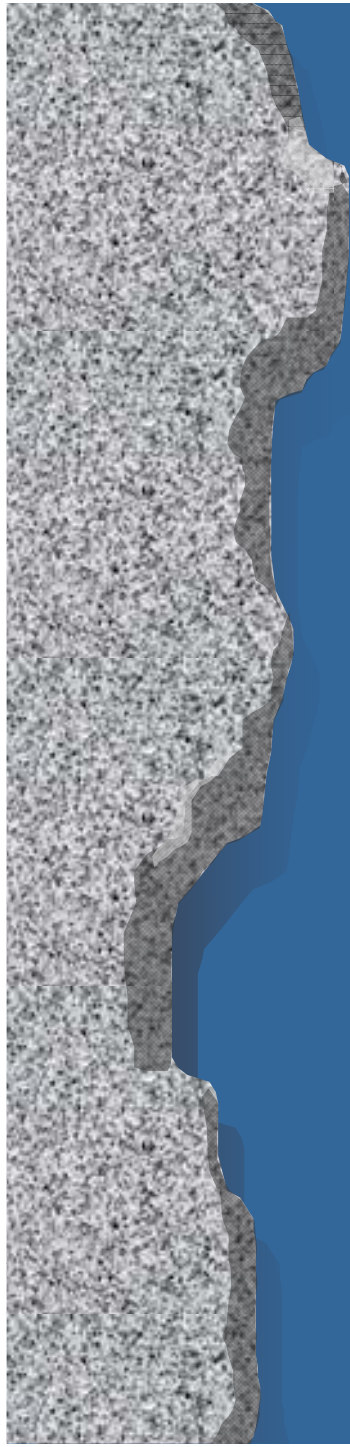
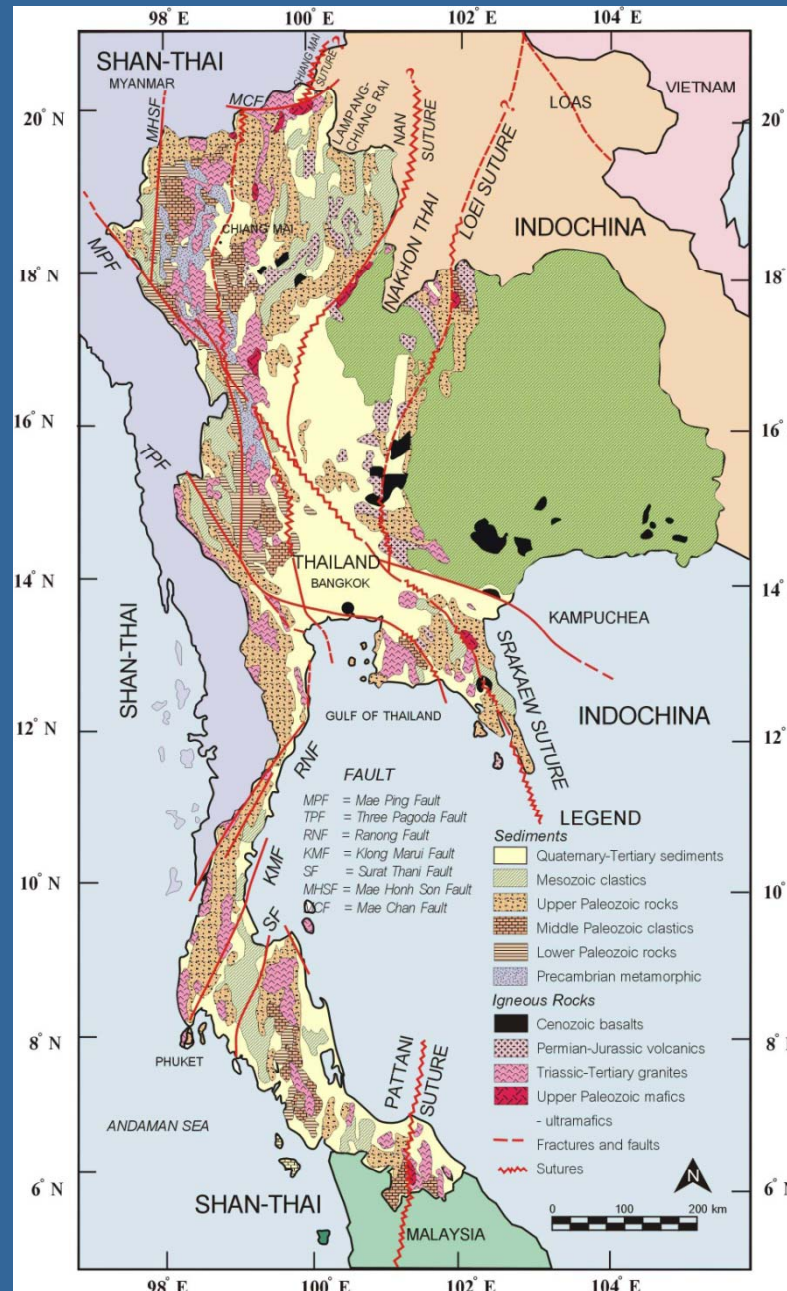
Tectonics

- Rifting & Rapid Drifting of ST & IC

Mineralization

- Gyp. & Coal - NE Thai
Cr ± Ni, Cu

Geotectonic map of Thailand



Stratigraphy

- β Shallow to deep marine
- β passive in west ST
- β arc - trench in NT & LC
- β Lagoonal in west IC

Tectonics

- β Subduction (Hercynian)
- β Volcanism (violent)
- β W-dip isoclinal = E - thrust
- β Half graben in west IC

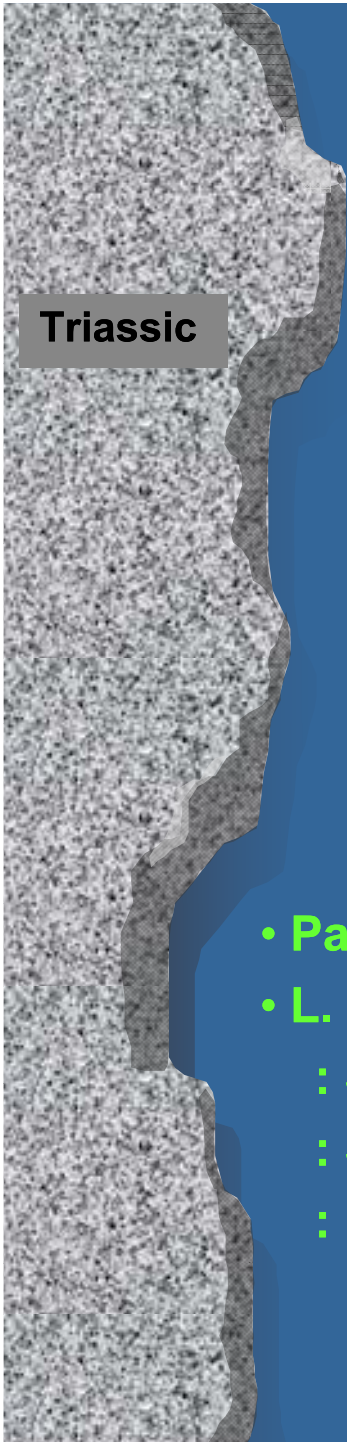
Plate

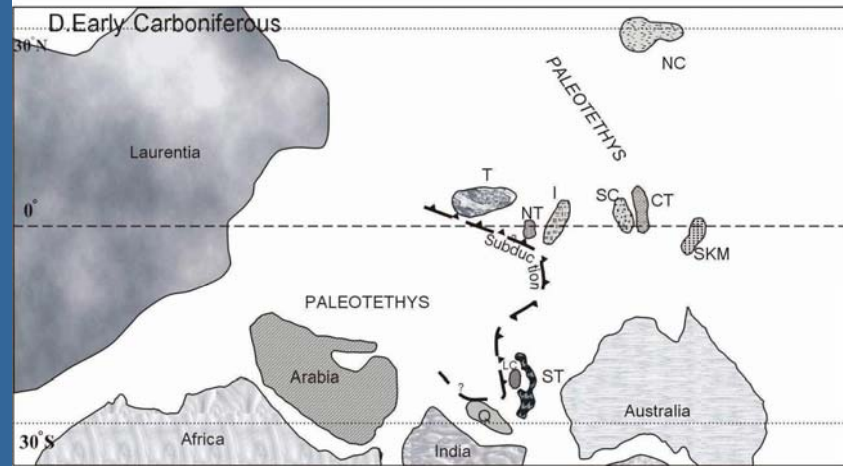
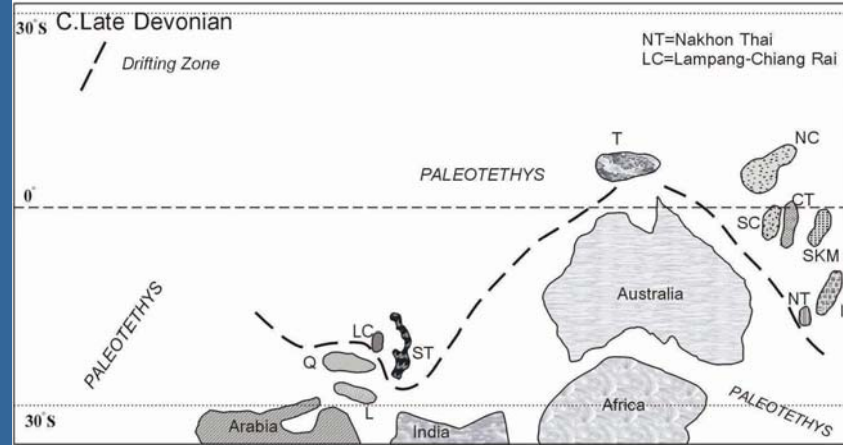
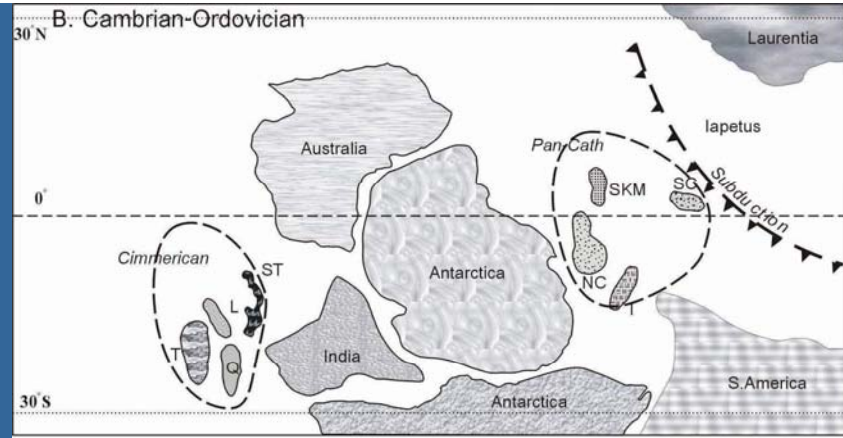
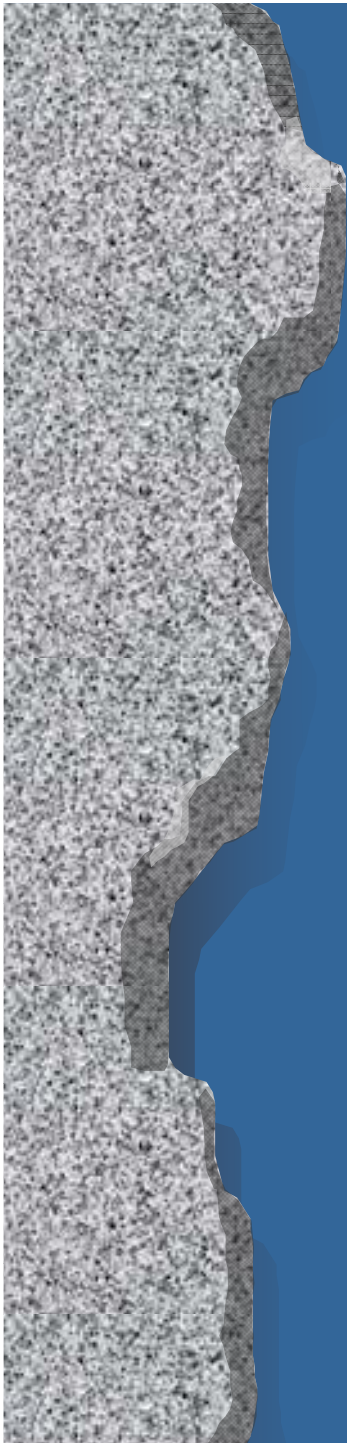
- Paleothythis (narrow to close)
- L. Perm. - E. Tr.
 - : ST & IC → across Equa., Low Lat.
 - : ST → S - Hem., clockwise
 - : IC → N - Hem., With S. China

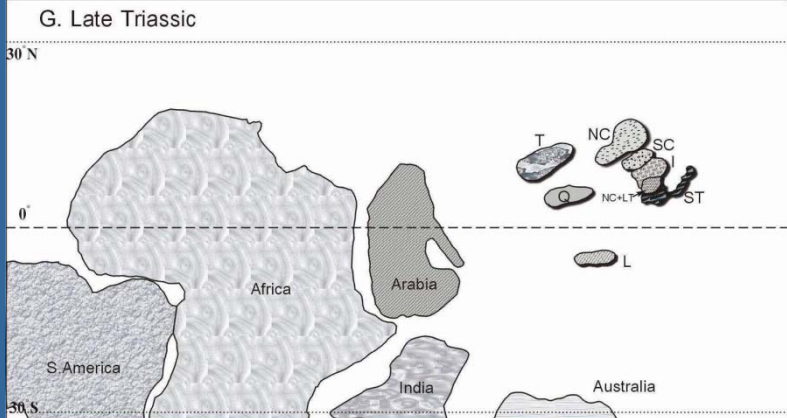
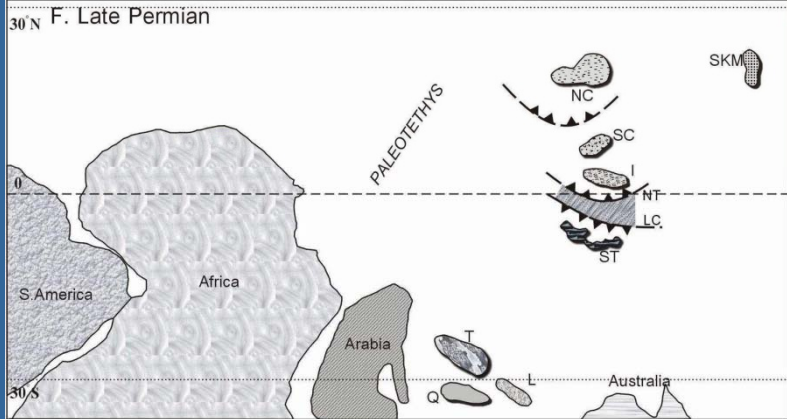
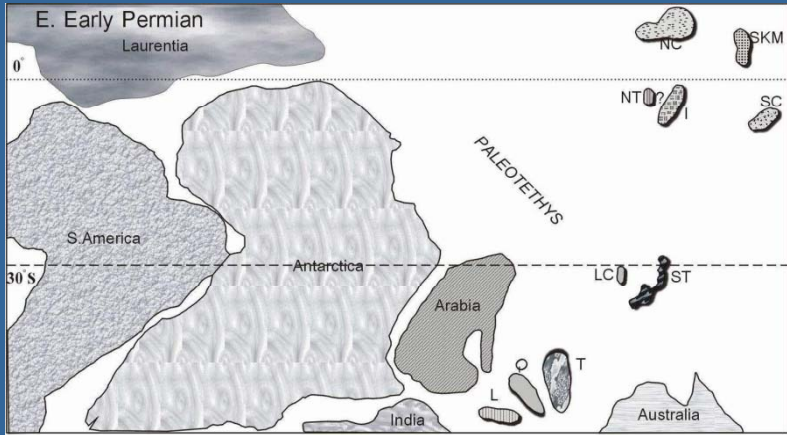
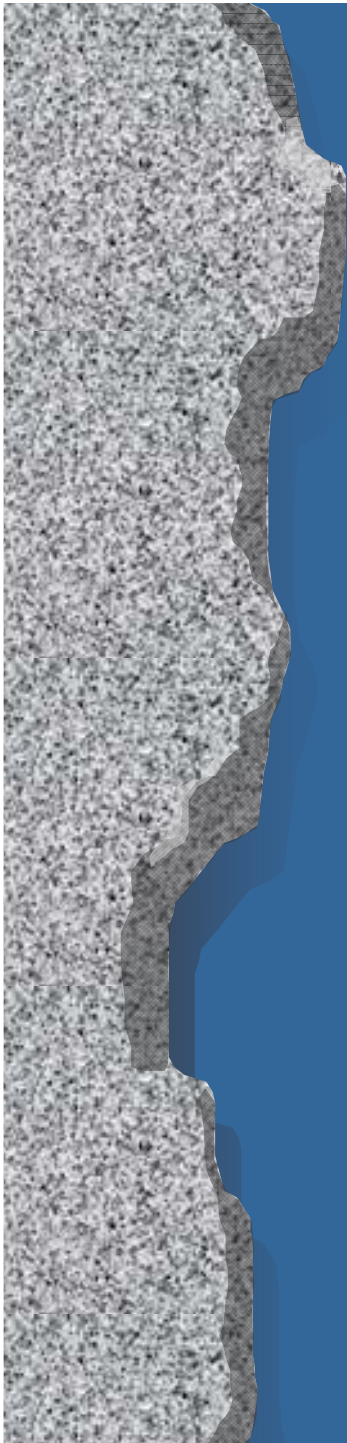
Mineralization

- S-granite + Sn-W-REE
- I-granite + Cu-Fe-Pb-Zn-Au-Sb porphyry (Kuroko)

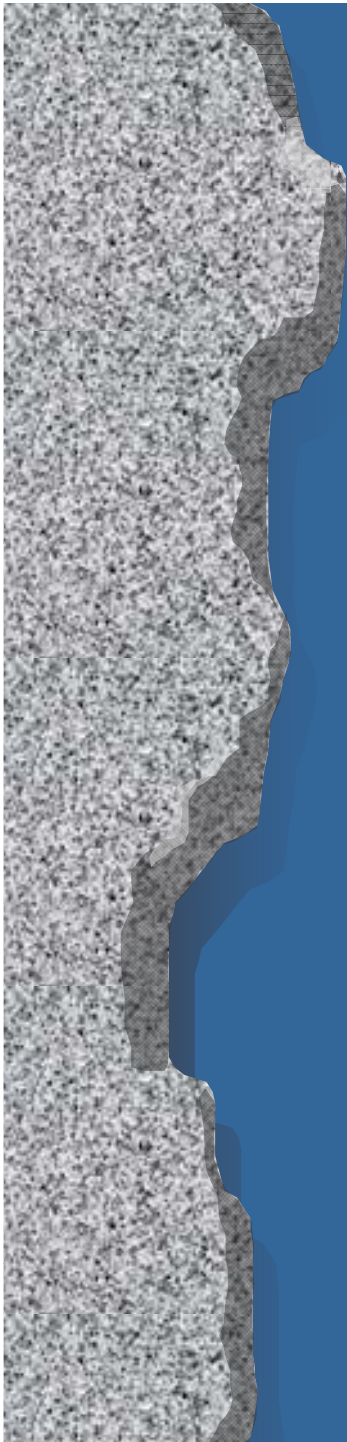
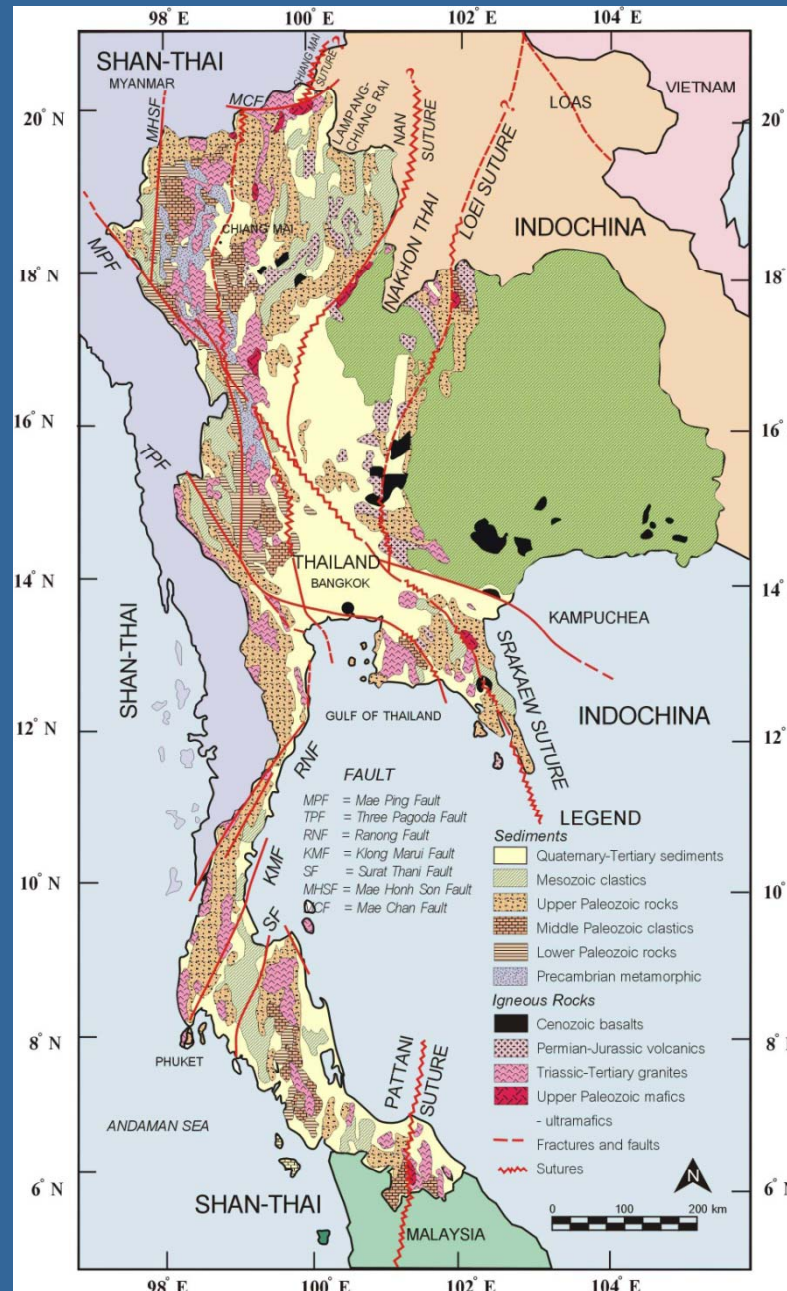
Triassic







Geotectonic map of Thailand





**Meso -
tectonic**

τ **Tectonics**

: all plate collision (IC = Tr - Jr)

: east upthrust

ST over IC = E & S Thailand, ST over LC = rest

LC over NT & NT over IC

: Major fault systems

τ **Stratigraphy Jr - K**

: Continental dep.

: lagoonal in west IC

: marine to non- marine in west ST

τ **Mineralization**

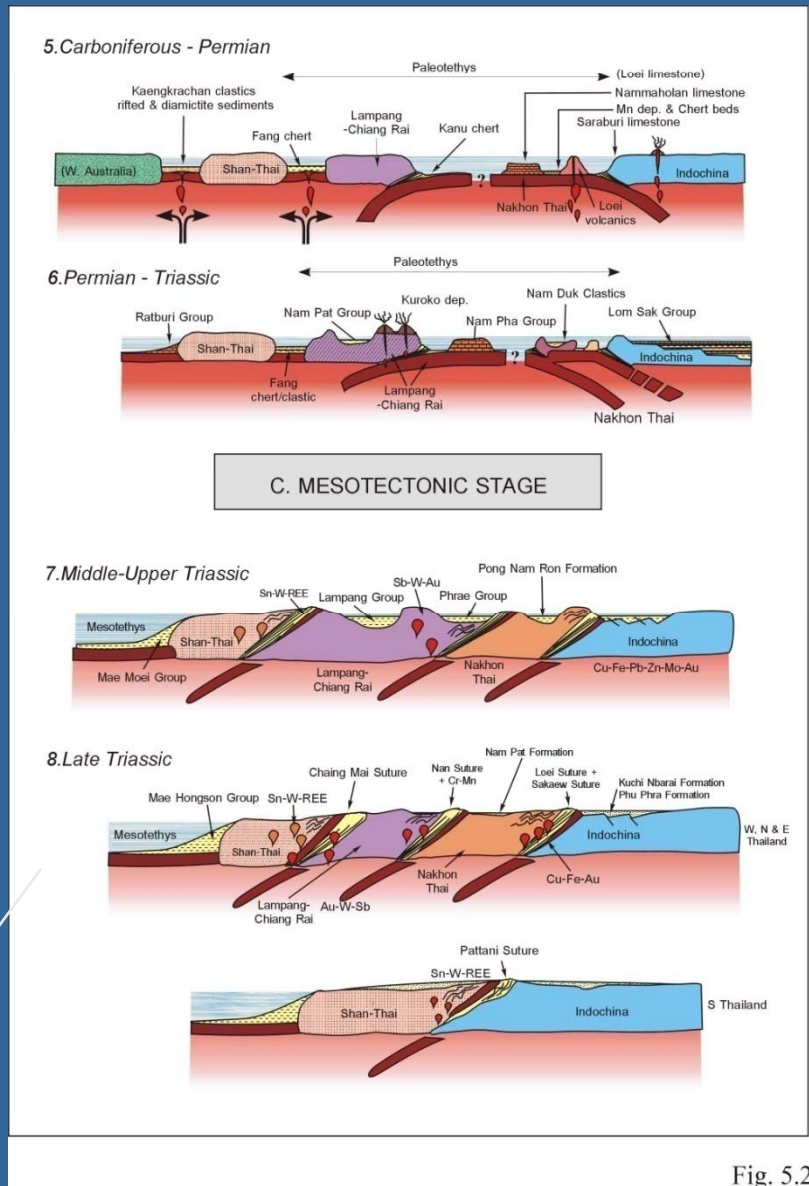
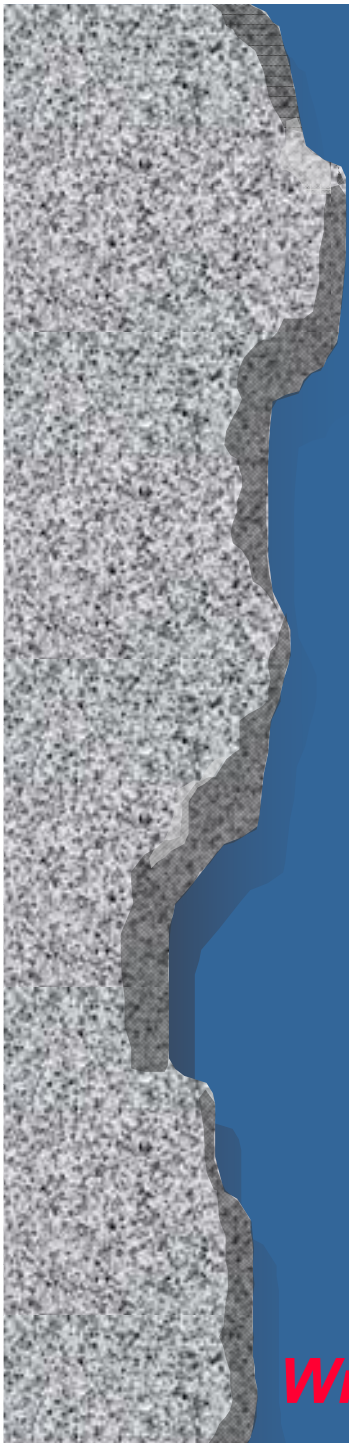
: S-granite + Sn-W-REE

: U-dep. in Khorat sst.

τ **Plate**

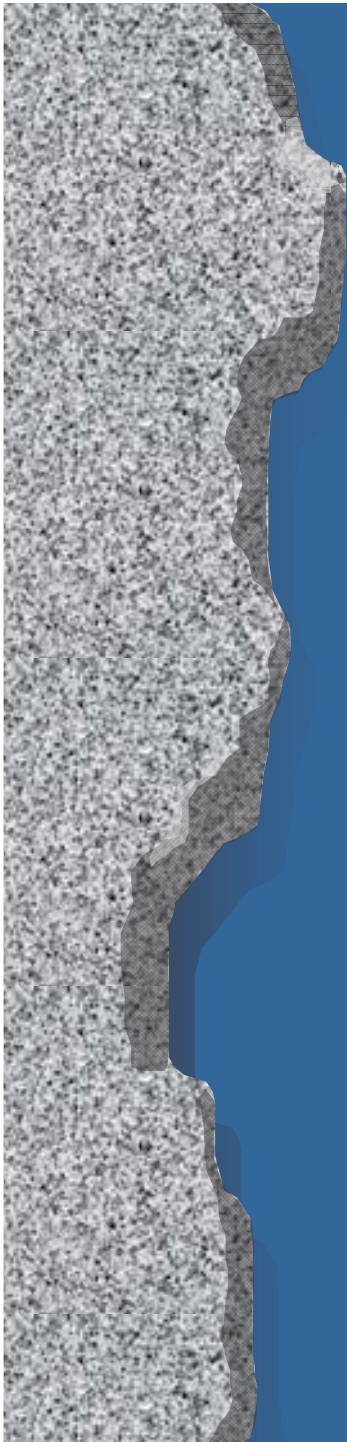
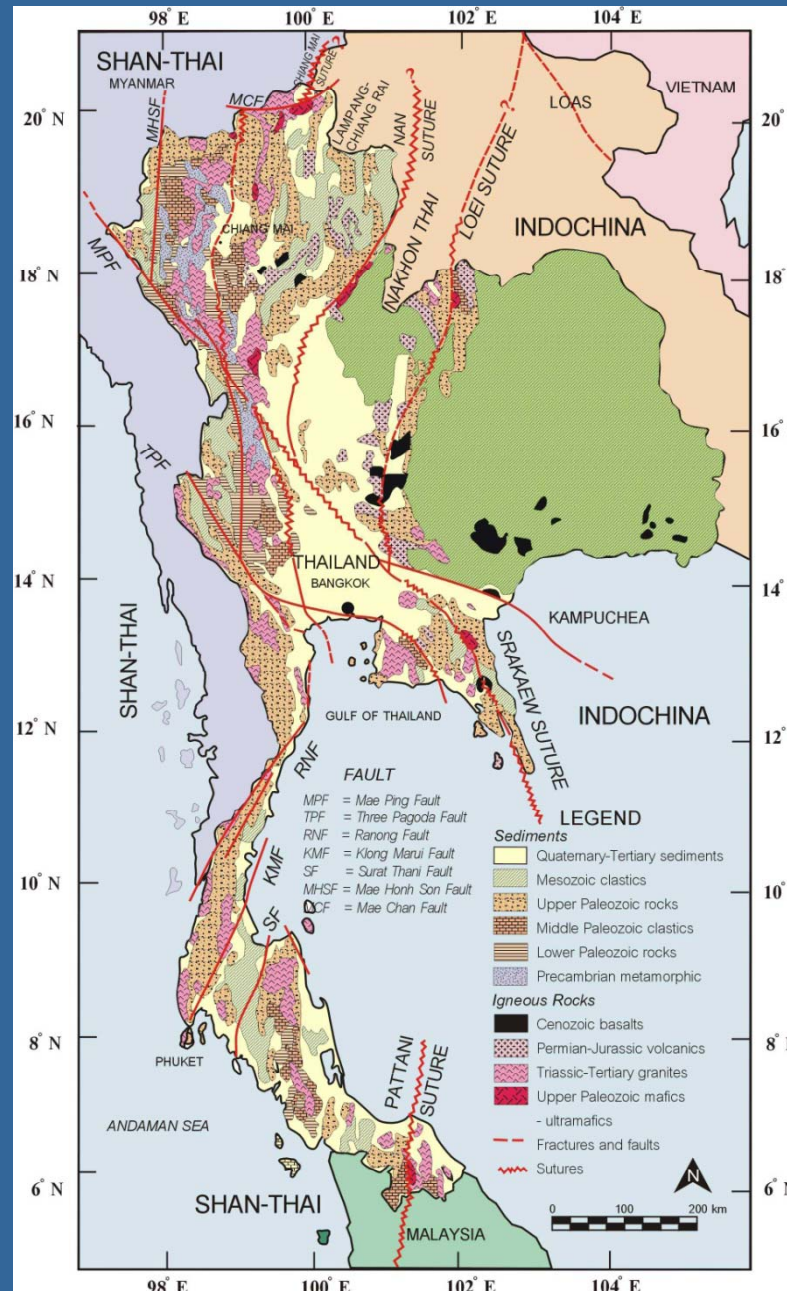
: Progressive clockwise

: W. Burma + ST = Mesotethys closed



Wrong ! Eastward subduction (by new evidence)

Geotectonic map of Thailand





Neuvo - tectonic

Tectonics

- : Progressive change in tect. Region (Himalaya)
 - : Extrusion, Phu Phan Uplift
 - : Reactivate fault movement, pull - apart basin
 - : Thai Gulf., S. China, Andaman Seas
-
-

Stratigraphy

- : more fluvio-lacustrine + superlittoral in the Gulf
 - : more massive in Andaman
-
-

Plate

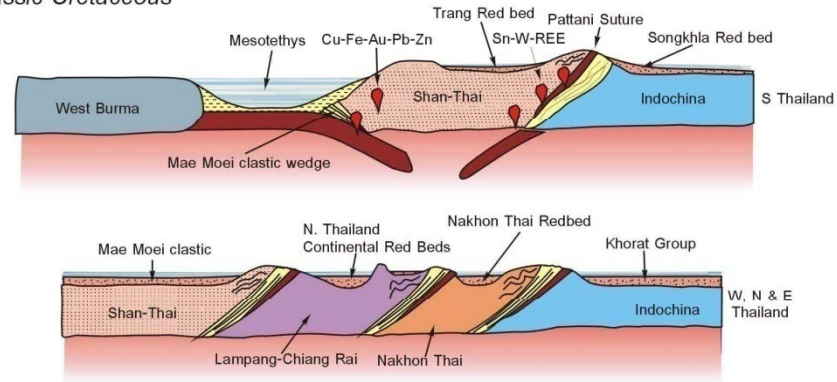
- : stress - accumulated
 - : mild clockwise rotat. (10^0 India, W & SE Asia)
-
-

Mineralization

- Metal : I-gr. + Cu-Fe-Au-Sb
- : S-gr. + Sn-W-REE

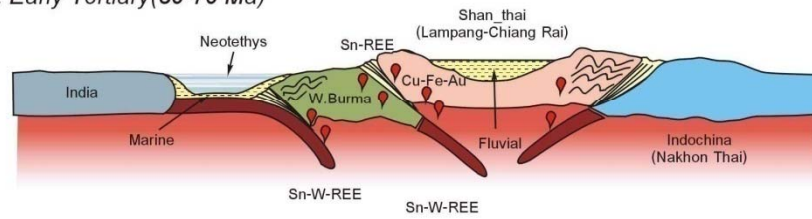
Nonmetal : clay, diatomite, Coal, Gems (basalt)

9. Jurassic-Cretaceous

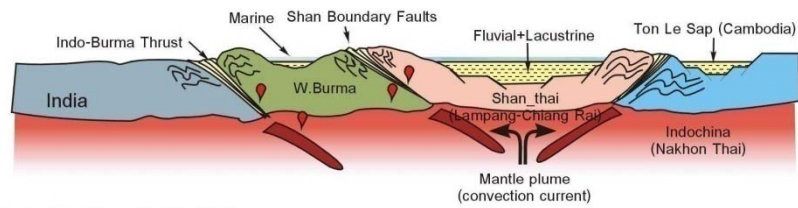


D. NEOTECTONIC STAGE

10. Early Tertiary (80-70 Ma)



11. Middle Tertiary (45-50 Ma)



12. Late Tertiary (2-30 Ma)

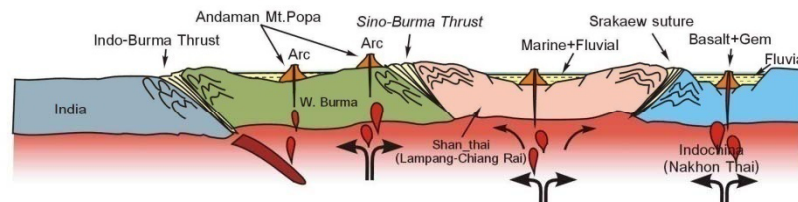
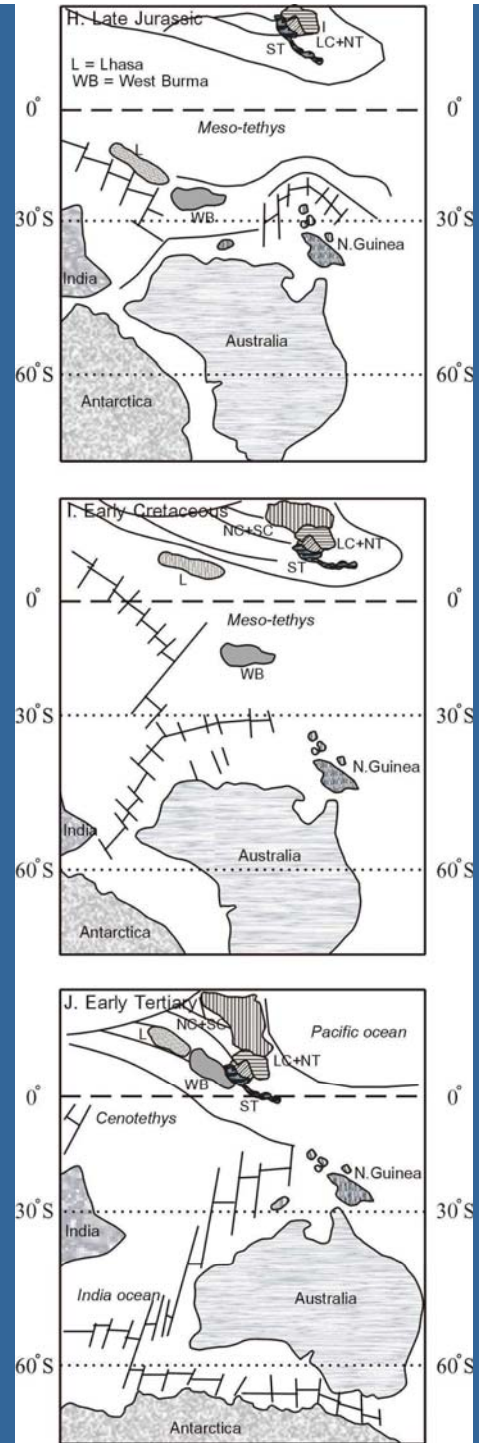
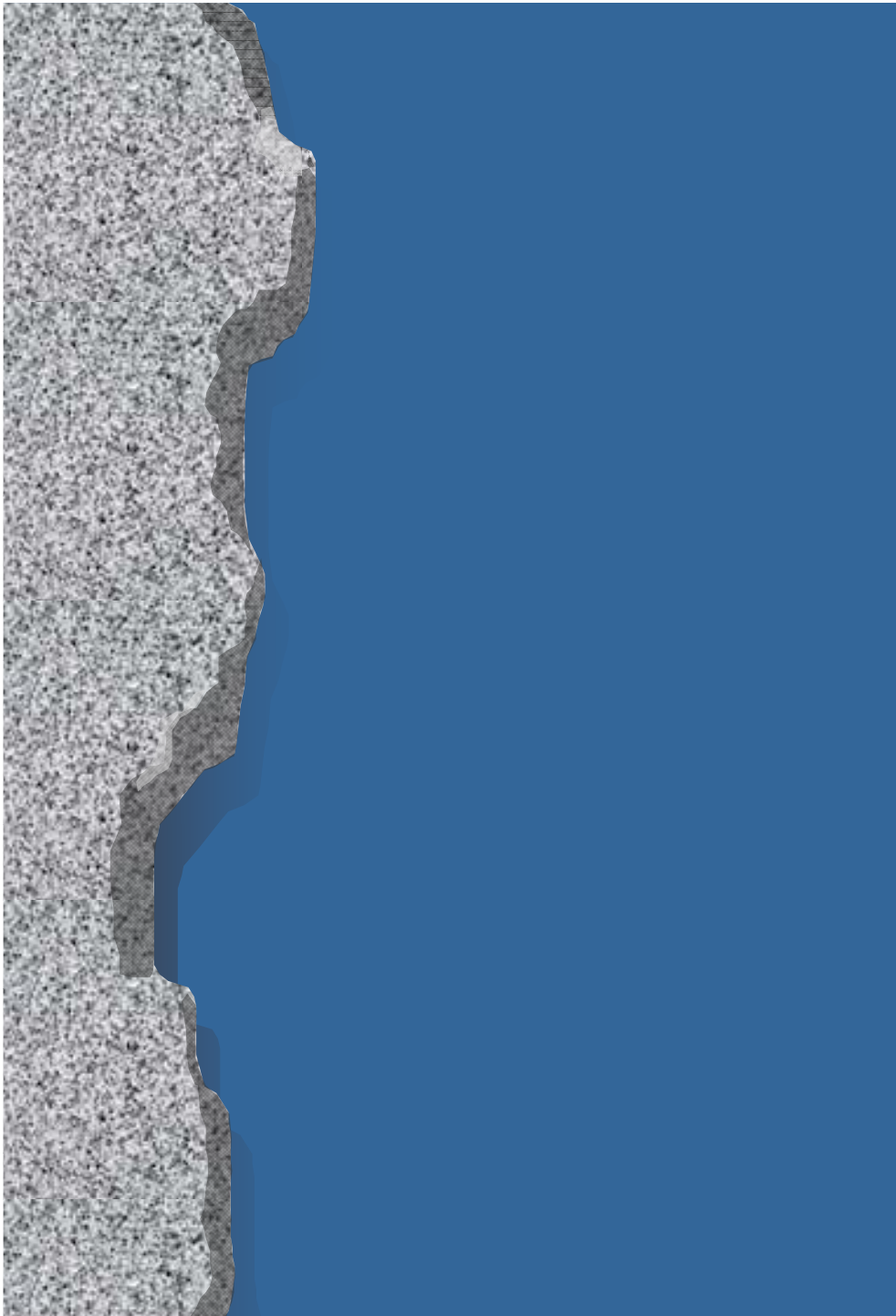
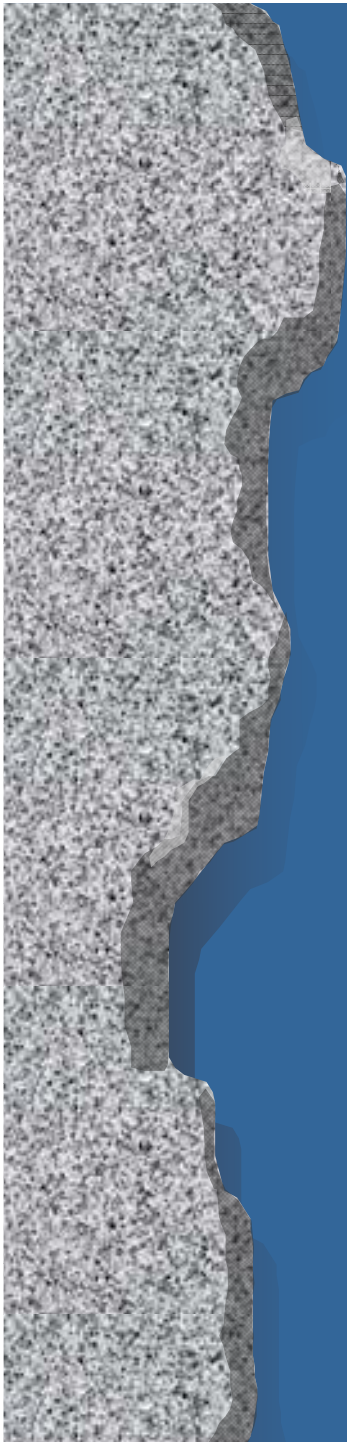
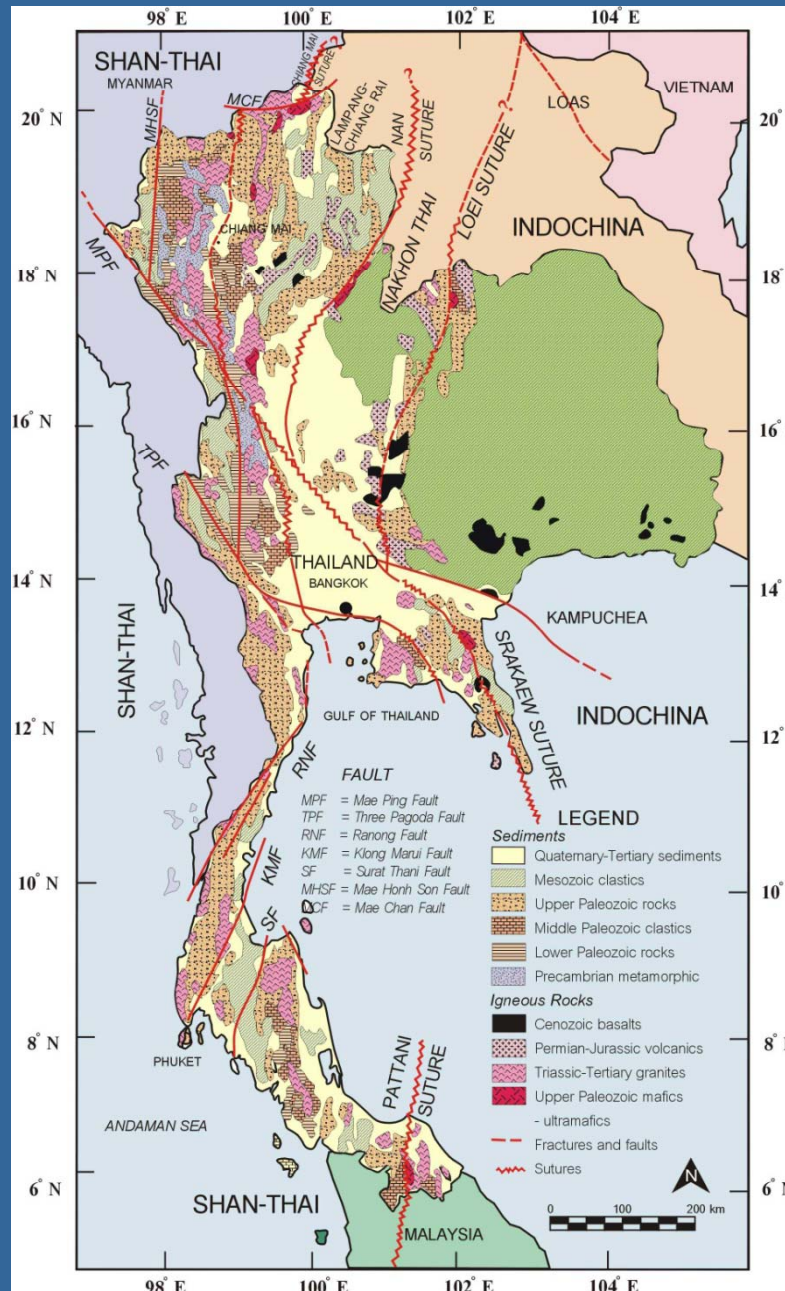


Fig. 5.3



Geotectonic map of Thailand





**Neuvo -
tectonic**

Geomorphology

- Alluvial terraces & fans in Central Thailand

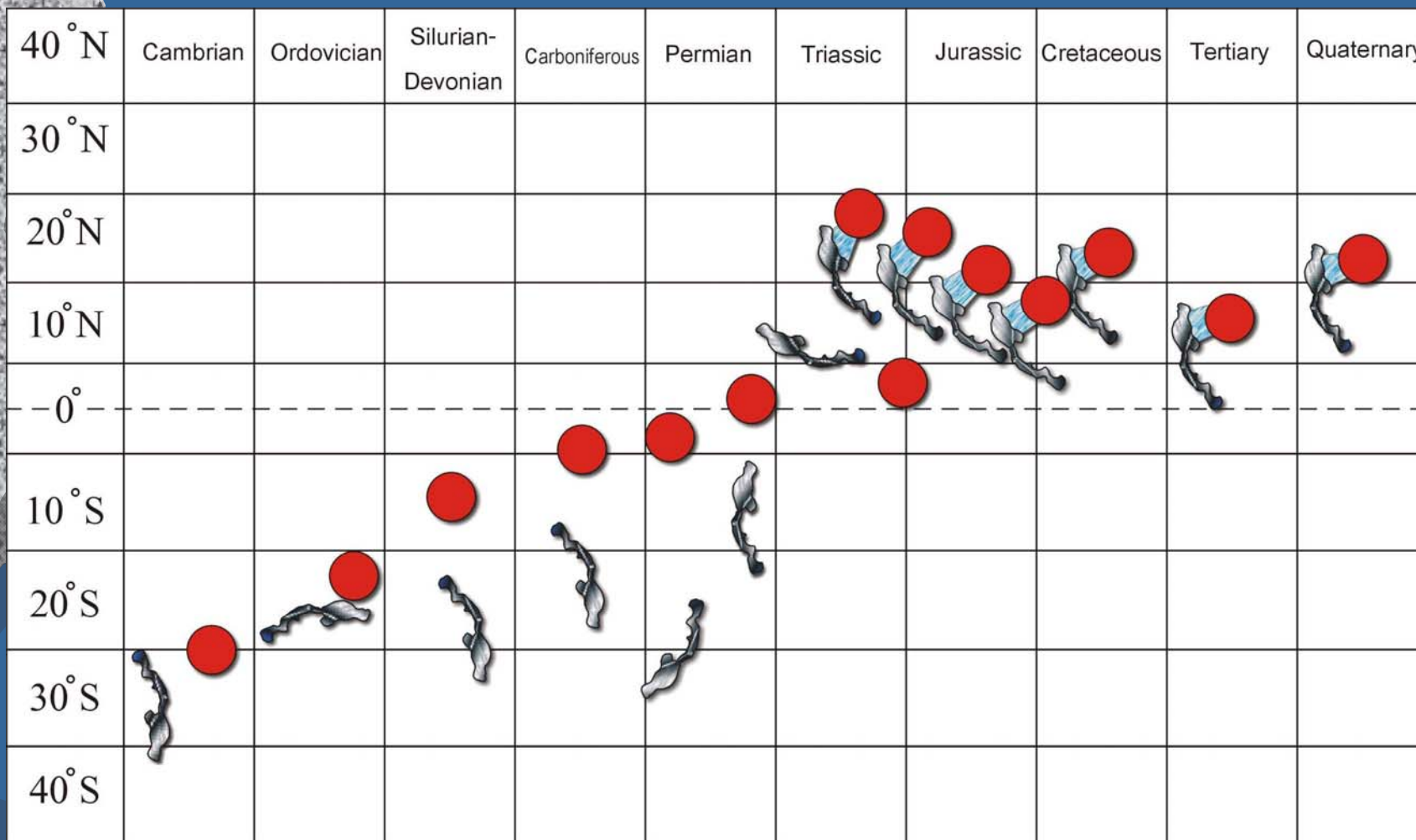
Mineral Deposit

- Uplift, denudation & placer deposit of major Sn-Au- and Gem mineral

Tectonic

- Impact of **0.7** Ma Thailand tektite
- Continuous W-tilting of Thai Pennin.
 - emergence of E-coast (Gulf)
 - submergence of W-coast (Andaman)
- Hot spring, high heat flow region
- present day & historical EQ

Paleolatitude of Shan-Thai and Indochina blocks



Shan - Thai

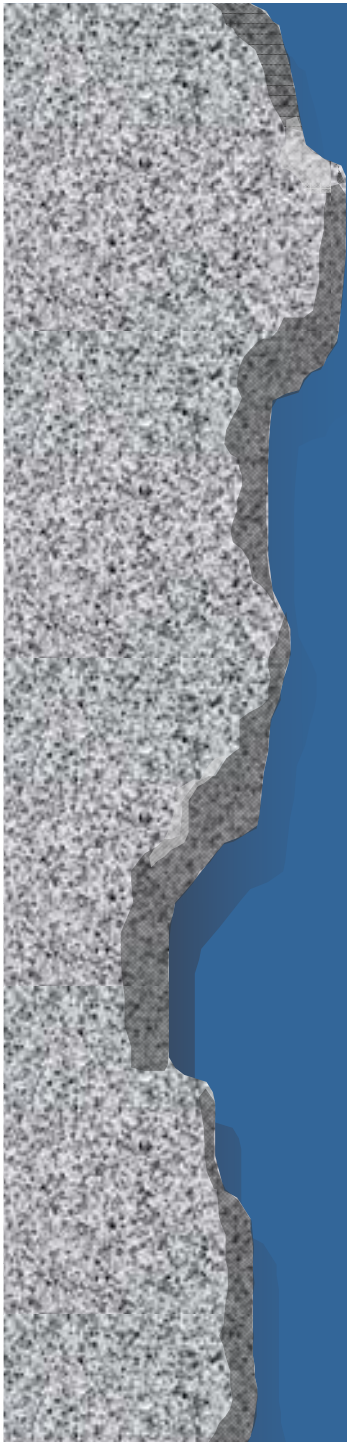
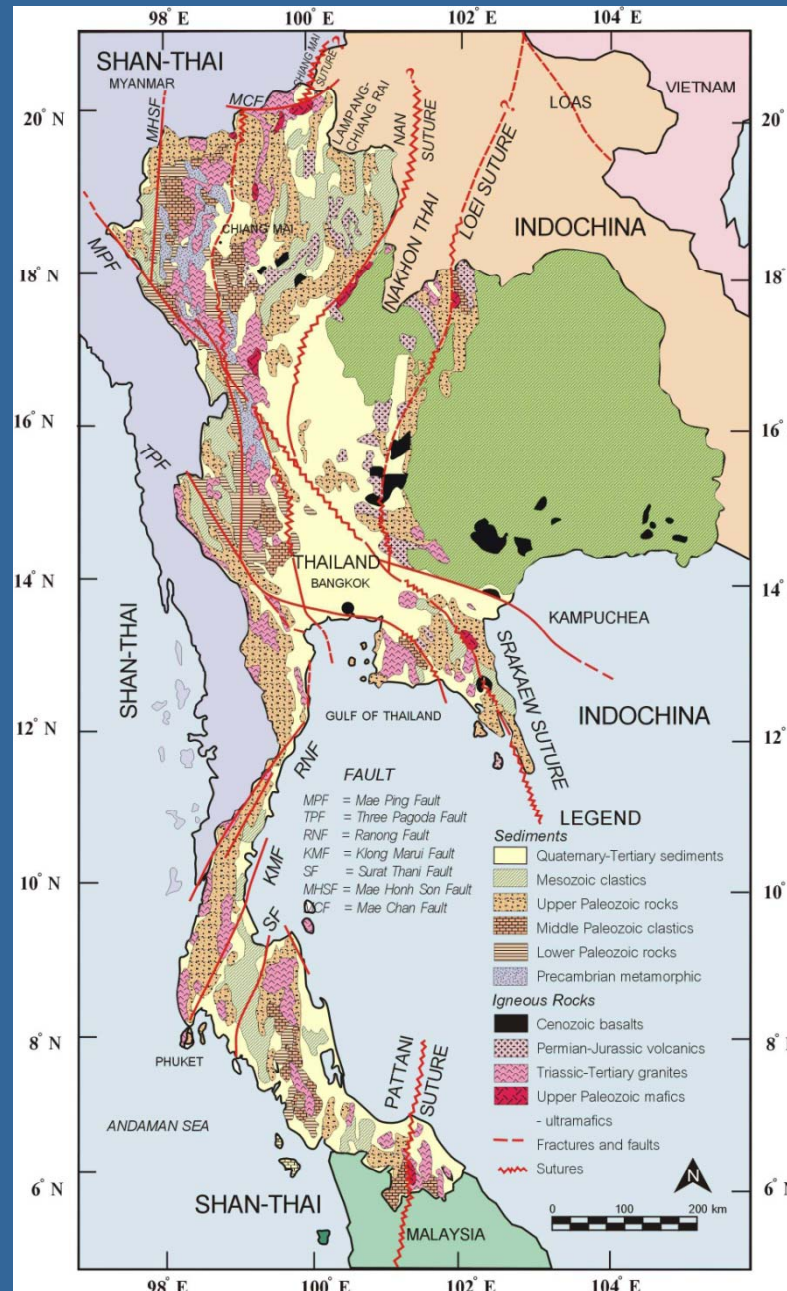


Indochina



Lampang-Chiang Rai & Nakhon Thai

Geotectonic map of Thailand





Evidences of 2 New Terranes

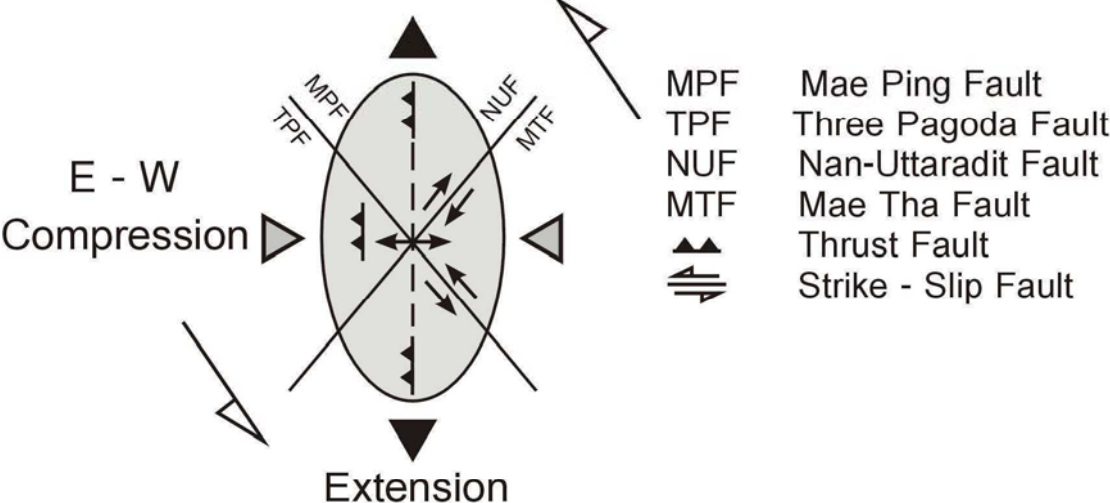
Evidences

- **Structural Synthesis**
 - West dipping thrust and intense foldings
- **Lithological Relationship**
 - Ocean-floor basalt, chert & 1st. platform in Loei
 - serpentinite bodies, dismembered ophiolite (Chiangrai, Loei, Pak Thong Chai, Srakaew, Narathiwat)
 - Fang, deep water + chert beds with Carboniferous volcanic rocks

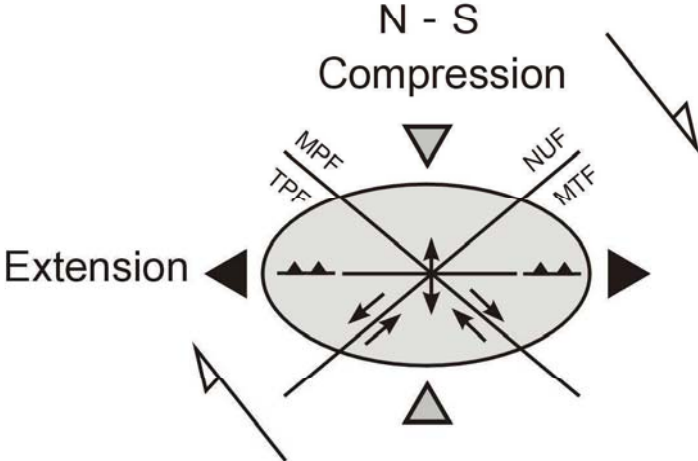
Evidences of 2 New Terranes

- **Geochemistry**
 - Volcanics indicate source to the east of Loei and Lumnarai (Intasopa, '91)
 - Detrital Spinel in Nam Duk Fm. = to the east (Chutakosinon et al., '97)
- **Regional Geology**
 - Extension of NT & LC to Laos & Yunnan along the fault zone

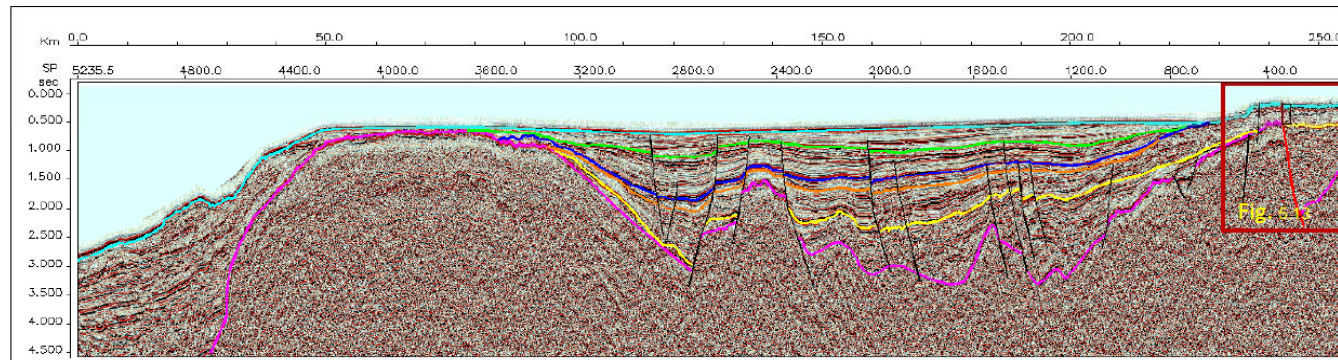
Ellipsoids and development of major faults in Thailand



Transpression sinistral shear (NE-SW direction)



Transpression sinistral shear (NW-SE direction)



- Seafloor
- Top of Thalang formation
- Top of Trang formation
- Top of Kantrang formation
- Top of Ranong formation
- Basement
- Unassign fault
- Ranong fault

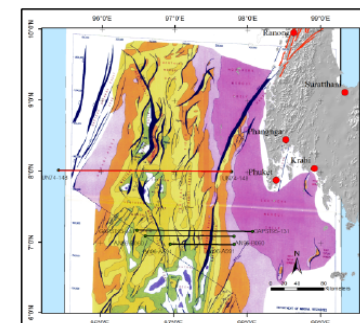
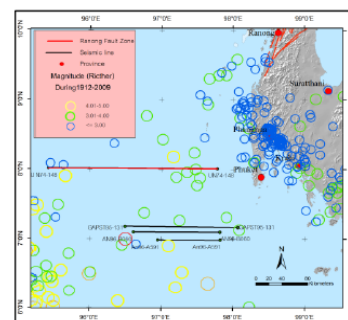
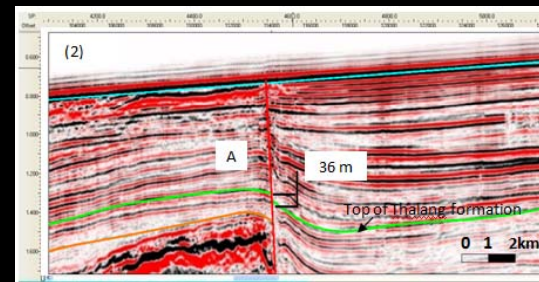
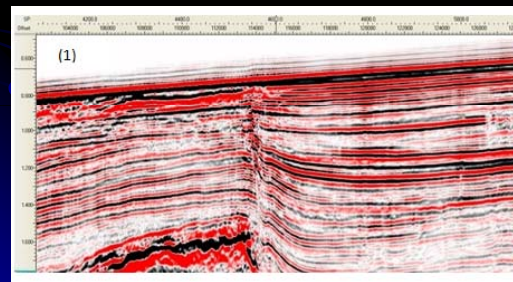
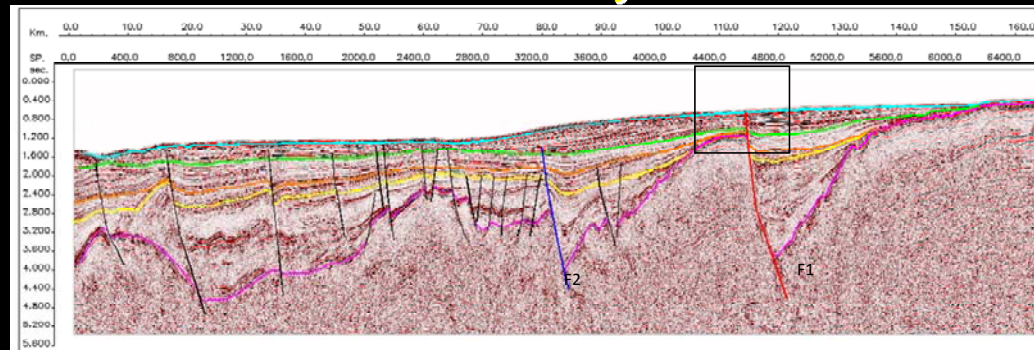


Figure 5.11 seismic cross-section of seismic line survey AN1

S. Thipyopass et al., 2013 prep)¹

Seismic line survey AN2





THE END

**More Geochronological,
geochemical Work and
More Paleontology and
Paleomagnetic Studies**