

เอกสารประกอบการสอน

ธรณีวิทยาประเทศไทยช่วง

Paleozoic & Mesozoic



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โครงการหนึ่งอาจารย์ หนึ่งผลงาน ประจำปี 2553

มหาวิทยาลัยเทคโนโลยีสุรนารี

THAILAND

- 1) North & upper West
- 2) Central
- 3) Loei-Phetchabun
- 4) East
- 5) Khorat plateau
- 6) South & lower West
- 7) Gulf
- 8) Andaman

PRECAMBRIAN

❖ Summary

❖ 3 parts (from lower to upper)

- ❖ Lower part: Ortho-gneiss/migmatite/anatexis (granite mixing with para-gneiss) and consist of K-fsp, quartz, plagioclase, biotite, muscovite, garnet, silimanite.
- ❖ Middle part: Para-gneiss & schist are consist of K-fsp, quartz, plagioclase, biotite, garnet, andalusite, quardialite.
- ❖ Calc-silicate & marble are consist of quartz, calcite, diopside, phlogopite, epidote, garnet.
- ❖ Upper part: Calc-silicate & marble are consist of calcite, dolomite, phlogopite, epidote, garnet, actinotite-tremolite, plagioclase, K-fsp, scisite, diosiqe.

❖ North & upper West

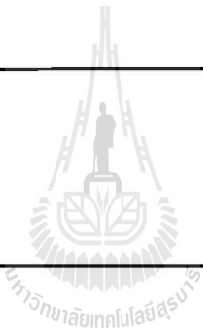
❖ Chiang Mai, Tak

- ❖ Precambrian is under the younger rocks as fault contact or erosion contact.
- ❖ From bottom: lower (ortho-gneiss/migmatite), middle (gneiss, schist), upper (calc-silicate. marble, cataclastic/mylonite, with minor quartzite)

❖ South & lower West

❖ Nakhon Si Thammarat, Prachuap Khiri Khan

- ❖ Precambrian is under the rocks which contained cambrian fossils.
- ❖ From East (gneiss) to West (schist) with gneissic granite.



❖ East

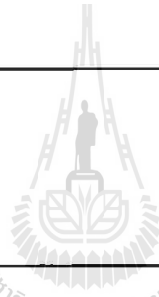
❖ Chonburi

❖ Bunopas, 1981 (from lower to upper)

- ❖ Lower migmatite (granite)
- ❖ Middle para-gneiss (hornblend, diopside, biotite, garnet, Ca-fsp, amphibolite)
- ❖ Upper schist (silimanite)

Metamorphism

- ❖ Regional metamorphism
 - ❖ Cordierite/orthoclase, Amphibolites (Abukuma type = HT & LP)
- ❖ Contact metamorphism
 - ❖ Andalusite, Silimanite, Wollastonite, Grossularite, Orthopyroxene, Olivine (HT than regional met.)
- ❖ Mickein, 1997 Institute for geology & dynamic lithosphere, Gottingen, Germany dating from U/Pb, Sm/Nd, Rb/Sr, K/Ar
 - ❖ 1st Regional met. ~ 200 ma (Triassic/Jurassic)
 - ❖ 2nd Regional met. ~ 117-72 ma (Cretaceous)

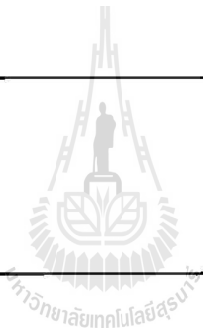


Detail

- ❖ Precambrian is high grade metamorphic rocks.
 - ❖ Ortho-gneiss/migmatite/anatexis (partial melting), paragneiss, schist, calc-silicate, and marble.
- ❖ 1st Regional met. ~ 200 ma (Triassic/Jurassic)
 - ❖ Foliation and granite/pegmatite (partial melting).
- ❖ 1st Cataclastic deformation
 - ❖ Fsp is overturned as isoclinal folds and parallel with the 1st foliation
- ❖ 2nd Regional met. ~ 117-72 ma (Cretaceous)
 - ❖ Large crystal of garnet cut the 1st foliation
- ❖ 2nd Cataclastic deformation
 - ❖ Steep dip of narrow zone angled with the 1st Cataclastic deformation

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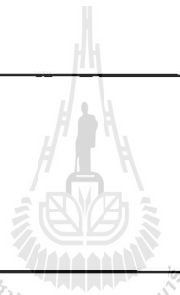


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❖ **Original rock**

- ❖ Baum et al. (1970): sedimentary rock & limestone
- ❖ Mantajit (1975): impure arenaceous sediment
- ❖ Bunopas (1983): flysh sediment
- ❖ Puthapiban et al. (1987): inter-bedding of greywacke & shale with pyro-clastic grading to limestone at the top.
- ❖ Macdonald et al. (1992): granite



LOWER PALEOZOIC

❖ Lower Paleozoic (Cambrian-Devonian) is well exposed in the North & upper West, South & lower West, East.

- ❖ Cambrian (Tarutao group)-Ordovician (Thung Song group):
 - ❖ Lower sandstone (with cross bed & conglomerate),
 - ❖ Middle shale (with thin limestone, Graptolite),
 - ❖ Upper thick carbonate (with Conodont).
- ❖ Silurian-Devonian: (Tanaosri group)
 - ❖ low grade metamorphic rocks: schist, phyllite, quartzite in the East.

❖ North & upper West

Cambrian

❖ Mae Hong Son, Tak

❖ Pha Bong Quartzite: is over the Precambrian rock as fault contact (possible angular unconformity). It is brown color, F-M quartz/chert grain, well sort, associated with thick ortho-gneiss, conglomerate, thin slaty shale. (marine?)

❖ Kamphang Phet

❖ Pong Nam Ron Quartzite: is over the Precambrian rock as fault contact. It is quartzite, schist, graded bedding, overturned syncline, cross bed, well sorting. (shelf)

❖ Kanchanaburi, Uthaithani

❖ Chao Nen Quartzite: sandstone, quartzite, brown, fine-medium grain, graded bed, the upper part is inter-bed of sandstone & limestone (trilobite, cephalopod, gastropod).



Ordovician

❖ Chiang Mai

❖ Hot limestone: is over the Mesozoic as thrust fault contact and over the Precambrian gneiss as unconformity. It is consist of lower (thin limestone), middle (shale, sandstone, limestone), upper (limestone). It also found conodont.

❖ Khamphang Phet

❖ Suan Mark limestone: limestone with slate, quartzite.

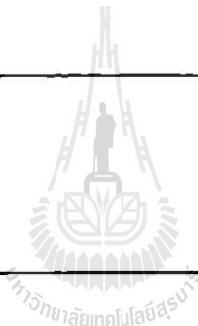
❖ Kanchanaburi

❖ Tha Manao limestone: is over the Cha Nen quartzite as continuous contact and under the Silurian-Devonian rocks as continuous. It is inter-bed of thin limestone & shale.

Silurian-Devonian-Carboniferous

❖ Mae Hong Son-Tak

- ❖ Doi Musur group: is consist of lower (brown quartzite, phyllite, sandstone, shale, limestone, chert); middle (green siltstone); upper (grey shale). It also found bryozoa, fusulinid and indicated lower Permian.
- ❖ Mae Hong Son formation: is over the Hot limestone as gradational contact. It is inter-bed of black chert, grey sandstone, shale, limestone. It also found conodont, fish scale and indicated Silurian-Devonian-Carboniferous.
- ❖ Mae Ping formation: is consist of limestone with thin shale/phyllite/schist in the lower part. It also found nautiloid, conodont.



❖ Kanchanaburi

- ❖ Thong Pha Phum group (Kanchanaburi/Tanaosri): is over the Tha Manao limestone and under the Sai Yok limestone as gradational contact. It is consist of lower (marl), middle (shale, siltstone), upper (limestone). It also found graptolite, conodont and indicated Ordovician-Silurian-Devonian-Carboniferous-Permian.

❖ Chiang Mai

- ❖ Fang chert: is consist of lower (inter-bed of shale & sandstone with fault cut), middle (thin chert & shale), upper (sandstone). It also found graptolite, radiolarian, conodont.

❖ Lampang

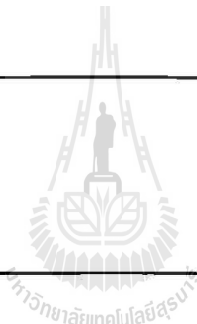
- ❖ Donchai group: is consist of lower (quartzite) & upper (phyllite, schist). (Foreland sediment?)

❖ Chiang Rai

❖ Mae Ko complex: is consist of meta-volcanics (Silurian-Devonian) and cut by stress granite (Carboniferous).

❖ Uttaradit

❖ Pha Som group: is consist of quartzite, phyllite, schist with dike cut (diabase, pyroxenite, serpentinite), well cleavage. (trench sediment?)



❖ **South & lower West**

❖ Cambrian (Tarutao group): lower (sandstone with cross bed, siltstone, shale) middle (siltstone with thin limestone) upper (Thung Song limestone)

❖ Ordovician (Thung Song group): thick limestone with dolomite, shale (graptolite)

❖ Silurian-Devonian (Kanchanaburi group): shale, sandstone with limestone lenses; in some area we found phyllite, slate, quartzite

Cambrian

- ❖ Satun
- ❖ Tarutao group: (from lower to upper)
 - ❖ Lower (inter-bed of sandstone & shale with cross bed);
 - ❖ Middle (siltstone with thin limestone);
 - ❖ Upper (Thung Song limestone).
- ❖ It also found trilobite, brachiopod.

Ordovician

- ❖ Satun
- ❖ Thung Song group: It is consist of 7 formations (from lower to upper). It is over the Tarutao group as gradational contact. It is consist of thick limestone with dolomite, shale. It also found graptolite in shale.

- ❖ Malaka: is algal limestone with pyroclastic sandstone at the lower part. It also found bioturbation, mud crack, vertical burrow (inter-tidal/tidal flat).
- ❖ Tolo dang: is nodular limestone with thin shale, cross bed at the lower part. It also found borrow. (lagoon)
- ❖ La Ngu: is cross bed limestone with dolomite. It also found burrow, mud crack, tidal channel. (barrier bar)
- ❖ Pa Nan: is stromatolite limestone. (sub-tidal/shore-face)
- ❖ Lae Tong: is hummocky limestone with thin shale. It also found brachiopod, trilobite, nautiloid. (shelf)
- ❖ Rung Nok: is bryozoa reef limestone with dolomite on top. It also found crinoid, sponge, bryozoa, trilobite, coral, nautiloid. (reef)
- ❖ Pa Kae: is pelagic thin limestone & shale. It also found stromatolite. (deep marine)



Silurian-Devonian-Carboniferous

- ❖ Satun
- ❖ Thong Pha Phum group: It is over the Thung Son group as gradational/fault contact and under the Kang Krachan group. It is consist of shale, sandstone, limestone, phyllite, slate, quartzite and divided into 3 formations (from lower to upper):
 - ❖ Wang Tong: is inter-bed of chert & shale with sandstone. It also found trilobite, brachiopod, graptolite. (deep marine)
 - ❖ Kuan Tung: is algal limestone. It also found trilobite, conodont.
 - ❖ Pa Samed: is Bouma sequences of shale & sandstone. It also found ammonite, trilobite, brachiopod, cephalopod, graptolite, nautiloid, tentaculite. (deep marine)

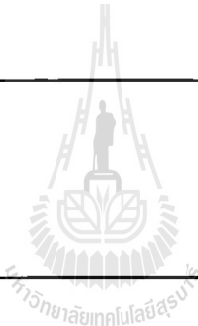


- ❖ Naratiwat, Yala
- ❖ Ban To formation: It is over the Thung Son group as gradational/fault contact and under the Carboniferous as angular unconformity.
 - ❖ It is consist schist, phyllite, quartzite, shale, sandstone, limestone, chert, tuff.
 - ❖ It also found tentaculite, brachiopod. (volcanic arc)

❖ **Central:**

Silurian-Devonian-Carboniferous

- ❖ Sukhothai, Nakhon Sawan, Kamphang Phet
- ❖ Thung Saliang group: 3 formations (from lower to upper)
 - ❖ Khao Kieo Tuff: is pyro-clastic (tuff, agglomerate, sandstone), chemistry (limestone), metamorphic (slate, phyllite).
 - ❖ Thung Saliang limestone: is clastic (re-crystalline limestone, shale, sandstone), metamorphic (marble).
 - ❖ Khanu chert: is chert with tuff lamination. It also found radiolaria. (thick chert usually associated with back arc/fore arc basin)



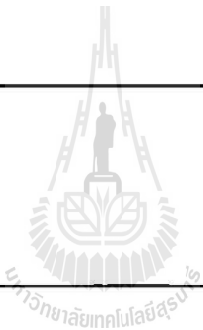
❖ **Kanchanaburi**

- ❖ Bo Phloi formation: It is over the Ordovician limestone as gradational contact.
 - ❖ It is consist of quartzite, phyllite, sandstone, shale, chert, limestone, with tuff.
 - ❖ It also found tentaculite.

❖ Loei-Phetchabun

Silurian-Devonian-Carboniferous

- ❖ Loei
- ❖ Pak Chom Chert formation: is consist of inter-bed chert, limestone, shale. It also found radiolaria, corals.
- ❖ Nong Dok Bue formation: is inter-bed of chert, limestone, shale, sandstone, quartzite with ash. It also found radiolarian, corals, spore, sponge.



❖ East

- ❖ Chonburi & islands, Rayong
- ❖ Cambrian-Ordovician: quartzite, slate, schist, sandstone, limestone
- ❖ Silurian-Devonian: shale, chert, quartzite, limestone, and contact metamorphic rocks of schist, phyllite, quartzite
- ❖ The lower Paleozoic is over the Precambrian and under the Permian as fault contacts.

Cambrian

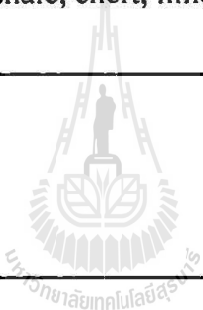
- ❖ Chonburi
- ❖ Ko Lan quartzite: is consist of quartzite, slate.

Ordovician

- ❖ Chonburi
- ❖ Si Chang limestone: is over the quartzite, schist. It is consist of limestone. It also found nautiloid

Silurian-Devonian

- ❖ Rayong
- ❖ Sattahip shale: is consist of slaty shale, sandstone with thin limestone.
- ❖ Kleang schist & phyllite: is consist of schist, quartzite, phyllite, slaty shale, chert, limestone. It also found nautiloid



UPPER PALEOZOIC

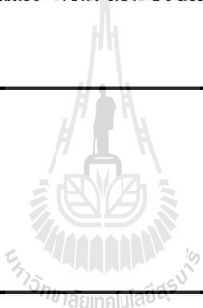
- ❖ Upper Paleozoic (Carboniferous-Permian) is consist of limestone & tuff and deposit in marine.

❖ North & upper West:

Carboniferous

- ❖ Mae Hong Son
- ❖ Doi Kong Mu formation: is over the Silurian-Devonian as unconformity contact in the west but gradational contact in the east.
 - ❖ It is consist of lower conglomerate (well bed, poor-mod sort, pebble of chert, sandstone, quartzite), middle sandstone (coarse grain, well sort), upper shale.

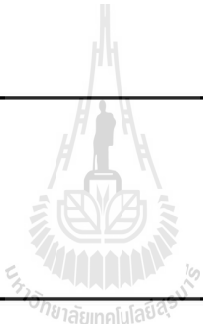
- ❖ Chiang Mai, Lamphun, Lampang, Phrae, Uttaradit
- ❖ Mae Tha group: is over the Silurian-Devonian as unconformity contact.
 - ❖ It is consist of lower (conglomerate), middle (sandstone, shale, chert, limestone), upper (rhyolite, andesite, tuff, agglomerate). The thick conglomerate & sandstone indicated slow uplifting.
- ❖ Sukhothai, Nakhosawan, Chainan
- ❖ Dan Lan Hoi group: is over the Silurian-Devonian as unconformity contact. It is back-arc sediments and consist of 3 formations (from lower to upper):
 - ❖ Khao Khi Ma Pyroclastic formation: is consist of sandstone, siltstone, shale with ash sediment and deposit in sub-marine fan.



- ❖ Lan Hoi formation: is consist of sandstone, siltstone, shale with ash and deposit in shallow marine.
- ❖ Khao Luang Pyroclastic formation: is consist of agglomerate (pebble of rhyolite, phyllite, limestone), tuff and deposit in sub-marine fan.
- ❖ Nan, Phrae, Sukhothai
- ❖ Phrae group: 2 formations (from lower to upper)
 - ❖ Mae Sai formation: is over the Silurian-Devonian as angular unconformity. It is consist of lower chert, middle agglomerate (pebble of chert, andesite, diorite), upper shale, sandstone, conglomerate and deposit in arc-trench.
 - ❖ Rong Kwang formation: is under the Mesozoic as unconformity contact. It is consist of sandstone, shale, limestone with ash. It also found fusulinid, nautiloid, brachiopod.

Permian

- ❖ Lampang, Phrae, Uttaradit, Nan
- ❖ Ngao/Ratburi group: 3 formations (from lower to upper)
 - ❖ Kiu Lom: is consist of lower (tuff, agglomerate), upper (sandstone, conglomerate, shale, limestone). It also found fusulinid (lower Permian), brachiopod, gastropod, crinoid.
 - ❖ Pha Huat: is consist of lower (inter-bed recrystalline limestone & tuff), upper (massive limestone with chert layer). It also found fusulinid (middle Permian).
 - ❖ Huai Tak: is consist of shale, sandstone, conglomerate, limestone (inter-tidal). It also found fusulinid (upper Permian), fenestellid, bryozoa, brachiopod, crinoid.



- ❖ Phra Woh limestone: is under the Mesozoic rock as fault contact or angular unconformity.
 - ❖ It is consist of lower (massive limestone, inter-bed sandstone & dolomitic limestone), upper (claystone, sandstone, inter-bed dolomitic limestone & chert).
 - ❖ It also found fusulinid, brachiopod.
- ❖ Meesook et al. (1985): 3 units (from lower to upper)
 - ❖ Lower clastic & carbonate unit: conglomerate, sandstone, limestone, contact with granite (hornfel, slate, marble). It also found brachiopod, bryozoa, bivalve, crinoid.
 - ❖ Dolomite & dolomitic limestone unit: It also found fusulinid.
 - ❖ Massive limestone unit: limestone, shale, sandstone.

❖ South & lower West

Carboniferous

❖ Kanchanaburi

❖ Thong Pha Phum group (Kanchanaburi/Tanaosri): is over the Tha Manao limestone and under the Sai Yok/Ratburi limestone as gradational contact.

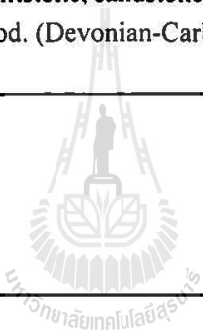
❖ It is consist of lower (marl), middle (shale, siltstone), upper (limestone). It also found graptolite & conodont. (Ordovician-Silurian-Devonian-Carboniferous-Permian)

❖ Trang

❖ Turulut formation:

❖ It is shale, claystone, siltstone, sandstone.

❖ It also found brachiopod. (Devonian-Carboniferous)



❖ Songkhla

❖ Mackie et.al. (1980): 2 formations (from lower to upper)

❖ Songkhla sandstone: is consist of sandstone, shale, chert with submarine slumping, convolute, cross bed.

❖ Kho Hong argillite: is consist of argillaceous rocks.

❖ Songkhla, Satun

❖ Tansuwan et.al. (1985): 2 formations (from lower to upper)

❖ Kuan Klange: is consist of sandstone, shale, chert. It also found brachiopod, trilobite.

❖ Phu Chaba: is consist of claystone, shale, sandstone, hornfel, quartzite, slate with slumping structures.

❖ Songkhla

❖ Muenlek et al. (1985)

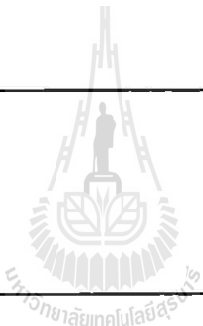
❖ Yaha formation: is inter-bed of sandstone, siltstone, shale, chert.

❖ It also found brachiopod.

❖ Phetchaburi

❖ Kaeng Krachan group 1: is equivalent Phuket group, it is up graded formation from Thong Pha Phum group and divided into 3 formations. (from lower to upper)

❖ Huai Phu Noi: is over the Kanchanaburi quartzite as fault contact. It is consist of pebbly shale with pebble of quartzite, granite. It also found brachiopod.



❖ Khao Pha: is consist of sandstone, pebbly shale with pebble of quartzite, granite. It also found brachiopod, bryozoa.

❖ Khao Chao: is consist of sandstone, siltstone, claystone, shale. (turbidite)

❖ Phetchaburi

❖ Kaeng Krachan group 2: 4 formations (from lower to upper)

❖ Khao Wang Kadat: inter-bed of sandstone, claystone. (turbidite)

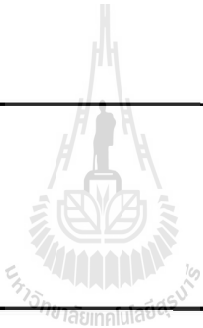
❖ Spillway: siltstone, sandstone with bioturbation, dropstone, cross bed, hummocky. (storm deposit)

❖ Ko He: diamictite with channel structure.

❖ Khao Phra: claystone, siltstone, sandstone with bryozoa bed.

❖ **Phuket group: 8 facies (from lower to upper)**

- ❖ **Laminated mudstone:** is inter-bed of bioturbation mudstone & ripple sandstone. (shallow marine)
- ❖ **Pebbly mudstone:** (mass flow deposit)
- ❖ **Turbidite:** inter-bed of sandstone, claystone with cross bed, load structures.
- ❖ **Slumping:** inter-bed of sandstone, claystone.
- ❖ **Limestone pocket in claystone.**
- ❖ **Well sort sandstone & conglomerate:** (channel deposit)
- ❖ **Bryozoa bed:** siltstone, claystone with bryozoa, crinoid stem, brachiopod, solitary coral. (shallow marine, warm)
- ❖ **Thick bedded sandstone & shale:** clay drapes of tidal indicated delta deposit.



Permian

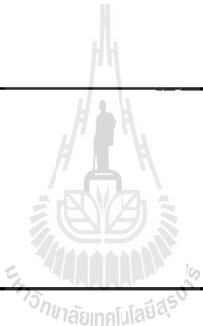
❖ **5 formations (from lower to upper):**

- ❖ **Permian clastic:** is consist of lower (sandstone), upper (claystone with limestone).
- ❖ **Thung Nang Ling:** is consist of limestone. It also found crinoid stem.
- ❖ **Phap Pha:** is consist of limestone with shale, claystone, chert nodule.
- ❖ **Phanom Wang:** is consist of limestone with dolomite, chert nodule.
- ❖ **Um Luk:** is consist of massive limestone.

❖ Loei-Phetchabun

Carboniferous

- ❖ Loei
- ❖ Group 1: 2 formations (from lower to upper)
 - ❖ Nong Dok Bue: is inter-bed of chert, limestone, shale, sandstone, quartzite with ash. It also found radiolarian, corals, spore, sponge. (Silurian-Devonian- Carboniferous)
 - ❖ Wang Sapung: is consist of lower (inter-bed of conglomerate, sandstone, shale with pebble of quartzite, chert & matrix of sandstone, shale), middle (sandstone, shale, limestone), upper (shale, sandstone, conglomerate, limestone)



- ❖ Udon, Khon Kaen, Phetchabun
- ❖ Group 2: 2 formations (from lower to upper)
 - ❖ Dok Du: is consist of chert, sandstone, shale, quartzite.
 - ❖ Huai Som: is under the Khorat group as angular unconformity. It is consist of sandstone, shale, limestone.

Permian

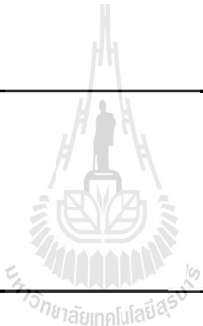
- ❖ Loei, Phetchabun, Saraburi
- ❖ Saraburi group 1: (Bunopas 1981, Hinthong et al. 1985) 3 formations (from lower to upper):
 - ❖ Khao Luak: is consist of sandstone, shale, laminate limestone. It also found fusulinid, bryozoa, brachiopod, bivalve, coral. It is marine shelf.

- ❖ Saraburi limestone: is consist of massive limestone with slate, sandstone, chert. It also found fusulinid, crinoid, bryozoa, bivalves, brachiopod, coral (lower – middle Permian). It is shallow marine near reef.
- ❖ Dan Sai shale: is consist of sandstone, siltstone, shale, pocket limestone. It also found fusulinid (upper Permian), leaves. It is paralic environment.
- ❖ Saraburi, Nakhon Ratchasima, Phetchabun
- ❖ Saraburi group 2: Hinthong et al. (1985) 6 formations (from lower to upper)
 - ❖ Phu Phe: is consist of limestone, chert, shale, slaty shale. It also found fusulinid = Sakmarian/lower Permian.
 - ❖ Khao Khwang: is consist of limestone, chert with dolomite, volcanic rock. It also found fusulinids, brachiopods, crinoid stem which indicate Sakmarian.



- ❖ Nong Pong: is consist of inter-bed of shale & limestone with chert, volcanic rock. It also found fusulinid (Artinskian – Kungurian). It is lagoon environment.
- ❖ Pang Asok: is consist of shale with slaty shale, hornfel, sandstone, limestone. It also found bivalves, leaves.
- ❖ Khao Khad: is consist of limestone with chert, dolomite, shale, siltstone, marble, calcsilicate, hornfel, volcanic dikes. It also found fusulinids (Artinskian – Kungurian), brachiopods, gastropods, ammonites, cephalopods, corals, bryozoa, crinoids, algae.
- ❖ Sap Bon: is consist of shale, siltstone, with sandstone, limestone, chert, slate, phyllite, schist. It also found fusulinids (Kungurian – Kazanian).

- ❖ Loei, Phetchabun, Chaiyaphum
- ❖ Saraburi group 3: Chonglakmani & Satayarak (1984)
3 formations (from lower to upper)
 - ❖ Pha Nok Khao: is consist of limestone with shale, chert.
(lower – middle Permian)
 - ❖ Hua Na Kham: is consist of shale, sandstone, limestone.
(middle Permian)
 - ❖ Nam Duk: is consist of shale, limestone, Bouma sequence.
It also found fusulinids (middle Permian).



- ❖ Loei, Nong Bua Lamphun
- ❖ Saraburi group 4: Charoenprawat et al. (1984) 3
formations (from lower to upper)
 - ❖ Nam Mahoran: is consist of limestone with dolomite,
marble, shale, sandstone, chert. It also found fusulinid,
brachiopods, algae, corals, crinoids which indicated
Gzhelian-Murghabian.
 - ❖ E-Lert: is consist of shale, chert with limestone, ash, cross
bed, Bouma sequence. It also found ammonites in shale,
fusulinids in limestone, foraminifera & bryozoa in chert
which indicated lower-middle Permian. It is inter-
fingering with Nam Mahoran.
 - ❖ Pha Dua: is consist of shale, sandstone, with ash, cross
bed, folding, Bouma sequence. It also found ammonites
which indicated middle-upper Permian.

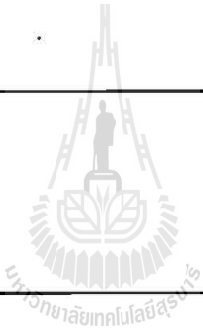
❖ **East**

Carboniferous

- ❖ It is consist of 2 parts (from lower to upper):
 - ❖ Lower: quartzite, schist, sandstone, shale, thin limestone (2 time of metamorphism).
 - ❖ Upper: thick limestone with chert.
 - ❖ It also found bryozoa, brachiopods, foraminifera, corals.

Permian

- ❖ W-East:
 - ❖ It is consist of sandstone, shale, siltstone, chert, limestone.
 - ❖ It also found fusulinid, foraminifera, algae, bryozoa.



❖ Mid-East:

❖ It is over the Carboniferous rocks as unconformity / fault contact and under the Triassic rock as gradational contact.

- ❖ It is consist of lower (conglomerate, pyroclastic, volcanic, chert), upper (shale, siltstone, with pocket limestone).
- ❖ It also found brachiopod, bivalve which indicated middle-upper Permian.

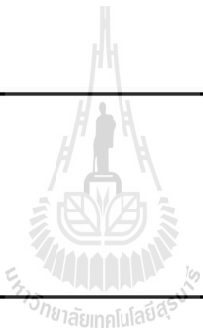
❖ E-East:

❖ Chantaburi group: 2 formations (from lower to upper)

- ❖ Srakaew: is consist of radiolarian chert, limestone, melange assemblages with ophiolite & ultra-mafic rocks.
- ❖ Khao Chakan: is consist of limestone.

❖ Chaodumrong: 2 formations (from lower to upper)

- ❖ Wang Nam Yen: is consist of radiolarian chert, thrust sheet complex.
- ❖ Khao Ta Ngog: is consist of limestone. It also found fusulinid, crinoid (barrier reef).



MESOZOIC

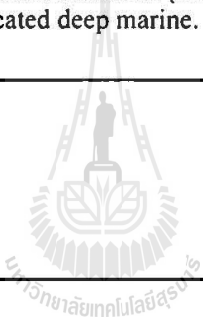
- ❖ Triassic: marine + continent (grey + red bed)
- ❖ Jurassic: marine + continent (grey + red bed)
- ❖ Cretaceous: continent (red bed)

Triassic

❖ North & upper West:

- ❖ Lampang, Chiang Rai, Phrae
- ❖ Lampang group: 7 formations (from lower to upper)
 - ❖ Phra That: is consist of lower (sandstone, conglomerate, siltstone, claystone), upper (claystone with limestone). It also found cross bed, mottle, fine up and indicated shoreline sediment.

- ❖ Pha Kan: is consist of limestone with claystone, limestone. It also found oncolid, bioclastic, ooid, bivalve and indicated shallow marine.
- ❖ Hong Hoi: is consist of mudstone with sandstone. It also found fine up turbidite, ammonite, conodont (lower Triassic) and indicated deep submarine fan.
- ❖ Doi Long: is consist of massive limestone. It also found peloid, algae, oncolid and indicated shallow marine.
- ❖ Pha Dang: is consist of sandstone, siltstone, claystone, conglomerate. It also found Halobia, fine up Bouma, bioturbation, mud cracked and indicated fan delta.
- ❖ Kang Pla: is consist of limestone with sandstone, claystone. It also found Halobia, Brachiopod, conodont (middle Carnian – lower Norian).
- ❖ Wang Chain: is consist of claystone with sandstone. It also found Bouma, Halobia, conodont (middle Carnian – lower Norian) and indicated deep marine.



- ❖ Uttaradit, Nan
- ❖ Nam Pat group: 2 formations (from lower to upper)
 - ❖ Huai Lat: is consist of conglomerate with sandstone, limestone, chert. It also found poor sort and indicated gravity flow sediment.
 - ❖ Huai Bo Khong: is consist of inter-bed of sandstone & claystone. It also found conodont (lower Triassic), graded bed.
- ❖ Mae Hong Son
- ❖ 2 formations (from lower to upper)
 - ❖ Lower: laminate chert, claystone, limestone
 - ❖ Upper: conglomerate, sandstone, claystone
 - ❖ It also found graded bed, fine up, radiolarian, bivalve (Halobia).

❖ **Tak**

- ❖ Mae Sot: is consist of shale, sandstone, limestone. It also found Halobia, ammonite, radiolarian.
- ❖ Mae Ping fault: is consist of conglomerate, sandstone, chert, limestone. It also found bivalve (middle Carnian).



❖ **East**

❖ Chanthaburi, Rayong

❖ 4 formations (from lower to upper)

- ❖ Sookpriwan: is consist of lower limestone with shale, pyroclastic. It also found foraminifera, algae and indicated lower-middle Triassic.
- ❖ Noen Po: is consist of claystone, shale, with chert, pyroclastic. It also found radiolarian (middle- upper Triassic).
- ❖ Pong Nam Ron: is consist of tuffaceous sandstone with limestone, claystone, conglomerate. It also found fine up, fusulinid.
- ❖ Noen Phu Yai Yua: is consist of sandstone with claystone. It also found Bouma, graded bed.

❖ South & lower West

❖ Kanchanaburi

❖ It is consist of limestone with sandstone, siltstone, claystone, shale, marl.

❖ It also found Halobia, conodont, foraminifera.

❖ Songkhla 1

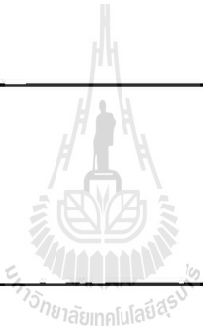
❖ 4 formations (from lower to upper)

❖ Suan Cham: is consist of siltstone, sandstone.

❖ Chedi: is consist of conglomerate, quartzite with sandstone lenses.

❖ Khlong Kom: is consist of limestone (back reef).

❖ Sani: is consist of siltstone, sandstone, chert, conglomerate.



❖ Songkhla 2

❖ 4 formations (from lower to upper)

❖ Mi kiat: is consist of conglomerate, quartzite.

❖ Na Thawi: is consist of siltstone, sandstone.

❖ Wang Yai: is consist of siltstone.

❖ Lam Long: is consist of sandstone.

❖ Phatthalung

❖ 4 formations (from lower to upper)

❖ Phanomwang: is consist of limestone.

❖ Chiak: is consist of limestone with chert nodule.

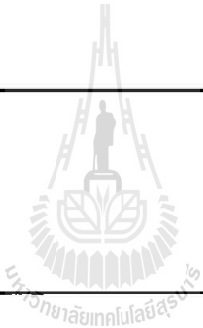
❖ Phukhaothong: is consist of limestone, dolomite.

❖ Chaiburi: is consist of limestone, dolomite.

Jurassic

❖ North & upper West

- ❖ Mae Hong Son
- ❖ Huai Pong group: 3 formations (from lower to upper)
 - ❖ Pa Lan: is consist of inter-bed of sandstone, shale. It also found ammonite, bivalve, foraminifera and indicated lower-middle Jurassic.
 - ❖ Mai Hung: is consist of limestone with sandstone, siltstone.
 - ❖ Kong Mu: is consist of sandstone.



- ❖ Tak
- ❖ Huai Fai group: 3 formations (form lower to upper)
 - ❖ Khun Huai: is consist of limestone, marl, shale. It also found ammonite, bivalve and indicated lower-middle Jurassic. (shallow marine)
 - ❖ Doi Yot: is consist inter-bed of limestone, shale.
 - ❖ Pha De: is consist of limestone, marl, shale.
- ❖ Umphang group: 4 formations (from lower to upper)
 - ❖ Klo Tho: is consist inter-bed of sandstone, shale
 - ❖ Ta Sue Kho: is consist of sandstone.
 - ❖ Pu Khloe Khi: is consist of limestone.
 - ❖ Lu Kloc Tu: is consist of sandstone.
 - ❖ It also found ammonite, foraminifera, algae and indicated lower-middle Jurassic.

❖ South & lower West

❖ Prachuap Khiri Khan, Chumpon:

❖ 3 units (from lower to upper)

❖ Lower: is consist of claystone, sandstone.

❖ Middle: is consist of claystone with thin sandstone.

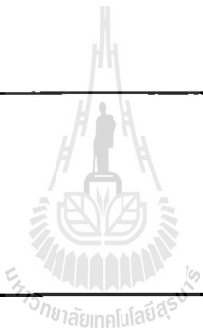
❖ Upper: is consist of claystone with conglomerate.

❖ It also found ammonite and indicated early Bajocian.

❖ Nakhon Si Thammarat:

❖ Pra Bat: is consist of sandstone, claystone, siltstone.

❖ It also found bivalve, leaf, track and indicated Toarcian.



❖ Khorat Plateau

❖ Khorat group: 9 formations (from lower to upper)

Jurassic

❖ Huai Hin Lat: is over the Nam Duk formation/Permian as unconformity. It is consist of lower (conglomerate with limestone), upper (sandstone, claystone with limestone).

❖ Nam Phong: is consist of lower (siltstone, sandstone, claystone), middle (sandstone, conglomerate), upper (shale, claystone, siltstone).

❖ Phu Kradung: is consist of siltstone, claystone, sandstone, conglomerate with concrete nodule, caliches.

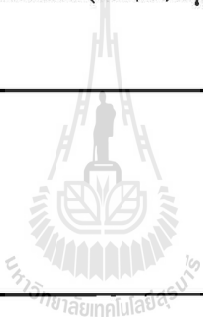
❖ Phra Wihan: is consist of sandstone with siltstone, mudstone, conglomerate.

Cretaceous

- ❖ Sao Khua: is consist of claystone, siltstone, sandstone, conglomerate. It also found caliches, calcrete nodules, nodular silcretes.
- ❖ Phu Phan: is consist of sandstone, conglomerate. It also found cross bed, well round, poor sort.
- ❖ Khok Kruat: is consist of claystone, siltstone, sandstone, conglomerate. It also found caliches, calcrete nodules.
- ❖ Maha Sarakham: is consist of basal anhydrite, lower rock salt, lower claystone, middle rock salt, middle claystone, upper rock salt, upper claystone.

Cretaceous - Tertiary

- ❖ Phu Thok: is consist of thick sandstone (brown, M-F, cross bed), thin sandstone & siltstone (red, F, ripple marks).



❖ Loei Phetchabun

❖ Phisanulok

❖ 2 formations (from lower to upper)

- ❖ Phu Khat: is under the Khao Ya Puk as unconformity. It is consist of sandstone (brown, F-M, well sort) with siltstone, mudstone, calcareous, conglomerate (poor sort, well round).
- ❖ Khao Ya Puk: is consist of lower siltstone & claystone (brown), middle sandstone & siltstone (brown, F, mud crack, ripple marks), upper thick sandstone (red, C, well round, well sort) with claystone, siltstone, conglomerate (brown, cross bed, ripple marks).

❖ North & upper West

Triassic

❖ Phisanulok

❖ (from lower to upper)

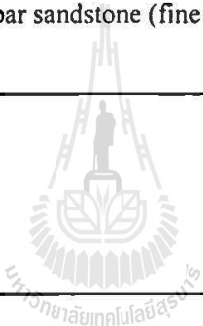
❖ ms 1: is over the Triassic rock as gradation/unconformity. It is consist of conglomerate, sandstone, claystone, shale.

❖ ms 2: is consist of volcanic rocks, tuff.

Jurassic

❖ ms 3: is consist of lower fine up of conglomerate, sandstone, siltstone & claystone; upper laminated siltstone, claystone, shale with calcrete nodules, mud crack, ripple marks.

❖ ms 4: is consist of point bar sandstone (fine up, cross bed)



❖ Phu Kradung

❖ Phra Wihan

Cretaceous

❖ ms 5: is consist of sandstone (F), siltstone & claystone; with calcrete horizon, climbing ripple.

❖ Sao Khua

❖ Phu Phan

❖ Maha Sarakham

❖ East

Jurassic

❖ Chanthaburi, Trat

❖ Lam Sing formation: is over the Triassic rock as gradation/unconformity. It is consist of conglomerate, sandstone, claystone, shale.

❖ Phu Kradung

❖ South & lower West

Jurassic-Cretaceous

❖ Chumphon, Nakhon Si Thammarat

❖ 4 units (from lower to upper)

❖ Lower most (M1): is consist of shale, siltstone, limestone. It also found bivalve, leaf.

❖ Lower (M2): is consist of sandstone, siltstone, with limestone lenses. It also found bivalve.

❖ Middle (M3): is consist of siltstone, sandstone, conglomerate, with limestone, dolomite. It also found leaf.

❖ Upper (M4): is consist of sandstone, shale.



❖ Trang group: 4 formations (from lower to upper)

❖ Chumphon red bed: is over the Sai Bon formation as unconformity. It is consist of the inter-bed of red sandstone, siltstone, shale.

❖ Klong Min: is consist of the inter-bed of limestone, shale.

❖ Sam Chom: is consist of conglomerate, sandstone.

❖ Phun Phin: is under the Tertiary rock as unconformity. It is consist of fanglomerate, sandstone, siltstone, shale. It also found cross bed.

