



## Status on Rare Earth Elements in Thailand: Investigations and Researches



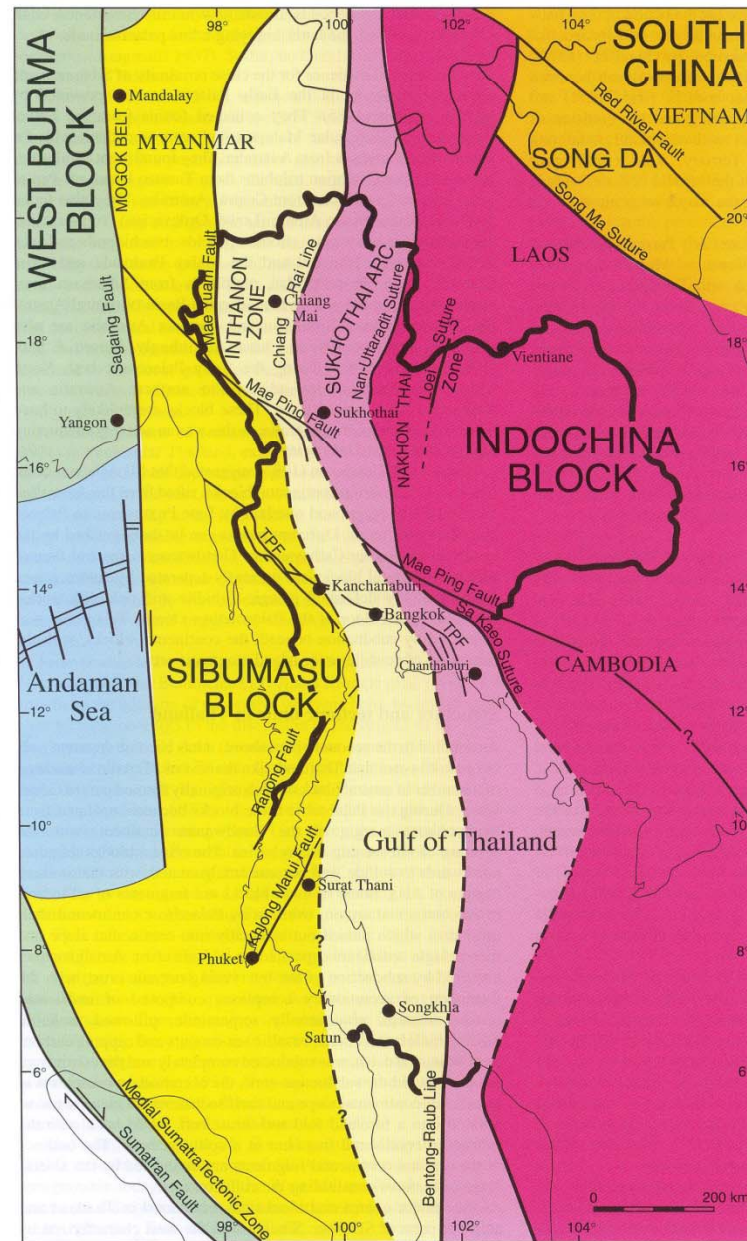
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Ridd et al.  
(2011)



**Fig. 19.1.** Tectonic Units in Thailand, based on Metcalfe (1996) with modifications after Sone & Metcalfe (2008a), Ueno (2002) and Searle & Morley (2011). Note that the Inthanon Zone of Barr & Macdonald (1991) and Sone & Metcalfe (2008a) is extended into the Peninsula and West Malaysia to include the foreland fold-and-thrust belt formed by the collision between the Sibumasu and Indochina blocks during the Triassic Indosinian Orogeny. TPF, Three Pagodas Fault.

# Outline of talk

*1 Introduction*

*2 REE status*

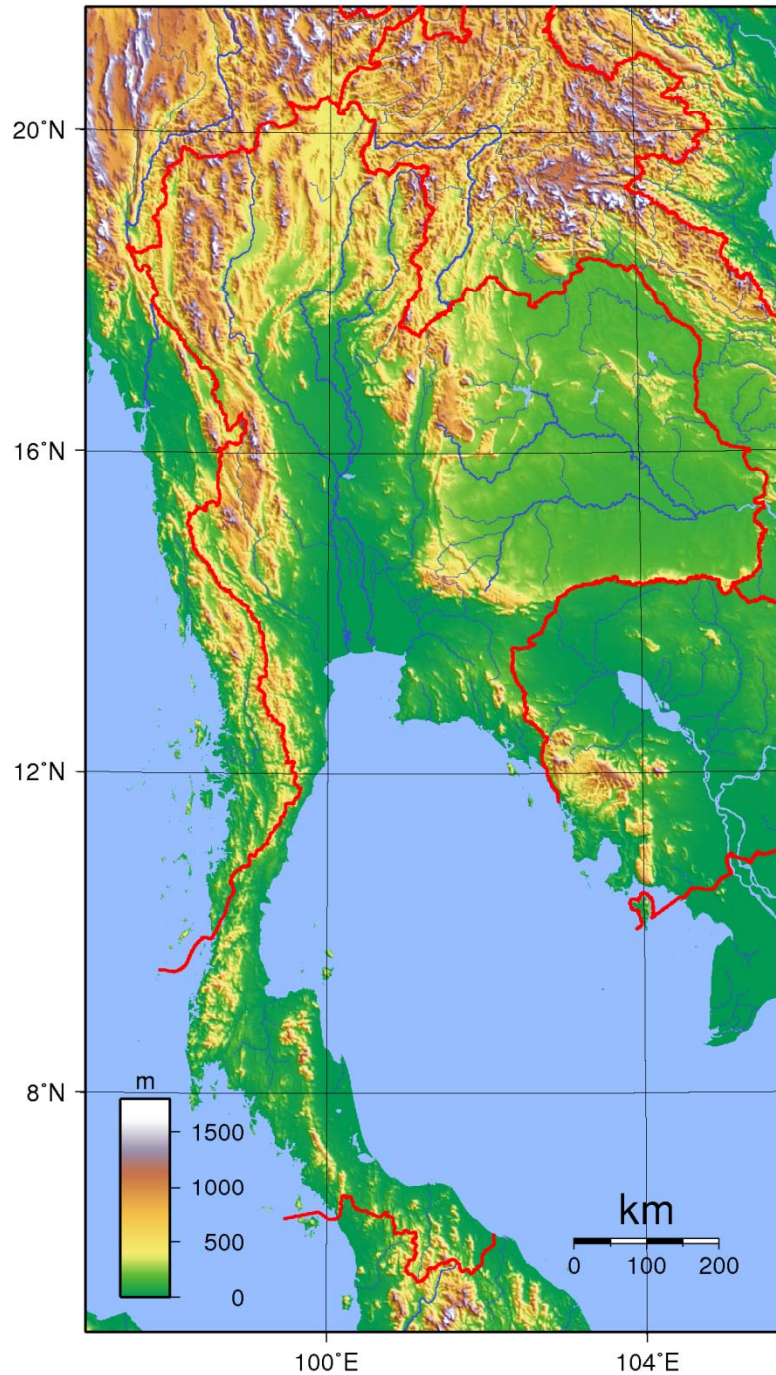
*–Previous investigation (before 2000)*

*–Current investigation (after 2000)*

*3 Discussion on new exploration strategy*

*4 Conclusion*

# Physiographic map of Thailand



# Introduction

- **Thailand**: one of the richest ASEAN countries in mineral resources.
- Most important **ores** (tin and tungsten minerals), which **are temporally and spatially associated granites**.
- The granites are long and arcuate Mesozoic granites in the N-S – trend.
- They occur within the so-called “tin belts of Southeast Asia” with the length of 1,500 km in Thailand.
- Major ores are cassiterite, as well as wolframite + scheelite. They were once the most important exporting ore of the country.

# Introduction

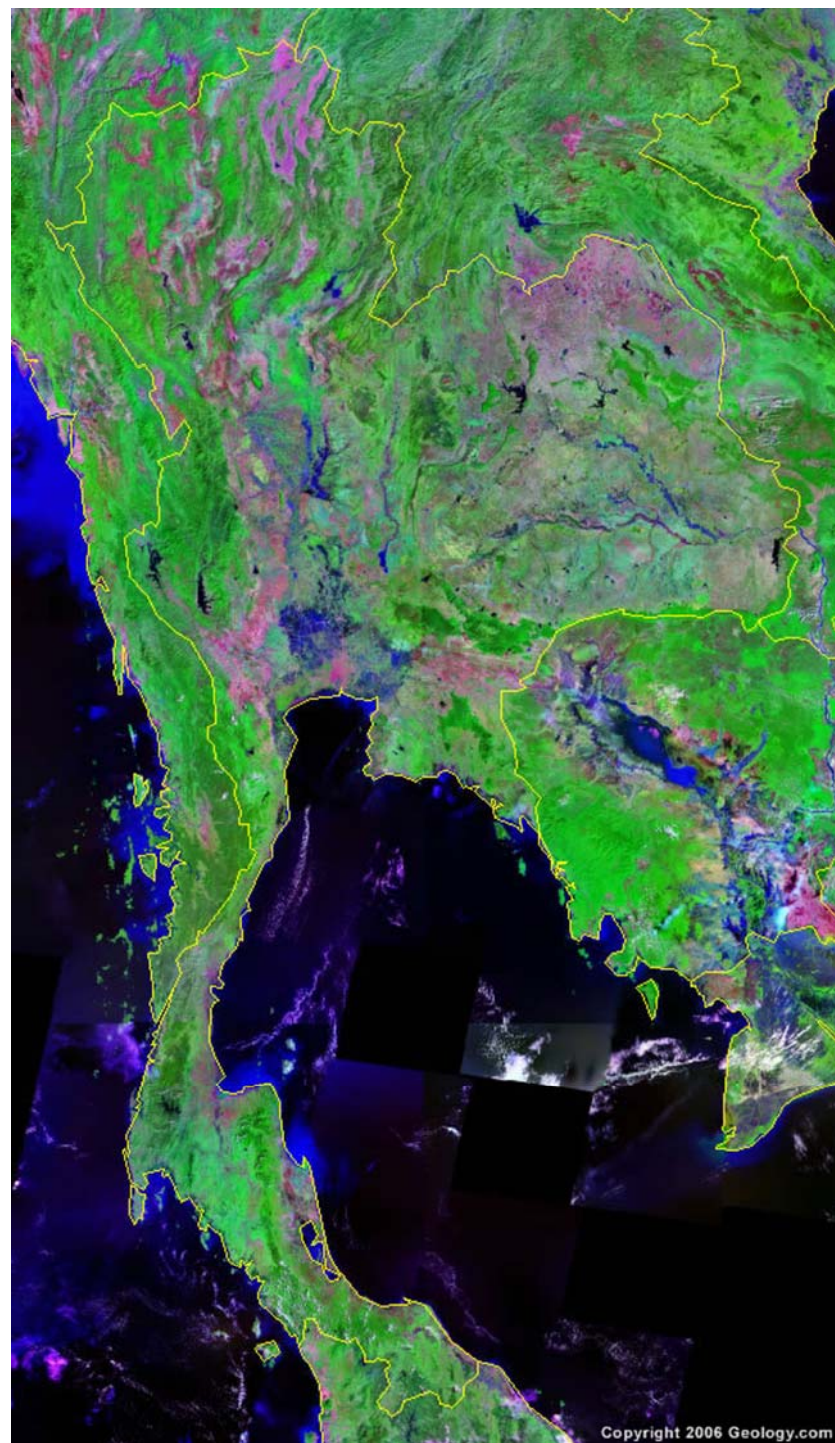
- **Rare-Earth Element (REE)** – bearing minerals are frequently by - products associated with cassiterite and wolframite.
- These REE minerals, particularly **monazite and xenotimes**, as gangue minerals mutually associated with Sn- and W- minerals.
- This situation leads to **devalue** the exported tin ore grades and of course causes its price lower than usual.
- The main interest was concentrated on the origin of tin ± REE deposits associated with granites.

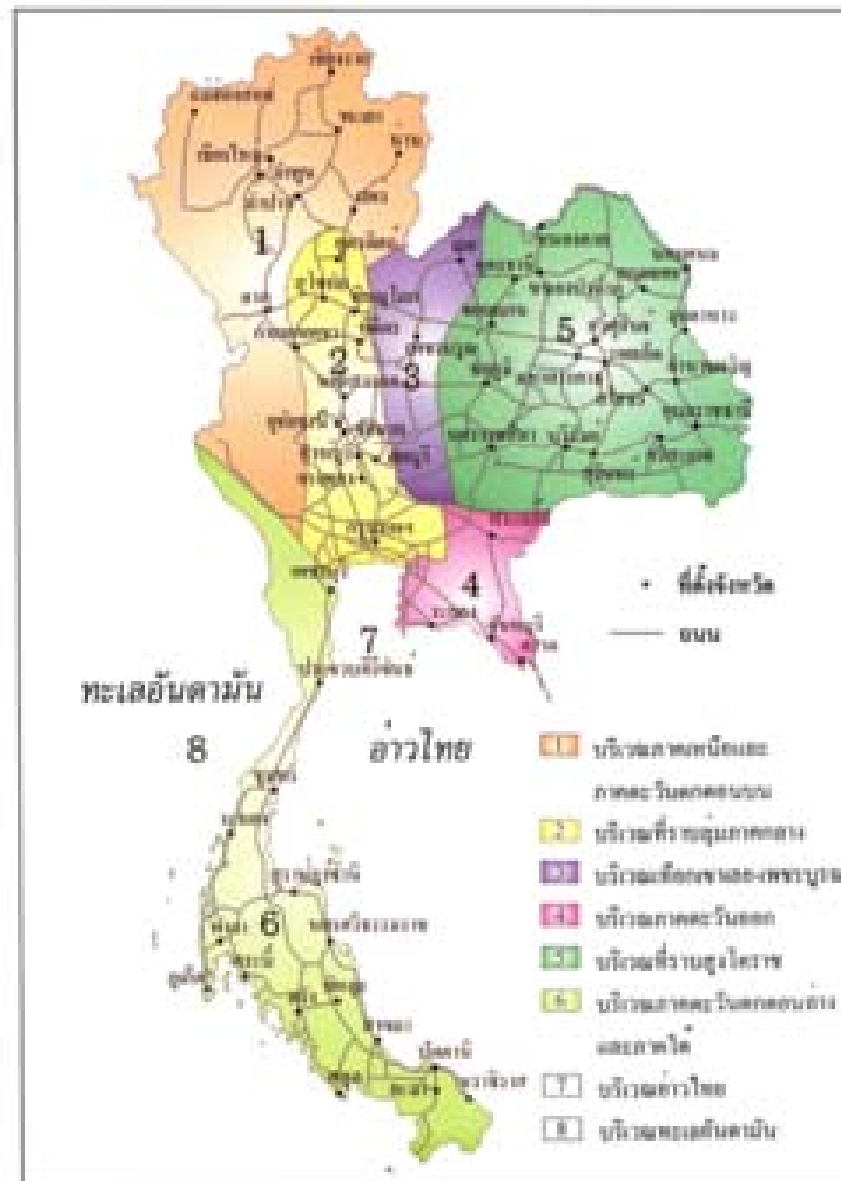
# main objective

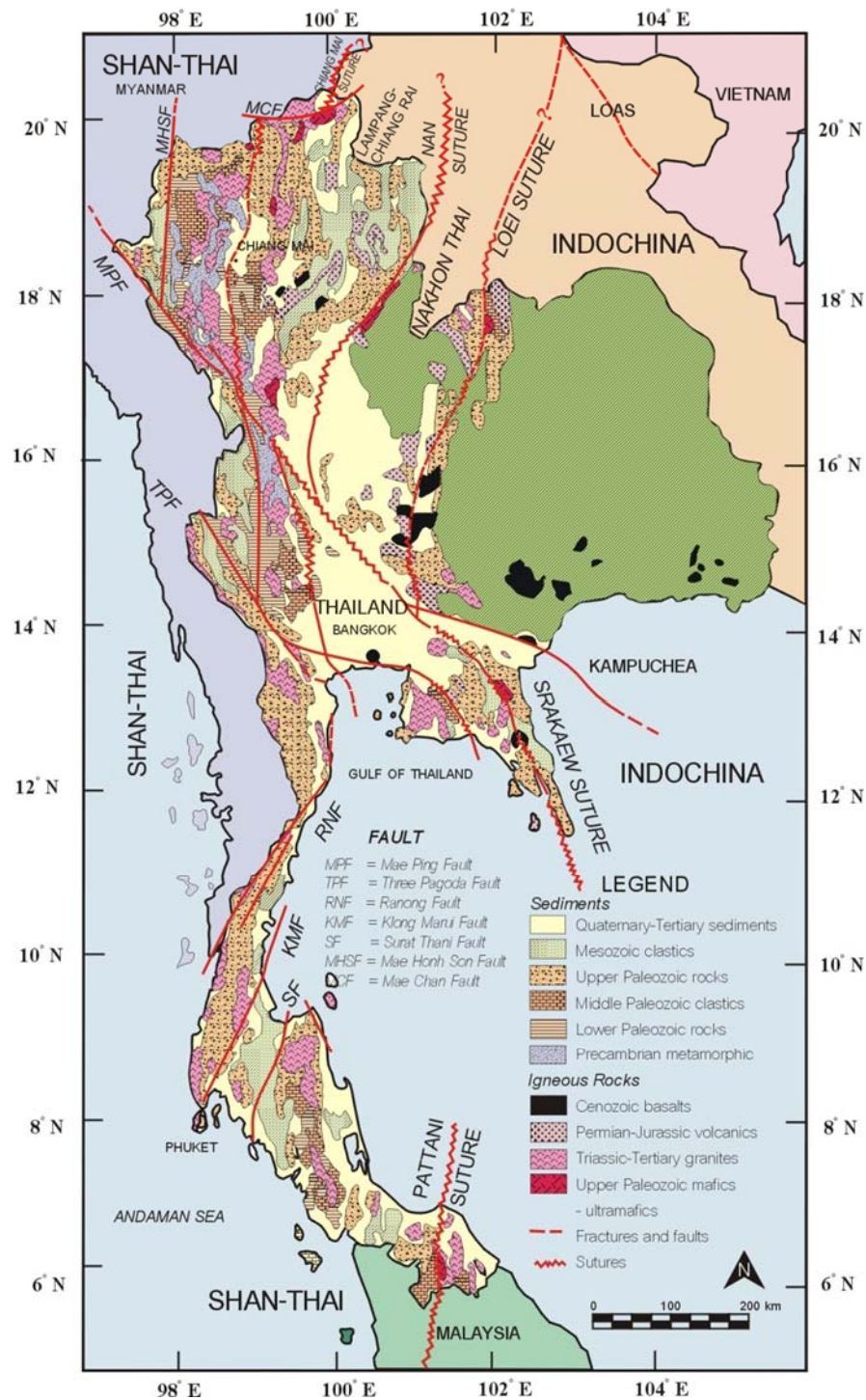
- +to document the status on rare earth element potentials in Thailand using preexisting and available information obtained from domestic and oversea agencies
- + to identify the new target for the REE investigation

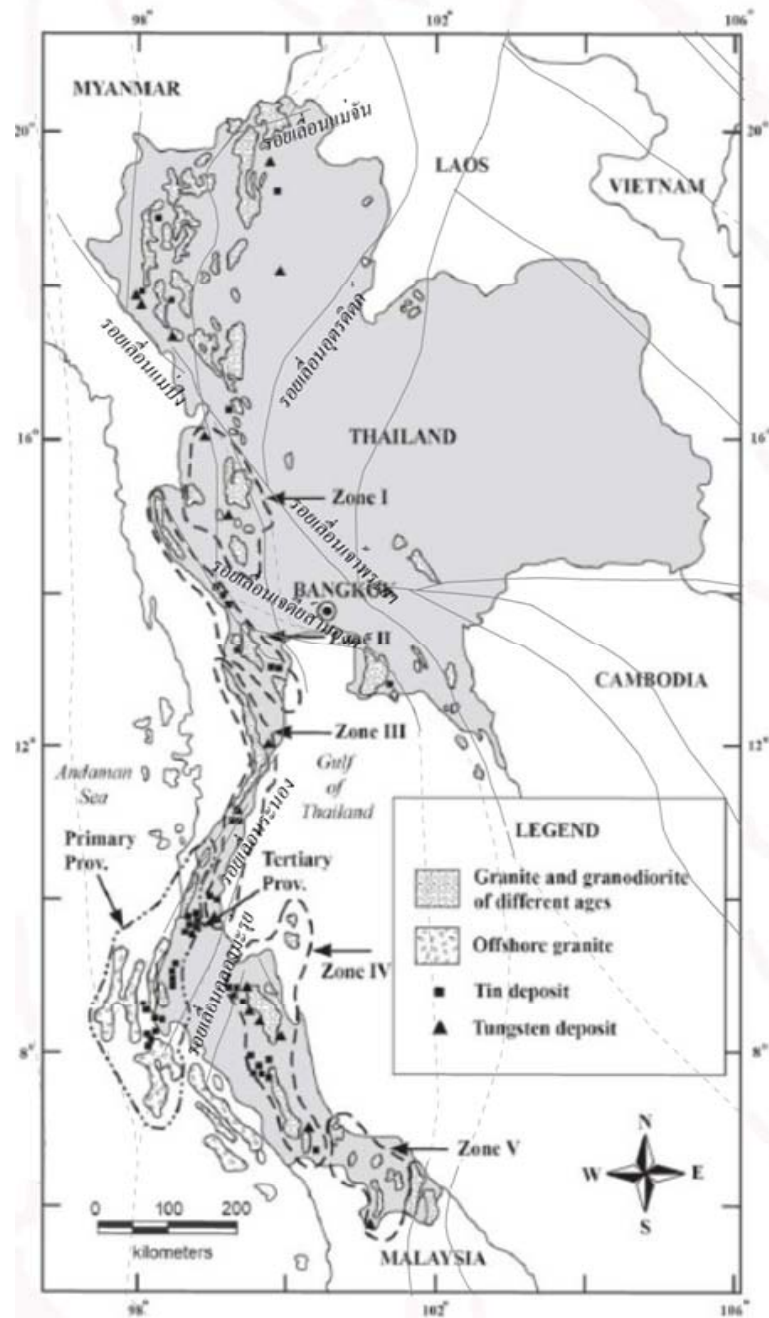
# Prime goal

- "By knowing more about how REE deposits form, geoscientists and mining technologists can more accurately target rocks that might contain mineable concentrations of these critical minerals."









# Previous studies

- Aranyakanon (1954, DMR) considered to be the pioneer geologist who worked on of the REE-bearing phosphate minerals as well as tantalum and niobium – bearing tantalite and columbite ores.
- His main interest was concentrated on the origin of tin deposits associated with granites.
- In early 1970's these REE and heavy minerals were discovered in significant amount as secondary deposits, as alluvial and beach placer tin deposits, particularly in south-central and peninsular Thailand.

# Previous studies

- Collaboration between geoscientists of Department of Mineral Resources (DMR) and German Geological Mission (GGM) to Thailand was made in 1965-1970 with an aim to investigate potential areas of heavy metal and REE abundances.
- Several areas in southern peninsular Thailand were discovered at that time, and many of which are mainly located in tin placer deposits.<sup>2</sup>

# Previous studies

- 1980's DMR with the cooperation of Japan International Cooperation Agency (JICA) investigated REE-bearing mineral deposits in northern and north-central regions.
- DMR reports of investigations with several volumes have been published.
- Primary sources of Sn+W & REE are two mica granite and biotite granite

# Previous studies

- In the south, several secondary tin deposits and weathering-crust granites were studied to contain abundant REE – bearing phosphate minerals by DMR geologists( Pungrassmi and Pradidwan).
- Several potential granites closely related to REE – bearing ores have been investigated using classifications proposed by Ishihara<sup>5</sup> and Chappel and White<sup>6</sup>.

# Previous studies

- 1990's, hard rock geology has been investigated by CU, CMU, and DMR research geoscientists.
- Many publications, including books, reports, open files, maps and scientific papers were published.
- Triassic to Tertiary granites of S-type granites seems to be the source of REE concentrations
- (using Chappel and White 's classification)

# Previous studies

- REE – bearing mineral deposits were systematically and continuously studied afterwards.
- specific types of granites and pegmatites have been investigated in detail by DMR, JICA, and Geological Survey of Japan (GSJ) since 1995.
- In 1998 to 2002 the work on regional exploration by CU geoscientists granted by National Research Council of Thailand grant was reported.
- Classification of REE deposits are in association with granites and tectonic elements is proposed.

# Recent studies

- In 2000's, several geoscientists of GSJ and Kyushu University (Japan) as well as DMR (Thailand) in collaboration with CU (Thailand), have studied systematically target areas where REE deposits can be economically developed.
- Conclusion: Weathering crusts of S-type, ilmenite-series granites have been regarded as highly potential and exploitable sources of REE ores.

# Recent studies

- Researches on REE potential areas and minerals have been on-going till present.
- However, due to limited budget and accessibility, not much work has been done so far for the exploitation research.
- Much of the work is still focused on the potential areas where by clay minerals have capability on adsorbing total REE contents.

# Recent studies

- Granites in several places of northern and central Thailand have been collected and REE analyses have been carried out by GSJ and Kyushu univ geoscientists (Prof. Imai) .
- Very recently Kasetsart University geoscientists have been working on classifying REE – bearing granites using enhanced air-borne magnetic/radiometric and remote sensing data.
- Chulalongkorn University team concentrates on potential areas in Ranong province of southern Thailand.

# Recent studies

- Very recently, eastern Thailand granites and igneous rocks at Chatree mines, central Thailand

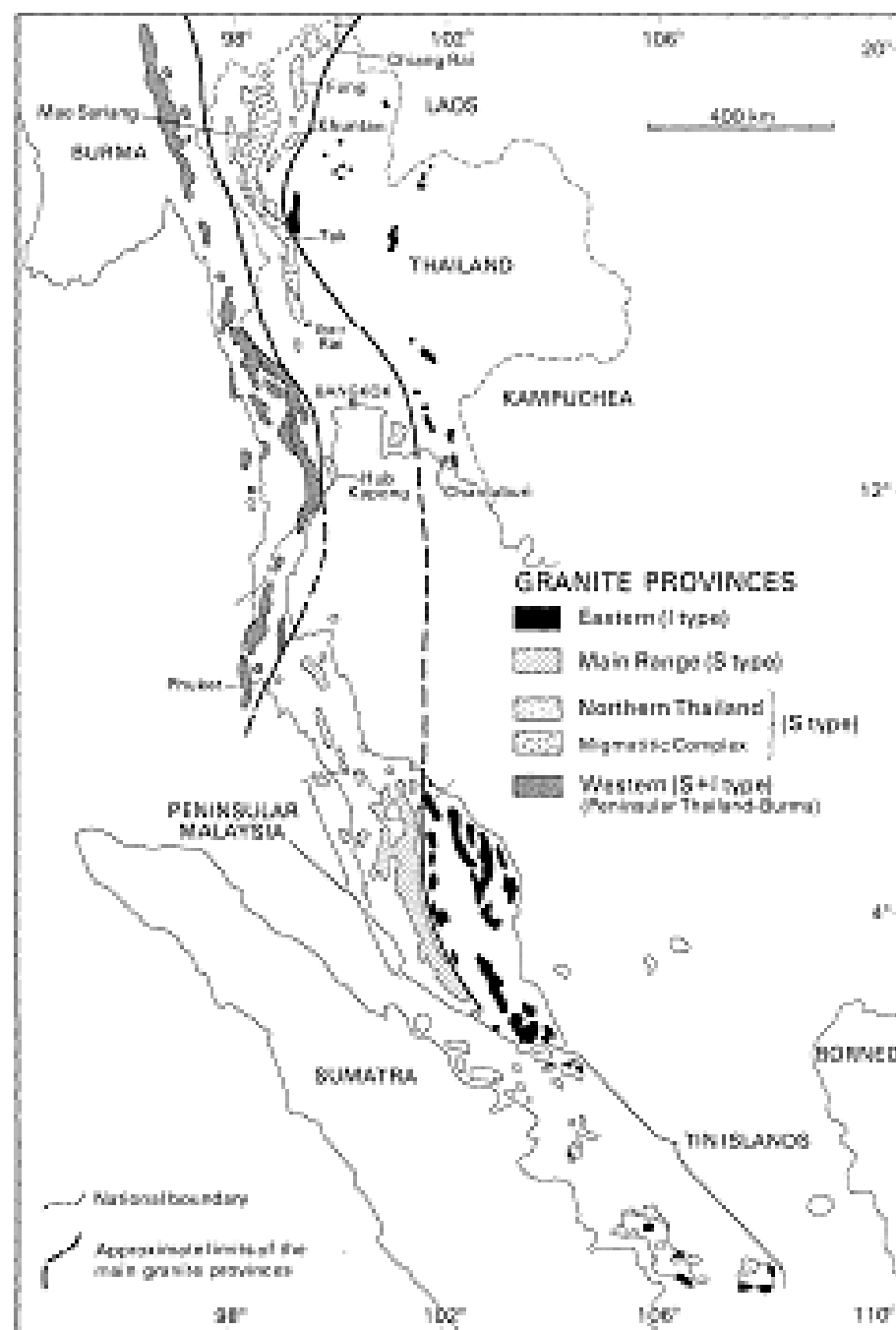
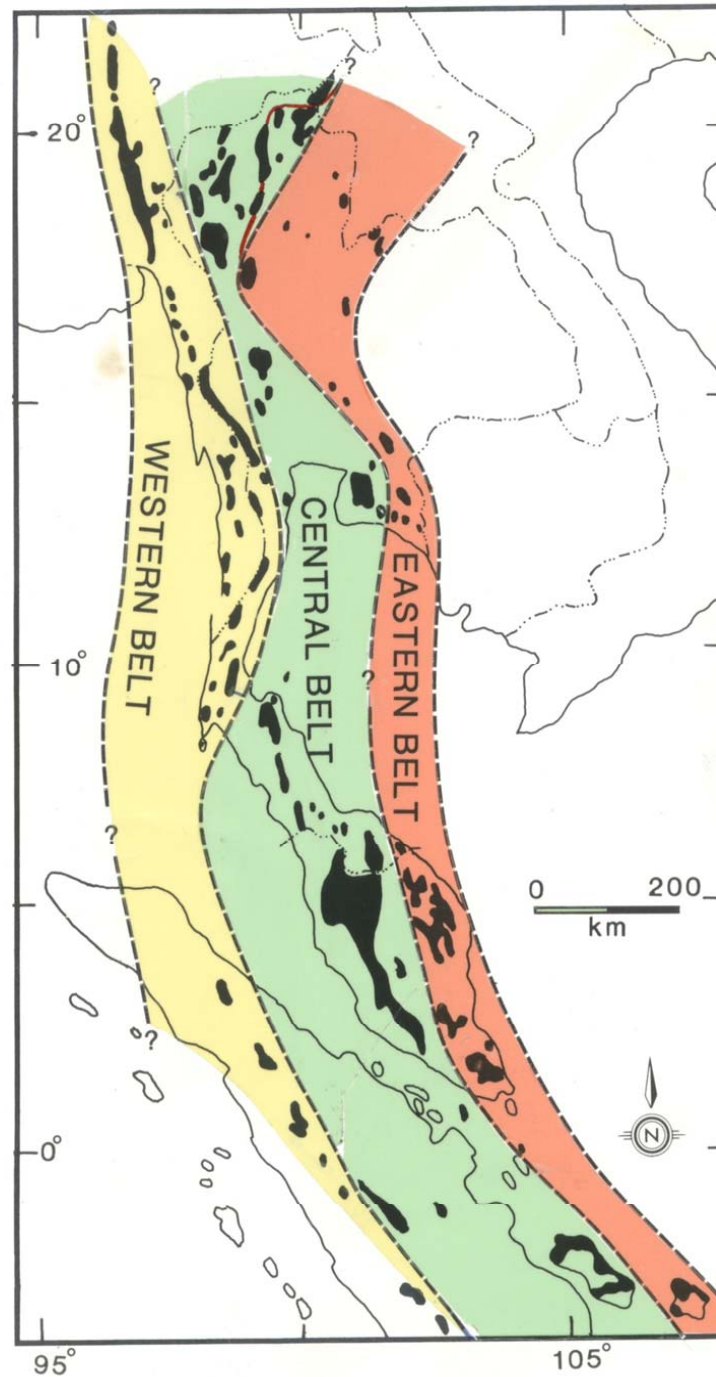
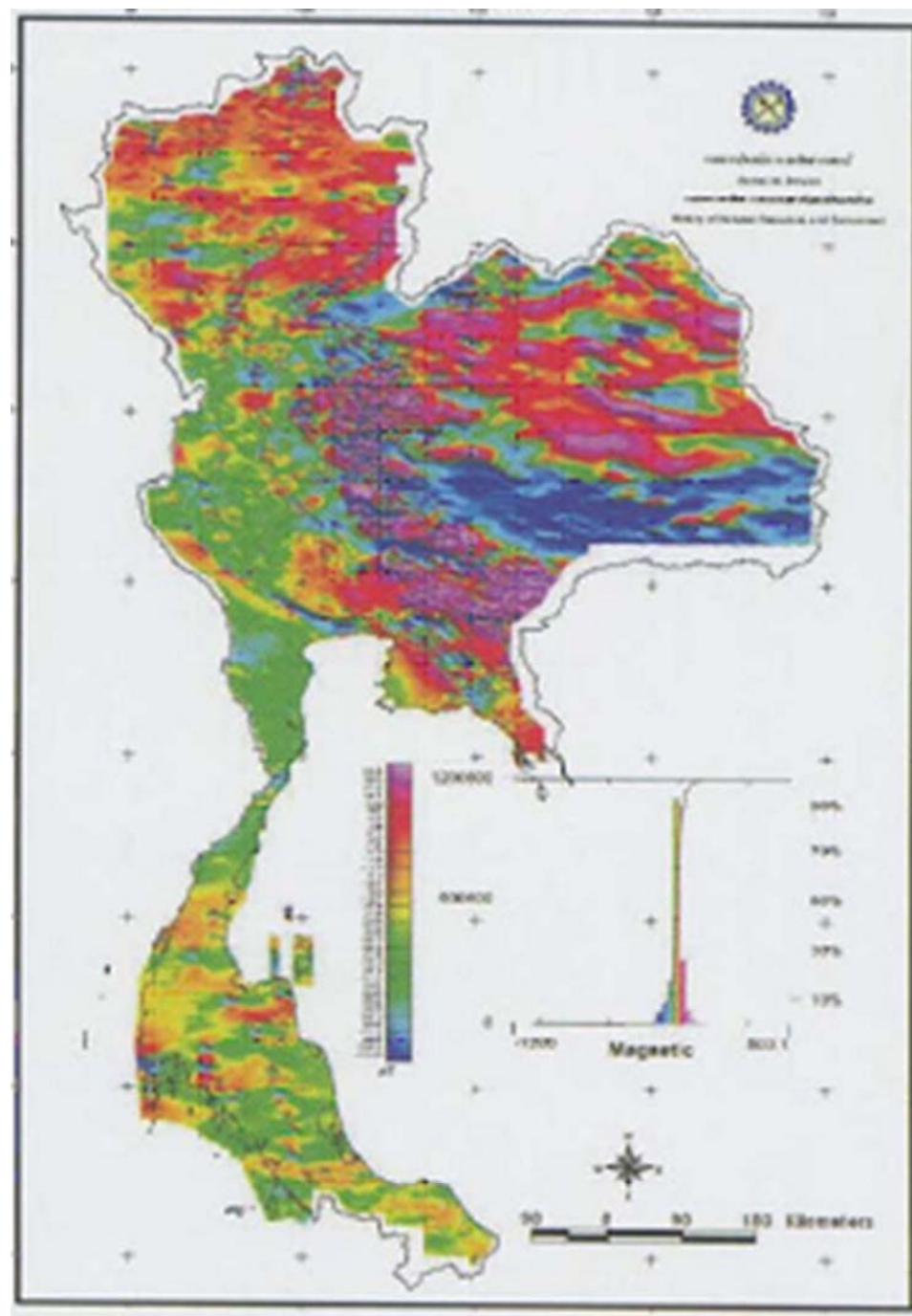


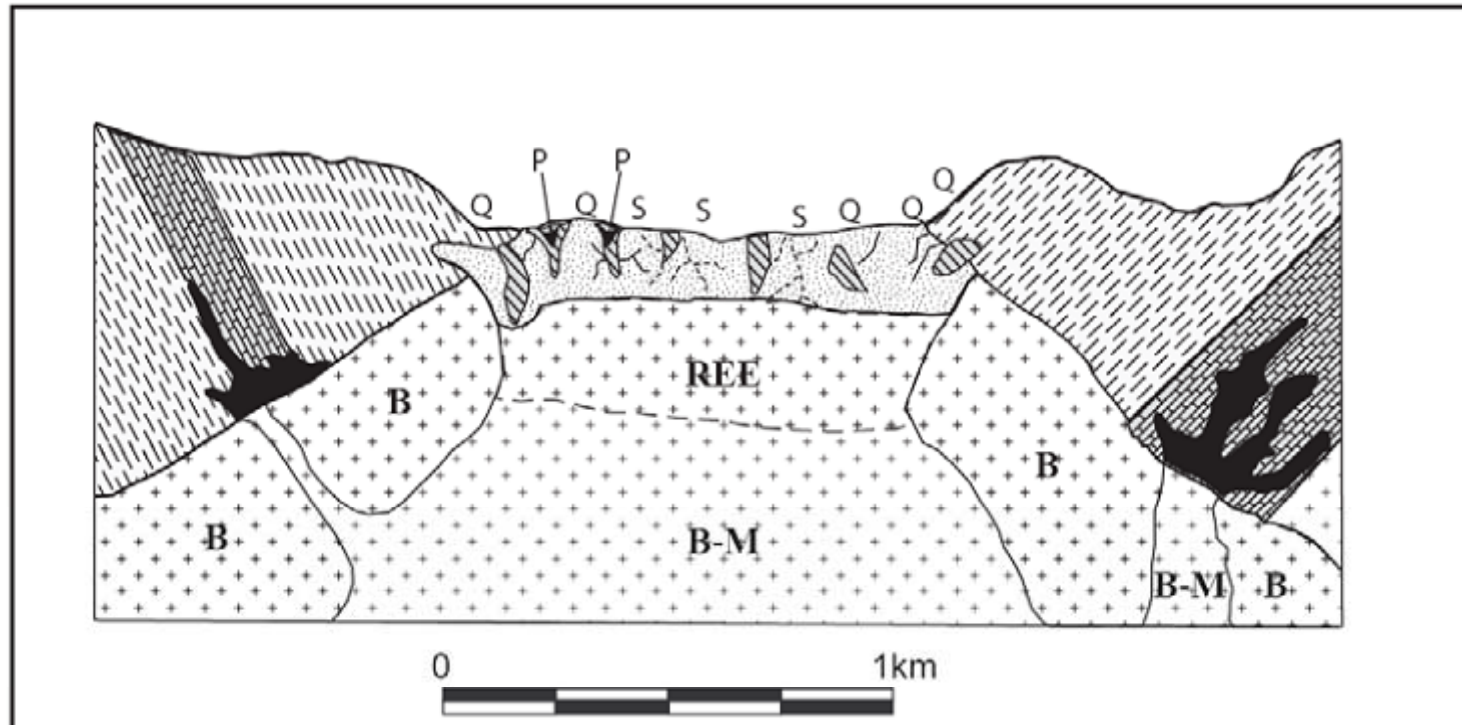
Figure 1. Distribution of granite provinces within the Southeast Asian Tin Belt.

- Granite belts of Thailand (Charusiri et al., 1993)

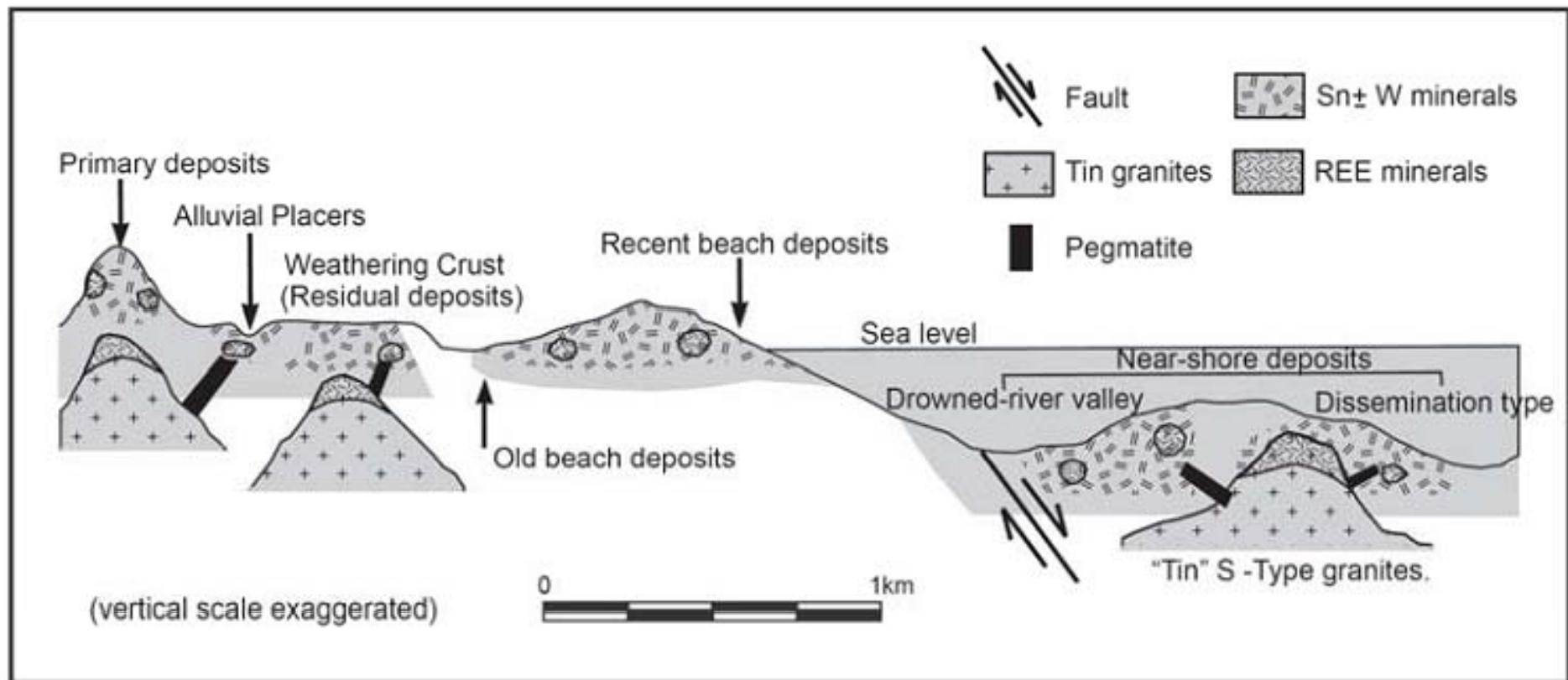




# Genetic model of the REE – bearing primary Sn±W deposits of Thailand



Charusiri et al. (2006)



Charusiri et al. 2009

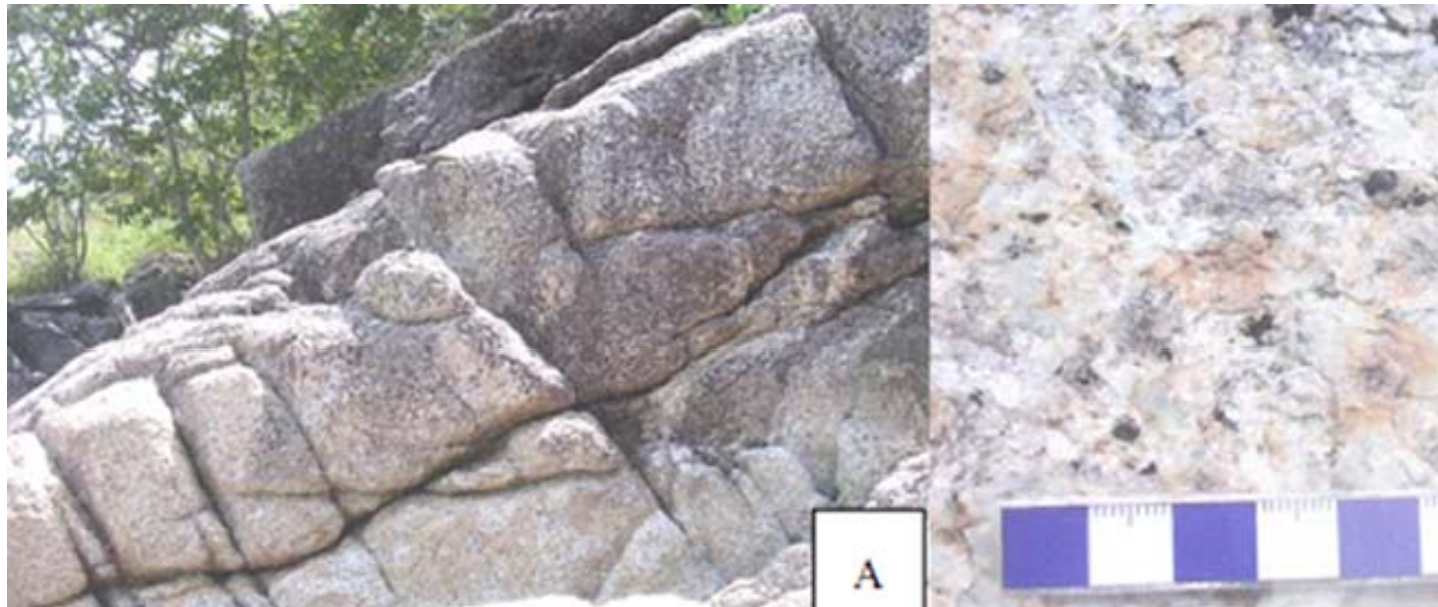
# Look for alkaline granites with rifting

- The report "Bokan Mountain peralkaline granitic complex, Alexander terrane (southeastern Alaska): Evidence for Early Jurassic rifting prior to accretion with North America" has been published in the Canadian Journal of Earth Sciences

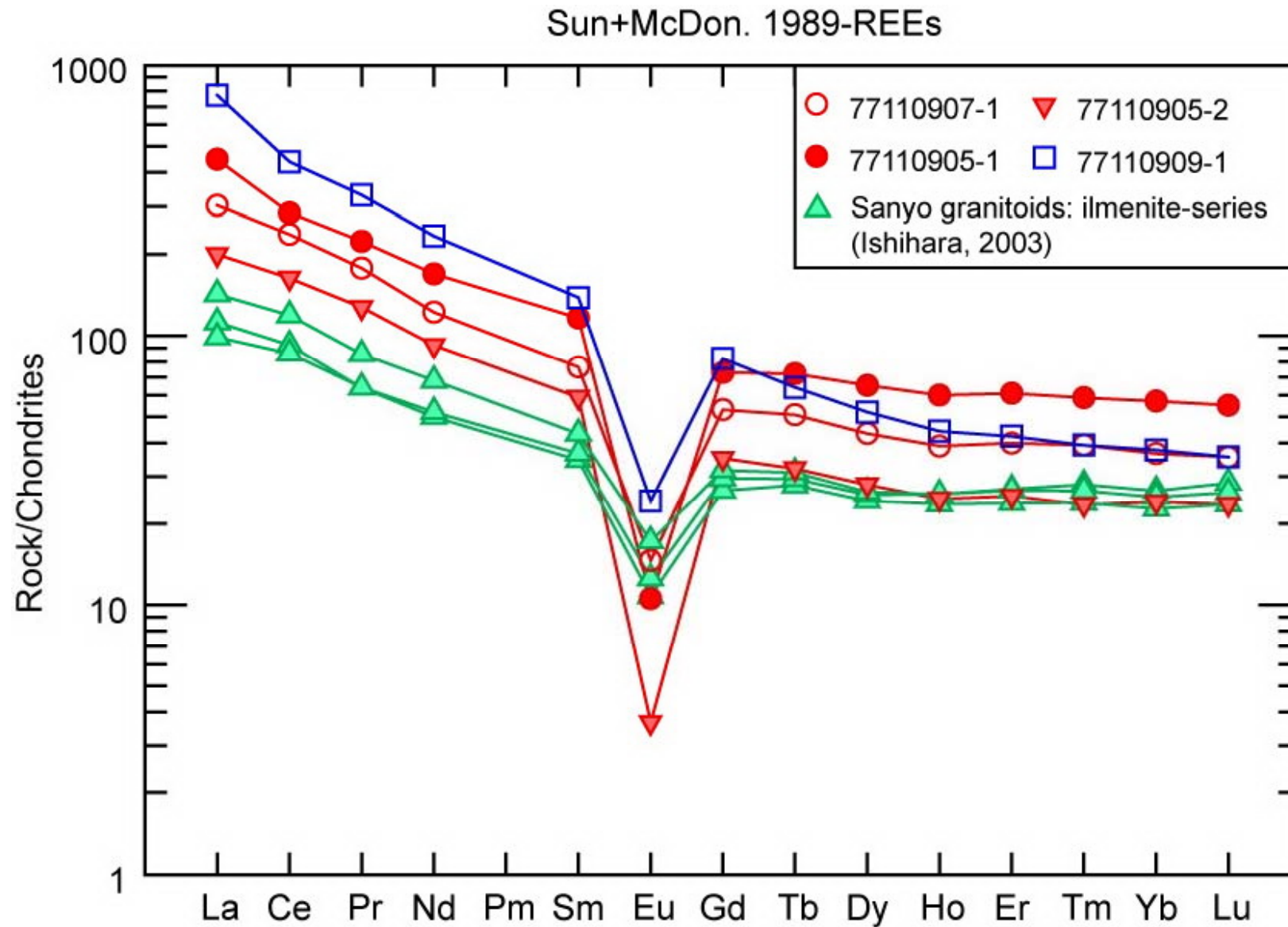
# Geologic map of Samui Island



# Outcrop and slab of Samui island



# Samui Island (Charusiri et al., 2012)



# Chantaburi granites, eastern Thailand



# Chantaburi Granites

~ N-S Thrust cutting conjugate joint sets



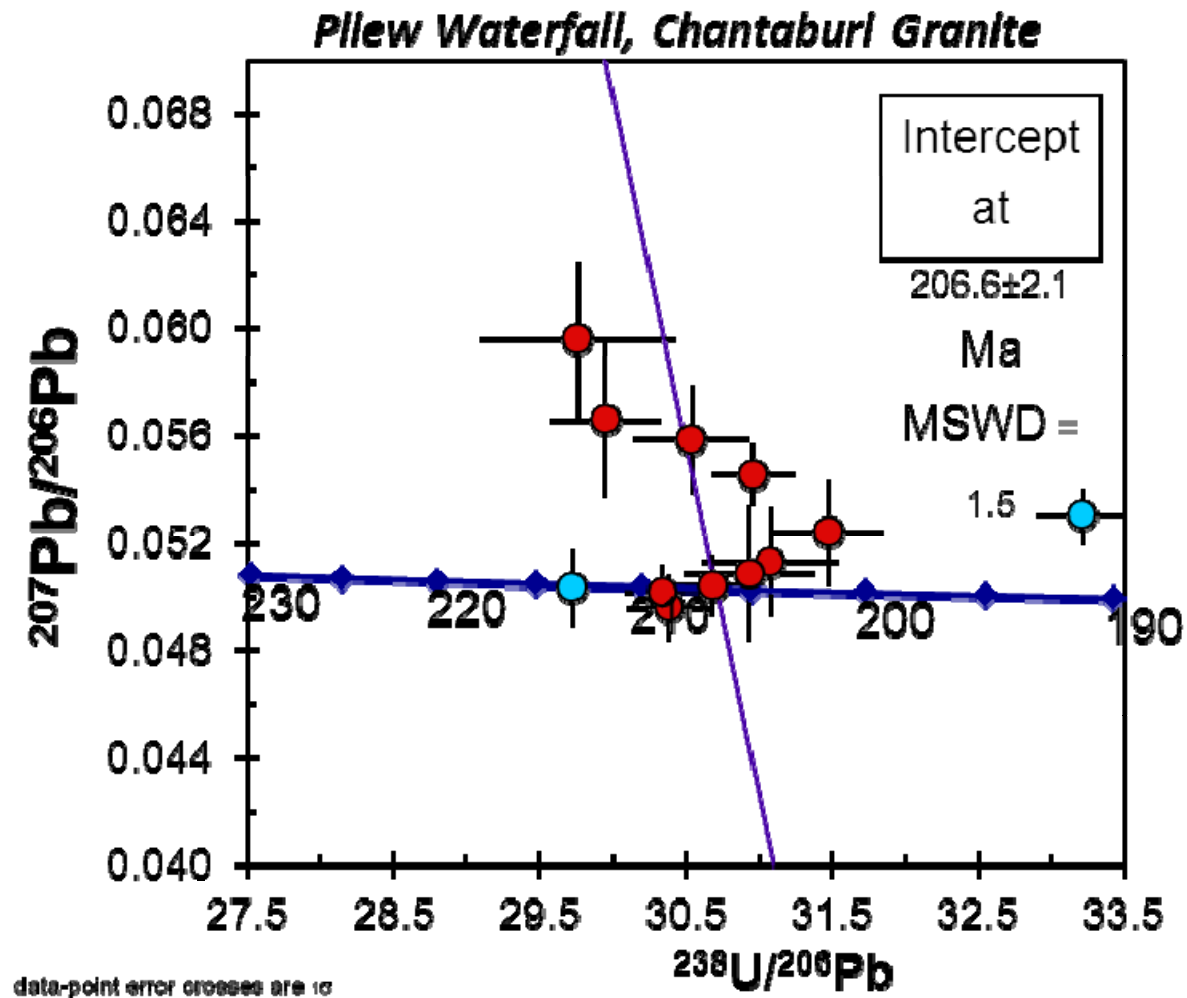
# Chantaburi granites



# Chantaburi granites

- REE Geochemical data suggest that granites are of I – type affinity
- However, they are younger than we expected
- Total REE contents up to 800 ppm

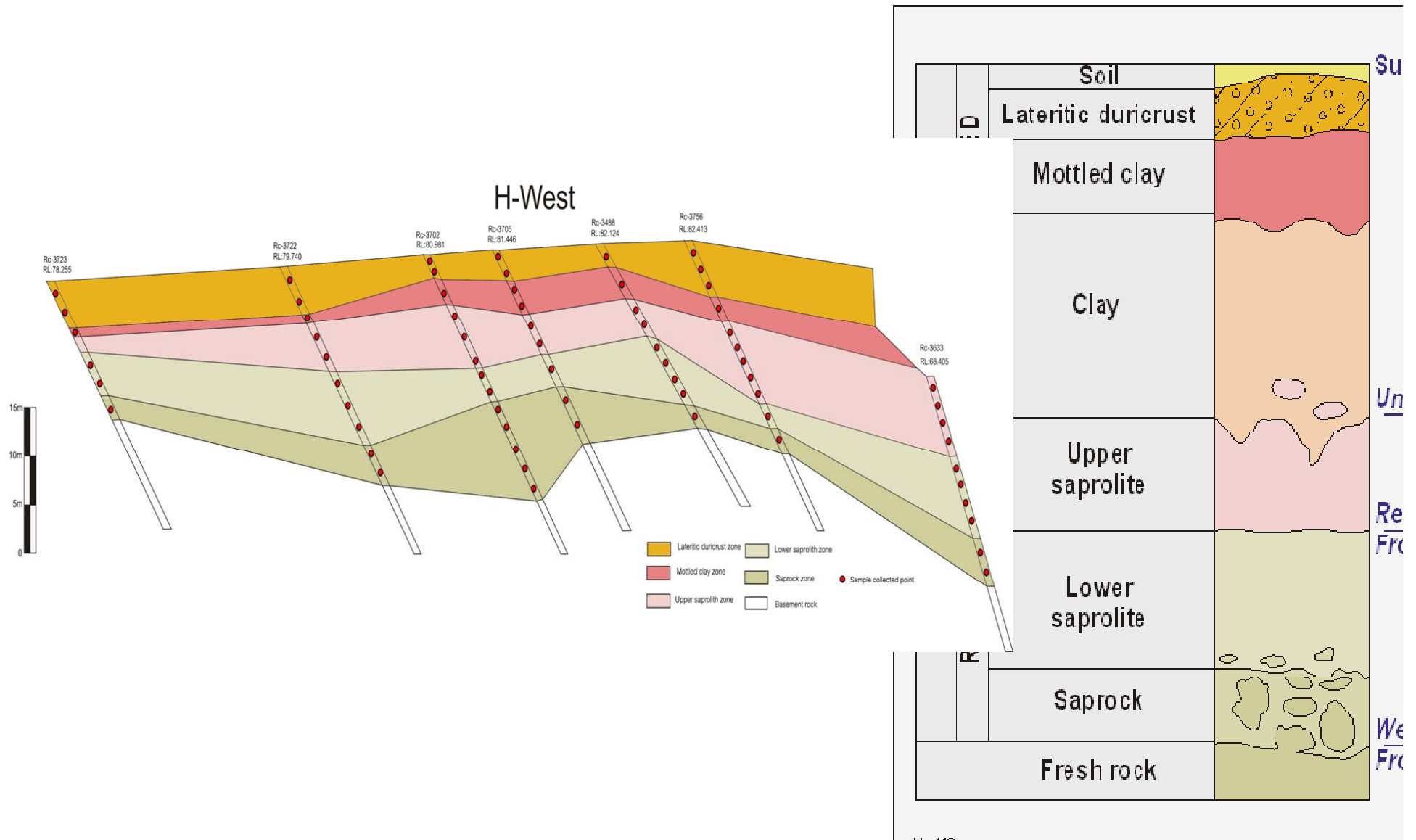
# 206 Ma zircon U-Pb age

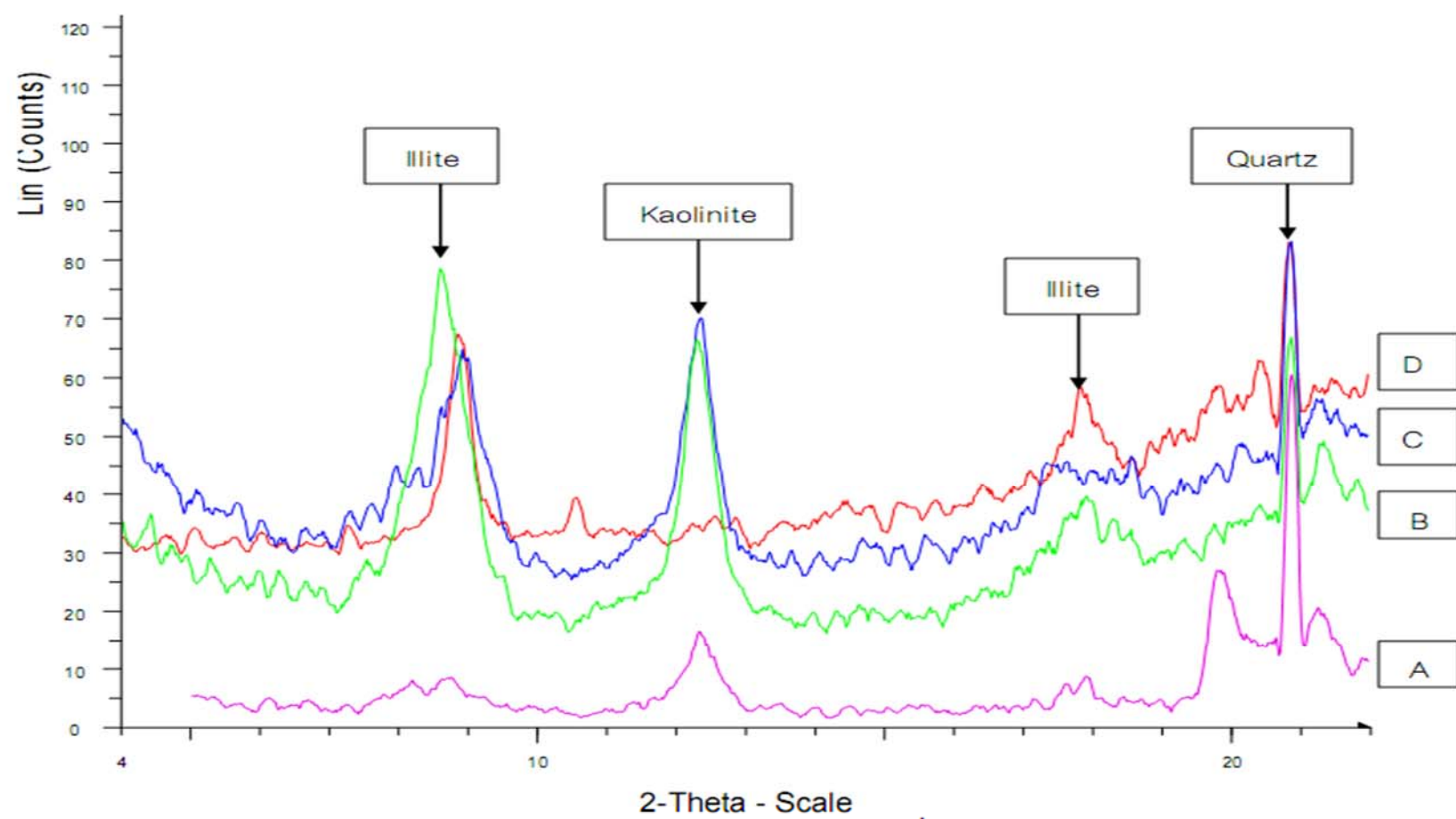


# Chatree mine



# Regolith with REE (t) 648 – 1,000 ppm





# conclusion

- • Granites of Chantaburi and Samui areas are investigated; they both are granites “sensu stricto”. The Samui Granite is of S-type affinity and the Chantaburi Granite is of I-type affinity. The ages of these two granites are considered to be Late Triassic to Juro-Triassic based upon standard radiometric datings.

# conclusion

- +Monazite and xenotime minerals have been found as accessories in tin and tungsten ore deposits developed in association with strongly altered S-type granites and pegmatites
- +Current investigations have been also performed in areas dominated by deeply weathered granites

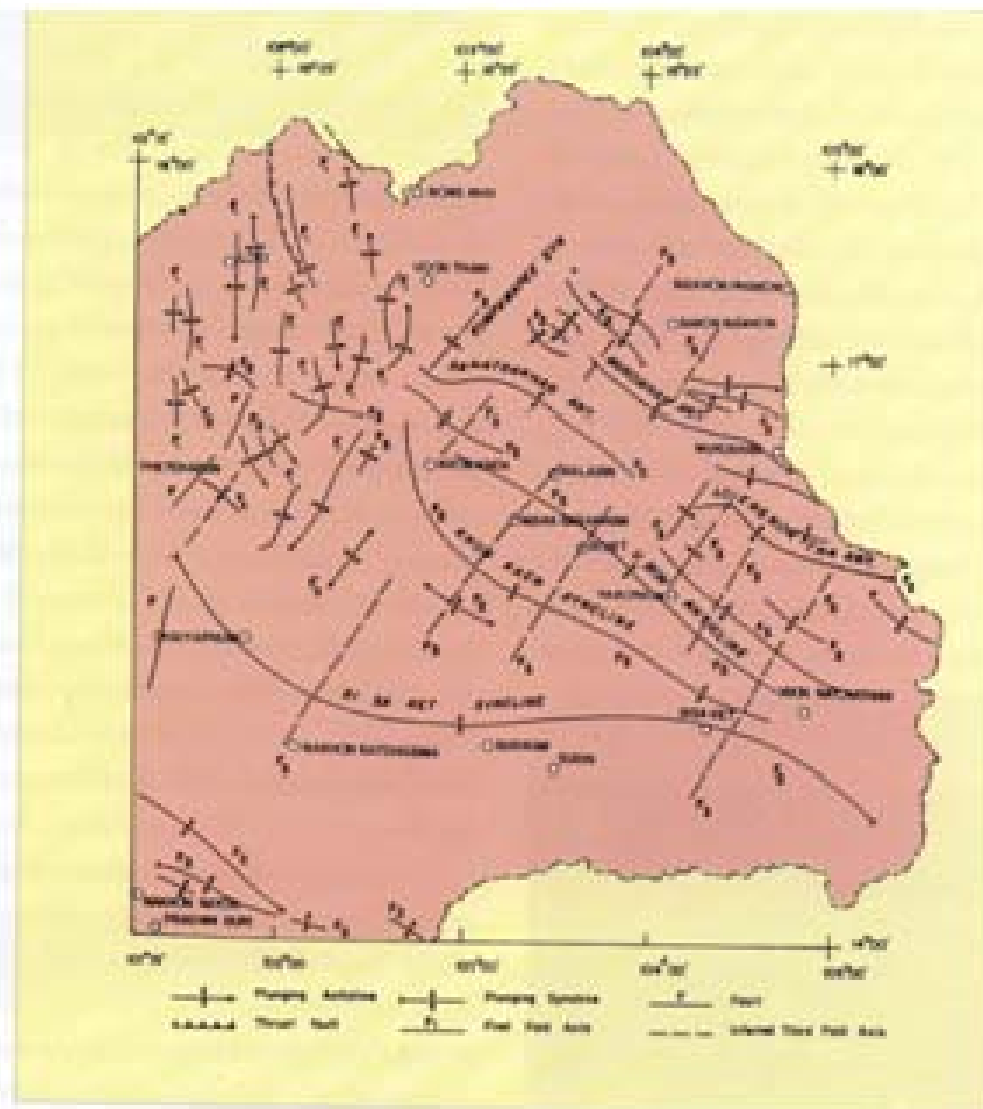


- However, a close look into the A-type, alkaline granites occurring in rifting tectonic regime is regarded to be essential

- On-going researches on REE minerals need to be done in Thailand.
- A special care is taken into new targets for REE sources, particularly areas dominated by altered A-type granites, apart from altered S-type granites as previously thought

- However, resource exploitation in Thailand is limited and difficult due to environmental condition.
- Mining license seems to be very difficult if the concerned areas are in the very upstream forest zone.





รูปที่ 10.10 แผนที่ธรณีวิทยาของภูมิภาคโขงในลาวตอนใต้และภาคตะวันออกเฉียงเหนือ (จาก Chantana, 1987)