Status on Rare Earth Elements in Thailand: Investigations and Researches

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Ridd et al. (2011)
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 temporarily 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."
รูปที่ 1.1 แผนที่แสดงระบบการแบ่งภูมิภาคของประเทศไทย ที่ได้ใช้อยู่ในเอกสารนี้
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.
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 Ishihara5 and Chappel and White6.
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)
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.
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 แผนที่แสดงลักษณะภูมิศาสตร์ความรุนแรงของชั้นหินที่มีการ饰品ปริมาณของแก๊สและสารมัลติโลก
แหล่งผลิตในโกลโด้ชีน (จาก Chawroon, 1997)