CHAPTER I

INTRODUCTION

1.1 General statement

Intrusive rocks or granitoids in Thailand have not only been an important target for mineral exploration for a long time but they are also an important source of dimension and decorative stones being exploited in construction industry in the last several decades. They are therefore subjected to intensive studies by several researchers.

In 1970's to 1980's, the intrusive rocks, especially granitoids with associated tin-tungsten mineralization were the most interesting group. Consequently, systematic studies on the intrusive rocks were undertaken by many researchers and as a result whole-country intrusive rocks have been divided, on the basis of lithological, geological, and geochronological characteristics, into three belts, namely the Western, the Central, and the Eastern Belts (Mitchell, 1977; Pongsapich et al., 1983; Charusiri et al.,1993). According to Nakapadungrat (1982, 1984) and Charusiri (1989), during the 1970's to 1980's, the granitoids of the Western and the Central belts, owing to their associated tin and tungsten mineralization and mining activities, seemed to have more studies than those of the Eastern belt. Though the tin-value was on the decline due to the decreasing of demand toward the end of the decades but the intrusive rocks in these belts were still the subject of many researches with more interest toward their associated rare-earth bearing minerals (Suwimolpreecha, 1989, Khantaprab et al.,1990).

In the last decade, however, intrusive rock with associated precious metals, such as gold and silver or base-metals, such as copper, lead and zinc, become more interesting group. These intrusive rocks belong to the Eastern belt which is the target for extentive exploration for gold mineralization and subsequent mining activities, such as the Chatree gold mine in the Pichit province. Hence understanding of granitic rocks in the Eastern belt becomes increasingly more important. However it appears that the basic lithological details are still lacking especially for the granitoids around Phetchabun province which are clearly located in the gold mineralized area. Therefore intrusive rocks in the study area which according to previous division are situated in the Eastern belt are very interesting and are therefore chosen to be the main topic of this study.

1.2 Location and accessibility

The study area is located between the latitude 15^{0} $52^{/}$ N to 15^{0} $58^{/}$ N and longitude 100^{0} $45^{/}$ E to 100^{0} $54^{/}$ E on the Royal Thai Survey topographic map scale 1:50,000, sheet number L7017, series 5140 I, Khao Phra. The area is situated about 340 kilometres to north of Bangkok and covers 176 square kilometres. The location of study area is shown in Figure 1.1.

There are at least two routes to access to the study area. Firstly, from Bangkok to Sara Buri province takes the highway number 1, then goes further north to Amphoe Bung Sam Phan along the highway number 21. From Amphoe Bung Sam Phan it can be reached to the study area by the highway numbers 225 and 1286, respectively. Secondly, starts with the same way on the highway number 1 to Nakorn Sawan, then turns into number 225 from west to east until reaching the highway number 1286. All routes accessed to the study area can be used all year round.

1.3 Objectives

Even though intrusive rocks in the Eastern granitoid belt have been reported to have a spatially and temporally association with volcanic rocks which show a close relation with gold mineralization, they are still lacking of petrographic and geochemical details. It is the fact that at least four distinctive intrusive rock-types can be distinguishable in the field in the study area without any detailed study. Therefore, it is the aim of this research to carry out the petrographic and geochemical study of those intrusive rocks in order to classify them into exact nomenclature and to find out their petrogenetic link.

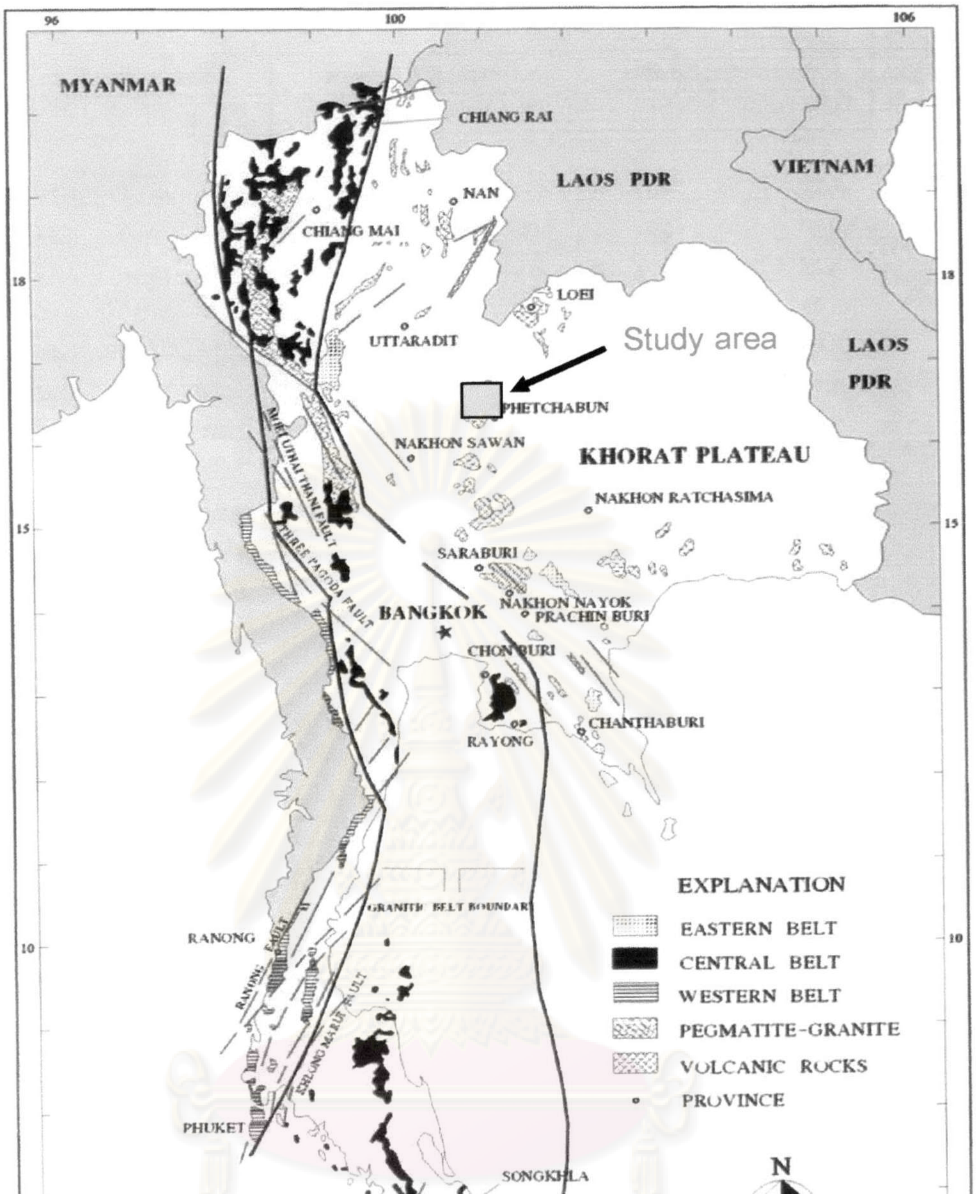

Figure 1.1 Map shows location of the study area, distribution of volcanic rocks and granitic belt of Thailand (after Puttapiban, 2002).

1.4 Previous works

Igneous complex in the study area has previously been studied by Jungyusuk et al.(1985) who mapped a detail geology with the scale of 1:50,000, of the Khao Phra sheet. They reported two types of intrusive rocks, namely quartz diorite and hornblende-biotite granodiorite with a subordinate gabbro. These intrusive rocks associated with older volcanic complex, basalt, andisite porphyry, rhyolite porphyry and basic pyroclastic.

Intasopa (1993) studied andesite, basaltic andesite and basalt from Amphoe Wichianburi of Phetchabun province approximately 30 kilometres to the south of the study area. She concluded that such volcanic rocks were subduction-related continental margin derived rocks. Two $^{40}Ar/^{39}Ar$ dating of hornblende in basaltic andesite and andesite gave the ages of 238 ± 4 and 237 ± 12 Ma, respectively.

Yaowachirapong and Pakapat (2001) studied a petrography and geochemistry of igneous rocks at Khao Mae Kae area and found that intrusive rocks around the Khao Mae Kae showed a linear trend of major oxide composition toward the east.

1.5 Tectonic framework of Thailand

The tectonic evolution of Thailand has been systematically re-constructed by Bunopas and Vella (1983) and subsequently revised by Bunopas and Vella (1992) and Charusiri et al. (2002), respectively. Based on the tectonic evolution syntheses of Bunopas and Vella (1992), Thailand was composed of two main tectonic terranes, the Shan-Thai in the west, and the Indochina in the east. Their amalgamation line situated along the Nan Suture. The Shan-Thai block underlied eastern Myanmar, western Thailand, Laos, Cambodia and some parts of Vietnam. In Thailand, the Shan–Thai terrane comprised basement of granitoids and high–grade metamorphic rocks which were believed to be of Precambrian age. The basement was overlain by sedimentary and metamorphic sequences of Palaeozoic, Mesozoic and Cenozoic ages. While the Indochina terrane comprised Permian platform–carbonate and deep–water clastic rocks, covered by the Mesozoic sequence of the Khorat Group, without any exposed Precambrian rocks. Bunopas and Vella (1992) stated that Shan–Thai and Indochina blocks were amalgamated along a moderately high angle, westward–dipping Benioff zone, to form the so–called Nan Suture, before the end of the Triassic. There were two fold–belts, originating from mid–Paleozoic to Triassic sedimentary basins, located between the Shan–Thai and Indochina. They were the Sukhothai Fold–Belt and the Loei Fold–Belt, along the eastern side of the Shan–Thai block and the western side of the Indochina block, respectively. Bunopas and Vella (1992) divided the tectonic evolution in Thailand into four episodes: Archaeotectonic, Palaeotectonic, Mesotectonic and Neotectonic (Figure 1.2).

During the ***Archaeotectonic stage*** (Precambrian to Lower Palaeozoic), Shan–Thai and Indochina blocks were part of the Gondwana supercontinent, and were connected to NW Australia in the southern hemisphere. The ***Palaeotectonic stage*** (Middle Palaeozoic to Lower Triassic) could be subdivided into three periods. During the first period, approximately from Silurian to early Lower Carboniferous. These two microcontinents were split from the original craton, but they were still in positions adjacent to the original craton. Localized sedimentary basins began to from on both micro-continents in this period. The second period started when the micro-continents drifted far apart in the palaeotethys, but they were still in low southern latitudes during the late Lower Carboniferous to early Upper Permain. In the last period of the palaeotectonic stage, the Shan–Thai microcontinent moved rapidly over enormous distance from a low southern latitude across the equator to low latitudes in the northern hemisphere. The Shan–Thai block subsequently collided with Indochina block, which were possibly arrived at that position earlier during the Permain, over thrusting the latter to the eastward. According to palaeomagnetic investigation (Bunopas,1981), the Shan–Thai shifted from a low latitude in the southern hemisphere to a low latitude in the northern hemisphere, in the process turning almost 180 degrees in the horizontal plane, between early Carboniferous and early Triassic times. The Shan–Thai concurrently collided with the Indochina and the South China block in the Middle Triassic in the Indosinian orogeny.

The ***Mesotectonic stage*** started after the collision and led to mountain building along the suture, especially along the over-thrust edge of the Shan-Thai block, as well as igneous activity, including intrusions and rhyolite eruptions. Molasses, particularly alluvial–plain red–beds, were deposited on both sides of the suture.

The ***Neotecnic stage*** involved the opening of Thailand as well as rifting in the Southeast Asian continent during late Cretaceous to Tertiary, and subsequent Quaternary mountainous uplift.

Charusiri et al. (2002) collected more recent information, particularly geochronology and petrology, and presented the latest synthesis of Thai tectonic evolution. They proposed two new small geological terranes, named as the Lampang – Ching Rai block and the Nakhon Thai block in the former Sukhothai fold–belt and Loei fold-belt, respectively (Figure 1.3). These new geological blocks were related to major terranes, Shan–Thai and Indochina, which were initially associated with the Gondwana supercontinent.

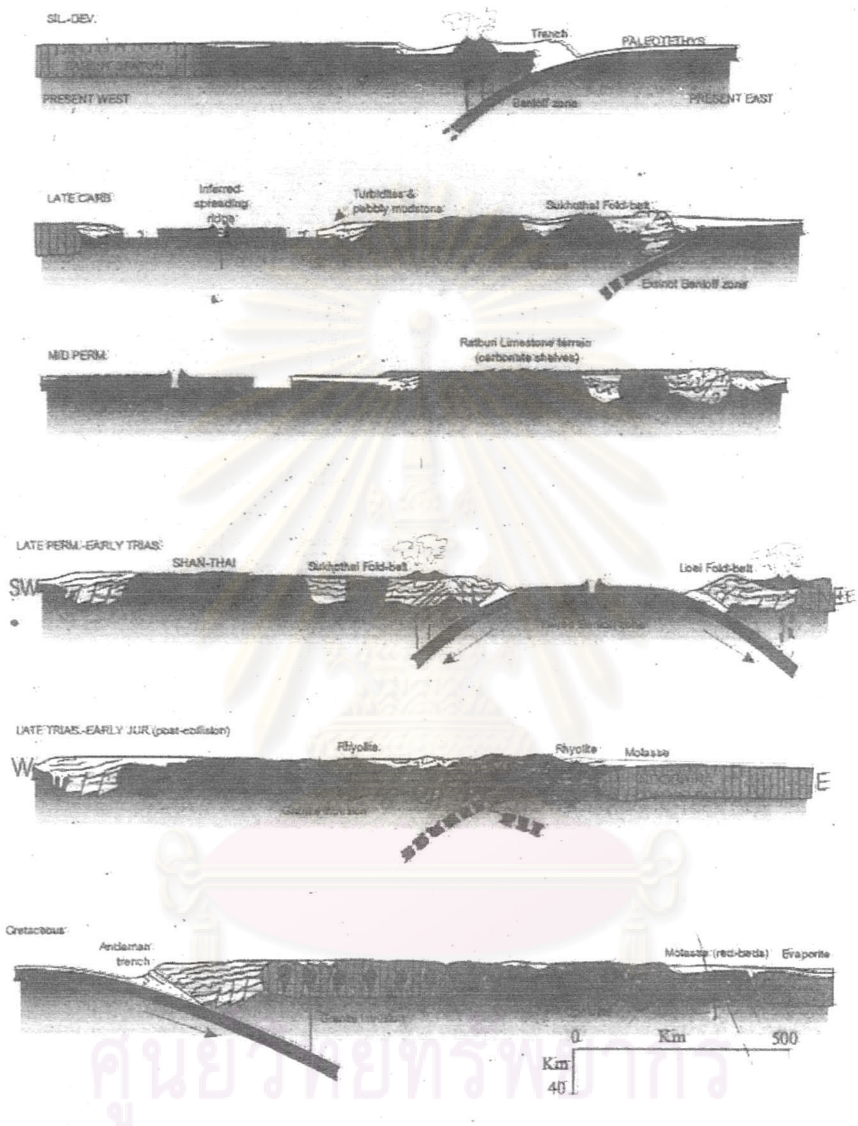

Figure 1.2 Tectonic evolution of Thailand (after Bunopas, 1981; Bunopas and Vella, 1992)

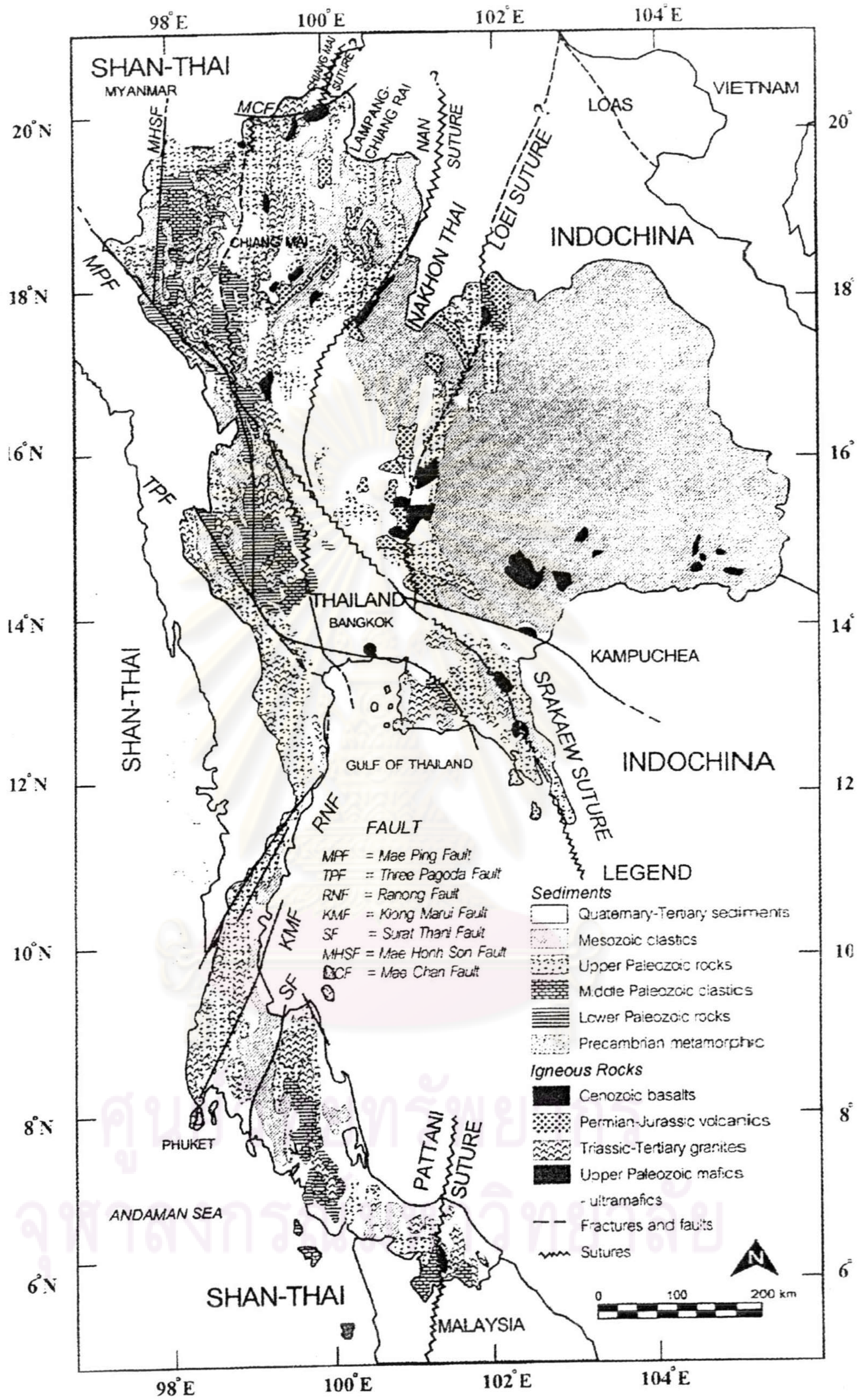

Figure 1.3 Simplified geological map of Thailand showing the distribution of various rocks, major suture/fault system and tectonic plates. (after Charusiri et al., 2002).

1.6 Granitoid belts of Thailand

The geological setting of granitoid rocks in Thailand has been studied intensively (Baum et al., 1970; Bignell, 1977: Punyaprasiddhi, 1980; Charusiri, 1989: Nakhapadungrat, 1982; Hansawek, 1983; Mahawat, 1982; Putthapiban, 1984), as well as receiving attention in more regional syntheses (e.g., Mitchell, 1977). On the basis of Rb-Sr whole-rock isochron data, Beckinsale et al. (1979) and Nakhapadungrat et al. (1984) assigned the granitoid magmatism of Thailand to four major episodes, at 240 Ma, 220-200 Ma, 130 Ma, and 90-75 Ma.

Mitchell (1977), Hutchison (1978), Pongsapich et al. (1983), have divided the granitic rocks of Thailand and Southeast Asia into three major belts on the basis of lithological, geological, and geochronological characteristics. These have been named the Western, Central, and Eastern Belts, Their details have been re-synthesized by many authors later based on new data, i.e. Charusiri et al. (1993). The characteristics of these granitic belts are summarized and illustrated in (Figure 1.1) and Table 1.1.

Table 1.1 Summary of granitoid belts of Thailand.

Topic	Western belt	Central belt	Eastern belt
Composition	True granite (Streckeisen, 1976), syeonogranite, monzogranite, quartz monzodiorite, quartz monzonite.	Sensu stricto (Streckeisen, 1976), syenogranite, monzogranite, quartz syenite and quartz monzonite.	Gabbro, through quartz diorite and granodiorite, to granite.
Age	130-90 and 45 Ma ; Rb-Sr W.R. 50-88 Ma ; $^{40}Ar / Ar^{39}$ 130 -78 Ma ; $^{40}Ar / Ar^{39}$	180 – 220 Ma ; $^{40}Ar / Ar^{39}$ 220-240 Ma ; Rb-Sr W.R. 73 Ma ; K-Ar biotite age	243 -200 Ma 210 - 245 Ma; $^{40}Ar / Ar^{39}$
Country rocks	Permian to Carboniferous clastic sedimentary rocks without volcanic associate.	Late Paleozoic to Early Mesozoic clastic sedimentary rocks without associated volcanic or tuff.	Upper Paleozoic clastic and volcanic tuff, sediments and shelf carbonates.
Pluton characteristics	Small to moderate batholith and pluton of restrict compositional range, commonly contain pegmatite and aplite.	Mesozonal, biotite-rich plutons	Display varying zone from "true granite" in the central part of the batholith graded to more mafic rich granitoid (quartz diorite, granodiorite) at the edge of the batholith.
Mineral assemblage	Quartz, microcline, biotite, muscovite and rarely hornblende	Quartz, muscovite, biotite feldspar (microcline) and microcline – perthite) with rarely green hornblende.	Quartz, alkali-feldspar (orthoclase), plagioclase (oligoclase to andesine), greenish brown to green hornblende and biotite with subordinate muscovite.

Table 1.1 Summary of granitoid belts of Thailand(cont.).

Grain size and textures.	Coarse grained porphyrytic with large K-feldspar phenocryst.	Megacrystic to equigranular and porphyritic, medium to coarse- grained. well-defined clastic texture, well-defined subhorizontal foliation	mostly medium-to-coarse- grained and equigranular, but are locally porphyritic
Accessory mineral	Illmenite, apatite, sphene and zircon.	Allanite, apatite, garnet, monazite, sphene, tourmaline, zircon.	Apatite, sphene, zircon, magnetite and allanite.
Associated deposits	Tin-tungsten, Rare earth-barring mineral.	Tin-tungsten, Rare earth-barring mineral.	Base-metal, gold and iron mineralization tin-tungsten deposit
Origin of magma		partial melting of pre-existing crustal rocks origin.	Originate from differential crystallization or partial melting from "true magma
Affinity	S-type ahd I-type affinity	S- type affinity.	I-type affinity
Ishihara (1977)	ilmenite-series and magnetite-series	Ilmenite and magnetite – series.	magnetite series
initial Sr isotopic ratio	0.719 – 0.744	0.725 -0.730 and 0.710 – 0.727	0.705 – 0.715
Distribution	Dominant in Myanmar, Tak, Kanchanaburi, Prachaub Khirikhan, Ranong, Phang Nga and Phuket	Chiangrai, Chiangmai, Lampang, Lamphun, Chonburi, Rayong, Suratthani, Nakorn Srithammarat , Songkla and Yala.	Billiton Island, Indonesia, through eastern-Peninsular Malaysia, along western Khorat plateau edge ofThailand.