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REVIEWS OF FELSIC PLUTONIC ROCKS OF THAILAND

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INTRODUCTION

Felsic plutonic rocks have been the main object of interest and research activities among geologists who work in Thailand for decades. The prime reason for this interest inevitably depends much upon the close association of valuable tin and tungsten minerals as well as other economic minerals such as, fluorite and barite with the felsic plutonic rocks. The felsic plutonic rocks exposed in Thailand are just a portion of an arcuate belt of Southeast Asia batholithic intrusions (Figure 1). This batholithic belt, which is over 2,500 km long, runs from Indonesia in the south through the Thai-Malay Peninsula into the Shan State of eastern Burma and into northeastern Thailand and western Laos (Garson and others, 1975) then veers northeastward through Yunnan, Kwangsi, and Kwangtung of South China (Burton, 1969). In Thailand the granitic rock concentrates mainly along the western part and the Peninular Thailand. Subordinate numbers of small and scattering masses are, however, found along the western flank of Khorat plateau and along the eastern Gulf of Thailand.

In the early days, the granitic rocks of Thailand have been primarily classified into younger Cretaceaus granite and older Triassic granite by Brown and others (1951). Later an addition of Carboniferous granite was reported by Burton and Bignell (1961) which subsequently was adopted by Javanaphet (1969) in his compilation of the geologic map of Thailand. In the early 70's, the Precambrian granite (orthogneiss), was believed to exist along the high grade metamorphic terrain of inferred Precambrian age. Von Braun (1969) and Baum and others (1970) suggested from their geologic mission in the northern part of Thailand that the plutonic emplacements were linked closely to the major orogenic episodes in Precambrian, Carboniferous, Triassic, and also late Cretaceous - Tertiary. During the last decade enormous radiometric age data of the granitic rocks have been produced all over the country (Snelling and others, 1970; Besang and others, 1975; Teggin, 1975; Garson and others, 1975; Bignell, 1972; von Braun and others, 1976; Beckinsale and others, 1979; Ishihara and others, 1980; Nakapadungrat, 1982). It is clearly illustrated from figure 2 that among those granitic rocks, the Triassic granites are by far the dominant phases exposed in this region.

Mitchell (1977) and Hutchison (1978) have recognized and defined the granitic rocks in Malaysia and Thailand into three main parallel belts namely, the Eastern, the Central, and the Western Granitic Belts.

The Eastern Granitic Belt includes the Belitung Island, the eastern Malaysia, the eastern Thailand and possibly small plutons on the western flank of the Khorat Plateau. It is characterized by plutonic rocks ranging from gabbro through quartz diorite, granodiorite, adamellite to granite with their ages ranging from Permian to early Triassic especially in Malaysia. Recently Mahawat (1982) has also included the Tak Batholith of Triassic age into this eastern belt (Figure 1).

The Central Granitic Belt consists of the Banka,the Singkep, and the Tuju islands of Indonesia, the Main Range of Malaysia, the Penisular, the Central, and the Northwestern Thailand. This belt covers at least three - fourth of the granitic rocks of Thailand. It is characterized principally by mesozonal porphyritic biotite granites of Triassic age, usually associated with highly folded Paleozoic metasediments.

The Western Granitic Belt comprises the Peninsular Thailand and Burma, and the western Shan States. It is characterized chiefly by high level adamellites, granites and granitic pegmatites of Cretaceous to Eocene ages.

PRECAMBRIAN GRANITES

Eventhough the age of "Precambrian" granite in Thailand has not been proved definitely by the method of radiometric age dating, many granitic rocks associated with gneiss and high grade metamorphic complex are believed by many workers to be Precambrian in ages (e.g., Campbell, 1973; 1975; Dheeradilok, 1973; Workman, 1975; Bunopas, 1976). The Precambrian granites in their association with the basement complex distribute along a north-south trend in the Central Belt (Mitchell, 1977) from the north to the central portion of Thailand. Von Braun (1969) suggested that the Precambrian granites should have occurred especially in the northern region of Thailand. Mitchell and others (1970) suggested that the granite pebbles in pebbly mudstone of the Phuket Group were derived from Precambrian granite. The granite pebbles in pebbly mudstone of Malaysia (Jones, 1968) were later determined radiometrically to be Precambrian by Stauffer and Snelling (1977).

TRIASSIC GRANITE OF THE EASTERN BELT

Though three of granitic rocks along the eastern belt have been dated radiometrically, at 230 Ma for Chiang Khan granite of Changwat Loei (Jacobson and others 1969), 255 Ma (Pitakpaivan, 1969) and 212 Ma and 208 Ma (Teggin, 1975) for Tak Batholith, and 144 Ma (Burton and Bignell, 1969) and 170 Ma (Bignell, 1972) for Nam Tok Plieu pluton in changwat Chanthaburi, only the Tak Batholith has been mapped and studied in details (Teggin, 1975; Pongsapich and Mahawat, 1977; Mahawat, 1982). The Tak Batholith can be summarized in general to be a composite batholith of at least four intrusive phases (Mahawat, 1982). They are zoned plutons and may range in composition from quartz diorite to granodiorite and monzogranite. Pink colored and hornblende-bearing rocks are their typical characteristics. They are normally medium-to coarse-grained and equigranular with locally porphyritic. Major mineral constituents are plagioclase, potash feldspar, quartz, biotite and hornblende. The plagioclase composition varies from albite to sodic oligoclase in monzogranite, sodic oligoclase to calcic oligoclase in granodiorite, and calcic oligoclase to sodic andesine in quartz diorite. The common accessory minerals of these rocks are apatite, zircon, magnetite, sphene, and allanite. Mafic inclusions of different shapes and sizes are ubiquitous along the western part of the Batholith. The main phases of the granitic plutons have subsequently been intruded or surrounded by later phases of microgranite, aplite, feldspar pegmatites, and quartz feldspar dikes. These late magmatic rocks are white, fine-to medium-grained which presumably eqinvalent to the white granite mentioned by Teggin (1975).

Based on the criteria of small amount of corundum normative calculated from chemical data, moderately high initial $^{87}Sr/^{86}Sr$ ratio of 0.7104 in pink granite and 0.7158 in white granite (Teggin, 1975), and the occurrence of magnetite rather than ilmenite in these high level multiple plutons, Mahawat (1982) suggested that the Tak Batholith is the I-(Caledonian) type (Pitcher, in press) granite. The moderate values of the initial $^{87}Sr/^{86}Sr$ ratio is probably attributed to the contamination of mantle derived magma by crustal material (Beckinsale, 1979).

TRIASSIC GRANITES OF THE CENTRAL GRANITIC BELT

The central granitic belt covers at least three-fourth of the batholithic terrain in Thailand from the north to the south. Detailed studies have been carried out along this granitic belt both geologically and geochronologically by many workers. It is, therefore, suitable to discuss this Triassic granite of the Central belt by following geographic setting namely, the northern - central zone and the peninsula zone.

The Northern-Central Zone

Geologic map of the Northern Thailand apparently illustrates three approximately north-south trending belts of crystalline rocks. These are the central crystalline basement complex which trends from just west of Changwat Chiangmai to Changwat Tak and another two chains of granitic rocks which align subparallel to the east and the west of the central basement complex.

The central crystalline basement complex is composed of inferred Precambrian gneisses and metasediments. Granitic rocks that are associated with this complex were mentioned previously in the Precambrian granite. The eastern chain comprises Mae Chan granitic pluton of Changwat Chiangrai, followed by a continuous north-south elongated belt of Fang-Mae Suai-Wiang Pa Pao-Doi Saket, and small granitic bodies of their southern extension at Lampang (Khuntan), Bang Hong, and Li. The western granitic chain comprises composite granitic masses, starting from Pai through Samoeng, Mae Sarieng, to the west of Tak.

Large granitic plutons in the central region are those exposed along the western part of Changwat Uthai Thani and Changwat Chonburi-Rayong. The general geology of this region has been summarized by Bunopas (1980 a, 1980 b). A detailed geological study of granitic rocks in the Thong Lang area on the west of Changwat Uthai Thani was carried out by Nakapadungrat (1982). The petrology and geochemistry as well as ages of the Thong Lang granites are essentially similar to the granites of the central belt in the northern Thailand. Therefore, the description of the northern granites will, in general, apply to the granites of the central region as well.

Information on geology of Thailand especially those of the granitic rocks concerned has been studied intensively by many workers (Baum and others, 1970; Piyasin, 1972; Teggin, 1975; Suensilpong and others, 1977; Chuaviroj, 1980; Punyaprasiddhi, 1980; Jiyathanond, 1981; Thanasuthipitak and Sinthusan, 1981; Hansawek, 1983). Von Braun (1969) mentioned that the Triassic granite in northern Thailand was spectacularly uniform in its texture and mineralogy. In general, the granite is medium-to coarse-grained, frequently porphyritic, biotite granite with occasionally a hornblende-bearing variety. According to modal classification, rocks mainly belongs to the monzogranite group. Granodiorite and syenogranite are only subordinate varieties. Biotite, potash feldspar, plagioclase, and quartz are the major mineral composition and were crystallized in the successive order. Potash feldspar is either orthoclase or microcline and essentially forms prominent phenocrysts. It is perthitic and poikilitic. Plagioclase ranges in composition from sodic oligoclase to calcic andesine. Normal zoning appears to be common in plagioclase. Accessory minerals are apatite, zircon, monazite, allanite, and opaques. Andalusite and cordierite have been rarely reported to be present in the Bang Hong Granite (von Braun and others, 1976). Petrochemically, this granitic rock shows high excess of corrudum normative (Suensilpong and others, 1977; Punyaprasiddhi, 1980; Jivathanond, 1981; Hansawek, 1983). The main porphyritic biotite granitic phase was intruded subsequently by medium- to coarse- grained and equigranular muscovite-biotite granite. Post intrusive fine-grained leucocratic granite, aplite, pegmatite, and quartz dikes are found cutting through the main granitic phase. Generally, each individual pluton shows sharp and steep contact with the Paleozoic country rocks and with minimum contact metamorphic effect.

The Rb-Sr and K-Ar age determinations on the granitic rocks in the north and central zones have been carried out by several authors (Teggin, 1975; von Braun and others, 1976; Beckinsale and others, 1979). They are all in good agreement and well clustered around Triassic age. Only few samples show deviation in ages from major Triassic to Carboniferous and Permian (Table 1 and Figure 2). It is believed that granites of different ages found in the same region may probably indicate repetition of magmatism. It is noteworthy here to point out that many age data determined by method of K-Ar on biotite and/or muscovite are commonly discordant with that of Rb-Sr whole rock method. K-Ar ages concerned here are those of younger Cretaceous or even early Triassic. These age discrepancies have been attributed to the resets by the effects of faulting that provide heat and hot solution to cause outgassing (Bignell and Snelling, 1977), or by a very slow rate of denudation (Hutchison, 1977), or by other unknown geological events (Beckinsale and others, 1979).

Initial $^{87}Sr/^{86}Sr$ ratios of the granites from the northern-central zone of the central granitic belt are always higher than 0.7200. This high initial strontium ratio as well as the petrochemical characteristics of these granite (as suggested by Chappel and White, 1974) have led to the idea of S-type granite for this magmatic model.

The Peninsular Zone

Reports on the geology of granites in the southern Thailand particularly those belonging to the central granitic belt are rather limited. Although the granitic rocks are distributed throughout the Peninsula sufficient data are only available from Changwat Prachaub Khirikhan in the upper peninsula and from Changwat Nakorn Sri Thamarat to Thai-Malay border in the lower one.

The detailed petrography and geochemistry of gneissic granitoids from Hub Kapong and Hua Hin areas in Changwat Prachaub Khirikhan have been studied by Putthapiban and Suensilpong (1975) and Pongsapich and others (1980) and in the Pranburi areas by Pongsapich and others (1980) and Vedchakanchana and others (1978). Putthapiban and Suensilpong (1978), in their study of the Hup Kapong and Hua Hin plutons, have identified three granitic phases namely, the coarse-grained biotite porphyroblastic gneissic granite, the medium-to coarse-grained equigranular to porphyroblastic granite gneiss and the younger non-foliated granite. Among these three granitic rocks, the coarse-grained biotite porphyroblastic gneissic granite is the oldest and most abundant in the area. The radiometric age of the coarse-grained biotite porphyroblastic gneissic granite reported by Beckinsale and others (1979) is 210 ± 4 Ma for a whole rock Rb-Sr age and 63 ± 4 Ma for a K-Ar of biotite. This age evidence has led Putthapiban and Suensilpong (1978) and Beckinsale and others (1979) to conclude that the Hub Kapong and Hua Hin gneissic granites, previously mapped as Precambrian orthogneiss, are of Triassic in ages. Putthapiban and Suensilpong (1978) further iterated that the coarse-grained biotite porphyroblastic gneissic granite and the medium-to coarse-grained equigranular to porphyroblastic granite gneiss including mylonite in the vicinity of Hua Hin were originally granites that later were sheared during the tectonic activity in early Tertiary. Subsequently, the nonfoliated granite with its associated tin and tungsten mineralizations were intruded in Tertiary. Pongsapich and others (1980), however, questioned the timing of granitic intrusions, metamorphic and tectonic events on the basis of field evidence that the Pranburi mylonite zone was not cut into the Permocarboniferous Ratburi Limestone and therefore should be pre-Permocarboniferous in ages.

Most of the granitic rocks from Hub Kapong and Hua Hin areas have their mineralogical and geochemical characteristics compatible with the model of S-type granite proposed by Chappel and White (1974). This S-type granitic model are also supported by the field evidence (i.e., the presence of alumina-excess minerals, such as sillimanite) and by their high values of initial $^{87}Sr/^{86}Sr$ ratio (0.7237, Beckinsale and others, 1979).

In comparision to those in the Hub Kapong and Hua Hin areas, the granite gneiss in Pranburi area is essentially a cataclasite ranging from ultramylonite through mylonite to protomylonite (Vedchakanchana and others, 1978; Pongsapich and others, 1980). Dark igneous inclusions have been reported to be present in the protomylonite. Pongsapich and others (1980) considered the Pranburi gneiss to be the I-type granite based upon their similarity in petrochemical characters to the I-type granitic model defined by Chappel and White (1974).

In the lower Peninsula information concerning the granites of the central belt is almost entirely obtained from the work of Ishihara and others (1980). The granites are mostly coarse-grained porphyritic biotite granites, some are equigranular biotite granites and muscovite-biotite granite. From the modal analysis, they are classified into monzogranite and syenogranite (as suggested by Streikensen, 1973). The monzogranite is the dominant phase and is usually coarse-grained whereas the syenogranite is subordinate and commonly is fine-grained. Occasionally rocks are weakly foliated and may contain some metasedimentary xenoliths. Late pegmatite and aplite are also abundant but frequently small in size. Phenocrysts are mostly microcline or microcline perthite. Because of the low magnetic susceptibility (less than 50×10^{-6} emu/g) of all of these granites, they were classified as ilmenite-series granitoid by Ishihara and others (1980). These granites are also considered in general to be of S-type granite by the same authors.

A number of radiometric age data of granitic rocks from the Peninsula is listed in Table 1. For the granitic rocks exposed from the Klong Marui fault zone to Thai-Malay border of the central granite belt, the Rb-Sr age data are rather limited and scattered from Carboniferous to Cretaceous whereas the K-Ar age data display a scatter from early Triassic to Tertiary with no clearly defined peak. In general, the granites of central belt appears to give somewhat older age as compared with those of the western belt (i.e., Phuket and Phangnga areas). The K-Ar age resets have been reported in several localities in the central belt (Ishihara and others, 1980).

CRETACEOUS GRANITES OF THE WESTERN BELTS

Small granitic stock at Mae Lama, granitic belt at Khao Daen and granites at Ranong, Phangnga and Phuket are all grouped into the western granitic belt in Thailand. A number of geological information of these granites are available from the Mae Lama area by Pitragool and Panupaisal (1978) from the Phangnga-Takua Pa areas by Garson and others (1975), from the Phuket island by Garson and others (1975), Hummel and Phawandon (1976), and from the western offshore of the Peninsula by Rasrikriengkrai (1976).

In general, the granites of the western belt are hornldends-biotite adamellite or biotite adamellite, medium-to coarse-grained porphyritic biotite granite, and fine-to medium-grained two mica granite. The porphyritic biotite granite is evidently the major phase of these granitic rocks and is subsequently intruded by the muscovite-biotite granite. The geochemical data, in particular from the vicinity of the Phuket area, reveal that the granites are of calc-alkali affinity and differentiation proceeds from the biotite granite to the higher differentiated muscovite-biotite granite (Charusiri and Pongsapich, 1982). The plutons are subsequently cut by highly differentiated granitic materials, e.g., aplites, pegmatites, and hydrothermal quartz veins. Tin and tungsten mineralizations and also greisenization effects are commonly found associated with these late magmatic materials.

The Rb-Sr radiometric ages of the granitic rocks from this western belt (Table 1 and 2) suggest, but not conclusively, that the granites are of Cretaceous in ages. The deviations from the median Cretaceous are the age of samples from La-Un and Ban Set Takuat, Changwat Ranong (307 $\pm$ 18 Ma, Burton and Bignell, 1969; and 331 Ma, Bignell, 1972) and samples from Haad Surin and Khao To Sae, Changwat Phuket (209 Ma, Bignell, 1972; and 169 Ma, Ishihara and others, 1980). On the contrary, the K-Ar ages show a range from 55 to 65 Ma. This discrepancy in ages is attributed to major argon reset events on these granites at this time (Ishihara and others, 1980).

Almost all of the initial strontium-isotope ratios of the granitic rocks of the western belt are comparatively high in their values and are considered to originate from crustal material (or S-type magma). There are, however, two exceptional cases, one is from the Mae Lama pluton which shows the initial $^{87}Sr/^{86}Sr$ ratio of 0.7085 (von Braun and others, 1976; Beckinsale and others, 1979) and the other from the Phuket Island which shows the initial $^{87}Sr/Sr^{86}$ ratio of 0.7072 (Snelling and others, 1972). These exceptional low values of initial strontium ratios may possibly indicate that these granites were originated from the mantle source.

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Table 1. Isotopic Age Determination of Granitic Rock in Thailand

A) Western Granitic Belt

	Sample Location	Lithology	Radiometric Age (Ma) Rb/Sr	K/Ar	References
1)	Mae Lama	granite	130.4±4.4	B 53.4±1.4	Beckinsale and others (1979)
2)	Mae Lama, 40 km south of Mae Sarieng	(greisen) granite	69.5-78	-	von Braun and others (1976)
3)	Khao Daen, Kanchanaburi	granite	93±4	B 71.1±2.2 M 73.9±8.5	Beckinsale & Nakapadungrat (1981)
4)	Ranong	Coarse-grained porphyritic adamellite	111±6	M 73±3	Burton and Bignell (1969)
5)	La-un, Ranong	Microcline granite	307±18	M 66±3	Burton and Bignell (1969)
6)	Ban Set Takuat, Ranong	Foliated B-M granite*	331	M 66.4±2	Bignell (1972)
7)	Road 3.5 km east of Ranong	Coarse-grained porphyritic B.M granite	120	M 66.4±2	Bignell (1972)
8)	Nam Tok Ngao, Ranong	Coarse-grained porphyritic B granite (adamellite)	122 113±8	B 63.3±2 B 63±3	Bignell (1972) Burton and Bignell (1969)
9)	Chon Mine, South Ranong	Stanniferous pegmatite	93	M 66.3±2	Bignell (1972)
	Boulder on main Road 55 km north of Phuket, Takuapa	B granite	222		Bignell (1972)
10)	Beach on West Coast, north of Phuket island, Takuapa, Phangnga	Coarse-grained B granite	119		Bignell (1972)
11)	Khao Khanim, south of Takuapa, Phangnga	Porphyritic B granite	107	B 70.2±2.5 M 64.9±1.9	Bignell (1972)
12)	Khao Kuan Kha, SW of Phangnga	Porphyritic B granite	102+5		Garson and others (1975)
13)	Bang I Tum Mine, Phangnga	Lepidolite pegmatite		L 52.1±1.5	Bignell (1972)
14)	Takuapa, Phangnga	granite	78±2	-	Beckinsale & Nakapadungrat (1981)

Sample Location	Lithology	Radiometric Age (Ma) Rb/Sr	K/Ar	References
15) Ko Phuket	Granite	74±4	-	-ditto-
16) Quarry 1 km north of Phuket	Granite	75	M 56±1.5	Bignell (1972)
17) North end of Phuket Island	B-M granite	139		Bignell (1972)
18) Quarry near Phuket town (Chao Fa Mine?)	B granite	140		Bignell (1972)
19) Had Surin Beach, Phuket	Coarse-grained porphyritic B-H granite	209		Bignell (1972)
20) Khao Khekni Phuket	Porphyritic B granite	114	B 54.4±1.7	Bignell (1972)
		114+7	B 54+	Garson and others (1975)
21) Khao Prathiu Phuket	H-B granite	109	B 53.7±1.8	Bignell (1972)
	H-B adamellite	109+40	B 54+2	Garson and others (1975)
22) Phuket town, Road to Ban Patong	M-T pegmatite		M 56.6±1.8	Bignell (1972)
23) Khao Mai Khao, Phuket Island	M granite		M 60±5 M 85±5	Pitakpaivan (1969)
24) Phuket Island	B granite	124±4 (0.7072±13)		Snelling and others (1970)
25) Phuket Island	B-M granite	108±5 (0.7293±5)		Beckinsale (1979)
26) Toh Saeh quarry Phuket	B-M granite	169 (0.7829)	Ishihara	Ishihara and others (1980)

B) Central Granitic Belt

Sample Location	Lithology	Radiometric Age (Ma) Rb/Sr	K/Ar	References
1) Doi Saket-Wiang Pa Pao	Granite	215±3	-	Beckinsale & Nakapadungrat (1981)
2) Li, Lampang	Granite	236±4	-	von Braun and others (1979)
3) Khuntan, Lampang	Granite	240	B 212	von Braun and others (1979)
4) Khuntan, Lampang	Granite	212±12	-	Beckinsale and others (1979)

	Sample Location	Lithology	Radiometric Age (Ma) Rb/Sr	K/Ar	References
5)	Fang-Mae Suai	Granite	240±64	-	Beckinsale and others (1979)
6)	Samoeng,	Granite	204±15	-	Beckinsale and others (1979)
7)	Thong Lang,	Granite	237±25	-	Nakapadungrat (1982)
8)	Thong Lang, Uthaithani	Granite	68±8.4	-	Nakapadungrat (1982)
9)	West of Payao	H-B granite	62	-	von Braun (1970).
10)	East of A. Sa*, Nan	H-B granite	62	-	von Braun (1970)
11)	North of A. Pai, Mae Hong Son	Coarse-grained porphyritic B granite	240	B 198 M 194 M 201	Besang and others (1975) also von Braun and others (1976)
12)	Southeast of A. Pai Mae Hong Son	Coarse-grained porphyritic B granite	240 -	B 77.5 B 204	Besang and others (1975) also von Braun and others (1976)
13)	Southeast of A. Mae Sariang Mae Hong Son	T-bearing microgranite vein slightly foliated	-70	B 68.2±0.7 M 69.7±0.5	Besang and others (1975) also von Braun and others (1976)
14)	Mae Sariang, Mae Hong Son	Medium-grained porphyritic B-rich granite with green amphibole	-	B 205±1	Besang and others (1975) also von Braun and others (1976)
15)	Mae Sariang, Mae Hong Son	Aplite	190±7	-	Besang and others (1975) also von Braun and others (1976)
16)	Mae Sariang, Mae Hong Son	Porphyritic B-granite (adamellite)	-	68 -	Besang and others (1975) also von Braun and others (1976)
17)	East of Mae Sariang,,Mae Hong Son	B granite	-		also von Braun and others (1976)

Sample Location	Lithology	Radiometric Age (Ma) Rb/Sr	K/Ar	References
18) North and south of A. Pai, Mae Hong Son	B granite	344	-	von Braun (1970)
19) West of A. Hod, Chiang Mai	B granite	344	-	von Braun (1970)
20) Southeast of A. Hod	B granite	266	-	von Braun (1970)
21) 50 km due west of Chiang Mai	Coarse-grained porphyritic granite with flow texture	57.5±3	B 45.8±0.5	Besang and others (1975) also von Braun and others (1976)
22) 10 km northeast of no. 14	Microgranite vein, foliated, with pegmatite streak	33.5±0.8	M 20.6±0.15 M 22.4±0.2	Besang and others (1975) also von Braun and others (1976)
23) 25 km northwest of Chiang Mai	Cataclastic	-	B 34.8±0.3	Besang and others (1975) also von Braun and others (1976)
24) 10 km northwest of Mae Taeng, Chiang Mai	Fine-grained leucocratic granite	40.7±0.8	B 32.3±0.3	Besang and others (1975) also von Braun and others (1976)
25) 20 km southwest of Mae Taeng Chiang Mai	Fine-grained foliated granite	140	B 18.55±0.1	Besang and others (1975) also von Braun and others (1976)
26) Fang-Mae Suai	Medium to coarse-grained B granite	232±31 229±32	B 209	Besang and others (1975) also von Braun and others (1976)
27) Samoeng, Chiang Mai	Porphyritic B granite	-	B 57±3.9 - 57.5±3.9	Besang and others (1975) also von Braun and others (1976)
28) Samoeng, Chiang Mai	Porphyritic B granite	195±5	K 35 - 108 B 43±1-71±1	Teggin (1975)
29) East of Ban Hong, Lamphun	'Medium-grained B B granite	236±5	B 210	Besang and others (1975) also von Braun and others (1976)

	Sample Location	Lithology	Radiometric Age (Ma) Rb/Sr	K/Ar	References
30)	Li-Doi Tao Road, Lamphun	Porphyritic	236±14	B 201-208 M 203-207	Besang and others (1975) also von Braun and others (1976)
31)	35 km southwest of Ban Hong, Lamphun	Granodiorite dike, slightly foliated (in Basement)	-	B 19.6±0.15	Besang and others (1975) also von Braun and others (1976)
32)	Khuntan, Lampang	Porphyritic B granite	365±14	B 201-212	Besang and other (1975) also von Braun and others (1976)
33)	Khuntan, Lampang	Porphyritic B granite	206±4	K 94-191 B 199±4 M 202±5	Teggin (1975)
34)	Mae Salid, A. Ban Tak, Tak	B granite	225±10	B 215±10	Pitakpaivan (1969)
35)	Tak	B granite with mafic xenolith	212±4	-	Teggin (1975)
36)	Tak	Leucocratic granite	208±4	-	Teggin (1975)
37)	Khao Taphao Khwam, Rayong	Two-mica	272±14	M 72±3	Burton and Bignell (1969)
38)	Khao Taphao Khwam, Rayong	B-M granite	290	M 72±3	Bignell (1972)
39)	Boulder by water tower in Army Camp, Chonburi	Porphyritic B granite	385	-	Bignell (1972)
40)	Boulder by water tower in Army Camp, Chonburi	T-bearing vein + M pegmatite	-	M 57.2±1.6	Bignell (1972)
41)	Bang Saen Beach, Chonburi	Medium-grained B-M granite foliated	273	-	Bignell (1972)
42)	Quarry by Wat Ang Sila, Chonburi	Fine-grained B-M granite	95	-	Bignell (1972)
43)	Ang Sila Beach, Chonburi	Fine-grained B-M granite	92±2	-	Bignell (1972)
44)	13 km south of Hua Hin, Prachuab Kirikhan	B-gneiss	560	B 32.6+1.5	Bignell (1972)
45)	Khao Ta Kiep, Prachuab Kirikhan	B-gneiss	391	B 36±1.1	Bignell (1972)
46)	Rapids on Huai Yang, Prachuab Kirikhan	Coarse-grained B-granite	200	B 50.5±2	Bignell (1972)

	Sample Location	Lithology	Radiometric Age (Ma) Rb/Sr	K/Ar	References
47)	Huai Yang Prachuab Kirikhan	Microcline adamellite	186±11	B 50±2	Burton and Bignell (1969)
48)	Hub Kapong Petchaburi	Coarse-grained B gneissic granite	210±4	B 63.6±4	Beckinsale and others (1979)
49)	Khao Phanom Bencha, north of Krabi	Porphyritic H granite	53	B+H 55.2± 1.9	Bignell (1972)
50)	Khao Nam Tok Kylong, Bannang Star,	Adamellite	-	B 34+1	Pitakpaivan (1969)
	Southeast Yala	Coarse-grained B-M granite	297	B 33.8±1.5	Bignell (1972)
51)	Khao Nam Tok Tan To, Bannang Star,	Adamellite	-	B 229±7	Pitakpaivan (1969)
	Southwest Yala	B granite		B 229±7	Bignell (1972)
52)	Ku Long, 11 km South of Yala	M-B granite	258	B 52.9±1.6	Ishihara and others (1980)
53)	Khao Krachong Trang	Adamellite	-	B 180±5	Pitakpaivan (1969)
		Coarse-grained B-M granite	314	B 180±5	Bignell (1972)
54)	Khao Luk Chang, Songkhla	Sodaclase adamellite	-	B 181±6	Pitakpaivan (1969)
55)	Ban Lam Noi, A. Haad Yai, Songkhla	Adamellite	-	B 171±5	Pitakpaivan (1969)
56)	Khao Muang Hin, Songkhla	Coarse-grained B-M granite	207	M 181±6	Bignell (1972)
57)	Khao Ban Dai Nang, Songkhla	Coarse-grained B-M granite	180	B 171±5	Bignell (1972)
58)	Thung Pho Mine, Muang Yi Rung Songkhla	Corundum Bearing B granite	-	B 191±6	Ishihara and others (1980)
59)	Wang Pha Mine, Songkhla	T-M quartz rock	-	M 187±6	Ishihara and others (1980)
60)	Khao Luang, W of Nakhon Si Thammarat	Fluorite-T M rock	-	M 187±6	Ishihara and others (1980)
61)	Yod Nam mine, Sublevel B, Nakhon Si Thammarat	Corundum bearing quartz-M rock	81.1 (0.8413)	M 67.8±2.1	Ishihara and others (1980)
62)	Leam Mai Kaen mine, drift, Ko Samui	B-M-T quartz rock	-	M 202±6	Ishihara and others (1980)
63)	Buke, Hin Thai Co. quarry, Ban Kuwa, Sungai Padi	B-granite	-	B 124±4	Ishihara and others (1980)

	Sample Location	Lithology	Radiometric Age (Ma) Rb/Sr	K/Ar	References
64)	Tan Yong, West of Khao Tan Yong, east of Narathiwat	T-M granite dikelet	252 (0.9269)	M 206±6	Ishihara and others (1980)
65)	Ruso, Ban Ma Ru Bo, Yi Ngo	T-M granite dikelet	330 (0.7782)	B 245±5	Ishihara and others (1980)

C) Eastern Granitic Belt

	Sample Location	Lithology	Radiometric Age (Ma) Rb/Sr	K/Ar	References
1)	Rayong-Bang Lamung	Granite	221±11	-	Nakapadungrat (1982)
2)	Rayong	Granite	220±13	-	Beckinsale (1979)
3)	Phu Kwai Ngoen, 8 km due east of Chiang Karn	Granite	-	H 230	Jacobson and others (1976)
4)	Nam Tok Plieu, Chantaburi	H adamellite	144±65	B 190±8 H 198±8	Burton and Bignell (1969)
5)	Nam Tok Plieu, Chantaburi	Coarse-grained porphyritic B-H granite	170	B 190±5 H 198±6	Bignell (1972)
6)	Nam Tok Plieu, Chantaburi	Fine-grained granite (intruded no. c5)	-	B 179±5	Bignell (1972)
7)	Chantaburi-Krating Road	Porphyritic B-H granite	-	B 51±3	Bignell (1972)
8)	Nam Tok Krating, Chantaburi	Porphyritic B-H granite	-	B 135±4	Bignell (1972)
9)	East of Khao Kamut, A. Makham Chantaburi	Coarse-grained porphyritic H granite	208	B 116±4	Bignell (1972)
10)	Khao Cha Mao, Chantaburi	B granite	58	-	Bignell (1972)

B = biotite, M = muscovite, H = hornblende, T = tourmaline, K = potassium feldspar   A = Amphoe

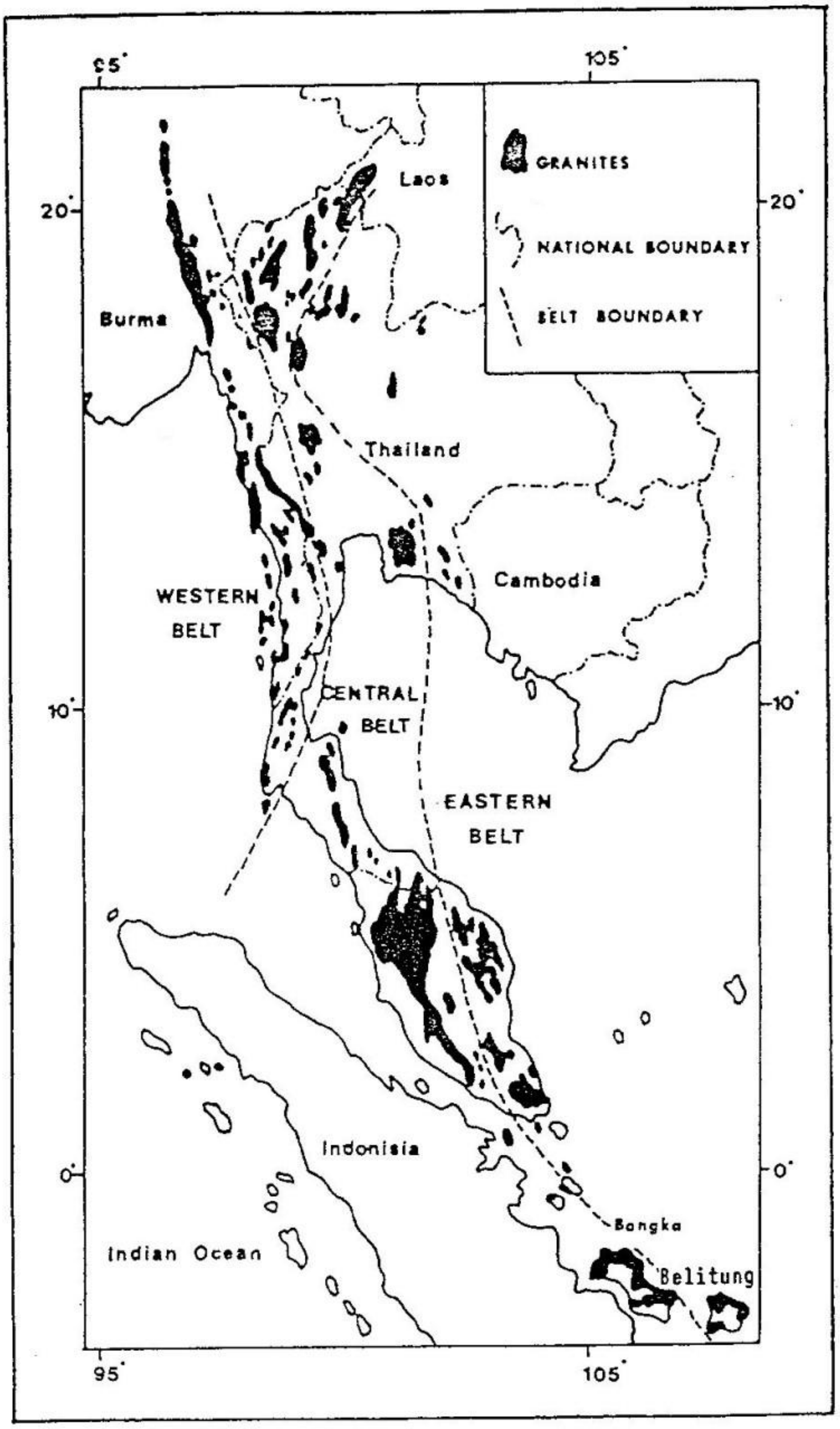

FIG.1 Regional Distribution of granite Belts in SE Asia.

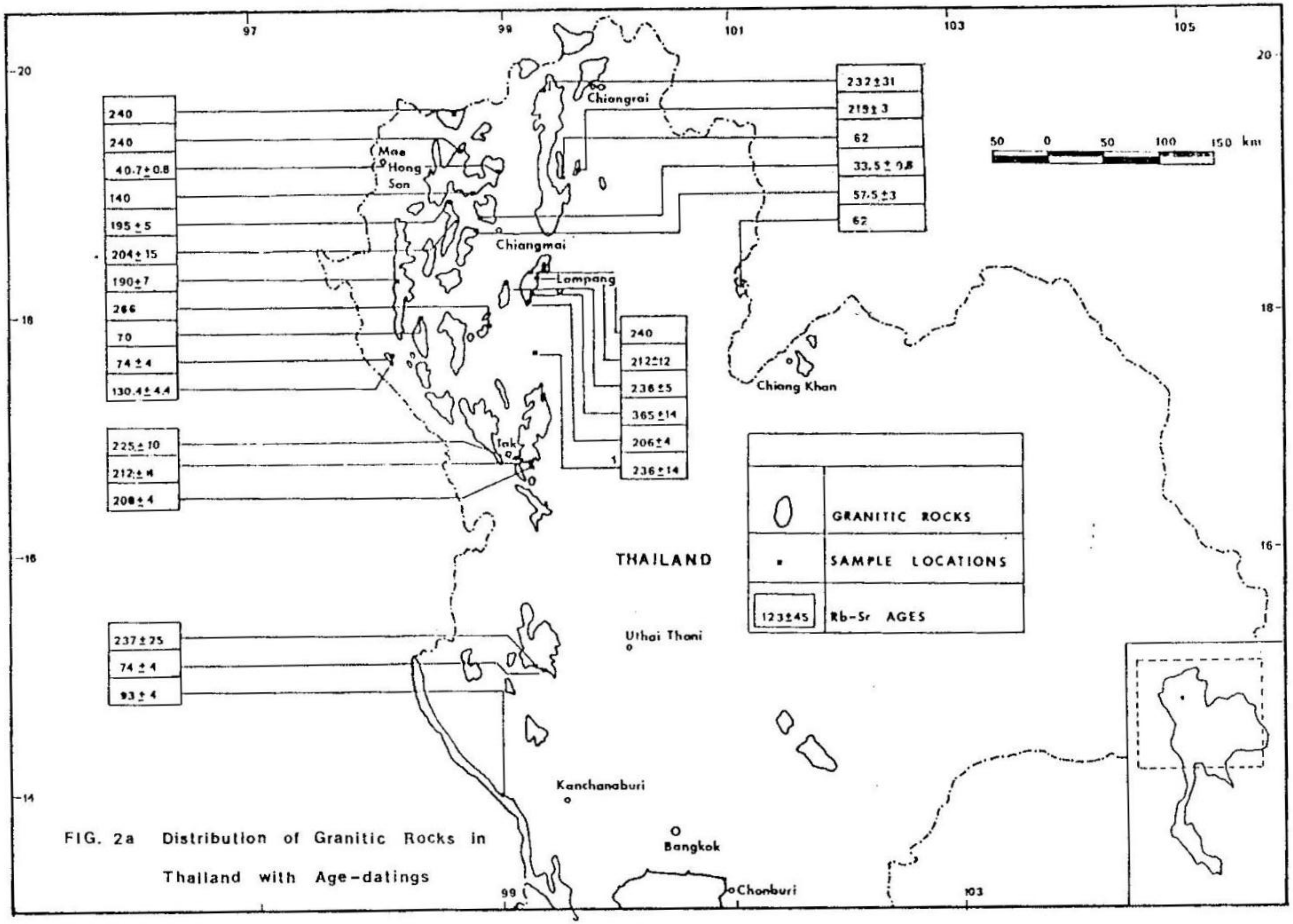

FIG. 2a Distribution of Granitic Rocks in Thailand with Age-datings

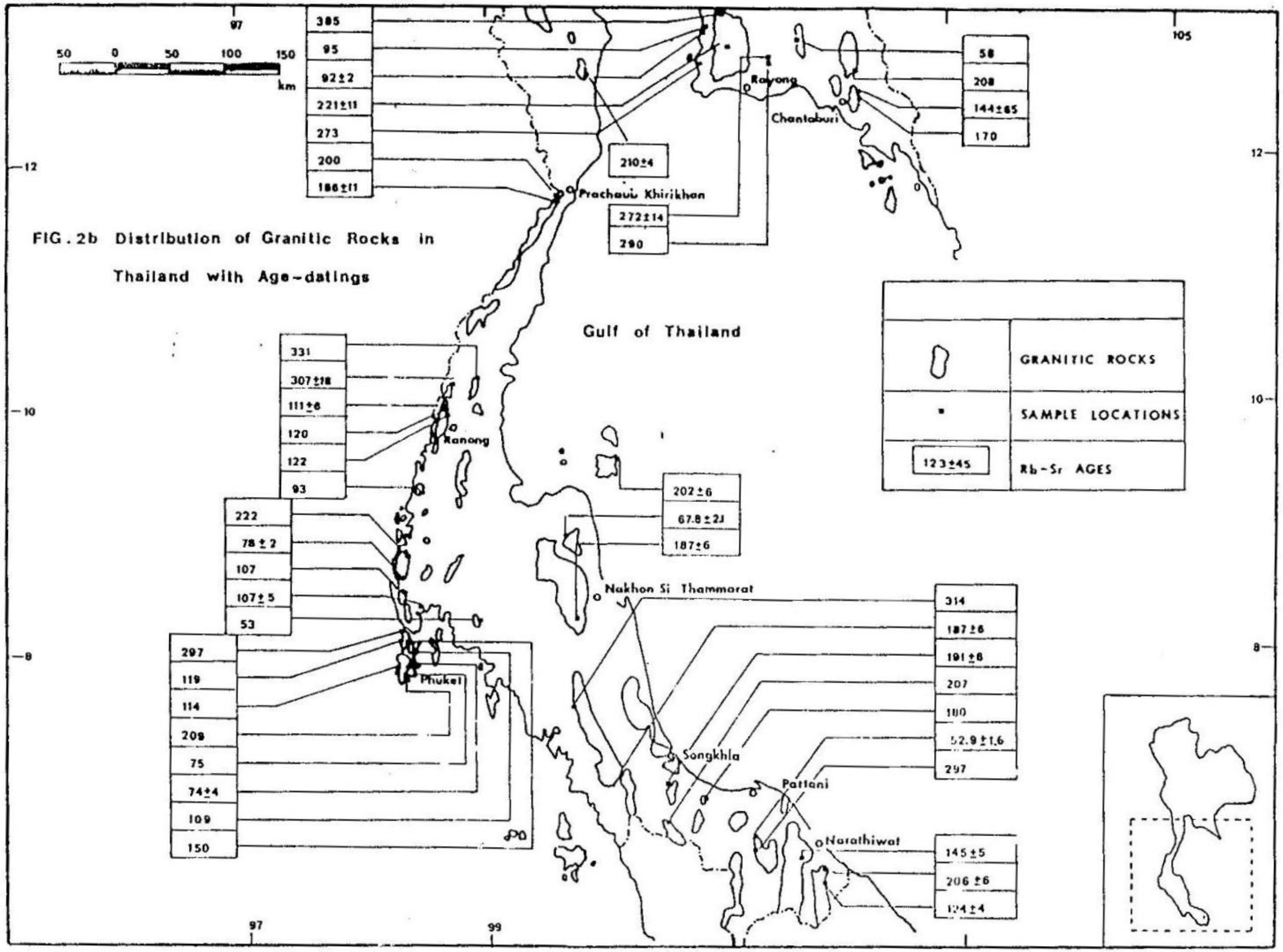

FIG. 2b Distribution of Granitic Rocks in Thailand with Age-datings