

CHAPTER 2

General Geology

The geology of the study area reported here is the result of the present field observation and the previous works. Based on data modified from previous field workers (Dhamdusdi and Chitmanee, 1984; Hinthong, *et al.*, 1986; Sareerat and Silapalit, 1987; Boripatkosol, *et al.*, 1987(a); Silapalit and Sareerat, 1987; Boripatkosol, *et al.*, 1987(b); Boripatkosol, *et al.*, 1989(a); Boripatkosol, *et al.*, 1989(b); Chuaviroj, *et al.*, 1992, and Assavapatchara, and Kitisarn, 2001), the study area comprises 11 rock units; (1) Precambrian metamorphic rocks; orthogneiss, paragneiss, amphibolite schist, quartz-mica schist, quartz-kyanite schist, sillimanite-mica schist, quartzite, marble, calc-silicate rock, migmatite and pegmatite., (2) Silurian-Devonian metamorphic rocks, (3) Carboniferous sedimentary and metamorphic rocks, (4) Carboniferous-Permian sedimentary rocks, (5) Lower Permian sedimentary rocks, (6) Middle Permian sedimentary rocks, (7) Triassic sedimentary rocks, (8) Middle Triassic sedimentary rocks, (9) Middle-Upper Triassic sedimentary rocks, (10) Quaternary terrace deposits; gravel, sand, silt, clay, and laterite., and (11) Quaternary fluvial deposits; gravel, sand, silt, and clay of channel, river bank, and flood basin. In addition, the study area consists mainly of the igneous rocks that can be divided into 3 rock units; (1) Permo-Triassic volcanic rocks that are made up of rhyolite, andesite, ash-flow tuff, volcanic breccia, rhyolitic tuff and andesitic tuff, (2) Triassic igneous rocks that are made up of biotite granite, tourmaline granite, granodiorite, biotite-muscovite granite, muscovite-tourmaline granite, and biotite-tourmaline granite, and (3) Cretaceous volcanic rocks that are composed of fine to medium - grained syenite and porphyritic rhyolite (Figure 2.1).

Metamorphic rocks of the study area are Precambrian to Carboniferous age. The Precambrian rocks are high grade metamorphic rocks and are deformed by the Mae Ping Fault that is distributed in the north western part of the study area. After that, Wang *et al.* (2016) suggested these metamorphic rocks are Triassic age (214 ± 1 Ma).

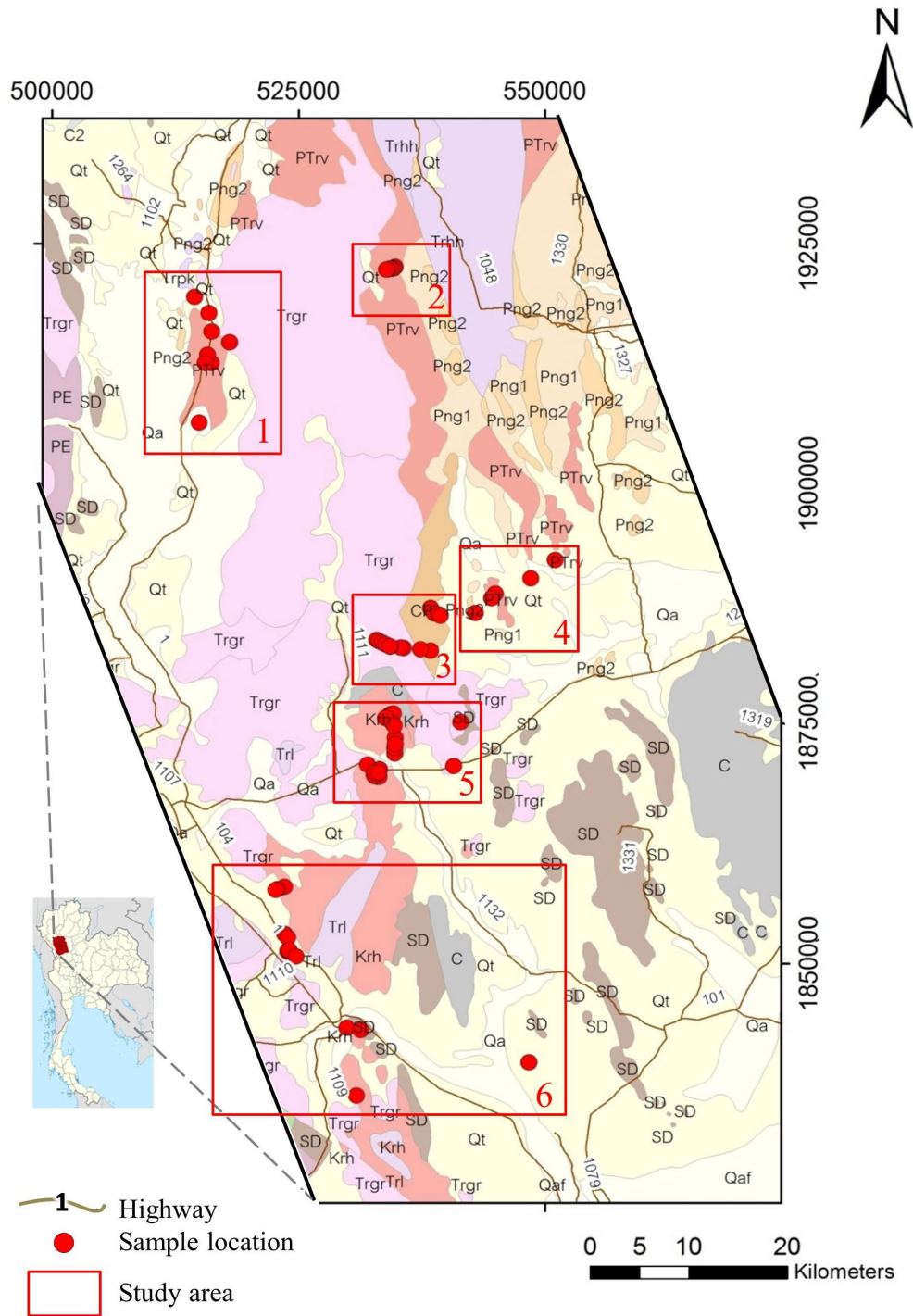


Figure 2.1 Geologic map of the study area; geologic data modified from Dhamdusdi and Chitmanee (1984), Hinthong *et al.* (1986), Sareerat and Silapalit (1987), Boripatkosol *et al.* (1987a), Silapalit and Sareerat (1987), Boripatkosol *et al.* (1987b), Boripatkosol *et al.* (1989a), Boripatkosol *et al.* (1989b), Chuaviroj *et al.* (1992) and Assavapatchara, and Kitisarn (2001).

Explanation

Sediments/ Sedimentary and Metamorphic Rocks	
Qa	fluvial deposits: gravel, sand, silt, and clay of channel, river bank, and flood basin
Qt	terrace deposits: gravel, sand, silt, clay, and laterite
Trhh	Lampang Group-Hong Hoi Formation: mudstone, gray to dark gray, intercalated sandstone, thin- to thick-bedded, common with bivalve <i>Halobia</i> sp., <i>Daonella</i> sp..
Trpk	Lampang Group-Pha Kan Formation: limestone, dark gray, medium-bedded to massive; minor sandstone and mudstone at the middle part.
Trl	basal conglomerate, red, calcareous; shale, gray interbed with siltstone and sandstone.
Pngt	Ngao Group-Pha Huat Formation: limestone, bedded and massive, gray, black, interbedded with shale and sandstone
Pngl	Ngao Group-Kiu Lom Formation: tuffaceous sandstone, sandstone, shale, gray to grayish green, limestone in the upper part
CP	sandstone, agillaceous limestone, shale, and chert
C	conglomerate, sandstone, shale, slate, chert, and limestone
SD	phyllite, carbonaceous phyllite and quartzitic phyllite
PE	ortho gneiss and paragneiss, banded, augen; amphibolite schist, quartz-mica schist, quartz-kyanite schist, sillimanite-mica schist; quartzite; marble; calc-silicate rock; migmatite and pegmatite
Igneous Rocks	
Kch	rhyolite and syenite, fine- to medium-grained, porphyritic
Trgr	biotite granite, tourmaline granite, grano diorite, biotite-muscovite granite, muscovite-tourmaline granite, and biotite-tourmaline granite
PTrv	rhyolite, andesite, ash-flow tuff, volcanic breccia, rhyolitic tuff and andesitic tuff

Age	Sediments/ Sedimentary and Metamorphic Rocks	Igneous Rocks
Quaternary	Qa	
	Qt	
Tertiary		Kch
Cretaceous		
Jurassic		
	Upper	Trhh
Triassic	Middle	Trpk
	Lower	Trl
Permian	Upper	Pngt
	Middle	Pngl
	Lower	CP
Carboniferous	Upper	C
	Lower	
Devonian		
Silurian		SD
Ordovician		
Cambrian		
Precambrian		
		PE

The Silurian to Carboniferous rocks are generally distributed in the central part of the study area and are composed of low - grade metamorphic rocks. These metamorphic rocks derived from fine - grained clastic sedimentary or/and ash tuff. They have similarly lithology, slaty-phyllitic texture, and foliation/ lineation so it is difficult to separate one from another.

Sedimentary rocks are generally distributed in the study area and have Carboniferous, Permian, and Triassic age. Bunopas (1981) proposed that the Permian limestone is part of the Thung Saliang Group (Silurian-Devonian). The Thung Saliang Limestone regarded as a Permian age on radiolarian evidence (Sashida and Nakornsri, 1997). Piyasin (1972) divided Permian rocks in the middle northern region into three formations in ascending sequence; the Kui Lom, Pha Huat and Huai Tak Formations that are occupied in Ngao Group. Shallow marine facies persisted through deposition of the group with extensive carbonate platform. Triassic sedimentary rocks can be divided into 3 formations; Phra That, Pha Kan, and Hong Hoi formations that are the part of Lampang Group. Volcanic rock fragments and feldspars are the common constituents in these rocks. Rock sequences in the lower part of the Phra That Formation consist of a brownish-red sandstone, conglomerate, siltstone, and mudstone. Fining-upward sequences and cross bedding are also found. In the upper part of this formation, the rocks comprise greenish-gray mudstone with interbedded limestone. Fossils of the bivalves *Costatoria sp.* were dated as early Scythian to early Anisian (approximately 250 -238 Ma) (Sashida and Nakornsri, 1997). Sedimentation of the Phra That Formation was believed to occur in both continental and marine environments. Pha Kan Formation conformably overlies the Phra That Formation and underlies the Hong Hoi Formation. Most of the rocks in this formation are limestone. Sandstone and mudstone occur in the middle of the formation. *Dasycladacean* algae, bioclasts and ooids are found in limestone sequences that are grey to dark grey bedded limestone and massive beds of grey to light grey calcareous mudstone. Mudstone and sandstone can be found in the bivalve *Pecten sp.* These formations were dated as Anisian (approximately 238 Ma). Fossils found in the Pha Kan Formation indicate an age of early Triassic to late Anisian (approximately 250-235 Ma) and deposition in shallow marine water (Chaodumrong and Rao, 1992). In some locations, the Hong Hoi Formation conformably overlies red beds of the Phra That Formation (Chaodumrong, 1992). The

Hong Hoi Formation commonly consists of both laminated and massive greenish-gray mudstone. Thick bedded sandstones show fining upward and Bouma sequences. Fossils in the limestone include the bivalves *Daonella sp.* and *Posidonia sp.*; the ammonoid *Paratrachyceras sp.*; and conodonts *Hadrodontina anceps* and *Pachycladina symmetrica*. These fossils indicate the age of the Hong Hoi Formation to be the Lower Triassic to Lower Upper Triassic.

Intrusive igneous rocks, which are generally distributed in the study area is Triassic granite. Triassic granite consists mainly of biotite granitic rocks with subordinate hornblende granitic rocks with a small amount of pegmatite and aplite. Granitic rocks in this area are grouped in the eastern granite belt of Thailand (Mahawat, 1982). A wide range of chemical composition was found in the eastern granite belt. Granite in this belt is classified as an extended series of calc-alkaline. The granite mainly comprises equal sized crystals (equigranular texture) and are made up of coarse or fine-grained crystals. The irregular orientation of crystals and xenoliths of dark color igneous and volcanic rocks were found. These granites have formed with age ranging between 213-256 Ma. Volcanic rocks distribution is extended from the north to the south of the study area and comprises crystal and lithic ash tuff to agglomerate and volcanic rocks. They are composed of rhyolite, andesite, andesite porphyry, andesitic basalt, rhyolitic tuff and andesitic tuff. Sareerat and Silapalit (1987), Boripatkosol *et al.* (1987a), and Boripatkosol *et al.* (1987b) mapped Permo-Triassic tuff separate from Permo-Triassic volcanic rocks based on the texture of these rocks, whereas other geologists have grouped together pyroclastic and volcanic rocks. Some subvolcanic rock/shallow intrusive masses intruded the Triassic granite rocks and are believed to be formed after the upper Triassic-lower Jurassic.

The other area is partly covered by the recent sediments that are made up of alluvial and terrace deposits. Recent sediment deposits are mainly semi-consolidated and unconsolidated sediments. The fluvial deposits (Quaternary) comprise gravel, sand, silt, and clay of channel, river bank, and flood basin. The terrace deposits (Quaternary) consist largely of gravel, sand, silt, clay, and laterite.

The rock type and name are summarized in Chapter 2, which classified by petrography (Chapter 3) and geochemistry (Chapter 4) data and all of the samples reported in Appendix A.

2.1 The Mae Phrik Area

The study area is located in the southern part of Mae Phrik District in Lampang Province (Figure 2.1). The Mae Phrik area sits along the highway number 1 which runs from Thoen District (Lampang Province) to Tak Province. The rock units in this study area are made up of sedimentary strata, volcanic rocks, and granitic intrusions. The sedimentary strata consist of Permian to Triassic rocks, which are partly overlain by quaternary sediments (Figure 2.2). The Permo-Triassic volcanic rocks are made up of rhyolite, andesite, ash-flow tuff, volcanic breccia, rhyolitic tuff and andesitic tuff. Some areas, this volcanic rock unit occurred associate with basalt. The granitic intrusions present in this area have formed in Triassic. It is locally named as Tak Batholith. Basaltic dike which intruded into this batholith is normally present.

Fifteen rock samples were collected from the Mae Phrik area in Permo-Triassic volcanic rocks, Triassic granitic rocks, and Quaternary sediments units for petrographic study, which are made up of rhyolite (3 samples), basalt (2 samples), pyroclastic rocks (8 samples), and granitic rocks (2 samples). Five studied samples; rhyodacite and basalt were collected for geochemistry.

2.2 The Mae Salaem Area

The study area is located in the southern part of Thoen District in Lampang Province and is the part of Mae Wa National Park. The Mae Salaem area sits along the local highway which runs from Thoen District to Ban Mae Salaem (Figure 2.1). The rock units in this study area are made up of sedimentary strata, volcanic rocks, and granitic intrusions. The sedimentary strata consist of Permian to Triassic rocks, which are partly overlain by Quaternary sediments (Figure 2.3). The Permo-Triassic volcanic rocks are made up of rhyolite, andesite, ash-flow tuff, volcanic breccia, rhyolitic tuff and andesitic tuff. The granitic intrusions present in this area have formed in Triassic. It is locally named as Tak Batholith.

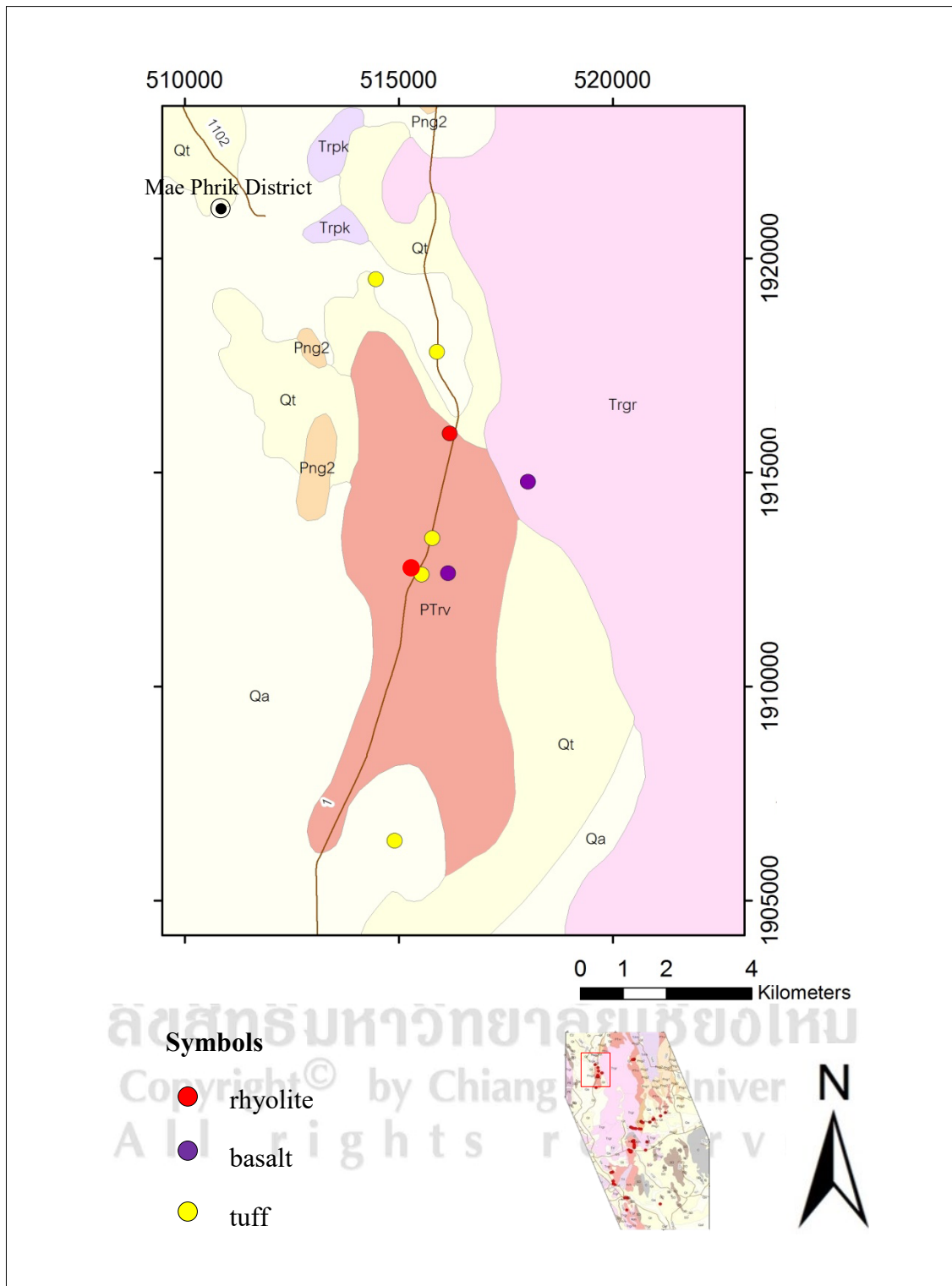


Figure 2.2 Geologic map of the Mae Phrik area and location of collected samples (explanation as figure 2.1) in the study area (modified from Boripatkosol *et al.* (1989a) and Boripatkosol *et al.* (1989b)).

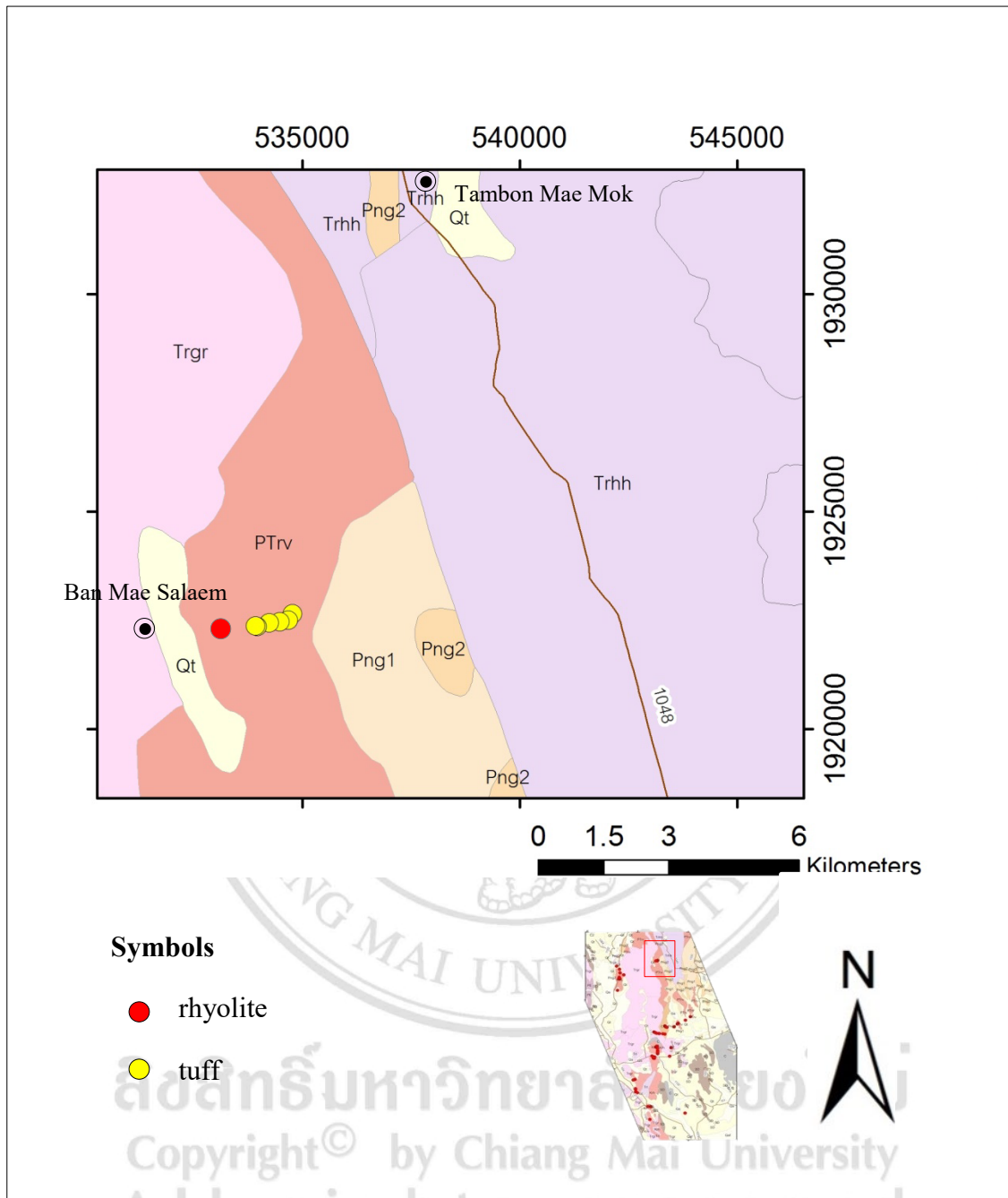


Figure 2.3 Geologic map of the Mae Salaem area and location of collected samples (explanation as figure 2.1) in the study area (modified from Chuaviroj *et al.* (1992)).

Fourteen rock samples were collected from the Mae Salaem area in Permo-Triassic volcanic rocks unit for petrographic study, which are made up of rhyolite (1 sample) and pyroclastic rocks (13 samples). Rhyolite was collected for geochemistry.

2.3 The Pong Daeng Area

The study area is located in the eastern part of Ban Pong Daeng, Mueang Tak District in Tak Province (Figure 2.1). The rock units in this study area are made up of sedimentary strata, volcanic rocks, and granitic intrusions. The sedimentary strata consist of Carboniferous to Permian rocks, which are partly overlain by Quaternary sediments (Figure 2.4). The studied rocks, basalt and tuff, are mapped in Carboniferous-Permian sedimentary rocks unit. The granitic intrusions largely present in this area have formed in Triassic and are made up mainly of granodiorite with subordinate biotite granite and small amounts of tourmaline granite, biotite-muscovite granite, muscovite-tourmaline granite, and biotite-tourmaline granite. The volcanic rocks erupted in the Cretaceous period and are composed of fine-grained to medium-grained and porphyritic volcanic rocks. They are rhyolite and syenite composition.

Twenty-eight samples were collected from the Pong Daeng area in Carboniferous-Permian sedimentary rocks and Triassic granitic rocks units for petrographic study, which are made up of basalt (1 samples), pyroclastic rocks (14 samples), and granodiorites (13 samples). Basalt was collected for geochemistry.

2.4 The Wang Luek Area

The study area is located in the southern part of Ban Wang Luek, Ban Dan Lan Hoi District in Sukhothai Province (Figure 2.1). The rock units in this study area are made up of sedimentary strata and volcanic rocks. The sedimentary strata consist of Permian to Triassic rocks, which are partly overlain by Quaternary sediments (Figure 2.5). The Permo-Triassic volcanic rocks are made up of rhyolite, andesite, ash-flow tuff, volcanic breccia, rhyolitic tuff and andesitic tuff. In addition, some areas have a gabbroic dike that intruded into the Permo-Triassic volcanic rocks.

Twenty samples were collected from the Wang Luek area in Permian sedimentary rocks, Permo-Triassic volcanic rocks and Quaternary sediments units for petrographic

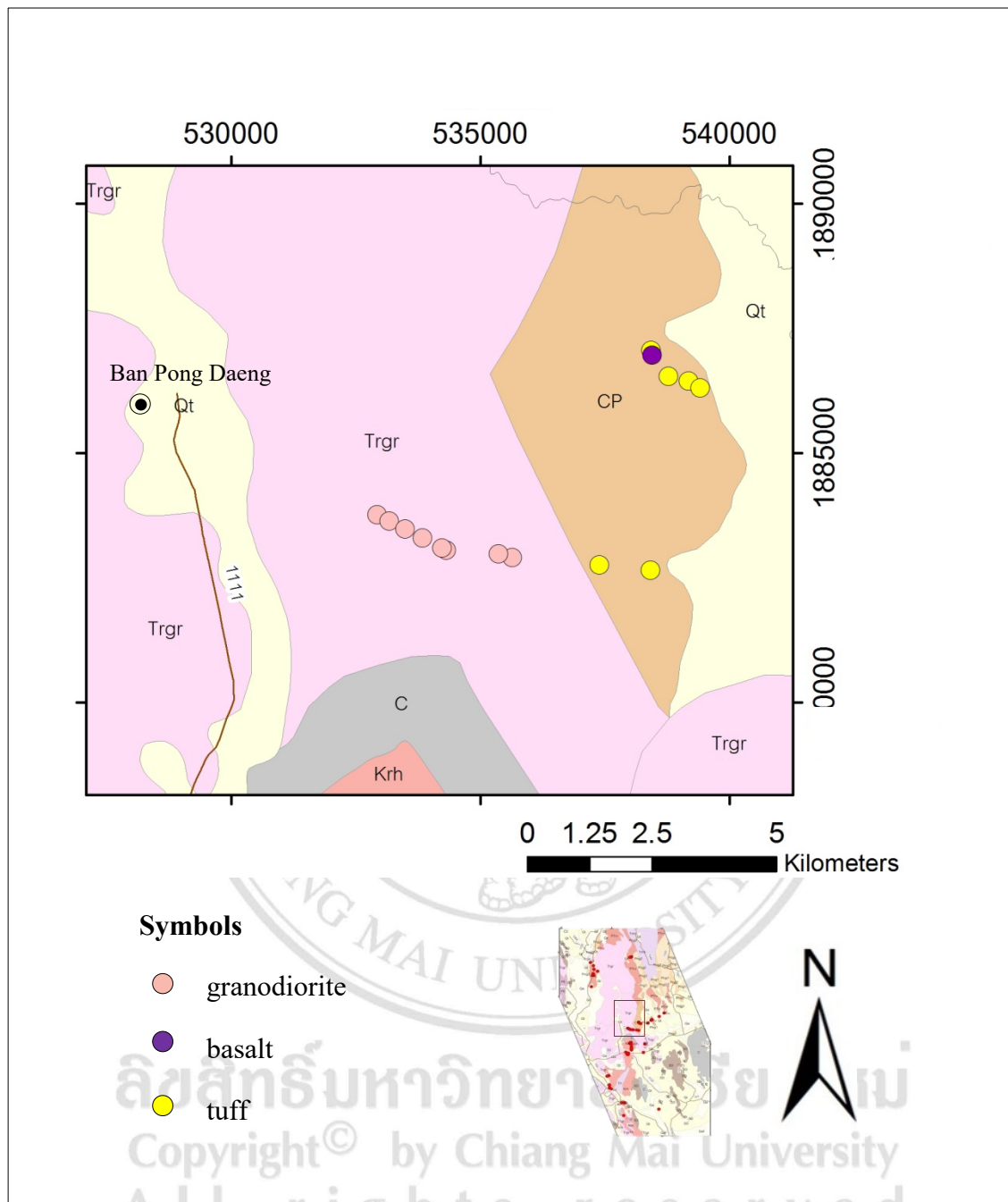


Figure 2.4 Geologic map of the Pong Daeng area and location of collected samples (explanation as figure 2.1) in the study area (modified from Dhamdusdi *et al.* (1984)).

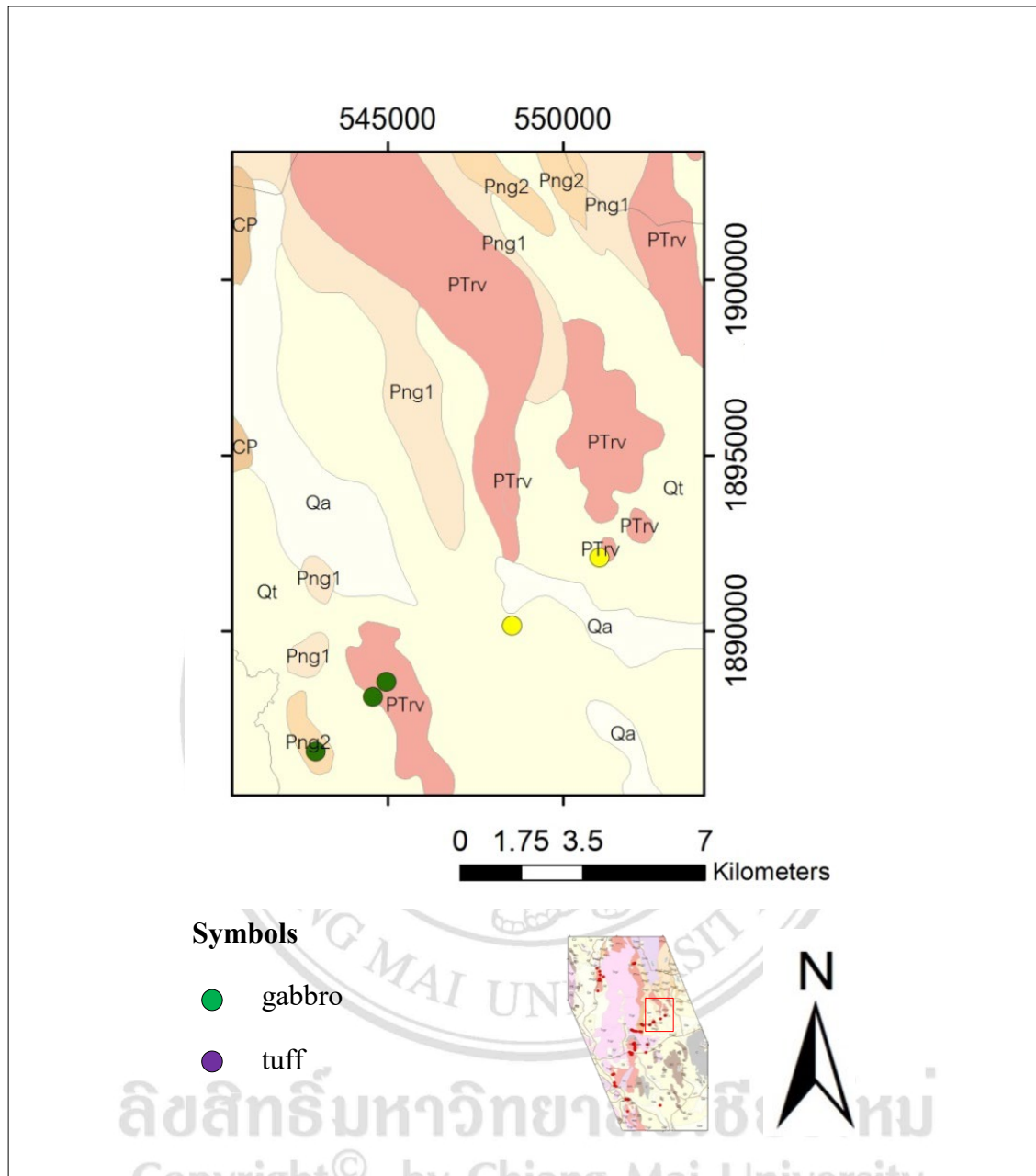


Figure 2.5 Geologic map of the Wang Luek area and location of collected samples (explanation as figure 2.1) in the study area (modified from Dhamdusdi *et al.* (1984)).

study, which are made up of cumulus gabbro (4 samples), gabbro (2 samples), and pyroclastic rocks (14 samples). Cumulus gabbro and gabbro were collected for geochemistry.

2.5 The Wang Prachop Area

The study area is located in Ban Wang Prachop, Mueang Tak District in Tak Province. The Wang Prachop area sits along highway number 12 which runs from Tak to Sukhothai Provinces (Figure 2.1). The rock units in this study area are made up of sedimentary strata, volcanic rocks, and granitic intrusions. The sedimentary strata consist of Silurian-Devonian to Carboniferous rocks, which are partly overlain by Quaternary sediments (Figure 2.6). The granitic intrusions largely present in this area have formed in Triassic and are made up mainly of granodiorite with subordinate biotite granite and small amount of tourmaline granite, biotite-muscovite granite, muscovite-tourmaline granite, and biotite-tourmaline granite. The volcanic rocks erupted in the Cretaceous period are composed of fine-grained to medium-grained and porphyritic volcanic rocks. They are rhyolitic and syenitic composition, while some areas show basaltic composition as dike and lava flow.

Thirty samples were collected from the Wang Prachop area in Triassic granitic rocks and Cretaceous volcanic rocks units for petrographic study, which are made up of rhyolite (1 sample), andesite porphyry (7 samples), and pyroclastic rocks (22 samples). Rhyolite and andesite porphyry were collected for geochemistry.

2.6 The Wang Chao Area

The study area is located in the southern part of Tak Province and northern part of Kamphaeng Phet Province (Figure 2.1). The Wang Chao area is the biggest studied area and sits along the Ping River and highway number 104 and number 1 which run from Tak to Kamphaeng Phet Provinces. The rock units in this study area are made up of sedimentary strata, volcanic rocks, and granitic intrusions. The sedimentary strata consist of Silurian-Devonian to Triassic rocks, which are partly overlain by Quaternary sediments from the Ping River (Figure 2.7). The granitic intrusions largely present in this area have formed in Triassic and are made up mainly of granodiorite with

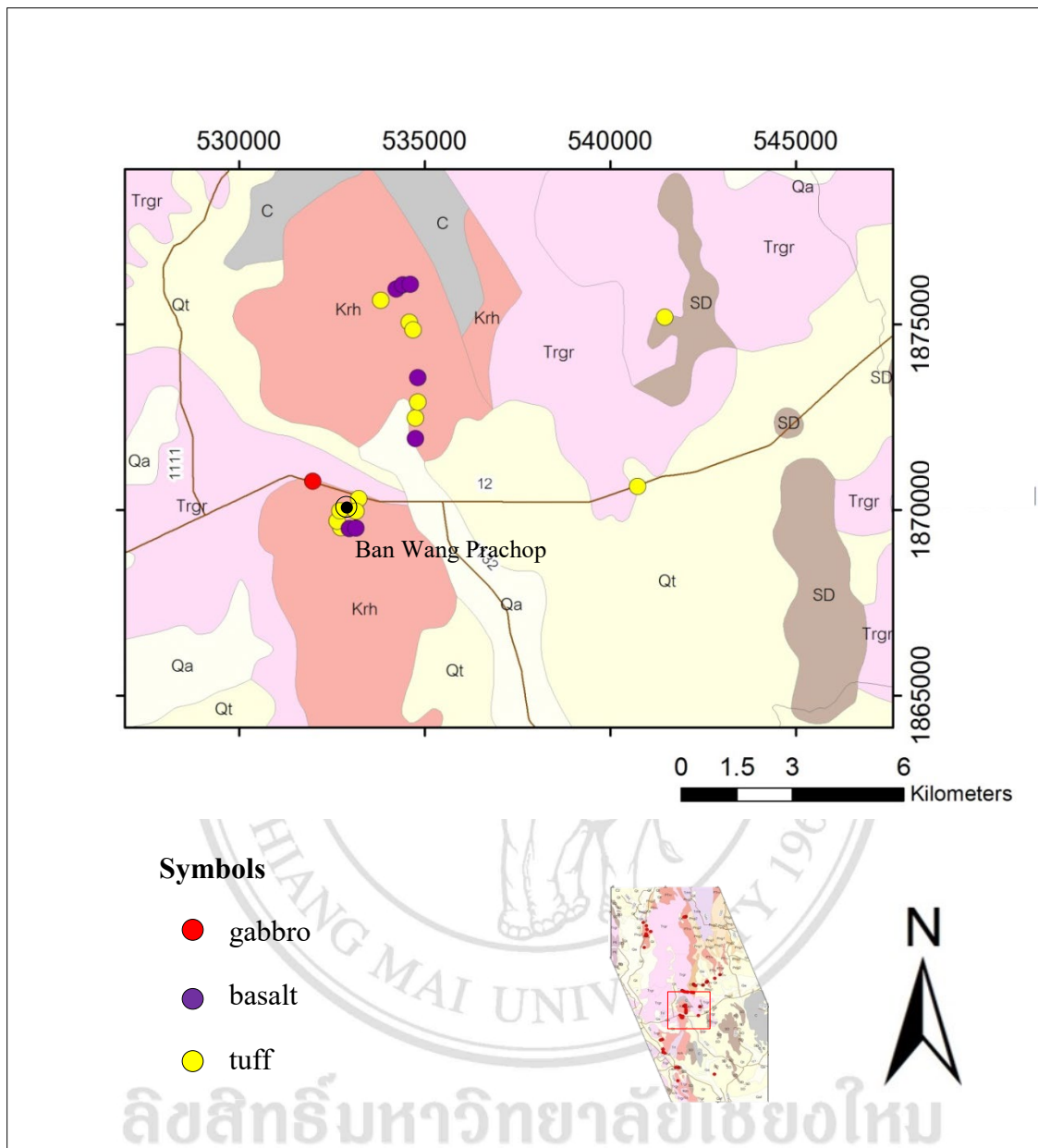


Figure 2.6 Geologic map of the Wang Prachop area and location of collected samples (explanation as figure 2.1) in the study area (modified from Boripatkosol *et al.* (1987a)).

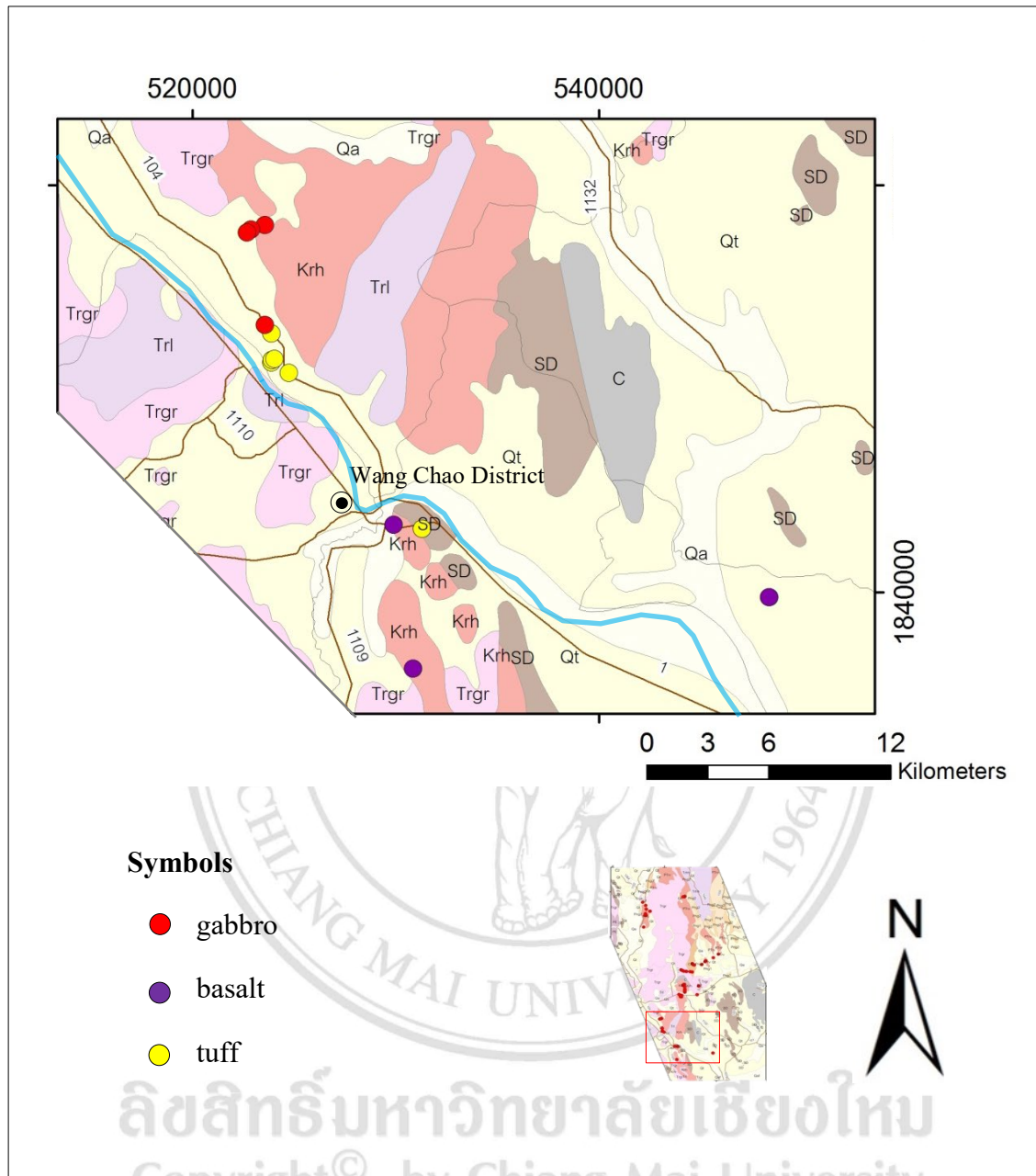
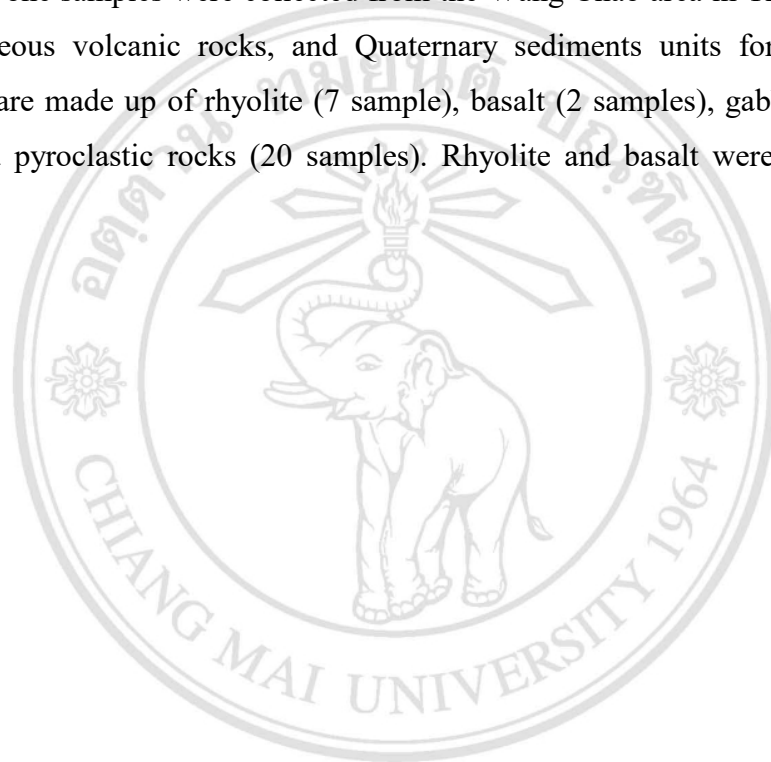


Figure 2.7 Geologic map of the Wang Chao area and location of collected samples (explanation as figure 2.1) in the study area (modified from Hinthong *et al.* (1986), Sareerat and Silapalit. (1987), and Boripatkosol *et al.* (1987a)).

subordinate biotite granite and small amount of tourmaline granite, biotite-muscovite granite, muscovite-tourmaline granite, and biotite-tourmaline granite. The volcanic rocks erupted in the Cretaceous period are composed of fine-grained to medium-grained and porphyritic volcanic rocks. They are rhyolitic and syenitic composition, while some areas show basaltic composition as dike and lava flow. The Mae Ping River flows in a NW to SE direction that is controlled by Mae Ping Fault.

Thirty-one samples were collected from the Wang Chao area in Triassic granitic rocks, Cretaceous volcanic rocks, and Quaternary sediments units for petrographic study, which are made up of rhyolite (7 sample), basalt (2 samples), gabbroic rocks (2 samples), and pyroclastic rocks (20 samples). Rhyolite and basalt were collected for geochemistry.



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved