



CHAPTER II

REGIONAL GEOLOGY

2.1 Geology of the Khorat Group

The Khorat Group is known as a sequence of continental Mesozoic sedimentary rocks which form the bed rocks of the Khorat Plateau. The Khorat Group consists mainly of continental red and gray sandstone, siltstone, and shale with some paralic and salt deposits, ranging in age from Upper Triassic to Cretaceous. The term “Khorat Series” was proposed and used by many authors. Subsequently, Ward and Bunnag (1964) proposed the term “Khorat Group” instead of Khorat Series. They divided the Khorat Group into seven formations. Since then the Khorat Group has been reclassified by several geologists, but most of their classifications followed the work of Ward and Bunnag (1964), while new formations were proposed only the upper and lower parts of the Group. The Khorat Group is formally divided into 9 formations (Department of Mineral Resources, 2001) based on lithostratigraphic cycle including the Huai Hin Lat, Nam Phong, Phu Kradung, Phra Wihan, Sao Khua, Phu Phan, Khok Kruat, Maha Sarakham, and Phu Thok Formations, in ascending order.

The details of the type section and palaeo-depositional environment interpretation follow the Department of Mineral Resources (1992). The age of the formation is obtained from the palynological data reported by Racey *et al.* (1994), plant fossil and pollen by Konno and Asama (1973), bivalves by Meesook *et al.* (1994, 1995), and the summarized age by Department of Mineral Resources (2001). The descriptions are as follow.

2.1.1 Huai Hin Lat Formation

The type section is located in Huai Hin Lat, Km 108 of Khon Kaen – Loei Highway. This formation was interpreted as deposited in fluvio-lacustrine depositional environment. The age was proposed to be Carnian to Rhaetian (Late Triassic) by Department of Mineral Resources (2001).

The formation consists of conglomerate, limestone conglomerate, gray to very dark sandstone; siltstone; shale and marl containing plant fossils, *Neocalamites* sp., *Clathropteris* sp. The thickness is 140 m at the type section.

2.1.2 Nam Phong Formation

The type section is located in Nam Phong, Amphoe Phu Kradung, Changwat Loei. This formation was interpreted as deposited in fluvio-lacustrine depositional environment. The age was proposed to be Rhaetian (Late Triassic) by Department of Mineral Resources (2001).

The formation consists of alternating thick-bedded siltstone and resistant sandstone and conglomerate. The thickness is 1,465 m at the type section.

2.1.3 Phu Kradung Formation

The type section is located in Phu Kradung, Amphoe Phu Kradung, Changwat Loei. This formation was interpreted as deposited in fluvio-lacustrine environment. The age was proposed to be Berriasian to Barremian (Early Cretaceous) by Racey *et al.* (1994) and Middle to Late Jurassic by Department of Mineral Resources (2001).

The formation consists of soft siltstone and non-resistant sandstone with greenish gray calcareous conglomerate. Bone fragments and teeth were collected. The thickness is 1,001 m at the type section.

2.1.4 Phra Wihan Formation

The type section is located in the southern slope of Khao Phra Wihan. This formation was interpreted as deposited in fluvio-lacustrine environment. The age was proposed to be Berriasian to Barremian (Early Cretaceous) by Racey *et al.* (1994) and Middle Jurassic to Early Cretaceous by Department of Mineral Resources (2001).

The Formation consists of white quartz sandstone and thin laminations of red siltstone. The thickness is 56-136 m.

2.1.5 Sao Khua Formation

The type section is located at Km 35.2-41.5 of Udon Thani – Nong Bua Lamphu Road, which this formation was interpreted as continental deposit. The age was proposed to be Barremian to Aptian (Late Early Cretaceous to Early Middle Cretaceous) by Racey *et al.* (1994) and Early Cretaceous by Department of Mineral Resources (2001).

The formation consists of non-resistant siltstone and conglomeratic sandstone. The thickness is 404-720 m.

2.1.6 Phu Phan Formation

The type section is located in Phu Pha Phung in Phu Phan Range, which this formation was interpreted as fluvial depositional environment. The age was proposed to be Barremian to Aptian (Late Early Cretaceous to Early Middle Cretaceous) by Racey *et al.* (1994) and Early Cretaceous by Department of Mineral Resources (2001).

The formation is composed of thick-bedded and cross-bedded conglomeratic sandstone and conglomerate. The thickness is 183 m.

2.1.7 Khok Kruat Formation

The type section is located at Km. 207 and Km. 209 of Friendship Highway. This formation was interpreted as fluvial depositional environment. The age was proposed as Aptian to Albian (Middle Cretaceous) by Racey *et al.* (1994) and Department of Mineral Resources (2001).

The formation consists of soft siltstone and moderately resistant sandstone and caliche-siltstone pebble of calcareous conglomerate. The thickness is 709 m.

2.1.8 Maha Sarakham Formation

The type section is located at Amphoe Borabu, Changwat Mahasarakham.

The formation comprises salt-bearing claystone, mudstone, siltstone and sandstone. The thickness is 1,000 m. the age was proposed as Cenomanian (Late Cretaceous) by Department of Mineral Resources (2001).

2.1.9 Phu Thok Formation

The type location is located at Phu Thok, Amphoe Bung Kan, Changwat Nong Khai. This formation was interpreted as deposited by wind with minor fluvial. The age was proposed as Cretaceous to Early Tertiary.

The formation consists of sandstone, brick red, fine- to medium-grained, thick-bedded to massive, very large scale cross-bedding and small scale wavy bed. The thickness is 100 m.

2.2 Geomorphology and Geology of the study area

2.2.1 Geomorphology

The topography of the study area can be broadly divided into two main features, i.e. highland and lowland areas (Figure 2.1). The highland area consists of the mountain ranges and valley. The mountain range is the basin-shaped mountain

consisting of 2 concentric ranges, the higher outer range and the lower inner range. Both mountain ranges are cuestas with gentle slope towards the low-lying area in the center and steep slope on outside. The valley is situated between outer range and inner range. The lowland area consists of undulation and floodplain occupying the central area of the ranges.

The main streams are Huai Bong flowing from southwest to northeast, and Huai Yang Haeng flowing from north to south. Both of them combine are combined in the center of the lowland area and flow eastwardly through the mountain gate.

2.2.2 Geology and stratigraphy

The Phu Wiang area is composed of the sedimentary rocks and unconsolidated sediments. The sedimentary rocks, deposited since Berriasian through Aptain, are distributed in the highland area and exposed in some undulations of the lowland area, whereas the unconsolidated sediments are distributed in the lowland area and valley. The geologic map scale 1:250,000 sheet Changwat Khon Kaen had been done by Chonglakmani *et al.*, 1985, in which Phu Wiang mountain range is located in the northwestern part of this map (Figure 2.2). The sedimentary rocks of Phu Wiang mountain range formed the geosynclinal structure as the basin-shaped mountain consisting of the Phu Kradung, Phra Wihan, Sao Khua, Phu Phan, and Khok Kruat Formations, respectively in ascending order. The unconsolidated sediments are Quaternary in age.

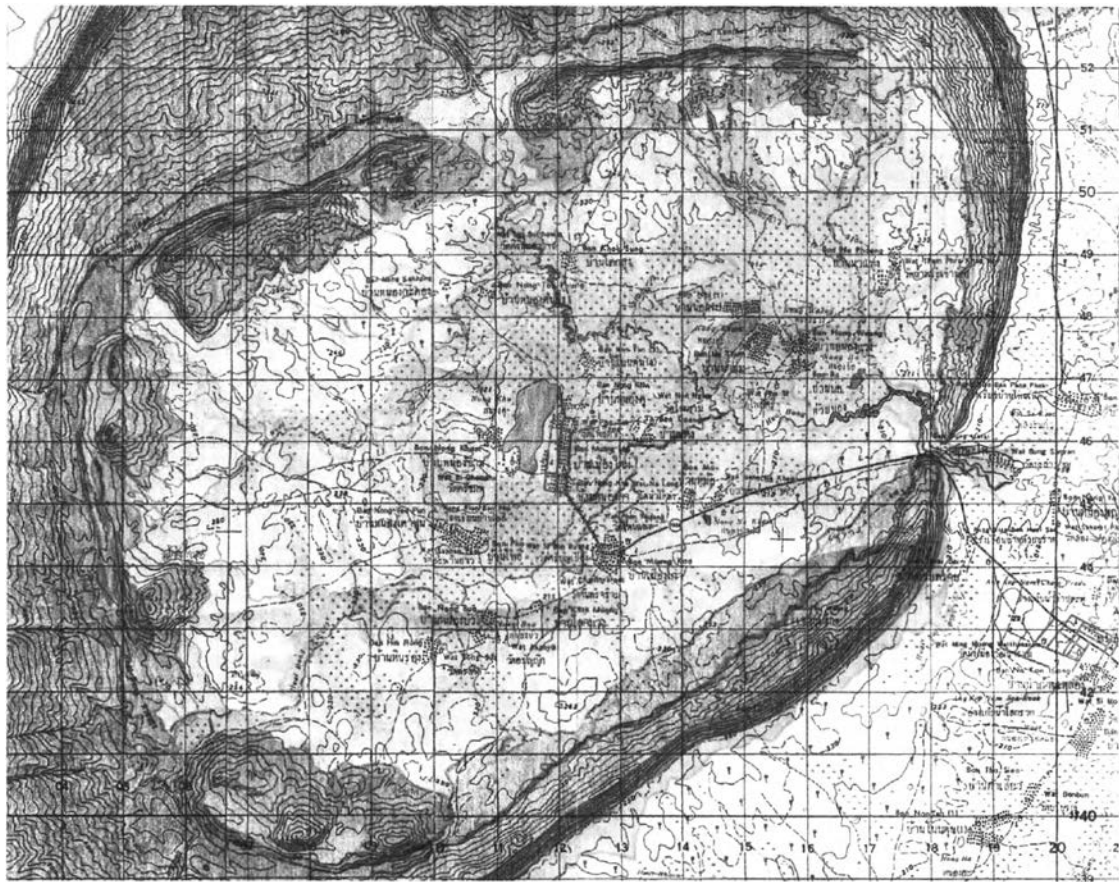













Figure 2.1 Geomorphological map of Phu Wiang Inner Mountain Range

Highland Area

Lowland Area

-  OUTER MOUNTAIN RANGE
-  INNER MOUNTAIN RANGE
-  HILL
-  HILLOCK
-  OPEN FIELD
-  CLIFF
-  SLOPE
-  HIGHLAND
-  HUMID MOUNTAIN DRY FOREST
-  VALLEY

-  STREAM
-  POND AND LAKE
-  VALLEY PLAIN 1
-  VALLEY PLAIN 2
-  FLOODPLAIN
-  NATURAL LEVEL


1,000 m

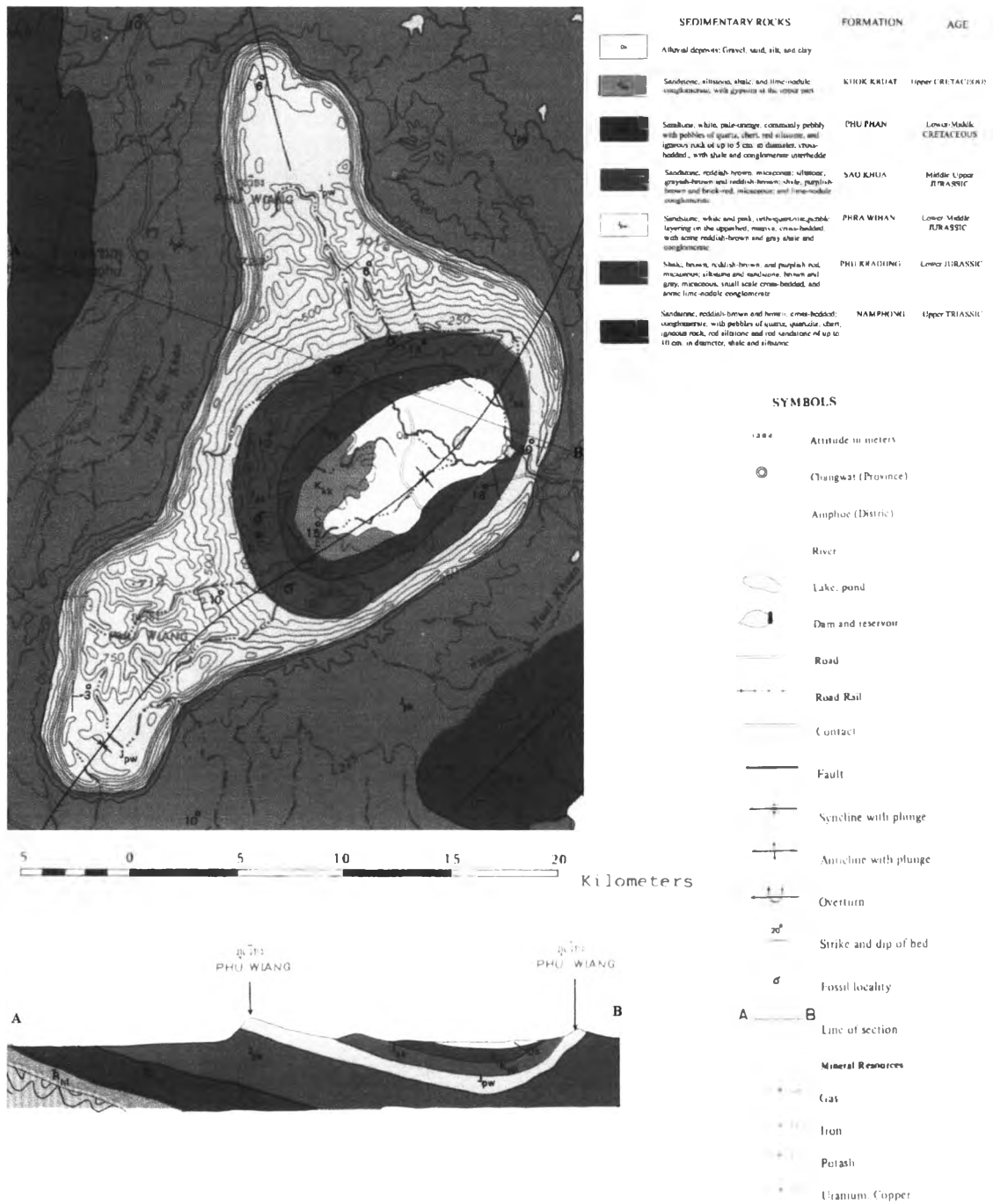


Figure 2.2 Geological map of the Phu Wiang area (modified after Geological map of Thailand sheet Changwat Khon Kaen, NE 48-13, Chonglakmani *et al.*, 1985)

Wongprayoon (2001) made the geological map scale 1:50,000 sheet Amphoe Phu Wiang (Figure 2.3), which the descriptions of the following formation are shown below in ascending order.

2.2.2.1 Phu Kradung Formation

The Phu Kradung Formation in the study area consists of sandstone, brown to maroon, fine- to medium-grained, poorly sorted, interbedded with grayish white, felspathic, medium-grained sandstone; siltstone and claystone, reddish brown, micaceous, calcrete horizons are present. The formation exposes along the foot of the outer side of outer Phu Wiang mountain range.

2.2.2.2 Phra Wihan Formation

The Phra Wihan Formation in the study area overlies the Phu Kradung Formation, it consists of sandstone, grayish white, quartzitic, fine- to coarse-grained, moderately sorted, subrounded with pebbles of quartz, gray and black cherts, quartzite, cross-bedded; siltstone and claystone, gray to dark gray, thin bedded, are intercalated locally. The formation exposes as an outer range of Phu Wiang mountain.

2.2.2.3 Sao Khua Formation

The Sao Khua Formation in the study area overlies the Phra Wihan Formation. Sandstone brown, reddish-brown, fine- to medium-grained, poor sorted; siltstone, and claystone, reddish brown, micaceous; and calcrete horizons are present. The formation exposes as an inner range of Phu Wiang mountain with has yielded abundance of vertebrate and bivalves.

2.2.2.4 Phu Phan Formation

The Phu Phan Formation in the study area consists of sandstone, grayish white, conglomeratic, medium- to coarse-grained, poor-sorted, subangular to subround with pebbles of quartz, red, gray, black, brown and green cherts, volcanic rock fragments and quartzite, cross-bedded; siltstone and claystone, gray to dark gray, thin-bedded, and conglomerate are intercalated locally. The formation is exposed as the small hills in the inner side of the inner range and some localities are exposed as a small hillock.

2.2.2.5 Khok Kruat Formation

The Khok Kruat Formation in the study area is composed of sandstone, brown, reddish brown, fine- to medium-grained, poorly sorted; siltstone and claystone, reddish brown micaceous; calcrete horizons are present. The outcrop exposes in the outer rim of the central lowland.

2.2.2.6 The Quaternary Deposits

The uppermost lithostratigraphic unit of the Phu Wiang area is clastic sediments consisting of undulated plain and floodplain areas.

a) Undulated plain

The undulated plain is mainly association of unconsolidated gravel, coarse to fine sand, and silt. These undulated plains cover the outer part of the central area, which their outer sides connect with foothill of the inner ranges. The thickness of the terrace deposits is unknown, the age is assumed as Pleistocene.

b) Alluvial deposits

The alluvial deposits are unconsolidated sand, silt, and clay underlying the recent floodplain of Phu Wiang basin in the central part of the concentric mountain ranges. The age of these deposits is assumed as Holocene.

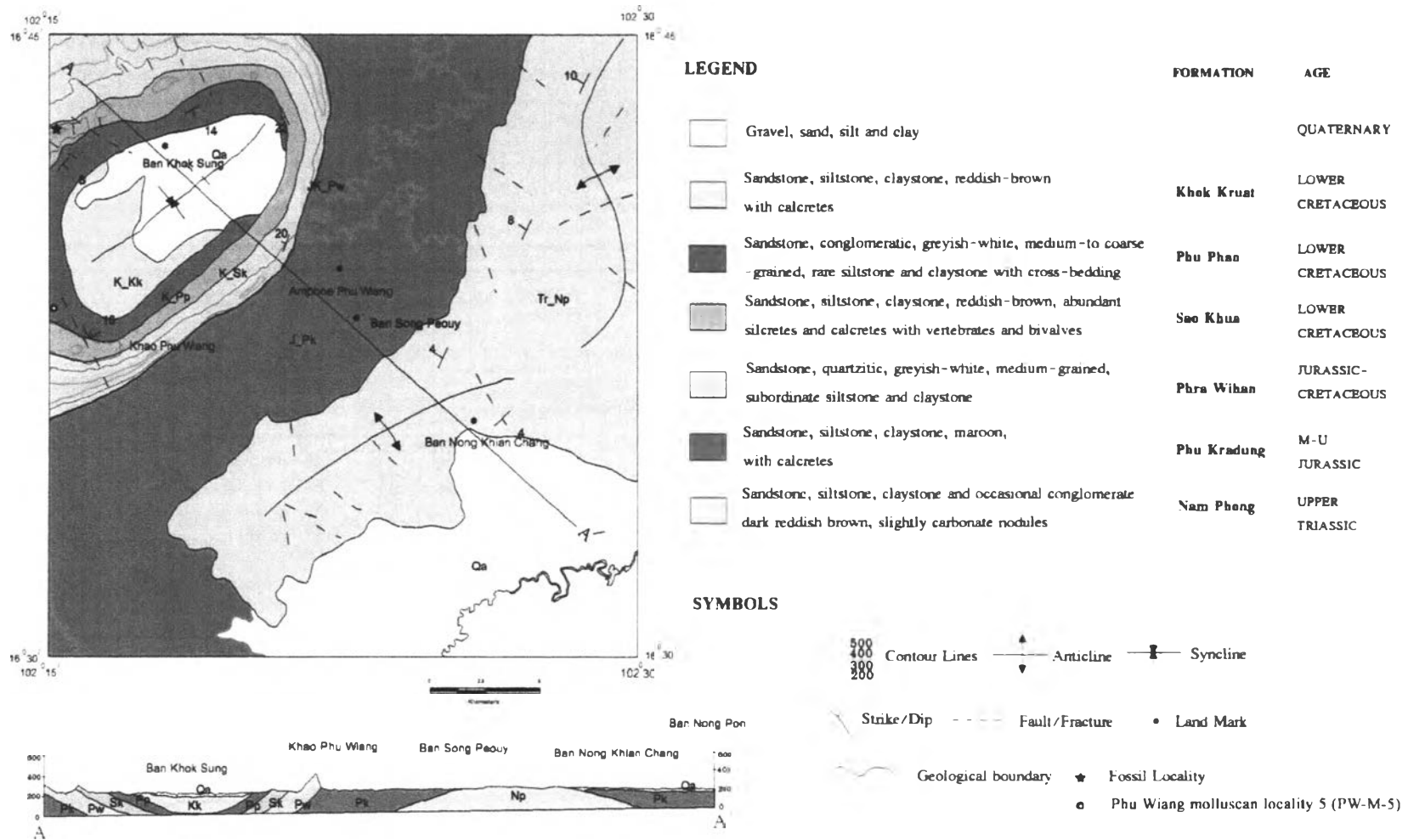


Figure 2.3 Geological map of the Phu Wiang area (modified after Geological map of Thailand sheet Amphoe Phu Wiang, 5442 II, Wongprayoon, 2001)