CHAPTER 1

INTRODUCTION

1.1 General statement

Among the various Gondwana-derived Asian terranes, two continental blocks of them, Indochina and Sibumasu blocks, are intimately related to the geologic evolution of Southeast Asia, especially of Thailand (Fig. 1). Many attempts have been carried out to understand better their geotectonic evolution. Generally it is believed that two continental blocks, named Sibumasu or Shan-Thai (Bunopas, 1981; Bunopas and Vella, 1983; Metcalfe, 1988) of the eastern Cimmerian continent and Indochina (Bunopas, 1981; Bunopas and Vella, 1983; Metcalfe, 1988) of Cathaysian domain are essential for the geotectonic evolution of Thailand during Late Paleozoic and Early Mesozoic times (Bunopas, 1981; Bunopas and Vella, 1983; Metcalfe, 1988).

The Sibumasu and Indochina blocks have geotectonically independent origin. The Sibumasu block originated in NW Australian Gondwana. Cambrian to Early Permian faunas of the Sibumasu block have strong Gondwana affinities, and in particular show close relationships with western Australian (or eastern Gondwana) faunas (Metcalfe, 1988, 1996a, 1998). The hypothesis of the origin of this block is supported by the presence of Upper Carboniferous to Lower Permian

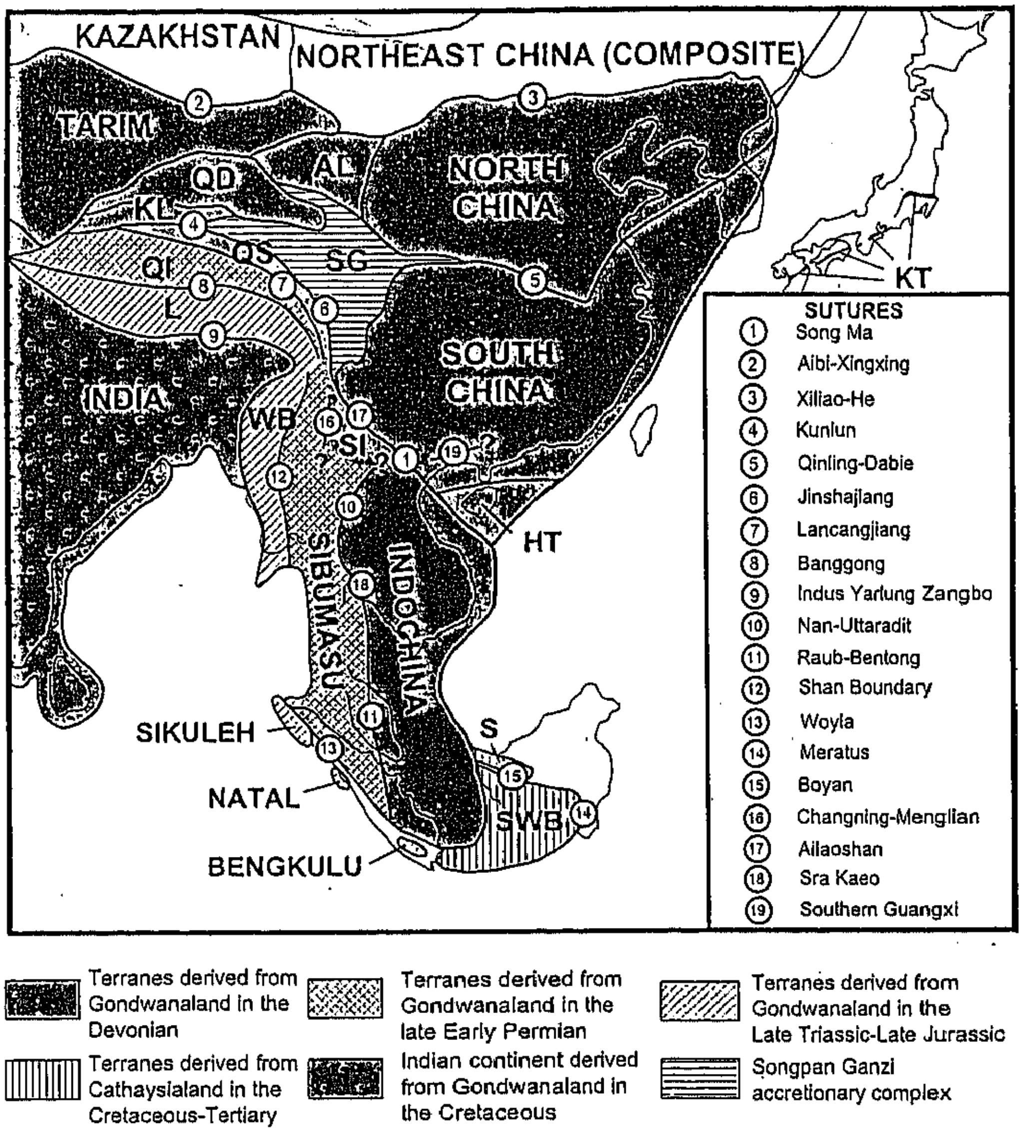

Fig. 1 Distribution of principal continental terranes and sutures of East and SE Asia (Metcalfe, 1998). WB = West Burma, SWB = SW Borneo, S = Semitu Terrane, HT = Hainan Island Terranes, L = Lhasa Terrance, QI = Qiangtang Terrane, QS = Qamdo-Simao Terrane, SG = Songpan Ganzi accretionary complex, KL = Kunlun Terrane, QD = Qaidam Terrane, AL = Ala Shan Terrane, KT = Kurosegawa Terrane.

glacial-marine diamictites (Stauffer and Lee, 1986), the peculiar Early Permian brachiopod with a Gondwana affinity (Waterhouse, 1982), and the low-diversified foraminiferal faunas indicating cold-water condition in close proximity to the Late Paleozoic glaciated Gondwana (Waterhouse, 1982).

On the other hand, Carboniferous and younger faunas and floras of the Indochina and her affinities (North China, South China and Tarim terranes) are typically Cathaysian in nature, and they show no relationship with those of Gondwana (Metcalfe, 1988). The Indochina and her affinities were also situated at paleolatitudes. It indicates that the Indochina and her affinities were no longer attached to the margin of Gondwana from the Carboniferous onwards (Zhao et al., 1996). Metcalfe (1986) believed that the origin of the Indochina Block was on the northern Gondwana margin. The Indochina separated from Gondwanaland in the Devonian (Metcalfe, 1994, 1996a, 1996b). Sibumasu and her contiguous Qiangtang and Lhasa blocks continued to remain on the margin of Gondwana until the Permian to Triassic, though the Lhasa terrane remained attached to Gondwana possibly until the late Triassic, and Sibumasu and Qiangtang separated in the late Early Permian.

The Gondwana-derived Sibumasu and Indochina blocks were collided and completely joined together in the Late Triassic (Bunopas, 1981; Metcalfe, 1988). Their continent-continent collision zone in Thailand, which represents a main Paleo-Tethyan ocean, has been traditionally named as the Nan-Uttaradit and Sa Kaeo Sutures (e.g. Bunopas, 1981; Metcalfe, 1996, 1999; Hada et al., 1997, 1999). However, Ueno (1999) redefined the Sibumasu block based mainly on the distribution of Paleo-Tethyan oceanic sedimentary rocks as well as Late Paleozoic foraminiferal distribution and paleobiogeographic characteristics, and the recognized two other geotectonic units between the Indochina and "revised Sibumasu" blocks (Fig. 2). They are the Sukhothai Zone of volcanic arc origin, and the Inthanon Zone of Paleo-Tethys remnant. Furthermore, the Nan-Uttaradit Suture has been interpreted as a remnant of the marginal sea such as a closed back arc; it is neither the Gondwana/Tethys divide nor the mutual boundary between the Sibumasu and Indochina blocks (Ueno, 1999).

The above-mentioned investigation had been mainly limited in northern Thailand. Geology and tectonic evolution in eastern Thailand is, however, not much mentioned.

1.2 The study area

1.2.1 Location

The Sa Kaeo-Chanthaburi area in eastern Thailand (Fig. 3) has been of interest in terms of tectonic setting of Thailand since several geologists (e.g. Bunopas, 1981; Metcalfe, 1988, 1999; Hada et al., 1997, 1999) proposed that the collision zone between the Sibumasu and Indochina blocks is laid in this region. It extends from the southern part of Sa Kaeo province to the northern part of Chanthaburi province near the border line between Thailand and Cambodia. The study area is bounded by the latitudes 12°45′ N and 13°40′ N and the longitudes 102° E and 102°30′ E, covering more than 6000 km^2 in area.

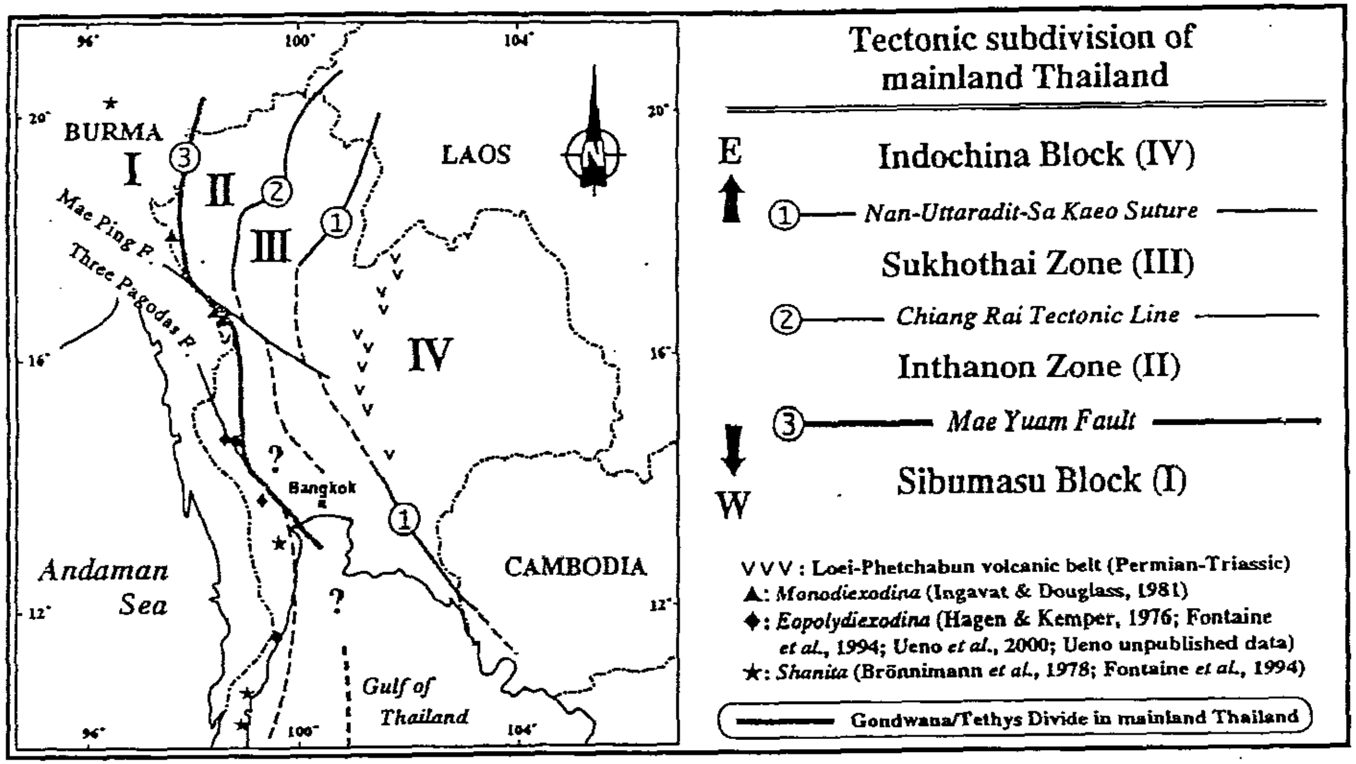

Fig. 2 Geotectonic subdivisions of Northern Thailand (Ueno, 1999).

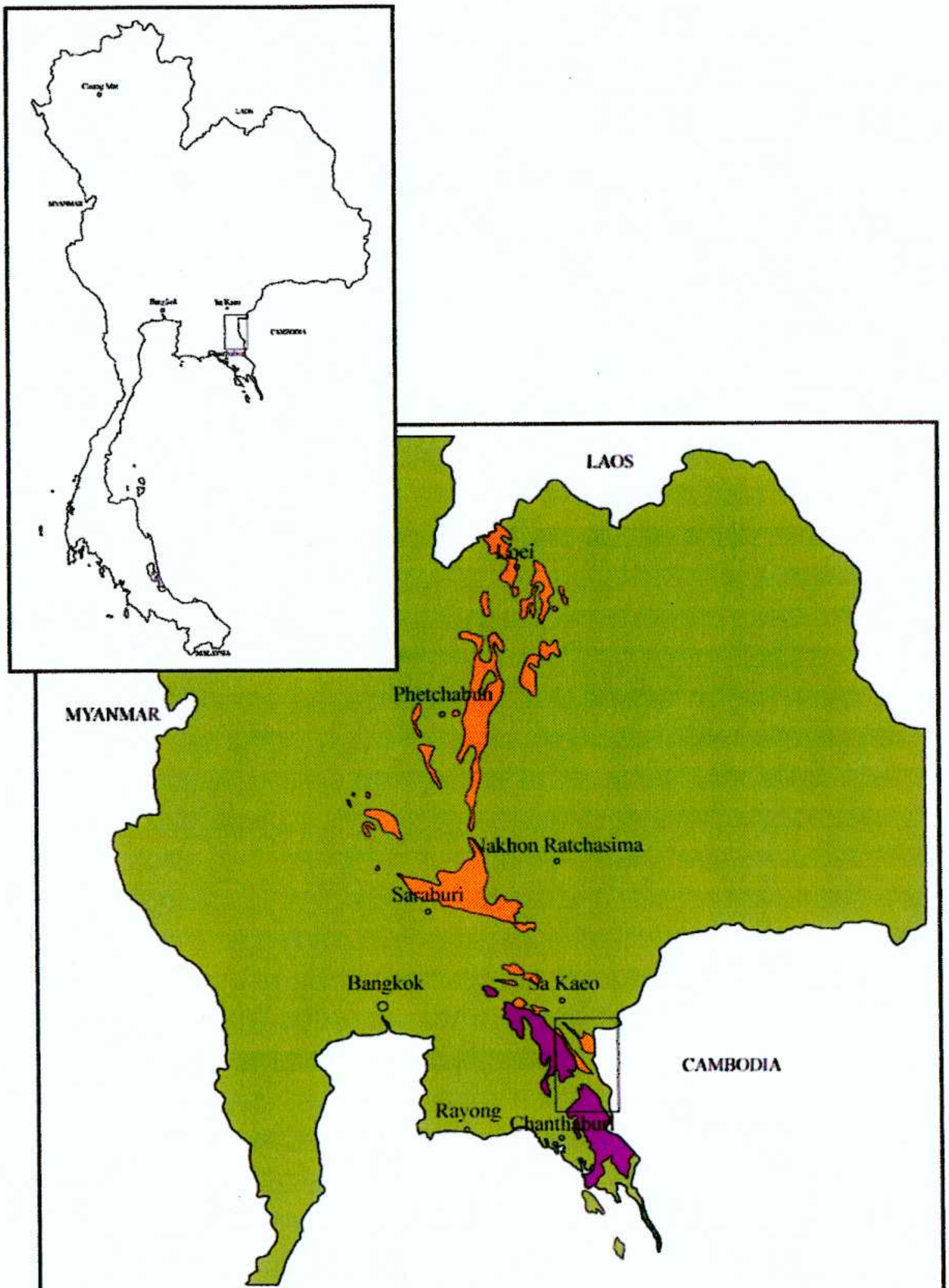

Fig. 3 Location of the Sa Kaeo-Chanthaburi area, eastern Thailand (inserted block) with the distribution of Permian (orange color) and Triassic (purple color) rocks of marine sedimentary deposits along the western margin of Khorat Plateau.

1.2.2 Accessibility

The study area is about 300 kilometers to east of Bangkok. There are two convenient routes to the study area, north and south routes. The north route, Bangkok-Prachinburi-Sa Kaeo, leads us to the north of the study area. The south route, Bangkok-Chonburi-Klaeng-Chanthaburi, leads us to south of the study area.

The study area is characterized by an approximately NW-SE trending, mountain range, with the various elevations from less than 100 meters to 1670 meters above the mean sea level. Most of the study area is covered by subtropical jungle with bushes and agriculture areas. Therefore, it is difficult to search and reach good exposures.

The Highway 317 is a main route in the N-S direction that passes through the entirely lithologic succession of the study area. There are some sub-roads diverging from this main road.

1.3 Objectives

The eastern Thailand is of interest in terms of tectonic evolution of SE Asia since the exposed rocks of the Sa Kaeo-Chanthaburi area have been believed as remnants of Paleo-Tethys after the collision between the Indochina and Sibumasu blocks. Although the previous studies on this complicated region have already been published, there are seemingly very few details available to elucidate the tectonic evolution. Therefore, the detailed studies of geology, tectono-stratigraphy and petrology of rocks of the remnants of Paleo-Tethys, which we are newly proposed as the Sa Kaeo-Chanthaburi Accretionary Complex, are critically required.

The purposes of this investigation are the following;

(1) To study the geology and tectono-stratigraphy of the Sa Kaeo-Chanthaburi accretionary complex.
(2) To study the petrography and tectonic provenance of sandstones from the Pong Nam Ron Formation.
(3) To study the appearance, distribution, morphology and composition of detrital chromian spinels in sandstones and volcaniclastic rocks.
(4) To determine chemical compositions and provenance of possible parent rocks of detrital chromian spinels.

1.4 General approach and research methodology

Techniques of the sandstone provenance studies conceptually fall into three approaches. The first is the basic detailed stratigraphic studies on the related strata and field mapping. The second involves characterization of the bulk composition of the sandstone, typically by point-count determination of modes for detrital framework grains (Dickinson and Suczex, 1979; Dickinson et al., 1983; Dickinson, 1985; Lash, 1985) Lastly the third approach is to quantify characteristics of a single-mineral analysis to increase confidence in provenance interpretation and simultaneously add the detail unavailable from the first and second approaches (Basu et al., 1975; Trevana and Nash, 1981; Cookenboo et al., 1997; Chutakositnon, 1999; Chutakositkanon et al., 2001b).

Detrital chromian spinels studies of a single-mineral analysis are applied to determine tectonic setting of the source. In addition, the electron probe microanalysis of detrital chromian spinels in the sandstone is used to supply the basic geological studies of this research. Detailed studies of basic geological approach and geochemistry of the detrital chromian spinels are desirable in order to evaluate geological processes for tectonic evolution along the collision zone.

In the present study, a detailed mapping was performed based upon the topographic maps at scale of 1:50,000 (Amphoe Pong Nam Ron, Ban Klong Hat, Ban Bung Chanang Klang, Ban Chan Khrem, Amphoe Wang Nam Yen, and Ban Khao Chakan) of the Royal Thai Survey Department (RTSD). It covers more than 6000 km^2 in area. Field investigations were done mainly along the roads or in quarries. GPS data were recorded for the precise location, together with the mile poles set up along the roads. The entire exposures along the roads and in some localities along off-roads were visited on foot, and described for field data in details. Rock samples were collected for laboratory studies.

In order to fulfill the objectives and scopes of the study, the method of investigation has been systematically performed as explained below:

(1) The first stage involves related case studies of basic geology and chromian spinel theory together with reviews of geological setting of the study area from previous investigations. Detailed field and laboratory studies have been

subsequently formulated and carried out.

(2) The second stage is the detailed field investigation that involves the geological mapping and collecting proper samples for further investigation in the laboratory of the Sa Kaeo-Chanthaburi Accretionary Complex, including the Pong Nam Ron Formation.

(3) The third stage commences with laboratory investigation. The sedimentary structure, textures, and compositions have been studied by petrographic techniques. Subsequently, the appearance, distribution, morphology and composition of detrital chromian spinels usually found in volcaniclastic rocks and sandstones are petrographically identified, and later on are geochemically analyzed. The quantitative major element analysis of detrital chromian spinels is carried out by the Electron Probe Microanalysis (EPMA) at the Chemical Analysis Center, the University of Tsukuba, Japan.

(4) The forth stage is to prepare and to examine all the geological and geochemical data obtained from the previous stages in such a manner that they can be appropriately utilized for tectono-stratigraphic and facies analyses. Numerous graphic representations are finally prepared, notably geological map, detrital chromian spinel distribution-map, and geologic cross-section.

(5) The fifth stage involves tectono-stratigraphic and facies analysis which is a prerequisite of the tectonic interpretation. Detrital chroman spinels can carry the genetic data of their parent igneous rocks. Such the analysis can bear the reconstruction of ancient tectonic setting. And finally the

geological evolution of the Sa Kaeo-Chanthaburi Accretionary Complex has been synthesized and proposed.