Field Check
GUIDE BOOK
The 9th MT-JGSC
THE NINTH MALAYSIA-THAILAND BORDER
JOINT GEOLOGICAL SURVEY COMMITTEE (MT-
JGSC) MEETING
Surat Thani-Samui Island-Nakhon Si Thammarat
13-16 September 2012
by Thai Working Group
Preface

This Manuscript is prepared for a four days field check programme in order to fulfill the meeting of the 9th MT-JGSC held in Trang, Thailand from 10-16 September 2012. The main aims of the project are to minimize the geological discontinuities along the Malaysia-Thailand border and to update the geological information of the two countries in various scales.

Details on geology of the Transect along the Malaysia-Thailand border have been presented and discussed during the meeting held at Thamrin Thana. Correlation of rock units and stratigraphy of the northern part of the Malaysian side and southern part of the Thai side can be made at some levels.

Field check routes show a large variety of geological evidences on the Thai side including typical rock units, minerals, fossils and other geological interests at the Bang Khan-Thung Yai area, Khanom area and Samui Island. The first and second places are known as the two significant areas for Mesozoic and Paleozoic rocks whereas the third place is known as the area for Triassic granite and Paleozoic roof pendants with famous geotourism sites.

Finally, the organizers of this joint field trip do hope that this manuscript will benefit not only for all participants of this trip but also for those who are interested in geoconservation and future geopark managements particularly in this region.

Thai Working Group
September 2012
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Ko Samui island of Surat Thani Province (or Koh Samui), or often, simply Samui as it is referred to by locals, is an island off the east coast of the Kra Isthmus in Thailand, close to the mainland Surat Thani town and in Surat Thani Province. It is Thailand’s second largest island after Phuket, with an area of 228.7 km² and a population of over 50,000 (2008) attracting 1.5 million tourists per year. It is rich with natural resources, white sandy beaches, coral reefs and coconut trees.

History

The island was probably first inhabited about 15 centuries ago, settled by fishermen from the Malay Peninsula and Southern China. It appears on Chinese maps dating back to 1687, under the name Pulo Cornam. The name Samui is mysterious in itself. Perhaps it is an extension of the name of one of the native trees, mui, or from the Malay word Saboey, meaning “safe haven”. Ko is the Thai word for "island".

Until the late 20th century, Ko Samui was an isolated self-sufficient community, having little connection with the mainland of Thailand. The island was even without roads until the early 1970s, and the 15 km journey from one side of the island to the other involved a whole-day trek through the mountainous central jungles.

Ko Samui has a population of about fifty-five thousand (source: Samui Mayor’s Office) and is based primarily on a successful tourist industry, as well as exports of coconut and rubber. It even has its own international airport, Samui Airport, with flights daily to Bangkok and other major airports in Southeast Asia such as Hong Kong, Kuala Lumpur and Singapore. Whilst the island presents an unspoiled image to the public perception, economic growth has brought not only prosperity, but changes to the island’s environment and culture, a source of conflict between local residents and migrants from other parts of Thailand and other countries. Reflecting Samui’s growth as a tourist destination, the Cunard ship MS Queen Victoria (a 2000-plus passenger ship) docked at Samui during its 2008 world cruise.
**Geography**

Ko Samui is located in the Gulf of Thailand, about 35 km northeast of Surat Thani town (9°N, 100°E). The island measures some 25 km at its widest point. It is surrounded by about sixty other islands, which compose the Ang Thong Marine National Park (Mu Ko Ang Thong National Park) and include other tourist destinations (Ko Phangan, Ko Tao and Ko Nang Yuan).

The central part of the island is an almost uninhabitable jungle mountain, Khao Pom, peaking at 635 m. The various lowland areas are connected together by a single 51 km road, running mostly along the coast to encircle the bulk of the island.

The old capital is Nathon, on the southwest coast of the island. It remains the major port for fishing and inter-island transportation. Nathon is the seat of the regional government, and the true commercial hub of the Samui locals. It has a charming pace, and is almost small enough to walk everywhere. The old Chinese shop houses along the middle street whisper of an exotic history.

Each of Samui’s primary beaches is now also nominally considered as a small town, due to the number of hotels, restaurants and nightlife that have sprung up in recent years.

**Economy**

Historically the island’s economy has been based around subsistence agriculture and fishing, with coconuts as the main cash crop. From the 1980s onwards, tourism has become an economic factor and is now the dominant industry. The construction of a stable, high-speed internet connection in recent years has also made the island a feasible location for IT-based enterprises, which are beginning to provide a certain degree of economic diversity. The island’s climate and accessibility make it particularly attractive for international investors. Koh Samui transport links have made it a destination for tourists seeking to explore the other islands in the area.
Excursion Programme

THE NINTH MALAYSIA-THAILAND BORDER JOINT GEOLOGICAL SURVEY COMMITTEE (MT-JGSC) MEETING

Thursday 13th September 2012
08.00-09.30 Checkout from the Tammarin Thana hotel, Trang, leave for Bang Khan District, Nakhon Si Thammarat Province
09.30-10.15 **STOP 1**: The succession of the brackish water and lagoonal environment Jurassic sequence of the Thung Yai Group for Geoconservation sites at Bang Khan, Nakhon Si Thammarat
11.00-12.00 **STOP 2**: Gypsum deposits within sedimentary rock beds at currently gypsum mine, Thung Yai District, Nakhon Si Thammarat
12.00-13.30 Lunch on the way
15.30-17.45 Ferry from Don Sak Port, Surat Thani Province to Samui Islands
18.00 Overnight at the Al’s Resort, Cheweng beach, Samui Islands, Surat Thani
19.00-21.00 Dinner at the front beach of Al’s Resort, Chaweng beach

Friday 14th September 2012
07.00 Breakfast in Al’s Resort
09.00-10.00 **STOP 3**: The succession of the Ordovician-Carboniferous rocks with fossils at Laem Phanga, Samui Islands
10.15-10.50 **STOP 4**: Triassic muscovite-biotite granite at the Hin Lat area, Samui Islands
11.10-12.00 **STOP 5**: The Lower Carboniferous rock succession at Laem So, Khao Jedi, Samui Islands
12.15-14.00 Lunch and Dzuhur prayer at Malayu Samui Seafood Halal restaurant, Ban Hua Thanon, Samui Islands
14.15-15.15 **STOP 6**: Triassic porphyritic biotite granite phase and geotourism at the Hin Ta Hin Yai attraction area, Samui Islands
15.45-16.30 **STOP 7**: Evidence of NW-SE major faults in Samui Island at Ban Suan Turian, Samui Islands
17.30 Overnight at the Al’s Resort, Cheweng beach, Samui Islands, Surat Thani
19.00-21.00 Dinner at Fahria Halal restaurant, Chaweng city

Saturday 15th September 2012
08.00 Checkout from the Al’s Resort in Samui Islands, Surat Thani
08.10-08.40 Sightseeing the bird eye view of Chaweng beach in Khao Hua Chuk peak
09.30-11.45 Ferry from Samui Islands to Don Sak Port, Surat Thani Province
12.15-13.30 Lunch and Dzuhur prayer at Don Sak, Surat Thani Province
14.15-15.15 **STOP 8**: inferred Pre-cambriam, gneiss at Khanom District, Nakhon Si Thammarat
15.30-16.30 **STOP 9**: Carboniferous rocks with abundant fossils at Khanom District, Nakhon Si Thammarat
18.00 Overnight at the Twin Lotus hotel, Nakhon Si Thammarat City
19.00-21.00 Dinner at Nakhon Si Thammarat City

Sunday 16th September 2012
08.00-10.00 Checkout at the Twin Lotus hotel, Nakhon Si Thammarat, Sightseeing: the archaeology site at this city, and leave for Wang Prachan checkpoint, Satun
12.15-13.30 Lunch and Dzuhur prayer at Chalung District, Satun Province
14.00 Malaysian participants depart at the Wang Prachan check point, Satun Thai participants depart to their destinations.
Geology and stops of the Southern Thailand.
Geology and stops of the Southern Thailand.
General Stratigraphy

Precambrian Rocks is inferred to be the oldest rocks in the southern region. They are found in Nakhon Si Thammarat Province. High grade amphibolite facies comprises schist, paragneiss, marble, calcilicate rocks and augen gneiss. This Precambrian unit lies in the north-south direction and underlies Cambrian rocks.

Cambrian rocks occur on the eastern side of Ban That mountain range extending down to Phatthalung Province and west of Tarutao Island. Thickness of Cambrian rocks in Tarutao Island is 800 meters, in which the lower part consisting of thick brown beds of fine-grained, cross bedded sandstone, and interbeds of siltstone and shale. Alternating beds of siltstone and thin bedded limestone are at the top of Cambrian rocks underlying the Ordovician limestone.

Ordovician rocks are generally known as the Thung Song Group. The rocks are widely distributed, covering areas in Satun Province extending northerly along Ban That mountain range, Khao Luang mountain range to Surat Thani Province. The rocks generally consist of thick to very thick beds of grey to black limestone. Oolitic texture in limestone and dolomitic limestone are also found. In the top of the group, inclusion of mud in limestone, interbeds of shale and graptolite fossil are revealed. Thickness of this group of rocks is more than 1,600 meters (Bunopas, 1983).

Silurian-Devonian rocks are generally known as the Thong Pha Phuam Group. The rocks are conformably underlain by the Ordovician rock. Outcrops of these rocks are found along two belts i.e. the first belt starting from Surat Thani Province to Satun. They comprise shale, sandstone with limestone lens. Fossils are found in pink shale, indicating Middle Devonian; the second belt is found in Yala and Narathiwat Provinces, including shale, argillite, phyllite, chert, and limestone lens. The metamorphic rocks are found to be amphibolite schist, mica schist and slate.

Upper Paleozoic rocks: Age of Carboniferous rocks in the South was confirmed by certain fossil assemblages. The rocks crop out all the way from Phattalung, Trang, Songkhla, Satun, Yala and Pattani Provinces. Carboniferous rocks are composed of siltstone, claystone, and white shale.
Lower Permian rocks are known as the Kaeng Krachan Group. The rocks comprise mudstone, quartzitic sandstone, pebbly sandstone and pebbly shale. Interbeds of chert, limestone lenses and conglomerate are also found in some places. Pebby mudstone in the middle part of the Kaeng Krachan Group is distinctive by occurrence of clasts, consisting of quartz, quartzite, chert, limestone, black shale and granite. Size of clasts is 0.5-80 centimeters. Rocks in the upper part of the Kaeng Krachan Group consist of sandstone, shale, silicified shale and chert. A lot of brachiopod fossils are found in the upper part.

Permian rocks of the Ratburi Group stretch in the north-south direction from Sangkhla to Phetburi Provinces, Yala and Narathiwat Provinces. Most of them occur as single hills in Surat Thani, Phatthalung etc., or as islands in Phangnga Bay. The rocks generally comprise dense limestone. Chert nodules in limestone are also found. Dolomitic limestone, dolomite and marble are found in some places. Fossils in the rocks indicate the Middle Permian age.

Triassic rocks are found in Songkhla, Nakhon Si Thammarat and Surat Thani Provinces consisting of cross bedded conglomerate and reddish brown sandstone, fine-grained sandstone alternated with siltstone, shale and fossiliferous dolomitic limestone.

Jurassic-Cretaceous rocks crops out at the northernmost location in Sangkhla, Chumphon, Surat Thani, Phangnga, Krabi and Trang Provinces. The rocks are also found on the eastern side of Ban That mountain range in Phatthalung and Songkhla Provinces. Jurassic-Cretaceous rocks consist of red sandstone, siltstone, shale and conglomerate. Cross bedding is apparent in the rocks. Mudstone, deposited in continental environment is found. Interbeds of tuffaceous rocks are also found in some locations. Fossils of the Middle Jurassic to Late Cretaceous age are found.

Tertiary rocks in this region are found in low land basins. Size of the basins varies in according to geology of the area. Tertiary basins are found in the lower western and southern region. Stratigraphy of Tertiary rocks in Krabi basin is clearly seen. Therefore, the Krabi group was well defined, consisting of conglomerate, grey and red sandstone, sandy shale, claystone, limestone and lignite. Age of Tertiary fossils is determined to be 20-40 million years ago.

Quaternary sediments are unconsolidated covering more than 40 per cent of total area in the South. Sediments that were originated by stream and long shore current can be divided as follows. Stream terrace sediments consist of gravel, sand, soil, lateritic soil, and tufa. Terrace deposit occurs at foot of the mountain and low hills. Some terraces are 200 meters high. Alluvial sediments were transported by river stream. They cover low land from sea shore up to foot of terrace. The sediments are composed of gravel, sand, clay and mud. Beach sediments were deposited along sea shore, consisting of sand, quartz sand, shell fragments and coral. Muddy sediment in mangrove forest is grey consisting of mud and silt with thickness of 3-7 meters. Swamp
sediment accumulates in lake, marsh, bog, or fen. It is similar to those in Songkhla Province.

Igneous rocks

Granitic rocks in the South can be seen along Burmese border in Kanchanaburi Province or so-called “The western granite belt”. It extends southerly to Phuket Island, consisting of porphyritic, phaneritic and aphanitic textures. Age of granite varies in different areas. Granite at Khao Dan was dated 93 million years ago (Nakapadungrat et al, 1988). The rock was originated from partly melting of earth crust (Beckinsale et al, 1979). Granite at Phuket Island was dated to be 78-100 million years ago. This western granite rock is source of most of tin that was previously mined in Thailand.

Porphyritic granite with regular arrangements of quartz and feldspar crystals are found in Petchaburi Province, Hua Hin District, Prachuap Khiri Khan Province, Samui Island, Surat Thani Province, Nakhon Si Thammarat Province, and Yala-Narathiwat Provinces. Granite at Hup Krapong was dated to be 210 ± 4 million years old, whilst granite at Samui was 202 million years ago. They are so-called “The central granite belt”.

Granite and granodiorite are sporadically found in To Mo Mountain, Sukhirin District and along border to Malaysia at Waeng District, Narathiwat Province. Grey biotite hornblende granite with aphanitic and greenish grey granodiorite with phaneritic texture are found in the mentioned areas. Regular arrangements of crystals, shearing structure and veins of quartz, aplite, and feldspar are seen in these rocks. In some locations, foliated porphyritic granite cognate was found in Cretaceous granite. The granites are found associated with gold mineralization in these areas. They are so-called “The eastern granite belt”.

Other igneous rocks, found in the South are lamprophyre and andesite. These rocks are found as dykes cross cutting granite in the area south of Hup Krapong, and at Phangnga Province. Andesite dykes cross cut granite at Khao Tan Yong and Ban Kumung, Narathiwat Province. Serpentinite at Ban Kumung, Narathiwat Province exposes as ridge with 300 long. Granodiorite is discovered at Khao Hua Lan, Khlong Thom District, Krabi Province.
Geology of the Samui Island

Samui Island is a part of main core on the Sibumasu Plate, consists of the sequence of marine Paleozoic succession in the western and southern parts with Triassic granite intrusion in the middle part, eastern and northern part. Quaternary sediments are occasionally residual, colluviums, beach, and marine sediments deposits. General strike of these sedimentary and local metamorphic rocks is lying in the N-S trending whereas the granitic rocks are generally disturbed by NW-SE fault movements. Mineral occurrence of this island is fluorite found in the northeastern part, and REE in weathered granite.

Stratigraphy

The oldest rocks are situated in the southwestern part of the Island. The succession consists of limestone, dark grey in fresh and white colour on weathered surface, thin to thick bedded interbedded with shale, thin- to medium-bedded. Stylolitic and stromatolitic layers on limestones strata are common. The younger, Silurian-Devonian rocks are located in the southwestern part of the Island. It is conformably overlain by the Carboniferous rocks. The Formation is composed of 80-100 m sequence of thin-bedded, dark grey to black shale to slate. Tentaculites sp. is very abundant in shale. The younger, Carboniferous rocks occur as the roof pendants in the south and central parts of the Island. The Formation is also contributed at Ko Bo Tan, located in the southern part of the Samui Island. The rocks are lithic, arkosic and quartzitic sandstones, greenish grey, white, and reddish brown, medium- to thick bedded. Shales are also intercalated in some parts. Coarsening upward sequence is generally revealed.

Quaternary deposits in the Samui area are composed of four units. The first unit is the marine shoreline deposits. It is restrictively located in the mangrove area, western part of the Island. It is characterised by the presence of sticky clay to sandy clay with plant remains and shells. The second unit, beach sand deposits, is located in the eastern and southern parts of the Island. General characteristic of these sediments is white to yellow, loose sand, medium- to coarse-grained, rounded to well rounded, well- sorted. The third unit is colluviums and residual deposits. Their distribution is overlain by the weathered granitic rocks in the middle part. The fourth unit is recent alluvial plain deposit. According to the dating by carbon fourteen method in two peat layers, The upper peat beds (7-8.5 m in depth) and lower peat bed (22-23 m in depth) give the age of the recent sediments is 2,820 and 9,270 years ago, respectively.
Igneous rocks

Granitic rocks in Samui Island consist of two types, the first is minor phase, located in the southwestern part of the Island. It is composed of late stage granite, biotite-muscovite granite, equigranular, fine- to medium-grained. The second granite phased is the main granite in Samui Island, distributed in the mountainous area in the central and eastern parts including the Hin Ta Hin Yai attraction area. Characteristics of these rocks are biotite-granite, porphyritic to equigranular, coarse-grained. Both types of granites are assigned to be Triassic age.

Structure

Structurally, rock units in the Samui Island are N-S trending. However, beds are ranging from NE-SW to NW-SE trending affect by faults and intrusion. Parasitic folds, close folds and developed cleavages are usually found in argillite. General faults in the area are NW-SE trending dominated by the oblique strike-slip fault type. Conjugated faults are normally in the NE-SW direction.

Geo attraction and Minerals

Geo-atraction sites consist of three beautiful sand beaches, such as Chaweng, Lamai and Mae Nam beaches. The Hin Ta Hin Yai, erosional morphology of granite by wave, rain season is very famous for tourism. The beautiful waterfalls by fault movements on granite pluton are mainly found in this island.

Mineral potential of this island is fluorite occurrences in the northeastern part. High REE is also recorded in the granite wash and loose sediments.
GEOCONSERVATION SITE: **STOP 1**

**Location**  Ban Khlong Lam Nao, Mu 18, Bang Khan Subdistrict, Bang Khan District, Nakhon Si Thammarat Province

**Grid ref:**  0549541E 0897188N in Amphoe Lam Thap (4825 II) Sheet

**Highlight:** The succession of the brackish water and lagoonal environment Jurassic sequence of the Thung Yai Group for Geoconservation sites
<table>
<thead>
<tr>
<th>FORMATION</th>
<th>UNIT</th>
<th>THICKNESS (m)</th>
<th>LITHOLOGIC COLUMN</th>
<th>FOSSIL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16</td>
<td>4.2</td>
<td></td>
<td></td>
<td>Mudstone, grey to brownish grey, calcareous, intercalated with thin bedded, fine-grained sandstone containing <em>Myrion sp.</em>, marl, 15 cm thick, is intercalated at the bottom part. <em>Actinostreon sp.</em> and <em>Praemytilus sp.</em> are found in the marl bed.</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>0.6</td>
<td></td>
<td></td>
<td>Marl, grey showing thickening upward sequence with <em>Actinostreon sp.</em></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>3.2</td>
<td></td>
<td></td>
<td>Mudstone, brown to dark brown, with the ostracod <em>Darwinidilla sp.</em>; thin bedded sandstones and recrystallized limestones (mainly calcite) are intercalated. <em>Myrion sp.</em> is found in the limestones.</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>0.5</td>
<td></td>
<td></td>
<td>Marl, pale grey; concave-upward <em>Praemytilus sp.</em> at the bottom part.</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>1</td>
<td></td>
<td></td>
<td>Mudstone, brownish grey, calcareous with abundant <em>Neomioidon sp.</em>, <em>Euastersa sp.</em>, convex-upward <em>Praemytilus sp.</em> presents at the top part.</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>0.5</td>
<td></td>
<td></td>
<td>Limestone, pale grey, marly; coquina beds with broken oysters (oozeoliths).</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.6</td>
<td></td>
<td></td>
<td>Mudstone, brownish grey, calcareous with oysters and <em>Euastersa sp.</em></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>0.8</td>
<td></td>
<td></td>
<td>Marl, pale grey to grey, medium bedded with <em>Actinostreon sp.</em></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>1</td>
<td></td>
<td></td>
<td>Mudstone, grey to dark grey, calcareous; fossils contain <em>Protocodrill sp.</em>, <em>Praemytilus sp.</em> and <em>Actinostreon sp.</em></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>0.8</td>
<td></td>
<td></td>
<td>Marl, pale grey to grey; fossils of <em>Praemytilus sp.</em> and <em>Actinostreon sp.</em></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>0.5</td>
<td></td>
<td></td>
<td>Mudstone, brownish grey to grey, calcareous; fossils of oysters.</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1.1</td>
<td></td>
<td></td>
<td>Limestone, brownish grey, marly, oolitic at the bottom part; fossils of <em>Actinostreon sp.</em>, <em>Darwinidilla sp.</em> Thin bedded mudstone is intercalated.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>4.8</td>
<td></td>
<td></td>
<td>Mudstone, grey to dark grey, calcareous with <em>Euastersa sp.</em> and plant remains; sandstone and siltstone, thin bedded, graded bedding, calcareous, are intercalated containing <em>Myrion sp.</em>, <em>Actinostreon sp.</em> and <em>Praemytilus sp.</em> are found at the bottom part.</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.3</td>
<td></td>
<td></td>
<td>Marl, grey to dark grey, intercalated with thin bedded mudstone at the top part. Fossils are abundant with <em>Actinostreon sp.</em>, <em>Praemytilus sp.</em>, <em>Protocodrill sp.</em>, <em>Anomia sp.</em>, and <em>Myrion sp.</em></td>
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<td></td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>Mudstone, dark grey to grey, calcareous. Abundant fossils contain <em>Praemytilus sp.</em>, <em>Anomia sp.</em>, <em>Myrion sp.</em>, <em>Protocodrill sp.</em>, and <em>Actinostreon sp.</em></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>Mudstone and siltstone interbedded, grey to dark grey, calcareous, thin bedded, fine-grained, calcareous sandstone beds are intercalated; calcareous fine-grained sandstone concretions are present. Fossils are not abundant consisting of <em>Euastersa sp.</em>, the ostraced <em>Darwinidilla sp.</em> and a few insect remains.</td>
</tr>
</tbody>
</table>

**LEGEND**
- Sandstone
- Siltstone
- Mudstone
- Marl
- Marlly limestone
- Sandstone concretion
- *Actinostreon sp.*
- *Praemytilus sp.*
- *Modiolus sp.*
- *Myrion sp.*
- *Protocodrill sp.*
- *Neomioidon sp.*
The brackish water Jurassic sequence in the Ban Khlong Lam Nao area, 25 m in thickness, is well exposed as a quarry at Ban Khlong Lam Nao. The sequence can be divided into 16 units based on their lithologies and fossil assemblages.

The Jurassic in this study area consists of a sequence of the Khlong Min Formation of the Thung Yai Group. This sequence is unconformably underlain by marine Triassic rocks as reflected by basal conglomerates around the Thung Song-Khlong Thom and Thung Yai areas, and is conformably overlain by Cretaceous rocks, and unconformably overlain by Quaternary strata.

A depositional history of the marine to brackish water Jurassic strata cropping out in the study area are reported, based on oyster assemblages with additional data from other brackish water bivalves, conchostracans, gastropods, plant remains, and ostracods. Generally, the oysters in most beds are rich in mud-stickers, and recliners of Actinostreon, Praemytilus, and Deltoidium. Of these, Actinostreon and Praemytilus dominate. The diversity of this assemblage was influenced by energy level, substrate, sedimentation rate and salinity. Low to intermediate energy levels and rather soft fine-grained siliciclastic substrate are proposed as factors governing faunal distribution and explaining the greater abundance and diversity of recliners than mud-stickers. Based on the presence of upward-facing concave shells of Praemytilus sp. in the lower part of some marl beds together with coquina beds, the rocks are interpreted as having been deposited by storm influences. The presence of very thin-bedded, fine-grained, calcareous sandstones intercalated in dark grey mudstones with calcitic pseudomorphs after authigenic gypsum, and the heterodont bivalve Myrene sp., indicates the deposition in extreme salinity conditions i.e. hypersaline. The environment of deposition had eventually changed from brackish water to nonmarine condition.

Discussion: ........................................................................................................................................
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Location: Ban Sai Tien, Thung Yai District, Nakhon Si Thammarat Province

Grid ref: 0541546E 0922088N in Amphoe Thung Yai (4825 I) Sheet

Highlight: Gypsum deposit within sedimentary rock beds at current gypsum mine
Description:

Geology of this stop is assigned by geological map on scale 1:50,000 Amphoe Thung Yai (4825 I) Sheet to be the Carboniferous-Permian rocks. Generally characteristic of this unit consists of arkosic sandstone interbedded with siltstone and shale. General structure of this area is normally in the N-S direction.

The current mine is a large quarry, 100x100 meters and more than 30 m depth. General structure of this area is in the 85/325 or NE-SW direction. Gypsum ore, more than 30 m thick, is parallel to the structure. The northwestern part of this mine is limited by dark grey to black slaty shale and carbonaceous shale whereas the southeastern part is mainly deformed sandstones.

Two types of gypsum ore are recognized in this mine. The main product, alabaster type, is characterised by black and white thin band gypsum (more than 10 m thick) and massive white gypsum (2-5 m thick). Sugarly texture is commonly found. The minor type of gypsum is a good crystal of selinite occurring near the fault zone in the middle part of the mine.

Discussion: ........................................................................................................................................................................
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PALEOZOIC SUCCESSION: **STOP 3**

**Location**: Khao Laem Kom-Khao Tok, Samui Island, Surat Thani

**Grid ref**: 0602126E 1041838N to 0602303E 1041526N in Ko Samui (4927 I) Sheet

**High light**: The succession of the Ordovician-Carboniferous rocks with fossils at Laem Phang Ka, Khao Laem Kom-Khao Tok, Samui Islands
Description:

Geology of this stop is assigned by geological map on scale 1:50,000 Ko Samui (4927I) Sheet to be the continuous Paleozoic sequence from Ordovician to Carboniferous rocks. Generally, structure of this area is strongly folded trending from the NE-SW to NW-SE direction with moderate to high eastward dipping.

The first measured section, 200 m long, is representative of the continuous sequence of Carboniferous to Silurian-Devonian rocks. Generally, structure is open fold
with high eastward dipping (65/105, 70/110). NW-SE trending fault sets with slight movement of beds are common. Stratigraphically, the sequence is described in ascending order as follows:

1. Silurian-Devonian rocks are characterized by laminated shale, dark grey to black, very thin- to thin-bedded, well-bedded, sharp, even, parallel. The thickness of unit exceeds 10 meters.

2. Carboniferous rocks are characterized by the presence of
   - **Lower portion:** thick to very thick beds of fine- to medium grained, quartzitic sandstone, white to pale yellowish brown. Shale, mudstone, thin- to very thin-bedded are intercalated.
   - **Middle portion:** Interbeds of light grey to white, fine-grained, quartzitic to lithic sandstone, thin – to medium beded (10-30 cm) and mudstone, dark grey, purplish grey, thin – to medium beded (10-30 cm). Discontinuous laminar, and rip up clasts of shale are occasionally found. Iron oxide hard pan beds are present.
   - **Upper portion:** Medium- to thick bedded, fining and thinning upward sequences of lithic-quartzitic sandstone, light grey, light brownish grey interbedded with argillite.

The second measured section, 100 m long, is representative of the continuous sequence of Silurian-Devonian to Ordovician rocks. Generally, structure is open fold with moderate to high angle westward dipping (35/220, 80/270). NW-SE trending fault sets with slight movement of beds are common. Stratigraphically, the sequence is described in ascending order as follows:

1. Silurian-Devonian rocks are characterized by laminated shale to carbonaceous shale, dark grey to black, thin bedded, well-bedded, sharp, even, parallel. Parasitic folds are common. *Tentaculites* sp. is abundant. The thickness of unit exceeds 10 meters.

2. Ordovician rocks are stylolitic limestone and stromatolitic limestone. Characteristics of these limestones are light grey to grey, packstone to grainstone, thin to medium bedded (10-40 cm). Recrystallized texture and flaser beds are recognized in these limestone. Laminated argillite with 3-10 cm in thickness of beds is intercalated. The thickness of unit exceeds 15 m.

**Discussion:** ……………………………………………………………………………………………..
LATE STAGE GRANITE: **STOP 4**

**Location**  Rocky beach at Hin Lat temple, Samui Island, Surat Thani

**Grid ref:**  0604034E 1041472N in Ko Samui (4927 I) Sheet

**High light:**  Triassic muscovite-biotite granite phase at Samui Islands
Description:

Geology of this stop is assigned by geological map on scale 1:50,000 Ko Samui (4927I) Sheet to be the Triassic muscovite-biotite granitic rocks.

The granitic rocks in this stop, in detail, consist of leucocratic granite and aplite. Characteristic of these rocks is white to light grey colour, fine – to medium-grained and equigranular with some sparsely phenocrysts (5-10% by volume). Most phenocrysts have lath shape, subhedral, K-feldspar with 0.5x2-3 cm in size. Calsbad twin is usually observed. Mineral composition of groundmass is quartz (30%), K-feldspar (50-60%), biotite (10%), muscovite (5%) with chlorite and tourmaline? (10%). Quartz and feldspar are generally anedral. Biotite is flake and book with some biotite patches. Muscovite is single flake. Xenolith is rare. The granite is not represented by the orientation of crystals, however, small dykes of smoky quartz which NW-SE and NE-SW directions along the major structure of the Samui Island.

Discussion: ..........................................................
CARBONIFEROUS ROCKS: STOP 5

Location  Rocky beach at Laem So, west of Jedi Laem So temple, Samui Island, Surat Thani

Grid ref: 0606057E 1040165N in Ko Samui (4927 I) Sheet

High light: The succession of the Lower Carboniferous rocks
Description:

Geology of this stop is assigned by geological map on scale 1:50,000 Ko Samui (4927I) Sheet to be the Carboniferous rocks.

The Carboniferous rock in this stop is the lower sequence of the succession. The unit consists of 10 m thick of quartzitic sandstone sequence. The characteristic of rocks is white to light grey, medium-grained, medium to thick bedded (60-120 cm), lamination and well compaction. Bedding is generally N-S with low to moderate westward dipping (30/255). NW-SE and NE-SW directions of closed space joints are usually observed.

Discussion: .................................................................
ATTRACTION GRANITE: **STOP 6**

**Location** Rocky beach at Hin Ta Hin Yai attraction sites, Samui Island, Surat Thani

**Grid ref:** 0614129E 1044994N in Ko Samui (4927 l) Sheet

**High light:** Triassic porphyritic biotite granite phase and geotourist attraction area, of Samui Islands *(hammer is prohibited in this stop)*
Description:

Hin Ta Hin Yai is a large stone located in the beach. Weathering surfaces shaped like male and female organs are classified as one is the symbol of Koh Samui. The tourists, both Thais and foreigners, visit to explore the circulation. On the way to visit the Hin Ta Hin Yai, souvenirs, variety of handmade souvenirs such as batik, handicrafts, coconut, and Kalamae (A Thai dessert) display for sale.

Geology of the stop is assigned by geological map on scale 1:50,000 Ko Samui (4927I) Sheet to be the Triassic porphyritic biotite granitic rocks as the main phase of granite in Samui Island. In detail, the rocks in this tourist area are mostly porphyritic biotite-graninite. Characteristics of the rocks are light grey to white, orientation of minerals is normally in the E-W direction. Phenocrysts are 50-70% by volume, consisting of K-feldspar, lath shape (0.5-2 x3 cm). Groundmass is coarse-grained, consisting of quartz (50%), feldspar (40%) and biotite (10%). Quartz and feldspar crystals represent anhedral to subhedral. Biotites are flake and book. Cognates of aplite with 10-15 cm in diameter are also found.

This granite is affected by two joint sets i.e NW-SE and N-S directions which parallel to the main structure. Two closed space joints in these rocks together with the erosion by wave, wind and rain should be the reasons for the miracle landform in this area.
FAULT EVIDENCES: STOP 7

Location: Abandoned quarry at Ban Suan Turian-Kunaram temple, Samui Island, Surat Thani

Grid ref: 0610048E 1044848N in Ko Samui (4927 I) Sheet

High light: Triassic porphyritic biotite granite phase and geotourist attraction area, of Samui Islands (Please be careful of the rock fall in this stop)
Description:

Geology of the stop is assigned by geological map on scale 1:50,000 Ko Samui (4927I) Sheet to be the Carboniferous rocks which are passed by the major NW-SE trending fault.

In detail, the rocks are represented as the fault gouge within fault zone. Basement of rocks is Carboniferous succession. They are composed of interbeds of quartzitic sandstone with high silica, white, pale yellowish brown, medium- to coarse-grained, thick bed (1 m) and mudstone, purplish red, pink, lamination, medium- to thick bedded (50 -200 cm). Thin bedded sandstone beds are sometime intercalated within mudstone sequence. Iron oxide hard pans are occasionally found.

General structure of the area is parallel to the NW-SE fault direction (55/060 - 70/060). Slickensides on surface of the cliff and crushed rocks are important evidences of the fault movements in this area.

Discussion: ...........................................................................................................................................
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**PRE-CAMBRIAN ROCKS:  ** STOP 8

**Location**  Rocky beach at Ban Nai Phlao-Had Tong Yee, Khanom District, Nakhon Si Thammarat

**Grid ref:** 0598634E 1007642N in Amphoe Khanom (4927 II) Sheet

**High light:** Pre-Cambrian, gneiss at Khanom District, Nakhon Si thammarat
Description:

Geology of the stop is assigned by geological map on scale 1:50,000 Amphoe Khanom (4927II) Sheet to be the inferred Pre Cambrian rocks.

The rock is mainly biotite gneiss and biotite sillimanite gneiss, occurring is alternating layer, which posses differences in grain size (ranging from fine- to coarse-grained). The internal layer range in thickness from a few tens of centimeters to a few meter. It is noted worthy that the medium-to coarse-grained gneiss is remarkably porphyroblastic texture whereas the fine-grained gneiss is commonly equigranular affinity. General trend of these foliation is NW-SE with low angle dipping to northeast.

These gneiss are cut by deformed pegmatites and aplites. The pegmatites, ranging I thickness from 10 to 150cm, consist principally of large crystals of quartz, K-feldspar and muscovite with sparsely distributed fine-to medium-grained garnet (maximum size about 2 cm). the aplites, varying from 2 to 50cm thick, comprise similar mineral constituents to the pegmatite. In a number of occurrences, the gneiss is outstanding found interlayered with calc-silicate rocks.

Discussion: ..........................................................
**FOSSIFEROUS BEDS: STOP 9**

**Location**  Abandoned quarry of Khao Sri In, Khanom District, Nakhon Si Thammarat

**Grid ref:** 0595569 E 1017582 N in Amphoe Khanom (4927 II) Sheet

**High light:** Carboniferous rocks with abundant fossils
Description:

Geology of the stop is assigned by geological map on scale 1:50,000 Amphoe Khanom (4927II) Sheet to be the Carboniferous rocks.

The rock sequence is measured to be 10 m thick. They consist of interbeds of sandstone and mudstone. Sandstone is characterized by light yellowish brown, light grey and white, medium-grained, thick bedded. Pebbly clasts of quartz and chert are usually found in the bottom part. Mudstone is represented by light grey, light greenish grey, thick-very thick sequence. Lamination is usually found. Posidonomya sp. and trilobite are also recorded, indicating the Carboniferous age.

General structure of these rocks is in the E-W direction with southward dipping (30-40/190). Reverse fault movements having the NW-SE direction (70/035) are shown in this stop.

Discussion: ...........................................................................................................
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1) REE-rich granites of Ko Samui, Ko Phuket and Yod Nam Mine in the Southern Thailand
By Shunso Ishihara, Takeru Moriyama and Hideo Hirano

2) Structure Geology of the Khanom Gneiss Complex, Nakhon Si Thammarat Province, Southern Thailand
By Suwith Kosuwan and Punya Charusiri

3) การสำรวจเพื่อปรับปรุงแผนที่น้ำบาดาลเกาะสมุย จังหวัดสุราษฎร์ธานี
(Investigation for Improvement of Samui Groundwater Map)
โดย ทัศนีย์ เนตรทัศน์ พรอุษา อุดมศิลป์ นงนุช ดวงอาภัย และวันเพ็ญ บัวระพา