THE TECTONIC EVOLUTION OF MYANMAR: A BRIEF OVERVIEW

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I. INTRODUCTION

Myanmar

- A north-south-elongated Southeast Asian country comprising its northwest corner portion,

- Located between the East Himalayan Syntaxis (EHS) and Andaman Sea to the south.

- Washed by the Bay of Bengal on the west, Myanmar forms the northwestern corner and part of the west margin of the mainland of Southeast Asia,

- Linking the Alpine- Himalayan orogenic belt to the west with its extension in the rest of Southeast Asia. (Figure)
I. INTRODUCTION continued

- Myanmar territory is composed of two north-south-trending paleo-continental slivers or blocks of probable Gondwana origin welded together:

- the larger **Shan-Thai Block (STB)** on the east which is also broadly addressed as **Sibumasu** Block and

- the smaller **West Myanmar Block (WMB)** on the west, and

- An **accretionary terrane, Western Ranges (WR)**, was subsequently added to the **WMB**.

- The two amalgamated continental blocks are separated from each other since Miocene by a still active dextral slip transform **Sagaing Fault (SF)** mostly extending along the old suture zone. (figure)
Composed of two paleo-micro-continental blocks: 
**East and West Blocks**, both believed to be of Gowndana origin

They were sutured in Mid-K.

**East Block** belongs to **Shan-Thai block** or **Sibumasu block**

**West Block** composed of original **WMB** and an attached accretionary wedge (**WR**) on the west is also known as **Burma Plate**
**Sagaing Fault in Myanmar**

- **Sagaing Fault** connecting Andaman Spreading Center with east Himalayan Syntaxis, dividing Myanmar territory into two parts: Shan-Thai & West Burma Blocks

- It is an active dextral strike-slip continental transform fault comparable to San Andreas fault of California

- Offsets the WMB dextrally northward forming a Sliver Plate known as the Burma (Myanmar) Plate

- Initiated ~ in Miocene
- Current motion ~ 20 mm/yr
- Estimated dextral offset ~333 km
Myanmar plate (West Myanmar Block)
II. EARLY HISTORY

It seems probable that the WMB and the Sibumasu were formerly independent blocks or slivers which rift at different times off a supercontinent known as the Gondwanaland in the southern hemisphere (Ridd, 1971, Stauffer, 1974), and drifted northward across different generations of Tethys Oceans, and collided and amalgamated with Asia, and also with each other (Metcalfe, 1997). The present available data supported the above tectonic scenario for the Sibumasu Block, more convincingly than for the early history of the WMB which needs more research work to verify.

The Sibumasu Block probably rift off the northwestern Australia which was attached to the frigid Antarctica to the south, both forming parts of the Gondwana supercontinent until Carboniferous, and drifted northward in late Early Permian, collided and sutured in Late Triassic with the Indochina Block (Indosinian Orogeny), also of the Gondwana origin, to form the Sunda Block or Plate, covering much of the mainland of Southeast Asia and its offshore continental shelves and also the southern margin of Asia (Figure 3).
II. EARLY HISTORY continued

- However, the south Asian margin remained passive until Jurassic when it became an active margin with repeated magmatic and metamorphic episodes, the latest thermal event occurring in late Miocene.

- WMB extending into West Sumatran block carrying an intra-oceanic magmatic island arc with continental basement also followed suit from the other part from the northern margin of Australia probably in Late Triassic to Early Jurassic, and frontal magmatic arc collided with the Sunda Block (Sibumasu part) in Mid-Cretaceous, while much farther south of their present position (Mitchell et al., 2007), leading to the formation of high-grade metamorphic Mogok Belt along the collision zone and generating both I-type and S-type granites in the belt. Subduction shifted to the west margin of the WMB.
Himalayan Arc

1. Eurasian Plate
2. India Plate
3. Sunda Plate
4. Burma Plate

SE Asian Plate or Sunda Plate

Sagaing Fault Zone

Major Structures

1. MBT = Main boundary Thrust
2. Sunda Megathrust
3. Sagaing Fault
4. Andaman Spreading

(After the GIAC Project)
MYANMAR AT THE JUNCTION OF FOUR TECTONIC PLATES

- Comprises a late Mesozoic-Cenozoic Magmatic Arc along its north-south medial axis and a high-grade metamorphic belt along the old suture zone on the W edge of the EH.

- Bounded by India/Asia convergent zone to the west, an active sea-floor spreading center to the south and a collision belt on the north.

- Sagaing Fault dislocated roughly along the old suture zone between the two continental fragments, offset the West block northward for 333 km.
Collision of Sibumasu Block with Indochina Block

Fig. Cartoon sections across Northern and NE Thailand to show the narrowing of the Palaeotethys ocean in the earliest Triassic and the final collision of the Sibumasu block with the Sukhothai Arc/Indochina block in the Late Triassic (modified from Sone & Metcalfe 2008). Triassic lithostratigraphic units have been added to show their interpreted plate-tectonic setting. NUS: Nan-Uttaradit Suture.
Alternative interpretation on Western Southeast Asia

East-ward verging Mawgyi nappe of mafic arc rocks and ophiolite in Myanmar and equivalents in Sumatra, Borneo and Tibet in Mid-Cretaceous. Myanmar west of Sagaing Fault restored to Mid-Cretaceous position.

(After A. H. G. Mitchell, 1993)
Geological terrane map of SE Asia (modified from Searle & Morley 2011) and the distribution of the Sukhothai and Inthanon zones in Northern and SE Thailand proposed by Sone & Metcalfe (2008) (a, Khlong Lan Bend in the Mae Ping Fault Zone; b, Mae Yuan Fault).
Here is the simple subdivision into Terranes of Cathaysian affinity and Gondwana affinity, depending upon when they separated from Gondwanaland. Cathaysian terranes are characterised by the equatorial Gigantopteris flora while Gondwana affinity terranes contain glacial pebbly mudstones in the Carboniferous-Permian.
PALEO-TETHYS SUTURE ZONES IN CENTRAL SOUTHEAST ASIAN REGION

(After A. J. Barber et al. (2011))
DISTRIBUTION OF MERGUI GROUP IN MYANMAR AND ITS HOMOTAXIAL EQUIVALENT KAENG KRACHAN GROUP IN ADJACENT PART OF THAILAND ON SIBUMASU BLOCK
PEBBLY MUDSTONES:

A: Singa Formation, Langkawi.
B: Phuket Group, Phuket Island.

(After Hutchison, 2008)
The scheme of rifting and drifting from Gondwanaland by Metcalfe shows East Malaya and South China already rifted and drifting away and near the equator in the Permian. Sibumasu was an integral part of Gondwanaland (shallow seas on its margin) in the Early Permian. Sibumasu and its larger Cimmerian Continent had moved away by the end of the Permian to collide with East Malaya in the Late Triassic (Indosinian Orogeny). The Palaeo-Tethys Ocean was eliminated by the Orogeny.
II. EARLY HISTORY continued

The latest arrival of a major block of Gondwana origin in our part of Asia is the Indian platform or subcontinent which left the parent Gondwanaland in Early Cretaceous, collided and sutured in Eocene with the Eurasian Plate, an assembly of sutured blocks, leading to the formation of the great Himalayan Mountain Range and the high Tibetan Plateau. (Fig. 2). The available data on India's rapid northward flight were more convincing for its origin, collision and suturing with the Eurasia Plate than those of the other blocks so far.

- The consequences of this collision (Himalayan Orogeny) and continuing convergence between the two blocks are, among others, propagation of major lateral shears, in part probably by reactivating the pre-existing structures, to the east and southeast, translating continental blocks out of the collision zone (see Figure; and rotation of the Sunda block or plate clockwise (Tapponner et al., 1986), the processes commonly known as "Extrusion or Escape Tectonics". (Figure 4)
III. COLLISION IN THE HIMALAYAN ARC

Generally accepted to be mostly the consequences of India/Asia collision in early Tertiary and continued convergence ever since.
COLLISION IN THE HIMALAYAN ARC

Tapponnier, et al., 2008
From MAURIN & RANGIN 2010
IV. GEOTONIC PROVINCES OF MYANMAR

- Himalayan Orogeny is still in progress, affecting the broad Asian continent widespread, Southeast Asia in particular which is being pushed aside or extruded from the collision zone to the east and southeast, between the Red River Fault to the northeast in southeast China and Vietnam, and the Papun and Three Pagoda Faults on the southwest in the eastern Myanmar and western Thailand.

Myanmar region could be divided into 3 or 4 Geotectonic Provinces:

1. **Eastern Highlands (HP)**, western part of Shan-Thai Block (Precambrian-Recent); Oldest province in Myanmar,

2. **Central Myanmar Belt (CMB)**, mostly the West Myanmar Block (Triassic-Recent)

3. **Western Ranges (WR)**—an accretionary wedge of flysch strata (Mesozoic-Eocene) lying mostly on the oceanic crust, and

4. **Rakhine Coastal Belt**, part of WR, but overlapped partly by Oligocene and younger mollasse strata.
FOUR MAJOR PHYSIO-TECTONIC BELTS OF MYANMAR

1. Eastern Highlands Province (EHP),
2. Central Myanmar Belt (CMB),
3. Western Ranges (WR), and
4. Rakhine Coastal Belt (RCB).

Onland Sedimentary Basins of CMB
- B = Bago Yoma
- C = Chindwin Basin
- D = Ayeyawady Delta Basin
- H = Hukaung Basin
- M = Minbu Basin
- M' = Mu River Basin
- P = Putao Basin
- P' = Pyay Basin
- PM = Pa-an-Mawlamyine Basin
- S = Sittoung Basin
- SF = Sagaing Fault
- TMB = Tagaung-Myitkyina Belt
- EHS = East Himalayan Syntaxis
- Quaternary Volcano
V. EASTERN MYANMAR BLOCK-EASTERN HIGHLANDS
PROVINCE
(Western Part of Shan-Thai Block)

- Underlain by high-grade metamorphic rocks (continental crust) as basement, successively overlain by weakly metamorphosed thick turbiditic sequence,
- By U. Cambrian-Mid-Devonian sequence of fine-grained clastic strata in the lower part, carbonate strata increasing in the middle and mixed clastic and carbonate strata in the upper part.
- U. Carboniferous- L Permian dominantly clastic strata including pebbly mudstones (diamictites) along western margin of the province,
- All the older rocks are overlain by M. Permian-M. Triassic Carbonate sequence known as Plateau Limestone widely on the Shan Plateau, followed by shallow marine carbonate strata and evaporites of latest Triassic-earliest J age
- Unconformably overlain by U. Triassic-L. Jurassic deep water turbidites, followed by shallow marine and coal-bearing M-Jurassic strata
- Unconformably overlain by U. J-L. K continental redbeds widely
- Coal-bearing U. Tert. clastic strata laid down in Intermontane Basins widely
EASTERN HIGHLANDS

- Composed of well dissected Plateau and highlands
- Probably an assembly of smaller continental blocks
- Composed of sequence Precambrian-mid-Devonian of mixed clastic and carbonate rocks, successively overlain by
  - Permian-M. Triassic carbonate sequence/ (C_P) diamictites,
  - U. Triassic-L Jur. Turbidite sequence,
  - U. Jur coal bearing sequence,
  - J_K redbeds and
  - U. T-Q fluvio-lasutrine deposits
- Intruded by granitoids and metamorphosed particularly along western edge
VI. WEST MYANMAR BLOCK OR BURMA PLATE

Composed of CMB, WR and RCB

- **CMB** is probably a **continental fragment** overlain by Triassic – Recent clastic strata intruded by a volcano-plutonic arc (Mid-K-R) along its medial axis, forming an intra-oceanic **magmatic island arc**.

- Collided with **Sibumasu** block in mid-K creating high- to medium-grade metamorphic belt and emplacement of both I-type & S-type granitoids along the suture zone, **Mogok Belt**.

- Further subducted by the oceanic lithosphere from the west; U. K-Eoc., flysch of accretionary wedge (**WR**) and co-eval sequence of Western Outcrops deposited respectively in a trench and forearc trough of the magmatic arc along the medial axis of **CMB**.

- In Oligocene the **accretionary wedge was uplifted** in the W, dextral shear basins and Sagaing Fault were formed in the E due to hyper-oblique subduction by the Indian/Australian Plate and subsequent indentation in Himalayan Arc following collision in the Himalayan Arc.

- Dextral slip **SF** transects mostly along the old suture zone, and Andaman Basin opened in Miocene, offsetting Burma Plate northward for ~333 km and pushing W Sumatra farther southwards.
VI-A. CENTRAL MYANMAR BELT (CMB)

Magmatic Arc—Backarc and Forearc
Western Outcrops
SF and Suture zone

Onland Sedimentary Basins of CMB
- B = Bago Yoma
- C = Chindwin Basin
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- Quaternary Volcano
PART OF THE WEST MYANMAR BLOCK (WMB)
VI-B. WESTERN RANGES (WR) AND RAKHINE COASTAL BELT (RCB)

- Mainly composed of well deformed and weakly metamorphosed turbiditic strata of flysch facies (U. Triassic, mid-K to Eocene) containing blocks of various sizes of ultramafic and sedimentary rocks, locally forming melanges, underlain by Mesozoic oceanic crust.

- Also composed of more metamorphosed schist (figure), closely associated with Ultramafic rocks of ophiolite affinity representing obducted oceanic crust.

- Hence flysch strata including melanges were interpreted to have been laid down in a trench as an accretionary wedge prior to upheaval as the folded and faulted mountain ranges (WR).

- **RCB** is part of the WR overlain partially by Miocene mollasse strata. In fact the accretionary wedge is still expending westward at present.
WMB with accretionary wedge is also known as BURMA PLATE

Accreted Terrane

Shan-Thai Block

Steckler et al. 2008

Indian Ocean

Fig. 5

Burma Arc

Central Burma Lowlands

Eastern Highlands

Ganges River

Brahmaputra River

Shillong Plateau

Sunda Megathrust
Schists of Gangaw Range

Schist of Katha-Gangaw Ranges
With the Kanpetlet schist of on the eastern edge of Western Ranges
NORTHERN PART OF WESTERN RANGES

Ganges

Brahmaputra

Shillong

Sylhet Basin

Ganges-Brahmaputra Delta

Steckler et al. 2008
(After Mitchell et al, 2010)
Fig 5. Schematic cross-section of subduction zone from the Indian craton across the GBD and Burma Arc to the Sunda plate. Modified from http://www.auburn.edu/academic/science_math/geology/hrl/ew.htm based on figure from Murphy(1988). Added hypocenters (1960-2000 USGS) are used to tentatively interpret the top of basement in the downgoing slab and project the megathrust to the near surface.
Myanmar at the junction of four tectonic plates

1. Sunda Plate
2. Burma Plate
3. India Plate
4. Eurasian Plate

Major Structures in the region

1. MBT= Main boundary Thrust
2. EHS= East Himalayan Syntaxis
3. Sunda Megathrust
4. Sagaing Fault
5. Andaman Spreading

(Modified from the GIAC Project, 2000)
PRESENT DAY TECTONIC SETTING OF MYANMAR

- MBT Sagaing fault (Sliver Fault)
- Chittagong–Tripura Fold Belt
- Dauki fault
- Sunda megathrust (Highly oblique subduction)
- 2004 Dec 26 Giant Earthquake
- Andaman spreading center

Modified from Robin Lacassin, IPG Paris, and Wang Yu, 2007
CONCLUSIONS continued

- Present-day Myanmar: located in Himalayan-Alpine Orogenic, or Alpide Seismic Belt; 2 component blocks or terraines--ST & WMB

- Myanmar is located at junction of 4 tectonic plates

- Active structures: Old sutures, subduction & collision zones; Strike slip faults; Sea Floor spreading, Escape tectonics and Sagaing Fault

- Important features: EHS, EHP, Mogok Belt, CMB, CVL, and WR

- Dextral Shear Basins of CMB initiated only in Oligocene, CMB not a huge graben as thought by previous workers

- Trench (WR & RCB) and Forearc Trough (WO)-K-Eoc and Post-Oligo Basins

- Burma Plate to day: composed of WMB, WR and RCB, bounded by Sagaing transform fault, Andaman spreading and Sunda convergent zone to the west.