FAUNAL INDICATION OF ASSEMBLING AND ACCRETION OF TERRANES IN MYANMAR

Hla Hla Aung
Myanmar Earthquake Committee
Federation of Myanmar Engineering Societies
MES Building, Hlaing Campus, Yangon, Myanmar

ABSTRACT

This present paper is a part of a book on terranes of Myanmar which was published in Myanmar, 2013. The name is Tectonic Style and Deformation Pattern of Terranes in Myanmar. It is based on Tectonostratigraphic Terranes Analysis. There are six sections with relevant figures, maps and tables. Among the contents, the reconstruction of the tectonic terranes of Myanmar territory is the most important tectonic history to be completed in every aspect of sedimentary basin, igneous rock, volcanic occurrences, tectonic events, fossil evidences and economic occurrences. The presentations of this paper were presented at different international conferences for three years: 2008, 2017, and 2018 whenever there is new investigation and new dada. The present paper is newly added fossil evidence for reconstruction of tectonic terranes in Myanmar territory. The work of reconstructing the paleogeography of terranes was conducted by using known distribution of Mesozoic representatives of Monotis, Halobia, and Daonella faunas in Myanmar. Distribution of these faunas in Triassic marine strata of Shan Massif and correlation with those of neighboring terranes of Asia gave the evidences that Shan Massif was a part of Gondwana in Carboneferous-Permian time.

Keywords: terrane, tectonic history, evidence, fossil, paleogeography, correlation,Gondwana

INTRODUCTION

The Halobia-bearing schist of Thanbaya Formation with Upper and Middle Triassic fossils, mostly of *Daonella* sp. had been recorded in Rakhine Western Ranges. The Shan Boundary belt of Lebyin-Taungnyo-Mengui-Phuket (in Thailand)-Sigma Formation (in Malay Peninsula) represents accretion and collision event between the Burma Plate and Indochina plate in late Cretaceous-Early Eocene. The Than Lwin Belt represents the site of consumption of Paleo-Tethys in Late Triassic-Jurassic. *Daonella indica* Britten and *Halobia salinarum* Broon-bearing shales (Upper Triassic) were found in mudstone and shale in Lwekyaw village near Than Lwin River (Fig.1). The Norian age (upper Triassic) *Monotis* sp. (mostly *Halobiidae*) is found in clastic and carbonate sediments of Pan-Laung Formation in the Shan Boundary Belt, west of Shan Plateau [1,2 3]. Such thin-shelled pectinacid bivalves of the genus *Monotis,* sensu lato, are widely distributed in Upper Triassic marine strata and different Monotis faunas are geographically restricted and their biogeographic studies will be of great importance for reconstructing pre- to mid-Jurassic intraoceanic plate boundaries and displacement histories of accreted terranes. [4]. Studying the different *Monotis* faunas occurred in Rakhine Western Ranges accreted belt and Shan Boundary accreted belt between the Burma and Indochina plate, indicate that these deposits are parts of allochthonous accretionary terranes, and hence, suggest that they are displaced by northward plate motion [1].

PLATE TECTONIC HISTORY OF MYANMAR REGION

The tectonic history of Myanmar region is related to regional geodynamics and plate motions between the India, Burma, Indochina and Eurasia plate. The supercontinent Pangea which originated during the Carboniferous time has been existed till Early Triassic time (248-224 Ma) [5]. The most significant Triassic convergent event was the Indosinian orogeny, the consolidation of Chinese blocks (South China) with Indochina and Shan Massif (Sibumasu) [5]. The detailed paleomagnetic analysis revealed that the collision of the Sibumasu terrane and Indochina terrane occurred during or before the Middle-Late Triassic times. A new paleomagnetic study on the Permian and Middle Triassic limestone from Shan State of eastern Myanmar implies that the Sibumasu terrane was located at a paleolatitude of -18.3°N during the Middle Triassic [6].The site of final closure of Paleo-Tethys Ocean during the Triassic-Jurassic was marked by the collisional event between the Shan Massif and Indochina plate in eastern Myanmar. Large complex of granitic rocks at the east of the Than Lwin River that can be correlated with the granites east of Fang (N. Thailand) was assigned to be early Triassic [7]. During Indocinian orogeny at Early Triassic (240Ma) Indochina and Shan Massif amalgamated along Loise-Loilen fault forming Paleo-Tethys suture zone in easternmost Myanmar, causing closure of Paleo-tethys Ocean [8]. Uplift of South China, Indochina and Shan Massif followed the conclusion of Indocinian orogeny in Cretaceous [6]. Indochina and Shan Massif uplifted in Cretaceous [9].

The Burma plate rifted and drifted from the neighbors of Gondwana in Middle Jurassic [10]. Burma plate accreted to the Indochina plate in Late Cretaceous-Early Eocene forming tin-tungsten-bearing igneous belt between the two plates by partial melting of Carboniferous-Permian aged marginal basin metasedimentry rocks of Mergui-Lebyin-Taungnyo Series during a long period of Eocene-Oligocene-Miocene.

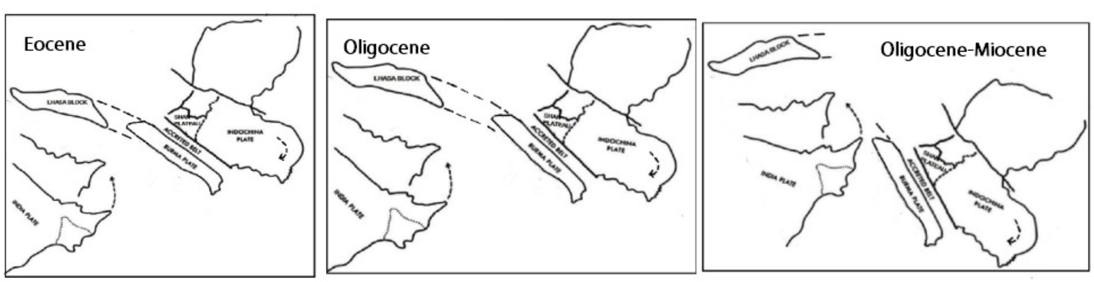
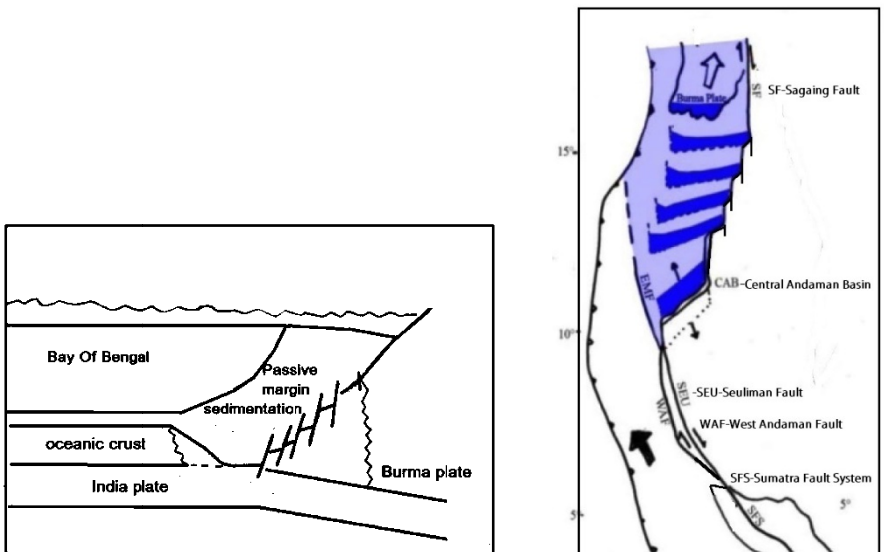


Fig.1. Paleogeography of the India, Burma, Indochina plates in Early Tertiary Period. The orientation of Burma plate is in NW-SE direction during accretion to Indochina plate

The age determination by the Argon-Argon dating method ($^{40}Ar/^{39}Ar$) on biotite, muscovite and phalogopite from igneous belt show that the granitic rocks are gradually young to the north to Kyause area in Manadalay area. [11]. Accretion of the

Burma plate to Indochina caused the clockwise rotation of the Indochina plate in Eocene (50Ma) (Fig.1). A series of basins formed in Central Myanmar Basin in response to the clockwise rotation of Indochina plate and north-eastward oblique convergence of India plate to the Sunda trench [12] due to regional extensional deformation. The formation of these basins commenced in the north at about Early Eocene to Early Miocene and shifted to the south to Central Andaman Basin where spreading occur in Pliocene (4-5 Ma) [13].



(b)

Fig.2.a.A cross-section showing a passive margin of the western side of the Burma plate.(b) A map showing dispersion model of the Burma plate from the Central Andaman Basin to the north.

The Burma plate rifted and drifted from the neighbors of Gondwana in Middle Jurassic that resulted in the development of a passive margin along the western edge of the plate (Fig.2a). A passive margins or rifted margins mark the sites where continents have rifted apart to become separated by an ocean as rift system. The rift is a series of segment offset by transform faults. It is a divergent plate boundary. It forms by sedimentation above an ancient rift and is consist of a seaward tapering wedge of continental crust that is bisected by faults, overlain by sedimentary basins and juxtaposed with oceanic crust. It is also a transition between oceanic and continental lithosphere. The 2000 km long, and approximately 200 km wide elongated tectonic zone, which includes the Central Myanmar Basin and Central Andaman Basin, has been wedged between the northward moving India plate on the west and southeasterly extruding Indochina plate on the east. As a result**,** the Central Myanmar Basin has a classic continental rift structures that are arranged in basin-and-uplift configuration, including seven sub-basins and five uplifts. Extension and rifting occur at around 11 Ma, and extension through seafloor spreading since 4-5 Ma [13]. N-S motion in the Andaman Basin is estimated at 27 mm/yr [14]. The internal rupture has assumed to have broken the Burma plate from that of Sumatra then move northward since the time of creation of rifting ie the time rifting began separating Alcock and Sewell Rises [15]. Seafloor spreading and transform faulting in the Andaman basin was accommodated to the north by slip along the Sagaing fault in Myanmar. The relative rate of movement of these crustal blocks in the Central Myanmar Basin amounts to 8 mm/yr from the result of GPS measurement [11]. The occurrence of earthquakes on each of basin bounding faults indicates the existence of transfer zone in Central Myanmar. The Burma plate moved northward away from the Sumatra, resulting in the development of a passive margin along its southern edge (Fig.2b)[16]. During the spreading time, hydrocarbon source rocks were developed on the shelf area under extensive warm shallow sea at low latitude where a large quantity of nutrients for hydrocarbon was obtained from the spreading center. The western and southern sides of the Burma plate are bordered by rifted margin Regional paleogeographic reconstruction can suggest potential source rock and favorable timing for petroleum generation.

Based on paleontologic studies and correlation with major paleogeographic provinces on the micro-fossil assemblages of Tertiary age (Table 1) and pectinatcid bivalve shells of Mesozoic representatives of Triassic fauna from different localities in Myanmar, a scenario of assembling of terranes accretion to the major continent in time and place was emerged to add the constraints given by the tectonic data.

AGE (my)	EPOCH		Benthic Foram / Planktonic Foram	Rakhine Coastal Terrane	Rakhine Western Ranges	Central Burma Basin Terrane	Neighbouring Countries Major Paleo-Biogeographic Provinces
5	Pliocene						
10 15 20	MIOCENE	Late Middle Early	Planktonic Foram		*Catapsydrax strainforth* *Globorotalia fobsifobi* (Pyawbwe Fm.)		Archipelago Series Andaman-Nicobar Ridge Telisa Formation Sumatra (Indonesia)
25 30 35	OLIGOCENE	Late Middle Early		*Globorotalia kugleria* *Globorotalia opima* *Globigerina cuperoensis* (Kalabon Formation)			Barail Series Bangladesh
25 30 35	OLIGOCENE	Late Middle Early	*Acarinina pentacamerata-* *Planorotalites palmerae* zone 1. *Acarinina Soldadoensis angulosa* *Morozorella aragonensis* zone 2. Lr. Eocene Laungshe Fm.			*Nummulites atacicus* (Tabyin Fm.) (Larger Foram) *Nummulites atacicus* (Laungshe Fm.) (Larger Foram)	Khirar Stage INDIA Laki Stage India Patala Shale N.Parkistan Zhepure Fm. (Tingri Region) Tibet Indonesia

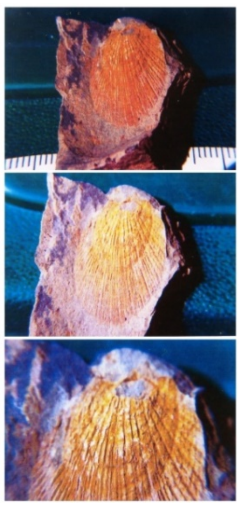
Table.1. Table explains Biostratigraphic correlation of Macro-an- Micro-foraminiferas between terranes of Myanmar and major paleobiogeographic provinces (data from previous and recent investigation)

OCCURRENCE OF MONOTIS FAUNA IN ACCRETED BELTS OF MYANMAR

Monotis fauna E, according to the diagnosed groupings in the paper of [4] is *Monotis (Monotis) Salinaria* group, small to medium Monotis; subeqivalved; shape oblique; posterior ear smooth, well-differentiated, ribbing fine to medium in strength, regular, commonly wrinkled or wavy posterodorsally, Fauna E was originally distributed in Tethyan region, which represent a wide range in water depths both oceanic and miogeogeonclinal sedimentary environment especially paleoequational seas. Different Monotis fauna are geographical restricted; their biogeographic interpretation bears on the displacement histories. [4].

- *Halobia*-containing beds of Karnian age at east edge of Rakhine Ranges.
- *Halobiidae* of Kalemyo and Te-Chaung in Pakokku District, occurred in dark gray shale, has indicated that they were pseudoplanktonic and condition of hostile to life at the sea floor.
- *Daonella Lamelli* [17] in Kalemyo, exhibits genus Halobia, occurred in dark micritic limestones which is equivalent to Thanbaya Formation.
- Halobids, Monotis and agglutinated formainiferas were found in thin beds of dark, grey, calcareous mudstone and micritic limestones of Thanbaya Formation.

- Occurrence of *Halobia comata H. lamelli* and Monotis suggest a Carnian to Norian stages [17].
- *Daonella* sp of Middle Triassic fossils have been found by the staff and the students of Geology Department of the Mandalay Arts /Science University, from several localities of the Eastern foothills of the Western Ranges between Gangaw and Kalamyo [18].
- *Halobia* Schists of Sumatra, lie on top of epimetamorphic Permo-Carboniferous Sequences [9].
- A specimen containing *Halobia* and *Monotis* sp was recorded (Riley, 1964) from Kayah State, but not confirmed by later geologists [9].



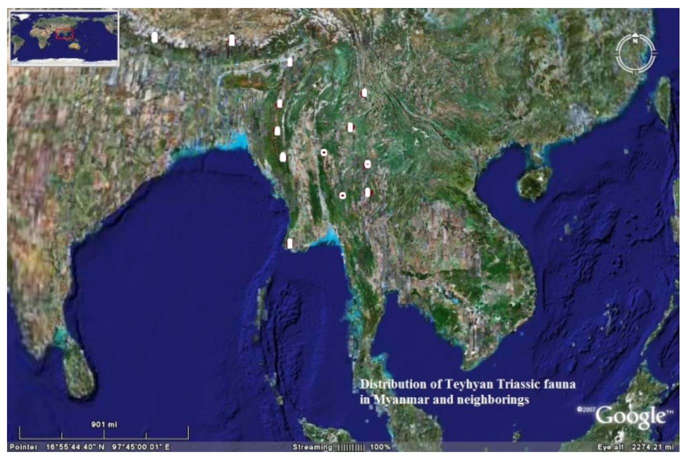


Fig. 3. Photos of Monotis, Dionella

Fig.4. Showing the relation and correlation between various Monotis species of Triassic in Myanmar, Himalaya and the Indochina.

- Bender mentioned in his book that *Holobiidae*-bearing Triassic sequence expected to occur in E. Kachin/Shan unit of Myanmar, as in Yunnan, Thailand and Malay Peninsula.
- Upper Triassic faunal assemblages also were discovered in the Ngapyawdaw Chaung Formation, Thabeikkyin Township, on the eastern side of Sagaing Fault.
- A taxonomic scheme has been adopted for the faunal assemblages of Halobia sp. from Shweminbon Formation in Southern Shan States.

RESULTS AND DISCUSSION

From these studies Monotis fauna distribution over Myanmar region, terranes in Myanmar are allochthonous terranes, migrated from the Gondwana and accreted to the major continental block in the north. Amalgamation within terranes and accretion to the continent at the end of Mesozoic was followed by the post-accretionary deformation mainly in Cenozoic.

Northward movement of crustal blocks along the Burma plate was evidently indicated by spreading rate in Central Andaman Basin and displacement on the Sagaing fault. The seismicity and the lateral sedimentary facies changes associated with fault scarp in pull-apart basins in Central Myanmar Basin also indicate that northward translation and rotation of crustal blocks are occurring in the past and at present. Deformation is still active reactivating the old tectonic lineaments in the terranes of SE Asia due to the reorganization of intraplate motion between India, Burma, Indochina and Australian plate. Faunal correlation has been made primarily by the author between terranes in Myanmar and terranes of Tethys domain in Asia to get the estimated paleogeographic position for the Myanmar terranes. Acccretionary tectonic provides the additional important constraints for reconstruct-tion of tectonic terranes. More detailed studies of biogeography of accreted terranes in Myanmar are needed for further completion of terranes analysis.

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