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The Indosinian orogeny in South-East Asia

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Introduction and Methods

The Late Triassic Indosinian orogeny was defined one hundred years ago in Vietnam, where the major unconformity was observed (Deprat 1913, 1914, Fromaget 1927, 1934, 1941, 1952, Golonka et al., 2018). This orogeny name was derived from Indochina, the region, which includes Vietnam, Laos and Kampuchea. It was later referred also to consolidation of Chinese blocks (e. g. Yin & Nie, 1996) and correlated with Cimmerian events in Europe and South-Central Asia (e.g. Sengör 1984, Golonka, 2004). The present authors attempt to put the Indosinian orogeny in the global context (Figs. 1, 2).

The presented plate tectonic maps, were generated by PLATES, PALEOMAP and GPLATES computer software using a plate tectonic model, which describes the relative motions between approximately 300 plates and terranes (Golonka et al., 2018). The calculated paleolatitudes and paleolongitudes were used to generate computer maps in the Microstation design (.dgn) converted later into Corel Draw (.cdr). Facies and paleoenvironment information were posted after reviewing database files, regional paleogeographic maps and relevant papers.(Golonka et al., 2018). The field observation in Indochina, Thailand and Myanmar were supplemented by information from several general, regional and paleogeographic papers (see references).

Collisional Indosinian Tectonics

The major collisional event and unconformity as observed in Northwest Vietnam. Lower – lowermost Upper Triassic (up to Carnian) marine depositsare deformed and arranged into nappes and thrusts in this region (Golonka et al., 2006, 2018). The Upper Triassic continental red conglomerates ("terraines rouges", see Deprat, 1913, 1914, also Golonka et al., 2006, 2018) unconformably covered older, deformed Triassic deposits. The main metamorphic event occurred around 250-240 Ma (Lepvrier et al., 2004, Maluski et al., 2001, 2005, Lepvrier and Maluski, 2008, Golonka et al., 2018 and references therein). The 225-205 Ma postorogenic plutonism in northeastern Vietnam was related to Late Triassic Indosinian orogeny (Hung, 2010, Faure et al., 2014). According to Faure et al. (2014) The Jinshajiang and Ailaoshan belts in China mark also the Indosinian Orogeny, which cause the closure of Paleo-Tethys Ocean (Figs. 1-5) along Raub-Bentong, Sra Kaeo and Nan-Uttaradit suture between Sibumasu and Indochina and Ailaoshan suture between Sibumasu and South China (Metcalfe

Fig. 1. Global plate tectonic map of Late Triassic at 224 Ma ago. Molweide Projection. 1–oceanic spreading center and transform faults, 2–subduction zone, 3–thrust fault, 4–normal fault, 5–transform fault.

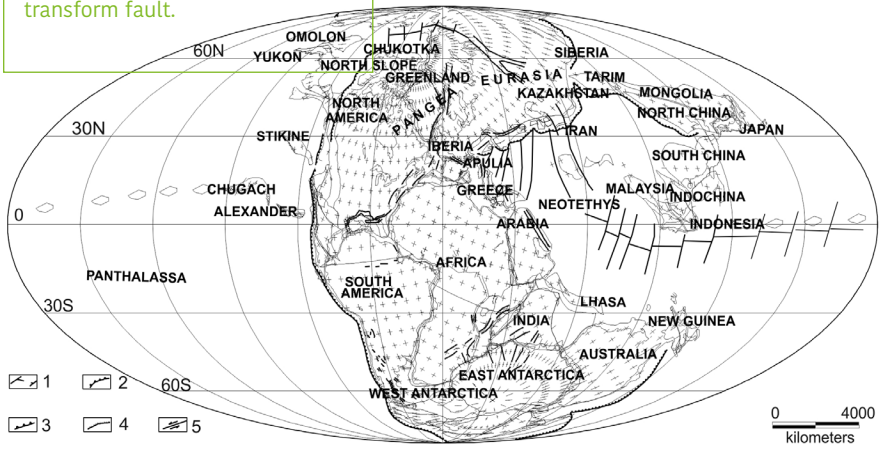

Fig. 2. Global plate tectonic map of Late Triassic at 200 Ma ago. Molweide Projection. 1–oceanic spreading center and transform faults, 2–subduction zone, 3–thrust fault, 4–normal fault, 5–transform fault.

1994, 1996, 2000, 20011, 2013a,b, Golonka et al., 2006 and references therein).

The Late Triassic orogenic event occurred also in Thailand/Myanmar trans-border zone and volcanogenic-sedimentary event in Myanmar correlates presumable with the synorogenic processes, which are represented by the Upper Triassic flysch deposits with basaltic pillow lavas. The Triassic-Jurassic succession in the Mae Sot area in northern Thailand, belongs to the Shan-Thai terrane, representing a remnant of Paleo-Tethys Ocean (Meesook & Sha 2010), which occupied a wide realm between Cimmerian Continent and Eurasian plate during Late Paleozoic-Early Mesozoic times. This block is subdivided into several zones from the west to east, including the Mae Sariang zone, within the Mae Sot area, contains rocks of Triassic cherts (radiolarites), carbonates and flysch (turbiditic) facies, which indicate both pelagic condition and synorogenic deposits (Golonka et al., 2018). The post-orogenic continental-shelf deposits including the oldest Jurassic bed, or the youngest Triassic bed, so-called "base-conglomerate", cover discontinuously older pelagic Triassic formations (Ishida et al., 2006; Meesook & Sha, 2010, Golonka et al., 2018). The events of Indosinian orogeny are diachronic, Early Triassic and Carnian/Norian transition orogenic time in Vietnam (Lepvrier et al., 2004) and close to Triassic/Jurassic transition in Thailand (Golonka et al., 2018), The Late Triassic volcanogenic-sedimentary event in Myanmar correlates presumable with such synorogenic processes, which are represented by the Late Triassic flysch deposits with basaltic pillow lavas [Shweminbon Group (Upper Triassic – Lower Jurassic turbidites), formerly part of Loi-an Gp.; Bawgyo Group (Upper Triassic) and their equivalents; Upper Triassic turbidites (Thanbaya/Pane Chaung group/formations; Bannert et al., 2011, Win Swe, 2012, Cai et al., 2017, Golonka et al., 2018]. The Late Triassic Indosinian orogenic event has been connected with docking and amalgamation of Indoburma, Shan-Thai (Sibumasu) and Indochina terranes, which constitute recently the main part of South East Asia (Golonka et al., 2018).

The collision between South Chinese plate and the North Chinese block began during the Late Permian and continued during the Triassic (Yin and Nie, 1996, Golonka et al., 2006). The Qinling orogenic belt records this collision. According to Dong et al. (2011) the Shangdan zone between the North and South Qinling belts is the suture separating the convergence and collision between North South Chinese plates. The post-suturing plutons were emplaced along the suture zone and on the adjacent plates (Bao et al., 2015, Liang et al., 2015, Lu et al., 2016). The new large Chinese-SE Asian plate including North and South China, Mongolia and eastern Cimmerian plates was consolidated at the Triassic-Jurassic boundary.

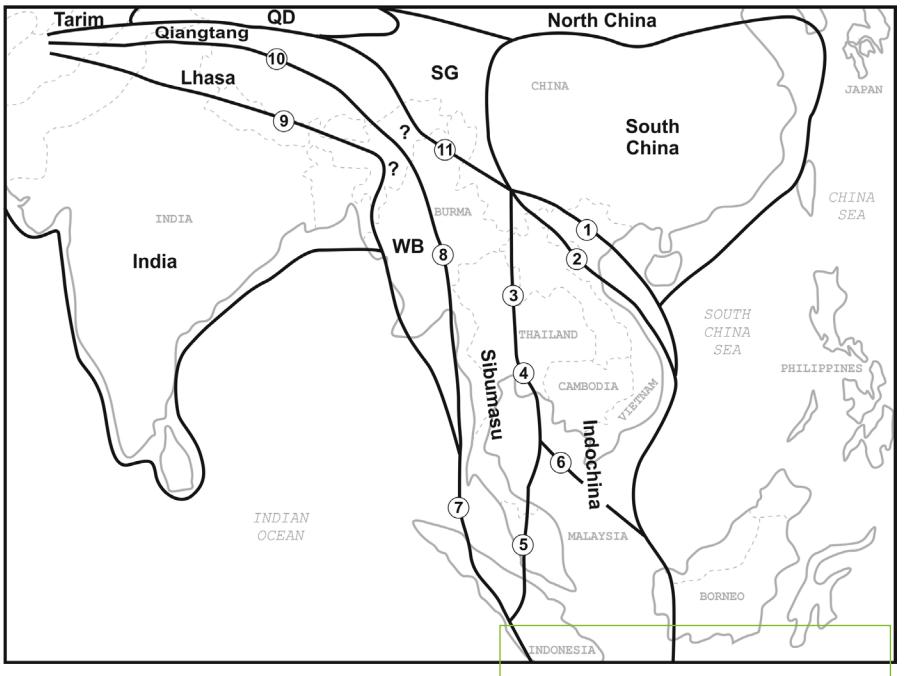

Fig. 3. Main plates, terranes and of Southeast Asia. Partially from Mecalfe, (1999), Golonka et al. (2006) WB - Myanmar, SG - Songpan Ganzi accretionary complex. QD - Quidam terrane. Sutures and major strike-slip faults:

1 - Red River zone,
2 - Song Ma,
3 - Nan-Uttaradit,
4 - Sra Kaeo,
5 - Raub Bentong, Three Pagodas,
7 - Woyla,
8 - Shan boundary,
9 - Indus Yarlung Zangbo,
10 - Banggong,
11 - Ailaoshan.

Conclusions

The consolidation of Chinese blocks with Indochina and Sibumasu constitute the main result of the Triassic Indosinian Orogeny. The Indosinian Orogeny is related to the Cimmerian events that happened in Europe and South-Central Asia. The docking and amalgamation of eastern Cimmerian plates that included Indoburma, Shan-Thai (Sibumasu) and Indochina terranes consolidated the main part of South East Asia. This plate docking caused also collision between South Chinese plate and the North Chinese block. The new large Chinese-SE Asian continental plate including North and South China, as well as eastern Cimmerian plates existed since Early Jurassic times.

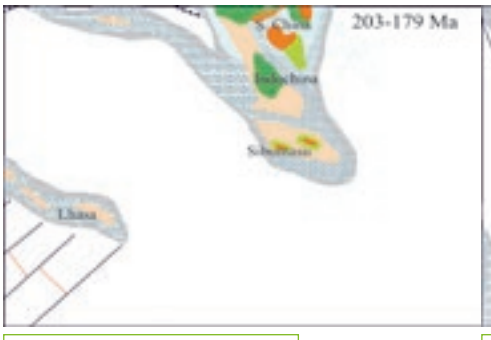

Fig. 4. Plate tectonic and lithofacies map of Southeast Asia during Late Triassic. Modified from Golonka et al., 2006. Explanations in Fig 4a.

Fig. 5. Plate tectonic and lithofacies map of Southeast Asia during Early Jurassic time. Modified from Golonka et al., 2006. Explanations in Fig 4a

Fig. 4a. Explanations to Fig. 4 and 5, . Qualifiers: B – bauxites/laterites, C – coals, E – evaporites, F – flysch, Fe – Iron, G – glauconite, M – marls, O – oolites, P – phosphates, R – red beds, Si – silica, T – tillites, V – volcanics.

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