Accretion and Dispersion of Southeastern Sundaland: The Growing and Slivering of Continent and Petroleum Implications*

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Search and Discovery Article #30261 (2012)**
Posted December 31, 2012

*Adapted from oral presentation at AAPG International Convention and Exhibition, Singapore, 16-19 September 2012

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Abstract

Sundaland presently constitutes the southeastern corner of the Eurasian continental plate. Terrane analysis reveals that the Sundaland is made up of a number of terranes originating from the northern Gondwanaland, which rifted, drifted, and amalgamated in the Late Paleozoic and Mesozoic.

Occupying the position of active continental margin, the Sundaland recorded the history of the growing of continent by accretion. A number of SE Sundaland accreted crustal masses have been identified: oceanic Meratus, continental Paternoster, Ciletuh-Luk Ulo-Bayat subduction complex, continental SW Sulawesi, Bantimala-Barru-Biru subduction complex, Flores Sea Islands, and continental Sumba Island. These crustal masses accreted the "original" SE Sundaland (Schwaner Core) during 150-60 Ma (Late Mesozoic).

Started at around 50 Ma, in the Middle Eocene, some of the accreted mass of SE Sundaland rifted and drifted apart. The dispersed masses include SW Sulawesi, Flores Sea Islands, and Sumba Island. The dispersion of SE Sundaland is considered due to trans-tension rifting related to tectonic escape of India-Eurasia collision and/or back-arc spreading by rollback movement of slower rate-subduction, resulting in opening of the Makassar Straits and Bone Basins, segmentation of East Java Basement and slivering of Sumba terrane.

A number of sedimentary basins developed during dispersion of SE Sundaland, provided by Paleogene tectonostratigraphic sequences with proven and potential sources, reservoirs and traps. Reconstruction of accretion and dispersion of SE Sundaland can reveal the evolution and development of the basins, important for exploration evaluation

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AAPG International Conference & Exhibition
Singapore, 16-19 September 2012

Accretion and Dispersion of Southeastern Sundaland: The Growing and Slivering of Continent and Petroleum Implications

Awang H. Satyana (BPMIGAS)

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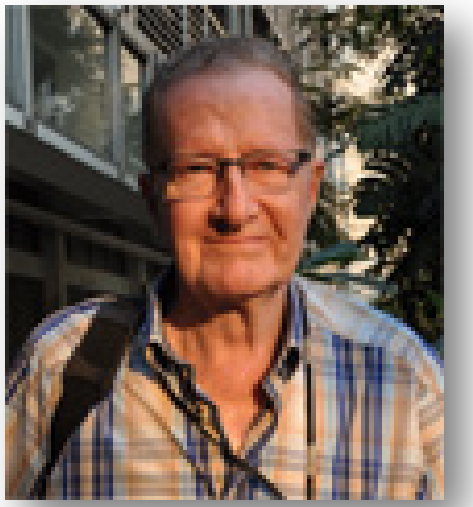
1. Introduction
2. Regional Setting
3. Accretion of Sundaland
4. Dispersion of Southeastern Sundaland
5. Petroleum Implications
6. Conclusions

Sundaland according to Prof. Charles S. Hutchison

- The term ***Sundaland*** strictly defines the landmass of south-east Asia, comprising Indochina, the Thai–Malay Peninsula, Sumatra, Java, Borneo, and the shallow marine shelf (the 'Sunda Shelf ') between them which stood above the sea during the low sea levels of the Pleistocene epoch.
- ***Sundaland*** is itself a composite of welded cratonic terrains and younger orogenic belts, which stabilized to form the single aseismic cratonic core of south-east Asia during Late Triassic times. Younger tectonic activity has occurred around its active margins.

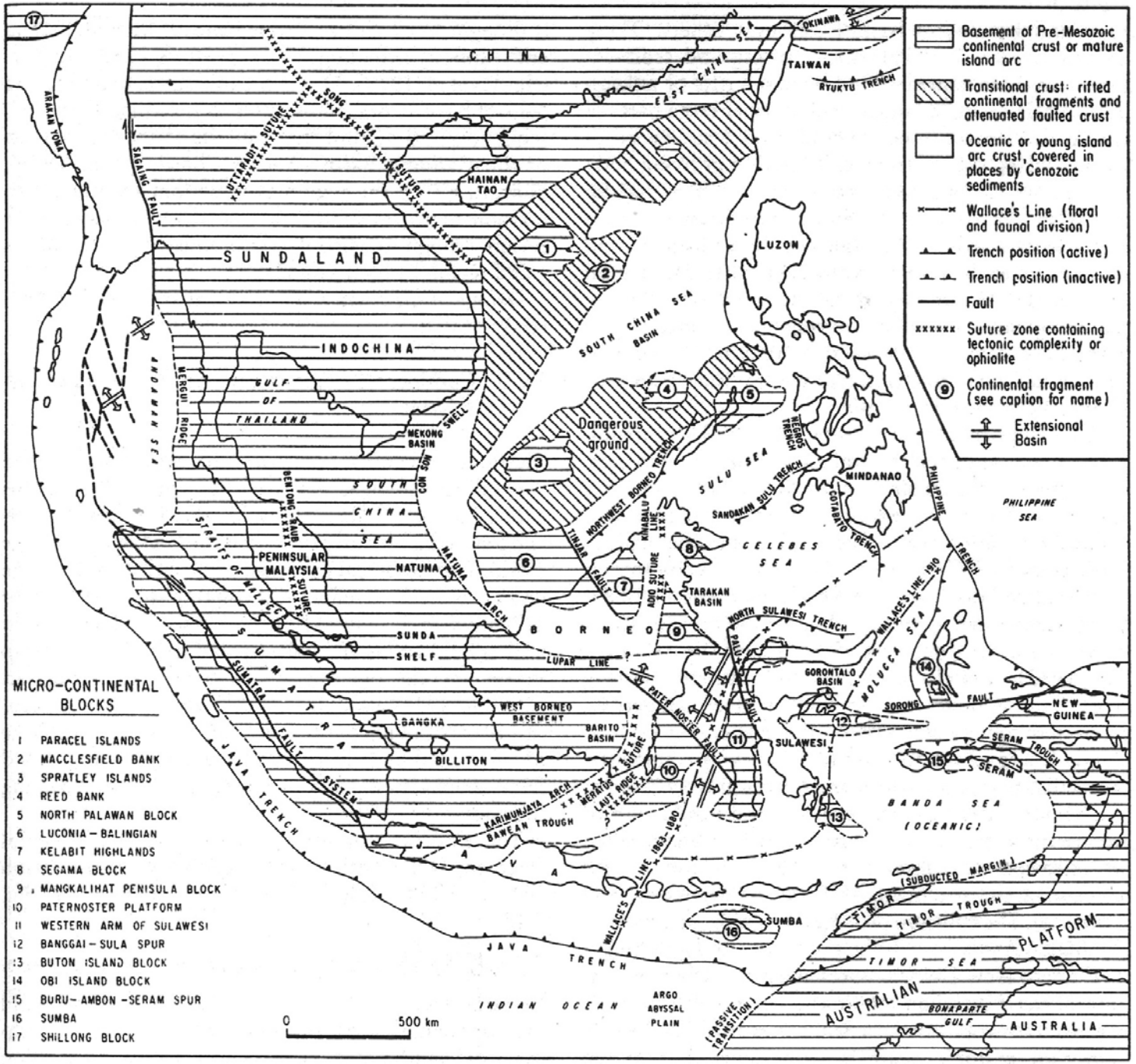


1933 - 2011

- The margins of ***Sundaland*** are somewhat fragmented and tectonically complicated on the east. The margins of ***Sundaland*** in south Borneo are also ill-defined.
- The Early Tertiary opening of the Makassar Basin has rifted away from Borneo the western now extinct volcanic arc of Sulawesi, which appears to have once formed the eastern margin of Borneo, and hence is regarded as a rifted part of ***Sundaland***.

Hutchison (1989), Geological Evolution of South-East Asia

Distribution of pre-Mesozoic continental basement in SE Asia



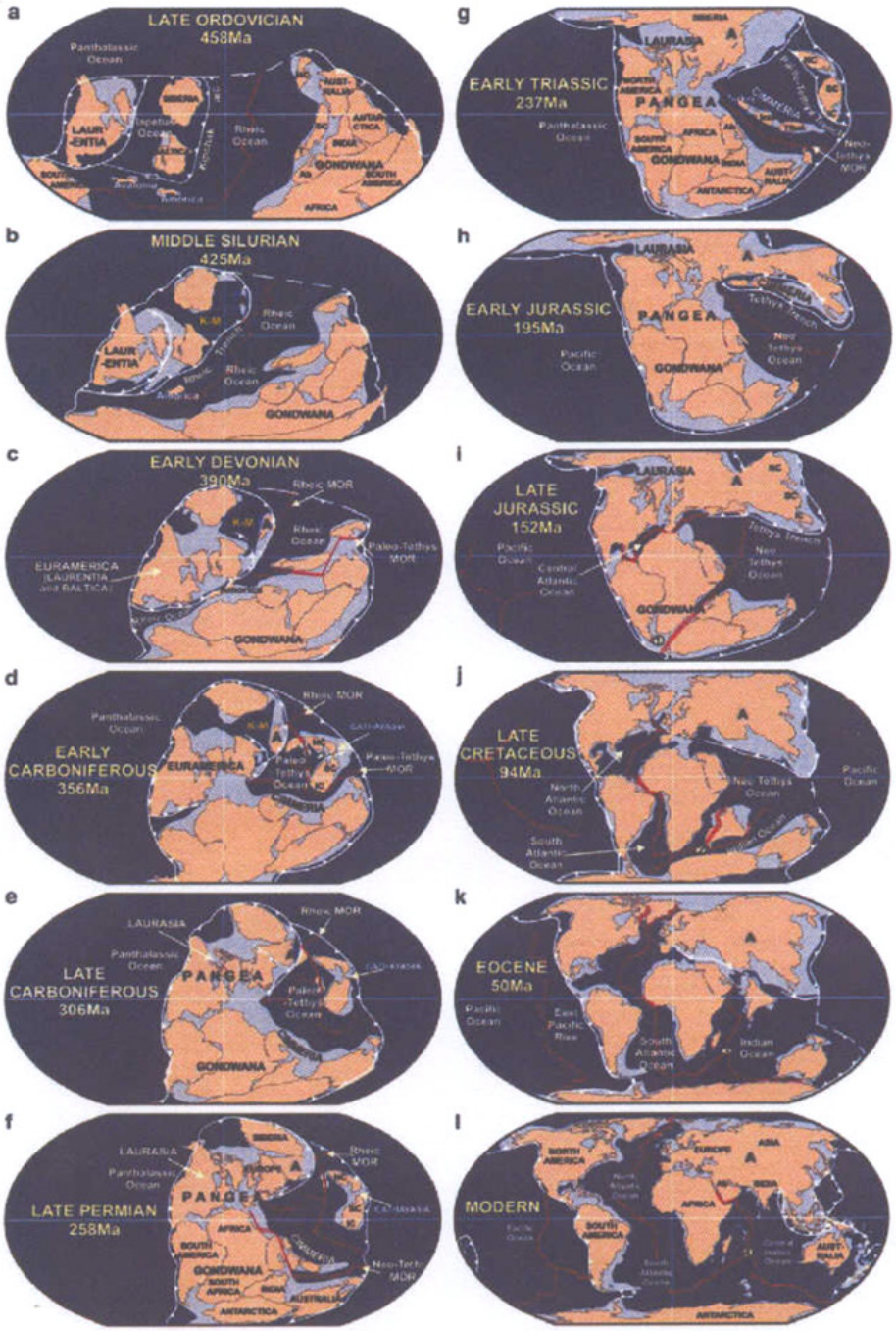
Hutchison (1984)

Accretion and Dispersion of Sundaland

- Sundaland was formed by *amalgamation* of continental blocks during the Triassic Indosinian orogeny and is surrounded by material mostly added later in the Mesozoic (Hall and Morley, 2004).
- The formation of present-day SE Asia involved the *progressive suturing* of terranes to each other during Late Palaeozoic to Cenozoic times and their subsequent *disruption*, principally caused by the collision of India with Eurasia. The ages of sutures in eastern and SE Asia become younger to the south and southeast (Metcalfe, 1996).
- Plate *fragmentation* of SE Asia by NW-SE shears (Wood, 1985) could have been produced by the collision of cratonic India with Eurasia (extrusion or escape tectonics (Tapponier et al., 1982, 1986). The continental lithosphere of SE Asia would be *displaced* towards the east and south-east as India indents (Sengor and Hsu, 1984; Hutchison, 1985).

amalgamation, progressive suturing = accretion
disruption, fragmentation = dispersion

Phanerozoic Plate Reconstruction



Continents passed their history through numerous alternating accretion and dispersion. Sundaland is a miniature to this.

Collins (2003)

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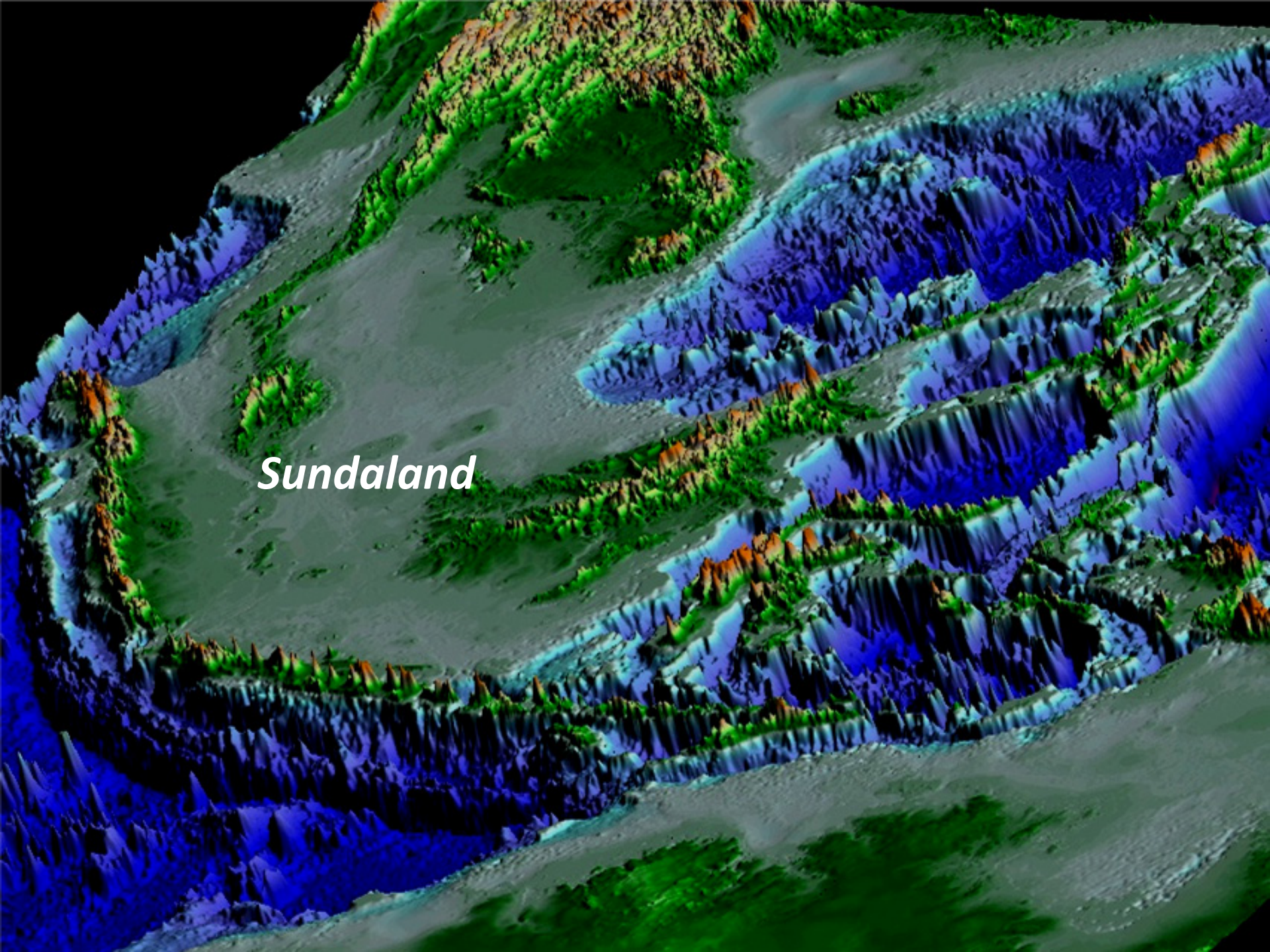
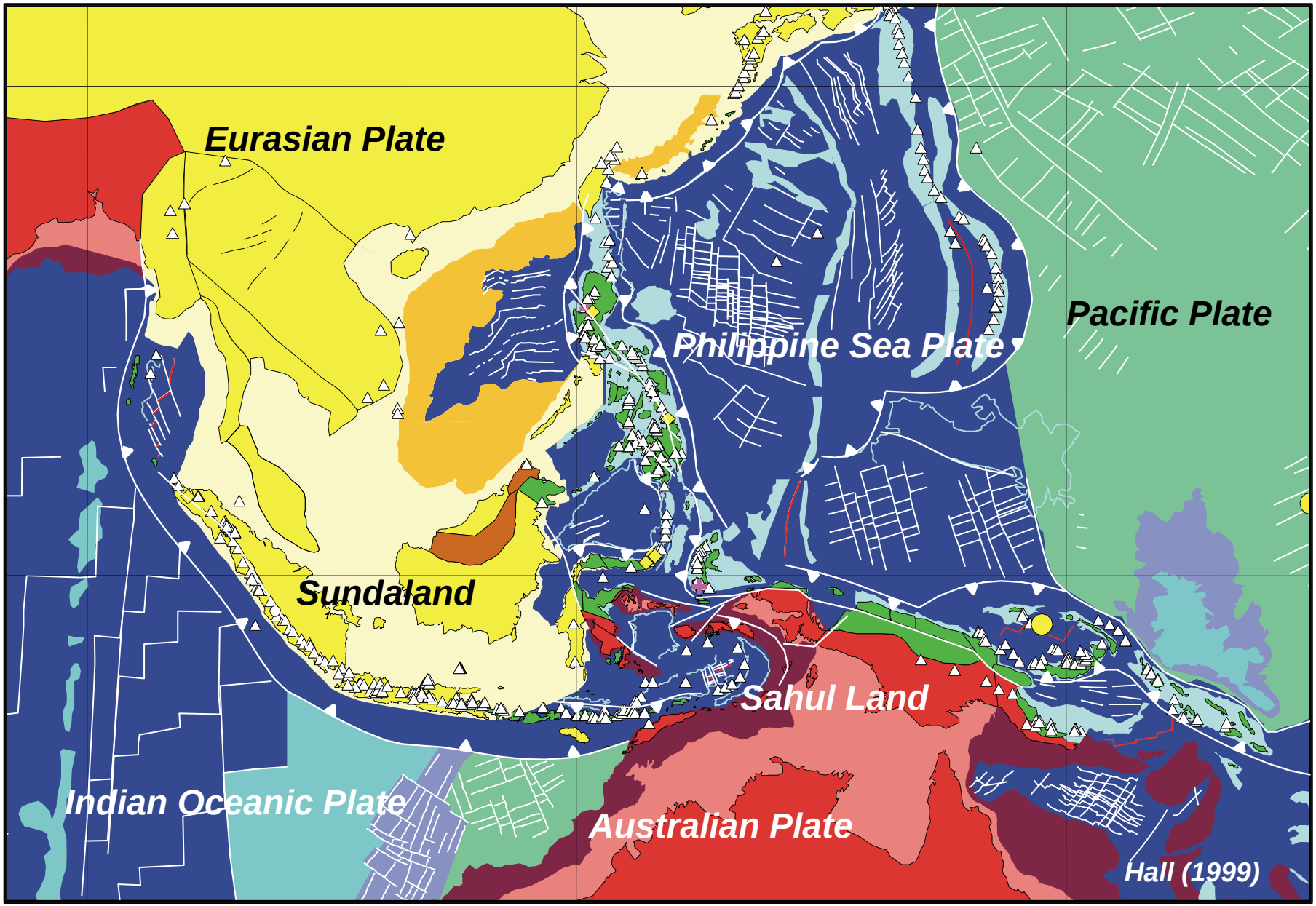
Sundaland

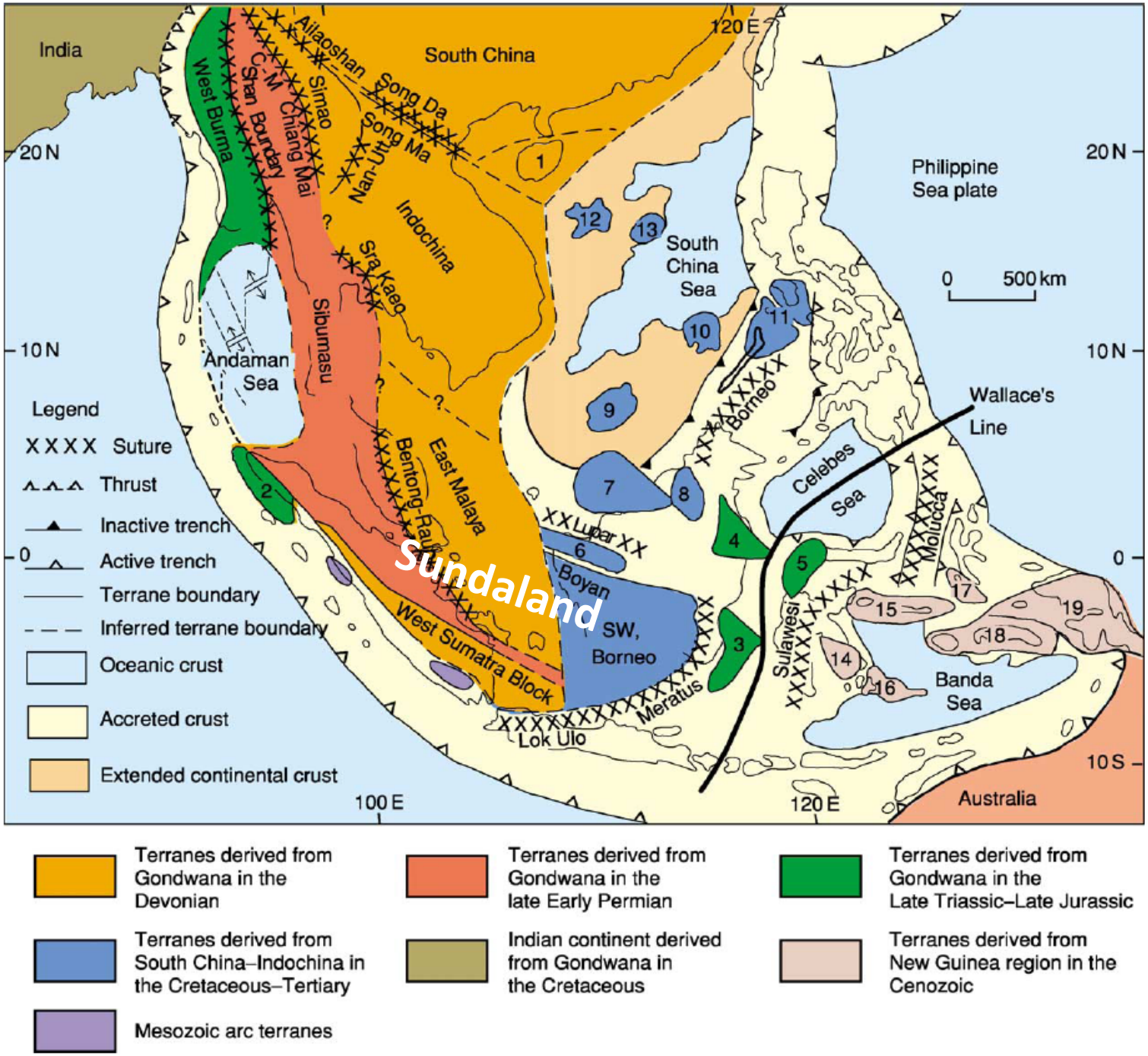

Sundaland



Present Tectonic Setting of Indonesia

Contents

Sundaland is an amalgamation of terranes



Terranes derived from Gondwana in the Devonian

Terranes derived from Gondwana in the late Early Permian

Terranes derived from Gondwana in the Late Triassic–Late Jurassic

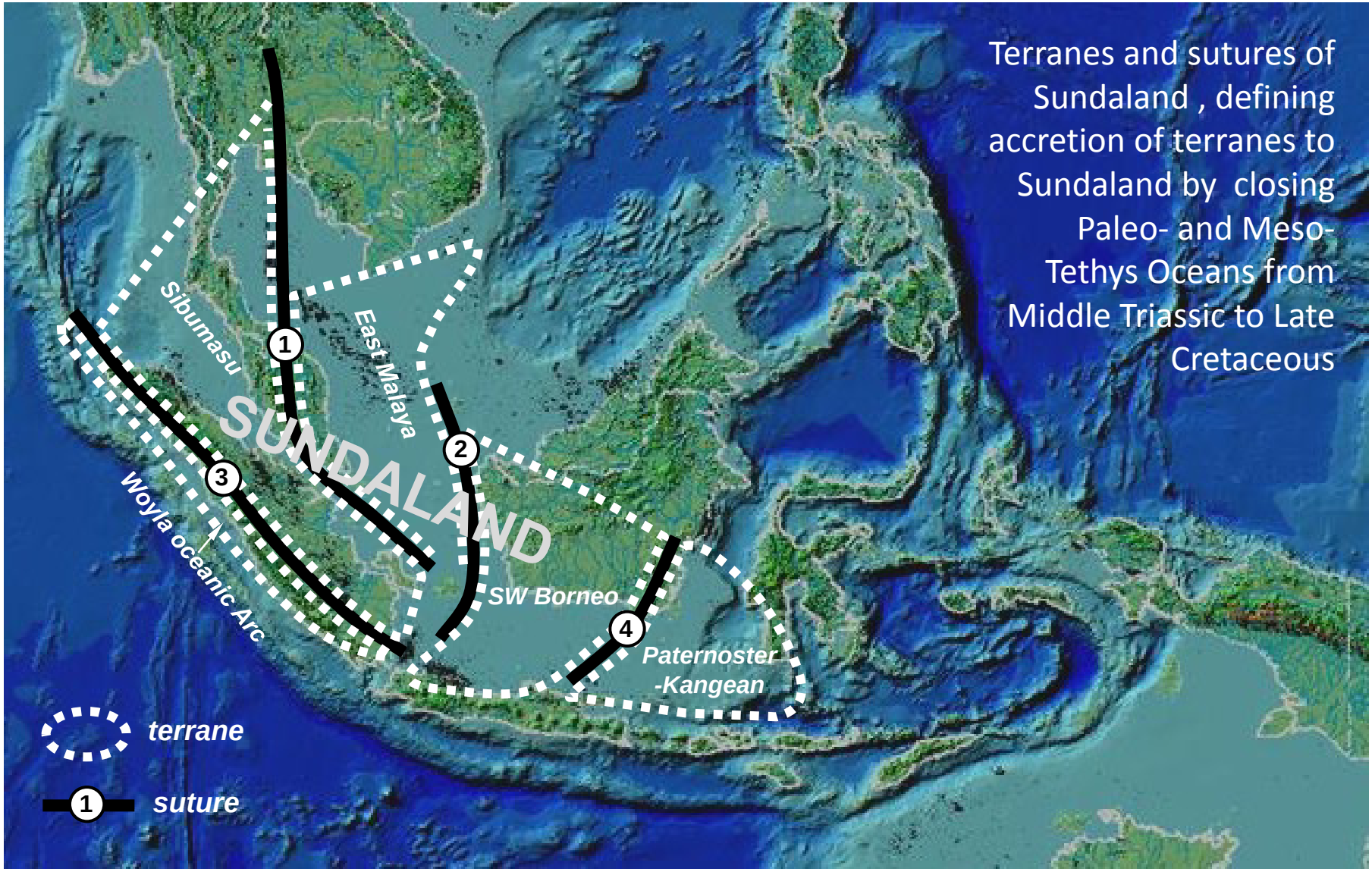
Terranes derived from South China–Indochina in the Cretaceous–Tertiary

Indian continent derived from Gondwana in the Cretaceous

Terranes derived from New Guinea region in the Cenozoic

Mesozoic arc terranes

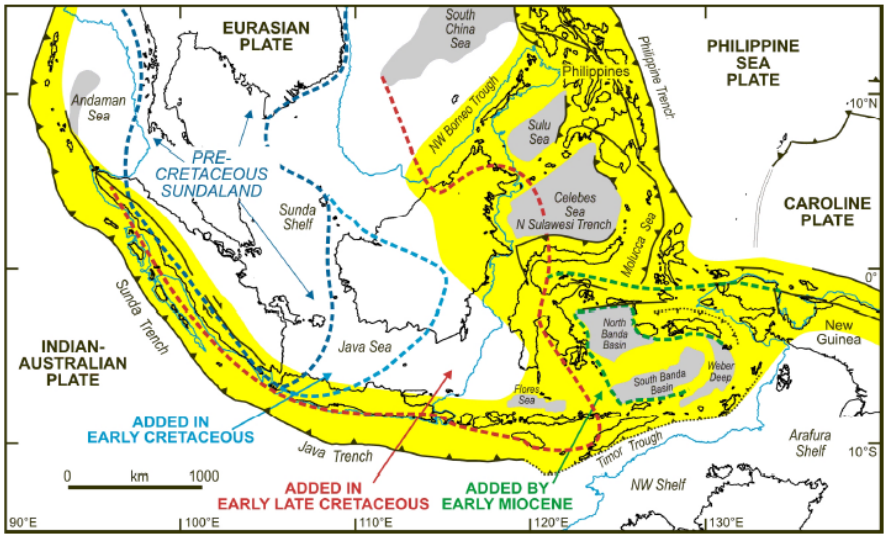
Metcalfe (1996)

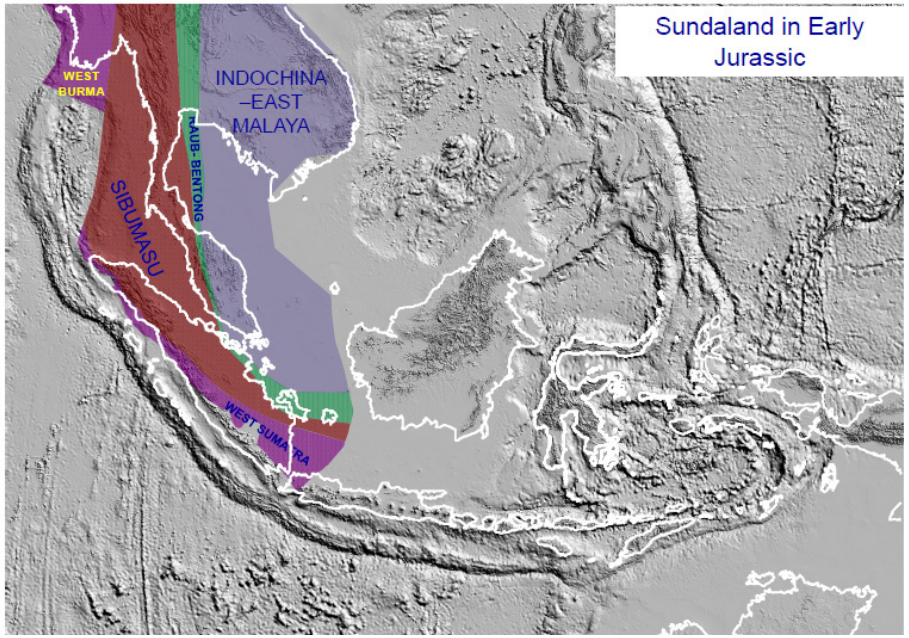


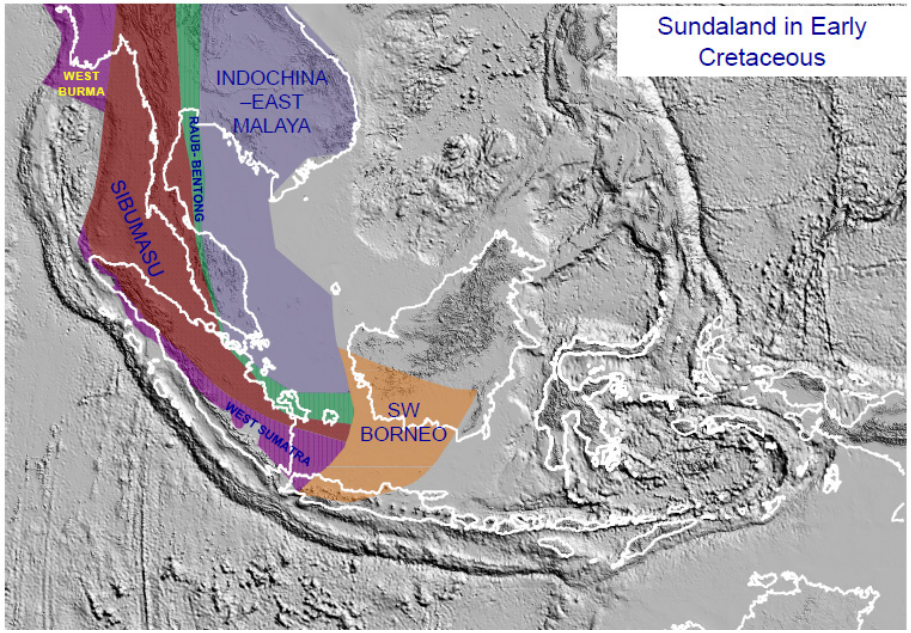
1. *Nan-Uttaradit, Raub-Bentong, Karimun-Bangka Paleo-Tethys suture (Middle-Late Triassic)*
2. *Natuna-Belitung Paleo-Tethys suture (Early-Mid Cretaceous)*
3. *Takengon-Bandarlampung Meso-Tethys suture (mid-Late Cretaceous)*
4. *Meratus-Bawean Meso-Tethys suture (early-mid Late Cretaceous)*

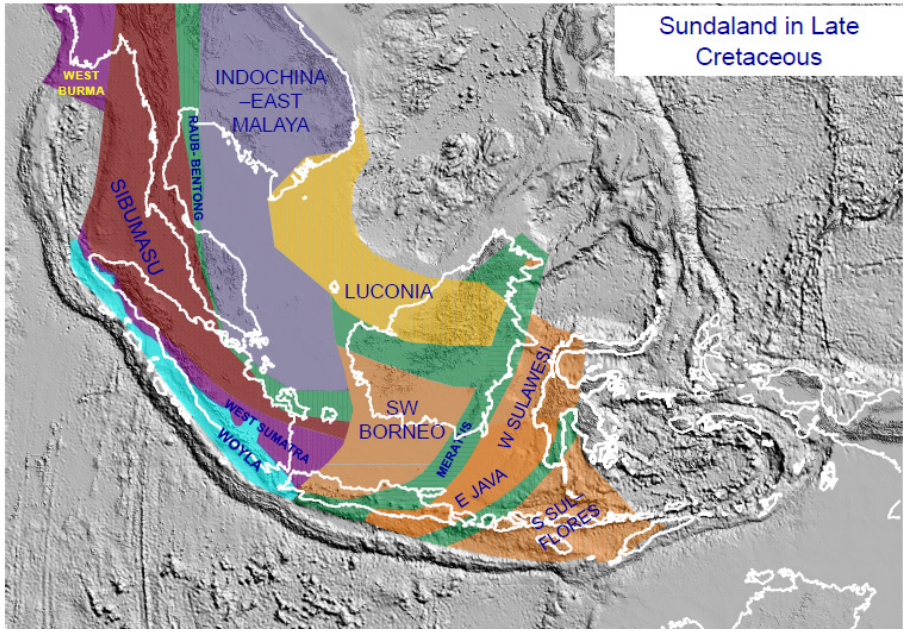
mod. after Satyana (2009)

Accretion of Sundaland

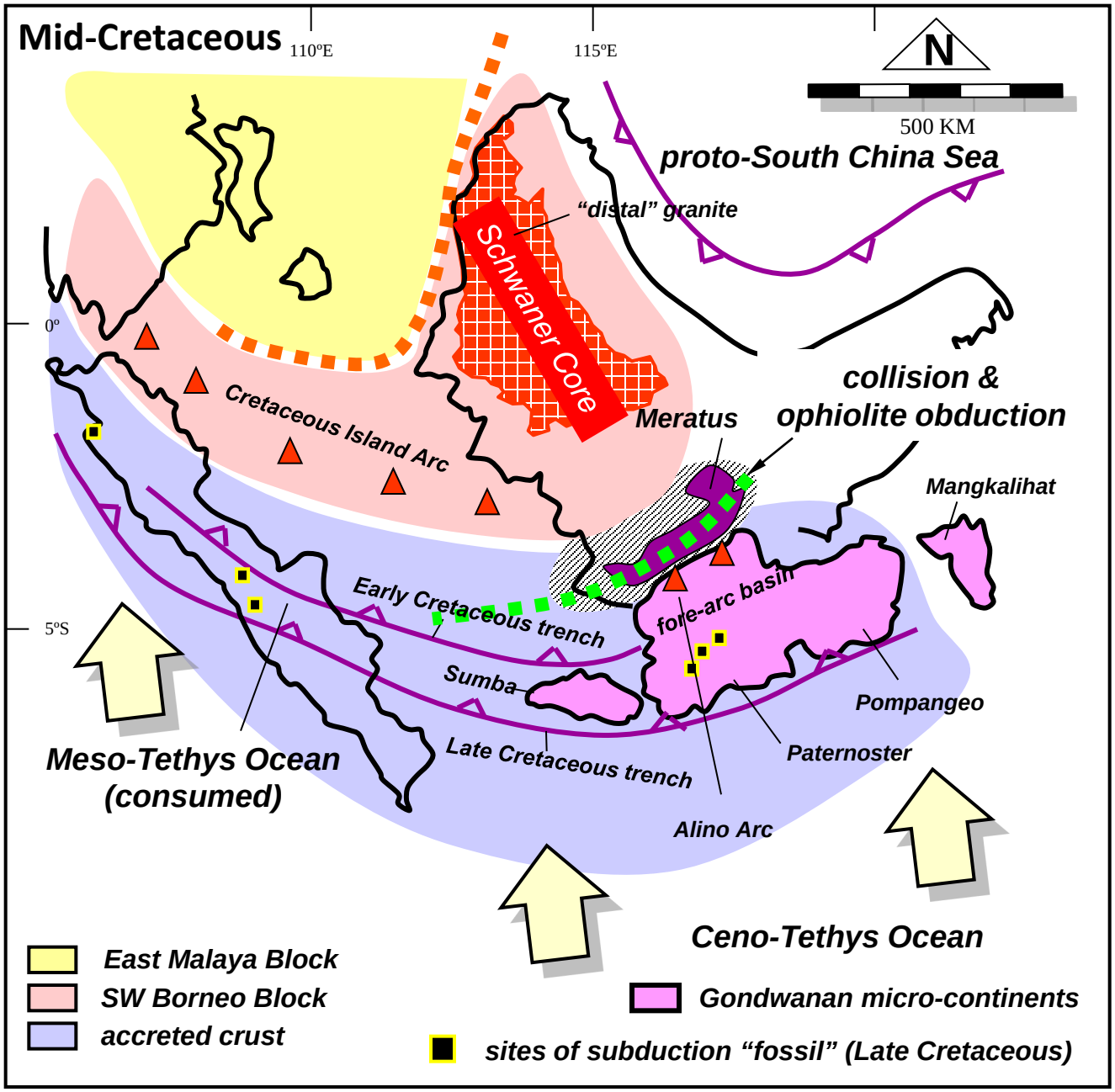








Hall (2012)



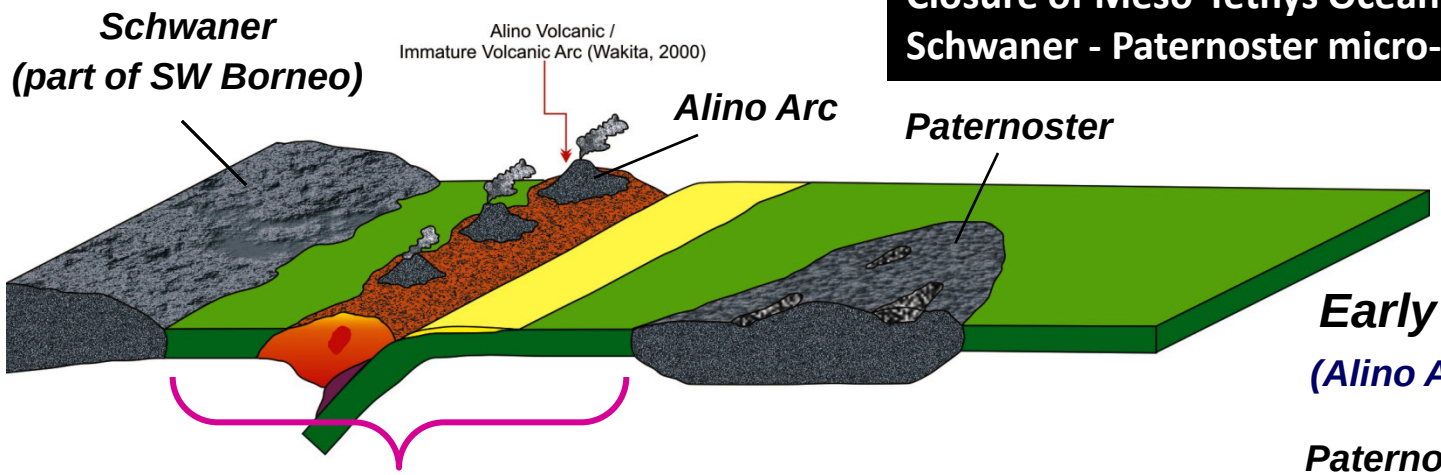
Accretion of Sundaland by Amalgamation of Paternoster to SW Borneo terranes, consuming Meso-Tethys Ocean, resulting in Meratus-Bawean suture

Meso-Tethys suture

Paleo-Tethys suture

modified after Parkinson et al., (1998); Satyana (2003)

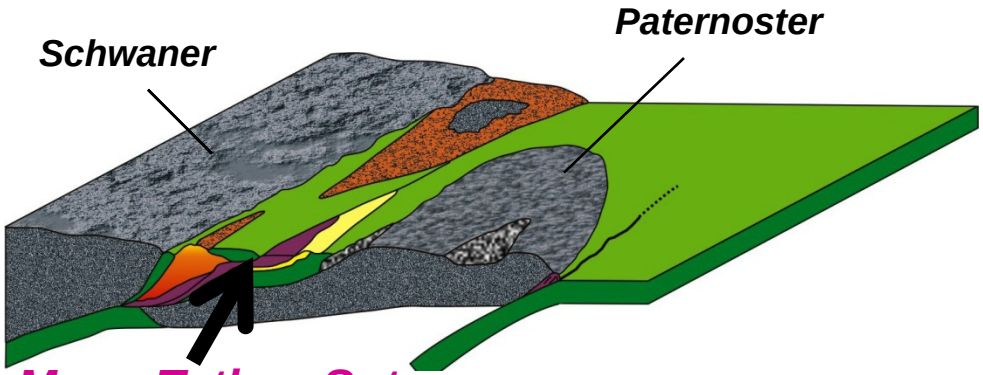
Closure of Meso-Tethys Ocean by Collision of Schwaner - Paternoster micro-continents



Early Cretaceous

(Alino Arc formation)

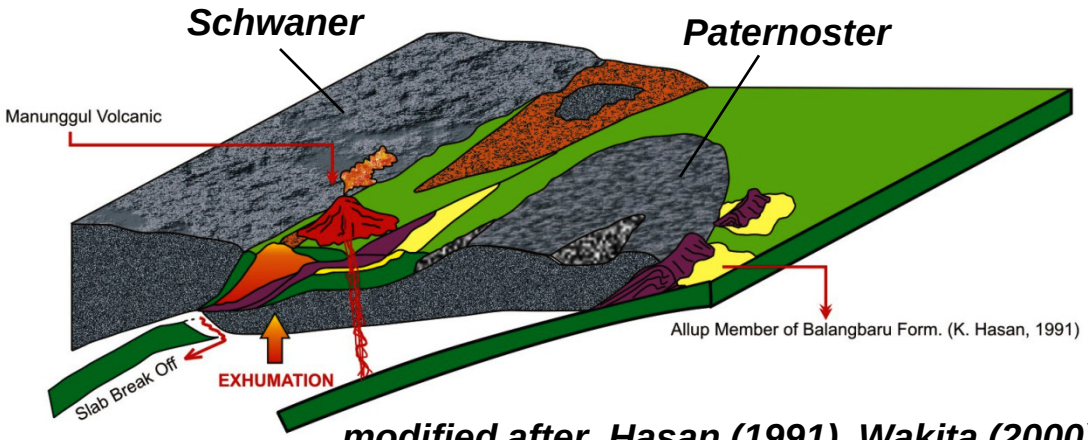
Meso-Tethys Ocean



upper Early Cretaceous

(collision and suturing)

Meso-Tethys Suture



Late Cretaceous

(Manunggul volcanics, slab break off, start of exhumation)

modified after Hasan (1991), Wakita (2000), Satyana and Armandita (2008)

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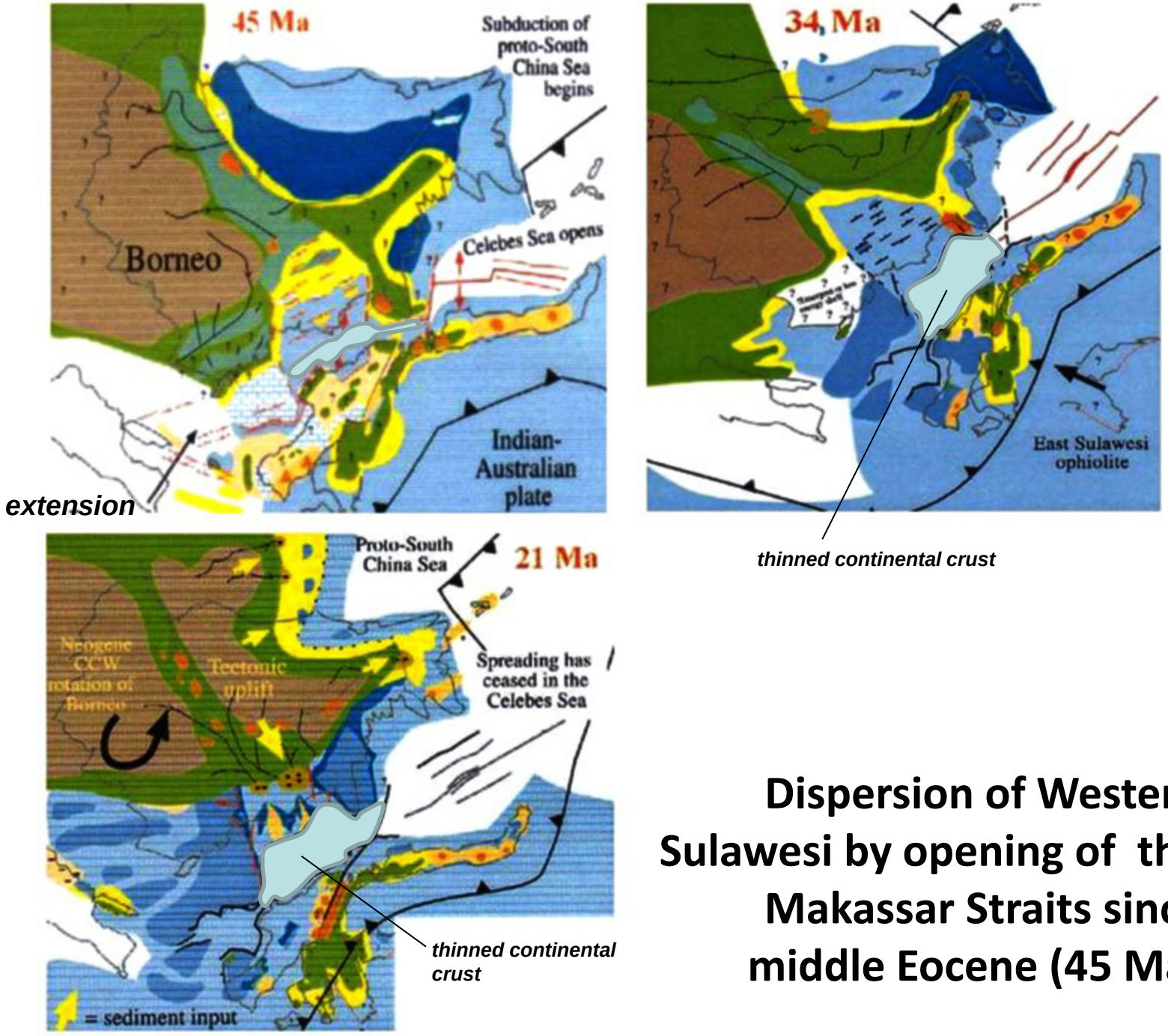
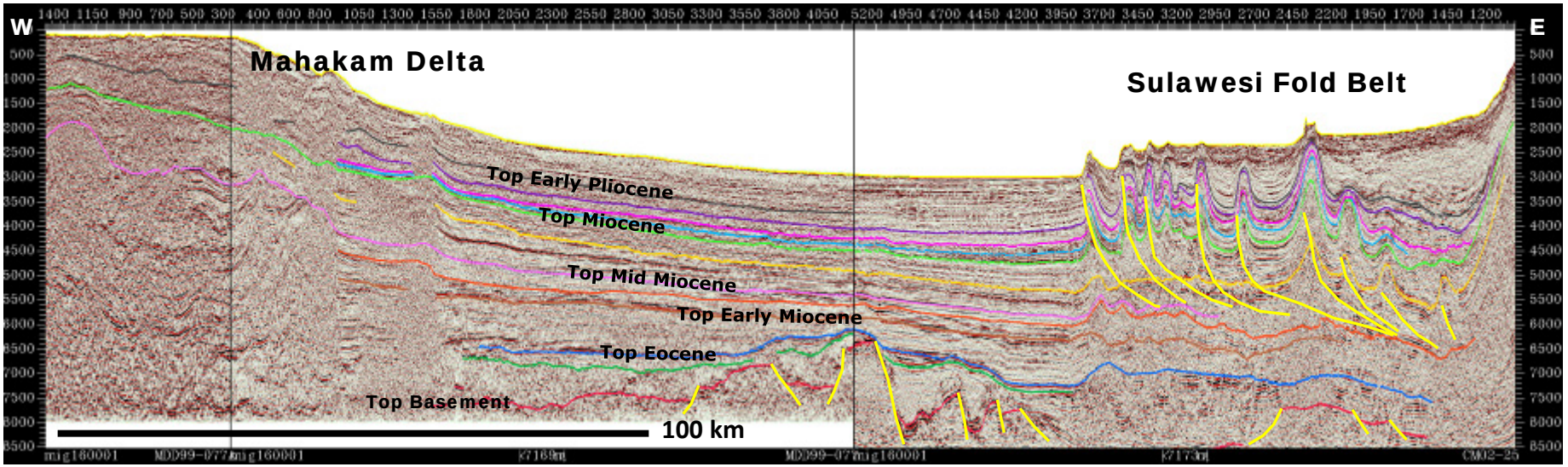
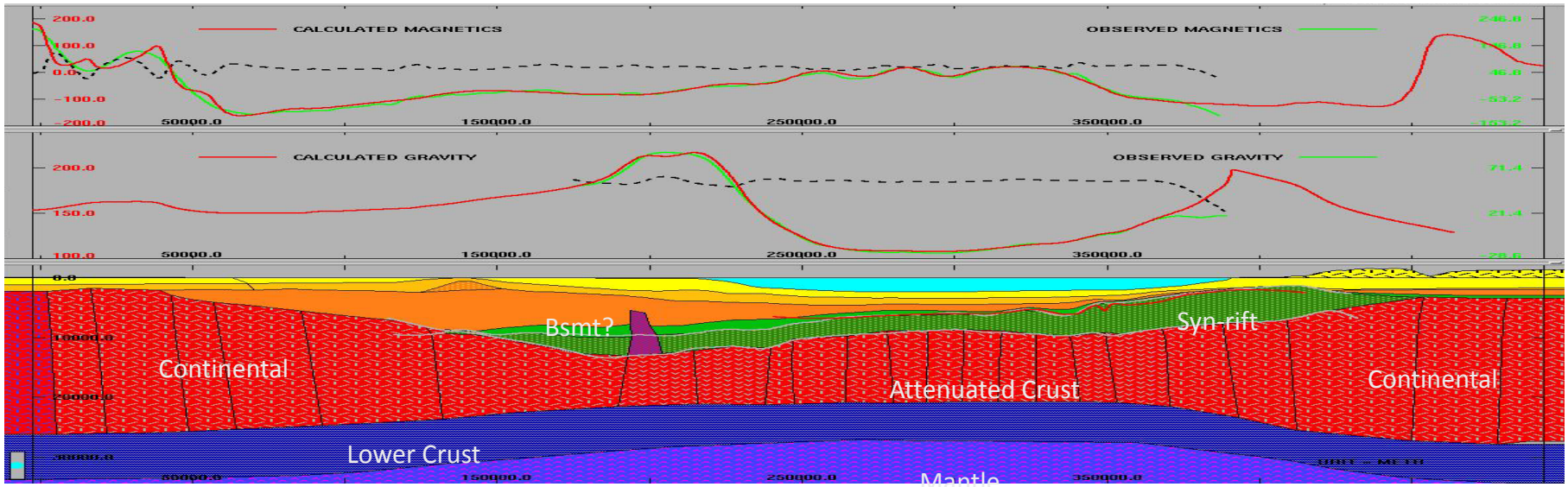


Dispersion of Western Sulawesi by opening of the Makassar Straits since middle Eocene (45 Ma)

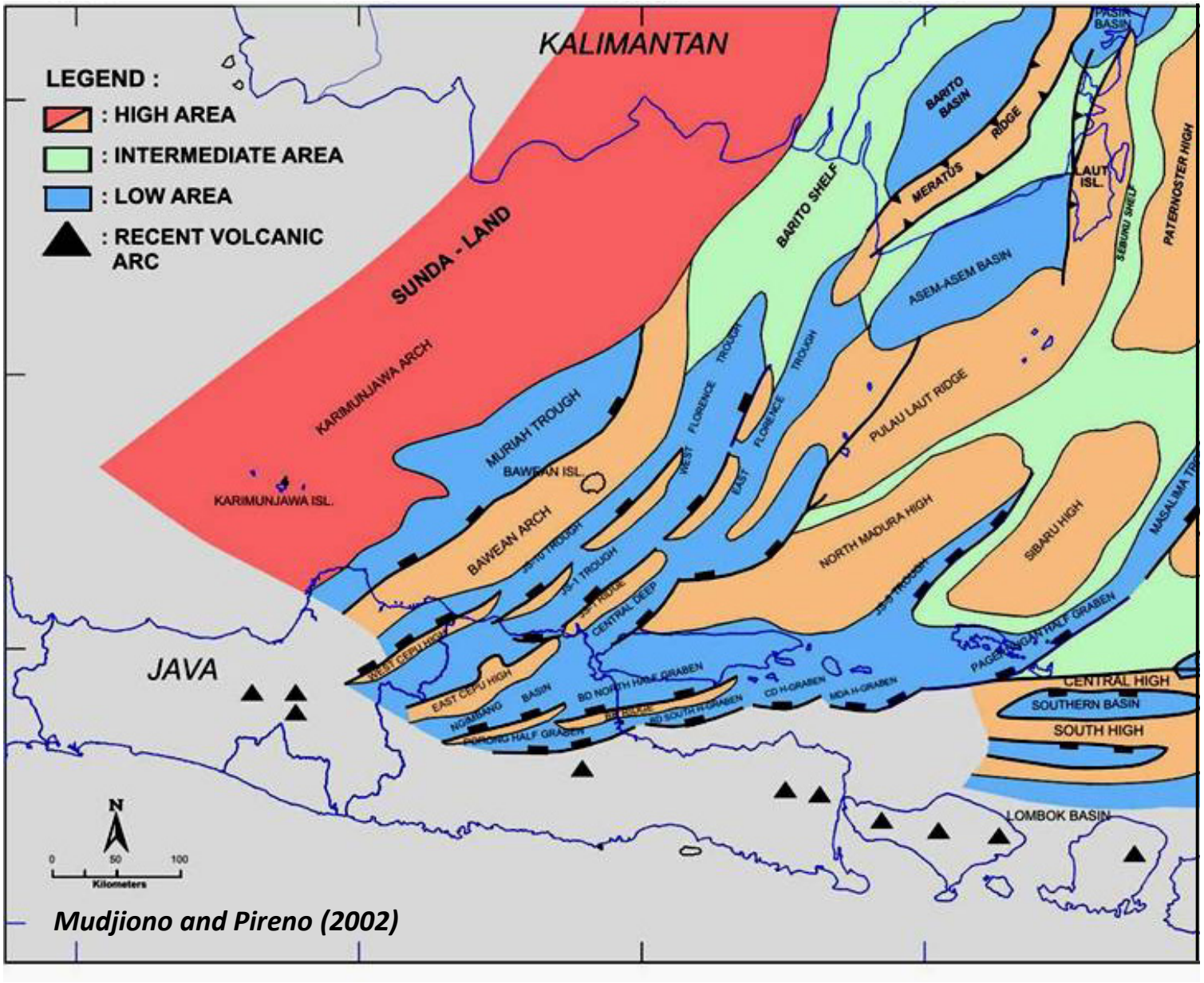
Makassar Straits Transects



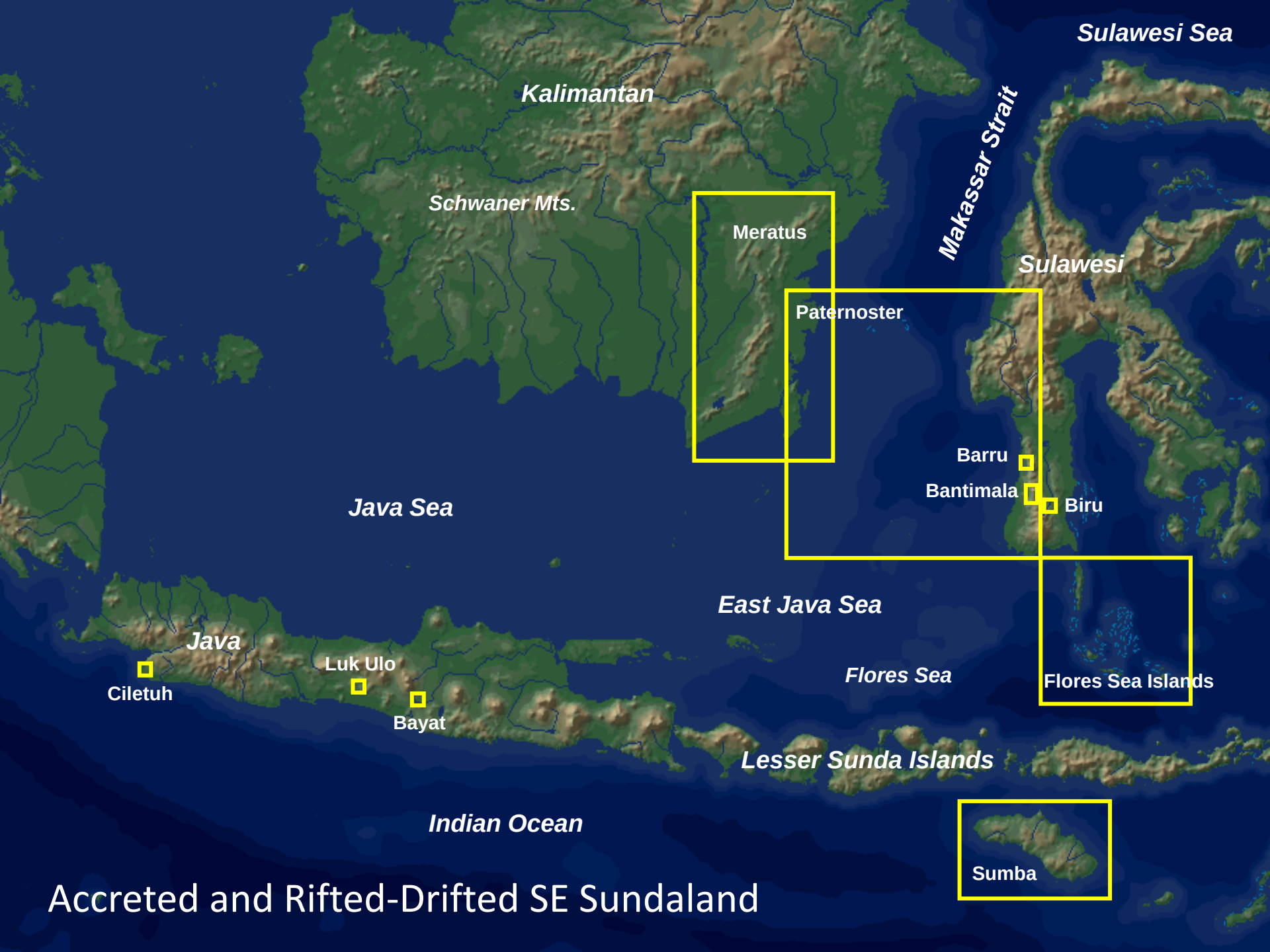


Gravity & Magnetics

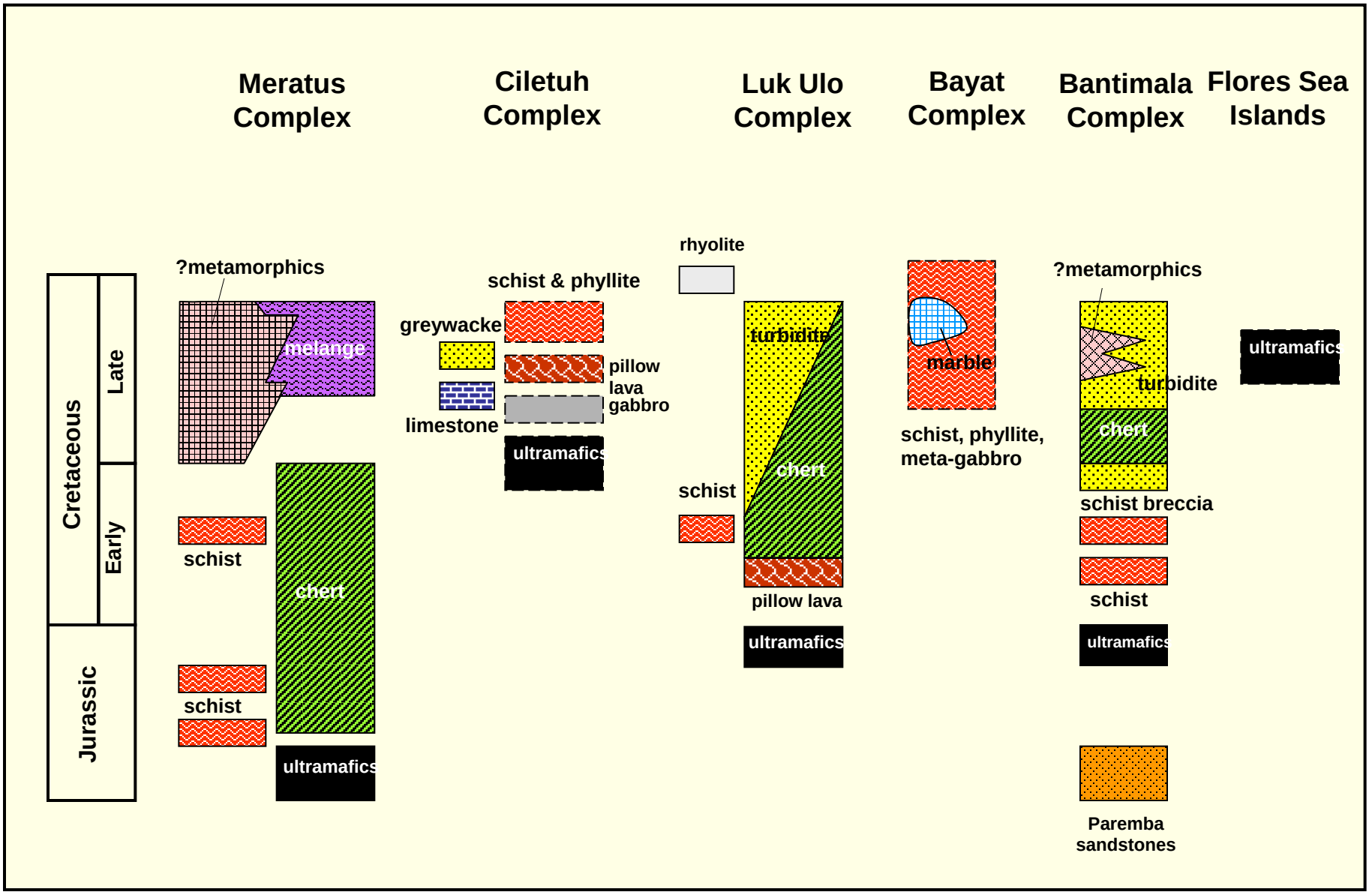
East Java Sea Rifted Structure



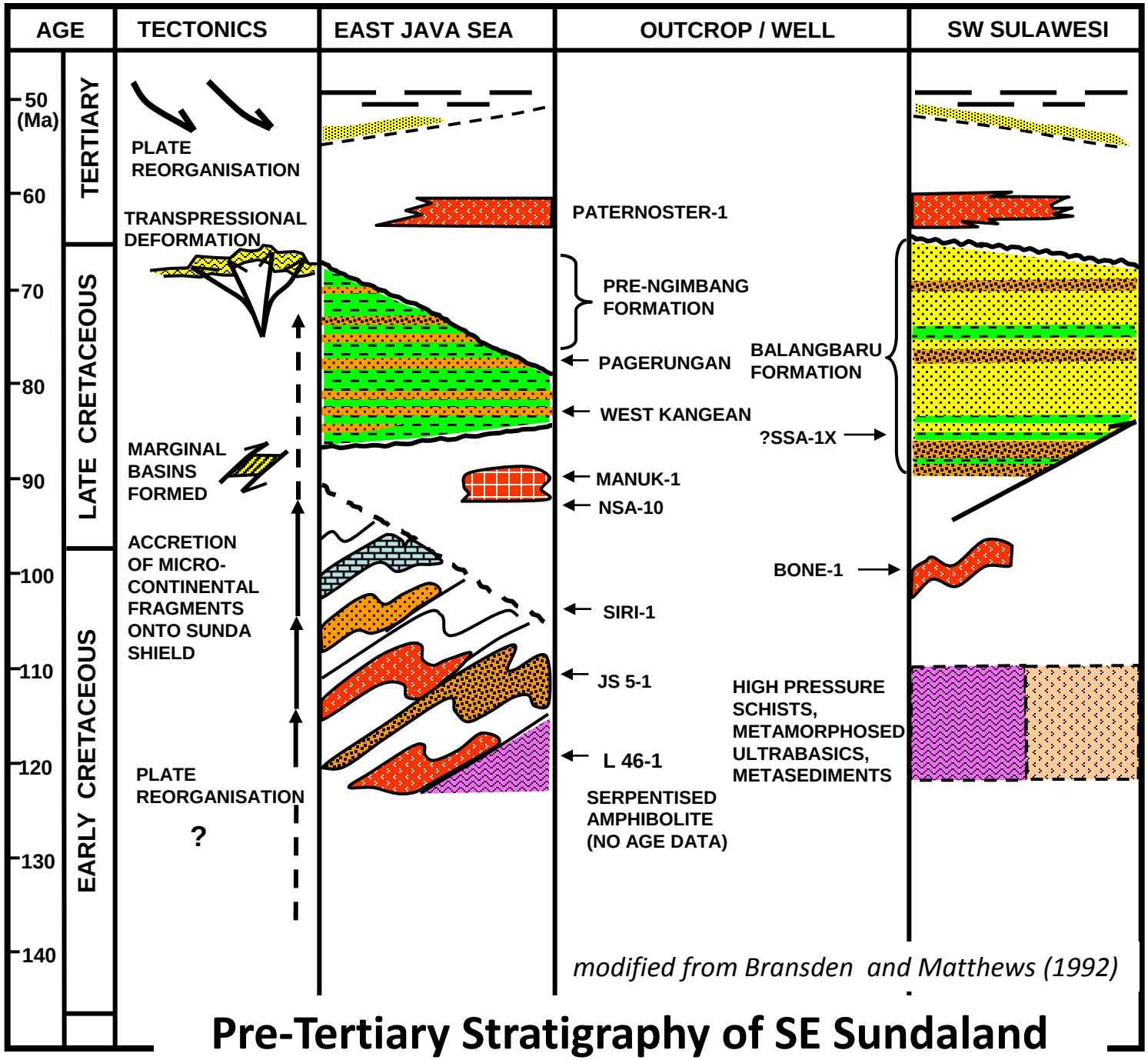
Mudjiono and Pireno (2002)



Accreted and Rifted-Drifted SE Sundaland

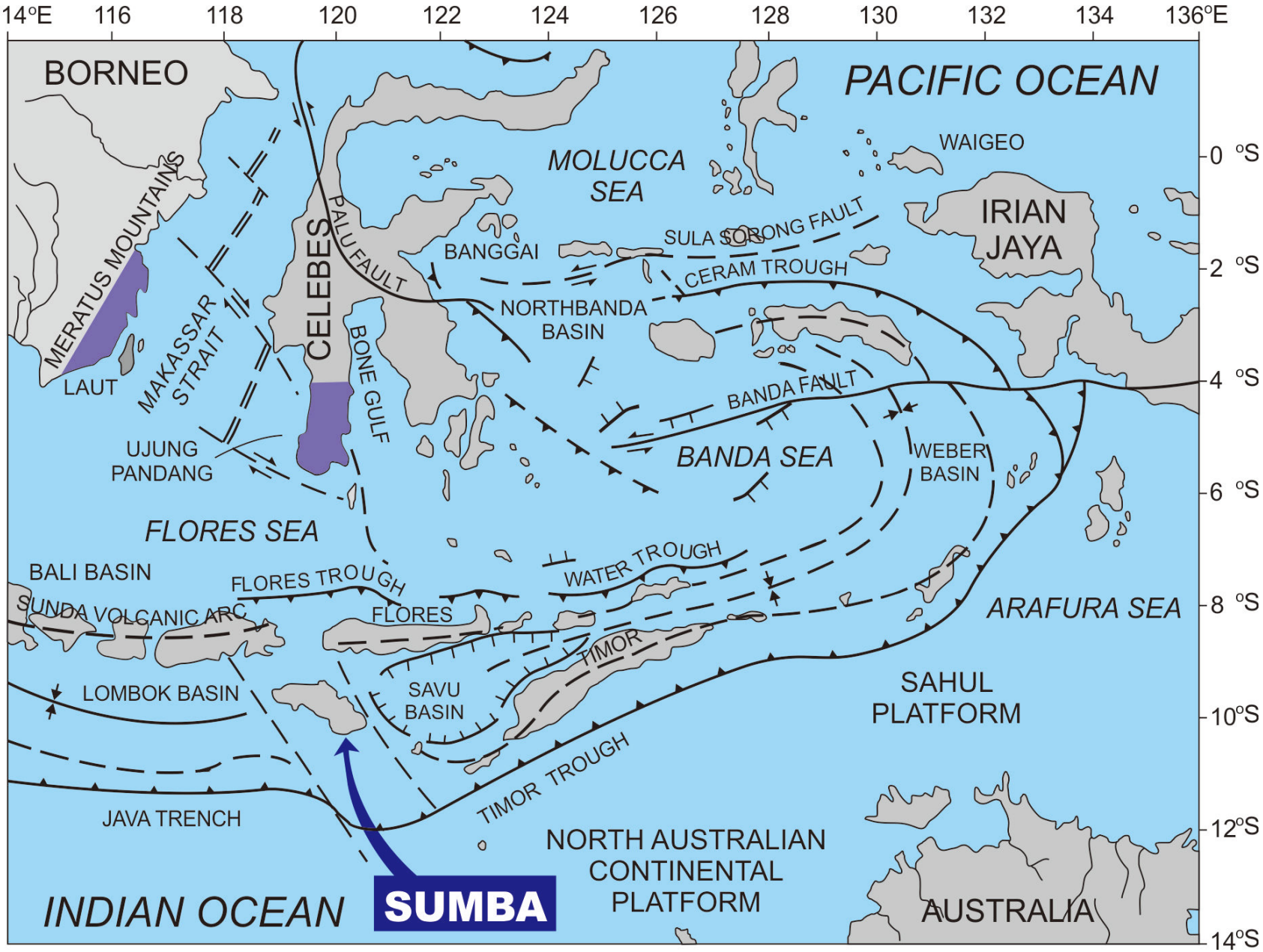


Stratigraphy of Accretionary Complex of SE Sundaland

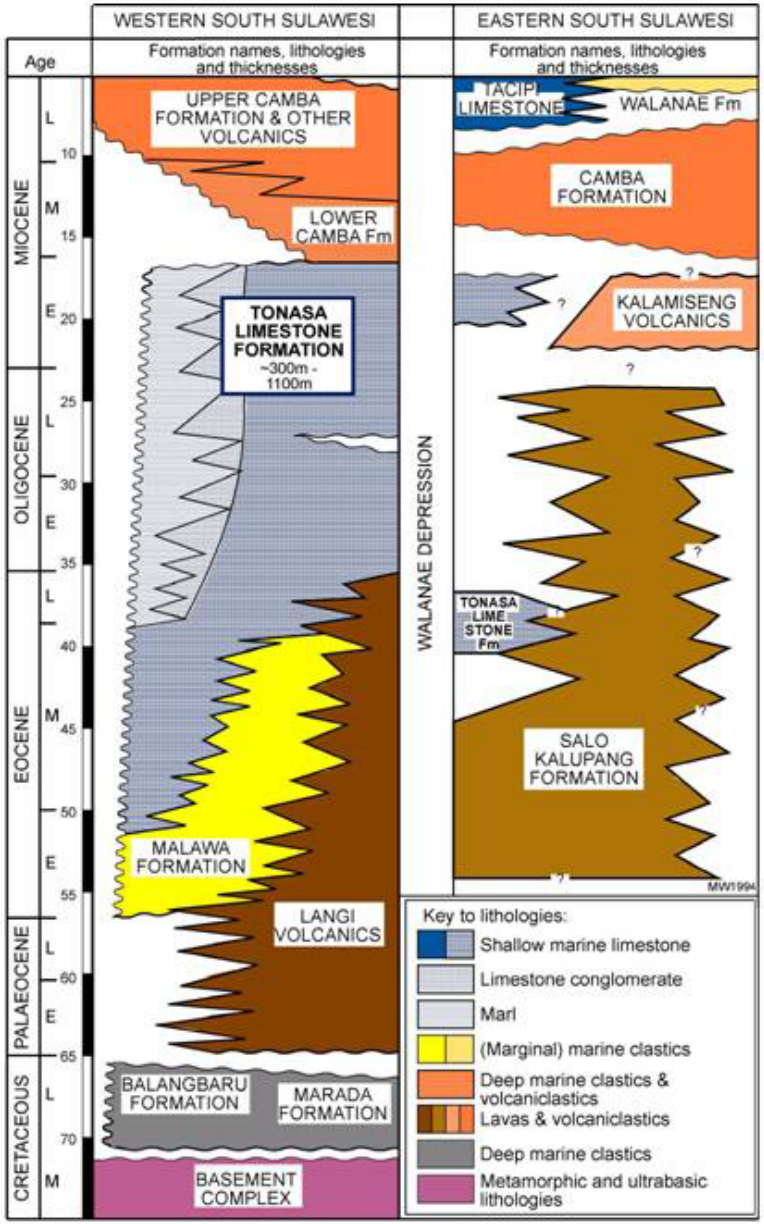


Pre-Tertiary Stratigraphy of SE Sundaland

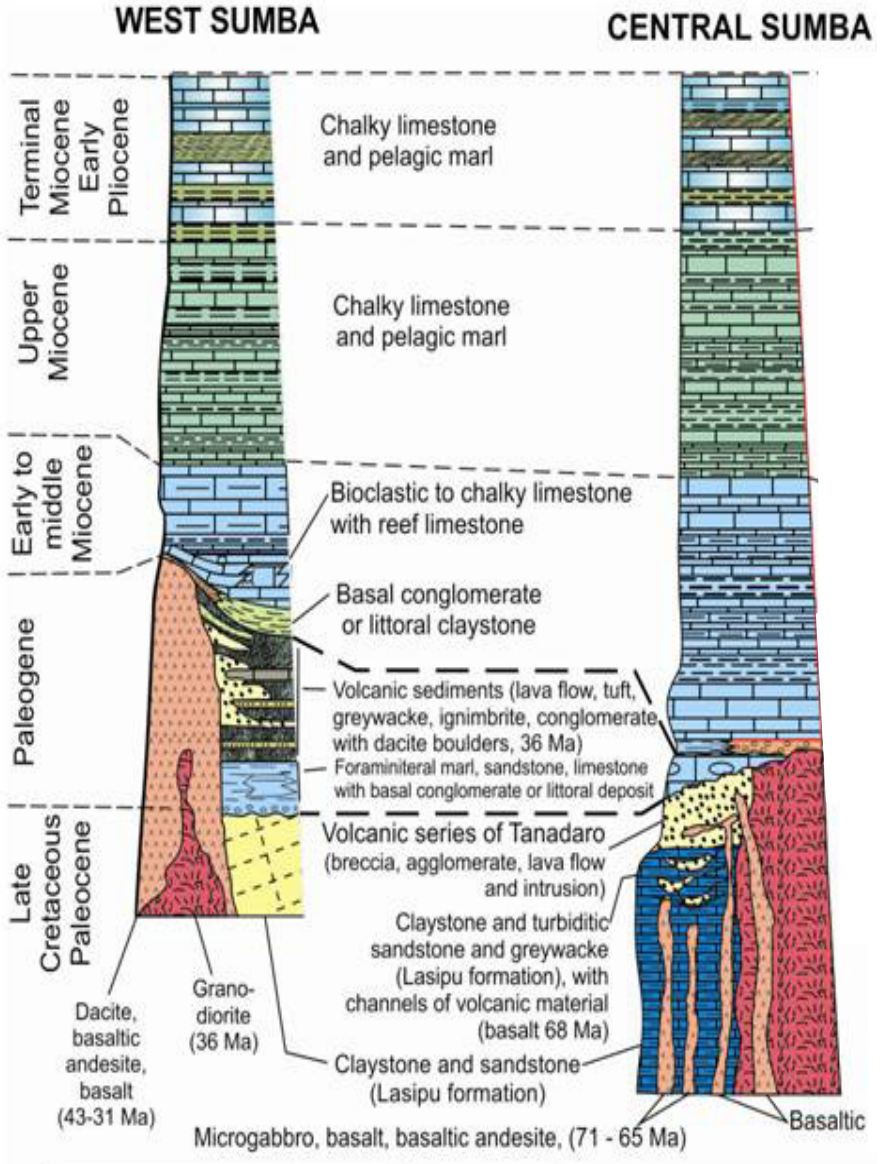
Regional Setting of Sumba Island



mod. after Hamilton (1979), Burollet and Salle (1981), Abdullah et al. (2000)

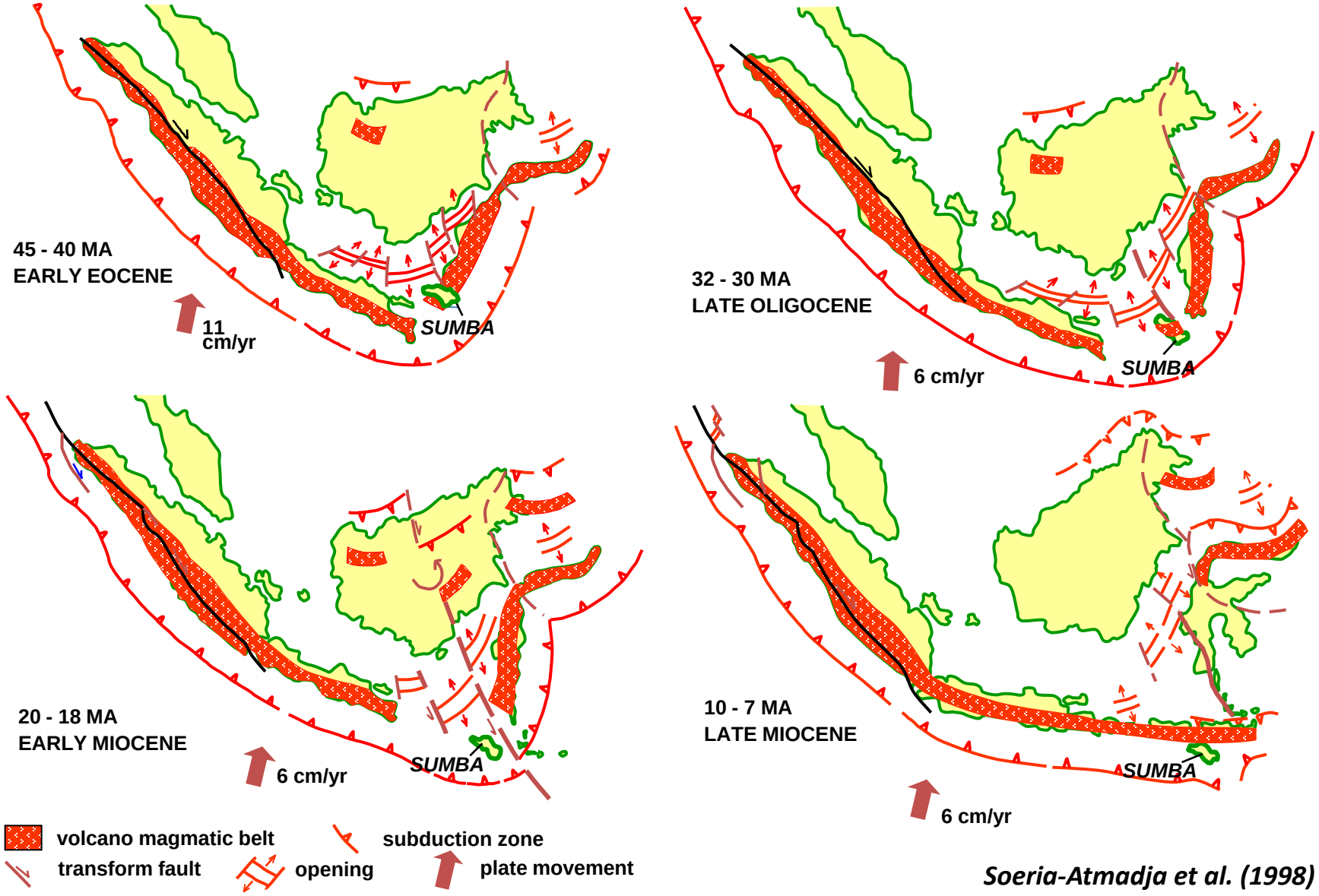


Wilson et al. (1996)



Abdullah (1994)

Stratigraphic Succession of South Sulawesi and Sumba



Soeria-Atmadja et al. (1998)

Detachment and Emplacement of Sumba Island

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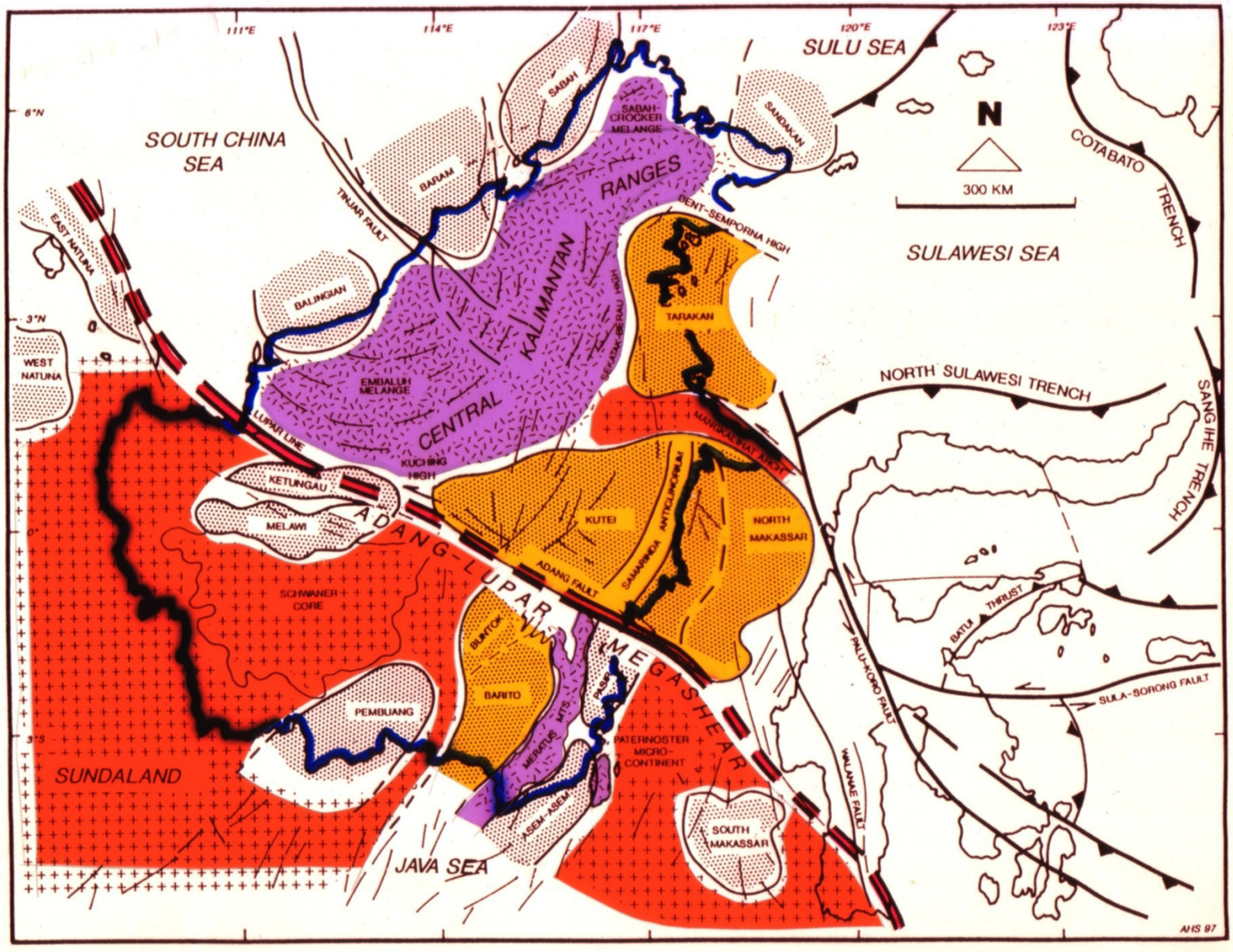
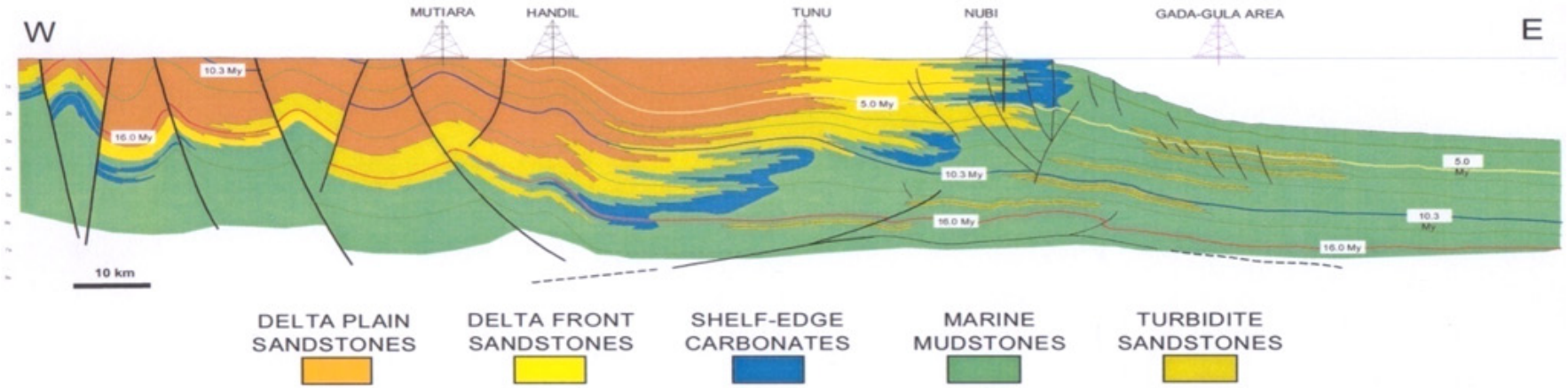


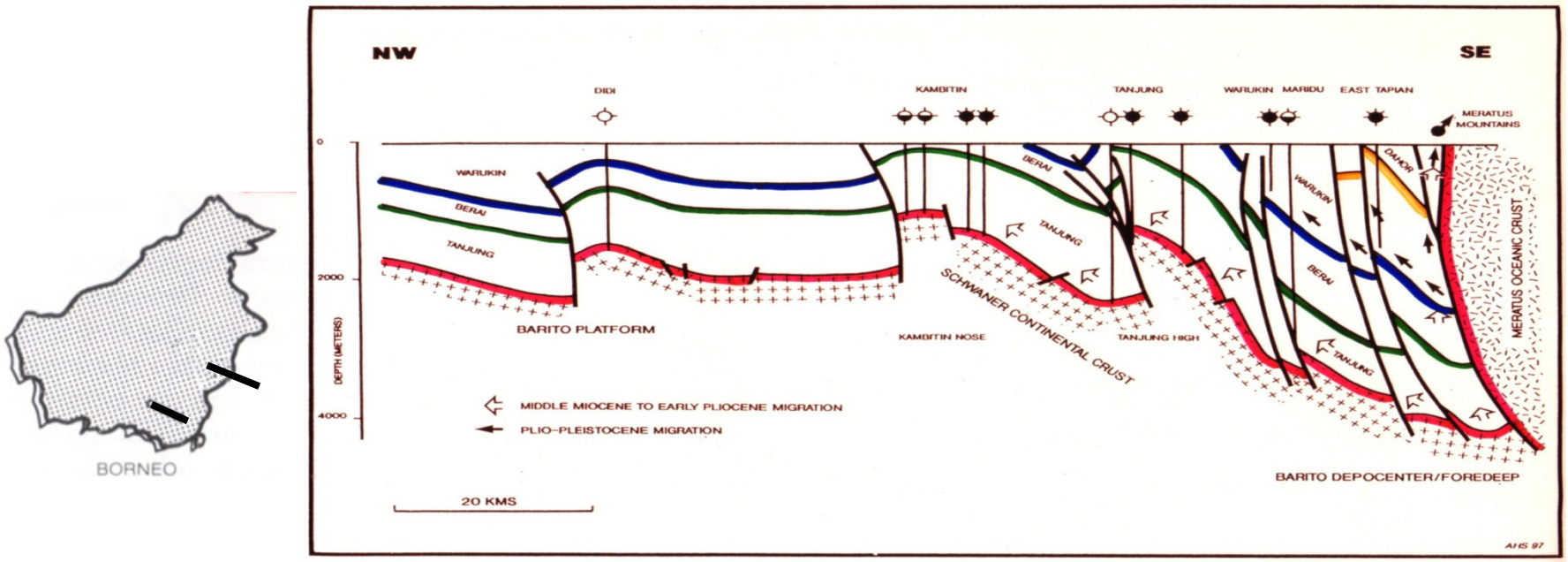
Kalimantan Tectonics and Basin Development

Satyana et al. (1999)

Kutei - North Makassar Basins

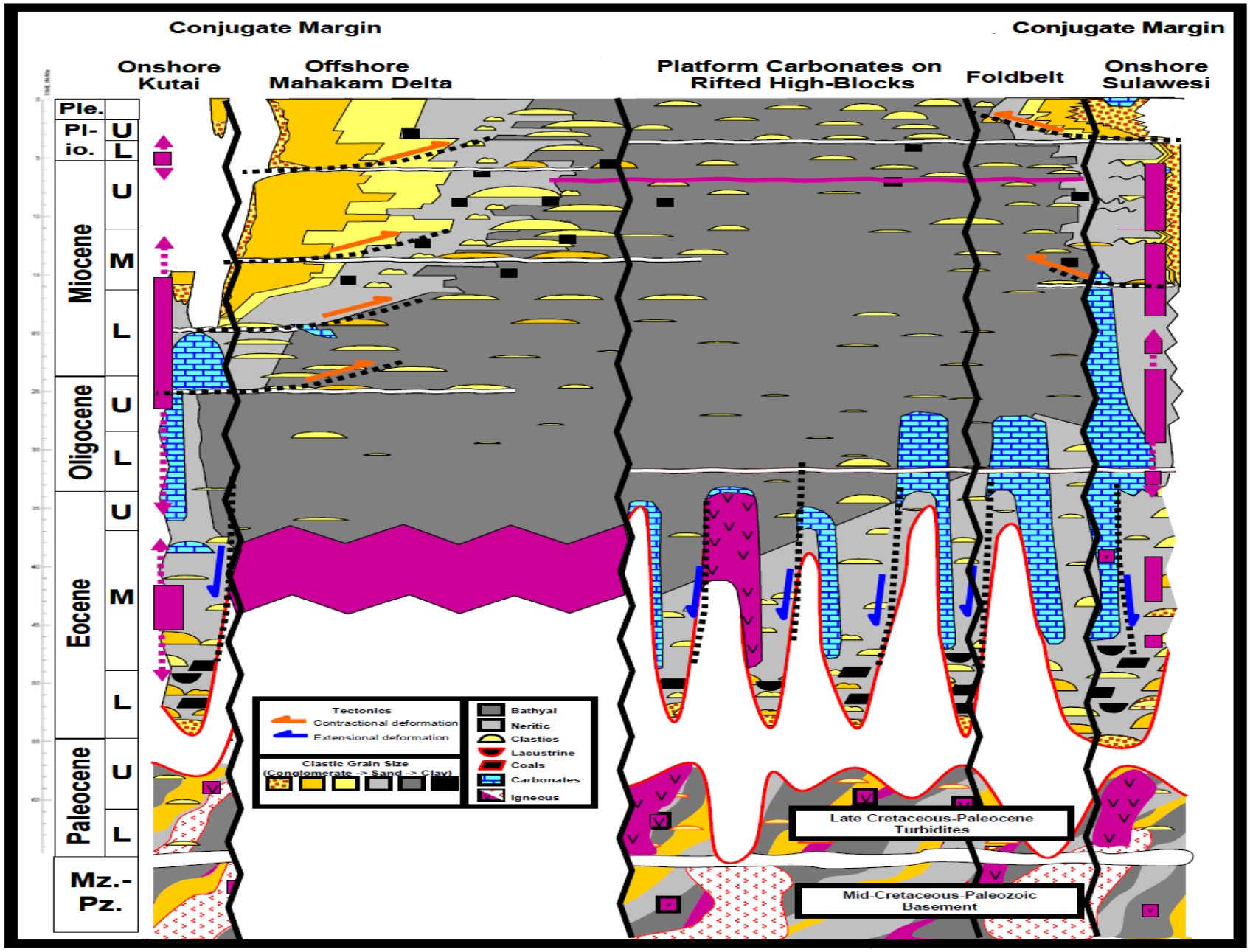


Barito Basin



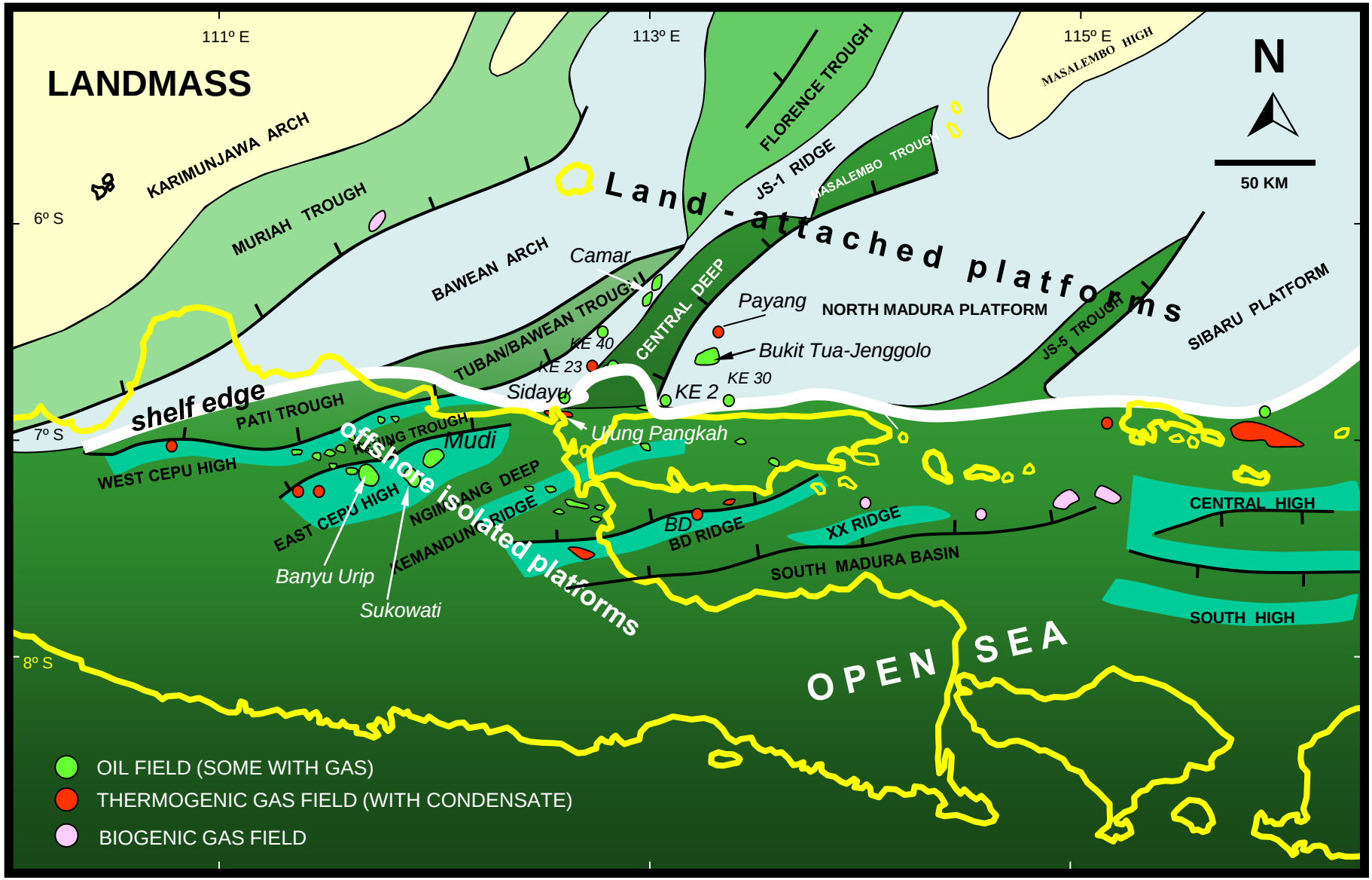
Satyana et al. (1999)

Sections across Kutei and Barito Basins



Trans-Eastern Sundaland Chronostratigraphy

Bacheller III et al. (2011)



Satyana & Purwaningsih (2002)

Paleogeography of East Java Basin during Paleogene

Contents

Conclusions

1. A number of terranes, originating from the northern Gondwanaland, amalgamated forming the Sundaland from the Middle Triassic to Late Cretaceous through subduction and collision, closing successive Paleo- and Meso-Tethys Oceans.
2. Southeastern parts of the accreted Sundaland started to disperse due to a number of mechanisms related to collision of India to Eurasia in 50 Ma (post-collision tectonic escape or rifting by subduction roll-back), separating its continental fragments, such as western Sulawesi and Sumba, through basement segmentation, rifting, slivering and displacement.

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Conclusions (cont'd)

3. Collision of Paternoster terrane to Sundaland, suturing the Meratus ophiolites formed foreland basin of Barito, the basin generated and trapped petroleum when the Meratus was uplifted started in mid-Miocene time.
4. Fragmentation of southeastern Sundaland resulted in basement horsts and grabens in present Makassar Straits, western Sulawesi and East Java basins where petroleum sources were deposited in grabens and reefal carbonates developed on horsts. This petroleum system is productive in East Java Basin and potential in the Makassar Straits and western Sulawesi.

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Thank you for your attention.

Acknowledgments

- *Management of BPMIGAS*
- *Prof. Robert Hall*
- *AAPG Technical Program Committee*