A Report from SEAPEX Evening Talk in Bangkok: Current Understanding of Sundaland Tectonics

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Introduction

Sundaland (Figure 1), the so called 'craton' and 'stable' core of SE Asia, may not be a real craton after all. New granite zircon dating, seismic tomography and heat flow data from the region all point towards relatively young, hot, heterogeneously assembled and easily defo rmed lithosphere with only local strong crusts. Ongoing research undertaken by Prof. Robert Hall and his team in the Southeast Asia Research Group (SEARG) of Royal Holloway, University of London (UK) shows strong evidences to argue that Sundaland is not a craton and neither are its characteristics similar to well-known cratons such Wyoming (US) and Gawler (South Australia). Their findings were presented by Prof. Hall in a recent SEAPEX Evening Talk that took place on the 31st of July 2012 in Bangkok, Thailand.

Reports

The Sundaland continental block was assembled mainly in the Triassic and Cretaceous from Tethyan sutures and Gondwana fragments (Hall et al., 2009). The Gondwana fragments were parts of the Australian continent that rifted in the Jurassic and arrived and collided with Sundaland in the Late Cretaceous (*ca.* 90–80 Ma). By this period, subduction was terminated and Sundaland was surrounded by mostly inactive plate margin, however local extension, subduction and strike-slip deformation still occurred. For example in the SW Borneo, which is considered as part of the Sundaland's core, local extension has led to the intrusion of Schwaner granites into pre-Carboniferous Pinoh metamorphics and formed the Borneo island. Age dating of detrital zircons within sandstones sourced from the Schwaner granites show consistent mid-Cretaceous age for the granite's emplacement.

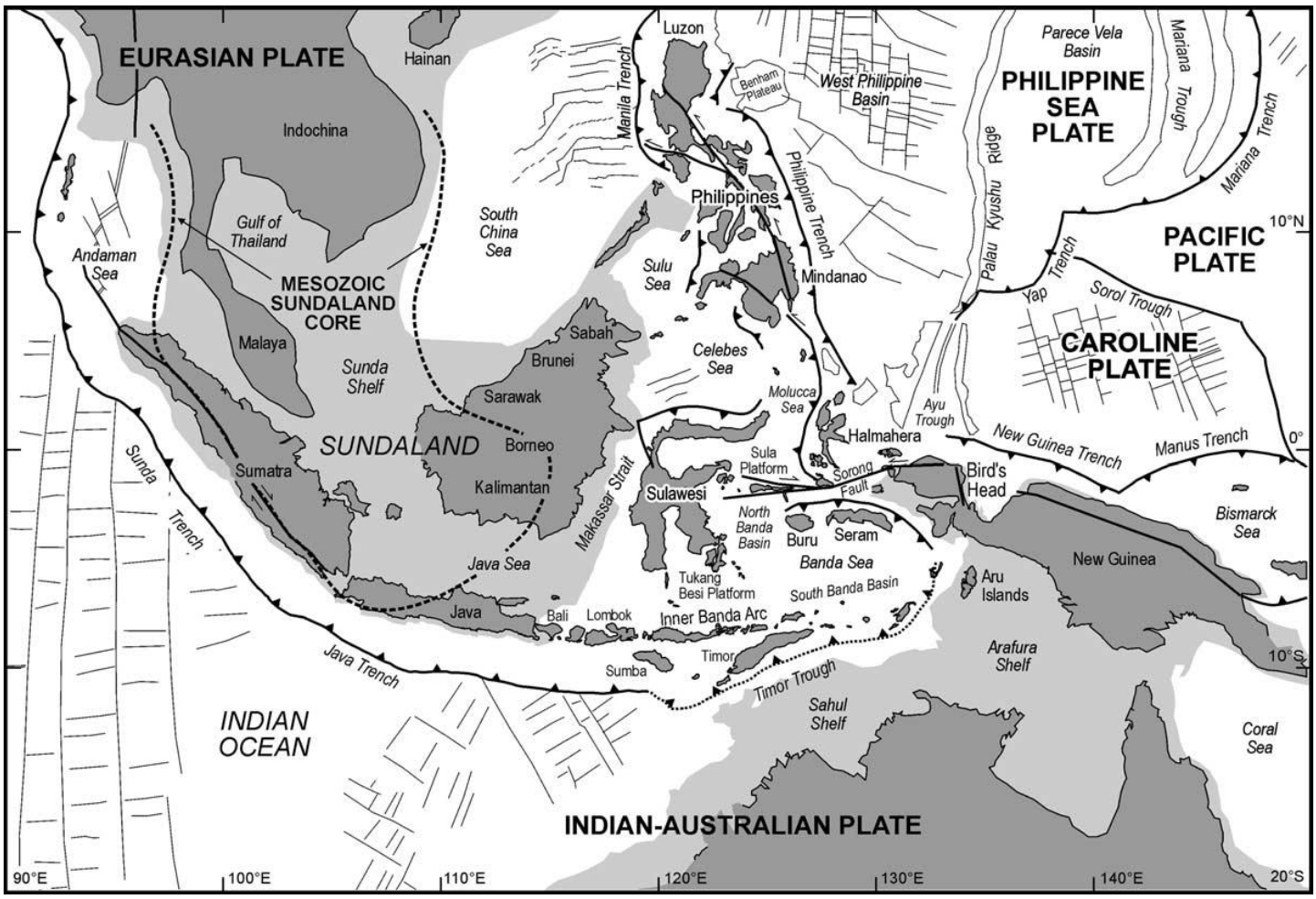


Figure 1. *Sundaland and nearby geographical features (Hall, 2002)*

Seismic tomography data show that at 150 km below surface, the Sundaland region has average seismic shear velocity (V_s). The low V_s occur mostly below mid oceanic ridge, suggesting thin and hot crust, while the high V_s are observed below continental crust such as Australia and India, which suggest thick and cold crust. The relatively low seismic V_s of the Sundaland's upper mantle indicate fairly thin, warm and weak lithosphere. This interpretation is supported by high present-day heat flow across much of the region, even in the area far away from volcanic belt such as the Gulf of Thailand. As a comparison, an average heat flow of a continental crust is approximately 60 mw/m^2, while across the Sundaland, it is mostly 80–100 mW/m^2.

The weak and unstable nature of Sundaland makes the region be easily deformed, as shown by the development of numerous Cenozoic extensional basins that captured thick sediments. Active deformation still takes place until the present-day in the form of fold and thrust belt (FTB) development that is also accompanied by subsidence on the opposite side of the FTB. This coupled FTB and extension are observed particularly at the NW Borneo-Palawan (offshore Brunei & Sabah), Sulu Sea and West Sulawesi (Makassar Strait). These FTBs all share some common features which include having onshore mountains, exposed young granites and deep crustal metamorphic rocks, rapid subsidence and rapid uplift, developing on areas that lack subduction slab evidence, have minimum seismicity and no volcanic activities.

Previous researchers attributed the formation of NW Borneo-Palawan and West Sulawesi FTBs to subduction and collision mechanisms, but Prof. Hall and his team believe that these FTBs were not formed by contractional mechanism. Instead, they proposed gravitational-driven mechanism through the rise of nearby mountains, such as Kinabalu Mountain in the case of NW Borneo-Palawan FTB; and Central Sulawesi Range for the West Sulawesi FTB.

Subduction in the NW Borneo-Palawan was taking place most likely until Early Miocene when the South China Sea was forming, but from Middle Miocene onward, there is no evidence to interpret the offshore Brunei FTB as a product of contraction due to a subducting slab. Likewise, interpretation of newly acquired seismic data around the Banggai-Sula continental block found no evidence to suggest that the block was transported from the Bird's Head by a major, left lateral, strike-slip fault (Sorong Fault). The strike-slip fault segments mapped around the Banggai-Sula block are disjointed and furthermore, they have right lateral sense of movement rather than left-lateral. Therefore, it is unlikely that the Banggai-Sula block travelled a long way to the west and then collided with the eastern arm of Sulawesi to form the West Sulawesi FTB on the other side of the island.
Current understanding of the Sundaland's tectonics as advocated by Southeast Asia Research Group promotes extension, not contraction, as more important in shaping basin evolution in the region. The upper crust of Sundaland may have gone up and down, moving vertically to create various deformations, including young fold and thrust belts that are active until the present-day.

References

Hall,R., 2002, Cenozoic geological and plate tectonic evolution of SE Asia and the SW Pacific: computer-based reconstructions, model and animations, Journal of Asian Earth Sciences, 20, p. 353–431.

Hall., R., Clements, B., and Smyth, H.R., 2009, Sundaland: Basement character, structure and plate tectonic development, Proceeding of Indonesian Petroleum Association 33rd Annual Convention & Exhibition, May 2009 (IPA09-G-134).