What caused deep, long-lived subsidence during Sundaland basin formation?

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1. Introduction

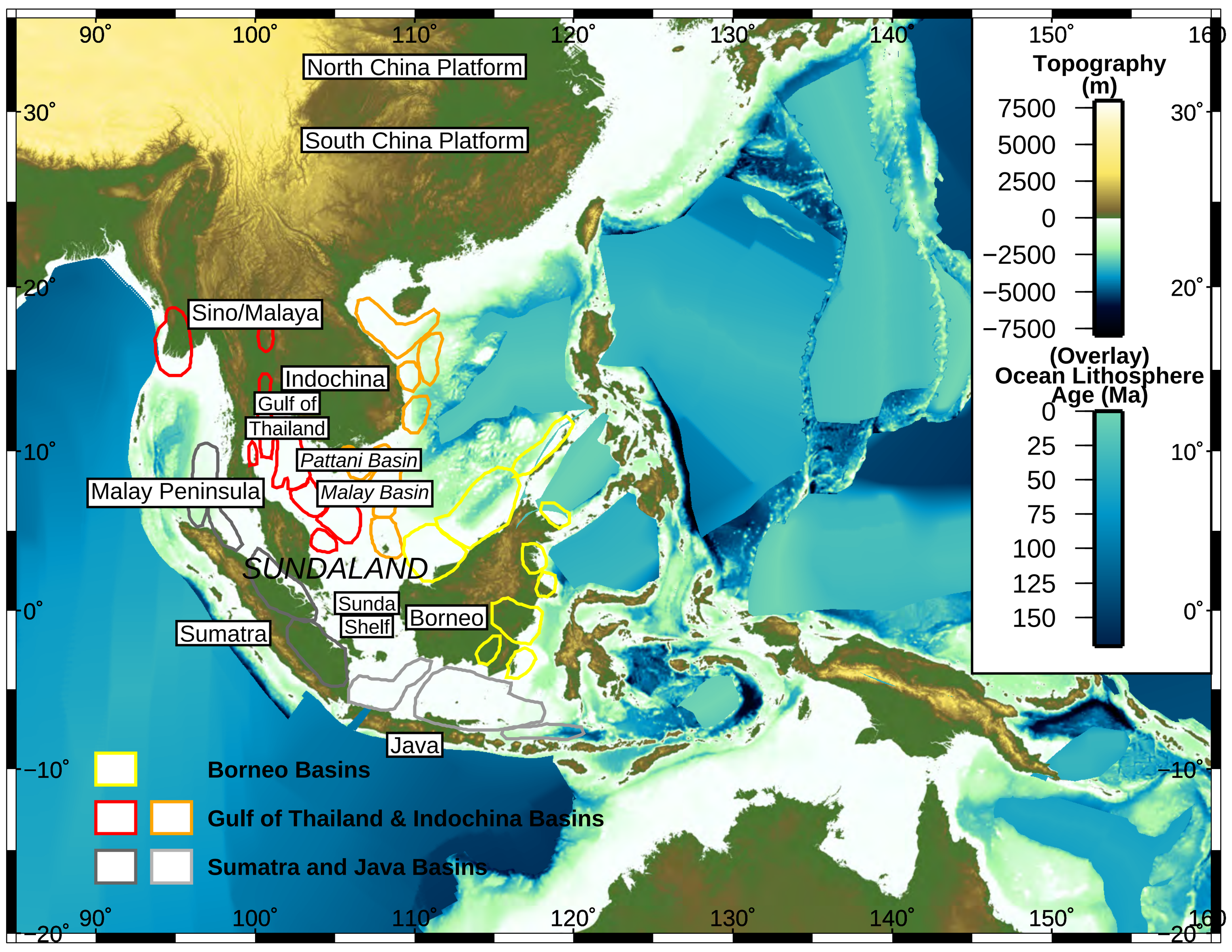


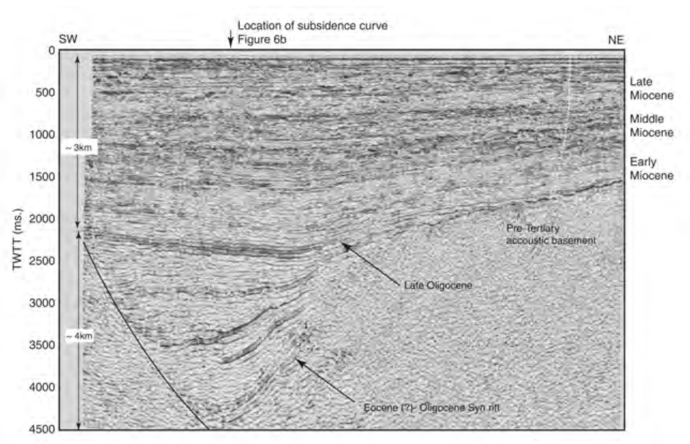
Figure 1: *Map of Sundaland Cenozoic basins.*

Cenozoic basins in Sundaland are broadly placed into three groups: (1) Sumatra and Java basins, (2) Gulf of Thailand and Indochina basins, and (3) Borneo basins [1]. The Sumatra and Java basins parallel the Sumatra and Java trenches. The formation of these basins is related to subduction zone processes which include plate loading and flexure as well as back-arc extension [1]. Highly oblique convergence along the Sumatra Trench means strike-slip processes also play a role.

In contrast, the Gulf of Thailand, Indochina and Borneo basins do not appear to have formed close to Sundaland subduction zones. The formation of these basins is enigmatic [1, 2]. Early stages of basin formation appear to be rift-related [1] and may be explained by syn-rift thinning and subsidence [3]. Thermal relaxation of thinned lithosphere can explain some post-rift subsidence [3] and basin growth. However, in central Sundaland, some basins are too deep (up to 18 km of sediment) and show too great a rate of post-rift subsidence (up to 1 kmMa^{-1}) for millions of years to be accounted for by two-stage "McKenzie-type" models of basin formation [2]. Displacement on major normal or strike-slip faults is not associated with most of the subsidence and present geotherms in Sundaland basins are high (30-75 ^{o}Ckm^{-1}) [2].

2. Pattani and Malay Basins

The Pattani and Malay basins are examples of deep basins with long post-rift growth in the Gulf of Thailand. Stretching factors of $2 < \beta < 4$ are calculated from conventional back-stripping, whereas stretching factors of $1 < \beta < 1.5$ are calculated from restoring throws on upper crustal normal faults [2]. This suggests that depth-dependent extension or other basin growth mechanisms are involved.



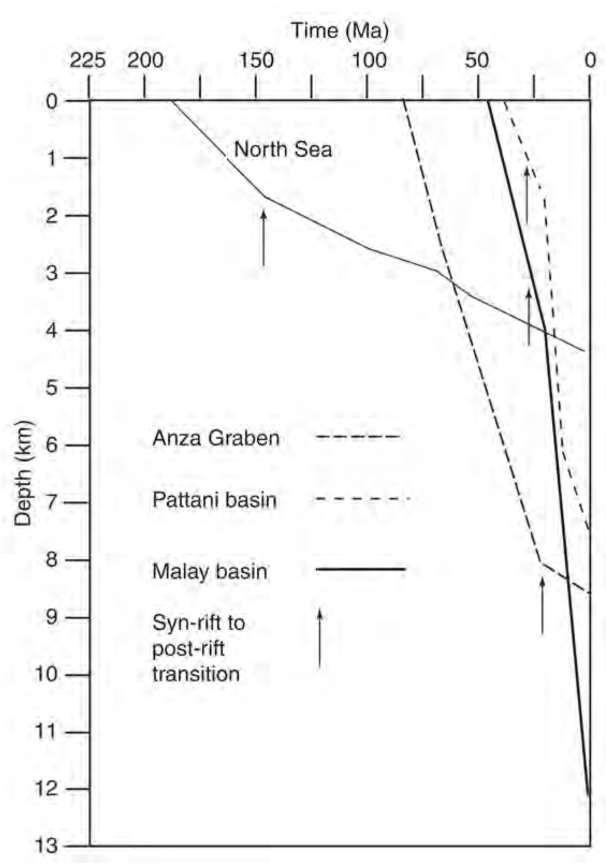


Figure 2: *(left) Seismic profile from North Malay basin from [2] showing the transition from syn-rift to post-rift subsidence in the Oligocene; (right) Subsidence history of Pattani and Malay basin (compared with North Sea Basins) from [2]*

3. Cenozoic tectonics

The Cenozoic tectonics of the Sundaland region include many basin formation settings such as subduction-related, rift and post-rift scenarios [1]. Lower crustal flow coupled to sediment loading may be important for sustaining topography and sedimentation during long-term basin growth in post-rift settings [2]. Southward-dipping subduction north of Borneo and northward-dipping subduction beneath Java are close together during the Oligocene and a compound effect due to doubly-convergent subduction on the development of Borneo basins may be relevent. Sundaland is a region of multi-slab descent into the mantle and slab avalanches at the transition zone (660 km) may impact horizontal and lateral stresses in the lithosphere and lead to basin formation in both upper and lower plates.

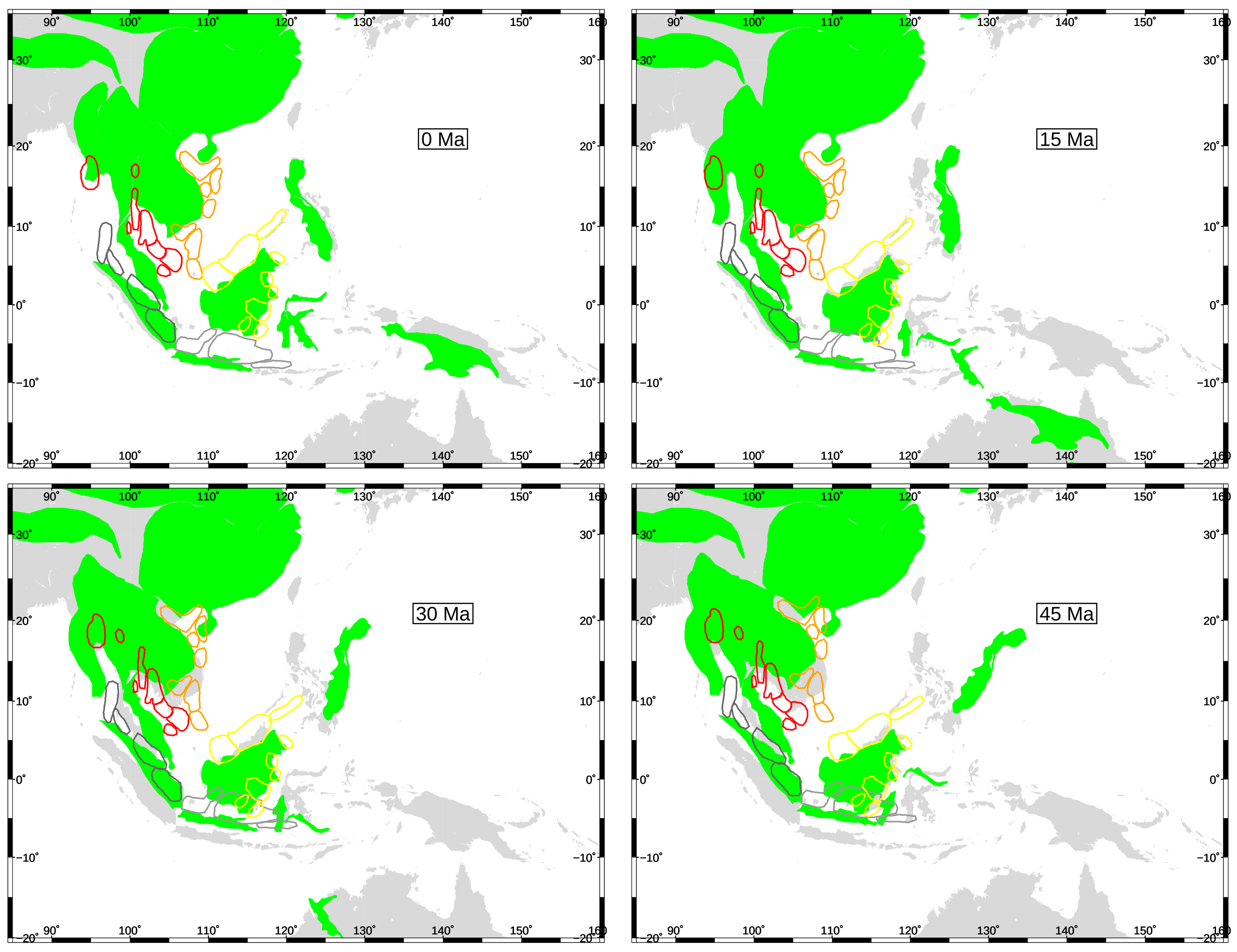


Figure 3: *Cenozoic reconstructions in a South China Platform reference frame for basic tectonic elements in Sundaland and associated basins.*

4. Research Goals

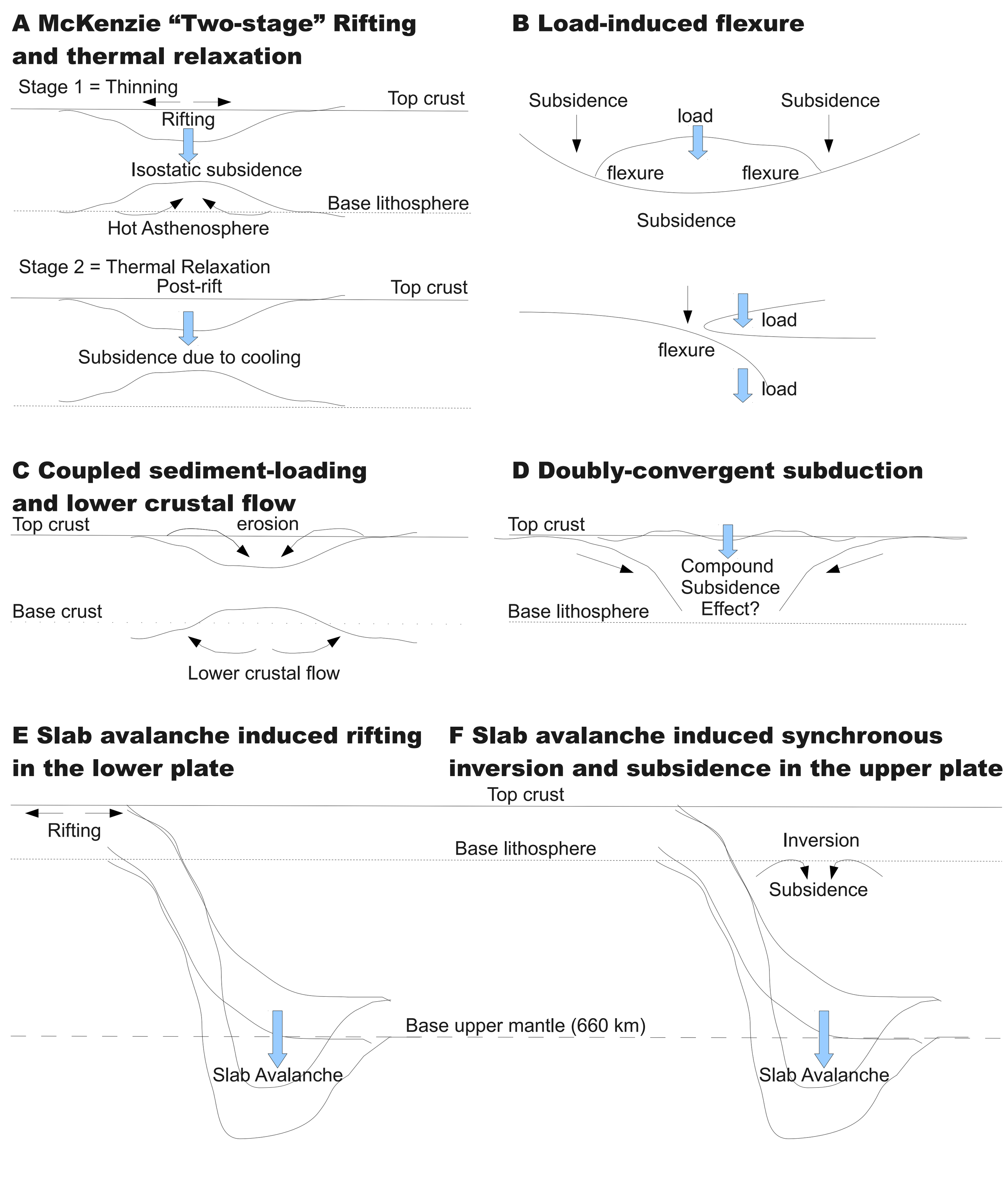


Figure 4: *Some basin formation mechanisms.*

The purpose of this research is to use the thermo-mechanical, incompressible, Stokes Flow code – GALE – to model: (1) rift and post-rift basin formation systems, and (2) subduction-related, double subduction-related and oblique subduction-related basin forming systems. The GALE code is an open source modeling tool available to the geodynamics research community but its potential for modeling lithosphere and upper mantle scale problems needs to be realized. Hopefully, insight into basin forming processes relevant to Sundaland basins will be forthcoming and model templates for extension and subduction will be created forming the basis for future, different directions of geodynamics research.

References

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