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Key Points:

- Apatite thermochronometry record South Vietnam margin exhumation history
- Thermal models are used to test different causes of thermal history
- Regional enhanced cooling and rock uplift between 37 and 30 Ma record early stage rifting

Supporting Information:

Supporting Information may be found in the online version of this article.

Correspondence to:

H. H. Nguyen,
nguyenhuuhiep@humg.edu.vn

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Author Contributions:

Data curation: Hiep Huu Nguyen, Andrew Carter
Formal analysis: Hiep Huu Nguyen, Andrew Carter, Sang Nhu Pham, Hau Bui Vinh
Investigation: Hiep Huu Nguyen
Methodology: Andrew Carter
Project Administration: Hiep Huu Nguyen
Software: Matt Fox
Visualization: Long Van Hoang
Writing – original draft: Hiep Huu Nguyen
Writing – review & editing: Andrew Carter, Long Van Hoang

Evolution of the Continental Margin of South to Central Vietnam and Its Relationship to Opening of the South China Sea (East Vietnam Sea)

Hiep Huu Nguyen[1], Andrew Carter[2], Long Van Hoang[3], Matt Fox[4], Sang Nhu Pham[1], and Hau Bui Vinh[1]

[1]Hanoi University of Mining and Geology, Hanoi, Vietnam, [2]Department of Earth and Planetary Sciences, Birkbeck, University of London, London, UK, [3]Petroleum Exploration & Production Center Vietnam Petroleum Institute, Hanoi, Vietnam, [4]Department of Earth Sciences, UCL, London, UK

Abstract The continental margin of south to central Vietnam is notable for its high elevation plateaus many of which are covered by late Cenozoic basalt flows. It forms the westernmost margin of a wide continental rift of the South China Sea (East Vietnam Sea), and uplift has been considered a result of either rifting or younger intraplate basalt magmatism. To investigate margin development apatite thermochronometry was applied to a dense array of samples collected from across and along the margin of south to central Vietnam. Results, including thermal history models, identified a distinct regional episode of fast cooling between c. 37 and 30 Ma after which cooling rates remained low. The fast cooling coincides with a period of fast extension across the South China Sea (East Sea) region that preceded continental break-up recorded by Oligocene grabens onshore. A thermal model is used test different processes that might influence the inferred cooling including a distinct pulse of exhumation; a decrease in exhumation followed by an associated transient decrease in geothermal gradients and, underplating coincident with rifting. Thermal relaxation following Mesozoic arc magmatism is ruled out as geotherms returned to background rates within 20 Myrs of emplacement, well before the onset of fast cooling. Models support fast cooling attributed to accelerated erosion during early stages of rifting. Some additional heating from either underplating and/or hot mantle upwellings is also possible. No evidence was found to support regional uplift associated with the intraplate magmatism, enhanced monsoon-driven erosion, or seafloor spreading dynamics.

Plain Language Summary This study used apatite thermochronometry to examine the uplift history of South-Central Vietnam to better understand how the elevated landscape formed, and to see if it is connected to the eruption of the widespread basalt flows that cover many of the high elevation plateaus. Results showed a match in the timing between a period of rapid cooling between 37 and 30 million years ago that affected the entire region and a period of fast rifting and extension that ended with continental breakup. To fully understand the cause of cooling thermal models tested different scenarios. Thermal relaxation after magmatism was discounted as it took place well before the period of rapid cooling. Models support fast cooling attributed to accelerated erosion during early stages of rifting. Magmatic underplating associated with rifting might also have produced additional heating but no evidence was found to support regional uplift associated with the basalt magmatism.

1. Introduction

The continental margin of Indochina represents the westernmost margin of the South China Sea, a wide continental rift that in the west is mostly submerged. In the region of south to central Vietnam, the location of this study (Figure 1), the continental margin extends offshore for >100 km before oceanic crust is reached. The extension that led to continental break-up has yet to be fully explained but is known to be related to the subduction of the paleo-Pacific plate, which at the time formed a wide Cretaceous magmatic arc with widespread calc-alkaline magmatism across south to central Vietnam and southern China. Subduction was directed to the northeast beneath southern China and westwards below Vietnam, the eastern margin of the Indochina block (Hall, 2012; Hennig-Breitfeld et al., 2021; Zhu et al., 2004).

Extension is imprinted on the landscape and geology of Vietnam but to what extent is not yet clear. It also remains uncertain as to when surface uplift took place. Was uplift staggered over a long time or did it occur within a short