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# Exotic origin of the Chinese continental shelf: new insights into the tectonic evolution of the western Pacific and eastern China since the Mesozoic

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**Abstract** The effect of paleo-Pacific subduction on the geological evolution of the western Pacific and continental China is likely complex. Nevertheless, our analysis of the distribution of Mesozoic granitoids in the eastern continental China in space and time has led us to an interesting conclusion: The basement of the continental shelf beneath East and South China Seas may actually be of exotic origin geologically unrelated to the continental lithosphere of eastern China. By accepting the notion that the Jurassic–Cretaceous granitoids in the region are genetically associated with western Pacific subduction and the concept that subduction may cease to continue only if the trench is being jammed, then the termination of the granitoid magmatism throughout the vast region at $\sim 88 \pm 2$ Ma manifests the likelihood of "sudden", or shortly beforehand ($\sim 100$ Ma), trench jam of the Mesozoic western Pacific subduction. Trench jam happens if the incoming "plate" or portion of the plate contains a sizeable mass that is too buoyant to subduct. The best candidate for such a buoyant and unsubductable mass is either an oceanic plateau or a micro-continent. We hypothesize that the basement of the Chinese continental shelf represents such an exotic, buoyant and unsubductable mass, rather than seaward extension of the continental lithosphere of eastern China. The locus of the jammed trench (i.e., the suture) is predictably located on the shelf in the vicinity of, and parallel to, the arc-curved coastal line of the southeast continental China. It is not straightforward to locate the locus in the northern section of the East China Sea shelf because of the more recent (<20 Ma) tectonic re-organization associated with the opening of the Sea of Japan. We predict that the trench jam at $\sim 100$ Ma led to the re-orientation of the Pacific plate motion in the course of NNW direction as inferred from the age-progressive Emperor Seamount Chain of Hawaiian hotspot origin (its oldest unsubdued Meiji and Detroit seamounts are $\sim 82$ Ma), making the boundary between the Pacific plate and the newly accreted plate of eastern Asia a transform fault at the location east of the continental shelf of exotic origin. This explains the apparent $\sim 40$ Myr magmatic gap from $\sim 88$ to $\sim 50$ Ma prior to present-day western Pacific subduction initiation. We propose that basement penetration drilling on well-chosen sites is needed to test the hypothesis in order to reveal the true nature of the Chinese continental shelf basement. This testing becomes critical and cannot longer be neglected in order to genuinely understand the tectonic evolution of the western Pacific and its effect on the geology of eastern China since the Mesozoic, including

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the cratonic lithosphere thinning, related magmatism/mineralization, and the mechanism of the subsequent South China Sea opening, while also offering novel perspectives on aspects of the plate tectonics theory. We also suggest the importance of future plate tectonic reconstruction of the western Pacific to consider the nature and histories of the Chinese continental shelf of exotic origin as well as the probable transform plate boundary from ~100 to ~50 Ma. Effort is needed to reveal the true nature and origin of the ~88 ± 2 Ma granitic gneisses in Taiwan and the 110–88 Ma granitoids on the Hainan Island.

**Keywords** Mesozoic granitoids in eastern China · Exotic origin of Chinese continental shelf · Trench jam · Transform plate boundary · Basal hydration weakening · Lithosphere thinning · Craton destruction · Mantle hydrous melting · Crustal melting · Plate tectonics · South China Sea

*"There are no facts, only interpretations."*
[Friedrich Nietzsche (1844–1900)]

## 1 Introduction

It has been a common knowledge that the continental shelf is the offshore extension of the continent covered with land-derived sediments. That is, the basement of the shelf is geologically part of the same continental lithosphere. As a result, this common perception has been widely accepted as a fact without doubt in all relevant studies. While this notion may still hold true in places, our analysis of the distribution of Jurassic–Cretaceous granitoids in the eastern continental China in space and time led us to an interesting conclusion, which is in nature a testable hypothesis of both regional and global significance, i.e., the basement of the Chinese continental shelf (beneath East and South China Seas) may actually be of exotic origin geologically unrelated to the continental lithosphere of eastern China. We predict the shelf basement to represent a sizable mass with large compositional buoyancy, transported to and collided with the continental China at ~100 ± 10 Ma. This new view is an element of our ongoing research in evaluating the possible consequences of paleo-Pacific subduction on the tectonic evolution of the western Pacific and continental China since the Mesozoic. In this context, we acknowledge that much effort has been expended in the past decades, in particular over the past ~10 years, to understand the *why* (triggers), *how* (mechanisms), *when* (timing and time span) and *where* (spatial extent) of the lithosphere thinning in eastern China with highly commendable achievements as evidenced by abundant publications, but it is our view that the *bottleneck* for any further insight lies in a genuine understanding of the nature and histories of the continental shelf of China.

In this paper, we do not wish to review the mounting literature on regional geology, geophysical investigations and many detailed petrological and geochemical studies, but report our findings and inferences that have led to the hypothesis. We then discuss the geodynamic implications of global significance in the regional context and plausible ways of testing the hypothesis.

## 2 Motivation of this study

The Paleozoic diamondiferous kimberlite volcanism in eastern China convinced many that there existed a long-lived North China Craton (NCC) with the lithosphere thickness in excess of 200 km. There was also the view that the NCC may not be a typical craton because of its widespread tectonomagmatic activities since the Mesozoic [1, 2]. The current consensus is that the NCC was once indeed a type craton, but lost much of its deep ~120 km portion since the Mesozoic, leaving its present-day thickness of 60–80 km [3–17] by means of delamination [4, 8–13], thermal and chemical erosion [3–5, 7, 15] and basal hydration weakening [18, 19].

While the potential effect of the paleo-Pacific subduction on the Mesozoic geology of the eastern continental China has been mentioned in the literature, Niu [18, 19] was the first to specifically advocate the concept of *basal hydration weakening* as the primary mechanism to convert the basal portion of the mantle lithosphere into asthenosphere, hence having thinned the lithosphere, beneath eastern China. The water that did so came from dehydration of the paleo-Pacific slab that lies horizontally in the mantle transition zone beneath eastern China [20, 21]. Different opinions may still exist, but the role of paleo-Pacific subduction is now widely accepted as manifested by the thematic conference "*The connection of the North China Craton destruction with the Paleo-Pacific subduction*" that took place on March 26–27, 2015, in Beijing, organized and supported by the NSFC. In this context, it is necessary to better inform the readers again of the essence of the *basal hydration weakening* concept: (1) It is not limited to the NCC destruction, but applies to the lithosphere thinning throughout eastern China at least east of the GGL shown in Fig. 1 [18, 19, 22] because the surface elevation directly reflects the lithosphere thickness [18]; (2) the wisdom is that the strength (and thus the stability) of mantle lithosphere is largely controlled by how dry it is (see Fig. 13 of Ref. [22]). The lithospheric root can be

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