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Bulldoze and rebuild: Modifying cratonic lithosphere via removal and replacement induced by continental subduction

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Establishing the mechanisms for craton modification is critical for understanding cratonic stability and architecture. Both plate tectonics and mantle plumes can cause weakening, mechanical decoupling, and even lithospheric removal. But craton modification – craton destruction accompanied or followed by craton rejuvenation – has received less attention. It is well-known that oceanic subduction dominantly destroys cratonic lithosphere with replacement to a lesser degree, and mantle plumes have been related to both destruction and rejuvenation. The role of continental subduction in craton modification, however, remains a comparatively open question. The North China Craton, as a previously stable continent with a lithosphere of more than 200 km since the Paleoproterozoic, was reworked and substantially destroyed since the Mesozoic, with intensive destruction occurring in the Early Cretaceous. Earlier in the Mesozoic, North China Craton experienced a continent-continent collision (as the upper plate) with the South China Block, forming the Sulu orogenic belt, providing an opportunity to understand the potential for craton modification due to deep continental subduction.

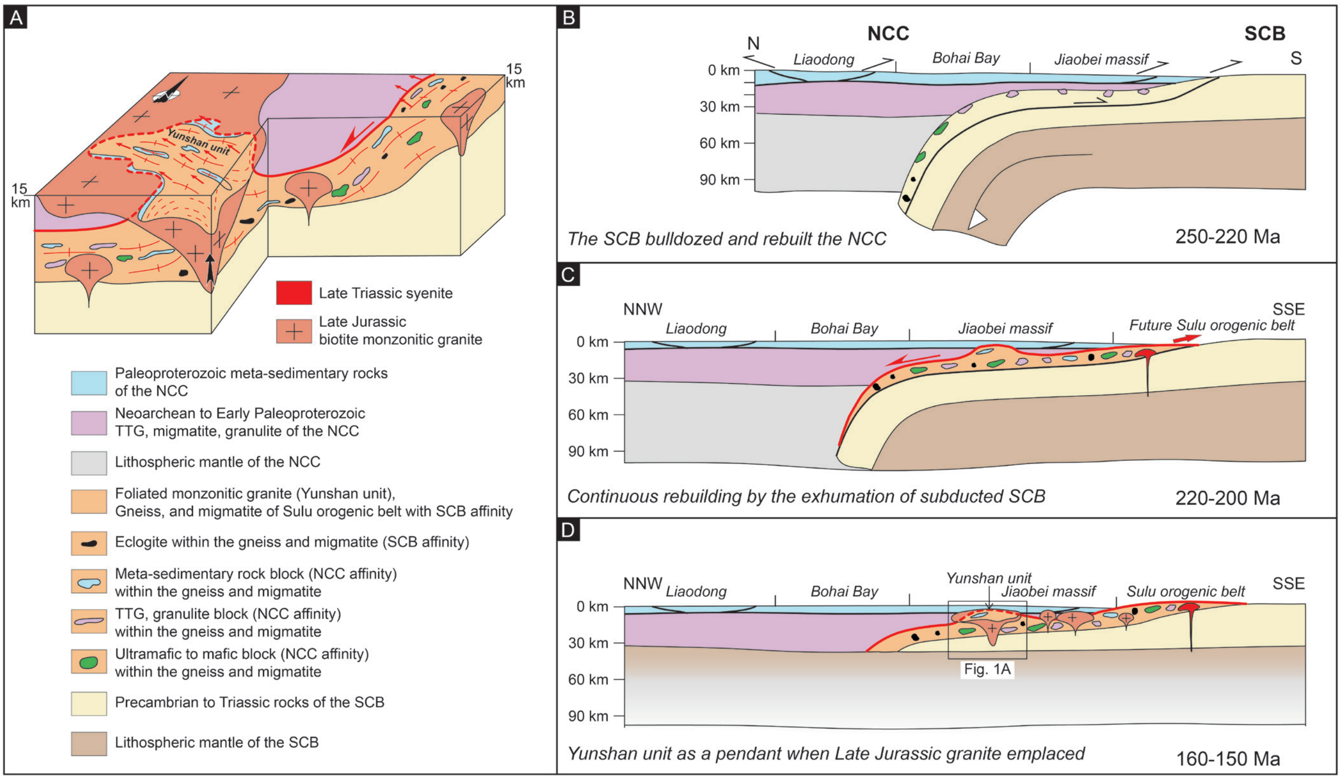

Fig. 1. "Bulldoze and rebuild" model of craton modification during continental subduction: A – geometry of the Yunshan unit in the Late Jurassic; B–D – tectonic evolution accounting for the 200-km-long tract of North China Craton (NCC) lithosphere below 16–20 km that was bulldozed and replaced by the subducted South China Block (SCB)

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In the North China craton, we report the presence of material (i.e., Yunshan unit) sourced from the underlying subducted plate. It is composed of foliated monzonitic granite and metamorphic sedimentary rocks that locally experienced crustal anatexis. Through detailed zircon U-Pb dating, it formed at latest Triassic (ca. 212 Ma). Importantly, the 800–700 Ma inherited zircons from the Yunshan foliated granite resemble those from the South China Block rather than the North China Craton. According to structural and magnetic data, the fabrics of the Yunshan foliated granite, characterized by gentle magnetic/mesoscopic foliations and conspicuous NW-SE-trending magnetic/mesoscopic lineations with a top-to-the-NW shearing. Its geometry, kinematics, and timing all compare favorably with the latest Triassic extensional structure accounting for the exhumation of the Sulu orogenic belt. We thus interpret the Yunshan unit to have been sourced from the subducted South China Block, then exhumed and emplaced into the overriding North China Craton (Fig. 1A).

Combining our new results with previous geological and geophysical data, we argue that from 250–220 Ma a 200-km-long tract of North China Craton lithosphere was bulldozed by the subducted South China Block, resulting in a lithospheric suture far from the suture zone at the surface. This lithospheric removal occurred at mid-lower crustal levels (16–20 km depth) – much shallower than previously thought possible. The bulldozed North China Craton lithosphere was simultaneously replaced by the reworked underlying South China Block plate. Such a "bulldoze and rebuild" lithospheric modification process minimized asthenosphere-lithosphere interaction, thus preventing the North China Craton from further modification (Fig. 1B–1D). Because there was essentially no net loss of lithosphere during deep continental subduction, the North China Craton largely maintained its stability for the time and did not suffer intensive destruction until later Early Cretaceous palaeo-Pacific oceanic subduction. This "bulldoze and rebuild" model can thus account for how a craton can maintain its stability during a collision with another continental plate.