What exactly is the “Paleo-Pacific plate”? 3-D mapping of the remnant slabs in the lower mantle and their connections with the Mesozoic geologic records in East Asia

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The “Paleo-Pacific plate” subduction played a dominating role in East Asian tectonics during the Cretaceous. It is often suggested that this subduction system resulted in a magmatic belt of Cretaceous age for more than 6000 km long, spanning Russian Far East, Japan, Korea, East China, Southeast China, Vietnam, and Borneo. It is also proposed that the “Paleo-Pacific” subduction strongly influenced, or controlled, the destruction of the eastern North China Craton and the intraplate deformation and magmatism in South China and Russian Far East. Nevertheless, the geometry and kinematics of this subduction system remains largely speculative, besides the consensus that the “Paleo-Pacific” slab has already penetrated into the lower mantle. Here we map the subducted slabs in the lower mantle under East Asia by interpreting high velocity anomalies imaged in global seismic tomography models. Two models, MIT_P08 and UU_P07, are mainly used for slab mapping due to their high resolution in this region, while other models (GAP, LLNL, TX2011, etc.) are used for comparison and cross-examination.

On first-order, our mapped slabs are characterized by wall-shaped geometry, NE trend, at ca. 1100-1800 km depths, and a length of ca. 6000 km. Projected onto surface, the slabs extend from Far-East Russia and Northeast China, through the Taihang Mountains in North China, to Sichuan and Yunnan Provinces of China, and the northern Indochina Peninsula. These observations suggest that the “Paleo-Pacific” slab is the only viable interpretation. Interestingly, this “slab wall” exhibits a slab gap roughly under the Taihang Mountains. To the north of this gap, the slab shows prominent, consistent high velocity anomalies and can be traced upward to the Pacific slabs in the mantle transition zone and subduction zone. This northern slab is thus interpreted as the subducted Izanagi slab. To the south, the slab, named “Yunnan slab”, is relatively diffuse in tomography models, showing less strong positive anomalies. Under the Indochina Peninsula, the Yunnan slab is truncated by a belt of WNW-trending, thousands of kilometer long high velocity anomalies, which is commonly interpreted as the Neo-Tethys slab.

We propose that the so-called “Paleo-Pacific plate” may consist of two provinces of oceanic slabs in the lower mantle, the Izanagi slab in the north and the Yunnan slab in the south. The newly-defined Yunnan slab is not the western extent of the present-day Pacific plate. Instead, it represents either part of the Izanagi plate separated by a slab tear, or an individual oceanic plate separated from both the Pacific and Izanagi plates. In either case, the subduction of the Izanagi-Yunnan slab could provide a first-order tectonic driver for the extensive arc-magmatism and related deformation and depostion along the entire East Asian margin, as well as the slab window-like magmatism in eastern China. Moreover, the truncation of the Yunnan slab by the Neo-Tethys slab in the lower mantle depicts a trench-trench-trench triple junction on surface when subducted during the Cretaceous, in which the NE-trending “Paleo-Pacific” trench is truncated by the NW-trending “Tethyan” trench. Our goal is to develop a refined plate model that incorporates the geometry of mapped slabs in the lower mantle and the extensive geologic records preserved on surface in East Asia.

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