Detailed structure of the lithosphere and deep dynamics beneath the Three River belt and western edge of the Yangtze craton

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There is a series of strike-slip fault systems and large ductile shear zones in the southeastern margin of the Qinghai-Tibet Plateau, and strong crustal deformation with active magmatism has permeated to the western margin of the Yangtze craton. How did the characteristic tectonic landform, the high temperature metamorphic belt and multi-metal metallogenic belt form over thousands of km? The "rigid block extrusion model" and "crustal flow" model and the "mantle plume" model proposed by previous authors cannot completely explain the dynamic mechanism and deep process of mineralization.

Focused on the key position of the abutment of the Yangtze Craton and the "Three River" orogenic belt, we carried out a deep seismic reflection profile (220 km), a deep seismic sounding (DSS) profile (410 km) and a magnetotelluric (MT) profiles (>600 km), and dense broadband seismic array to cover the two mining areas (Jinding and Beiya ore) and the Ailao Mountain. Combined with artificial source and natural source seismic data, a comprehensive study by various methods was made, such as full waveform inversion imaging, P-S wave travel time joint imaging and receiving function, etc.. By using the new data, a high resolution three-dimensional lithosphere structural model was constructed. It reveals the deep dynamic mechanism of the India-Asia lateral collision and enriched our understanding of metallogenic theory in collisional orogens.

The common mid-point stacking and migration section of the 220 km deep reflection seismic profile shows that a strong reflection zone exist in the southwest margin of the Yangtze craton beneath the surface at around 20 km. Roughly at that depth along the survey line, the DSS profile and MT profile reflect a low velocity and low resistivity layer that is considered as a residuum of a fluid-rich paleo-weathering crust or as a regional structural detachment zone. The reflectors from the Moho discontinuity become weak or disappear below the zone for a width of dozens of kilometers form the Jinsha River–Red River fault to the Cheng Hai-Binchuan fault, which shows an apparent transparent reflection area, reflecting the strong effects of deep mantle activity.

We accidentally recorded a moderately strong reflection appearing below the Moho (Pm at 16-17s twt) at 21-22 second of two-way time, that can only be seen in the southwestern margin of the Yangtze Craton.

This fact indicates that the low lithospheric structure of the Sanjiang belt is different from the Yangtze craton. In addition, we found that the 21 seconds seismic phase reflects from the interface with a velocity jump of 7.7km/s to 8.2km/s, which means that the lower crust of the southwestern margin of the Yangtze is now high speed. Has this lower crust experienced a deep process of underplating or eclogitization? We need more evidence form metallogeny, petrology and geochemistry.

There are 2 high-speed anomalies in the upper crust which appear in the contour map of the DSS velocity model section below the Jinding and Beiya mining area. They are considered to represent magmatic bodies by deeper material emplacement, then cooling and solidifying; this may be the source of ore forming materials in the Jinding and Beiya deposits.

The anisotropy of the broadband seismic observation shows that the mean delay time of the slow waves in the south of the NS seismic belt is greater than that in the north, reflecting the collision and extrusion of the Indian plate and the Eurasian plate, and anisotropy of the crust in the south increases and the tectonic deformation is strong. According to the anisotropic characteristics of the crust and upper mantle, it is suggested that there may be complex crust -mantle coupling phenomena in the study area. The results of the receiver function show that the Moho and LAB below the Ailao Mountain gold deposit area have an obvious break and fluctuation, which indicates that the lithosphere may have severe deformation, which may have caused the exchange of crust and mantle material and may be directly related to the formation of the Ailao mountain mine area.

The results of the magnetotelluric inversion and comprehensive interpretation of two profiles more than 600 kilometers long show that the electrical structure of the crust at the southeastern margin of the Qinghai Tibet Plateau is vertically divided into three layers, and the middle crust is a low resistance layer of about 10~15 km thickness that can be viewed as a "pipe flow" channel from inner part of the plateau to the southeast. Electrical characteristics indicate that the low resistivity layer may be partially molten such as in the southern Tibetan plateau. Our electrical structure features do not fully support the model of Bai et al. (2010) with two large-scale crustal flow channels, and emphasize that Jinhe-Huaping ductile shear zone may be more important than the Jinsha River-Red river zone in the whole crustal flow model. The Jinhe-Huaping low resistivity zone may be related to the upward thermal activity of the upper mantle (thermal column).

The above data improve our understanding and provide useful clues as to the overall characteristics of the lithosphere structure and the deep dynamic processes of the southwestern of Qinghai-Tibetan Plateau.

Project funding：The National Key Research and Development Project of China (2016YFC0600302)