

Research Advances

The Electrical Conductivity Structure of the Lanping–Simao Basin and its Implications for Mineralization

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Objective

The Lanping–Simao Basin in western Yunnan, located in the southeastern margin of the Tibetan Plateau, is tectonically in the transition zone between the Gondwana and Eurasia tectonic domains. It is also the frontier zone of northeastern extrusion of the Indochina Plate towards the Eurasia Plate as well as the escape zone for the deep material. The middle axial tectonic zone, also known as the Lanping–Simao Fault (LSF) in previous study, is a giant intraplate tectonic belt composed of a series of narrow uplift belt, rupture depression zone, metamorphic belt, alteration belt and marginal fracture system, which were formed by the compressional uplift of the central depression of the Lanping–Simao Basin. This tectonic unit controls the geological evolution, seismic activity, hot spring distribution and ore formation of the Lanping–Simao Basin since the Mesozoic and Cenozoic. The material structure and evolution mechanism of LSF are key factors to quantify the intraplate deformation caused by the southeastern escape of deep material from the Indo-Asian continental collision. This study also provides a new perspective for understanding the tectonic evolution of the Lanping Basin, the formation of alkaline rocks in the area, the formation and spatial distribution pattern of Jinding super-large lead-zinc deposit and the large gold mine related to alkaline rocks along the western margin of the Yangtze Craton.

Methods

In order to investigate the electrical conductivity of crust and upper mantle in the Lanping–Simao Basin, as well as the vertical and horizontal variations, we measured two magnetotelluric (MT) sounding sections across the Lanping Basin, and collected 21 MT sections in the Simao Basin. Our field data were acquired using SSMT 2000 (V5-2000) type earth electromagnetic instrument produced by the Canadian Phoenix Geophysical Company. The

magnetotelluric natural signal has been measured as five vector components, i.e., Ex, Ey, Hx, Hy and Hz with the acquisition frequency range of 300–0.0005 Hz. The data processing package SSMT2000 is provided by the Canadian Phoenix Company. The electric structure parameters of regional crust and the deep and abundant information of the deep through inversion simulation were obtained using the non-linear conjugate gradients method (Fig. 1).

Results

(1) Electrical structure of the Lanping Basin

The MT results indicate that the electrical structure of the northern Lanping Basin is zoned horizontally, while the vertical zoning is weak. The electrical characteristics can be divided into three categories: ① low resistance zone with resistivity of 2–100 $\Omega\cdot\text{m}$; ② relatively low resistance zone with resistivity between 200 and 1500 $\Omega\cdot\text{m}$; ③ high resistance zone with resistivity of > 2000–60000 $\Omega\cdot\text{m}$.

The MT resistivity section in the northern part of the Lanping Basin shows that the LSF is located in the intersected zone of two low resistivity zones, and the main part of LSF is an east-dipping deep structure. LSF is connected with the low resistivity body in the upper mantle, and the west side of the LSF is connected with the low resistivity body in the lower crust, implying that the low resistivity body was derived from the lower crust and the upper mantle. A high resistivity body occurs at the corresponding depth of more than 25 km, below the central axis tectonic zone with its top surface depth of about 3–4 km.

Based on the electrical characteristics, the south part of Lanping Basin can be divided into three types: background area (resistivity of 40–300 $\Omega\cdot\text{m}$), low resistance area (2–15 $\Omega\cdot\text{m}$) and high resistance region (500–10000 $\Omega\cdot\text{m}$). The low resistance and high resistance bodies are distributed as isolated island and strip in the background area. The LSF is located in the side and top of the low resistivity body which derived from the upper mantle. Due to the effect of

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the parallel slip of the transverse tectonic, the LSF is sub-vertical in the south of Huanglianpu, and downward for about 10 km to the deep to connect with the layered low resistivity body. Moreover, the LSF is connected with the low resistivity body from the upper mantle in the east.

(2) Electrical structure of the Simao Basin

The beaded high resistance and low resistance bodies are distributed alternately along LSF in the Simao Basin, with the top surface depth of several hundred meters to up to one kilometer. Those bodies get smaller from up to down, and can be seen clearly at the depth of 25 km even to 60 km. It might imply that some of the low resistance bodies are felsic or alkaline magmatic intrusion. The results show that the penetration depth is likely in excess of 60 km, close to the upper mantle, indicative of the existence of mantle source channel (Fig. 1).

The study suggests that the electrical structure of the Lanping–Simao Basin is characterized by the uplift of the low resistivity layer of the mantle. Coupled with the uplift of the low velocity layer of the mantle, the low Bouguer gravity anomaly, the high local aeromagnetic anomaly in the low background, hot springs along the fracture with heat flow values, frequent occurrences of shallow earthquakes, alkali-rich magmatism, transverse fractures like the transform faults as well as a series of ore deposits closely related to the deep geological process, those results suggest that the central axis tectonic (LSF) has similar geophysical characteristics and deep crustal and mantle structures as the classic rifts (such as the Panxi Rift Valley and the Rhine Graben Rift).

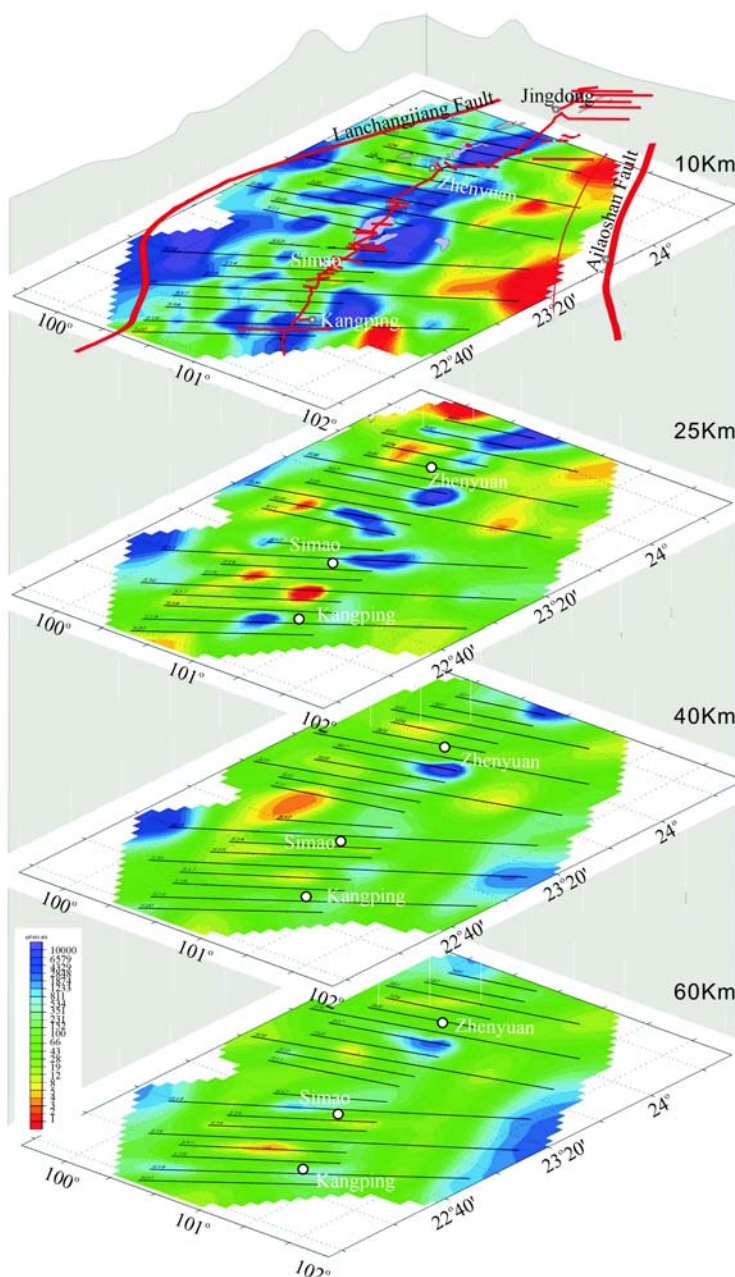


Fig. 1. Electrical structures of the Simao Basin.

Conclusion

Based on the crust and mantle structure of the basin, regional geology, magmatism, geochemistry, geothermal features as well as geological evolution of the Sanjiang area, it can be proposed in this study that the central axis tectonic (LSF) of the Lanping–Simao Basin in western Yunnan may be a continental rift system, which resulted from the continental collision, slip and uplift in the Sanjiang region in southwestern China. This may be the

dynamic mechanism of the Sanjiang metallogenic belt.

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