Characterizing suture zones in an accretionary orogenic belt: Insights from magnetotelluric measurements in the Beishan orogen

Lishui Zhou[1], Letian Zhang[1,2,3], Sheng Jin[1,2], Matthew J. Comeau[4], Michael Becken[5]
[1] School of Geophysics and Information Technology, China University of Geosciences (Beijing), China, zls961106@gmail.com
[2] State Key Laboratory of Geological Process and Mineral Resources, China
[3] Key Laboratory of Intraplate Volcanoes and Earthquakes, Ministry of Education, China
[4] Delft University of Technology, The Netherlands
[5] University of Münster, Germany

SUMMARY

Ophiolite mélanges are commonly found in ancient accretionary orogenic belts. However, they may have diverse origins because they can form in various tectonic settings, including fore-arc, back-arc, active continental margins, mid-ocean ridges, and continental rifts. Identifying and characterizing suture zones in accretionary orogenic belts is crucial for understanding their tectonic evolution. The Beishan Orogenic Collage (BOC) is located in the southernmost part of the Central Asian Orogenic Belt (CAOB), one of the world's largest accretionary orogens, and formed through ongoing subduction and consumption of the Paleo-Asian Ocean and its branch ocean basins. It contains four east-west trending ophiolite mélange belts: (1) Hongshishan; (2) Shibanjing-Xiaohuangshan; (3) Hongliuhe-Niujuanzi-Xichangjing; and (4) Liuyuan, from north to south. Despite abundant geochemical, structural, and geochronological data, no consensus on the settings in which these ophiolite mélange belts formed and their subduction polarities remains elusive. This uncertainty has resulted in several contrasting models hypothesized for the tectonic evolution of the Beishan region.

In this study, we used 60 broadband magnetotelluric measurements and 16 long-period magnetotelluric measurements sites recently acquired across the Beishan region in northwest China to obtain a three-dimensional electrical resistivity model. The model reveals a generally high-resistivity upper crust with several low-resistivity features aligning with suture zones and tectonic boundaries. The high-resistivity lithosphere beneath Niujuanzi is compatible with northward and southward subduction of the Niujuanzi Ocean, potentially revealing remnants of a cold fossil oceanic lithosphere. In contrast, the deep lithosphere beneath the other three ophiolite belts is characterized by low-resistivity features. Since MORB-type rocks have lower iron, hydrogen, and carbon content, they tend to exhibit high resistivity characteristics, compared to a back-arc basin or rift. The model suggest that the Njiujuanzi Ocean was possibly the major ocean of the southern branch of the Palaeo-Asian Ocean, and that it had bi-directional subduction polarity.

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