Deep electrical structure of Chuxiong Basin in southwest of China

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SUMMARY

The Chuxiong Basin in southwest China is near the southeastern margin of the Indo-Asia collision zone with highly complex and active tectonic features. The electric structures of this basin have been investigated by carrying out 2D inversion of magnetotelluric data of a large array of 1188 observation sites covering part of the basin. Preliminary interpretation of inverted resistivity sections has revealed the different patterns of deep electric structures below different part of the basin. Double in-crust conductive layers can be delineated below the western and central part of the basin, while only one conductive layer can be identified below northern and eastern part of the basin. It is also inferred that the in-crust conductive layers are dipping southward in large gradient according to the burying depth of the conductive layers for different traverses. 3D inversion of this set of data is underway and better resolution and reliability of inversion results can be expected.

Keywords: deep electrical structure, Chuxiong Basin, magnetotelluric sounding

INTRODUCTION

The Chuxiong Basin in the center of Yunnan Province is a relatively large Mesozoic tectonic sedimentary basin in southwest of China. Its location is near the southeastern margin of the Indo-Asia collision zone, and bordered by the Red River Fault belt to the west. This region is tectonically the mixed area of inner and edge of the plate, controlled by the uplift of the Qinghai-Tibet plateau. Its dynamic characteristics are very complicated (Kan et al., 1986) and is highly active with earthquake risk.

The basin was formed in late Triassic and subsequently experienced several violent tectonic movements (Wan et al., 1998). The northwest border of the basin is bounded by Chenghai Fault, and connected with the Yanyuan-Lijiang block of Songpan-Ganzi fold belt. The southwest is bounded by the Red River Fault and is adjacent to the famous Sanjiang fold system or the only Tethys tectonic region in China. The east border of the basin is defined by the Pudu River Fault and connected with the Kunming Fold belt of the Yangtze block. The Huaping Uplift is on the northern margin and separates this basin from the Shichuan Basin.

The development and application of magnetotelluric (MT) method have activated studies of electrical structures in Sanjiang fold system and its adjacent areas since 1980s. Some one-dimensional inversion results of MT data for the Nanhua-Tengchong and Menglian-Luoping profiles have indicated that there is a low resistivity layer in the upper crust of the region (Sun et al., 1989; Tang et al., 2012 and Li et al., 2014). Long period MT data of Yingjiang-Yaoan profile has revealed that there is indeed a low resistive layer in crust but with varying of depth and thickness along the profile, and also large scale of low resistive region has been illustrated in crust-mantle transition zone (Yu et al., 2017). These studies have given general knowledge of characteristics of deep electrical structures of Sanjiang fold zone and can be inferred to apply for neighbouring area indirectly. This work is trying to use a set of 3D MT data in Chuxiong Basin to obtain the detail information of its deep structural features and help to understand its dynamics mechanism.

DATA ANALYSES

This set of 3D MT data consists of 1188 observation sites composing 14 survey traverses with average 2km of site separation and about 10km of traverse separation. The distribution of observation sites and tectonic background are as shown in Figure 1. The survey area covers approximately 20000 km² of the central section of Chuxiong Basin in north-south direction and crossover in east-west direction.
Parameters derived from observed MT time series are mainly apparent resistivities, impedance phases and tippers, etc. by running data processing software of the measuring system. The distortion factors of observed MT data in this area are mainly the topography effect, surface electrical inhomogeneity and cultural noises. The average elevation of the survey region is about 2000 m but heavy rolling of peak and valley, with highest peak of 3395 m in southwest. The famous Jinsha River also crosses this region from east to west. The rugged topography causes severe topographic distortion specially to apparent resistivity curves. The effect of near surface electric inhomogeneity is usually termed as static effect and is always a problem for MT data acquired at region of poor surface conditions. Besides topography, the Chuxiong Basin is also an area of intensive tectonic activities with complex changes of stratigraphic facies at surface, resulting of the static shift of the MT apparent resistivity curves. Although the area is not densely populated, several small hydropower stations, mining tunnels and a dense powerline grid exist in the survey area, and strong powerline interferences accompany with observed MT series. Besides to partially take into account of the effect of topography and near surface electric inhomogeneity in the inversion scheme, data reprocessing measures, mainly power spectrum re-editing, denoising and distortion correction (Karsten, 1990), have been applied to some identified poor quality data set at the data processing stage.

**INVERSION**

The observation data can be processed by 2D inversion after carefully reprocessing. The crucial procedures for inversion are the determination of the initial model and the selection of mode of apparent resistivity curves to be used for 2D inversion scheme (Zhang et al., 1999). Some commercially available softwares are tested and the non-linear conjugate gradient (NLCG) algorithm (Rodi, 2001) is used for the joint inversion of TE and TM mode curves. The regularization factor Tau value is an extremely important parameter for 2D inversion, and Tau = 3 is selected for this study after evaluating inversion results of various Tau values.

**PRELIMINARY INTERPRETATION**

2D inversion results of some traverses are presented here for preliminary discussion of deep electric structures of the studied region. The ultimate goal of this study is to make better understanding of deep structures by means of 3D inversion of this MT data set, but the results are not ready currently.

Figure 2 shows the inverted resistivity section for traverse CX03. Notice that the parameter for vertical axis is elevation in km, and the maximum depth of the section goes to 100 km; the color scale for contours are blue for resistive and red for conductive formation. The traverse CX03 is located at the northern side of the study area which is adjacent to the Kangdian ancient land. There are four electric layers can be identified in general from the section plot and all strata tilt slightly eastwards. The surface is mainly covered with resistive stratum, and the thickness is gradually increased from about 1 km to about 5 km from west to east. Underlying is a continuous conductive layer with about 10 km in thickness and about 50 Ωm of...
resistivity. The Yongsheng-Binchuan (F4) and Dukou-Nanhu Fault (F17) can be recognized by the conductivity anomalies of first and second layer of this traverse. A relative uniform resistive (about 100 ΩM) layer of about 15 km in thickness is followed. The bottom layer below about 35 km is relative conductive with resistivity less than 100 ΩM, and more conductive at the west end of the traverse. The deep information given in this section is however less reliable since the periods of MT data not all long enough to well resolve the deep structure at maximum depth.

Figure 3 present the inverted resistivity profile of traverse CX07, which is located near the center of the survey area. The traverse is the longest, and not only crossing Chuxiong Basin from west to east but also extending eastward through Yuanmou uplift and Yunlong sag. Six electric layers can be identified in general from the resistivity section plot. The surface layer is not continuous in conductivity and depth, which may be a reflection of the surface stratigraphy. The underlying second layer is thick and mainly conductive for basin and sag area but intervened by two resistive uplifts which may be inferred as Dayao and Yuanmou Uplift. Four faults can be identified as F4, F17, F3 and F2 respectively from west to east according to conductive anomalies of this layer along traverse. The deep structure from here down for Chuxiong Basin area can be clearly divided into high - low - high - low resistive layer, namely the double low resistance structure, and the top boundary is at about 35 km for the first in-crust conductive layer and about 70 km for the second conductive layer. The deep structures below Yuanmou uplift to the Yunlong depression show somewhat different features from the basin region, only the first conductive layer can be well identified and the second conductive layer is not well resolved or diminished.

Figure 3. Inverted resistivity profile of CX07

The inverted resistivity profile of CX12 is shown in Figure 4. This traverse is located at the south end of the survey area which is more close to the center of the basin. The basic feature of electric strata is similar to that of traverse CX07, and six layers can be divided from the resistivity section. All layers show relatively simple structure and double conductive layers can be identified as well. The surface layer is thin (0~3 km) and resistive (100~1000 ΩM). The second conductive layer is relatively thick, with average resistivity 20ΩM and only Yuanmou uplift can be identified by the resistive anomaly of the profile plot. The double conductive structure in depth is well resolved, but with much deeper burying depth, about 50 km for the top boundary of the first conductive layer and about 90 km for the top boundary of the second conductive layer. The detection of burying depth and location of low resistivity layer is consistent with the results of MT exploration in the neighboring area (Li et al. 2014). The results and the existing geophysical data indicate that the western thrust belt and the central strike-slip thrust region have been characterized by thick low resistivity layer.

Figure 4. Inverted resistivity profile of CX12

CONCLUSIONS

From above preliminary 2D inversion results it can be concluded that (1) inverted resistivity sections for all profiles demonstrate somewhat similar pattern of electric strata, and is reasonably consistent with the known features of surface tectonics; (2) different features are identified for deep electric structures below different part of Chuxiong Basin, that is, double in-crust conductive layers can be delineated below the western and central part of the basin, and only one conductive layer can be inferred below the northern and eastern part (east of Yuanmou Uplift) of the basin; (3) the double conductive in-crust layers are quite uniform in thickness but dipping southward in large gradient; (4) 3D inversion for this large set of MT data is underway, better resolution and reliability of electric structures can be expected.
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REFERENCES


