

# Two-dimensional inversion of magnetotelluric profile data to image the structure of Nasrabad salt diapir, west Central Iran



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## ABSTRACT

This research focuses on a magnetotelluric (MT) dataset collected along a profile over the Nasrabad structure, part of the Shurab salt diapirs in west-central Iran. The inversion of MT data from the Nasrabad structure in the Qom sub-basin, northwest of Kashan, utilized Winglink software to produce smooth electrical resistivity model from the TE and TM mode impedances, along with tipper data. The resulting two-dimensional electrical resistivity cross-section reveals a conductive upper layer and deeper resistive structures.

## Introduction

Magnetotelluric (MT) data effectively characterize salt diapirs due to their ability to assess variations in electrical resistivity in rocks influenced by porosity, water content, and mineral composition. This study aims to delineate the dimensions and geometry of the Nasrabad salt diapir extension in the Qom sub-basin.

## METHODS

Apparent electrical resistivity and phase sounding curves from Profile 15 were analyzed to assess subsurface structures. The resistivity decreases sharply with increasing periods, indicating a near-surface conductive layer, confirmed by phase values above 45° at short periods. As periods increase, the resistivity rises again, suggesting that the EM fields penetrate deeper parts. Moving from southwest to northeast along the profile, the separation between TE and TM curves decreases and shifts to longer periods, implying simpler subsurface structures.

Dimensionality analysis using phase-sensitive skew ( $\eta$ ) and phase tensor skew angles ( $\beta$ ) reveals that  $\eta$  values are between 0.1 and 0.3 and  $\beta$  skew angles are below  $\pm 3^\circ$ , supporting a 2D modeling approach.

Impedance and tipper data were inverted using the smoothest model method in WingLink software to develop a 2D model of the regional electrical conductivity. The model, discretized into 61 rows and 165 columns, reveals a deep resistive layer (D2), a resistive body at shallow depths (D5), and a discontinuous surficial conductive layer (C1) overlaying the resistive structures.

## RESULTS AND DISCUSSION

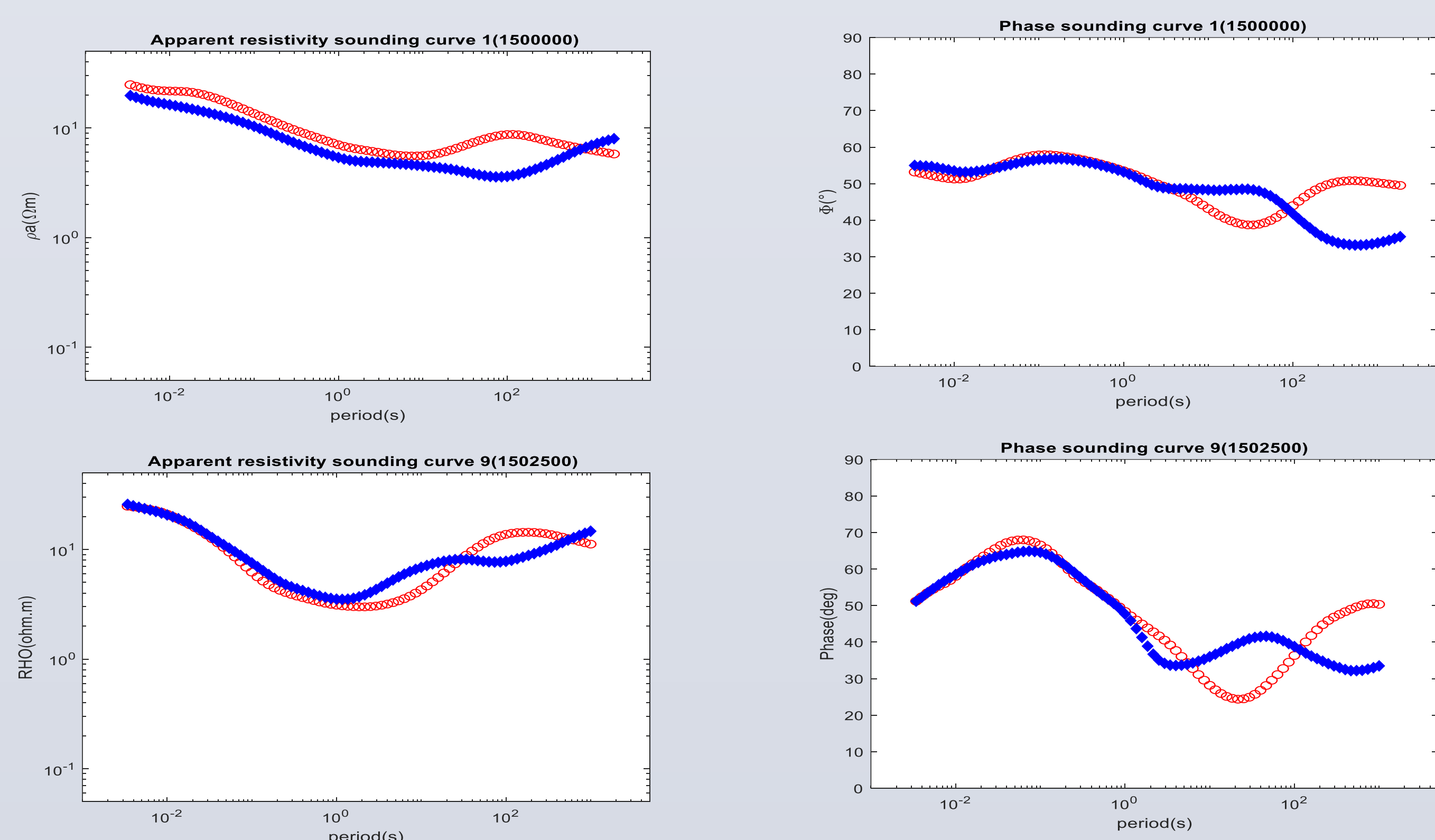


Figure 1. Apparent resistivity and phase soundings for two representative stations along profile 15.

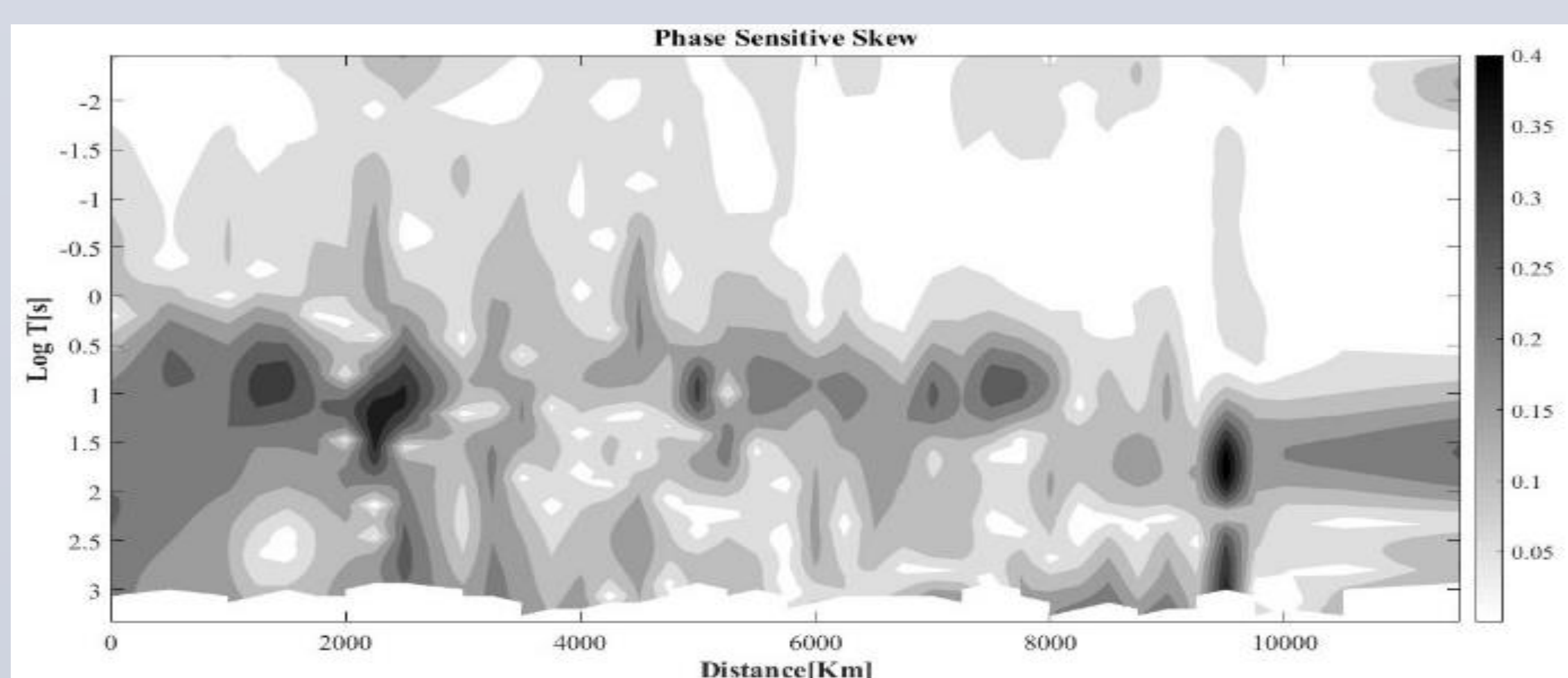


Figure 2. The phase-sensitive skew  $\eta$  plot for Profile 15.

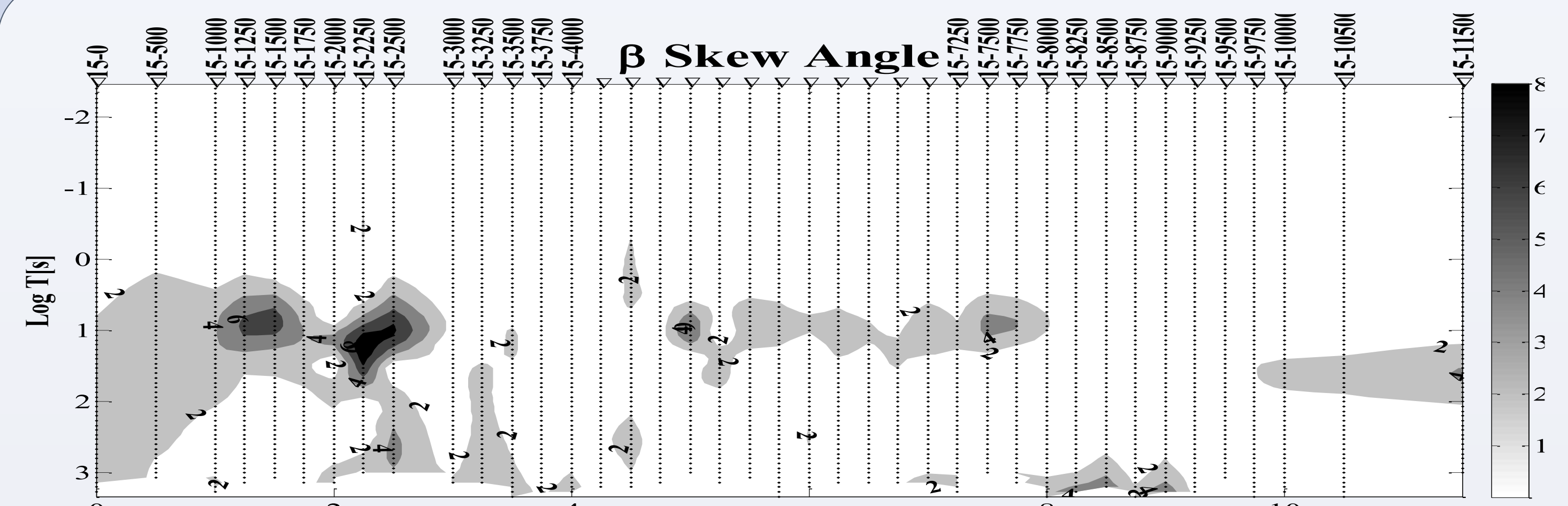


Figure 3. Phase tensor skew diagram related to profile 15

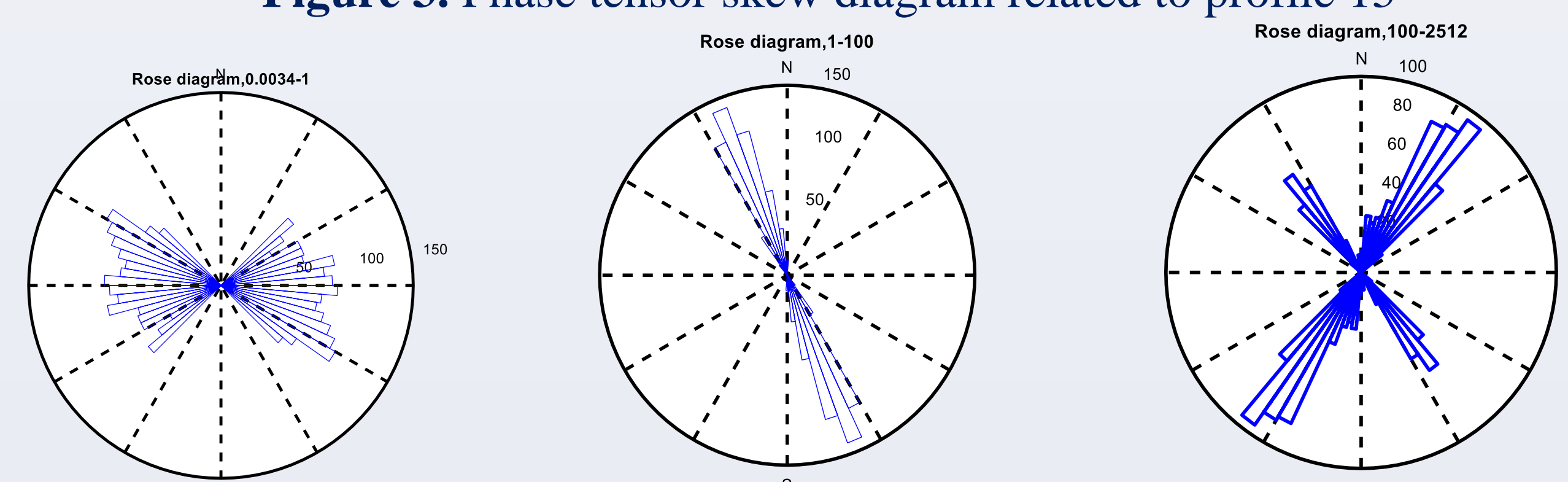


Figure 4. Alignment of regional structure trend calculated using phase tensor method for P15 profiles

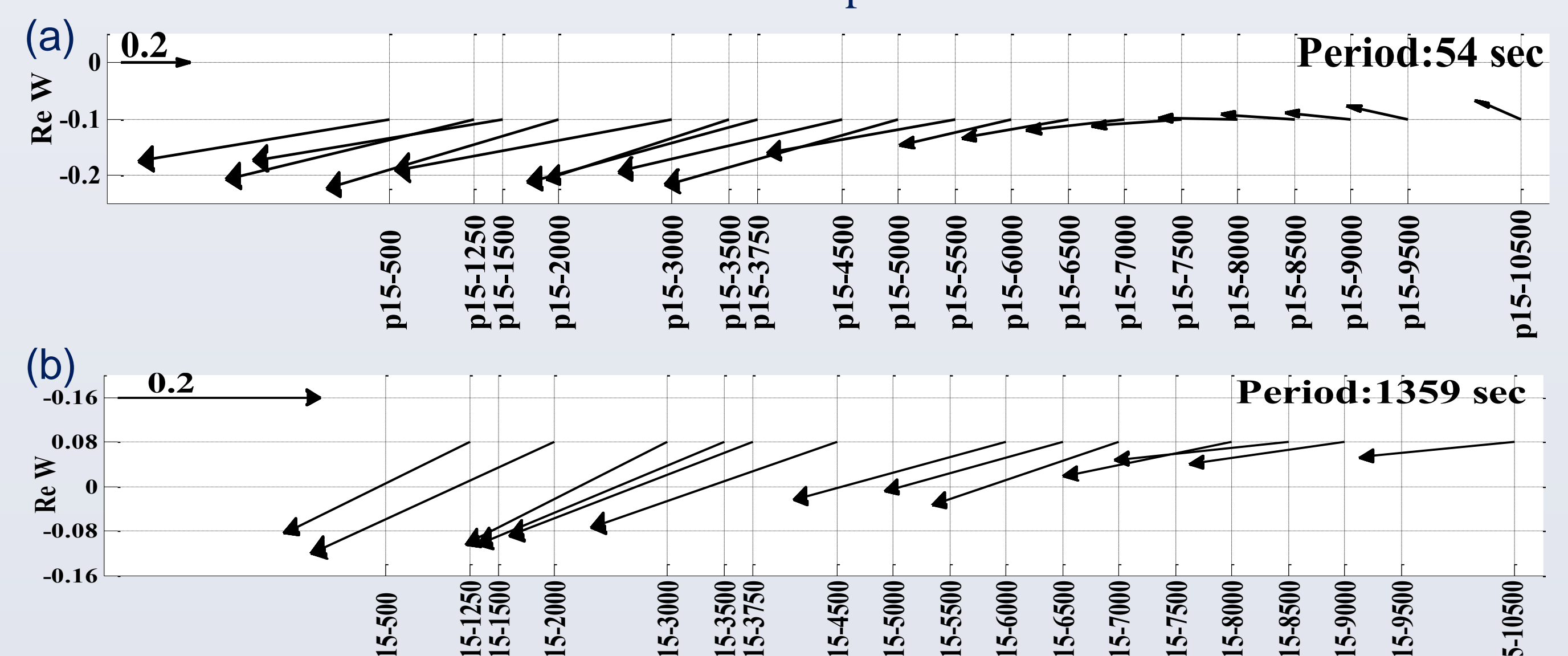


Figure 5. The real induction vectors were measured at two periods along Profile 15: (a) 54 seconds and (b) 1359 seconds.

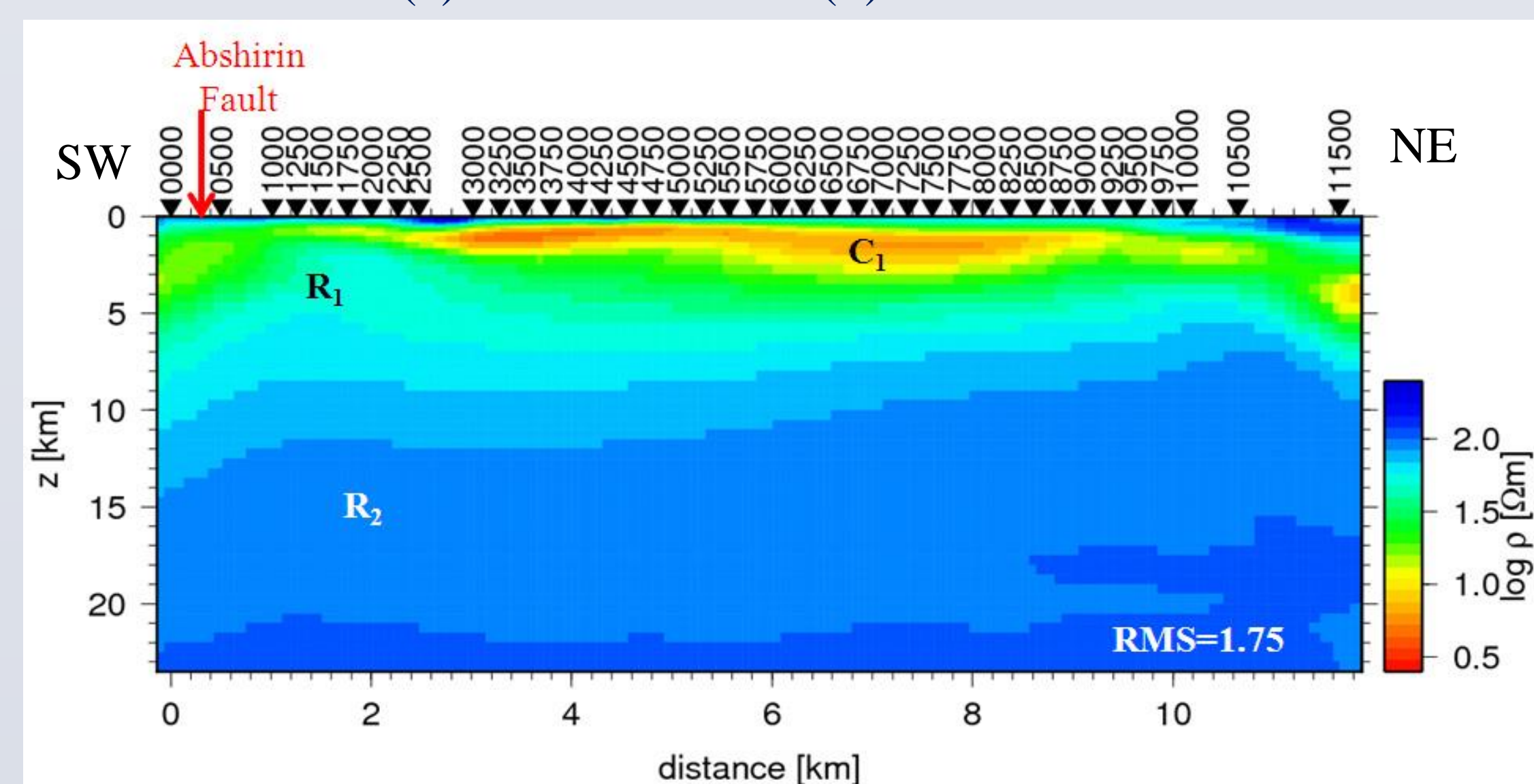


Figure 6. 2-D inversion result for MT data along profile P15

The shallow conductive layer is continuous in the northeast and becomes disrupted in the southwest due to structural complexity in this region.

The two-dimensional inversion results indicate a highly resistive deep structure ( $R_2$ ) rising as a distinct resistive body to a shallower depth ( $R_1$ ).

## CONCLUSIONS

- The impedance data for Profile 15 indicates a primarily two-dimensional regional structure with a strike direction of  $N30^\circ W$ .
- Phase tensor skew values suggest a simple, one-dimensional structure in the northeast up to a 10-second period.
- Increasing complexity at longer periods suggests a mix of 2D and 3D structures.
- The final strike direction aligns with regional tectonic trends.
- The inversion results show a continuous conductive layer in the northeast, becoming discontinuous in the southwest.
- The 2D inversion reveals deep resistive structures and a discontinuous conductive layer in the southwest, likely due to fault activity.
- Salt diapir No. 4 is consistently identified as a resistive feature across all data types.

## REFERENCES

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- Simpson, Fiona, and Karsten Bahr. *Practical Magnetotellurics*. Cambridge University Press, 2005.