



A Trial Study of 3D CEMP Survey Technique

三维电磁勘探技术试验研究

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- Is it necessary to extend 2D EM to 3D?

电磁勘探需要三维吗？

- How to put 3D EM into practice?

三维电磁勘探如何实施？

- What advantages does 3D EM possess?

三维电磁有什么优越性？



Is it necessary to extend 2D EM exploration to 3D?

➤ Geological prospecting needs

地质勘探的需要

Targets are 3D

地质目标多为三维

Volume effect of EM survey

电磁体积效应

2D can not accurately located

二维不能准确定位

drill requires

地质钻探要求

➤ Method development needs

方法发展的需要

3D seismic Effectiveness and popularity

地震三维有效而普及

3D EM is trend

电磁三维是必然趋势

Computer Technology

电子计算机技术

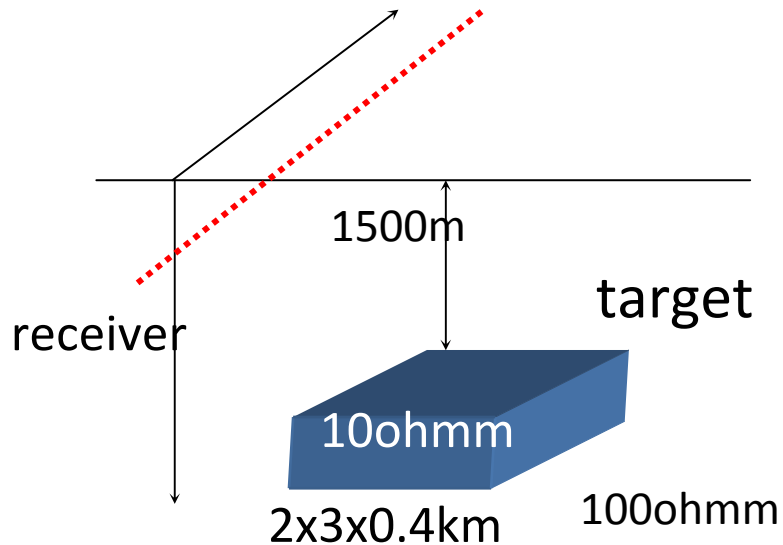
Progress with times

与时俱进

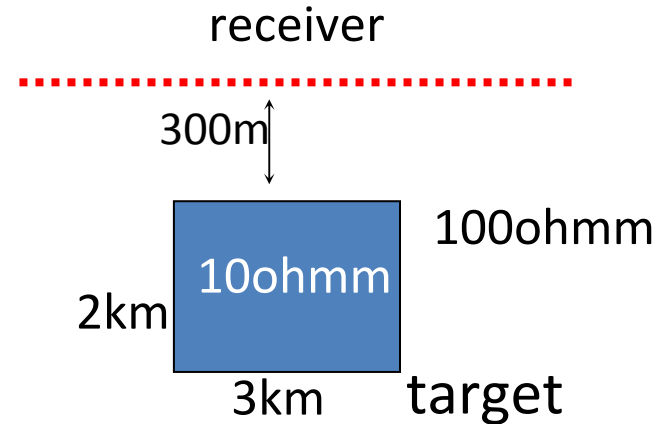


Is it necessary to extend 2D EM to 3D?

3D view



Plan view

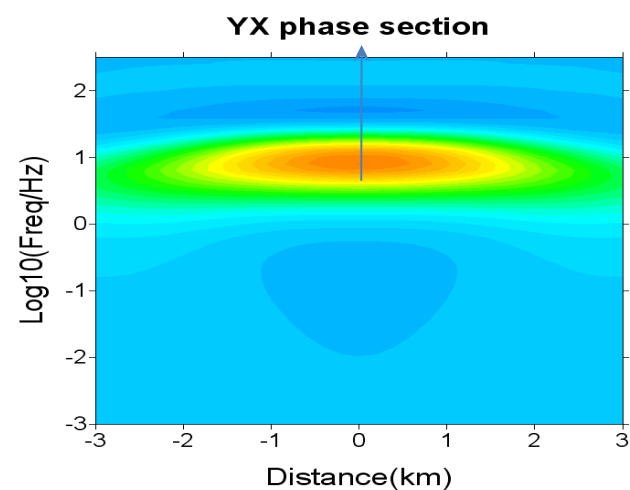
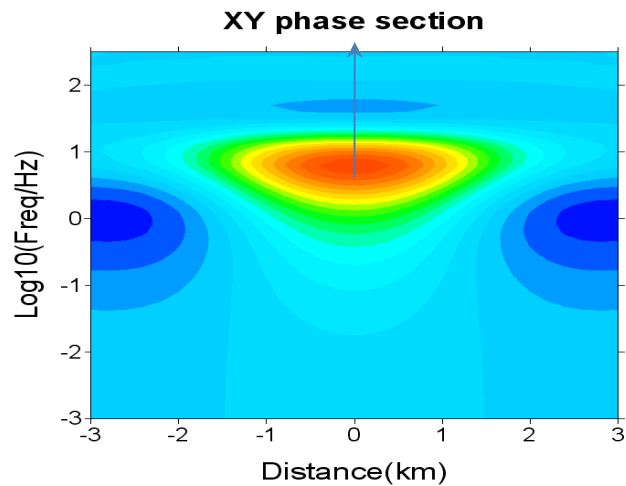
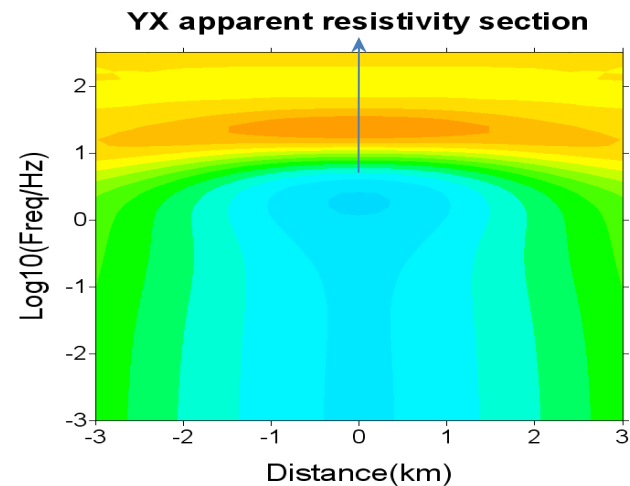
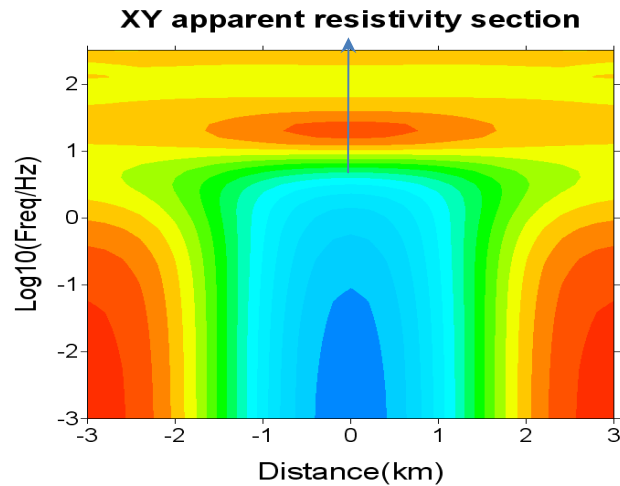


If a survey line goes by a 3D target instead of going just above it, what are the results measured with MT

测线在三维体旁300米穿过，而不在正上方，MT的结果如何？



Is it necessary to extend 2D EM to 3D ?



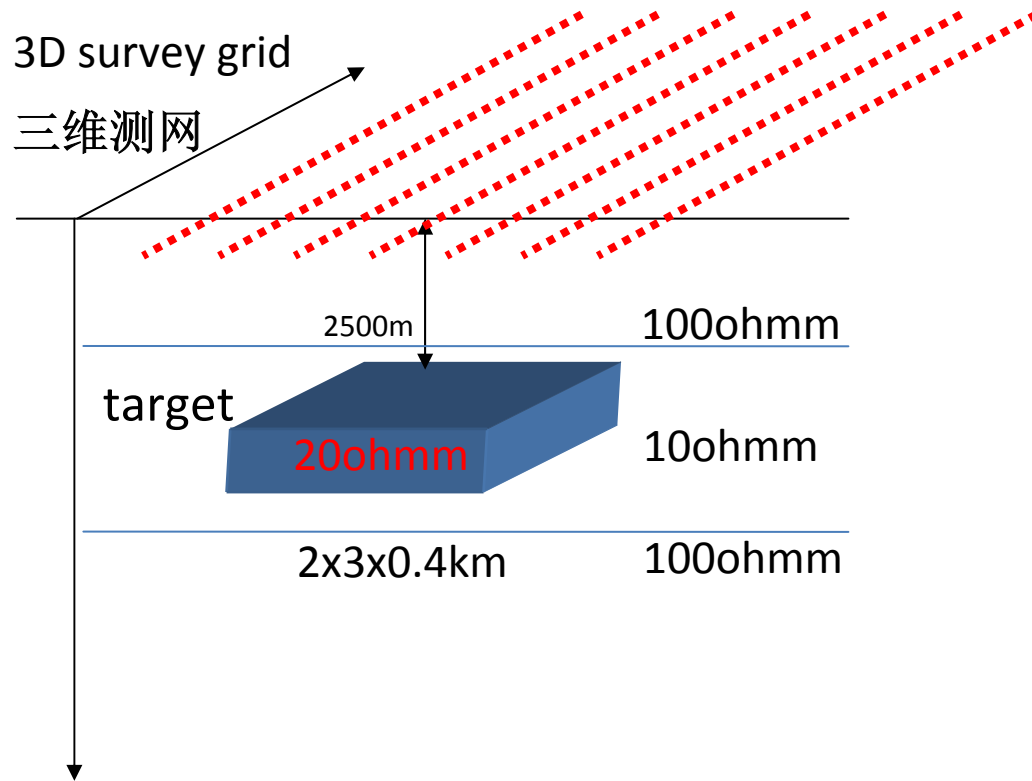
2D MT data shows obvious anomaly corresponding to the model, what result will be if a drill according to the 2D MT results. 旁侧目标在二维测线形成了非常明显的异常，如果就此部署钻探，意味着什么？



Is it necessary to extend 2D EM to 3D ?

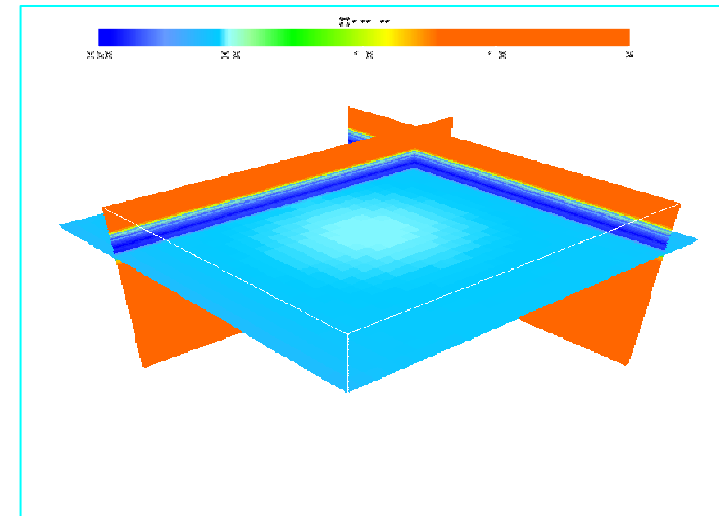
3D EM can overcome Volume effect

三维勘探能够克服体积效应

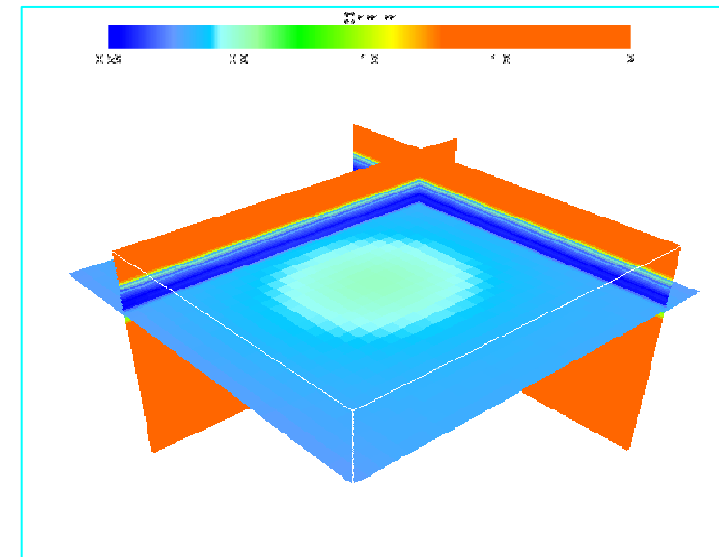


only 3D measurement can solve 3D effect of side target and 3D inversion can properly locate bodies.
旁侧异常体的三维效应只有应用三维勘探来解决，三维反演来解决！

3D inversion result



The upper slice (2.5km)



第九届国际地球电磁会议 2009 桂林



How to put 3D EM into applied?

- 3D EM is composed of acquisition, processing and interpretation. Here we will discuss data acquisition.

今天只讨论采集问题

- As for controlled source EM:

三维与二维的主要差别是激发与接收的相对位置不同。
三维则是将多道接收布成不同形状，接收多场源信号。

- As for MT :

三维与二维的主要差别是接收布设形状和方式。

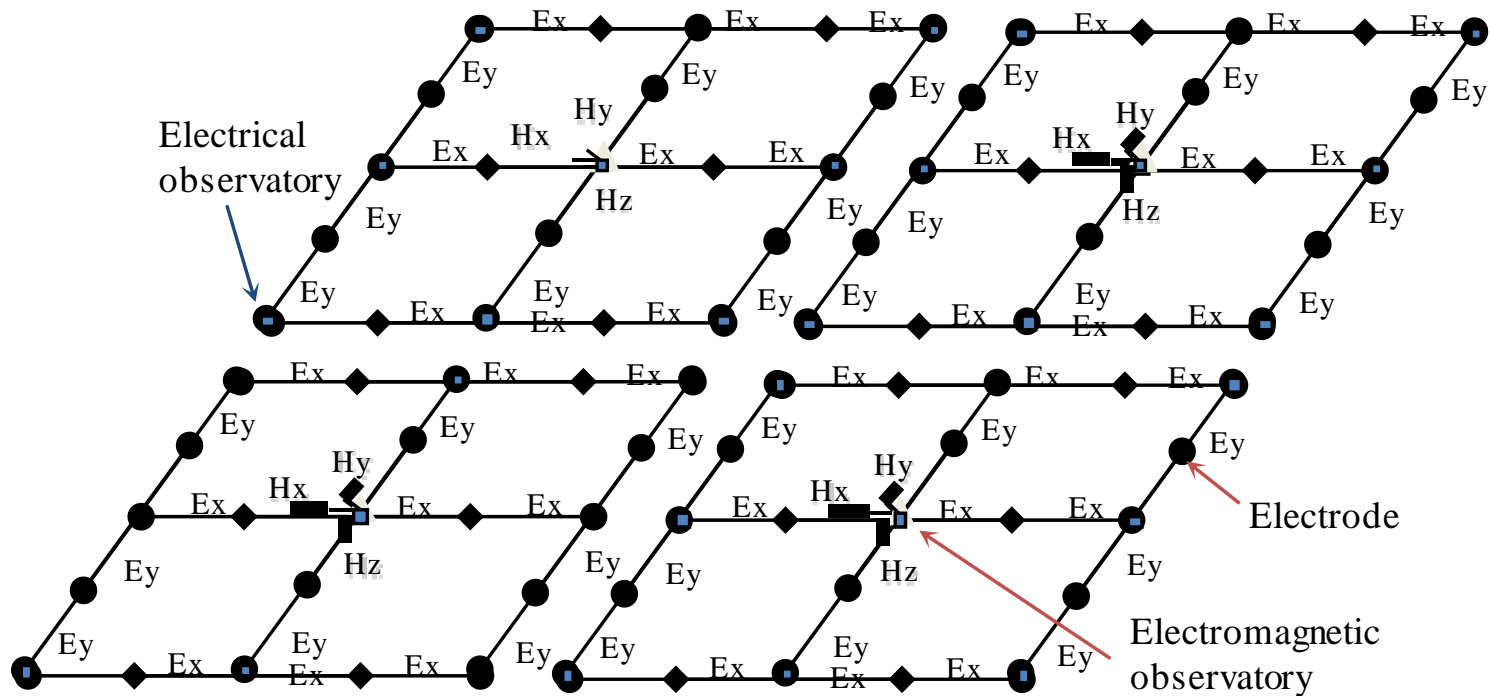


How to put 3D EM observation into practice?

3D MT data observation system

Small bin 3D CEMP observation system

小面元CEMP三维观测系统

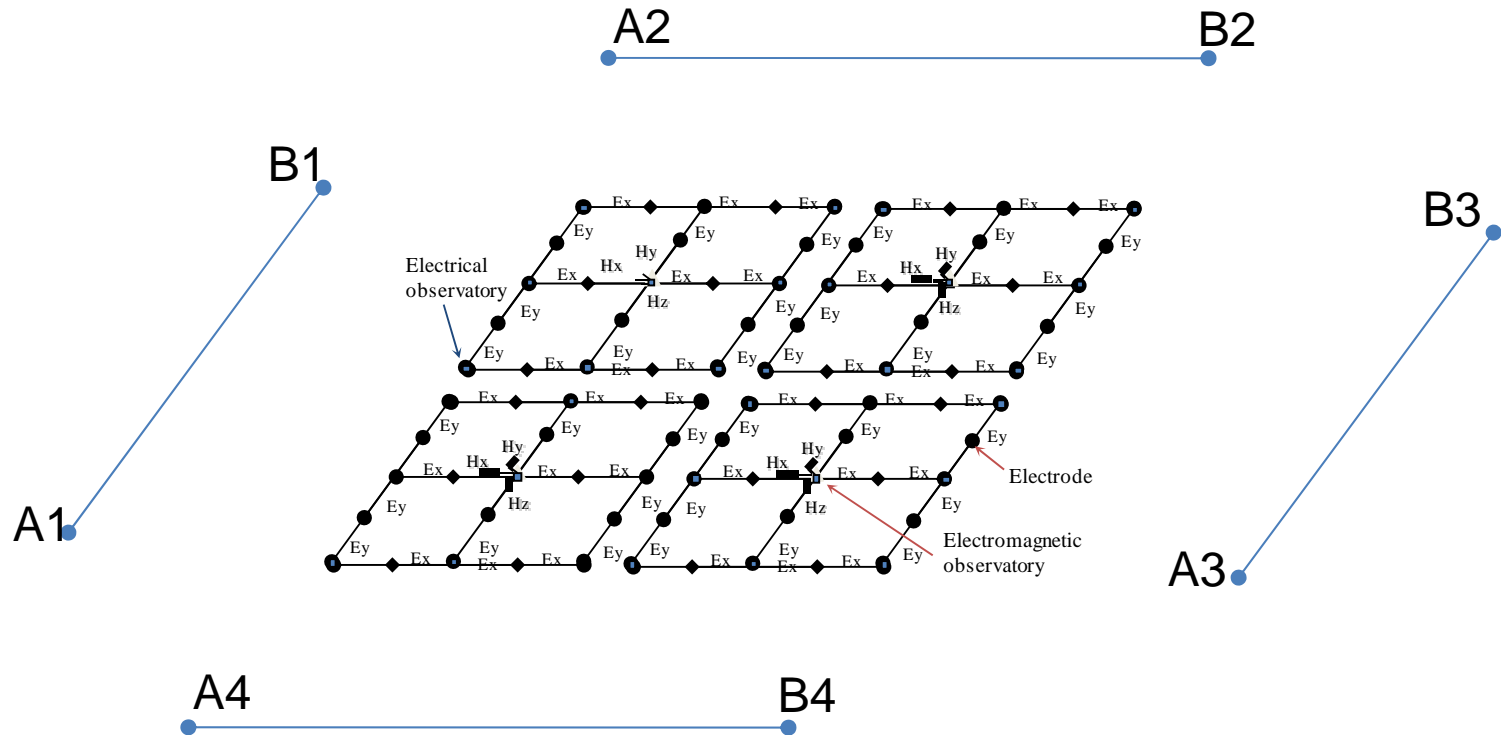




How to put 3D EM observation into practice?

3D CSEM data acquisition system

可控源电磁采集





3. What advantages does 3D EM possess?

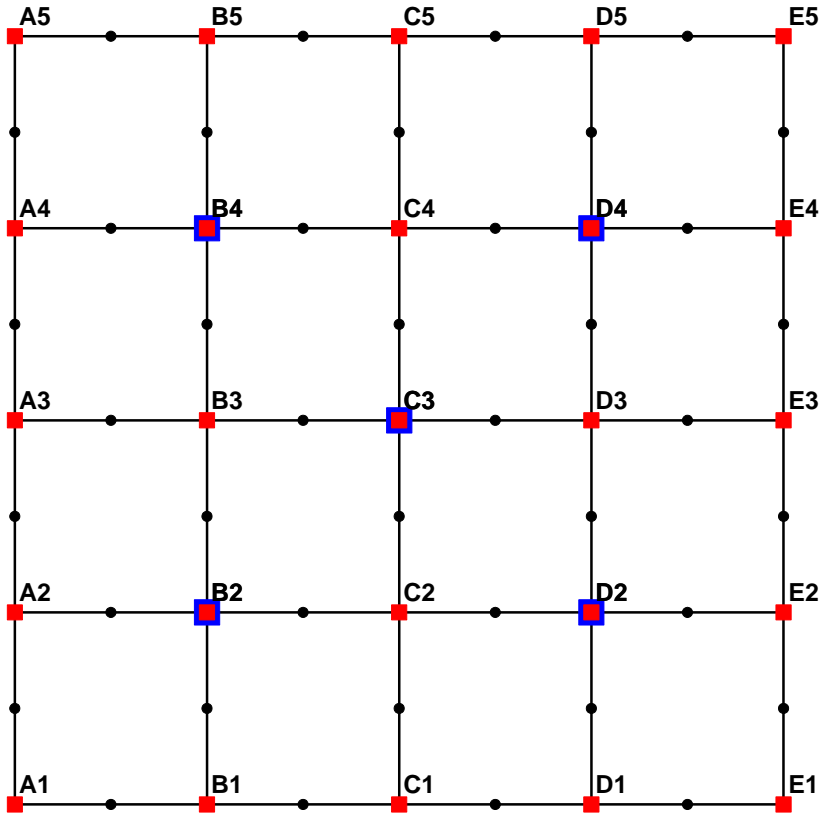
- To improve data quality.
改善记录质量;
- To increase the effect of suppressing noises.
提高抗噪能力;
- 3D data processing can improve accuracy.
三维处理和反演提高准确度;
- 3D interpretation can increase effect
三维地质解释提高构造推断效果;
- 3D visualization can intuitively and visual
三维可视化更形象直观生动显示。



3. What advantages does 3D EM exploration possess?

Small bin 3D MT observation test

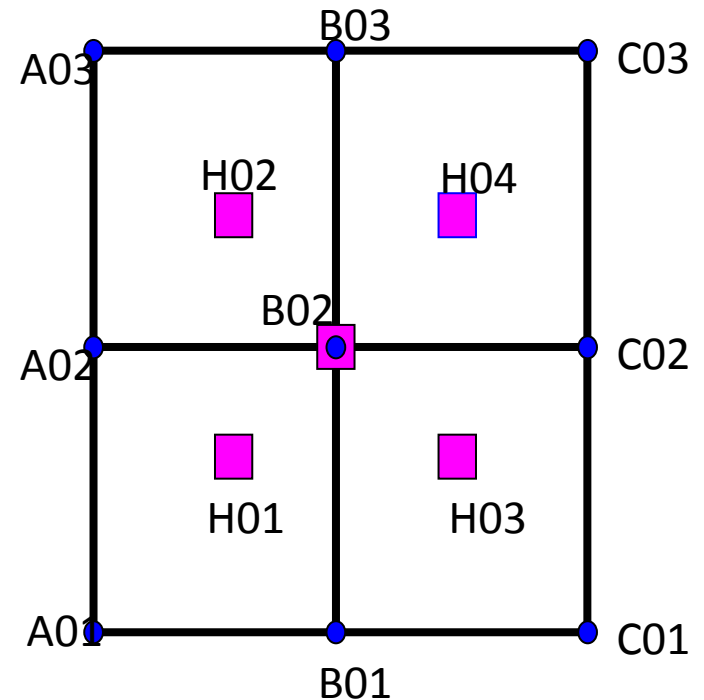
Test in Ku'erle 库尔勒试验点



Station interval: 250m,
 $5 \times 5 = 25$ survey sites
 $4 \times 4 = 16$ small bins

- Survey site location
- Magnetic station
- Commonly-used Electrodes 公用电极

Test in Hebei 河北试验点



Station interval: 250m
 $3 \times 3 = 9$ survey sites
 $2 \times 2 = 4$ small bins



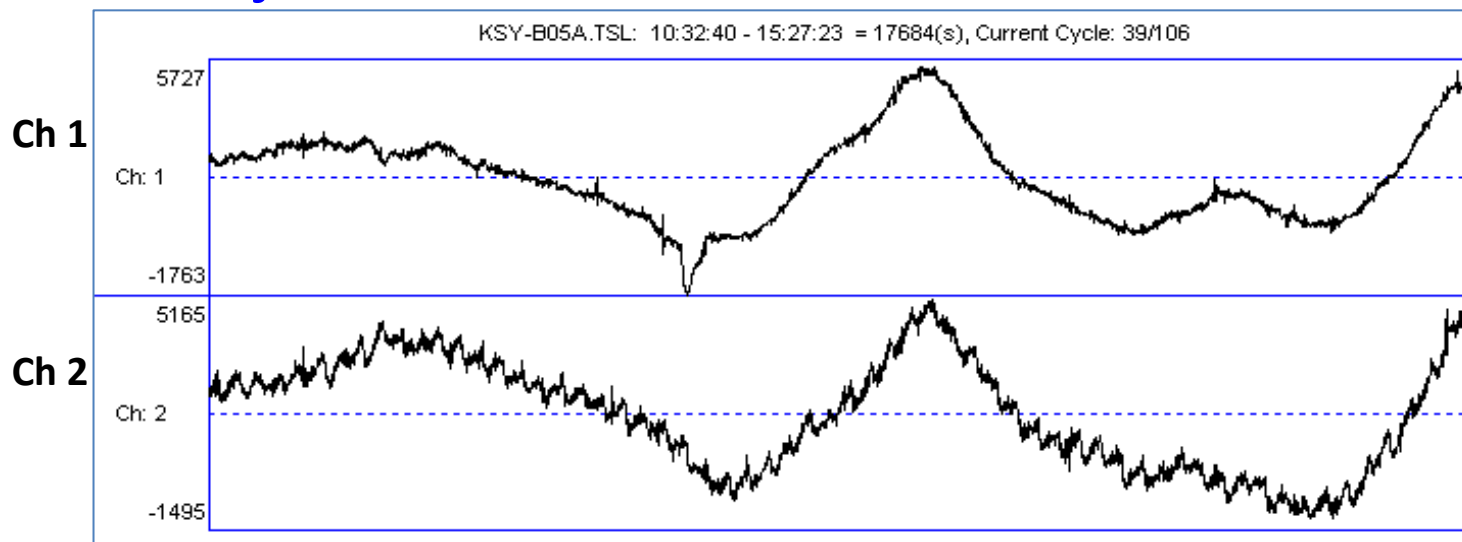
3. What advantages does 3D EM exploration possess?

3.1 3D de-noise and reconstruction

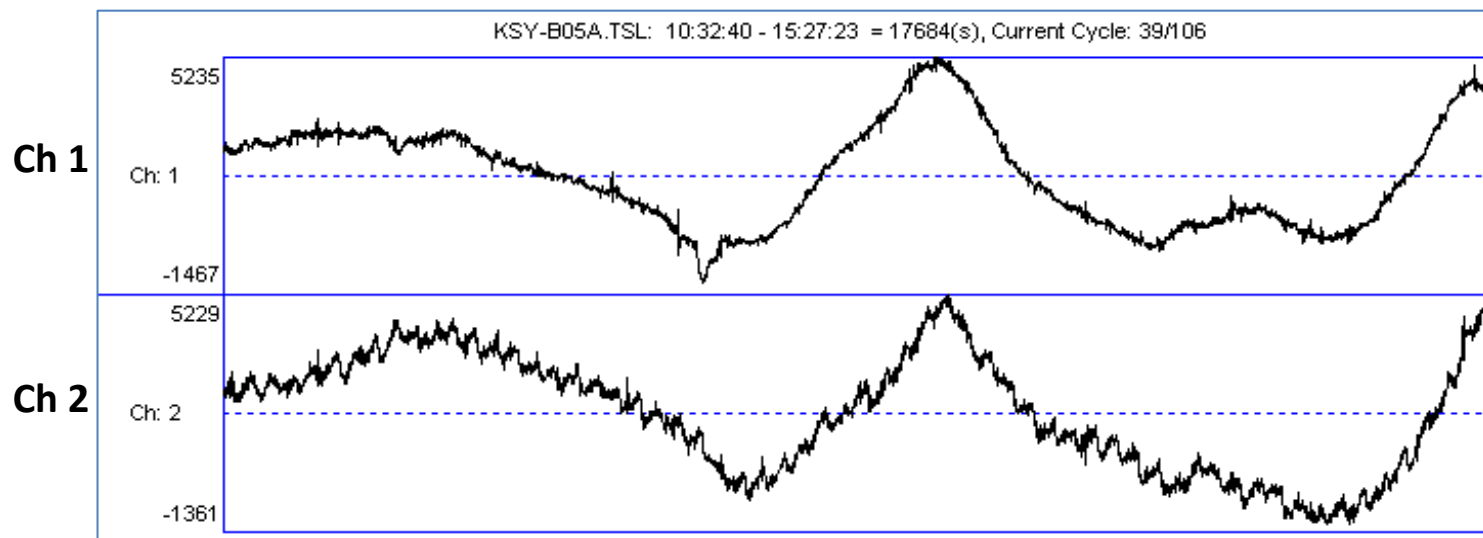
- To conduct spatial adjustment processing over time-series data
对时间系列数据进行空间平差处理
- synchronous electric signals at the same circuit will close
同一回路同步电场信号闭合
- Data in new form will be obtained after adjustment processing
平差处理后获得新的观测数据
- Power spectrum and the impedance tensor will be reprocessed.
重新计算功率谱及阻抗张量



Pre-adjustment

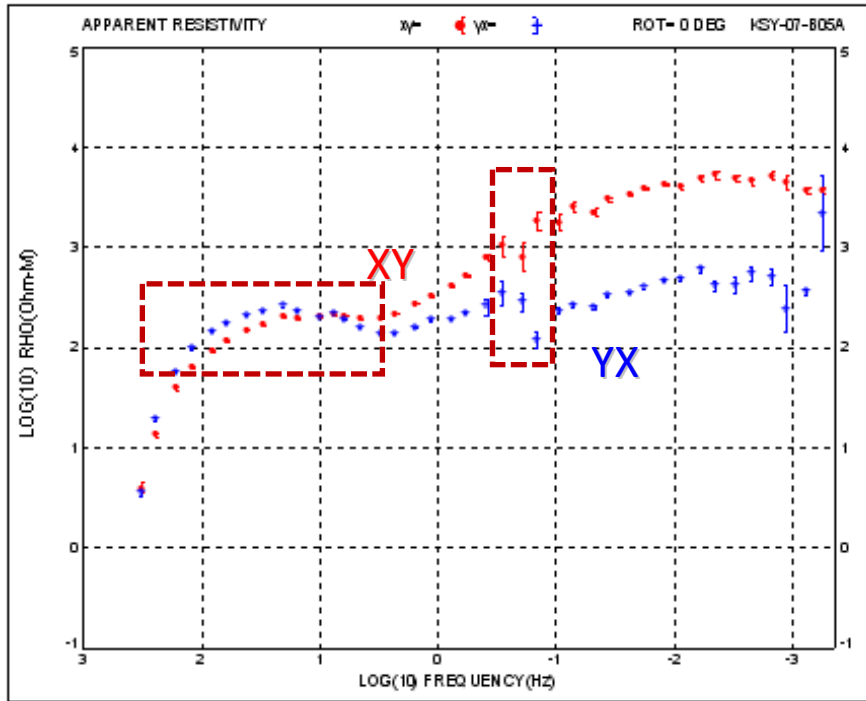


Post-adjustment



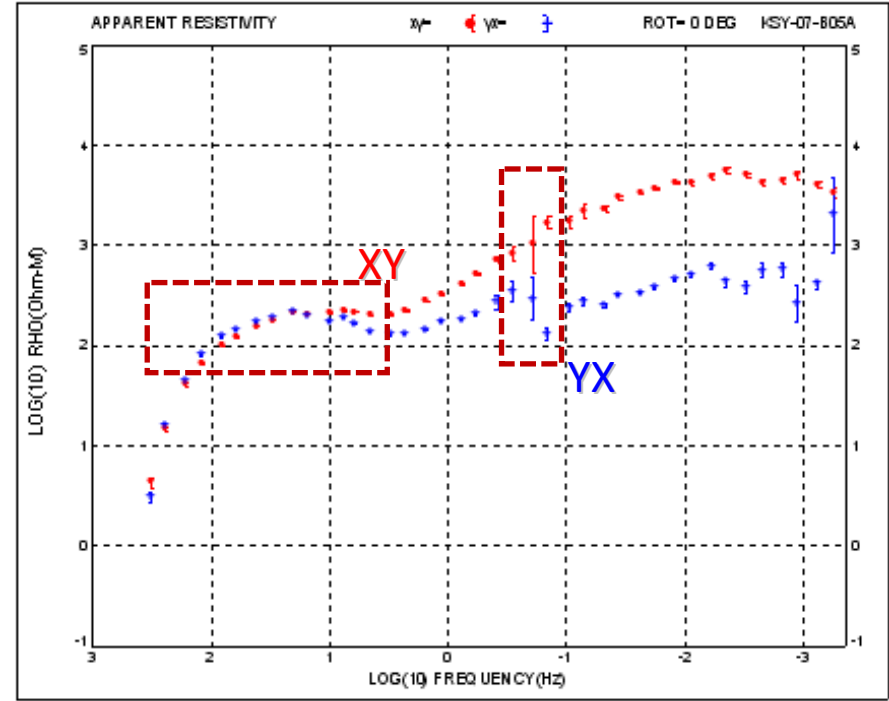


Apparent Resistivity curves



Pre-adjustment

Apparent Resistivity curves

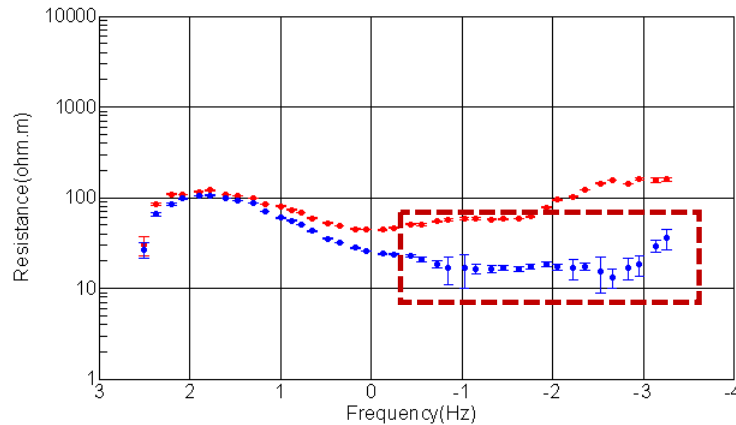


Post-adjustment

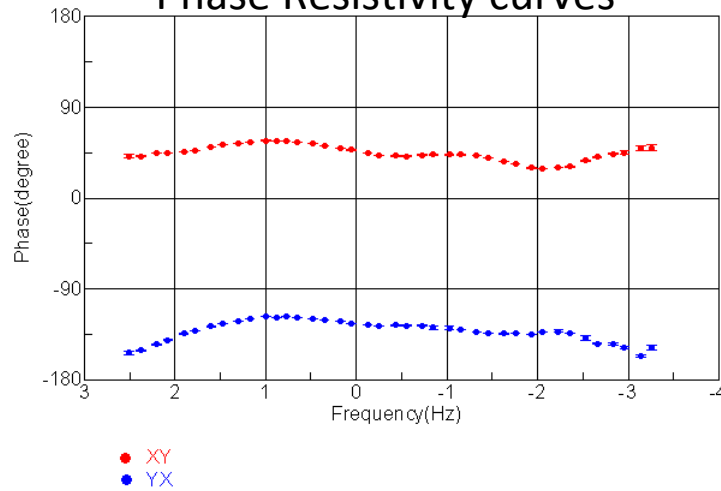
Noises in this area are small, curves difference between pre- adjustment and post- adjustment curves is little except head part of the pair post-adjustment curves are closer to each other than the former one.



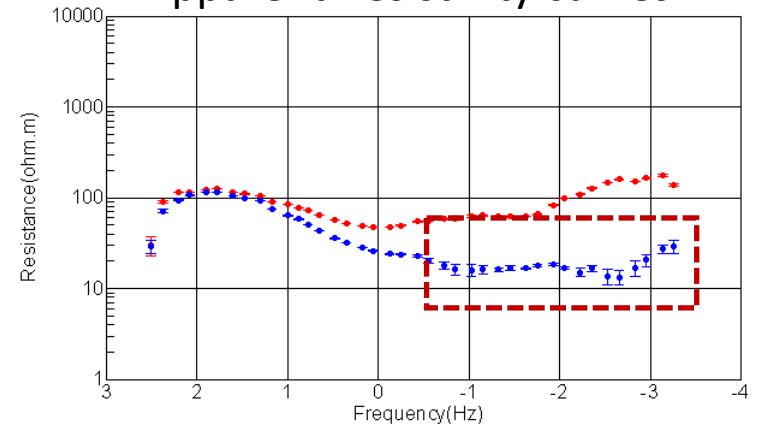
Apparent Resistivity curves



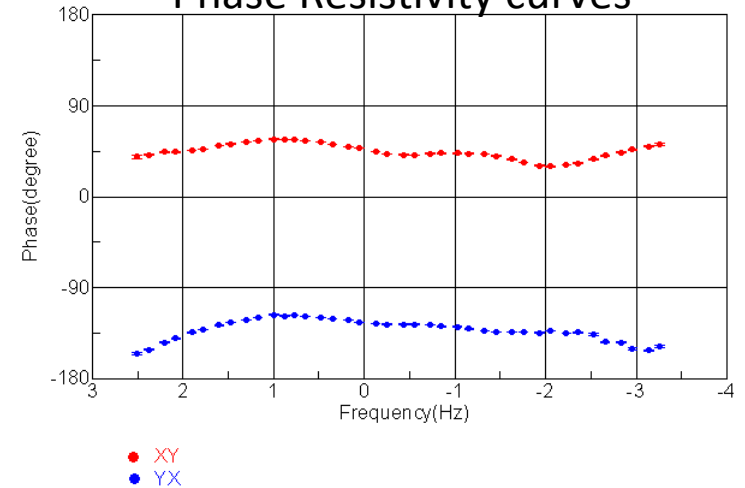
Phase Resistivity curves

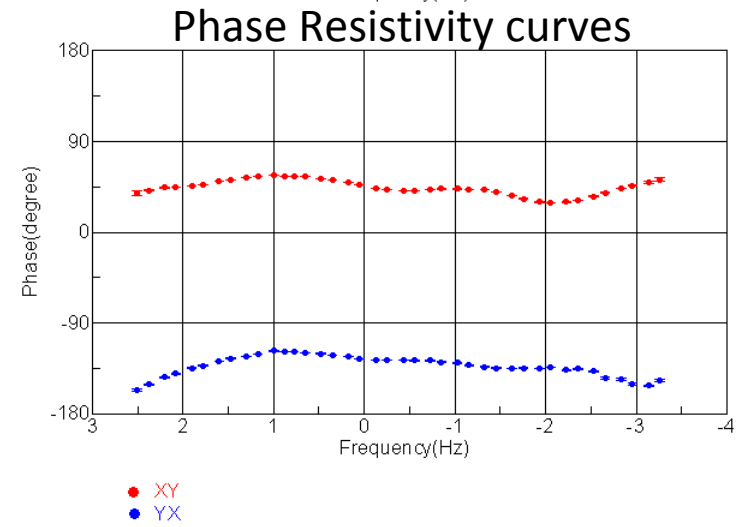
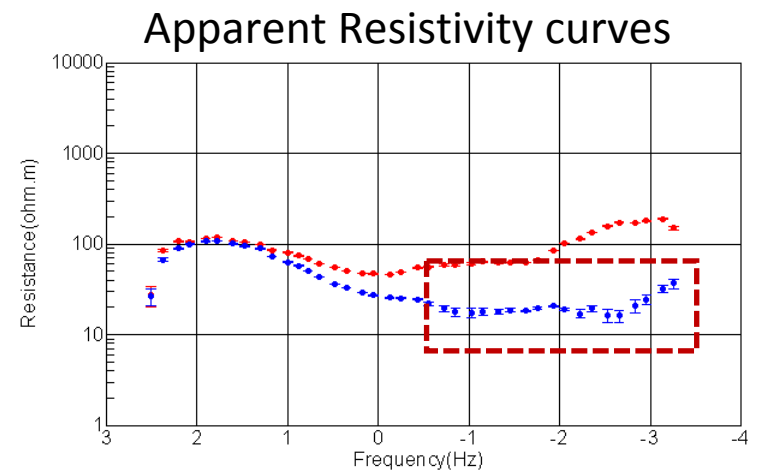
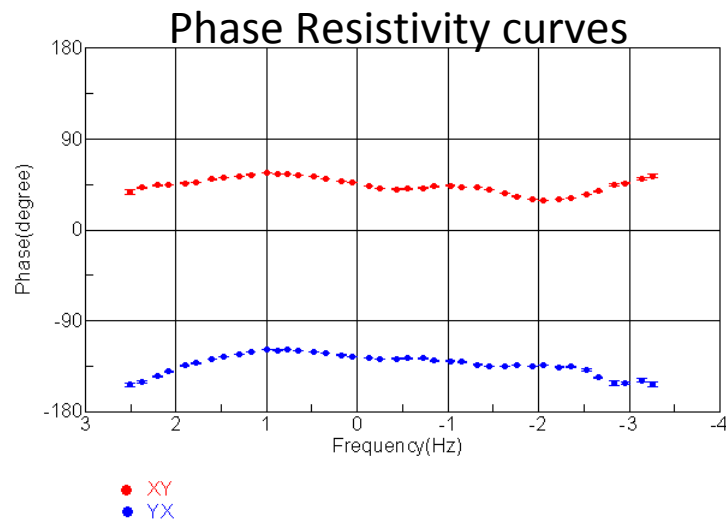
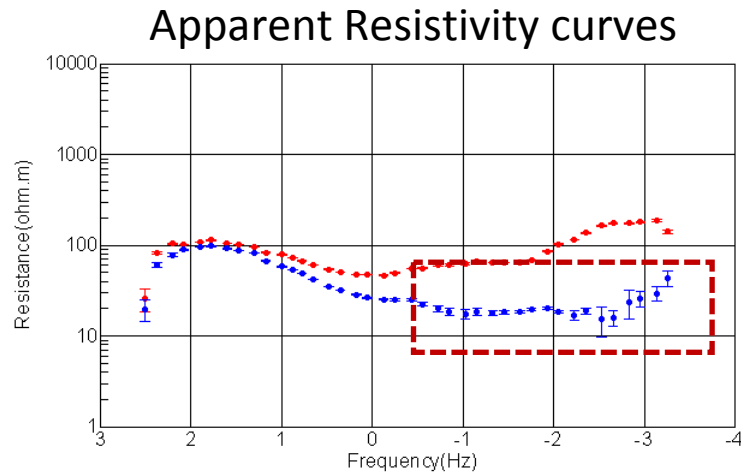


Apparent Resistivity curves



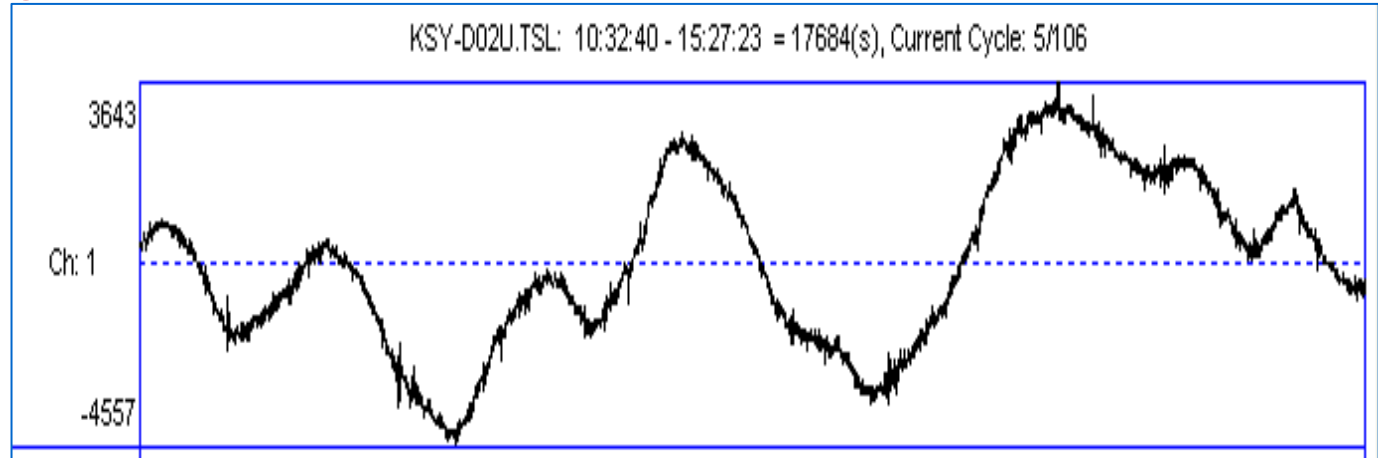
Phase Resistivity curves



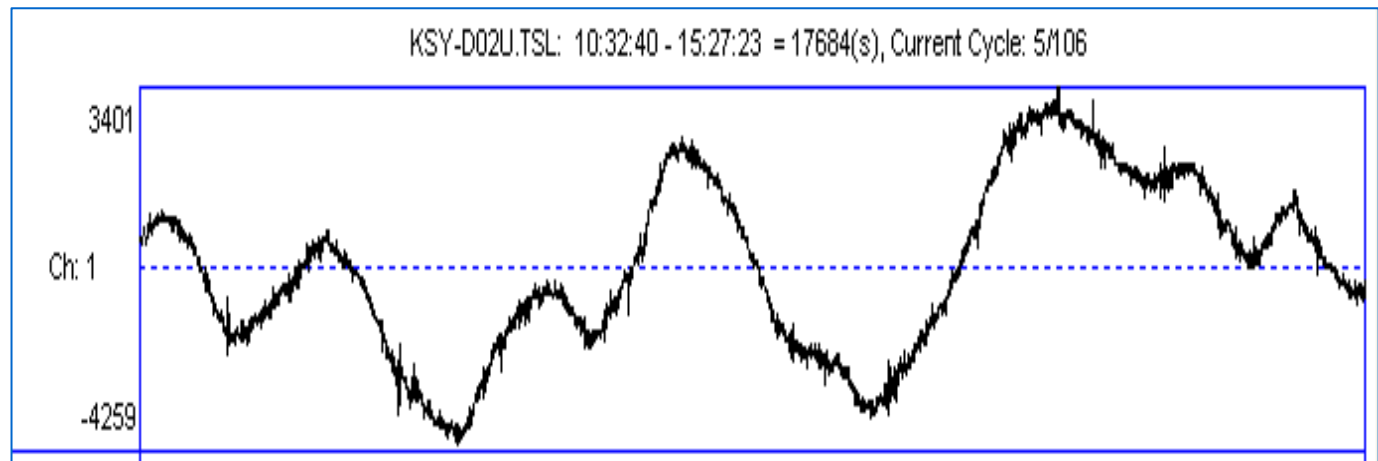




Original time series



Recovered time series



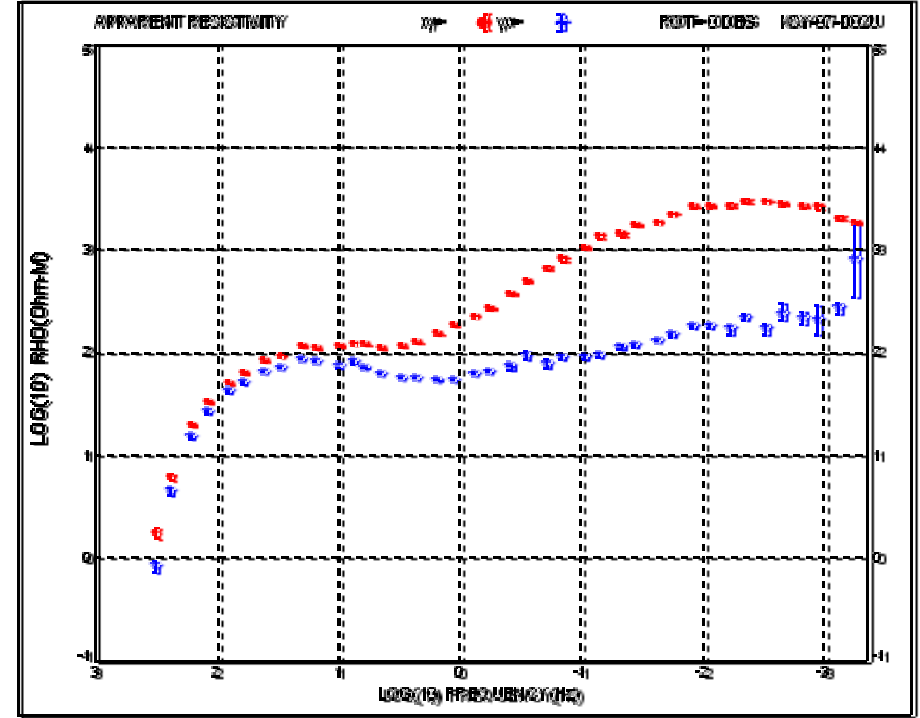


Apparent Resistivity curves



Original curve 原曲线

Apparent Resistivity curves

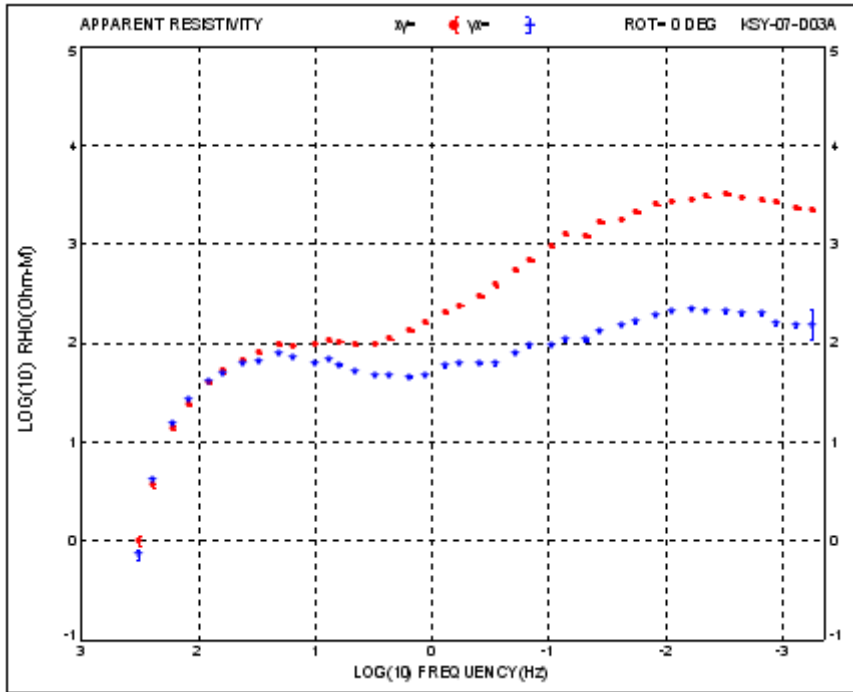


Recovered curve 恢复曲线

Unwanted curves can be recovered to its original form when observed data of their surrounding survey sites are good.

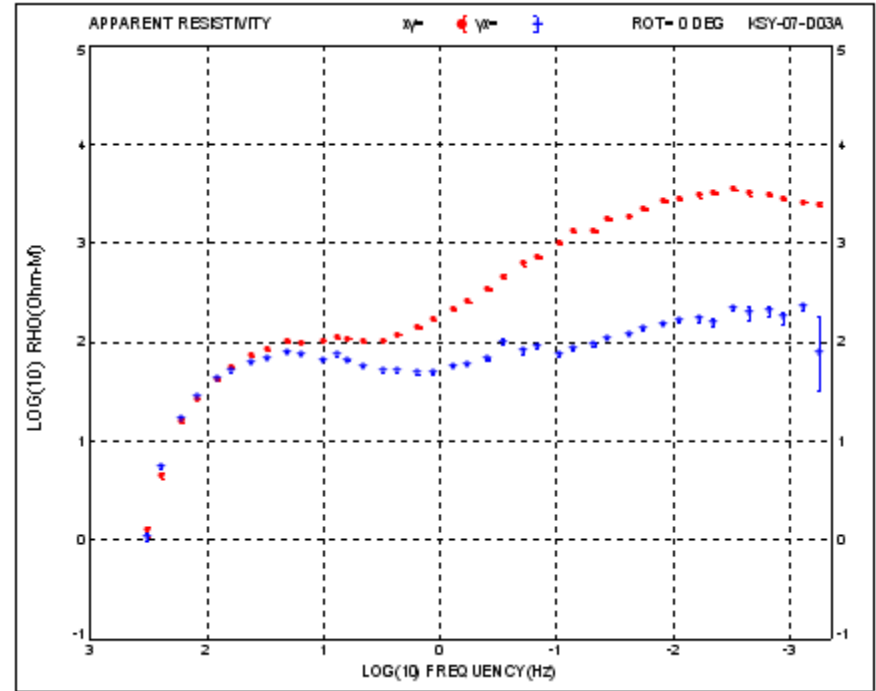


Apparent Resistivity curves



Original curve 原曲线

Apparent Resistivity curves



Recovered curve 恢复曲线

unwanted curves can be recovered to its original form when observed data of their surrounding survey sites are good.



3. What advantages does 3D EM exploration possess?

3.2 Static shift correction :

➤ **Static shift correction in time-domain: to conduct spatial filtering over synchronous time series signals**

在时域对同步时序信号进行空间滤波，包括二维和三维。

➤ **Frequency-domain static shift correction: it is similar to conventional method, including 2D and 3D.**

在频率域与常规静态位移校正相同，也包括二维和三维。

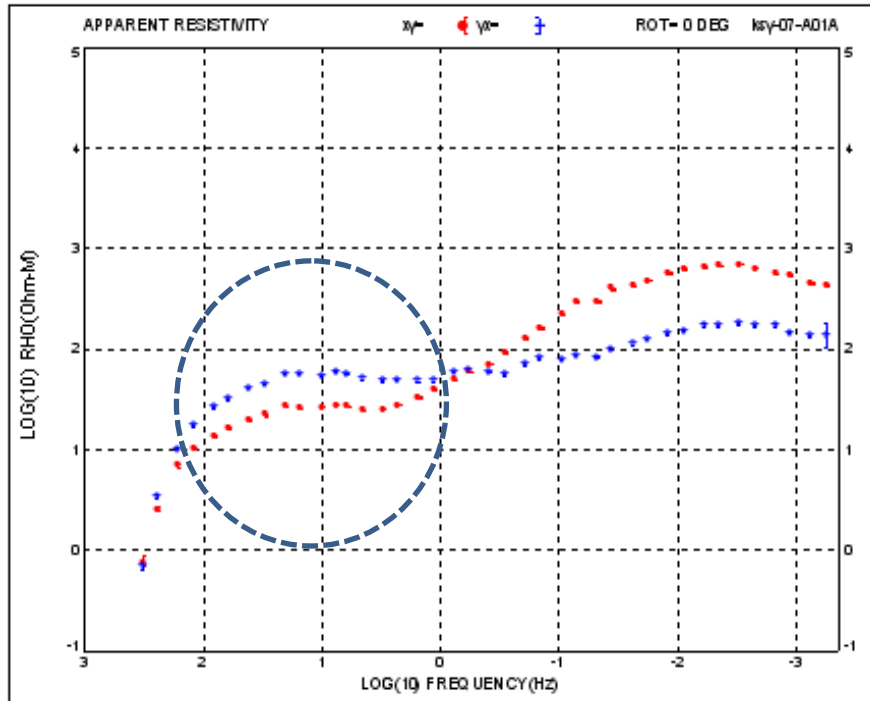


3. What advantages does 3D EM possess?

Receiver:A05

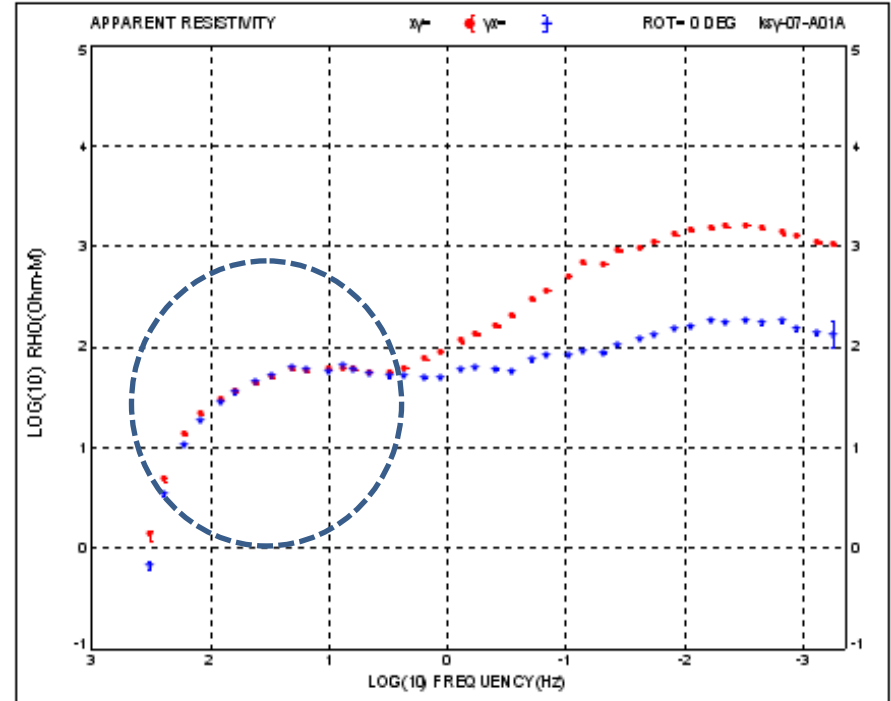
Static shift correction in time-domain

Apparent Resistivity curves



Curves before static correction

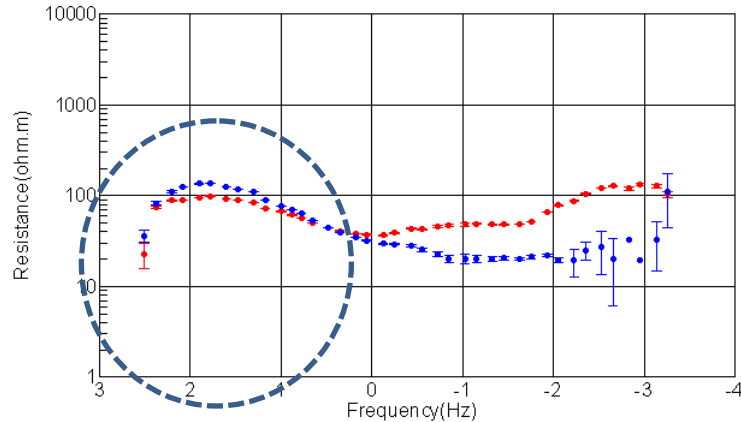
Apparent Resistivity curves



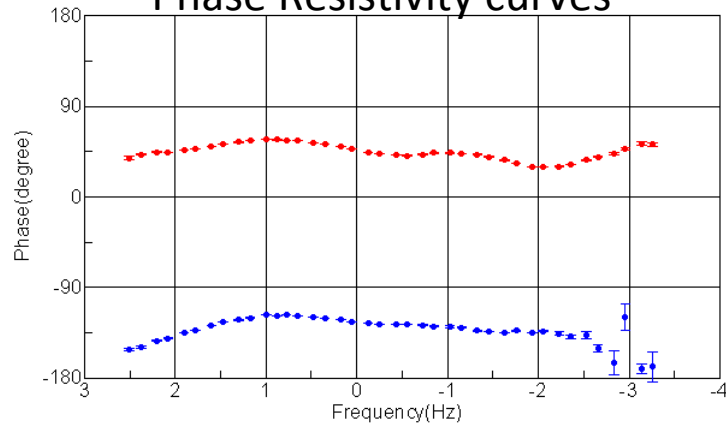
Curves after static correction



Apparent Resistivity curves

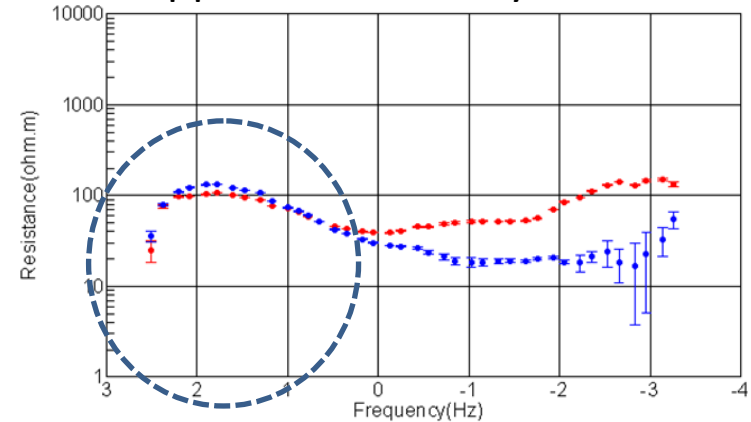


Phase Resistivity curves

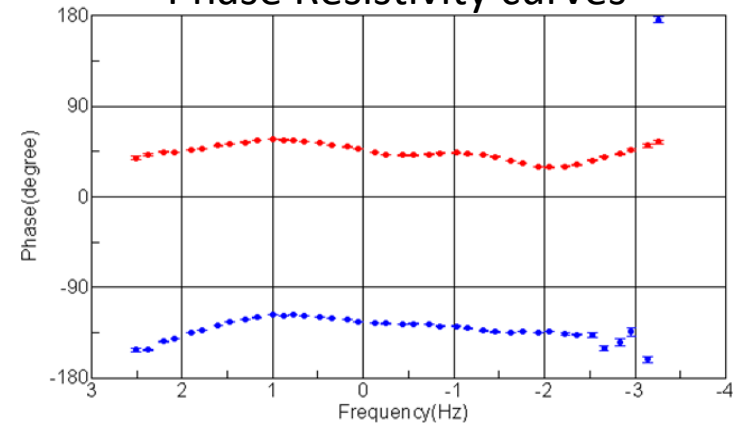


Curves before static correction

Apparent Resistivity curves



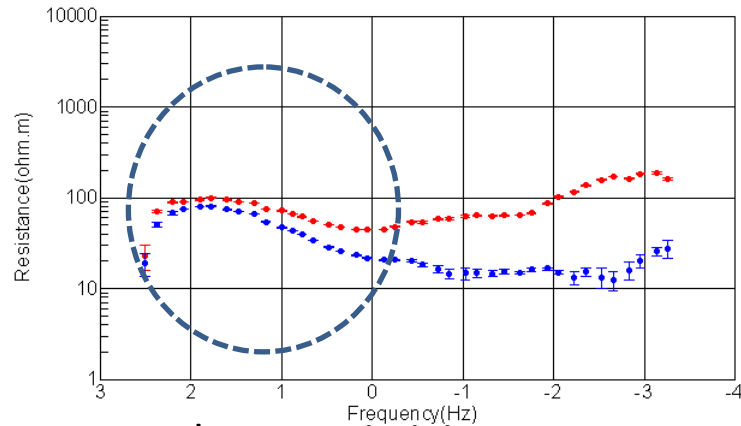
Phase Resistivity curves



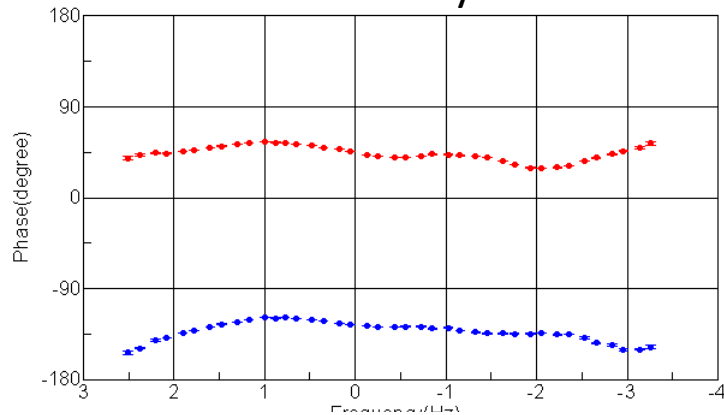
Curves after static correction



Apparent Resistivity curves



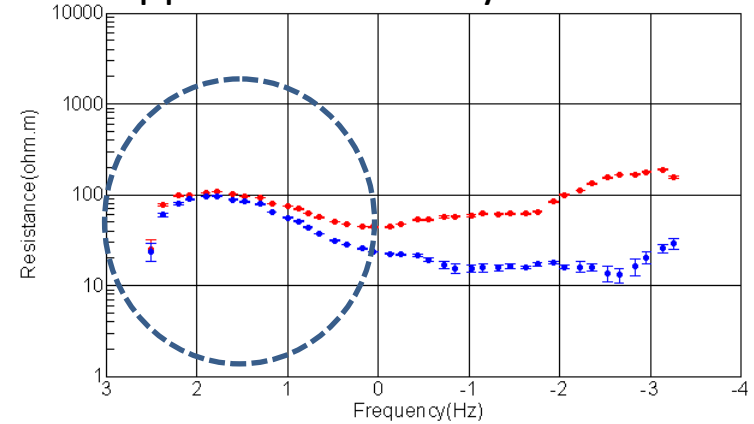
Phase Resistivity curves



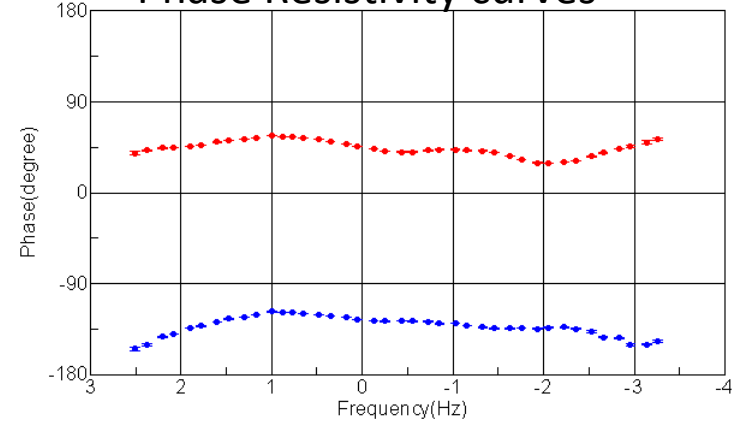
Curves before static correction

1.5

Apparent Resistivity curves



Phase Resistivity curves



Curves after static correction



Conclusions

1. Although data quality of the survey site is relatively poor, data quality of its surrounding survey sites are relatively good, so data quality of this site will be improved after experiencing adjustment or static correction.

本点质量较差，周围测点质量较好，平差或静校正出来的曲线质量一定改善；

2. Although data quality of the survey site is relative good, data quality of its surrounding survey sites are relatively poor, so data quality of this site will be worse even experiencing adjustment or static correction.

本点质量较好，周围测点质量较差，平差或静校正出来的曲线质量反而下降。



Conclusions

1. Techniques like small bin 3D MT, spatial adjustment, time domain static correction, recovery, etc. can improve data quality, especially, for sites with bad data quality or sites severely affected by noises.

采用小面元三维MT数据采集技术，运用平差、时域静校正、测点恢复等手段，可以提高数据质量，特别是针对质量较差或受到严重干扰的测点具有起死回生的作用；

2. Specifications on Field acquisition configuration are strict, such as synchronous acquisition, electrodes interval, site interval, etc.

对野外装置布设要求很高，如同步采集、电极极差、点位点距要求严格等；

3. Small bin 3D MT data acquisition and processing techniques need to be further improved.

小面元三维MT数据采集和处理方法技术需要进一步完善；



The End

Thank You For Your Attention