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First Marine Strata Thickness map of Entire South Yellow Sea By Aeromagnetic and Airborne Gravity Inversion

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Outline

- **Geological setting**
- Methodology
- Results and analysis

Location of South Yellow Sea

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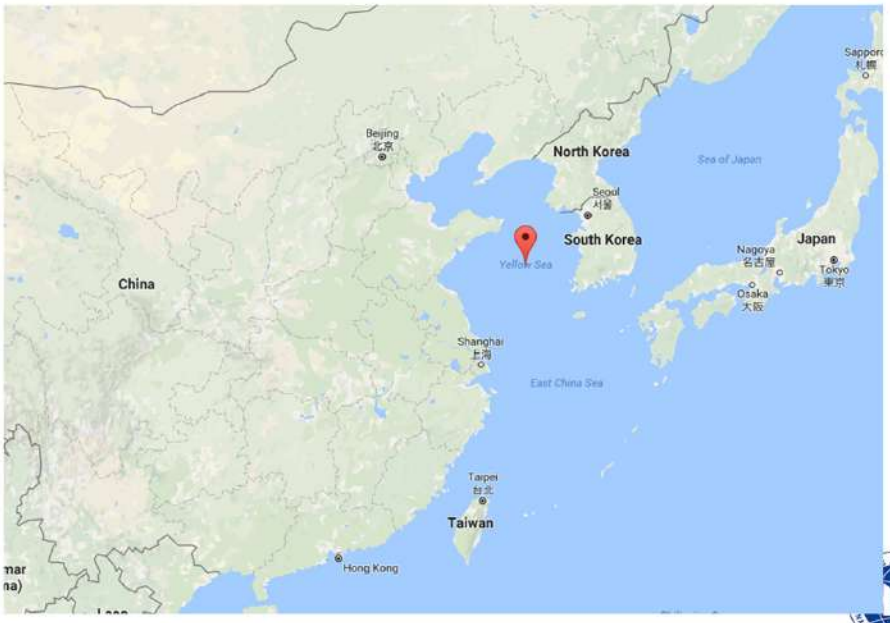
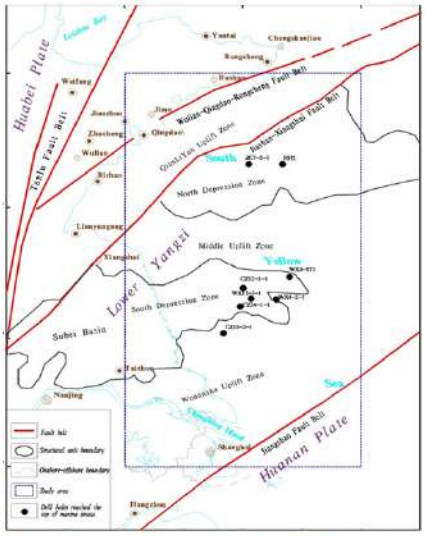


Marine strata distribution of the South Yellow Sea supports the oil-gas prospecting target , very meaning for determination of drilling location.

Recently, extensive geological and geophysical investigations and research on marine strata of South Yellow Sea has been carried out mainly on seismic prospecting technique, but the seismic prospecting has failed to acquire the entire marine strata distribution of the South Yellow Sea.

Our study is supported by China Geological Survey， aiming to obtain the entire distribution of the marine - strata of the South Yellow Sea by the latest surveyed aeromagnetic and airborne gravity data from China aero geophysical survey and remote sensing center for land and resources

Geological Tectonic background of the South Yellow Sea



Modified after Guo Y G et al.,1997 and Zhang M H et al.,2007

Geological setting

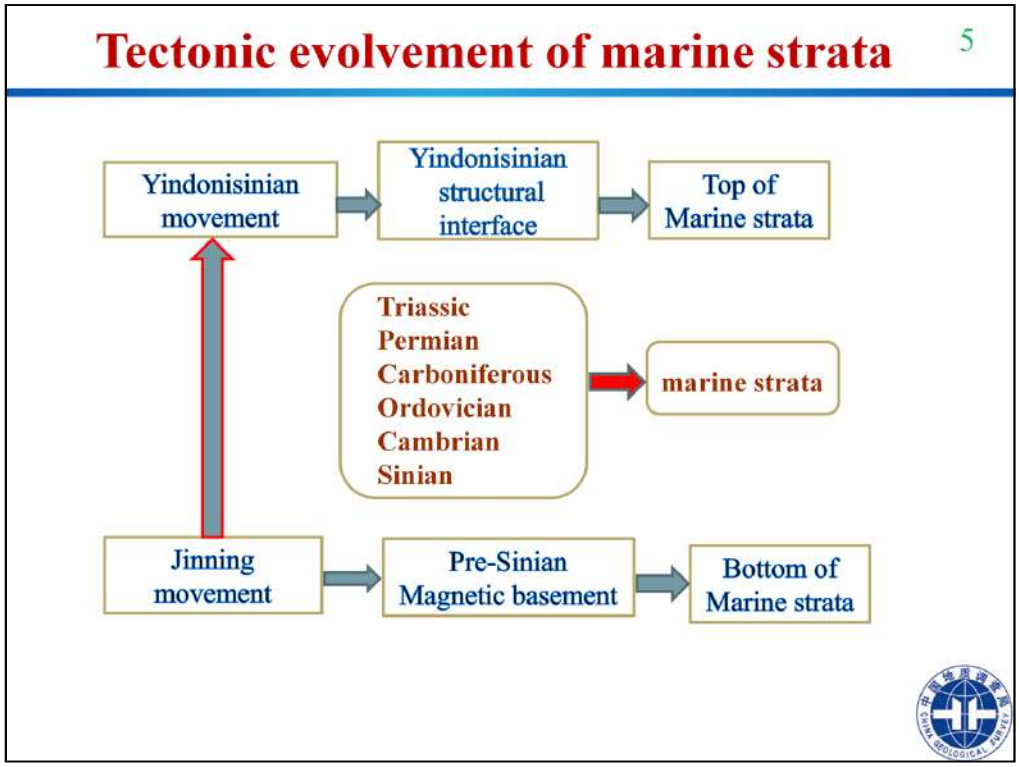
- Northeast lower Yangtze block
- West by the Tanlu fault belt
- North by the Wulian-Qingdao-Rongcheng fault belt
- South by the Jiangshao fault belt

Structural unit

- **three uplifts and two depressions**
- **Blue dashed rectangle is the study area of aeromagnetic and airborne gravity survey**

located in the northeast lower Yangtze block of the South China plate, and is bounded to the west by the Tanlu fault belt, and to the north by the Wulian-Qingdao-Rongcheng fault belt, and to the south by the Jiangshao fault belt .

According to the distribution of Mesozoic and Cenozoic terringenous strata, the structural units of the South Yellow Sea can be subdivided from north to south into the three uplifts and two depressions, namely Qianliyan uplift zone, the north depression zone, the middle uplift zone, the south depression zone adjacent to Subei basin and Wunansha uplift zone



started from Jinning movement and ended with Yindosinian movements, among which, Sinian, Cambrian, Ordovician, Carboniferous, Permian, Triassic marine strata have been developed

Previous studies verfied that Pre-Sinian metamorphic rocks was the formation facies of marine strata, namely the bottom of marine strata; and Yindosinian structural interface was seen as the top of marine strata of South Yellow Sea

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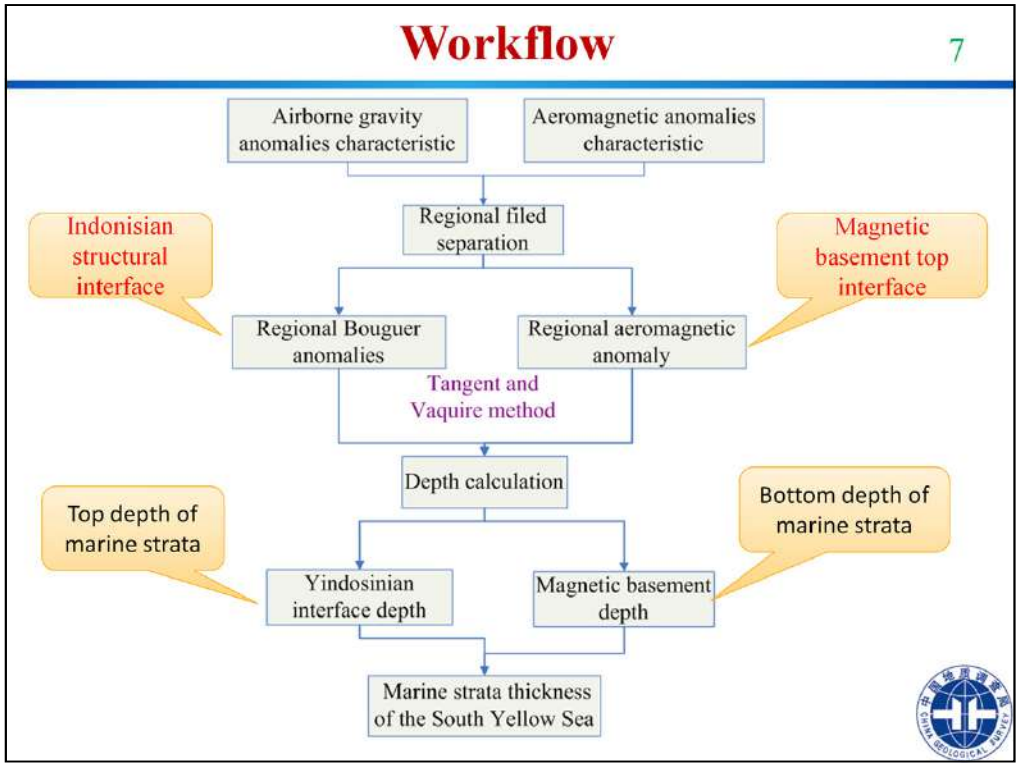
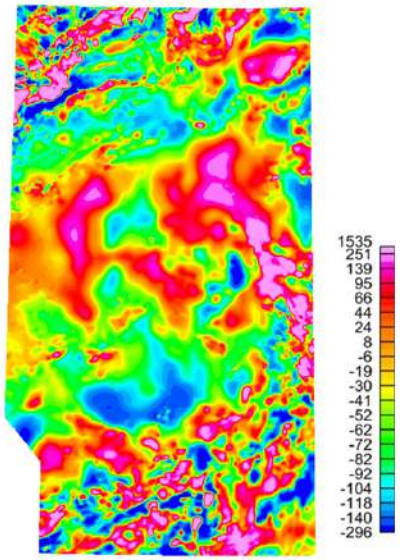


First ,based on analysis of airborne gravity and aeromagnetic anomalies data characteristic, combined with regional physical properties of strata and rocks, we conduct the geophysical field separation of marine strata interface. Then we obtained the regional bouguer gravity anomalies which mainly reflects the undulation of Indonisian structural interfaces, and regional aeromagnetic anomalies which mainly reflects the undulation of magnetic basement. Finally, using the Tangent and Vaquire method to calculate the depth on the regional Bouguer anomaly profile, obtained the Yindosinian interface depth ,namely the top of the marine strata, the same method was applied on the aeromagnetic anomaly profile to calculate the magnetic basement depth, namely the bottom of the marine strata. Using the Yindosinian interface depth to minus the magnetic basement depth to get the marine strata thickness.

Aeromagnetic anomalies analysis 8



Aeromagnetic anomaly grid data with reduced to the pole

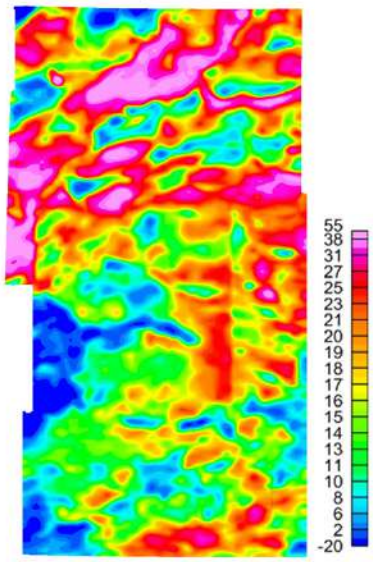
- Apparent susceptibility contrast between regional and local magnetic anomalies
- Magnetic basement composed of preSinian strata was the main contributor of the regional magnetic anomalies based on statistic of Susceptibility
- Solution for depth inversion of preSinian magnetic basement top interface is using the regional magnetic anomalies .

Aeromagnetic data

- aeromagnetic survey with 1 km line space
- **Aeromagnetic data with reduced to the pole by variable inclination**

The general aeromagnetic field characteristic of South Yellow Sea can be regarded as a dominated circle shaped gentle and high anomalies zone in the middle study area, surrounded by dramatically changing positive and negative magnetic anomalies in the south and north side.The aeromagnetic anomalies vary from -296 nT to 1535 nT in the whole study area

Airborne Bouguer gravity anomalies analysis



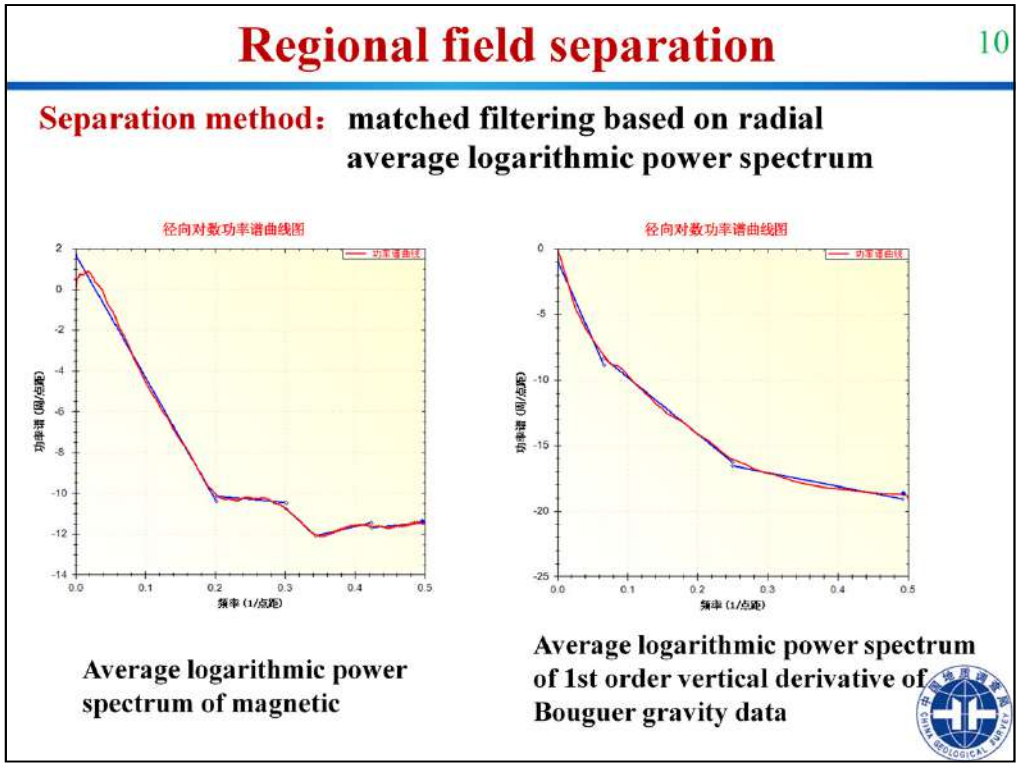
Airborne Bouguer gravity grid data of the South Yellow Sea

- Corresponded well with the structural framework of the "three uplift and two depression zone"
- Density contrast of Yindosinian structural interface lead to the regional Bouguer gravity anomalies
- Using the regional Bouguer gravity anomalies for depth inversion of Yindosinian interface

Airborne gravity data

- Russian GT-1A and GT-2A airborne gravimeter system
- A survey scale of 1:200,000
- flying altitude ranging from 400 m to 800 m
- Terrain correction
- **Airborne Bouguer gravity anomalies data**

It showed that from airborne Bouguer gravity grid data (Fig 2) the study area has apparent characteristic of anomalies zones and belts with anomalies values ranging from -20 to 55 mGal.



Therefore, the separation of regional anomalies of aeromagnetic data with reduced to the pole and airborne Bouguer gravity data became a primary and necessary processing before they are used for depth inversion of marine strata interfaces in this study.

The matched filtering based on radial average logarithmic power spectrum was proved to be an effective and practical method of separating deep source field and shallow source field (Wang et al, 2015).

In this study, We selected a typical study area to apply this method for experiment, the Fig is the logarithmic power spectrum of magnetic (and 1st order vertical derivative of Bouguer gravity data separately , based on their curve of average logarithmic power spectrum, we performed the fine linear fitting.

Regional field separation

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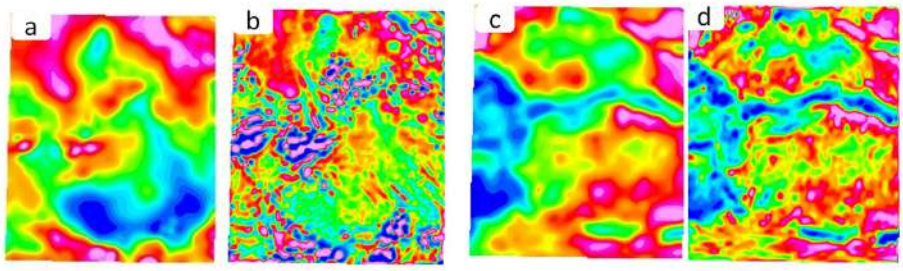


a Regional aeromagnetic anomalies
b Local aeromagnetic anomalies

c Regional airborne gravity bouguer anomalies
d Local airborne gravity anomalies

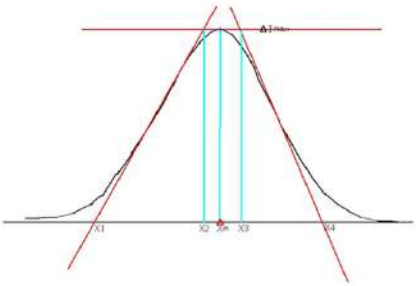
The method has been proved to be successful in separating regional and local anomalies of aeromagnetic and Bouguer gravity

Depth inversion of marine strata interface

Calculation method: Vacquier and tangent method (mature magnetic body depth calculation) for anomaly profile depth point calculation

Data required:

- Regional magnetic ΔT with reduced to the pole anomaly profile
- First vertical derivative of regional gravity anomaly profile



Software platform

- Home-developed Geophysical processing and interpretation software platform **Geoprobe**

Calculation results

- 16510 depth point calculated for Indosinian structural interface
- 18015 depth point calculated for magnetic basement interface

Comparison of Yidosinian structural interface depth by drilling and calculation

Drilling number	Drilling location	Marine strata top depth by drilling	Calculation depth by gravity	Deviation	Relative error
ZC7-2-1	North depression	1200	1410	210	17.50
CZ24-1-1	South depression	3341	3396	55	1.65
WX4-2-1	South depression	2708	2579	-129	-4.76
WX5-ST1	South depression	1410	1620	210	14.89
CZ35-2-1	Wunansha uplift	2077	1758	-319	-15.36
HH2	North depression	1706	1720	14	0.82
WX13-3-1	South depression	2805	2706	-99	-3.53
CZ12-1-1	South depression	2077	2486	409	19.69

The relative error of calculation is less than 20% ,which fully meets the accuracy requirement for geological interpretation.

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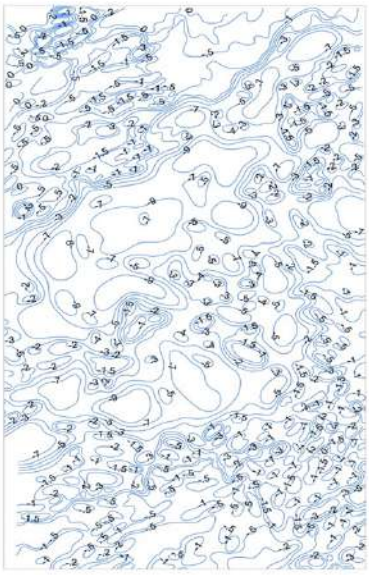
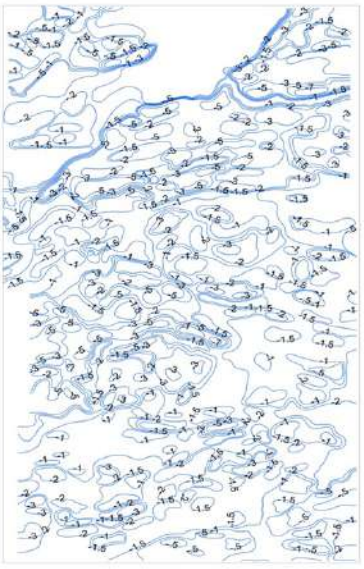
Analysis



pre-Sinian magnetic basement top contour (X kilometer)

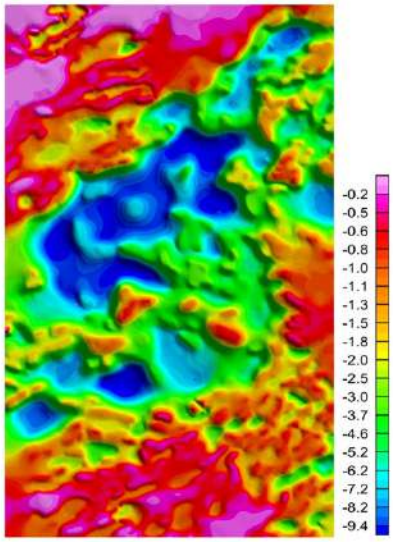


Yindosinian interface depth contour (X kilometer)

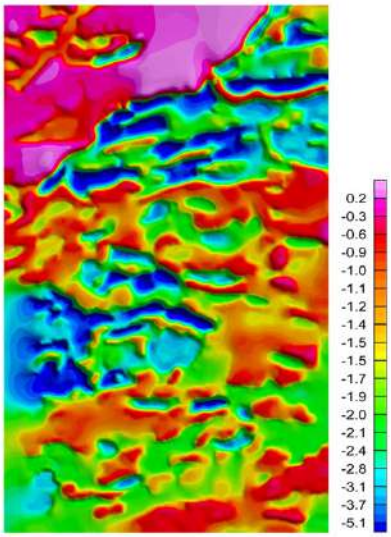
- Based on the calculated depth point
- referenced the regional geology, seismic profile, drilling materials
- varied contour space from 0.5,1.0,1.5,2.0,3.0,5.0,7.0,9.0.
- Drawing the contour along the geological structural trending.

completed compilation of depth contour map by interpretation

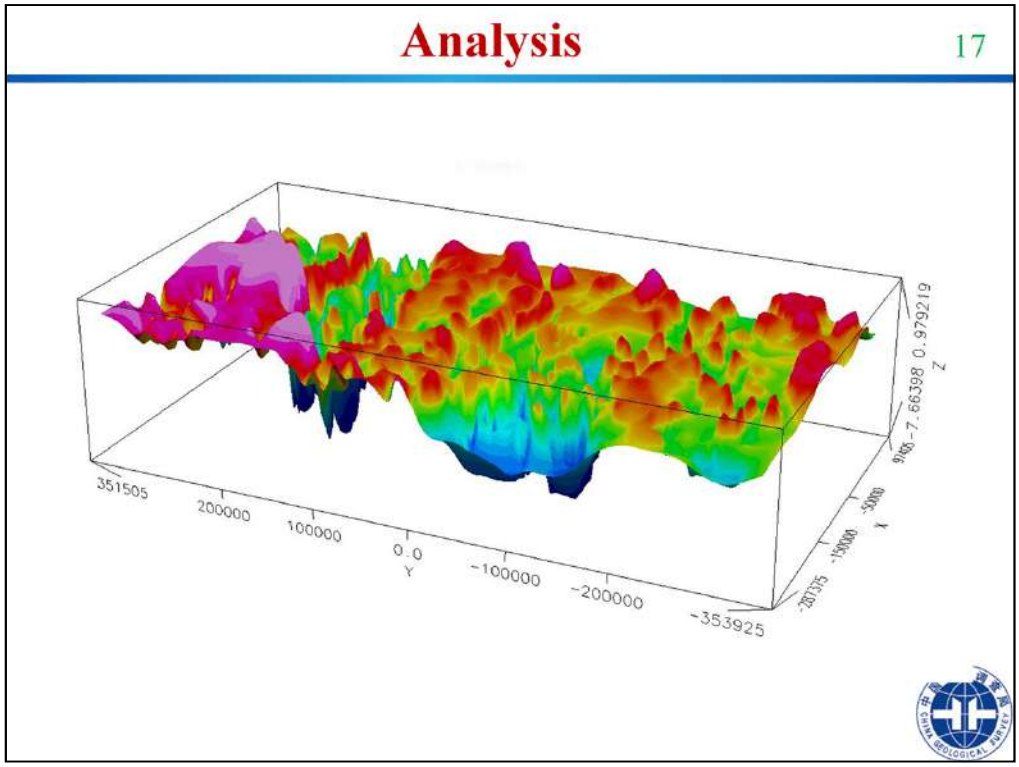
Analysis



pre-Sinian magnetic basement grid(bottom of marine strata)



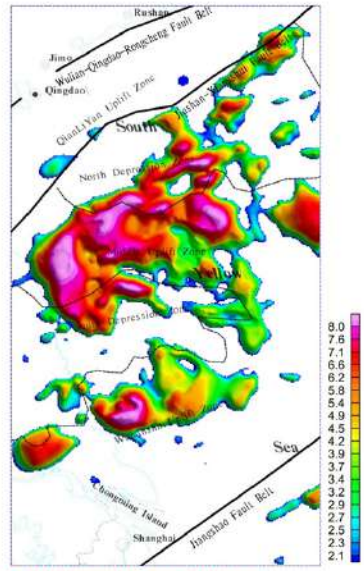
Yindosinian interface top depth grid (top of marine strata)

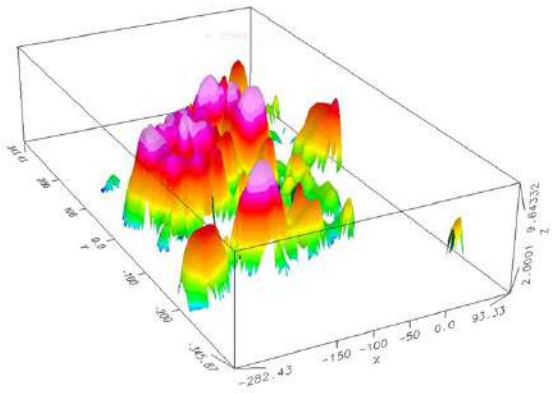


Much clearly from 3D view

1-The magnetic basement buried deeper in the Middle uplift zone while shallower in other structural unit.

2-**The Yindosinian interface depth is shallower in the Middle uplift zones, but deeper in the south and north depression zone.**





Marine strata thickness

1-The general marine strata thickness is ranging from 2km to 8km, and mean thickness is about 4.5 km

2-The Middle uplift zone and Wunansha uplift zone developed the much thicker Paleozoic-Mesozoic marine carbonate strata in the South Yellow Sea with maximum thickness up to 8km

3-There is no marine strata distributed in the Qianliyan uplift zone; limited marine strata remained in the North and South depression because of uplift denudation by structural movement.

Conclusion

- Obtained the first marine strata thickness of the entire South Yellow Sea by aeromagnetic and airborne gravity data with high precision
- The achievement of study provided significant materials for the new recognition of marine strata distribution of the entire South Yellow Sea
- The hydrocarbon exploration should concentrate on the Paleozoic and Mesozoic marine strata of the Middle uplift zone and Wunansha uplift zone for the following investigation.


Thanks