

The geological structures of continental China reviewd by aeromagneitc data

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Outline

Section1

Compilation of aeromagnetic series of maps

Section2

Geological interpretation mapping based on aeromagnetic data

一、航磁系列图件编制

Section1——Compilation of aeromagnetic series of maps

1. 中国航磁编图使用的数据
The data used in aeromagnetic map compilation

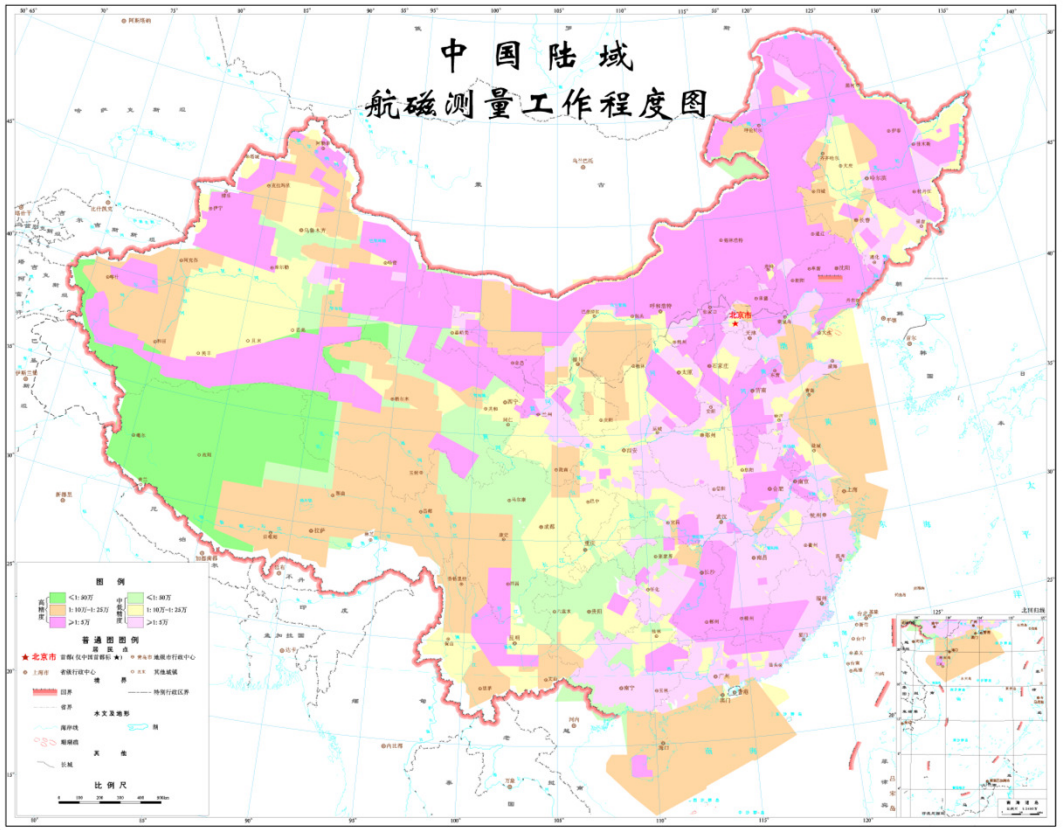
Data for mapping

- Using all the magnetic data materials acquired before 2011

- Covering 568 survey areas, including 425 survey area in low-middle precision, 143 area in middle-high precision

- Covering 22,330,000 km^2,17,190,000 line km, about 10,000,000 km^2 of actual covering area.

The area covered by aeromagnetic data



2.中国航磁图编制方法 Method of compilation

（1）编图采用的软件 Software used in mapping

- 采用航遥中心最新开发的 Geoprobe Mager 软件、国产 MAPGIS软件以及 Oasis 软件，在全数字状态下完成编图工作.
- Using Geoprobe Mager, the new developed software by AGRS, and national MAPGIS software, adding OASIS geophysical data processing software introduced from foreign company

（2） 数据整理与质量评价 Data processing and quality assessment

- 按单个测区对原始测量资料进行整理，包括数字化工作；
- Processing the original survey data by single survey area, including digitalization.
- 根据测量仪器灵敏度的差别、导航定位方法的差别、收录方式的差别、测量比例尺的差别和测量高度的差别等分别进行数据整理和质量进行评价。
- The data processing and quality assessing based on the sensibility of surveying instruments, difference of GPS method and data acquisition, adding the difference of survey scale and altitude etc.

2.中国航磁图编制方法 Method of compilation

（3）数据的选择 Data selection

- 尽量使用相对高质量数据:高精度覆盖中、低精度；数字收录覆盖模拟记录; 较新的覆盖老的；大比例尺覆盖小比例尺；低高度覆盖高高度数据。
- Selecting the high quality data with high precision area covering middle-low precision area; digital record covering analog record; large scale data covering small scale data; low altitude data covering high altitude data.

（4）正常场改正（IGRF）

- 按单个测区进行正常场改正。
- Normal field correction by single area

（5）网格化 Gridding

按单个测区采用随机网格化(最小曲率)方法进行网格化。为防止磁场畸变，对小比例尺数据采用逐级缩小网格间距的方法。

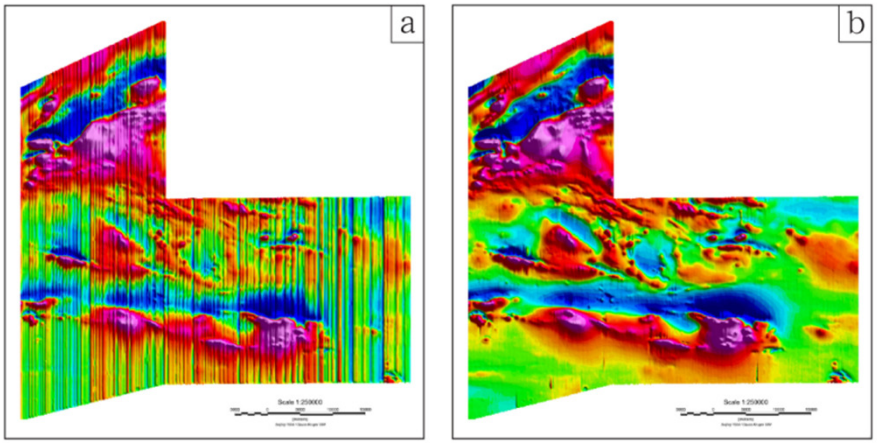
- Applying the random gridding method (Minimum Curvature Gridding) for single area gridding. For small scale, narrowing gridding space by its scale in case of magnetic distortion.

2.中国航磁图编制方法 Compilation method

（6）磁场调平 Leveling

采用切割线调平和微调平方法，对单工区进行磁场数据调平处理。

Applying the tie-line leveling and careful leveling for magnetic field data processing in single survey area

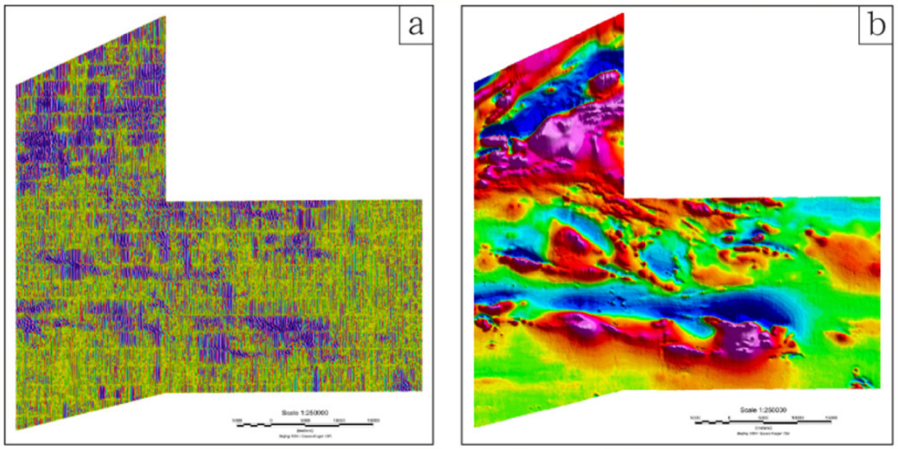


切割线调平前后对比图

Before and after tie-line leveling

微调平前后对比图

Before and after careful leveling

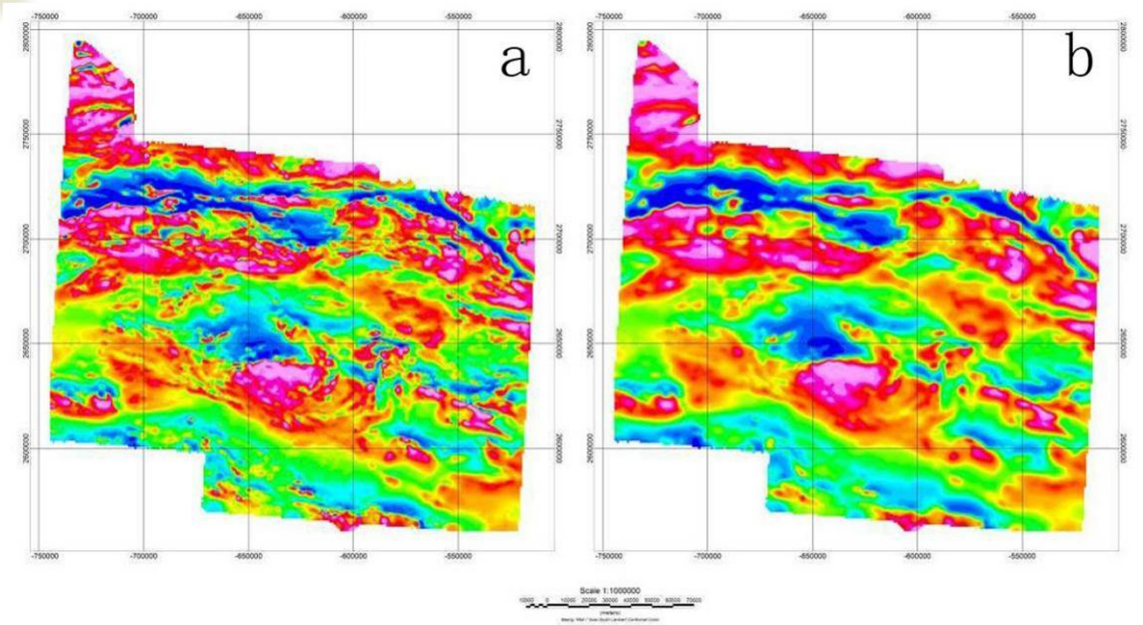


2.中国航磁图编制方法 Compilation method

（7）编图基准面归算 Base altitude determination for mapping

根据航磁数据的高度分布特征，将编图基准面高度确定为离地1000m。

Base altitude for mapping was calculated and finally determined as 1000m by the distribution characteristics of aeromagnetic data surveying altitude.



其中飞行高度大于500m的占39.3%(面积)，基准面高度确定为离地1000m

The data area with more than 500 m flying altitude accounted for 39.3%.

The base altitude was determined as 1000m

西部中高山区航磁测量的飞行高度多在500m～1000m、少部分地区大于1000m

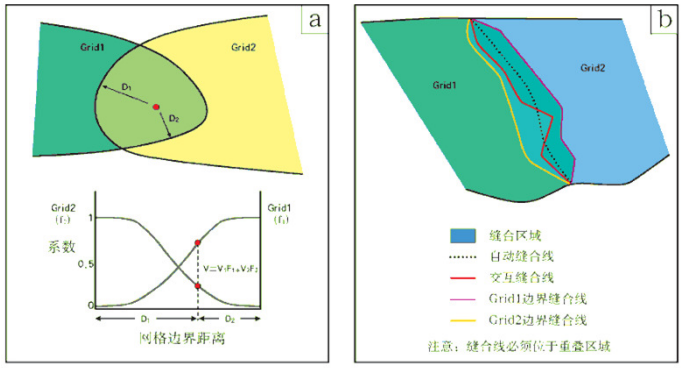
The flying altitude was mainly among 500m to 1000m in western middle and high mountain areas, and more than 1000m in small area.

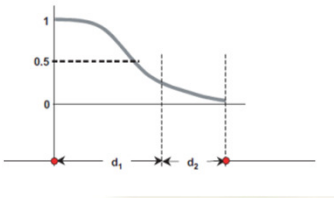
2.中国航磁图编制方法 Compilation method

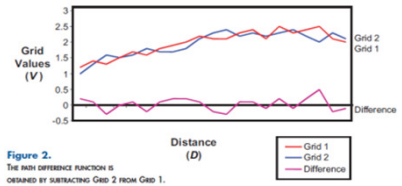
（8）网格拼接方法 Grid-stitching method

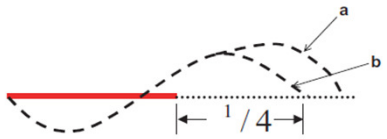
采用混合法和缝合法进行网格数据拼接。Applying blending method and suture method

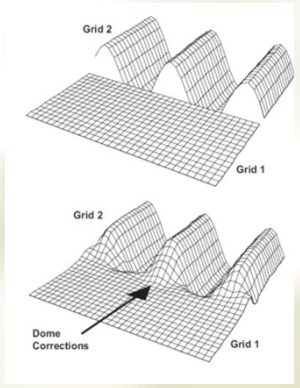












混合法：更适于在磁场相对平静，过渡趋势比较明显的情况下使用；

Blending method: More suitable for relatively quiet magnetic field with apparent transition trend.

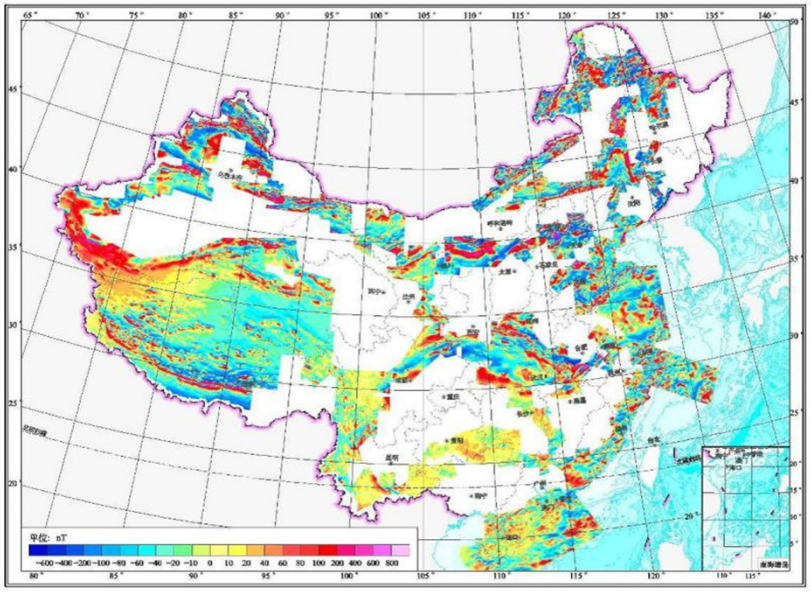
缝合法：主要用于磁场面貌差异较大且网格数据质量差异较大的网格进行拼接处理。

Suture method: Mainly used in grids knitting with great difference of magnetic field and data quality

2.中国航磁图编制方法 Compilation method

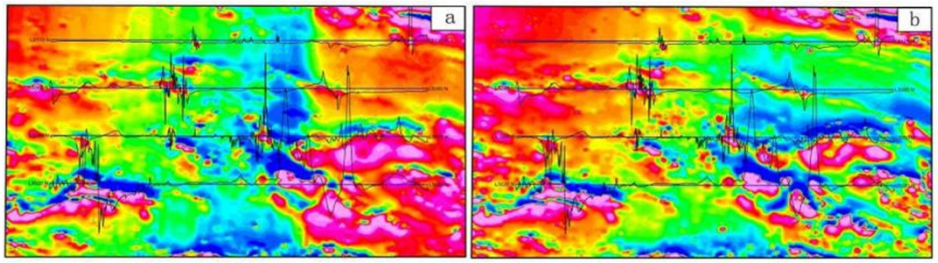
（8）高精度控制框架网格搭建

Construction of controlling grid framework with high precision data



使用定位精度高、彼此重叠好的单测量区块航磁网格数据搭建“框架”，以此作为全国航磁编图的**“控制框架”**，现误差的平均分配，减少误差累计。

The grid data with high location precision and good overlapped in single survey area was selected as controlling framework of national magnetic mapping in order for reducing error accumulation.



4条长切割线拼接的效果

The stitching effect of 4 long tie-line knitting

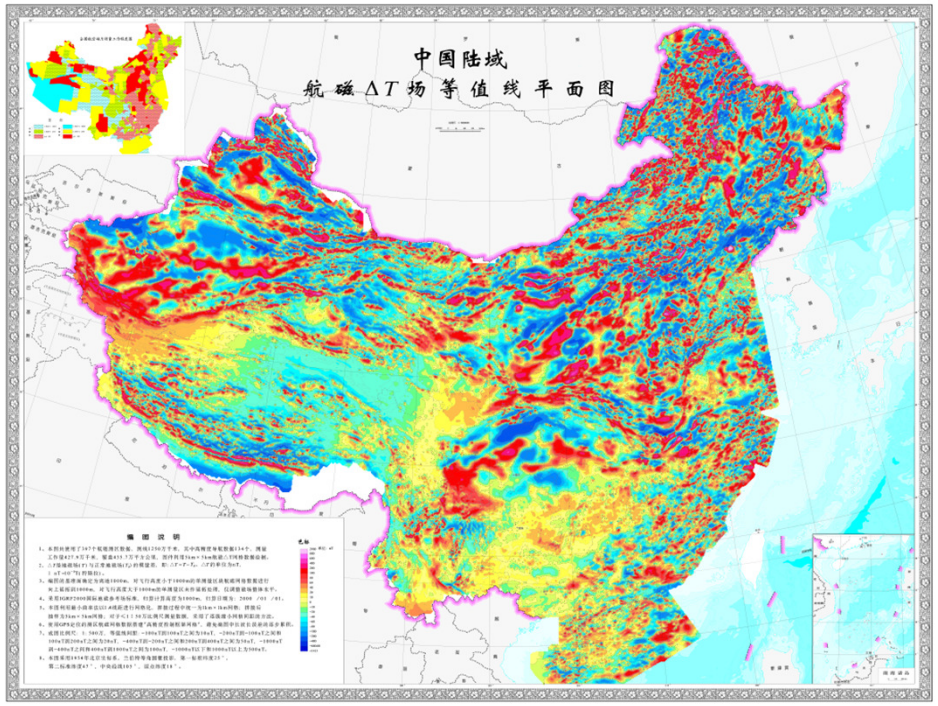
3. 编图结果与效果分析
Result and analysis of mapping

（1）全国航磁网格数据生成： Generation of China aeromagnetic grid data.
采用上述方法，编制出中国航磁△T磁场图。The method above was used to compile map of China aeromagnetic △T data

（2）编图效果分析 analysis of mapping result

图件反映的主要磁场特征清楚展示了区内规模较大断裂、隆起、坳陷区的范围、延展方向及构造 格架等，为研究 区域构造特征提供了丰富信息。

The faults in larger scale, the uplifts and the scale, trending direction and structure of depression areas are all clearly reflected and displayed by the main magnetic characteristics on the map, which could provide very useful information for the recognition of regional structural characteristics



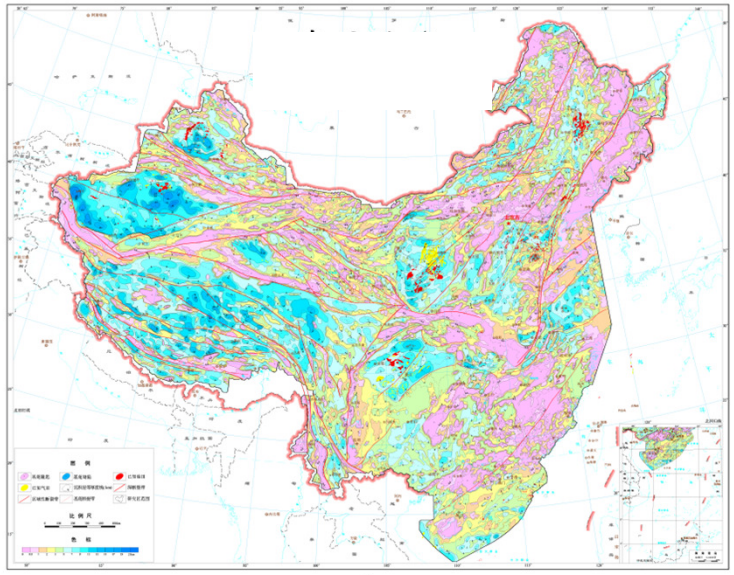
二、地质构造解释图件的编制
——基于航磁数据

Section2——Geological interpretation mapping based on aeromagnetic data

1、中国陆域磁性基底深度图
Magnetic basement depth map of continental China

编图方法

•根据实测航磁剖面异常对磁源进行了深度计算，获得了约120000个磁性体深度数据，在参考地质、钻井、地震、地球物理及岩石物性资料后，筛选出主要反映前寒武纪变质基底和磁性侵入岩的顶面埋藏深度，再依据磁场特征编绘而成中国陆域磁性基底深度图.



Methodology of compilation

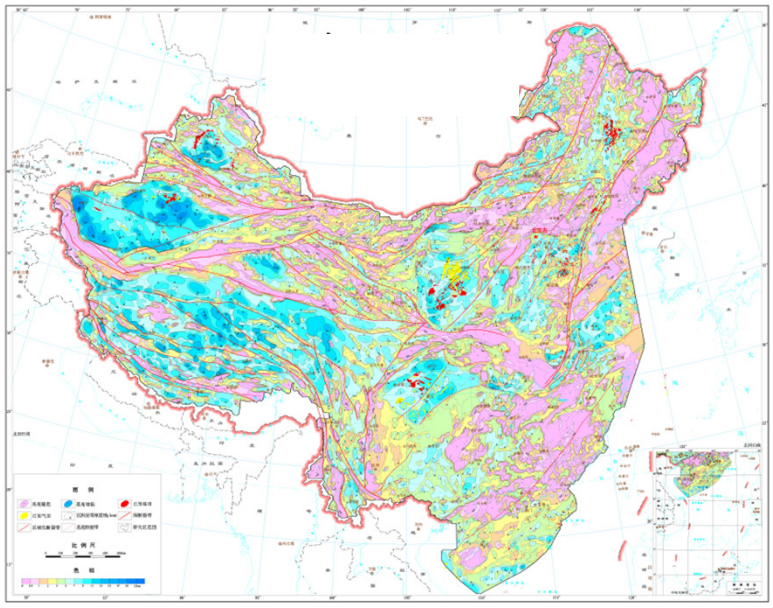
•About 12000 depth-related data of magnetic bodies were calculated from the original profiles of single surveyed area by using the tangent method, the Vecquire method,Euler deconvolution.

• Referenced the materials of geology, well drilling, earthquake, geophysics and petrophysics, the depth value of magnetic intrusive rocks and metamorphic basement of Precambrian was selected after seriously analyzing and rejecting the distortion of shallow magnetic body and volcanic rocks.

1、中国陆域磁性基底深度图
Magnetic basement depth map of continental China

编图结果及分析

该图主要体现了我国前寒武纪变质基底和规模较大的岩浆岩侵入岩体的顶面深度变化特征，同时直观地反映出沉积盆地的展布情况，以及沉积盖层（包括中新生界和古生界）的厚度和赋存现状。在研究深部构造特征及地质构造演化方面具有重要的实用价值，为我国开拓新盆地、新领域、新层系的油气勘探提供依据。



Analysis and Application

——shows characteristics of magmatic intrusive rock body depth of certain scale and metamorphosed basement in Precambrian era,

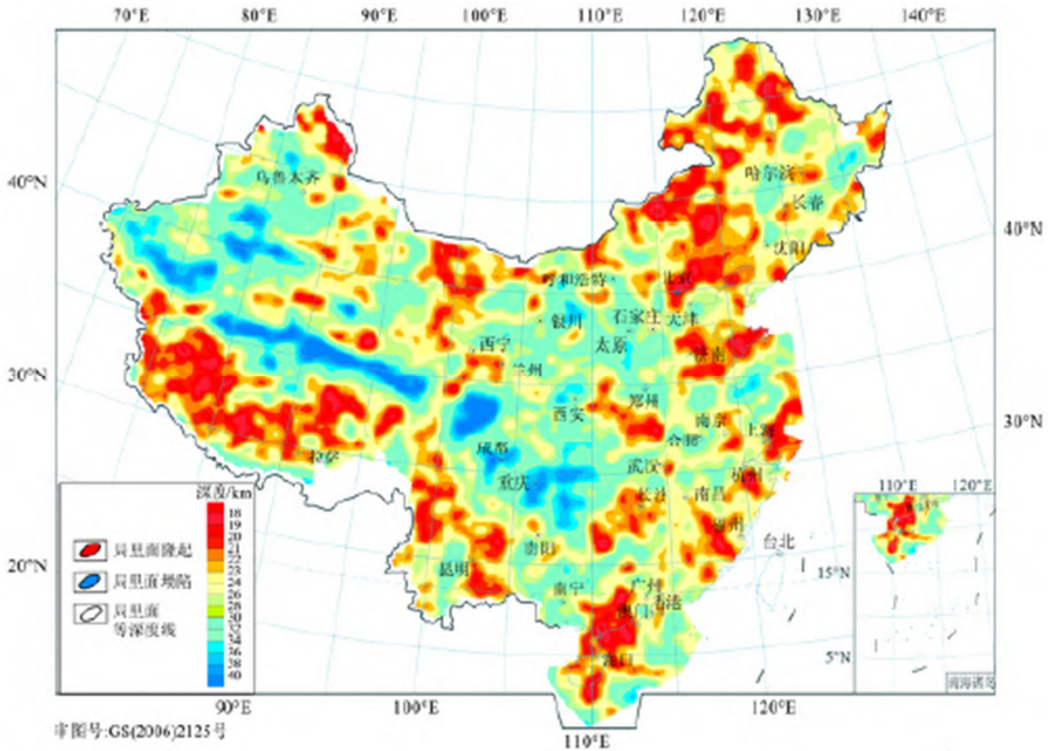
——also directly reflects the distribution, depth and current status of the sedimentary cover layer

——It has important practical value for the study of characteristics and evolution of the earth deep structures, providing useful information for the exploration of oil-gas buried in the new basin area.

2、中国陆域居里面深度图
Chinese continental curio point isotherm map

编图方法

居里点深度的计算就是基于该新编制完成的1：100万中国陆域航磁ΔT化极场网格数据，计算采用的方法是频率域高阶导数功率谱法,共获得8004个深度点。



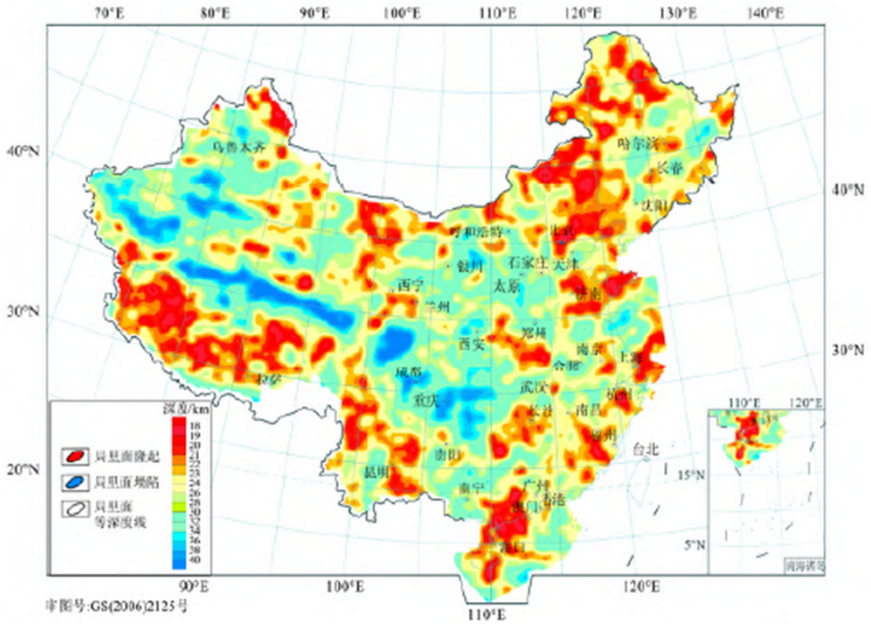
Methodology

Based on magnetic ΔT Grid data with reduced to the pole on the scale of 1:1000,000, we determined the method of power spectrum with high order derivative in time domain as the calculation method in our study based on magnetic data, and 8004 curio point depth was acquired in China continent.

2、中国陆域居里面深度图
Chinese continental curio point isotherm map

编图结果及分析

我国陆域居里面深度变化特征较好的反映了深部构造格局及深部岩石圈地温梯度变化规律.在稳定的克拉通陆块区居里面显示为深的块状拗陷区，在活动性大的造山系及岩浆岩发育区居里面主要反映为浅的区域性隆起区



Analysis

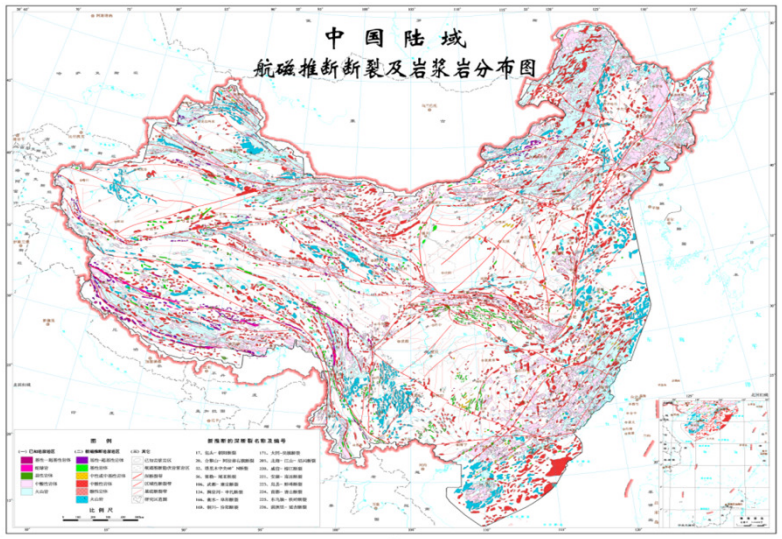
The Chinese continental curio point isotherm map has well reflection of deep tectonic framework and geothermal gradient changing pattern in the deep lithosphere.

From the curio point map, the deeper depression has well correspondence to the stable continental block, while the regional uplift zone mainly represents the active orogenic system or magmatic rocks developed area.

3、中国陆域断裂分布图编制
Faults distribution of continental China

编图方法——断裂划分

依据航磁资料并结合重力和遥感等资料能够寻找断裂构造的形迹。特征线（不同重磁场界线、线性异常带、串珠状异常带、线性梯度带、异常错动线等以及线性色变线、不同影像区的界线等）是断裂构造的反映，以此作为划分断裂的依据。



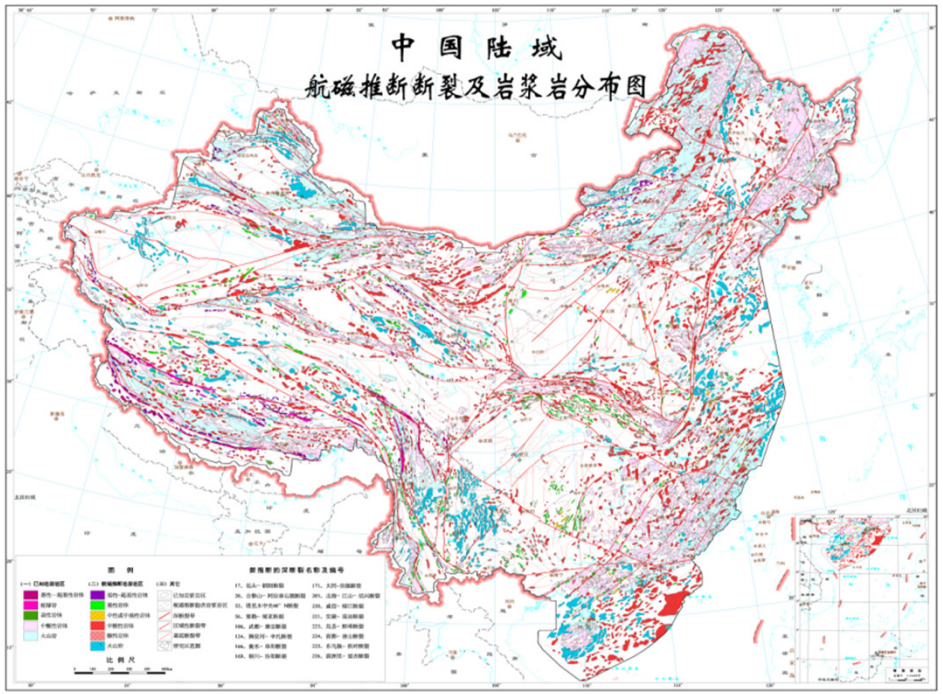
Methodology for recognizing faults

Based on aeromagnetic data, combined with gravity and remote sensing data, the fault structures can be recognized. The feature line, such as gravity and magnetic boundary, linear anomalies belt, string beads like anomaly belt, linear gradient belt, displacement line, boundary of different images, is the reflection of fault belt, and also the principle for the recognition of fault structures.

3、中国陆域断裂分布图编制
Faults distribution of continental China

编图结果

依据1/100万航磁图及数据处理图反映的我国陆域断裂构造信息，并结合重力、遥感等资料，共划分出499条断裂，并将断裂划分为三级，其中一级深断裂44条，二级区域性断裂46条，三级基底断裂409条



Results and analysis

499 faults are delineated and divided into three grades by the principle of recognizing fault and confirming its grade, including 44 faults in grade 1, 46 regional faults in grade 2,409 basement faults in grade 3

4、中国陆域岩浆岩分布图编制
Interpretation of China land magnetic rocks

编图方法——岩浆岩识别

主要依据其不同类型岩浆岩的磁性差异，一般随着岩石基性程度的增高而磁性增强，在磁场上能引起形态各异的磁异常，以此作为圈定岩浆岩的依据，建立解释标志，以航磁化极垂向一阶导数和化极场斜导数的异常梯度带确认磁异常和磁性体边界，同时依据地质资料能够确定其岩性。

依据磁异常特征及已知岩浆岩在磁场上的对比分析，编制了基性-超基性侵入岩，中性-中酸性侵入岩，火山岩分布图。

Principle and method of delineating magmatic rocks

Magnetic anomalies differences is the basis for the delineation of magnetic rocks and the establishment of interpretation mark. Magnetic anomalies and magnetic body boundary can be confirmed by the vertical first order derivative with reduced to the pole and tilt derivative data, and its lithology can also be determined according to the geological materials.

According to the comparison of magnetic anomalies characteristics and known varied magmatic rocks, distribution of rocks mafic-ultramafic, intermediate-felsic intrusive rocks, volcanic rocks map were compiled.

The distribution of magnetic rocks by aeromagnetic data in China
—mafic-ultramafic intrusive rocks

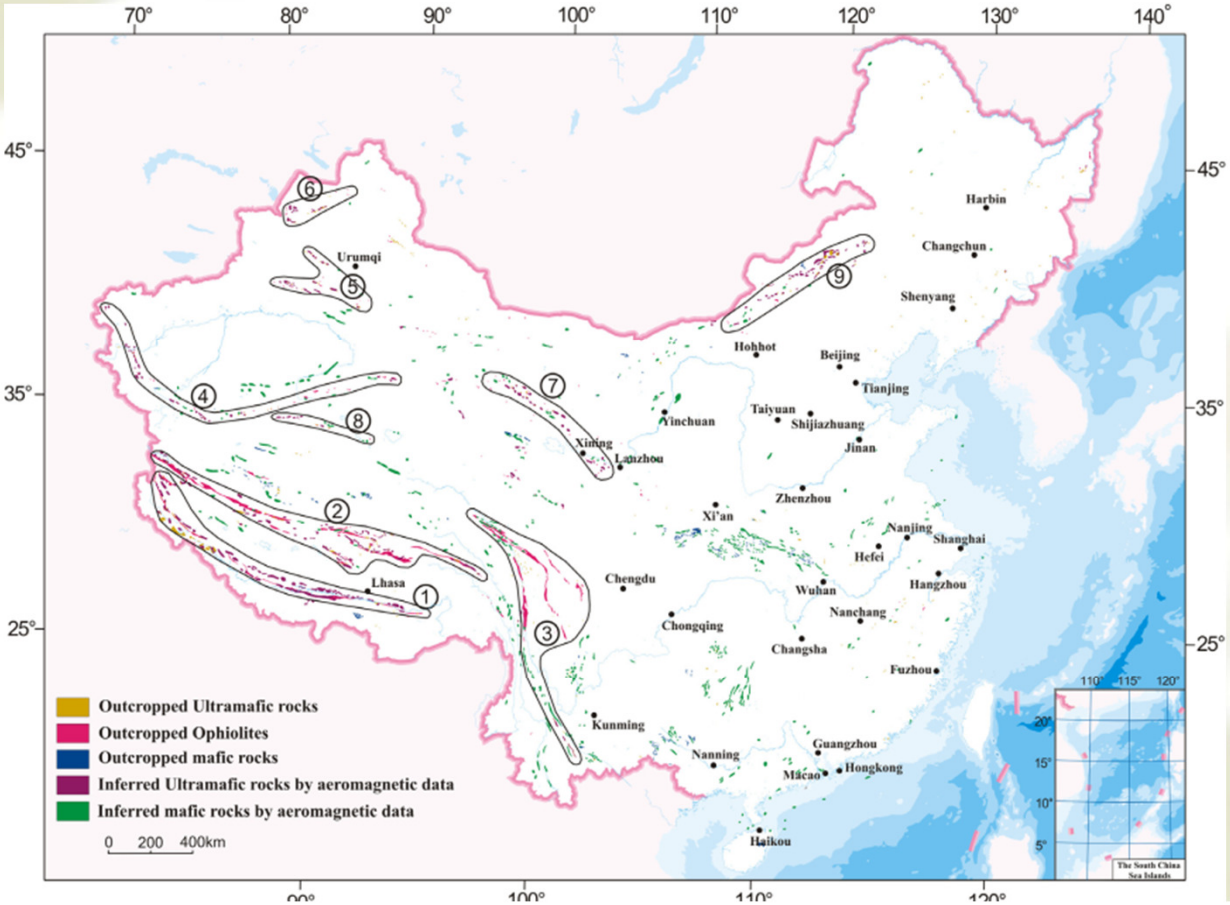
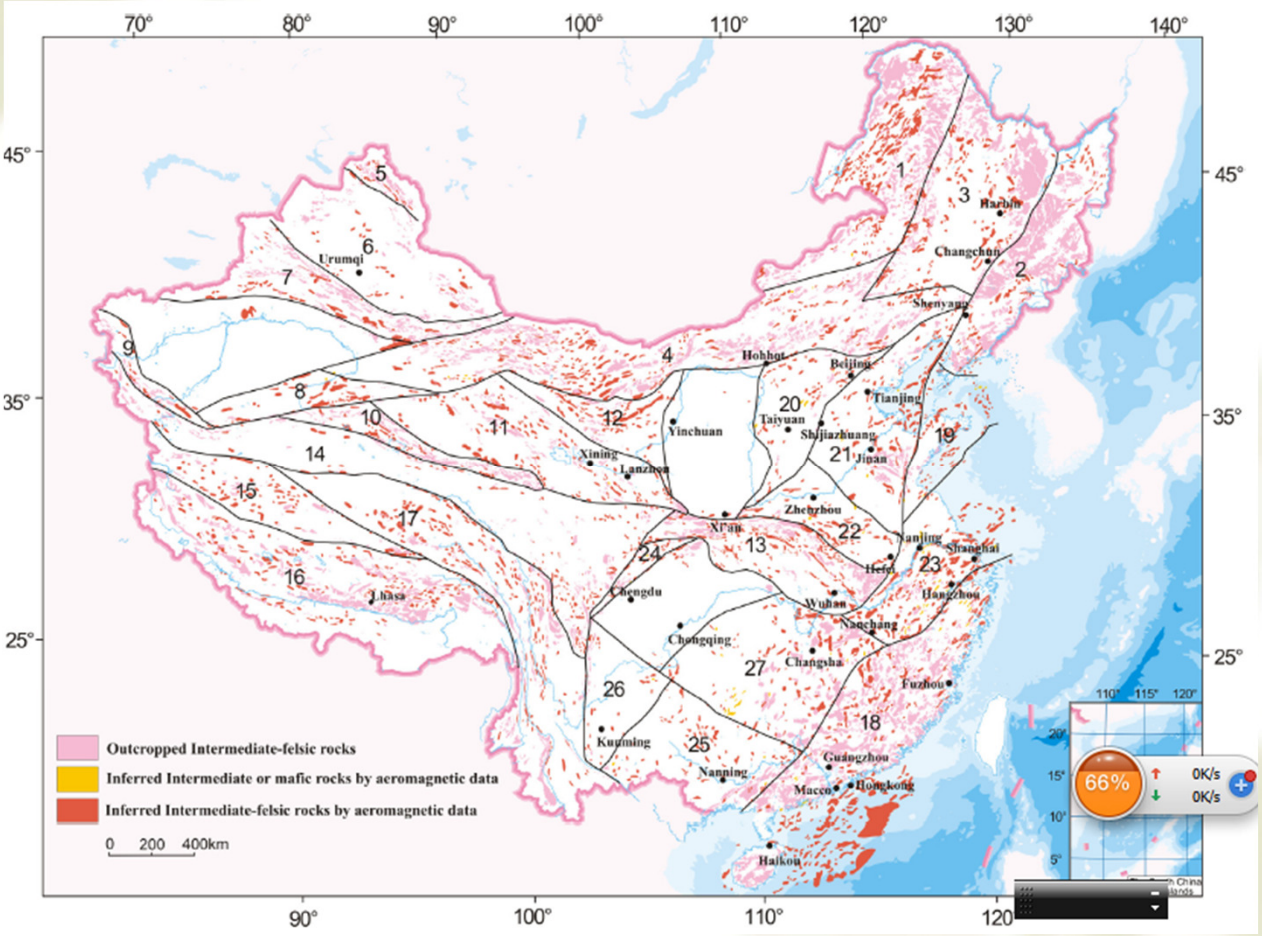


Fig. 2. The distribution of mafic–ultramafic intrusive rocks by aeromagnetic data in China. ① YarlungZangbo ultramafic rock belt, ② PangongTso-Nagchu ultramafic rock belt, ③ Jinshariver-Ailao Mtn. ultramafic rock belt, ④ Western Kunlun-Altun Mtn. ultramafic rock belt, ⑤ Qilian Mtn. ultramafic rock belt, ⑥ Eastern Kunlun Mtn. ultramafic rock belt, ⑦ Tianshan Mtn. ultramafic rock belt, ⑧ Junggar ultramafic rock belt, ⑨ Hegen Mtn.-Erenhot ultramafic rock belt.

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The distribution of igneous rocks by aeromagnetic data in China

—intermediate-felsic intrusive rocks



The division of intermediate-felsic intrusive rocks by aeromagnetic data in China.

The distribution of magnetic rocks by aeromagnetic data in China—vocanic rocks

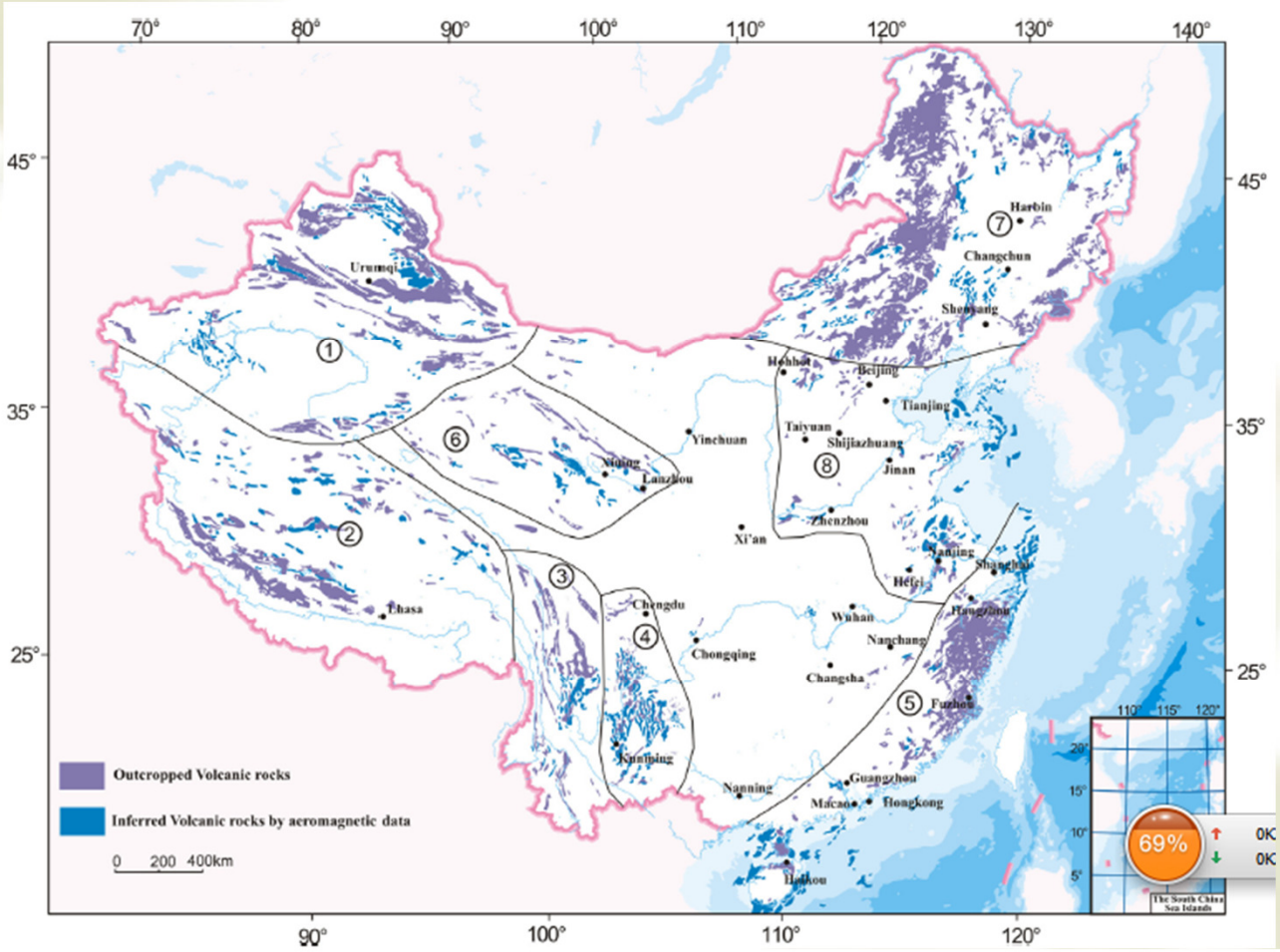


Fig. 4. The division of volcanic rocks by aeromagnetic data in China. ① Xinjiang area, ② Tibet area, ③ Sanjiang area in southwest China, ④ Kang Dian area, ⑤ Lower Yangtze and Southern China, ⑥ East Kunlun-Qilian Mtn. area, ⑦ Northeast China, ⑧ East of North China.

3、编图体会
Conclusion and comments

本次中国陆域航磁与地质构造特征研究，首次系统地对我国陆域及邻区1/100万航磁图进行了分析和研究，提出了一些新认识，对深化我国区域航磁资料的解释和地质构造认识具有重要意义。

The study on China continental aeromagnetic characteristics and geological structures systematically analyzed the national 1:1000000 aeromagnetic series of maps for the first time, putting forward some new understanding, which will have significant meaning for deepening interpretation of national regional aeromagnetic data and recognition of geological structures.

3、编图体会
Conclusion and comments

本次编图范围仅包括了部分近海海域，大部分海域和周边地区尚未涉及，有待今后开展1/100万我国海陆航磁连片编图及地质构造综合解释研究，与周边国家合作开展航磁综合编图与研究

However, the map compilation just conclude the most part of offshore areas, not covering the most sea areas and surrounding countries areas, and compilation of 1:1000000 magnetic contiguous map in China continent and its adjacent sea areas and study on comprehensive interpretation of geological structures remains to be studied by cooperating with the surrounding countries.