The New Achievements of Fundamental Geological Survey in China

（2011）

China Geological Survey

2011-11

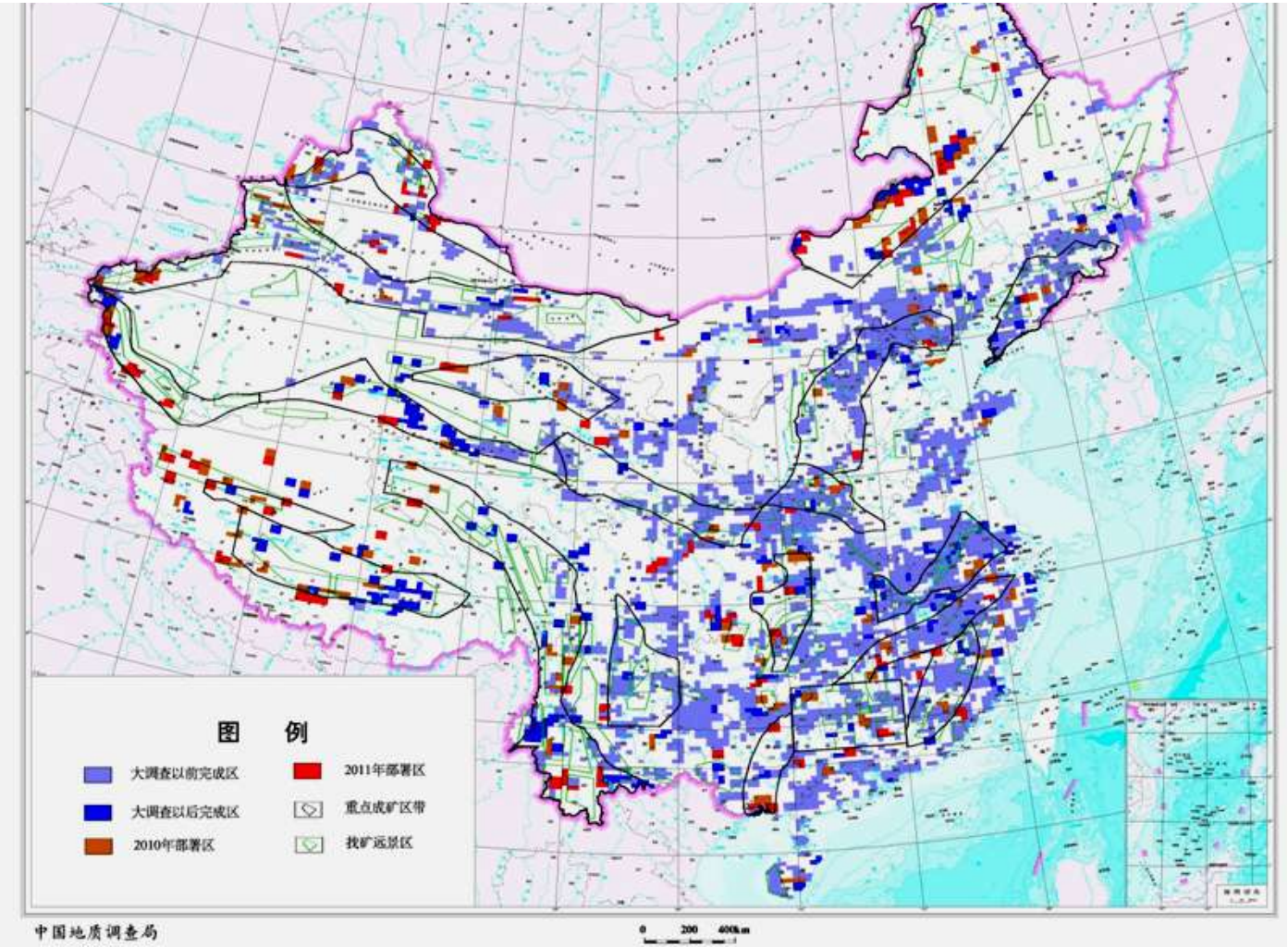
Compendium

- Major work and achievements
- Supporting for geological prospecting
- New cognitions for geology and tectonics
- Work in future

1. Major tasks and developments

- The fundamental geological survey: Regional mapping、 Regional magnetic airborne survey 、 Regional gravity survey、 Regional geochemical survey。
- Mainly deployed on: important mineral zones, important economic developed areas, national important engineering constructions and important geological issue area.
- For the important mineral zones, The fundamental geological survey were mainly deployed on: important metallogenic belts western China which have low level of mineral resources exploration and great potential for exploration, such as Gangdise 、 Kunlun-Altyn Tagh 、 Three River (or Sanjiang) Region and Da-Hinggan Mountains

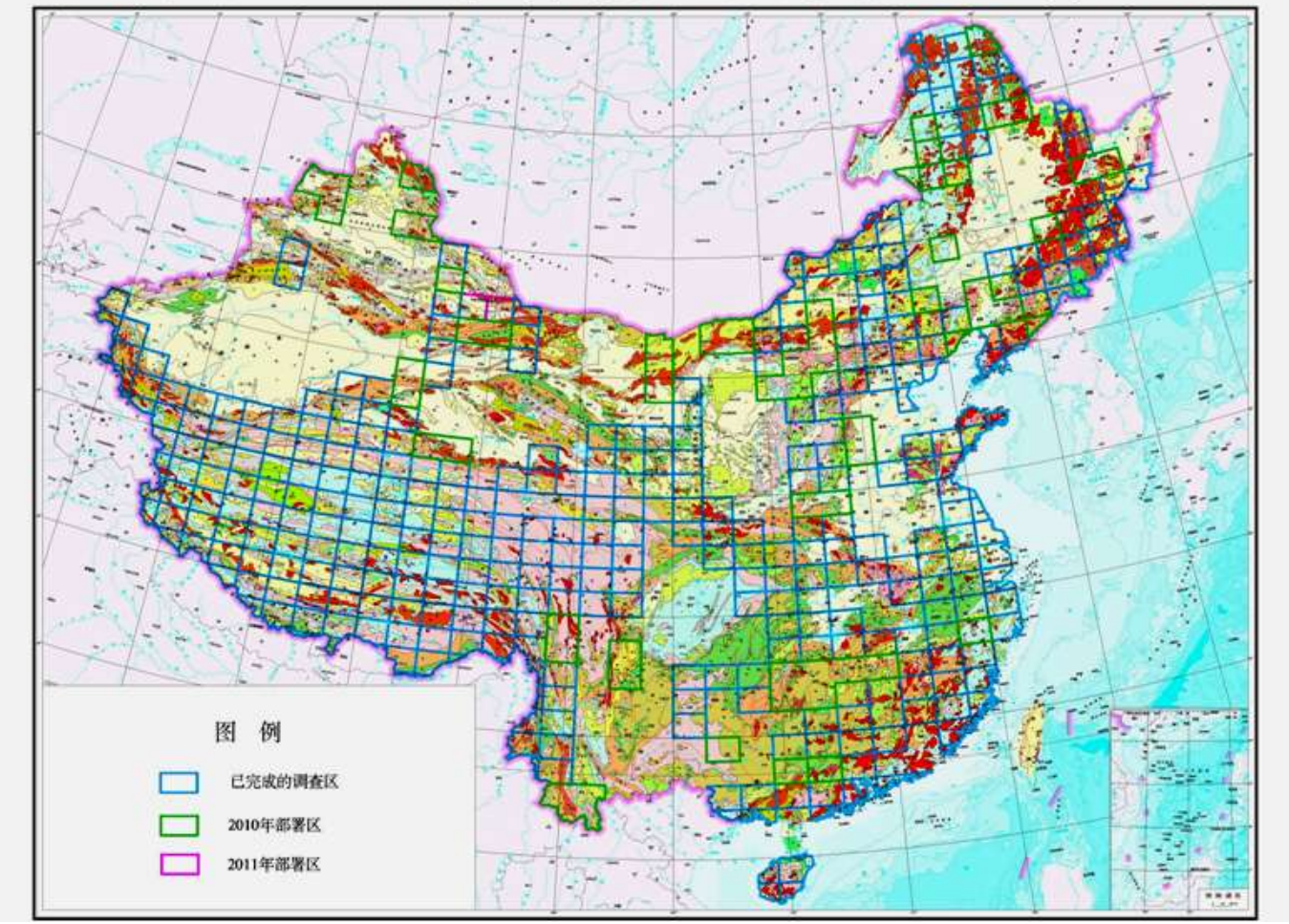
1：50000 mapping degree(after 2011)



Finished the 1:50000 mapping area 170,000 Km² in 2011;

All of the finished area is 2,370,000 Km², it is 24.6% of the national land area

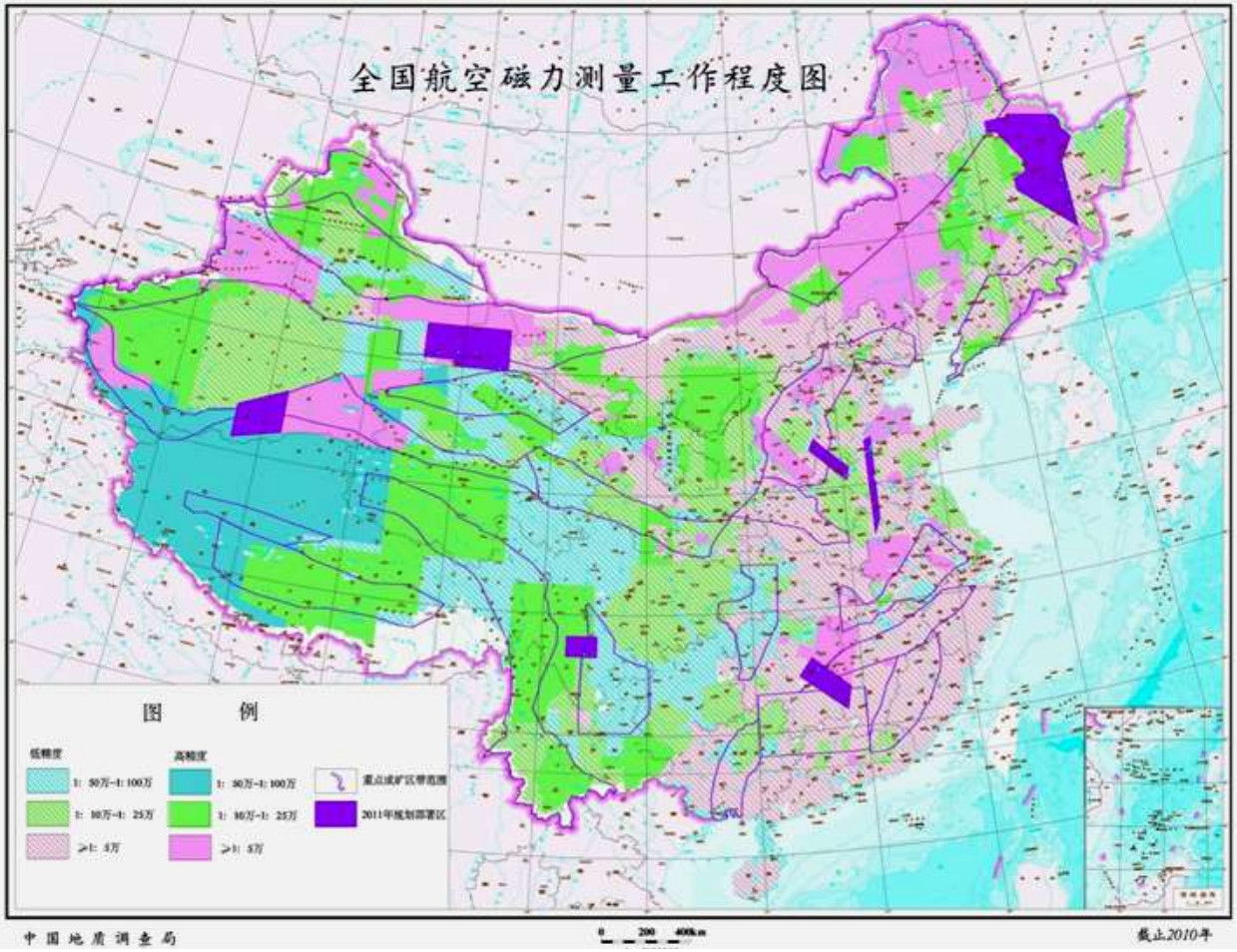
1：250000 mapping degree(after 2011)



Finished the 1:250000 mapping area 425,000 Km^2 in 2011;

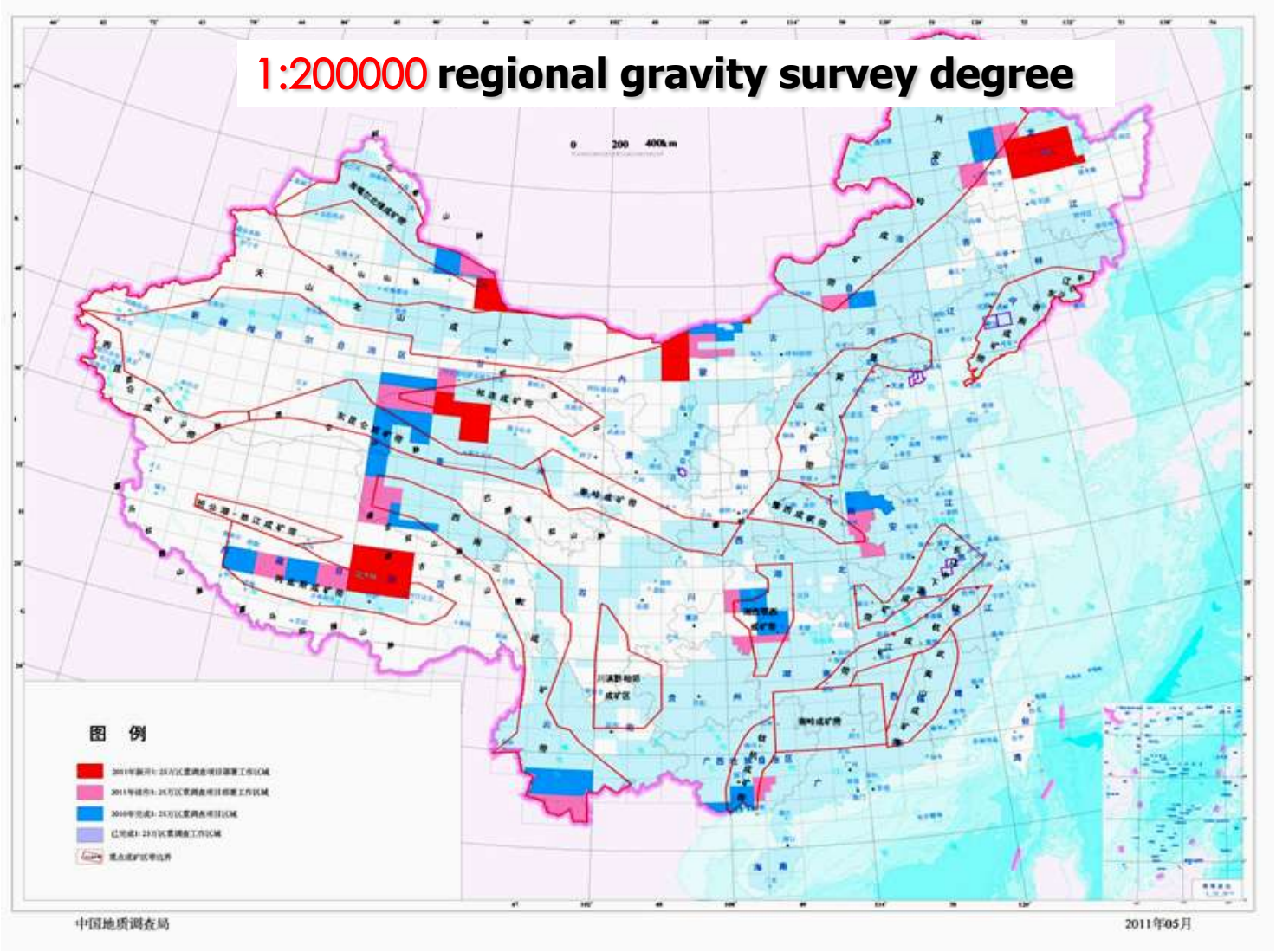
All the maps covered area is 5,365,000 Km^2, it is 56% of the national land area

1:50000 regional magnetic airborne survey degree



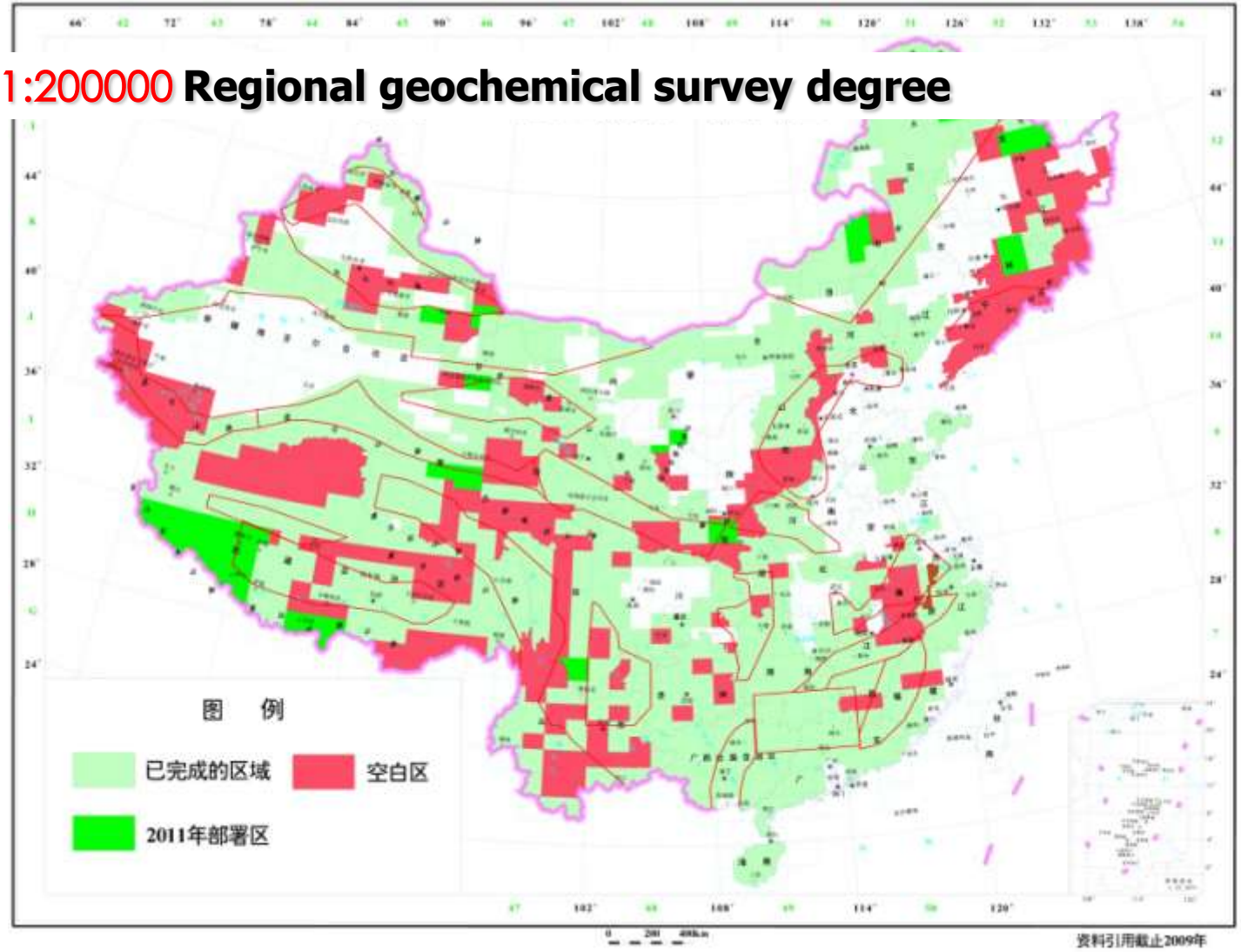
Finished the 1:50,000 regional magnetic airborne survey area 600,000 km^2 in 2011,

Accumulative area is 4,30,000 km^2, and covered 43% of the land area.



Finished the 1:200,000 regional gravity survey area 240,000 km^2 in 2011, Accumulative area is 4,940,000 km^2, covered 51% of the land area.

1:200000 Regional geochemical survey degree



Finished the 1:200000 Regional geochemical survey area 160,000 km^2 in 2011, Accumulative area is 6,000,000 km^2, covered 63% of the land area.

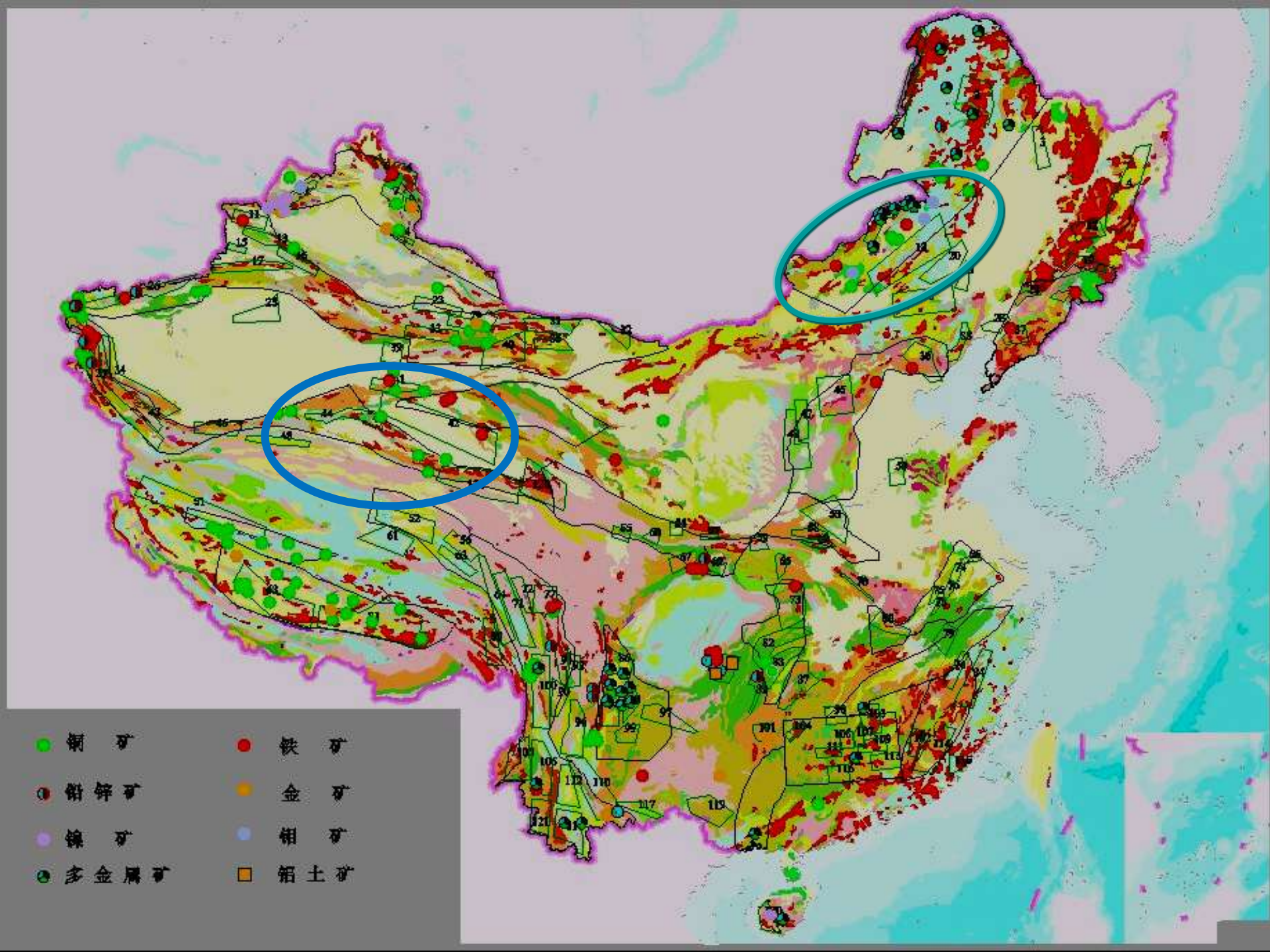
2. Supporting for the geological ore prospecting

2.1 Discovered some important prospecting clues

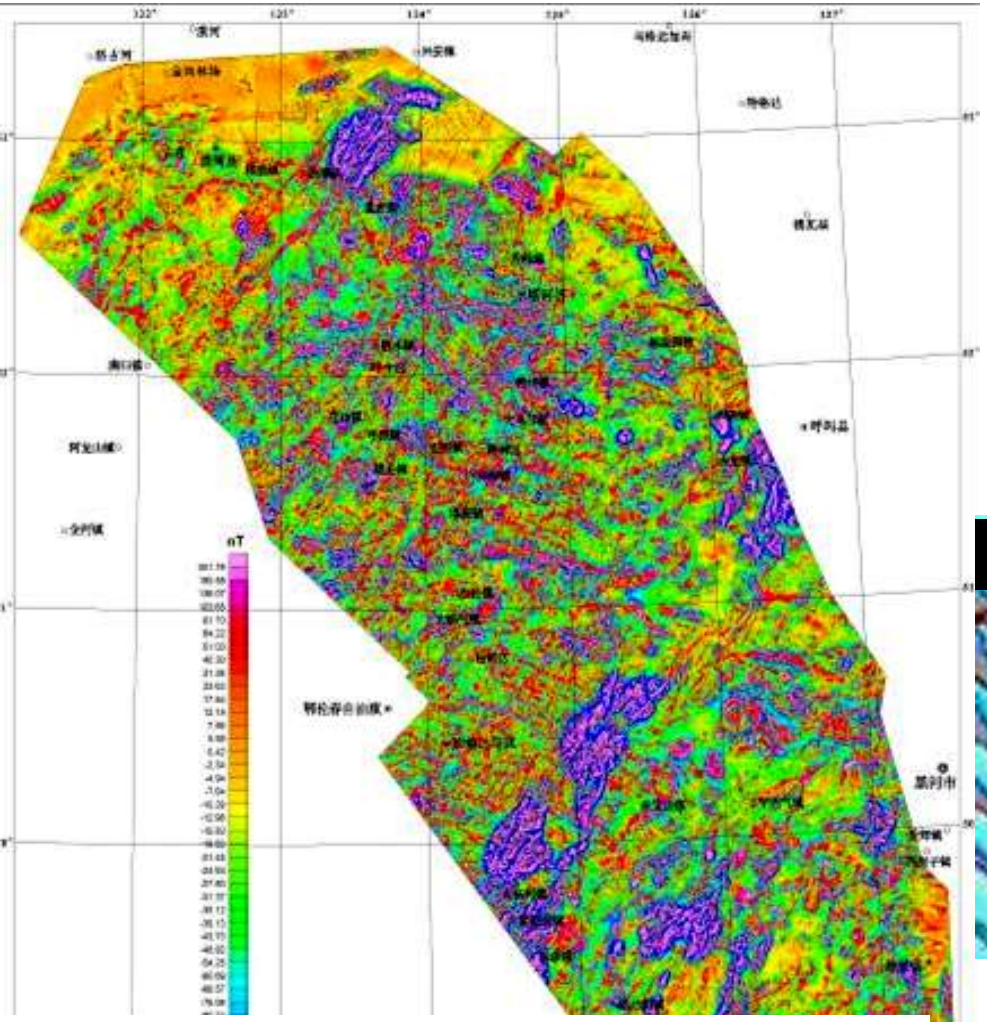
According to incompletely statistics, the Regional Geological Survey discovered 187 mineral occurrences in 2010-2011; the number for copper is 84, and the iron is 36.

Defined 3,600 magnetic airborne anomalies, and 530 important mineralizing anomalies. Depended on few verifying, the positive anomalies is 40 places.

Newly discovered 450 regional geochemical exploration anomalies.

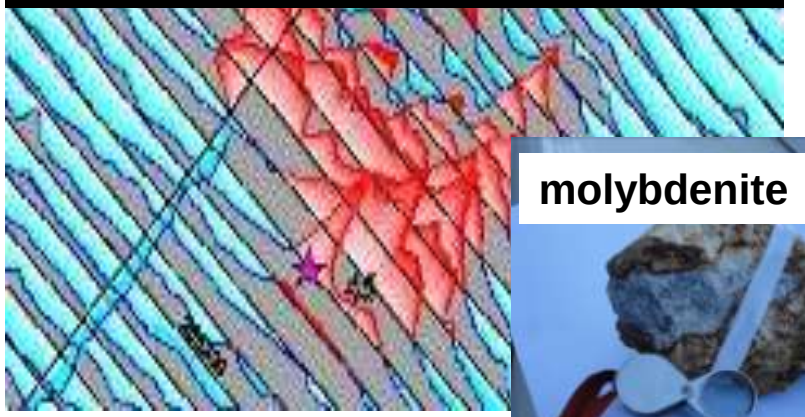

铜　矿
铁　矿
铅锌矿
金　矿
镍　矿
钼　矿
多金属矿
铝土矿

In Da-Hinggan Mountains the 1:50000 high-precision geophysical airborne explore have defined 1025 magnetic airborne anomalies and 36 aeroradiometric anomalies, in Heilongjiang province;
168 places have been checked, the positive anomalies is 10 places .



aeromagnetic residual anomaly after the reduction

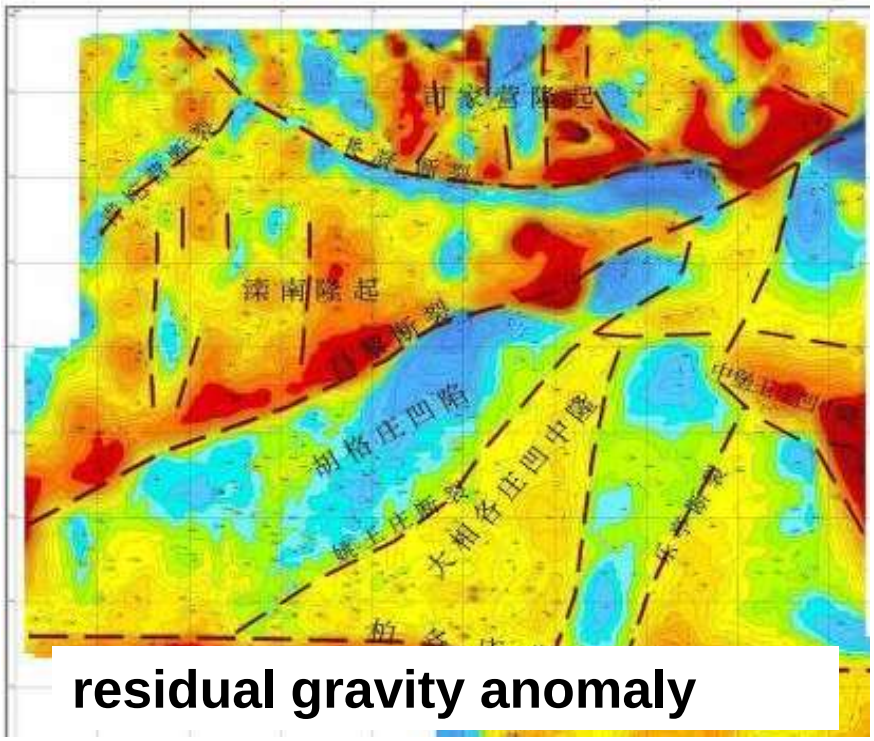
Hei C-10045 aeromagnetic anomaly



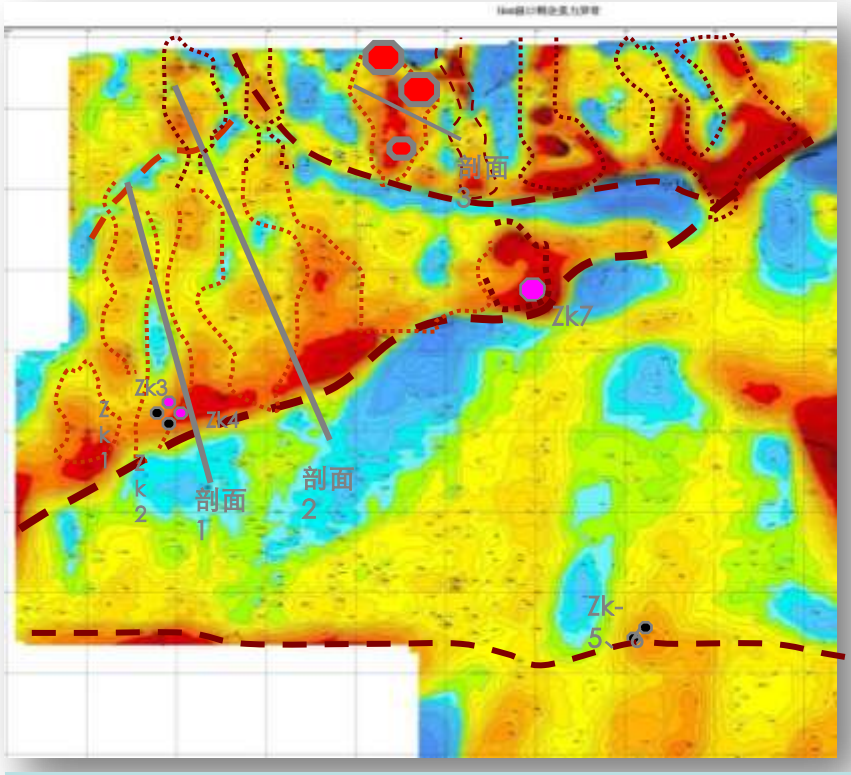
Hei C-10557 aeromagnetic anomaly

Discovered the porphyry copper-molybdenum ore

Depended on the 1:50000 gravity survey in east Hebei province, newly distinguish and indicate the Qingtuoyin fault, Changning fault, Hugezhuang depression, Yaowangzhuang fault, Xinzhai fault, Leting fault, Daxianggezhuang uplift, Zhongpuwangzhuang uplift, etc.



residual gravity anomaly



By preliminary validating:

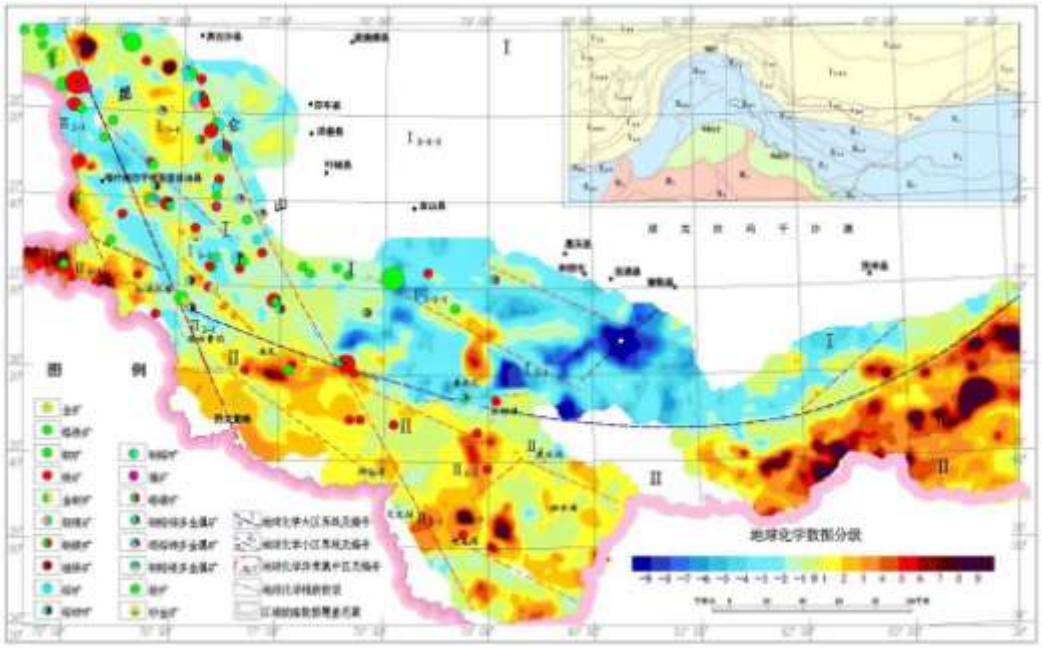
Discovered 20-115m iron ore body;

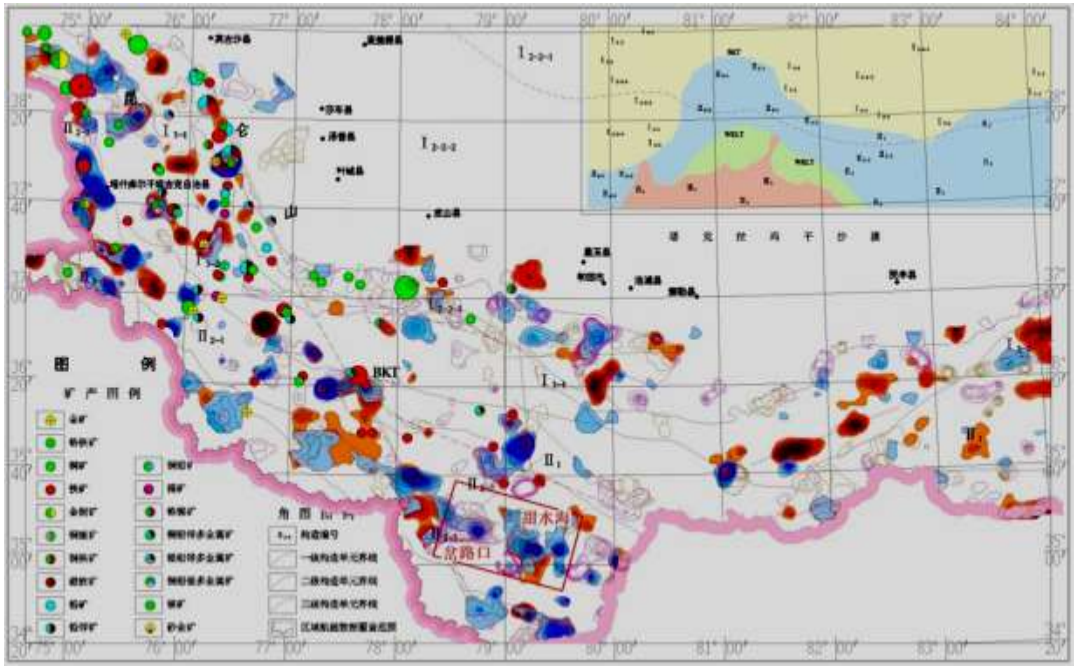
and in the ZK7 drill, the high-grade magnetite is 86.08m.

Regional geochemical survey in the Kunlun-Altyn metallogenic belts, discovered 392 integrated anomalies, verified 55 anomalies, defined 21 anomalies related to mineral deposit.

Discovered 22 Cu poly polymetallic mineral occurrences and mineralization places

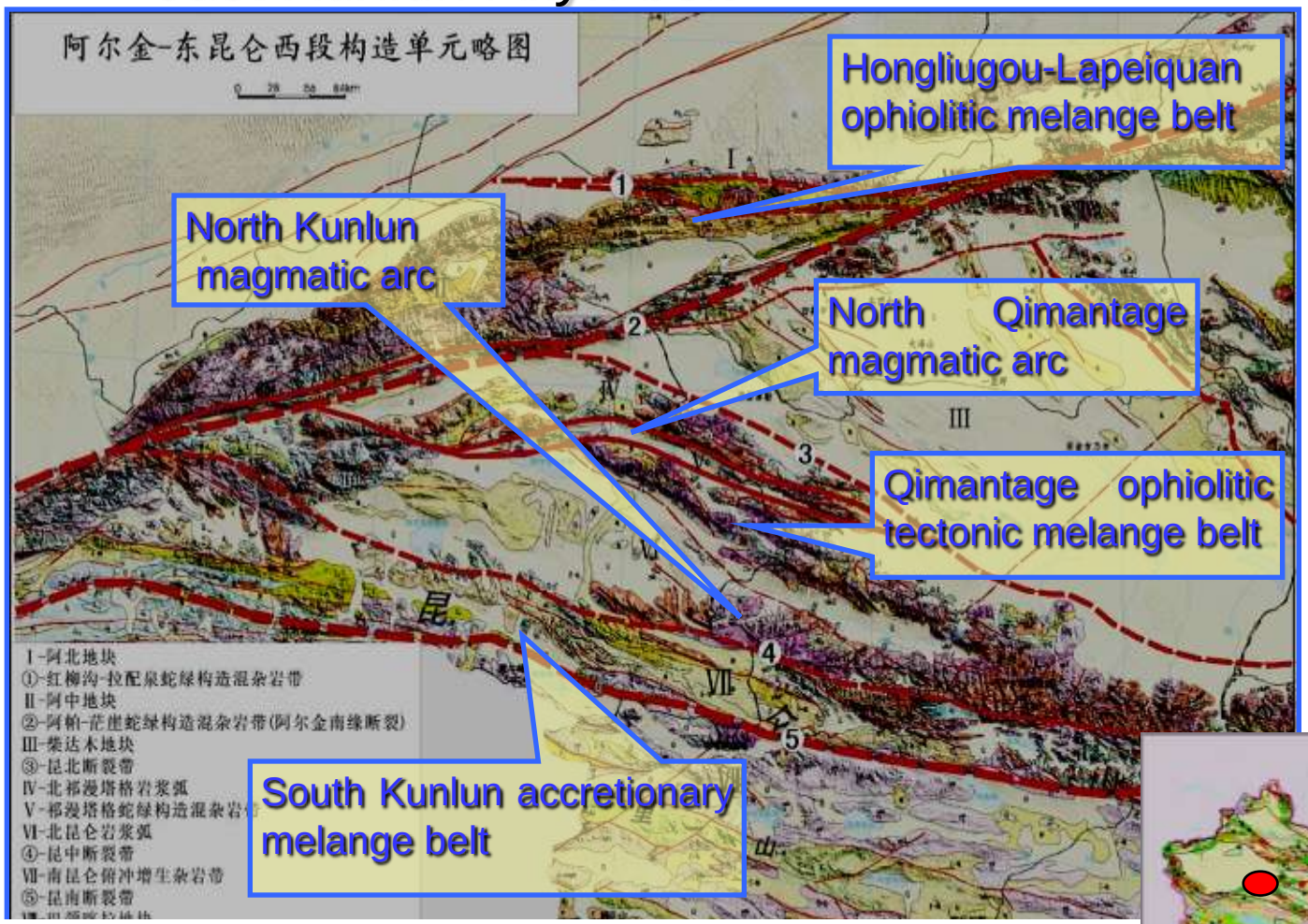
Newly discovered the Kazile Cu-Ag deposit, Weibao Pb-Zn deposit, Huangyangling Sb deposit, Fulougou Cu deposit, Changshangou Hg deposit, and strongly promote the geological prospecting in Qimantag and western Kunlun area in Xinjiang province.

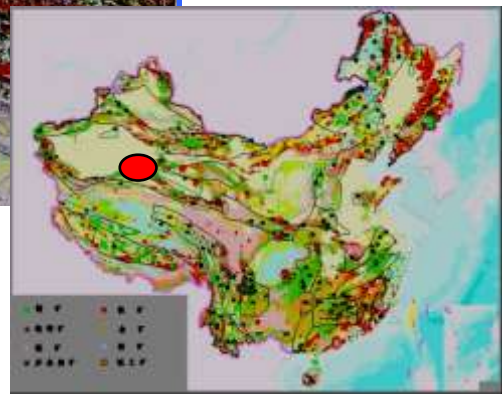




2.2 Reserching for Geological setting of metallization zone

2.2.1 east Kunlun-Altyn belt

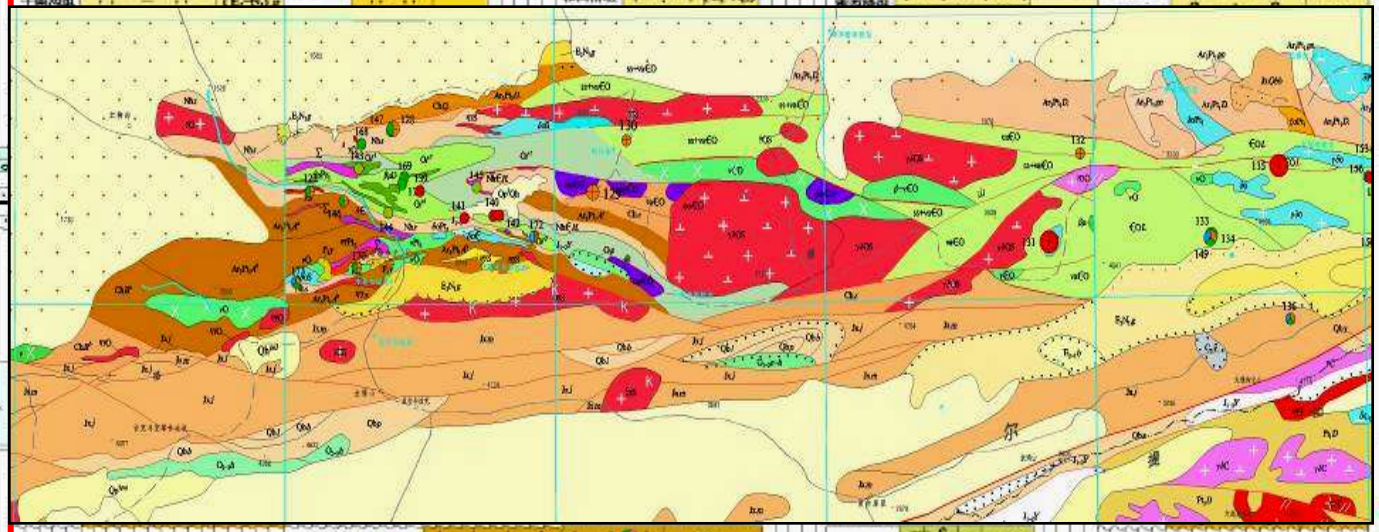




Built the regional tectonic framework,
Definited the metallogenic specialization for the tectonic units

Altyn

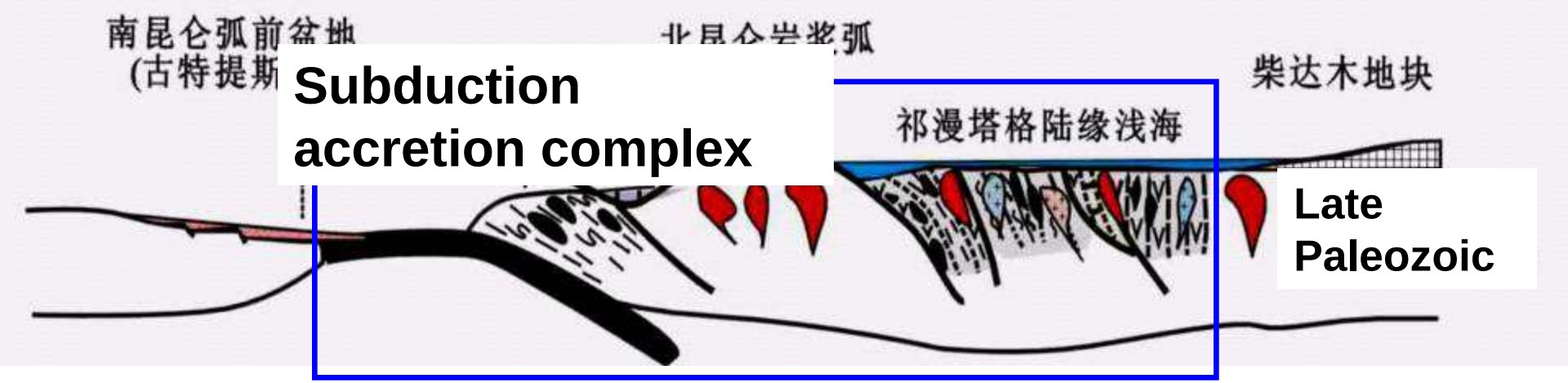
sedimentary formation and mineralization



Ordovician arc and back–arc volcanic and pyroclastic formation relate to the Fe, Cu, Pb, Zn polymetallic mineralization

Nanhua Period –Cambrian continental margin rift type pyroclastic, volcanic sedimental formation relate to the Cu, Au polymetallic mineralization

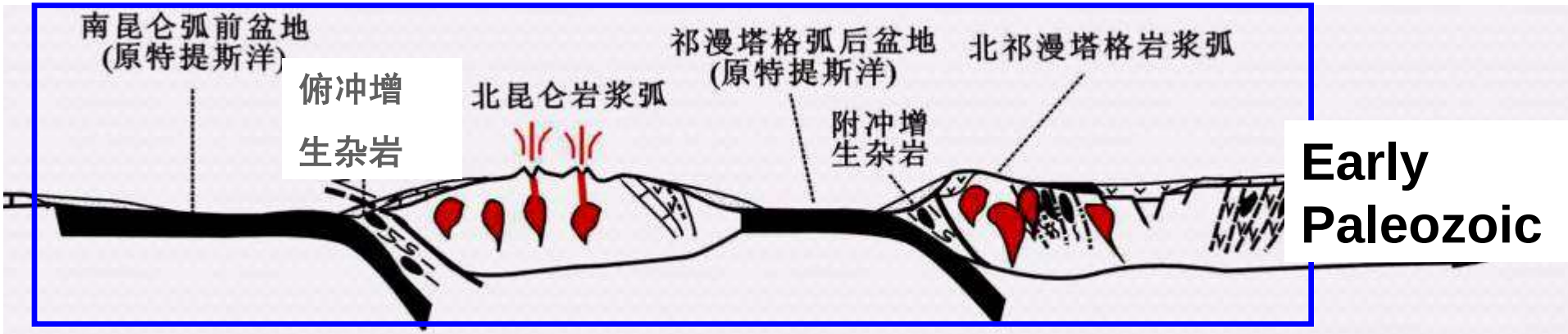
Jixian – Qingbaikou Period continental margin rift type pyroclatic sedimental formation formed the banded magnetite



Subduction accretion complex

Late Paleozoic

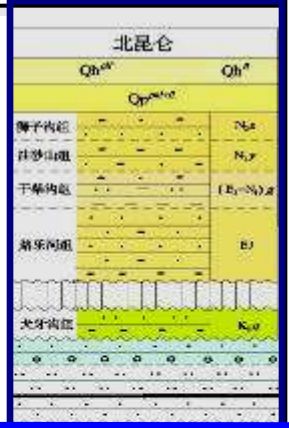
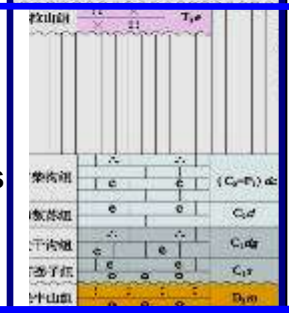
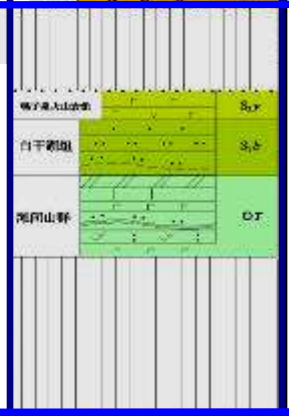
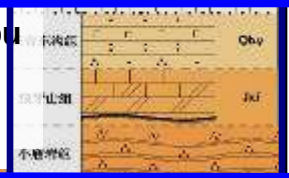
Late Paleozoic–Triassic: northern Kunlun magma arc and Qimantag pericontinental sea are effective areas for Fe, Cu, Pb and Zn.



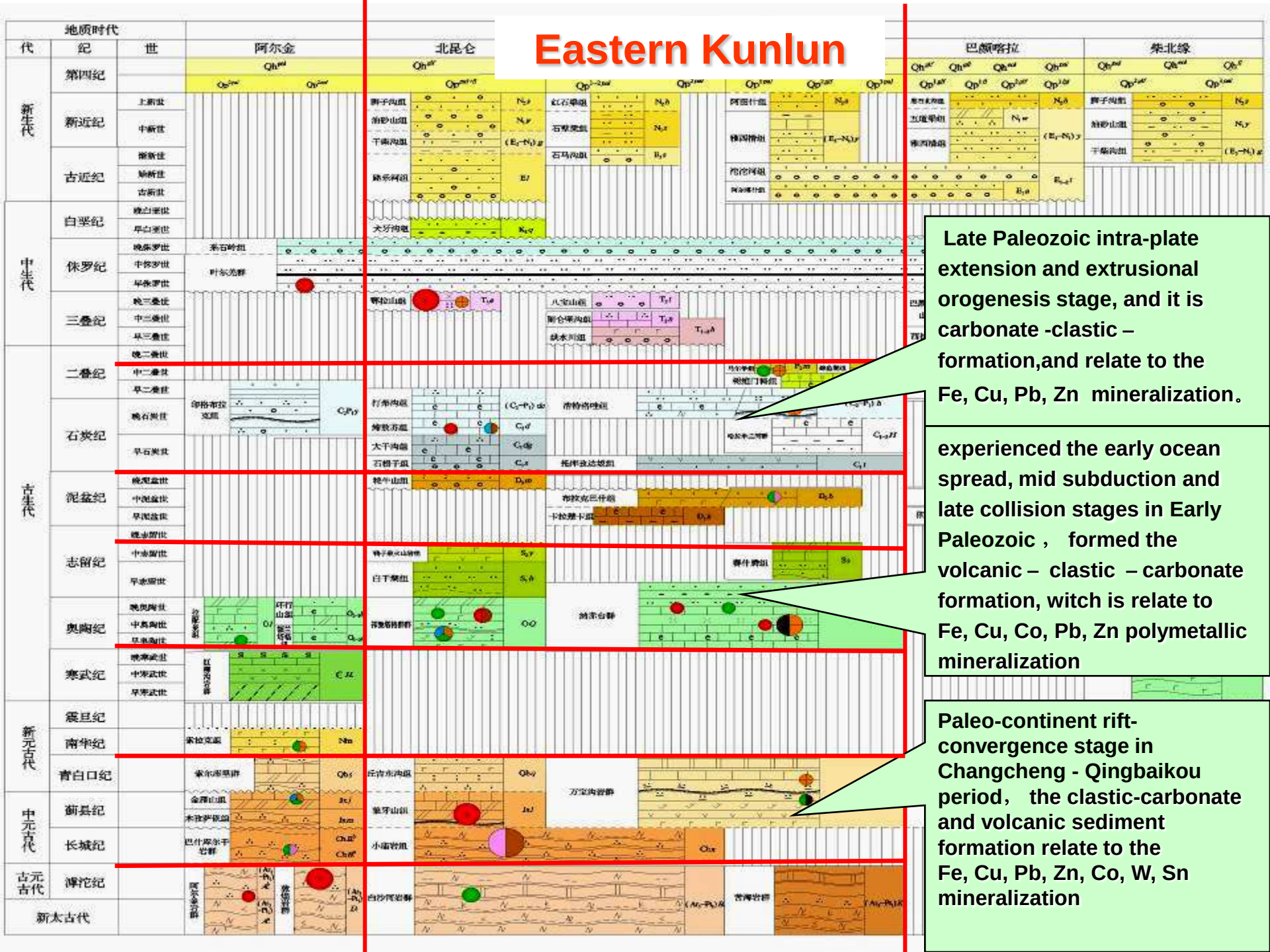
Early Paleozoic

Nanhua Period–Late Paleozoic: Rift-limited ocean, back–arc basin and northern Qimantag magma arc are effective areas for Fe, Cu, Au, Pb, Zn and Co.

Tectonic evolution and the mineralization

地质时代 代	纪			
新生代	第四纪	Meso-Cenozoic intra continental nappe orogenesis satge		contains the thrust orogeny, slip orogeny and uplift orogeny, and the tectonic magma associated with these orogenesises; developed the porphyry, hydrothermal , pegmatite and skarn type Fe, Cu, Sb, Li, Be mineralization
	新近纪			
	古近纪			
中生代	白垩纪			
	侏罗纪			
	三叠纪	Late Paleozoic – Triassic intra-plate extension and extrusional orogenesis stage		rift basin clastic—volcanic—carbonate formation，the magma activity is frequency formed the skarn type Fe (Yemaquan), Cu (Kaerqueka), Pb, Zn ore and sedimental Fe ore
古生代	二叠纪			
	石炭纪			
	泥盆纪	Nanhua - Early Paleozoic ocean-continent trans-stage		experienced the early ocean spread, mid subduction and late collision stages, the magma activity is frequency ; formed the volcanic-sediment Fe, Co polymetallic mineralization, （Kendekeke ）、magmatic melt titanomagnetite （Changqing）、skarn W-Sn deposit （Baiganhu）
	志留纪			
	奥陶纪			
	寒武纪			
新元古代	震旦纪			
	南华纪			
	青白口纪	Changcheng-Qingbaikou Paleo-continent rift-Convergence stage		clastic-carbonate and volcanic sediment formation and continental rift mafic-ultramaifc rock; develop the Fe, Cu, Co mineralization
中元古代	蓟县纪			
	长城纪			
古元古代	滹沱纪	Neoarchean – Paleoproterozoic basement formed stage		clastic-carbonate and intermediate-Basic volcanic active continental margin sediment formation; develop the metamorphosed sedimentary type Fe and Fe(Cu) deposit
新太古代				

Eastern Kunlun

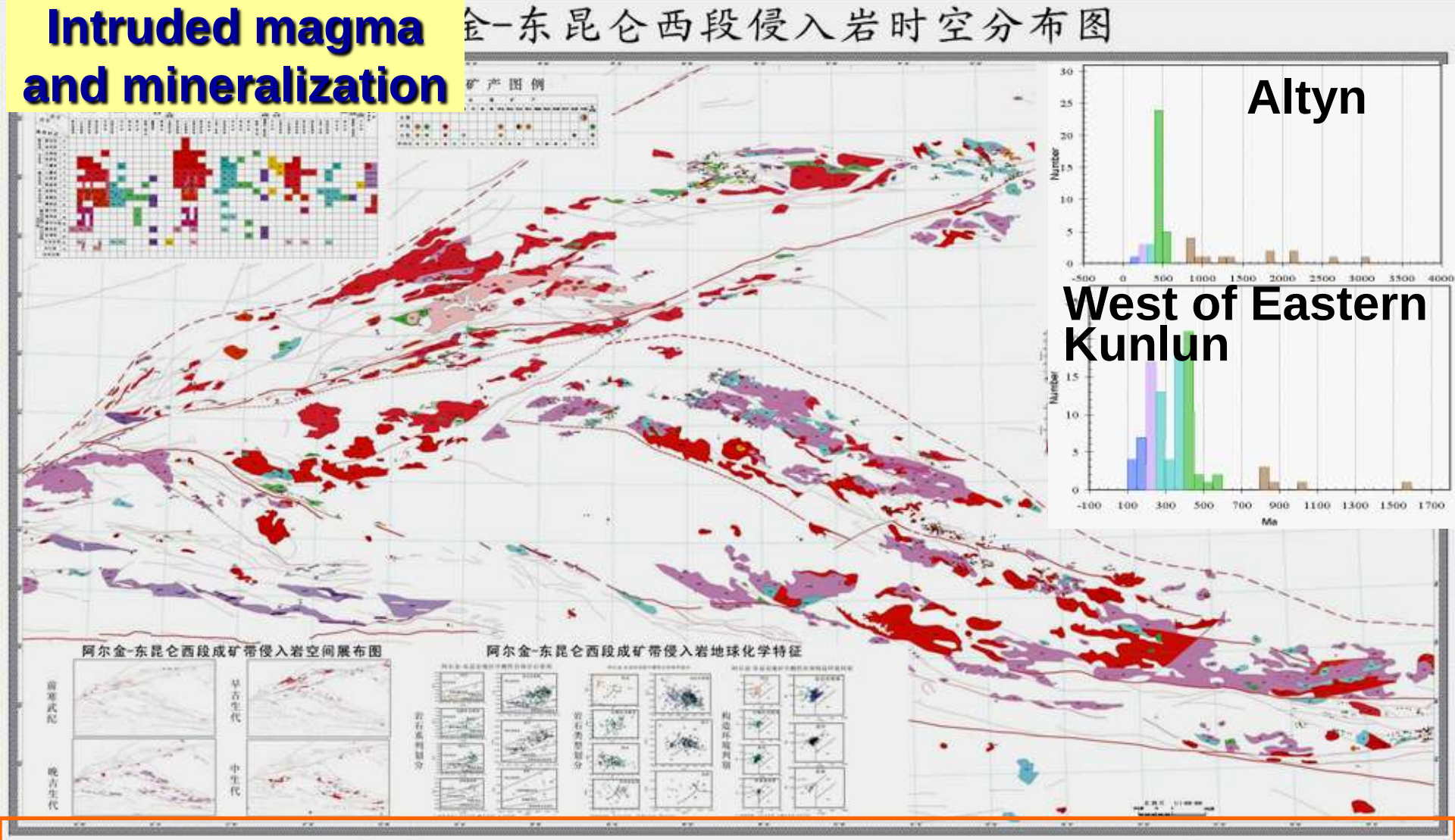


Late Paleozoic intra-plate extension and extrusional orogenesis stage, and it is carbonate -clastic – formation,and relate to the Fe, Cu, Pb, Zn mineralization。

experienced the early ocean spread, mid subduction and late collision stages in Early Paleozoic， formed the volcanic – clastic – carbonate formation, witch is relate to Fe, Cu, Co, Pb, Zn polymetallic mineralization

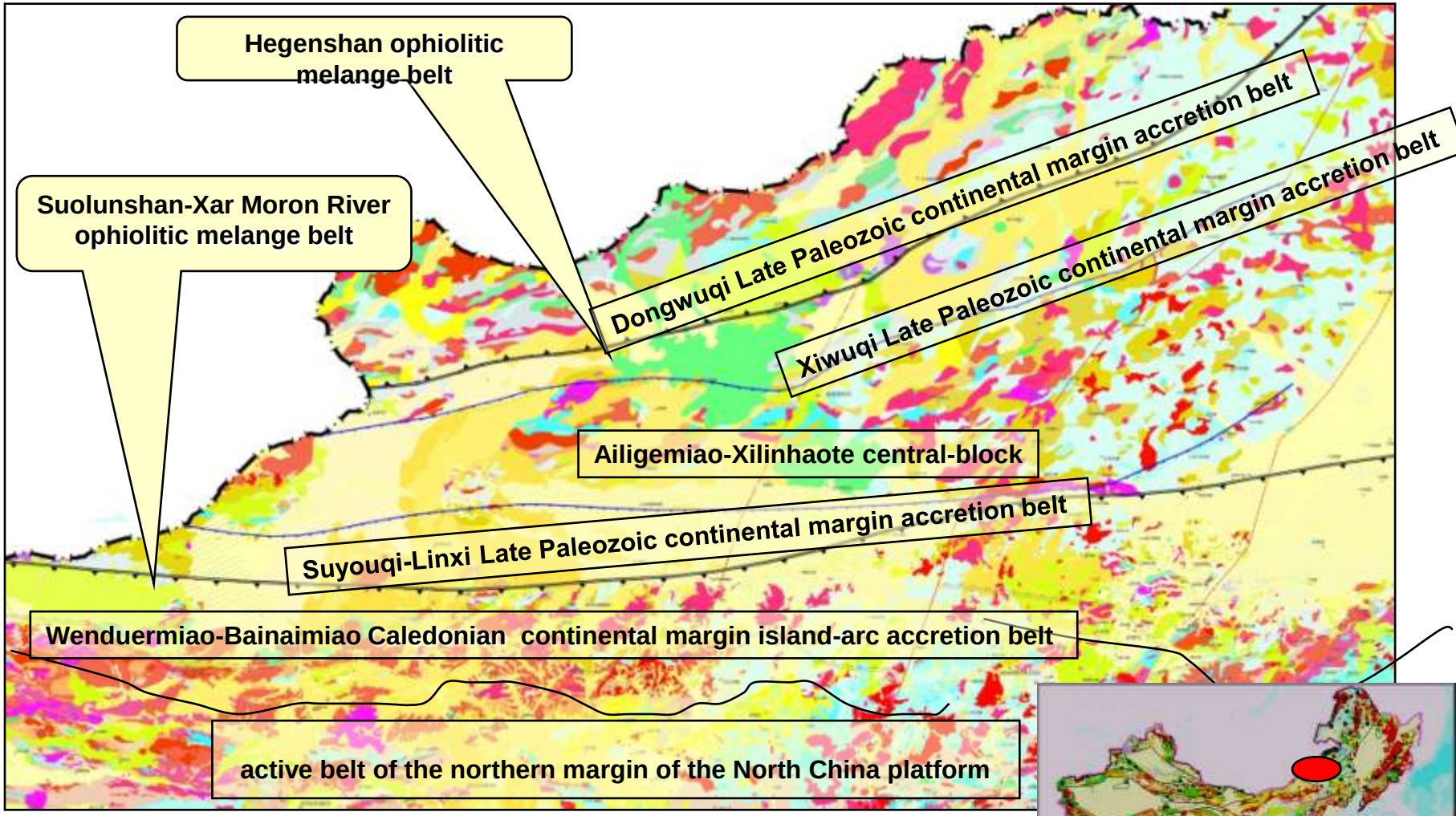
Paleo-continent rift-convergence stage in Changcheng - Qingbaikou period， the clastic-carbonate and volcanic sediment formation relate to the Fe, Cu, Pb, Zn, Co, W, Sn mineralization

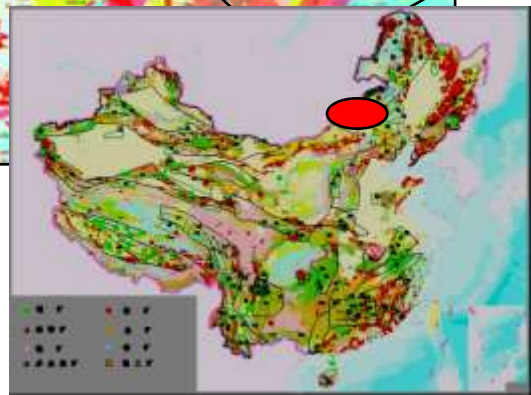
Intruded magma and mineralization



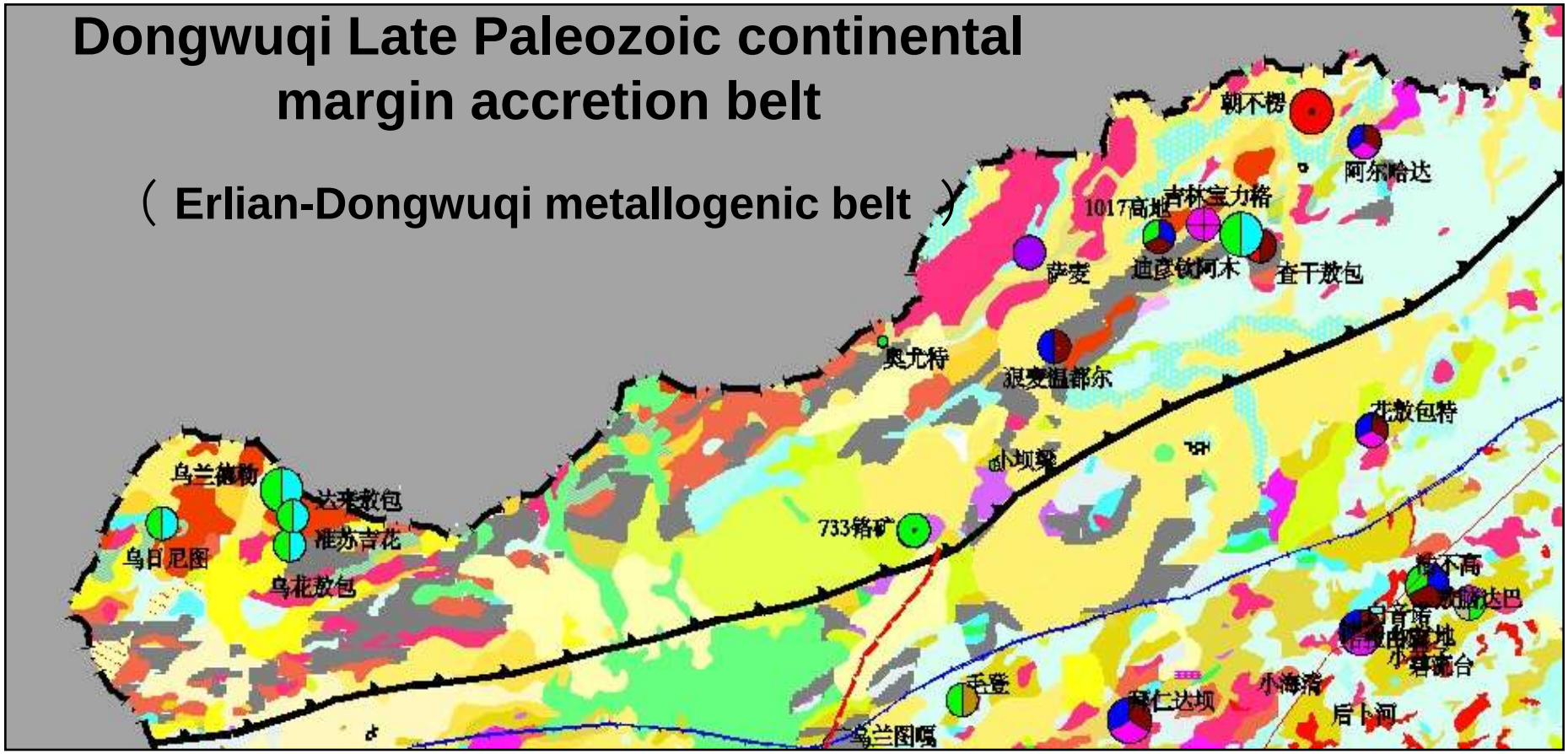
Built the space-time structure for the intrusion: the altyn area is dominant Caledonian, West of Eastern Kunlun is dominant Caledonian and Indosinian；Divided by the Qimantag ophiolitic melange belt，the north is Caledonian- Variscan mass, the south is Indosinian-Yanshanian mass； Divided by the Baiganhu fault, the west is early Paleozoic intrusion, the east is late Paleozoic – Mesozoic (Triassic dominant) intrusion.

2.2.2 Erlian-Dongwuqi metallogenic belt



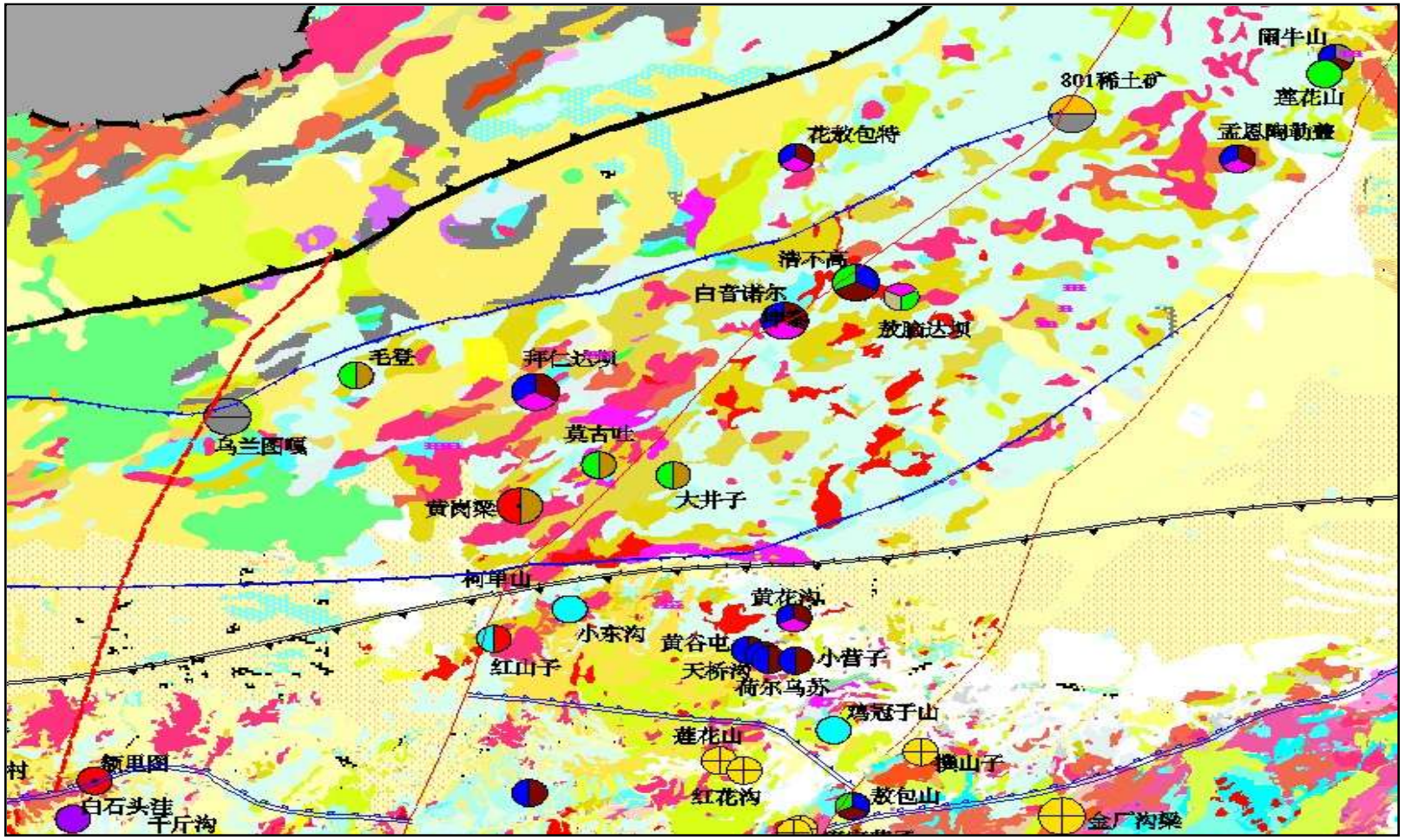


Built the regional strata, tectonic and magma frame, and summarized the geological background of each unit for the mineralization



Favourable area for the W-Mo, Cu polymetallic deposit related to Late Paleozoic and Mesozoic tectonic magma activity.

Tuquan-Linxi Yanshanian Sn-Zn-Ag-Cu polymetallic metallogenic belt



Late Paleozoic continental margin accretion belt and superposed by the Yanshanian magmatic belt. The Permian marine facies intermediate-mafic volcanic rock is developed, and it is favourable area for the marine facies volcanic Cu polymetallic deposit and Mesozoic porphyry W-Cu-Sn-Mo deposit.

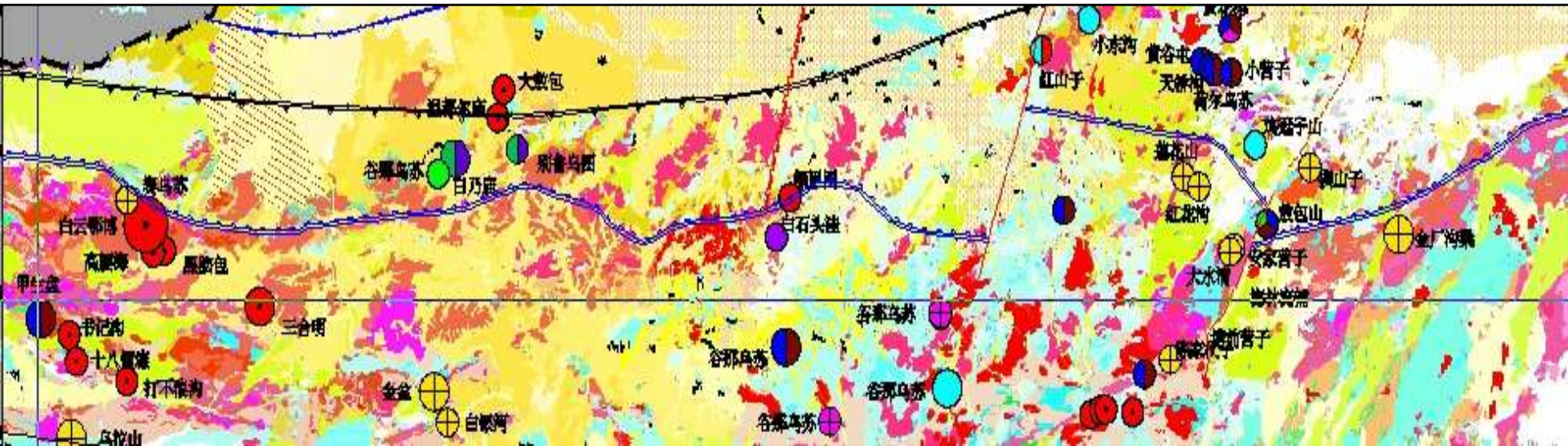
the northern margin of the North China platform

Proterozoic, Paleozoic, Yanshanian

Au-Ag-Fe-Nb-Cu-Pb-Zn polymetallic metallogenic belt

The south part is late Archean greenstone formation，and product the iron bearing formation and greenstone type gold ore, and also the large-sized gold deposit。

The north part is Paleo-Proterozoic rift, and sediment the clastic rock and carbonate, develop the Proterozoic-Paleozoic-Yanshanian granite，and product the super-large Fe-Nb-rare earth ore and copper deposit, Pb-Zn-Au deposit in the Bayan Obo Group



3. New recognitions for the geological tectonics

3.1 New recognitions for the Tibetan Plateau

New strata system

★discovered over 40,000 Paleontology Fossils

★newly built 152 lithostratigraphic units

★defined 1200 lithostratigraphic units

New tectonic magma frame

★discovered 4 different tectonic-magma assemblages

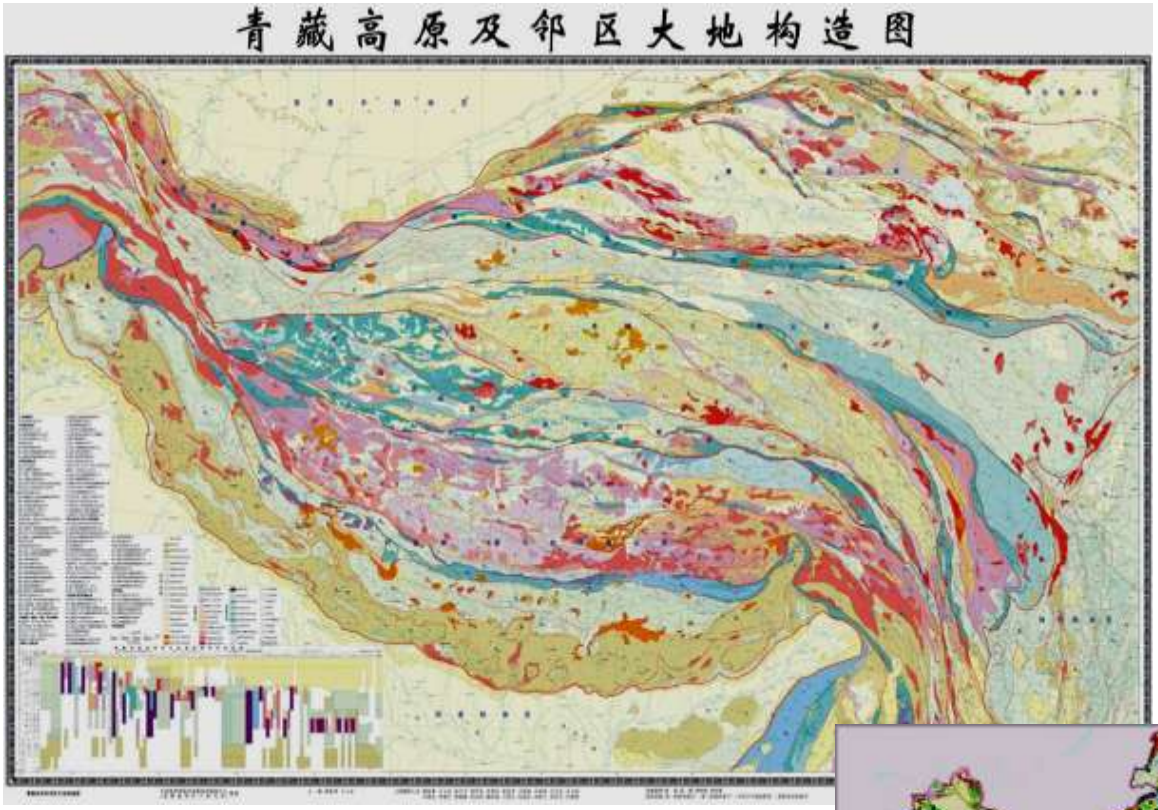
★3 lithosphere types and 2 crust types

★some evidences for the Slab break-off and mantle flow

Key records of the oceanic crustal slices

★confirmed 21 ophiolitic melange belt

★defined 16 high-ultrahigh pressure belt

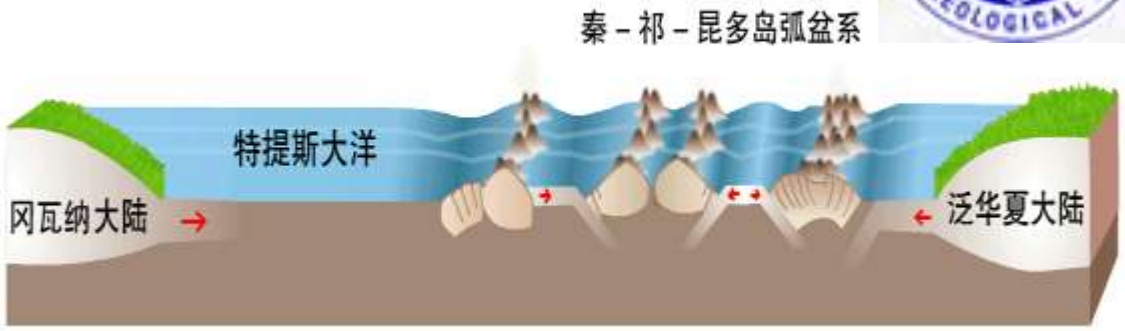


Tectonic framework： one ocean, two continental margins, and three arc-basin systems

Three stages of the Tethys tectonic evolution

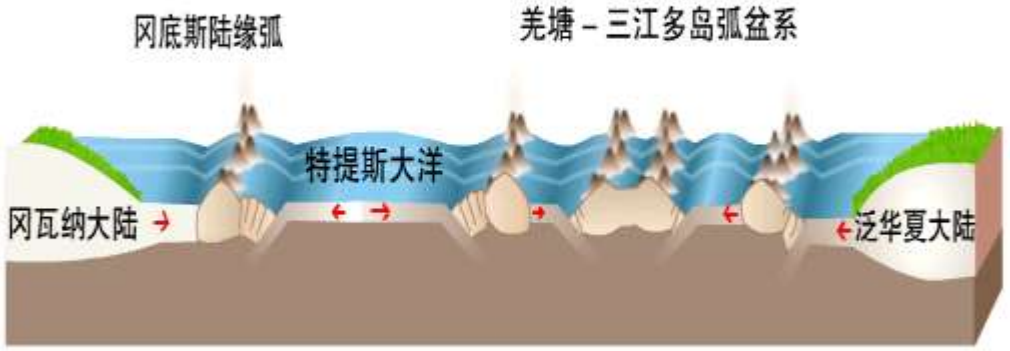
1. Unidirectional subduction of the Proto-Tethys ocean (540-400Ma)

- Indian passive continental margin
- Qinling-Qilian-Kunlun poly-arc-basin system
- accretion of the southern margin of the North China plate



2. Bidirectional subduction of the Paleo-Tethys ocean (400-230Ma)

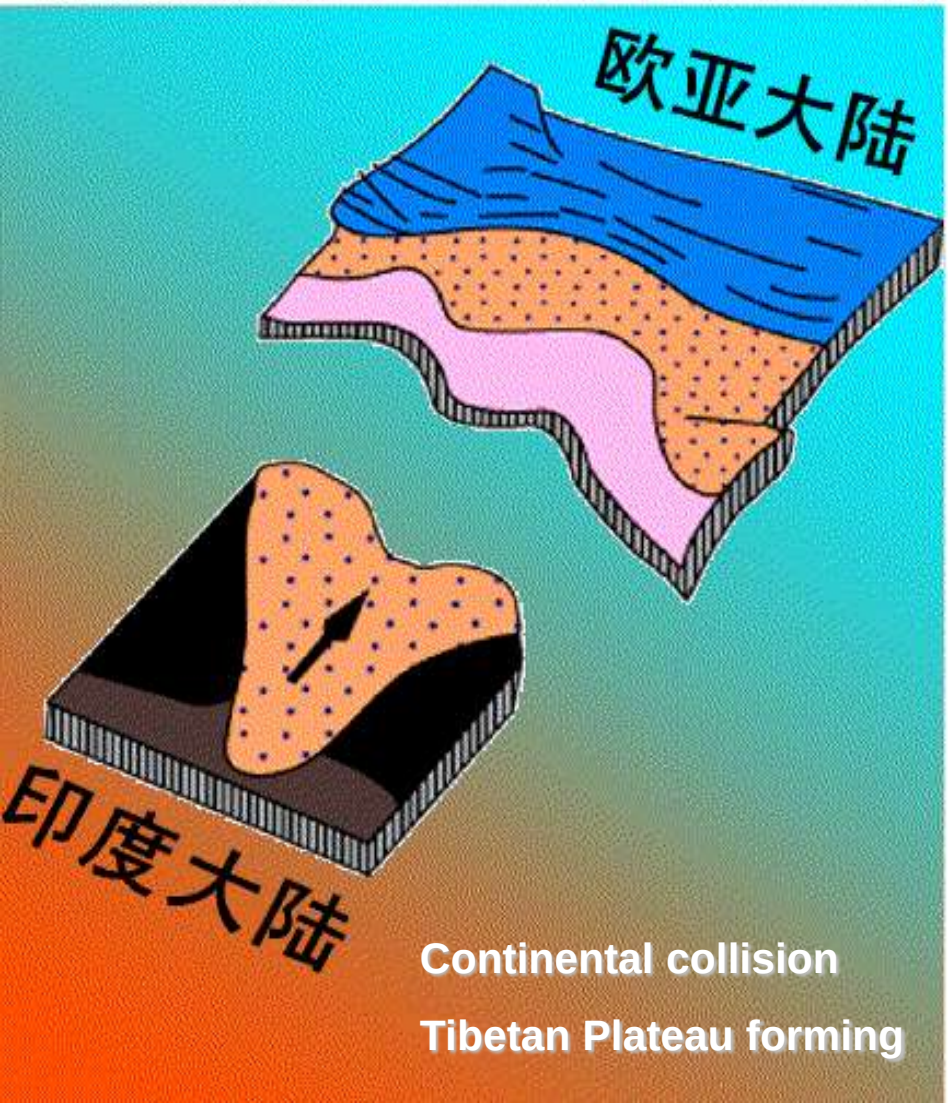
- Gangdese continental margin arc
- Three rivers poly arc-basin system
- bidirectional accretion of crust



3.Back-arc subduction of Neo-Tethys ocean (230-65 Ma)

- Gangdese poly arc-basin system
- reduce of back-arc oceanic basin
- Arc-Arc collision

Continental collision for Tibetan Plateau uplifting



1. Main collision stage（65- 40Ma）

Collision between the Indian continent and Eurasia continent

- ■crustal shortening and thickening
- ■Syn-collision magma
- ■peak metamorphism

2. Late-collision stage （40-25Ma）

Tectonic transformation

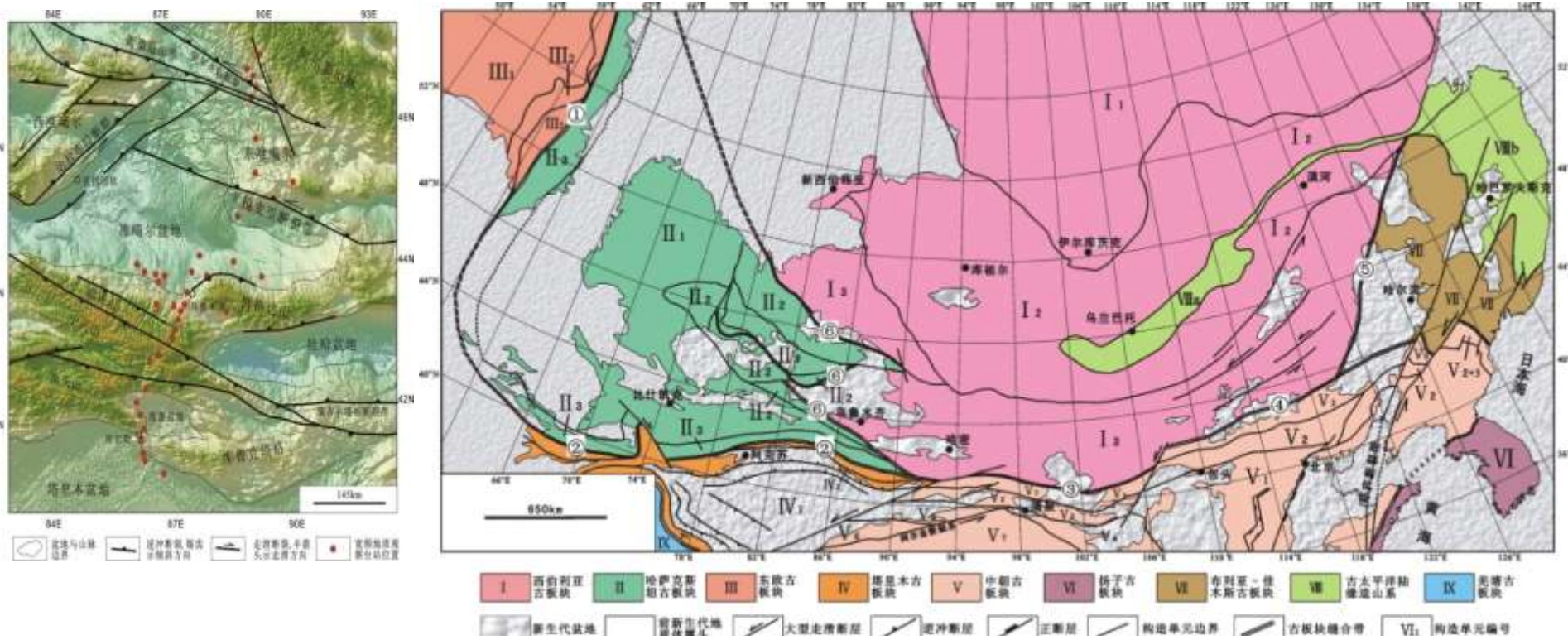
- ■nappe/slip/shear
- ■potassic crust / mantle-magma
- ■basin-fluid flow

3. Post-collision stage （25Ma-）

Crust extension

- ■normal fault/STD
- ■potassic and Ultrapotassic magma
- ■ leucogranite

3.2 Tectonic frame of the Tianshan-Xingmeng orogen

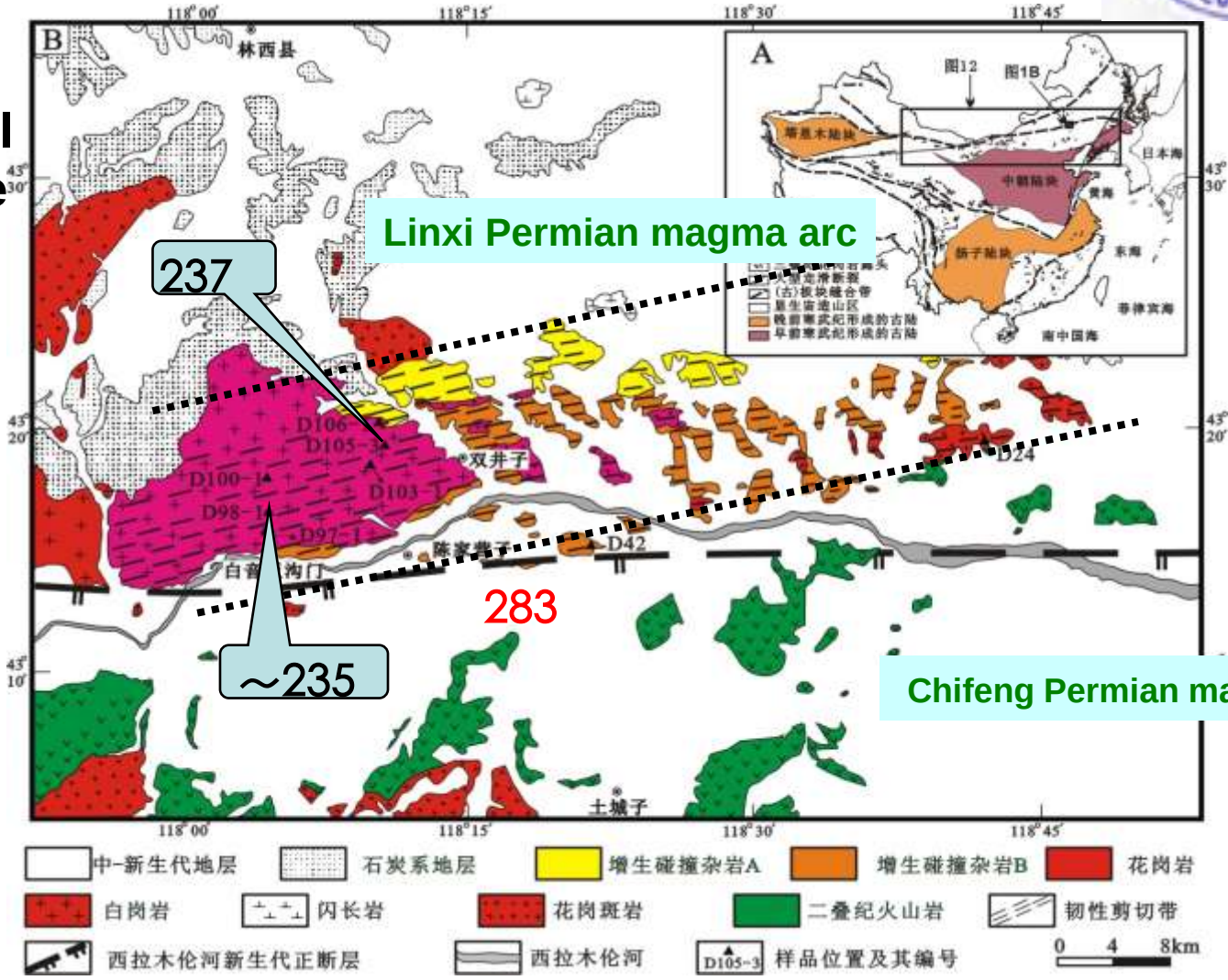


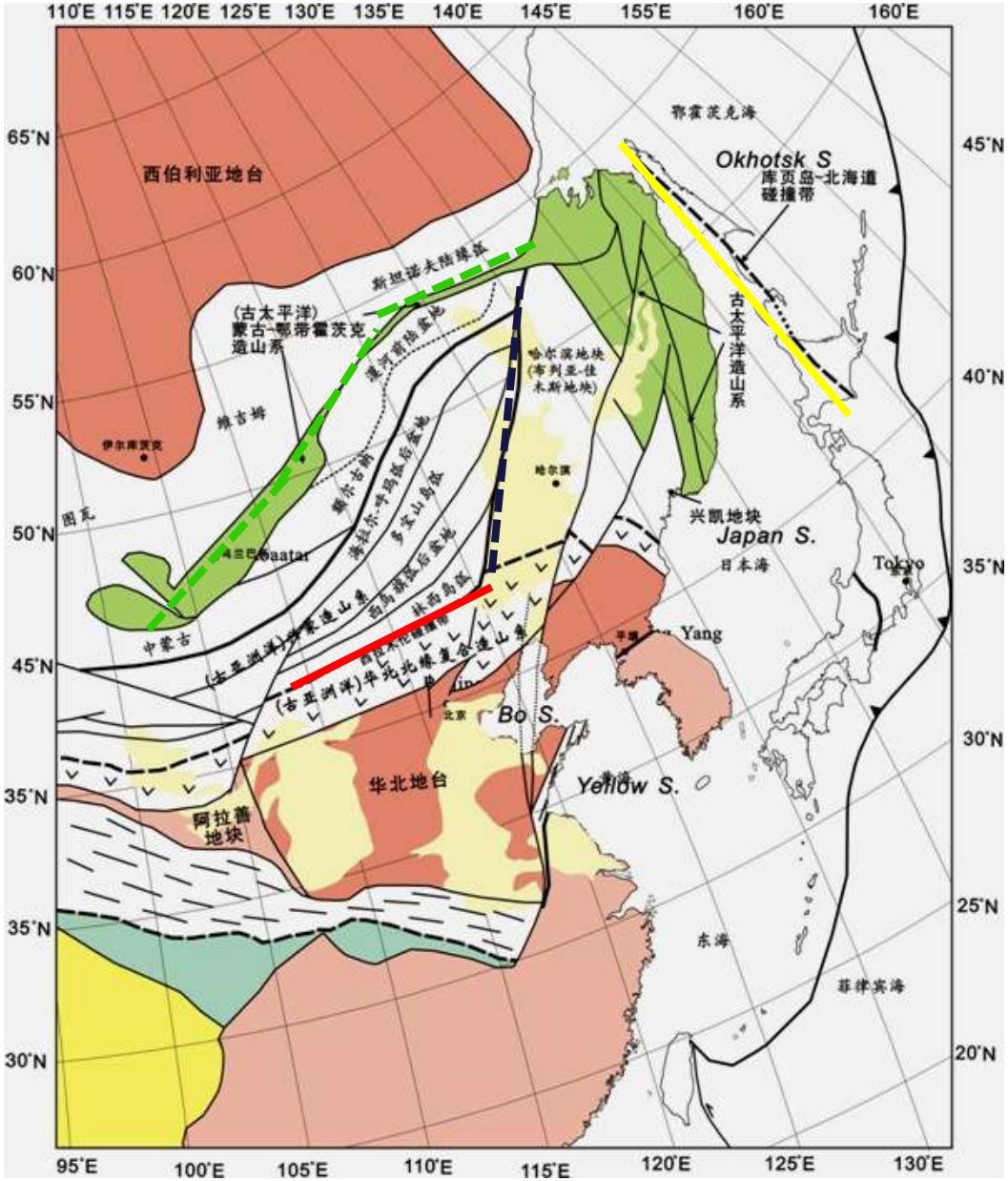
Based on the kinematic characteristics of the regional fault, proposal that the Altay、Eastern Junggar and Eastern Tianshan belong to the margin of the Siberia paleo-continent, western Junggar and western Tianshan belong to the Kazakhstan paleo-plate.

Based on the time (320Ma-300Ma) of the post-collisional magma emplaced in the collisional complex, defined the time of closing and collisional orogeny of the Paleo-Asia Ocean is Late Carboniferous in Central-Asia area.

The confirming of the Xar Moron River tectonic ophiolite belt

The Mid-Triassic crustal derived granite at the north of Xar Moron River indicate the collision is beginning at Permian and last to Mid-Triassic





Four sutures：

Suolun – Xar Moron – Yanji suture

Baicheng – Heihe-Xieliemuzha suture

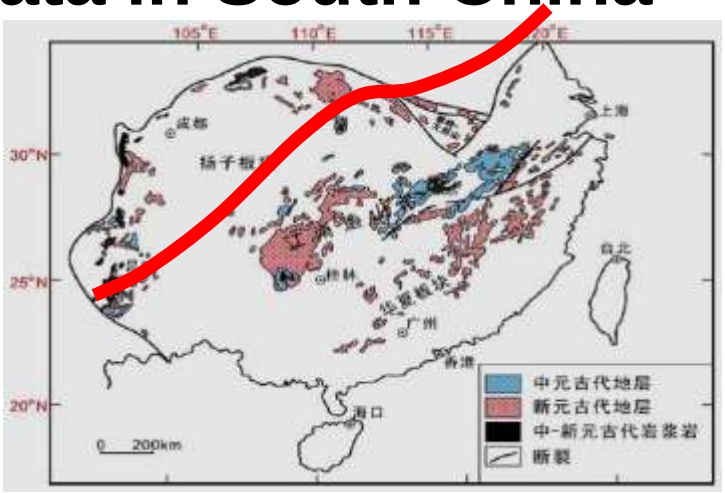
Okhotsk suture

Kuye island（Sahalin island）suture

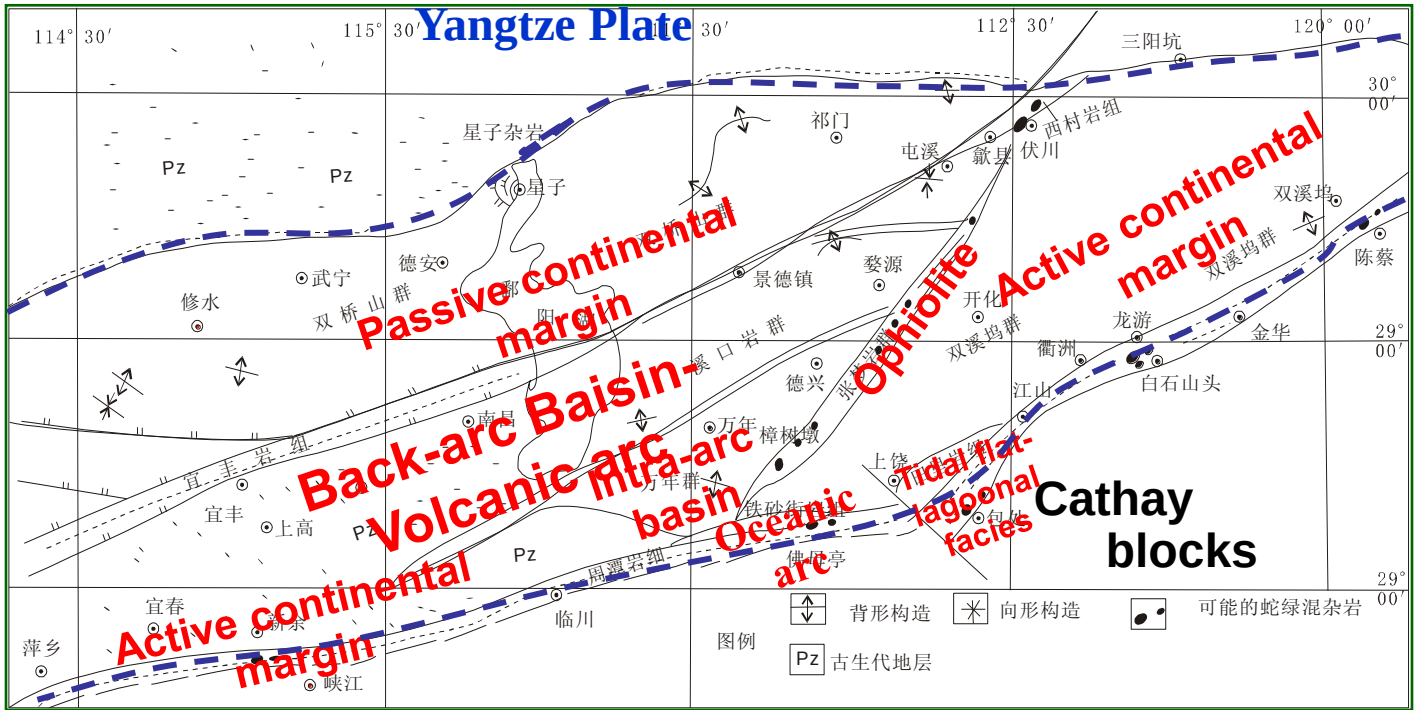
The continental margin and collisional belt (Late Neoprotorozoic-Early Permian)of the Paleo-Asia Ocean Between the Siberia and North China Plate, the collisional time is Mid-Permian.

The continental margin facing to the Paleo-Pacific of Siberia Paleo-continent (Late Protorozoic-Jurassic), the collisional time is Late Jurassic

3.2 New recognitions of the Protorozoic strata in South China



Depend on the regional mapping: Ascertained that the age of the Mid-Protorozoic strata is Neoprotorozoic. Generally ascertained there is a Caledonian collisional orogen between the Yangtze and Cathay block, which underwent the combination at Jinningian and break-up at Protorozoic, and it is a large-type metallogenic belt。



4. future work

4 aspects：

- Regional mapping, Regional magnetic airborne survey , Regional gravity survey, Regional geochemical survey in the important mineral zones, important economic developed areas, national important engineering constructions and important geological issue area, and focus on the important metallogenic belt

  ——on the 1：50000、1：250000 scales

- Comprehensive study and the fundamental map compilation

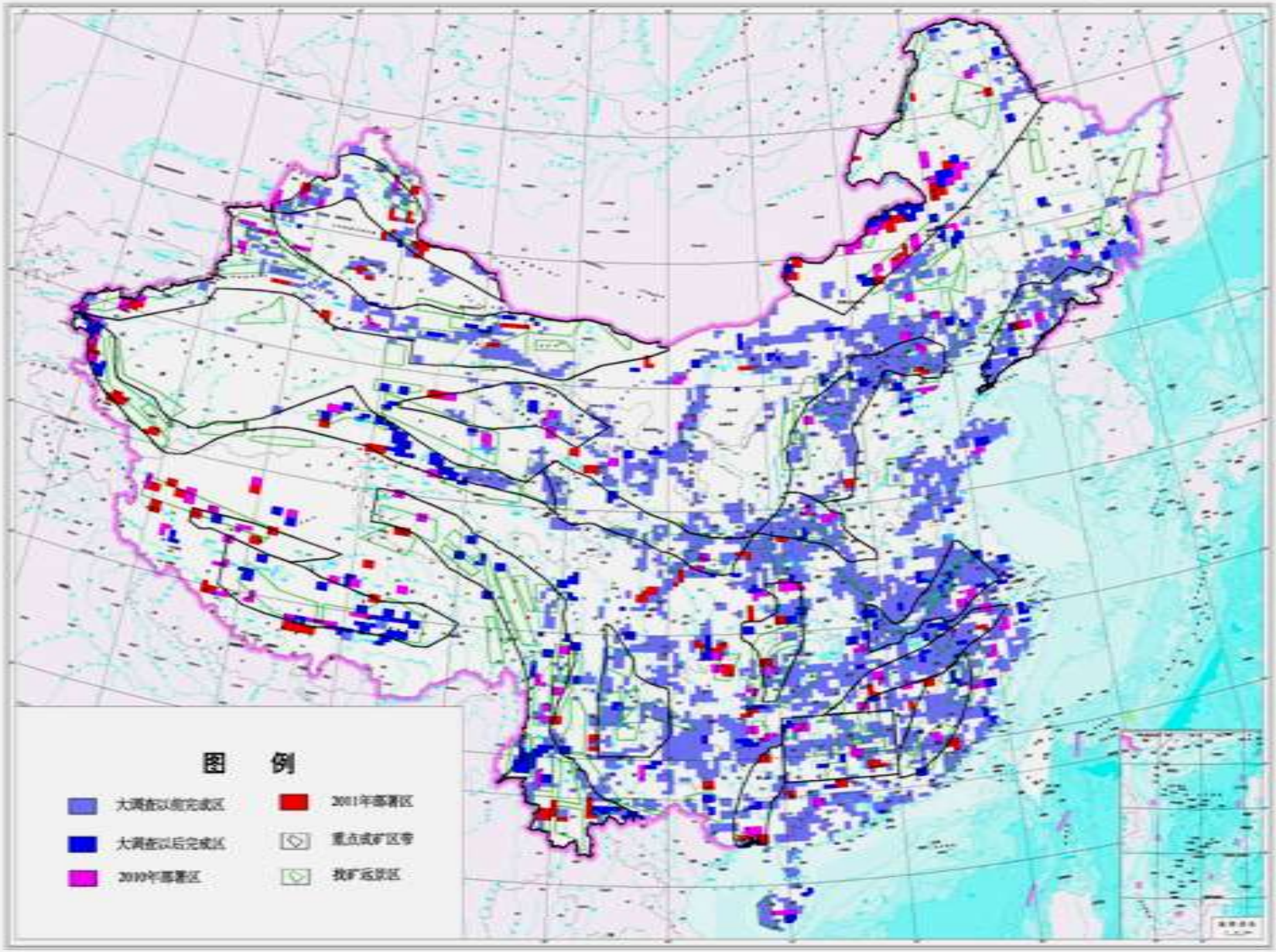
  ——divide on the metallogenic belt and main geological tectonic belt

- Key fundamental geological items and prototype study

- 3D geological mapping pilot

- ——Finish the 1:250000 regional magnetic airborne, gravity, geochemistry and mapping at important mineral zones
- ——basically complete 1：50000 mapping, magnetic airborne and remote sensing survey in the major mining prospective area and whole-exploration area
- ——finish the comprehensive research and series map compiling of the fundamental geological survey in 19 important metallogenetic belts
- ——finish the geological memoirs revision and map compiling of 34 provinces . Carrying out the compiling of major orogen and national geological memoirs, updating the fundamental geological maps
- ——achieve some developments on the Tibetan Plateau, Tianshan-Xingmeng orogen, Central orogen, Qinhang suture, Pre-Cambrian, Mesozoic magma, and etc

全国1:5万区域地质调查工作程度图(止2011年)



3D geological mapping pilot

Problem posing :

——1:1,000,000 regional magnetic airborne and gravity survey, and 1:250,000 regional geological survey have covered all of the land area

——Center scales regional magnetic airborne, gravity and geochemical survey have covered 1/2 of the land area

——1:50,000 magnetic airborne and geological survey have mostly finished at east area

——Deep prospecting

——Deep mechanism of the geological hazard

——Deep geological process

——Using of the underground space

General idea

Using the synthesis investigation method which combining the modern exploration techniques and 3D visible technique

- **Aim to the Deep prospecting, Deep geological hazard mechanism, Deep geological effect**
- **Divide to 3 levels with different scale for 3D geological mapping:**

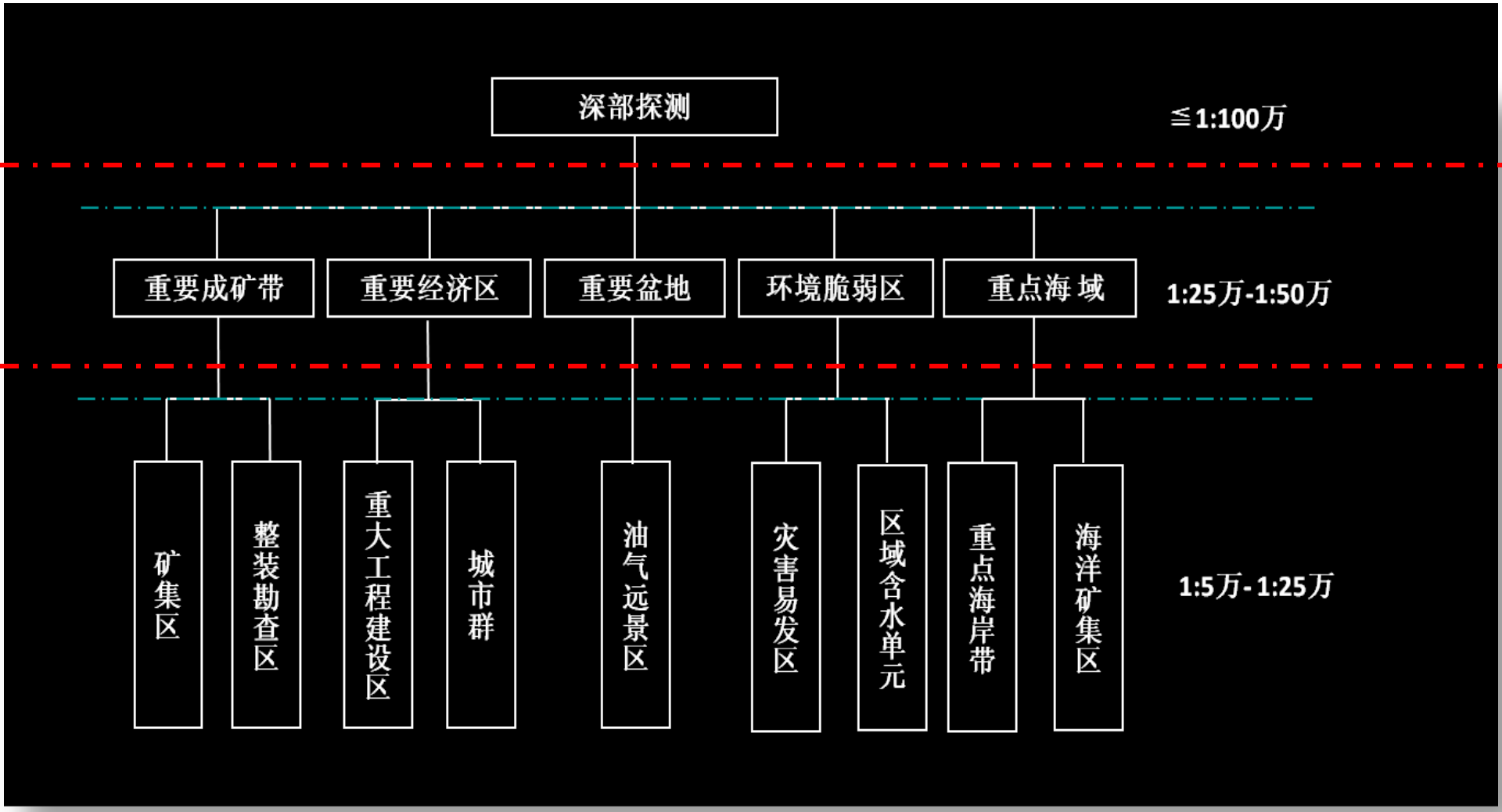
①small scale: deep structure of Chinese continent;

② small- medium scale: important mineral zones, important economic developed areas, important basins, environment damaged area and important sea area;

③ medium-large scale： ore concentration area, whole-exploration area, national important engineering constructions, city group, disaster susceptibility area, regional water containing unit.

- **Provide abundant fundmental geological data and information for the national economic construction, resources exploration and development , environment production and earth scientific development**

Framework

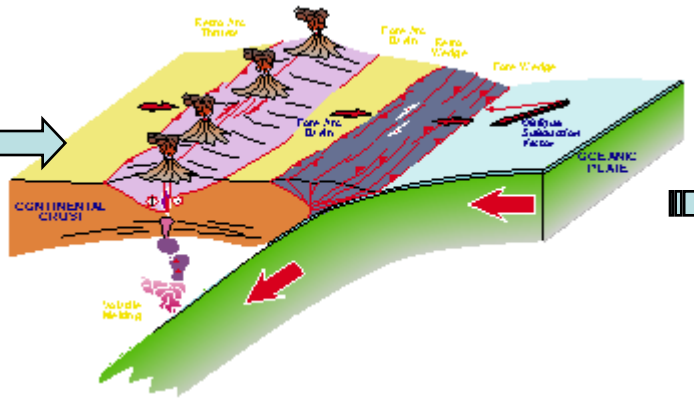


General frame for the 3D geological mapping

Geophysical deep exploration technique

3D mapping for crustal frame

1st level（±50km）



Natural seismic, Refraction, Deep reflection, Magnetotelluric, etc.

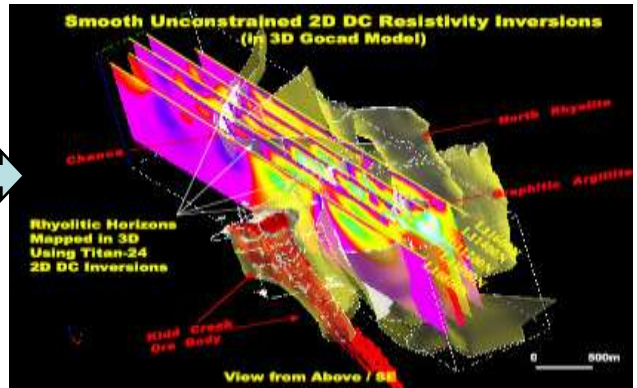
3D mapping for metallogenetic belts

2nd level（±5km）

High-resolution reflection, Magnetotelluric (MT/AMT), Gravity and magnetic, etc.

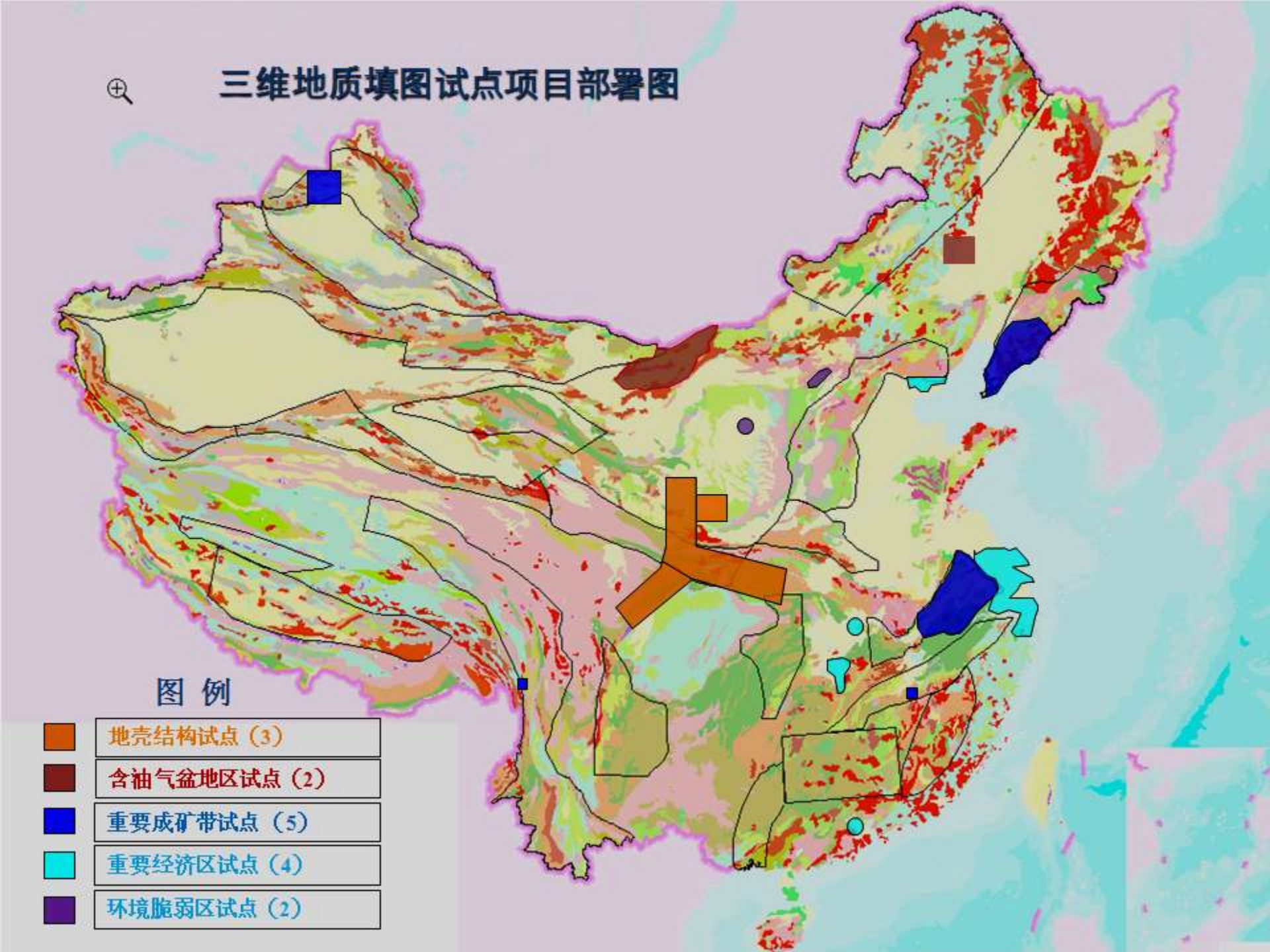
3D mapping for ore concentration area

3rd level（±2km）

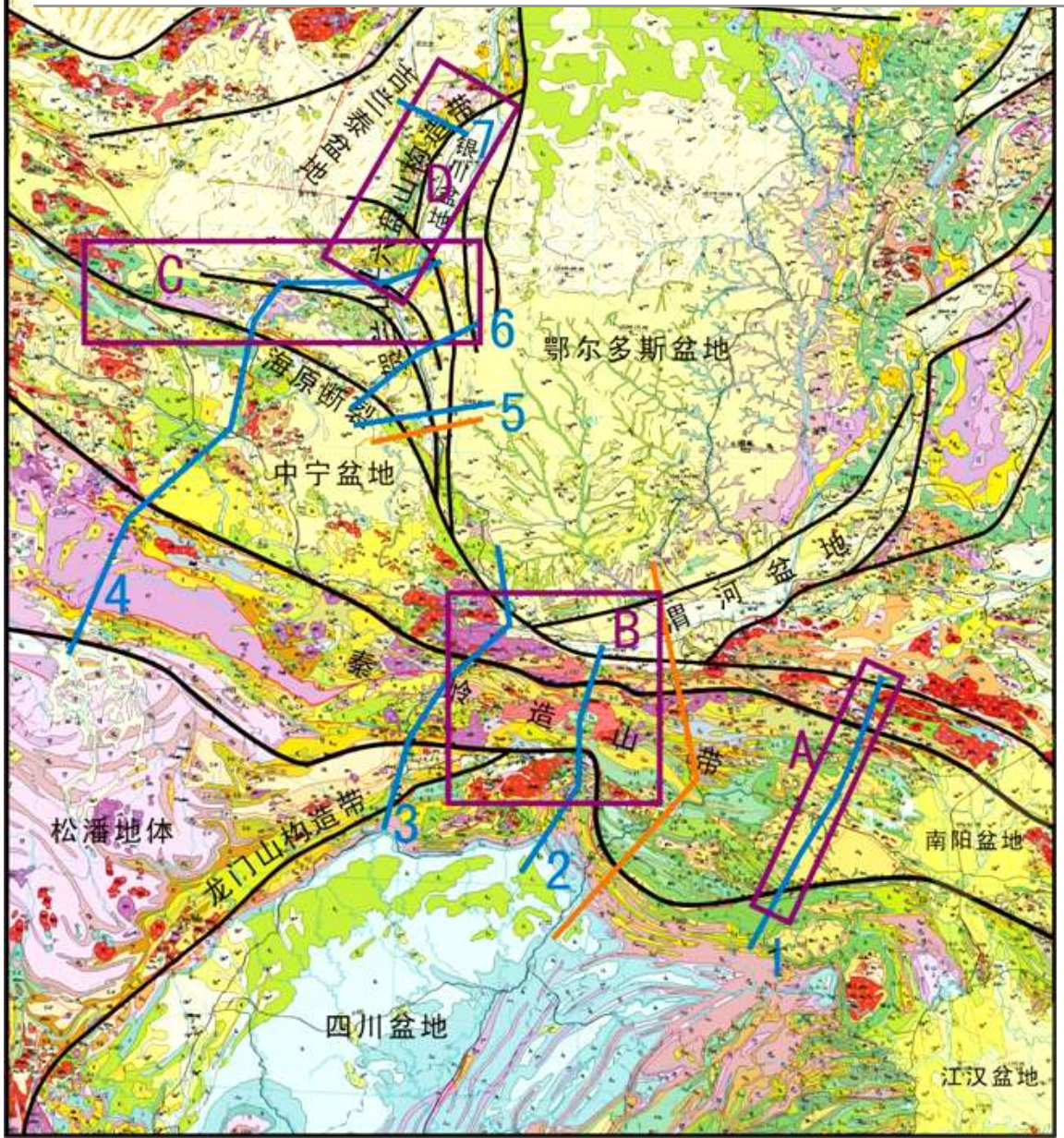


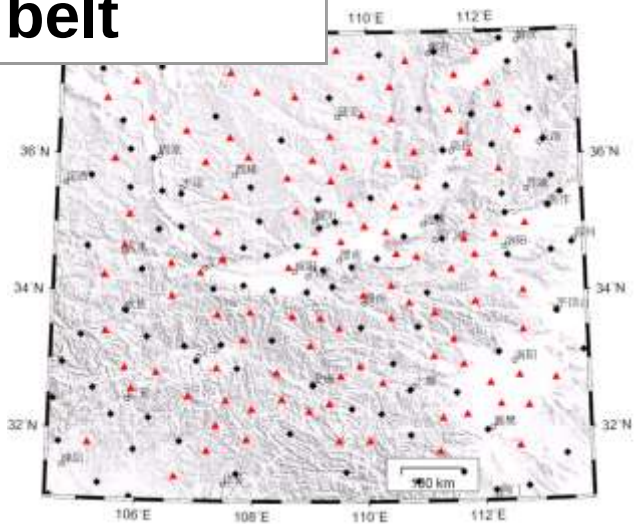
CSAMT, AMT, TEM, SIP, CR, High-density DC, Gravity and magnetic, reflection, etc.

三维地质填图试点项目部署图

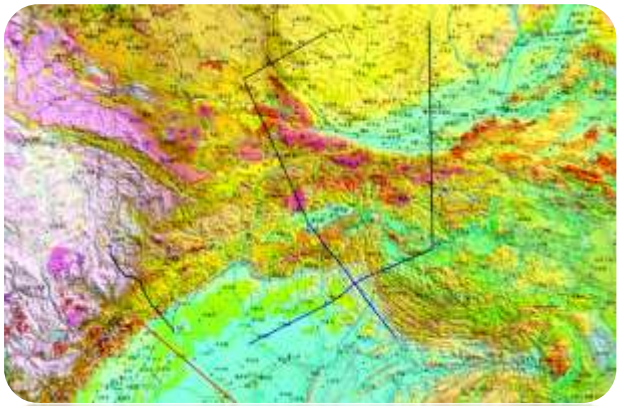


Project 1:Mapping at the joint part between the central orogen and N-S tectonic belt





The 1st stage Broad-band natural seismic recorder deployment



Deep seismic reflection profile deployment

Approaches：

Area: Deploy natural seismic array and magnetotelluric sounding based on a definite grid;

Line: Deploy deep geophysical comprehensive profiles across the main structural belts and important basins;

Point: deploy deep drilling calibrations in the key ponts.

Achievements：

Build the crustal 3D geological structural model in the intersection of central orogen and N-S tectonic belt, and reveal the compositions and structures of the main blocks and deep substance of orogen.

Find out the geological backgrounds of the important metallogenic belts and the main disaster areas. Solve the key scientific issues of deep metallogenesis and disasters. Innovate and develop the modern earth science theories.

Project 2. The pilot of 3D geological mapping for important petroliferous basins

Main Objectives:

- **Base on 3D geological mapping: find out the distribution characteristics of stratum above 6000 meters; systematic analysis the space variations of tectonism, sedimentary paleogeography, and geologic condition of oil and gas since the Mesozoic era.**
- **Build the 3D geological structural model based on structural features, sequence stratigraphy, depositional systems, reservoir characteristics, magmatism and oil and gas distributions.**

Techniques:

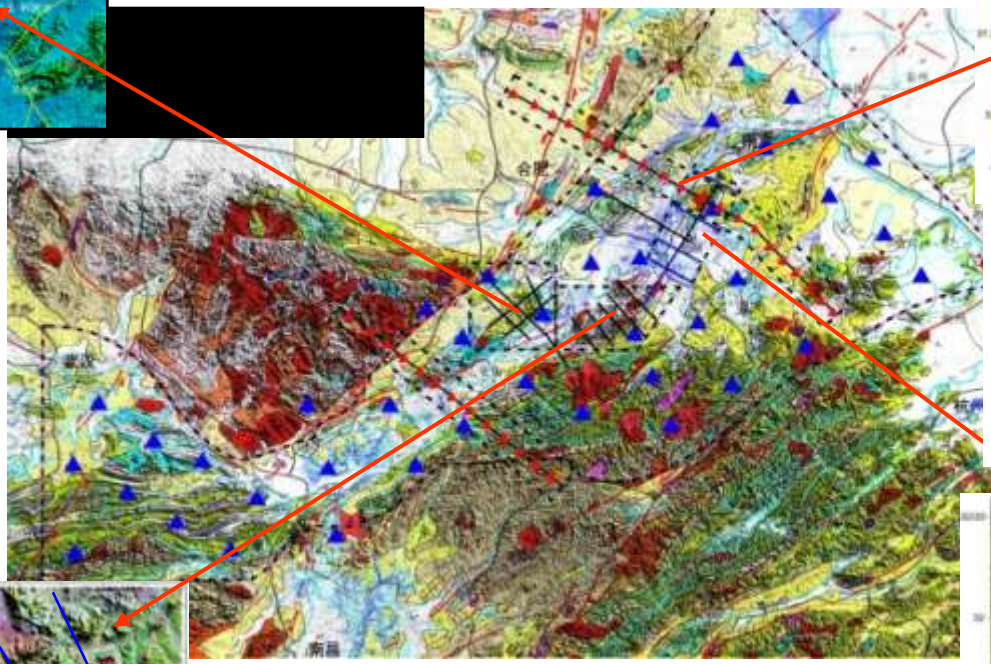
- **1:250,000 regional gravity and magnetic force and 1:250,000-1:500,000 magnetotelluric area measurements**
- **Deploy comprehensive geophysical precision measurement profiles mainly on seisms in the key areas, combined with moderate surface geological mapping and sedimentology studies.**
- **Drilling and comprehensive geophysical logging in crucial parts.**

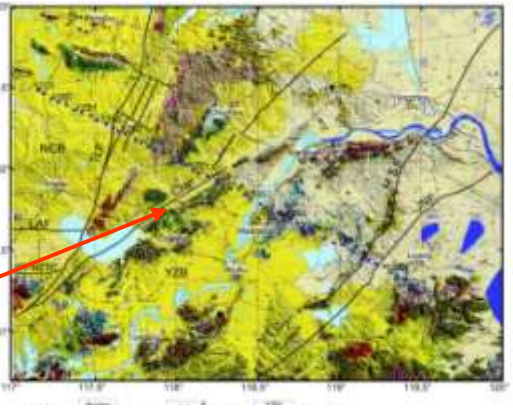
Project 3. The pilot of 3D geological mapping for important metallogenic belts and ore-concentrated areas

Main Tasks:

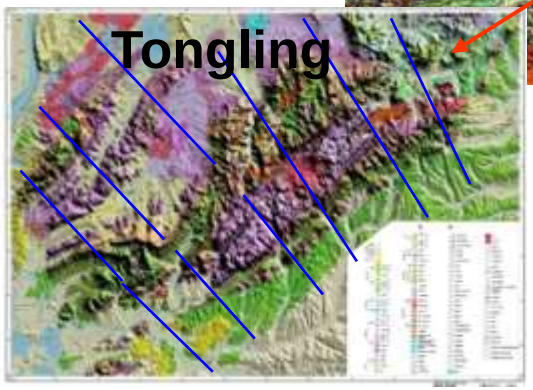
- **Metallogenic belts: Find out the regional metallogenic geological backgrounds, deep substance compositions of metallogenic belts, geology metallogenic processes. Make sure the distribution characteristics of the main metallogenic structures, ore-bearing stratum and rocks. Build the 3D geological model of metallogenic belts. Outline the prospects from 3D space scale with the main scale of 1:250000-1:500000.**
- **Ore-concentrated areas: aim at the main ore-controlling structures and ore-bearing geological bodies, find out the space distributions and structure relations and build 0-2000m deep 3D geological model to provide evidences for ore exploration at depth with the scale of 1:250000-1:50000.**

The deployment of metallogenic belts and ore-concentrated areas in the middle and lower reaches of the Yangtze River

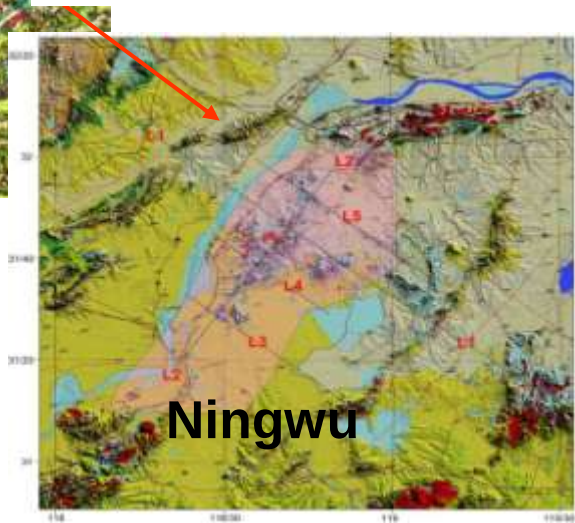




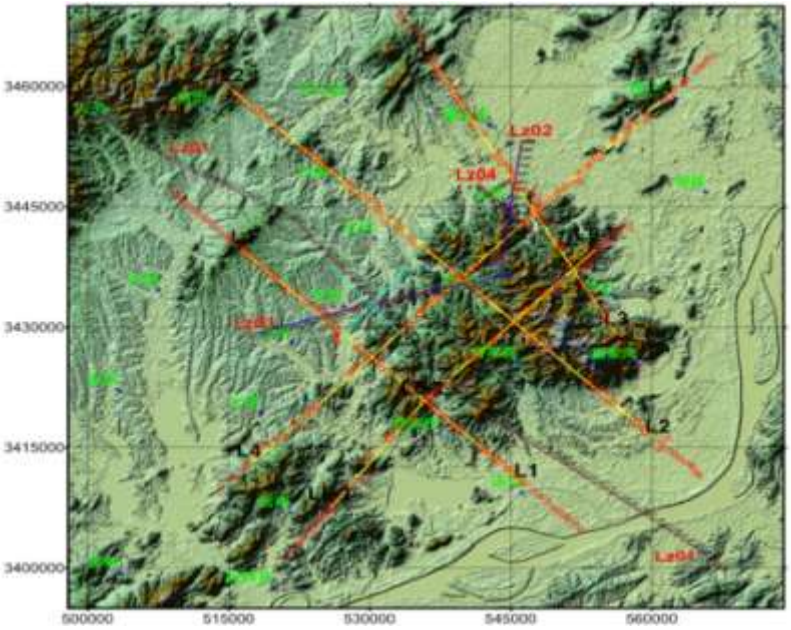
Broadband, Reflecti on, Refraction, Magnetotelluric.



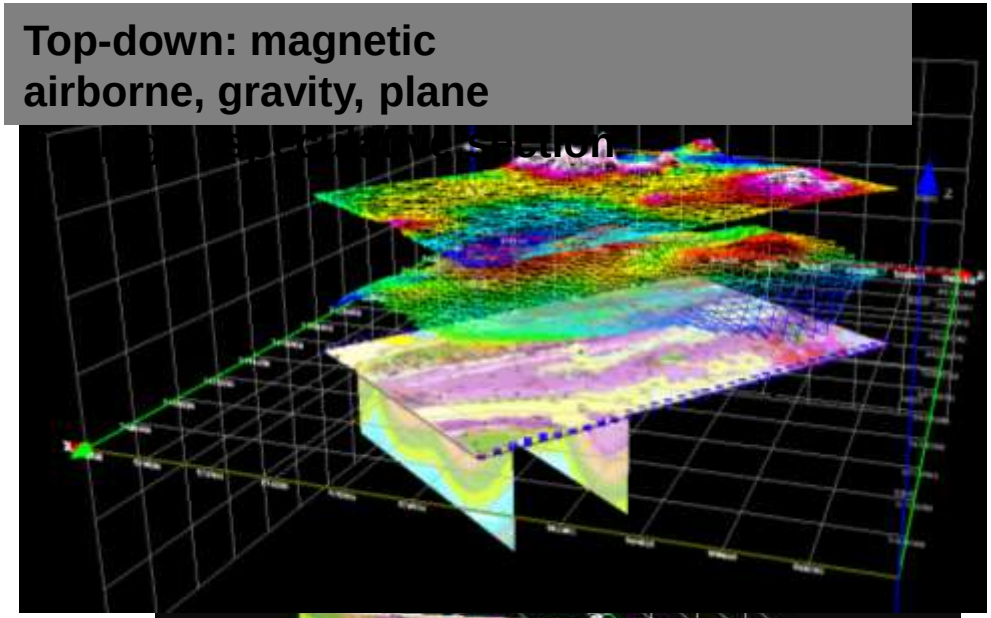
“1 net, 2 zones, 3 areas, much points”

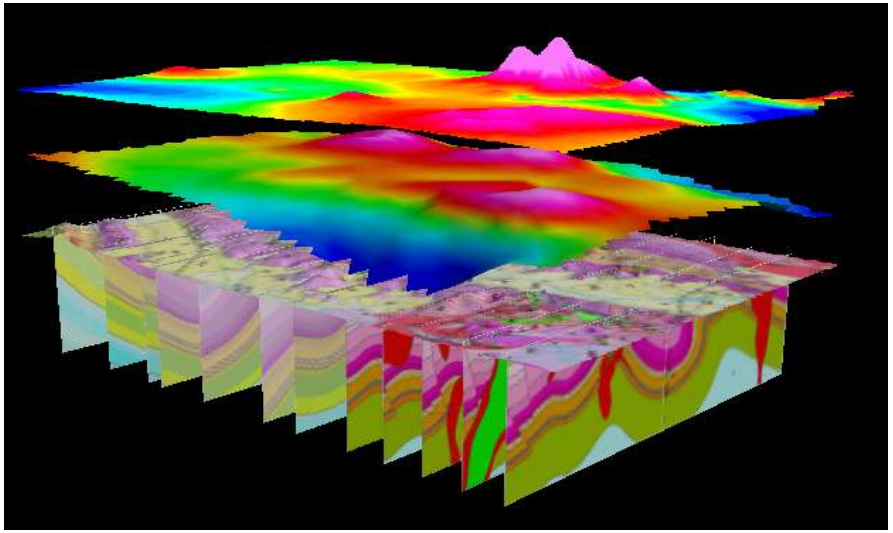


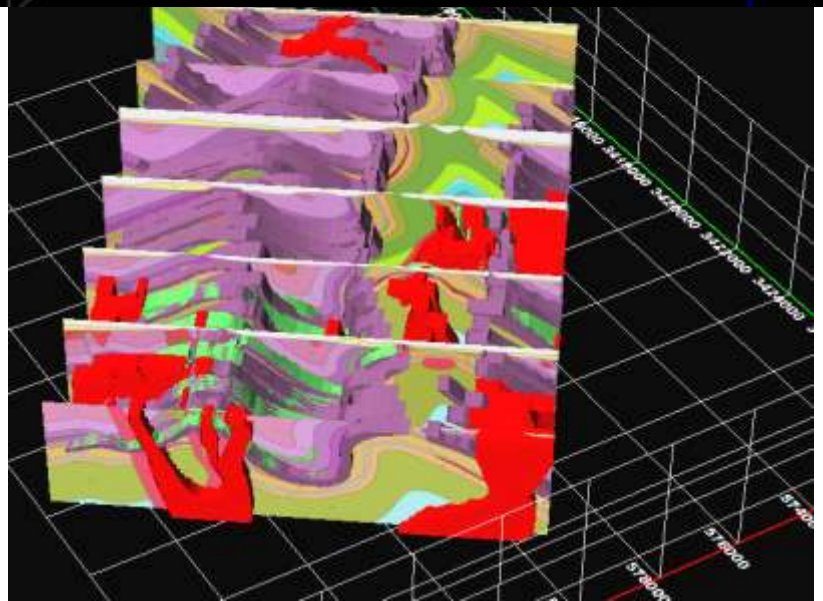
3D geological mapping of the ore-concentrated areas



Top-down: magnetic airborne, gravity, plane







Thanks
for your attention !