Geological Overview & Mining Districts of China

Liu Yikang

Minerals Exploration Branch of
China Mining Association

March.12, 2002, Toronto

"Mineral Resources and Investment Opportunities in the Peoples Republic of China" (PDAC 1995)

"How to Establish Mining JV in China" (PDAC 1997)

Schematic Tectonic Map of China

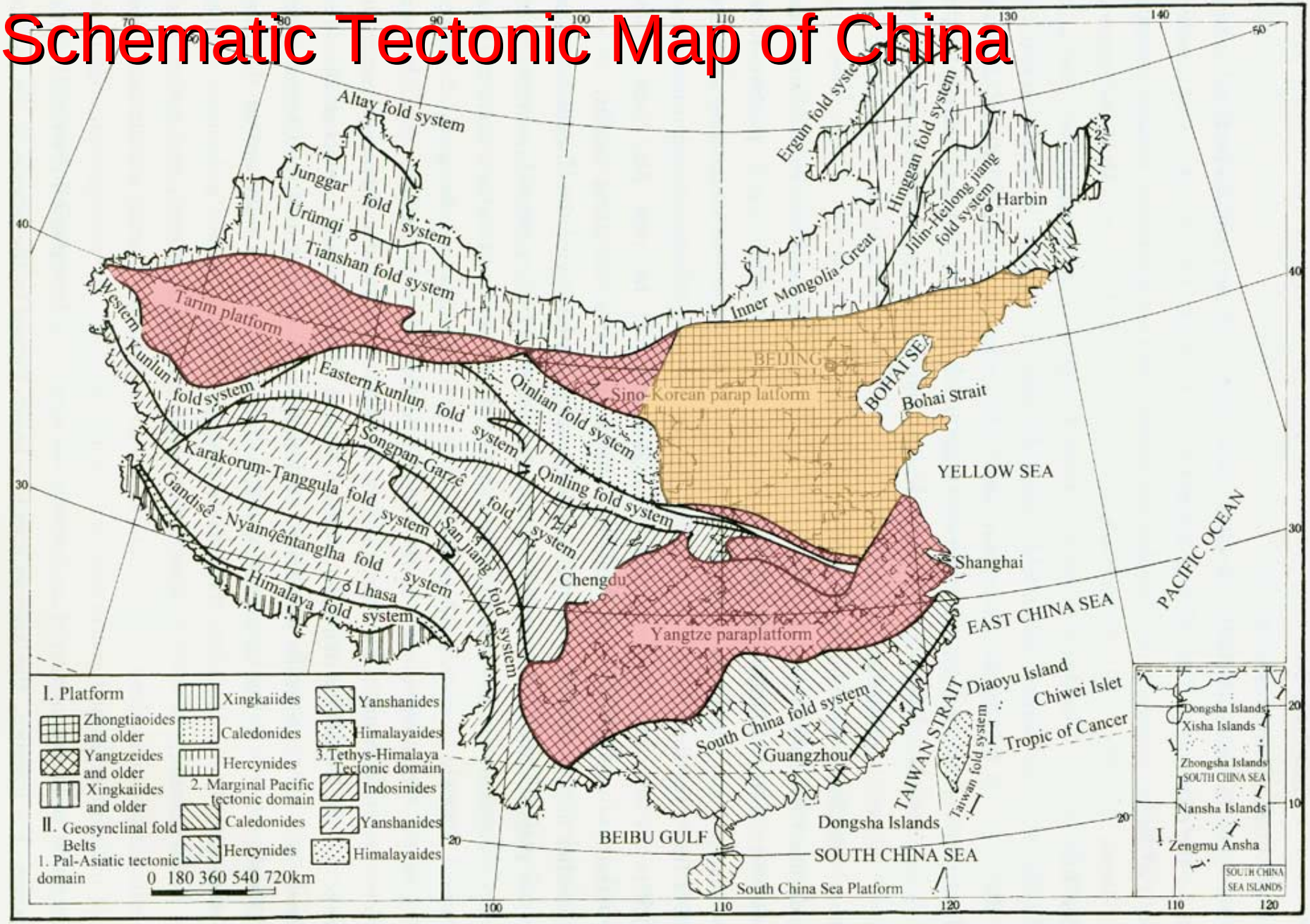


Fig.1

- Collision/accretion of several small cratons/micro-continents in different geological times; unified continent after early Mesozoic
- Collision with Siberia Plate in the late Paleozoic
- Collision with the India Plate and formation of the Himalaya Mountains in the Cenozoic
- Strong influence from Pacific Plate in Eastern China since the Mesozoic times

Main Metallogenic Belts/Provinces of China: metallic deposits only

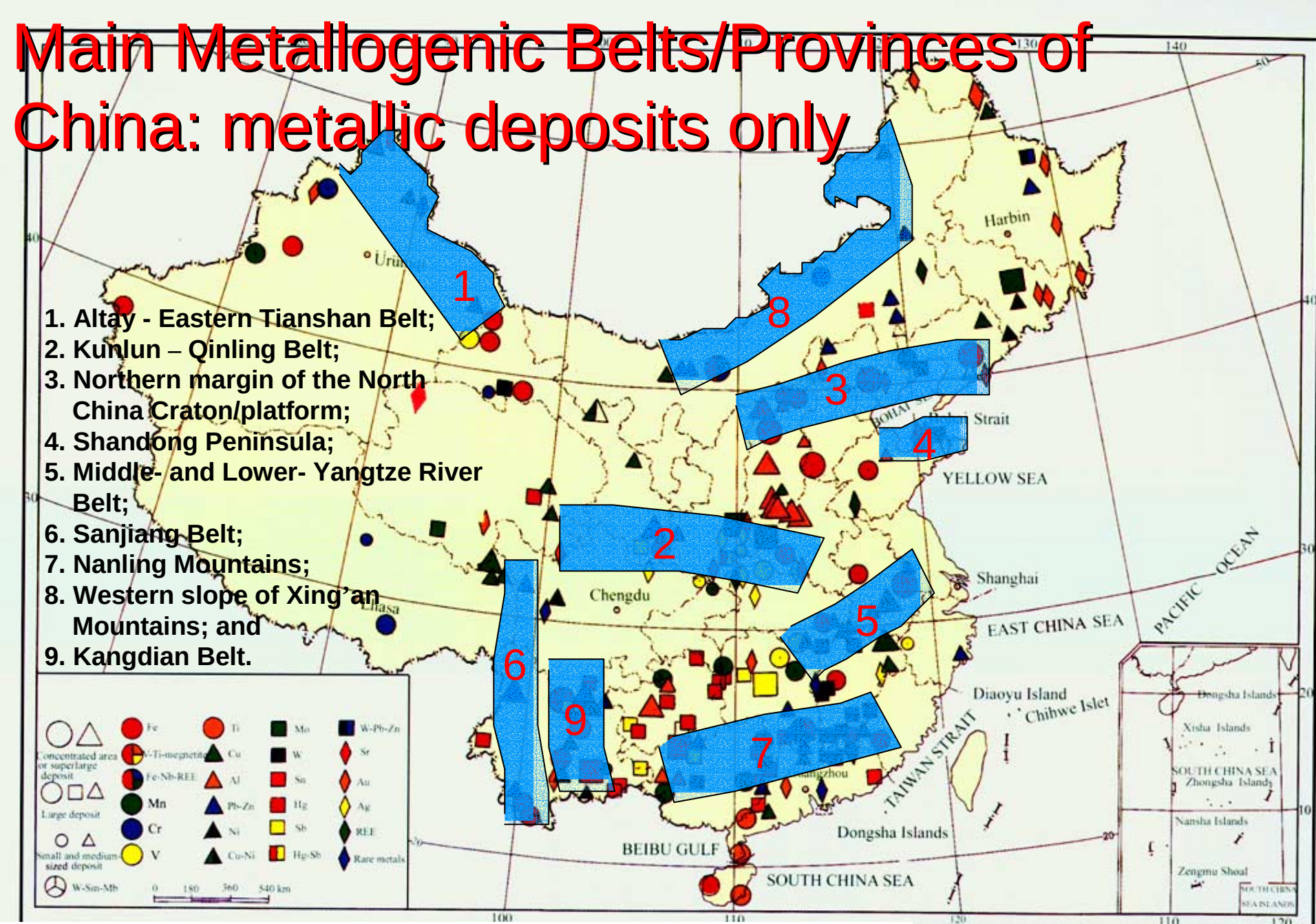


Fig.2

Table 1. Mineral commodities that possess great competitive advantages in the world

Mineral Commodity	Reserves/Resources				Rank in the world
	Unit	Reserve	Basic Reserve	Resource	
Coal	Million tonnes	58,212	282,696	726,642	3
Pb	Thousand tonnes of contained metal	6,884	11,352	23,530	4
Zn		20,951	32,501	59,370	4
Sn		936	1,797	1,848	2
Sb		627	1,026	1,668	1
Mo		1,721	3,434	4,926	2
W		1,242	2,683	2,636	1
REE		22,697	23,482	66,110	1

Table 2: Mineral commodities that China lacks

Mineral Commodity	Reserves/Resources (mt)			Production		Import in Year 2001
	Reserve	Basic Reserve	Resources	Amount (mt)	Rank in World	Amount (mt)
Fe	12,545	22,375	23,519	223	1	92.3
Mn	122	198	343	3.51	3	1.2
Cr	3.71	4.79	5.48	0.21	8	1.11
Cu	*16,712	27,462	35,457	1,371	4	**2.26
Al	360	495	1,768	***1,100	3	***1,330
Potash?	455		1,195	0.75	8	5.39

* unit: 1000 t of metal,** copper in concentrate ,*** unit:1000t of Al metal

Table 3: Annual consumption of mineral commodities in China

Commodity	Consumption (1000 t)		Global %		domestic supply %	
	2001	2002	2001	2002	1990	2002
Steel	170,000	210,000	22.7	25.0	85.3	57.6
Copper	2,110	2,300	14.2	15.0	82.5	47.1
Aluminum	3,640	3,900	15.3	15.9	71.7	56.0
Lead	660	750	10.3	11.8	141.8	44.9
Zinc	1,490	1,580	15.7	16.9	135.0	67.5

Mining industry in China

1. **66,000 mines in total; mining industry overall not integrated.**
2. **Mostly in eastern China (east of 105°E) - 80% of national mining productions; many mines now closing down.**
3. **Western China much less explored, hence with great potential.**
4. **Coal mines account for nearly half of the national mining production and labor; majority in North China.**
5. **High-grade and large tonnage non-ferrous metal mines, such as those of Pb, Zn, W, Sn, Mo and Sb occur mainly in southern China.**

- Mining districts of main mineral commodities;
- Major deposit types

Pb & Zn

1. Pb:Zn=1:2.6, generally Pb+Zn > 10%;
2. Annual Pb production: 0.92Mt, annual Zn production: 1.703 Mt;
3. Export of lead and zinc ranked the first and second in the world;
4. Cost of lead is 18.3•/lb.; Cost of zinc is 34.9 •/lb

Distribution of Pb-Zn mines in China

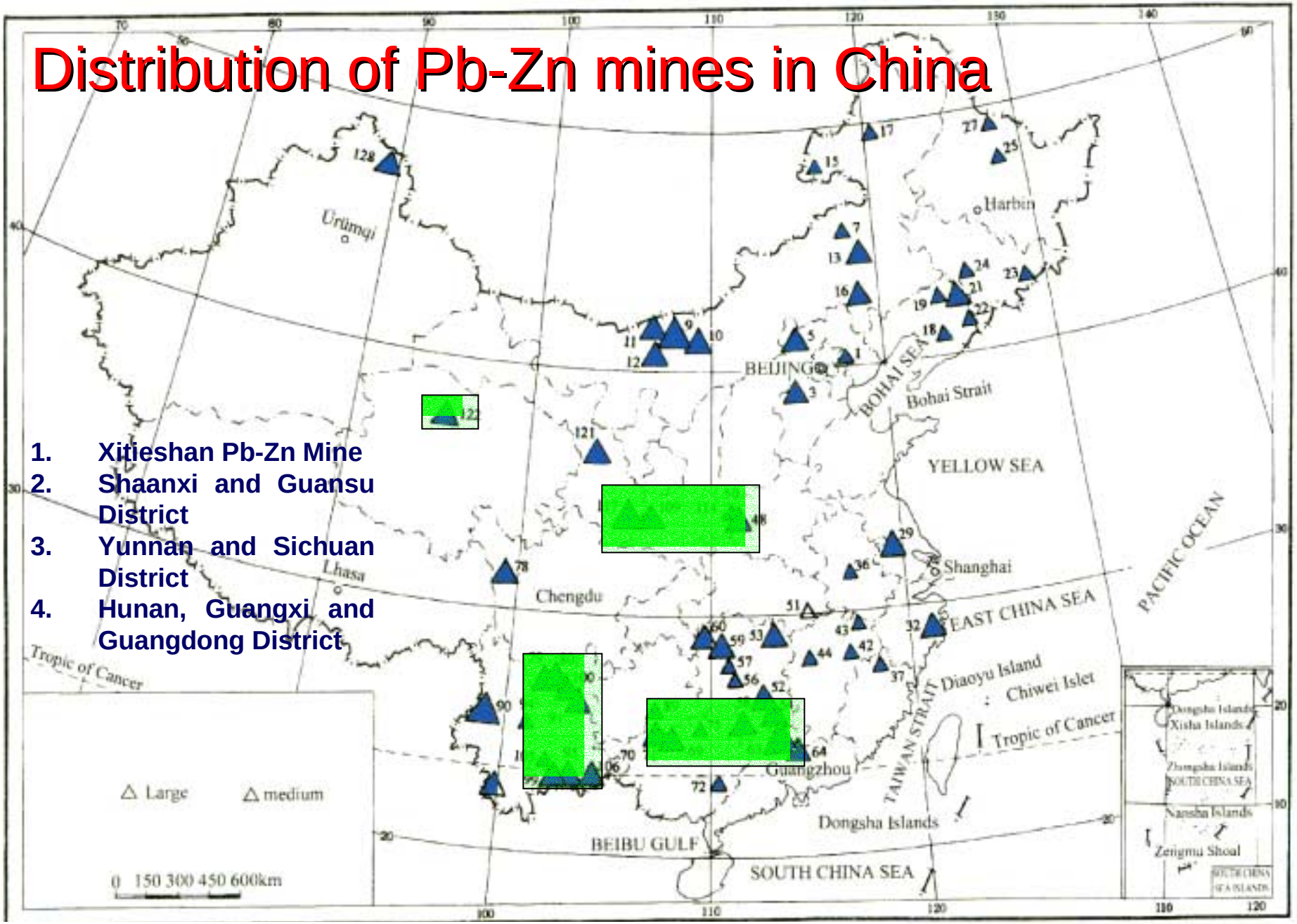


Fig.4

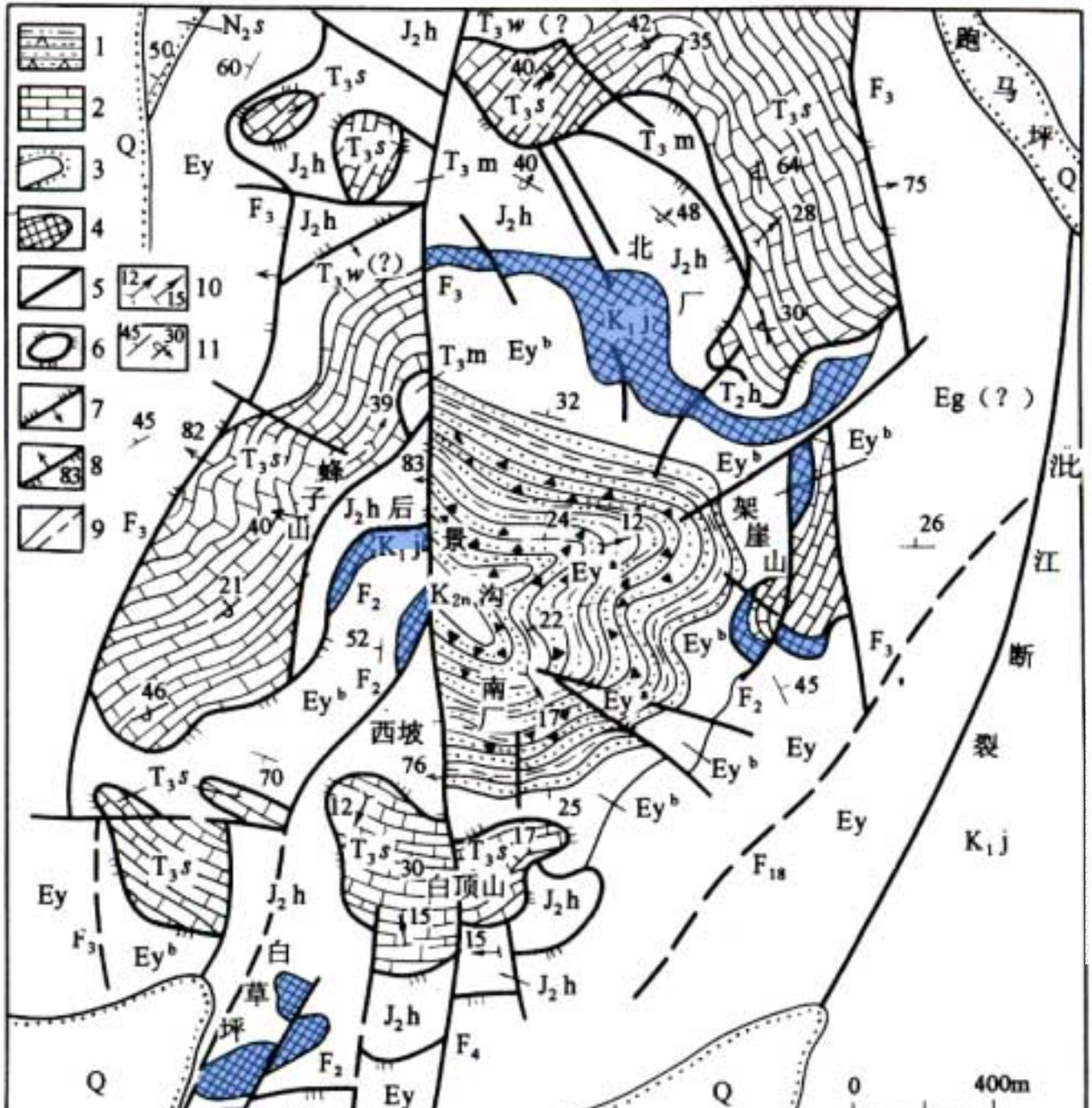


Fig.6 Geological Map of Jinding Pb/Zn

The first Sino-Foreign Exploration JV in China in1990, Kangdian JV of BHP and SMGEC, was to explore MVT Zn/Pb, in the Kangdian Belt

Dalianze Pb/Zn Mine

Reserve

1,960,000t (metal)

Pb 0.7%

Zn 12.3%

SEDEX Xitieshan Pb/Zn Mine

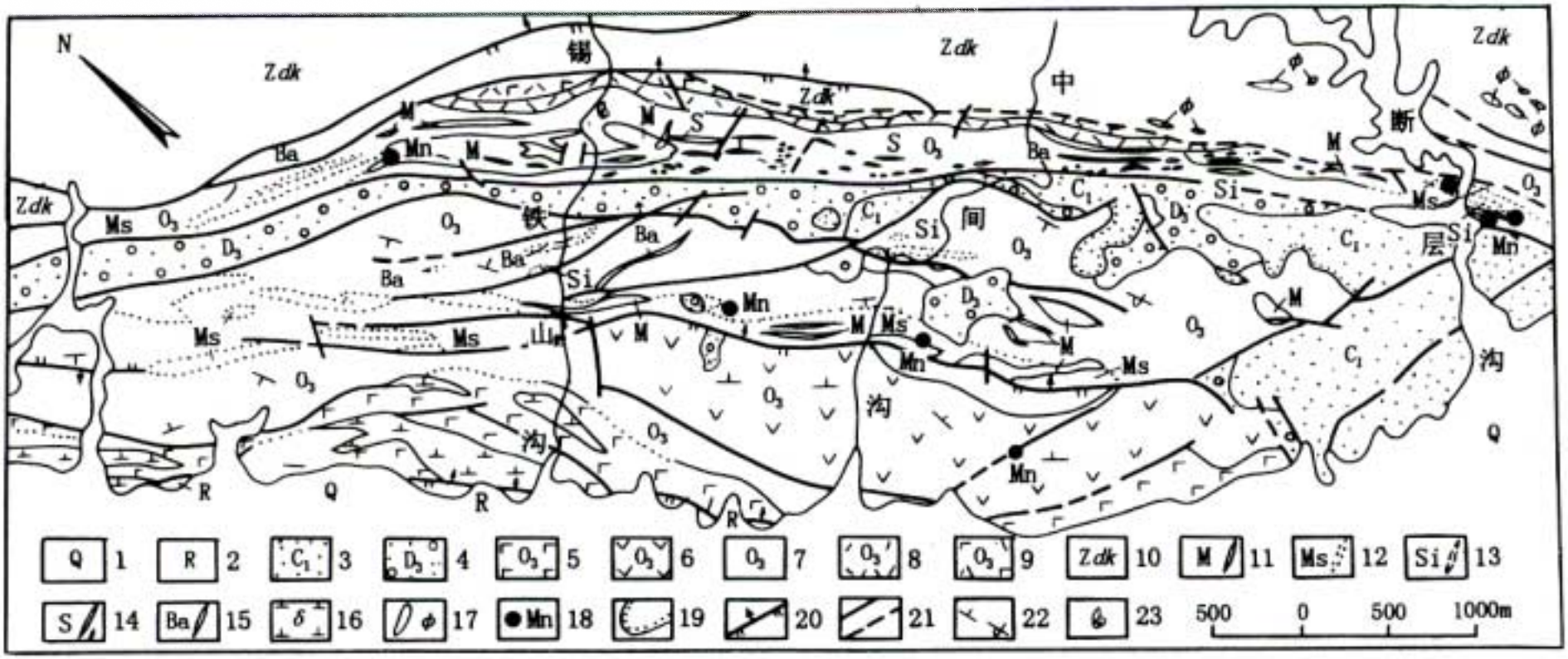


Fig.7 Geological Map of Xitieshan Pb/Zn

Reserve 1,960,000t (metal)

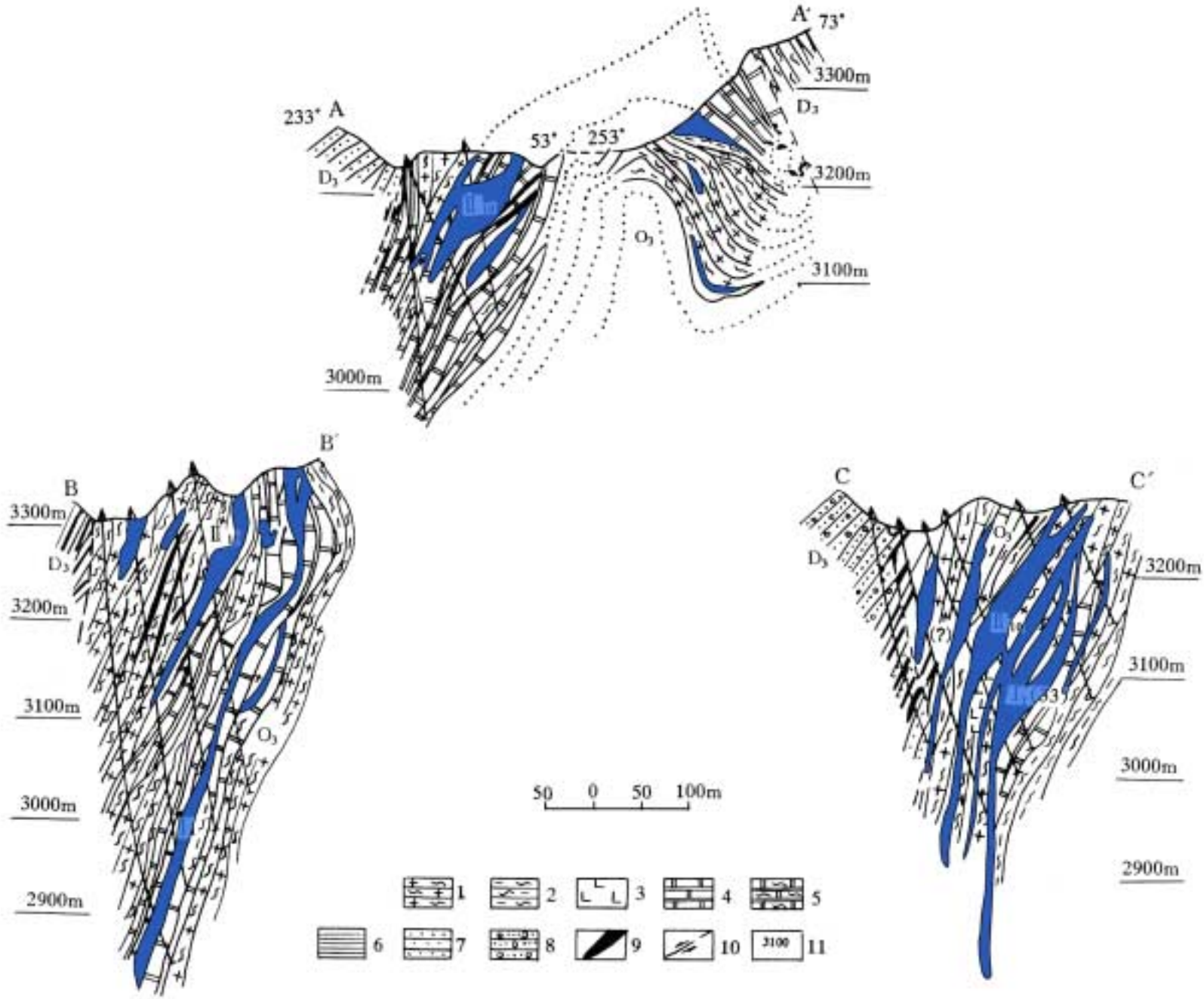
Pb 3.7%

Zn 7.2%

2002 Discovery at depth

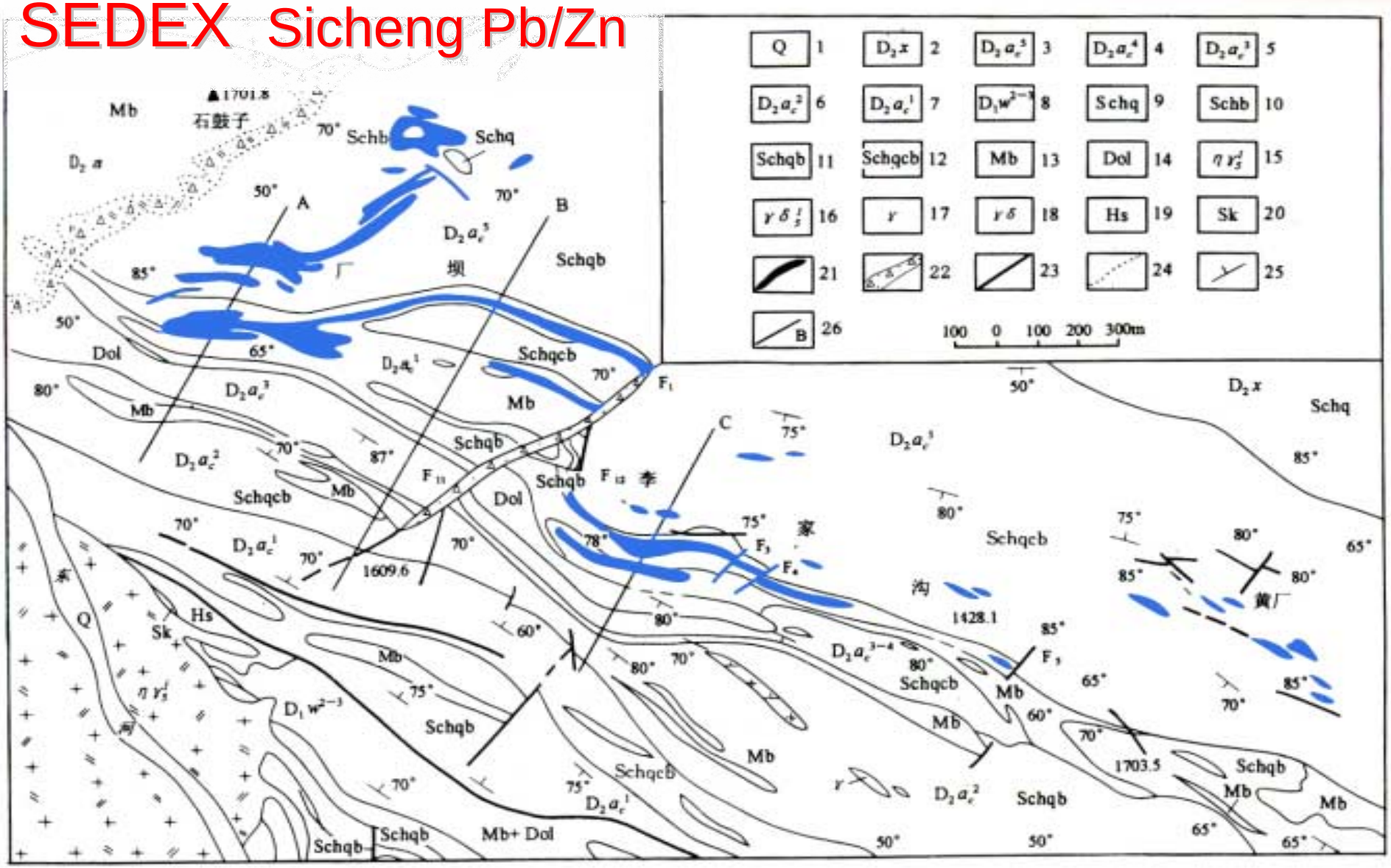
Reserve 20mt (ore)

Pb+Zn >10%


A
A′
233°
73°
53°
253°
3300m
3200m
3100m
3000m
D₃
O₃
B
B′
3300m
3200m
3100m
3000m
2900m
D₃
O₃
C
C′
3200m
3100m
3000m
2900m
D₃
O₃
50 0 50 100m
1
2
3
4
5
6
7
8
9
10
3100
11


路！

SEDEX Sicheng Pb/Zn



Reserve 13,000,000t (metal)

Pb 1.31%; Zn 7.34%; Ag 29 g/t

Nickel

1. 3 major Ni mines: Jinchuan, Panshi and Karatonck; Jinchuan produces 30,000 t annually, 80% of the national total. China is in great demand of Ni and its products;
2. No laterite type Ni deposits in China.
3. Two types of Ni deposits should have great potential in China, both of which contain PGM.

Distribution of Ni mines in China

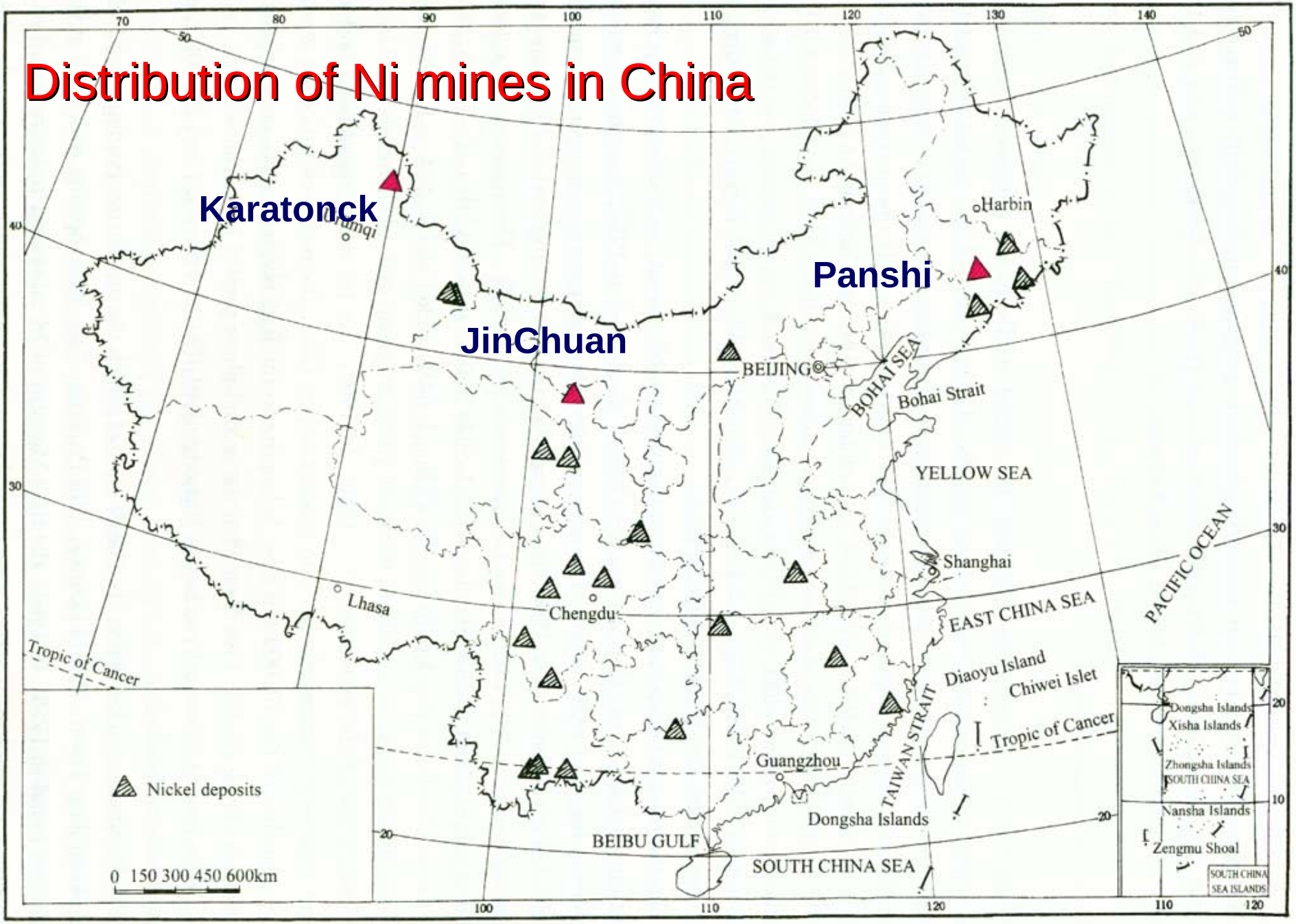
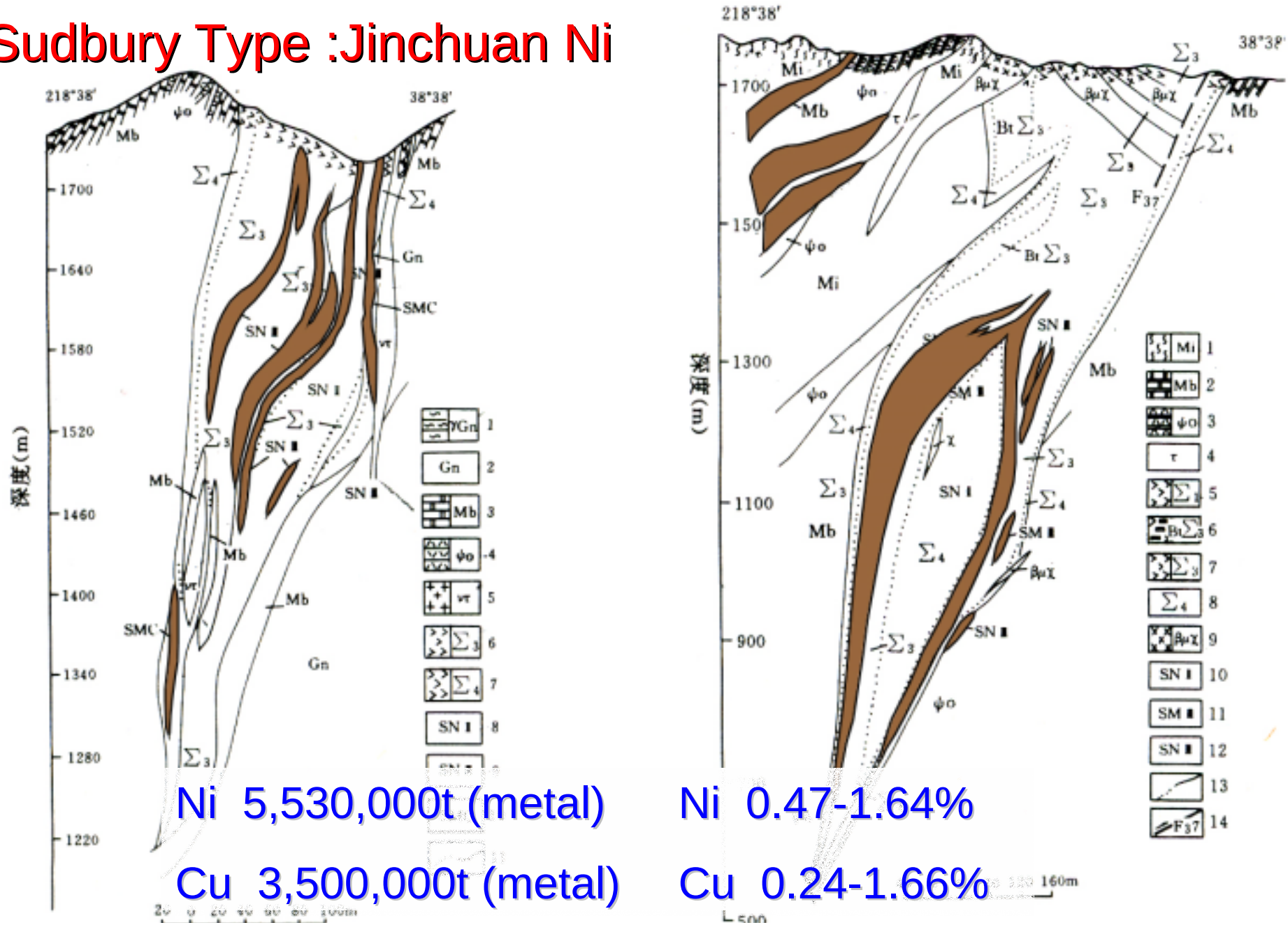


Fig.8

Sudbury Type :Jinchuan Ni



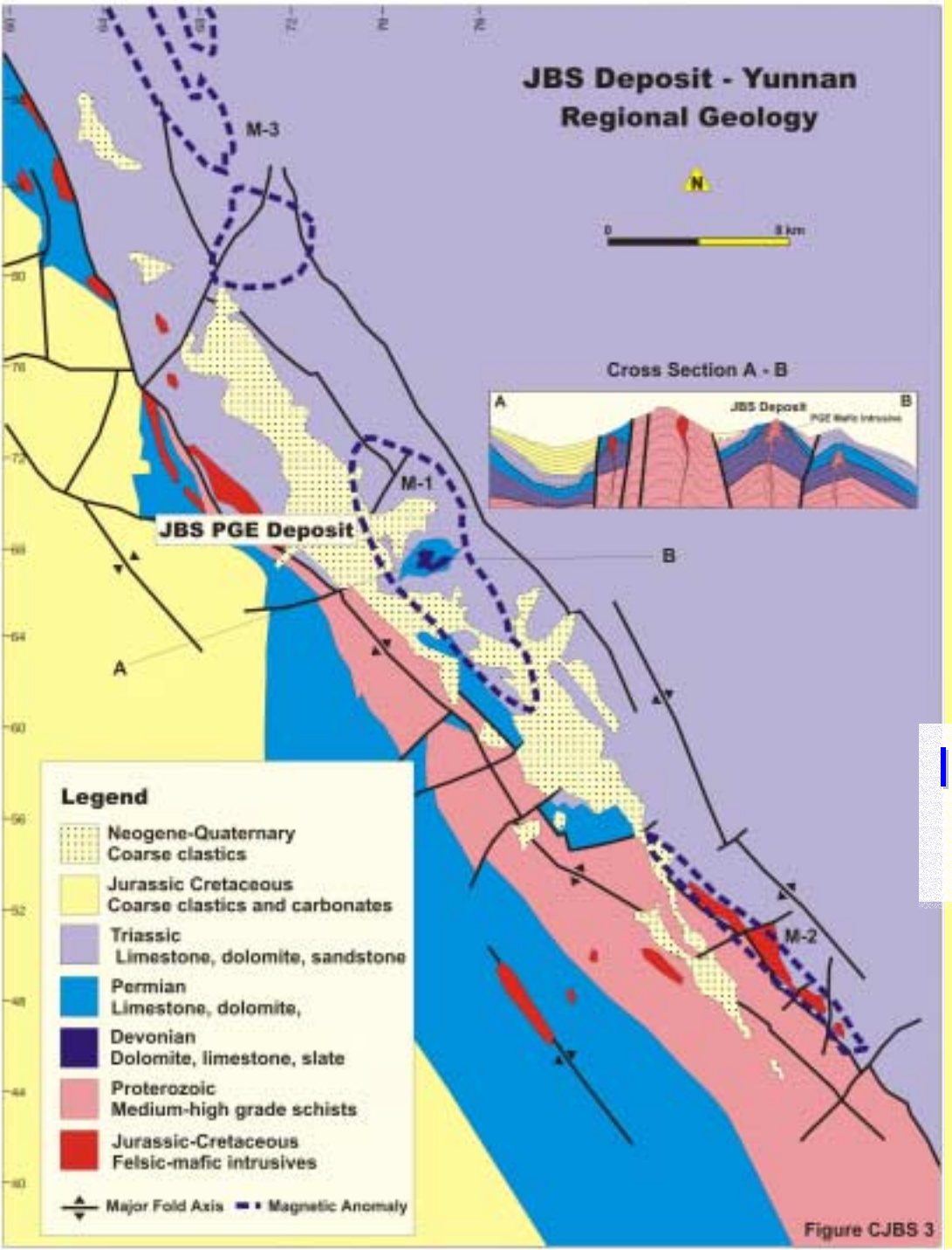
Ni 5,530,000t (metal) Ni 0.47-1.64%

Cu 3,500,000t (metal) Cu 0.24-1.66%

Fig.9 Geological Map of Jinchuan Ni

Noril’sk type

- Emeishan Basalt
- Continental flood basalt
- Potential Ni Type in China



JBS-PEM Deposit:The largest independent PEM deposit

Indicated Resource 9.4mt

1.67 g/t(Pt+Pd)

Gold

1. annual gold production around 160 – 180 tonnes;
2. a total of some 2,070 gold mines: 1,916 bedrock and 154 placer;
3. largest gold mine: Zijinshan, 150,000 ounces per year;
4. generally shallow explored and mining depth, about 350–600 m below surface;
5. many low-grade and refractory deposits potentially economic.

Distribution of gold mines in China

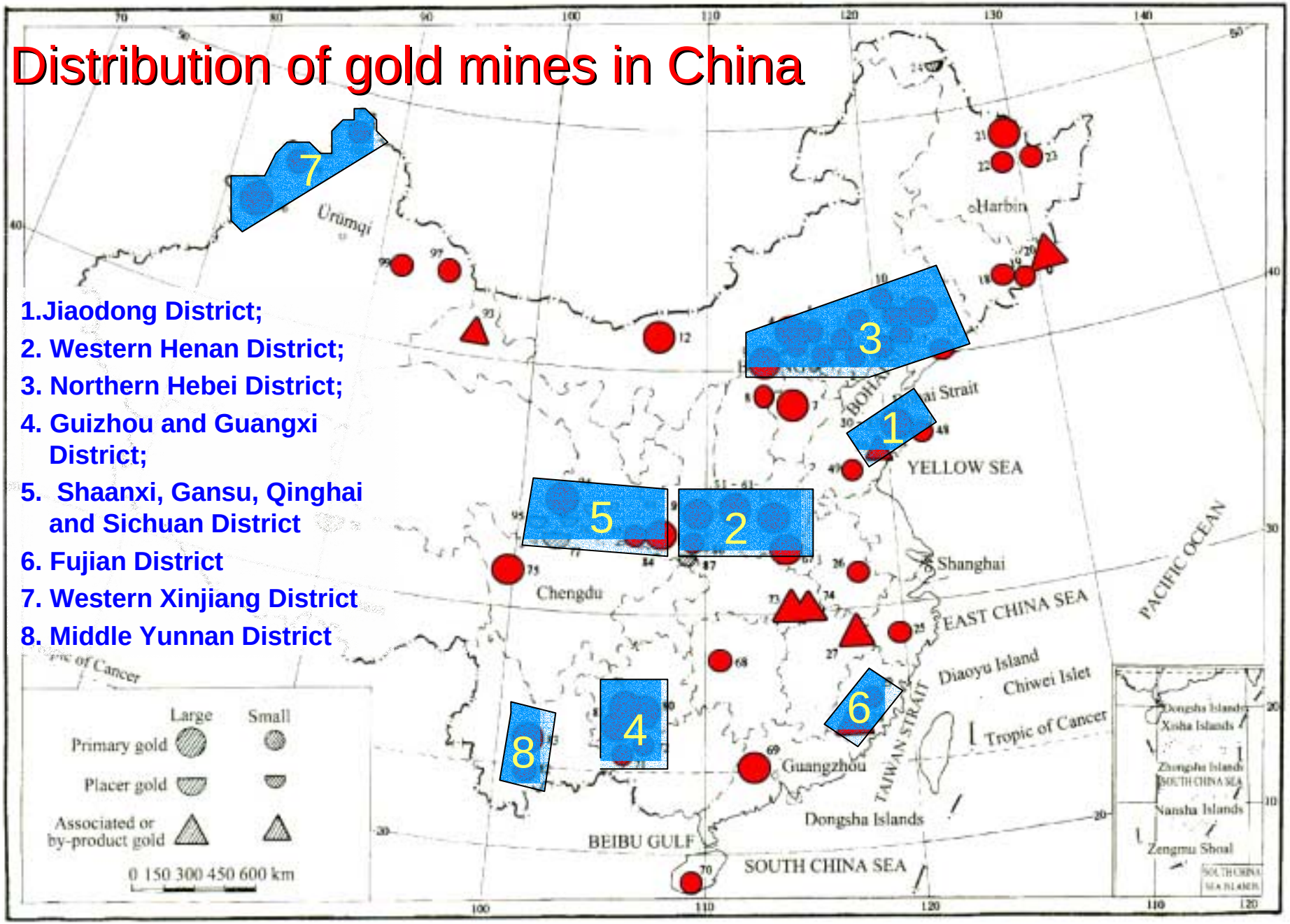
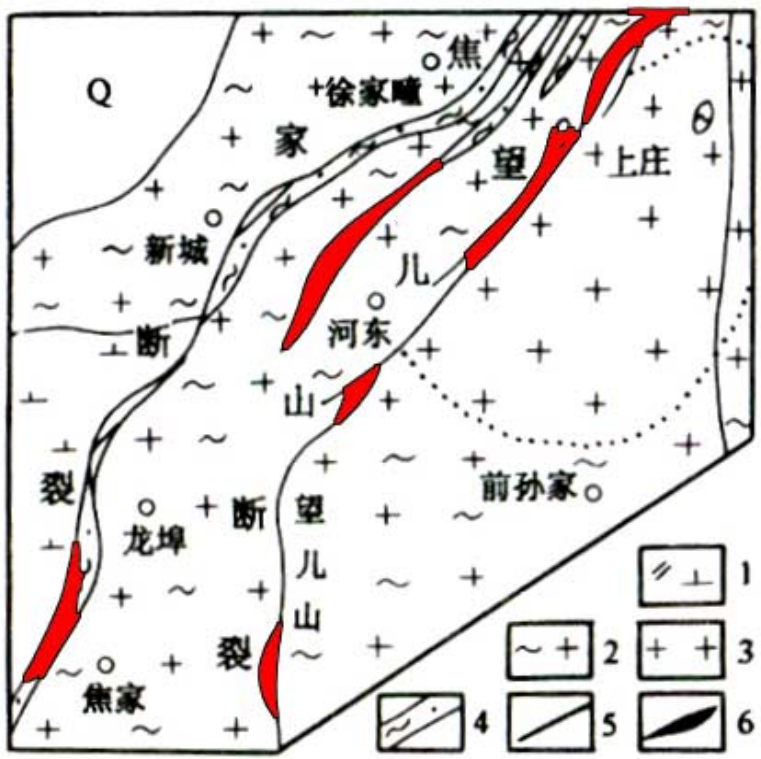
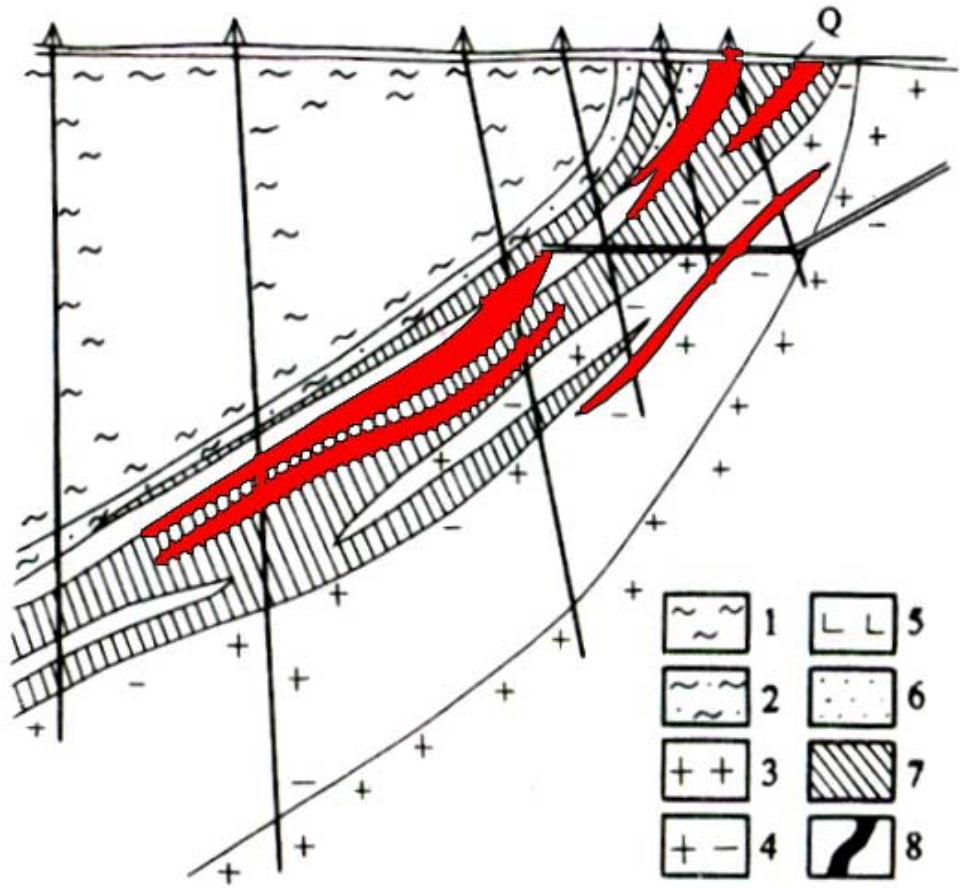


Fig.10





Altered Shear Zone Type: Jiaojia Deposit

Reserve • 2,000,000 oz, Au 3.07-52.59 g/t

Fig.11 Geological Map of Jiaojia Au

Atered Shear Zone Type: Gaojiapuzi Deposit

Basic Reserve 1,200,000 oz,

Indicated Reserve 3,000,000 oz

Au 8-10 g/t

Carlin Type: Caodi Deposit

Indicated Resource • 1,000,000 oz,

Au 3-6 g/t

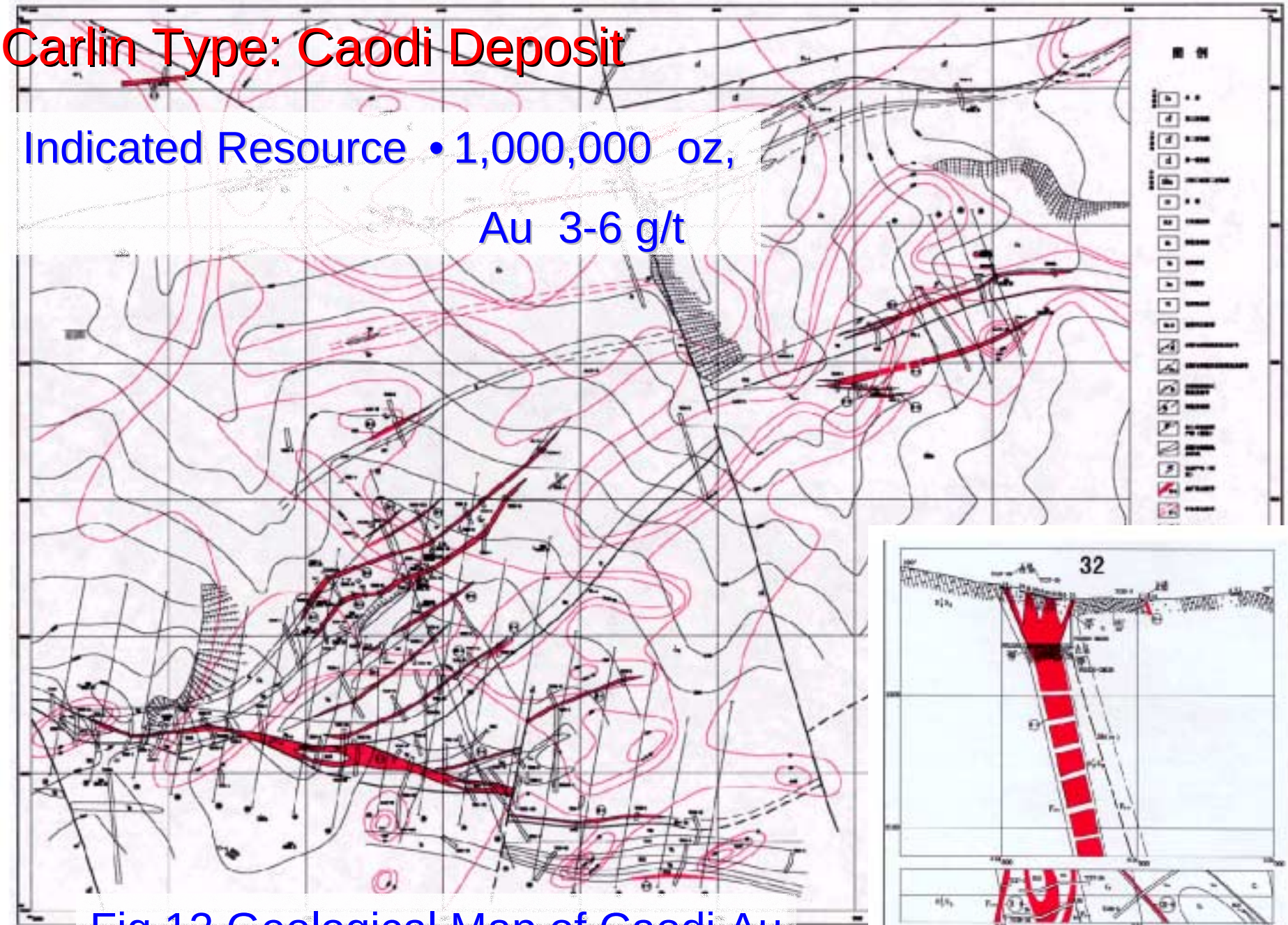
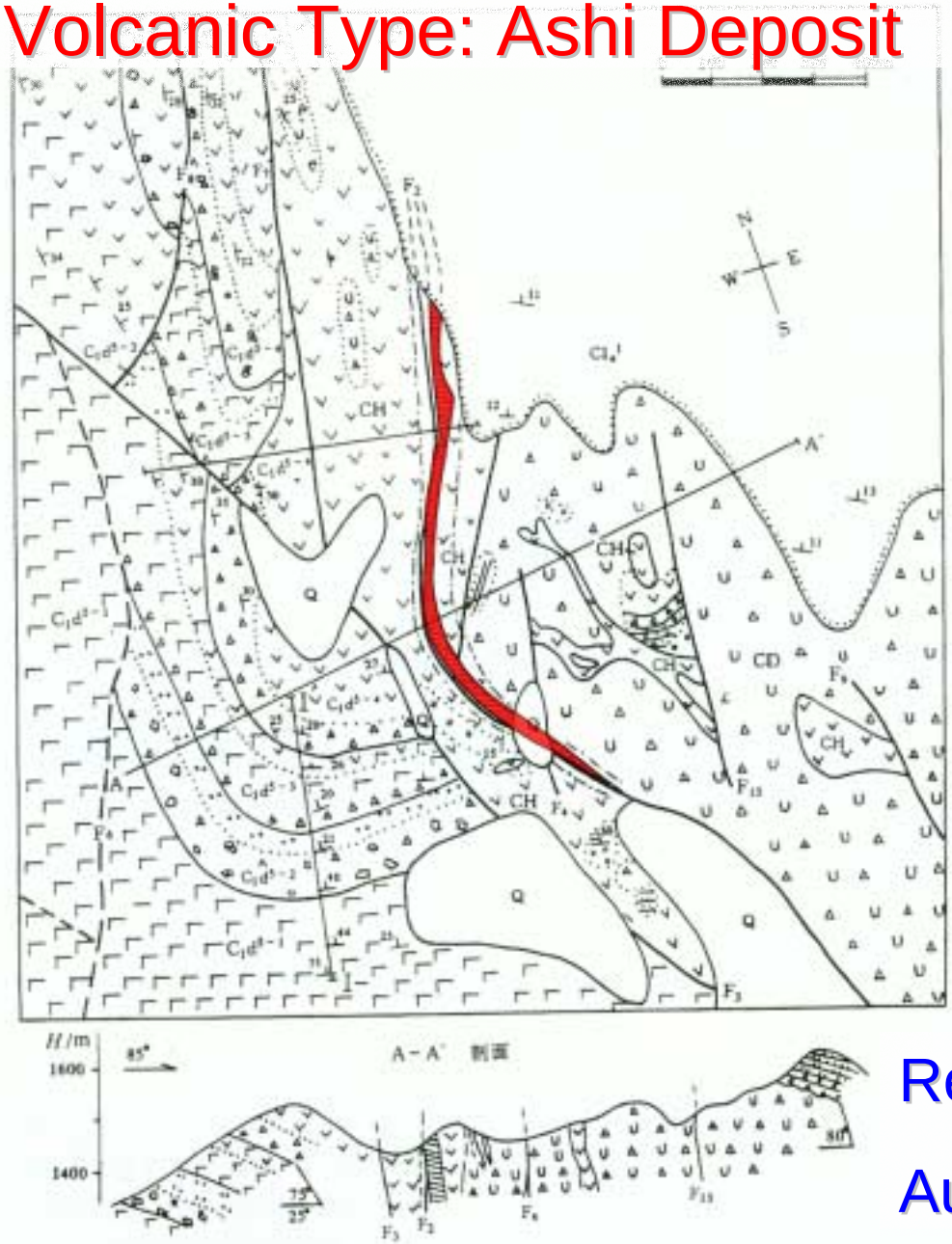
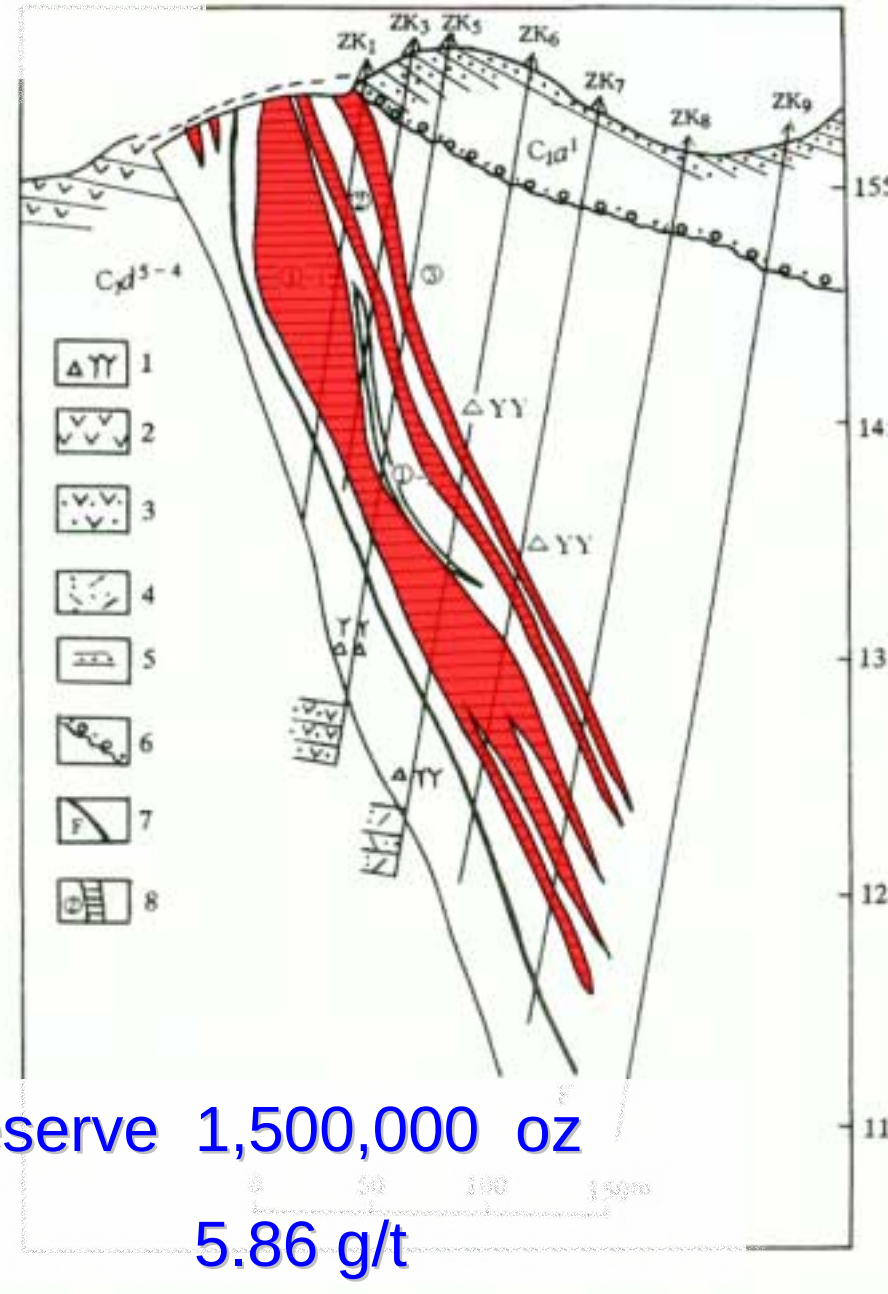


Fig.12 Geological Map of Caodi Au

Volcanic Type: Ashi Deposit

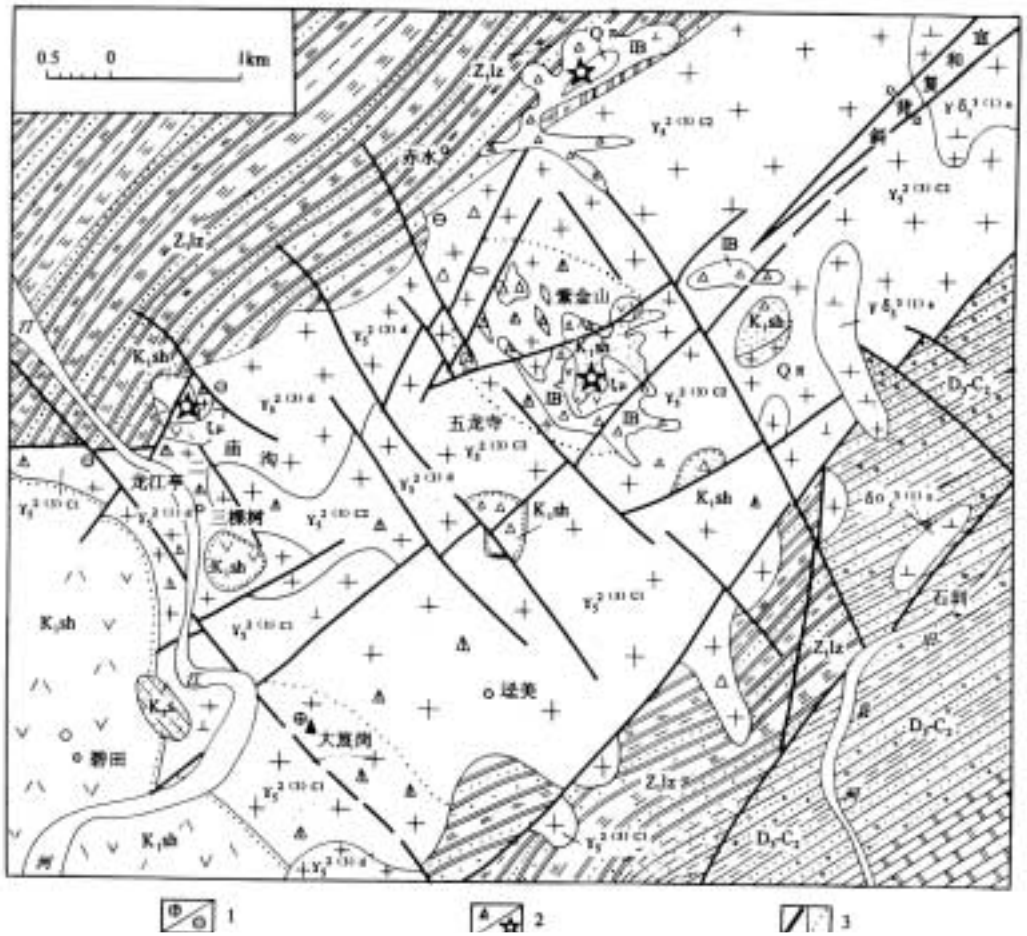


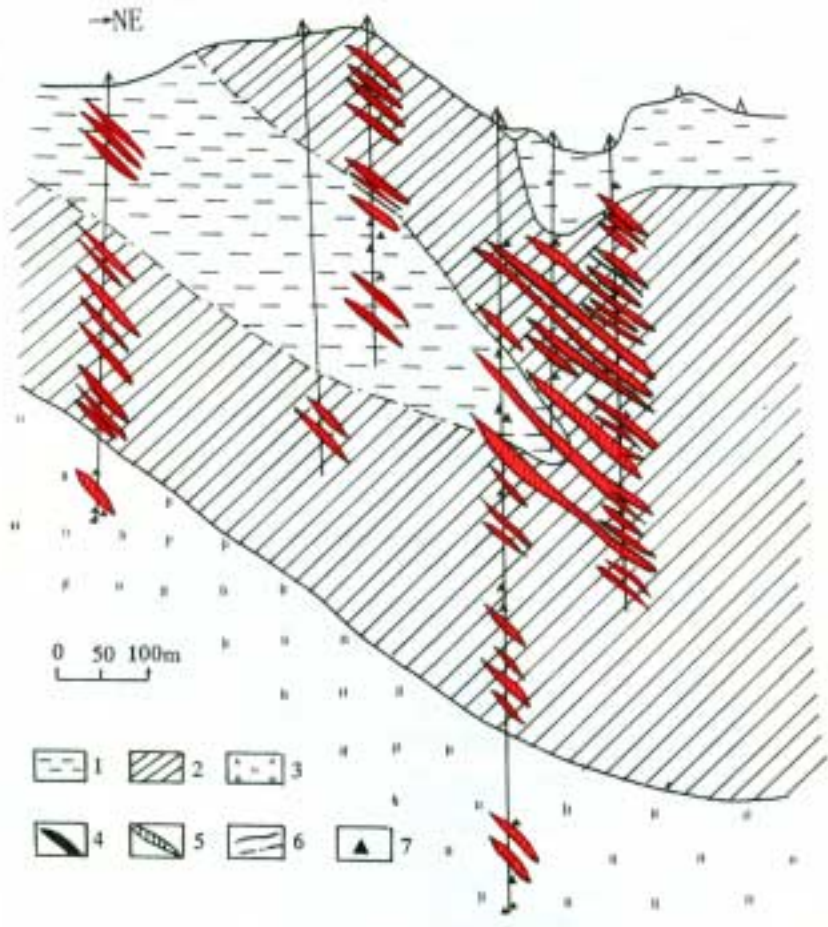


Reserve 1,500,000 oz

Au 5.86 g/t

Fig.13 Geological Map of Ashi Au





Volcanic Type: Zijinshan Deposit

Reserve 3,000,000 oz, Au 2 g/t

Fig.14 Geological Map of Zijinshan Au

Ag Distribution of silver deposits

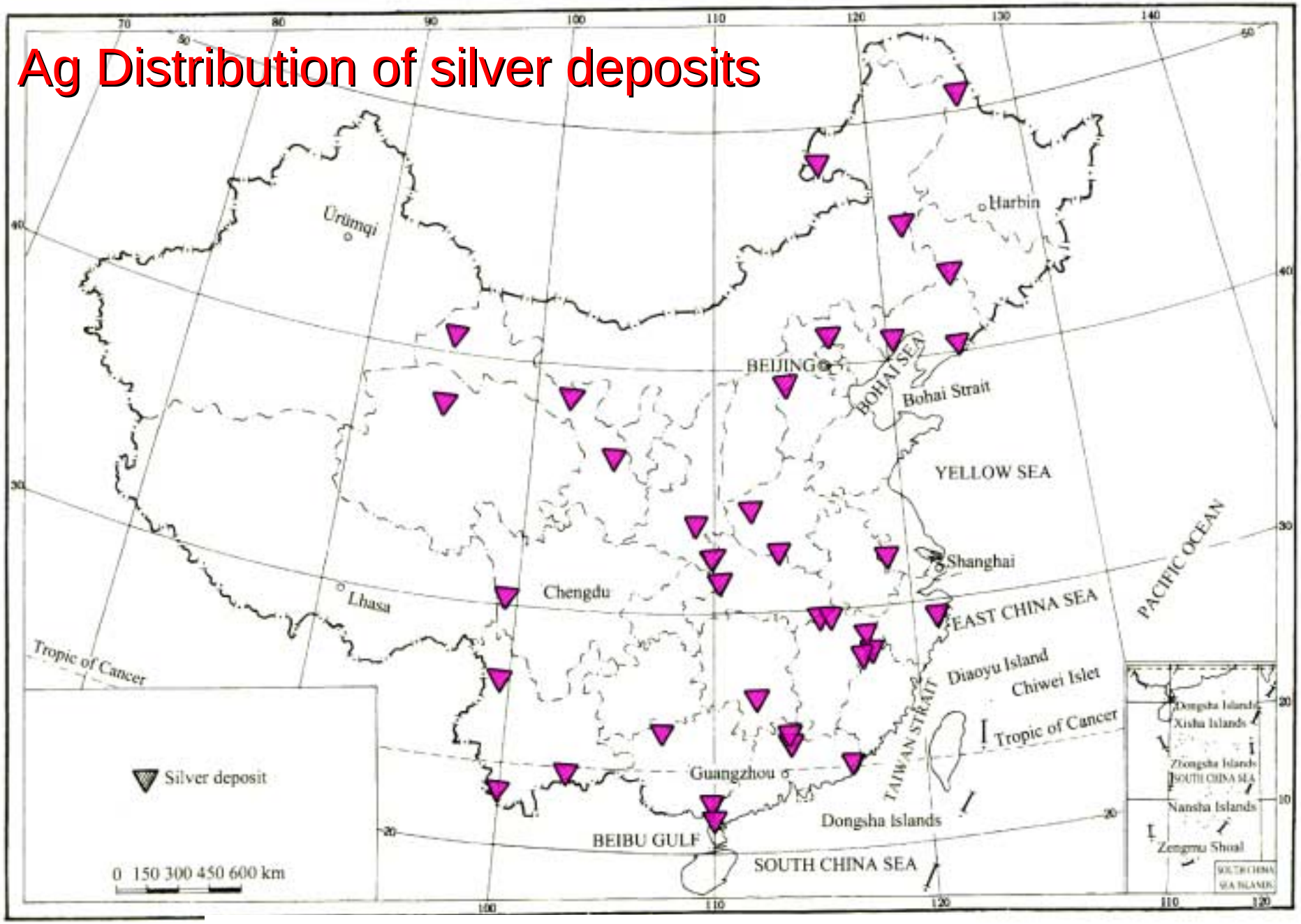


Fig.15

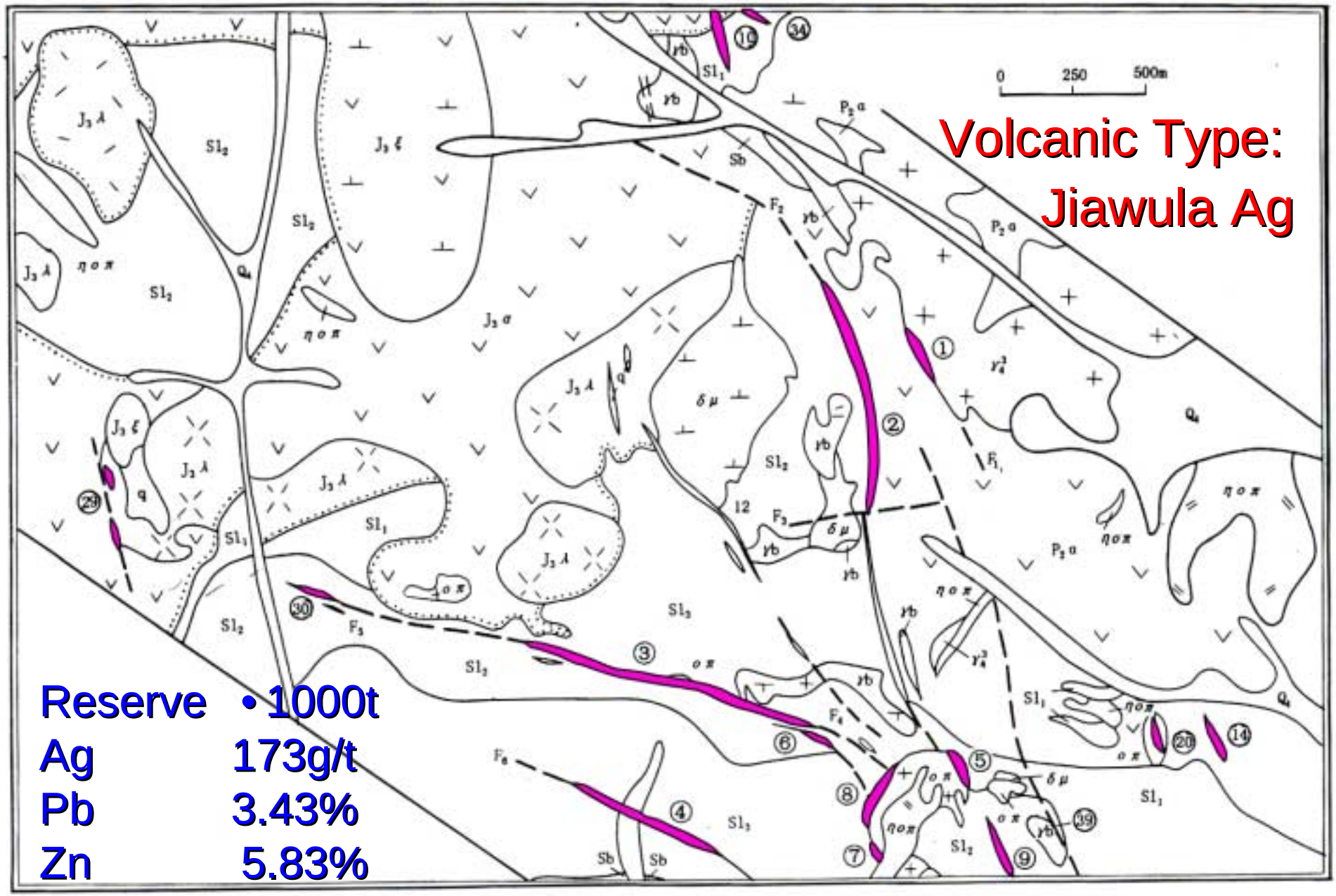


Fig.16 Geological Map of Jiawula Ag

Cu

- High cost copper production: average cost $2,074 - 2,385 US per tonne;
- only about 1/4 copper mines below the world average production cost;
- a large number of copper mines close to the end of mine life.

Distribution of Copper deposits

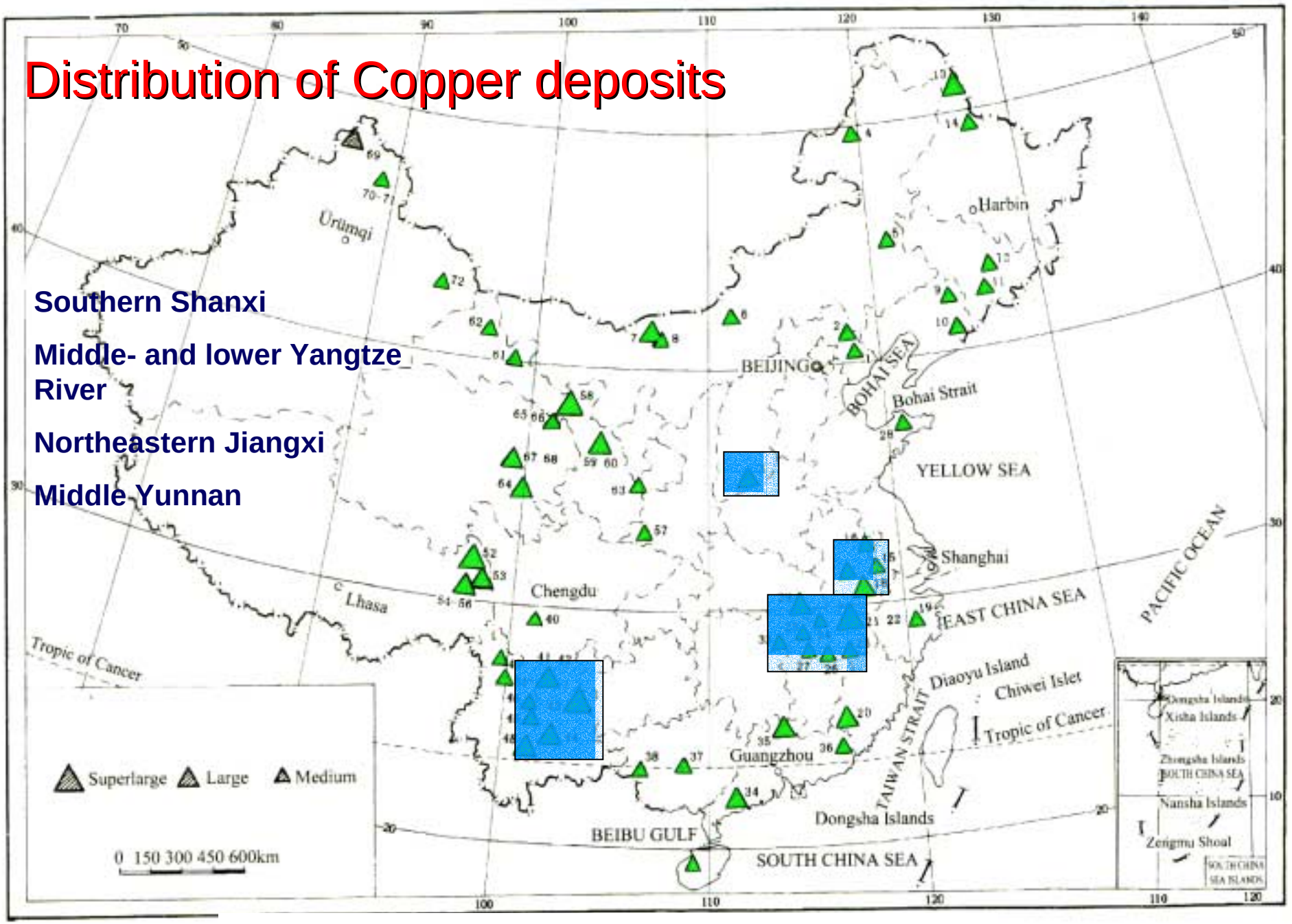
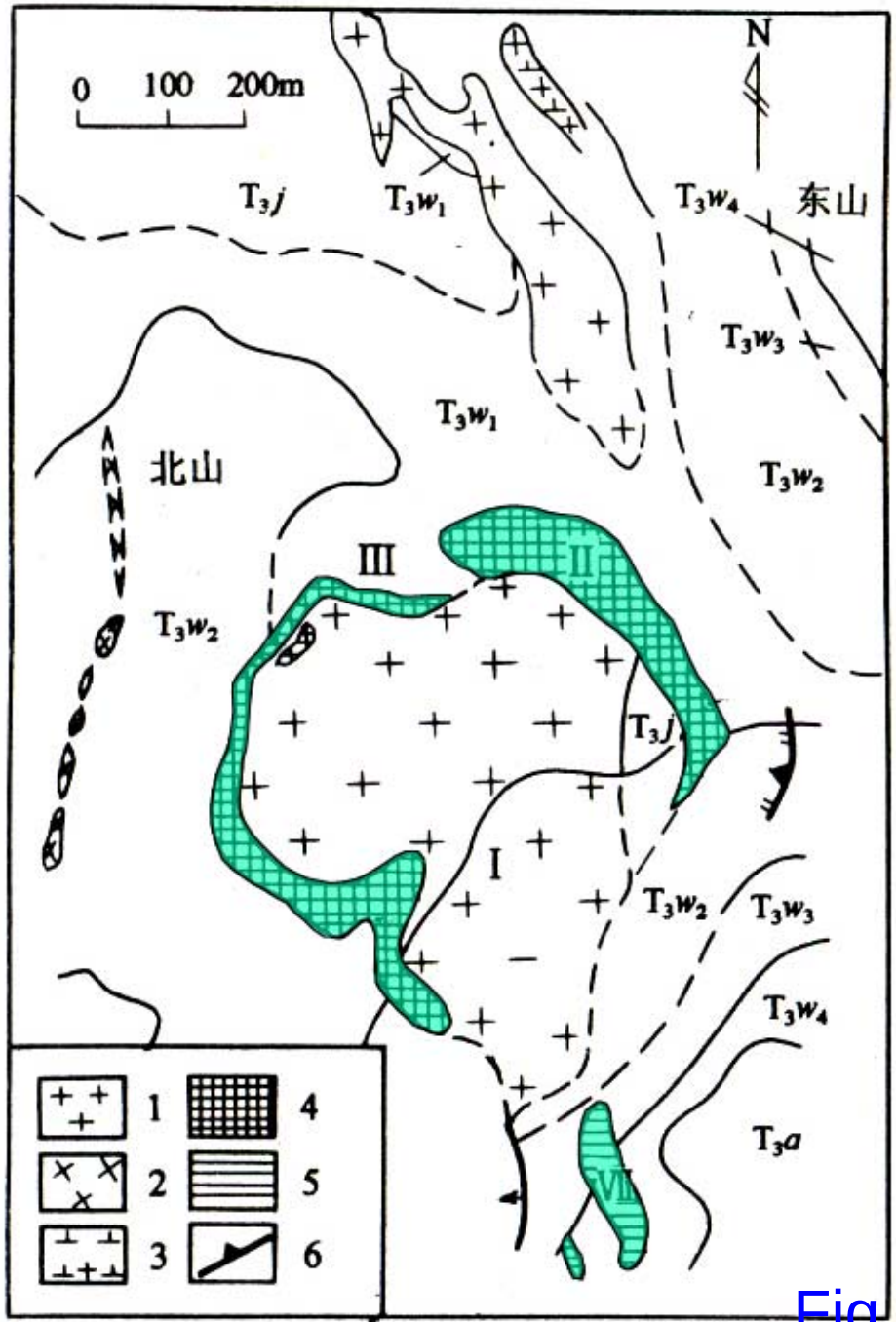


Fig.19

Porphyry Type:
Yulong deposit



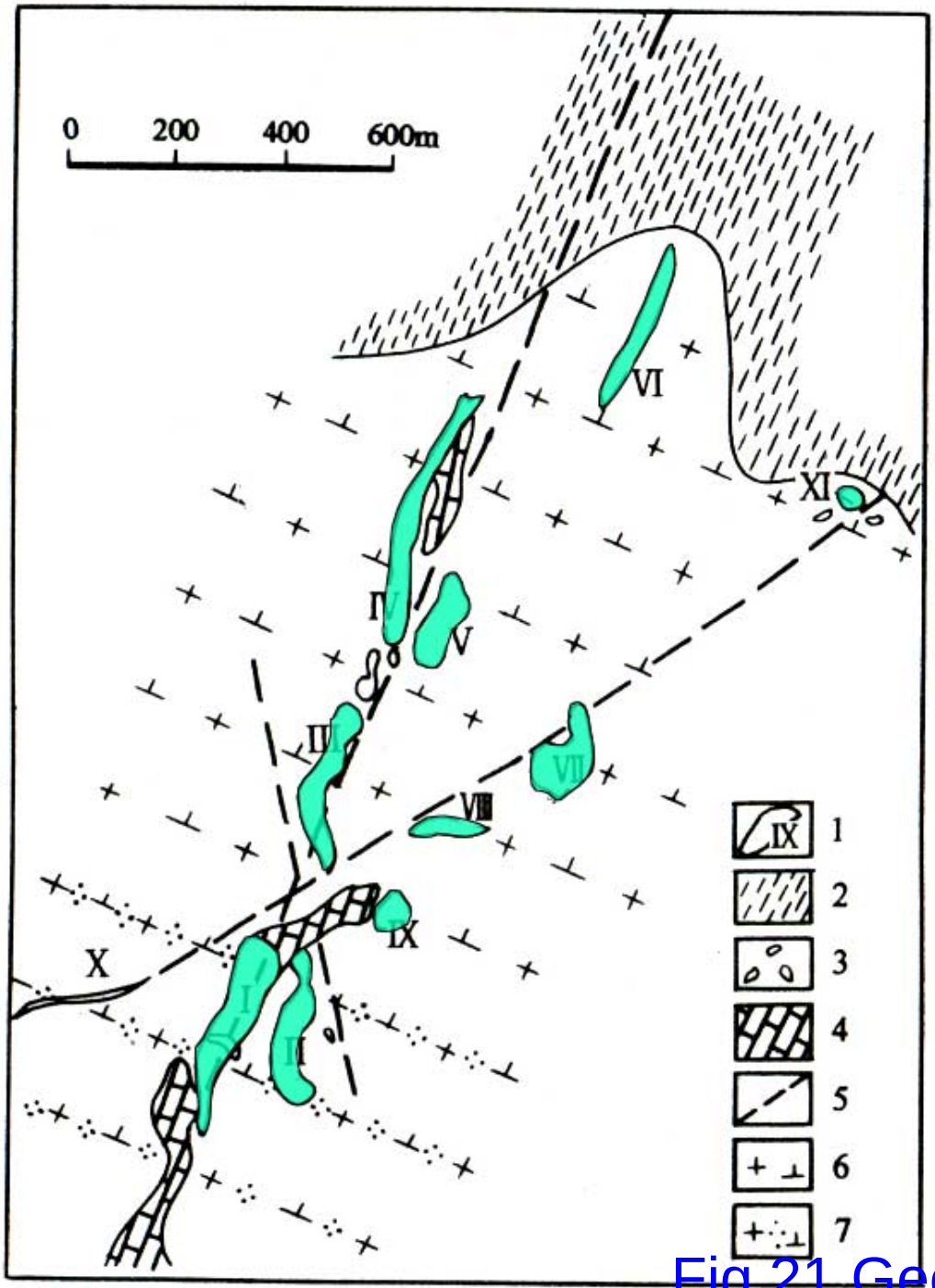
Reserve Cu 6,620,000t (metal)

Cu 0.94%

Mo 0.028%

Fig.20 Geological Map of Yulong Cu

Skarn Type:
Tonglushan Deposit



Reserve

Cu 1,110,000t (metal)

Cu 1.78%

Fig.21 Geological Map of Tonglushan Cu

Shale-hosted Type: Dongchuan Tangdian Cu

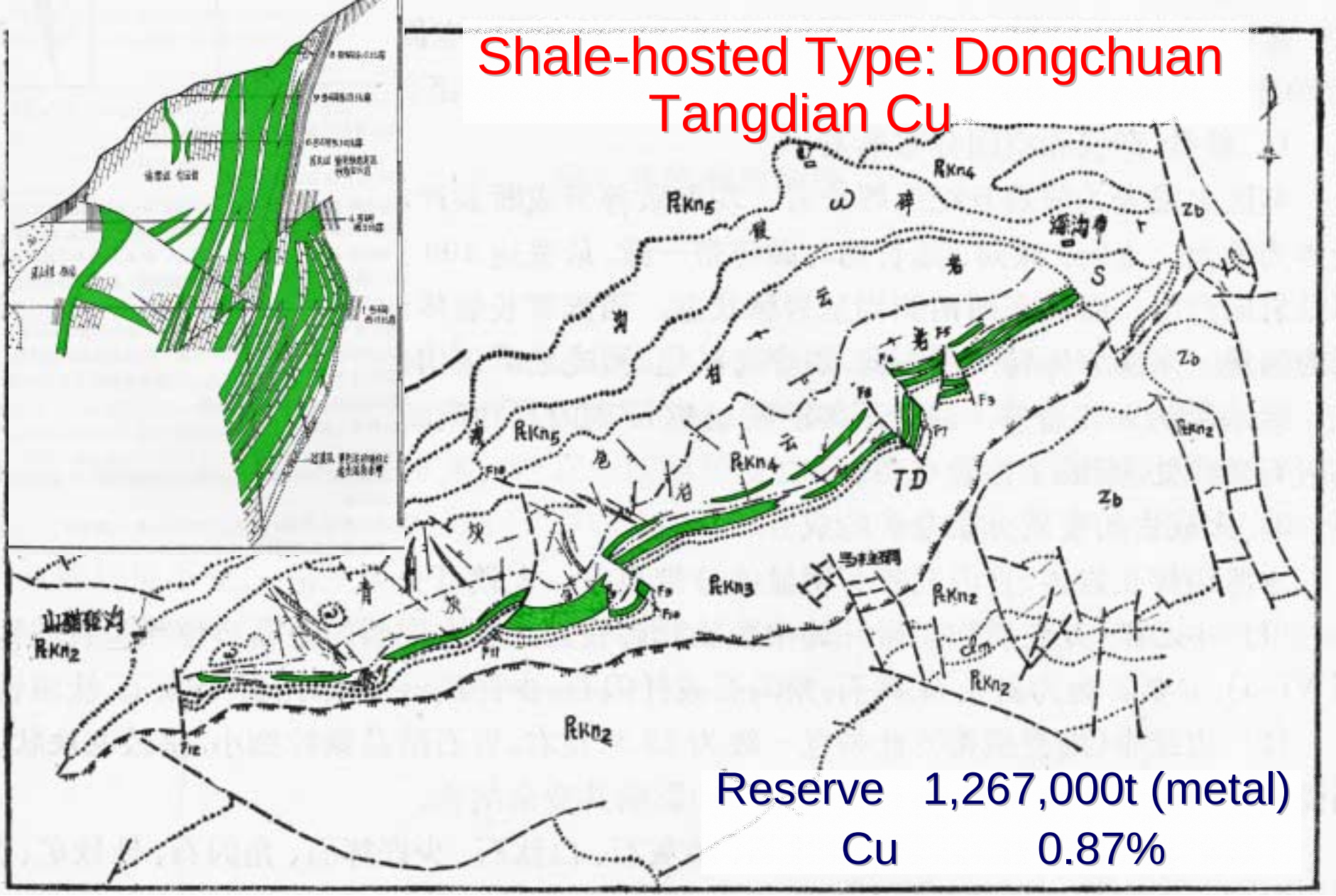
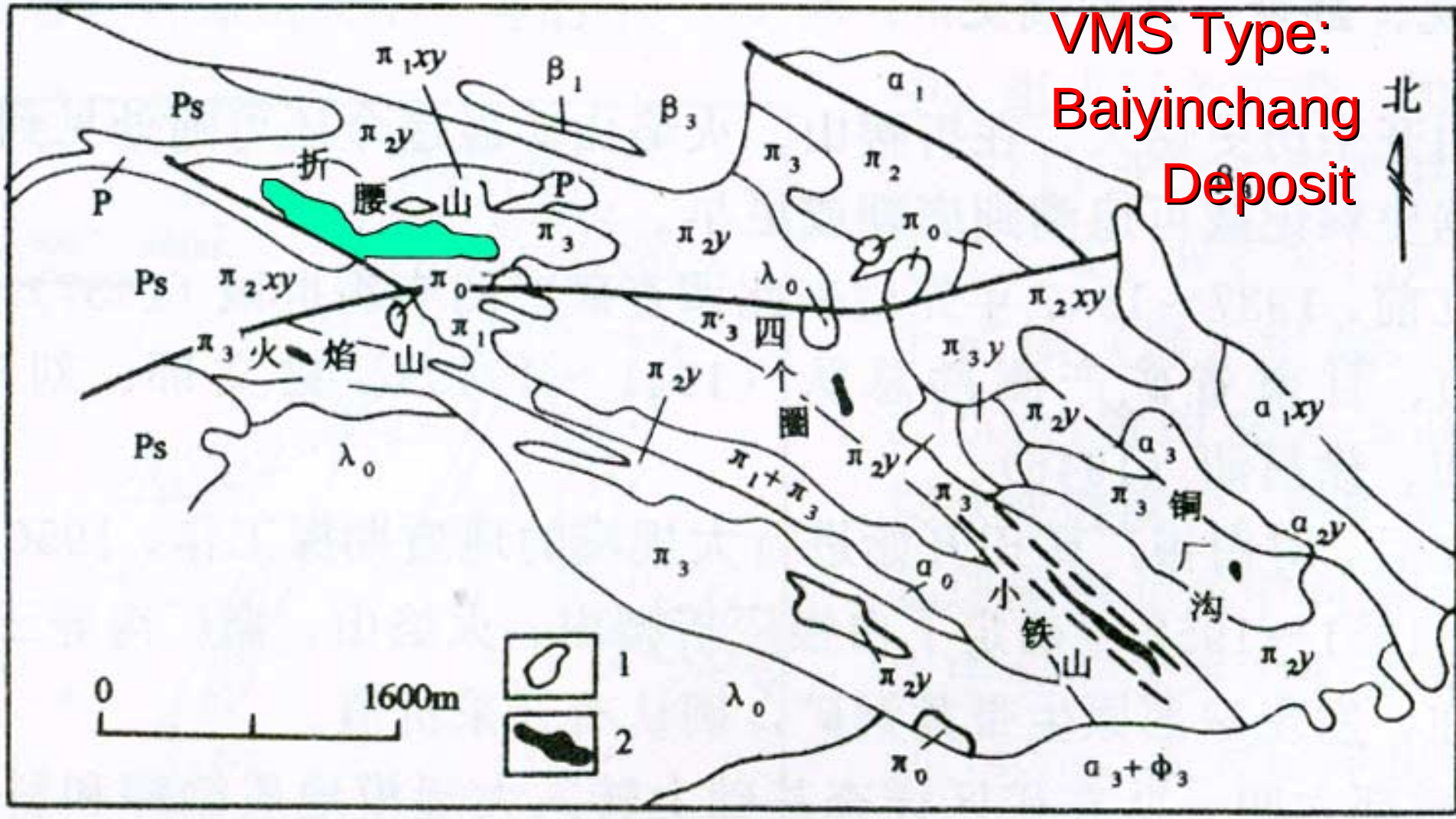


Fig.22 Geological Map of Dongchuan Cu

VMS Type: Baiyinchang Deposit



Cu	1,267,000t (metal)	Cu	1.17~2.84%
Pb	404,000t (metal)	Pb	0.84~3.39%
Zn	808,000t (metal)	Zn	2.10~5.34%

Fig.23 Geological Map of Baiyinchang Cu

Native Copper Type:Chaotong deposit

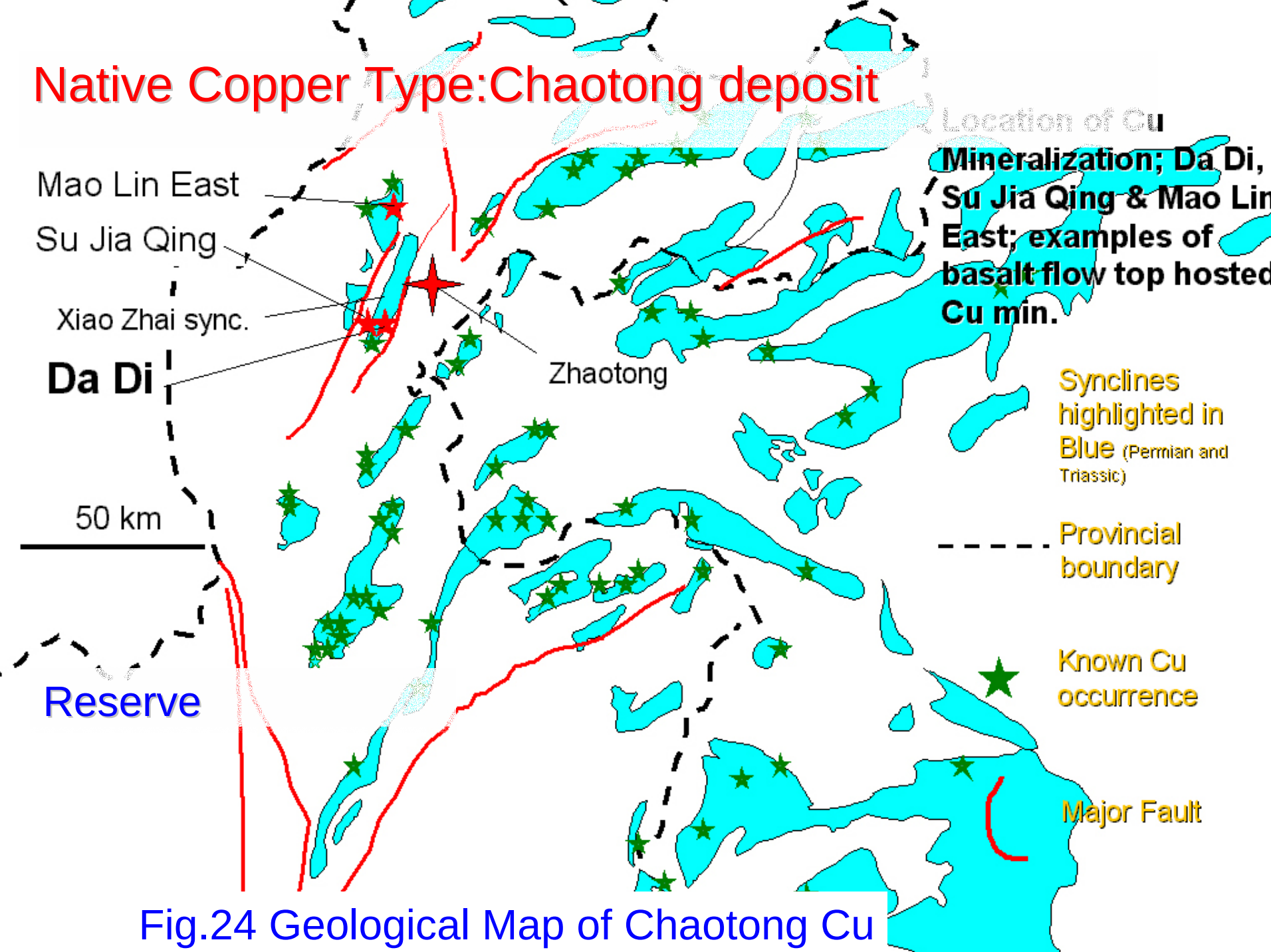
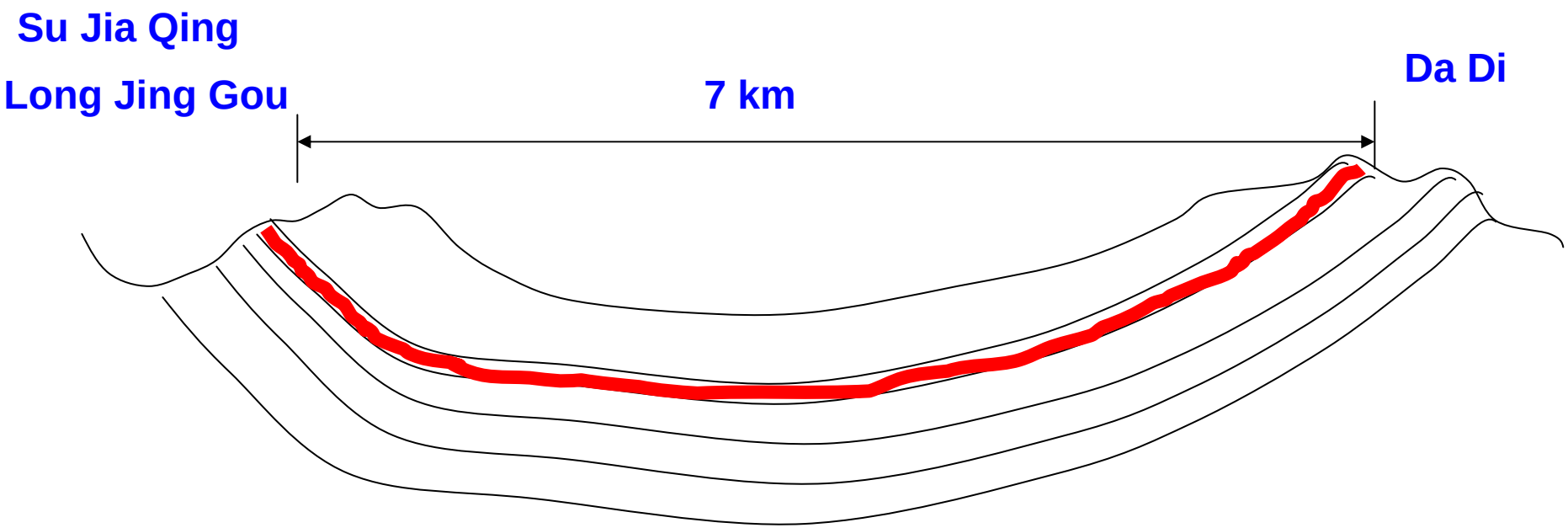


Fig.24 Geological Map of Chaotong Cu



Schematic Section of Xiao-Zhai Syncline


0 1 2 3 4 cm

Tin and Tungsten

- Possess great competitive advantages in the word;
- Often associated with other base metals.

Distribution of Tungsten and Tin deposits

W

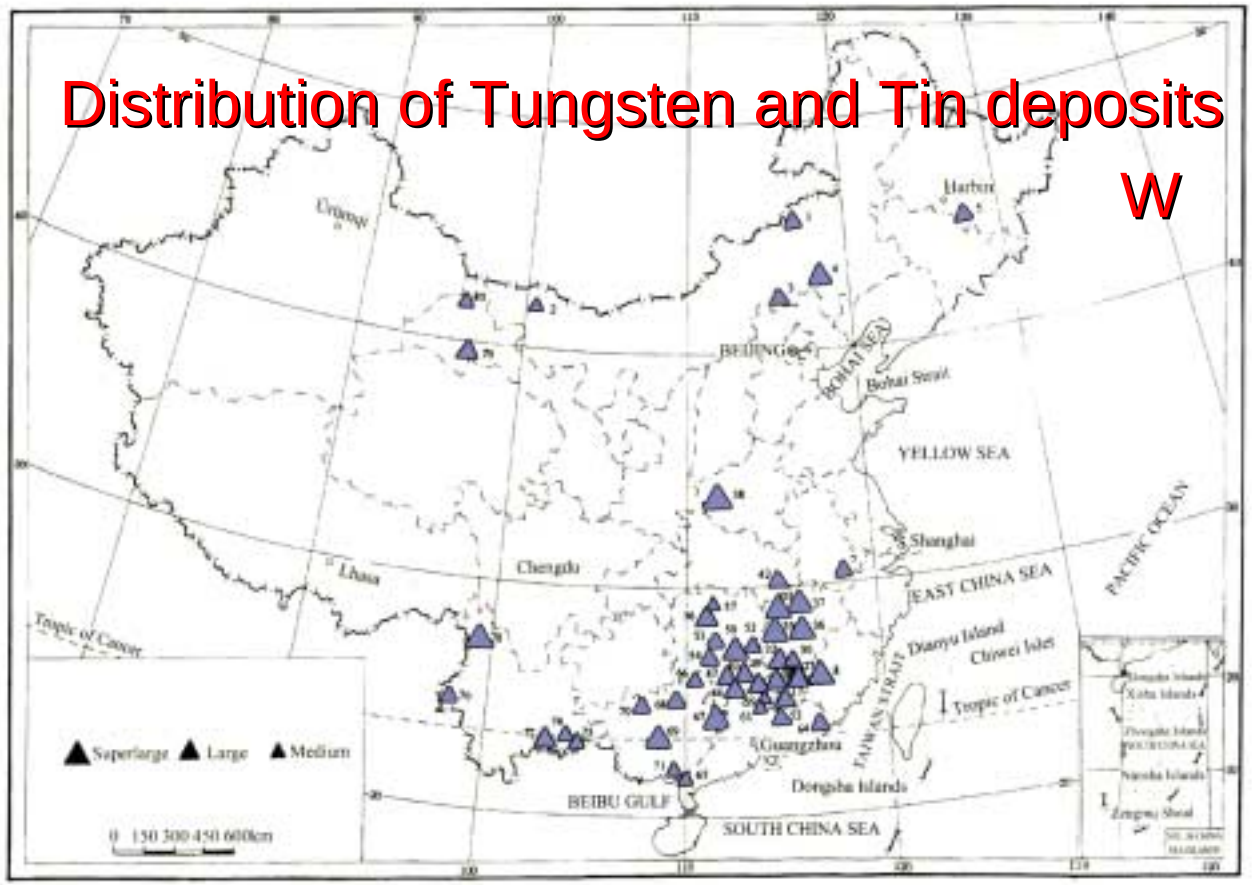
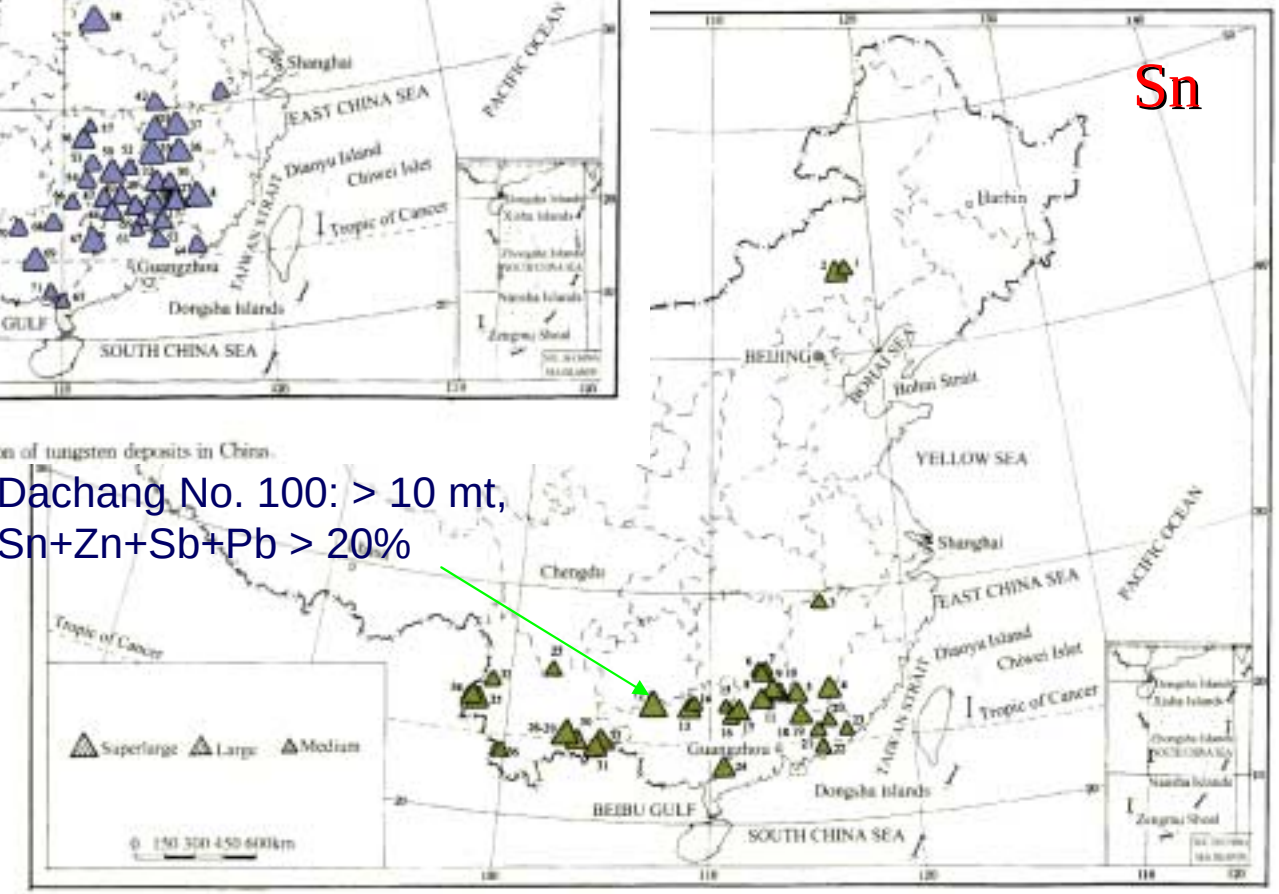


Fig. 3.12.1 Map of distribution of tungsten deposits in China

Sn

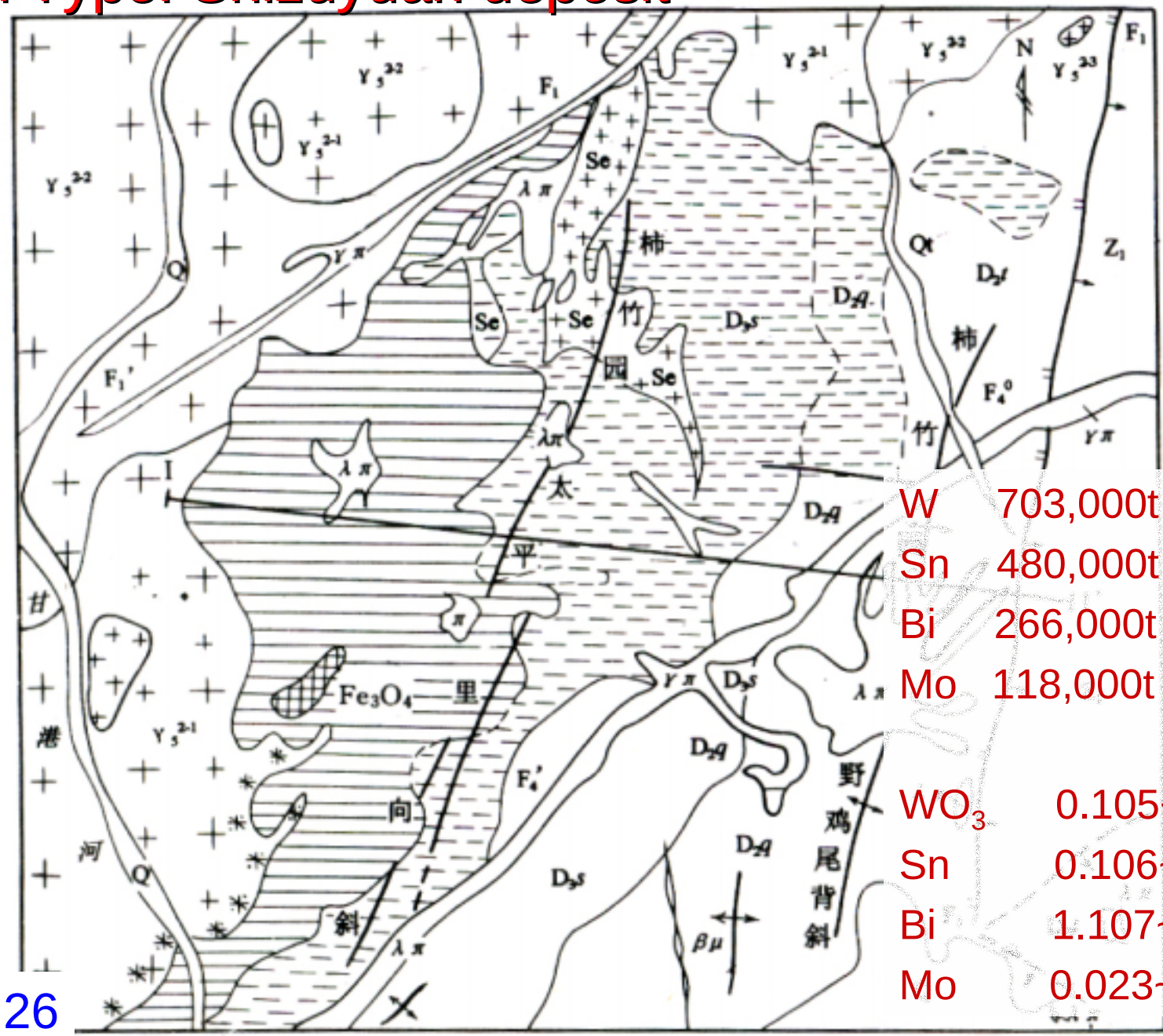


Dachang No. 100: > 10 mt,
Sn+Zn+Sb+Pb > 20%

Fig. 3.13.1 Map of the distribution of tin deposits of China

Fig.25

Skarn Type: Shizuyuan deposit



W	703,000t (metal)
Sn	480,000t (metal)
Bi	266,000t (metal)
Mo	118,000t (metal)

WO_3	0.105~0.46%
Sn	0.106~0.165%
Bi	1.107~1.48%
Mo	0.023~0.109%

Fig.26

Al

- bauxite ores mainly composed of diaspore;
- high production cost of alumina ($173 US);
- mainly sedimentary type deposits: thin and shallow-dipping orebodies.

Distribution of Bauxite Mines

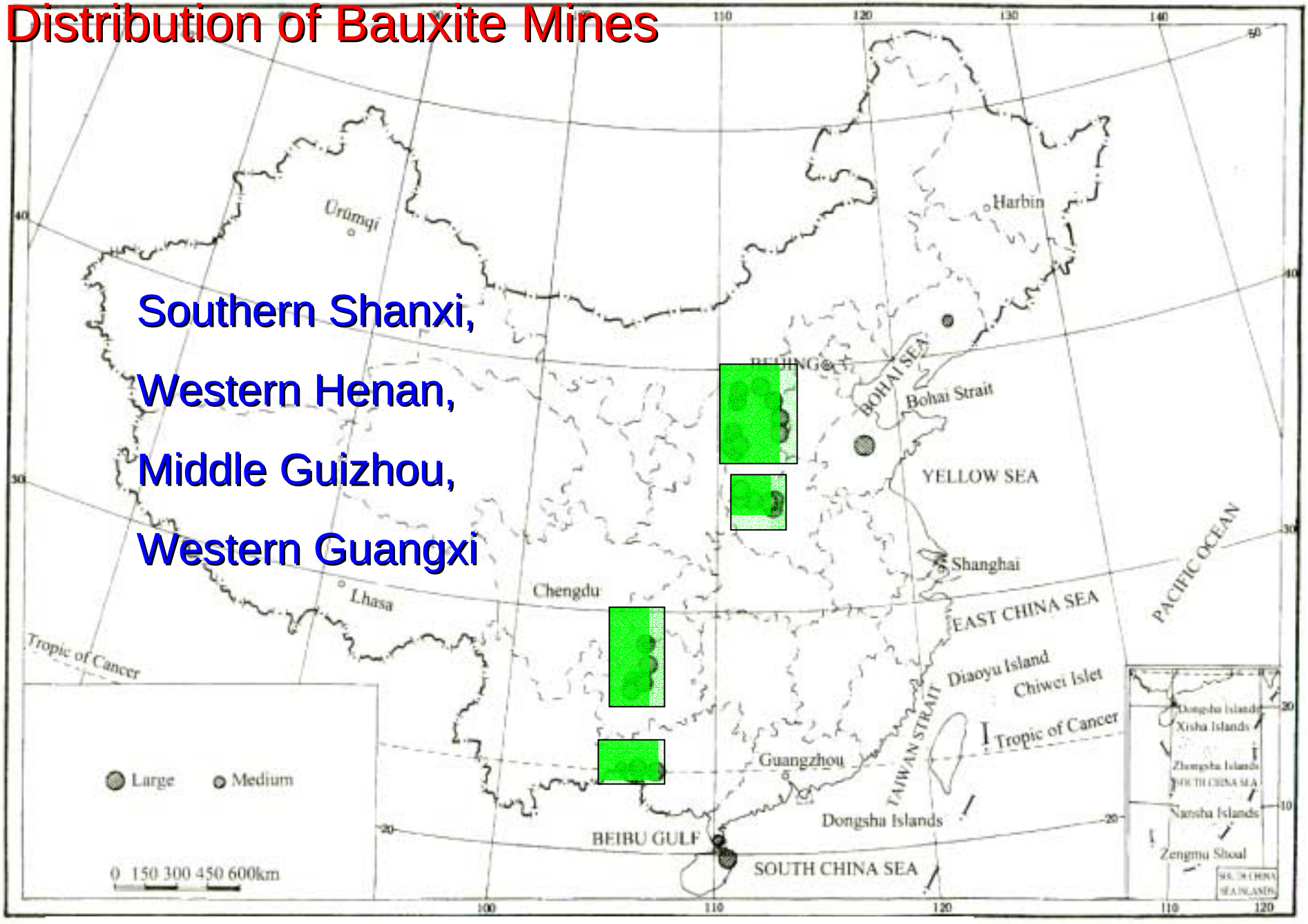


Fig.27

Eluvial Type: Pinguo Bauxite

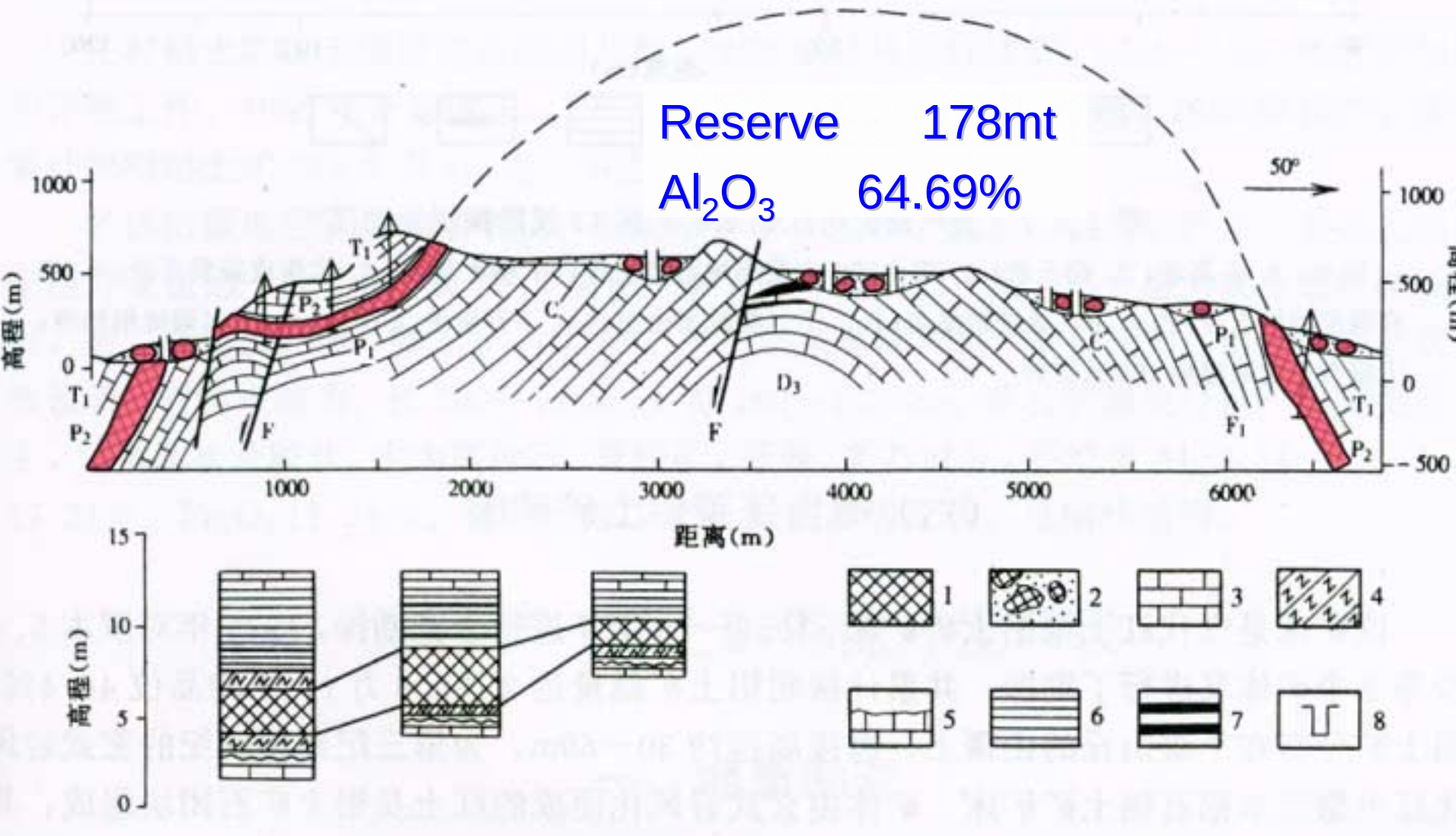


Fig.28 Geological Map of Pinguo Bauxite

Iron Ores

- all low-grade: only 3.2% of the total production from ores with > 55% TFe%;
- many other associated elements, ore dressing required;
- 90 million tonnes of iron ores were imported in 2002.

Distribution of Iron deposits in China

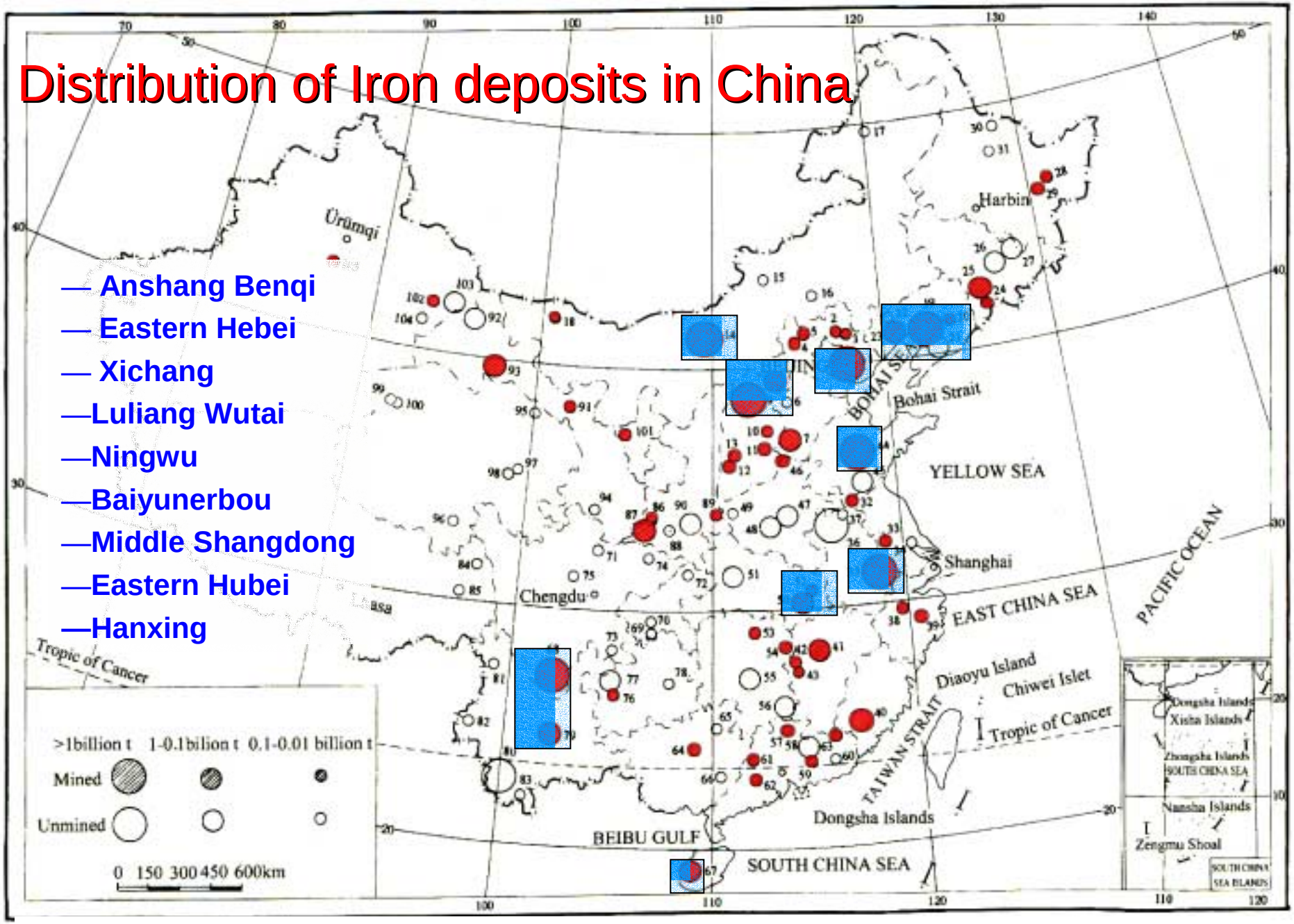
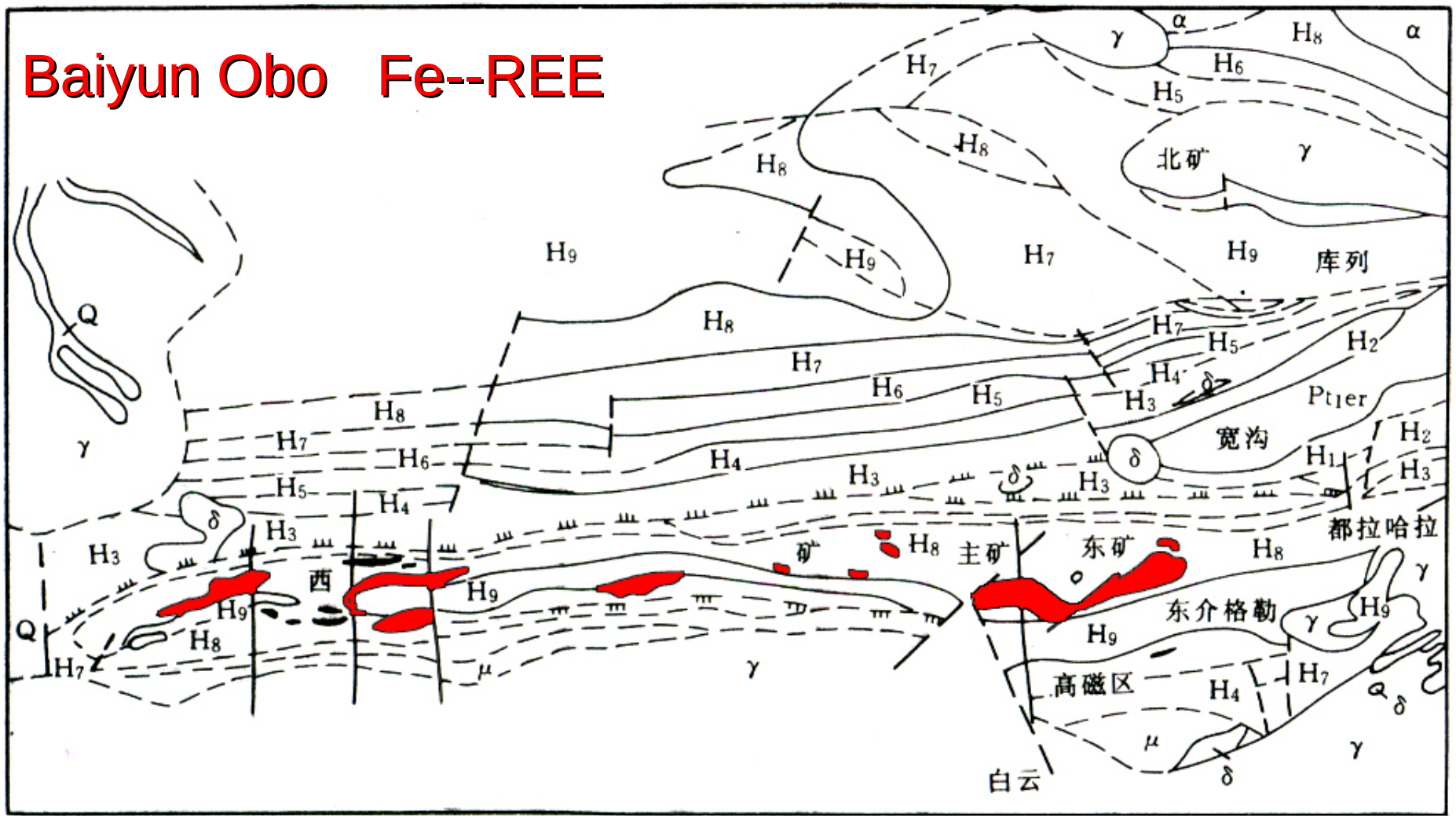


Fig.17

Main Types of Iron Deposits

- Sedimento-metamorphic type
- Skarn type
- Titanomagnetite deposits
- Baiyan Obo type

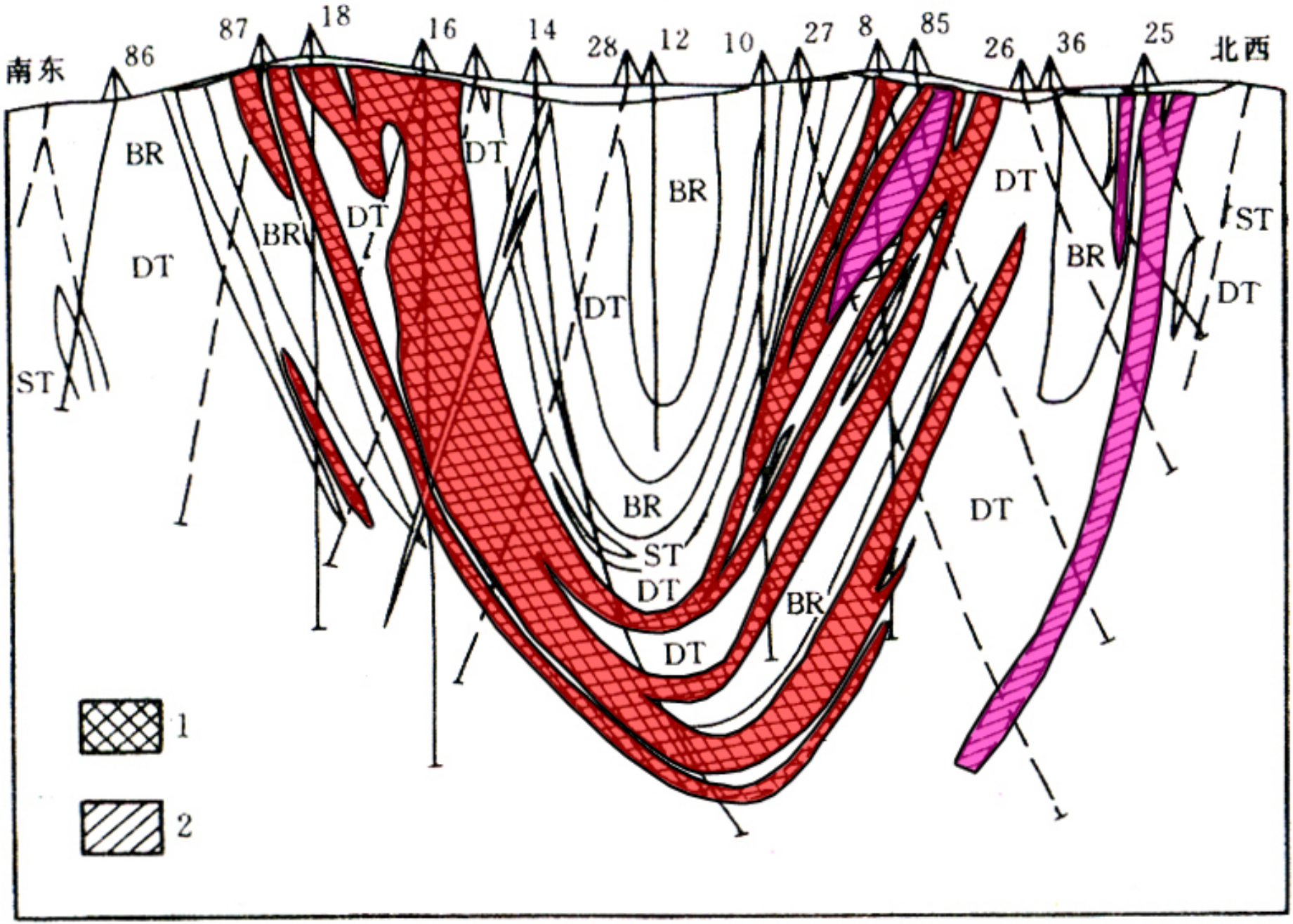
Baiyun Obo Fe--REE



Reserve Fe 1,467mt 33~35%

REE 86mt RE_2O_3 RE_2O_3 3~6%

Fig.18


南东
北西
86
87
18
16
14
28
12
10
27
8
85
26
36
25
BR
DT
ST
1
2

Coal

1. Annual production: 1,045Mt, 3 % from open pit operation; 17 mines over 10 Mt per year;
2. Mainly used for heat/power generation; there is a relative shortage of coking coal;
3. The restriction on the mining of high-sulfur coal will cause a change in the distribution of Coal mining;
4. Shortage of coal in south China; imports from Australia, Indonesia and Vietnam

Distribution of coal mines

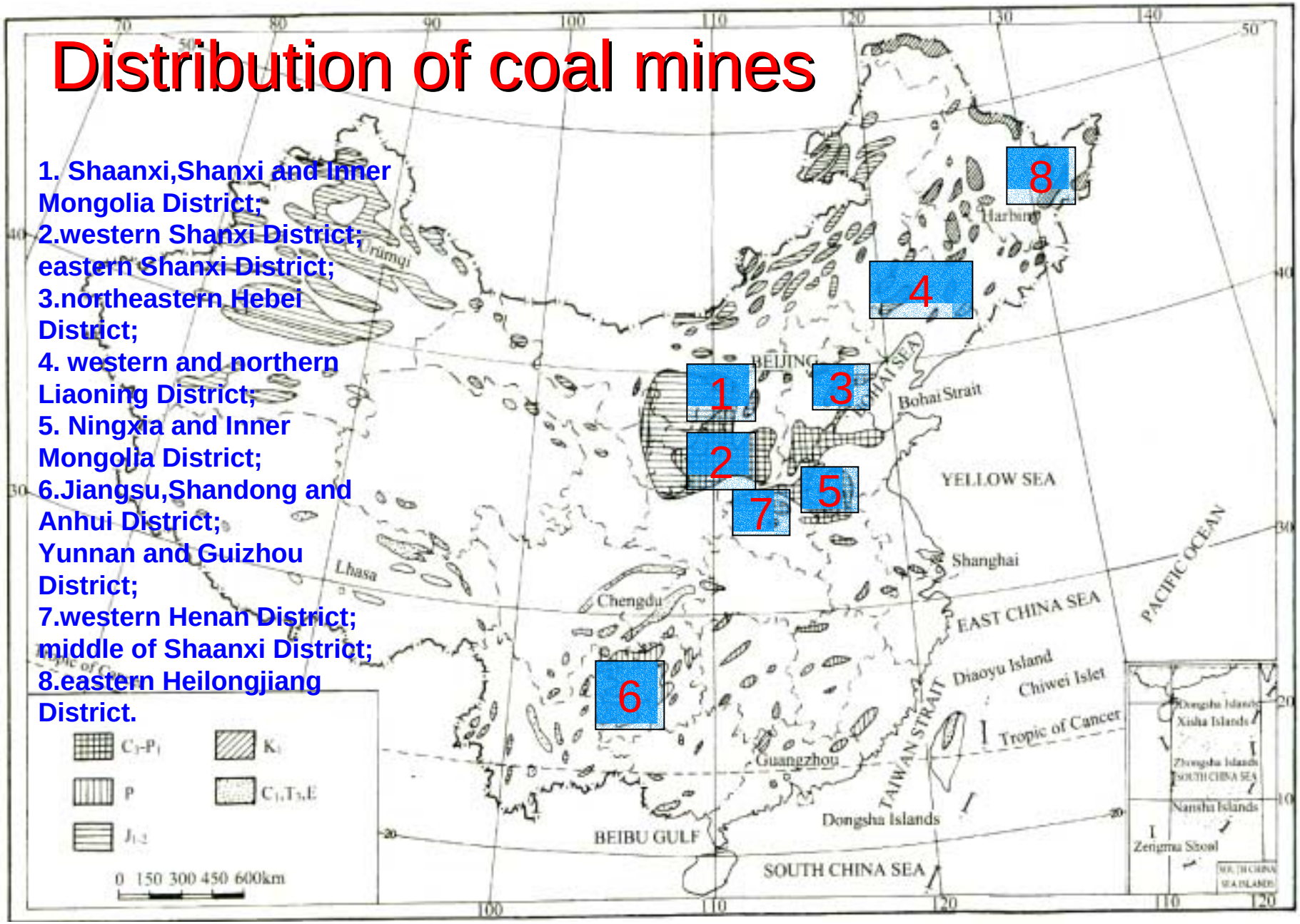


Fig.3

Great mineral potential in China:

- favorable geological environments to host world-class deposits;
- great number of geophysics and geochemistry anomalies not investigated;
- western China and the deep parts of existing mines in eastern China;
- Encouraging policies of the Chinese government for foreign investments in the exploration and development of mineral deposits.

The Mineral Exploration Branch of China Mining Association

- The only professional organization in the mineral exploration sector in China
- Currently 134 members,including :
  - Provincial Geological Bureaus;
  - Mineral Exploration Companies;
  - Mining Companies;
  - Contractors or Service Companies;
  - Consultant Geologists;
  - Investment Organizations;
  - Lawyer;
  - Geological Surveys;
  - Universities; and
  - Geoscience Institutes.

Thanks for your attention

See you in Beijing!