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# Recent Exploration Progresses on Sandstone-Hosted Uranium Deposits in Northwestern China


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# Recent Exploration Progresses on Sandstone-Hosted Uranium Deposits in Northwestern China

## Outline

1 Background

2 Exploration technique

3 Progress in Yili & Ordos Basin

4 Conclusion



# 1 Background

New start and expansion of the nuclear power program requires greater demand for uranium resources:

- Reactors in operation: 20 (17.9 GW)
- Reactors in construction: 28
- 2015 in operation: 40GW
- 2020 in operation 58GW

☞Chance and Challenge for Uranium exploration in China…



# 1 Background

◆Since 2005 more investments on exploration and studies have been leading to new discovery and expansion of uranium resources in both sandstone-hosted and hydrothermal uranium deposits in the whole of China…

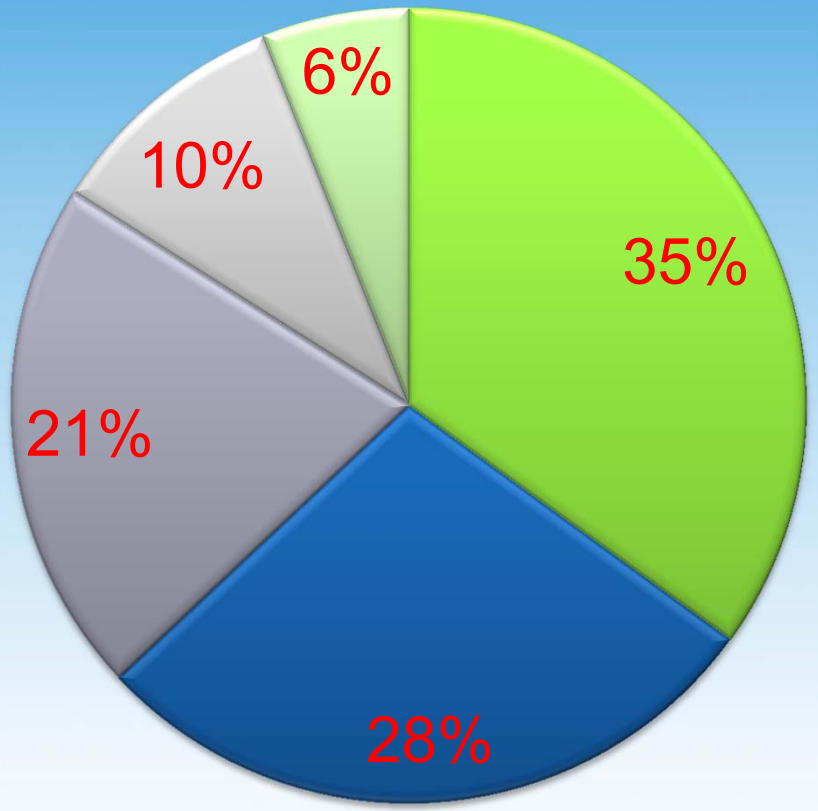
# Major progresses in both S. and H. U-deps

◆Big progress and more resource of sandstone-hosted uranium deposits in Yili, Ordos, Erlian and Songliao basins in the North China, and their reserve becoming from No.3 to No. 1

◆New more uranium resources of hydrothermal deposits discovered in bigger depth in the South China, exploration depth from 500m to 1000m…



# Major progresses in both S. and H. U-deps

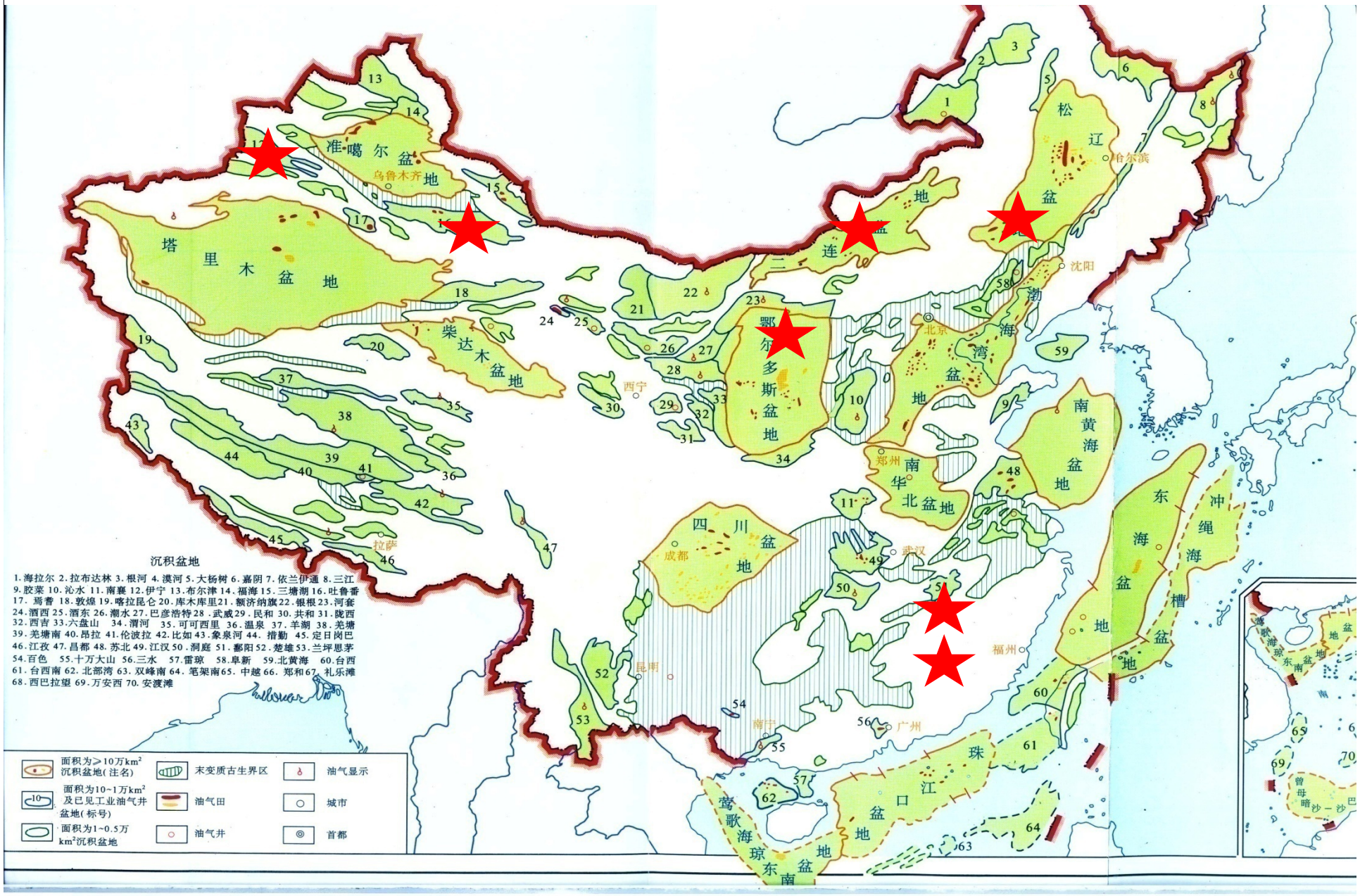



| |
|---|
| 1 Sandstone type 砂岩型 |
| 2 Granite type花岗岩型 |
| 3 Volcanic type 火山岩型 |
| 4 Black shale 黑色页岩型 |
| 5 Other types 其他类型 |

**Dominant types: Sandstone and Hydrothermal U deposit**



# Major progresses in both S. and H. U-deps



# 2 Exploration techniques

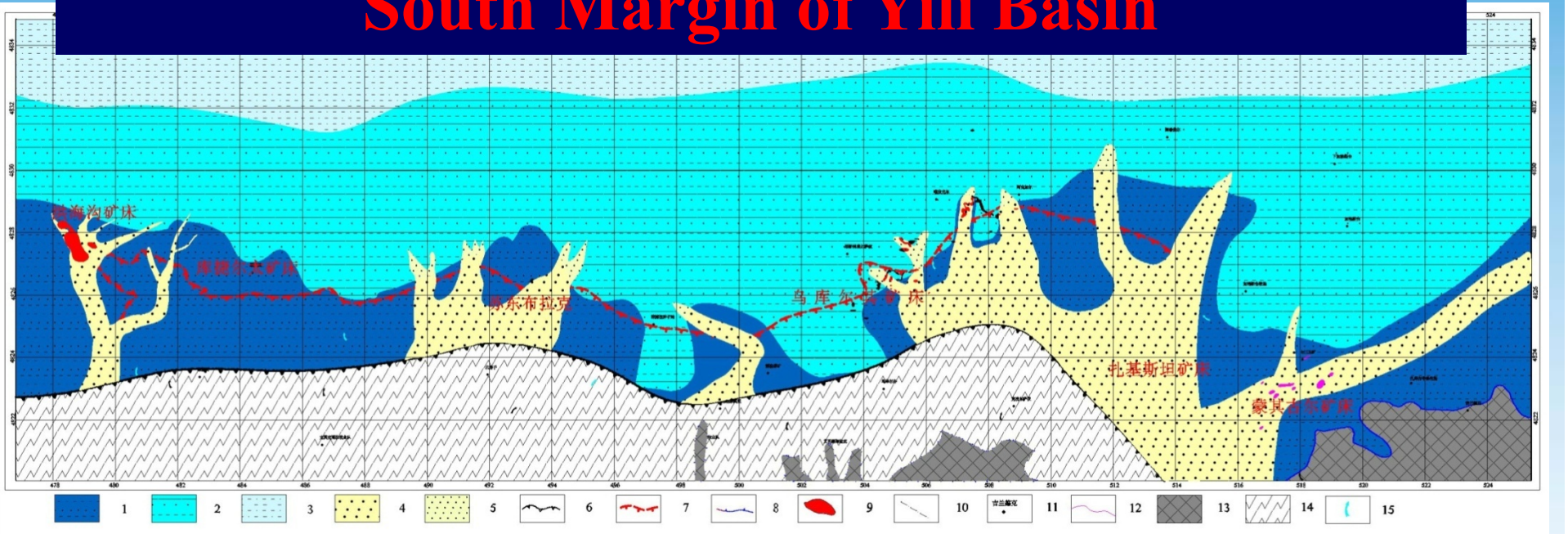
**The comprehensive exploration techniques used for target selection and location of uranium mineralization**

- ✓ **Detailed sedimentary facies**
- ✓ **Tectonic analysis**
- ✓ **High-precision magnetic survey**
- ✓ **Seismic survey**
- ✓ **Rn-survey**
- ✓ **Soil geochemical Survey…**



# 2 Exploration techniques

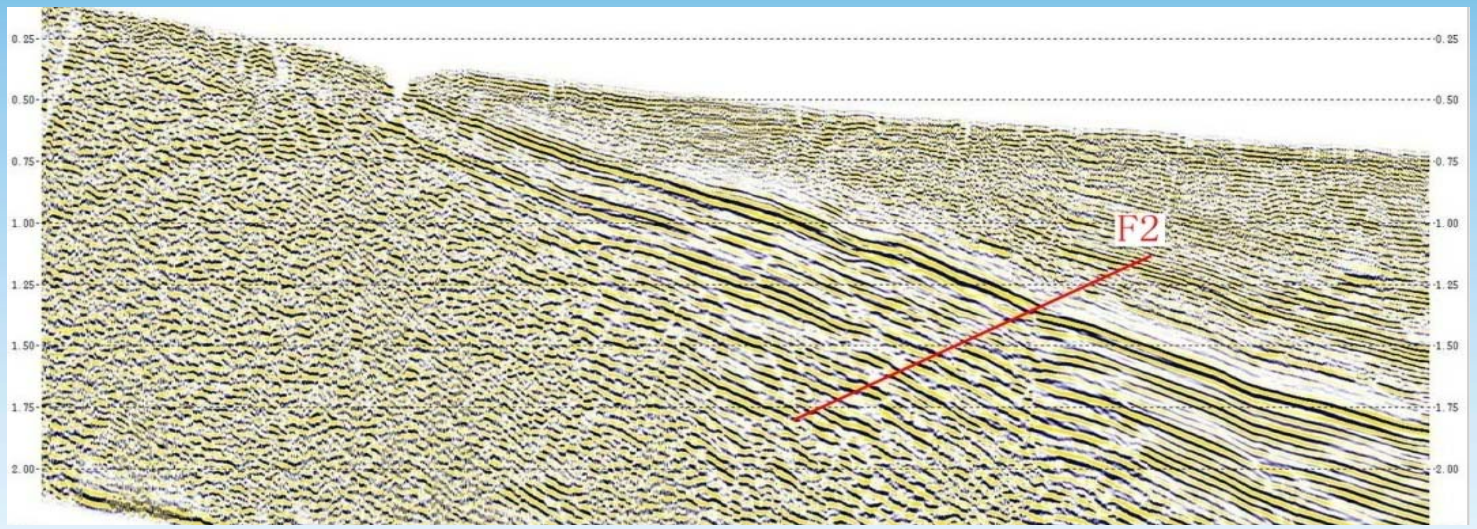
## ✓Sedimentary Facies of Sequence VII in South Margin of Yili Basin

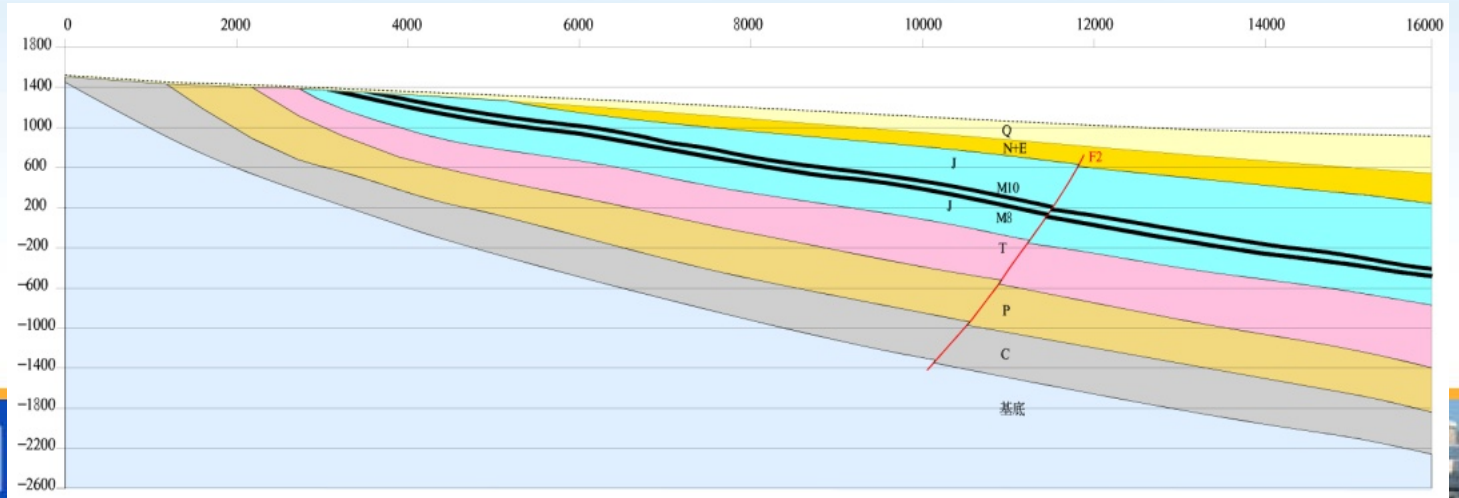



**Uranium mineralization in the secondary-order or branching channels of the braided river delta system**

# 2 Exploration techniques

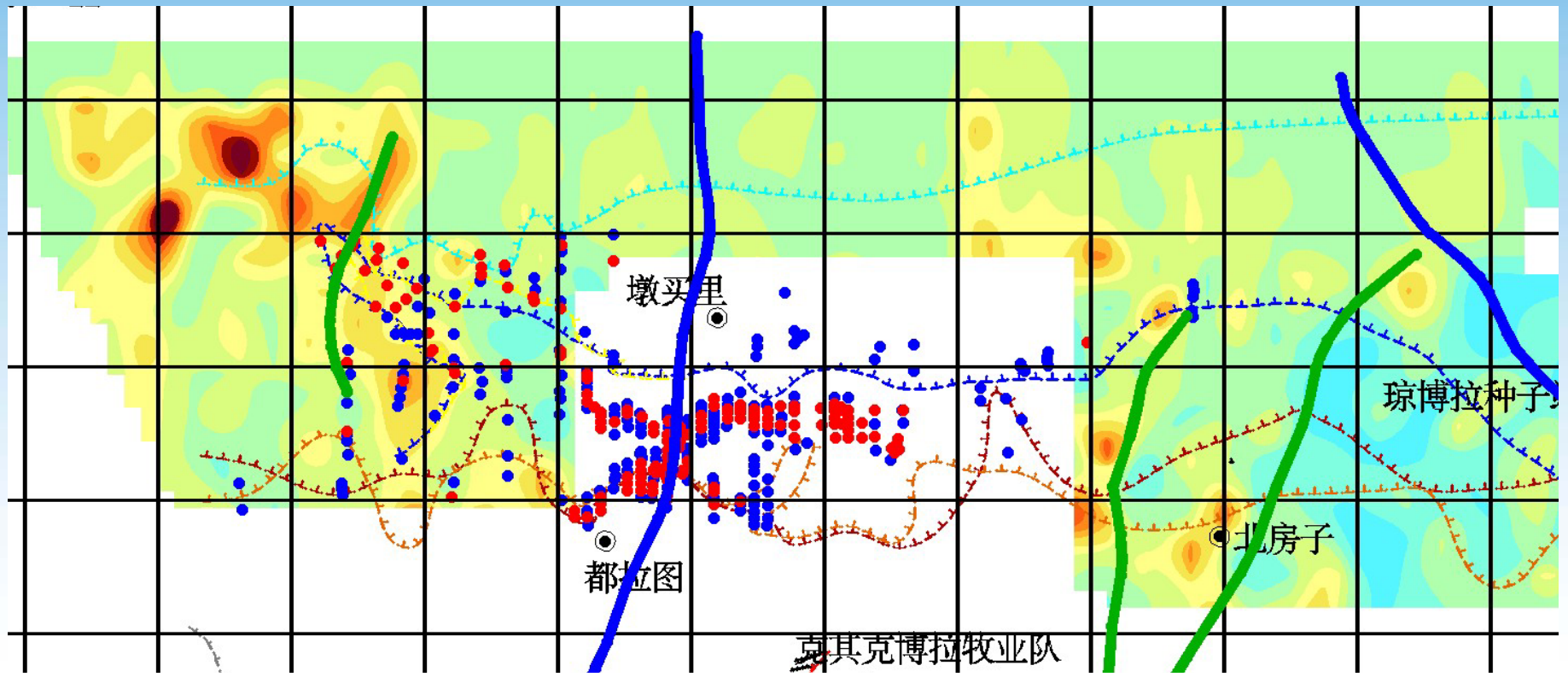
✓Seismic survey to find basin structure for targeting favorable ore bed…



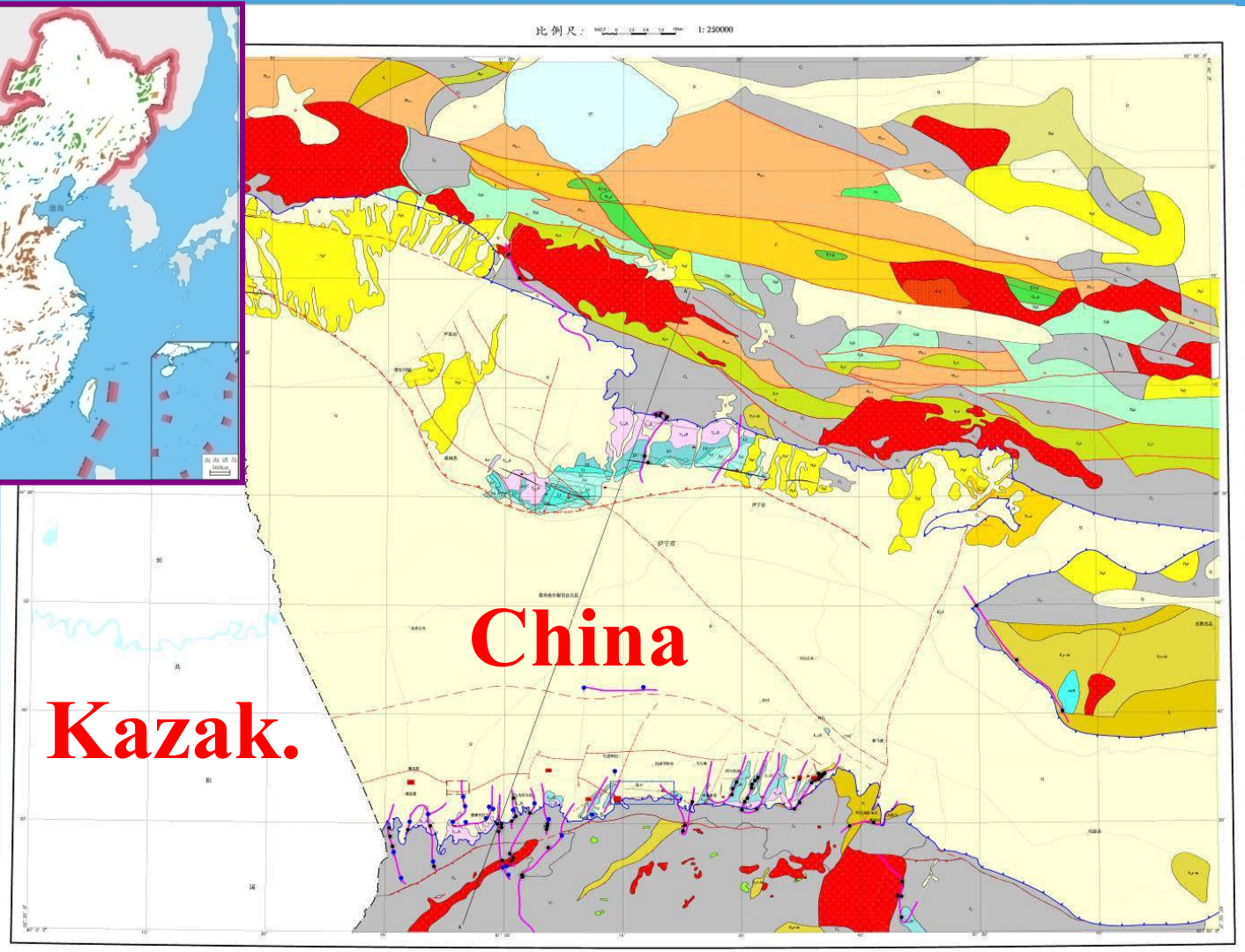



# 2 Exploration techniques

## ✓Rn-survey for targeting in Yili basin



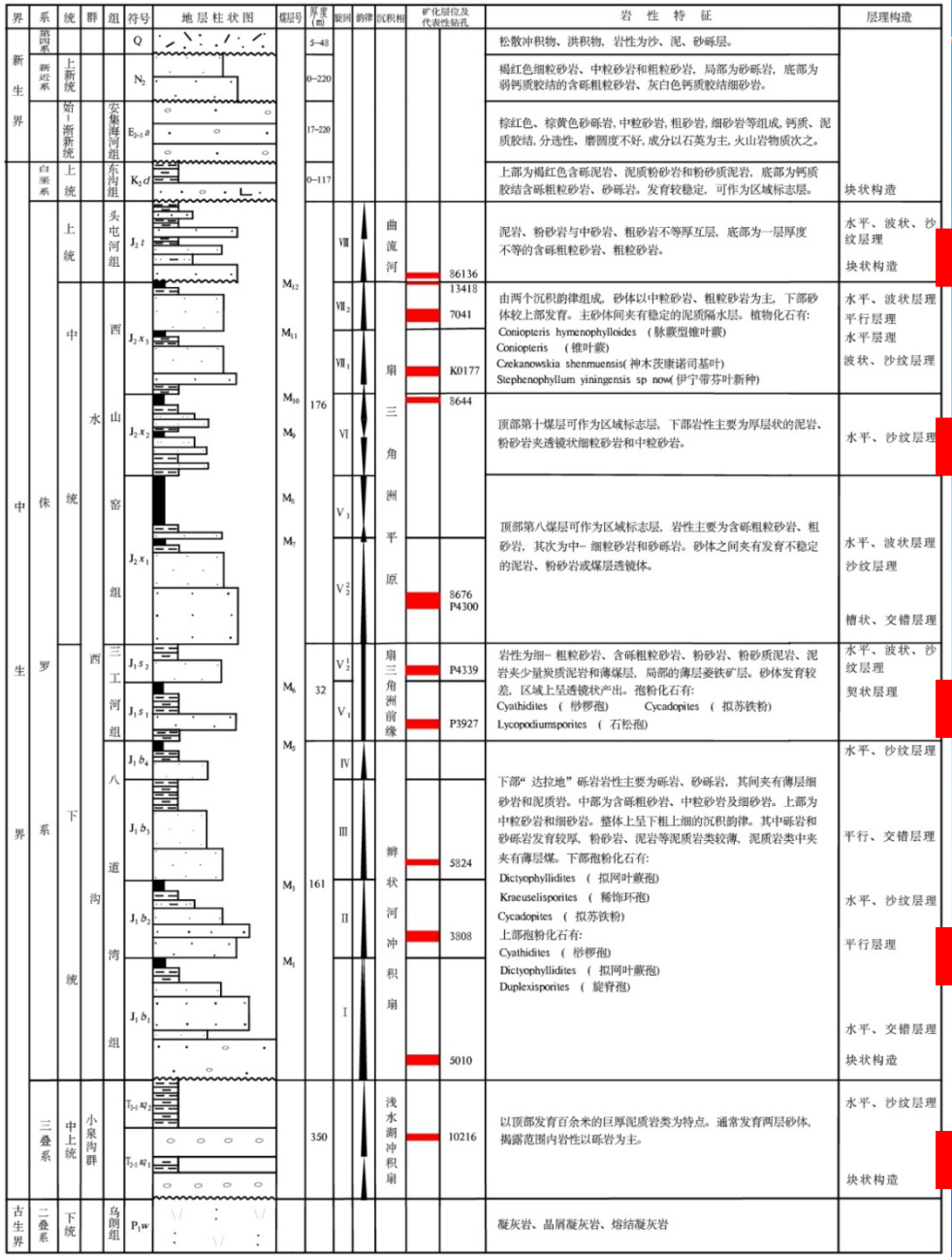
# 3 Progress in Yili Basin


**Geological Map of Yili basin**

# 3 Progress in Yili Basin

## New ore beds




**J3: Toudunhe F.**

**J2: Xishanyao F.**

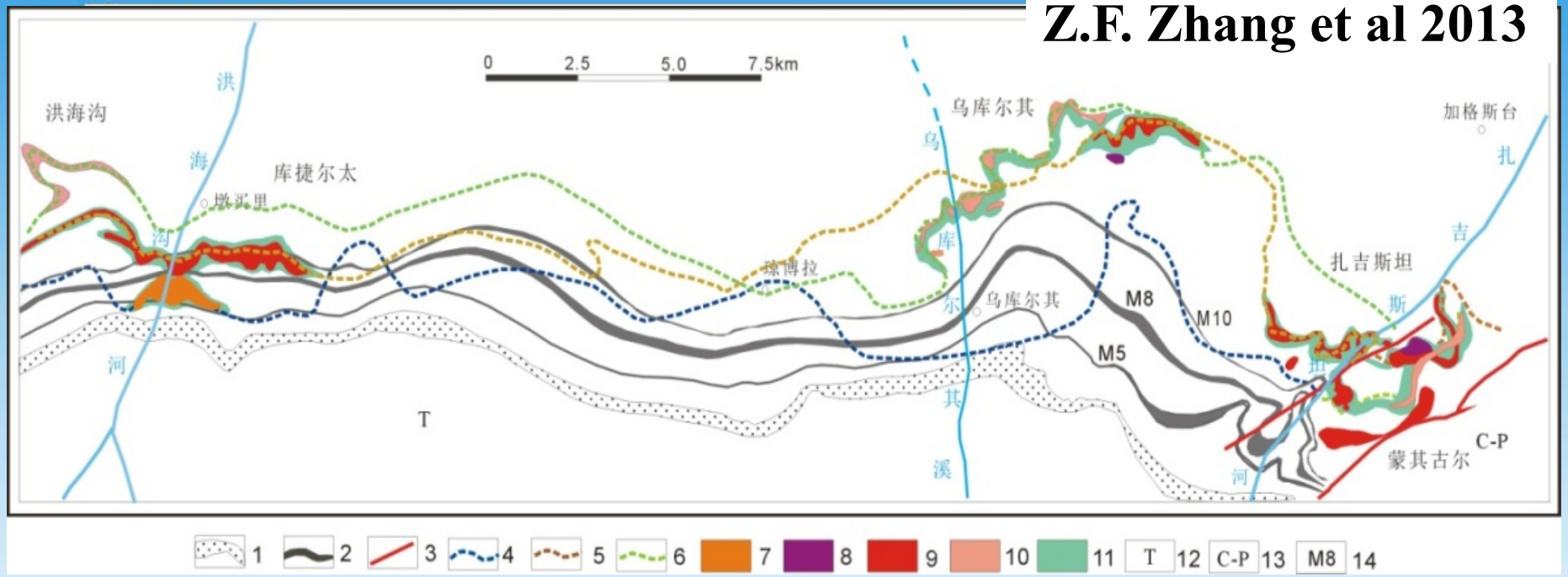
**J1: Sangonghe F.**

**J1: Badaowan F.**

**T2: Xiaoquangou G.**

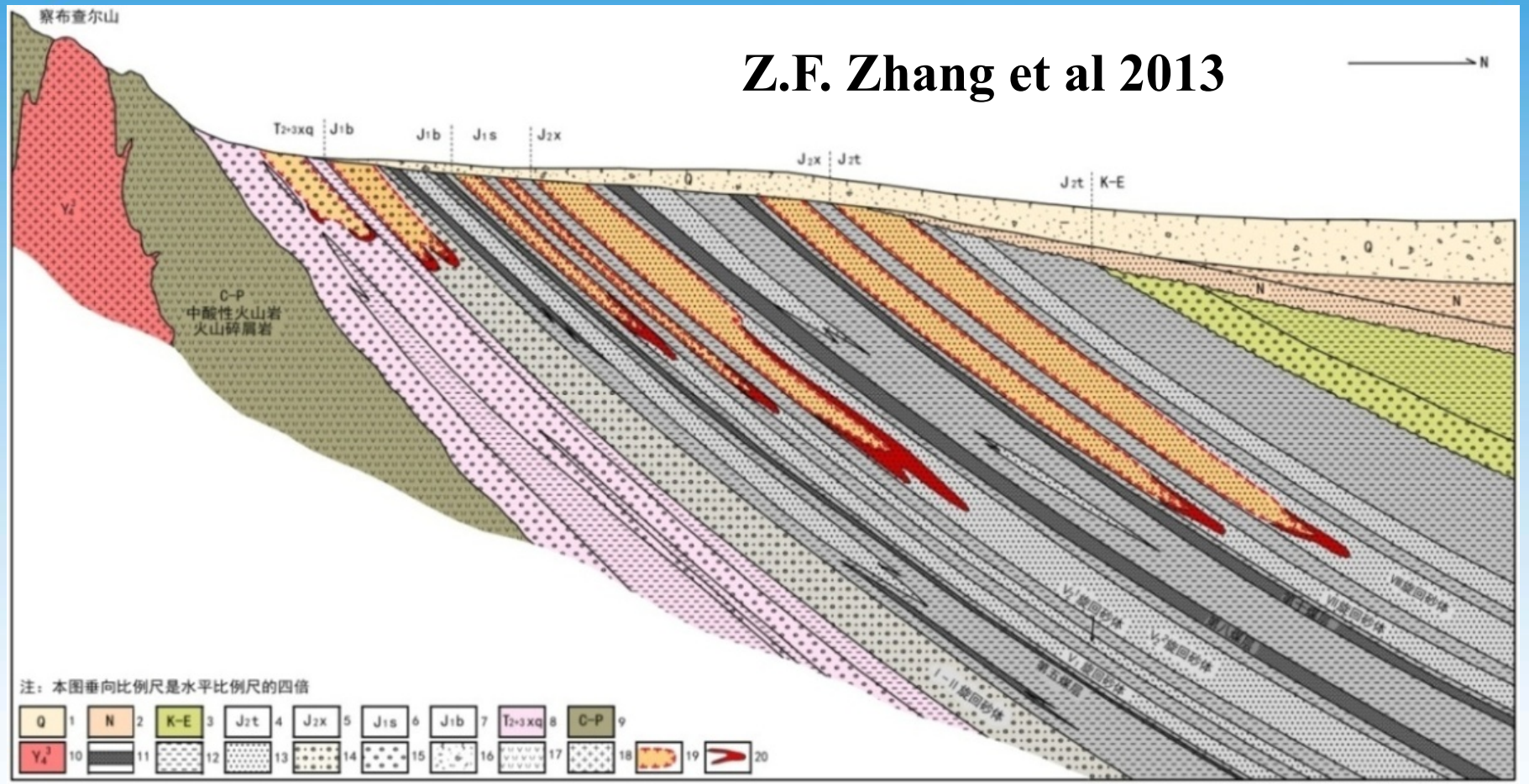
# 3 Progress in Yili Basin

Z.F. Zhang et al 2013



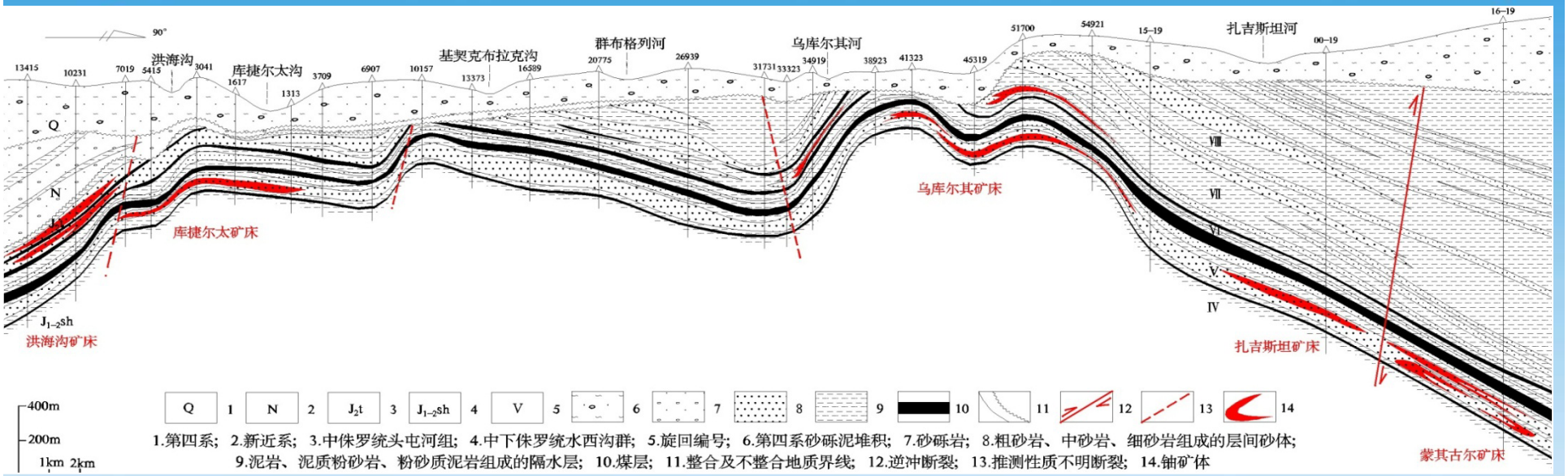

**1 Daladi conglomerate 2-Coal bed; 3-Fault; 4-Redox front of Badaowan F.; 5-Redox front of lower section of Xishanyao F.; 6-Redox front of upper section of Xishanyao F.; 7-Ore body in Badaowan F., 8-Ore body in Sangonghe F., 9-Ore body in lower section of Xishanyao F. ; 10-Ore body in upper section of Xishanyao F. ; 11-Ore belt**

# 3 Progress in Yili Basin




**Longitudinal section of orebody and J2-3 sequences in southern margin of Yili basin**

# 3 Progress in Yili Basin




**East-west section shows relationship among ore bodies, coal beds, tectonics, faults and sedimentary sequence (Geolgical Team.216)**

# 3 Progress in Yili Basin

**General features:**

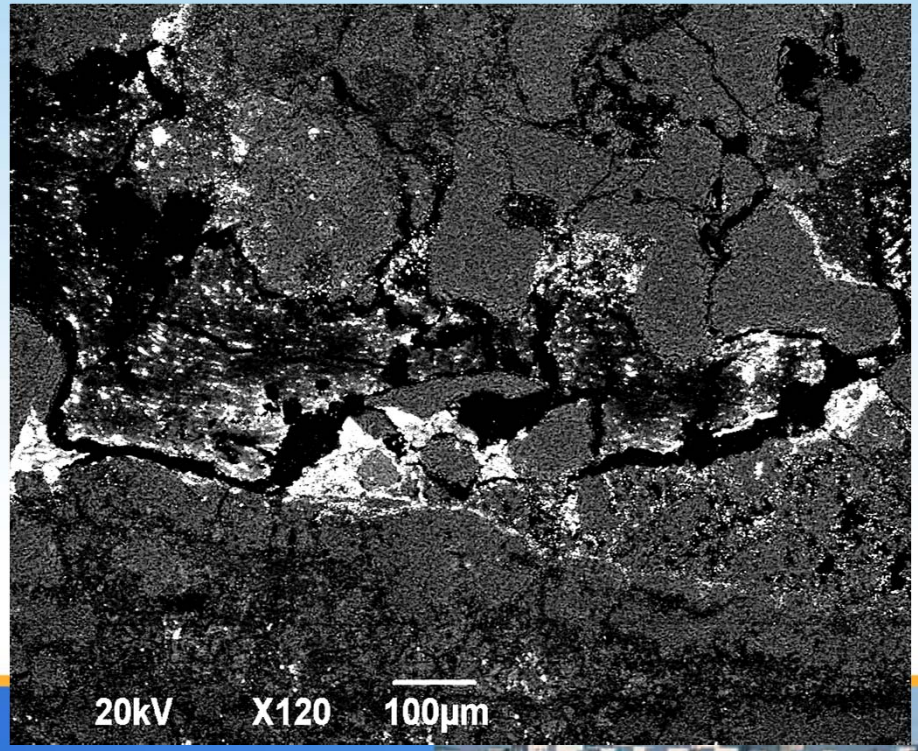
**Ore Miner.: Pitchblende and redox control**

**Ages: 51～30Ma、12～4Ma、1～0.7Ma**

**Depth: Up to 800 meters**

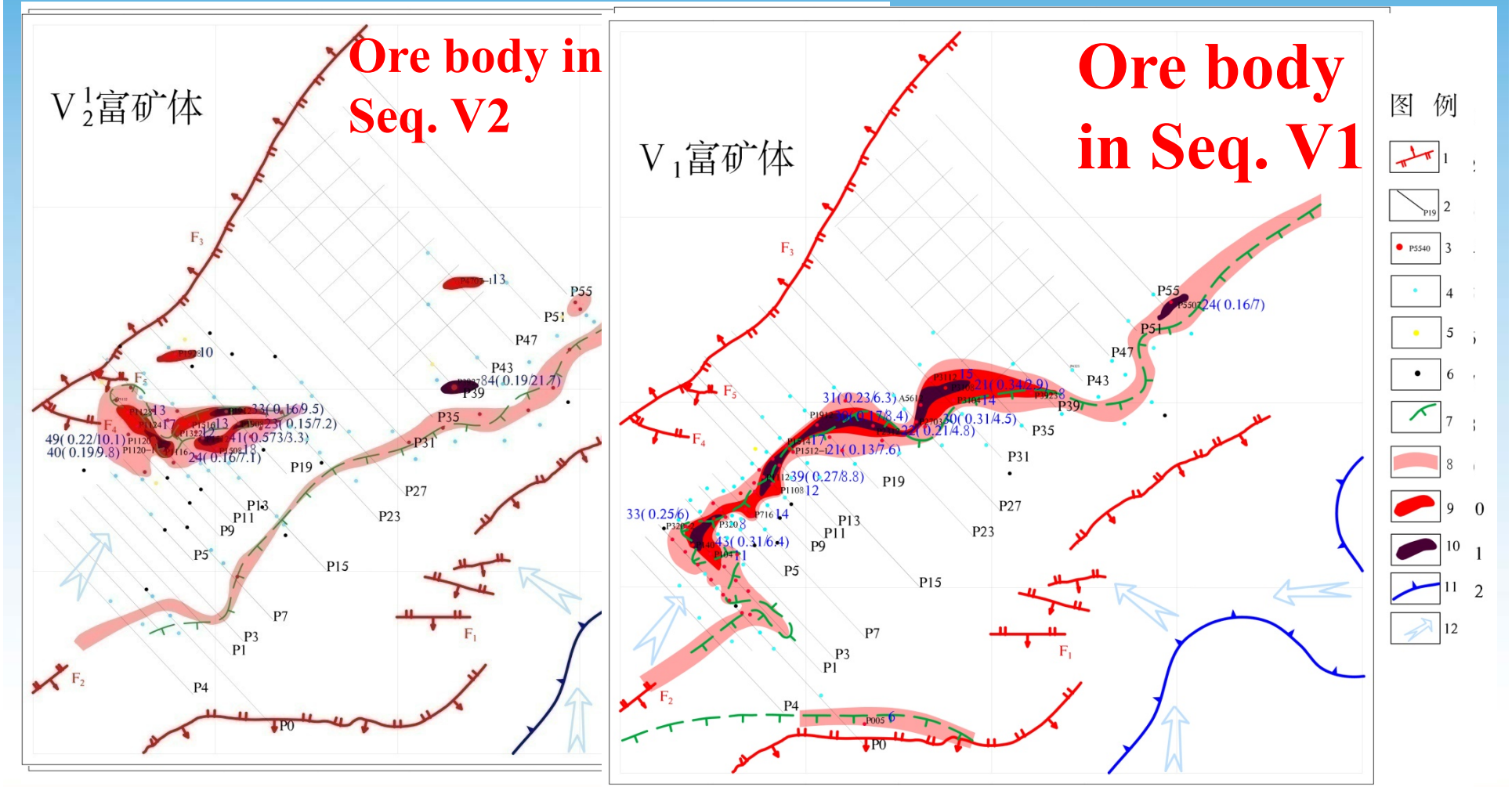
**Grade: 0.01%-2.3%**

**Thickness： n-nx10 m**



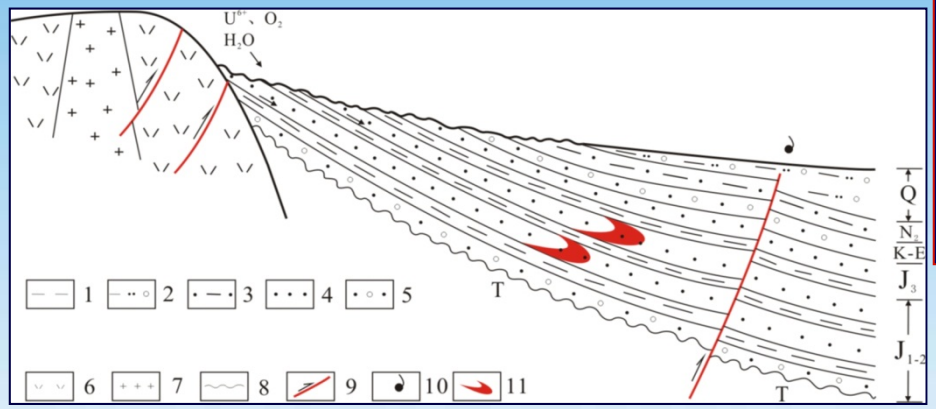
# 3 Progress in Yili Basin

## Mengqiguer Deposit: Tectonic important role

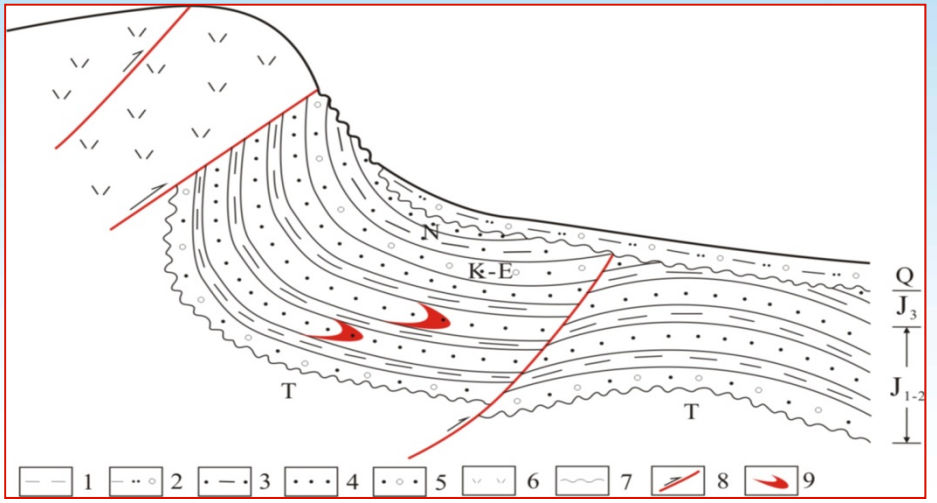


# 3 Progress in Yili Basin

## Uranium metallogenic Models in Yili Basin, NW China




**Eastern part under strongly dynamic background**

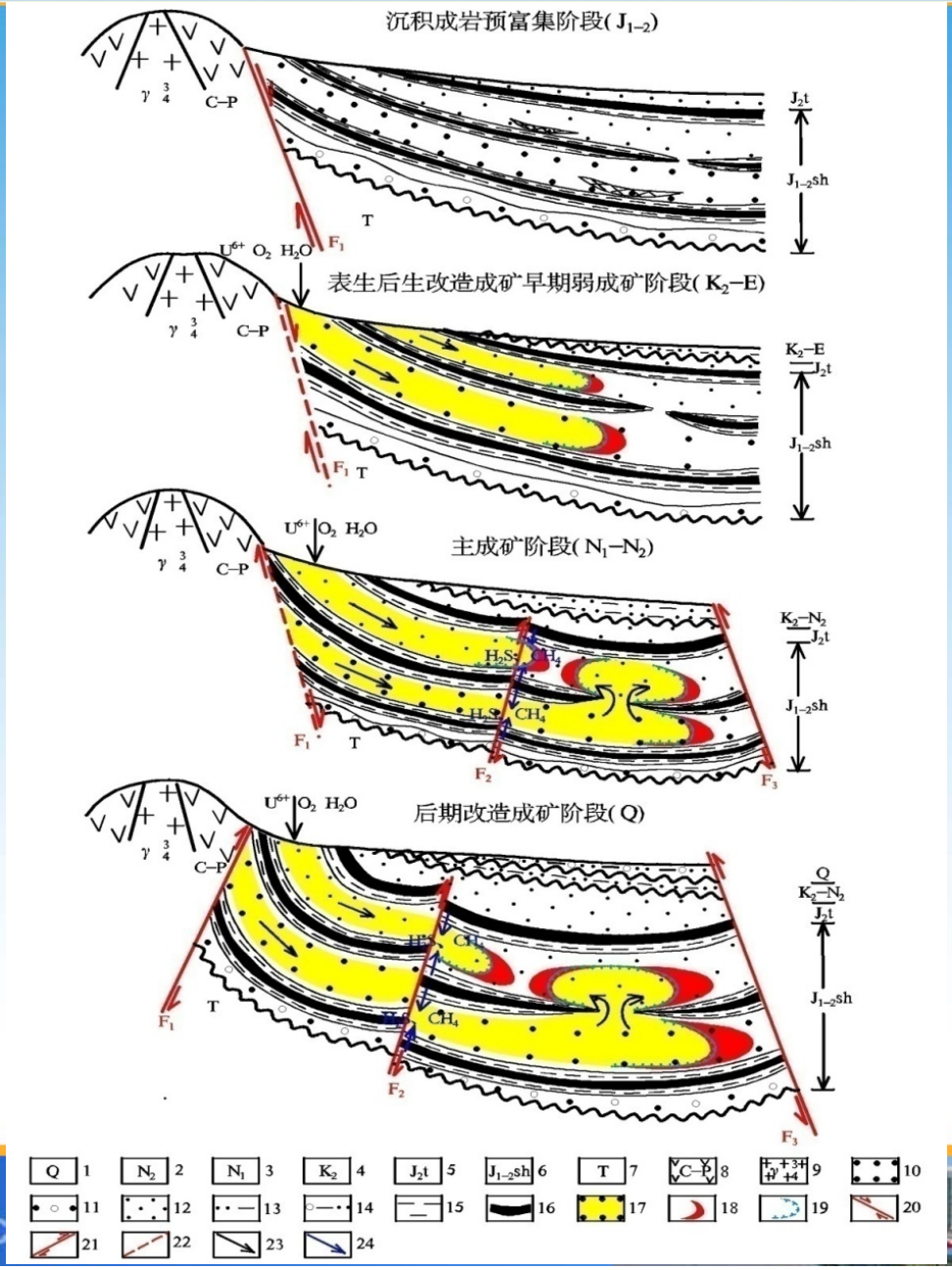



**Western part under weakly dynamic background**



# 3 Progress in Yili Basin

**Uranium metallogenic Models in Yili Basin, NW China**



# 1 Geological Setting

## ◆Location:

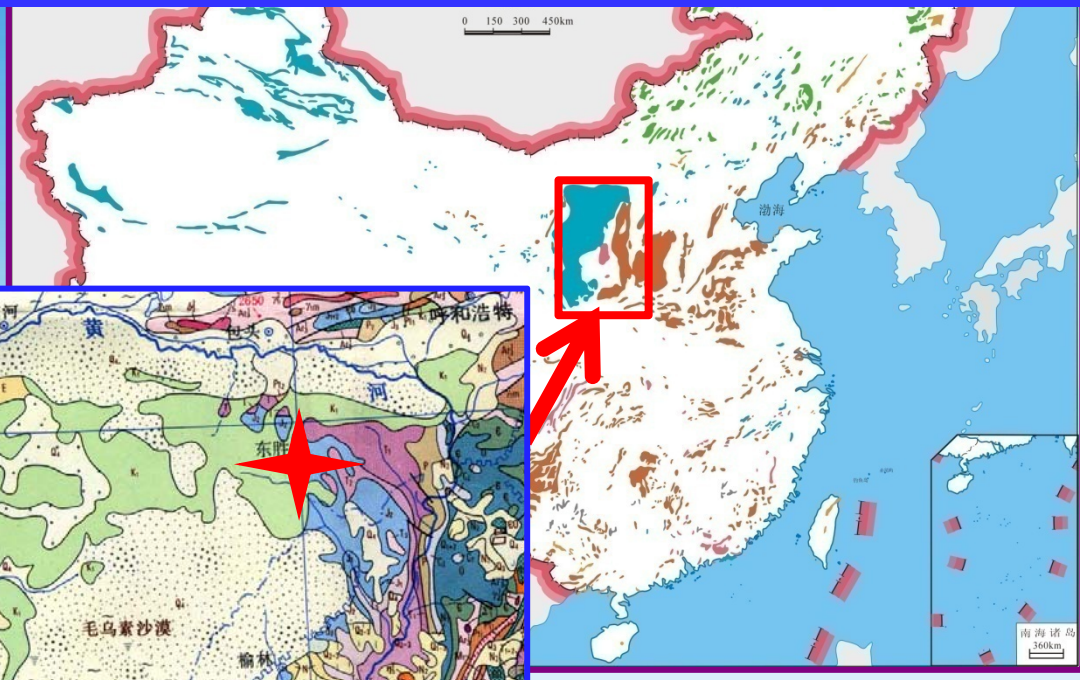
**NE of Ordos Basin in North China**

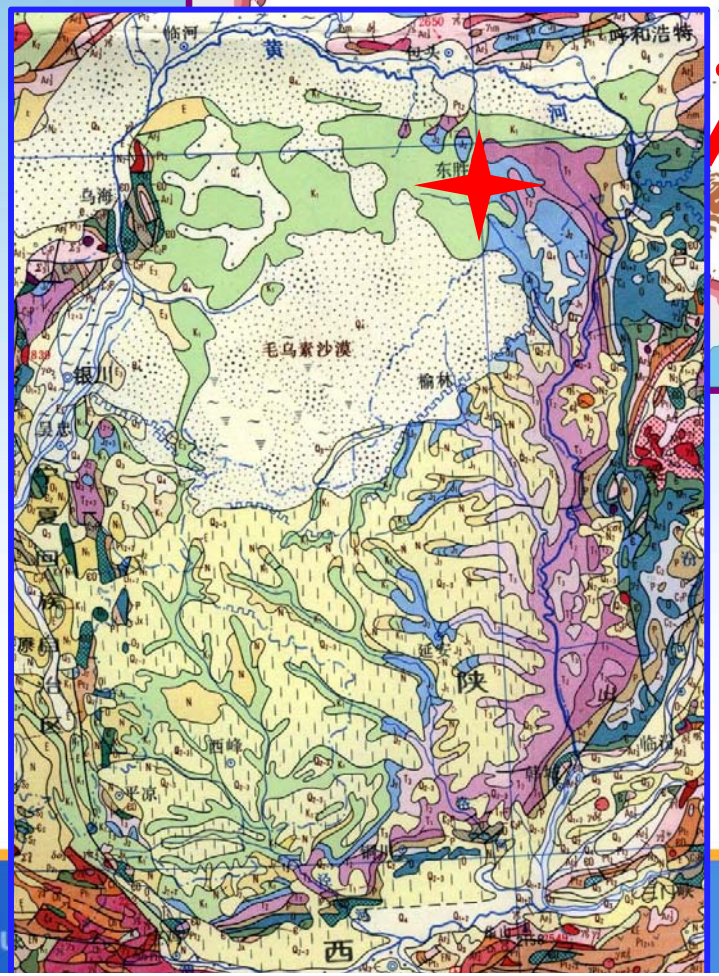
## ◆Size: $3x10^5$ $km^2$

## ◆Signature:

**Compound basin since palaeozoic**

# 3 Progress in Ordos Basin

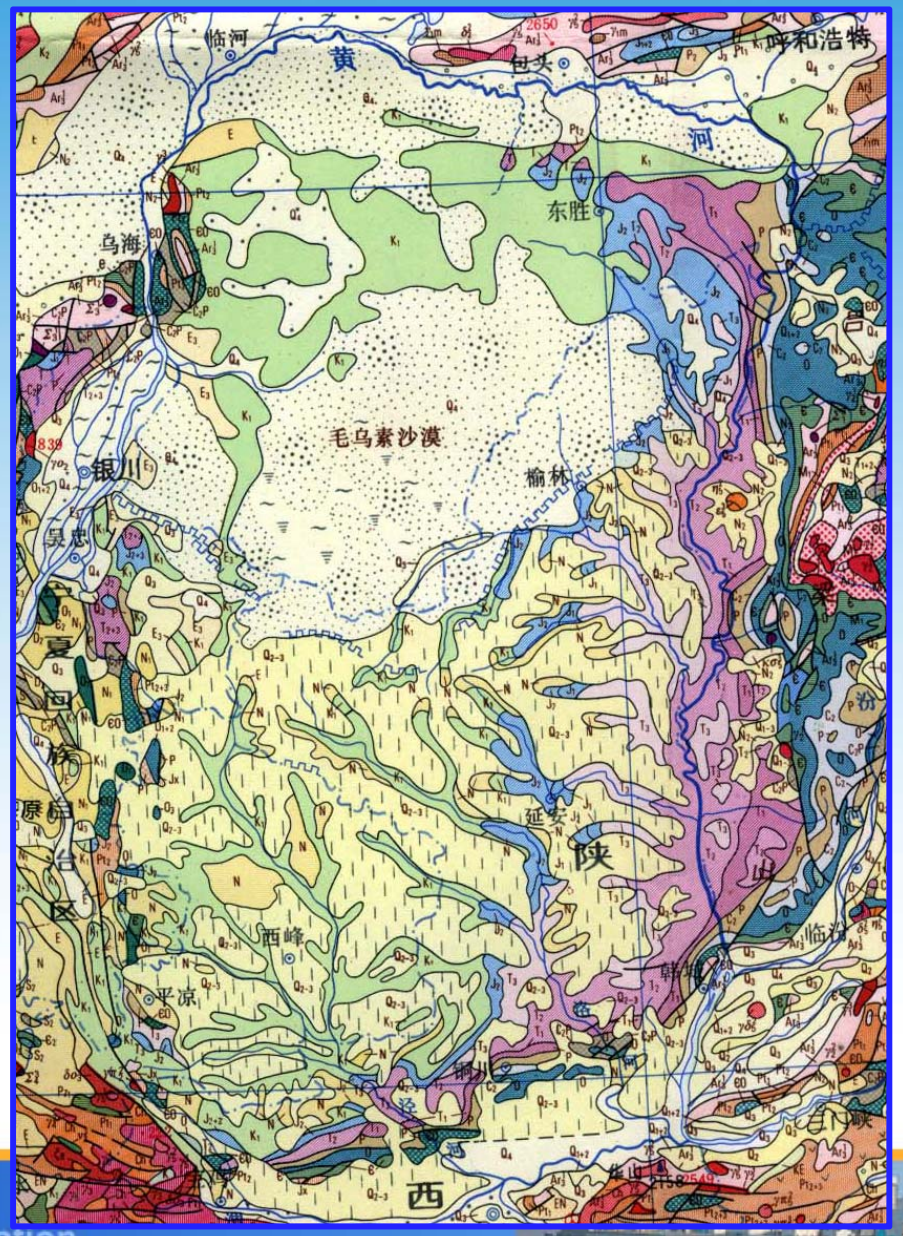



# 1 Geological Setting

☛ **Pre-Jurassic Basements:**

- **Archean and Proterozoic highly metamorphic rocks and migmatic granites**
- **Paleozoic lightly metamorphic rocks**

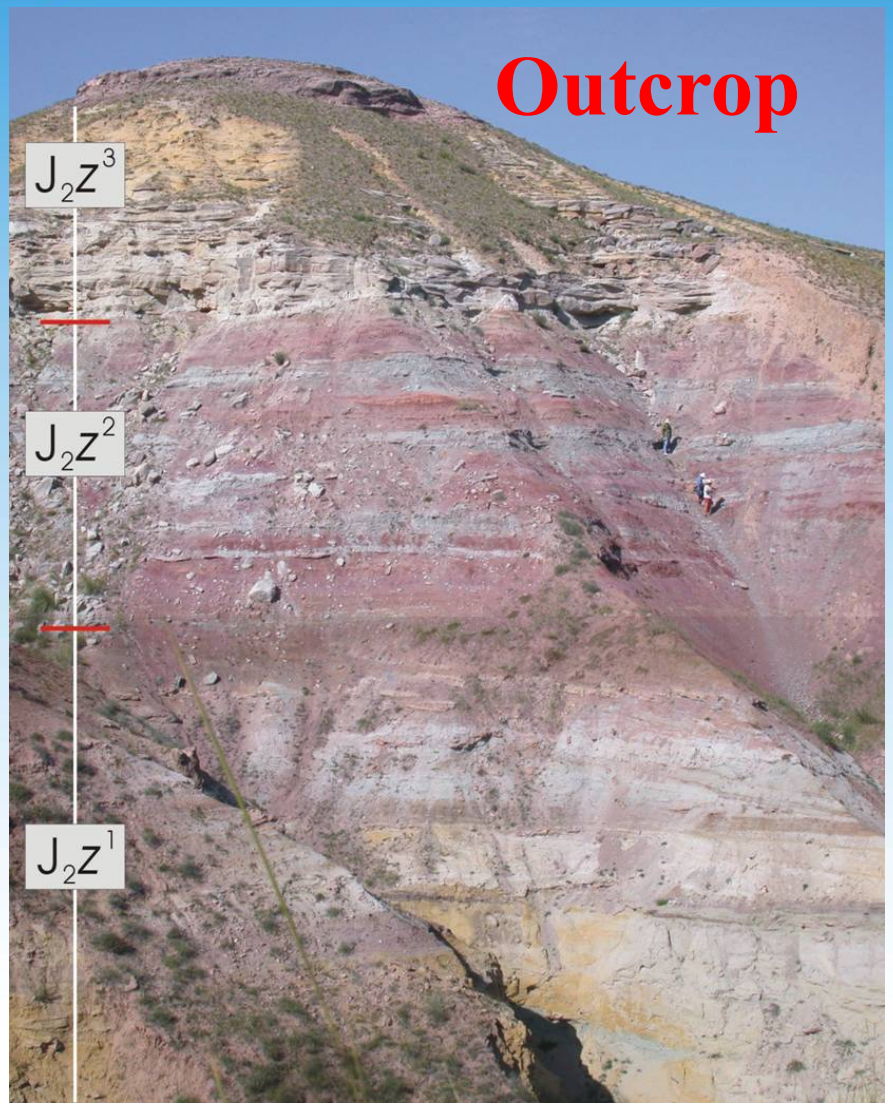


# ☞ Geological Setting

## Mesozoic covers & ore beds

| Series | Group/ Fm. | Sym. | （m） | Lith. | Dep. |
|---|---|---|---|---|---|
| Quat. | | Q | ＞41 | Quaternary sands and soils | |
| Lower Cretaceous | Zhidan Group | $K_1$ | 1780 | Red and gray sandstone and mudstone;Alluvial, fluvial and eolian origins. | |
| Upper Jurassic | Fenfanghe Fm. | $J_3f$ | 971 | conglomerate Poorly developed, Brown-red | |
| Middle Jurassic | Anding Fm. | $J_2a$ | 300 | Fine-grained red or brownish red siltstone and mudstone | |
| | Zhiluo Fm. | $J_2z$ | 300 | Gray, greenish sandstone, siltstone and mudstone | U |
| | Yanan Fm. | $J_2y$ | 450 | Arkosic sandstones, siltstone and mudstone interbeds | C, U |
| Lower Jurassic | Fuxian Fm. | $J_1f$ | 127 | Siltstone and arkosic sandstone | |
| Upper Triassic | Yanchang Fm. | $T_3y$ | >3000 | Gravel-bearing sandstone with siltstone and mudstone interbeds | Oil, C |

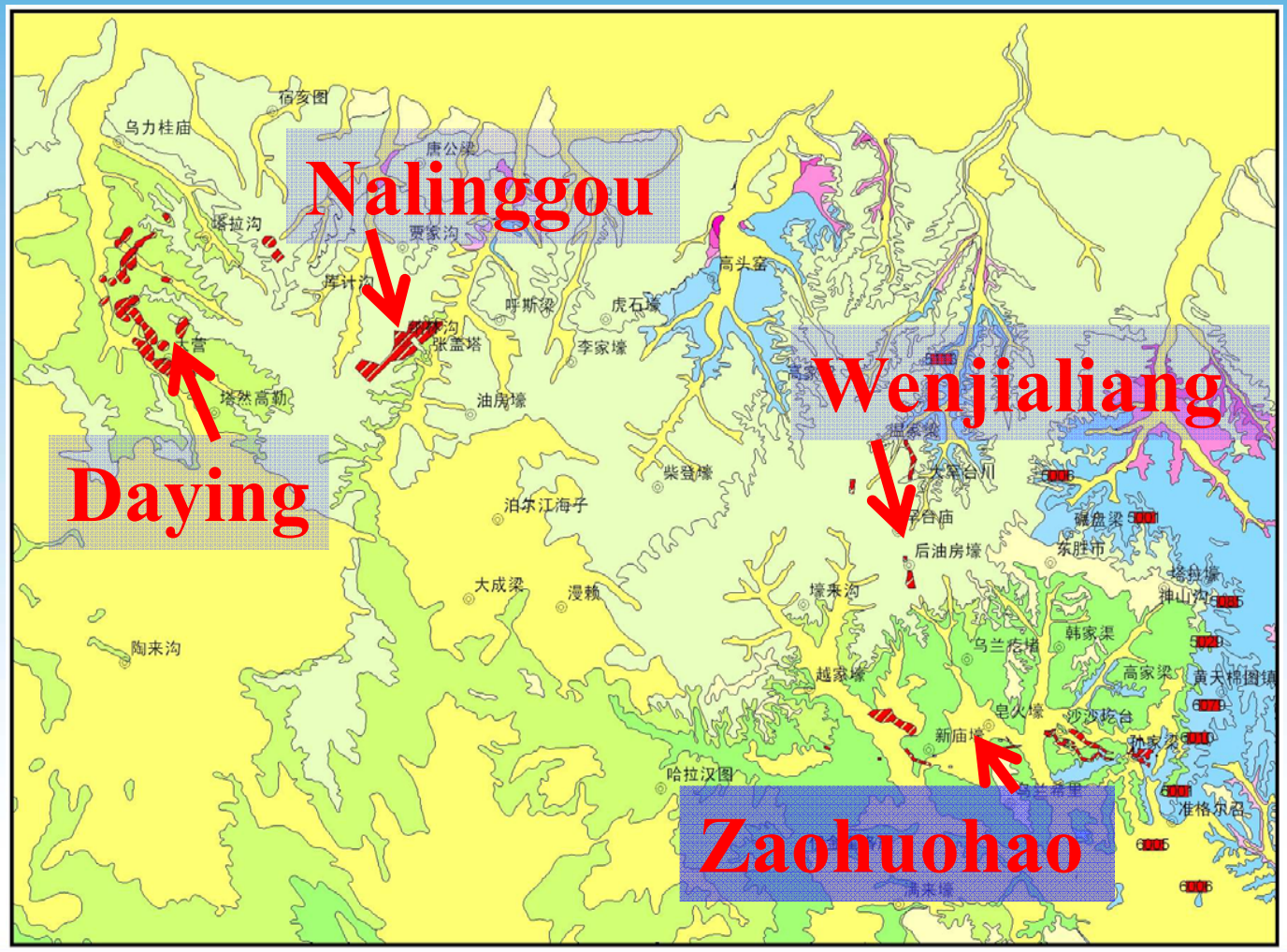
# Ore sedimentation sequences and lithology



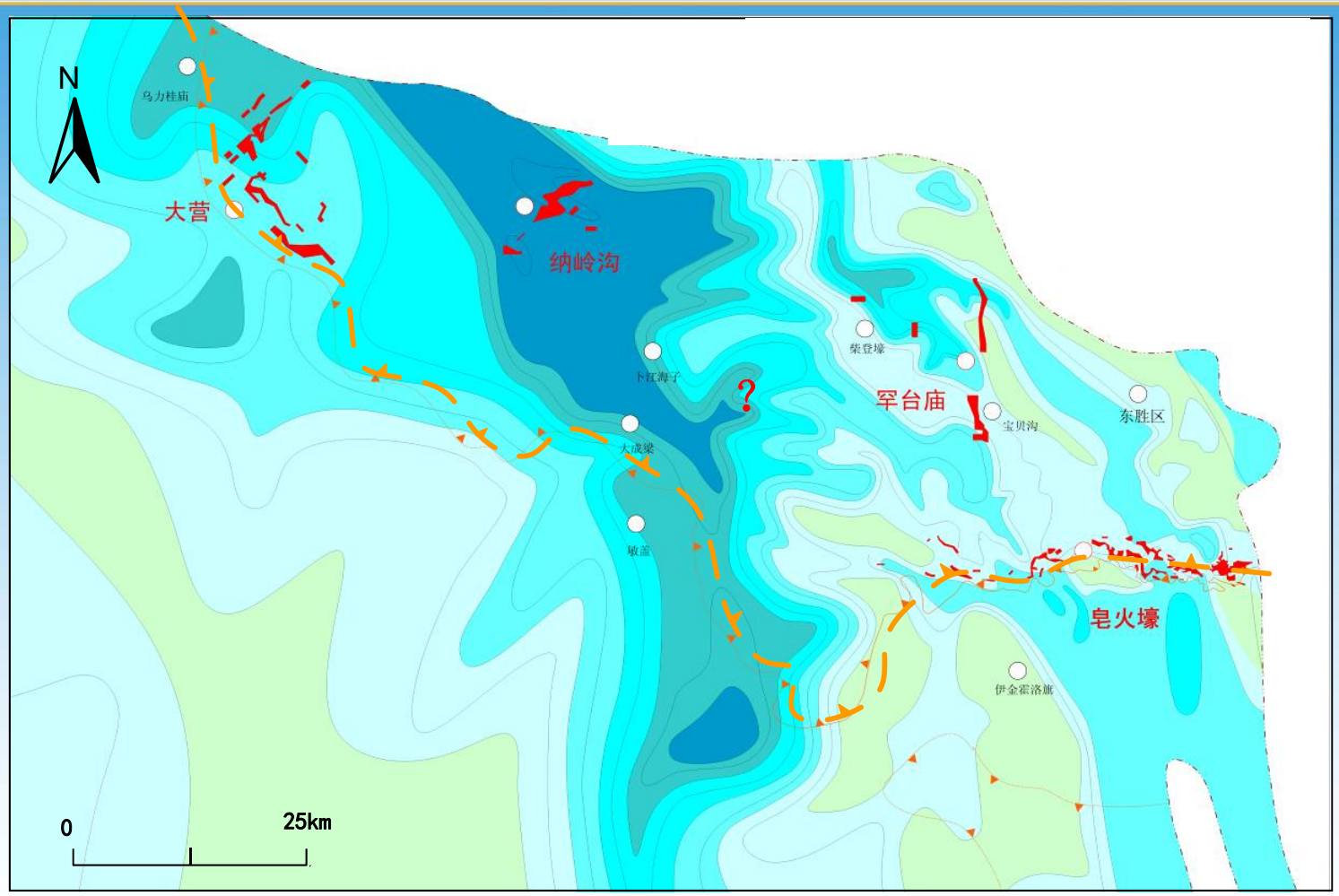


# 3 Progress in Ordos Basin

## ☞ New deposits discovered in Ordos basin

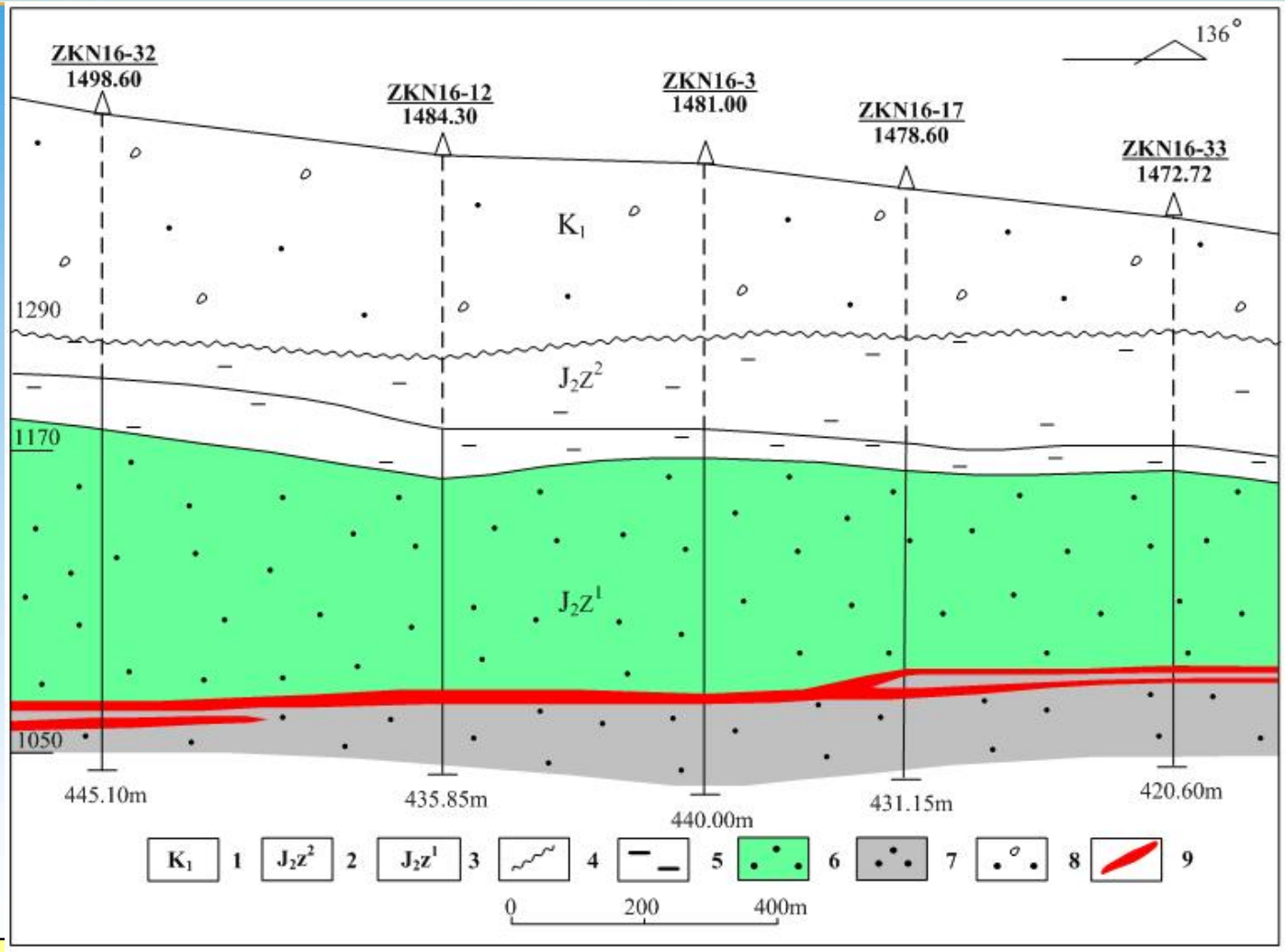


# 3 Progress in Ordos Basin

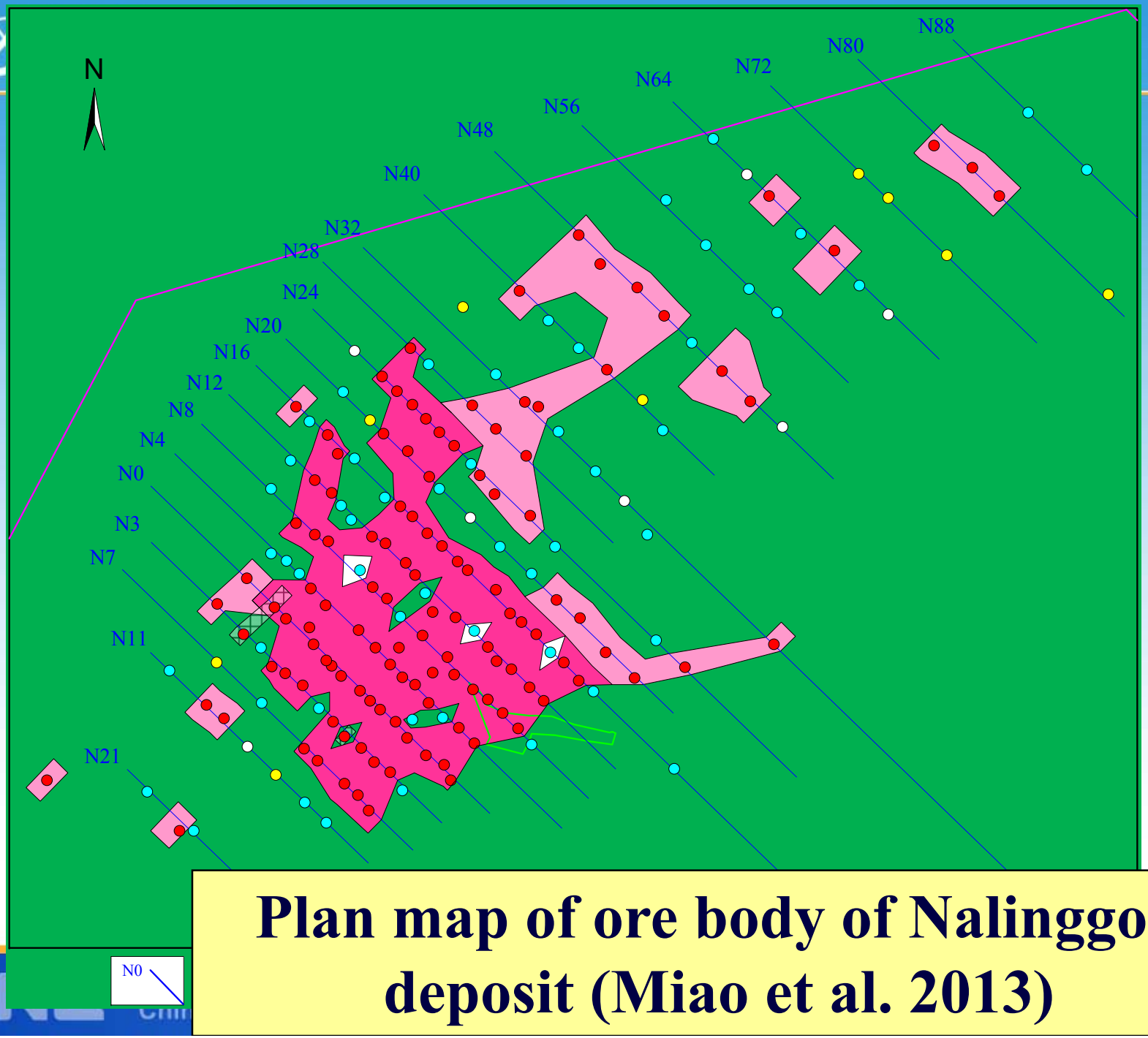



**NW-SE extending redox belt >100 km**

# 3 Progress in Ordos Basin

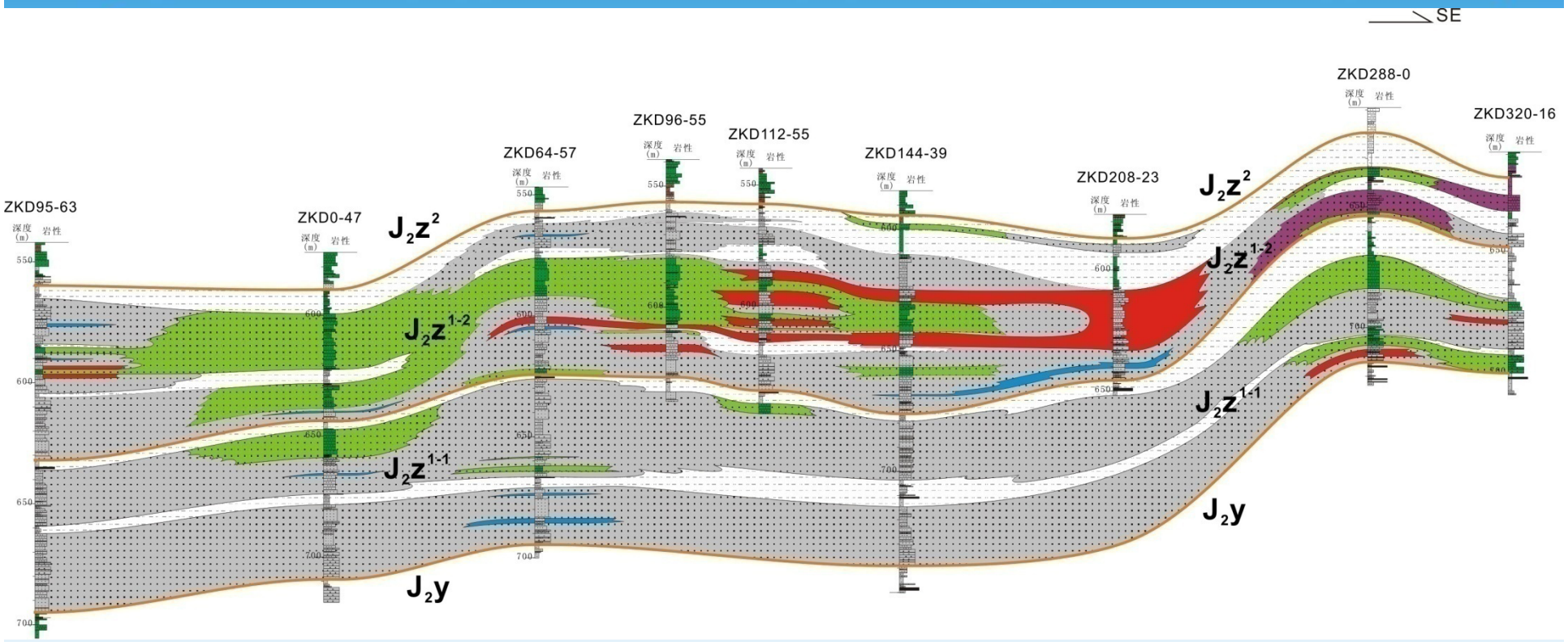



**Nalinggou deposit: plate shaped ore body, controled by redox zone**



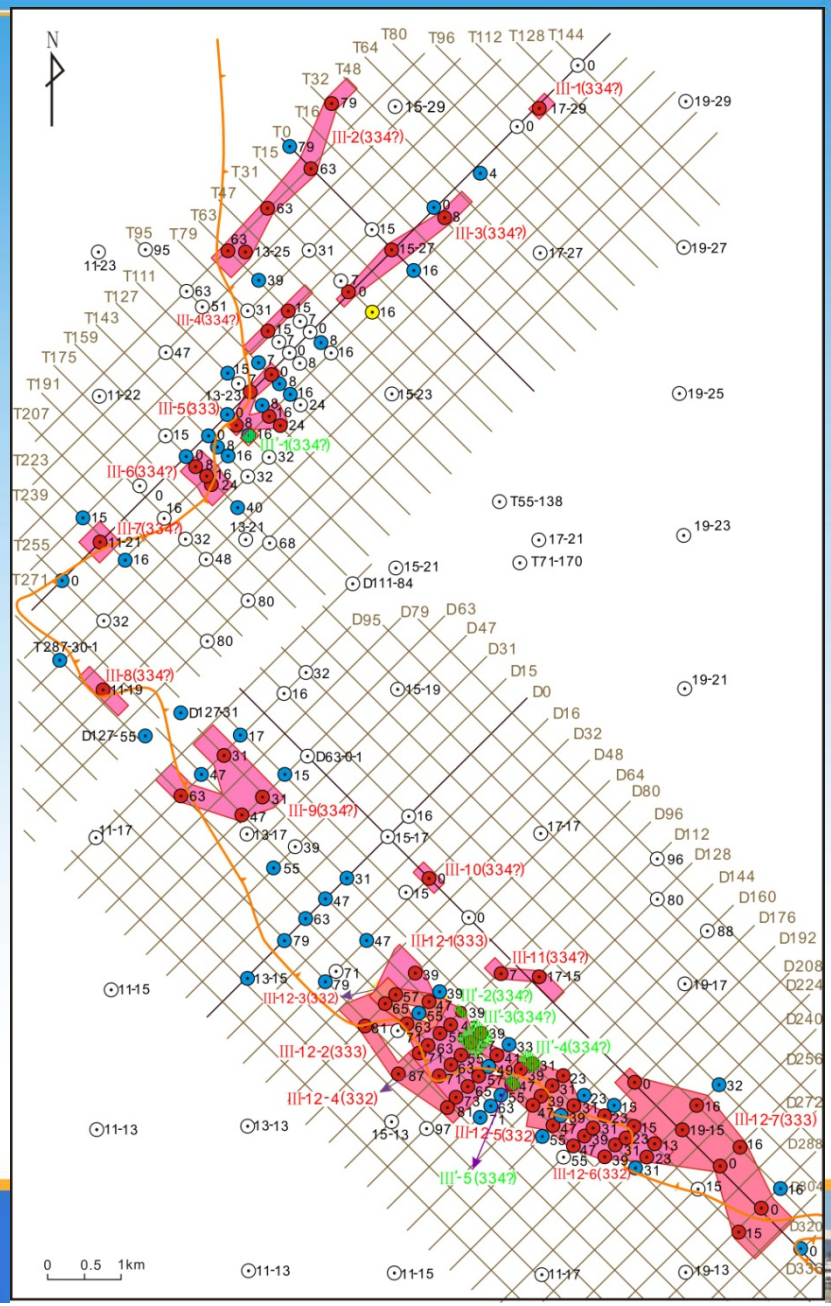

**Plan map of ore body of Nalinggou deposit (Miao et al. 2013)**

# 3 Progress in Ordos Basin




**Daying deposit: Roll-shaped ore body, controled by redox zone**

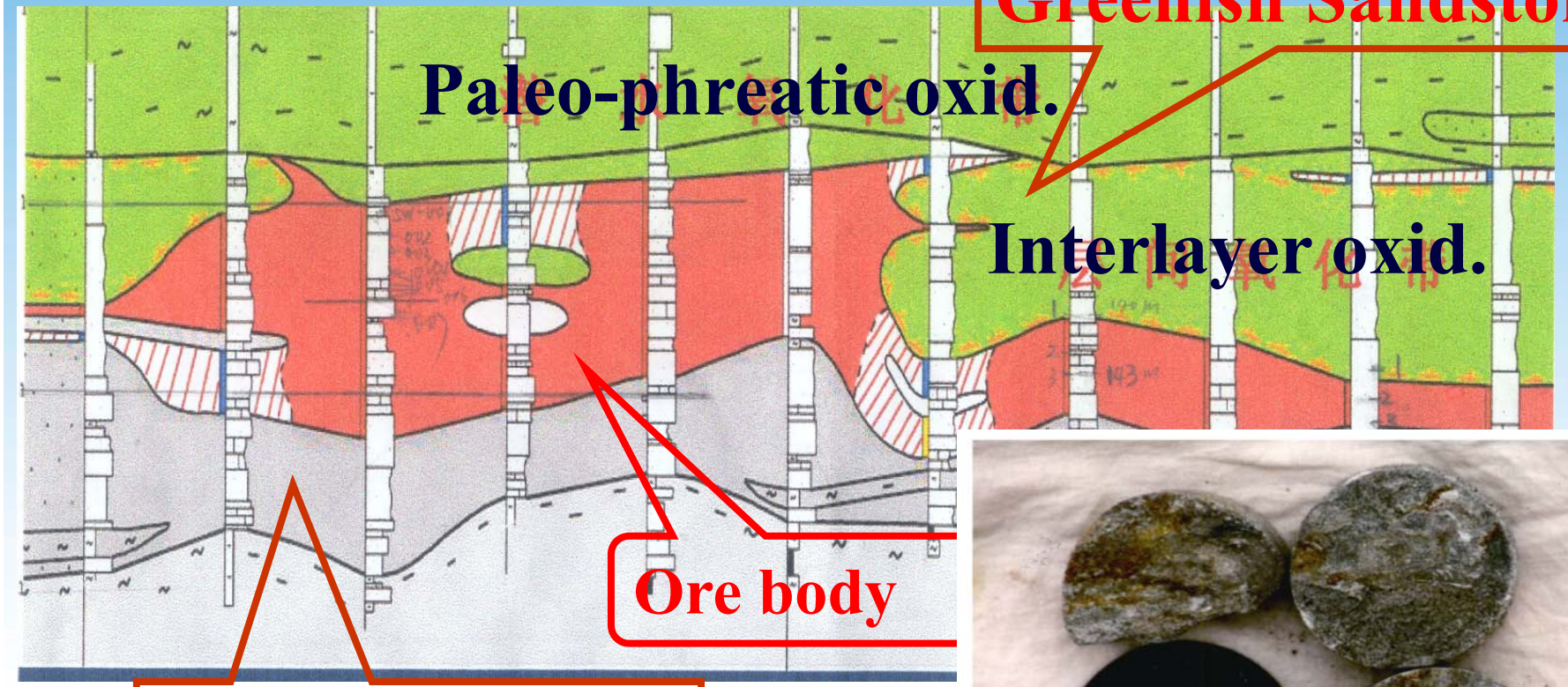
# 3 Progress in Ordos Basin




**Plan map of ore body of Daying deposit (Miao et al. 2013)**

# 3 Progress in Ordos Basin

☞ Uranium mineralization controlled by the redox zone between grey and grey-green sandstones



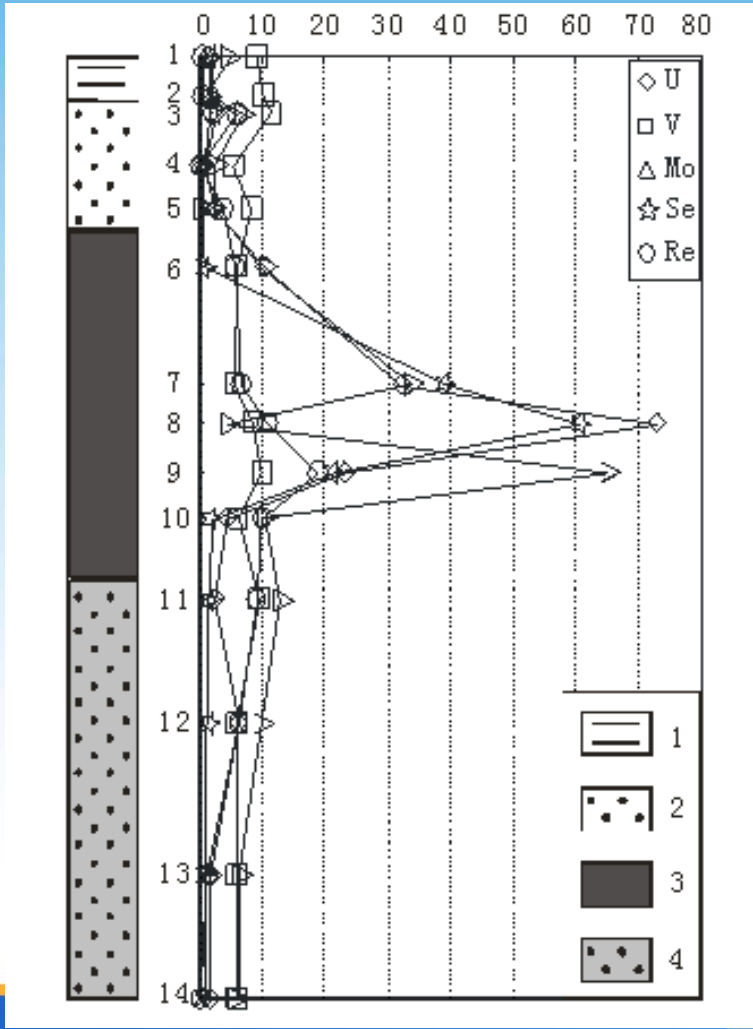

# 3 Progress in Ordos Basin

**Uranium found in the redox zone: formed by both paleo-phreatic and interlayer oxidation processes.**

# 3 Progress in Ordos Basin

➢**Redox condition:**

**Vertical Zonations: Indicating the paleo-phreatic oxidation process**



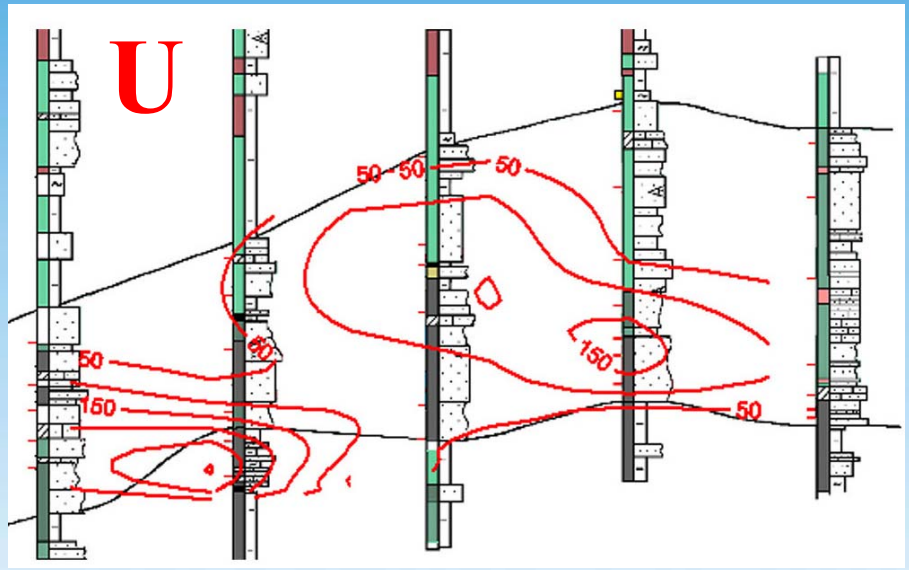

**Vertical Zonations: U、V、Mo、Se、Re**

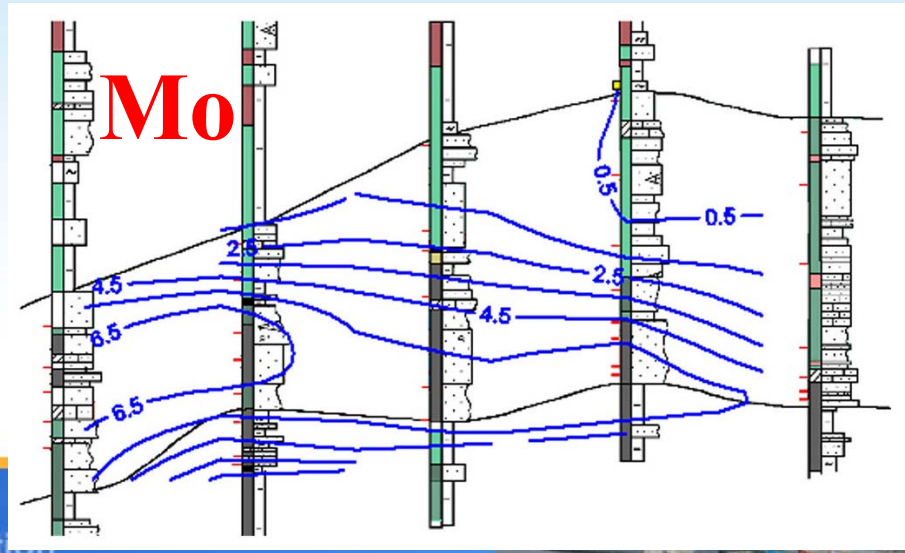
# 3 Progress in Ordos Basin

➢**Redox condition:**

**Horizontal Zonations indicating interlayer oxidation process:**

**U、V、Mo、Re、S …**



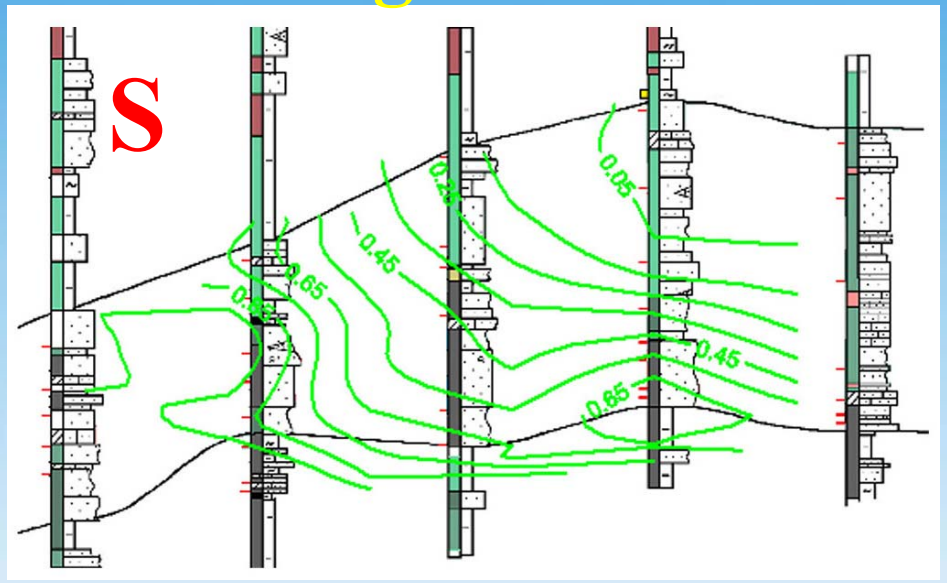
# 3 Metallogenic Conditions

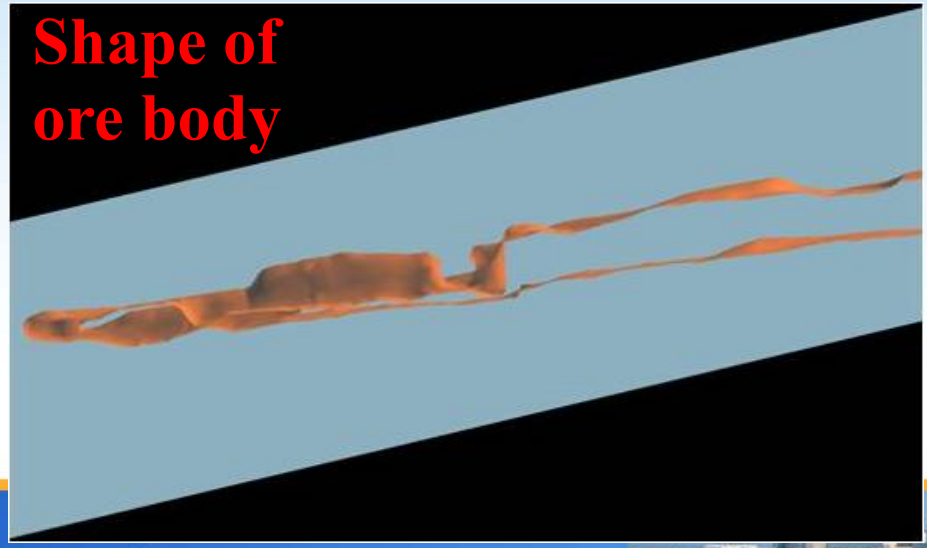
## ➤ Subsequent reworking conditions

➢**Redox condition:**

**Horizontal Zonations:**

**U、V、Mo、Re、S …**



# 3 Progress in Ordos Basin

- **Geochemical indication**

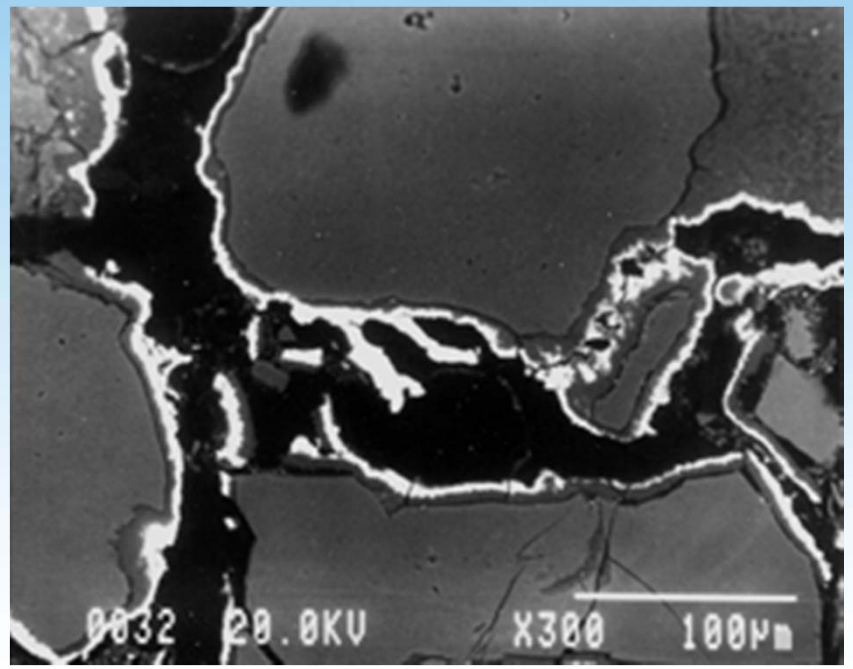
| Elements | CaO | $CO_2$ | S | $Fe_2O_3$/ FeO | U |
|---|---|---|---|---|---|
| Greenish S. | 3.96 | 2.83 | 0.04 | 0.41 | 3.4 |
| Grey S. | 1.64 | 1.02 | 0.75 | 0.12 | 14.3 |

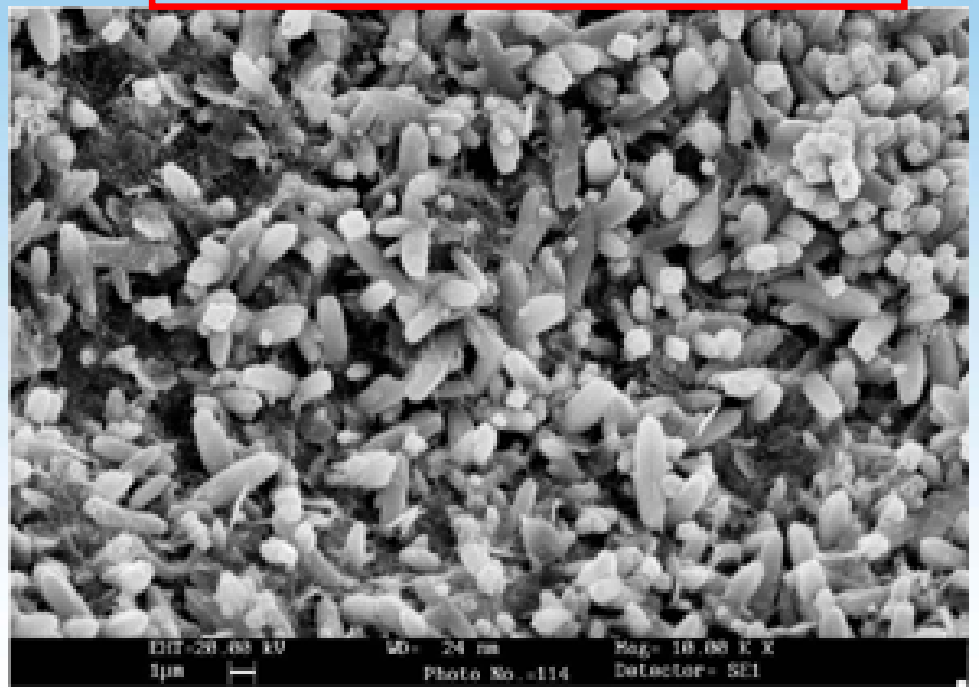


# 3 Progress in Ordos Basin

- **Coffinite dominant, not pitchblende**

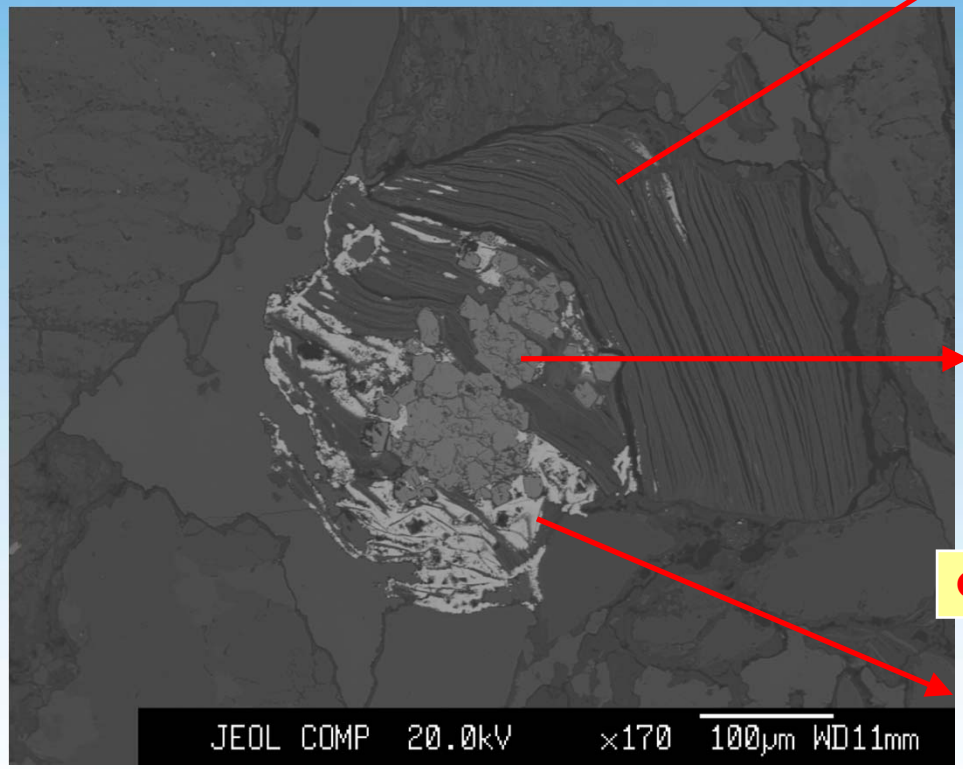
**Coffinite crystal**

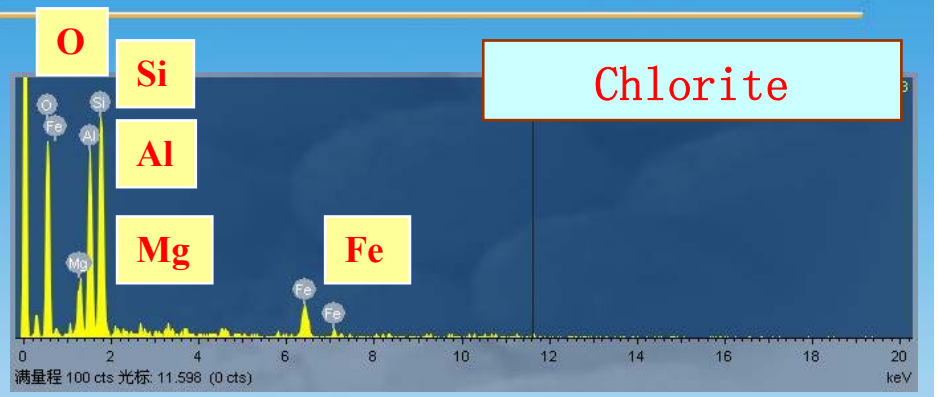


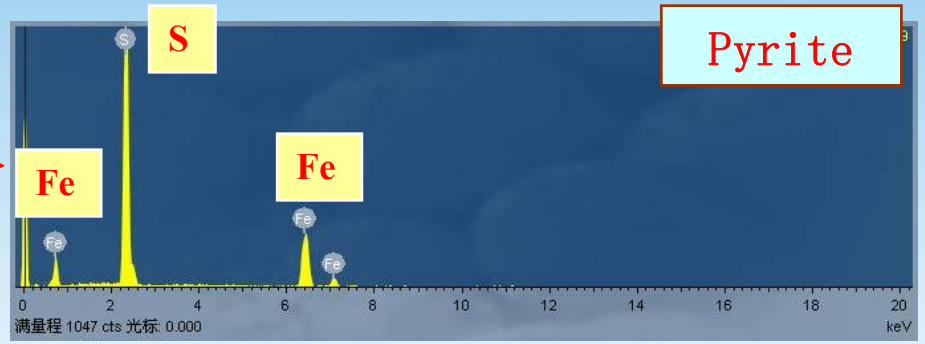



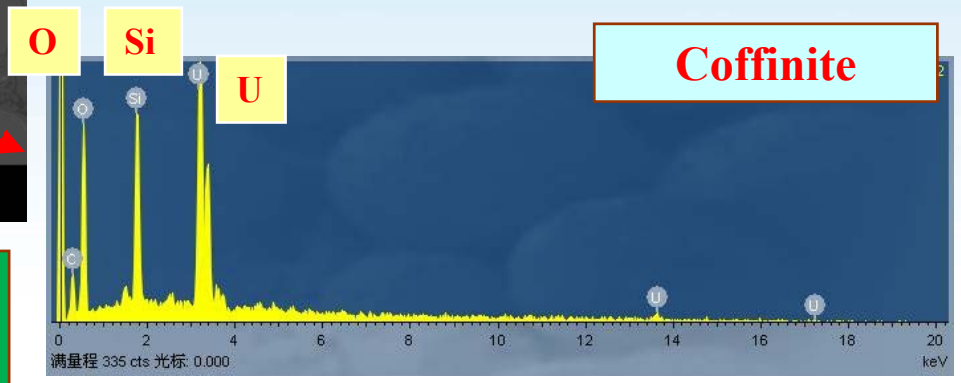


# 3 Progress in Ordos Basin



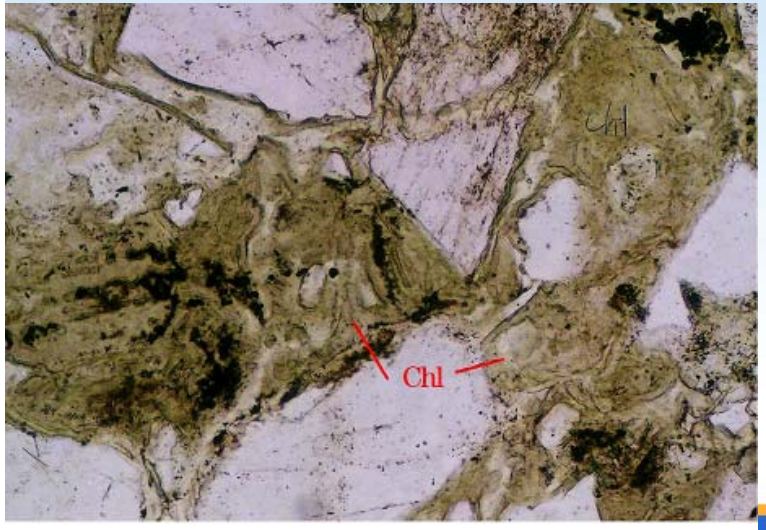

**Coffinite with chlorite and pyrite**

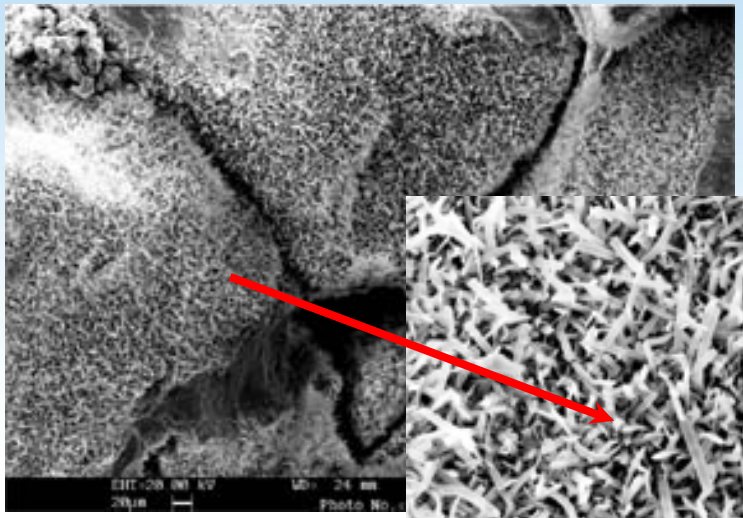
# 3 Progress in Ordos Basin

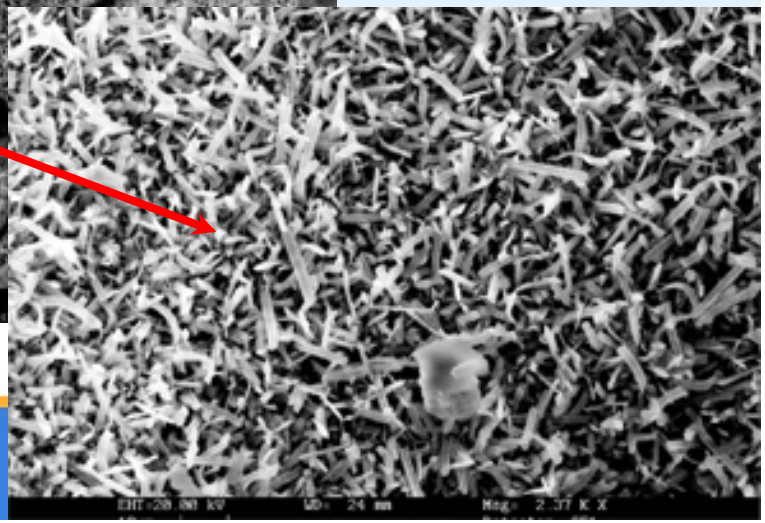
- **Origin of greenish sandstone: Secondary reduction processes:**

**Secondary reduction processes: Took place after the formation of uranium deposit**

**Green or gray-green sandstones: Paleo-oxidation zone ← chloritization and epidotization.**



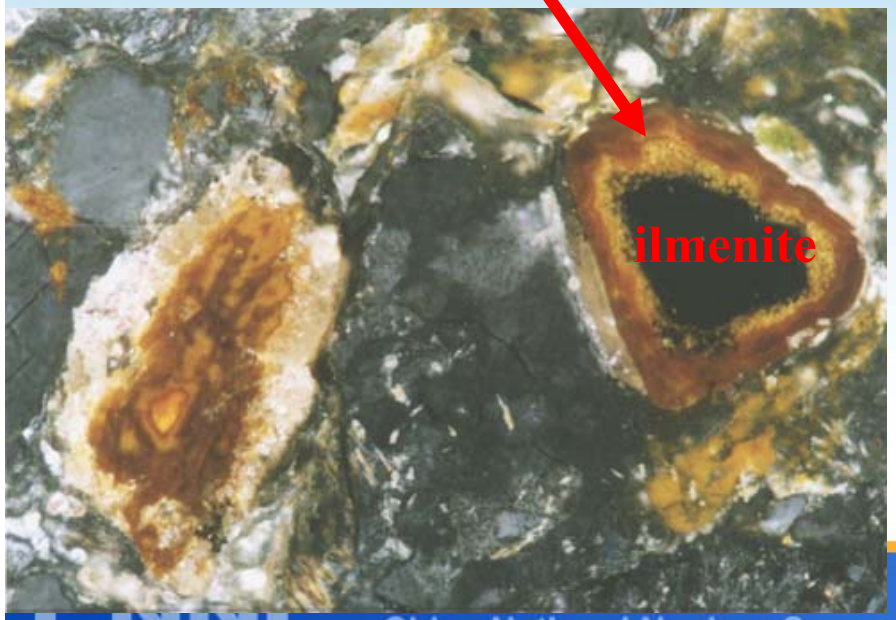



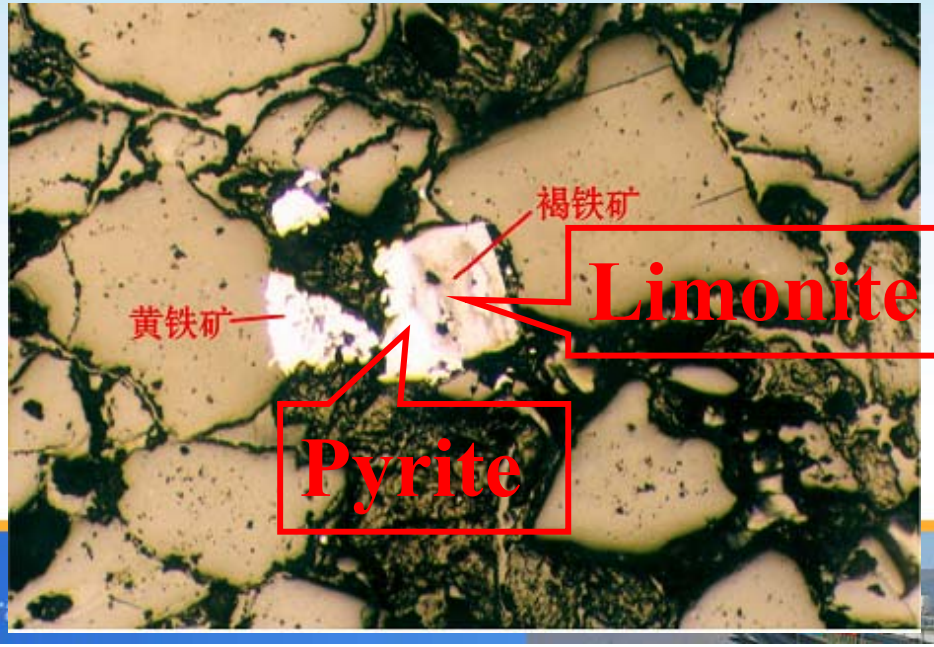


# 3 Progress in Ordos Basin

- Secondary processes: reduction Mineralogical evidence

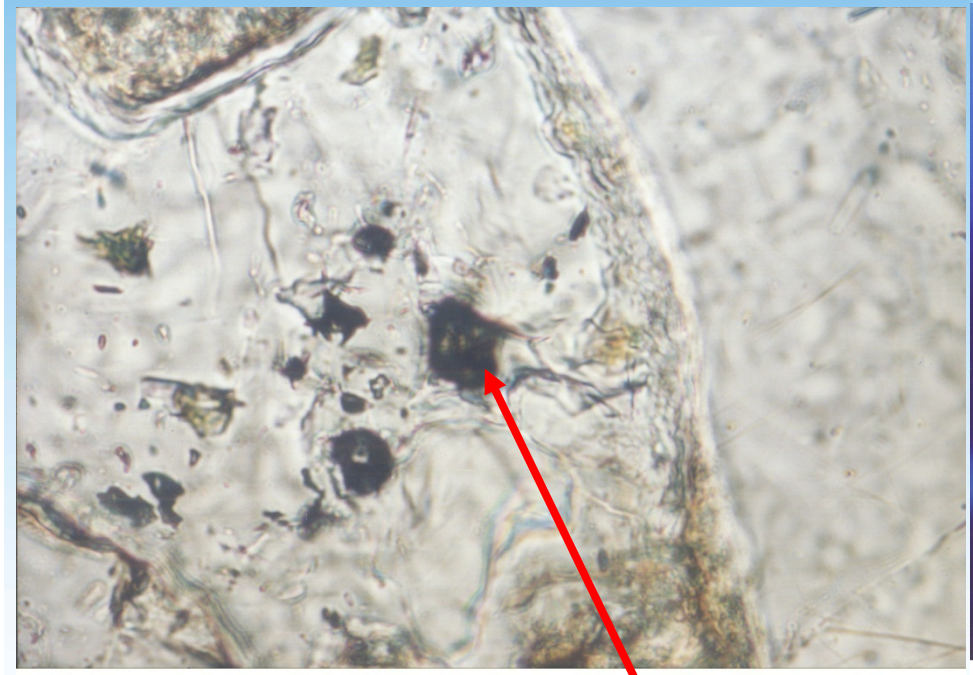
Oxidized ilmenite



# 3 Progress in Ordos Basin

## The greenish alteration is related to oil and gas secondary reduction processes.



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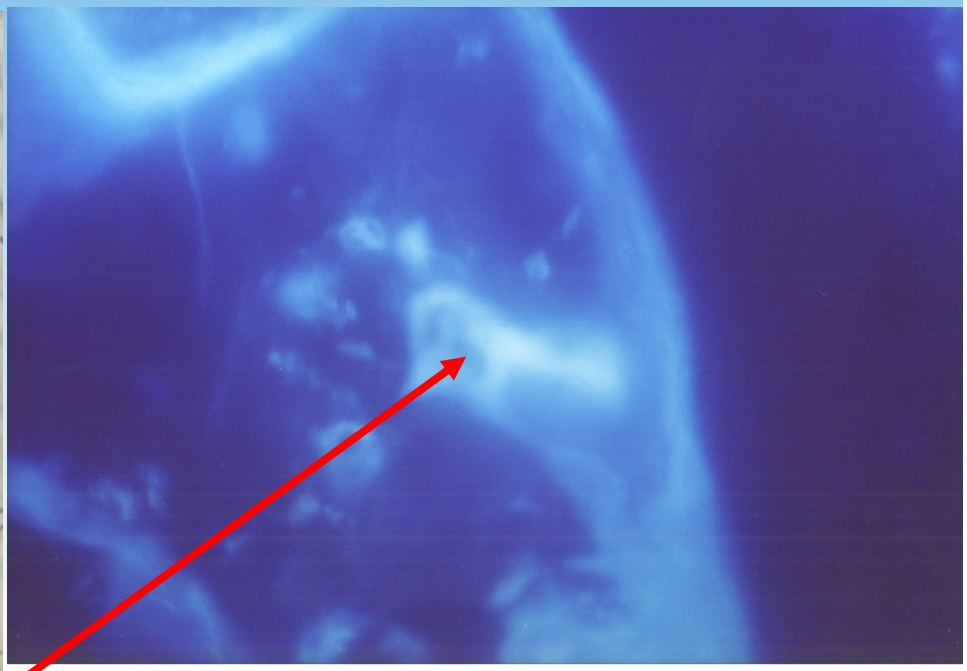
|---|---|---|
| 样品号：ZK16-40-09， | 井号：ZK16-40 | 井深：43.9m |
| 赋存岩矿：胶结方解石 | 放大：630× | 底片号：2270-5、6 |
| 包裹体特征：原生、呈灰色、淡黄-灰色的气烃、气液烃包裹体，显示蓝白色荧光。 | | |



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|---|---|---|
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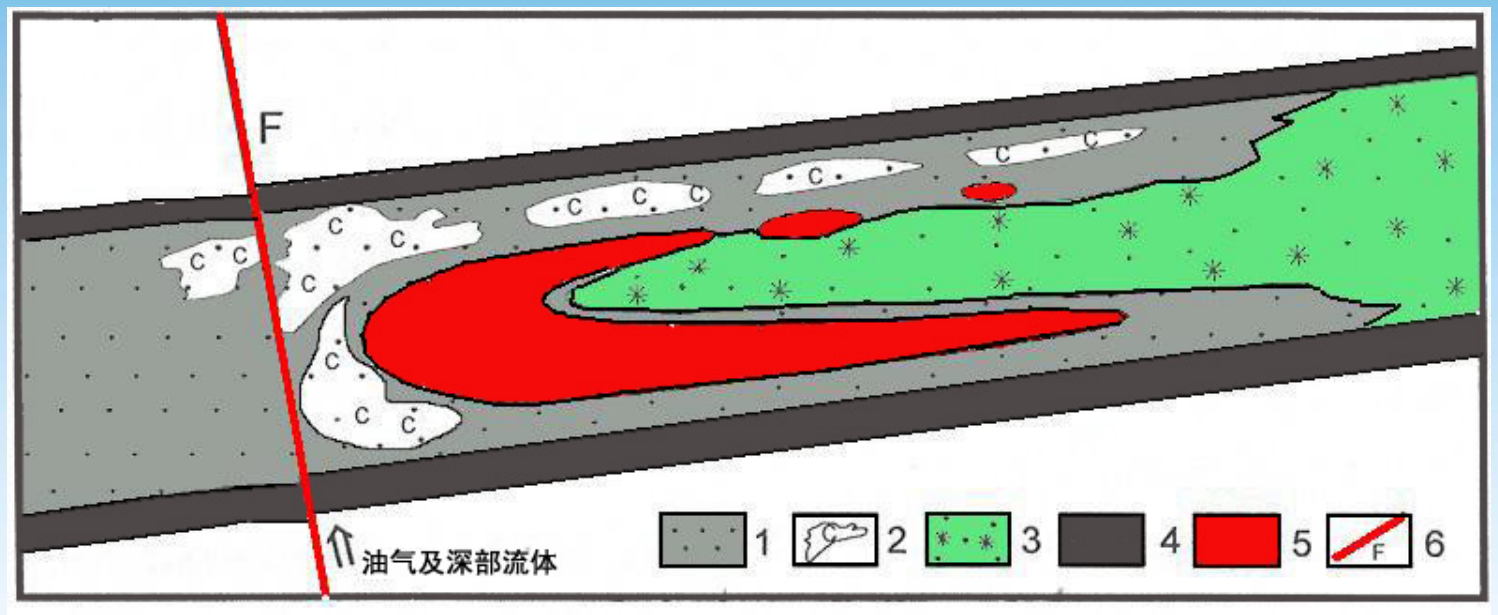
**Oil-Gas Inclusions**

# 3 Progress in Ordos Basin

## ➢New Metallogenic and Exploration Models




**Uranium deposit Models in Dongsheng area, Ordos Basin, N China**

# 4 Conclusion

1 China nuclear power development is stimulating exploration for uranium resources.

2 Big progress on exploration for sandstone-hosted uranium deposits have been made for recent years.

3 The combined exploration techniques are effectively used for locating ore beds and targeting uranium mineralization.



# 4 Conclusion

**4 Metallogenic models have played important roles in expansion and new discoveries of u-deposits.**

**5 Uranium is very mobile and can be enriched in the different types of rocks.**

**6 Greenish sandstone is due to chlorite alteration by secondary reduction process related to oil and gas and can be used to indicate uranium mineralization.**



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# 谢　谢!

# Thank you