Recent Progress in the Sedimentary Evolution of the Mesozoic Qiangtang Basin, Tibet, SW China*

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Abstract

A paleoweathering-crust regolith from decimeters to a meter thick was discovered recently in the Qiangtang Basin, overlying diachronously upon the Upper Triassic (?) Xiaochaka Formation and its underlying strata, including the Permian-Carboniferous. The regolith was then onlapped by the continental volcanic rocks, sedimentary-volcaniclastic rocks, and alluvial-fluvial sandstones and conglomerates from the Nadigangri Formation. Obviously the Nadigangri Formation represents the onset of a new sedimentary succession in the Qiangtang Basin. The SHRIMP zircon U-Pb isotopic dating gives the ages of 219.5 ± 2.1 Ma and 219 ± 2 Ma for the basalt and granodiorite from central Qiangtang, and 216.8 ± 2.1 Ma and 217.3 ± 2.5 Ma for the vitric tuff and crystal tuff from the Shenglihe and Wanghuling regions in the central and northern Qiangtang Basin. All these age determinations imply that the Nadigangri Formation's volcanic rocks, and then the onset of the Mesozoic Qiangtang Basin should be of Late Triassic, rather than just Early or Middle Jurassic, as reported previously. The deposition displayed a transition from the continental to marine sedimentary environments during the early evolution of the Mesozoic (i.e., T3-K1) Qiangtang Basin. The sedimentary onlapping started with the alluvial-fluvial sedimentation, accompanied by magma intrusion, volcanic eruption and pyroclastic deposition. This was followed by a basin-wide rapid subsidence and development of marine-dominated succession, including carbonates over 1200 meters thick. The new basin model implied a different evolution of hydrocarbon systems in the basin.

Recent progress in the sedimentary evolution of the Mesozoic Qiangtang Basin, Tibet, SW China

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Houston, US, 10 -13th April, 2011

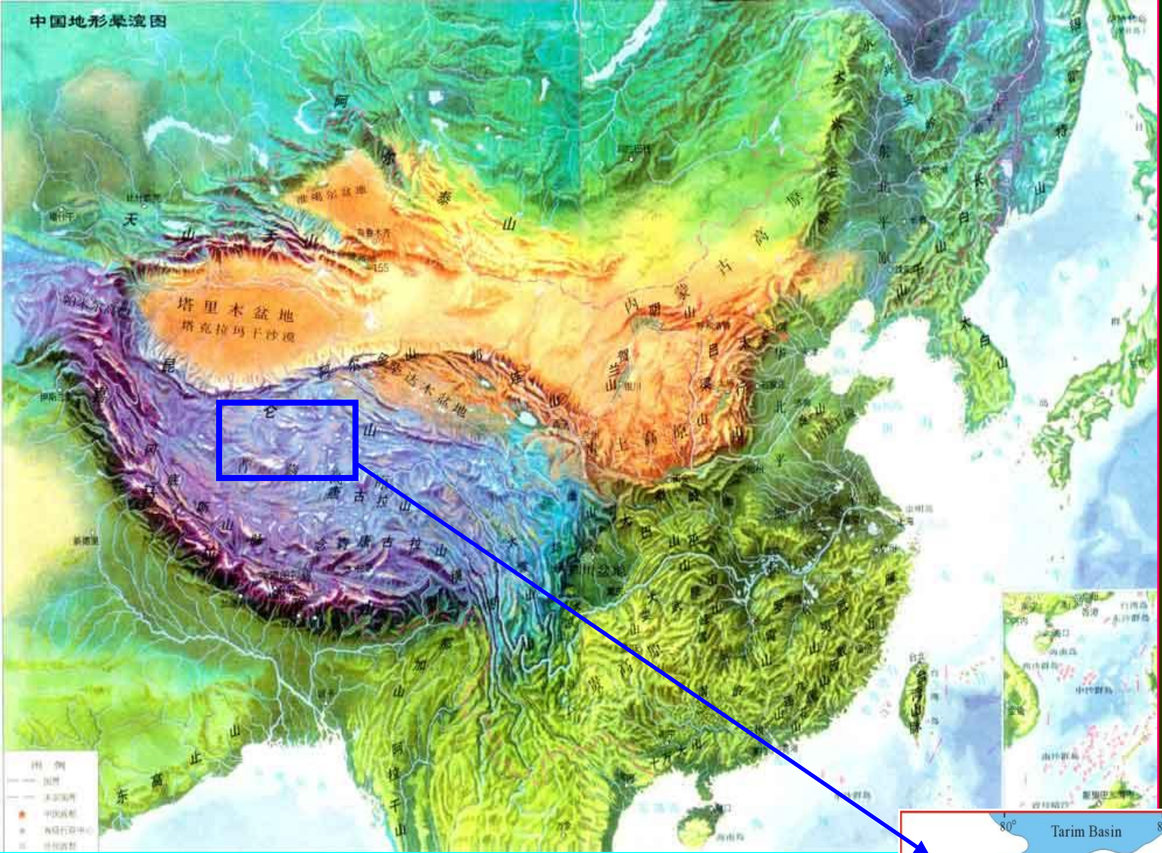
Through collaborations with
T. Z. Duan, X. G. Fu, F. W. Tan, M. Chen and J. L. He

OBJECTIVES

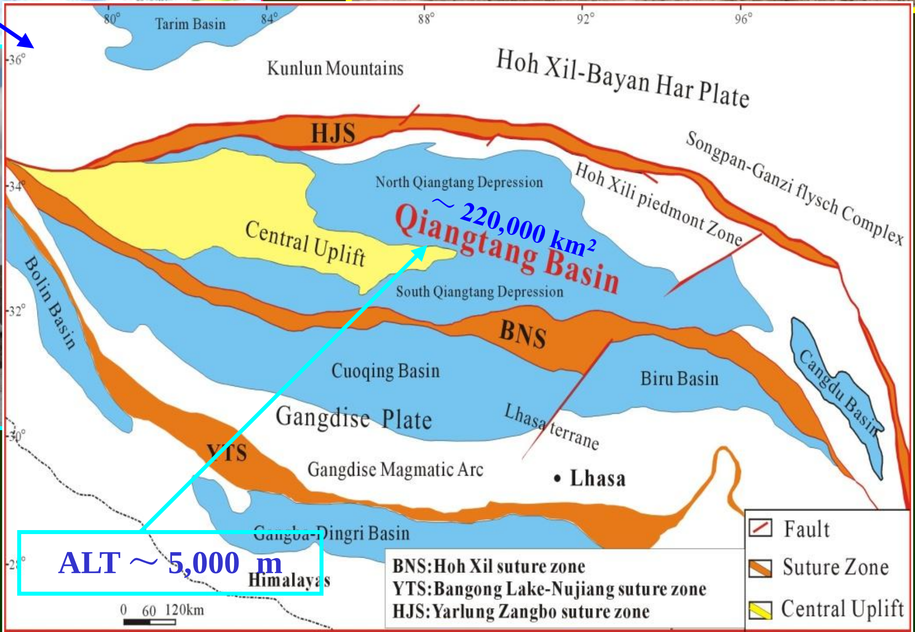
Introduce the depositional sections and paleogeographical maps of the Mesozoic Qiangtang Basin so as to provide a basic understanding for the basin evolution.

Present a new model for the Mesozoic Qiangtang Basin and its implication to hydrocarbon resources.

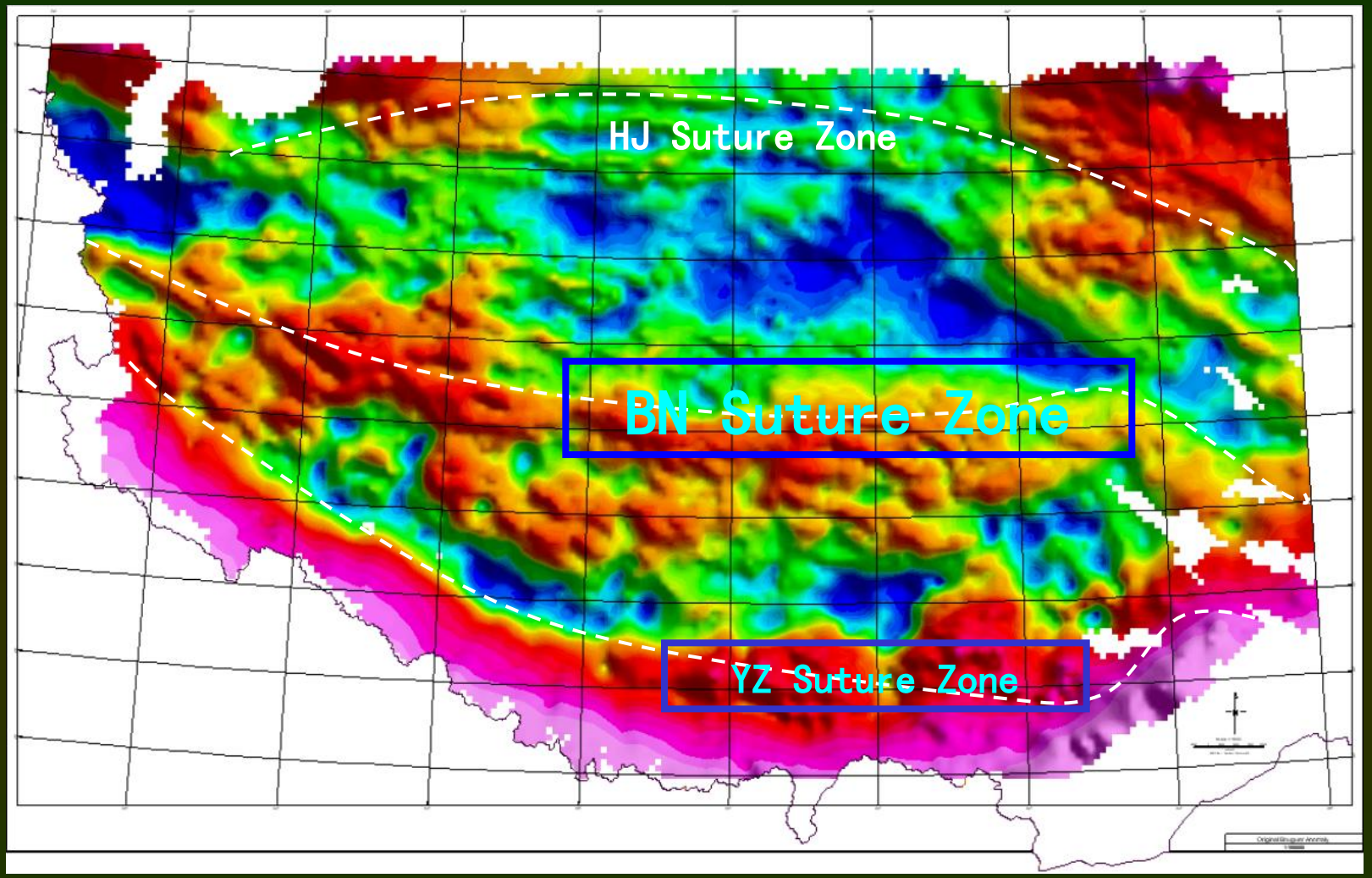
Part 1 Geological Setting


中国地形晕渲图
塔里木盆地
塔克拉玛干沙漠

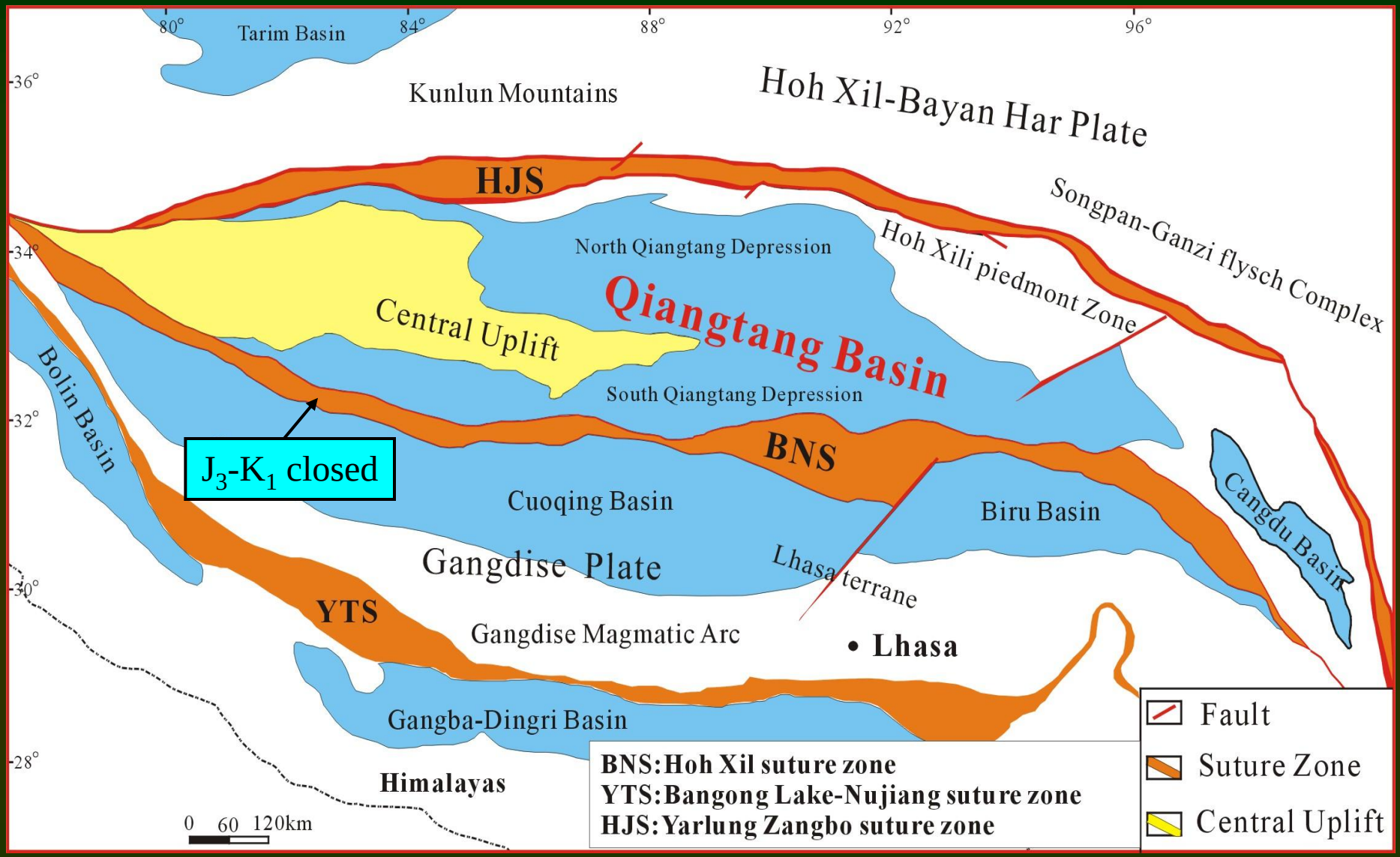

Very difficult to work here !!!


Tarim Basin
Kunlun Mountains
Hoh Xil-Bayan Har Plate
HJS
Songpan-Ganzi flysch Complex
North Qiangtang Depression
Hoh Xili piedmont Zone
Central Uplift
～ 220,000 km²
Qiangtang Basin
South Qiangtang Depression
Bolin Basin
BNS
Cuoqing Basin
Biru Basin
Cangdu Basin
Gangdise Plate
Lhasa terrane
YTS
Gangdise Magmatic Arc
• Lhasa
Gangba-Dingri Basin
Himalayas
ALT ～ 5,000 m
BNS:Hoh Xil suture zone
YTS:Bangong Lake-Nujiang suture zone
HJS:Yarlung Zangbo suture zone
Fault
Suture Zone
Central Uplift
0 60 120km
80° 84° 88° 92° 96°
36° 34° 32° 30°

The gravitational anomaly of the Tibet Plateau

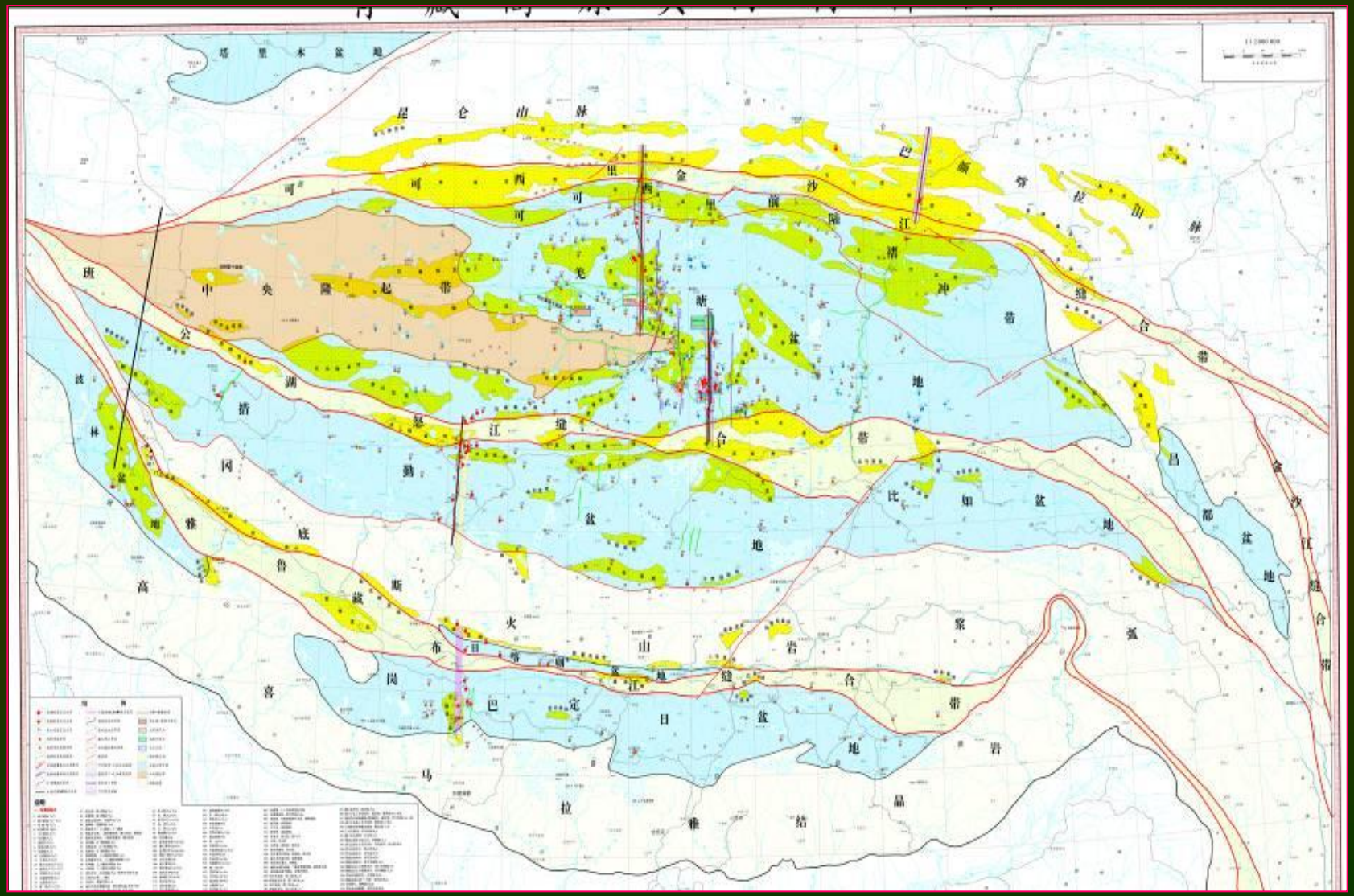


The previous research has disclosed that there are three major suture zones on the plateau: Yarlung Zangbo suture zone in the south; Bangong Lake-Nujiang suture zone in the middle, and Hoh Xil suture zone in the north.



The Bangong Lake-Nujiang suture zone was once a Mesozoic ocean which was opened around latest Triassic and closed during latest Jurassic to Early Cretaceous.

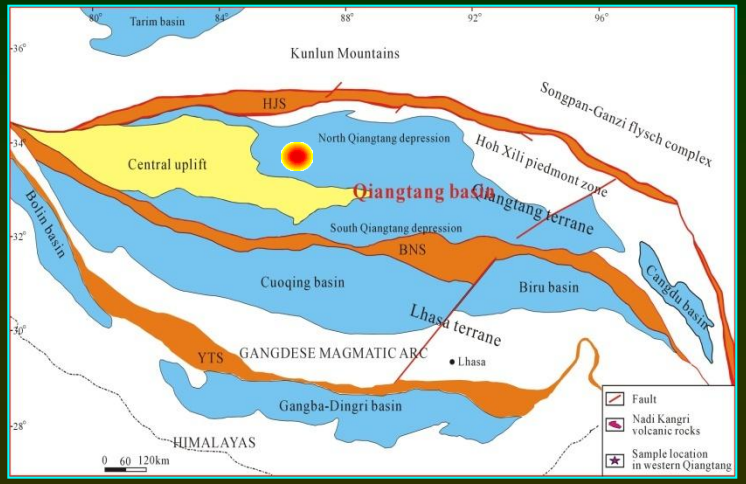
In recent years, we have finished 1:250,000 mapping of the whole basin, and thousands of km two-D seismic survey and non-seismic geophysical exploration, including gravity, magnetic and MT in the basin.

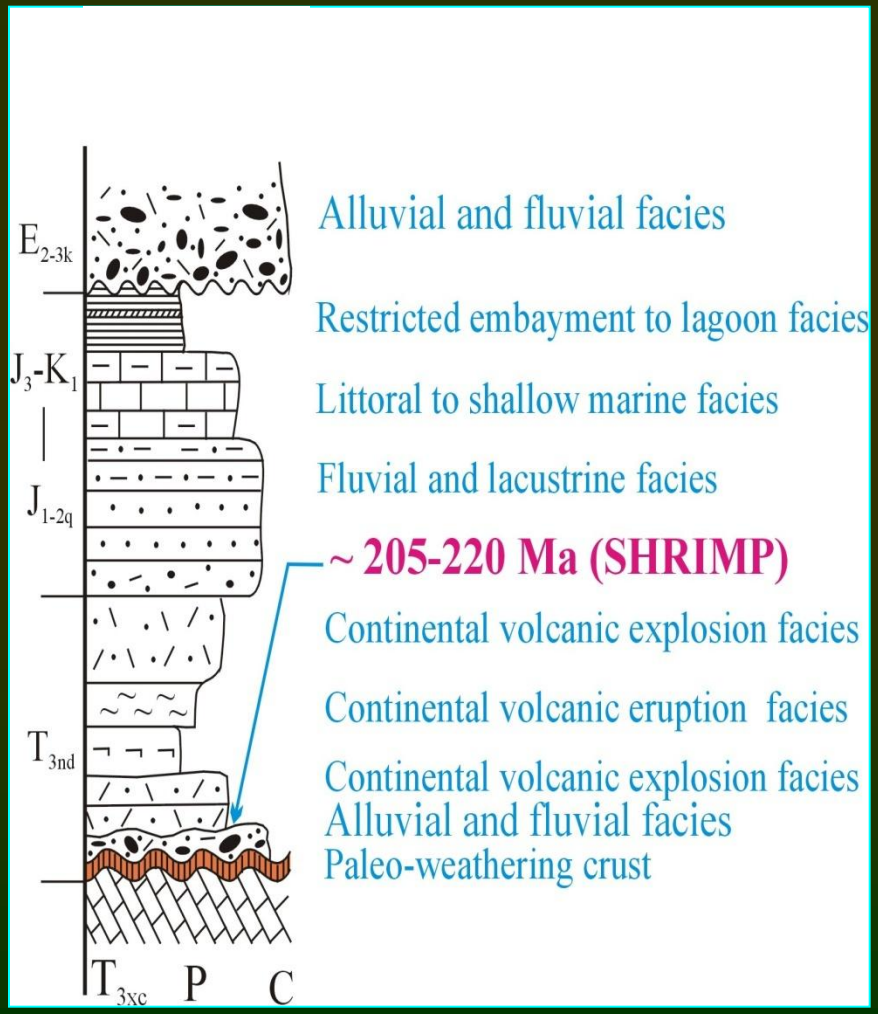


Part 2 Depositional Successions

From the bottom to top:

5. deep-sea facies and restricted gulf facies.
4. littoral to shallow-marine facies
3. fluvial and lacustrine facies
2. continental volcanic explosion and eruption facies
1. alluvial and fluvial facies

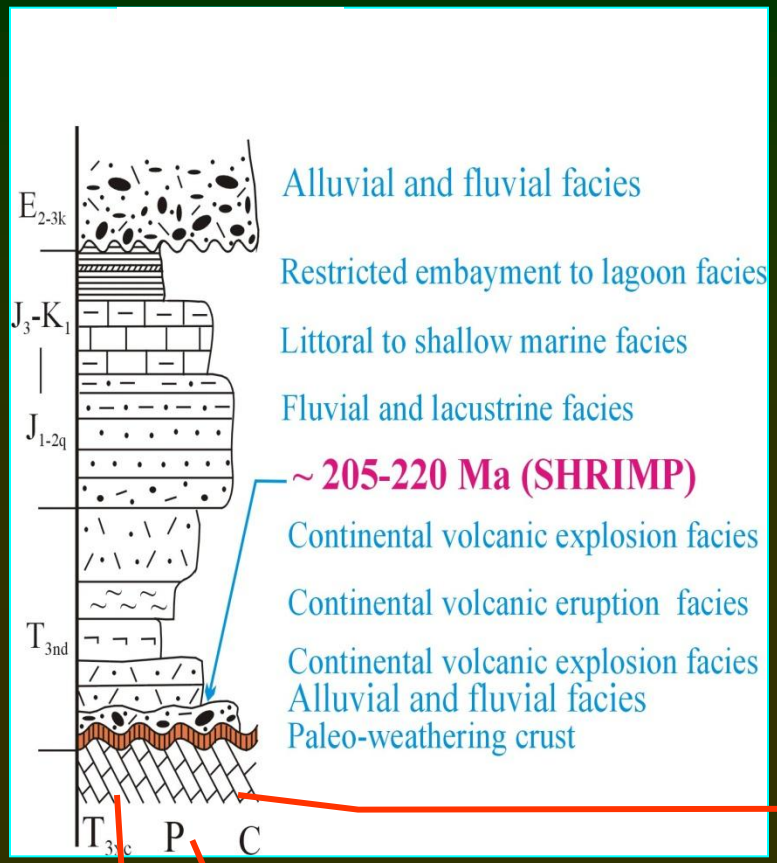


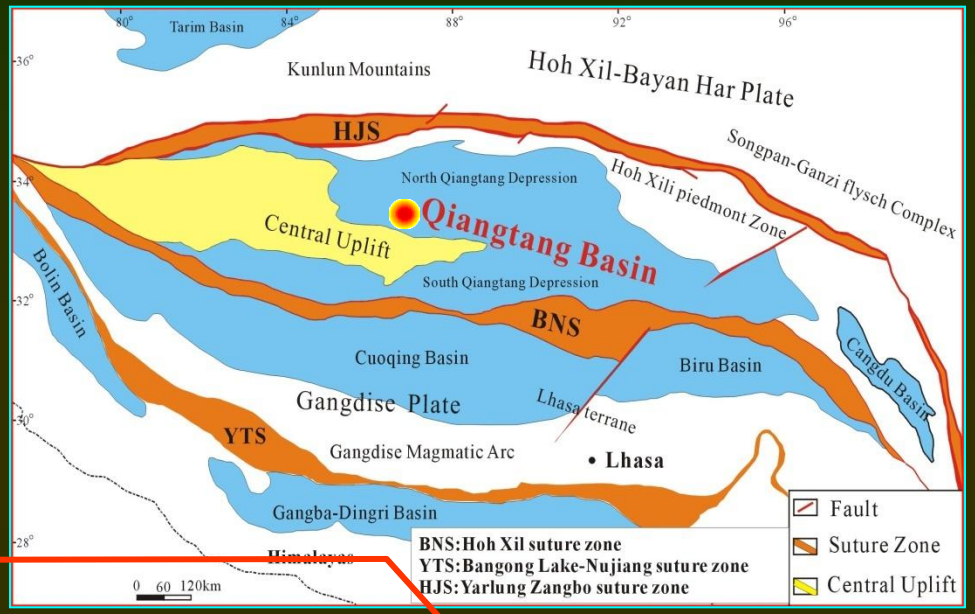


At the base is the paleo-weathering crust and angular unconformity. The alluvial and fluvial basal conglomerates of the Nadigangri Formation unconformably overlie the Carbonic, Permian strata and Xiaochaka Formation.

2.1 Pre-rifting: *unconformity and the underlying strata*

The strata below the unconformity consist of the Carboniferous tillites and Permian-Triassic carbonate rocks.



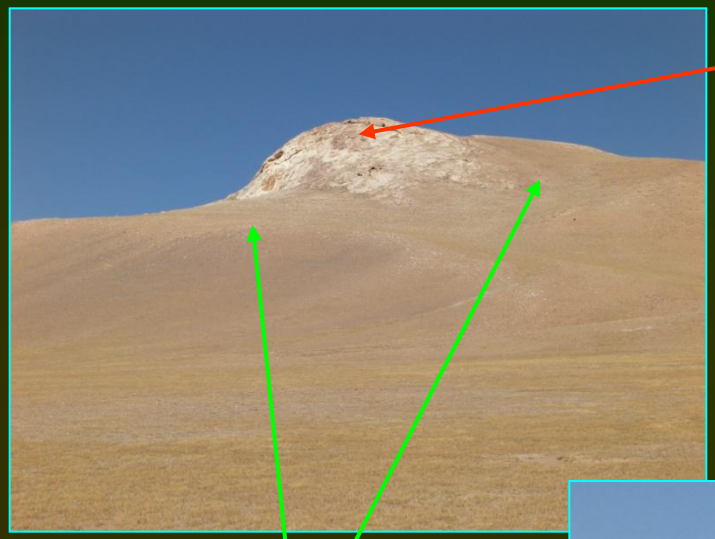


Late Triassic paleo-karst

Permian paleo-karst

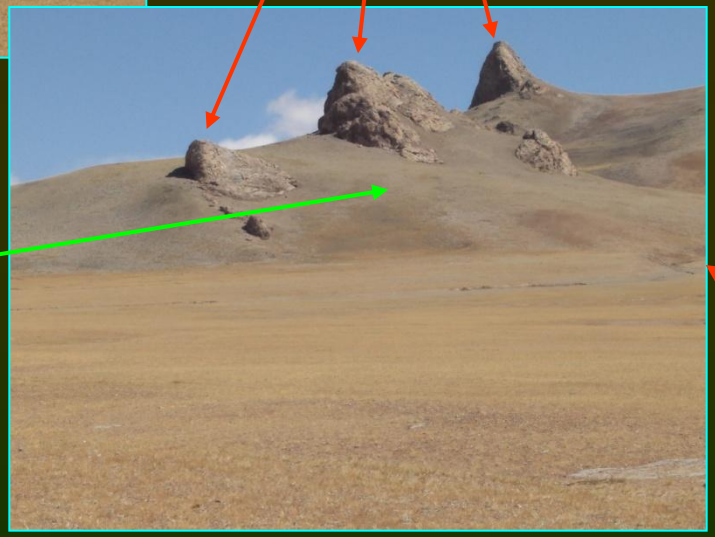
Carbonif. tillite

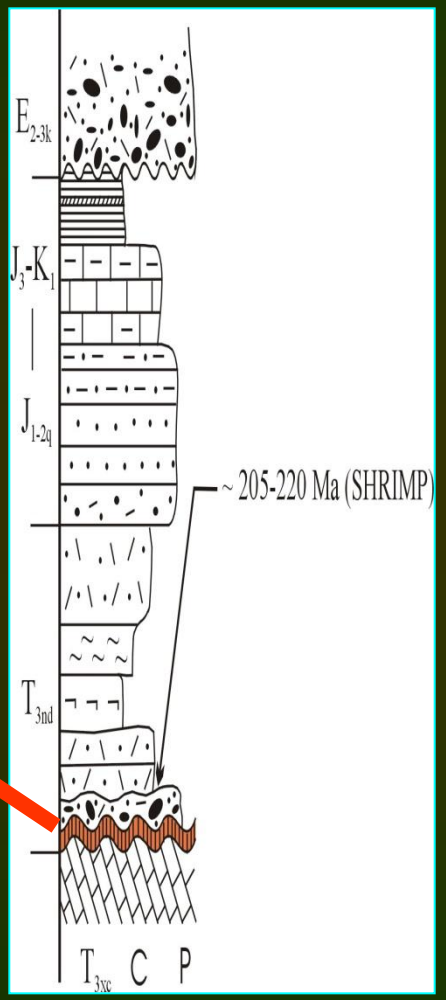
Paleo-weathering crust



underlying carbonate rocks

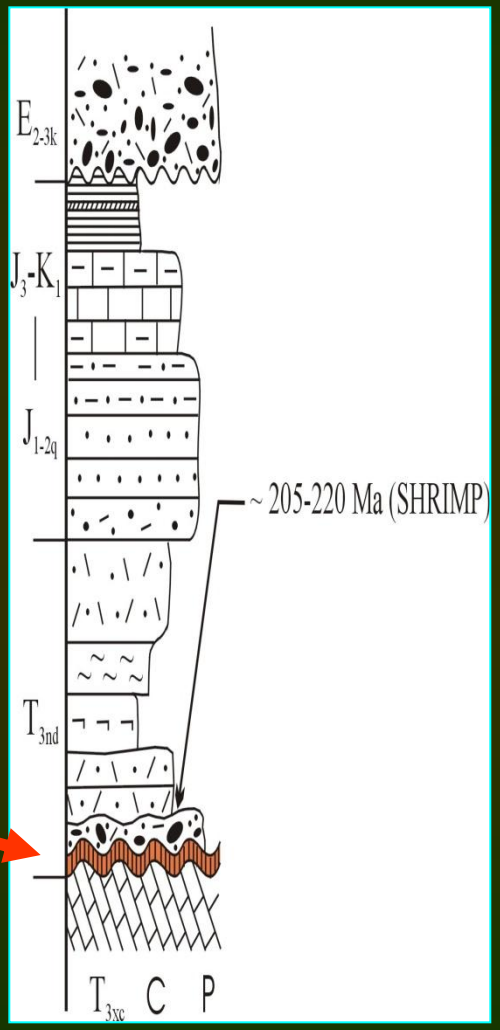
overlying volcanic-clastic rocks





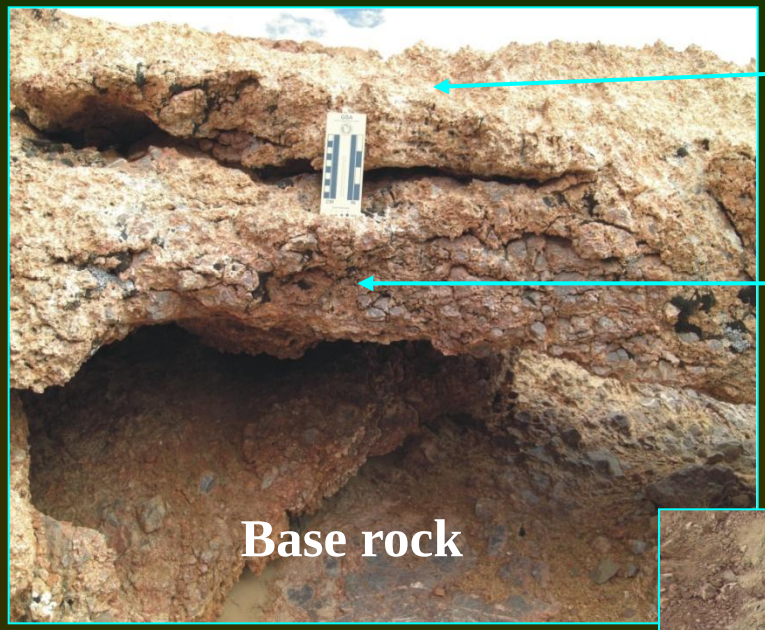
The continental volcanic clastic rocks and alluvial/fluvial conglomerates are overlapped unconformably on the Paleozoic and Triassic carbonate rocks .

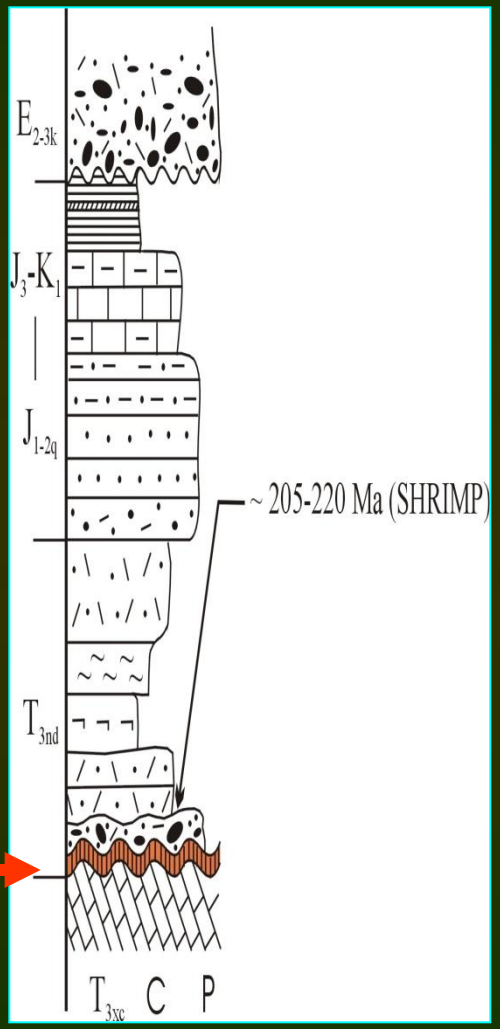
Paleo-karst occurred in the basal carbonate rocks



paleokarst cave structures

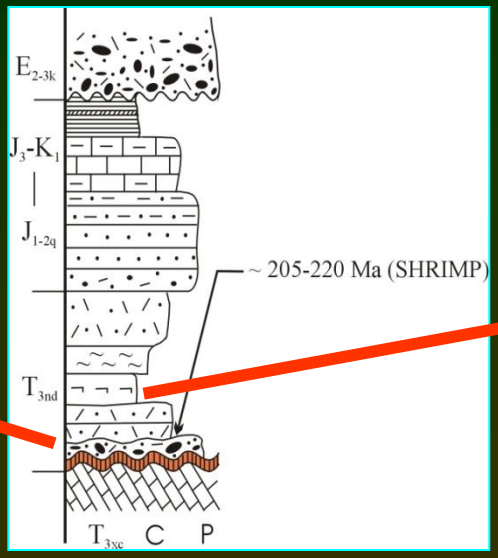
Cavity-filled breccias and weathering clay beds





2.2 Syn-rifting: *onlap sedimentation and bimodal volcanic deposits*

Fluvial conglomerate



Continental volcanic rocks

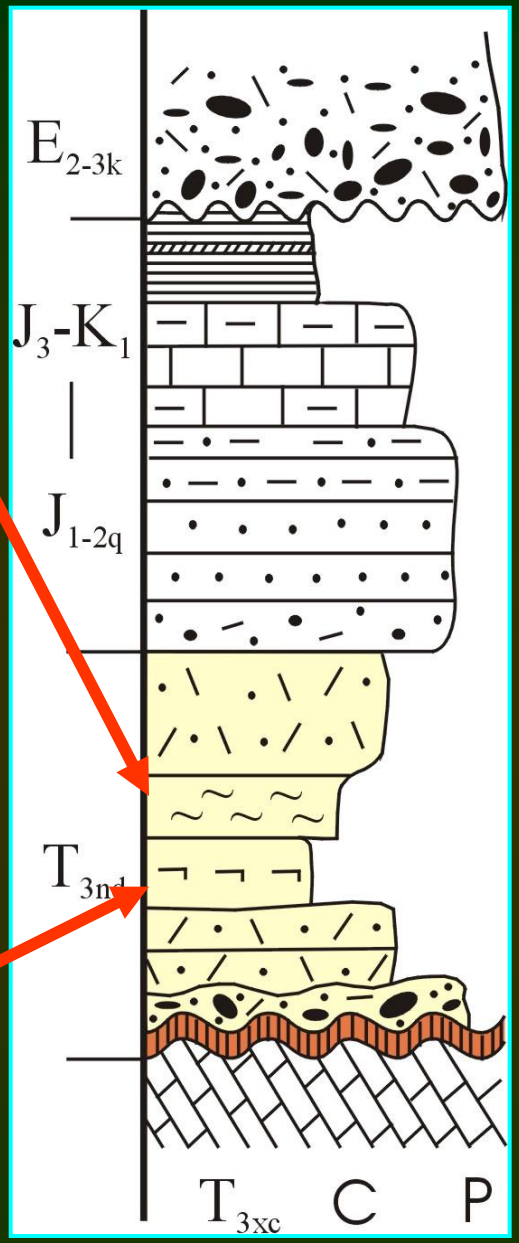
Above the unconformity, there are sedimentary basal conglomerate, or continental sedimentary-volcaniclastic rocks, or volcanics.

unconformity unconformity unconformity

Permian paleo-karst

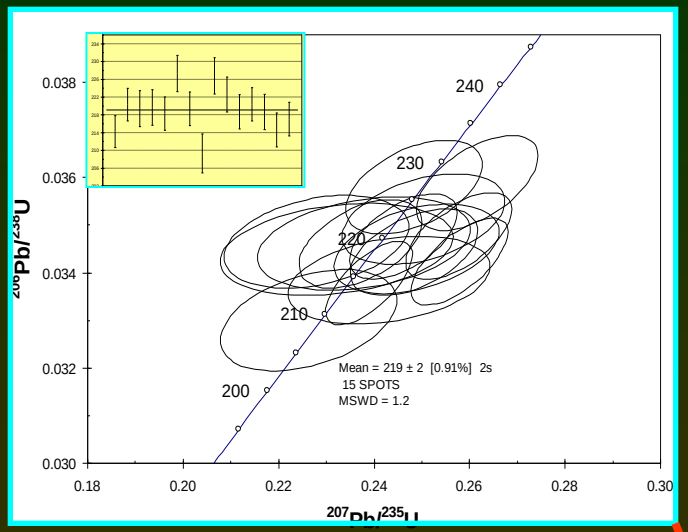
Carbonif. tillite

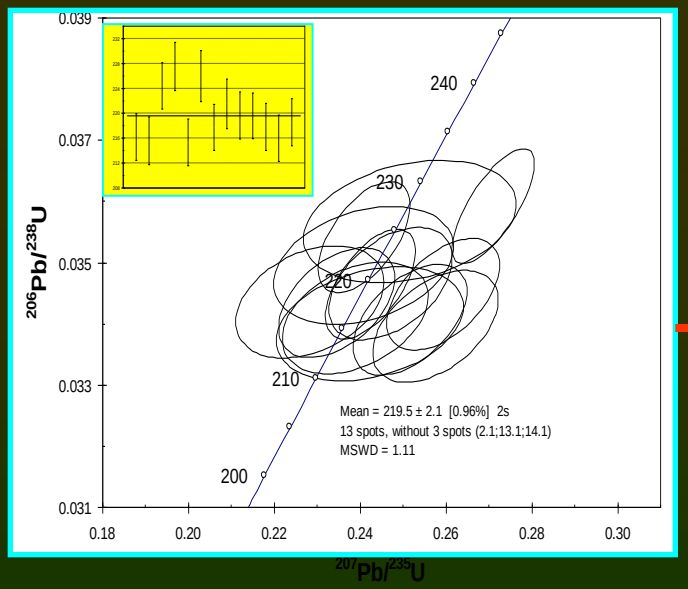
Late Triassic paleo-karst

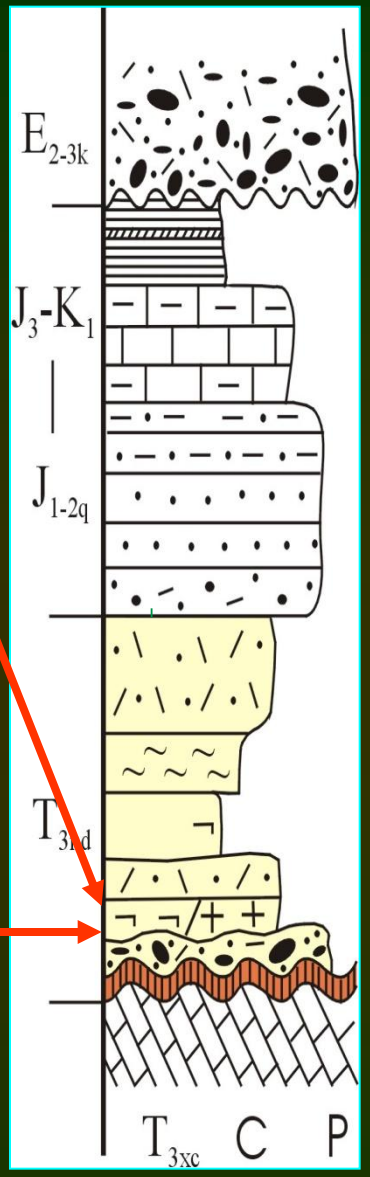


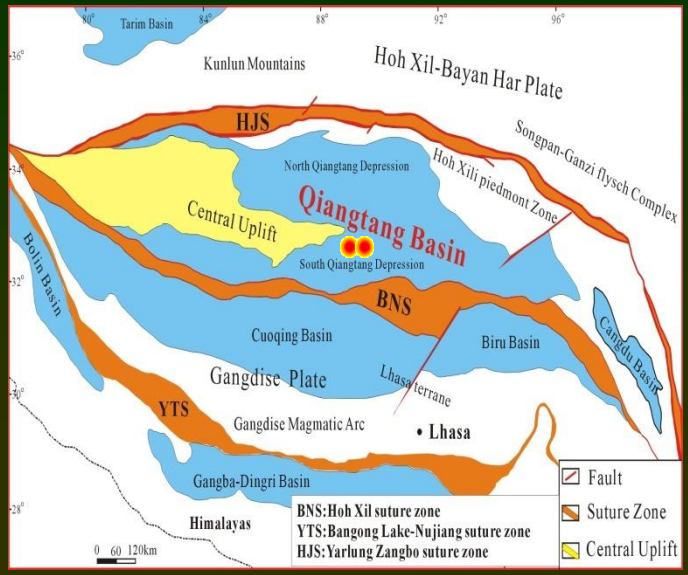
The succession of interbeded rhyolite and basalt represent one kind of bimodal volcanic rocks related to the rifting.

linear-flow structures in rhyolite, and columnar cleavage and vesicular-amygdaloidal structures in basalt.





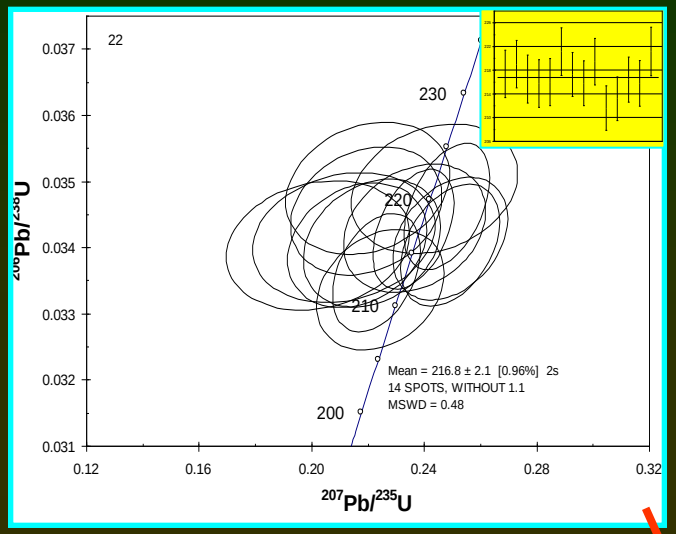


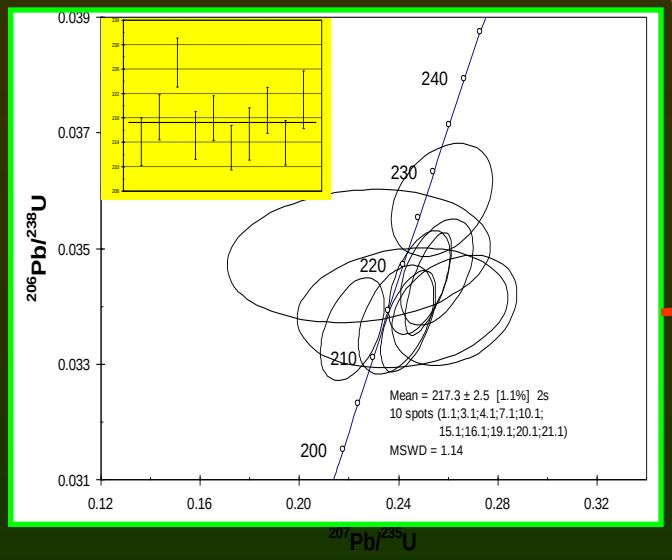


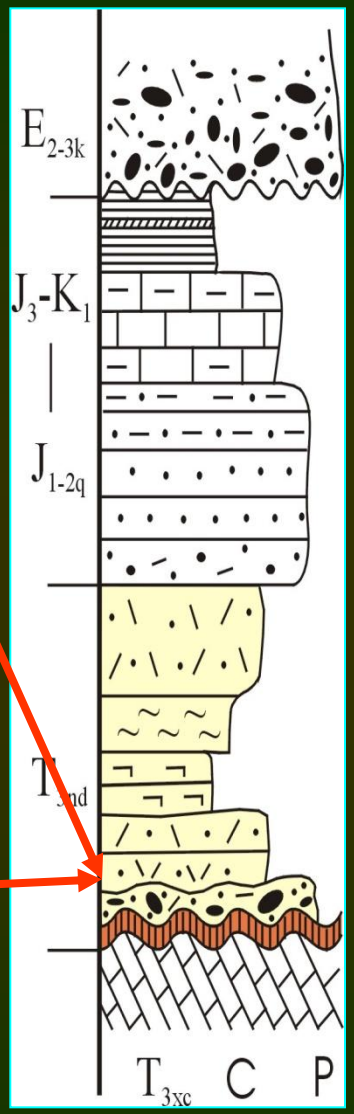
These two samples from Central Qiangtang Basin.

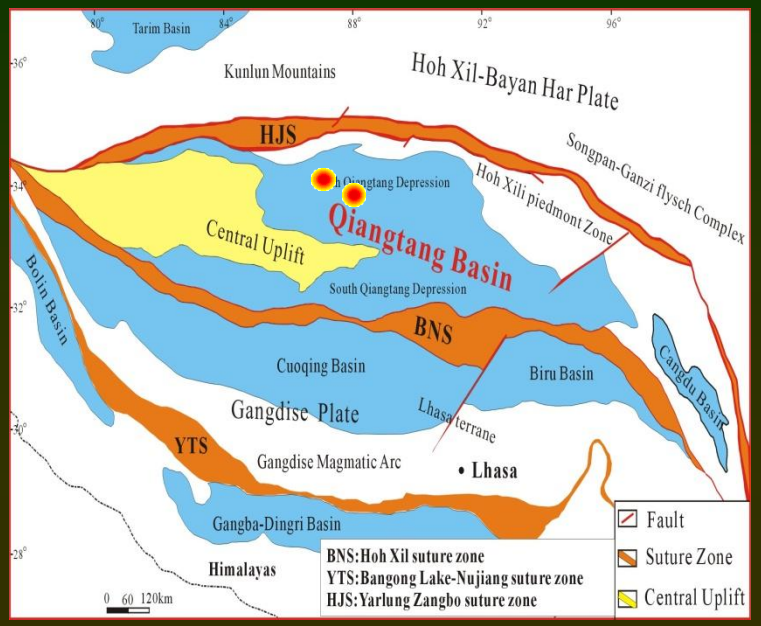
The zircon SHRIMP U-Pb isotopic ages of the basalt and granodiorite are dated about 219 and 219.5 Ma.

We have measured several samples of zircon SHRIMP uranium and lead isotopic ages from the basal part of the synsedimentary volcanic rocks.



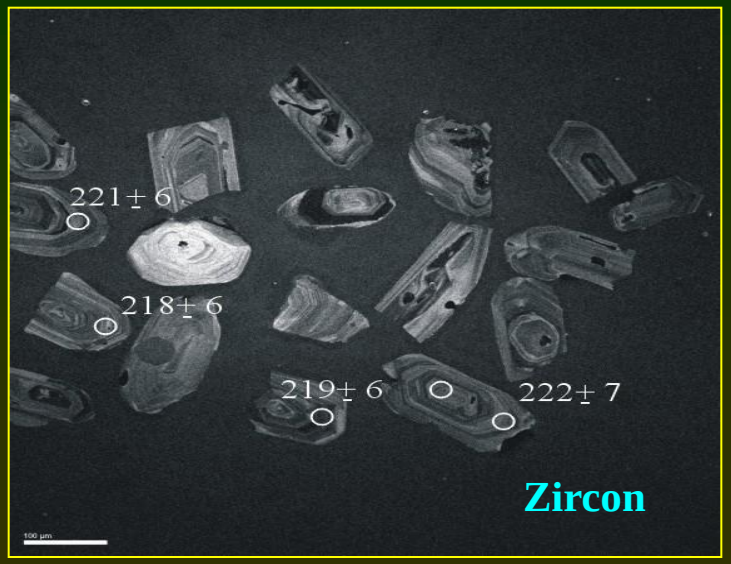


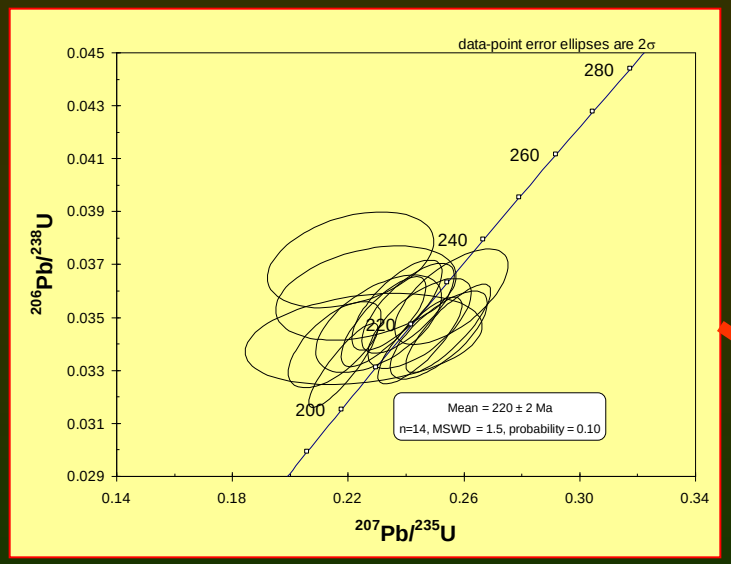


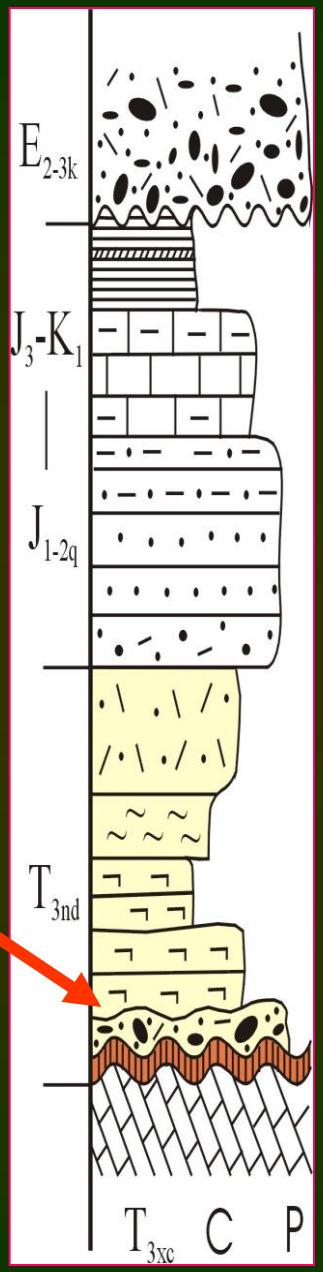


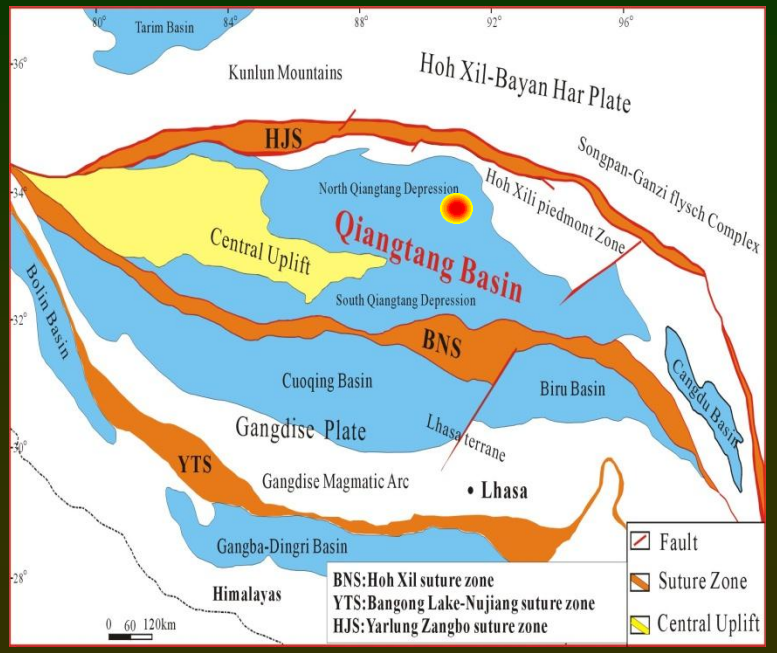
These two tuffaceous samples from Northwest Qiangtang Basin.

Their zircon SHRIMP U-Pb isotopic ages are dated around 217 and 219 Ma.



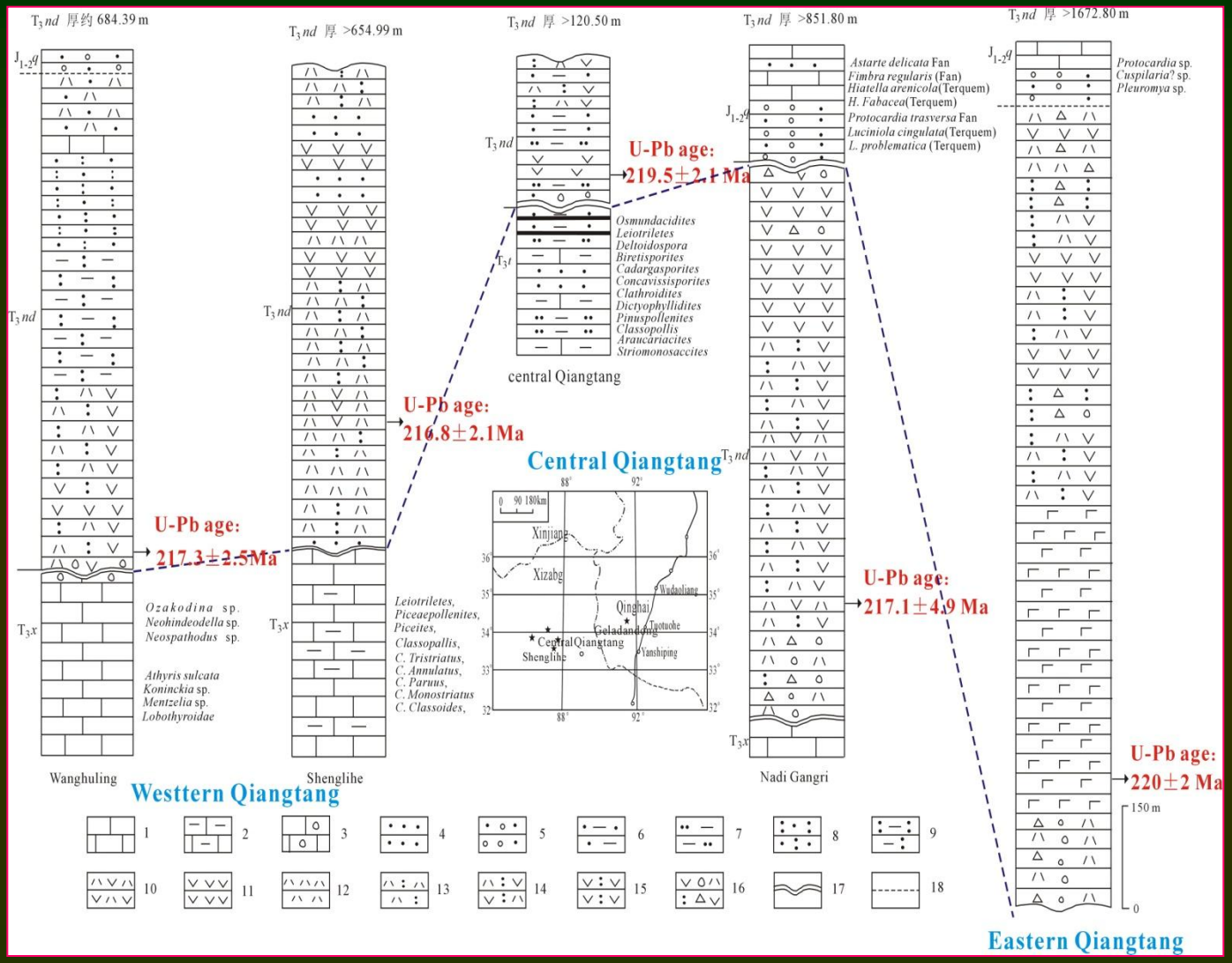






Tuffaceous sample from Northeast Qiangtang Basin

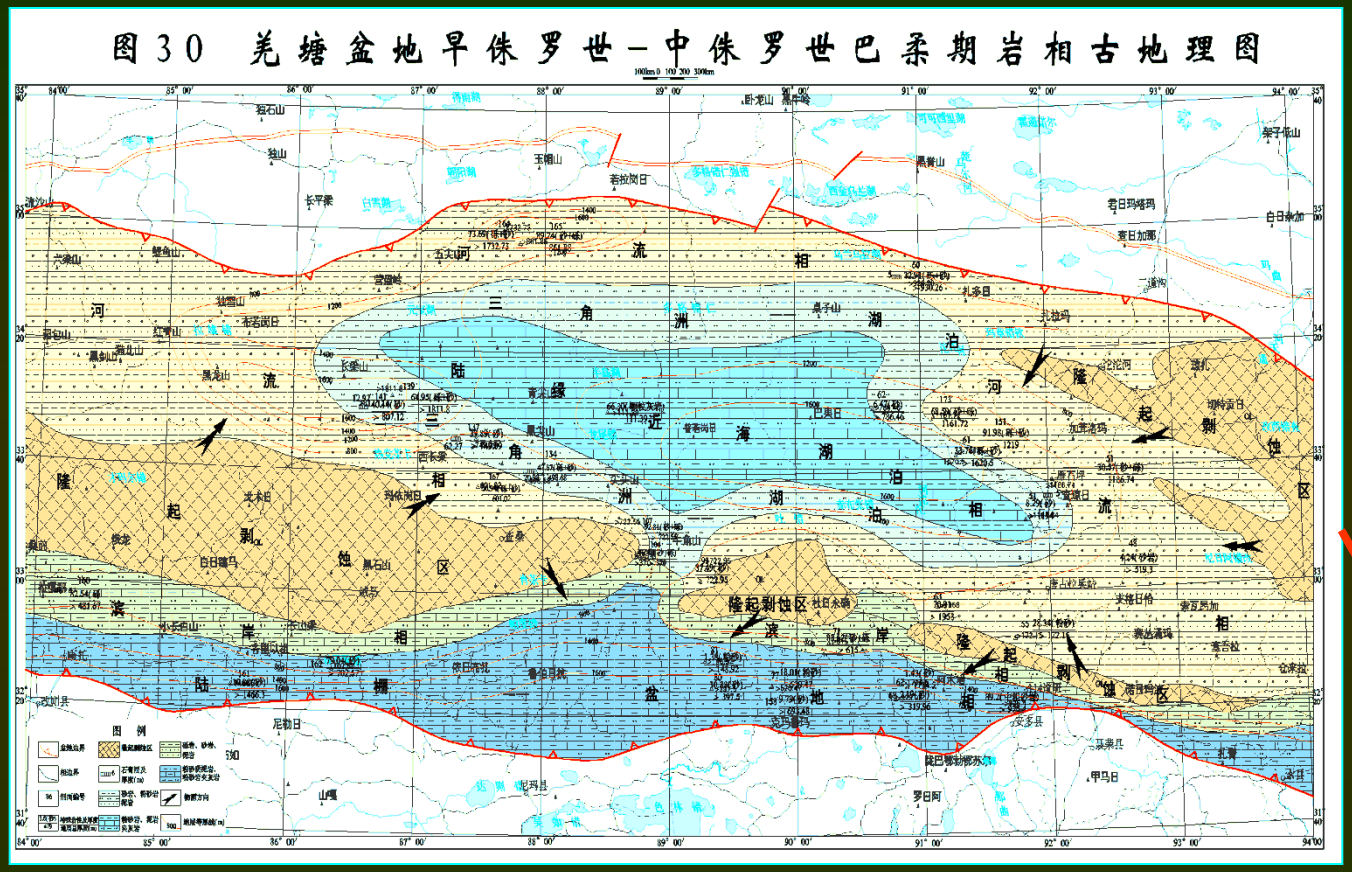
The Zircon SHRIMP U-Pb isotopic age is dated around 219 Ma.

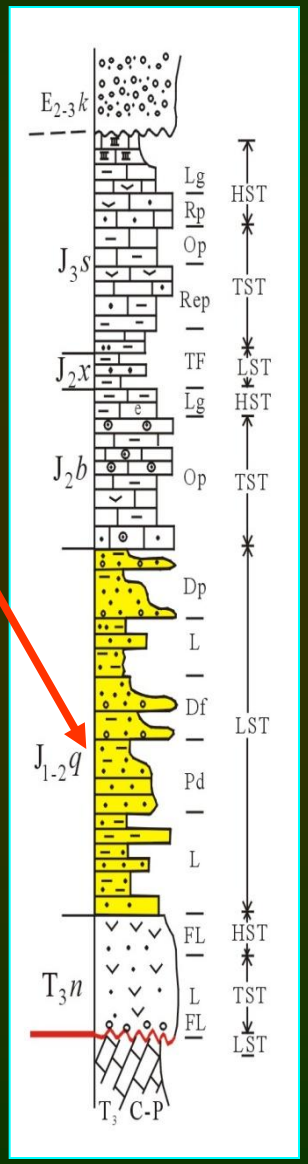


So, it follows that the Nadigangri Formation should be assigned to the Late Triassic rather than the previous Early-Middle Jurassic. On the other hand, the ages of the synsedimentary volcanic rocks which overlap upon the unconformity should represent the onset of the sedimentation of the Mesozoic Qiangtang Basin.

2.3 post-rifting: *carbonate-dominated succession(T_3 —K_1)*

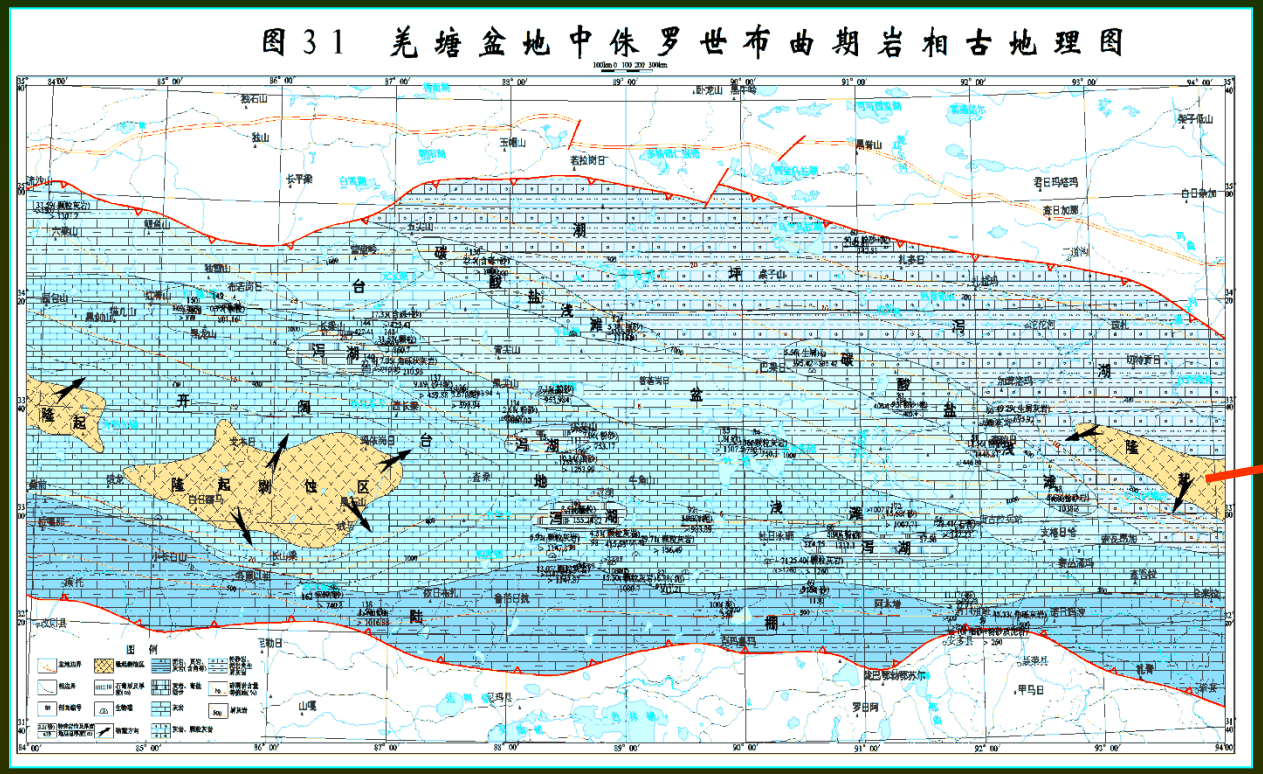
Lithofacies and paleogeographic map of the Early to early Middle Jurassic （i. e., the deposition of the Quemaco Formation), Qiangtang Basin

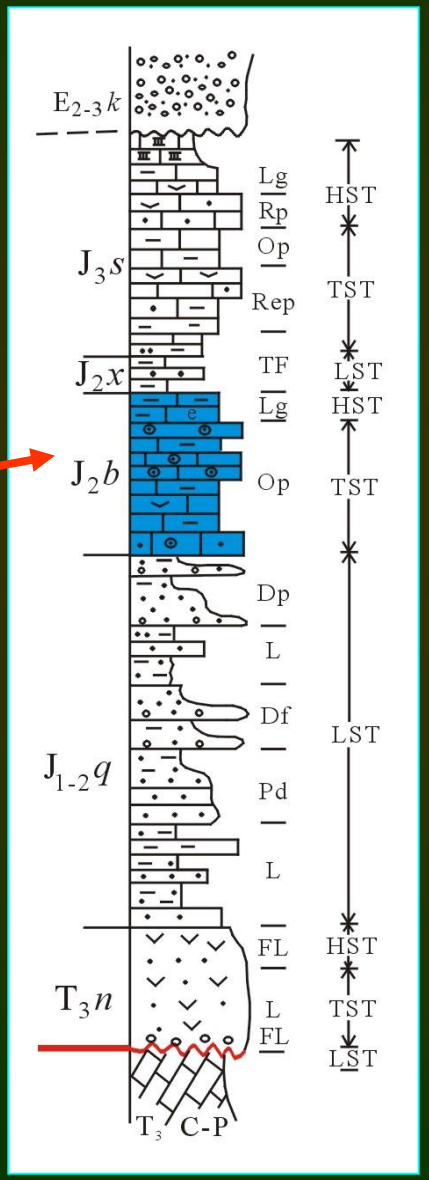




During this period, extensive transgressions continued, and the fluvial to lacustrine and delta depositional systems predominated.

Lithofacies and paleogeographic map of the middle Middle Jurassic (i. e., the deposition of the Buqu Formation), Qiangtang Basin



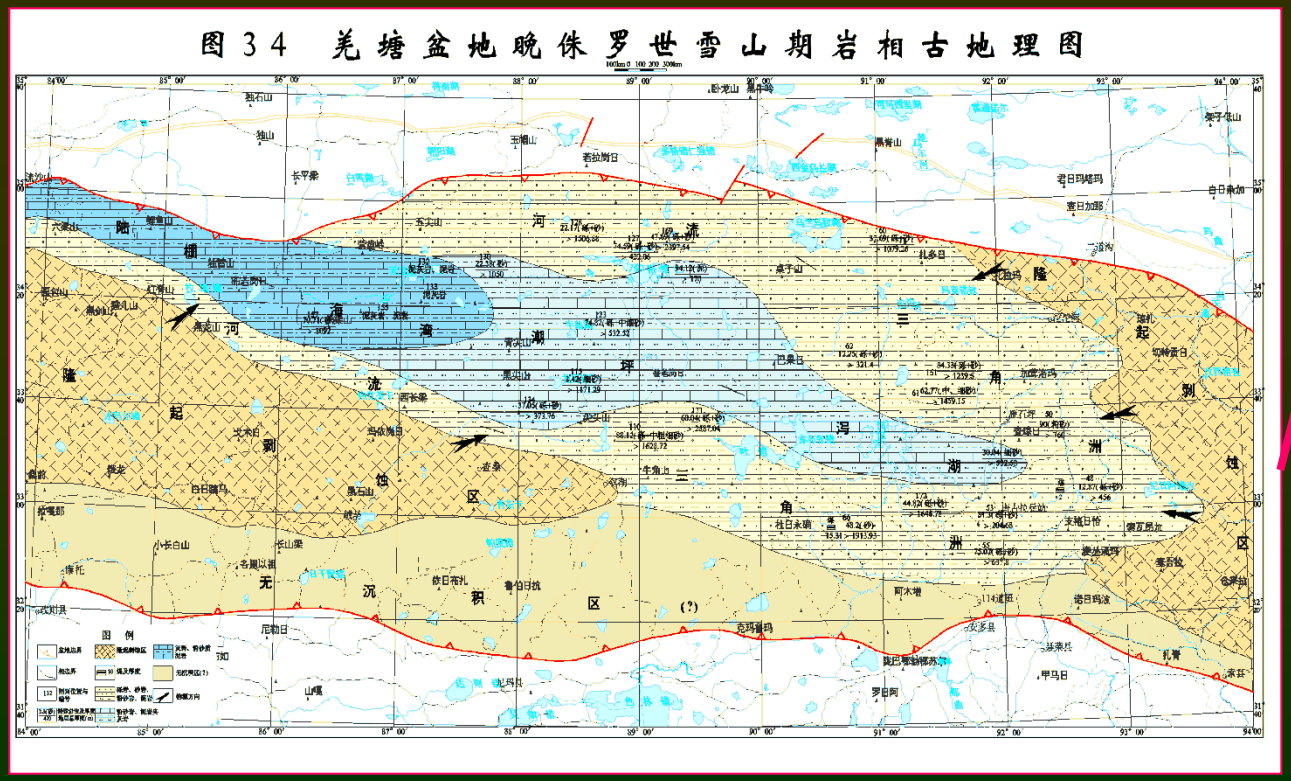


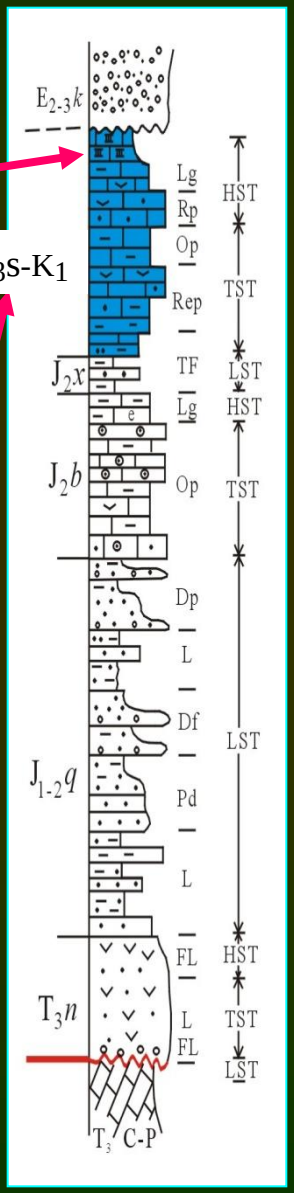
During this period, the extent of the transgressions continued to be expanded, and the carbonate platform systems predominated.

2.4 Basin closure: *restricted bay and lagoon deposition (J_3 —K_1)*

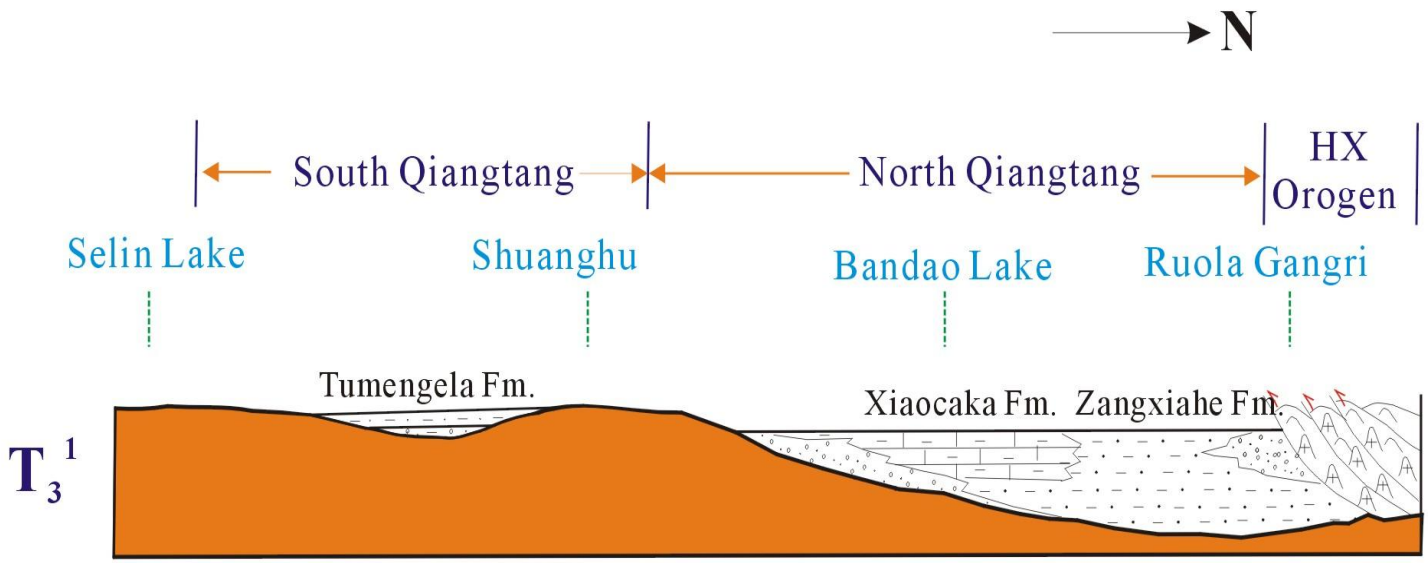
Lithofacies and paleogeographic map of Late Jurassic to early Early Cretaceous, Qiangtang Basin

During this period, the restricted bay and lagoon deposits were dominant. At the end of K_1, the basin was gradually closed; a succession of gypsum-oil shale sequences was developed.



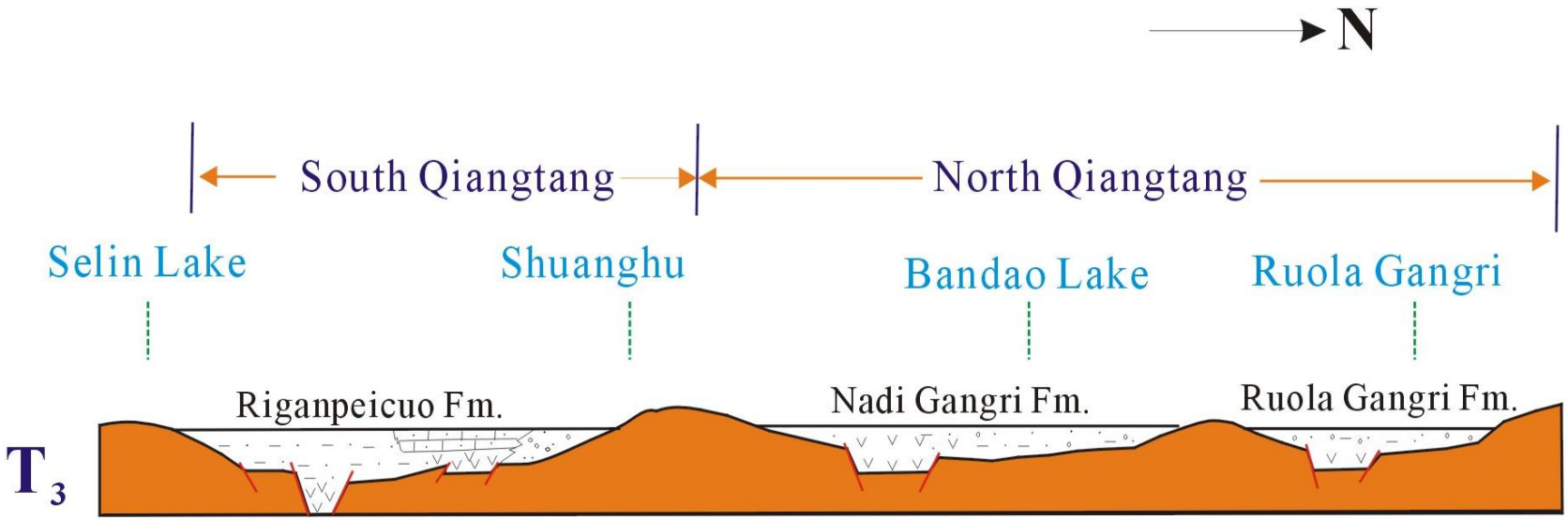


Part 4 Model



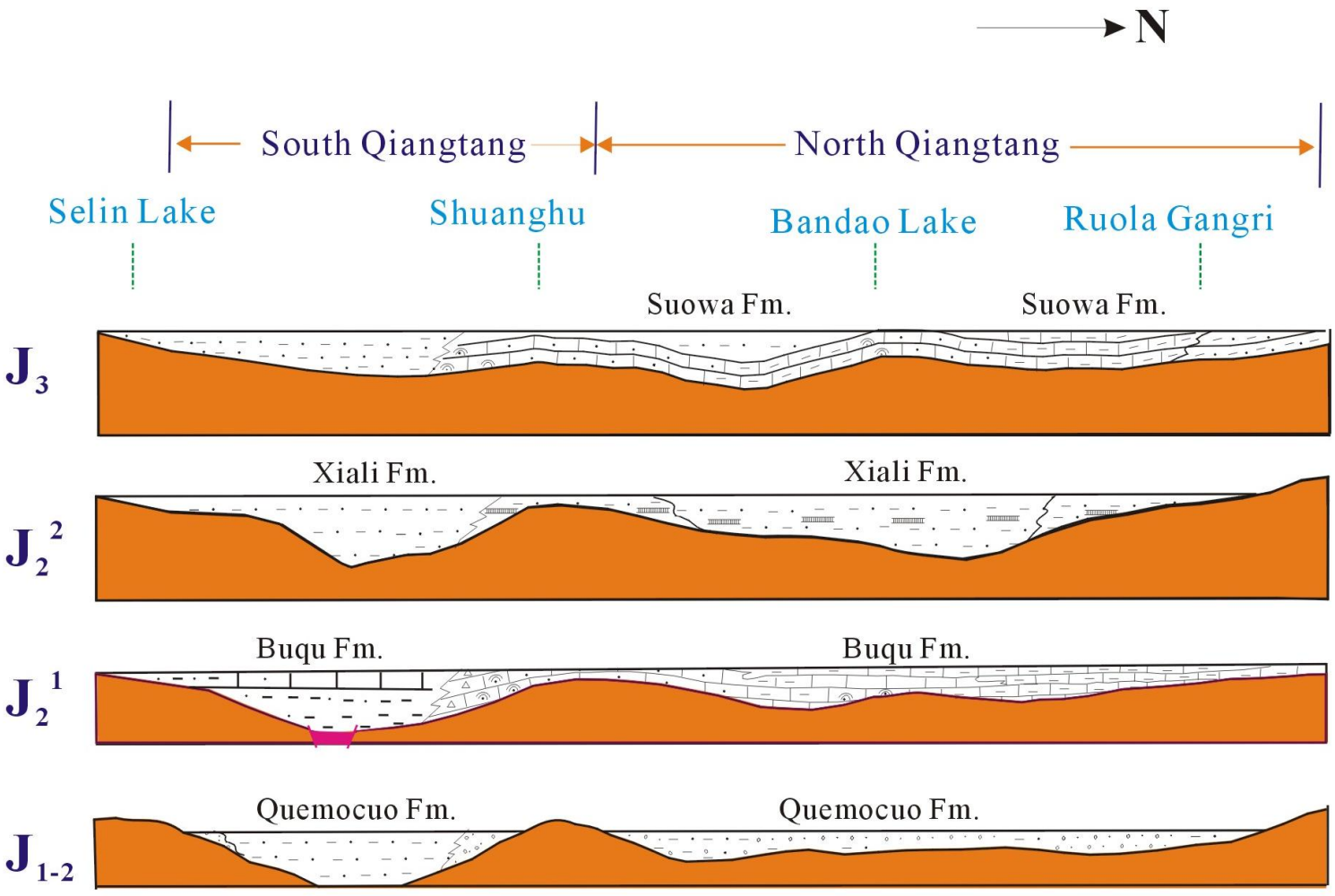
Foreland basin during the Early Triassic to early Late Triassic

During this period, in response to the closure of the Hoh Xil-Jinshajiang Ocean and the southward overthrust of the Hoh Xil orogenic zone, the North Qiangtang foreland basin was terminated (at the end of the early Late Triassic). Following, one regional palaeoweathering, crust was developed after the deposition of the coal-bearing strata.



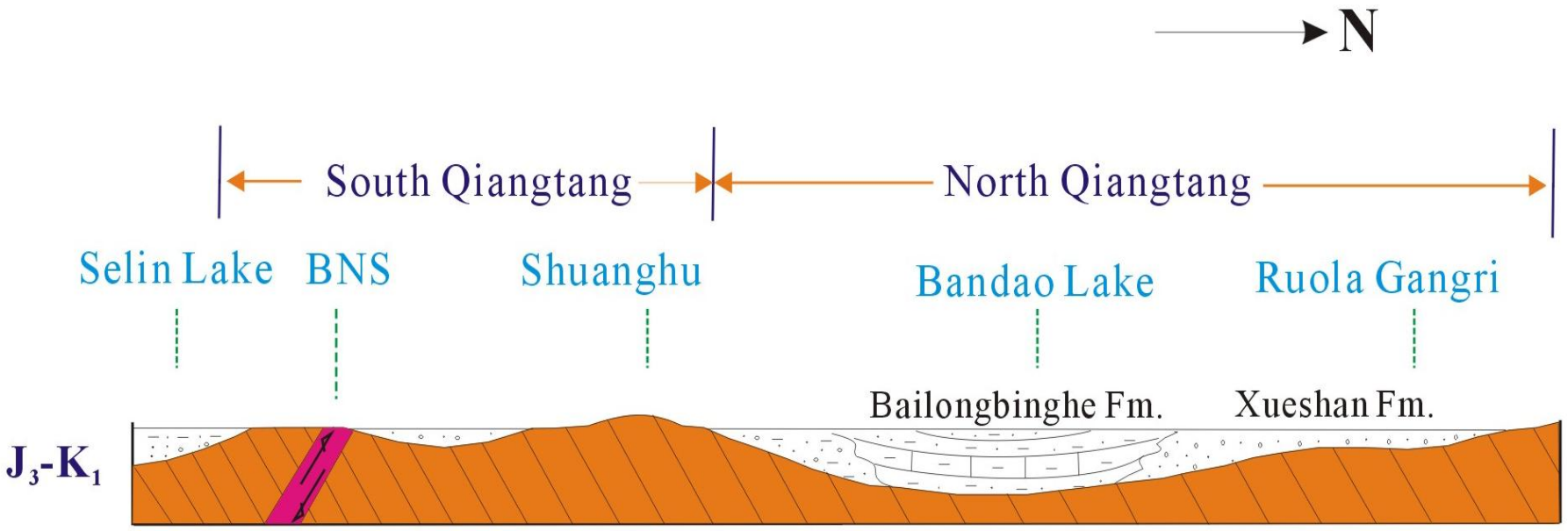
Rift basin during the Norian-Rhaetian stage

During this period, alluvial-fluvial terrigenous clastic rocks and bimodal continental volcanic rocks overlapped upon the paleoweathering crust and the basement.



During the Early to Late Jurassic, the transgressions continued, and the basin underwent evolution from the rifting to continental marine basin.

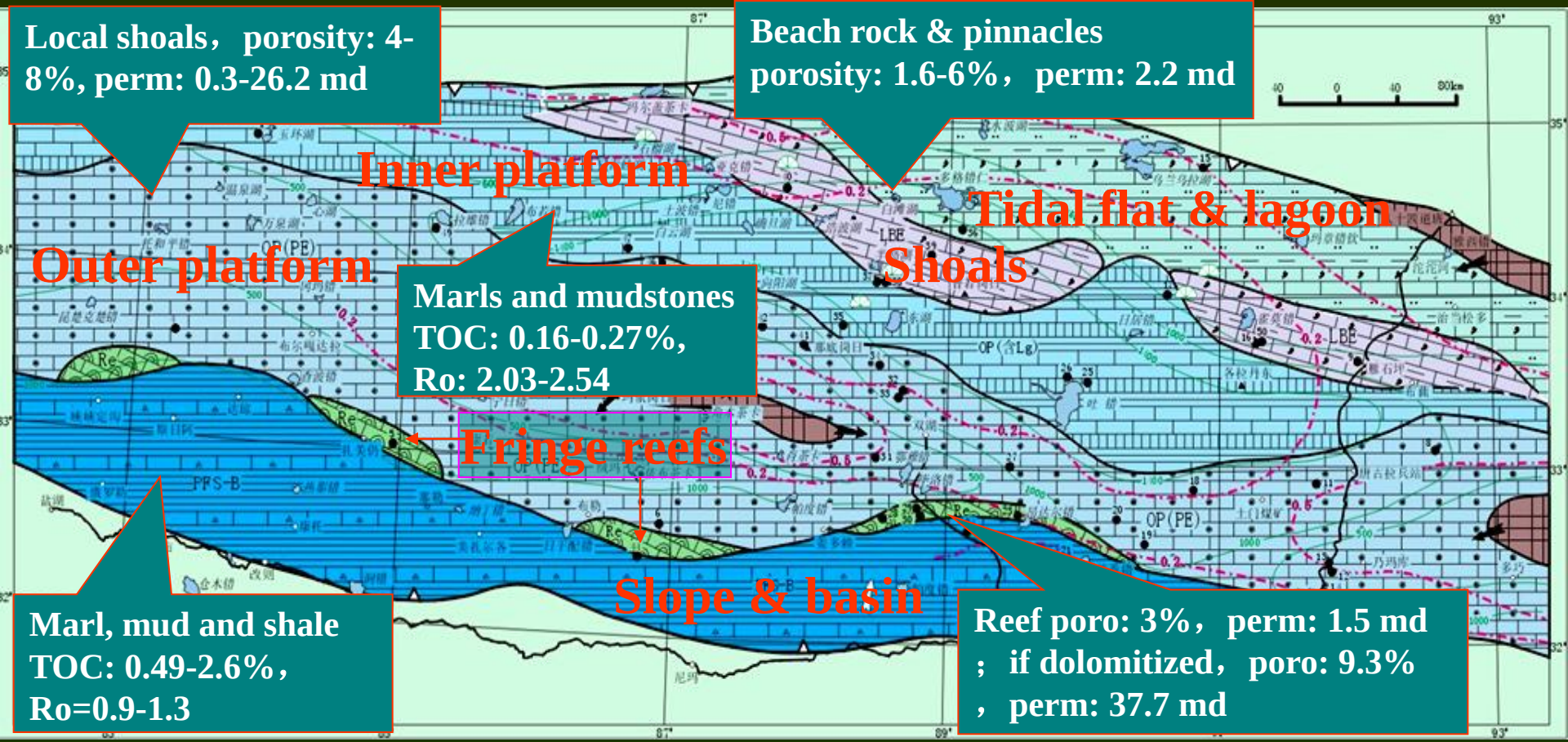
Until the end of the Jurassic, the carbonate platforms were widespread.



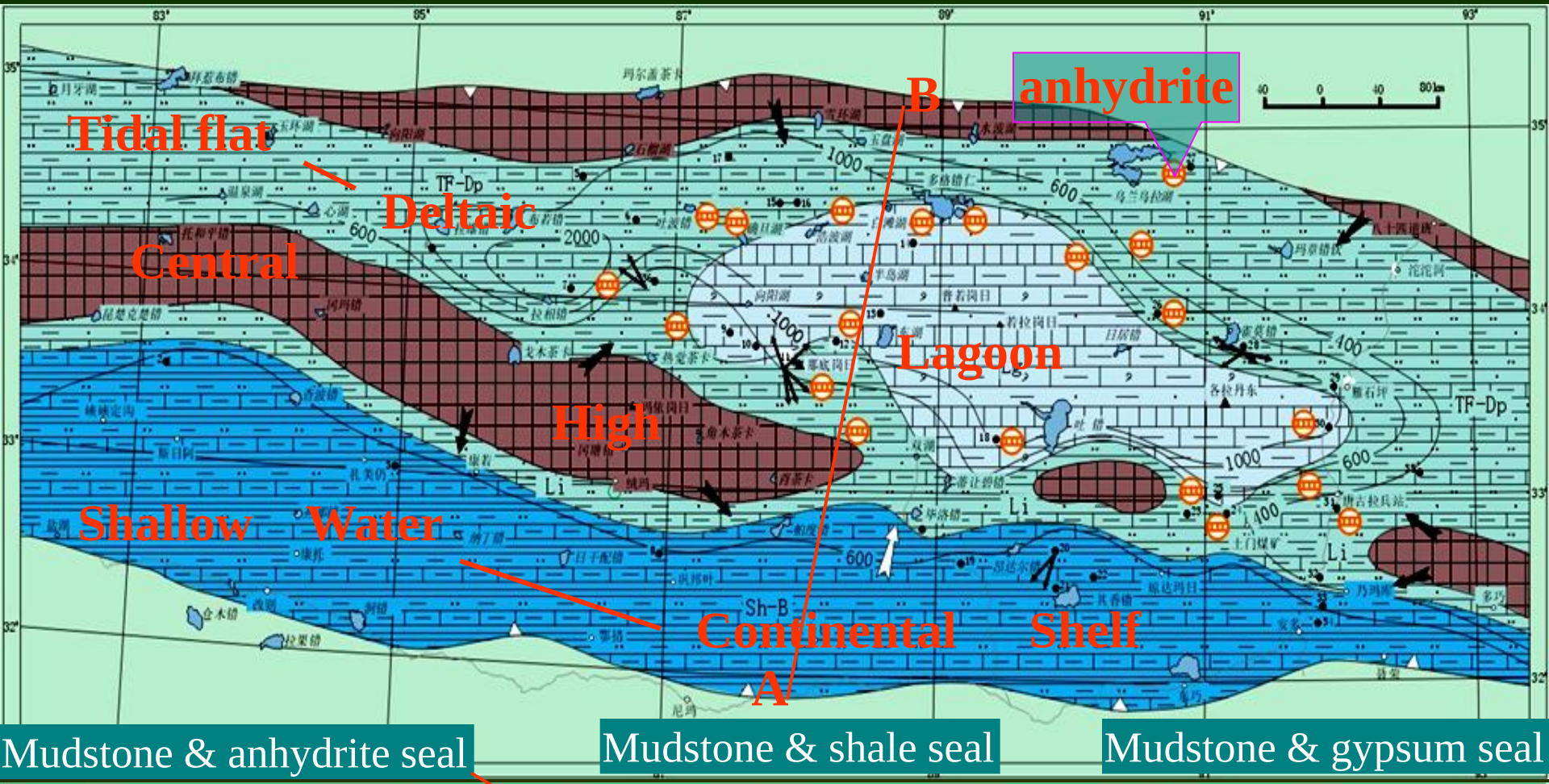
The Qiangtang Basin was terminated at last during the Late Jurassic to the Early Cretaceous.


角度不整合
Seals
Abushan Fm (K1-2a)
巨砾岩、砂砾岩、砂岩、粉砂岩组成若干韵律层
950
角度不整合
Xueshan Fm (K1-2x)
中上部长石石英细砂岩，夹粉砂岩下部砂质泥岩、泥质粉砂岩互层
600-1460
组合Ⅲ：
seal system
上统
Suwa Fm (J3s)
上部粉砂岩夹泥晶灰岩，下部泥晶灰岩、生物碎屑灰岩夹石膏
370-417
岩及石膏
储层：J2碳酸盐岩
Xiali Fm (J2x)
岩屑石英砂岩、灰质砾岩、粉砂岩、泥岩为主
600-1136
碎屑岩
生油岩：J泥岩、
seal system
中
Buqu Fm (J2b)
泥晶灰岩、生物灰岩、生物碎屑灰岩、鲕粒灰岩夹石膏
190-804
J2x J3s
Quemuco Fm (J2q)
砾岩、砂砾岩、长石石英砂岩、顶部常见石膏层
538-2517
J2q J3s
平行不整合
Quse Fm (J1q)
页岩夹砂岩、泥灰岩
951
角度不整合
平行不整合
eal system
组合Ⅱ：
上统
Xiaocaca Fm (T3x)
上部灰质页岩夹砂岩，下部泥微晶灰岩，下部泥灰岩、粉砂岩和灰质页岩
660-1190
盖层：T页岩
储层：T碳酸盐岩
角度不整合
平行不整合
碎屑岩
中
康南组 (T2k)
微晶灰岩夹泥灰岩、生物介壳灰岩、鲕粒灰岩
200-540

Batong Period（J_2^2) facies and source-reservoir-seal system



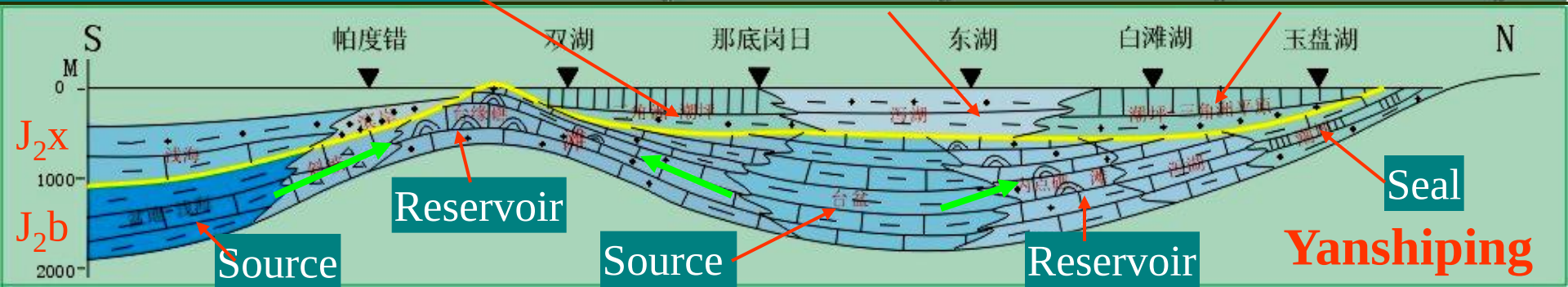
J_3 facies-paleogeography



Mudstone & anhydrite seal

Mudstone & shale seal

Mudstone & gypsum seal



Conclusions

1. Mesozoic Qiangtang Basin displayed a rifting-passive continental-margin basin rather than a foreland basin as known previously.
2. The Qiangtang Basin was initiated roughly during the Norian-Rhaetian of the Late Triassic (ca. 205-220 Ma), and closed during Late Jurassic to Early Cretaceous.
3. Major source rock was deposited in early post-rifting stage. Reservoir rock developed in late post-rifting carbonates and pre-rifting paleo-weathering crust. Seal was formed by gypsum and mudstone and oil shales.

Thank You For Your Attention!