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.
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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
Very difficult to work here !!!
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
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.
Paleo-weathering crust

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

- Clay Layer
- Dissolution Breccia
- Base rock

Diagram showing layers and geological features.
2.2 Syn-rifting: onlap sedimentation and bimodal volcanic deposits
Above the unconformity, there are sedimentary basal conglomerate, or continental sedimentary-volcaniclastic rocks, or volcanics.
linear-flow structures in rhyolite, and columnar cleavage and vesicular-amygdaloidal structures in basalt.

The succession of interbeded rhyolite and basalt represent one kind of bimodal volcanic rocks related to the rifting.
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.
The Zircon SHRIMP U-Pb isotopic age is dated around 219 Ma.

Tuffaceous sample from Northeast Qiangtang Basin
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 ($T_3-K_1$)
During this period, extensive transgressions continued, and the fluvial to lacustrine and delta depositional systems predominated.
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 ($J_3 - K_1$)
During this period, the restricted bay and lagoon deposits were dominant. At the end of K₁, the basin was gradually closed; a succession of gypsum-oil shale sequences was developed.
Part 4 Model
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.
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.
Batong Period (J$_2^2$) facies and source-reservoir-seal system

- **Inner platform**
  - Marl, mud and shale
    - TOC: 0.49-2.6%, Ro=0.9-1.3

- **Outer platform**
  - Marls and mudstones
    - TOC: 0.16-0.27%, Ro: 2.03-2.54

- **Shoals**
  - Local shoals
    - Porosity: 4-8%, perm: 0.3-26.2 md
  - Beach rock & pinnacles
    - Porosity: 1.6-6%, perm: 2.2 md
  - Reef poro: 3%, perm: 1.5 md
    - If dolomitized, poro: 9.3%, perm: 37.7 md

- **Fringe reefs**
  - Beach rock & pinnacles
    - Porosity: 1.6-6%, perm: 2.2 md

- **Slope & basin**
  - Beach rock & pinnacles
    - Porosity: 1.6-6%, perm: 2.2 md
  - Reef poro: 3%, perm: 1.5 md
    - If dolomitized, poro: 9.3%, perm: 37.7 md
$J_3$ facies-paleogeography

- Tidal flat
- Central Deltaic
- High
- Lagoon
- Continental Shelf

Sources and reservoirs:
- $J_2x$
- $J_2b$

Seals:
- Mudstone & anhydrite seal
- Mudstone & shale seal
- Mudstone & gypsum seal

Location: Yanshiping
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!