# Controlling Factors of Reefs in the Upper Triassic Maantang Formation and their Impact on Hydrocarbon Exploration in the Western Sichuan Basin, China*

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## Abstract

The Upper Triassic Maantang Formation has been examined in detail by many geologists because patch reef complexes are host to some of the world's most prolific and complicated hydrocarbon reservoirs. The Maantang Formation is the latest marine carbonate layer in the Sichuan Basin in south China (Figure 1); investigations (Figure 2) have been made on 22 patch reefs in this formation. These reefs were brought to the surface by the Longmenshan orogeny (Figure 3). Through measured sections, systematic sampling and analysis of the thin sections, it is concluded the Carnian reefs were mainly constructed by siliceous sponges (Figure 4).

## Reef Composition

It is concluded the Carnian reefs are mainly constructed by the hexactinellid sponge and the cyanobacteria in thrombolites, which based on the homoclinal carbonate ramp from 30 m to 200 m below the sea level and whose primary reef-building process is baffling. Fossils such as sponge, crinoid, foraminifer, bivalve, bryozoan in these reefs are commonly observed. The essentially in-place sponge groups are revealed. The subfacies in the reef complex (Figure 5) could be easily distinguished. The reef base is ca. 30-60 m in thickness and mostly composed of gray bedded oolitic limestone, sometimes relatively thin sparry bioclastic limestone in the top. The reef core, the reef flank and the interreef are composed of caesious or black gray bioclastic limestone, and their fossils are not obviously different but their occurrence is. The interreef is bedded and their thickness is thinner than the block reef core. The reef flank is looser than the reef core after they are weathered. The reef top is composed of black bedded mudstone, in which bivalves are commonly seen and the fauna vary between the reef core and flank.

The reefs have a relative topographic relief to the contemporaneous sea floor, their height ranging from 2 m to 70 m. The outcropping area of the reefs is along the Longmenshan Belt and the length of the area is ca. 65.6 km in northeast direction and 1-2 km in width.

## Reef Development

The growing, developing and extinction of the reefs in the Maantang Fm. may indicate the evolution process of the Sichuan Basin and adjacent area. The reef base (i.e., the oolitic bank) developed in shallow water and high energy without terrigenous material. Then increasing terrigenous material was deposited, the depth of the water increased, and the surroundings turned feculent and closed so the reefs died away. Consequently the silty mudstone in the Xiaotangzi Formation was deposited. The process could coincide with the movement of the orogenic belt on the edge of the Sichuan Basin. The sediment was not exclusively carbonate during Carnian in the western Sichuan Basin. The northwestern Sichuan Basin has more and more terrigenous material up to the top of the formation (Figure 6). This suggests the mountains close to northern Sichuan Basin uplifted and became the provenance. The upper part of the Maantang Fm. is also increasingly influenced by terrigenous material. And the Maantang Fm. in the Longshen Well 1 includes the lower part (the thin layer oolitic bank) and the upper part (a large suite of mudstone). The overlying formation of the Maantang Fm. is the Xiaotangzi Fm., mainly including silty mudstone. The sedimentary process should be related to the gradual raise of the Qinlin old land (Figure 7) and the Longmenshan Orogenic Belt.

There are not obvious early exposures of the Maantang Formation. The primary pores of the bank and reef have been almost filled and the secondary pores are not developed well (Figure 8). So the porosity and permeability of the outcrops of the Maantang Fm. are considerably low. For the analysis of the samples from the outcrops, the Bank/Reef only reaches the level of non-reservoir or low yield-reservoir. However, it is similar to the siliceous sponge reefs in the western Sicuan Basin and the Oxfordian siliceous sponge reefs in Europe. According to the evolution of the global siliceous reefs, the mound reflections in the seismic profiles (Figure 9 and Figure 10), and comparing to the series of the Oxfordian reefs, a shallow-sea high-energy reef/bank may be discovered near central Sichuan Basin (Figure 11); additionally, the Chuanke 1 well has been reported to have commercial gas, so this area should be a target for oil and gas exploration.

## References

Weislogel, A., S.A. Graham, E.Z. Chang, J.L. Wooden, G.E. Gehrels, and H. Yang, 2006, Detrital zircon provenance of the Late Triassic Songpan-Ganzi complex; sedimentary record of collision of the North and South China Blocks: Geology, v. 34/2, p. 97-100.

Wendt, J., W. Xichun, and J.W. Reinhardt, 1989, Deep-water hexactinellid sponge mounds from the Upper Triassic of northern Sichuan (China): Palaeogeography Palaeoclimatology Palaeoecology, v. 76/1-2, p. 17-29.

Xu, S., J. Yang, F. Li, and S. Xiao, 1997, Sedimentary sequence and paleoenvironments of the Early Cambrian “Bianmachong Formation” in the boundary area of Sichuan, Guizhou and Hunan: Earth Science Journal of China University of Geoscience, v. 22/5, p. 520-525.

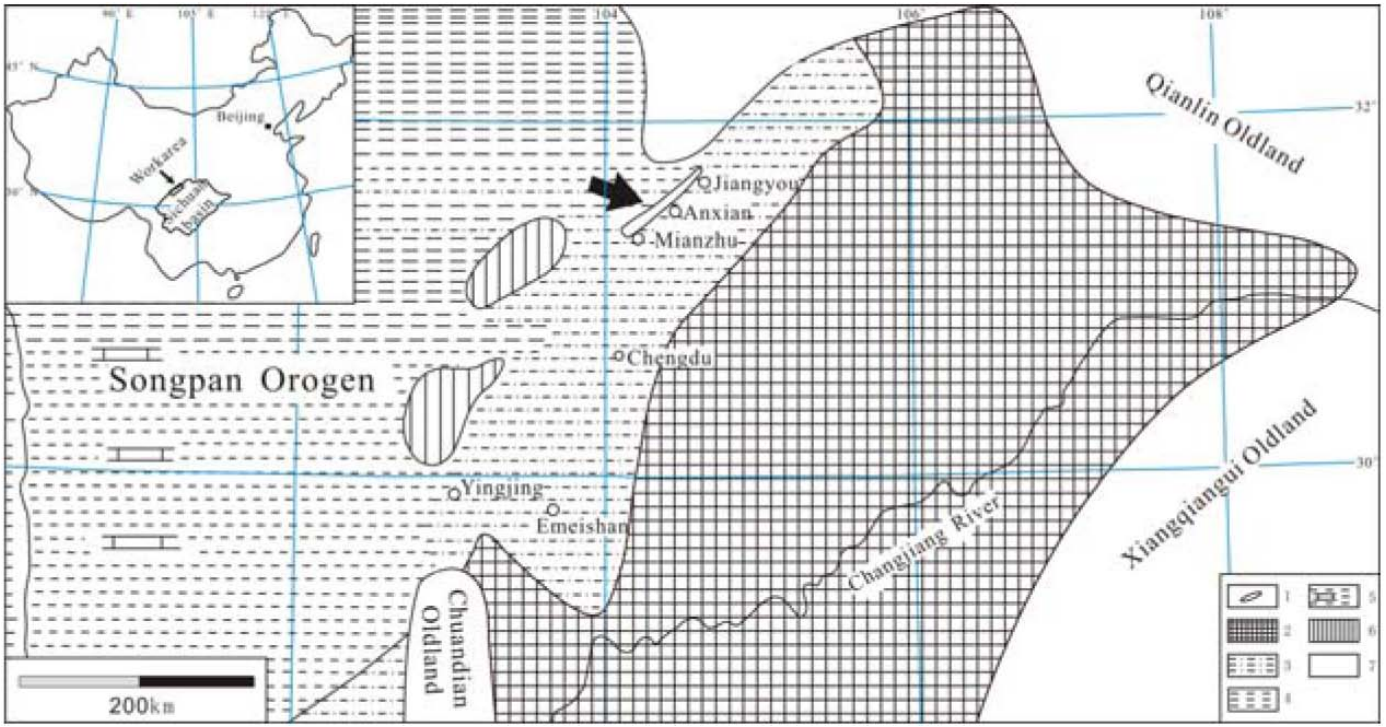


Figure 1. Paleographic map of Upper Yangtze in early Late Triassic (modified after Wendt et al., 1989).

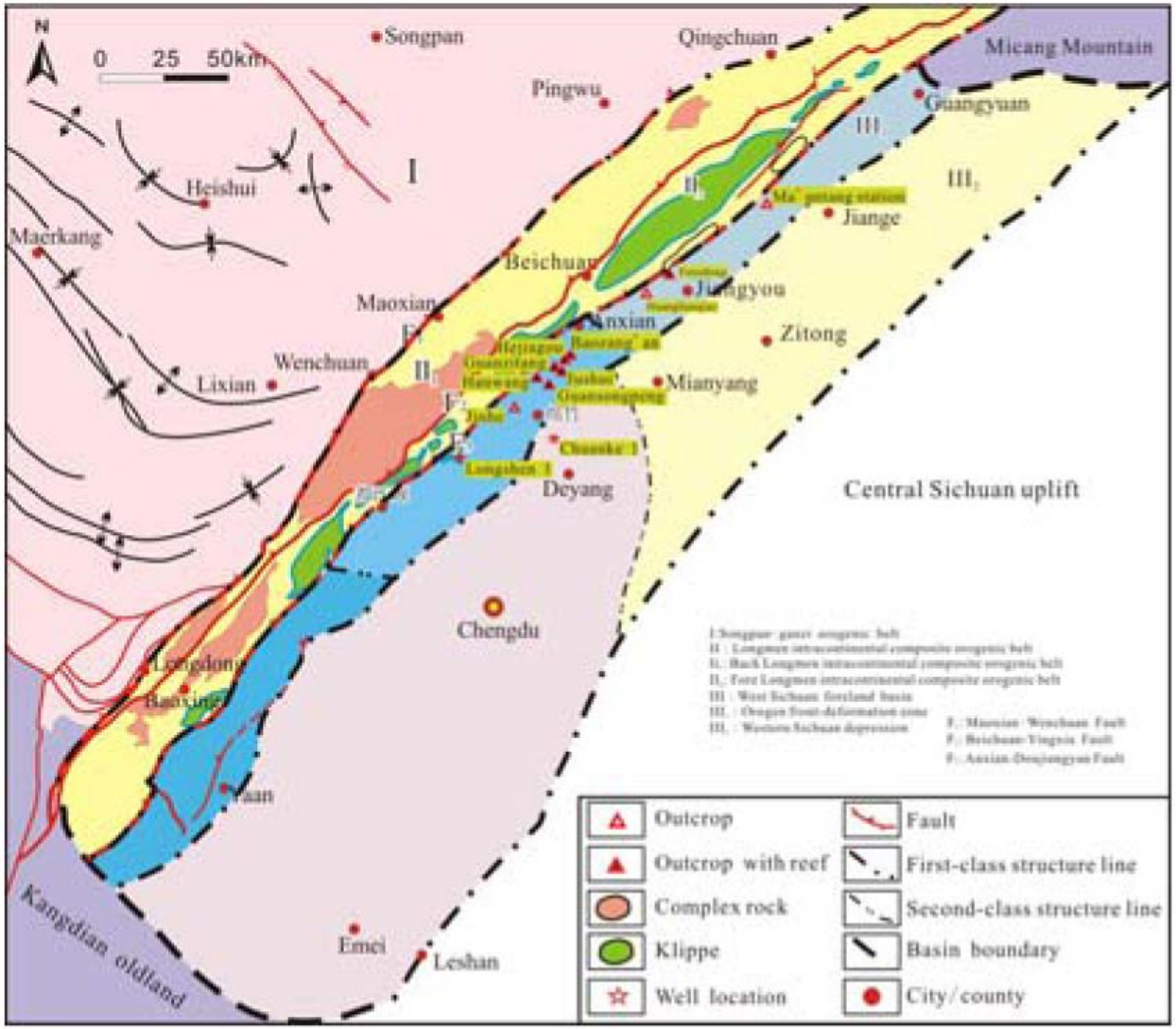


Figure 2. Distribution of outcrops and wells of Maantang Formation in Western Sichuan.

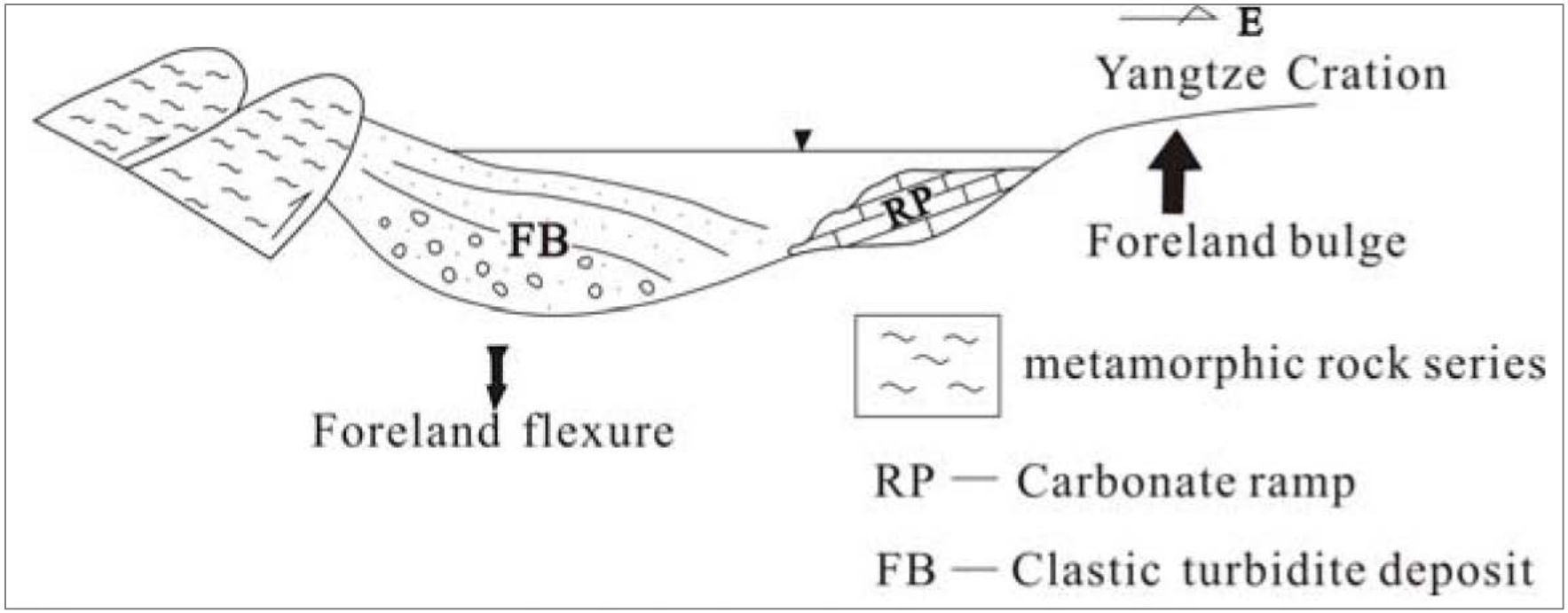


Figure 3. The movement of Longmenshan Belt in Late Triassic in western Sichuan (Xu et al., 1997).

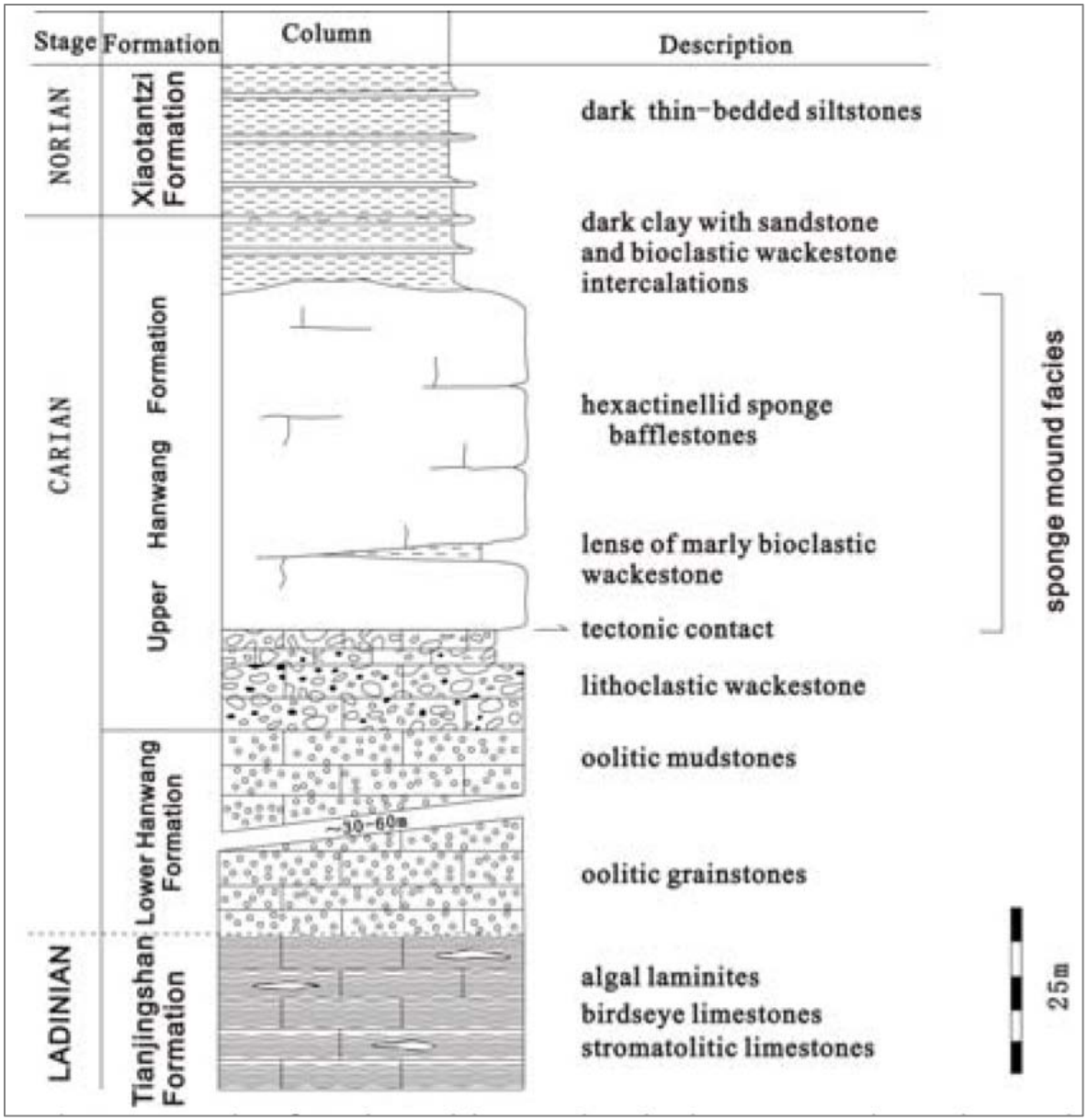


Figure 4. Upper Triassic composite stratigraphic section in An County (Wendt et al., 1989).

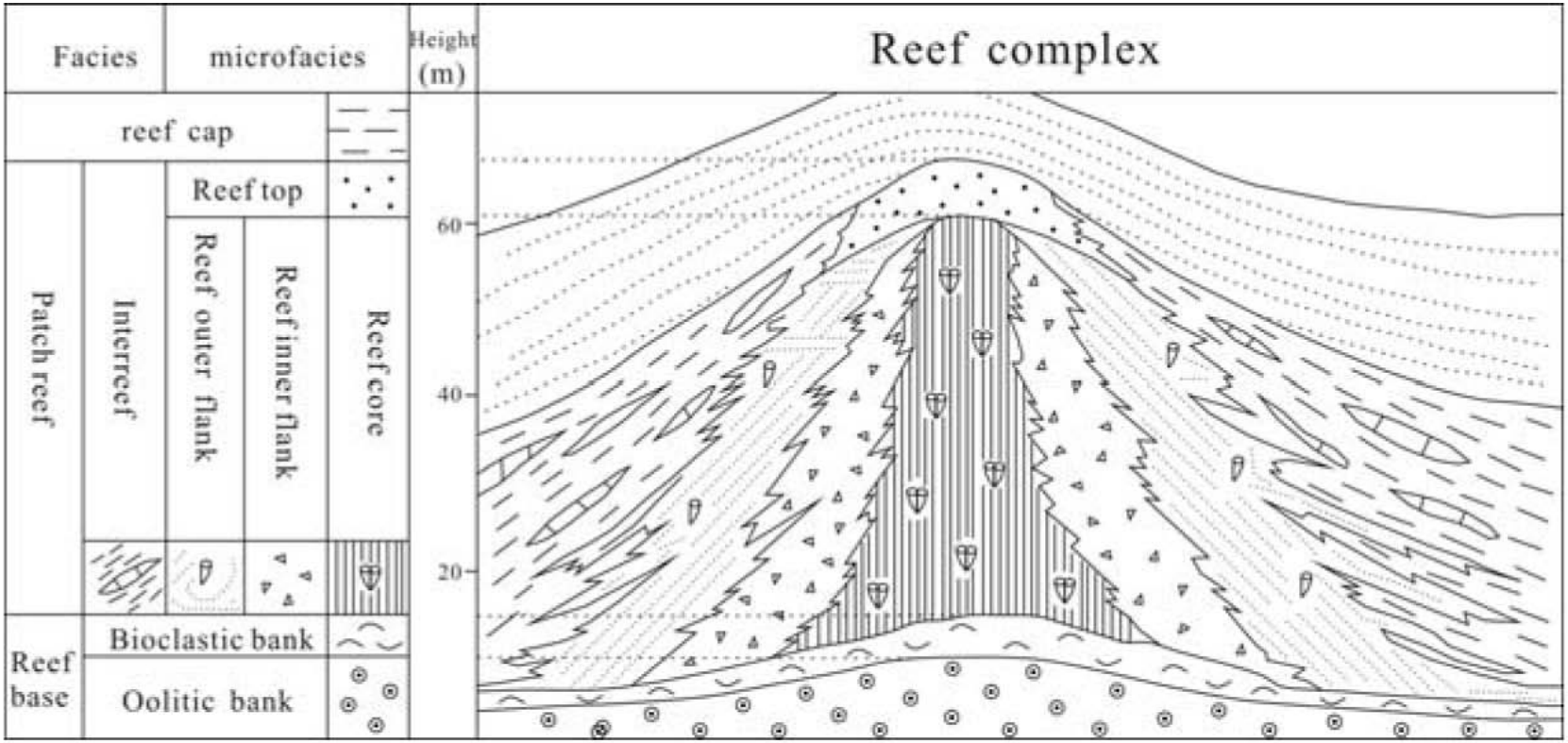


Figure 5. Map of reef complex.

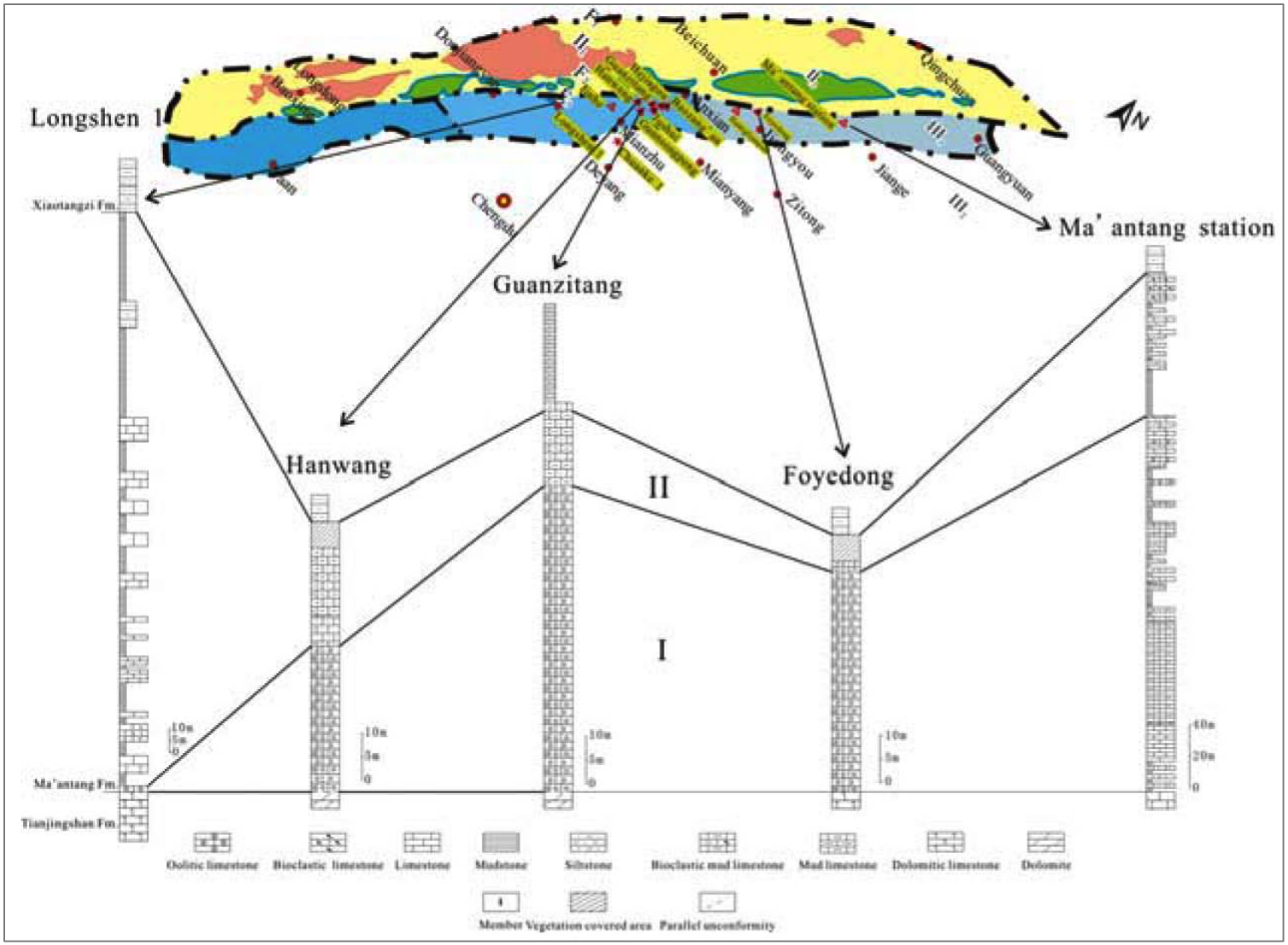


Figure 6. Sections correlation of the Upper Triassic Maantang Formation in the western Sichuan Basin.

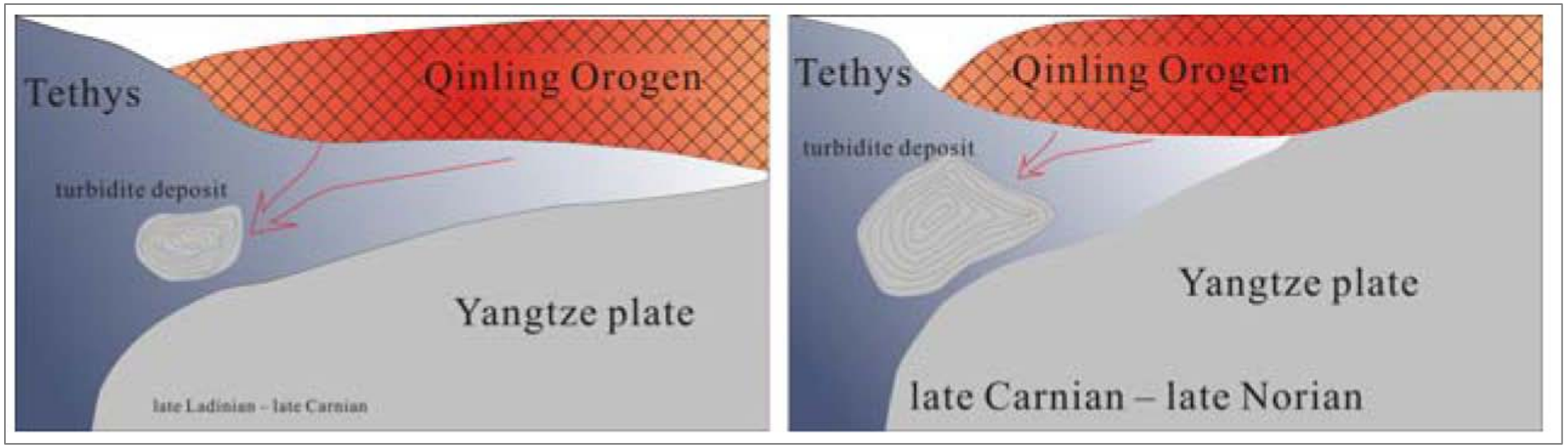


Figure 7. Reconstruction of Songpan-Ganzi complex paleodispersal systems during (A) Late Ladinian-Late Carnian time, and (B) Late Carnian-Late Norian time (Weislogel et al., 2006).

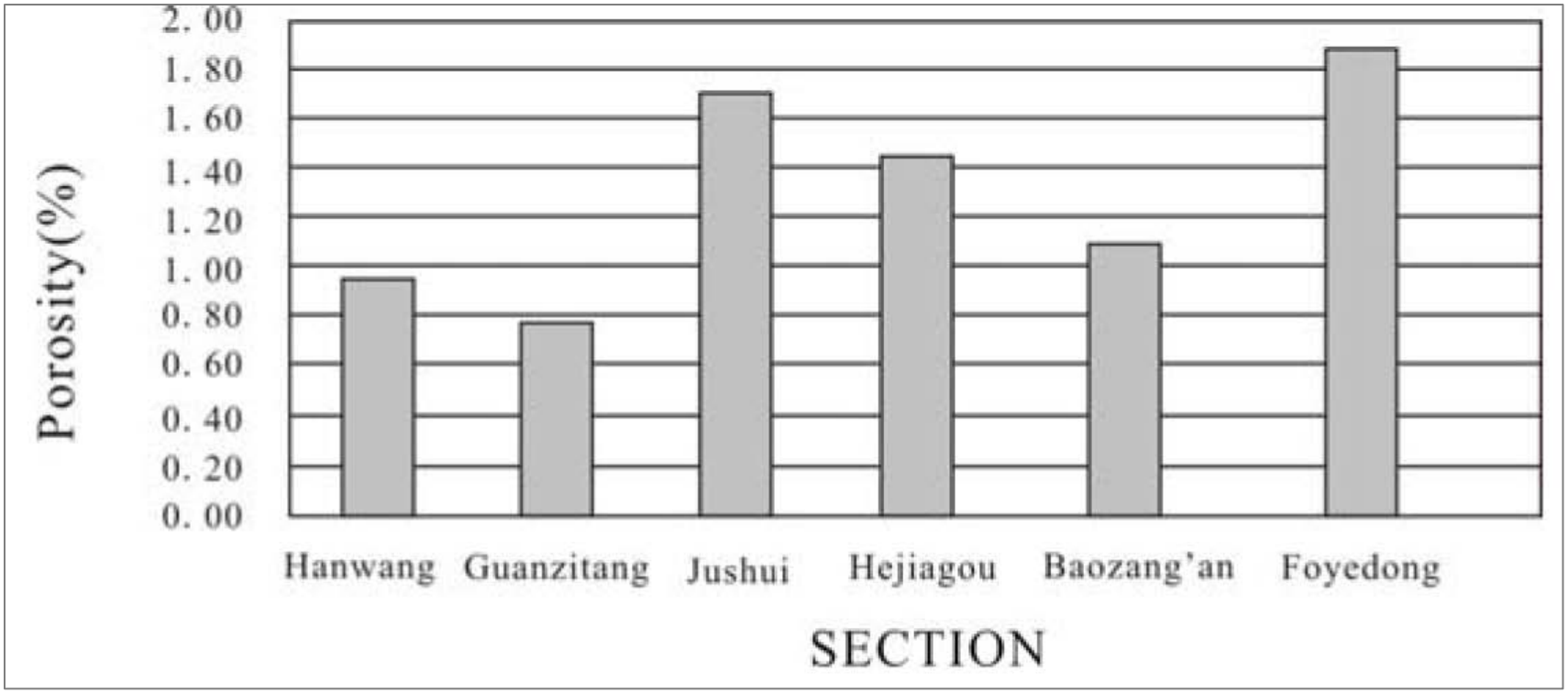


Figure 8. Porosity of the reefs in several sections.

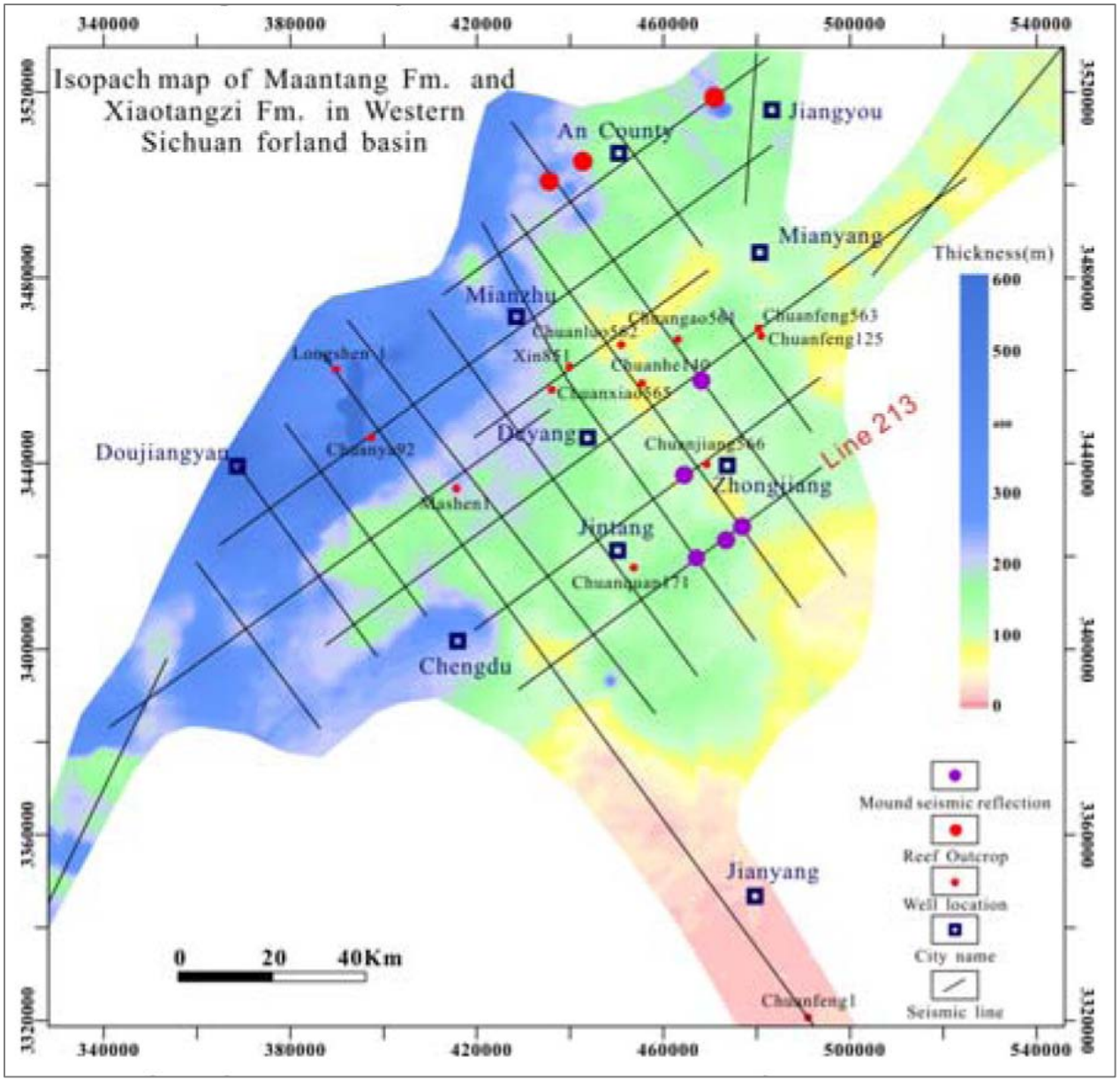


Figure 9. Location sites of reef outcrops and mound seismic reflecting bodies in the isopach map of Maantang and Xiaotangzi formations in Western Sichuan Basin.

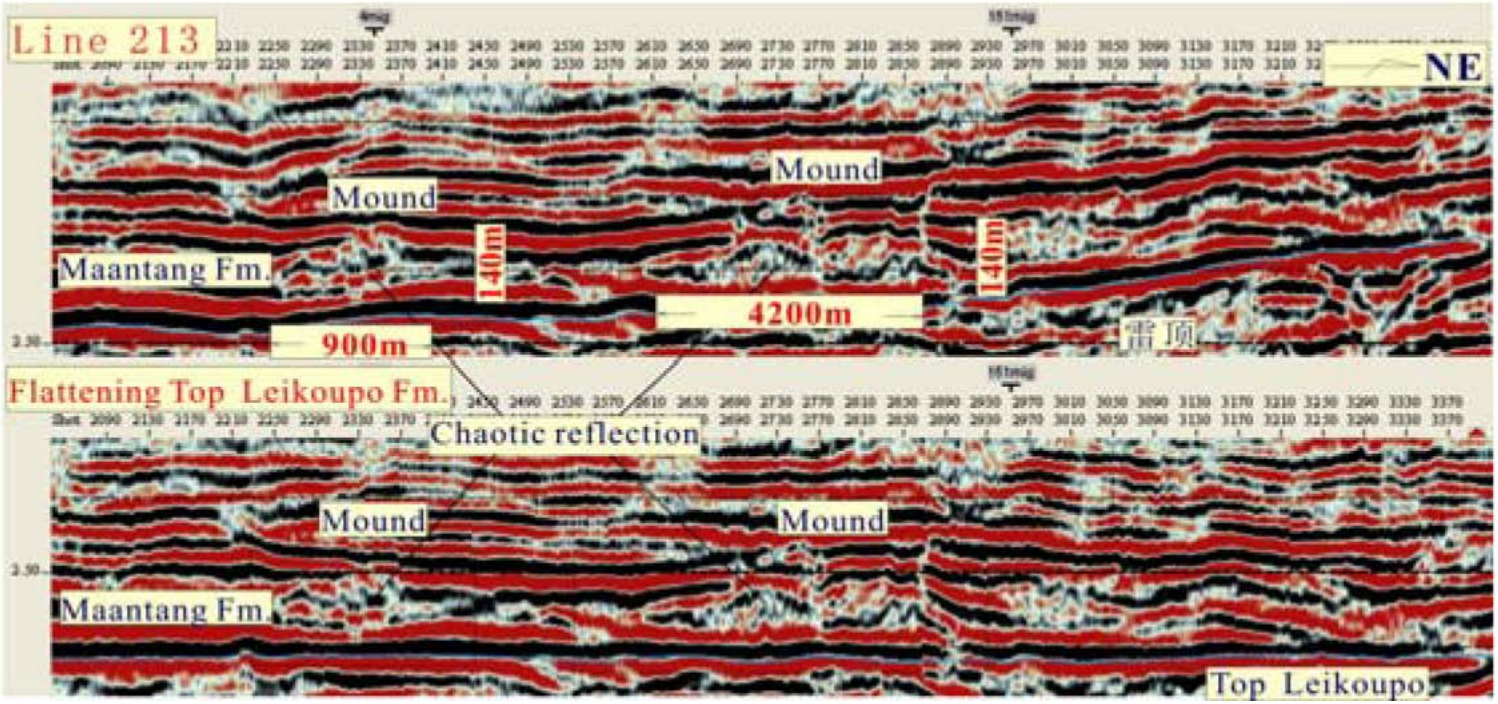


Figure 10. Mound seismic reflecting bodies in seismic line 213 in Western Sichuan Basin.

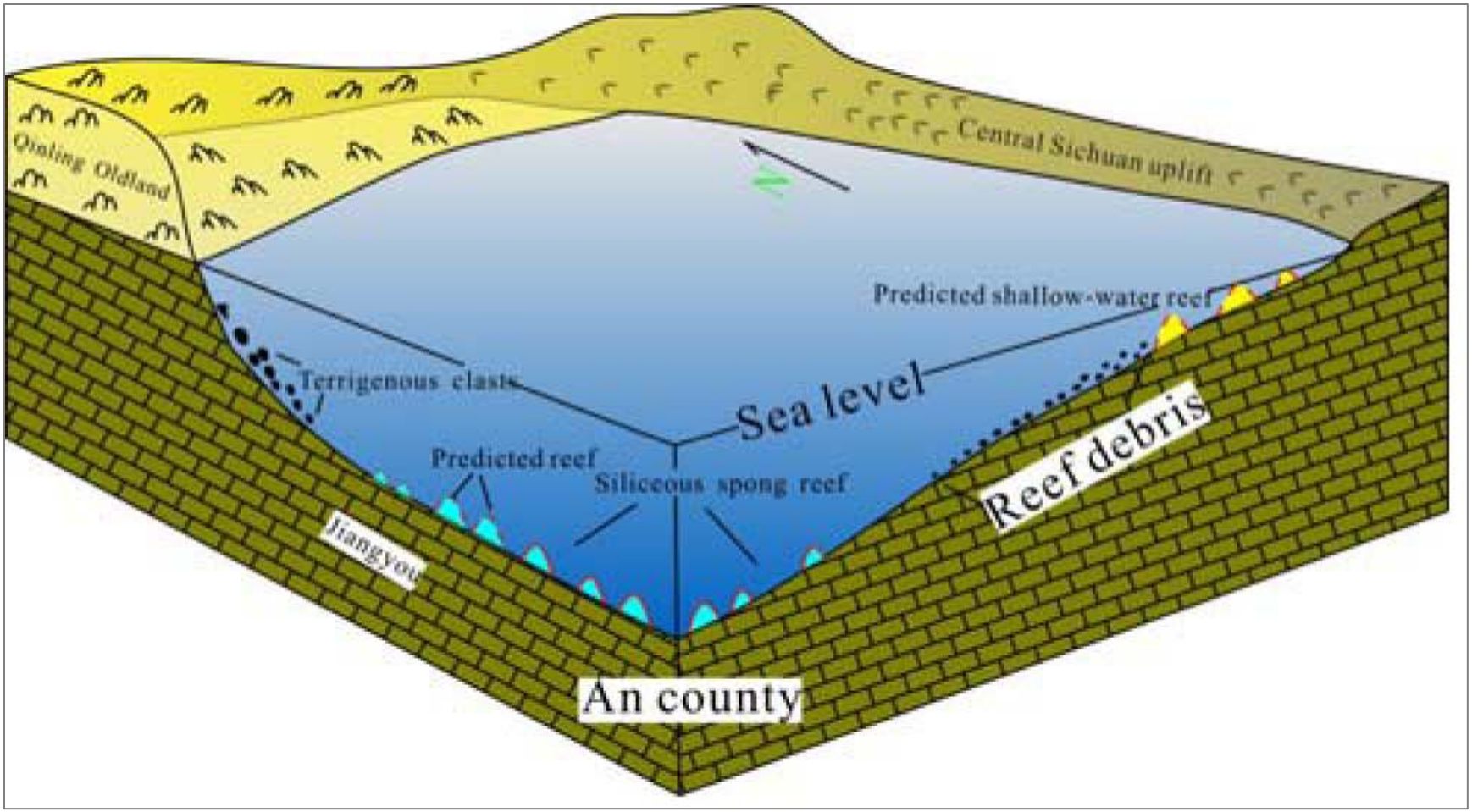


Figure 11. Distribution of Late Triassic reefs in Western Sichuan Basin.