



# Types and distribution of the shale sedimentary facies of the Lower Cambrian in Upper Yangtze area, South China



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**Abstract:** Based on comprehensive analysis of outcrops, cores, rock thin sections, mineral X-ray diffraction and Argon ion-milling - scanning electron microscopy, nine lithofacies types and five facies marks in the Lower Cambrian Meishucun Formation and Qiongzhusi Formation in the Upper Yangtze are identified, a classification scheme of the shale sedimentary facies is proposed, and the deposition and evolution model of the shale in the Lower Cambrian is figured out. This research shows there are difference in sedimentation, types and distribution of the sedimentary facies in the Meishucun Formation and Qiongzhusi Formation. The main sedimentation modes in the Meishucun Stage were mechanical-chemical and biological sedimentation, the sedimentary facies (from west to east) were carbonate ramp, shelf, and slope and bathyal basin. The main sedimentation of the Qiongzhusi Stage was clastic mechanical, argillaceous flocculation and biological deposition, and the sedimentary facies were shore, shelf, and ramp and bathyal basin. There are two depositional centers of organic-rich shale in the Upper Yangtze which are the prospective areas for shale gas exploration. The first one is in the Ziyang-Changning area in nearly north-south strike, which is characterized by multiple thin layers. The other one is in the Western Hubei-Eastern Chongqing-Middle Guizhou and Yichang-Jianshi-Fangxian, which is characterized by the thick-layer shale. The shale gas exploration in these areas should take pertinent strategies in line with their differences in the future.

**Key words:** shale; lithofacies; sedimentary facies; Lower Cambrian Qiongzhusi Formation; Lower Cambrian Meishucun Formation; Upper Yangtze area; Sichuan Basin

## Introduction

In recent years, with the success of exploration and exploitation of shale gas in America, Canada and China etc., the traditional understandings on shale from petroleum geology have been changed, and the new understandings on shale are: shale can not only generate and seal hydrocarbon, but also can be reservoir for oil-gas, capable of forming source-reservoir-cap in one reservoir, which had overthrown the conventional oil and gas exploration, meanwhile, made exploration of unconventional shale oil and gas a hot research spot in the world. Analysis of shale sedimentary facies is an indispensable foundational work of shale oil and gas exploration, and it is believed shallow shelf is the main sedimentary environment for marine organic-rich shale deposition<sup>[1, 2]</sup>. Sediments in ancient shallow shelf (epicontinental sea) and modern shallow shelf (marginal sea) have some different features, the former have a longer depositional time, bigger thickness and wider distribution, while the latter have shorter depositional time,

smaller thickness and limited distribution. Foreign experts consider that marine organic-rich shale deposited in black sea pattern and/or coastal ascending current pattern<sup>[3]</sup>. The research on Lower Silurian Longmaxi Formation in Sichuan basin shows that the deep shelf if the favorable facies for shale gas exploration<sup>[4]</sup>. In conclusion, researchers have realized that finding out favorable sedimentary facies through fine sedimentary facies division can provide important geological basis for shale oil and gas exploration.

A set of marine black shale developed in Early Cambrian in the Upper Yangtze area, large in thickness, high in TOC (total organic carbon), and wide in distribution range, it is one of the important exploration strata for shale gas in southern China (Fig. 1). Former researchers have carried out several rounds of paleogeographical mapping of multiple series<sup>[5–8]</sup>, and reached the important finding that Lower Cambrian shale was shallow shelf deposition in cratonic basin, but due to large mapping scope and few wells drilled, the maps drawn then can't meet

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