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Original research paper

Characteristics of lacustrine organic-rich shale: A case study of the Chang 7 member, Triassic Yanchang Formation, Ordos Basin, China☆

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Abstract

This paper presents a case study of lacustrine organic-rich shale from the Yanchang Formation, Ordos Basin, China. Sedimentary and geochemical analyses were performed on shale acquired from the Chang 7 member through its outcrop, core and thin section data indicate that depositional environments have a great impact on the distribution and quality of shale reservoirs. Shale in the Chang 7 member was interpreted to have been deposited mainly in delta-front and deep-lake environments. Delta-front shale is 2−10 m thick (average ~5 m), laterally discontinuous and commonly interbedded with equally thick layers of sandstone. In contrast, deep-lake shale is 5−74 m thick (average ~21 m), laterally continuous and locally interbedded with thin layers of sandstone. Delta-front shale was mostly massive without obvious sedimentary structures while deep-lake shale was characterized by abundant horizontal laminations. More importantly, delta-front shale primarily contains Type II_1 and III kerogen, with TOC commonly less than 2%. In comparison, deep-lake shale primarily contains Type I and II_1 kerogen, with TOC mostly higher than 2%. Based on the analysis and comparison between shales deposited in two types of environments, it is suggested that deep-lake shales in the Chang 7 member were favorable exploration target for hydrocarbons.
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Keywords: Organic-rich shale; Shale oil and gas; Depositional environment; Shale distribution; Yanchang Formation

1. Introduction

Sedimentary research of shale has been greatly focused on those of marine origin [1−3]. Studies on lacustrine shales are still rare even though non-marine shales have become increasingly important in hydrocarbon exploration (e.g., China). Compared to marine shales, lacustrine shales have mixed kerogen types, wider ranges of TOC, and generally less continuous both laterally and vertically, which makes it more challenging for hydrocarbon exploration and development. Consequently, there is a demand from the petroleum industry for robust sedimentary research on lacustrine shale.

The Triassic Yanchang Formation in the Ordos Basin was deposited in a lake environment. It was subdivided into 10 members, Chang 1−10 in ascending order. The Chang 7 member, which was deposited during the largest lake transgression, contains the thickest and most continuous dark shale and mudstone in the Yanchang Formation. The Zhangjiatan shale represented the maximum transgression [4,5]. When the Yanchang Formation was deposited, the basin was characterized by a long axis of NW−SE, with slopes that were gentle in

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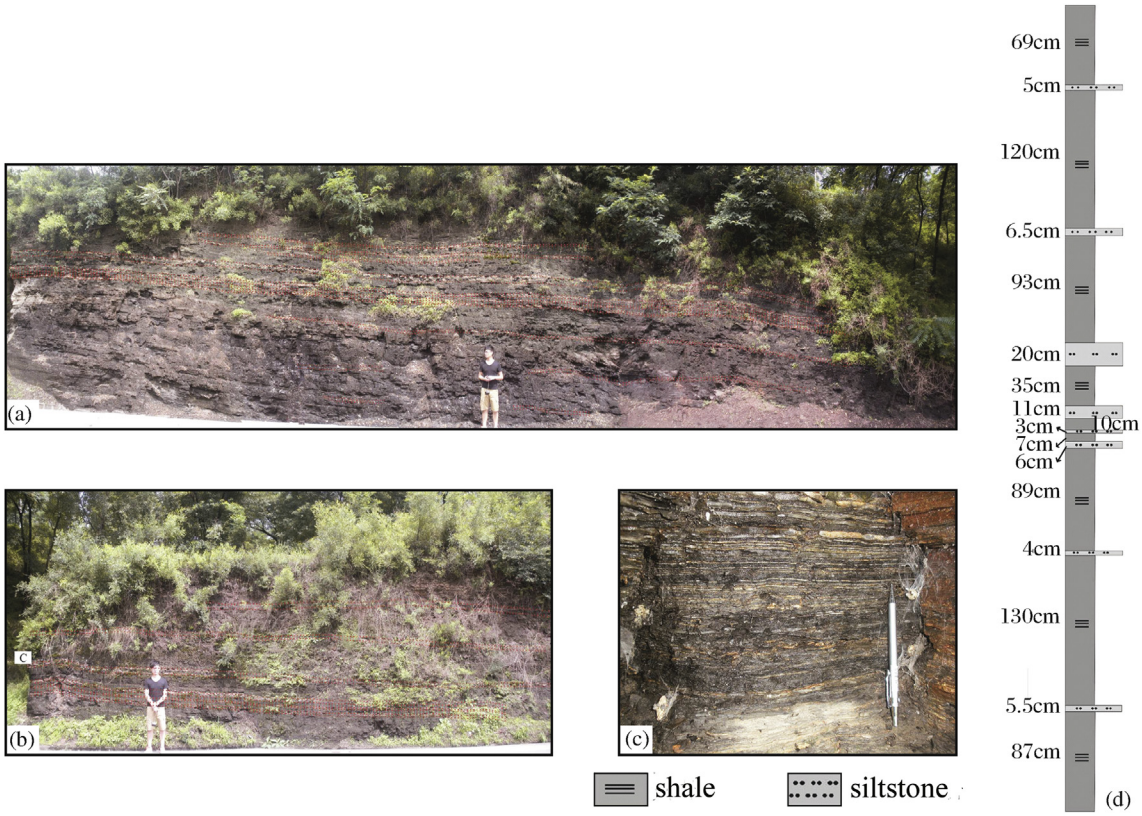

Fig. 1. Features of the Zhangjiatan shale of Chang 7 member in the Niejiahe field profile.

the NE and steep in the SW [6,7]. Previous researchers have identified several sedimentary facies in the Chang 7 member including lacustrine delta, semi-deep to deep lake, and deep-lake turbidites [8–10]. Deep lake facies include organic-rich shale, dark mudstone, sandy mudstone, muddy sandstone, and sandstone [11,12].

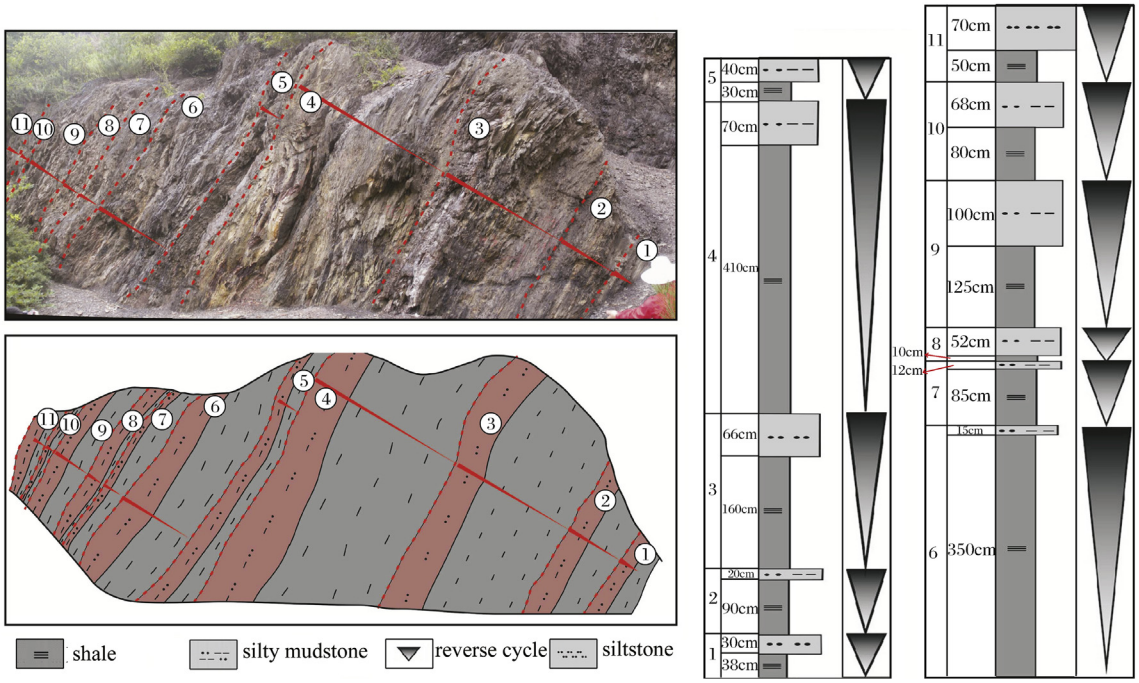

Fig. 2. Features of the Zhangjiatan shale of Chang 7 member in the Tangnihe field profile.

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