



## Shale characteristics in the southeastern Ordos Basin, China: Implications for hydrocarbon accumulation conditions and the potential of continental shales



Xuan Tang<sup>a,\*</sup>, Jinchuan Zhang<sup>a</sup>, Xiangzeng Wang<sup>b</sup>, Bingsong Yu<sup>c</sup>, Wenlong Ding<sup>a</sup>, Jinyu Xiong<sup>a</sup>, Yiting Yang<sup>d</sup>, Long Wang<sup>e</sup>, Chao Yang<sup>a</sup>

<sup>a</sup> Key Laboratory of Shale Gas Exploration and Evaluation, Ministry of Land and Resources, China University of Geosciences, Beijing (CUGB), 100083, China

<sup>b</sup> Yanchang Petroleum (Group) Co., LTD, Xi'an 710000, China

<sup>c</sup> School of Earth Science and Resource, CUGB, 100083, China

<sup>d</sup> PetroChina Xinjiang Oilfield Company, China

<sup>e</sup> CNOOC Oil and Gas Research Center, Beijing, China

### ARTICLE INFO

#### Article history:

Received 25 November 2013

Received in revised form 25 March 2014

Accepted 25 March 2014

Available online 3 April 2014

#### Keywords:

Continental shale

Ordos Basin

Shale gas

Shale oil

Upper Triassic

### ABSTRACT

Continental shales in China are generally characterised by low thermal maturity and high clay content, characteristics that are significantly different from those of marine shales documented in the USA and elsewhere. Whether such continental shales have commercial hydrocarbon potential as marine shale in the USA is a question for the China petroleum industry. Recently, vertical drills in the lacustrine shales in the Yanchang Formation produced an average of two to five tons of oil and 1000–3000 m<sup>3</sup> of gas per day by reservoir hydraulic fracturing, which demonstrates that the continental shales can also achieve viable hydrocarbon production. Shale and gas samples collected from the Chang 7 (C7) and Chang 9 (C9) Members, Yanchang Formation in the southeastern Ordos Basin were examined for geochemical, petrologic and gas content analysis. The results show that the C7 and C9 Members developed a huge volume of organic-rich shales (with 2–4 wt.% TOC) in the deep or semideep lacustrine, characterised primarily by type-II kerogen, with a relatively low thermal maturity and a vitrinite reflectance ranging from 0.5 to 1.5% Ro, which decreases from west to east. The hydrocarbon product varies with the thermal maturity. In the southwestern corner, the gas content measured by canister desorption equals 1.15–3.49 m<sup>3</sup>/t rock, and the gas-absorption capacity ranges from 3 to 5 m<sup>3</sup>/t rock, whereas in the eastern part, the gas content is low, and oil production is 1–4 m<sup>3</sup>/day on average. Nanometre-scale pores and micro-fractures are well developed. All of this indicates that the continental shales in the southeastern Ordos Basin might have huge shale hydrocarbon resources. However, the clay content of the continental shales of C7 and C9, ranging from 40 to 60% of the bulk mineral content, are much higher than for gas produced in marine shales, which might lead to significant challenges for successful development.

© 2014 Elsevier B.V. All rights reserved.

### 1. Introduction

Marine shale gas has recently gained significant success in the USA, and it has triggered a worldwide fever for shale hydrocarbon resources. In contrast, there has been little work done and less attention paid to

continental shale hydrocarbons. Continental shales, characterised by low thermal maturity and a high clay content, which differs from the properties of the marine shale documented in the USA and elsewhere (Curtis, 2002), are widespread in northern China. There is an urgent need to characterise continental shales and evaluate their hydrocarbon potential as a viable resource. The Ordos Basin is a large, hydrocarbon-prolific basin located in the middle of northern China, possessing giant gas fields in the Upper Palaeozoic and oil fields in the Ordovician, Triassic and Jurassic strata (Liu et al., 2012; Tang et al., 2012). In the Triassic Ordos is a typical intra-continental sedimentary basin, which has developed widespread lacustrine shale (F., Wang et al., 2010; Hu et al., 2008; Y. P., Wang et al., 2010) and has been regarded as the most important source rocks for the Triassic oil reservoirs, instead of the hydrocarbon host layers (Hanson et al., 2007; Hu et al., 2008; Li et al., 2012; Liu et al., 2010; Yang et al., 2005). Recently, vertical drills in the upper

\* Corresponding author at: China University of Geosciences, No. 29 Xueyuan Road, Haidian District, Beijing 100083, China. Tel.: +86 13811480512; fax: +86 10 82326850.

E-mail addresses: [tangxuan@cugb.edu.cn](mailto:tangxuan@cugb.edu.cn), [tangxuan1979@163.com](mailto:tangxuan1979@163.com) (X. Tang), [zhangjc@cugb.edu.cn](mailto:zhangjc@cugb.edu.cn) (J. Zhang), [sxycpcwxz@126.com](mailto:sxycpcwxz@126.com) (X. Wang), [yubs@cugb.edu.cn](mailto:yubs@cugb.edu.cn) (B. Yu), [Dingwenlong2006@126.com](mailto:Dingwenlong2006@126.com) (W. Ding), [Xiongjy1981@126.com](mailto:Xiongjy1981@126.com) (J. Xiong), [yangyitingxinjiang@126.com](mailto:yangyitingxinjiang@126.com) (Y. Yang), [37306585@qq.com](mailto:37306585@qq.com) (L. Wang), [944985906@qq.com](mailto:944985906@qq.com) (C. Yang).

<sup>1</sup> Xuan Tang obtained a Ph.D. in petroleum geology from CUGB in 2009. He taught petroleum geology and did research on shale gas in China for the past four years. He has work experience with Chinese oil companies in dealing with shale gas evaluation.

Triassic shales produced two to five tons of oil on average and 1000–3000 m<sup>3</sup> of gas per day by fracturing, which inspired oil companies to turn their eyes upon those shale themselves for hydrocarbon resources. Is it possible to find large oil and gas accumulations in these continental shale intervals? In this paper, we re-examined the upper Triassic continental shales in the southeastern Ordos Basin to investigate their geochemical and petrological character and physical properties, and we measured their gas and oil contents to evaluate the hydrocarbon-accumulation conditions and resource potential for continental shales.

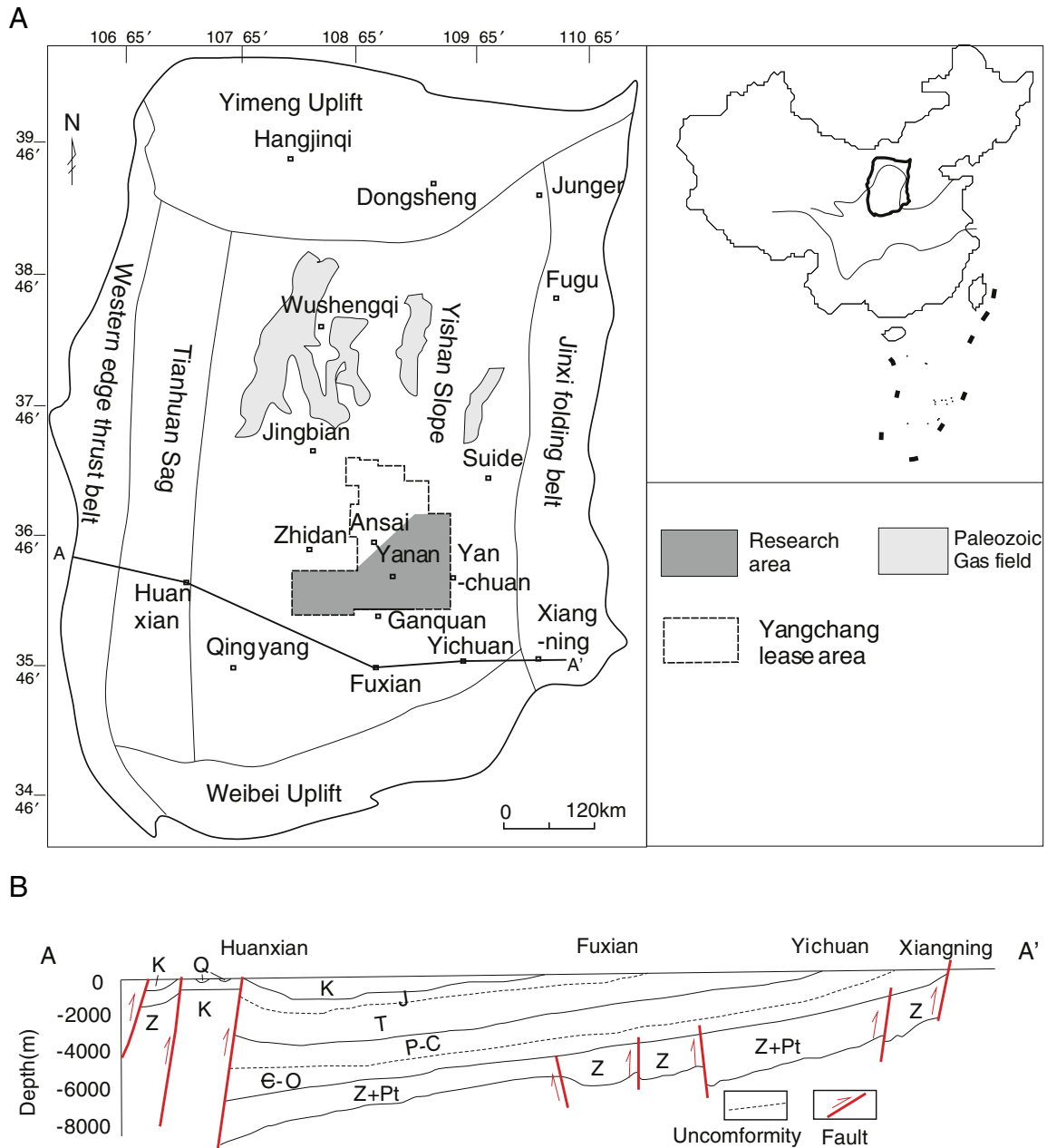
**2. Geologic setting**

The Ordos Basin, 26 × 10<sup>4</sup> km<sup>2</sup>, is located in the central part of the North China Plate, and it is a large, asymmetric syncline with a broad, gently dipping eastern limb and a narrow, steeply dipping western limb and with the Tianhuan Sag forming the syncline axis (Sun et al.,

1989). Tectonically, the basin can be subdivided into six substructures: the Weibei Uplift in the south, the Yimeng Uplift in the north, the Jinxi Fold Belt in the east, the Tianhuan Sag and the western edge thrust belt in the west and the Yishan Slope in the central part (Fig. 1A). The Yishan Slope has a 1–2° dip and covers a large area of the basin (Fig. 1B) where the main locations for petroleum exploration and development in the Ordos Basin are located.

**2.1. Tectonics**

The Ordos Basin, a typical cratonic basin developed on the base of Archean granulites and the lower Proterozoic greenschists of the North China block (Yang et al., 2005), has experienced four evolutionary stages: the Early Palaeozoic shallow marine platform, the Late Palaeozoic offshore plain, the Mesozoic intracontinental basin and the Cenozoic faulting and subsidence (Yang et al., 2005). The structural



**Fig. 1.** (A) The location of the research area and the structure zones of the Ordos Basin. (B) The geologic cross section AA' showing the profile from west to east through the Ordos Basin, modified from Yang (2004). The stratigraphy was interpreted from the seismic profiles and well data. The Paleozoic–Mesozoic strata in the principal part of the basin dip gently to the west. Upper Triassic shales are targets for shale hydrocarbon exploration at present.

Download English Version:

<https://daneshyari.com/en/article/1753052>

Download Persian Version:

<https://daneshyari.com/article/1753052>

[Daneshyari.com](https://daneshyari.com)