Organic Geochemistry 86 (2015) 55–70

Contents lists available at ScienceDirect

Organic Geochemistry

journal homepage: www.elsevier.com/locate/orggeochem

Organic geochemistry and petrology of Lower Cretaceous black shales in the Qiangtang Basin, Tibet: Implications for hydrocarbon potential

Ruofei Yang [a], Jian Cao [a,*], Guang Hu [b,a], Xiugen Fu [c]

[a] State Key Laboratory for Mineral Deposits Research, Department of Earth Sciences, Nanjing University, Nanjing, Jiangsu 210023, China
[b] School of Geoscience and Technology, Southwest Petroleum University, Chengdu, Sichuan 610500, China
[c] Chengdu Institute of Geology and Mineral Resources, Chengdu, Sichuan 610081, China

ARTICLE INFO

Article history:
Received 4 January 2015
Received in revised form 17 May 2015
Accepted 12 June 2015
Available online 29 June 2015

Keywords:
Shengli River black shales
Hydrocarbon generation
Lagoon
Unconventional hydrocarbons

ABSTRACT

Lower Cretaceous black shales have recently been discovered in the Qiangtang Basin (especially in its northern basin), Tibet, implying a new interval with hydrocarbon resource potential in the region. This potential, however, has not been investigated to date and is addressed in this paper based on organic petrology and geochemistry data from the representative Shengli River outcrop. Organic petrology, including optical and scanning electron microscope observations, indicates that the organic matter (OM) within these shale sequences has precursors from abundant benthic algae, some bacteria and amorphous OM and a few land plants, suggesting that the black shales were deposited in a generally reducing platform–lagoonal environment favorable for OM preservation. The shales have high total organic carbon (TOC) contents (1.74–7.71 wt%), type II kerogen (tending to type III), and high thermal maturity (vitrinite reflectance equivalent of ca. 1.3 %Ro). Biomarkers in the shales suggest deposition under reducing brackish or saline water with aquatic benthic organisms, bacteria and amorphous OM as the dominant input. Thus, the results of organic petrology, organic geochemistry and biomarker geochemistry are generally consistent and imply that the Shengli River black shale samples have significant hydrocarbon resource potential and most likely produced gas due to relatively high maturity and gas-prone kerogen. The neighboring black shales within the same stratigraphic interval as the Shengli River shales, if having moderate OM maturity and oil-prone kerogen, can be expected to generate oil. The presence of well-developed micropores and fractures, and abundant brittle minerals within the black shales suggests that they may have unconventional hydrocarbon resource potential, especially in intervals with high TOC > 4.0 wt%. These results provide new data and understanding for regional hydrocarbon exploration.
© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

The Qiangtang Basin is located in Tibet (western China), and is predicted to be prospective for oil and gas exploration (Zhao et al., 2000; Li et al., 2005), because it is located in the eastern sector of the Tethyan Hydrocarbon Province, one of the most significant regions of hydrocarbon resources worldwide (Klemme and Ulmishek, 1991). However, the high altitude of the area has resulted in only limited oil and gas exploration and the hydrocarbon resource potential remains unclear (Qin, 2006a). Previous research based on outcrop and limited core samples has focused on source rock intervals including the Upper Triassic Xiaochaka Formation (T_3x), the Middle Jurassic Buqu (J_2b) and Xiali (J_2x) formations, and the lower member of the Upper Jurassic Suowa Formation (J_3s_1) (Qin, 2006b; Ding et al., 2011, 2013; Wang et al., 2013).

Recently, a set of Lower Cretaceous black shales/oil shales were discovered within the basin and are particularly widespread in the north (Wang et al., 2007, 2009, 2010; Fu et al., 2009). Preliminary stratigraphic correlations across the area indicate that the shales are widely distributed, suggesting possibly significant hydrocarbon resource potential. However, most previous research on the shales has been focused on the age and depositional environment (Wang et al., 2007, 2009; Fu et al., 2009, 2010).

Here, we present organic petrology and geochemical analyses to evaluate the hydrocarbon resource potential and provide new data and understanding for regional hydrocarbon exploration. As the shales were influenced by key events in geological history, such as oceanic anoxic events (OAEs) (Erbacher et al., 2001; Herrle et al., 2003; Pauly et al., 2013), the results from this study may also have implications for understanding these geological events.

* Corresponding author. Tel.: +86 25 83686719; fax: +86 25 83686016.
E-mail address: jcao@nju.edu.cn (J. Cao).

http://dx.doi.org/10.1016/j.orggeochem.2015.06.006
0146-6380/© 2015 Elsevier Ltd. All rights reserved.

2. Geological setting

The Qiangtang Basin is located between 32°–35°N and 83°–93°E, and covers an area of approximately 180×10^3 km^2 (Fig. 1a). It is tectonically bounded by the Hoh Xil–Jinsha River Suture to the north and the Pangong Lake–Nu River Suture to the south, and consists of three second-order structural units: the northern Qiangtang depression, the southern Qiangtang depression, and a central uplifted area (Fig. 1a).

The Qiangtang Basin is a typical multi-stage basin which developed on a pre-Devonian basement. The basin has experienced a range of tectonic settings, including a Devonian–Triassic rift basin, a Triassic foreland basin, and a Jurassic passive continental margin that continues to develop to the present day (Nan et al., 2013). Most of the basin was covered by seawater between the Triassic and Late Jurassic, leading to widespread deposition of carbonates with some interbedded clastic sediments, forming a sedimentary package of several kilometers in thickness (Zhao et al., 2000). The Yanshanian orogeny at the end of the Jurassic caused the basin to shrink and transform into a residual continental basin by the end of the Late Cretaceous (Zhao et al., 2000). Thus, the Lower Cretaceous black shales in the study area were most likely deposited during the transition from marine to residual continental settings, resulting in sediments that include both carbonates and clastic rocks (Zeng et al., 2012). These sediments are divided into the following two lithofacies:

(1) Delta facies, present locally in the east of the Quemocuo area that contain mudstone, siltstone, and sandstone, all of which show a transition into continental sediments of the Xueshan Formation to the north and the Zhaworong Formation to the east; (2) tidal flat–lagoon facies, dominating the central part of the northern Qiangtang depression, which include a lower sequence of sandstone, micritic limestone, marl, limestone and shale, and an upper sequence dominated by gypsum.

The age assignment of the Lower Cretaceous has been characterized mainly from isotopic dating and palynological data (Wang et al., 2007; Fu et al., 2009). This is believed to be more precise than the stratigraphic constraints, which are still debated and cannot be precisely conducted due to a lack of continuously distributed outcrops. Stratigraphically, the Lower Cretaceous in this study roughly represents the upper part of the Upper Jurassic Suowa Formation (J_3s) in previous studies (Wang et al., 2013), while the lower part of the Suowa Formation belongs to the Upper Jurassic.

3. Samples and methods

A total of 28 samples were analyzed in this study. They were collected from an outcrop in the central part of the black shales in the Shengli River area which provided good sampling conditions (Fig. 1b), where the shales are intercalated with marls and micritic limestones (Fig. 2). The surfaces of the samples were removed

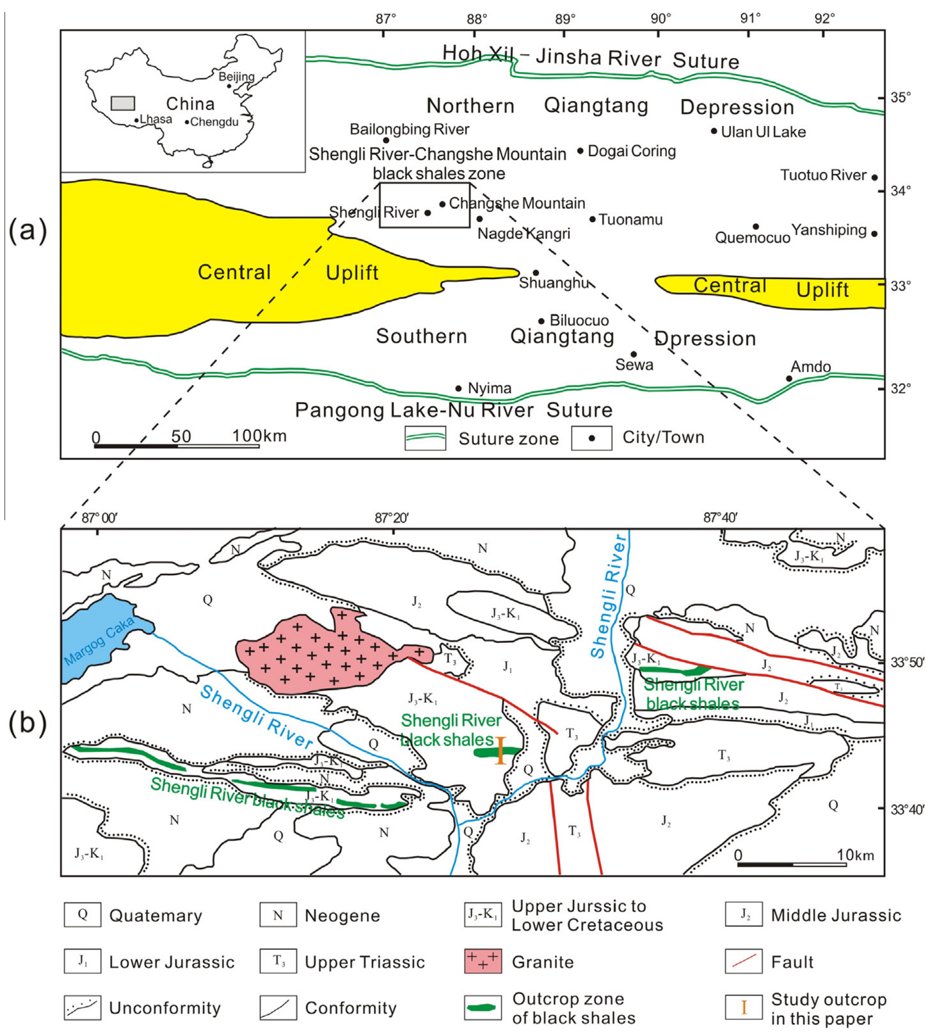

Fig. 1. Geological map of the study area: (a) structural units of the Qiangtang Basin; (b) location of the Shengli River black shale sequences.

Download English Version:

https://daneshyari.com/en/article/5162224

Download Persian Version:

https://daneshyari.com/article/5162224

Daneshyari.com