

# Shale gas accumulation conditions and gas-bearing characteristics of the Lower Cambrian Niutitang Formation in Well Changye-1 in northwestern Hunan Province

Tuo Lin<sup>1,2\*</sup>, Shujing Bao<sup>1</sup>, Jinchuan Zhang<sup>3</sup>, Zhi Zhou<sup>1</sup>, Kun Yuan<sup>1</sup>, Bo Li<sup>4</sup> and Shengyu Yang<sup>3</sup>

<sup>1</sup>Oil and Gas Survey, China Geological Survey, Beijing 100037, China

<sup>2</sup>Key Laboratory of Tectonics and Petroleum Resources of Ministry of Education, Wuhan 430074, China

<sup>3</sup>School of Energy Resources, China University of Geoscience, Beijing 100083, China

<sup>4</sup>China Huadian Engineering Co., Ltd., Beijing 100035, China

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**Abstract:** To evaluate the accumulation conditions and gas-bearing properties of shale gas in the Lower Cambrian Niutitang Formation, northwestern Hunan Province, the first shale gas parameter well (Well Changye-1) that takes the Niutitang Formation as the target horizon in the Hunan Province was selected preferably and drilled, cumulatively revealing the thickest dark shale horizon of the Niutitang Formation among the single-well drillings in China, with a true vertical thickness of 674.5m. Through analyzing the core samples in terms of organic geochemistry, rock mineralogy and reservoir properties, the black shale horizons in the Niutitang Formation of Well Changye-1 have high organic carbon content (average 3.9%), moderate maturity (equivalent  $R_o$  average 2.6%), high brittle mineral content (quartz content average 50.1%), low clay mineral content (average 32.4%), low porosity (1.7%) and low permeability ( $1.32 \times 10^{-3}$  mD), and well-developed meso to micro-pores and fractures, indicating good conditions for shale gas accumulation. Field desorption and laboratory isothermal adsorption measurements on core samples show that Well Changye-1 has good gas-bearing properties, and gas content generally increases with depth. The black shale horizons at the depth of 1100-1250m have an average organic carbon content up to 10.1%, total gas content of 0.5-2.1m<sup>3</sup>/t and 3.7-6.4m<sup>3</sup>/t, and this is the most favorable depth for shale gas development, indicating that the Niutitang Formation has good a prospect for shale gas exploration. Due to huge sedimentary thickness, the black shale in the middle-lower part of the Niutitang Formation should be given priority for exploration.

**Key words:** shale gas; gas-bearing properties; Niutitang Formation; Well Changye-1; northwestern Hunan

## 1 Introduction

Sichuan Basin and its peripheral areas have good geological conditions and resource potential for shale gas formation

(Zhang et al., 2008; Chen et al., 2010; Zou et al., 2010; Dong et al., 2012; Li et al., 2012). However, there is still rare research on northwestern Hunan neighbored with Sichuan Basin, also belonging to the Middle-Upper Yangtze Plate. In Lower

\* Corresponding author. Email: everdeer@163.com

Cambrian Niutitang Formation, black shale is developed widely with large thickness and high abundance of organic matter (Zhao et al., 2001; Nie et al., 2009; Nie et al., 2011; Xiao et al., 2012; Wang et al., 2013). Thus northwestern Hunan is regarded as the key breakthrough area for exploring the shale gas of Niutitang Formation in southern China. Accordingly, based on field geological investigation, the first shale gas parameter well (Well Changye 1) that takes Niutitang Formation as the target horizon in Hunan Province was selected and drilled. Through dense sampling, test and analysis, on-site desorption and other methods, this study systematically investigates the relevant indicators of black shale gas content in the Niutitang Formation of Well Changye 1, and quantitatively analyze the shale gas accumulation conditions and gas-bearing characteristics in the Niutitang Formation, thus providing an important parameter basis for evaluating the regional shale gas resource potential of northwestern Hunan.

## 2 Geological background

Geologically the northwestern Hunan area belongs to the Middle-Upper Yangtze Plate. From Sinian to Early Paleozoic, the area was part of a craton marine basin with a series of sedimentary marine strata (Ma et al., 2004; Ma et al., 2007). At the beginning of the Triassic, the basin experienced tectonic inversion due to regional tectonic evolution, forming a series of thrust nappe structures and para-foreland basins. The current NNE and NE trending fold and fracture system were mainly developed during the Jurassic and the Himalayan Orogeny (BGMRHP, 1988), and the topography is mostly shown as overlapping ridges and peaks, and as well as deep valleys (Fig. 1).

Among the Early Paleozoic sedimentary marine strata in the northwestern Hunan area, the Lower Cambrian Niutitang Formation is dominated by black shale, carbonaceous shale

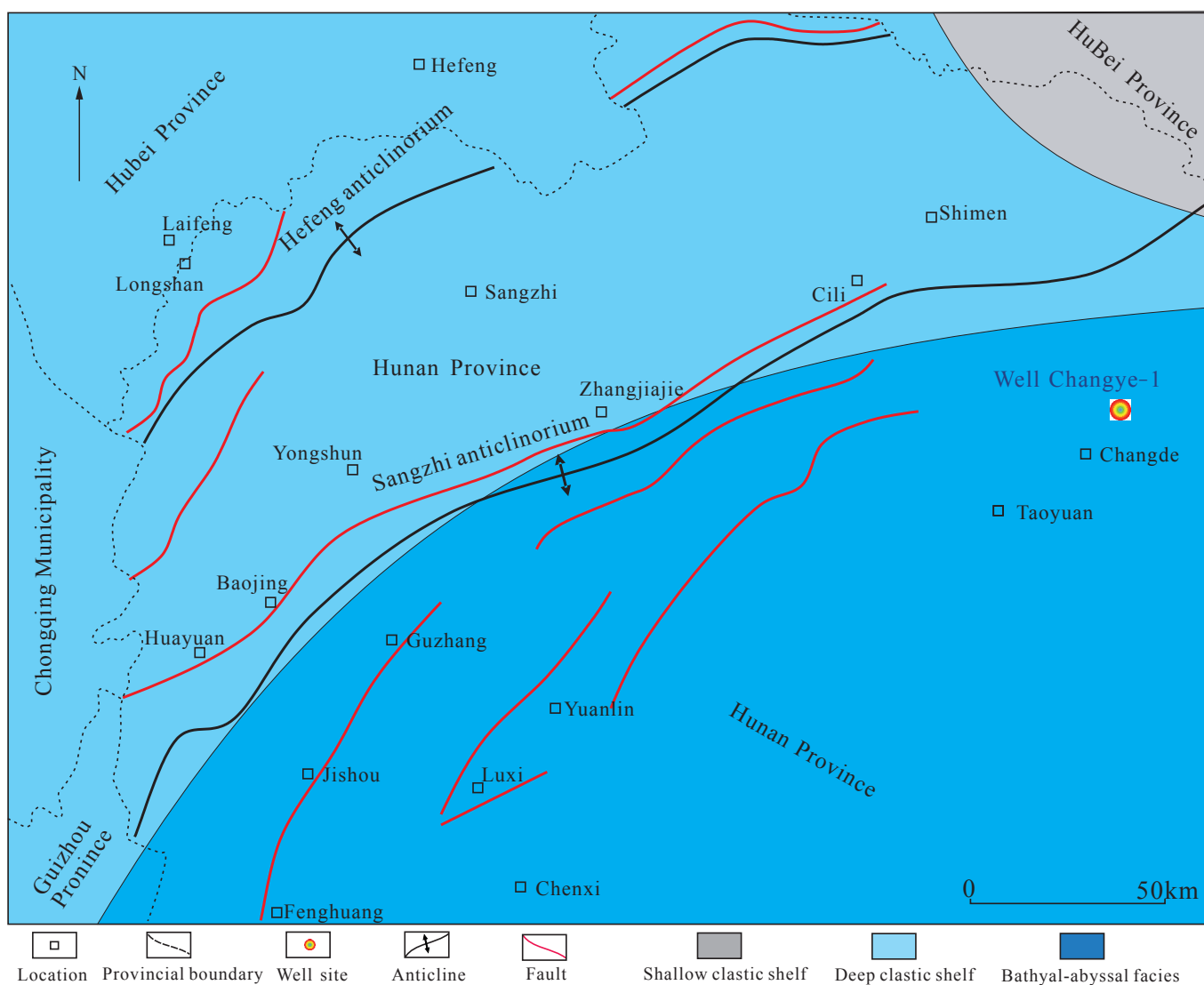


Fig. 1 Regional geological background and location of Well Changye-1 in northwestern Hunan

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