

## Hydrocarbon-Source Correlation and Timing under Post-Mature Conditions Using Re-Os Geochronology: The Neoproterozoic Dengying Formation of the Sichuan Basin, Southwestern China

Chunhua Shi<sup>1</sup>, Jian Cao<sup>1</sup>, Wenxuan Hu<sup>1</sup>, David Selby<sup>2</sup>, Xiucheng Tan<sup>3</sup>, and Hong Liu<sup>3</sup>

<sup>1</sup>Nanjing University

<sup>2</sup>Durham University

<sup>3</sup>Southwest Petroleum University

### Abstract

Hydrocarbon-source correlation and timing under post-mature conditions have been a research challenge for decades in petroleum geology and geochemistry. This issue may be addressed by Re-Os geochronology; a promising technique based on previous studies. Here, we present a case study in the Neoproterozoic Dengying Formation of the Sichuan Basin, southwestern China, which has received renewed exploration, with the Well Gaoshi 1 generating natural gas at approximately  $1.02 \times 10^6 \text{ m}^3/\text{day}$  in 2011. However, it is not clear when and where the gas is sourced. We analyze the Re and Os isotopes of possible source rocks in the region including the Qiongzhusi (Cam1q, Cam for Cambrian), Maidiping (Cam1m), and Dengying 3 (Z2dy3, Z for Sinian) formations, and bitumens in the Dengying Formation reservoir. Analytical results show that the bitumen geochronology is about 420 Ma, with initial  $^{187}\text{Os}/^{188}\text{Os} = 1.34 \pm 0.19, 1.69 \pm 0.24$ . Selected intervals of shale possess  $^{187}\text{Os}/^{188}\text{Os}$  compositions at 420 Ma of 1.10-1.65 (Ave. = 1.37, Cam1q in the Ziyang area), 1.12-1.28 (Ave. = 1.18, Cam1q in the Chuanzhong area), 1.01-1.03 (Ave. = 1.02, Cam1m in the Ziyang area), 0.77-1.20 (Ave. = 0.88, Z2dy3 in the Chuanzhong area). The Re-Os data imply that the main generation time of the bitumens is the late Silurian during the Caledonian Orogeny. The  $^{187}\text{Os}/^{188}\text{Os}$  data suggest that Cam1q Formation is the main source rock. However, our current data set suggests that bitumen with initial  $^{187}\text{Os}/^{188}\text{Os}$  values of 1.69 may be derived from the Cam1q source rocks with higher  $^{187}\text{Os}/^{188}\text{Os}$ . The Cam1q source rocks move into the main oil generation window during the Caledonian Orogeny and the generated oils were stored in the Dengying Formation dolomite. This understanding is different from the previously thought perspective, which suggests that the initial crude oil generation time occurred during the late Silurian and the main generation time is middle Triassic according to geological setting and basin modeling. In addition, the Re-Os bitumen systematics does not show evidence of disturbance post oil generation. This provides a potentially powerful method to address the challenging issue of hydrocarbon-source correlation and timing under post-mature conditions.