Thermal history and maturity history of southeast Chongqing in the eastern Sichuan Basin, southwest China

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Introduction

Shale gas is a clean and plentiful energy resource; thus, China government has carried out several shale-gas exploration programs in South China, especially, in the Sichuan Basin. The Sichuan Basin was a cratonic basin during the Sinian to Middle Triassic and evolved into a foreland basin in the Late Triassic. The southeast Chongqing at the edge of the eastern Sichuan Basin has the similar geological evolution. The sedimentary strata in this area rest on the Proterozoic crystalline basement and comprise Cambrian, Ordovician, Silurian, Permian, and Triassic sediments. Other strata are missing due to the tectonic movements. The Lower Silurian Longmaxi shale is the primary source rock for southeast Chongqing.

Although the southeast Chongqing has been popular for shale gas exploration in recent years, the thermal history and maturity history of this area is not known. By conducting basin modelling of six wells, the thermal history and maturity history of southeast Chongqing was obtained. The geological parameters used in the basin modelling included temperature data, the thickness of missing sections by erosion, paleo-water depth, etc. The model was calibrated using 121 measured vitrinite reflectance data and equivalent vitrinite reflectance data to ensure the validity of the reconstructed thermal history. Then, the thermal model was used to estimate the maturity history of Lower Silurian Longmaxi shale in southeast Chongqing.

Conclusions

The well calibrated thermal history showed that the heat flow was estimated to be approximately 55 ± 5 mW/ m\textsuperscript{2} in the Early Silurian. The heat flow gradually increased to 60 ± 5 mW/ m\textsuperscript{2} in the Late Carboniferous and subsequently experienced a sharp rise and fall in the Permian. The peak heat flow in southeast Chongqing was 74-82 mW/ m\textsuperscript{2}. The heat flow then gradually decreased to the present-day value of 52 ± 5 mW/ m\textsuperscript{2}. Although the existing of model uncertainties, the accuracy of reconstructed thermal history model was estimated as ±5%.

The maturity history of Lower Silurian Longmaxi shale showed that the formation has reached the oil window with the calculated vitrinite reflectance value of 0.55-0.75\%R\textsubscript{o}, at a depth of 2000 m in the Early Devonian. The formation entered the gas generation threshold with the calculated vitrinite reflectance value of 1.00-1.25\%R\textsubscript{o} in the Early-Mid Jurassic. The formation subsequently entered into over mature dry-gas stage at a depth of 7000 m in the Late Jurassic. Therefore, the hydrocarbon generation stage of Lower Silurian Longmaxi shale occurred during the Early Permian, the Early Triassic and the Early-Mid Jurassic.
Figure 1 Accuracy assessment of the thermal model (e.g. HJ1 well). (a) The accuracy is tested by increasing or decreasing the previous heat flow by 5% and (b) the accuracy is tested by increasing or decreasing the previous heat flow by 10%.

References


