Linking the Pore Characteristics of Graptolite-Bearing Shale to Thermal Maturity in the Wufeng-Longmaxi Formation, Southeast Sichuan Basin, China

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Abstract

This study focuses on linking organic matter thermal maturity to pores structures of graptolite-bearing shale from the Wufeng-Longmaxi Formation in Sichuan Basin, China. Previous research has documented that higher total organic carbon (TOC) corresponds to higher graptolite abundance in Silurian shale from the basin center. Here, we analyzed pore characteristics and pore distribution of the rock samples from well core using SEM, CO2 and N2 adsorption, high pressure mercury injection, and optical petrography. Graptolite reflectance (GRo), solid bitumen reflectance (BRo), and Raman spectroscopy were used to study the thermal maturity of the shale, as these samples lack of vitrinite. Within the samples solid bitumen spherulite pores can be observed, in contrast to graptolite, which exhibited little porosity. The observed graptolites pores were regularly distribution and with spindle structure. N2 and CO2 adsorption density functional theory (DFT) models indicate solid bitumen pores are primarily distributed in the micropore range (50 nm) pore sizes are limited, based on the IUPAC classification. The GRo and BRo values ranged from 1.7 to 4.81 and from 1.6 to 3.73, respectively, indicating a high degree of thermal maturity. These reflectance proxies are well correlated. Additionally, Raman estimates for thermal maturity shows good correlation with both GRo and BRo values. Our results suggest that shale-hosted organic matter from the Wufeng-Longmaxi Formation is highly over-mature and at this high thermal maturity organic porosity may be hosted primarily in solid

bitumen, as opposed to graptolite organic matter. These findings inform shale reservoir and shale sealing properties, corresponding with the displacement pressure and mechanical characteristics of shale. Furthermore, they can be used to increase understanding of the Wufeng-Lognmaxi shale thermal evolution in order to improve setting the thermal boundaries within the basin.