The Seal Capacity of Direct Cap Rocks: Insights from Rock Mechanical Properties

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Abstract

Tarim Basin, located at the eastern Tethys, is the biggest inland petroliferous basin of China, experienced superposition of multi-period structural movement in the long evolutional process of geological history. The quality of the oil and gas preservation condition is one of the important factors affecting exploration prospect and selected-area evaluation in the Tarim Basin. In addition to regional cap rocks, the effectiveness of direct cap rocks is an important factor for oil and gas preservation.

In order to better evaluate the effectiveness of direct cap rocks and to reveal the seal mechanism of cap rocks, ductile detection and physical property analysis are carried out based on Carboniferous, Ordovician, and Cambrian rock samples in the Tarim Basin. The parameters of maximum deflection and bending modulus obtained from rock ductile detection have been normalized. It takes a mean value normalized by the parameters of maximum deflection and bending modulus to measure the brittle property of rocks which can be called the brittle index (BI).

The results are listed as follows, for different rock samples, the values of maximum deflection distributed in the range of 0.15~0.6mm; the bending modulus value distribution range is 200~4500MPa. From which the value of BI distribution range is obtained with 0-70. BI value shows a positive correlation with breakthrough pressure but a negative correlation with porosity. Mudstone and marl have a large value of deflection and bending modulus compared with limestone which has a small value of deflection and a large value of bending modulus. Cambrian dolomite has a strong brittle property as indicated by the smallest value of deflection and the largest value of bending modulus among all rock samples.

The porosity value of the best, second best, and third class cap rocks boundary condition are 2.5%, 10%, and 15% respectively. A 35 BI value is intermediate boundary conditions. Carboniferous gypsum, which has a very low porosity and low BI, is the best cap rocks. Mudstone and limestone are the second best cap rocks with porosity value of 10% or less and BI value of 10 to 35. The seal capacity of Carboniferous mudstone is better than that of Ordovician limestone. Cambrian dolomite has the worse seal capacity among all rock samples with BI value above 35. The results indicate that BI value integrated with porosity is an effective index to evaluate seal capacity of cap rocks.