A Practical Petrophysical Approach for Brittleness Prediction from Porosity and Sonic Logging in Shale Reservoirs: Case Studies from the Woodford, Barnett, and Granite Wash

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Abstract

Brittleness has been used as one of the important descriptors for the characterization of unconventional shale reservoirs. The degree of brittleness in shale reservoirs is determined upon the basis of its mineralogical composition, which can be obtained from mineralogical logging tools or XRD tests in the laboratory. Generally, measurements of mineralogical brittleness are obtained from physical sources and lead to relatively reliable interpretation results. However, mineralogical logging is expensive and not commonly available in the shale play. Alternatively, brittleness can also be calculated from dynamic Young's modulus and Poisson's ratio, but the absence of shear slowness in some wells restricts its wide application. Internal friction angle based brittleness can give similar interpretation results as the preceding two methods, but its accuracy depends highly on the quality of correlations. It is observed that the curves of the three different brittlenesses demonstrate similar shapes. Therefore, we have attempted to build correlations between mineralogical brittleness and porosity or sonic compressional slowness for typical shale plays (Woodford, Barnett, and Eagle Ford shale), and have proven their validity with the data obtained from wells not included in the development of correlations. Applications of these findings include: (1) enabling the possibility of evaluating brittleness in plays lacking mineralogical and shear sonic loggings, thus reducing the quantity of laboratory testing, (2) inspiring operators to develop in-house correlations of brittleness for shale gas plays, and (3) investigating similar correlations in emerging unconventional oil plays, such as Granite Wash.