Investigating Rock Properties of Shales using Microseismicity

Lindsay T. Smith-Boughner,

And

Adam Baig, Ted Urbancic, and Gisela Viegas, Engineering Seismology Group

Eric Von Lunen and Jason Hendrick, Nexen

Summary

Understanding the mechanical properties of oil and gas shales is important for optimizing the stimulation programs and production from these reservoirs. Standard methods of estimating the mechanical properties are often costly and some methods, such as core sampling and well-logs, are only representative of a small area of the reservoir or are available through seismic imaging, but then suffer through the filtering of the Earth that compromises the resolution of these parameters. Moment tensor analysis of microseismic events generated by hydraulic fracturing can be used to estimate the local rock properties at higher resolution. The ratio of the compressional to shear wave velocity is controlled by the mechanical properties of the rock. Vavrycuk (2011) suggests that this ratio can be modeled from the eigenvalues of the moment tensor, in particular in relation to the non-double-couple components of these mechanisms. However, the proviso is that these apparent rock property measurements necessarily involve the whole system of the rock and crack and infilling fluid.

This method is demonstrated using microseismic events in the Horn River Basin in the Muskwa and Otter Park shale formations. For each stage studied, as the stage progresses the estimated apparent Vp/Vs are lower then increases, particularly for events near the perforation. These changes necessarily reflect the influence of pore fluid, increased fractures in the rock or the embedment of proppant. Estimating the apparent Vp/Vs can provide a window into the dynamic changes in a reservoir as the fracture progresses and can also provide some constraints on anisotropy and local changes in the rock. Further work is needed to understand the various mechanisms responsible for these changes in the wave mechanical properties of oil and gas shales.