Spatial distribution and temporal variation of microseismic attenuation during hydraulic fracturing

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At present, more and more attention is paid on the research of unconventional resources exploration. Hydraulic fracturing and horizontal drilling are two key techniques in unconventional exploration. Fluid injection activities may cause small fracturing events which are called as microearthquakes. During its propagation, microseismic energy is dissipated in the form of geometrical spreading, scattering, and attenuation. Due to its high-frequency characteristics (commonly 10-1000 Hz), the microseismic waveforms may be significantly influenced by the attenuation effect. Attenuation in sedimentary rocks could also be affected by the hydraulic fluid injection activities (Johnston et al., 1979). Therefore, it is vital to study the spatial distribution and temporal variation of microseismic attenuation during hydraulic fracturing.

In this paper, we used the Q factor (Knopoff, 1964) to represent the seismic attenuation and assumed it only related to formation structure (frequency-independent). The peak frequency method (Eisner et al., 2013; Wcisło and Eisner, 2016) is adopted to invert for the Q factor. Several numerical tests were performed to check the inversion method and compare it with the commonly-used spectral ratio method. We then applied the peak frequency method to a real borehole microseismic monitoring case in western China. We calculated the microseismic attenuation factor Q, and characterized its spatial distribution and temporal variation due to fracturing fluid injection activities. The inversion results can provide useful information for the microseismic source imaging and focal mechanism studies to obtain proper interpretations about the induced microearthquakes.

Keywords: Hydraulic fracturing, Microseismic, Attenuation

