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A Numerical Investigation of the Effects of Formation Stiffness on Injection Induced Seismicity Magnitudes

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Abstract

The rapid growth of the North American shale gas industry has been made possible through technology advances in extended-reach horizontal drilling and multistage hydraulic fracture stimulations. However, the injection of large volumes of fluids during hydraulic fracturing have also raised concerns regarding related induced seismicity. Several recent empirical and numerical studies have investigated the effects of operational factors such as injection volume and rate on the magnitude distribution of induced seismicity events; studies on the influence of geological factors are more limited. A key geological factor is the influence of rock mass stiffness. Results are presented here investigating the effects of a stiffness contrast between adjacent formations on the magnitude distribution of induced seismicity events. A representative scenario based on the Montney play is modeled using a series of 3-D distinct-element simulations. The results of this study will help to explain observations of induced seismicity below the formation targeted by hydraulic fracturing.