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Understanding Microseismic Events during Hydraulic Fracture Stimulation for Hydrocarbon Reservoir Monitoring and Characterization

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We have processed a total of nine thousand microseismic events to investigate the stochastic process of the stress mechanism as well as frequency-magnitude relation between microseismic, volcanic and intraplate events. Our data set is composed of all available three component data with magnitude range from 0.4 <M< 6.5 from both regions extracted from the Incorporated Research Institution of Seismology (IRIS) and from producing resevoir in the Middle East with magnitude range from -2.3 <M< -0.5. Seismic b-values are estimated using the maximum likelihood method (Aki, 1965) while the stress drops are derived from the Brune's source model (Brune, 1970). Volcanic and intraplate regions are selected in order to understand the fracture mechanism between the two regions with the hope to further correlate with the recorded microseismic events in the hydrocarbon reservoir. The results obtained so far show that b values (0.954 $\pm$ 0.04) and stress drop (26.15 bar) for the volcanic region are lower than that of intraplate region where b-values and stress drop are estimated as (0.998$\pm$0.05) and (31.82 bar), while microseismic events obtain b-values (1.54$\pm$0.2) and (0.125 bar) respectively. It shows strong dependency with seismic moment and corner frequency values from each regions. Full waveform analysis reveals that microseismic and volcanic events have a remarkably similar waveform type. The relatively high b-values and variation of stress drop in all the regions could be attributed to the crustal heterogeneity and high pore pressure related to a magma chamber, fracturing in the ductile porous rocks with low stress regime and fault pattern. From all the results, this study provides a better understanding and some possible features to distinguish microseismic events during hydraulic stimulation in the Middle East.