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The application of microseismic monitoring in unconventional reservoirs

Abstract

This chapter focuses on the microseismic application to unconventional resource with case studies, and also introduces the basic microseismic monitoring theory, data acquisition and processing methods. Microseismic monitoring is extensively used to image hydraulic fracture growth in unconventional reservoirs. The technology was developed in the late 1990s concomitant with engineering production of hydrocarbons from tight rocks. Originally designed for use in mining operations microseismic monitoring techniques were rapidly applied to identifying microseismic events created during hydraulic fracturing. Microseismic event location involves matching the arrival time of the P- and S-waves on each triaxial geophone/accelerometer along with the polarization of the P- and/or S-wave energy. Microseismic monitoring provides 3D maps of the hypocenters of seismic energy radiated as rocks deform at depth. Case studies in the chapter show how the application of microseismic monitoring to unconventional reservoirs has improved efficiency and productivity. Microseismic monitoring can not only delineate and map vertical and horizontal fracture growth patterns, but also provide a dimensional image of the stimulated volume and its propagation, which enables optimization of wellbore and well stage spacing, well production and reservoir development plan, and also minimization of potential environmental impacts. Advances in the microseismic methodology culled from traditional earthquake seismology have added value to existing datasets by delivering statistical information used in interpretation of relevant parameters, such as b-value, S/P ratios and moment tensor inversion (Zinno, 1999). These advances are necessary because the geomechanical control of rock fractures at depth remains relatively imperfectly understood mostly because of the limited information available. Microseismic data mitigates uncertainty during completions evaluation in unconventional reservoirs which is critically important as the economic challenges of development increase.

Key words: Microseismic monitoring, hydraulic fracturing, real-time processing and analysis, fracture optimization, geomechanics, statistical analysis.

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Please contact us (info@microseismic.net) for the details of the paper.