Locating Events Using Borehole Microseismic Monitoring by Inclusion of Particle Motion Analysis: a case study from Indonesia

Rexha Verdhora Ry[1], Sri Widiyantoro[2], and Andri Dian Nugraha[2]

[1]Master Program of Geophysical Engineering, Faculty of Mining and Petroleum Engineering, Institut Teknologi Bandung, Ganesha 10 Bandung 40132, Indonesia
[2]Global Geophysics Group, Faculty of Mining and Petroleum Engineering, Institut Teknologi Bandung, Ganesha 10 Bandung 40132, Indonesia

Abstract

Microseismic monitoring and constraining its hypocenters in and around hydrocarbon reservoirs provides insight into induced deformation related to hydraulic fracturing. In this study, we used data from a single vertical array of sensors in a borehole, providing measures of arrival times and polarizations. Microseismic events are located using 1-D velocity models and arrival times of P- and S-wave. However in the case of all the sensors being deployed in a near-vertical borehole, there is a high ambiguity in the source location. Herein we apply a procedure using azimuth of P-wave particle motion to constrain the initial source location. We used a dataset acquired during fracture stimulation of CBM field in Indonesia. We applied several step of location procedure to investigate a microseismic induced by these hydraulic fracturing activities. First, arrival times for 1,173 candidate events were manually picked. Then we estimated back-azimuth using Pwave polarization analysis. We also added the combination of polarities analysis to remove 180^{o} ambiguity. In the end, we determined hypocenters location using guided-grid-search method in the back-azimuth trace area to minimize all combinations of arrival times and sensors. We have been successfully removed the ambiguity and produced a good solution of hypocenters location as indicated statistically by small RMS. Most of the events clusters highlight coherent structures around treatment wells and inferred faults. This procedure can be applied to various other cases such as microseismic monitoring in the field of CCS (Carbon Capture and Storage), CBM (Coal Bed Methane), geothermal, and shale gas/oil exploration development.