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Retrieving Focal Mechanism using Double Couple - Tensile Constrained Inversion : Method and Synthetic Tests

IIDA, Shuhei[1*] ; KIM, Ahyi[1]

[1]Yokohama City University

Understanding the source characteristics of hydraulic fracturing induced microearthquakes is expected to provide better understanding of both the fracturing process and the influence of pre-existing structures on the distribution of events. However, details of the source characteristics of the microearthquakes remain largely unknown. One controversial issue is whether a significant volumetric change occurs because of the stimulation. Answering this question is important to provide the insight of the future effective and safer hydraulic fracturing. Although the moment tensor inversion is one of the best approaches for studying source mechanisms, it is often biased due to uncertainty of geologic model, sparse receiver coverage and low signal to noise ratio for this types of induced earthquake analyses. So it is necessary to quantify the factors which bias the solution. Herein, to address this question, we modified the double couple focal mechanism inversion method using the body-wave amplitude ratio and polarities developed by Snoke (2003) for stimulation induced microearthquake analysis. Since our goal is to figure out whether it is possible to identify volumetric change with limited receiver azimuthal coverage, it is necessary to incorporate the non-double couple mechanism in the inversion. Since the mechanism of the microearthquakes can be considered as 1) shear slip along the pre-existing fracture surface, 2) an tensile displacement which increase the porosity, or 3) a combination of these mechanisms, we added tensile crack component to the original method. In this manner, we have smaller degree of freedom to stabilize the inversion than that of full moment tensor case. In this study we will examine the performance of the method with synthetic tests under various conditions.

Keywords: induced seismicity, hydraulic fracturing, focal mechanism, tensile crack