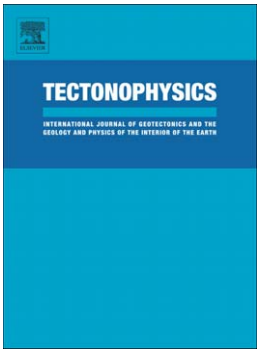

Accepted Manuscript

Fracture parameter inversion from passive seismic shear-wave splitting: A validation study using full-waveform numerical synthetics

Yousef, B.M., Almarzooq, H., Angus, D.A., Hildyard, M.W.

PII: S0040-1951(17)30280-9
DOI: doi: 10.1016/j.tecto.2017.06.034
Reference: TECTO 127546

To appear in: *Tectonophysics*

Received date: 8 March 2017
Revised date: 22 June 2017
Accepted date: 28 June 2017

Please cite this article as: B.M., Yousef, H., Almarzooq, D.A., Angus, M.W., Hildyard, Fracture parameter inversion from passive seismic shear-wave splitting: A validation study using full-waveform numerical synthetics, *Tectonophysics* (2017), doi: 10.1016/j.tecto.2017.06.034

Fracture parameter inversion from passive seismic shear-wave splitting: A validation study using full-waveform numerical synthetics

Yousef[1], B.M., Almarzooq[1], H., Angus[2], D.A. & Hildyard[1], M.W.

1. School of Earth & Environment, University of Leeds, Leeds, UK
2. ESG Solutions, Kingston, Canada

Abstract

Fractures are pervasive features within the Earth's crust and they have a significant influence on the multi-physical response of the subsurface. The presence of coherent fracture sets often leads to observable seismic anisotropy enabling seismic techniques to remotely locate and characterise fracture systems. Since fractures play a critical role in the geomechanical and fluid-flow response, there has been significant interest in quantitatively imaging in situ fractures for improved hydro-mechanical modelling. In this study we assess the robustness of inverting for fracture properties using shear-wave splitting measurements. We show that it is feasible to invert shear-wave splitting measurements to quantitatively estimate fracture strike and fracture density assuming an effective medium fracture model. Although the SWS results themselves are diagnostic of fracturing, the fracture inversion allows placing constraints on the physical properties of the fracture system. For the single seismic source case and optimum receiver array geometry, the inversion for strike has average errors of between 11° and 25°, whereas for density has average errors between 65% and 80% for the single fracture set and 30% and 90% for the double fracture sets. For real microseismic datasets, the range in magnitude of microseismicity (i.e., frequency content), spatial distribution and variable source mechanisms suggests that the inversion of fracture properties from SWS measurements is feasible.

Keywords: explicit fractures, finite-difference, fracture inversion, full-waveform synthetics, shear-wave splitting

1. Introduction

Fractures are pervasive features within the brittle crust, ranging in size over several orders of magnitude, from large scale faults (km) down to micro-cracks in core samples (mm). Fractures play a critical role in the multi-physical response of Earth materials, influencing the stress and strain fields leading to geomechanical deformation as well as acting as secondary conduits for fluid-flow contributing to fluid movement in porous media. Fractures also influence