Least-Squares Measurement of Shear-Wave Splitting

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Abstract

Knowledge of vertical fractures is important for understanding the flow of fluids in a reservoir. The most direct seismic method of estimating fracture orientation and fracture intensity is by analysis of shear-wave splitting. Shear-wave splitting arises when a shear wave naturally polarizes into a fast wave (S1) parallel to the fractures and a slow wave (S2) perpendicular to them. A common way to detect the direction of fractures from shear-wave splitting is to rotate the horizontal components to radial and transverse components, and then search for azimuthal directions in which the transverse component has an amplitude null. There is an associated change of polarity of the transverse component as a function of azimuth, which makes this direction readily apparent on data with good azimuthal sampling. In practice, irregularities in the acquisition geometry can compromise the azimuthal sampling. Standard analysis methods are adversely affected by these irregularities, giving sometimes erroneous estimates of fracture orientation.

In this paper we present a new least-squares method, which places much less stringent requirements on the distribution of azimuths within an analysis gather. We present a synthetic example, comparing the new method with a standard approach based on polarity changes, to illustrate the superior accuracy of the new method. We also present initial results on a 3-C field dataset, which indicate the new method performs well compared to an existing technique.