A model-based AVAZ inversion for azimuthal anisotropy

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ABSTRACT

AVAZ inversion can extract natural fracture network properties from 3D pre-stack seismic amplitudes, hence providing important information for unconventional reservoir characterization and hydraulic fracturing stimulation. The commonly used AVAZ inversion is a time sample-by-sample procedure to invert for the HTI symmetry axis direction, analog to dominant fracture orientation, and the anisotropic gradient B_{ani}, analog to fracture density. The technique is based on the Rüger equation for PP reflection-coefficients from a boundary of two HTI media. The near angle Rüger approximation results in a 90° ambiguity on the orientation estimate and relative, band-limited, B_{ani} values. We present a model-based AVAZ inversion to invert for interval B_{ani}. The method is coded using the Earth Signal Ltd processing system. Our method is, an extension of the isotropic model-based inversion by Hampson and Russell (2013) and simultaneously invert for isotropic elastic properties and B_{ani}. The orientation direction is input to our model-based AVAZ, estimated by a sample-by-sample procedure in which the 90° ambiguity is removed by constraining the results to the stress information provided by the major stress direction or well control. We have tested the proposed model-based AVAZ inversion on synthetic azimuthal gathers, and the inversion for interval B_{ani} was successful. This facilitates a meaningful interpretation of azimuthal anisotropy values, extracted from pre-stack seismic amplitudes.

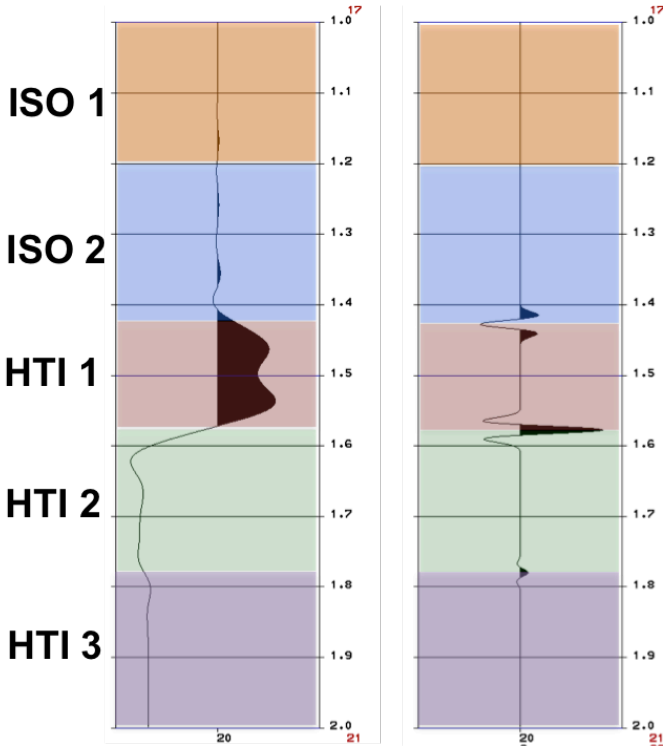

FIG. 1: AVAZ inversion results from synthetic data, generated over a five layer model. (left) B_{ani} estimate (interval property) from the proposed model-based AVAZ inversion. (right) B_{ani} estimate (relative property) from conventional AVAZ inversion.