Multicomponent processing and fracture characterization analysis of two Wyoming 3-D PS-wave surveys: Pinedale Field and Washakie Basin

James E. Gaiser, Richard R. Van Dok, WesternGeco, Denver, Colorado

Abstract

Multicomponent 3-D surveys where downgoing compressional (P) waves convert to upgoing shear (S) waves at interfaces provide a practical means for analyzing fracture properties. This is particularly important for delineating naturally fractured reservoirs by exploiting the unique characteristics of S-wave azimuthal anisotropy induced by vertical fracturing. In the presence of fractured media, S-waves split into a fast wave that is polarized parallel to fractures and a slow wave that is polarized normal to fractures. The amount of splitting (time difference between the two S-waves) is proportional to fracture intensities. To investigate this phenomenon we utilize a wide range of source-receiver azimuths in the processing and analyze the fast and slow S-waves to extract fracture information.

Two 3-D 3-component (one vertical and two horizontal geophones) surveys from Wyoming are presented: one acquired over the southern tip of the Pinedale Field in the Antelope area and the other in the Washakie Basin. The targets are naturally fractured gas sand reservoirs. From the analysis of fast and slow S-waves the same regional direction of anisotropy was observed in both areas. Layer-based analyses measured anisotropy in the overburden, which required compensation during the processing to isolate the variations at reservoir depths. Eight limited-azimuth volumes were created for the two horizontal geophone components. Azimuthal anisotropy analyses at the southern tip of the Pinedale anticline in the Antelope area indicate potential sweet spots of more intense fracturing. These occur along the flanks of the anticline and appear to be controlled by faulting. Similar association of azimuthal anisotropy with structural features (faults and lineaments) is also observed in the Washakie Basin.

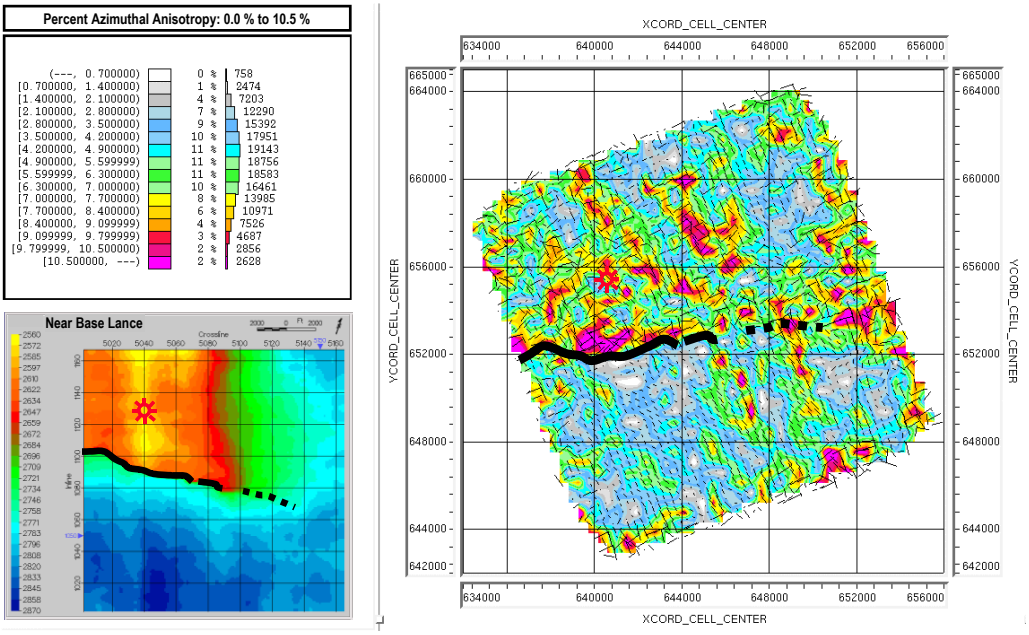

Figure 1. This shows the azimuthal anisotropy analysis (right) over the target for near base of Lance isochron (left) at Pinedale Field. Colors represent percent anisotropy (fracture intensity) from 0.0 to 10.5, which have a peak distribution of 5%. Note that more intense anisotropy occurs along the flanks of the Pinedale anticline and the east-west fault, but has shifted somewhat to the east. The principal orientation of the fast S-wave (fracture orientation) is predominantly N45˚W.