AAPG Datapages/Search and Discovery Article #90319 ©2018 GEO 2018 13th Middle East Geosciences Conference and Exhibition, Manama, Bahrain, March 5-8, 2018

Vector Attributes: An Approach Based on the Analysis of Normal Vector Field to Seismic Layering to Assist in Geological Interpretation

Aicha Bounaim[1], Marie Etchebes[1], Jarle Haukaas[1], and Hilde G. Borgos[1]

[1]Schlumberger, Stavanger, Norway.

ABSTRACT

In the petroleum industry, seismic attributes have been extensively used as a tool for prospect identification and reservoir characterization. Seismic amplitude remains by far the most widely used attribute, but does not contain all the aspects of the seismic signal. Therefore, there has been an increasing interest in developing more advanced attributes since the 90s. The significant progress in computing capacities has helped in this direction and has, consequently, led to improved geological interpretation. In general, seismic attributes are categorized as time-, amplitude-, phase-, or frequency-dependent quantities, and different mathematical methods are used to exploit these characteristics. In this study, we propose a new approach based on transforming the 3D seismic data into seismic vector attributes and shape metrics by defining a normal vector field to seismic layering. For consistency, vectors are normalized to unit length to be amplitude-independent and an upwards pointing convention is considered. This approach can be exploited at different spatial scales. First, straightforward 3D normal vector differential operations can be applied to highlight very local changes. In particular, the components of the curl of the normal vector field and its magnitude have been successfully used to delineate subtle discontinuities in unconventional reservoirs. The method is multi-scale and a neighborhood-based analysis of the normal vector field is proposed to take into account the size of the geological features to be extracted from the seismic data. For this purpose, a structure tensor is generated and analyzed in terms of eigenvectors and eigenvalues. Eigenvalues can be exploited individually, in particular, the first eigenvalue acts as an indicator for stratigraphy, or combined for detecting discontinuities or mapping salt bodies. Inspired from medical imaging, the analysis is further extended by introducing a Barycentric space on which the eigenvalues are projected and color-coded by the derived ‘vector attributes’. The new space provides an intuitive and interactive way to classify the geological structures from their seismic vector attribute response. The new vector attributes provide a well-established mathematical analysis that exploits the seismic orientation information into confidence metrics to assist interpreters in the geological tasks.