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Generating More Robust Geometric Attributes by Preconditioning Seismic Data with 5D Interpolation

Satinder Chopra[1] and Kurt J. Marfurt[2]

[1]Arcis Seismic Solutions, TGS, Calgary, Alberta, Canada
[2]The University of Oklahoma, Norman, Oklahoma, USA

Abstract

The most common preconditioning of seismic data improves the signal-to-noise ratio of the seismic data by removing spatial noise or enhancing the coherency and alignment of the reflection events, without unnecessary smoothing or smearing of the discontinuities. Although we usually think of removing unwanted features, we can also improve the signal-to-noise ratio by predicting unmeasured signal, such as dead traces and lower-fold areas corresponding to unrecorded offsets and azimuths in the gathers. Missing offsets and azimuths usually negatively affect pre-stack inversion and AVAz analysis. While missing offsets and azimuths may not result in sufficiently reduced signal-to-noise ratios of stacked data to impair conventional time-structure interpretation, they usually give rise to attribute artifacts. We begin our presentation by correlating missing data and areas of low fold to artifacts seen in seismic attributes. Various multi-dimensional interpolation methods have been proposed by different developers, but we discuss the application of the minimum-weighted norm method to the seismic data. We then show how 5D interpolation of missing data prior to pre-stack migration results in more complete gathers resulting in a better-balanced stack and the reduction of footprint and other attribute artifacts.

Whereas coherence attributes measure waveform discontinuities associated with fault offsets and channel edges, curvature measures folds, flexures, and differential compaction. We show a comparison of the principal most-positive curvature (long-wavelength) on the input data and then the same data with 5D interpolation. Missing traces give rise to inaccurate estimates of structural dip, which is input to volumetric curvature computations. We indicate the effect of dead traces on volumetric curvature and note that more continuous, better-focused lineaments are seen on curvature computed from the 5D-interpolated volumes.

Therefore, the inference we draw from this exercise is that regularization by 5D interpolation yields better focused events and features on seismic data volumes. Interpretation carried out on attributes generated on such volumes will definitely be more accurate than the one carried out on data without regularization.