

Surface-consistent Near Surface Deconvolution

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Abstract

A novel methodology for surface-consistent amplitude balancing of the near surface attenuation response has been developed using a new sorting domain that is dedicated to refracted energy to analyze the amplitude ratios of each trace compared to a reference average trace and discover amplitude residuals. Amplitude residual values are computed as a function of frequency in order to construct a surface-consistent deconvolution operator. Operators are derived around the transmitted early arrival waveforms to separate the near-surface attenuation response from the remaining seismic data. The developed methodology is fully automatic and doesn't require pretreatment of the data, it can be used as a typical preprocessing early in the seismic processing process. The method is demonstrated on a complex synthetic model with strong amplitude residuals which are balanced. With near surface surface-consistent deconvolution reservoirs can be monitored mitigating the risk of the near surface distortions. A monitoring program is showcased using this technology. Consisting of a land-based water/CO₂ injection water-alternating-gas (WAG) of an enhanced oil recovery (EOR) program near surface distortions in the acquisition are present. The acquisition consists of geophones located in boreholes and seismic vibrators sources. A circular pattern of borehole receivers is centered on the location of EOR operations. The results show near surface seasonal effects are present in the data. Also, viscoelastic behaviors seem to be present in the seismic data as indicated by a linear trend of the root mean square residual increasing over time. This implies that near surface surface-consistent deconvolutions is a methodology apt for land time-lapse as seismic data needs to be treated for time variations in phase and amplitude before it can be used for predicting the amplitude changes at the reservoir level.