Restoring High Resolution in Surface Seismic Data

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Higher seismic resolution has always been one of the main objectives of oil and gas exploration and development efforts. The resolution of seismic data is affected by many factors such as acquisition layout, strength and directivity of the source, and attenuation property of the earth. It is well known that seismic energy is scattered and attenuated as it propagates through the sub-surface and particularly, in the near-surface weathered layers. Unlike surface seismic data, VSP data propagate through the subsurface layers just once and therefore is less susceptible to the greater loss in high frequency.

We propose a technique that utilizes high resolution zero-offset VSP data to derive time and depth variant filter operators which are then used to recover the attenuated frequency components of the surface seismic data. The methodology is quite simple; we analyze the frequency decay of the VSP direct arrivals as a function of receiver depth, calculate time and depth variant filter operators based on this decay and then convolve these filter operators with the surface seismic data to recover the attenuated high-frequency components. The VSP data analysis can be performed in either the time or the frequency domain which produces inverse filter operators at each consecutive receiver depth and assumes that the earth's filtering response is spatially invariant over the entire survey area. A successful implementation of this methodology using 3D seismic data will be shown to illustrate the robustness of this technique.

Abstracts by First Author