Multi-Step Auto-Regressive Reconstruction of nonuniformly Sampled, Aliased Seismic Records

M. Naghizadeh and M. D. Sacchi
University of Alberta, Edmonton, AB, Canada
mnaghi@phys.ualberta.ca

Abstract/Excerpt

A methodology for the reconstruction of nonuniformly sampled, aliased data is introduced. First, the low frequency (nonaliased) part of the data is reconstructed. Using data inside the reconstructed band, a Multi-Step Auto-Regressive (MSAR) operator extracts the ensemble of prediction filters that are used to reconstruct the high frequency portion of the data. The applicability of the MSAR method to synthetic and real seismic data is discussed.

Reconstruction of seismic data using statistical approaches is one of the ongoing research topics in exploration seismology. While they are based on statistical estimation theory, they also utilize information from the physics of wave propagation by taking into account proper apriori information and assumptions. Methods proposed by Spitz (1991), Porsani (1999) and Gulunay (2003) successfully address the problem of removing alias from regularly sampled data. These methods utilize low frequency information to recover high frequency data components. Spitz (1991) computed prediction filters (Auto-Regressive operators) from low frequencies to predict interpolated traces at high frequencies. This methodology is applicable only if the original seismic section is regularly sampled in space. Irregularly sampled data can be reconstructed using Fourier methods. In this case the Fourier coefficients of the irregularly sampled data are retrieved by inverting the inverse Fourier operator with band limiting (Duijndam et al., 1999) and/or sparseness constraints (Liu and Sacchi, 2004).We introduce a new strategy that combines the strengths of both prediction error methods and Fourier based methods to cope with the problem of reconstructing nonuniformly sampled, aliased data. The proposed algorithm involves the reconstruction of spatial data at low frequencies. The reconstructed low frequency portion of the data is used to extract a suite of prediction error filters (PEFs). Then, the extracted PEFs are used to reconstruct the aliased part of the data in Fourier spectrum.