Efficient Supergrouping Approach for Enhancement of High-Channel Count and Single Sensor Seismic Data

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ABSTRACT

Any seismic processing technique that requires pre-stack information is a challenge to apply to data acquired in the desert environment of Saudi Arabia. A complex near surface with strong acoustic contrasts and heterogeneities creates an incredibly complex wavefield. In the past, large arrays of shots and receivers were employed in the field to suppress surface waves and backscattered noise, so that reflections can be recorded with reasonable signal-to-noise ratio (SNR). Modern seismic acquisition is steadily moving to finer spatial sampling, with smaller field arrays or point sources and receivers, while typical distances between shot and/or receiver lines remain relatively large compared to inline sampling. As a result, we obtain hundreds of terabytes of data with low SNR. Processing huge amounts of data with poor SNR becomes challenging both geophysically as well as computationally. The traditional land seismic data processing workflow cannot compensate for the loss of signal, making it very difficult to obtain a reliable estimation of pre-stack parameters, such as velocities, deconvolution operators, statics, and surface-consistent scalars. Proper estimation of these parameters is a prerequisite for any further processing. In this study we describe a computationally efficient algorithm of four-dimensional supergrouping that handles high-channel count and single-sensor data comprising hundreds of terabytes of data. While similar in concept to field source/receiver array forming, supergrouping may be applied to data already acquired with field arrays. Unlike field grouping, we supergroup data with kinematic corrections and overlapping apertures, and have the ability to make corrections for intra-array statics and wavelet variation. We demonstrate noise-removing properties of such generalized supergroups with NMO corrections, and illustrate applications to challenging land seismic data from Saudi Arabia. Such applications cover various steps of land seismic processing, from first-break picking and FWI, to deconvolution, statics, and imaging.