Enhance – Estimate – Image: New Processing Approach for Challenging Seismic Data with Low Pre-Stack Signal-To-Noise Ratio

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ABSTRACT

With the advent of single-sensor recording in land environments, the problem of noise on seismic records has become a significant challenge. The failure to remove noise can adversely affect subsequent processing steps and the ultimate usefulness of the data. For decades arrays of sensors were commonly deployed to attenuate noise; through field summation of multiple elements to attenuate random noise and through clever designs to suppress specific wavelengths of surface waves. If single-sensors are spaced close enough to sample groundroll unaliased, it can be removed with F/K techniques. Strong unorganized noise; however, can be a much tougher problem requiring a new approach. Proper estimation of the seismic signal spectrum for deconvolution operator determination requires a fairly noise-free dataset. To overcome the strong random noise often seen in high-channel count and single-sensor data we need to enhance the data first through a process we term Enhance – Estimate – Image. Array forming via smart supergrouping of the data in the shot/receiver or other domains can produce levels of random noise attenuation formerly accomplished with field arrays. However; unlike field arrays we can vary the configuration and number of elements until we get the desired signal-to-noise ratio. With this enhanced dataset we can better estimate the signal spectrum to produce proper deconvolution operators. These operators can be applied back to the original data set or to another level of supergrouping tuned for other processes. The Enhance – Estimate – Image process was applied to a 2D single-sensor dataset with a high random noise level. The data was supergrouped in both the shot and receiver domains at various levels until the random noise was reduced to an acceptable level. The deconvolution operators estimated from the supergrouped data were then applied to data with lighter supergrouping. The resulting cdp stack showed both greater continuity and a broader spectrum than the original stack where deconvolution operators were estimated from noisy data. The Enhance – Estimate – Image approach is critical for modern high-channel count data when estimating any type of pre-stack parameters requires noise free data. The Enhance part can be tuned differently for each task (decon, scalars, residual statics, etc.) based on physics and data quality. Iterative processing approaches represent a practical solution to processing high-channel count data with poor signal-to-noise ratio.