Random Sampling Compressive Sensing Acquisition.

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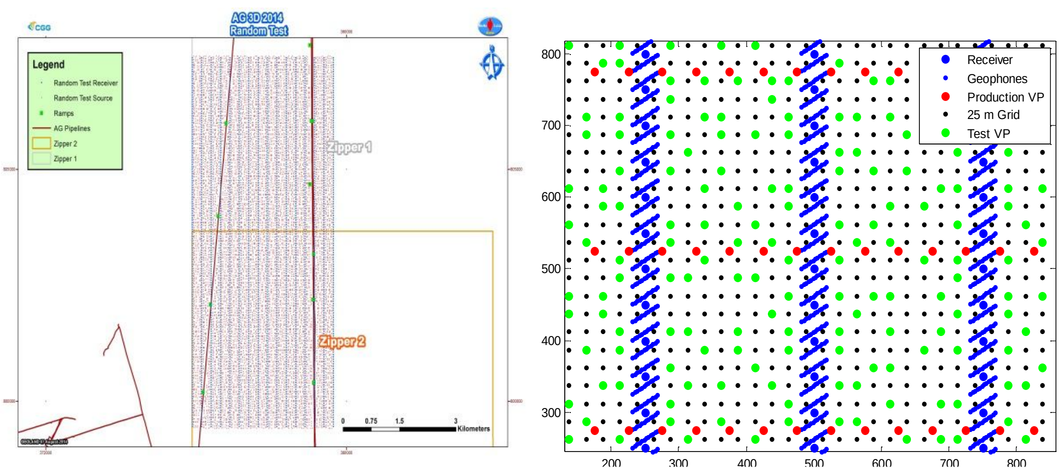
Common Receiver or Shot gathers are superior to Cross spread for back scatter noise attenuation which is one of the main problem in many middle-east desert areas (Vermeer, G., O., J. [2008]).
With the advances of simultaneous sources acquisition techniques, acquiring fully sampled common receiver gathers with carpet shooting is now economically feasible, but we still have to make compromise on the aliasing condition. The Compressive sensing theory shows us that as long as we can find a representation of our data which is sparse enough, we can advantageously acquire our simultaneous data on a random grid where the density of our grid and our blending factor is only limited by the sparsity of our data in our chosen representation (Herrmann 2009, Lin 2009)..

An experiment was conducted in cooperation with Apache in order to assess the advantages of random spatial sampling combined with simultaneous shooting in the Egyptian western desert.

The production data was acquired in orthogonal geometry with a sampling of 50 m between stations and 250 m between lines for both sources and receivers. The sources were 3 vibrator arrays in slip-sweep mode. For the compressive sensing test, the receivers were kept unchanged and the source grid is a subset of 25m x 25m grid with a decimation of 75%. Figure 1b shows in green the VP acquired and in black the omitted position. Compared to a 50mx50m grid the trace density is unchanged and the total vibrator path is only slightly increased.



(a) (b)

Figure 1: (a) test source and receiver positions. (b) source grid decimation

The source is single vibrator in unconstrained mode, the vibrator shake as soon as they have reached the predetermined positions. The reference sweep is a classical low-dwell sweep. In order to limit the crosstalk level each vibrator has a different pilot designed by adding a perturbation on the instantaneous frequency of the reference sweep, such as the final spectrum has a maximum of 3db deviation from the reference sweep (figure 1a). The cross-correlation matrix (figure 1b) shows that the maximum level of cross-correlation, in the temporal domain, is ranging from -8db to -14 dB below autocorrelation level. During the chuncking/deblending process, each vp is de-convolved by its associated ground-force in order to compensate for the differences in the vibrator pilot and signatures.

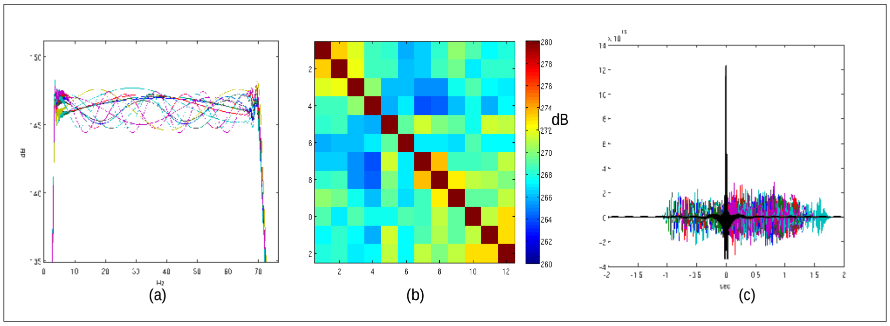


Figure 2: (a) Spectra of the 12 vibrator pilots (b) maximum of cross correlation of the pilots (c) examples of autocorrelation (black) and cross-correlation (colors) for vibrator 6

Compared to the production, the time to acquire the test is reduced by 40% for a total number of VP multiplied by 5.

A raw prestack migration was run on production data and test data without de-blending. It shows that without processing the quality of the compressive sensing test is superior, with better faults delineation and events continuity. Additional improvements are expected after de-blending and interpolation of the test dataset.

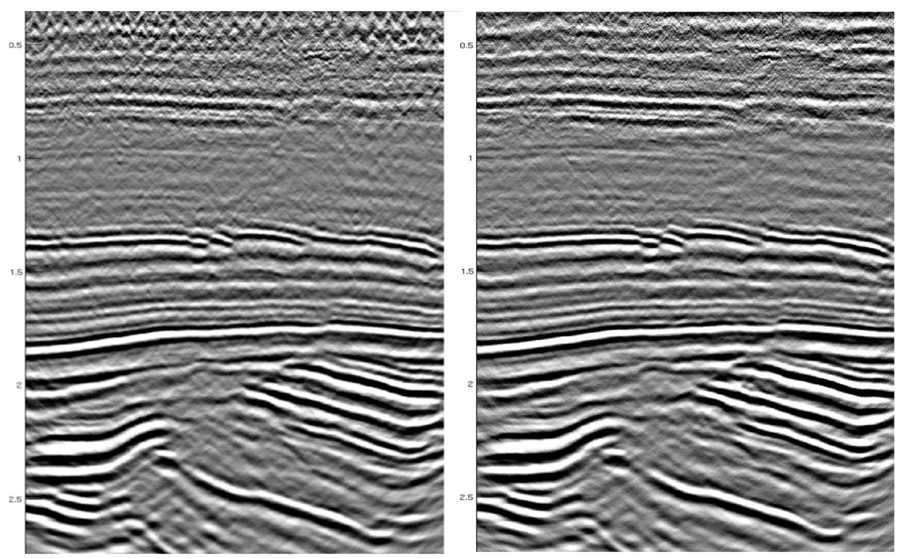


Figure 3: Raw PSTM. Left production, right compressive sensing test

References.

Vermeer, G., O., J. [2008] Alternative strategies for tackling scattered noise. *78th SEG Annual Meeting*, Expanded Abstracts 94-99.

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