Reversing entropy: deblending physical model data

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Introduction

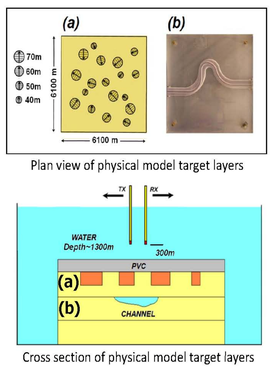
Physical modeling encounters many of the ***same constraints as seismic data acquisition in the field***—including the time required for data acquisition. Hence, a technique often applied in the field—***deploying simultaneous sources***—was used to acquire an extensive 3D seismic survey over a physical model at the CREWES physical modeling facility.

As with a field survey, the ***first step*** in processing the resulting data is to untangle or ***'deblend'*** the wavefield information from the seismic trace 'supergathers' into individual source gathers for each of the eight sources.

We demonstrate here a simple method, consisting of ***2D NMO correction***, coupled with radial trace ***(RT) domain wavefield separation***, that successfully extracts the wavefield for each source from its supergather with a minimum of residual 'crosstalk' from other sources.

The model

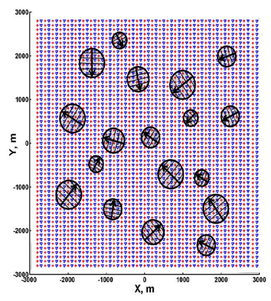
Figures 1 and 2 illustrate the model and its acquisition geometry. The actual acquisition was performed with a source array of ***8 piezopin sources***, separated by 4 station intervals. The survey was conducted in deep water as a 'marine' survey; and the ***single piezopin receiver*** transducer was positioned successively at each of 112 stations along each of 56 receiver lines. The collection of traces for each receiver line constituted a ***'supergather' corresponding to 8 shots fired simultaneously into 112 receivers***.



Plan view of physical model target layers

Cross section of physical model target layers

FIG. 1. Upper panel shows target layers of the model in plan view, lower panel shows cross section of the assembled model immersed in water.



Acquisition geometry for physical model relative to 'puck' layer

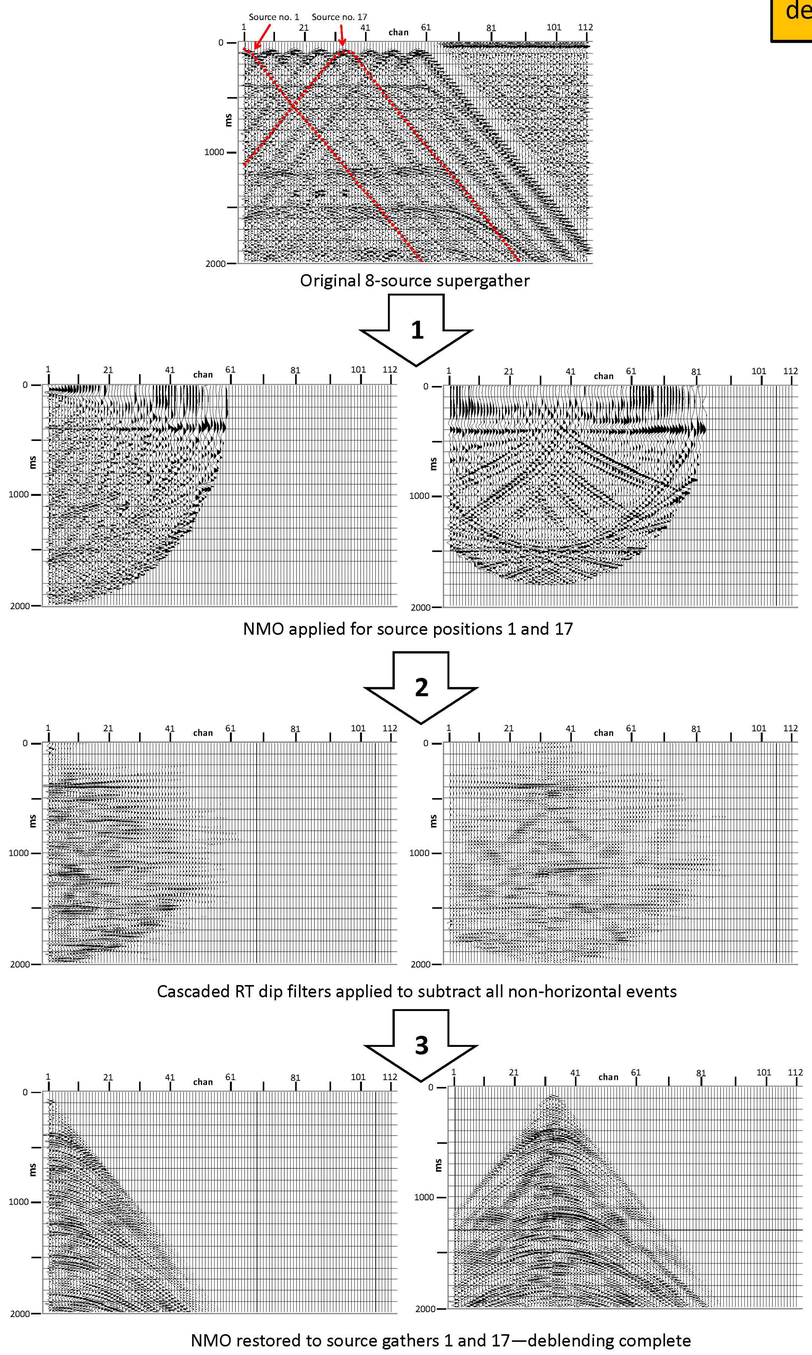
FIG. 2. Plan view of the acquisition geometry layout for the physical model—red dots are receiver positions, blue dots are source positions.

The data

Because of the size of the complete survey (over 25,000 supergathers), we chose to process only a subset of ***about 450 supergathers***, attributable to one corner of the model, to prove the method. This choice limits the imaging that can be done with the deblended data to certain selected ***2D quasi-CMP stacks.***

The method

1. NMO correction centred on a selected source position flattens desired reflections and de-aliases the overall wavefield.
2. Application of cascaded radial trace (RT) dip filters attenuates non-flat events.
3. Restoration of NMO completes deblending



Original 8-source supergather

NMO applied for source positions 1 and 17

Cascaded RT dip filters applied to subtract all non-horizontal events

NMO restored to source gathers 1 and 17—deblending complete

FIG3. Two source gathers deblended from their original supergather. In all, 8 source gathers can be extracted from this supergather.

The result

After all source gathers have been deblended from all 8-source supergathers, they can be imaged in various combinations to form ***2D quasi-CMP stacks***. Figure 4 shows a ***'broadside' stack*** where all sources fired into one receiver line are stacked by CMP. Figure 5 shows three ***'cross-stacks'*** where all traces within a certain offset range of a designated crossline are stacked by CMP. The purpose of these displays is just to ***check for artifacts*** remaining from the deblending process.

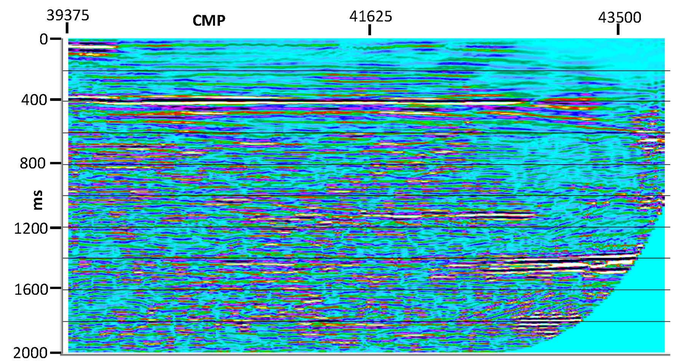


FIG.4. Broadside 2D quasi-CMP stack between source line 1 and receiver line 1. Strong event at 400ms is the top surface of the physical model; event at 1400ms is the bottom of physical model

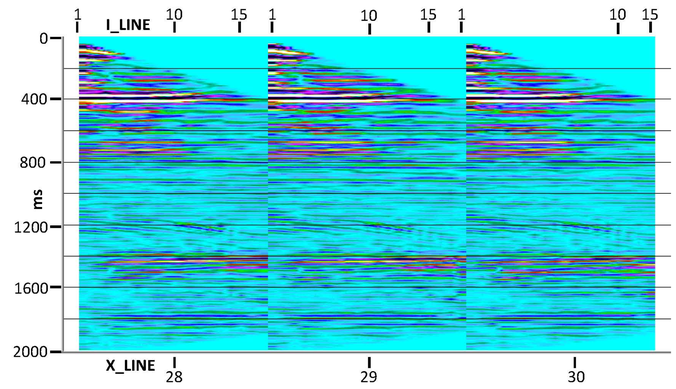


FIG. 5. Three 2D quasi-CMP Cross-stacks . Strong event at 400ms is the top surface of the model; event at 1400ms is the bottom of physical model