When On-Coming Traffic Gets Too Close (or "Results of Some Re-Binning and MegaBin Simulations in a Structured Area")

Norm Cooper - Mustagh Resources Ltd., Calgary; Ed Stacey – Petro Canada, Calgary

Summary

A regular orthogonal 3D survey was recorded in the spring of 2000 in the MacKenzie Delta area. This is an area exhibiting significant structure at a variety of depths. Conflicting dips are often present. Steeply dipping reflectors juxtaposed with short flat segments can often be an indicator of gas-water interfaces. Therefore, it is critical to the interpretation to properly resolve and migrate all dips.

The survey design generated natural subsurface bins of 30 meters by 30 meters. However, significant midpoint scatter rendered the choice of bin size somewhat arbitrary. Therefore, we were readily able to re-stack the data in several different bin sizes (20, 30, 40 and 50 meters). We also attempted some MegaBin simulations by discarding alternating rows of bins then using prediction filters to restore that data. Both normal data sets and MegaBin simulated data sets were post-stack migrated.

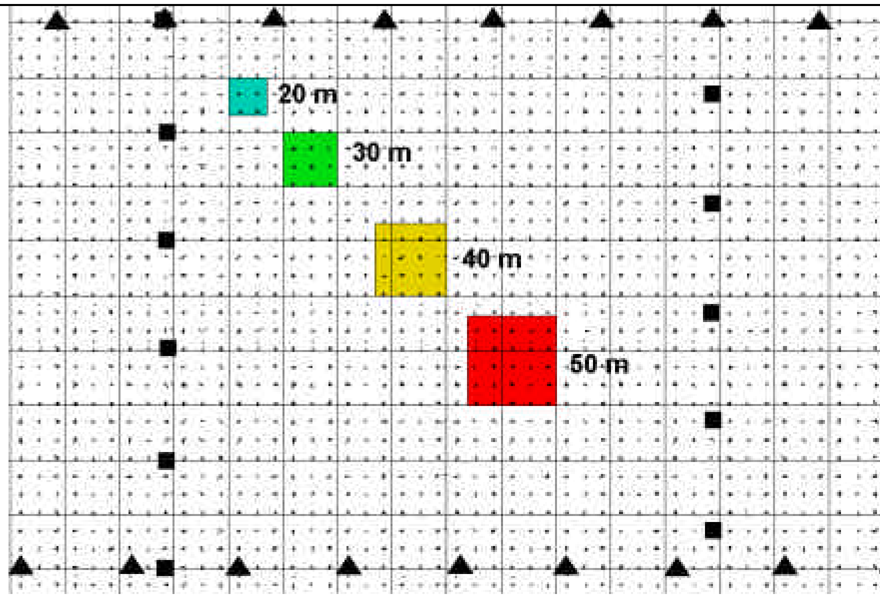

Figure 1 Mid-point scatter enabled re-binning to a variety of bin sizes.

In these tests, the fold will also increase proportionally to the square of the bin size.

Figure 2 shows a set of lines resulting from the 20 meter re-binned volume. We present both pre-migration and post-migration displays for both the normal data volume and the MegaBin simulation volume.

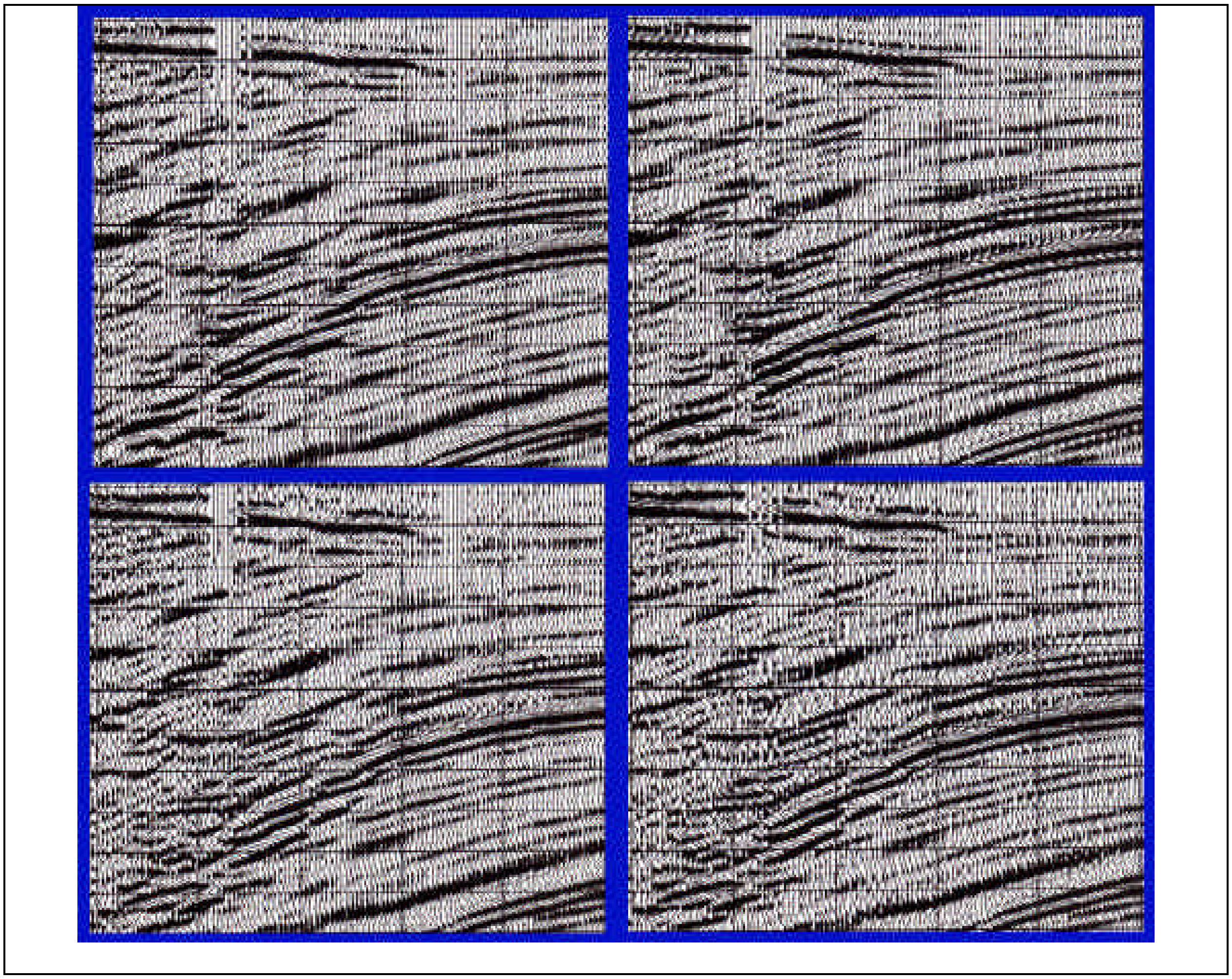

Figure 2 20 meter bin size, 14.9 fold (in deeper zones)

Top left is all data before migration. Top right is a structure stack with every second trace eliminated, then reproduced using FX Prediction filtering (MegaBin simulation). The bottom plots are the same as the top but after post-stack migration.

The relatively flat reflector near the top of each panel is a shallow unconformity that is important to image for resolution of statics. The dominant structural dips in the deeper section are quite obvious. In the lower left quadrant of each panel, we see one example of conflicting dips typical of this area. All four representations provide adequate and similar imaging for the interpreter, although there is some evidence that the interpolated version is not as stable as the original data set.

The average fold for the offset range of 0-2200 meters (typical useable offsets for the deeper part of these panels) is 14.9. Note that in Figure 3 (same sequence of displays, but from the 50 meter re-binned data) that the average fold for the same offset range is 93.1.

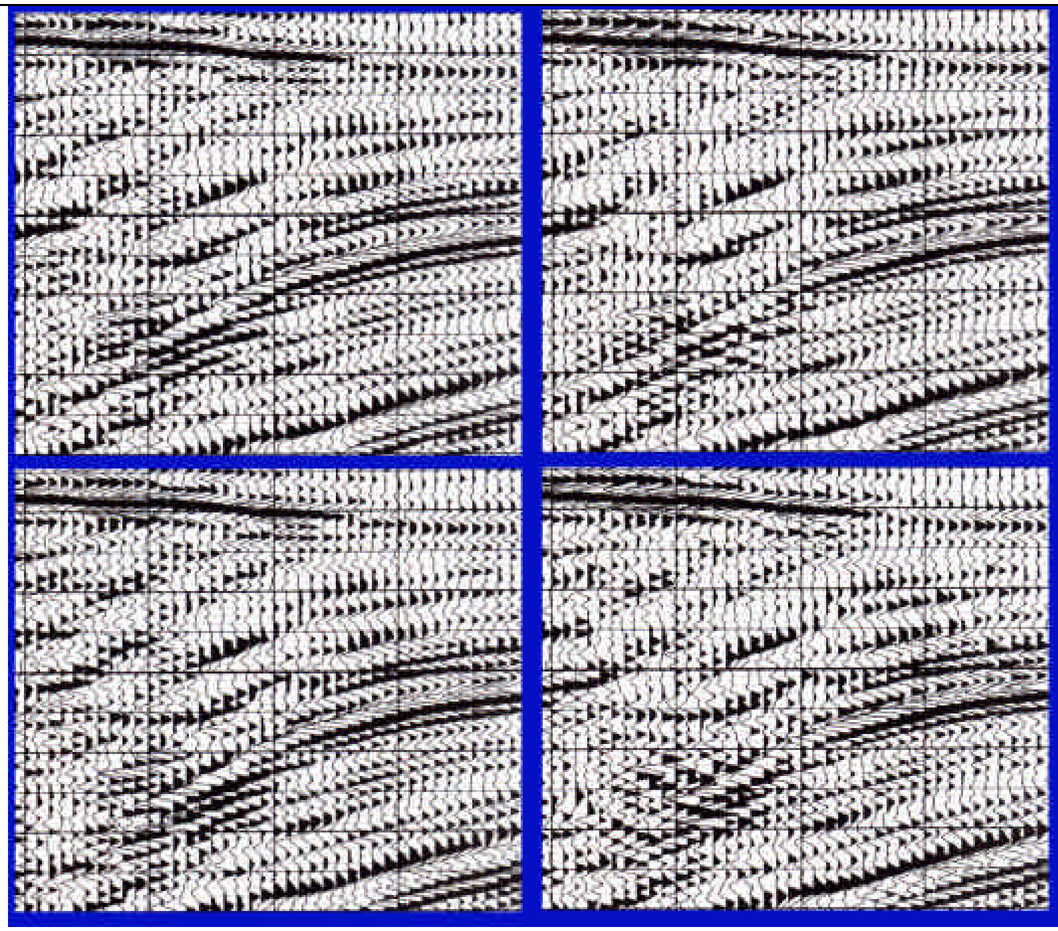

Figure 3 50 meter bin size, 93.1 fold (in deeper zones)

Top left is all data before migration. Top right is a structure stack with every second trace eliminated, then reproduced using FX Prediction filtering (MegaBin simulation). The bottom plots are the same as the top but after post-stack migration.

From figure 3, we observe a failure of the large bins to image the same details that we see in figure 2. We believe this is due to the fact the returning wavefield contains useful details smaller than 50 meters in size. Furthermore, the strongest dips and diffractions are beginning to alias and are not properly imaged. Aliased energy is beginning to distort the appearance of otherwise non-aliased areas.

The MegaBin simulation (structure stack) shows the inability of the prediction filter to reproduce strong and conflicting dips accurately at this spatial sample interval. The migrated version of the MegaBin simulation exaggerates the effect of the unresolved aliased data.

Figure 4 summarizes the progression from 20 meter bins through 30 and 40 to 50 meter bins for the normal data after migration. The evaluation of the interpreter working this data set was that the data up to 30 meter bins provided adequate imaging of the most important features. Better fault definition and sharpness of image was obtained by re-binning to smaller bins. Although the 40 meter bins look almost sufficient in these panels, other structures were poorly imaged at this bin size. Definitely, the 50 meter bins are unacceptable.

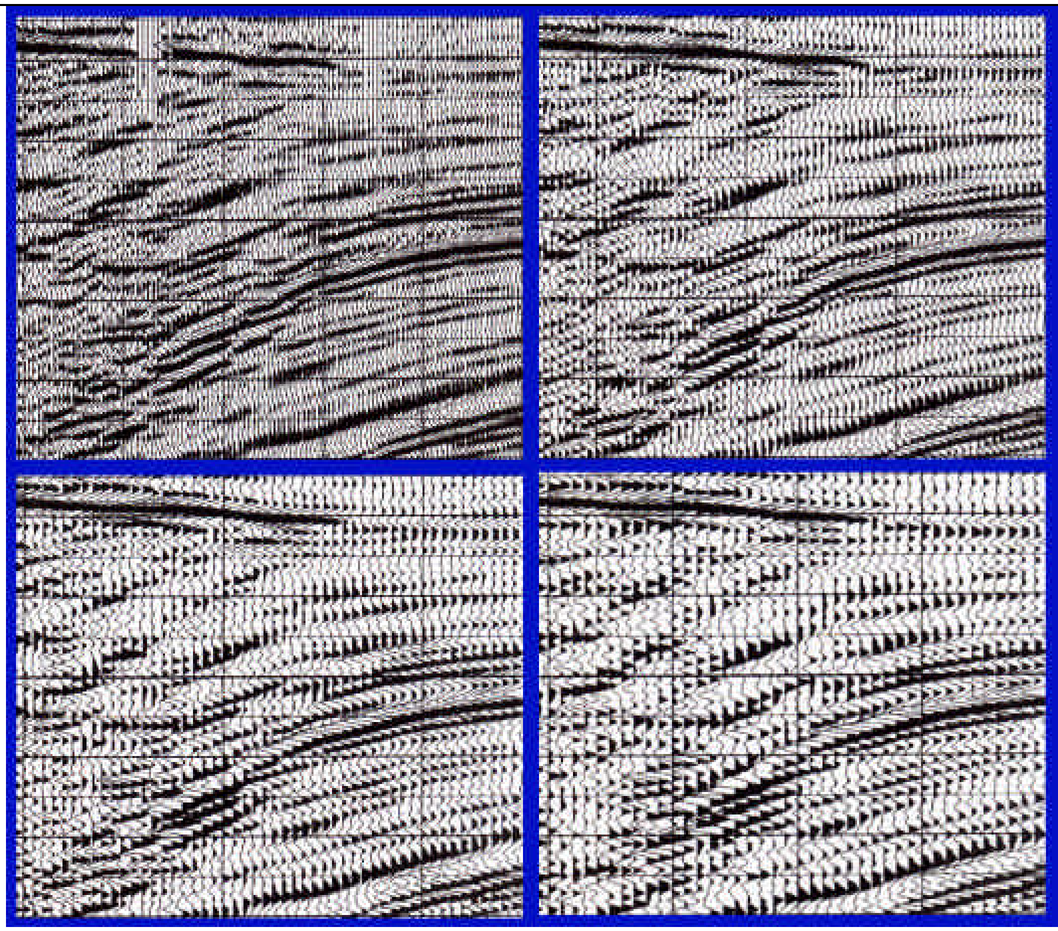

Figure 4   Normal re-binned data after post-stack migration for different bin sizes.

Top left is re-binned to 20 meter bins, Top right is 30 m bins, Bottom left is 40 m bins and Bottom right is 50 m bins.

Average fold (limited to 2200 meter offsets) is be 14.9, 33.5, 59.6 and 93.1 respectively.

Intuitively, we expect a linear relationship between bin size and data integrity. However, we found that data quality deteriorated abruptly for bins larger than 30 meters. Why should imaging fail obviously at a certain bin size while smaller bins do not show warning signs of the failure?

Perhaps Ed's analogy is the best: A car is driving westbound on a four-lane highway. A fully loaded logging truck is driving eastbound on the same road. If each is in their respective outside lane, neither will have a problem. In fact, if each changed lanes 5 meters towards to the centerline, there would still be no problem. Another 5 meters and they are still OK. But at some point, there will be a 5 meter change that will result in something of a disaster.

This paper shows one method that might be used to determine the spatial sampling limits that can be approached without invoking just such a disaster.