LOSING SIGNAL BY DOING AND UNDOING NMO?

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Seismic reflection lines that we regularly deal with when working on crustal scale data are of very large size. Processing this data consumes a lot of disk space and CPU time. To save on disk space and CPU time we often resample regional seismic lines acquired at 4 ms rate to 8 ms. Doing this seems perfectly justifiable because LITHOPROBE regional seismic reflection lines are never collected having signal frequencies exceeding 60 Hz. However, by doing so, we neglect any limitations of the INSIGHT software. In fact, some of the INSIGHT modules expect the data to be liberally oversampled. Here, we would like to present one particular case where the sample rate of the data does influence significantly the quality of the output obtained using INSIGHT software.

During the seismic reflection data processing, sooner or later, application of the normal move-out (NMO) correction is inevitable. But we may apply the NMO correction more than once during the processing. For example, to remove the linear noise events, like surface waves, shear waves or vibrator noise, we must first apply the normal move-out correction. When better velocities are estimated later, the previously applied NMO correction has to be removed first and then a new NMO correction done. It is useful to know that every time an ordinary NMO correction is applied or removed using INSIGHT software, a part of the input information may be lost. An example of the problem is shown in Figure 1. Section (a) shows a small part of the common shot gather 320. It is acquired as a part of Line 23, for the Abitibi - Grenville transect. Data have been resampled to 8 ms and partially processed so the reflectors are clearly visible, but the NMO correction has not yet been applied. If the data from section (a) is subjected to two passes of NMO correction followed by removal of the same correction and then the difference between the result and section (a) is taken (sample to sample), section (d) is obtained. All sections are plotted at the same amplitude scale. This difference, is huge and in the form of stripes radiating from the shot point. The NMO/unNMO process has dramatically changed amplitudes so reflectors lose their continuity.

The problem disappears if the data sampling is increased. Figure 1(c) and 1(b) show the difference records for resampling to 4 and 2 ms, respectively. It is clear that as the sample rate of the data gets higher, the INSIGHT NMO correction software works better. Since saving disk space often is essential we believe the best available way to apply NMO correction using INSIGHT software is to resample the data just before it is NMO-corrected and then resample it back to its original sample rate before it is written to the hard disk. A simple procedure is shown below.
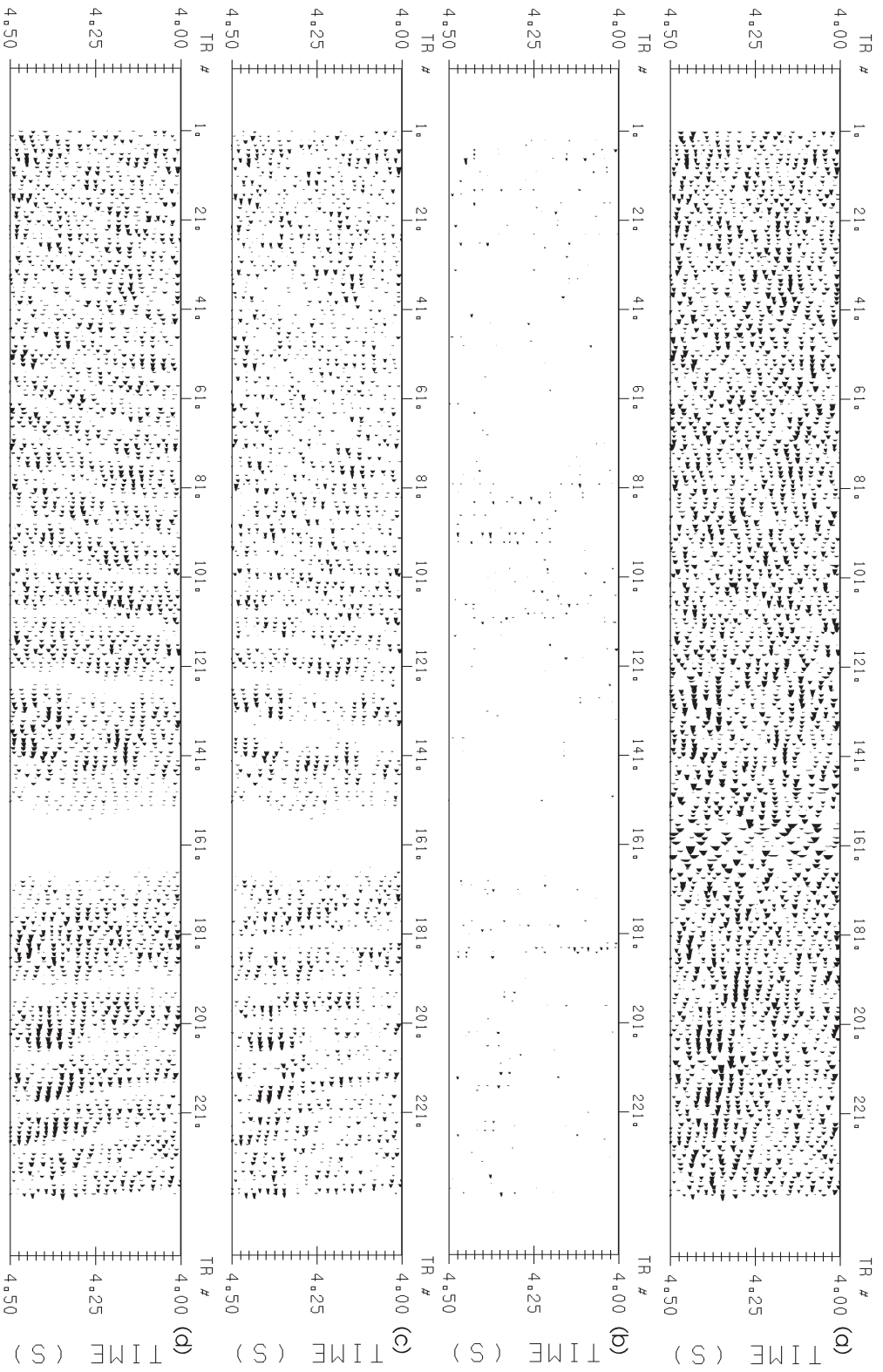
Figure 1. Showing the error accumulated in twice doing and removing NMO on an 8 ms sampled shot gather, with and without resampling.
(a) A small part of the original gather.
(b) Difference after processing with resampling to 2 ms.
(c) Difference after processing with resampling to 4 ms.
(d) Difference after processing with no resamplig.

Figure 1:

Table 1: NMO ALGORITHM WITH RESAMPLING FROM 8 TO 4 ms

open	1 1 '/data7/nedim/23r/test-input.dat'
setf	1 1 0.0 18.0 0.008
open	2 2 '/data7/nedim/23r/test-output.dat'
onmo	'/data4/nedim/23r/l23.vel'
bsec	1
opmm	
getr	1 0 1 240 0.0 18.0
rsmp	5.0 10.0 50.0 58 -2
nmo2	26 1 0.4
rsmp	5.0 10.0 50.0 58 2
putr	2 0 1 240 0.0 18.0
getm	
clmm	
esec	
clos	1 1
clos	2 2
end	

There is a certain limit to the size of the array INSIGHT software can work with. If the limit is exceeded the processing will break down at the very beginning. This happens for 18 seconds/240 traces shot records when resampled to 2 ms. To get around this problem, shot gathers can be processed in two or three runs, part by part, then appended and sorted back to the common shot position. A much more convenient way is to change the size of the maximum sample array INSIGHT software can accept for prestack processing. Of course, this is only if your computer has enough memory to handle larger data arrays.