Seismic Data in Rough Terrain: How about Multicomponent?

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Summary

Single sensor three component receivers provide better data than groups of geophones in rough terrain. The images from the 3C data have better resolution and better imaging of dipping reflectors. The 3C receiver interval was half the 1C group interval. We used the 3C data to attenuate noise using polarization filters. No such polarization filtering is possible with 1C data.

Introduction

Imaging deep targets in rough terrains like the Canadian foothills and the mid continent overthrust belt in the USA, is a challenge. Recent advances in acquisition technology include single sensors and multi-component systems. To test the applicability of such systems in rough terrain we acquired and processed a 2D line over Lake Ridge in the Green River Basin, southwest Wyoming.

Terrain and Acquisition

The survey was conducted in rough terrain over the Darby thrust fault (Figure 1). The elevation along the line is 2200-2500 m. At the center of the line the elevation varies 200 m vertically over a horizontal distance of 400 m (26 degrees slope). Local slopes along the line, as meaured by LiDAR (Wagaman and Sfara, 2005) reach 45 degrees.

The data were recorded along a 8.8 km 2D line. The source was 5kg Pentolite at 18 m hole depth, with 50 m shot interval. Three types of receivers/groups were connected to one (Sercel 408) recorder:

1. 176 groups of 12 geophones, 50 m linear array at 50 m interval.
2. 176 groups of 36 phones, 50X50 m areal array at 50 m interval.
3. 352 single-sensor 3C (DSU3) accelerometers at 25 m interval.

To reduce the effect of inter-array statics, the group size was smaller in the steep segments. The DSUs were deployed in vertical shallow augered holes.

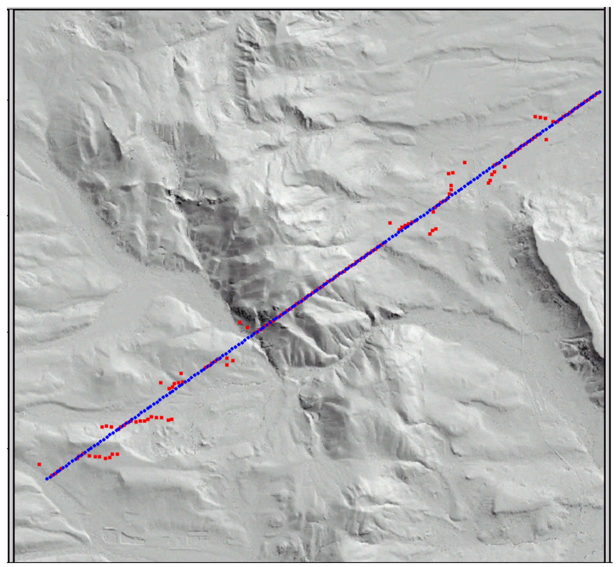


Figure 1. LiDAR image of the survey area

Processing

The processing sequence included tomographic refraction statics, multi-component polarization filters with an SVD based method (Meersman and Kendall, 2005; Jin and Ronen, 2005), coherent and random noise attenuation, surface consistent deconvolution, two iterations of velocity analysis and resiudal statics with further noise attenuation, trim statics, stack, post stack random noise attenuation, and post stack kirchhoff migration. The data and the results are shown in Figures 2-4.

Conclusion

We compared various receiver types and group types in rough terrain. The 3C data provides better resolution and better imaging of dipping reflectors.

References

Kristof De Meersman and Robert Kendall, 2005, A complex SVD-polarization filter for ground roll attenuation on multi-component data: submitted to the EAGE convention in Madrid

Side Jin and Shuki Ronen, 2005, Ground roll detection and attenuation by 3C polarization analysis: submitted to the EAGE convention in Madrid.

Mark Wagaman and Ron Sfara, 2005. Applications of LiDAR in Seismic acquisition and Processing: submitted to the CSEG convention in Calgary.

a)

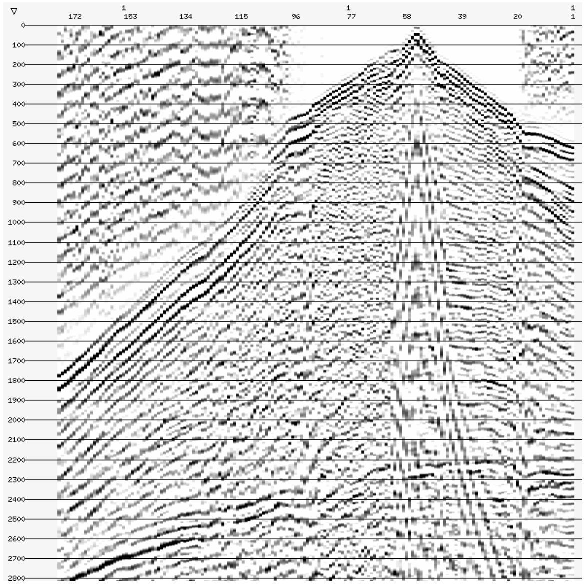
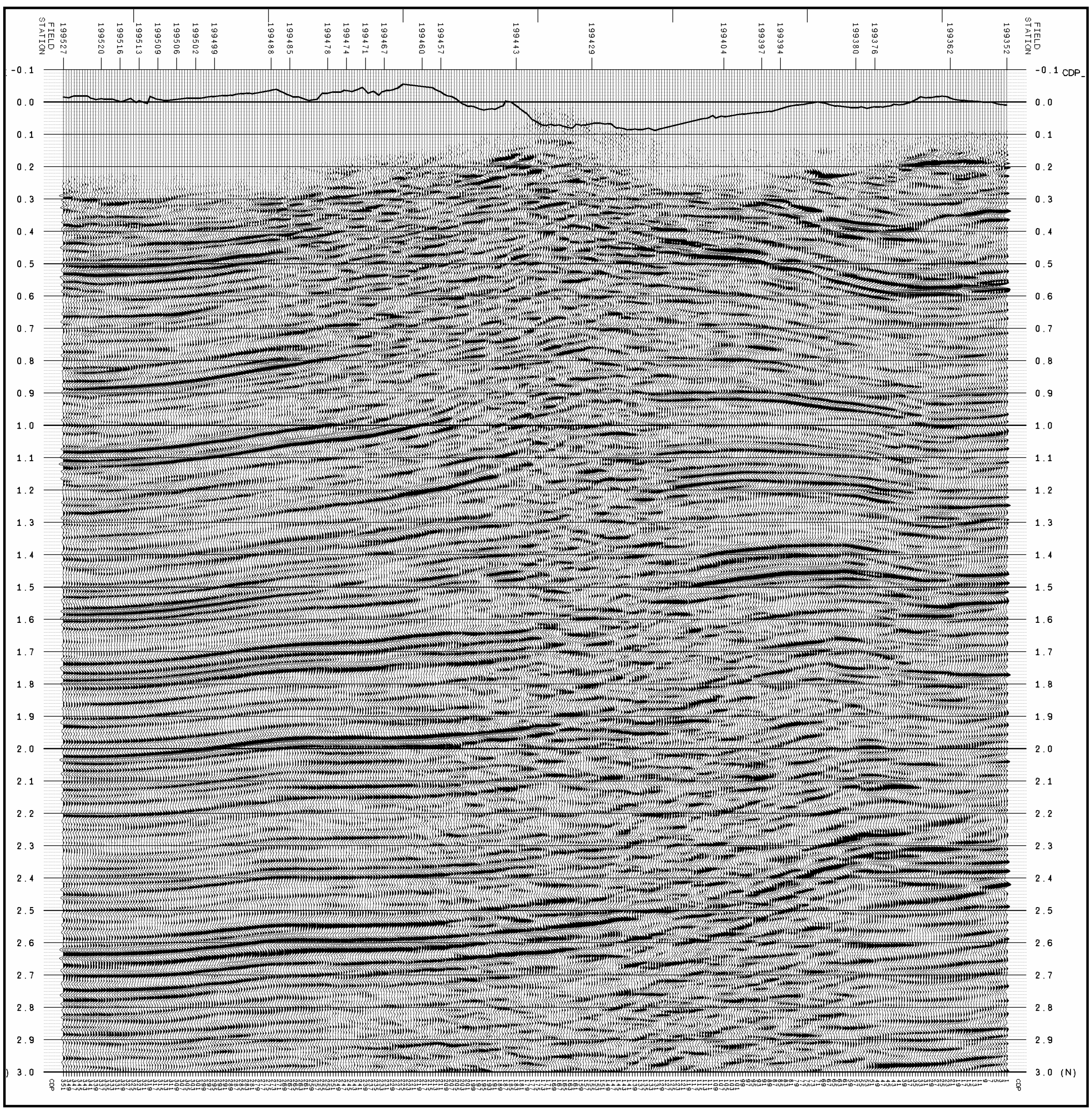


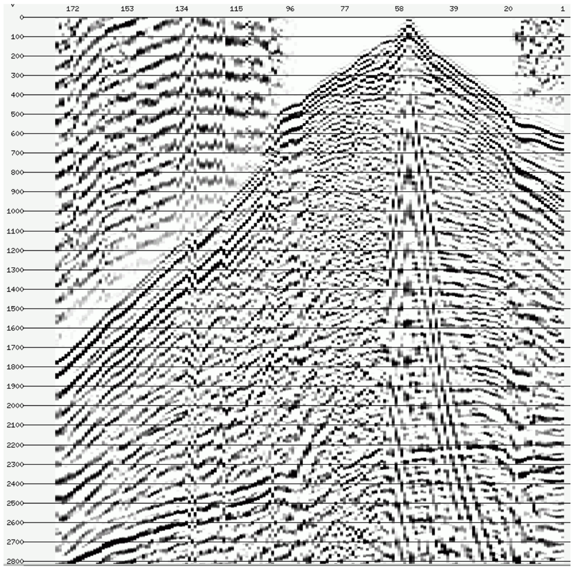
Figure 2. Data from groups of 12 geophones with 50 m group interval, deployed at 50 m linear arrays except in high slope segments where the array length was smaller.

(a) Prestack data.

(b) Image after post stack migration. Note the significant loss of image in the rough terrain under the ridge

b)



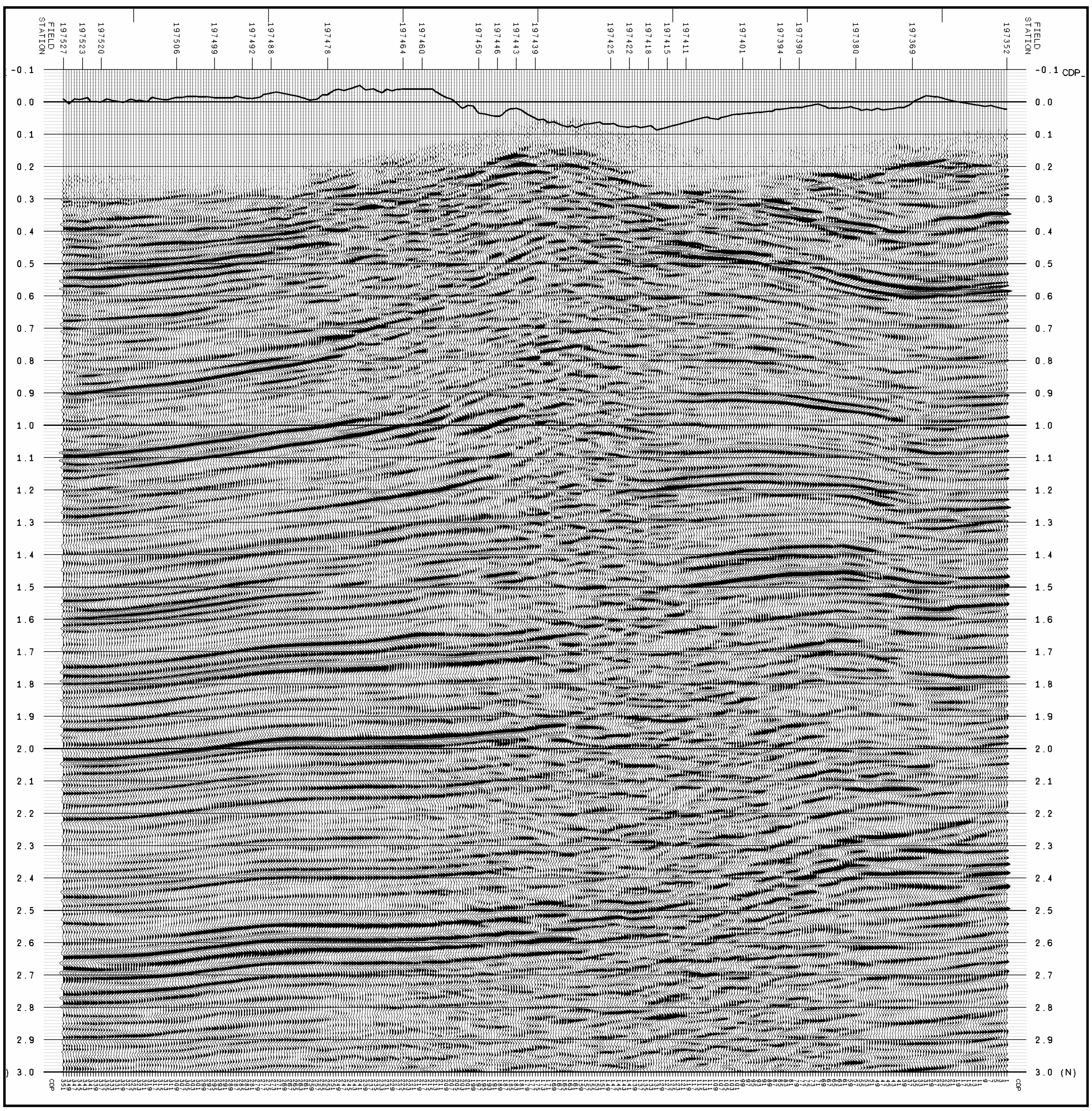


a)

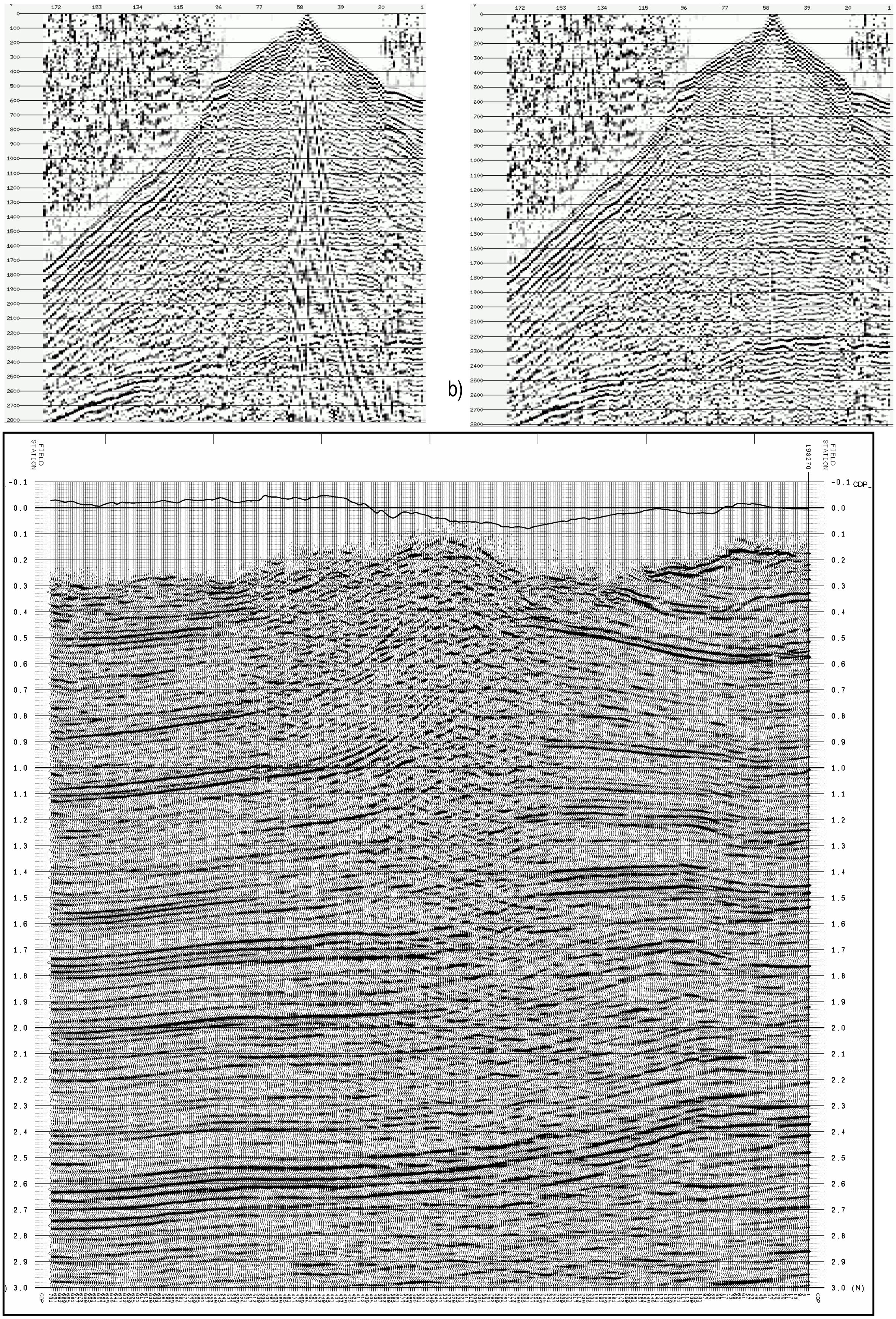
Figure 3. Data from groups of 36 geophones with 50 m group interval, deployed at 50x50 m areal arrays except in high slope segments where the array size was smaller.

(a) Prestack data.

(b) Image after post stack migration. The image quality is much better than the groups of 12 (Figure 2) but there still is a significant loss of image in the rough terrain segment under the ridge



b)



a) b) c)

Figure 4. DSU data at 25 m receiver interval. Shot (a) before and (b) after Polarization Filtering. (c) PP image. Note the imaging of the dipping reflectors at 0.6 and 0.8 seconds that the 1C data failed to image, and the reflector at 2.5 seconds.