GeoConvention 2015
GEOSCIENCE
new horizons
Telus Convention Centre • 4-8 May 2015 • Calgary, AB Canada

Recording seismic on geophones within ground screws

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Summary

Seismic records were obtained from geophones installed within devices known as ground screws, normally used as bases for small buildings and structures. The data were acquired along with other records at CREWES' Priddis test site in November/2014. Analysis is at a preliminary stage, but comparisons may be made with surface geophones at the same recording stations

Introduction

We have long been interested in methods to improve the acquisition of shear data at the earth's surface (Manning, 2012). The reason for our interest is the poor quality of surface shear wave data compared with that obtained in boreholes (for an example, see Eisner et al 2009).

The idea of inserting geophones deeply into the ground inside an earth screw was developed and patented by Ross Huntley and informally presented to CREWES staff at the 2014 geophysics and geology conference in Calgary. Mr. Huntley then shipped a number of Krinner ground screws to CREWES in October so they might have geophone elements installed and tested as part of the larger test program at Priddis in early November/2014. The method is designed to increase the coupling of the geophone substantially over conventional methods.

CREWES bought a set of SM7 geophone elements, 15 vertical and 30 horizontal, which were inserted into casings designed for spike geophones. These casings had to be trimmed in order to fit into the ground screws. The elements were soldered and wired into a small circuit board along with a shunt resistor, and then joined to the Cooter connectors. A ground screw, a casing with elements, and a connector set is shown in Figure 1.

Initial fitting showed that the geophone casing would center the elements at about the top of the screw threads, and it appeared that a friction fit would provide sufficient coupling for the duration of the experiment. However, when most of the elements and casings had been installed, it was found that the casing depth within the screw ranged over almost 2.5 inches. This range was not considered a problem as far as recording depth was concerned, but there were concerns about the coupling of the elements to the casing.

Field work

The ground screws were installed at 10 metre intervals along one of the receiver lines laid out for the main program. Figure 2 shows the top of a ground screw along with other geophones, including a conventional three-component geophone with the same SM7 elements (orange case)

The ground screws were driven into the ground with a fabricated wrench, which allowed torque to be applied at a convenient working height. Slots were provided to fit over the bolt in the top, and a third slot allowed the geophone leads to emerge. Unfortunately, two aluminum versions of the wrench failed after several plantings, and finally a steel version had to be used

The screws were quite readily reversed out of the ground at the end of the project.

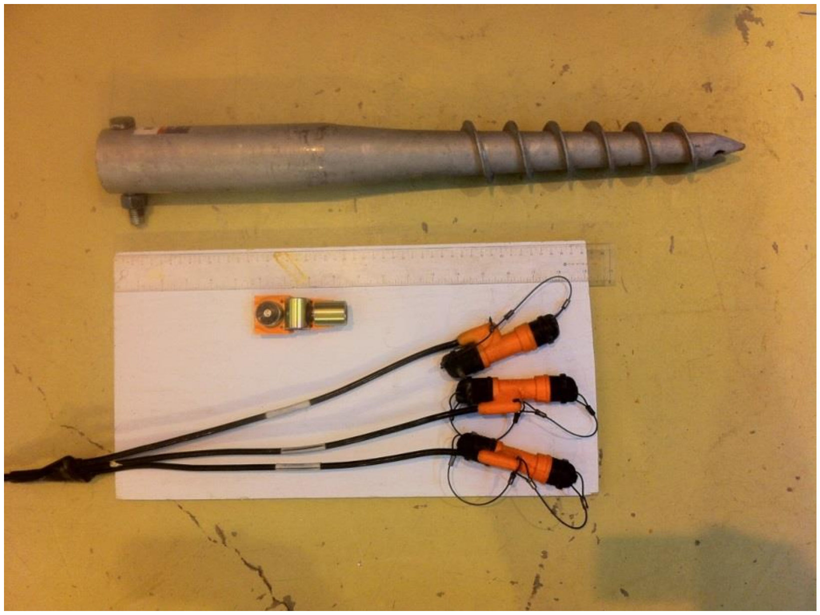

Figure 1: The Krinner ground screw is at the top, a set of three elements in an opened casing is on the paper, and the Cooter connectors are below. The transparent ruler is 30 inches long.

Figure 2: The sensors under test at station 165. The top of the ground screw appears slightly above and right of center. The comparable 3-component SM7 surface geophone is to the left in the orange case.

Data examples

The records displayed have constant scaling, which is consistent between comparable pairs.

The ground screw vertical geophone data (Figures 3 and 5) are almost identical to the conventional data (Figures 4 and 6), except that they exhibit much less high frequency air blast. The horizontal data appear to have some problems with dead and or poorly wired channels, and with the coupling between the elements and the ground screw casing.

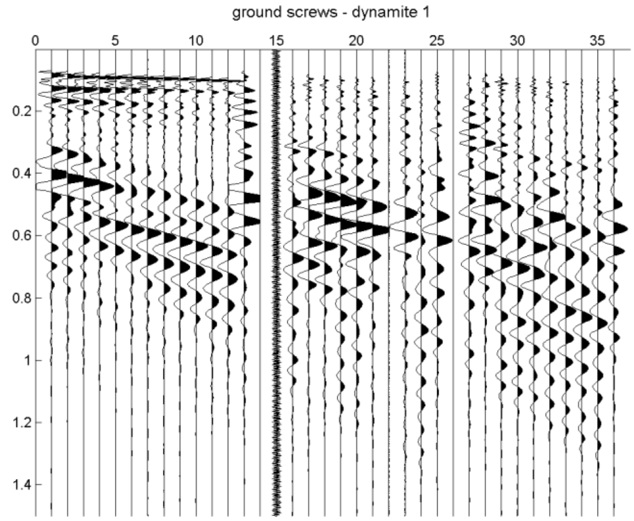

Figure 3:Dynamite data recorded from geophones installed in ground screws. There are 12 traces each of vertical data, in-line horizontal data, and cross-line horizontal data. There are several missing and noisy horizontal traces.

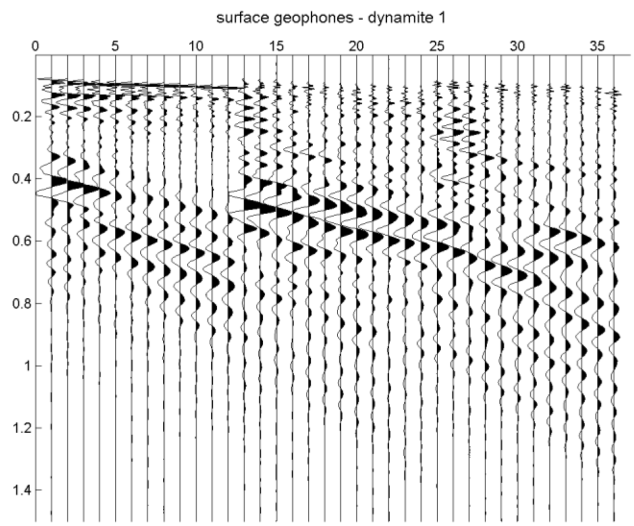

Figure 4: Dynamite data recorded from conventional surface three-component geophones with identical elements for comparison.

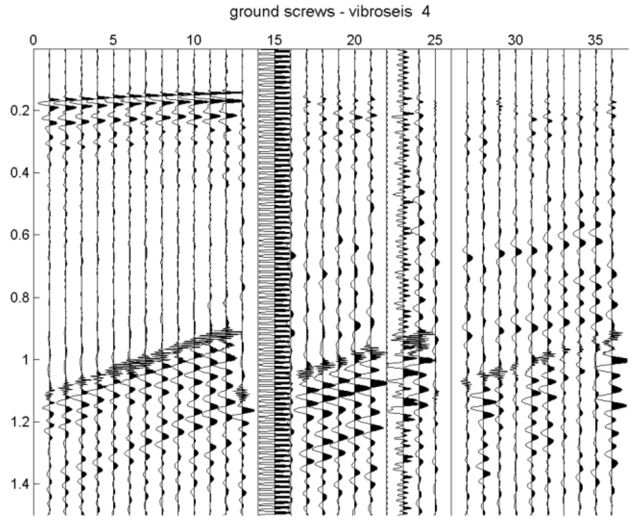

Figure 5: Vibroseis data recorded from geophones installed in ground screws. The missing and noisy traces are obvious, but the high frequency air-blast noise is less than in the conventional record.

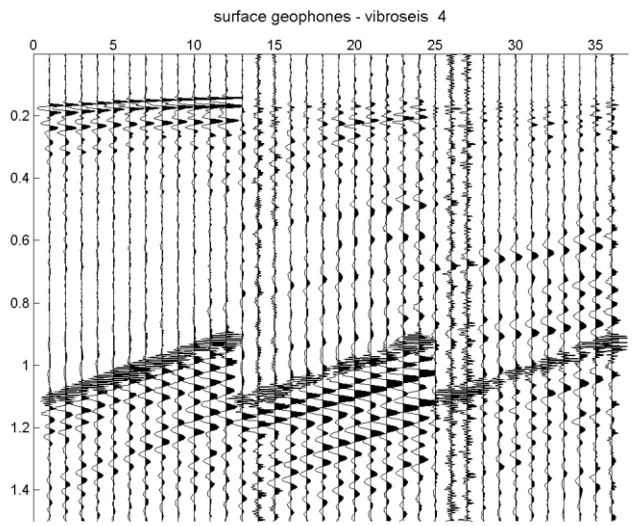

Figure 6: Vibroseis data recorded from conventional surface three-component geophones with identical elements for comparison.

Conclusions

Ground screws may be inserted into the ground quite readily to the depths used on this project. It may be significant that they were also easily extracted.

The ground screws used here recorded vertical data which appears to be comparable to conventional geophones. The only advantage seen at this stage is a reduction of air blast noise.

The coupling of the horizontal elements within some of the ground screw casings was not satisfactory because of some internal conditions, and some electrical connections were faulty. Despite these problems, there are some signs of improvement for these data.

Acknowledgements

We would like to thank other CREWES members, our sponsors, and NSERC.

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