Recording seismic on geophones within ground screws

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ABSTRACT

Seismic records were obtained from geophones installed within devices known as ground screws, normally used as bases for small buildings. 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. A patent on this type of recording is held by Ross Huntley.

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.

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.

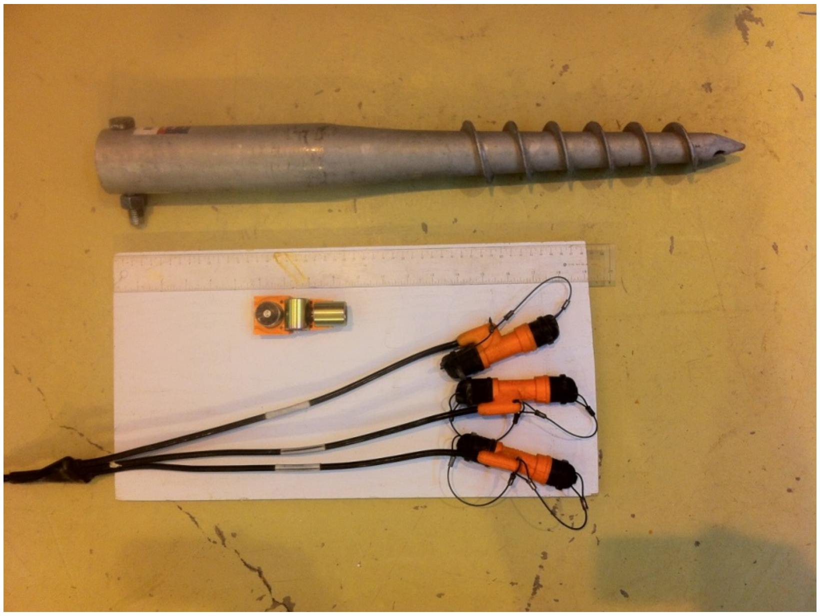

Figure 1: The Krinner ground screw is at the top, a set of three elements in an opened casing is on the paper, and the Cooter connectors are below. The transparent ruler is 30 inches long.

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)

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.

Two foot (61 cm) deep pilot hole were drilled using a gas powered augur..The ground screws were then 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, the wrench, constructed of aluminum pipe, failed after several plantings. The second version of the tool was constructed using thin-walled steel pipe, and also failed. The final version of this tool was made from thick-walled steel pipe.

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

DATA EXAMPLES

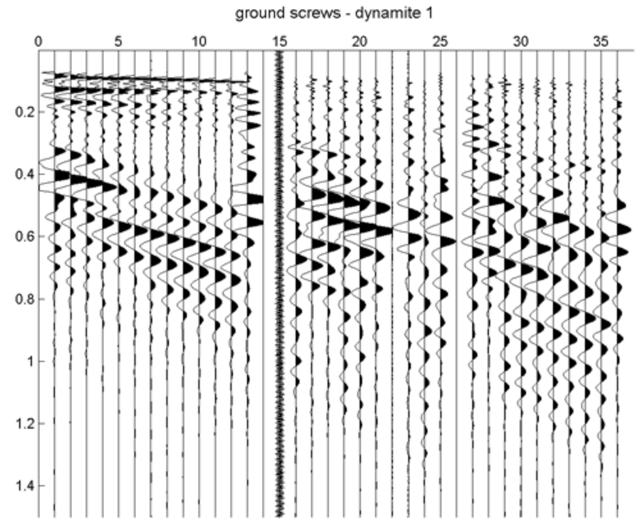

Figure 3: Dynamite data recorded from geophones installed in ground screws. There are 12 traces each of vertical data, in-line horizontal data, and cross-line horizontal data. There are several missing and noisy horizontal traces.

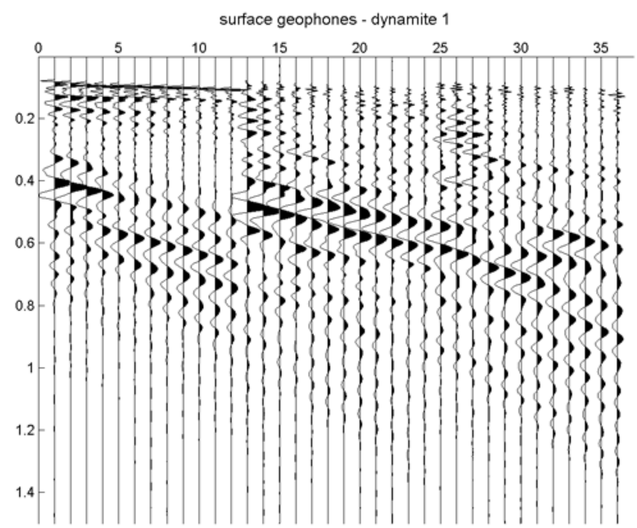

Figure 4: Dynamite data recorded from conventional surface three-component geophones with identical elements for comparison.

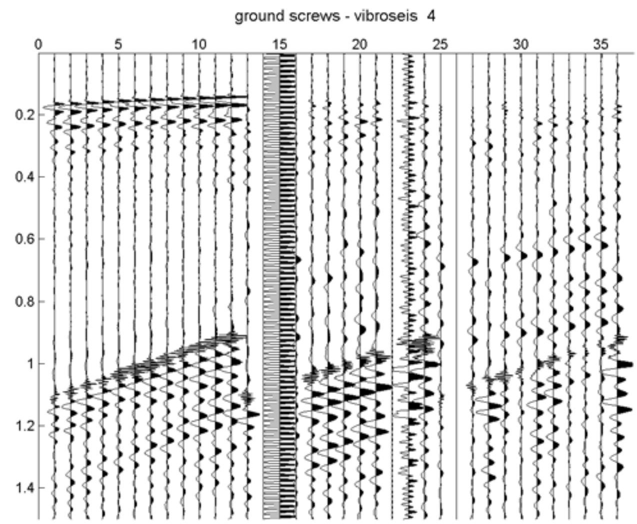

Figure 5: Vibroseis data recorded from geophones installed in ground screws. The missing and noisy traces are obvious, but the high frequency air-blast noise is less than in the conventional record.

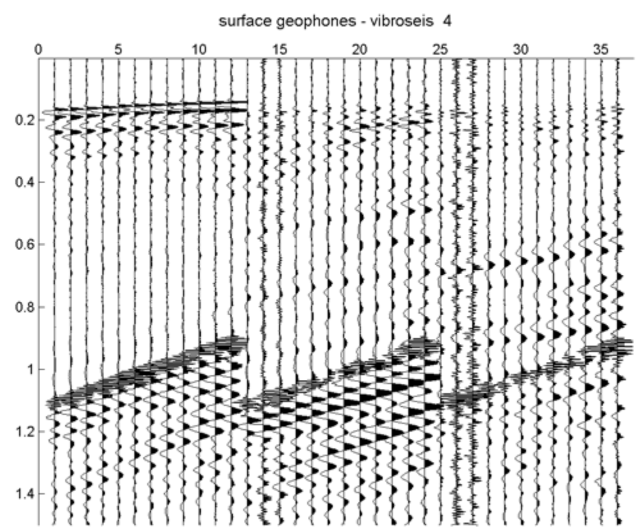

Figure 6: Vibroseis data recorded from conventional surface three-component geophones with identical elements for comparison.

The ground screw vertical geophone data are almost identical to the conventional data, except that they exhibit much less high frequency air blast. The horizontal data have problems, most likely with the coupling between the elements and the ground screw casing.

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 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 the ground screw casing was not satisfactory. The reason is likely that the manufacturer had no reason to adhere to any design standards for the bottom of the cavity.

Ground screws have not yet been proven advantageous for horizontal data. They are less susceptible to air blast, and there are places where they might record less noise of other types, but the data problems encountered in this experiment do not allow us to draw any firm conclusions.

If ground screws of the type described here are used again, their interior will have to be carefully prepared, or have some kind of filler cast inside the cavity.

FUTURE WORK

Check out the bottom of the ground screw cavity, and correct the coupling problem.

Design an extension for the ground screw, and see what it takes to drive it deeper.

Repeat the testing, covering a significant range of planting depths.

ACKNOWLEDGEMENTS

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REFERENCES

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