Field acquisition in 2017

Kevin L. Bertram, Kevin W. Hall, Malcolm B. Bertram, Donald C. Lawton and Kristopher A. H. Innanen

ABSTRACT

CREWES continues to be one of the few research consortiums that has access to industry acquisition equipment. CREWES also has the collective knowledge to use this equipment to design and carry out acquisition experiments at any time of year. This provides the opportunity to take ideas formed in the office to the field. These experiences are also used to educate staff and students on the procedures and realities of data acquisition.

Acquisition that was carried out by CREWES in 2017 include: a) a multi receiver 3D 3C seismic survey at FRS with vibe and thumper sources in May; b) GPS experiments at Priddis in June; c) another multi receiver 3D 3C seismic survey at FRS with just the vibe as a source in July; d) the geophysics undergraduate field school in August; e) a final multi receiver 3D 3C seismic survey at the FRS in October.

INTRODUCTION

Although not actually acquisition the first out of office expedition of 2017 was a display at Earth Science for Society, Figure 1. CREWES has been attending this function for a few years now. This is an opportunity for the public, more specifically students of local schools, to get an exposure to the world of earth science. Every year CREWES brings a display with a computer run slide show, a seismometer, a 3C geophone connected to a scope, a ground penetrating radar unit or two, a truck, and the Geometrics Geode acquisition system.

FIG. 1. Marie, Yu and Jian set up for a day of ESfS.

The first acquisition project was carried out in May at the Containment and Monitoring Institute (CaMI) Field Research Site (FRS) (REFERENCE DON PAPER). This survey used both the IVI Envirovibe and shear wave thumper as sources. Recording was done using Aram Aries 3C for geophones as well as optical fibre.

The second experiment was a GPS test completed in June. The focus of this test was to try and determine the accuracy of a non-differential GPS receiver. This test was carried out at one of the test hole locations at the Rothney Astrophysical Observatory.

The third project was again at the CaMI FRS in July. The Envirovibe was the only source this time. A mixture of both Inova Geophysical Hawk nodes and Aram Aries cabled systems were used to record the 3C geophones. Once again optical fibre was used as well.

The fourth project was the GOPH549 undergraduate field school in August. The focus here is a little less on data acquisition and instead more focused on the methods and obstacles of data acquisition.

The final project of the year saw a return to the CaMI FRS for a final survey. The number of 3C geophones used to record was significantly cut down and more attention was placed on the fibre data.

EQUIPMENT AND SAFETY

CREWES has access to several different industry standard data acquisition and survey equipment. The system that gets the most use is the Aram Aries cabled system, Figure 2. CREWES has access to both eight channel and twenty four channel acquisition modules. This allows for the recording of both single component and three component analogue geophones with essentially the amount of equipment deployed. Although this system has reached end of life it is still used by research and exploration companies around the word. The primary advantage of this system is the ability to display data as soon as a shot has completed. This makes it an invaluable tool for teaching.

FIG. 2. Aries RAMS, taps, batteries, and cables ready for deployment.

One of the systems designed to directly replace the Aram Aries is the Inova Geophysical Hawk nodal system, Figure 3. Available to CREWES is 1500 channels worth of nodes. This is currently configured to record 500 three component geophones but can be used to record either three components of accelerometer receivers or three individual single component receivers. The main advantage of this system is its ease of layout and pickup as there are no receiver cables to deploy or pick up. The main disadvantage is that data cannot be instantly viewed after a shot. Instead the nodes must be brought back to the lab and have the data downloaded, and if a vibe source is used, stacked and correlated.

FIG. 3. A Hawk node, battery, and 3C geophone.

A smaller more portable cabled system that sees quite a bit of use is the Geometric Geode system, Figure 4. This is designed to be carried in to remote locations by a small crew. Each Geode box is capable of recording twenty four channels of data and all data is then transferred through Ethernet cables to a laptop. CREWES has access to both end tap and centre tap cables for this system.

FIG. 4. The Geometrics Geode system.

To generate seismic energy for source driven acquisition CREWES uses a variety of sources. The most famous of which is the IVI Envirovibe, Figure 5. This is a small vibrator buggy capable of being transported on a trailer pulled by a truck. It is low impact and very capable of getting in and out of tight spaces.

FIG. 5. The IVI Envirovibe.

Another source that is starting to get more attention is the s-wave thumper, Figure 6. This thumper is a small trailer that uses a nitrogen spring to accelerate a mass towards a foot. It can be used in vertical and tilted forty five degrees to either side (Asuaje et. Al. 2013).

FIG. 6. The s-wave thumper source.

The final commonly used source is a simple hammer and plate. This is used primarily with the Geode system for refractions surveys.

When surveys are conducted the exact location of sources and receivers needs to be known. For this CREWES uses a differential GPS system, Figure 7. A base station is set up at either a known point or left to average location readings over a period of time. This station then records its GPS location, compares it to the stored location and uses a radio to transmit corrections to a rover. This rover then applies these corrections to its own location reading. So long as the base and rover are using the same set of satellites this allows for very accurate GPS location readings.

FIG. 7. The differential GPS, base station on the left, rover on the right.

With all this equipment being used there is a large priority placed on safety. Safety is addressed through preparation, training, and proper equipment. Before any acquisition is done hazard assessment and emergency response plans are created. These identify any likely hazards that might be encountered in the field and how and who to contact is something does go wrong. Before the start of any day of acquisition these are discussed as well as any concerns that may come up while in the field. Proper Personal Protective Equipment is also essential to keeping everyone safe. It is worth noting that CREWES has never had a situation where medical services were needed.

FRS IN MAY

Malcolm Bertram has put together a method of permanently installing 3C geophones at the FRS site. This involves gluing a geophone into the bottom of a PVC pipe and then drilling a hole in the ground to install the pipe in, Figure 8. The cable from the geophone come up the pipe and either exits through a slot in the cap for recording or stored in the pipe for storage to protect the cable from cattle. The cable is designed to be connected to an Aram Aries twenty for channel receiver cable.

FIG. 8. A permanently installed geophone.

These geophones are placed in a ten by ten grid around the injection well and have ten metre spacing between them.

The Aries system was connected to these geophones as well as more 3C phones deployed along a trench which has fibre buried in it, Figure 9.

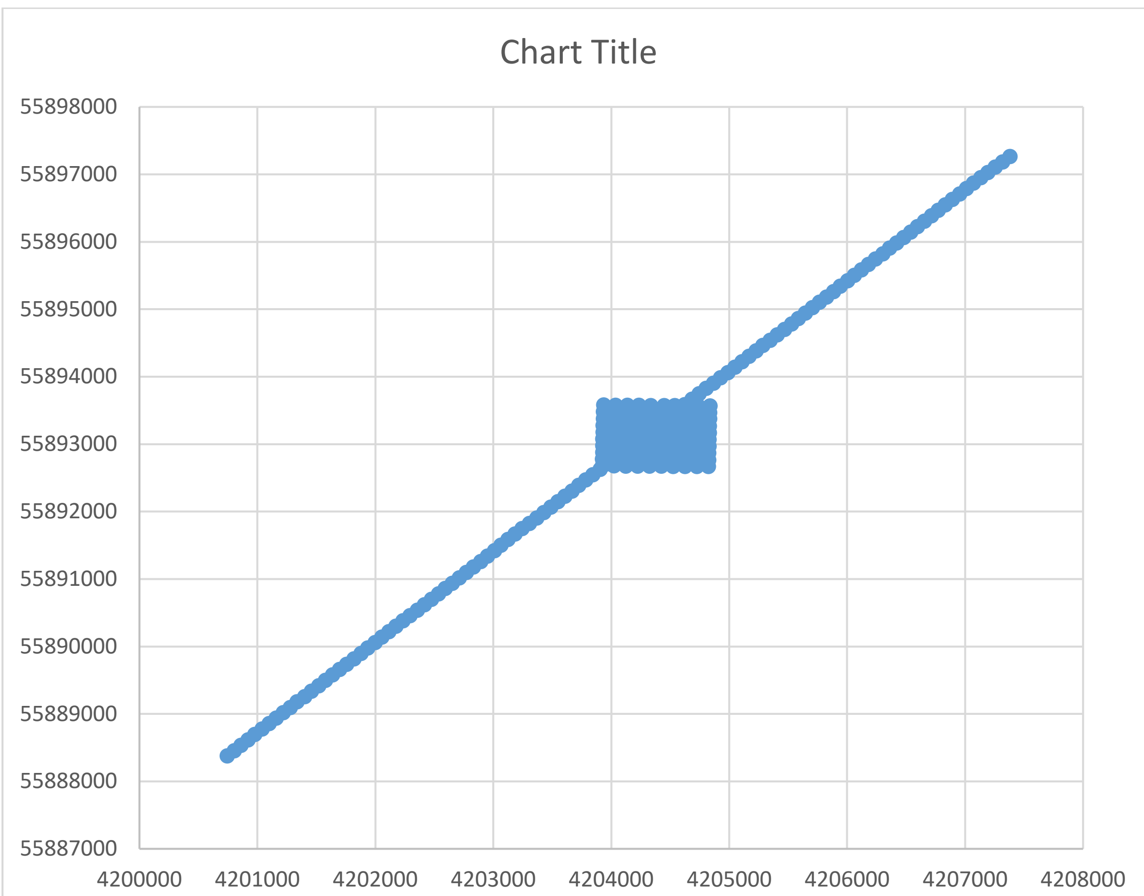

FIG. 9. The receiver layout.

The Geometrics Geodes were also brought along to be connected to the 3C geophones that are permanently mounted around the casing of the observation well. The cables from the downhole phones are brought to a junction box on the surface near the well. The junction box then has conduit running into the Atco trailer on site, Figure 10. Currently the Geodes connect to the cable inside the trailer. There is discussion of moving the connection point to the junction box on the surface as the Geode system does pick up a significant amount of 60Hz noise in the trailer.

FIG. 10. The Geodes in the trailer.

The fibre was then connected to an interrogator brought by Lawrence Berkeley National Laboratory, Figure 11.

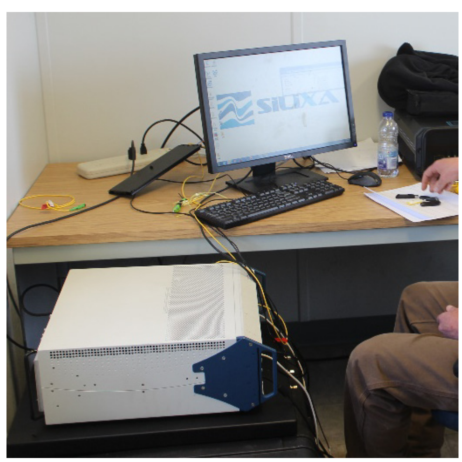

FIG. 11. The fibre optic interrogator.

For sources the experiment started with the Vibe as the source, Figure 12. This was triggered by the Aries system. In order to trigger the Geodes and fibre interrogator another vibe controller was used to monitor the start and correlation signals.

FIG. 12. The envirovibe near the observation well at FRS.

The source locations for the vibe was along the fibre optic trench line with another line perpendicular to this line at the well, Figure 13.

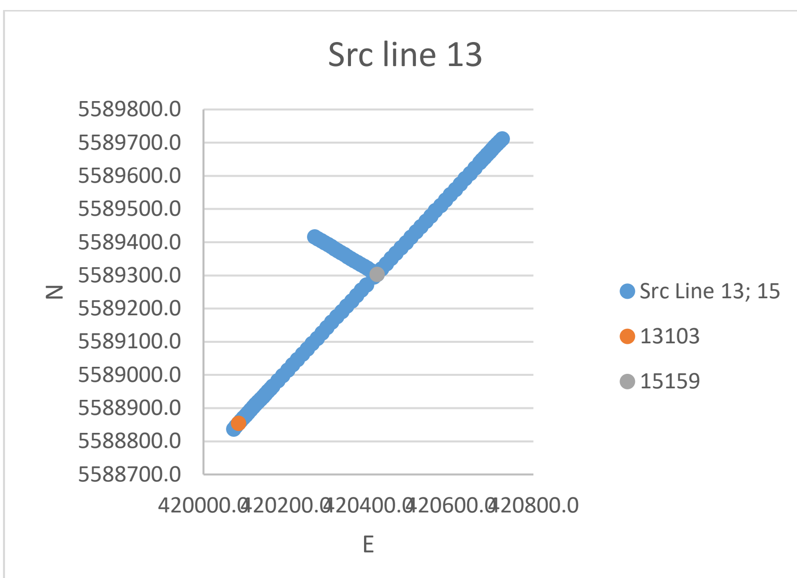

FIG. 13. The vibe locations.

Once the vibe had finished the survey the thumper was then used at the four corners of the buried geophone patch, Figure 14. The thumper was used with a Seismic Source brand Wireless Trigger Box. The output of this box was adapted to an Aram Polaron harness to trigger the Aries system. This signal was also split off using a board built by Kevin Bertram to trigger the Geode, fibre interrogator, and Veri-fi GPS Synchronization unit. Having this work successfully means that it should be fairly trivial to use the Hawk system with the thumper as the source.

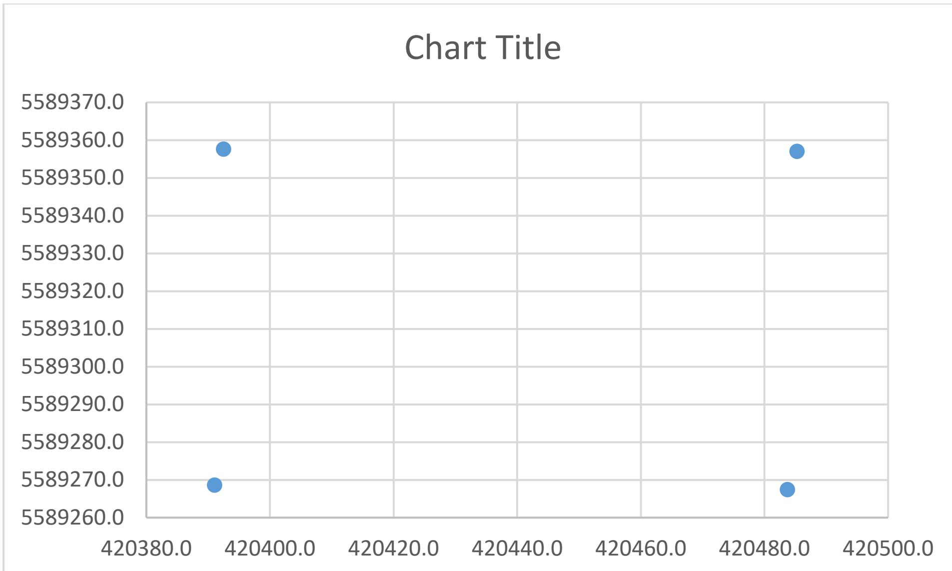

FIG. 14. The thumper source locations.

GPS TEST

Inova Geophysical has used the Priddis test site several times for equipment tests. As the Hawk nodal system uses GPS for both timing and location they wished to leave some Hawk nodes out for a few days. For comparison CREWES deployed the base station of the differential GPS to take a sample every second and left it for a day and a half, Figure 15.

FIG. 15. The GPS base station near a test hole at Priddis.

Using only half of the GPS system meant that there were not corrections being made with the recorded position. After 73,196 samples were collected and plotted the results were a little surprising. The accuracy was worse than expected as can be seen in Figure 16.

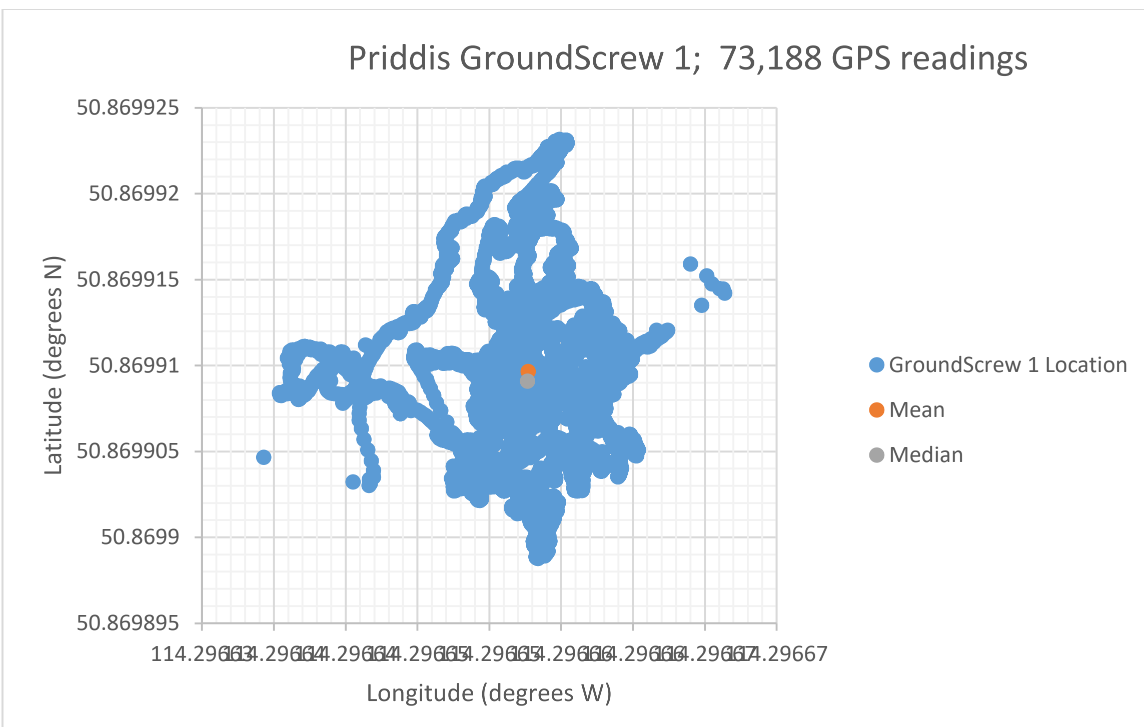

FIG. 16. The resulting data from the GPS sitting for a day and a half without corrections.

FRS IN JULY

A repeat of the experiment carried out in May was carried out in July. There were two major differences. First the thumper was not used as a source this time. Secondly the Hawk were deployed to record the permanently installed grid of 3C geophones. Aries was still used to record the geophones along the trench line.

This time the sources were located in four lines. One line was south to north, another east to west, a third southwest to northeast, and a final one southeast to northwest, Figure 17.

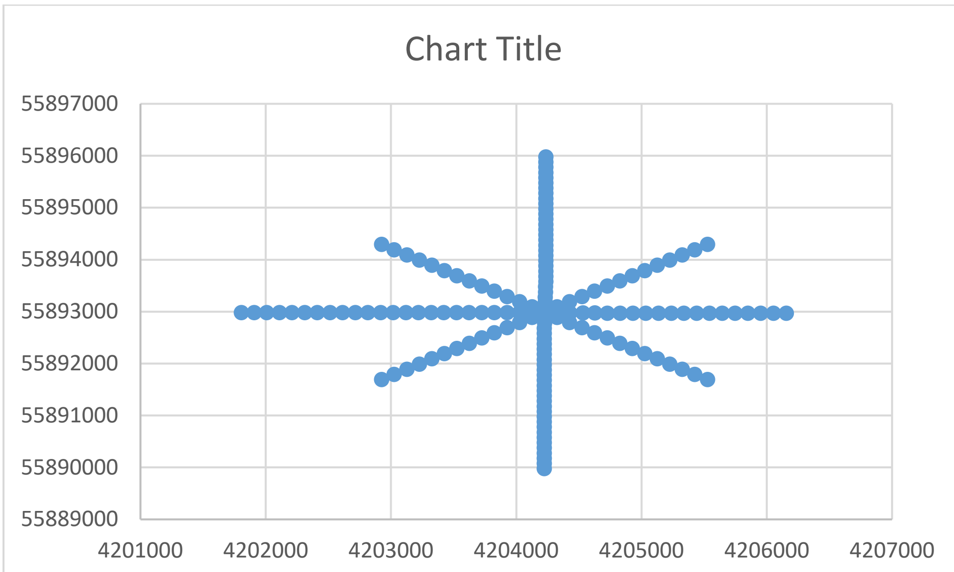

FIG. 17. The source locations for the vibe.

FIELD SCHOOL

CREWES has been helping the University of Calgary's Geophysics 549 undergraduate course for many years. This course is unique in that is allows geophysics students to experience the process of data acquisition. This has been seen as a major advantage by companies looking to hire geophysics graduates from the University of Calgary. CREWES staff has many years of practical acquisition knowledge that is used to educate the students. This creates a better understanding of why data may look the way it does. Field school is usually split into two groups, one focused on seismic acquisition and the other on non-seismic methods.

Months before the field school begins the planning starts. Staff and students have been staying at the Castle Mountain Ski Resort for several years in a row now. It is generally assumed that the non-seismic portion will take place in and around this resort. The seismic portion typically happens in the area around the towns of Beaver Mines or Pincher Creek, a thirty minute or so drive away.

The first task is to scout the area to find a suitable location for the seismic to take place. Once this has been found the permitting process can begin. Permitting is handled by Outsource Seismic. Once permission has been granted by the local government a leaflet drop needs to be done for all local residences within a certain distance from the survey. CREWES does both the scouting and the leaflet drop.

This year the seismic line was located along Township Road 65 just east of highway 507. This provided nice wide ditched for the vibe to be used in, Figure 18. The survey used single component receivers that were spaced ten metres apart in the north ditch as close to the fence as possible. The vibe was also used in the north ditch, Figure 19.

FIG. 18. The north ditch of Township Road 65.

FIG. 19. Vibe in the ditch.

Students on the seismic line were split into two groups. First group is the line crew. This group is responsible for layout and pick up of gear, chaining notes, and GPS surveying of both source and receiver locations, Figure 20. The second group is put in the recorder to oversee the entire operation, Figure 21. They are also responsible for some quick real data interpretations to answer exercises.

FIG. 20. Students learning about the GPS.

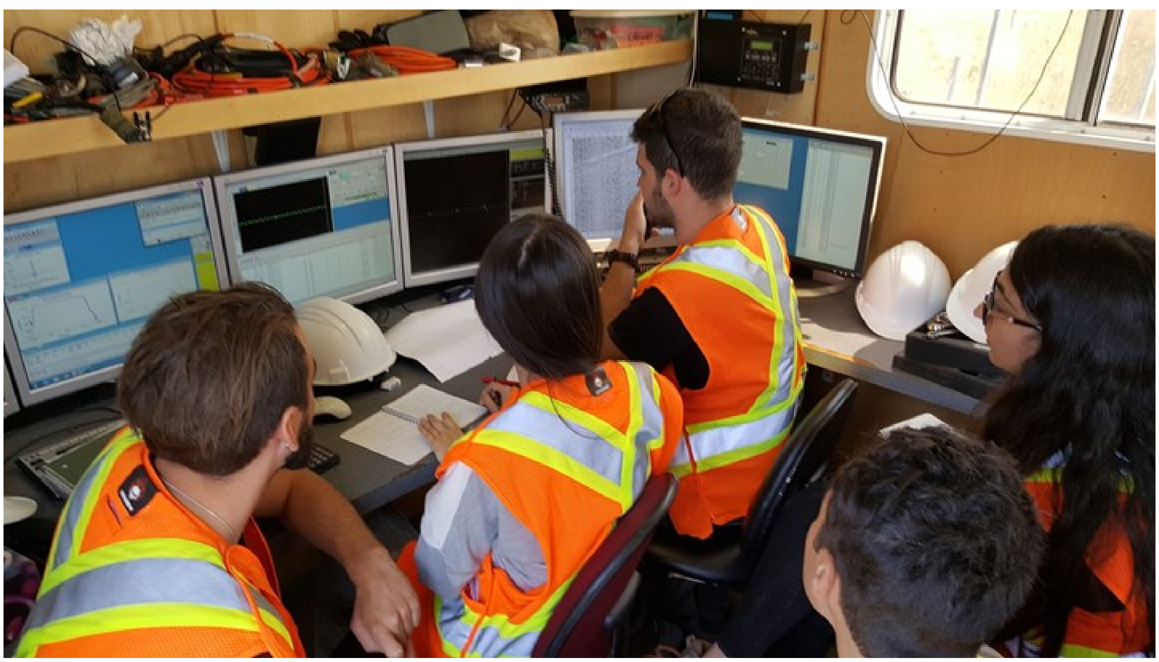

FIG. 21. Students in the recorder.

The non-seismic portion performed ERT, GPR, refraction and VSP surveys.

FRS IN OCTOBER

A final acquisition survey was conducted in October. The plan was to layout the Hawks to record the permanently installed geophone grid, connect the Geodes to the downhole geophones, and record using the fibre. The vibe was to be the only source.

On Wednesday October 11th a trip was made to drop off the recorder, vibe, and trailer full of gear. The Hawks were deployed and some initial setup of the Geodes and Aries was done. It was decided to only lay out one cable of Aries for this job as a simple QC. The primary focus would be on the Hawk, downhole, and fibre data. This was just a day trip.

The following Monday, October 16th more setup was done and the vibe was tested to ensure that all systems could be triggered. The plan was to start acquisition on Tuesday. Unfortunately the Tuesday proved to be too windy to acquire data. The wind was strong enough to blow the porta potty on the site over, Figure 22. The decision was made to return the following week in the hopes that the wind would die down.

FIG. 22. Evidence of wind.

A final trip to the FRS was made on October 23rd to finally acquire data. The survey was carried out two days using the Lawrence Berkeley National Labs interrogator. On the first day there was a problem with the Geodes in that the software claimed it was recording and was displaying QC information, but no files were being created. On the third day Fotec brought out their interrogator and some of the shot points were repeated. Everything was then packed up returned to Calgary.

CONCLUSIONS

In the past the Priddis Test Site has been the go to area for testing equipment and carrying out experiments. It is convenient as it is less than an hour's drive from the University of Calgary. However the FRS site has proven that it has more interesting data and with the continuing work by CaMI will likely see more data acquisition than the Priddis Test Site for the foreseeable future.

The University of Calgary's Geophysics Field School is recognized and desired by the industry as one of the best learning experiences for students. Not many university geophysics programs provide the access to real world industry level acquisition that many feel is beneficial to gain an appreciation for the data used in processing and interpretation.

ACKNOWLEDGEMENTS

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- CaMI for the use of the FRS.
- Inova Geophysical for equipment and continued technical support.

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