CREWES in the Field, acquisition and preliminary results

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ABSTRACT

CREWES is unique in that it has access to modern commercial grade seismic survey equipment. Every year this equipment is used to perform real world experiments as well as to demonstrate how acquisition is done. In 2013 CREWES completed the following acquisition projects: a) a GPS survey for new observation well installation at the Priddis test site; b) a small demonstration of the recording system to the new students of CREWES; c) a small test survey to test downhole geophones as well as some fibre optic sensors; d) resurveying the well location for permitting reasons; e) the 2013 GOPH549 undergraduate Field School project within the city of Calgary, Alberta; f) an experiment at the Priddis test site to test the response from the geophones and fibre installed in the well as well as various different sources.

INTRODUCTION

For many years now the CREWES project has had access to professional grade field acquisition equipment. There are also two locations which are owned by the University of Calgary that can be used to carry out experiments to test new theories and equipment. One of these locations is near Market Mall on the university's campus. This area is certainly not know for its data quality but is often used to test equipment to ensure that it is functioning properly before taking it beyond the city limits. The other location is just south of Calgary near the small town of Priddis. This is also the location of the Rothney Astrophysical Observatory.

The first project of the year was a straight forward GPS survey at the Priddis test site on January 25th. The purpose of this survey was to record the proposed locations of the new test wells that would be installed later in the year (Hall et al., 2013). On May 31st the new students of CREWES went out with some of the staff to learn about a small portion of the field side of data acquisition.

The next project was a two day test on the fourth and fifth of April of the geophones that were to be permanently installed down one of the new wells. This was also the first test of the new USSI fibre optic sensors. Some of the standard land geophones stocked by CREWES were also used. Both the Envirovibe and elastic weight drop thumper were used.

Every year new students are brought into CREWES. The new students for this year were taken to the field for some basic training in acquisition techniques and some of the equipment available. This was a one day trip on May 31st.

For many years now CREWES has aided in the execution of the GOPH549 Geophysics Field School. This year was different than previous in that it was held in

Calgary. With the flooding in 2013 there was interest in the history of the Bow River and how flooding has affected the area in the past.

On September 9th another GPS survey of proposed well locations was done. This was required as a finalization as to where the wells would go for permitting reasons.

The construction of a new thumper seismic source was completed in the second half of this year. Eager to get it running in the field it was connected to a triggering system and tested on campus on September 11th.

Every year CREWES strives to perform one major experiment. This year the big project was the new observation wells that were drilled at the Priddis test site. It was important to test the permanently installed geophones that were in the well. Some dynamite source tests were also done at the same time. These tests were carried out over the week of October 14th to 18th which gave the cement time to dry in the well.

The last experiment of the year was a rewiring of the downhole geophones to try and get them ordered from top to bottom. A small surface spread was laid out as well and some testing of new vibe sweeps was also carried out.

EQUIPMENT

CREWES is one of the few research groups that have access to real world commercial grade acquisition equipment. This allows the members of CREWES to test theories beyond running simulations.

In 2012 CREWES acquired a new differential GPS system which replaced the older differential GPS system. Differential GPS requires the use of two GPS receivers, a base station and a rover. The base station is set up in a known and/or repeatable location. The exact coordinates of this location can then be input into the base station so it knows exactly where it is. Alternatively the base station can be told to record a certain number of samples as read from the GPS satellites and then average the samples to determine its location. Once the base station has been set up it starts to broadcast corrections over a radio. This unit, the MB1000-SP-BB Hemisphere GPS has the option of using either an internal or external radio to broadcast the corrections. The internal radio is good for small areas and the external radio is good for several kilometres. The correction data is obtained by the base station reading its location according to the GPS satellites and then comparing that to the coordinates which it has in its memory. The base station with the external radio setup can be seen in Figure 1.

FIG. 1. The GPS base station and external radio.

The other half of the differential GPS is the rover. This is a unit identical to the base station in terms of hardware, but instead of transmitting corrections it receives them. It then applies the corrections to the information it receives from the GPS satellites. This allows for much greater accuracy than most hand held navigation GPS systems. With proper set up accuracy down to centimetres is possible. The GPS rover on the range pole and the data collector can be seen in Figure 2.

FIG. 2. The GPS rover and data collector.

The limiting factor of the differential GPS is that in order for it to work properly both the base station and the rover are required to receive information from the same set of satellites. One of the problems with the old system was that the satellites it used were just the United States units, which meant that they were almost always to the south of us. The problem would worsen in the afternoon. This meant that the horizon mask would have to be decreased on the receivers just to get enough satellites to obtain a position. Accuracy suffered as a result. The new GPS system uses the United States satellites as well as Russian satellites. This increases accuracy and usability.

The new units are advertised as more robust and reliable, however there have been a couple of annoyances. The base station seems to drain to internal batteries quite quickly. Since this discovery the practise has been to always use the larger external battery. The old GPS unit also had an external battery as well as external power supplies. It had battery chargers built in allowing for the units to charge the batteries simply by plugging them in. The new units have done away with this feature meaning that the internal batteries need to be removed and placed in a separate charger to be recharged. This would be fine with the exception of the battery doors on the units. Because they are weather tight and relatively new they are difficult to remove, often resulting in sore fingers.

CREWES has had access to two seismic acquisition systems for years now. The smaller of the two is the Geometrics Geode system. This system is designed to be broken down and carried by hand to remote locations. It consists of Geode boxes connected to a receiver line with twenty four geophone channels and an Ethernet style cable to connect the boxes together. Twelve volt batteries provide power to all the boxes. In this case deep cycle twelve volt automotive batteries are used. Another Ethernet cable is then used to interface to a laptop running the Geometrics software. Each box also has a connection for a trigger input. This system is usually used for refraction surveys using either hammer or thumper sources.

The other acquisition system is an Aram Aries system. This consists of gear that is laid out on the ground and some equipment that is usually placed in the recording truck. Aram now exists as part of Inova.

The gear that is laid out on the ground consists of geophones, receiver cables, remote acquisition modules (RAMs), line taps, base line cables, and batteries. Each RAM is capable of recording eight channels of data (four on either side of the box). This data usually comes to the RAM from a geophone through the receiver cable. The RAM then digitizes this data and stores it in internal memory while also transmitting it through digital transmission wires within the receiver cable towards the direction of the recording truck. It stores the data in its memory just in case a cable is cut during a shot and it can't be immediately transmitted to the recorder. This is important for non repeatable sources such as dynamite. A RAM, battery, receiver cables and geophones are show in Figure 3.

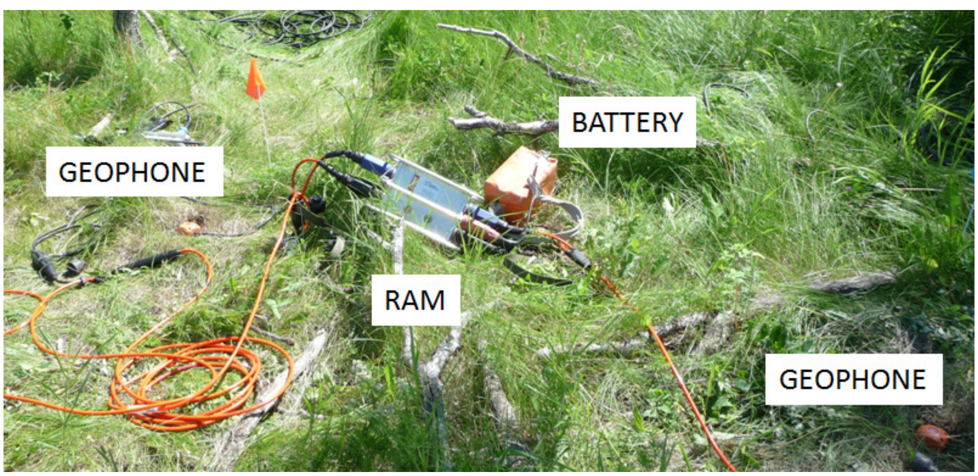

FIG. 3. Geophones, RAM and battery.

Typically a line tap is used to take the digitized information from the receiver lines and then transmit it to the truck through the purely digital base line, which don't have takeout connectors for geophone. Each RAM and line tap is an "intelligent" device, meaning that it has to be powered by a battery in order to function. A line tap is shown in Figure 4.

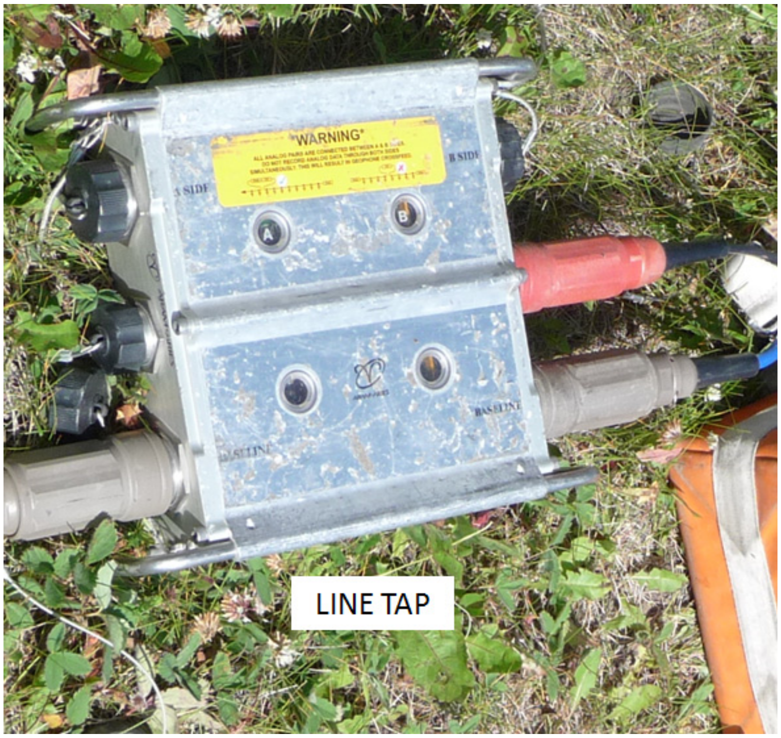

FIG. 4. An Aries line tap.

Within the recording truck is an Aries Seismic Processing Module Lite (SPML). The light version is a "portable" computer that has a limited number of channels it can record. For CREWES this is perfect as the areas of interest are typically smaller than commercial seismic. It proved handy in 2011 when it was transported to New Zealand and installed in a cargo van for use there. The inside of the recorder can be seen in Figure 5.

FIG. 5. The recorder in the middle of acquiring data.

Also in the recording truck are a couple of source controllers. There is a Pelton VibPro and a Pelton ShotPro. Pelton also now exists as part of Inova. The VibPro is required to run a vibroseis source. Typically there is another VibPro located within the vibroseis source and the two units communicate over a radio. There is a lot of timing information used to ensure that the recording system starts recording at the proper moment when the vibe starts a sweep. The ShotPro is a source controller for dynamite sources. The one in the recorder isn't often used as the VibPro can be programmed to pretend that it is a ShotPro. This is handy as it means the wiring harness doesn't need to be switched out in order to switch between dynamite and vibroseis sources.

Everything in the recording truck is powered by a diesel generator mounted on the back of the truck. This generator powers the fluorescent lights and a heavy duty battery charger/inverter directly. This battery charger powers four deep cycle twelve volt batteries mounted next to the generator. An inverter is connected to the batteries and provides 110 volts to the computer systems. The source controllers and radios are powered directly from the twelve volt batteries. The reason this is done is threefold. First, this provides "clean" power to the recoding computers minimizing electrical noise from the generator damaging recorded data. Second, it provides a buffer should something happen to the generator to cause it to stop working. And third, sometimes it is required to have everything as still as possible during a survey, in which case the generator can be shut off for a while during recording. However, the batteries are getting a bit old now and do not seem to be able to keep the equipment powered for more than a few minutes.

New for 2013 is a US Seismic Systems Inc (USSI) three axis fibre optic downhole geophone system. This system is still very new and has already been sent back for repairs and upgrades.

CREWES has access to several seismic sources to coincide with the recording systems. The smallest is a hammer switch which is typically mounted to a sledge hammer. This hammer is then swung to hit a steel or aluminum plate on the ground. This source is typically used with the Geode recording system. The hammer switches are actually sold by Geometrics.

Supplying a little more energy into the ground is an elastic weight drop thumper built into a trailer, which can be seen in Figure 6. This has been functioning for a few years now. This unit uses a hydraulic pump mounted to a gas engine to raise and lower a base plate, provide tension to an elastic band, and lift the hammer. During operation the base plate is lowered to take the weight of the trailer on it. The hammer typically goes down with the base plate at this point. An elastic band is threaded through the top of the hammer and both ends are wrapped onto bars at the end of hydraulic rams. The rams are then pushed down to provide some tension to the elastic. The hammer is then raised using hydraulics again. Once the hammer reaches the top of its travel a switch activates a dump valve that releases all the hydraulic fluid holding the hammer up into a reservoir. The elastic then pulls the hammer down to hit the base plate. Unfortunately the electronics have suffered some water damage this year. A new trigger design is in the works.

FIG. 6. The elastic weight drop thumper behind a Ford F550.

New for 2013 is a shear wave thumper source (Lawton et al., 2013) (Figure 7). This thumper uses hydraulics to move the various mechanical bits around, but instead of using elastics this unit uses compressed gas to drive the mass down. The hammer part of this unit can be tilted forty five degrees from vertical in order to act as a shear wave thumper source.

FIG.7. The new shear wave thumper.

The most impressive (size wise) of the available sources is the Industrial Vehicles International Envirovibe. This is quite literally the poster child of the CREWES seismic sources. Although it is the largest source available to CREWES it is smaller than the typical vibroseis sources used commercially. The Envirovibe can be seen in Figure 8.

FIG. 8. The Envirovibe.

The transportation of all this equipment is usually done by four vehicles. There are two Ford F350 crew cab trucks which have seismic cages installed in the beds for the ground gear. A Ford F450 has the recording cabin mounted on the back of it as well as the generator. A final Ford F550 is used to pull a trailer with the vibe on it as well as a slip tank for in field fueling. There is also a flat deck trailer and a covered trailer used to haul equipment when needed.

CREWES also has a shared ownership of a Pulse Ekko Pro ground penetrating radar system seen in Figure 9.

FIG. 9. The Pulse Ekko Pro GPR system.

SAFETY AND FIELD READINESS

In recent years safety has come to the forefront of the public eye. Gone are the days of just going and doing something. Now forms must be filled out with travel plans and locations as well as identifying all the possible hazards. By no means is this a bad thing. If nothing else this ensures that the very impressive safety record of CREWES in the field will continue. Since CREWES began twenty five years ago not a single incident requiring medical attention has occurred.

Before any field work happens anywhere, an emergency response plan (ERP) and hazard assessment are created. These documents detail expected hazards and locations of field work as well as the nearest emergency services should they be needed. Daily check-in procedures are used in order to ensure that everyone is accounted for at the end of each day. At the beginning of each day a safety meeting is held to ensure that safe practices are carried out.

All CREWES staff in the field have had training in standard first aid and their certifications are kept up to date. Other certification examples are for the crane in the bay where the gear is kept as well as training for ATV use. If someone's certification expires that member of CREWES is not allowed to use the equipment until he or she is recertified.

As many field experiments start with a need to get some data quickly, the gear is maintained and stored in such a way that it can usually be deployed in half a day to a day. Mechanical maintenance is done regularly and problems with field equipment are communicated. To ensure that all equipment is used properly a minimum of one or two CREWES staff will accompany it in the field at all times.

PRIDDIS GPS

In 2012 the new GPS system was used to do a comprehensive survey of the Priddis test site. This provided a detailed map that could be used to plan future experiments at the test site. The results of this survey have been plotted on a satellite image in Figure 10.

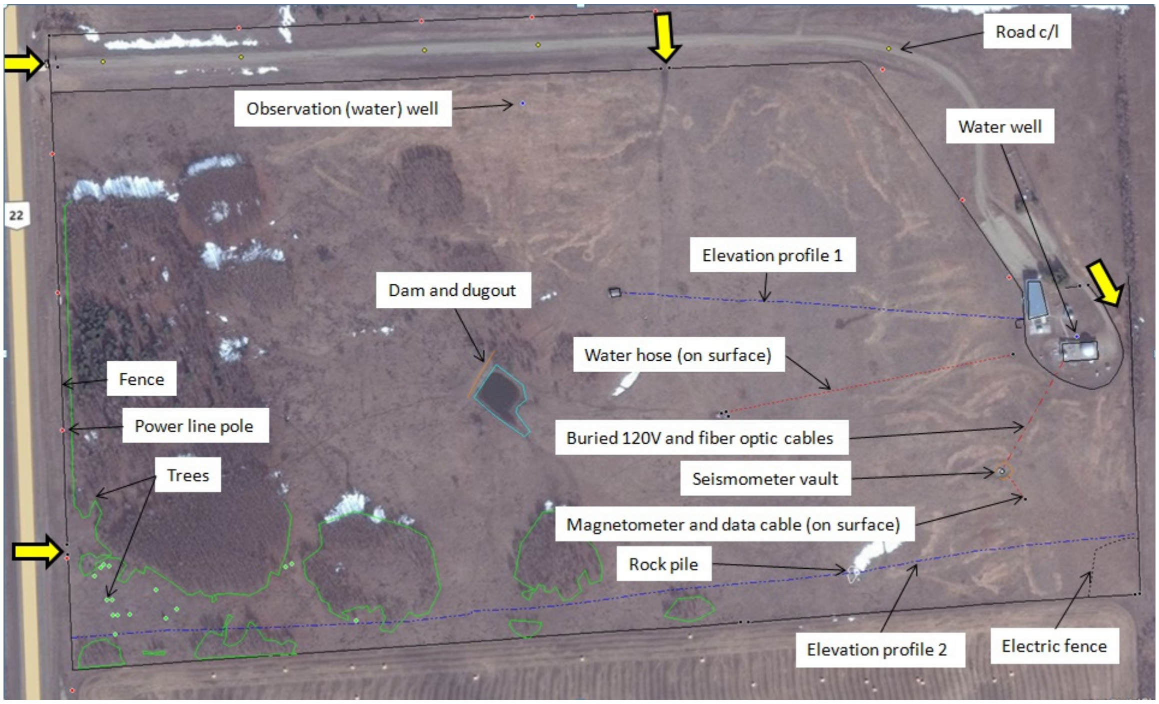

FIG. 10. The detailed map from 2012.

This year the first field work was to take the GPS back to Priddis on January 25th and determine possible locations for the observation wells that were being planned (Figure 11). Three CREWES staff packed up the GPS and spent a day performing this task.

The first step was to set up the base station at the southwest corner of a concrete slab that is used to support a telescope at the Rothney Astrophysical Observatory. This is the same location that the base station is set up at every time an experiment involving the differential GPS at Priddis is used. Since this is the same location as the survey done in 2012 the location of the base station was read from that file.

Once the base station was set up the rover was initialized and the possible locations of three new observation wells along with the location of the old observation well were recorded. These were sighted by eye and didn't need to be centimetre accurate.

FIG. 11. The initial estimated location of Well #1.

Later in the year when the drilling plan was confirmed there was a need to perform a more accurate survey for permitting purposes. This allowed the use of a feature of the GPS that had previously never been used. Instead of finding a point and recording its location the GPS was loaded with the desired location and would then guide the user to that point. Once there the point was recorded and that information was used for well locations and a stake was driven into the ground at each location for the drillers to find as seen in Figure 12. The three possible well locations were then submitted for drilling.

FIG. 12. Placing a stake at the actual location of Well #1, the shadow of the GPS rover can be seen on his shirt.

Since the corner of the concrete pad that the base station is set up is always used while at Priddis the location of the nearest survey monument was recorded using the rover. Using the recorded location of the survey monument as well as the official location of the monument found online allows for the base station reference file to be corrected making the differential GPS even more accurate. This new corrected file is what will be used in the future for GPS at Priddis. Occasionally the survey monument will be re-surveyed with the GPS to verify accuracy.

TAKING NEW STUDENTS TO THE FIELD

Every year new students are brought into CREWES to replace those that have moved into the workforce. Because it is so unique for CREWES to have fulltime access to commercial grade seismic equipment it was decided that the new students should get a demonstration of the equipment. The plan was to run a “mini field school” for just one day and allow the students to gain some hands on experience with gear layout, pickup and data acquisition. The students can be seen laying out gear from the truck in Figure 13.

FIG. 13. New CREWES students in the field.

The Priddis test site was chosen for this excursion. The students laid out a 1C receiver line along the access road to the Rothney Astrophysical Observatory. Once the line was laid out the start up and testing procedures of the equipment were explained and the students tested all the gear that was laid out and got the Envirovibe in position for the first source point.

Unfortunately as the ground was very wet one shot was all that was accomplished that day. After the shot was taken the vibe tried to move up to the next point but it had sunk into the wet ground (Figure 14).

FIG. 14. The vibe getting that sinking feeling.

In order to get the vibe out of the mud we had to enlist the help of a local farmer who had a back hoe heavy enough to pull the vibe out. After the vibe was unstuck it was time to pack up the gear and head back. The students didn't get to see the example of acquisition as hoped, but they did learn that things do not always go according to plan.

ON CAMPUS EQUIPMENT TEST

Since it was known that there would be some observation wells being drilled this year it was important to test the equipment that was destined to be permanently mounted in the well. These downhole phones are three component units with GS-14 elements. These units were built by Weir-Jones and consist of eleven cables with four 3C phones on each and one cable with one 3C geophone. They were originally purchased for a project that stalled many years ago.

During that project adapter boards were manufactured to plug these cables into the Aries system as seen in Figure 15. These had been sitting in a box for many years and needed to be dusted off and tested. During this test it was discovered that one of the cables that connected the RAM to the adapter board had a short in it. After this was fixed all the downhole geophones appeared to be functioning fine. The geophones were all placed laying flat on the ground with the exception of the last one on the cable. This was stood upright in a little hole (Figure 16).

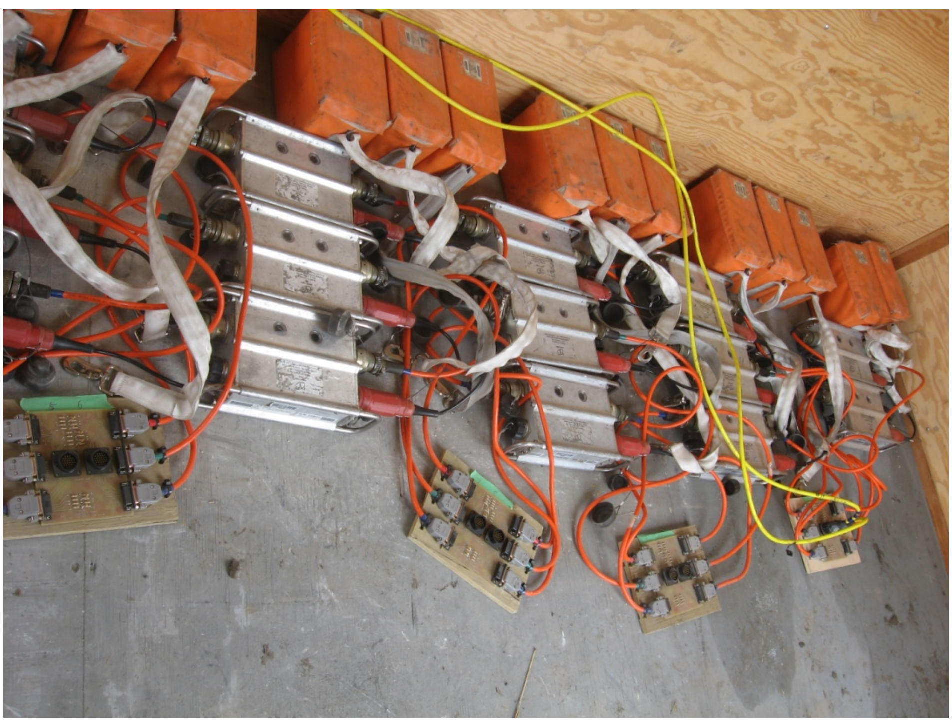

FIG. 15. Aries adapter boards, only the far right one has the Weir-Jones cables connected.

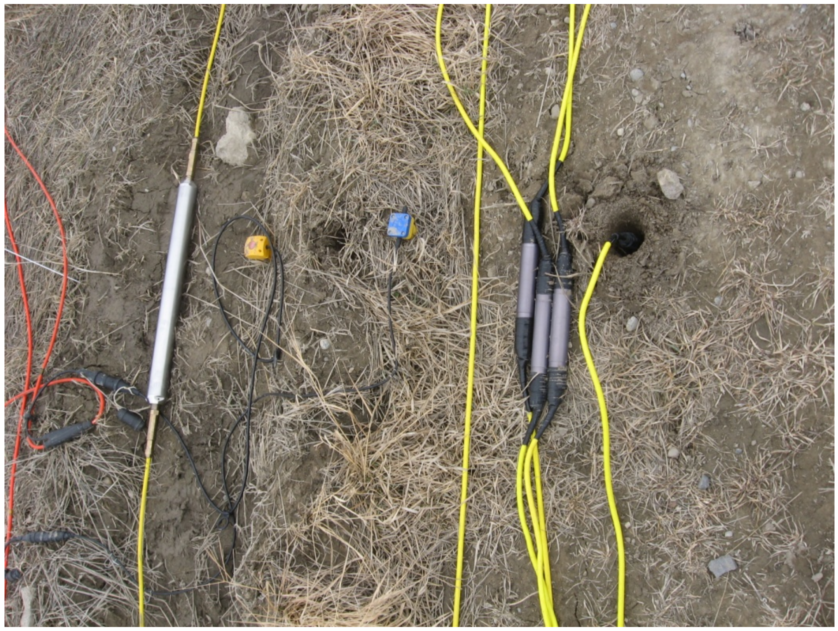

FIG. 16. From right to left, fibre optic three axis receiver, 3C geophone, 4.5Hz 1C geophone, three Weir-Jones 3C downhole geophones lying on the ground, one Weir-Jones 3C geophone in a shallow hole.

The USSI fibre optic system was also used in this test. The units are designed to be used in observation wells but for this experiment they were laid flat on the ground. To help increase coupling some of the receivers had weights placed on top of them. Figure 17 shows some of the receivers with concrete blocks being used to weigh them down.

FIG.17. The search for better coupling.

Also used in this experiment were the three component SM-24 geophones and some single component 4.5Hz phones.

Both the vibe and the elastic weight drop thumper where used as sources for this experiment. The vibe can be seen on the spread in Figure 18. It was determined that everything was working with the exception of the one channel that was shorted. The thumper was used to try and get some comparisons of the receivers. This proved to be a little difficult as the triggering system wasn't working. Instead we just recorded for a set amount of time and made sure there was a thump near the beginning of this time. The start point in the records then had to be manually picked out.

FIG. 18. The vibe being used as a source for the equipment test.

After this experiment it was discovered that the USSI wasn't working quite as it should. The problem was traced back to the power supplies within the unit itself. This unit has been sent back for calibration and upgrading. The software will be upgraded as well. The fibre optic "geophones" have also been sent back to be installed on different cables and to have a clamping system mounted.

Just for interests sake a frequency response from each of the different receiver types was done using a weight drop shot. Figure 19 shows the results. This was done using a single thumper shot. The results from the USSI had to be integrated as the fibre optic sensor is sensitive to acceleration and not velocity like the geophones.

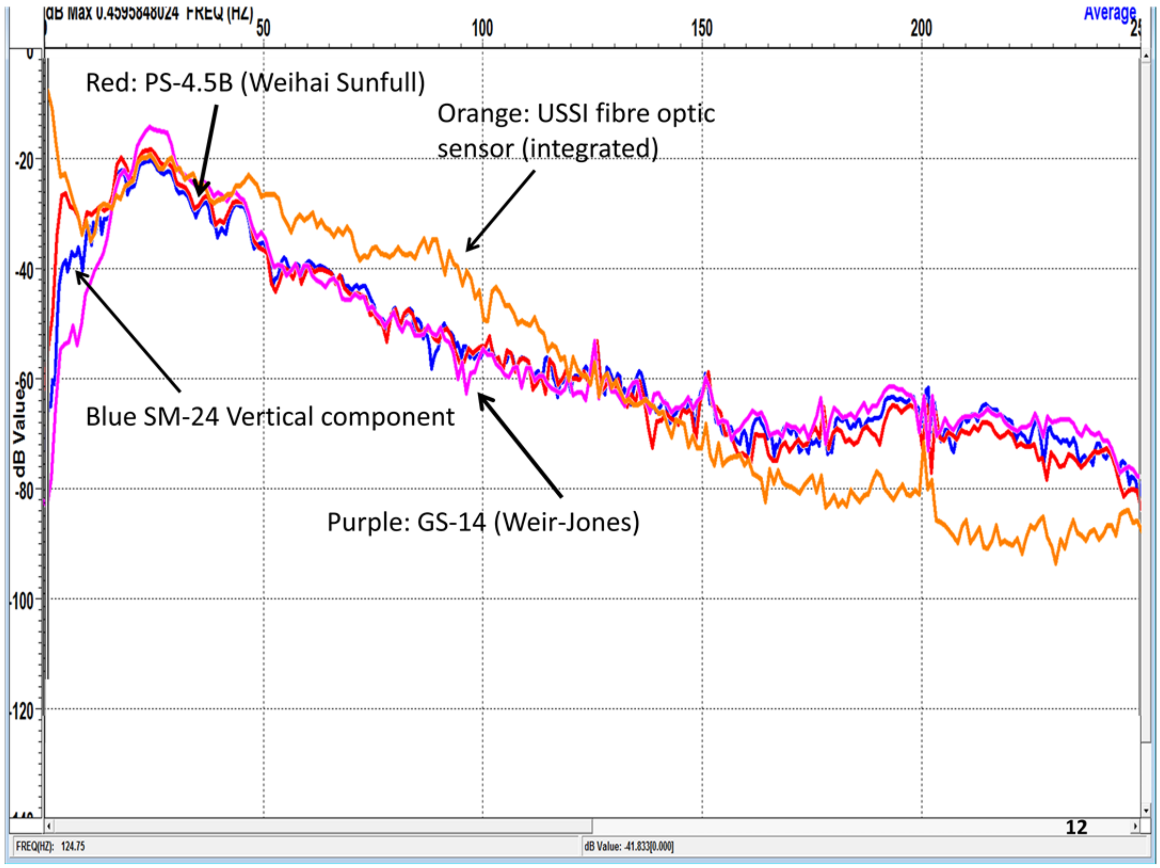

FIG. 19. The four different receiver's frequency response (0-250Hz).

From Figure 19 it can be seen that there is a lower frequency "bump" of the 4.5Hz receivers. This is to be expected. What wasn't expected was the lower frequency drop off of all the receivers below that. This section has been zoomed in a bit in Figure 20.

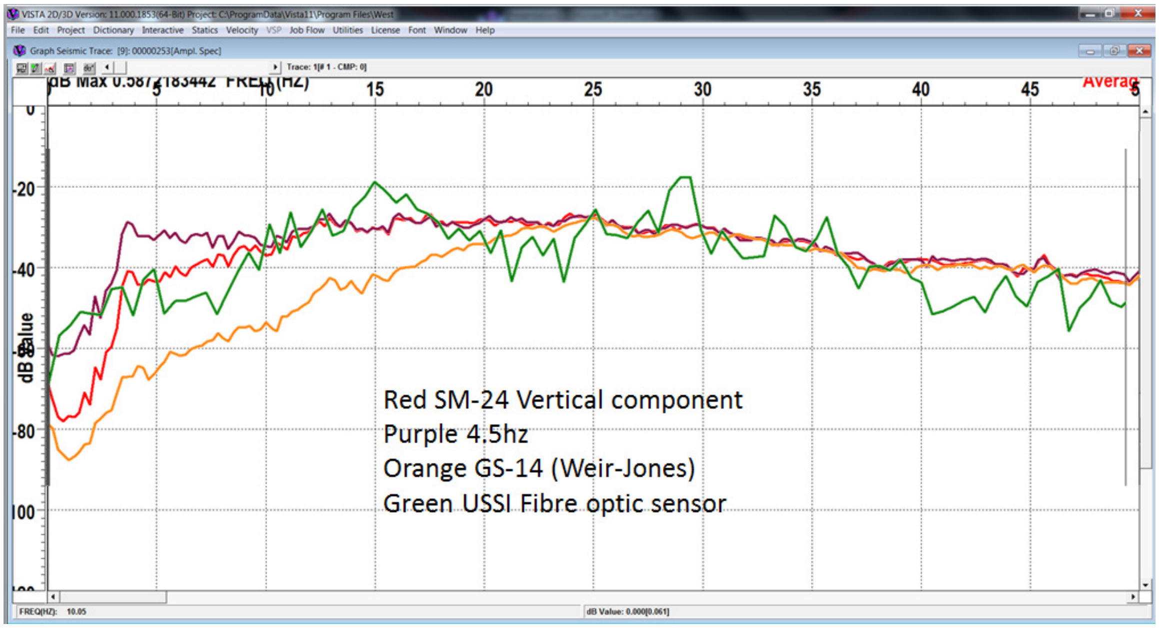

FIG. 20. The four different receiver's frequency response (0-50Hz).

As can be seen in Figure 20, the three geophones decrease in energy similarly at the lower frequency. This is due to operator error with the Aries software. Standard practice with the Aries recording system is to run with a 3Hz low cut. Since CREWES is interested in low frequency a 0Hz low cut switch is usually used when recording data. In this case it was not activated. It should be noted that the USSI trace in Figure 20 is not integrated, so it can't be used for a direct comparison.

FIELD SCHOOL

For many years now CREWES has provided equipment, experience, and staff to the Geophysics 549 Field School. This year field school was held on the last two weeks of August. This field school provides students with the unique experience of performing hands on geophysics acquisition with commercial grade equipment. This gives them an understanding of seismic data that they would not otherwise obtain.

This year's field school was different than years prior as it took place within the Calgary city limits (Figure 21). In the past this class has been held out under open skies with the students residing in a camp or hotel for the duration. This year the students went home each night and it was done in the form of "field days".

FIG.21. The vibe at Inglewood with downtown Calgary in the background.

The class was held at two locations in the city. One was at the Inglewood wildland park which is an old oil refinery site near the Inglewood bird sanctuary and the other was at the Shouldice dog park. The areas of interest were near the river with the hopes of obtaining some data that can give some insight into the flooding history of the locations.

The Inglewood portion focused mainly on the methods of seismic reflection using the Aries recording system and the Envirovibe as a source (Figure 22). Unlike commercial crews that have all the source and receiver points surveyed before hand and a file loaded into the recording system the receivers were laid out first and then acquisition was started. This was done to ensure that the students that were assigned to the line crew would have something to do. As the class went on more lines were laid out. As the lines were put out they were surveyed using the differential GPS.

FIG. 22. Students learning about seismic reflection surveys at Inglewood.

The Geode system was used with a hammer source at Shouldice Park for a refraction survey (Figure 23). The lines that were done here were along pathways. The GPR was also used along these same lines.

FIG. 23. Students look at a record recorded with the Geode system.

Inova brought out their new nodal system, Hawk, for testing at the Inglewood survey (Figure 24). This required that the Envirovibe source be synced to GPS time. To that end Inova donated the use of a newer VibPro in the recorder that has the ability to read GPS time signals. Unfortunately at the time of writing this report the data was not available.

FIG. 24. The Inova Hawk trailer.

Local observation wells were also used for a VSP survey as Shouldice. Resistivity experiments were also done at Shouldice as well.

Student safety is always a priority during this class and so personal protective gear and safety practices were used. Every morning there was a safety meeting describing all the dangers and how to avoid them.

As with real seismic crews there was some equipment failure at this field school. Wild animals chewed through two of the receiver cables overnight and the vibe broke down. The cables were picked up and replaced and the damaged ones have since been repaired by a local cable repair shop. The vibe had a more serious issue. It turns out that the engine control unit developed a fault. It was replaced in the field by a John Deere technician and has been running strong ever since.

A handful of RAMs developed faults as well and have been sent in for repair.

Helen Isaac has processed some of the data from the Inglewood lines and some of the results are shown in Figure 25.

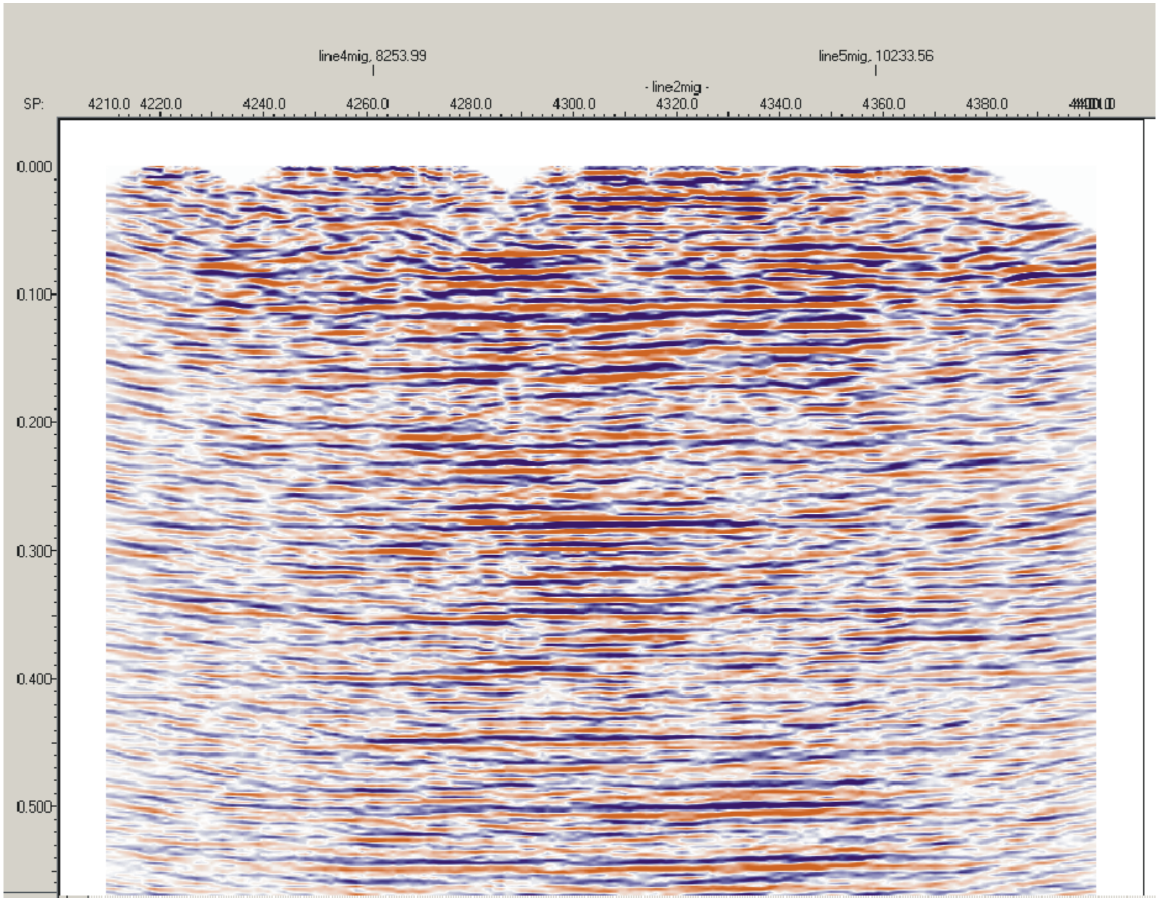

FIG. 25. Migrated results from an Inglewood seismic line.

TESTING THE NEW THUMPER

With the new thumper completed there was a need to ensure that it could actually be used. A triggering system was set up using old radios and electronics that were originally designed to work with a thumper that has since been decommissioned. The trigger itself is actually an old geophone strapped to the foot of the thumper. Although it is a little crude it works and will trigger the Aries system with decent reliability.

A short 3C receiver line was laid out on the campus land and testing was started. The original test concept was to try the thumper at different pressures in the nitrogen system and in three different orientations (vertical, forty five degrees to the east, and forty five degrees to the west). The initial pressure was set to 300psi at the beginning of the line. The thumper was set up vertically and ten thumps were acquired to be stacked later. Each shot point had ten thumps in each orientation done.

Satisfied that it was triggering and data could be collected the pressure was increased to 600psi and the three orientations were shot again. With everything looking good the pressure was increase again to 900psi and the shot repeated. The decision was made to keep the maximum thumper pressure at 900psi.

The thumper was then moved up twenty receiver stations (halfway up the line) and the three different orientations done there at 900psi. The plan was then to decrease the pressure and redo this shot point with 600psi and then 300psi. However, it was then discovered that there was not bleed system installed. The only way to decrease the pressure was to disconnect the gas lines. A decision was made to keep the pressure at 900psi.

The thumper was then moved to the end of the line and the three orientations were done again. After that was done the thumper was moved so it could thump inline at the end of the line with the mast tilting to the north and south (away from the line and into the line). Although the main purpose of this test was to try and dial in the triggering mechanism of the new thumper it did produce useable data (Asuaje, 2013). It was also discovered that if the foot isn't reseated on the ground every few thumps it will bend the pin that attaches the foot to the mast.

PRIDDIS EXPERIMENT

Now that the two new test wells had been drilled (Hall et al., 2013) and the geophones attached to the outside of the casing it was time to try and acquire some data from them. The experiment was designed to be centred on the wells. The first goal was to obtain enough data to determine the orientation of the geophones in the well. The experiment was designed with two 306 metre long lines of 3C phones oriented north-south and east-west centred on the well. However in reality the east-west line was not a full 306 metres due to the fact that there were cows grazing in the east end of the field and we didn't want to run the receiver cables under the electric fence for fear of the cows damaging them.

Because of the use of 3C phones the amount of data being recorded was triple what is normally recorded with a 1C survey. The setup that was used requires that the number of rams be tripled, one for the vertical component and two for the horizontal components. The connection method was determined at the office before leaving for the field.

Other tests done at this time involved the use of dynamite as a source. One area of interest here was the effect of depth of the impulse source on the survey. The dynamite shots were loaded prior to the survey (Figure 26). A shot hole with several sources at different depths was loaded. The shots were hard-coupled together with benotinite filled plastic tubes between them in the hole. As such, when they were fired off in order from the bottom to the top the uppermost shots moved up in the hole.

FIG. 26. Drilling and loading the multi-depth charges for the up hole experiment, note the number of shot leads in the bottom right.

Other dynamite tests involved angled shot holes. This is a case of someone being able to see the effects of tilted shot holes on a simulation and wanting to try it in the field. These shot holes were drilled with the vertical shots directly east and west of the well and then four more shot holes angled at thirty degrees drilled to the north and south of the vertical holes (Figure 27). The idea was to have the six charges the same distance from the well at the same depth under the surface. Two of these would be angled towards the well and two would be angled away from the well.

FIG. 27. The shot hole rig drilling at an angle.

Additional surface receivers were laid out to cross at the well and line up with the angled shot holes. Figure 28 shows the initial surface spread layout idea.

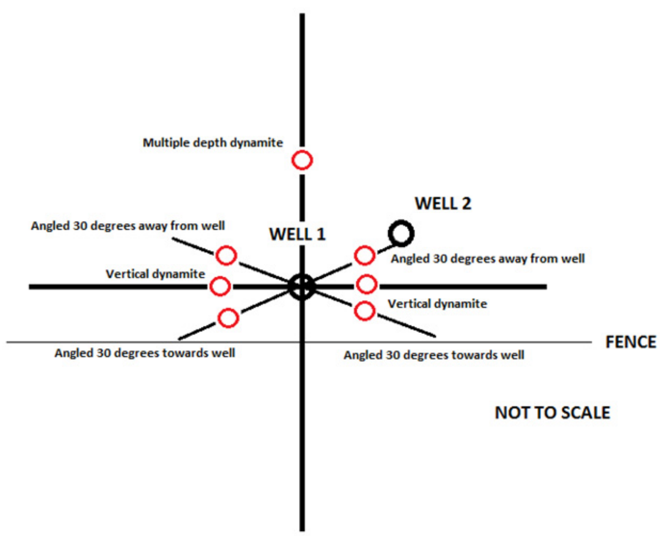

FIG. 28. A diagram from the original layout proposal for this field experiment.

The Envirovibe was used along the surface spread and the new thumper was also used to get several shots. There were 100 shots taken with the new thumper close to the well at the request of a member of the CREWES staff.

An interesting point here is that the downhole geophones were designed for a much deeper well than the one that they were mounted in. As such instead of having the four receivers of the first cable at the deepest depth then the four receivers of the second cable following it they were interleaved. The effects of which can be seen in Figure 29.

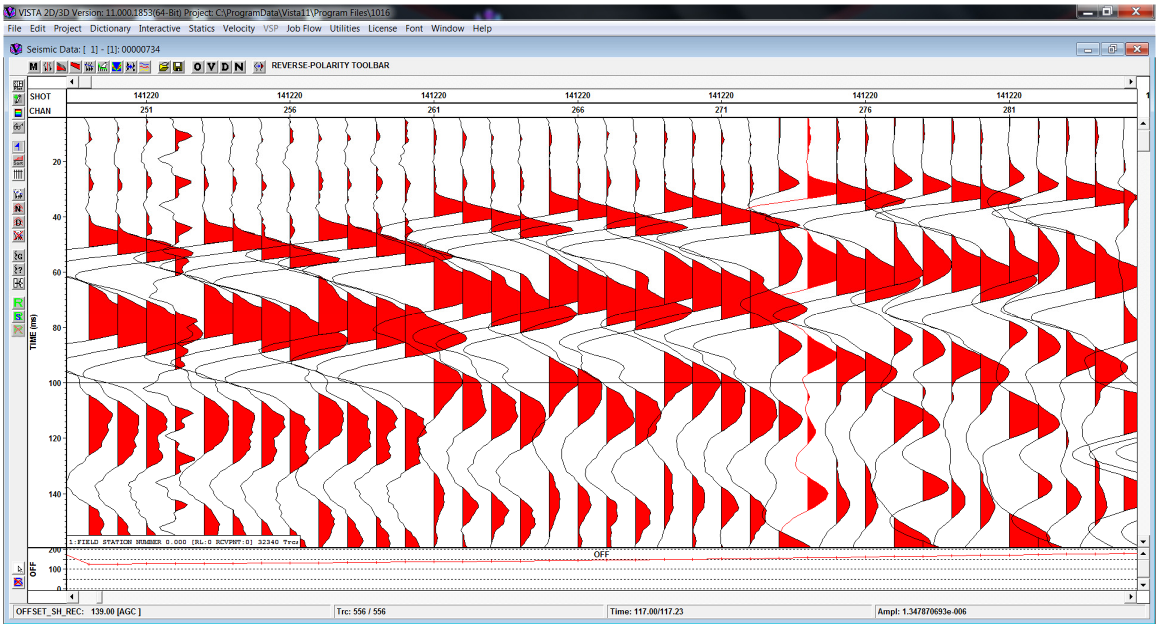

FIG. 29. The first breaks of the downhole geophones as they were recorded.

RETURN TO PRIDDIS

After the last experiment at Priddis a method of rewiring the downhole geophones was devised. The cable were cut and then reconnected to the ends with the connectors using a data communications punch down card set as seen in Figure 30. The newly organized cables were connected to the adapter boards again (Figure 31) and another small surface spread was laid out consisting of only north-south and east-west lines. The new thumper was brought out as was the vibe.

FIG. 30. Reorganizing the cemented downhole geophones while at the same time reducing the cable length to something more manageable.

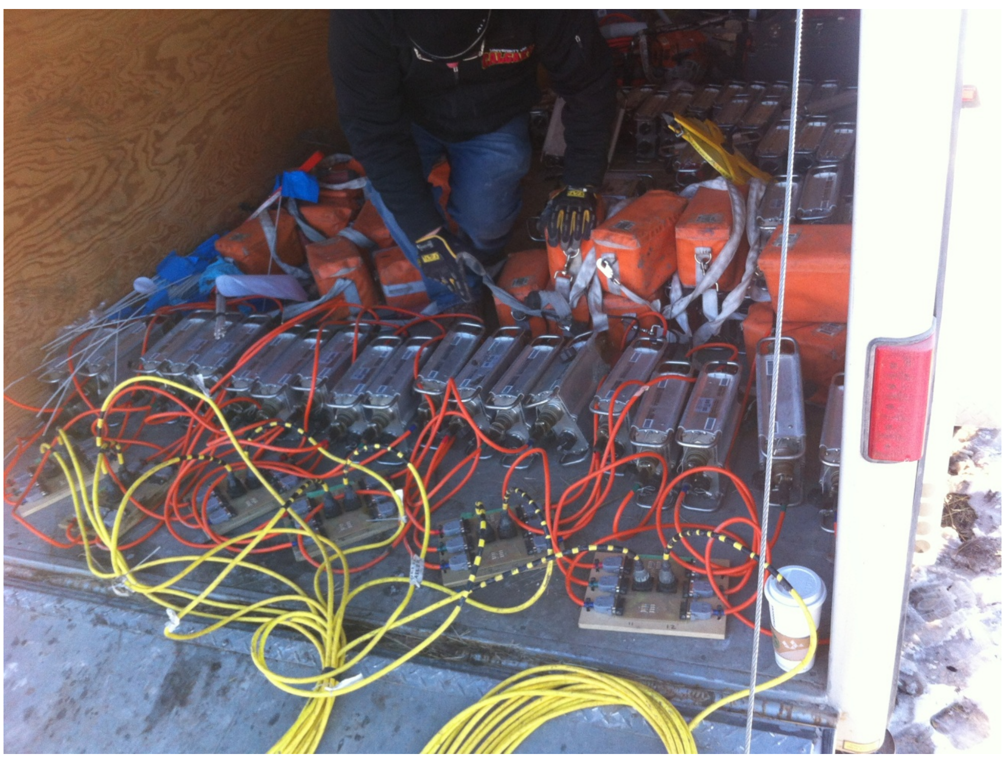

FIG. 31. Connecting newly shortened cables to the Aries system through the adapter boards.

The thumper was used to determine if the cables were wired up correctly. As it turns out they were not. Although they are closer than they were. They are now grouped together in threes, but the order of the groups is wrong. Figure 32 shows this. Figure 33 is what it should look like.

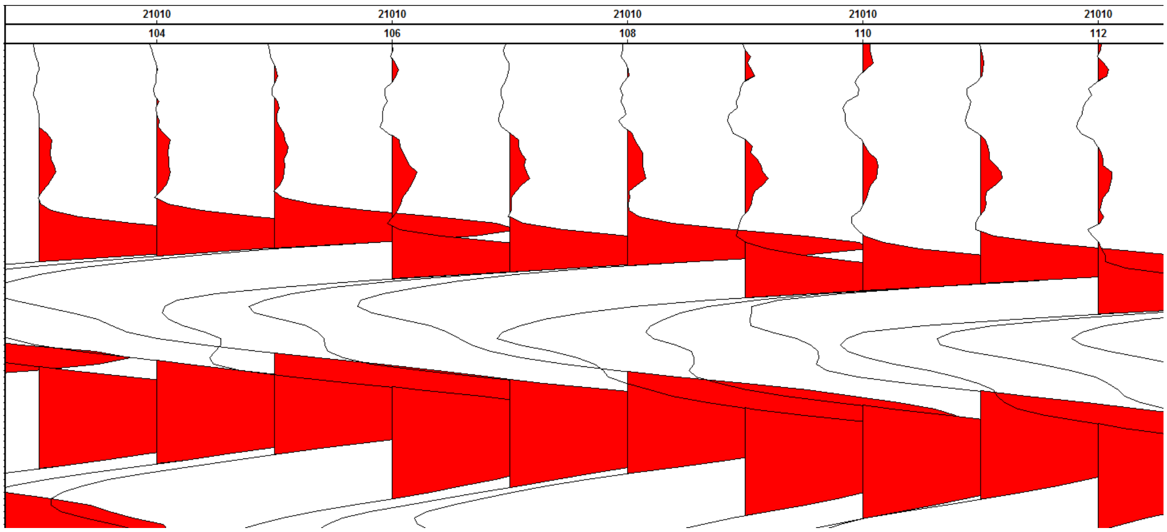

FIG. 32. The first break as recorded after rewiring the downhole geophones.

As can be seen from Figure 32 the first breaks are in sets of three. Each set of three is backwards. This will be rewired to be correct on the next trip to the Priddis test site.

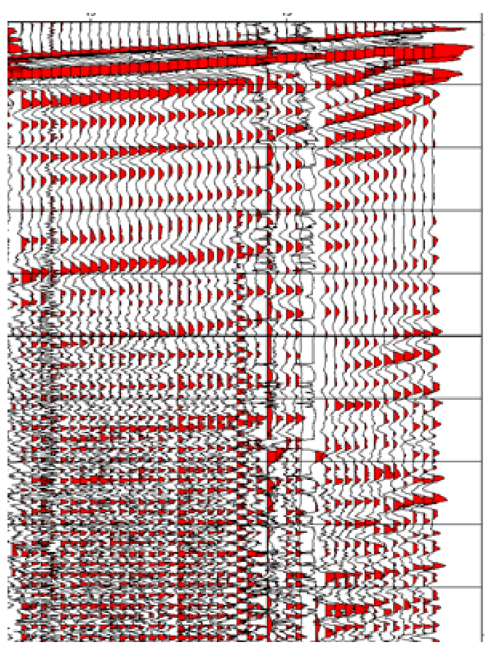

FIG. 33. Vertical component of downhole phones in correct order.

Joe Wong also wanted to attempt to run a pseudo random sweep using the Envirovibe (Wong et al., 2013). The focus here was to simply see if it was possible to drive the vibe in such a manner with the equipment at hand. The vibe did sound unnatural whilst running these sweeps.

CONCLUSIONS

Data from all these field projects is available to sponsors upon request.

The wells should provide a source of many experiments in the coming years. There is a need to return to rewire the cables for what should be the last time. Once the USSI fibre optic system is returned it will more than likely be used in the second well for further experimentation.

The new thumper is working well and is yielding quite positive results.

The University of Calgary Geophysics field school is one of the best currently running. It provides a deeper understanding of the realities of seismic data and some of the challenges that can arise while acquiring these data.

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