CREWES in the field, 2012

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ABSTRACT

CREWES carries out several acquisition and field experiments each year. In 2012 CREWES has completed the following acquisition projects: a) an extensive GPS survey of the often used Priddis test site; b) a pulse-probe experiment at the Priddis test site; c) the 2012 GOPH549 undergraduate Field School project with a seismic line along a road near Beaver Mines, Alberta; d) a refraction survey at the Priddis test site.

INTRODUCTION

Students and staff at the CREWES project have access to commercial grade field acquisition equipment. This means that real world data can be acquired to be used for instruction, and development and improvement of field methods and processing techniques. It also means that acquisition theories can be tested fairly easily. Both staff and students look forward to spending time in the field acquiring data as it offers an escape from the from the office.

The first project this year was carried out in June of 2012. This was a GPS survey of a patch of land where many acquisition projects have been carried out and many more are anticipated in the future. This was also the first full field test of the newly acquired differential GPS system.

The second project was a pulse probe experiment carried out from July 9 to July 12. Like the Hussar low frequency experiment of 2011, this experiment was completed with the combined efforts of CREWES staff, students, and industry sponsors. This experiment used several different receivers, two Aries recording systems, one Vectorseis recording system, and an Autoseis nodal recording system. Two vibroseis buggies and dynamite were used as sources.

The third project was the GOPH549 Geophysics Field School shot by the undergraduates in that class. The project was designed to provide information about the structure beneath the surface near Beaver Mines, Alberta at the base of the Rocky Mountains. This line was shot using the Aries recording system and single component geophones. The University of Calgary's EnviroVibe was used as the source.

The fourth project this year was a small refraction job done at the Priddis test site in September. This used the Aries recording system and the EnviroVibe again. The receiver spacing was five metres with the source at ten metres. This experiment is a prime example of how a small experiment can be prepared for and carried out in just a few days.

EQUIPMENT

CREWES is unique in that is has access to commercial grade acquisition equipment which is used regularly for field experiments. This allows for the staff and students of CREWES to validate theories from the office with real world acquisition data.

In 2012 the old differential GPS system was upgraded to the MB1000-SP-BB Hemisphere GPS from Bench-mark. This is a differential system meaning that it uses a base station and a rover. The base station is set up in a known, or at least repeatable, location. Ideally it would be set up over a survey monument. The base station is then either told where it is by way of the survey monument data or is allowed to calculate its location by averaging a number of readings. Once it is set up it starts broadcasting corrections using an internal radio for smaller jobs or an external radio for increased range. The correction signal is simply the difference between the base's known location and the location it receives from the GPS satellites. The GPS system is shown in Figure 1.

FIG. 1. The differential GPS.

The rover is the other half of the differential GPS system and receives the broadcast corrections on its internal radio. It then mathematically applies these corrections to the position it receives from the GPS satellites to obtain readings that are accurate down to centimetres.

CREWES also has access to two seismic acquisition systems. The more portable of the two is the Geometrics Geode system. This system uses a laptop computer loaded with the Geometrics software that connects to the Geode boxes through an Ethernet cable. These boxes are then connected to receiver lines with up to twenty four geophones, or channels, per line. A trigger signal can also be connected to any of the

Geode boxes. All the boxes run on twelve volts, and the entire system can be hiked into remote areas by a small crew.

The larger system is a fully functioning Aram Aries recorder. This system is truck mounted and although it is considered a portable system, it rarely leaves the truck. Also in the truck are a Pelton VibPro and a ShotPro. The whole system uses four deep cycle twelve volt batteries supplying power to an inverter which provides a clean 110 volt sixty hertz power source. The batteries are charged by a charger/inverter powered by a diesel generator. The charger/inverter is new as the old charger was damaged in New Zealand last year. The recorder is shown in Figure 2.

FIG. 2. The recorder.

Accompanying the truck mounted equipment is the ground equipment. This includes several Remote Acquisition Modules and assorted cables. The typical receivers used with this setup are either single channel phones or three component phones. As all the RAMS that are currently in the shop are eight channel, it is required that three lines be set up to record one three component line with the three component phones. A line truck loaded with equipment is shown in Figure 3. Figure 4 shows a Ram and a battery on the line.

FIG. 3. Phones and cables loaded in a line truck

FIG. 4. Remote Acquisition Module and battery on the line.

CREWES also has access to a number of seismic sources. The simplest of these is the hammer and plate. This is simply a hammer with a trigger switch mounted to it which closes when the hammer strikes the ground or one of the various plates.

The next step up is the thumper. The thumper was custom built in 2009 by the CREWES project. The thumper uses hydraulics to raise and lower a base plate, set the elastic belt tension and raise the weight. Currently the thumper is controlled by an old Polaron source controller system. However, the radio communications are not functional at this time. The thumper is shown in Figure 5.

FIG. 5. The seismic thumper.

The largest source currently available to CREWES is an I.V.I. Envirovibe. This machine is smaller than most used in commercial seismic, but has the advantage of being portable and can maneuver in tighter areas. The vibe is shown in Figure 6.

FIG. 6. The IVI Envirovibe.

CREWES also has a shared ownership of a Pulse Ekko Pro ground penetrating radar system (Figure 7).

FIG. 7. The Pulse Ekko Pro GPR system.

FIELD READINESS AND SAFETY

The equipment is maintained in such a manner that it is ready to go at any time. The only set back is the amount of time it takes to get it loaded and transport it to the field. In order to ensure that the equipment is always used properly one or two of the CREWES staff accompany it to the field to provide knowledge and technical support. CREWES strives to remain in good standing with the manufacturers of the equipment to ensure that any problems can be resolved as quickly as possible. CREWES is also available to test and provide feedback on new/modified equipment.

Safety is the biggest priority in the field. CREWES is proud to state that since its beginnings in 1989 not a single injury requiring medical attention has occurred in the field. To insure that this impeccable record of safety continues guidelines are put in place to ensure that all field work is carried out in the safest possible way. Hazard assessment and emergency response plans are filled out before anyone leaves the campus. Personal protective gear is a must and anyone who is not wearing their PPE is asked to put it on or leave the field. Depending on what equipment is being used PPE can include, but is not limited to hard hats, safety vests, eye protection, steel toed boots, hearing protection and gloves. Furthermore sunscreen and insect repellent are brought to the field. Each vehicle that CREWES uses is equipped with a first aid kit and road flares. Familiarization of all equipment used in the field is carried out before anything is started. Safety meetings in the field on every day of field work are held before that day's work begins.

Another aspect of safety is training. All CREWES staff that perform work in the field are trained in standard first aid. Other training includes overhead crane operations training, all terrain vehicle operator training, and H2S alive training. The overhead crane is used to load and unload gear for field work. Essentially, if formal training is available for a certain piece of equipment, only those trained are allowed to use it.

PRIDDIS GPS

The Priddis site that is often used for acquisition experiments is located to the South of Calgary. The Rothney Astrophysical Observatory is located at the East end of the site atop a hill. There are two fields that are used here, the North field and the South field. Both fields are rented to a local farmer who uses the North for grazing cattle and the South for crops.

With the Priddis tests site being used for so many experiments over the years and a new GPS system needing to be broken in a decision was made to take a fairly complete GPS survey of the North field. This was mainly prompted by the upcoming pulse probe experiment and the desire to bury a permanent seismic monitoring system.

The base station was set up on the southwest corner of a concrete slab that is used as a base for a telescope near the classroom on the east end of the property. Once this was set up the rover was walked out around the field. Several fence posts were surveyed to get an outline of the property. The access gates in the fence were also surveyed. Other points of interest such as power lines and buried cable markers, the small pond on the land, and an old building were also surveyed.

Since it was known that the pulse probe experiment was to happen along the south side of the north field an estimation of where that line would be was surveyed. More attention was paid to this part of the field in respect to groups of trees. This was used to determine where the vibroseis sources could travel in the western part of the field. All this information was used in the planning of the pulse probe experiment.

Finally the proposed buried sensor line was surveyed for an elevation profile. This survey was carried out in one day. The points that were measured can be seen overlaid on a map in Figure 8.

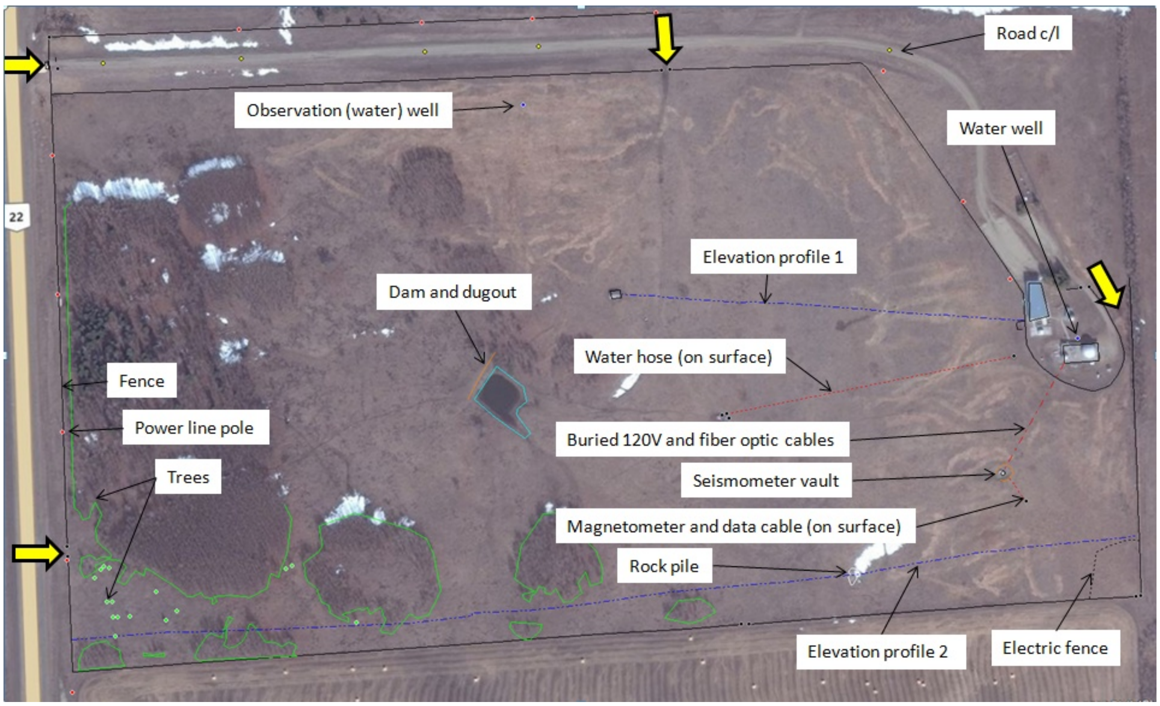

FIG. 8. The Priddis GPS results.

The GPS system functioned very well, and did outperform the old GPS in terms of maintaining a fixed GPS location in vegetation and near buildings. However, it was discovered that the battery life of one battery on the rover was about eight hours of constant use. The old GPS system had battery chargers built into the receiver units that allowed the batteries to be charged without removing them. The new system requires that the batteries be removed and placed in an external charger. Due to the water resistant battery ports they are difficult to remove, although this may get easier with continued usage.

PRIDDIS PULSE PROBE EXPERIMENT

The pulse probe experiment was carried out in July. Like the Hussar low frequency experiment of 2011 it involved several CREWES Sponsors. The original purpose of this experiment was to see if a vibe running a mono frequency sweep could affect the data recorded using another vibe running a more traditional linear sweep. A Mertz 22 was used for the mono frequency and the Envirovibe was used for the linear sweep. The two vibes are shown in Figure 9. The experiment grew from there to using several different receivers, including a string versus pods geophone string layout comparison, as well as a dynamite charge size test. This experiment took place over the course of one week.

FIG. 9. The Mertz 22 and the Envirovibe.

FIG. 10. The receiver line.

The first part of the job to take place was to chain two receiver lines two metres apart. Flags were laid out at two and ten metre spacing, making this a rather dense survey. The receivers were then planted at the flags. The flagging and some of the receivers can be seen in Figure 10.

The first receiver line was a line of SM7 3C phones from flag 101 in the west to flag 493 in the east on the two metre line (Figure 11). Alongside this line are the Vectorseis receivers, again at every flag from 101 to 493 (Figure 12). At every fifth station 32CT receivers were planted in two variations. The first line was laid out in strings and the second was laid out in pods (Figure 13). The hope here was to record a good comparison between the two different layout techniques. Next to these same flags the Autoseis nodes were also planted (Figure 14). Another experiment regarding ground coupling involved 20DM 3C receivers sitting on top of the ground with sandbags on top of them (Figure 15). These were placed on every fifth flag from station 211 to 306. Finally a down hole 3C tool was place in the well. This well is on the opposite side of the field from the sources and the initial raw data looked weak. Figure 16 shows an overview of all the receivers laid out.

FIG. 11. SM7 3C Geophone.

FIG. 12. Vectorseis Receiver.

FIG. 13. A pod of 32CT receivers.

FIG. 14. An Autoseis nodal recorder.

FIG. 15. Laying a sandbag on top of a geophone.

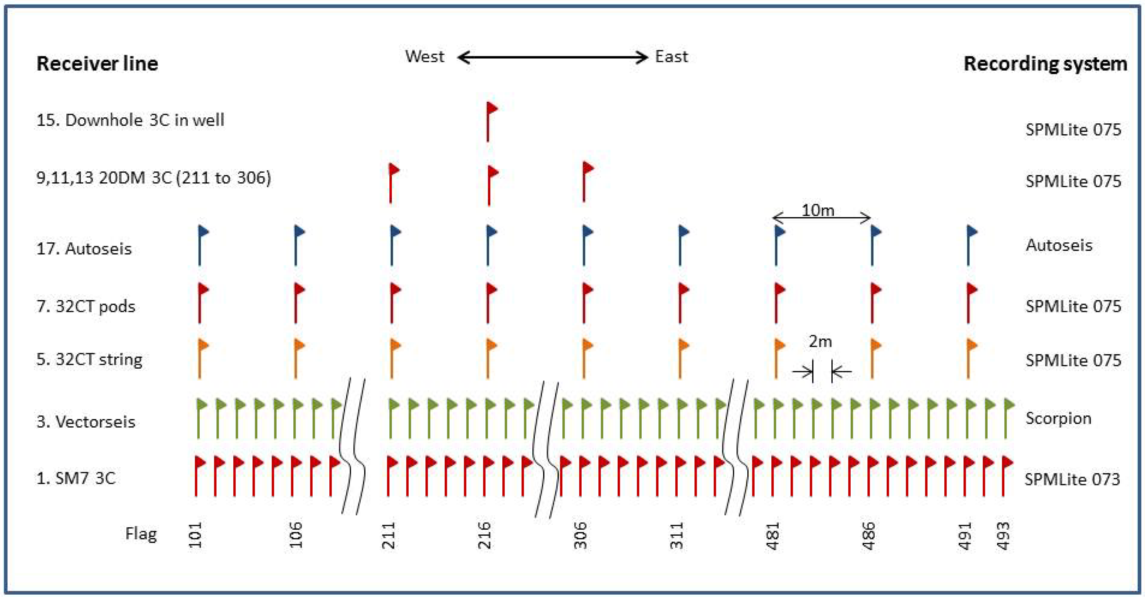

FIG. 16. An overview of how the receivers were laid out.

Because of the number of channels that were being recorded and the number of different receivers being used we had to setup extra recording systems. Like Hussar in 2011, Geokinetics supplied a Scorpion recorder and recorded using the Vectorseis receivers. They also started the source(s) from their recorder. An extra SPMLite recording system from Inova Rentals was installed in the CREWES recorder. A special source harness was used to trigger both the recording systems in the CREWES recorder and was actually modified by Inova technicians just days before the experiment to ensure that it was working properly.

One of the problems experienced at the Hussar experiment was timing confusion amongst the recording systems. It was found that the different systems had different times set up on the clocks and that shot times were file creation times and not shot starting times. This added an increased layer of difficulty when it came to comparing the different data sets. So for this experiment a GPS time recorder was integrated into the CREWES recording system. Figure 17 shows the Verif-i GPS synchroniser.

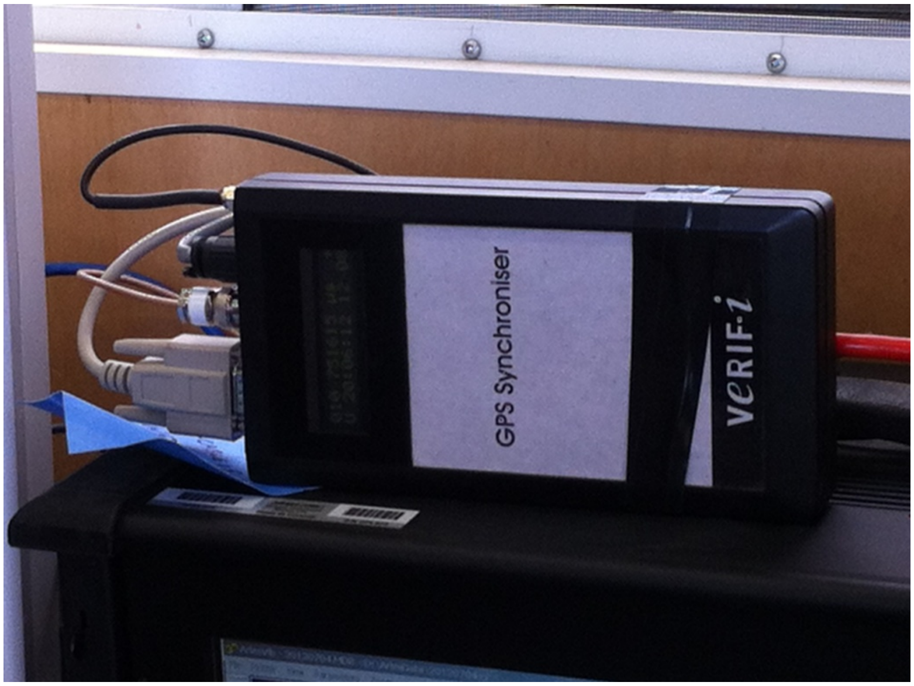

FIG. 17. The Verif-i GPS Synchroniser

Other challenges that came up included layout mix ups, vibe control problems, and time delays due to backing up large amounts of data over USB1 to external hard drives.

Layout and pickup of all the equipment was handled by Geokinetics and CREWES staff and students. Outsource handled all the permitting.

FIELD SCHOOL

For the past several years CREWES has aided the Geoscience Department at the University of Calgary to run its geophysical field school by providing equipment, people, and experience. This year the field school was based out of the Castle Mountain Ski resort south of Beaver Mines. The seismic section was held on Township Road 63/63A between highway 507 and Township Road 64B, just to the north of Beaver Mines. The line was a 1C-2D crooked line of just over six and a half kilometres. The line was located at the base of Rocky Mountains and the hope was to find dipping reflectors prominent enough to be seen in the raw data. The line ran primarily east/west however turned to the north at the eastern end.

Geophone spacing was ten metres and shots were taken at every station, except near the end of the survey when time constraints resulted in every second station being shot, with some infill at the eastern end.

Data quality was mostly good, however, the wind on some days did have negative effects on the data. Just as important as the data is the experience for the student's. Working with commercial grade acquisition equipment and trying to manage a crew gives them a glimpse into the level of organization required to acquire data. Figure 18 shows students operating the recorder. Field school also allows them to see how real world obstacles affect data and some of the limitations in seismic surveys.

FIG. 18. Students operating the Aries seismic recording software

A re-occurring problem at this field school was mechanical and electrical problems with the vibe. The first challenge was the fact that the Vibpro had held onto the bit of code from the pulse probe experiment causing a two second delay before the start of the sweep. At the same time radio failure made it difficult to troubleshoot. Once that was sorted the vibe started to have mechanical failures. The high pressure accumulator started leaking. The problem was tracked to a blown o-ring and it was replaced. It began to leak a second time and was replaced again. At this point another o-ring was replaced while it was apart and the replacement ended up being the wrong size. The most dramatic moment occurred when the accumulator actual blew off the vibe and ended up on top of the engine compartment. The problems continued even after the vibe had been taken back to Calgary to be repaired. CGGVeritas donated spare parts and a vibe mechanic for several hours to carry out the repair. Although it still leaked, it was functional for most days and the entire line was shot out. Since field school the vibe has had a new and improved accumulator system installed. The old troublesome accumulator can be seen in Figure 19.

FIG. 19. The faulty accumulator.

CREWES also brought the differential GPS to field school so the students could use it to survey x, y and z co-ordinates for the SEGP-1 file. It was found that the internal batteries on the base station do not last for a full day's work without having the external battery connected. The external radio was used for more than just a test for the first time as well. This allowed unintentional testing to see how the external radio antenna and tripod handles windy environments. It fell over.

The Geode system was also used to do a hammer and plate refraction survey by the Castle Mountain Ski Resort.

PRIDDIS REFRACTION SURVEY

In September an opportunity to perform a refraction survey alongside a resistivity survey performed by Larry Bentley's research group presented itself. This survey would provide information about the subsurface where a new permanently installed seismic recording system might be installed. Dr Bentley's group also wanted to do an independent refraction survey using the Geode system with a hammer and plate source as well as the refraction survey using the Envirovibe and Aries recording system. This refraction survey only took one day to lay out, shoot and pick up. The resistivity survey took a couple of days to complete. The receiver spacing was five metres and the source spacing was ten metres.

Although this data is fairly new some processing has been done. There is a near surface velocity model done by Helen Isaac which can be seen in Figure 20.

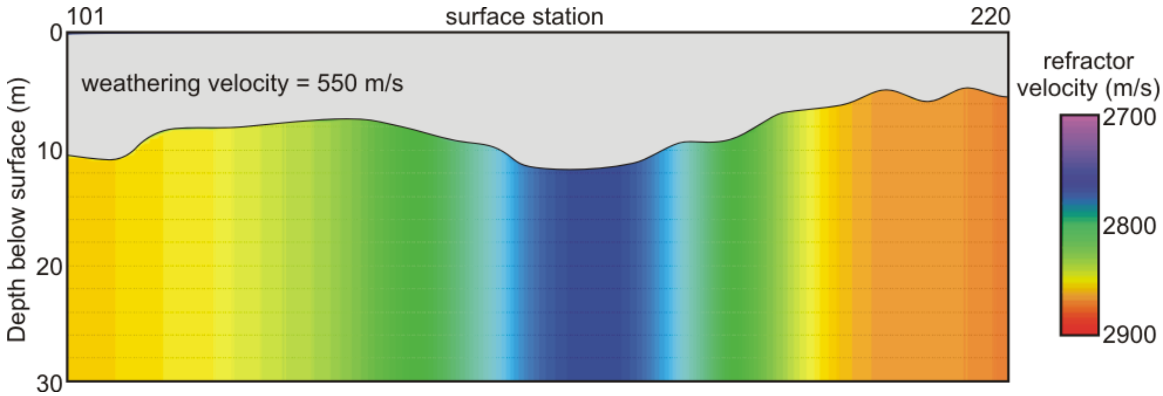

FIG. 20. The near surface velocity model done by Helen Isaac

CONCLUSIONS

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

The pulse probe experiment proved to be more challenging than standard seismic surveys as it added a second source in a way which it is not typically used.

The field school experience is one which not only educates students on the realities of seismic acquisition, but also provides good workable data. Further processing of this data has not yet been done. Because of the quality of the data and the general interest in the region, there are plans to return to the area next year, possibly to do a small 3D survey.

The refraction survey yielded surprisingly good results. This opens up the possibility of performing more refraction surveys with this equipment in the future to build on this experience.

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- Helen Isaac for the velocity model of the refraction data
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