CREWES in the field 2016, a brief overview

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ABSTRACT

CREWES has the distinction of being one of the very few research consortiums that has year round access to industry acquisition equipment. This allows acquisition research to be carried out by CREWES as well as giving students the opportunity to witness in field data acquisition. This benefits the students greatly in that it shows them what is possible as well as some of the limitations of data gathering.

Acquisition projects that CREWES has been a part of in 2016 include: a) two collaborative seismic projects in New Zealand; b) a seismic acquisition test at the Priddis Test Site using both downhole 3C receivers and two different types of surface 3C receivers; c) the 2016 undergraduate field school which performed a 1C 2D line near Pincher Creek, Alberta; d) a return to Priddis to use a shear wave source to record a 3C 2D surface line and downhole 3C.

INTRODUCTION

The first project was carried out in January and February of 2016. This involved shipping the Aries recording system and IVI Envirovibe seismic source to New Zealand (Hall et al., 2016). The first survey area was on the South Island in the Whataroa Valley. This survey consisted of a VSP as well as several surface surveys. Another survey was then done on the North Island in the Hauraki Rift and was a 1C 2D line.

The second project was an equipment test acquisition in June that was done in collaboration with Inova Geophysical. The main focus of this test was to determine what kind of difficulty would be encountered trying to run several acquisition systems at once. It was also used as an opportunity for Inova to test a new version of their nodal system software and firmware. Testing of a new s-wave thumper wireless controller was also carried out. A 3C surface spread using both cabled and nodal systems was used for recording as well as 3C downhole geophones.

The third project was the GOPH549 undergraduate field school in August. The survey was designed to expose students to seismic acquisition and quick raw data analysis. Geophone and shot spacing was 10 metres. The Envirovibe was used exclusively as the source.

The final project of the year was a return to the Priddis Test Site for a single day in October using a single line of 3C geophones as well as the downhole 3C geophones. This survey only used the s-wave thumper as the source.

EQUIPMENT

CREWES has access to industry standard survey equipment. This allows for testing of equipment and methods both new and old.

The "go to" gear that is used most often is an Aries cabled system built by Aram (now Inova Geophysical), Figure 1. The system is capable of recording both 1C and 3C analogue receivers in 2D and 3D configuration. The system consists of a Seismic Processing Module Lite (SPML) computer connected through cables to Remote Acquisition Modules (RAMs). Typically the RAMs are able to record eight sensors worth of data and transfer that back to the SPML. New this year twenty four channel RAMs have been acquired which allows for simple recording of 3C geophones. The previous method for doing this required three times as many eight channel RAMs connected to special cables.

FIG. 1a. An Aries eight channel RAM with battery and dirt.

FIG. 1b. An Aries twenty four channel RAM with battery and stick.

Although the Aries system is still used around the world today it is aging technology. The industry is trending towards nodal systems now. CREWES has access to 1500 channels of an Inova Geophysical Hawk nodal system, Figure 2. This is currently set up to run 500 nodes of 3C geophones. The Hawk system requires accurate GPS timing of the source to properly record and correlate source driven acquisition. It also has the ability to perform passive monitoring.

FIG. 2. Hawk node, each one connects to a battery and three analogue or digital channels.

A smaller portable cabled system is used for surveys in remote areas as well as refraction surveys with much smaller receiver spacing. This system is the Geometrics Geode system. This system consists of Geode boxes that record twenty four channels worth of data per box. This data is then transmitted to a laptop for recording, Figure 3.

FIG. 3. The Geometrics Geode system being used with a laptop and a hammer and plate source.

For recording accurate survey location a differential GPS system is used, Figure 4. This gives greater accuracy than standard GPS by using a base station at a known location to transmit corrections based on the GPS data compared to its location. These corrections are received by a rover unit that then applies the correction to the data it is receiving from the

GPS satellites. This set up assumes that both the base station and the rover are calculating their positions from the same satellites and that the error is consistent between the two.

FIG. 4. The rover half of the GPS with the data collector.

Typically when recording with either the Aries or Hawk is carried out accurate GPS timing for each shot is recorded using a Verif-I GPS Synchronizer unit. This unit outputs the GPS time when it detects the trigger of a seismic source. This has found to be very useful when using multiple recording systems at the same time as the system clocks more often than not aren't synced up or even set to be in the same time zone.

On the other side of recording are the sources. The source that is most often used by CREWES is an IVI Envirovibe, Figure 5. This is a vibrator source mounted to a tractor like vehicle. It is considered to be a small source by industry standards, but this has the advantage of being low impact and capable of getting into places that larger sources can't. It has even been used within city limits.

FIG. 5. The IVI Envirovibe.

The second most used source is a simple hammer and plate. Typically this is used with the Geode system for small refraction surveys.

The other source that is used is a small thumper. This thumper was built recently and works on a nitrogen spring system. This means that a mass is lifted against pressurized nitrogen and released. The nitrogen forced it back down to hit a foot which transfers the energy into the ground. This thumper also has the ability to tilt its mast forty five degrees in either direction to act as an s-wave source, Figure 6.

FIG. 6. The accelerated weight drop trailer tilted for an s-wave shot.

SAFETY

Safety is the first priority in field work. Data collection comes second. Safety is addressed through training and having a set of rules in place. Everybody in the field is required to have the correct PPE. Every day in the field starts with a safety briefing, Figure 7. Before leaving for the field a hazard assessment and emergency response plan is created.

FIG. 7. Every day spent in the field begins with a safety tail gate meeting.

To this day, CREWES has not had an incident requiring the need to seek medical assistance.

NZ SURVEY

CREWES returned to New Zealand at the beginning of 2016 to participate in two collaborative surveys (Hall et. al., 2016). CREWES supplied a cabled Aries 1C acquisition system as well as the IVI Evirovibe source.

The first survey took place on the South Island in the Whataroa Valley. The main purpose of this survey was to try and provide some better imaging of the Alpine Fault. There were both surface receivers and downhole receivers for VSP surveys.

The second survey took place a on the North Island in the Hauraki Rift. This survey consisted only of a 1C 2D surface line. The survey line was set up over the Kerepehi fault. This fault has been detected using gravity data, and this survey was to determine how well faults could be surveyed using an Envirovibe source.

Before any of the equipment could be shipped off to New Zealand all the gear had to first be cleaned in order to prevent the transmission of invasive plant species. Unlike the 2011 New Zealand survey, the equipment was shipped down by boat and not flown. As such the packing of the gear had to take place late in 2015.

The surveys took place with many interested parties taking part, included students from local universities. For the South Island survey the recording system was set up in a cargo container, Figure 8. For the North Island survey, since a rolling line would need to be used, the recording system was set up in a Toyota van, Figure 9.

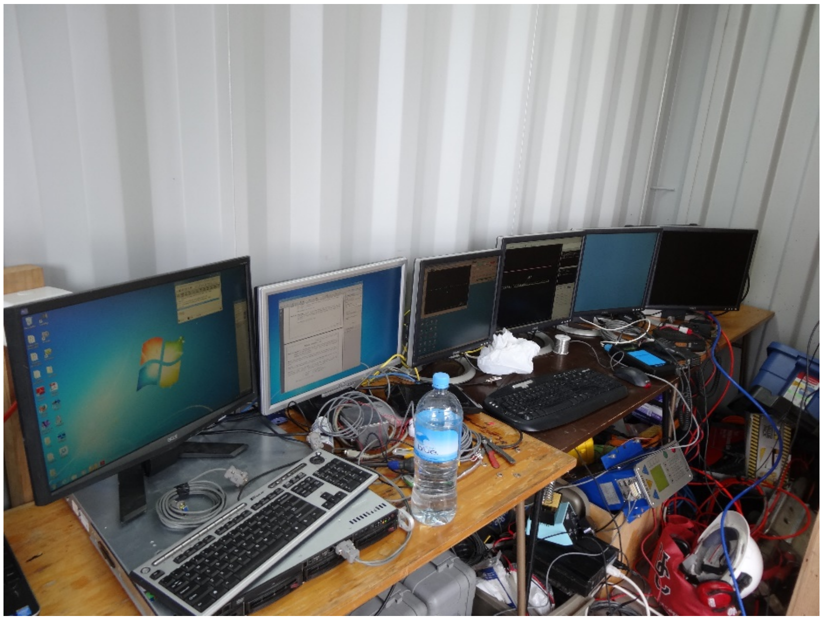

FIG. 8. The Aries recording system set up in a cargo container.

FIG. 9a. A more mobile setup for the recorder on the North Island.

FIG. 9b. The receiver line being laid out on the North Island.

Once the surveys were completed the gear was once again cleaned and packed for it three month journey back to Canada on a cargo ship.

PRIDDIS

In April of 2016 an experiment using the shear wave thumper as a source was discussed. The goal was to use the shear wave source with both surface and downhole 3C receivers, specifically the new Hawk nodal system. Around this time Inova Geophysical approached CREWES to discuss the viability of testing new firmware/software for the Hawk nodal system. After meeting with Inova, it was decided that CREWES would provide the equipment for recording two lines of cabled receivers and the downhole receivers and Inova would provide the nodes (Bertram et. al. 2016).

CREWES students were invited to participate in this experiment so they could gain an understanding of what kind of equipment CREWES has access to. They also provide an excellent source of labour for layout, pickup and troubleshooting, Figure 10.

FIG. 10. CREWES staff and students laying out the 3C geophones.

Another main interest in this survey was to determine the viability of CREWES being able to record a survey using both the Aries cabled system and the Hawk nodal system at the same time.

And finally, CREWES wanted to test the shear wave thumper using the new wireless thumper controller (Bertram, 2016), Figure 11.

FIG. 11. The proof of concept prototype thumper controller.

The survey worked well for the surface 3C cabled system and the Hawk nodal system. Unfortunately the downhole system had trigger problems causing time zero to be inconsistent and often late. The entire survey was completed using the IVI Envirovibe as a source. The thumper was then sent to reshoot the source points, but unfortunately a mechanical failure that could not be repaired in the field cut the survey short.

FIELD SCHOOL

CREWES has been aiding the University of Calgary's Geoscience department with their Geophysics 549 undergraduate course for many years now. For many students this is the first opportunity they get to experience the methods of actual data acquisition. CREWES provides knowledgeable staff to aid in the use and maintenance of the equipment as well as providing a wealth of in field experience. Field school is typically broken up into two main sections, one being seismic methods and the other being non seismic methods. CREWES primarily aids with the seismic methods section.

Preparation for field school begins months ahead of the scheduled course date. A suitable location needs to be determined and then permitting for the work to be done needs to be taken care of. Permitting this year was handled by Outsource Seismic. As part of the permitting process the location needs to be scouted and local residence notified by leaflet drop. CREWES assisted on this trip.

This year the non-seismic portion took place at the Castle Mountain Ski Resort and the seismic portion took place alongside Township Road 60, Figure 12. The receivers were placed on the South side of the road and the Vibe shot on either side depending on conditions. Both source and receiver spacing was ten metres. The active patch was 2 kilometres either side of the source and students were introduced to the concept of a rolling spread.

FIG. 12. The vibe on the South side of Township Road 60.

As the start date of the course approaches the equipment that is to be used needs to be check over and loaded for transport. Albert One Call is also notified two weeks ahead of time to ensure that no damage to buried services would occur.

Both members of CREWES and teaching assistants travelled to the location of the seismic acquisition survey the day prior to any students arriving and started placing marker flags for receiver and shot point locations. A few hundred metres of receivers are then laid out so that the students that are attending the course will have something to record with on their first day.

The seismic survey uses the Aries cabled system for recording with the IVI Envirovibe as a source. The differential GPS is also used to provide accurate location data for all sources and receivers. With the exception of the Envirovibe the students are trained in the first part of the day how to use the equipment and are then perform the survey themselves.

Beyond just acquiring data the students are asked to do some light interpretation of raw records, Figure 13. They were asked to determine first break velocities and identify ground roll and air blast. At this location there were some good reflectors seen on the records and students were asked to estimate their depths.

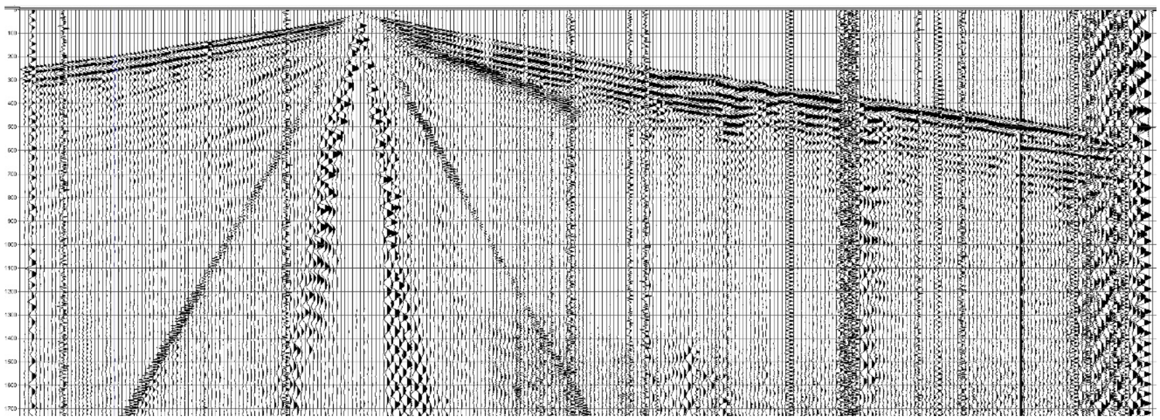

FIG. 13. A single shot point acquired along Township Road 60.

The geology of the area is interesting and works well as a teaching location. There is a significant dipping structure that come to the surface on the spread. Because of this velocities of the first breaks on the records are different either side of the source.

RETURN TO PRIDDIS

After the June Priddis field experiment there was significant interest in using the shear wave thumper with the downhole geophones. After the thumper was fixed it was decided to return in October to perform a quick one day survey with just the thumper, the downhole geophones and a single 3C line of surface receivers to the North of the well (Lawton et. al., 2016).

Unfortunately for this survey the new control system had been taken apart for upgrading and was not available so the original thumper controls were used. The survey was laid out, shot and picked up in a day, Figure 14.

FIG. 14. Laying out the cable with the recorder in the distance.

Shot and receiver spacing on the surface was five metres. Each shot consisted of two thumps with the mast in each orientation. The acquisition was concluded with two thumps towards the well and two thumps away from the well at shot point 112, Figure 15.

FIG. 15. Calling it done, the thumper can be seen behind the truck. The front of the truck is facing east so the thumper can be tilted North and South. For reference this picture was taken from the approximate well location.

CONCLUSIONS

The data from all field project is available to sponsors upon request.

Further work at the Priddis Test Site will be conducted. This site works very well as an equipment proving ground. Its proximity to Calgary makes it easily accessible and convenient.

The University of Calgary's Geophysics Field School is recognized by the industry as one of the best field schools. The ability to demonstrate real world seismic acquisition to the geophysicists of tomorrow is incredibly valuable.

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