A brief overview of CREWES field work in 2020

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ABSTRACT

CREWES tries to get as much real world data from field work as possible. This year is obviously different with the current pandemic restricting travel and keeping people at home. The number of times that CREWES made it to the field has been greatly diminished. CREWES has been involved in only two surveys for a total of three days in the field so far.

The first survey was carried out to provide data for Dr. Rachel Lauer's student Tom Wilson.

The second survey was a repeat of walk away VSP at the CaMI FRS.

INTRODUCTION

The ability to perform real world data acquisition is one of the unique advantages that CREWES has. Every year researchers look forward to leaving the office and spending time outdoors. With the current pandemic causing chaos throughout the world field work has had to be scaled back significantly. New guidelines for working in the field have also had to be put in place.

The first survey was conducted for Tom's research into the Sulphur Mountain fault zone. This survey was led by Tom and involved a mixture of academics, students, and CREWES researchers.

The last field work carried out prior to the CREWES Sponsor's Meeting was a repeat of the walk away VSP using source locations permanently flagged last year.

EQUIPMENT

Although both surveys were very different in their research goals they mostly used the same equipment. All equipment belongs to and is maintained by the Seismic Group at the University of Calgary, Figure 1.

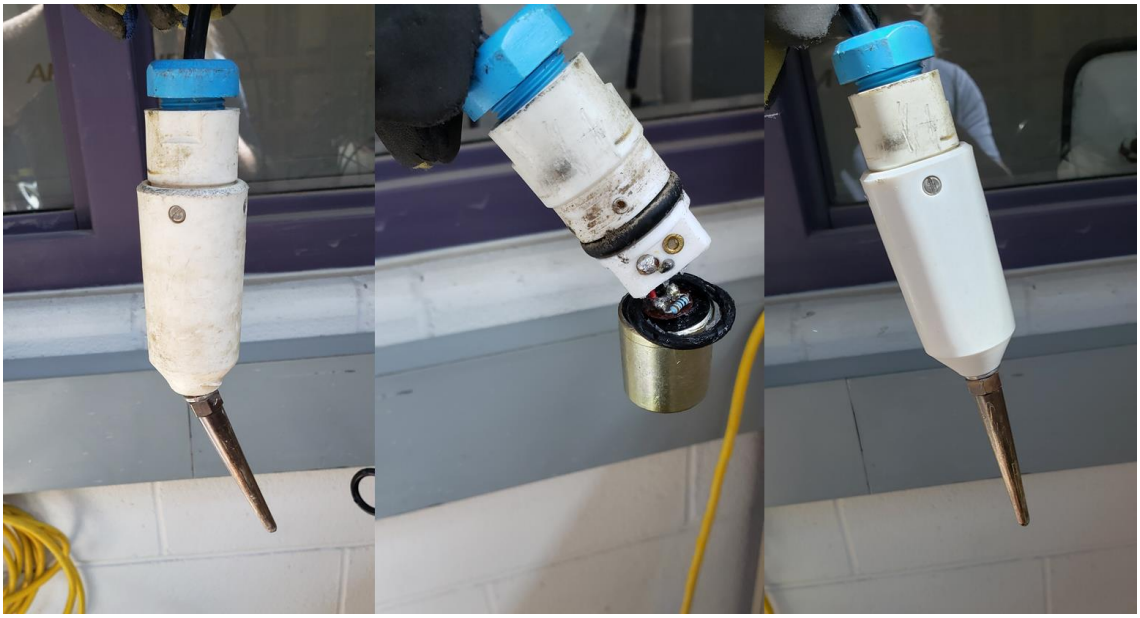


FIG. 1. A geophone before, during, and after repair.

For a source the IVI Envirovibe was used, Figure 2. This is the most famous piece of equipment that CREWES uses in the field. It has appeared on several research posters and picture online since it was acquired. Being a smaller vibroseis unit is can be used in areas that the larger ones can't. It has a very low environmental impact as well.

FIG. 2. The IVI Envirovibe at CaMI FRS in 2019.

For data collection the Aram Aries system was used. This is a cabled system that uses Remote Acquisition Modules (RAMs) that record, digitize, and transmit data from connected geophones. The RAMs are connected to a special computer housed in a truck equipped with a generator, Figure 3. The Aries system works with a Pelton VibPro II to control the sweeps and timing used by the Envirovibe.

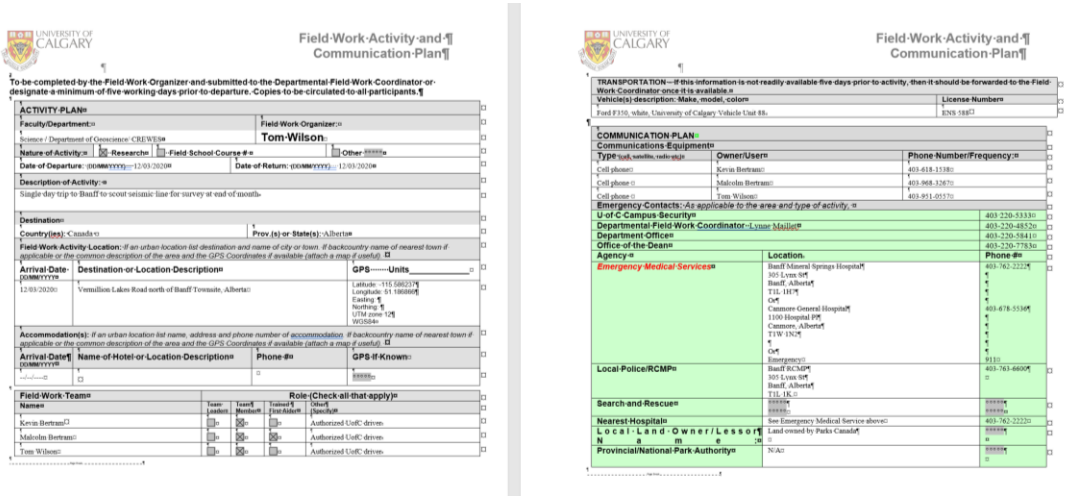
FIG. 3. The Seismic Group recorder truck.

The geophones used are 1C SM24 10Hz units.

NEW SAFETY PROTOCALS

Being safe while in the field is the highest priority. There are several hazards that are present in any field work, and each one must be addressed to ensure that there are no injuries or damage to equipment.

Field work starts with a plan well ahead of time the work takes place. Worked into the planning are the locations of the nearest emergency services if they need to be accessed. This information goes into the Emergency Response Plan. This form also details where the field work is taking place both with GPS location and address where possible. Should emergency services, or even non-emergency services, be needed this form will give the individual(s) calling for aid the location to request the services to. The ERP also lists all the people present on the day of the work and what vehicles will be in the field, Figure 4.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Field Work Activity and Communication Plan

To be completed by the Field Work Organizer and submitted to the Departmental Field Work Coordinator or designate a minimum of five working days prior to departure. Copies to be circulated to all participants.

ACTIVITY PLAN

Faculty/Department: Science / Department of Geoscience CREWES

Field Work Organizer: Tom Wilson

Nature of Activity: Research Field School Course # Other

Date of Departure: 12/03/2020

Date of Return: 12/03/2020

Description of Activity: Single day trip to Banff to scout seismic line for survey st end of month.

Destination

Country(ies): Canada

Prov.(s) or State(s): Alberta

Field Work Activity Location: If an urban location list destination and name of city or town. If backcountry name of nearest town if applicable or the common description of the area and the GPS Coordinates if available (attach a map if useful).

Arrival Date	Destination or Location Description	GPS Units
12/03/2020	Vermillion Lakes Road north of Banff Townsite, Alberta	Latitude: 51.186860 Longitude: -115.586217 Easting: Northing: UTM zone: 12 WGS84

Accommodation(s): If an urban location list name, address and phone number of accommodation. If backcountry name of nearest town if applicable or the common description of the area and the GPS Coordinates if available (attach a map if useful).

Arrival Date	Name of Hotel or Location Description	Phone #	GPS if Known

Field Work Team					Role (Check all that apply)	
Name	Team Leader	Team Member	Trained First Aider	Other Specify		
Kevin Bertram					Authorized UofC driver.	
Malcolm Bertram					Authorized UofC driver.	
Tom Wilson					Authorized UofC driver.	

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Field Work Activity and Communication Plan

TRANSPORTATION -- if this information is not readily available five days prior to activity, then it should be forwarded to the Field Work Coordinator once it is available.

Vehicle(s) description: Make, model, color	License Number
Ford F350, white, University of Calgary Vehicle Unit 88.	RNS 588

COMMUNICATION PLAN

Communications Equipment

Type (cell, satellite, radio, etc.)	Owner/User	Phone Number/Frequency:
Cell phone	Kevin Bertram	403-618-1538
Cell phone	Malcolm Bertram	403-968-3267
Cell phone	Tom Wilson	403-951-0557

Emergency Contacts: As applicable to the area and type of activity.

U of C Campus Security		403-220-5333
Departmental Field Work Coordinator - Lynne Maillet		403-220-4852
Department Office		403-220-5841
Office of the Dean		403-220-7783
Agency	Location	Phone #
Emergency Medical Services	Banff Mineral Springs Hospital 305 Lynx St Banff, Alberta T1L 1H7 Or Canmore General Hospital 1100 Hospital Pl Canmore, Alberta T1W 1N2 Or Emergency	403-762-2222 403-678-5536 911
Local Police/RCMP	Banff RCMP 305 Lynx St Banff, Alberta T1L 1K	403-763-6600
Search and Rescue		
Nearest Hospital	See Emergency Medical Service above	403-762-2222
Local Land Owner/Lessor Name	Land owned by Parks Canada	
Provincial/National Park Authority	N/A	

FIG. 4. The standard emergency response plan form.

All the known hazards that are present in the field work location are listed on the Hazard Assessment form. This is the form that is used at the safety briefing every morning before work can commence. Hazards include environmental dangers such as sun burn or frostbite, wildlife in the area, and specific equipment used in the research, Figure 5.

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Field Activity Risk Assessment and Control

Faculty : Science — Department: Geoscience

Field Activity: Scouting trip for future work — Date Prepared: March 11, 2020

Site Name: Test site near Brooks

Potential Hazard	Controls	Assessment of Risk			
		H	M	L	NA
Natural Environment					
Temperature Extremes (Hot/Cold)	Clothing, sunscreen, water, hat, seek shelter if necessary.		X		
Uneven/Slippery Walking Surfaces	Correct footwear (hiking boots/steel toed boots, no running shoes). Use caution when walking. Do not walk backwards. Watch out for holes dug by wildlife		X		
Sharp Objects—rocks, vegetation	Field experience, suitable footwear, gloves		X		
Heights/Drop-offs (including high elevation)	Stay away from cliff edges, crevasses		X		
Falling Objects/Obstructions	Hardhats, maintain a safe distance from the base of cliffs		X		
Tight Spaces/Narrow Openings/Overhangs	Avoidance if possible, extreme caution if unavoidable.		X		
Darkness/Low Light	Ensure out of field before dark				X
Strong Sunlight (including sunburn)	Clothing, hats, sunscreen		X		
Foul Weather—wind, rain, snow, lightning, flash flood	Work ceases in these conditions				X
Fire Hazard	Fire extinguishers on all vehicles, do not park vehicles in tall grass, no smoking in the field. No lighting of fires outside of designated fire pits. No unattended fire in designated fire pits.		X		
Smoke/Dust/Fog	Evacuate if necessary. Be alert to those with asthma			X	
Toxic/Allergic Sources (vegetation, pollen)	Personal medication. Inform instructor if you have a condition which may result in an emergency in the field			X	
Animals—insects, reptiles, mammals, other	Clothing (no shorts/skirts, wear pants), boots, insect repellant, bear spray. Ensure food and other aromatic items are stored in bear lockers whenever not in use. No food or aromatic items anywhere but in designated food area. Ensure others are aware of any allergies (e.g. bee stings). ALWAYS work and travel in groups (no exceptions), make noise. Beware of snakes and insects in holes and shaded ares. Avoid any and all interaction with wildlife. Be respectful and wary of domesticated animals in area. Areas with fresh bear signs will be avoided and/or vacated. Participants are aware of the presence of Hantavirus in local areas, associated with Deer Mice. Certain insects expected in local areas are known to carry disease, including but not limited to West Nile virus (certain mosquitoes) and *Rickettsia rickettsii* (Rocky Mountain Spotted Fever) (ticks).		X		
Water/Current—streams, waves, tides, depth	When streams are crossed, the trip leader will first access the intensity of the flow and water depth and consult others if appropriate. Appropriate footwear will be worn while crossing streams and a pogo stick or hikingpole will be used. Any moving water deeper than the knee height of the shortest person present will not be crossed.			X	
Man-Made Environment					
Vehicular Traffic—roads, railroads	(Low volume traffic on range/tonship roads.) Warning signs in place. Wear safety vests. Drive carefully, obey traffic signs. Park vehicles in safe locations.			X	

FIG. 5. The first page of the standard hazard assessment form.

Personal protective equipment is also required in the field. The equipment varies based on the task at hand, but the bare minimum includes sturdy footwear, long pants, and safety vests. While working around/with equipment gloves and hard hats are added. If working with loud equipment hearing protection is required.

New for this year are guidelines to try and control the spread of the COVID-19 virus. These include wearing a mask that covers the mouth and nose while working or commuting with others. Limit of two people per vehicle who must sit as far away from each other as possible. The addition of having the ability to wash hands while in the field, Figure 6.

FIG. 6. A hand washing station in the field made from a water jug, bucket for the dirty water, and soap.

BANFF SEISMIC LINE

The research that Tom Wilson guided is an expansion of work he had previously done in the past. His interest focuses on the flow of hot fluids in the Sulphur Mountain Thrust fault zone in Banff National Park. The springs at the higher elevations have had flow stoppages in the past few years. The goal is to image the subsurface to predict future spring flow.

The plan for the seismic acquisition began at a very informal meeting in 2019. There was discussion of the resources belonging to the Seismic Group and how they weren't being used as often as they could be. Tom expressed interest in performing a survey that could image a kilometre below the surface. A plan started to form.

The area of interest is along Alberta Highway 1. In this stretch of highway there are outcroppings visible from the Sulphur Mountain Thrust. Being able to see this above ground gave a good indication of where the area of interest under the surface may be. Vermilion Lakes Road runs roughly parallel to Highway 1 and would allow an area to survey while not having to worry as much about high speed traffic, Figure 7. Tom contacted Banff National Park and acquired permission to perform the survey here. Although this sounds simple, there were a lot of hoops to jump through. A scouting trip was done to determine where it would be best to park equipment and layout the receiver line.

FIG. 7. The area of interest is shown with the aqua coloured line.

The survey was planned to take place in the later half of March. Unfortunately, this is when the university had to inform all the staff and students to remain home to try and prevent the spread of the virus. The field work was put on hold. At first for a few weeks, but it was soon learned that it would take longer.

The restrictions were lifted enough in the late summer to allow for field work and a plan was formed over an online meeting, Figure 8. The field work was rescheduled to begin on August 17th. The equipment was loaded on the vehicles the week before, Figure 9. Knowing that staying at a hotel was still out of the question long days of work were expected. Tom arranged for several students to come out and help with the survey. In fact, during the week that the equipment was being loaded Tom took some volunteers and chained the line. Flags were not permitted here so the ground was painted with survey paint instead.

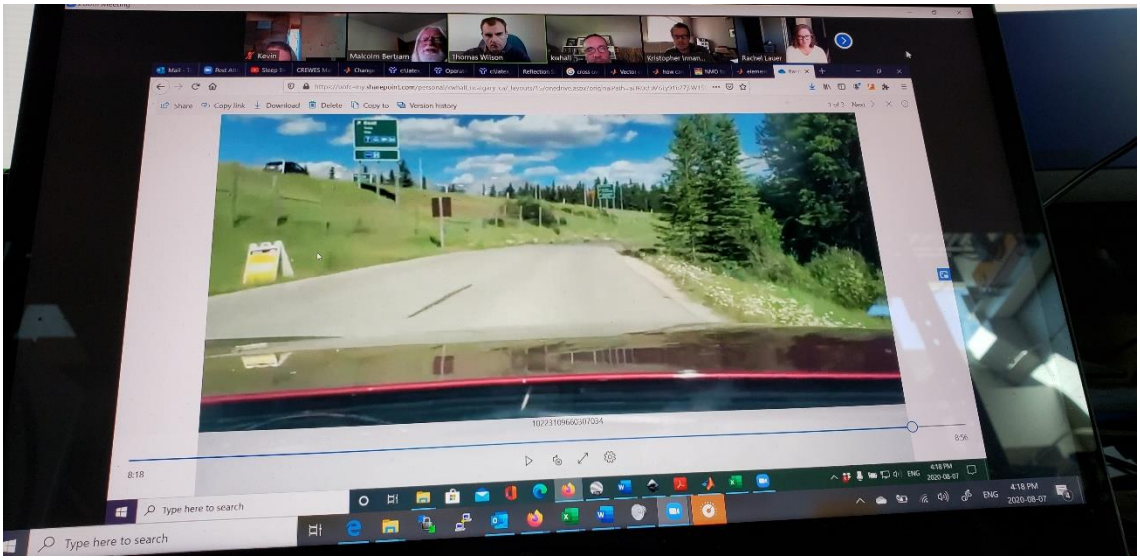

FIG. 8. Reviewing footage from a scouting trip to Banff National park over a zoom meeting.

FIG. 9. A line truck loaded with seismic gear ready to head to the field.

In total four kilometres of receivers at a ten-metre spacing were laid out on the north side of the road, Figure 10. After some testing a sweep profile of 10 to 100Hz over ten seconds with 0.2 second cosine tapers at either end was chosen. Four sweeps were stacked together at each energy source point. Data was collected until the late afternoon, Figure 11.

FIG. 10. Seismic receiver cables being laid out on the north side of Vermilion Lakes Road.

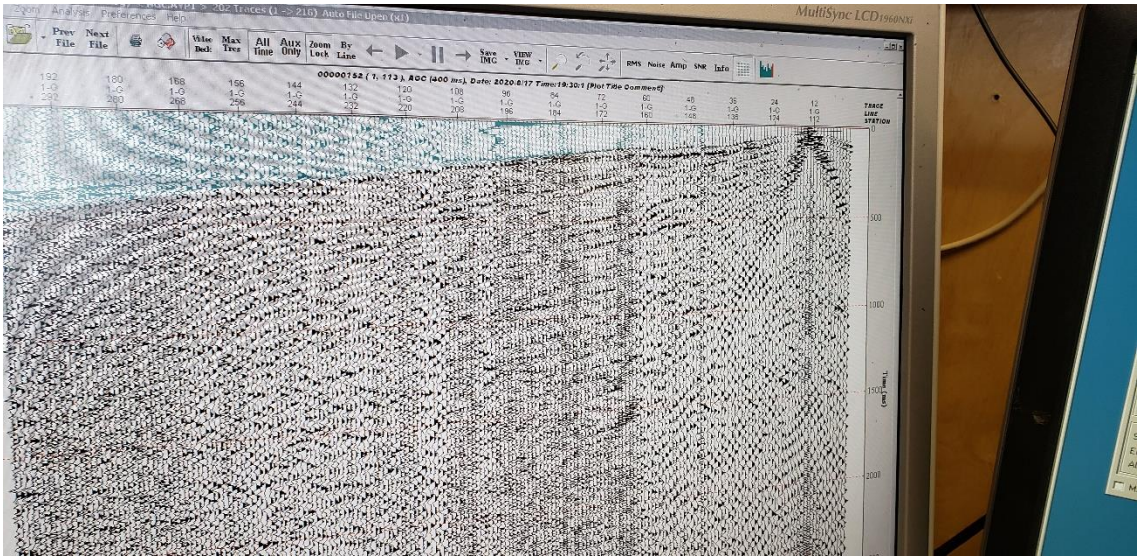

FIG. 11. Raw data collected by stacking two sweeps and correlating with the pilot trace.

One of the concerns that the employees of Banff National Park had was that wildlife could become tangled in the cabling that was laid out on the ground. To alleviate these concerns the cables were all picked up at the end of the day and loaded into the back of the line trucks. The geophones were left planted.

On Tuesday August 18th the cables were laid out an connected again. After troubleshooting the line data collection began again. To everyone's surprise the line was shot out by mid afternoon. All the seismic equipment was then picked up and brought back for maintenance and storage.

Having planned the whole week to perform the seismic survey Tom and some of the students/academics he had helping him returned the next day to carry out an 800 metre ERT survey.

CAMI FRS VSP

CaMI has been working with 3P Technology Corp to test a new seismic source. It is a high energy electrical discharge device.

The first challenge was to find a way to interface the source with the recording system to ensure that a correct impulse start time could repeatably be used to start the instruments recording. This was achieved by using a five-volt TTL signal from their source to trigger the Wireless Trigger Box. The Aries system already has an interface built for this using a Polaron source interface harness. Some custom circuitry was built to provide five-volt pulses to trigger the Verif-i and Geometrics Geode recording system that is connected to the permanently installed geophones in the geophysics well.

Once the circuitry was built the recorder was brought to 3P for testing. Parking the truck outside their workshop the source was set off inside at a low level. The Aries system and the Verif-i triggered each time they were supposed to.

With everything tested the plan was to go to the FRS the next week, Figure 12. Unfortunately, the source was damaged during testing over the weekend. There was still interest in repeating the walkaway/walkaround VSP that was carried out last year.

FIG. 12. The CaMI FRS is located southwest of Brooks Alberta.

Single component geophones were planted along the trench line using previously surveyed GPS location. Instead of staking the source points a decision was made to see if the Envirovibe could run a stake-less survey using only GPS. To achieve this a tablet with the needed GPS software was borrowed from Echo Seismic Ltd.

It was discovered shortly before the survey began that the points in the file for the sources along the trench were incorrect. The lower numbers were to the north instead of to the south where they should be, Figure 13. The best guess at this point is that the GPS locations for the permanently installed electrodes for the ERT system were loaded. For the shot points along the trench the geophones were used for reference instead. A 10 to 150Hz over sixteen second sweep with 0.2 second cosine tapers was used for this survey. Each source point had two sweeps stacked. Both the Aries (for surface receivers) and the Geodes (for downhole receivers) were used to record data.

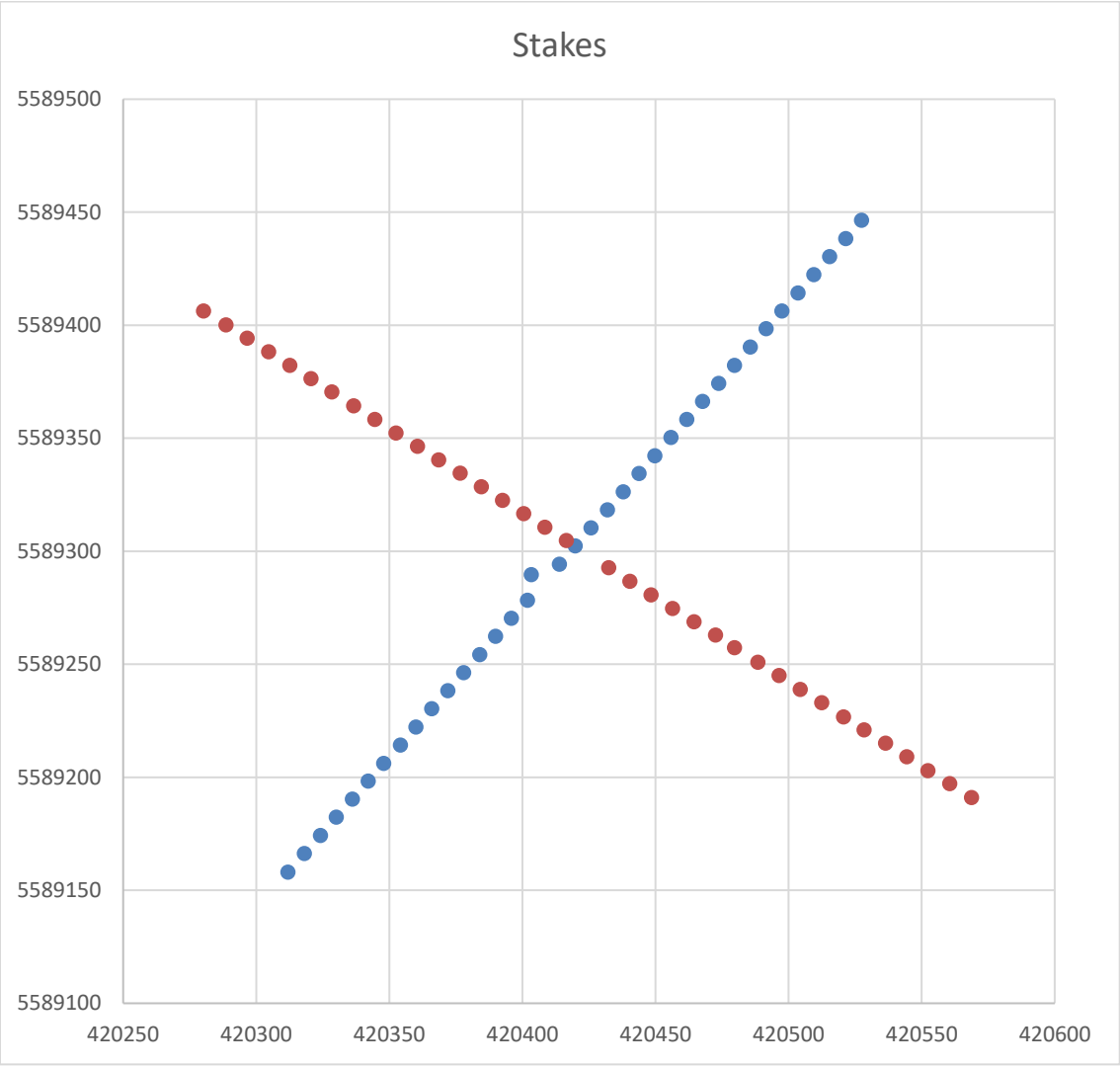

FIG. 12. The layout of the permanently marked walk away VSP source locations.

Fortunately, the line perpendicular to the trench line did have the correct points in it, so this was used. There were plans to perform the walk around survey points as well, however

the sun had already set before the walk away shots were complete, so the walk around was not done.

The walk around source points were remnants from the "snowflake" survey of (Hall et. al. 2018). The walk around points are two points each on twelve lines. Since this would be a bit of a nightmare to keep straight from acquisition to processing this line was renumbered as line 41 with twenty-four point starting at the northern most point and counting up in the clockwise direction, Figure 14.

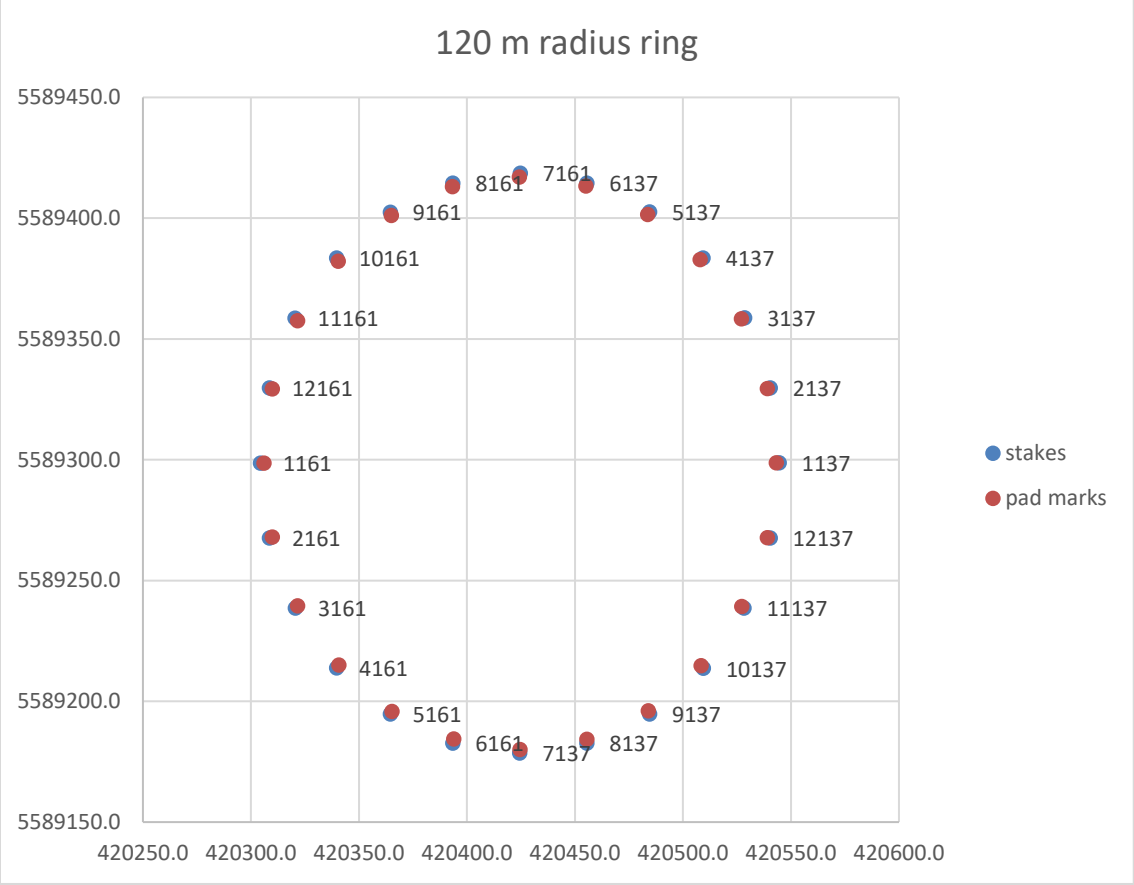

FIG. 14. The old numbering system for the walk around VSP survey.

FUTURE WORK

Shortly after the CREWES Sponsors' Meeting there is a planned return to the FRS. 3P Technology Corp. has the new source up and running again. The testing of this source at FRS is scheduled to take place the week after the Sponsors' Meeting.

There is also discussion regarding running another survey to increase the amount of data to an experiment carried out in 2019 (Innanen et. al. 2019). This experiment involved keeping the vibe in a single spot for a long time and running multitude sweeps while CO2 is being injected into ground to try and determine how the gas affects the seismic waveforms.

Beyond that there is uncertainty as to how many surveys can be run in the current situation. There is hope that a geophysics field school will take place next year. Nevertheless, CREWES will be out in the field acquiring geoscience data again.

ACKNOWLEDGEMENTS

This work would not be possible without the continued support of CREWES sponsors. This work was funded by CREWES industrial sponsors, NSERC (Natural Science and Engineering Research Council of Canada) through the grants CRDPJ 461179-13 and CRDPJ 543578-19. Partial funding also came from the Canada First Research Excellence Fund. The data were acquired at the Containment and Monitoring Institute Field Research Station in Newell County AB, which is part of Carbon Management Canada.

Special thanks to the students who aided in the layout and pickup of the seismic line in Banff National Park. The acquisition project would likely not have been completed without them.

Thanks to Echo Seismic Ltd. for the use of the GPS equipment which allowed the Envirovibe to run a stake-less survey.

REFERENCES

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