GUANACO PROJECT
Glacial **U**plift **A**fter **N**eoglaciation in the **A**ndean **Co**rdillera

High resolution seismic reflection data
APRIL 27-MAY 2, 2019

CRUISE REPORT

GUANACO
Glacial Uplift After Neoglaciation
in the Andean Cordillera

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CRUISE OBJECTIVES

The high-resolution seismic reflection survey is one of the components of a larger, multi-institutional, multi-year and multidisciplinary project that focused on providing first order observational constraints on glacial isostatic adjustment (GIA) around the rapidly shrinking Southern Patagonia Icefields (SPI), where the fastest uplift rates on the planet have been measured (Richter et al., 2014). This region offers a unique opportunity to understand how complex tectonics including a volcanic arc and a "slab window" may strongly influence GIA. The project integrated different datasets (including the data acquired during the cruise described in this report), with the ultimate goal of producing the latest generation of GIA models for Patagonia and to understand the processes driving orogenic uplift.

Within this context, the overarching goal of the seismic reflection survey was to quantify and correlate the significance of the rapidly melting Southern Patagonian Icefield (SPI) to the anomalously fast uplift rate of the Andes centered around the SPI by understanding the pre-glacial basement, glacial moraines, and post-glacial sedimentary deposits preserved in the proglacial environment of Lago Argentino along the eastern margin of the Southern Patagonia Icefield. The data have been used to calculate sediment accumulation and erosion rates for Neoglacial and Late-Glacial glaciers into the channels and main lake, therefore providing masses mobilized and transferred through time. The seismic survey was also used to guide the core site selection of the coring component of the GUANACO project, which acquired piston and gravity cores in the main lake and valleys. Crustal thickness and mantle viscosity would be estimated from broadband seismic data deployed around the Southern Patagonia Icefield.

Specifically, the high-resolution marine seismic reflection survey focused on mapping the submerged frontal position of the ice during the Neoglacial and Lateglacial stages as preserved in the lake stratigraphic record, and on determining sediment yields during the Neoglacial and Lateglacial advance and retreat cycles of glaciers in the valleys. In addition, the survey planned to image the characteristics of the proglacial sedimentary sequences in the glacial valleys and in the main body of the lake, to assess the relationship of glacial sediment production, glacier mass balance and history of advance/retreat.

SHIPBOARD PARTY

Science Party

M. Beatrice Magnani (SMU)	Chief Scientist
Anastasia Fedotova (SMU)	Scientist
Mason McPhail (SMU)	Scientist
Dana Peterson (Cornell Univ.)	Scientist
Jorge Lozano (Universidad de Buenos Aires)	Scientist
Donaldo Bran (Universidad de Buenos Aires)	Scientist
Cesar Distante (CONICET)	Scientist

CRUISE SUMMARY

The cruise acquired over 350 km of single-channel Compressed High Intensity Radar Pulse (Chirp) subbottom profiler data and 250 km of coincident multi-channel seismic reflection (MCS) data across Lago Argentino and its submerged glacial valleys (*Figure 1*). The MCS source, streamer, and Chirp system were towed from three separate towing points on the stern of the *M/V Leal*, a local commercial vessel (*Figure 2*). The 12 kHz Knudsen Chirp system consisted of a Deep-Water Chirp 3212 echosounder connected to a KEL571 transducer mounted on an inflatable pontoon (*Figure 3*). Data were acquired using water depth-dependent pulse lengths (4-64 ms) and ping rates (0.5-4 s), and a sampling rate of 0.03 ms. The MCS system utilized a 150J boomer source towed on a catamaran of buoys generating a broad-spectrum minimum phase pulse (*Figure 4, 5*). The MCS recording system was a 50 m-long, 24-channel analog solid streamer with three hydrophones per group and a 2 m group interval. The source fired at 4 s intervals, translating to a nominal shot interval of ~6 m at a towing speed of 3 knt, which varied depending on wind and surface current conditions. MCS data were digitized with a Geometrics Geode, sampled at 0.25 ms, and the geometry of acquisition resulted in a nominal fold between 3-5, depending on acquisition conditions. The survey was run using the SGOS by Geometrics.

Navigation: The exact position of the CHIRP and of the vessel was carefully monitored by three Garmin GPS units. One was attached to the pontoon that floated directly over the CHIRP transducer (*Figure 3*), the other two were mounted to a location on the upper deck of the M/V Leal to ensure sky view (*Figure 5*). The signal from these latter GPS units fed into a buffer box that strengthened the signal and was powered by a 12V battery. This signal was then sent to a field laptop where the Fugawi mapping software recorded the location, speed, course and time once every second to plot our course, and to the acquisition field laptop running the Geometrics SGOS. This meant our position was recorded once for just under every meter we traversed. This process generated Geode log files *(.log* file extension) and GPS log files (*Nav.txt* file extension), in addition to seismic trace data files *(.sgy* file extension).
The GPS from the CHIRP was also fed into a buffer box before connecting to the CHIRP acquisition laptop that recorded our position once per second. The CHIRP program extracted the latitude and longitude of the closest second for each ping and saved this information into each ping’s trace header.

The MCS system was capable of penetration sufficient to image the full extent of draping sediment packages, underlying glacial deposits, and tectonic basement structures down to a depth of ~1 km, while the single channel system acquired data to a depth of up to 40 m in soft sediment with ~0.1 m vertical resolution. The combination of both systems resulted in multi-resolution imaging of moraines, sediment packages, and deeper structures, allowing a comprehensive understanding of the pre-, syn- and post-glacial processes that have occurred in the area.

MCS Acquisition Parameters

Streamer: #channels/length	24 channels/50 m
Streamer group interval	2 m
Near trace source / receiver offset	10 to 20 m
Shot interval	6 m
Source Type	150 Joule Boomer
Source Depth	1 m
Streamer type	Geometrics MicroEel/analog/solid
Cable Depth	~3 m
Sample interval	0.5-0.125 ms
Record length	1-1.5 s
Stacking fold	3-5
CDP interval	3 m (nominal)
Recording System	SGOS by Geometrics
Processing System	Landmark SeisSpace
Navigation Type	Fugawi Marine Navigation

CHIRP Acquisition Parameters

Frequency Range	700 Hz – 12k Hz
Vertical Resolution	8-20 cm
Penetration (typical)	5 m (coarse sand) 40 m (clay)
Pulse interval	4-64 ms
Sample interval	0.03 ms
Ping rate	0.5-4 ms
Source depth	1 m

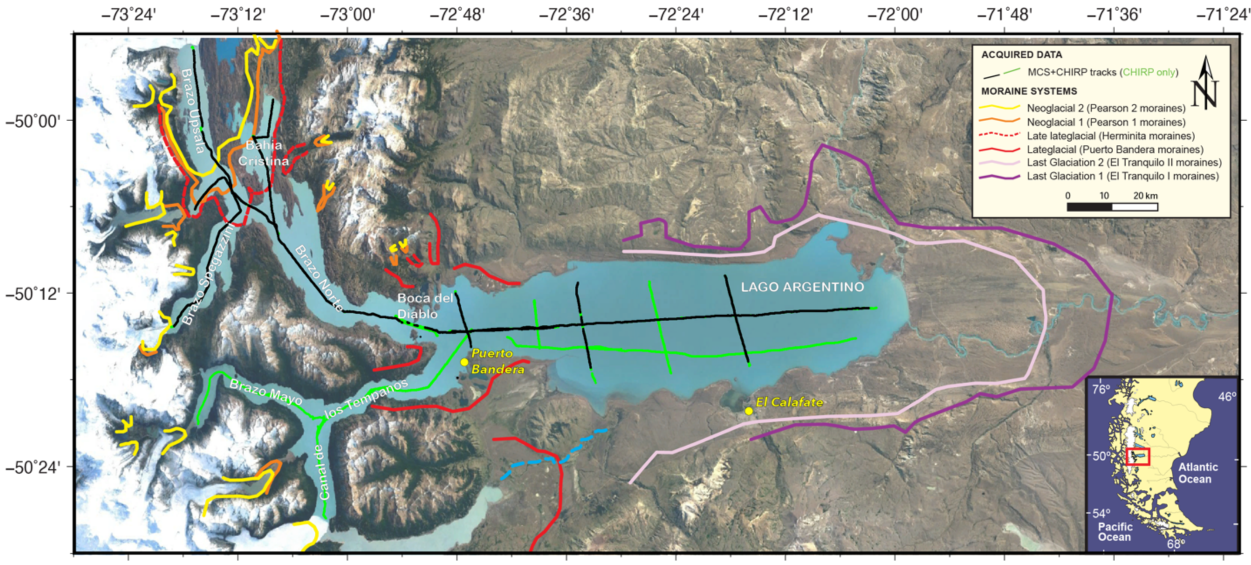

Figure 1 - Location map of the Lago Argentino showing the GUANACO high resolution seismic reflection survey (multichannel and CHIRP profiles) acquired in 2019 as part of the GUANACO project.

Figure 2 - M/V Leal on dry dock for State Inspection upon arrival of the science team in Puerto Bandera.

Figure 3- Assembled pontoon and pole mount CHIRP transducer. The pontoon was towed behind the M/V Leal and co-located with a GPS antenna.

Figure 4 - View of the seismic acquisition system from the stern of the M/V Leal. The boomer is mounted on a catamaran with buoys (to the left). The end of the streamer is marked by the red tail buoy. The pontoon tows the pole mount CHIRP transducer. Layout of the configuration are shown in Figure 5. In the background is Boca del Diablo, the entrance to the glacial valleys.

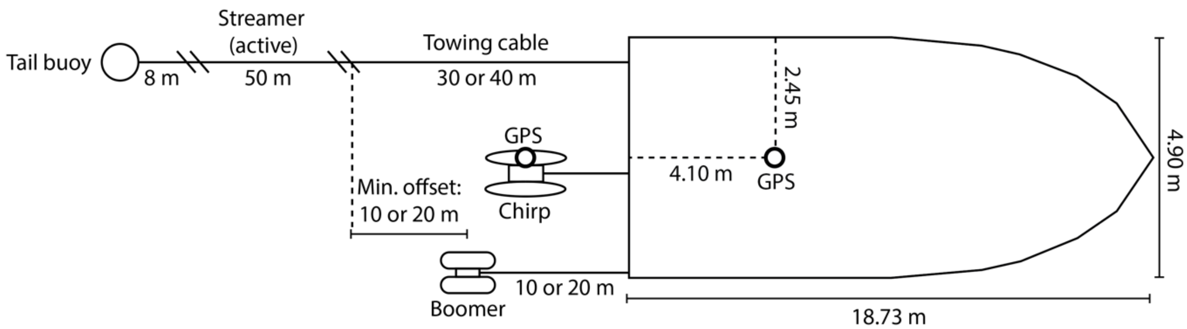

Figure 5. Geometry configuration and parameters of the M/V Leal during seismic acquisition. Three Garmin GPS units monitored the CHIRP and the vessel position throughout the survey (one mounted on the CHIRP pontoon, two mounted on the M/V Leal upper deck)

DAILY NARRATIVE

This narrative summarizes the events that took place during the marine seismic reflection research expedition across Lago Argentino and its auxiliary channels in Patagonia, Argentina between April 27-May 2, 2019.

April 28, 2019 (JD 118): A team of four scientists – Beatrice Magnani, PI, Southern Methodist University (SMU); Anastasia Fedotova, Ph.D. student, SMU; Mason Macphail, post-doc, SMU; and Dana Peterson, Ph.D. student (Cornell) – arrived in Buenos Aires to meet with Argentinian collaborators that evening.

April 29, 2019 (119): The team traveled to El Calafate to arrive at their housing accommodation by nightfall. The following day was spent to purchase tools, settle in and to visit the *M/V Leal*, which was undergoing state inspection process. By nightfall the seismic equipment arrived from Mendoza transported by Cesar Distante (CONICET), another member of the science team.

May 1, 2019 (JD 121): Major national holiday. We spent the day setting up the computers for codes and preparing the equipment (towing cables and umbilical, testing the functionality of the GPS and navigation software).

May 2-5, 2019 (JD 122-125): The equipment was transported to Puerto Bandera, where the *M/V Leal* was located. The days are spent setting up the equipment, ballasting the streamer and building the chirp pontoon, testing chirp and streamer signal, in addition to setting up processing flows on field laptops.

May 6, 2019 (JD 126): The *M/V Leal* has passed the state inspection and is now in the water. We meet with the captain and the crew and discuss the plan ahead. Further testing and setting up of the vessel by the crew, while we move the small equipment onboard.

May 7, 2019 (JD 127): We load the large equipment on the *M/V Leal*. Started compression sequence failed to start. The following three days are spent testing the compressor intended to supply air to the airgun that was originally planned to be used as the seismic source, and testing the chirp in the water. After three days of tests and troubleshooting it becomes clear that the vessel power phase and of the compressor power phase were incompatible and, options for procuring an external generator were explored. Beatrice contacts the group of Alejandro Tassone at the Universidad de Buenos Aires, who has field equipment for seismic reflection data acquisition, to rent a seismic source and arranges to rent from the group a boomer source. The GUANACO project will also support travel for two CONICET students (Jorge Lozano and Donaldo Bran) who will join us for the rest of the cruise. Their expected arrival is May 17. In the meantime we will start collecting CHIRP data. We proceed to collect six days of CHIRP data in areas containing pre-Neoglacial moraines that have been previously mapped on land by Strelin et al., (2014).

May 10, 2019 (JD 130): On the first day of acquisition, the group traveled along Canale de los Tempanos, deploying the CHIRP at the front of glacier Perito Moreno and acquiring the route back to port. Deployment and retrieval of the CHIRP pontoon from the stern of the *M/V Leal* are made much more efficient thanks to a pulley mechanism constructed by the crew members of the *M/V Leal*. We have problems connecting the GPS with the CHIRP software upon boot up, and after a half hour of tampering with the connections, we decide to proceed with data acquisition without loading GPS data directly onto the CHIRP headers. We are simultaneously recording tracks in Fugawi navigation software and combining it with the data after acquisition. The slowest speed the *M/V Leal* can move is ~3knts and we sail through the brazos at that speed. In Canale de Los Tempanos, the team imaged the water bottom at over 500 meters in depth, gentle shallowing of the water bottom moving north in the canal, and a steep drop off in bathymetry at the confluence with Brazo Mayo. Several short tests were acquired while en route and we lost the water bottom several times. Today is also the last day of Mason Macphail's participation in the experiment. We will lose his great expertise as he returns to the US tomorrow.

May 11, 2019 (JD 131): Today we transited to the glacial front in Brazo Mayo and acquired CHIRP data on the way back to port (Puerto Bandera). Acquisition was stopped when the line of the previous day was reached. The water was calm and it began snowing in the early afternoon. Shortly after the bend in Brazo Mayo, the team imaged what appeared to be a glacial moraine that hadn't been mapped on land! Unfortunately, as we are still learning to set the CHIRP acquisition parameters in these conditions, the moraine was only imaged by the CHIRP until the water bottom fell out of the user-defined search range, and therefore was only partially captured. We hoped to return to this location at a later date, time permitting, to reimage the moraine.

May 12, 2019 (JD 132): Today was forecasted to be very windy (>40 km/hr) in El Calafate and accordingly even windier in Puerto Bandera, so we decided to remain in El Calafate to process CHIRP data. The CHIRP SEGY files were written out exactly as they had appeared on screen during acquisition, which displayed a series of vertical shifts in the data as the water bottom shallowed or deepened to be outside of the viewing window. We will have to process the data post acquisition to arrange for the time shifts associated with changes in water depth. The team shuffled about El Calafate that afternoon.

May 13, 2019 (JD 133): Another very windy day, too windy to sail to the brazos. We worked on data processing and proceeded to process the CHIRP data time shift.

May 14, 2019 (JD 134): The weather finally allowed us to get out and acquire more data. The acquisition consisted of a west-east line across the southern portion of Lago Argentino with an overnight stay on an anchored *M/V Leal* behind a small island just north of El Calafate. The acquisition was a success for the most part, aside from losing the water bottom at the Puerto Bandera moraine.

May 15, 2019 (JD 135): we set out at 9:00 AM to transit to the far east end of the lake. We acquire CHIRP data westward until we reach the unfinished line from the previous day. Afterwards, the we transit back to the beginning of the unimaged Puerto Bandera moraine from the previous day, and successfully recaptured 5 km of data including the flanks and peak of the moraine. The CHIRP parameters and software are now set and data are streaming in beautifully! We transit to the north end of a planned north-south line in the western portion of the lake. The acquisition of this line starts with some difficulty finding the bottom. When the signal is locked, we observe a series of sharp diffractions superimposed on gradual undulations in the bathymetry.

May 16, 2019 (JD 136): The seismic equipment we rented from UBA is expected to arrive in the evening. Today we return to Brazo Mayo to reimage the Herminita moraine while acquiring a portion of uncovered glacial valley immediately in front of Puerto Bandera on transit.

May 17 2019 (JD 137): we transit to the central portion of Lago Argentino to acquire a north-south line. The weather conditions are perfect for acquisition – overcast and serene. The lake is completely still, perturbed only by the gentle wake from the *M/V Leal*. We observe a lack of undulating structures in this day's data compared to the north-south line just west of this one. The lake bottom is completely flat and subbottom well-stratified. CHIRP signal penetration neared 30 m of sediments, and a possible tephra layer ~6 m deep was observed in this line, which appeared to be a constant presence in the data collected thus far. The coring campaign scheduled for July this year will verify the nature of this reflector. The acquisition day ends at 1:30 pm to return to El Calafate to pick up the UBA students and the rented equipment arriving that evening. Unfortunately, upon arrival at the airport we discover that the equipment had been inconveniently transported to a different location in town that is already closed for the day and opens at 10 AM tomorrow.

May 18, 2019 (JD 138): we pick up the equipment from the storage facility and the new team – Dr. Magnani, Anastasia, Dana, Cesar, Donaldo, and Jorge – travel to Puerto Bandera to unload and set up the new equipment. We spend the afternoon to test the boomer and condenser. We are excited to finally acquire MCS data tomorrow.

May 19, 2019 (JD 139): today marked the first trial day with MCS system. The team deployed the CHIRP pontoon, boomer, and streamer to acquire a south-north line in the western part of the lake. The streamer was attached to starboard-side railing in the back of the boat, pontoon in center, and boomer from the port-side railing. Unfortunately, waves were coming from the west and pulling the streamer against the wave direction and across the rest of the equipment. Acquisition paused several times to ensure that the streamer wasn't caught in the boomer plate. The MCS data show spikes of synchronous noise arriving to all channels of the streamer with random, high amplitude source signatures, along with lots of 50 Hz noise. In addition, the boat is rocking side to side and thereby tugging and jerking the CHIRP pontoon, resulting in spotty data.

May 20, 2019 (JD 140): Too windy to acquire. We travel to Puerto Bandera to troubleshoot the problems encountered in the MCS data on the previous day. Dana and Anastasia wrap the Geode in aluminum foil (without much success), and move the geode away from cables and outlets (with little success). We then ground the geode (by attaching the ground cable reaching from the geode to a brass bell just outside of the entry door of the boat) to finally see a significant reduction in the electrical noise. Tomorrow's acquisition should be significantly better.

May 21, 2019 (JD 141): We will attempt to acquire a long west-east line beginning just inside of Boca del Diablo. This is going to be inherently difficulty because Boca del Diablo is a narrow and shallow passage that connects the glacial valleys to the main lake and syphons the water from the Southern Patagonia Icefield to the east. The passage is notorious for strong currents and acquiring data trying to maintain a constant speed and steady position will be tricky. We switch the towing positions of boomer and streamer for ease of streamer deployment and retrieval (the streamer was being stored on the top deck, and the staircase to the top deck was on the right-hand side of the back of the boat). We also have a rocky start as the boomer appears to be triggering at the same rate as the CHIRP (every <16 ms instead of 4 seconds). Removing the boomer trigger from the CHIRP battery appears to solve the issue. We start sailing into the straight, with the wind to our the back and large swells (up to 2 m), which make data very noisy (MCS) and spotty (CHIRP). The wind picks up to the point that we decide to cut acquisition short and turn back to Puerto Bandera in the early afternoon to avoid damaging the equipment.

May 22, 2019 (JD 142): in an effort to avoid the problems of the previous day, the science team and *M/V Leal* crew plan to acquire data along the long east-west line starting at the far eastern side of the lake and moving west, against the wind. Unfortunately, upon arrival to the starting point after a three-hour transit, the wind picks up. The equipment is deployed and, like the previous day, the data is very noisy and spotty. As wind condition worsen, the CHIRP pontoon bounces up and down in the water so much that we can rarely find the water bottom. The boomer is often completely submerged and we observed the streamer breaking the surface of the water with every passing wave. It is at this point that PI Magnani decides to pull in the CHIRP and reel in the rest of the equipment to avoid damage. Shortly afterwards, the *M/V Leal* captain orders to return to port. The *M/V Leal* then begin a tumultuous journey back to port, through swells exceeding 5 meters in height. After a painstakingly slow and rocky 6-hour transit beating against the wind and waves, the *M/V Leal* arrived to the Puerto Bandera pier around 9 pm. Upon inspection of the upper deck equipment, we find that the 350 kg air tank crate had leaned over to rest diagonally against the rails of the boat, but was still securely and firmly attached to the boat. Minimal damage to the wooden base of the crate is observed.

May 23, 2019 (JD 143): In consideration of the weather conditions forecasted we decide to avoid the open lake for the next few days (which is fully exposed to the elements) and instead, we head to the more protected brazos for our next days of acquisition. The most critical portion of the survey is in Brazo Upsala, where the youngest Neoglacial moraines that have been mapped on land are presumed to be preserved underwater as well. The team decides to acquire data northward from Boca del Diablo along Brazo Norte, and then spend the night on the boat at Puesto de las Vacas, a sheltered location. Upon deployment of the equipment at Boca del Diablo, we find that the UBA boomer's GPS (required for the triggering software to operate) is not being recognized by the triggering computer. We therefore transfer one of the two SMU navigation GPS to the UBA triggering computer, thereby losing the navigation software Fugawi. This solved the problem temporarily while the UBA boomer's GPS underwent dissection. As we start acquisition we discover that the boomer's condenser has ceased receiving power from the boat. As we continue to troubleshoot the condenser issue, we decide to go ahead with CHIRP acquisition. Thirty minutes later (and a boomer reassembly and a torn wire sauntered back) the equipment is back functioning. With all the equipment functioning, the first MCS line of the day was started. The team was able to successfully image the Herminita and Pearson I moraines at the entrance to Brazo Upsala before transiting to Puesto de las Vacas for the night.

May 24, 2019 (JD 144): the *M/V Leal* set out at 8:30 AM to transit to the northernmost portion of the study area – Brazo Upsala. The captain of the *M/V Leal* deemed it safer to first transit through the icebergs leading up to glacier Upsala as opposed to acquiring on the way up. This ensured that the straightest line possible could be acquired southward through the icebergs and everyone would be aware of what to expect of the weather and navigation on the return. The icebergs turned out not to be a big issue, although they were mildly distracting to the team members due to their sheer size, proximity to the vessel, and mesmerizing beauty. Upon reaching glacier Upsala, the wind picked up just enough to make deployment of the equipment and attempts to maintain the boat at 3 kn with the wind blowing behind the *M/V Leal* a hassle, to the point that the vessel reached a 7 kn speed in some points. Such a high acquisition velocity pushed the limits of the resilience of the CHIRP pontoon and boomer, as well as decreased the fold of the MCS data. Luckily, after about half an hour, the wind died down and the *M/V Leal* managed to slow down to the correct 3 kn acquisition speed. Part-way down the line and in front of a large landslide that occurred in 2013, the team noticed some strange undulating signal appearing above a bright and well-stratified sediment bottom, which may have been sideswipes from rocks and deposits adjacent to the acquisition line. The day turned out to be an overall success because the team imaged ~30 km of seismic reflection data, including youngest series of moraines yet encountered – Pearson II. The team returned to Puerto Bandera by 6 pm.

May 25, 2019 (JD 145): the team set out to the northern brazos for another overnight venture. This time, they acquired a line north through Bahia Cristina up to the edge of the Pearson I moraine, turned 90° to acquire a short line moving east, and finally turned 90° back north to complete the line up to Estancia Cristina. Such maneuvers had to be planned because the Pearson I moraine in Bahia Cristina extended above the surface of the water, and due to its Neoglacial origin, it was critical for the team to image as much of the edge of the moraine and sediments as possible before the water shallowed. Apart from a few mishaps – the boomer trigger losing the GPS for a second, forcing the team to end and restart the MCS line along with the nuisance of avoiding tangling the streamer with the other equipment by partly reeling it in during turns – the day was a success. The team had imaged the Herminita moraine upon entering Bahia Cristina, the edge of the Pearson I moraine, and some interesting deep reflectors visible in the near-offset channel display. The group spent another night at Puesto de las Vacas, and having arrived there before nightfall this time, seized the chance to explore the ex-gaucho land in the vicinity as well as celebrate 25 de Mayo that evening with the crew (May Revolution day of Argentina).

May 26, 2019 (JD 146): the team and crew set out at 8:00 AM to the southwest end of Brazo Spegazzini right up to the edge of glacier Spegazzini. The team acquired the entire span of Brazo Spegazzini, the curve through a brief portion of Brazo Upsala, and completed the line in Bahia Oneli. Acquisition conditions were the best yet encountered with the MCS system in place, and this was the first day that not a single hiccup occurred in the acquisition. The team imaged an unmapped Herminita moraine (presumed) in Brazo Spegazzini, reimaged the Herminita and Pearson I moraines in Brazo Upsala, and imaged two moraines in Bahia Oneli positioned in a manner contrary to land maps of Strelin et al. (2014) but supporting those of Aniya et al., (1995). The *M/V Leal* turned around and returned to port by 3 PM.

May 27, 2019 (JD 147): the team returned to Boca del Diablo to re-acquire a half of the west-east line across the main lake that was previously attempted on JD141. Luckily, the weather was on the team's side and acquisition went smoothly. The team returned to Puerto Bandera by 6 pm and planned to complete a final overnight stay on the lake the following day.

May 28, 2019 (JD 148): the team transited to where the previous day's line was stopped and completed the second half of the east west-line across the lake. Luckily, the weather again was calm enough for acquisition. This day marked a milestone in the survey: the most important data – a continuous line from Brazo Upsala to the eastern edge of Lago Argentino – was finally acquired despite all odds. The team spent the night on board anchored by the small, rocky island just north of El Calafate and celebrated the accomplishment.

May 29, 2019 (JD 149): Today is the final day of acquisition. The team successfully acquired two north-south crosslines in the lake. The second line was located at the far western side of the lake and was full of undulating structures and diffractions. The nearby massive rocks of Boca del Diablo protruding above the surface of the lake strongly hinted to the team that the water bottom was of similar character. The *M/V Leal* returned to Puerto Bandera by 4 pm, and the team began packing some of the equipment that afternoon.

May 30, 2019 (JD 150): the team packed all boxes in the morning and the *M/V Leal* crew assisted in unloading equipment from the boat with their Holland machine in the afternoon. The science team also took measurements of the broken air tank pallet and upon return to El Calafate, purchased replacement wooden planks. The UBA equipment was also dropped off to the transporting center to be returned to Universidad de Buenos Aires.

May 31, 2019 (JD 151): the team arrived at Puerto Bandera by noon to rebuild the air tank pallet, label and band all boxes, and load the equipment onto Cesar's truck with the aid of Marpatag's heavy machinery. That evening, the Jorge and Donaldo departed to Buenos Aires, and Beatrice Magnani, Anastasia, and Dana celebrated the conclusion of the experiment at their most beloved restaurant in town, "Pura Vida".

June 1, 2019 (JD 152): Beatrice, Dana, and Anastasia departed El Calafate to return to the USA. Cesar departed El Calafate to drive the equipment to Mendoza where it will be shipped back to the US.

Table 1: MCS Seismic Data Log for Guanaco Lago Argentino seismic reflection survey

Line	Date	Jday	First Shot	Start Lat	Start Lon	Last Shot	End Lat	End Lon	.sgy file	rec len(s)	sampling rate (ms)	y offset (m)
001	19-May	139	448	-50.2776400	-72.5592460	1425	-50.242520	-72.570664	296	1.0	0.5	10.0
002	19-May	139	1427	-50.2380810	-72.5719780	1609	-50.227180	-72.574647	1435	1.0	0.5	10.0
004	19-May	139	1610	-50.2228520	-72.5759090	2225	-50.188481	-72.579616	1610	1.0	0.5	10.0
005	21-May	141	2258	-50.2342000	-72.8932980	2330	-50.240923	-72.857062	2255	1.0	0.125	10.0
006	21-May	141	2334	-50.2409230	-72.8570620	4704	-50.240579	-72.625139	2289	1.0	0.125	10.0
007	22-May	142	4705	-50.218413	-72.043013	5454	-50.219564	-72.097551	4705	1.0	0.125	10.0
008	22-May	142	5455	-50.219542	-72.099302	5587	-50.220284	-72.104854	5455	1.0	0.125	10.0
009	23-May	143	5599	-50.2348090	-72.9021960	5653	-50.234612	-72.902339	5588	1.5	0.25	10.0
010	23-May	143	5655	-50.2339350	-72.9045710	5761	-50.230486	-72.91175	5655	1.5	0.25	10.0
011	23-May	143	5762	-50.2300810	-72.9128780	10124	-50.098494	-73.185131	5762, 7482, 9202	1.5	0.25	10.00
012	23-May	143	10109	-50.0980370	-73.1862660	10571	-50.08401	-73.211758	10108	1.5	0.25	10.00
013	24-May	144	10573	-49.9191810	-73.2829590	12180	-50.007803	-73.266588	10572	1.5	0.25	20.00
014	24-May	144	12181	-50.0142300	-73.2671130	14047	-50.085589	-73.211736	12181, 13901	1.5	0.25	20.00
015	25-May	145	14063	-50.1260320	-73.1314810	15341	-50.055827	-73.148581	14048, 14049, 14064	1.2	0.25	20.00
016	25-May	145	15342	-50.0550250	-73.1491670	16087	-50.019468	-73.174036	15342	1.2	0.25	20.00
017	25-May	145	16088	-50.0198330	-73.1720930	17224	-49.976471	-73.137411	16088	1.2	0.25	20.00
018	26-May	146	17226	-50.2390200	-73.3184880	21995	-50.1041217	-73.2804000	17225,19370, 21515	1.2	0.25	20.00
019	27-May	147	22000	-50.2447817	-72.8096150	23200	-50.2421900	-72.7057767	21996	1.2	0.25	20.00
020	27-May	147	23202	-50.2421033	-72.6949817	26791	-50.2300633	-72.3864533	23202, 25347	1.2	0.25	20.00
021	28-May	148	26794	-50.2300867	-72.38751	27278	-50.2282550	-72.3487467	26792	1.2	0.25	20.00
022	28-May	148	27279	-50.2280383	-72.3458333	28258	-50.2266267	-72.2656521	27279	1.2	0.25	20.00

023	28-May	148	28260	-50.2266417	-72.2625517	30815	-50.2182283	-72.0482683	28260, 30405	1.2	0.25	20.00
024	29-May	149	30822	-50.2799850	-72.2684983	32777	-50.1807083	-72.3114000	30816	1.2	0.25	20.00
025	29-May	149	32779	-50.2012300	-72.8037500	33918	-50.2631800	-72.7755583	32778	1.2	0.25	20.00

Table 2: CHIRP Seismic Data Log for Guanaco Lago Argentino seismic reflection survey

Line #	Julian Day	Central Time Zone Start Time	Central Time Zone End time	BOL Latitude	BOL Longitude W	Water Depth (m)	Speed (SOG)	Segys (time stamp in file name)
130_001	130	10:28		-50.4306	-73.0428	150-200m	4.5 km/hr	0946, 0947, 0949, 1019*_000, 1019*_001, 1021, 1142, 1152, 1208, 1210, 1212, 1231*_001, 1231*_002
130_002	130	13:00		-50.34635	-70.045	515	5.0 km/hr	1303
130_003	130	13:19		-50.3237	-70.0756	177	6.0 km/hr	1322
131_001	131	10:07	13:04	-50.3521	-73.2748	174	5.8 km/hour	1009, 1105, 1254
131_002	131	13:05	13:16	-50.320765	-73.1256	53 m	5.9 km/hr	1301, 1306, 1307, 1314, 1316
131_003	131	13:16	14:21	-50.3248	-73.1097	311 m	5.6 km/hr	1318
134_001	134	7:58		-50.25176	-72.7088	14	5.0 km/hr	801
134_002	134	8:03	15:01 (laptop time stamp)	-50.25327	-72.7034	200	5 km/hr	806, 0838, 1011, 1016, 1017, 1018, 1429
135_001	135	8:01	9:23	-50.253218	-72.0718	30 m	5.5 km/hr	0804, 0805, 0907, 0924, 1102, 1103
135_002	135	11:04	11:59	-50.266044	-72.5024	116 m	5.5 km/hr	1106
135_003	135	12:47	14:09	-50.209993	-72.6596	66 m	5.7 km/hr	1248, 1249, 1252, 1257, 1300, 0006_1301, 0007_1301, 1410
136_001	136	7:41	11:03	-50.243225	-72.7742	76 m	5.6 km/hr	744, 750, 752, 1033
136_002	136	11:06	12:00	-50.325186	-72.9774	530 m	5.4 km/hr	1108
136_003	136	12:56	13:45	-50.330734	-73.0928	315 m	5.3 km/hr	1259, 1342
137_001	137	9:11	11:36	-50.187883	-72.4496	120 m	5.2 km/hr	913, 1111
139_001	139	10:05	10:18	-50.302303	-72.5487	21	4.8 km/hr	1008

139_002	139	10:25	12:38	-50.289155	-72.5559	56 m	5.5 km/hr	1028, 1037, 1043, 1047, 1049, 1050, 1053
141_001	141	8:18	8:44	-50.230584	-72.911	120 m	6 km/hr	0001_0821, 0002_0821, 0822, 0823, 0002_0826, 0003_0826
141_002	141	8:44	11:52	-50.2342	-72.8933	263 m	7.6 km/hr	0847, 1010, 1011, 1031
142_001	142	11:05	12:18	-50.21768	-72.0346	30 m	4 km/hr	1108, 1109, 1110, 1112, 1146
143_001, 143_002, 143_003	143	9:06	16:03	-50.250213	-72.8375	315 m	4.5 km/hr	0908, 0909, 0911, 1000, 1002, 1004, 1006, 1523, 1544
144_001	144	8:51	13:01	-49.915957	-73.2861	584 m	8.6 km/hr	0854, 0856, 0957, 1125, 1219, 0001_1220, 0002_1220
145_001	145	9:56	13:44	-50.132006	-73.127	410	4.8 km/hr	0958, 1050, 1103, 1104, 1107, 1115, 1116, 1118, 1123, 1152, 1155, 1226, 1229, 1238, 1303
146_001	146	7:25	12:50	-50.24045	-73.3237	160 m	5.3 km/hr	0728, 0803, 1134, 1219, 1224, 1227
147_001	147	8:09	13:44	-50.245193	-72.8157	381 m	5.6 km/hr	0811, 0829, 0912, 1153
148_001	148	9:31	11:27	-50.229553	-72.3907	110 m	5.4 km/hr	0931, 1121
148_002	148	11:42	14:08	-50.22488	-72.2306	65 m	5.4 km/hr	1144, 1203, 1311, 1349
149_001	149	7:11	9:29	-50.2851	-72.267	80 m	5.1 km/hr	0713, 0844
149_002	149	11:59	13:23	-50.198785	-72.8039	118 m		1202, 1221, 1303