

Holocene Environmental Change in the Maritime Antarctic. Interactions between permafrost and the lacustrine environment

HOLOANTAR



**REPORT ANTARCTIC CAMPAIGN
NOVEMBER-DECEMBER BYERS'12**

Summary

HOLOANTAR is a multidisciplinary project in which researchers from the University of Lisbon (Portugal) and the Federal University of Viçosa (Brasil) lead research activities in collaboration with other scholars from the Universidad of La República (Uruguay), University of Alcalá (Spain) and also from several Spanish research organisms such as Centro de Estudios y Experimentación de Obras Públicas (CEDEX), Instituto Geológico y Minero de España (IGME), Agencia Estatal del Consejo Superior de Investigaciones Científicas (CSIC) and Parque Natural de Peñalara.

The project is led by the Institute of Geography and Spatial Planning - Centre for Geographical Studies of the University of Lisbon through the research group Antarctic Environments and Climate Change Research Group (ANTECC). Results of HOLOANTAR project will contribute to the understanding of the landscape evolution and climate changes in the South Shetlands Islands following Holocene environmental evolution in Byers Peninsula (Livingston, Antarctica).

The South Shetlands Islands are located in the northwestern tip of the Antarctic Peninsula, one of the Earth's regions that have experienced a stronger warming signal during the second half of the 20th century. The terrestrial ecosystems in the ice-free areas of this archipelago are supported by permafrost, one of the key components of the cryosphere, as recently defined by the World Climate Research Programme, though the reaction of permafrost to climate change is still poorly known. However, in the recent years a very important effort has been conducted to monitor the thermal state and characteristics of permafrost in order to study its response to the recent warming trend. Our team is involved on several of these long-term monitoring projects (PERMANTAR, PERMANTAR-2), but HOLOANTAR, in addition, offers a new integrated approach aiming to bridge the gap between contemporary and past changes in permafrost environments.

HOLOANTAR is based on two hypotheses:

- a) A multi-proxy analysis of lake sediments will allow to reconstruct the palaeoecological and palaeoenvironmental evolution in the Maritime Antarctic and the role played in it by permafrost and active layer dynamics,
- b) The detection of activity rates, spatial patterns and geographical controls of contemporary key-geomorphic processes and permafrost distribution, will permit to define their boundary climatic conditions that will be used to interpret the sedimentary record.

Antarctic campaign November-December 2012

Participants

Dermot Antoniades (Universidad La República) - DO

Santiago Giralt (Institute of Earth Sciences Jaume Almera, CSIC) - SG

Ignacio Granados (Parque Natural de Peñalara) - IG

Marc Oliva (IP, University of Lisbon) - MO

Manuel Toro (Centro de Estudios y Experimentación de Obras Públicas) - MT

Ricardo Leizer (technician from the Brazilian Antarctic Program) - RL

Dates

Flight to Punta Arenas

- SG and MO: from Barcelona (Spain), 3rd November
- IG and MT: from Madrid (Spain), 4th November
- DO: from Montevideo (Uruguay), 4th November

Departure Punta Arenas-Frei: 6th November

Field work in Byers: 10th November – 1st December

Uruguayan research station: 9-11th December

Frei-Punta Arenas: 11th December

Flight home:

- DO: to Montevideo (Uruguay), 13th December
- IG and MT: to Madrid (Spain), 14th December
- SG and MO: to Barcelona (Spain), 14th December

Logistics

Logistics was supported by the Brazilian and the Uruguayan Antarctic programs.

Brazil provided:

- Flight Punta Arenas-Frei.
- Accommodation and transport by ship to Byers and the way back from Byers to Fildes.
- Helicopter support.
- Camp equipment (tents, food, WC, fuel, etc.).
- An expert climber to support field work in Byers (Ricardo Leizer).

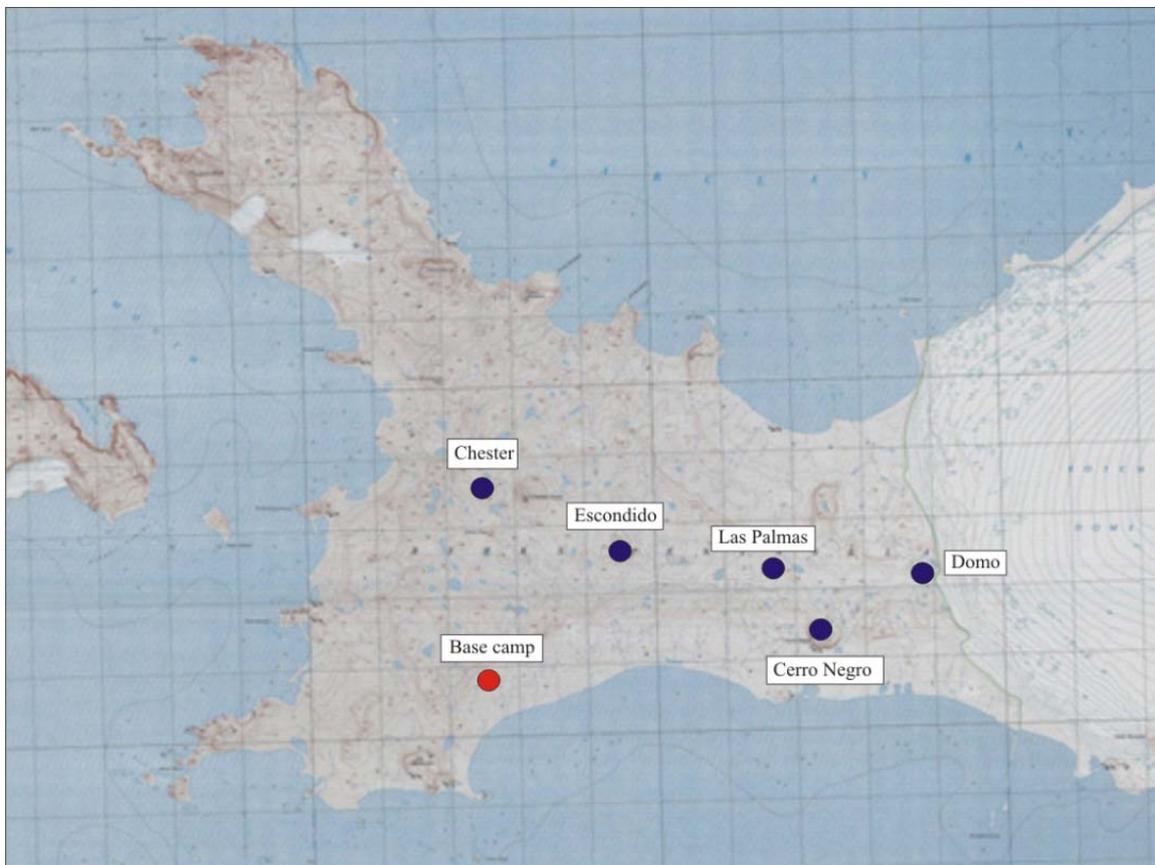
Uruguay provided:

- Accommodation at the Uruguayan base between 9-11th December
- Flight Frei-Punta Arenas.

Study area

Our research was centred on Byers Peninsula, the largest ice-free area in the South Shetland Islands. It is a protected area in Livingston Island with the largest biodiversity in Antarctica (Toro et al., 2007). Byers has a relatively flat relief with more than 110 lakes/ponds (López Martínez et al., 1996) that started to originate during the Early Holocene, from ca. 8300 cal. years BP to 450-500 BP (Bjorck et al., 1996; Toro et al., in press). All the activities carried out in Byers were framed within the Management Plan for Antarctic Specially Protected Area No. 126 (Byers Peninsula, Livingston Island).

The camp was installed in the southern beaches, close to the Spanish igloos. An official application to the Spanish Antarctic Committee was requested in order to have access to the two igloos, which facilitated field work activities and our daily stay in Byers.



Map of Byers. Distribution of the lakes.

In spite that the research carried out by members of HOLOANTAR is also centered on other ice-free areas of the South Shetland Islands (e.g. Barton and Potter Peninsulas, King George Island), the interest of doing research in Byers is explained by several important reasons:

- It is the largest ice-free area in the South Shetland Islands with the largest biodiversity in Antarctica (Toro et al., 2007) and contains more than 110 lakes/ponds (López Martínez et al., 1996).

- Members of HOLOANTAR have already carried out research in lakes in Byers in the past in the framework of LIMNOPOLAR project (Spanish funding). The fact of conducting research in this area with prolific results has raised several questions which have not been yet solved and to which HOLOANTAR wants to address. A CALM site for permafrost monitoring is also maintained in Byers since the International Polar Year 2007-2008 providing data on active layer dynamics.
- Recent published data has revealed an unexpected timing for the deglaciation in Byers which contradicts what has been published up to now (Toro et al., *in press*). More research should confirm the new deglaciation timing with higher accuracy data.
- Therefore, research in Byers Peninsula has a huge potential in order to provide key datasets to answer the major uncertainties related to how the natural system in the ice-free areas is responding now to the warming trend recorded in the Antarctic Peninsula region (and has responded to warm periods in the past).

Objectives of the campaign

The goal of the project was to collect sediment samples from lakes. Although initially other field activities (namely geomorphological monitoring) were programmed to be done during this campaign the thick snow cover in Byers did not allow conducting them. Samples for cosmogenic dating were not taken due to the high degree of weathering of the rock surface in Byers.

Sampled lakes were selected according to the following criteria: presence of moss layers interbedded in the lake sediments that ensured the construction of reliable and robust radiocarbon chronological model, deglaciation gradient E-W from Rotch Dome glacier to West Coast; altitude, distance to sea coast; watershed characteristics (area, geomorphology, relief); ice-cover period length; lake size/volume/depth; and limnological data available. To collect longer sediment cores, an Uwitec Piston Corer was used to reach the diamicton at the deepest part of the lake. A gravity UWITEC corer was used to ensure the collection of undisturbed water - sediment interface.

Cores were collected from lakes:

- Chester
- Escondido
- Domo
- Cerro Negro

Activities

We arrived on 6th November to Frei with a Hercules from the Brazilian Air Force. A helicopter picked us at Frei and transported to the Maximiano ship. From 6th November to 10th November we were on Maximiano heading to Byers.

Report of activities done in Byers:

Day: 10/11/2012

Weather: Sunny changing to cloudy, moderate wind, -3 to -1°C

Start time: 10 h

End time: 20 h

Activities: Operations started at 9 h and finished at 14 h. All boxes were left at the base camp and the lake coring equipment near Chester lake. In the afternoon we started organizing the equipment and setting up the tents, both for sleeping and WC. We also made a preliminary organization of the boxes.

Cores collected: -

Day: 11/11/2012

Weather: Fairly cloudy, strong wind, -3 to -1°C

Start time: 8 h

End time: 20 h

Activities: We organized the boxes (food, equipment, water). We cleaned the igloos and prepared the working material for the following day.

Cores collected: -

Day: 12/11/2012

Weather: Moderate rain, strong wind, 0 to +2°C

Start time: 8 h

End time: 20 h

Activities: The very strong wind prevented from working in the field. We stayed at the base camp with the purpose of starting work tomorrow. We set up a new tent for the WC.

Cores collected: -

Day: 13/11/2012

Weather: Cloudy with light snow, moderate wind, -1 to +1°C

Start time: 8 h

End time: 19 h

Activities: We transported two pulks from the camp to Chester lake. The very soft snow made more difficult the portage. Once in the lake, we organized the equipment and set up the tripod. We left everything prepared to start working tomorrow morning.

Cores collected: -

Day: 14/11/2012

Weather: Cloudy with light snow, moderate wind, -1 to +1°C, getting better in the evening.

Start time: 8 h

End time: 19 h

Activities: We collected the first cores from Chester Lake despite technical problems with the corer.

Cores collected: CH12/01-01G, CH12/01-01

Day: 15/11/2012

Weather: Snow by night. Sunny day, very strong wind, -8 to -3°C

Start time: 8 h

End time: 17 h

Activities: Despite the extreme cold conditions we went to Chester lake to collect sediment samples. However, technical problems with the coring equipment impeded us to collect long cores. We tried to solve these problems.

Cores collected: CH12/02-01, CH12/02-02

Day: 16/11/2012

Weather: Cloudy, cold, weak wind, -2 to -6°C

Start time: 8 h

End time: 19 h

Activities: We kept working at Chester lake despite of the cold. We had to solve more technical problems with the coring equipment.

Cores collected: CH12/03-01, CH12/03-02

Day: 17/11/2012

Weather: Cloudy, foggy, light snow at night, no wind, -1 to +2°C

Start time: 9 h

End time: 20 h

Activities: We changed the location of the base camp due to the presence of elephant seals. They were very noisy at night and we couldn't rest properly. We moved the tents 100 m away from the igloos. In the afternoon we went to the penguin colony although we did not arrive due to a dense fog. We arrived at president Beaches. The way back to the base was long and hard.

Cores collected: -

Day: 18/11/2012

Weather: Cloudy, foggy, light snow at night, no wind, -1 to +2°C

Start time: 11 h

End time: 20, 22 h

Activities: Another night without sleeping due to elephant seals. MO and RL spent all day digging a trench around the tents to prevent them from entering the

tent area. The rest went to Chester and came back with two long cores. They arrived at 22 h.

Cores collected: CH12/04-01, CH12/04-02, CH12/05-01G, CH12/05-01, CH12/06-01G, CH12/06-01

Day: 19/11/2012

Weather: Cloudy, foggy, light snow at night, -2 to +4°C (temperature dropping in the afternoon)

Start time: 13 h

End time: 20 h

Activities: During the morning we organized, marked and sealed the previously retrieved cores. At 13 h IG and MO went to Chester Lake to take the auger, PVC tubes and caps. After they went through a dense fog to Escodido lake, where they met the rest at 15 h. Escodido had 1.35 m thickness of ice. DA and MO went back to Chester lake to pick the extension of the auger. We collected two cores with the UWITEC gravity corer.

Cores collected: ES12/01-01G, ES12/02-01G

Day: 20/11/2012

Weather: Snow, weak wind, cloudy in the afternoon, -2 to 0°C

Start time: 15 h

End time: 19 h

Activities: Day off. Everybody stayed at the camp in the morning. In the afternoon MT, KG and DA went to Limnopolar Lake to make some measurements. SG went walking by the beach and MO and RL stayed at the base camp.

Cores collected: -

Day: 21/11/2012

Weather: Moderate to heavy snowfall, strong wind increasing, -2 to 1 ° C

Start time: 8.30 h

End time: 19 h

Activities: Finally, we reached the bottom sediments in Chester lake after three failed attempts. RL stayed at the base camp organizing and cleaning.

Cores collected: CH12/07-01, CH12/07-02, CH12/06-01, CH12/08-01

Day: 22/11/2012

Weather: Very windy night, with heavy snow storm. Morning fairly cloudy, with weak wind. In the afternoon, the wind got stronger, cloudy with light snow, -3 to 0° C

Start time: 10 h

End time: 20 h

Activities: MT and SG went to Las Palmas with the UWITEC gravity corer, but they did not find ice-free water in the lake water column. When they reached the

theoretical water - sediment interface with the auger, they tried to collect lake sediments without success. The rest shoveled the fresh snow from the trench and after they went to Chester lake to dismount the tripod, collect the equipment, pack and transport to Escondido. The portage with two very loaded sleds on very wet snow was exhausting. After one portage, they returned to Chester to prepare the pulks for the following day. Then they went back to the camp.

Cores collected: -

Day: 23/11/2012

Weather: Night with moderate wind. Partly cloudy in the morning, becoming very cloudy with snow showers. Constant moderate wind, -4 to 1°C

Start time: 10.30 h

End time: 16.30 h

Activities: We shoveled the snow accumulated by the wind last night in the trench. We went to Escondido to carry the equipment from Chester lake. IG and MO made two portages to Escondido. The rest, meanwhile, set up the tripod and left it ready for use. We returned back to the camp all together.

Cores collected: -

Day: 24/11/2012

Weather: Night with strong wind. Cloudy in the morning becoming sunny in the evening. Weak wind from the SW in the afternoon, when the temperature drops, -5 to 0°C

Start time: 11 h

End time: 20 h

Activities: IG and MT left at 10.30 to Escondido to check if the auger works. SG, DA and MO left an hour later to the same lake. We spent all day coring, collecting several cores. The coring in this lake was almost finished; we left everything prepared to finish the coring tomorrow.

Cores collected: ES12/03-01, ES12/03-02, ES12/04-01, ES12/05-01, ES12/06-01.

Day: 25/11/2012

Weather: Sunny, weak W wind, -5 to 1°C

Start time: 9 h

End time: 19 h

Activities: We went to Escondido to take a back-up core from the base of the sediments but failed to collect it. Neither with plastic nor with metal tubes. We packed and prepared the material to be collected by helicopter.

Cores collected: ES12/07-01, ES12/08-01, ES12/09-01, ES12/10-01.

Day: 26/11/2012

Weather: Partly cloudy with periods of sun. Weak to moderate SW wind in the afternoon, -4 to 0 °C

Start time: 16 h

End time: 19 h

Activities: Relaxing day. In the afternoon MT, MO and SG went along the beach. We went to bed early in order to wake up soon the following day to go to Domo.

Cores collected: -

Day: 27/11/2012

Weather: Partly cloudy with periods of sun. Weak to moderate SW wind in the afternoon, -4 to 0 °C

Start time: 6.30 h

End time: 21.30 h

Activities: We got up very early to go to Domo lake. We went to Escondido and Las Palmas to collect the material that was left there. We arrived at Domo and collected a number of cores with the UWITEC gravity corer. Afterwards, we visited the present-day active moraine system. At 17 h we went to Cerro Negro, where we collected lacustrine sediments. After this lake we went back to the base camp, where we arrived exhausted at 21 h.

Cores collected: DO12/01-01G, DO12/02-01G, DO12/03-01G, DO12/04-01G, DO12/05-01G, DO12/06-01G, CN12/01-01 G, CN12/02-01 G, CN12/03-01 G

Day: 28/11/2012

Weather: Partly cloudy with periods of sun. Weak wind, -3 to 2 °C

Start time: 11 h

End time: -

Activities: Packing coring and infrastructure material to be returned to the ship and sealing cores.

Cores collected: -

Day: 29/11/2012

Weather: Snow at night. Foggy, with snow showers/rain. NW wind, -2 to + 2°C

Start time: 17 h

End time: 20 h

Activities: Packing coring and infrastructure material to be returned to the ship and sealing cores. In the afternoon we went to the penguin colony.

Cores collected: -

Day: 30/11/2012

Weather: Partly cloudy with snow at night. Weak W wind, -3 to + 1°C

Start time: 17 h

End time: 20 h

Activities: Packing coring and infrastructure material to be returned to the ship and sealing cores. In the afternoon IG, SG and RL went again to the penguin colony.

Cores collected: -

Day: 1/12/2012

Weather: Partly cloudy with heavy snow showers. Moderate northern winds, -3 to +1°C

Start time: 10 h

End time: 18 h

Activities: At 10 h the material picking-up operations of Maximiano started. A snowstorm delayed 3-4 hours the process. At 14:00, two Brazilian researches got isolated by a snow storm in the CALM site and two persons from Byers camp went to look and bring them to the camp.

Cores collected: -

We stayed at the Maximiano ship until 9th December. During these days we sliced the uppermost part of four (one per lake) gravity cores for Pb210 dating, and reviewed field notes and digital images from the campaign. We also carried out several other activities, such as making a helicopter trip in Deception or taking a bath and visiting Whaler's Bay.

We disembark at the Uruguayan base on 9th December and stayed at this research station for two days. The team flew back from Frei to Punta Arenas on 11th December and went back to their home countries on the 13-14th December.



HOLOANTAR researchers at their arrival at Frei (from left to right: Marc Oliva, Santiago Giralt, Ignacio Granados, Manuel Toro, Dermot Antoniades and the Brazilian climber Ricardo Leizer). Photo courtesy of Ricardo Leizer.

Table-summary of the lakes, cores and operations done in this campaign.

Lake	Day	ID	Sediments collected (cm)	Operation (cm)
Chester	14/11/2012	CH12/01-01G	35	0-35
		CH12/01-01	107	0-117
	15/11/2012	CH12/02-01	115	0-115
		CH12/02-02	70	0-70
	16/11/2012	CH12/03-01	135	0 a 172
		CH12/03-02	0	172 a 262
	18/11/2012	CH12/04-01	153	0-180
		CH12/04-02	0	180-300
		CH12/05-01G	53	0-53
		CH12/05-01	0	120-278
		CH12/06-01G	31	0-31
	CH12/06-01	120	120-240	
	21/11/2012	CH12/07-01	0	0-150
		CH12/07-02	0	37-173
		CH12/06-01	0	150-250
		CH12/08-01	137	130-220
Escondido	19/11/2012	ES12/01-01G	20	0-20
		ES12/02-01G	23	0-23
	24/11/2012	ES12/03-01	60	0-103
		ES12/03-02	149	50-168
		ES12/04-01	0	15-103
		ES12/05-01	69	15-187
		ES12/06-01	100	15-190
Domo	27/11/2012	DO12/01-01G	23	0-25
		DO12/02-01G	46	0-70
		DO12/03-01G	0	0-61
		DO12/04-01G	55	0-65
		DO12/05-01G	30	0-30
		DO12/06-01G	63	0-63
Cerro Negro	27/11/2012	CN12/01-01 G	48	0-48
		CN12/02-01 G	50	0-50
		CN12/03-01 G	116	0-116

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