

# The Puerto Bandera moraine system: A test case for documenting late glacial climate change in the Southern Hemisphere

M. Kaplan, J. Schaefer, A. Putnam: Geochemistry

## Summary

The aim is to understand better climate change during the last glacial to interglacial transition in the southern middle latitudes. We propose to initiate a major cosmogenic-dating campaign to date one of the best expressions of late-glacial (15-10 ka) climate variability in the Southern Hemisphere. Specifically, funds are requested for 1) a two-week field season in April to gather samples from a suite of moraines 2) to prepare a subset of priority samples for  $^{10}\text{Be}$  measurement. This study ties into a larger project by the PIs to understand past climate change in the southern latitudes. This study will be a 'pump-priming' effort for a larger NSF proposal.

## Problem

The nature of the last glacial to interglacial transition in the middle latitudes of the Southern Hemisphere is still a matter of intense debate and remains unresolved. For example, the following questions remain unanswered. Was there climate variability during late glacial time? How does the paleoclimate of the southern latitudes compare to that of the North Atlantic region and Northern Hemisphere? Was there a climate reversal during the Younger Dryas chron or Antarctic Cold Reversal?

A relatively recent approach to address the above questions is to date glacial moraines by measuring the accumulated *in situ*  $^{10}\text{Be}$  in glacial erratics. However, the production rate of this cosmogenic isotope still needs to be confirmed or improved to date 'convincingly' at the millennial time scale.

## Our approach

We are studying arguably one of the best sites in the middle latitudes of the Southern Hemisphere to address the questions above and to understand better the last glacial to interglacial transition. Our focus is on the Puerto Bandera moraine system in the Lago Argentino area,  $\sim 50^\circ\text{S}$ .

Particularly germane to this project and its goals, two independent-dating approaches can be used to define the age of this moraine system, using  $^{14}\text{C}$  and  $^{10}\text{Be}$ .  $^{14}\text{C}$  dating affords maximum and minimum age limits for the moraines.  $^{10}\text{Be}$  allows direct age control for the moraines. The specific goal of this project is to gather samples from the Puerto Bandera moraine system for  $^{10}\text{Be}$  dating.

$^{14}\text{C}$  data are used also to confirm or 'check' the  $^{10}\text{Be}$  production rates in the middle latitudes of South America. The confirmed production rate will have an implication for the value over, in general, the southern middle latitudes.

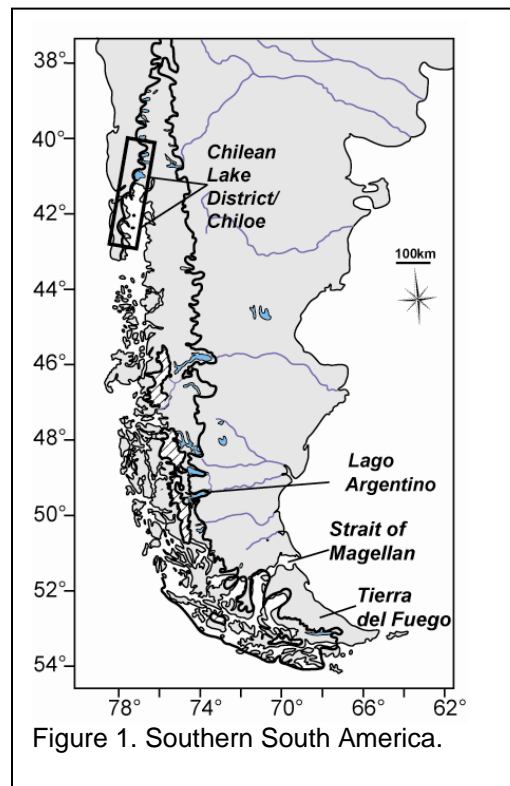


Figure 1. Southern South America.

## Background

The Puerto Bandera moraine system in the Lago Argentino area, ~50°S, has been studied since the 1920s (*Caldenius, 1932, Geografiska Annaler; Mercer, 1983, Quaternary Research; Strelin and Malagnino, Quaternary Research, 2000*). Prior  $^{14}\text{C}$  dating efforts on the Bandera system indicated that it was deposited during a climate reversal during the last glacial to interglacial transition. At present, collaborators Jorge Strelin (Universidad Nacional de Córdoba) and George Denton (University of Maine) are carrying out an independently-funded  $^{14}\text{C}$ -dating campaign to improve the moraine age. Preliminary data indicate that this moraine may have formed between ~13,500 and 12,500 cal yrs BP (*Strelin and Malagnino, Quaternary Research, 2000 and unpublished  $^{14}\text{C}$  data*).

In the last two years, M. Kaplan joined J. Strelin in the field and collected samples around western and northern Lago Argentino. The priority during the past field seasons has been to collect samples from Holocene moraine sequences within the Andes. Although Kaplan took advantage of being in the area and also collected some samples from the northern part of the Bandera system (Fig. 2), this was not a priority during either of two field seasons. The requested funds will be used specifically for a field season to prioritize sampling on the Bandera moraines where  $^{14}\text{C}$  age constraints exist.

## Research Plan

Field work will be undertaken by M. Kaplan and A. Putnam in collaboration with J. Strelin in April, 2008. Main areas that will be targeted (Fig. 2) include the northern side of the Lago Argentino and the central area east of Brazo Rico where minimum  $^{14}\text{C}$  data exist from meltwater spillways formed when the ice disintegrated. A third southern area (Fig. 2) will be investigated for its potential to provide high quality erratics for cosmogenic dating. Putnam's plane ticket and field work are covered by G. Denton through the University of Maine. Once in the field, lodging and car hire are mostly covered by Strelin. Requested funds are to cover Kaplan's field season. Subsequently, samples will be processed at the cosmogenic laboratory in Geochemistry by Kaplan and Putnam under the supervision and assistance of Schaefer. We also ask for funds to offset the cost of preparing ~20 'priority' samples. Funds for AMS analyses (400 each sample) will be sought elsewhere (e.g., NSF).



Figure 2. Three areas where  $^{10}\text{Be}$  dating will be focused are outlined in red. In the northern area, Kaplan has already started to collect samples in a previous field season (maximum  $^{14}\text{C}$  ages exist here of ~13 cal ka). A proposed field season in April, 2008 will allow a focused collection effort in the middle area where minimum  $^{14}\text{C}$  ages exist in the blue spillway (~12.5 cal ka; Mercer, 1982, Strelin and Denton, unpubl.), in the northern area, and in the southernmost area where no samples exist. Holocene moraines, which have been a focus in past field seasons, are to the west and north and they are not shown.

## Significance

$^{10}\text{Be}$  measurements from the well-mapped Bandera moraines (Fig. 2) will provide quantitative ages on the timing of snowline depression that caused their formation. Overall, the data will allow 1) firm dating of a moraine system deposited during the last glacial to interglacial transition 2) comparison to similar sites and studies in the Southern Hemisphere, including New Zealand where the investigators are working, and in the Northern Hemisphere. In combination with  $^{14}\text{C}$  data, this site provides an opportunity to provide one of the best-dated Southern Hemisphere moraine sequences deposited during the Late Glacial interval. The  $^{14}\text{C}$  ages will also provide confirmation of the  $^{10}\text{Be}$  production rate, which is applicable elsewhere in South America. Furthermore, confirming the production rate in the Lago Argentino area has implications for the value in other areas at similar latitudes in the Southern Hemisphere (e.g., New Zealand).

The field season and samples collected will form a 'pump-priming' exercise for a NSF proposal to be submitted this winter, 2008. This proposal will focus on the late glacial and Holocene period in the Lago Argentino area. We will mention in the NSF proposal that the samples will be in hand immediately upon the start of the award (compared to waiting until the following field season of winter 2008/2009 for samples). If the NSF proposal is declined, then the samples provide data for a resubmittal in the following proposal deadline.

## Budget

### Field work

Plane ticket RT JFK to El Calafate, Argentino	1200
Taxis to and from JFK to Kaplan's house	150
Taxis in El Calafate	25
Food per diem 16 days at \$20 per day	320
Lodging (taken care of by J. Strelin)	0
4x4 Rental Car (2 days)	80
Chisels and sample bags	100

### Laboratory work

Preparing 20 samples in cosmogenic lab at LDEO (\$200 per sample)	4000
---	------

## TOTAL

**\$5875**

## Justification

Expenses are requested for one 2 week field season (plus two days of traveling) for Kaplan. Putnam's travel is covered by collaborator G. Denton through the University of Maine. Lodging will either be covered by Strelin in El Calafate, or we will camp. During the field season, car hire will be mainly covered by Strelin, except we request two days for opportunities that may arise to go to additional areas to collect (e.g., two field teams in two areas for more efficient collecting). Funds are also requested to process in the cosmogenic lab a priority set of 20 samples.