Quaternary Science Reviews 200 (2018) 287–312

Contents lists available at ScienceDirect

Quaternary Science Reviews

journal homepage: www.elsevier.com/locate/quascirev

Asynchronous glacier dynamics during the Antarctic Cold Reversal in central Patagonia

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ARTICLE INFO

Article history:
Received 19 July 2018
Received in revised form
17 September 2018
Accepted 18 September 2018

ABSTRACT

We present 14 new ^{10}Be cosmogenic nuclide exposure ages quantifying asynchronous readvances during the Antarctic Cold Reversal from glaciers in the Baker Valley region of central Patagonia. We constrain glacier and ice-dammed palaeolake dynamics using a landsystems approach, concentrating on outlet glaciers from the eastern Northern Patagonian Icefield (NPI) and Monte San Lorenzo (MSL). Soler Glacier (NPI) produced lateral moraines above Lago Bertrand from 15.1 ± 0.7 to 14.0 ± 0.6 ka, when it dammed the drainage of Lago General Carrera/Buenos Aires through Río Baker at a bedrock pinning point. At this time, Soler Glacier terminated into the 400 m "Deseado" level of the ice-dammed palaeolake. Later, Calluqueo Glacier (MSL) deposited subaerial and subaqueous moraines in the Salto Valley near Cochrane at 13.0 ± 0.6 ka. These moraines were deposited in an ice-dammed palaeolake unified through the Baker Valley (Lago Chalenko; 350 m asl). The Salto Valley glaciolacustrine landsystem includes subaqueous morainal banks, ice-scoured bedrock, glacial diamicton plastered onto valley sides, perched delta terraces, kame terraces, ice-contact fans, palaeoshorelines and subaerial push and lateral moraines. Boulders from the subaqueous Salto Moraine became exposed at 12.1 ± 0.6 years, indicating palaeolake drainage. These data show an asynchronous advance of outlet glaciers from the Northern Patagonian Icefield and Monte San Lorenzo during the Antarctic Cold Reversal. These advances occurred during a period of regional climatic cooling, but differential moraine extent and timing of advance was controlled by topography and calving processes.

1. Introduction

1.1. Late Quaternary palaeoclimate and the Patagonian Ice Sheet

During the Last Glacial Termination in the Southern Hemisphere, a phase of warming atmospheric and ocean temperatures from ~18.0 ka was interrupted by cooling during the Antarctic Cold Reversal (ACR; 14.7 to 13.0 ka) (Jouzel et al., 2001; Morgan, 2009; Putnam et al., 2010; Pedro et al., 2016). The ACR dominates Southern Hemisphere palaeoclimate records up to at least 40°S (Pedro et al., 2016), therefore potentially affecting glaciers of the Northern Patagonian Icefield and Monte San Lorenzo ice cap (NPI and MSL, respectively; Fig. 1) in the Patagonian Andes of South America. Glacier readvances during the ACR have been documented in the tropical Andes (10–20°S) (Jomelli et al., 2014, 2017), for Colonia Glacier of the NPI (Nimick et al., 2016), for Tranquilo Glacier of MSL (Sagredo et al., 2018), in Cordillera Darwin (54°S) (Menounos et al., 2013), and in Torres del Paine (51°S) (Fogwill and Kubik, 2005; García et al., 2012). However, some have argued that a significant readvance also occurred during the Northern Hemisphere Younger Dryas (Ackert et al., 2008; Glasser et al., 2012, 2016; Rasmussen et al., 2014; Nimick et al., 2016). Palaeoclimatic controls on glaciers and the role of the bi-hemisphere seesaw (Pedro et al., 2018) in modulating climate in central Patagonia therefore remain poorly resolved.

Topographic controls and glaciolacustrine dynamics also have the potential to influence the timing of moraine formation (Barr and Lovell, 2014), which may account for the range of published ages from ~15.0 to ~10.0 ka for moraines at broadly coincident ice margin positions in this region (e.g. Glasser et al., 2012; Nimick et al., 2016). In order to use the geomorphic record of glacier advances as proxy data for reconstructing the structure of these past climatic changes, detailed landform mapping and geochronological data are required from a larger sample of moraines. Furthermore,

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https://doi.org/10.1016/j.quascirev.2018.09.025

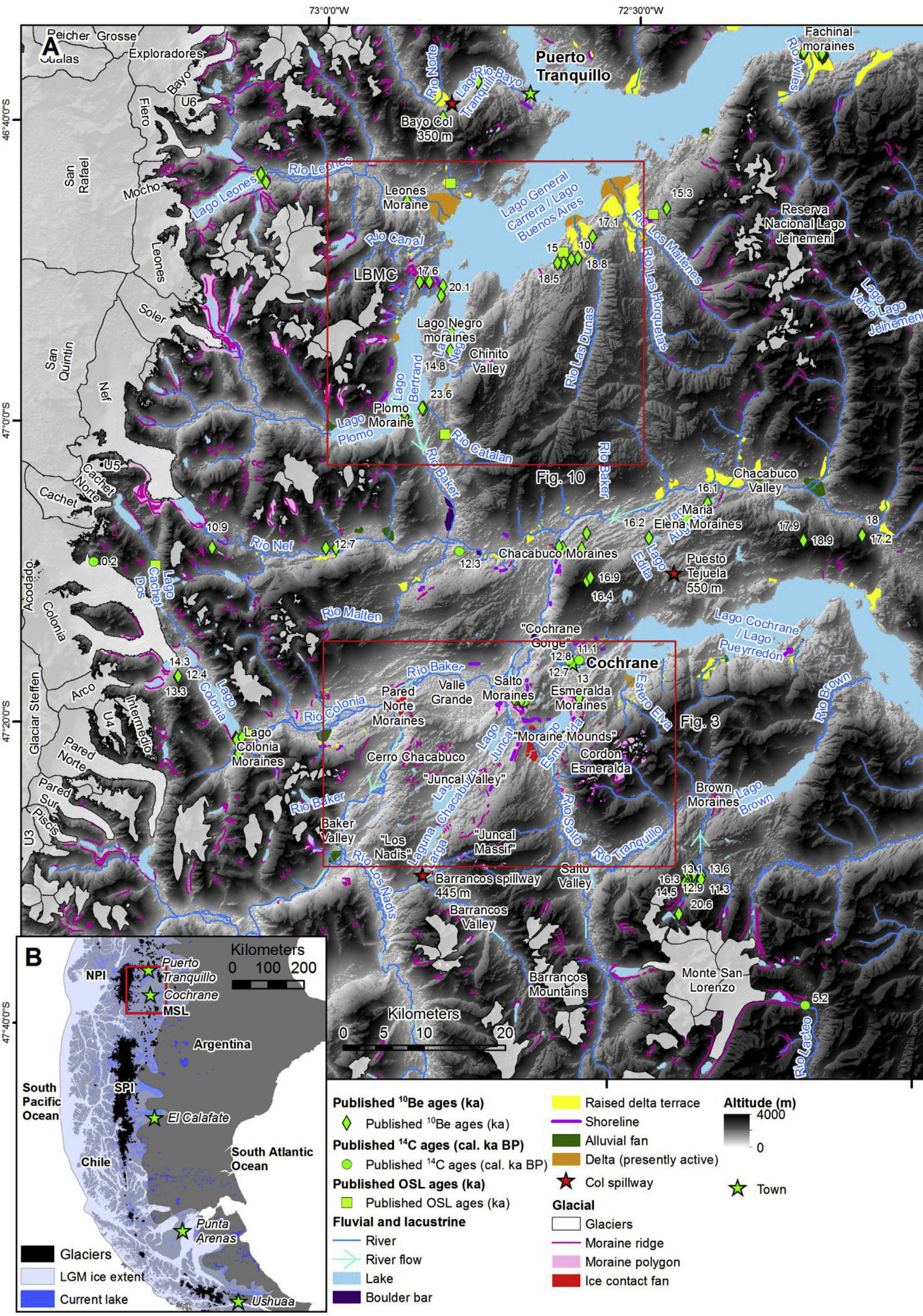

Fig. 1. A. Regional overview of study area, showing rivers, lakes, glaciers and key geomorphology. Moraines and sandar are modified from Glasser and Jansson (2008). Delta terraces modified from various authors (Bell, 2008; Bell, 2009; Bourgois et al., 2016; Glasser et al., 2016; Bendle et al., 2017b; Thorndycraft et al., 2018). Boulder bars from Thorndycraft et al.