



A record of multiple glacial events at Lago Pueyrredón, Argentina, from the Last Glacial Maximum to the Greatest Patagonia Glaciation (~ 1.1 Ma)

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This research demonstrates the potential for determining the magnitude and timing of glacial events in southern South America. It is based on the cosmogenic nuclide exposure age chronology of glacial marginal features throughout the Quaternary. This is directly compared with global deep sea and ice core climate proxy records.

Patagonia holds arguably one of the most complete and best-preserved records of glacier fluctuation throughout the Quaternary. Repeated sets of glacial limits reflecting multiple extended positions of ice sheets from the Andean Cordillera are well recorded by Caldenius (1932) and have subsequently been investigated by many authors. The position of the Last Glacial Maximum has been well explored and dated either by radiocarbon or cosmogenic nuclide exposure methods. The outermost limits (The Greatest Patagonian Glaciation – GPG) have been constrained by their stratigraphic position relative to two separate lava flows, themselves dated using Argon-Argon methods to ~ 1.1 Ma.

Few glacial limits have been directly dated beyond these extremes, although the record indicates that there are at least three, probably more, separate events between them. It is difficult to date the older surfaces using available techniques, and it is only in a few places that glacial deposits impinge on lava flows making Argon-Argon techniques possible. Previous attempts to directly date these mid-Quaternary glacial events using cosmogenic nuclide methods have aimed to date boulders on moraine surfaces. This technique often runs into difficulties because of moraine degradation, surface erosion rates and the exposure-dating of apparently-younger boulders exhumed from the moraine matrix. We have developed methods that rely on obtaining cosmogenic surface ages from outwash terraces that can be stratigraphically associated with specific glacial events. We use age profiles through the terrace surface to demonstrate low erosion rates and exclude nuclide inheritance. This has enabled us to establish reliably a complete dated sequence of glacial limits in the Lago Pueyrredón valley, Patagonian Argentina. These are associated with the LGM, Marine Isotope Stage (MIS) 8, MIS 16, and an age that corresponds broadly to the GPG at ~ 1.2 Ma. In particular, the indication of a MIS 8 advance seems anomalous in relation to global records and potentially conflicts with other results obtained from Lago Buenos Aires immediately to the North where an MIS 6 advance is possibly indicated by Kaplan and others. This record is the first directly dated glacial sequence of this age to be obtained from South America.