**Supplementary Material: Extended Results**

1. **Geomorphological mapping criteria**

**Table S3.** Geomorphological mapping identification criteria.

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| **Landform** |  | **Criteria** |
| Moraine belts | : | Continuous group of rounded hills that have lateral continuity and overall arcuate plan form, consistent with a former glacial margin at a particular time. |
| Moraine systems | : | Group of moraine belts linked together by broad association in space and by similar morphology. Interpreted as being deposited during semi contemporaneous origin, due to similarities in shape, grade of erosion and spaced close to each other |
| Ridges/crests | : | Group of hills that have curvilinear continuity, generally located within the moraine belts. |
| Outwash plain | : | Low relief and low angle surface formed by glaciofluvial sediments in the distal part of the moraine margin. |
| Dissected mounts | : | Rounded mounds with high amplitude crests that are cut by water channels. |
| Streamline mounts | : | Low relief mounds with rounded borders or limits, their shape is elongated in a direction of former ice flow. |
| Alluvial deltas | : | Deltas formed at the mouth of a river by the downhill accumulation of material transported by river channels. |
| Paleo shorelines | : | Former shorelines indicating previous lake levels. At the Skyring lobe, these can either be in the form of broad, rounded shoreline berms, usually located at the front part of the lobe, or as low angle planar shoreline terraces, located at the lateral margins of the lake. |
| Paleo lakes | : | Former lakes or former lake extensions, identified by the presence of former shorelines or flattish relief surrounding current lakes. |
| Major meltwater spillway | : | Major erosional channel cut into rock or sediment, produced by former paleo lake drainage. |
| Meltwater channels | : | Elongate erosional features cut into rock or sediment, which can flow away from moraines or sub-parallel to them where they can mark a former ice margin position. |
| Scarps | : | Small cliffs cut in sediments or rock, usually by (glacio) fluvial erosion in the study area. |
| Lakes | : | Isolated water bodies. |
| Fjords | : | Glacial valleys flooded by marine water. |
| Elongated bedrock | : | Bedrock eroded such that outcrops are elongated shapes in a former ice direction. Likely formed under subglacial conditions. At the Skyring area this bedrock is mostly relatively soft rock (sandstone). |
| Glacial lineation | : | Long, narrow elongated features shaped in the direction of former ice flow. With length to width ratios approx. 20:1. |
|  |  |  |

1. **Stratigraphic log from Terrace 6 section**



**Figure S1.** Stratigraphic log from an exposure into T6. Codes for horizontal scale are C, Si, S and G for clay, silt, sand and gravel respectively. Lithofacies codes, Gm (clast-supported gravel), Sm (massive sand), Flv (fine lamination with varves), Gms (matrix-supported gravel), St (medium to very coarse sand with trough cross-bedding), d (dropstones), thicker contact is erosive, from Evans and Benn (2021). Star indicates the location of the OSL sample shown in Figs 6 and 7 (main text)*.*

**3. Erosion rate applied to quartzite lithology boulders.**

**Table S4**. 10Be ages for boulders with quartzite lithology from Skyring ice lobe, an erosion rate of 0.7mm/kyr is applied.

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| --- | --- | --- | --- | --- | --- |
| **Sample name** | **Lm** |  | **St** |  | **LSDn** |
| **Age ka** | **± Int ka** | **± Ext ka** |  | **Age ka** | **± Int ka** | **± Ext ka** |  | **Age ka** | **± Int ka** | **± Ext ka** |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Laguna Blanca Moraine III** |  |  |  |  |  |  |  |  |  |  |
| SSK1801 | **27.69** | **1.47** | **2.75** |  | 28.28 | 1.51 | 2.81 |  | 26.94 | 1.43 | 2.66 |
| SSK1809a | **24.87** | **1.23** | **2.42** |  | 25.37 | 1.25 | 2.47 |  | 24.24 | 1.20 | 2.34 |
| SSK1814 | **26.87** | **1.44** | **2.67** |  | 27.44 | 1.47 | 2.73 |  | 26.16 | 1.40 | 2.59 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Laguna Blanca Moraine IV** |  |  |  |  |  |  |  |  |  |  |
| SSK1819 | **23.97** | **1.32** | **2.40** |  | 24.44 | 1.342 | 2.445 |  | 23.36 | 1.28 | 2.324 |
| 10Be ages calculated in the online calculators formerly known as the CRONUS-Earth v.3 (Balco et al., 2008). We applied the Patagonian production rate of Kaplan et al. (2011), the calibration data set was obtained from calibration.ice-d.org. No shielding correction for snow cover or vegetation. Pressure flag: std. Summary statistics are calculated for each group of samples for a dated landform. |
| Ages are presented in three different scaling schemes. Lm is the time-dependant scaling scheme of Lal, 1991 and Stone, 2000, we use this for this study (highlighted in bold). St is the time independent scaling scheme of Lal (1991) and Stone (2000). LSDn is the time-dependent scaling scheme of Lifton et al. (2014). Ages are reported with 1 standard deviation internal (int) and external (ext). Int include analytical uncertainty, and ext includes systematic uncertainties associated with scaling scheme and production rate. Ages are rounded using three significant figures. |

**References**

Balco, G., Stone, J.O., Lifton, N.A., and Dunai, T.J. (2008). A complete and easily accessible means of calculating surface exposure ages or erosion rates from 10Be and 26Al measurements. *Quaternary geochronology* 3(3)**,** 174-195.

Evans, D.J., and Benn, D.I. (2021). *A practical guide to the study of glacial sediments.* QRA.

Kaplan, M.R., Strelin, J.A., Schaefer, J.M., Denton, G.H., Finkel, R.C., Schwartz, R., et al. (2011). In-situ cosmogenic 10Be production rate at Lago Argentino, Patagonia: implications for late-glacial climate chronology. *Earth and Planetary Science Letters* 309(1-2)**,** 21-32.

Lal, D. (1991). Cosmic ray labeling of erosion surfaces: in situ nuclide production rates and erosion models. *Earth and Planetary Science Letters* 104(2-4)**,** 424-439.

Lifton, N., Sato, T., and Dunai, T.J. (2014). Scaling in situ cosmogenic nuclide production rates using analytical approximations to atmospheric cosmic-ray fluxes. *Earth and Planetary Science Letters* 386**,** 149-160.

Stone, J.O. (2000). Air pressure and cosmogenic isotope production. *Journal of Geophysical Research: Solid Earth* 105(B10)**,** 23753-23759.