

Early deglaciation and paleolake history of the Río Cisnes Glacier, Patagonian Ice Sheet 44°S

Supplementary information on the cosmogenic nuclide dating approach used in this study

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Introduction

This supplementary document provides detailed information about the cosmogenic nuclide dating approach applied in this study in addition to the basic information provided in the main text.

¹⁰Be cosmogenic dating approach

Samples were crushed, sieved and the 125-710 µm size fraction was further separated using heavy liquid techniques, prior to leaching with a mixture of weak HF/HNO₃ in Universidad Católica following Kohl and Nishiizumi (1992). The purity of the resulting quartz separates was then tested on using ICP-OES, before spiking

the samples with a commercial Be carrier (Scharlab 1000 mg/l Beryllium ICP standard) and dissolving in hot concentrated HF/HNO₃ in Cologne University. Although Al was not considered to be measured as part of this project, samples were spiked, where necessary, with Al carrier (Scharlab 1000 mg/l

Aluminium ICP standard) to allow future measurements should the need arise. Samples were then heated to dryness several times in the presence of aqua regia, an aliquot was taken for future elemental analysis and the dissolved samples were then prepared as AMS (Accelerator Mass Spectrometry) targets following the single-step column procedure outlined in Binnie et al. (2015). Additionally, an Ag co-precipitation method adapted from Stone et al. (2004) was used prior to final pressing. $^{10}\text{Be}/^9\text{Be}$ values were measured on Cologne AMS (Dewald et al., 2013), normalized

to the ICN standards prepared by Nishiizumi et al. (2007). Concentrations of ^{10}Be (atoms/gram quartz) are reported after the subtraction of a reagent blank, which was processed and measured in tandem with the samples and whose value is less than 2% of the total number of ^{10}Be atoms measured. The precision of the ^{10}Be concentrations were derived by propagating the uncertainties in the AMS measurements of the blank and the samples, along with a 1 % uncertainty in the mass of ^9Be added as carrier.

References

Binnie, S.A., Dunai, T.J., Voronina, E., Goral, T., Heinze, S., Dewald, A., 2015. Separation of Be and Al for AMS using single-step column chromatography. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 361, 397-401.

Dewald, A., Heinze, S., Jolie, J., Zilges, A., Dunai, T., Rethemeyer, J., Melles, M., Staubwasser, M., Kuczewski, B., Richter, J., Radtke, U., von Blanckenburg, F., Kein, M., 2013. CologneAMS, a dedicated center for accelerator mass spectrometry in Germany. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 294, 18-23.

Kohl, C.P., Nishiizumi, K., 1992. Chemical isolation of quartz for measurement of in-situ-produced cosmogenic nuclides. *Geochimica et Cosmochimica Acta* 56, 3583-3587.

Nishiizumi, K., Imamura, M., Caffee, M., Southon, J., Finkel, R., McAninch, J., 2007. Absolute calibration of ^{10}Be AMS standards. *Nuclear Instruments and Methods in Physics Research Section B* 258, 40-413.