

Signature of modern meteorological and glacial lake outburst floods in fjord sediments (Baker River, Chilean Patagonia)

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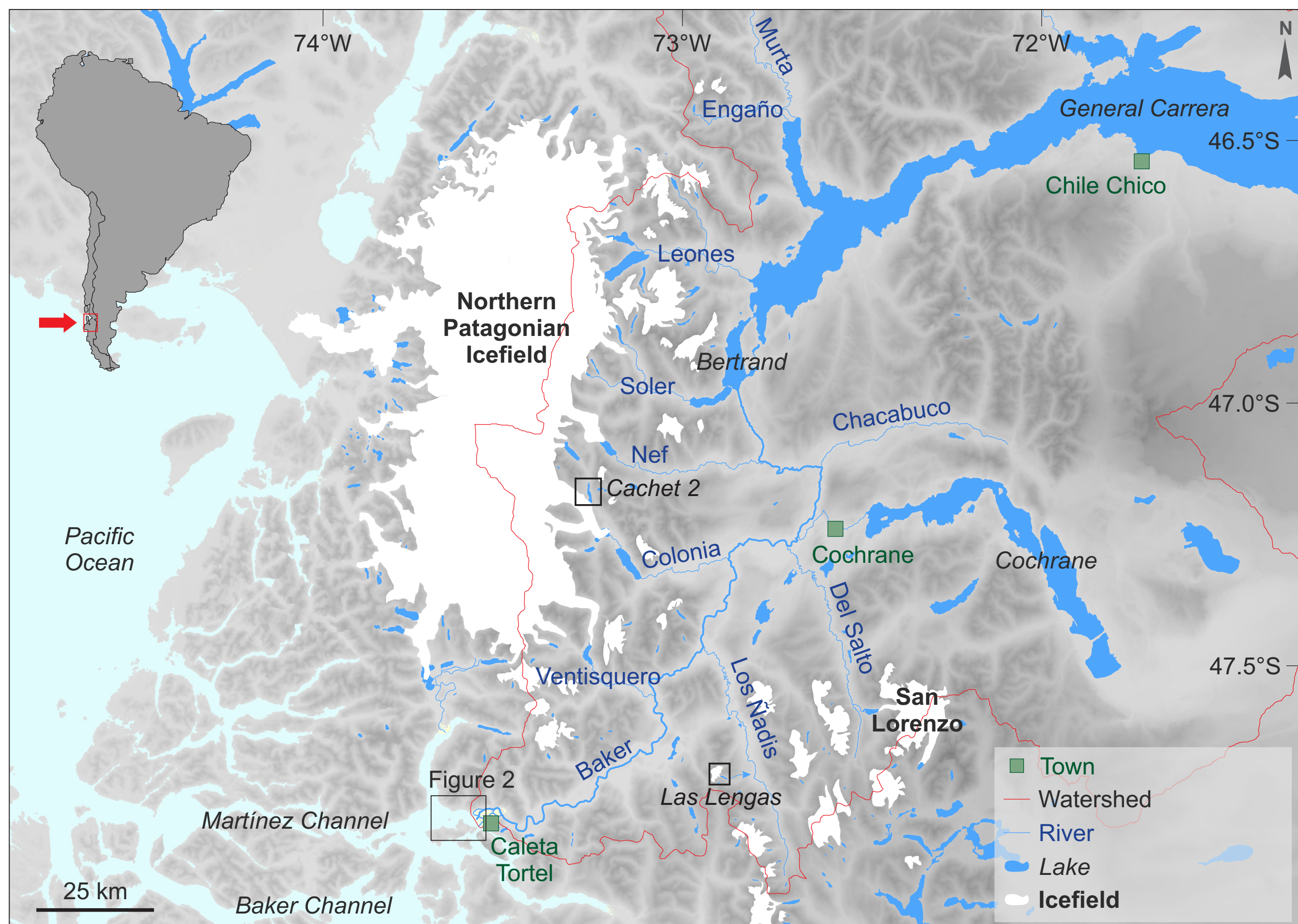
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Introduction

Floods are among the most destructive natural hazards on Earth. In paleohydrology, sediments are generally considered as one of the best archives to extend flood records to pre-historical timescales. Doing so requires being able to identify flood deposits from sediment archives and decipher between flood types. The latter is particularly important in glacierized regions, where meteorological floods frequently co-occur with Glacial Lake Outburst Floods (GLOFs).

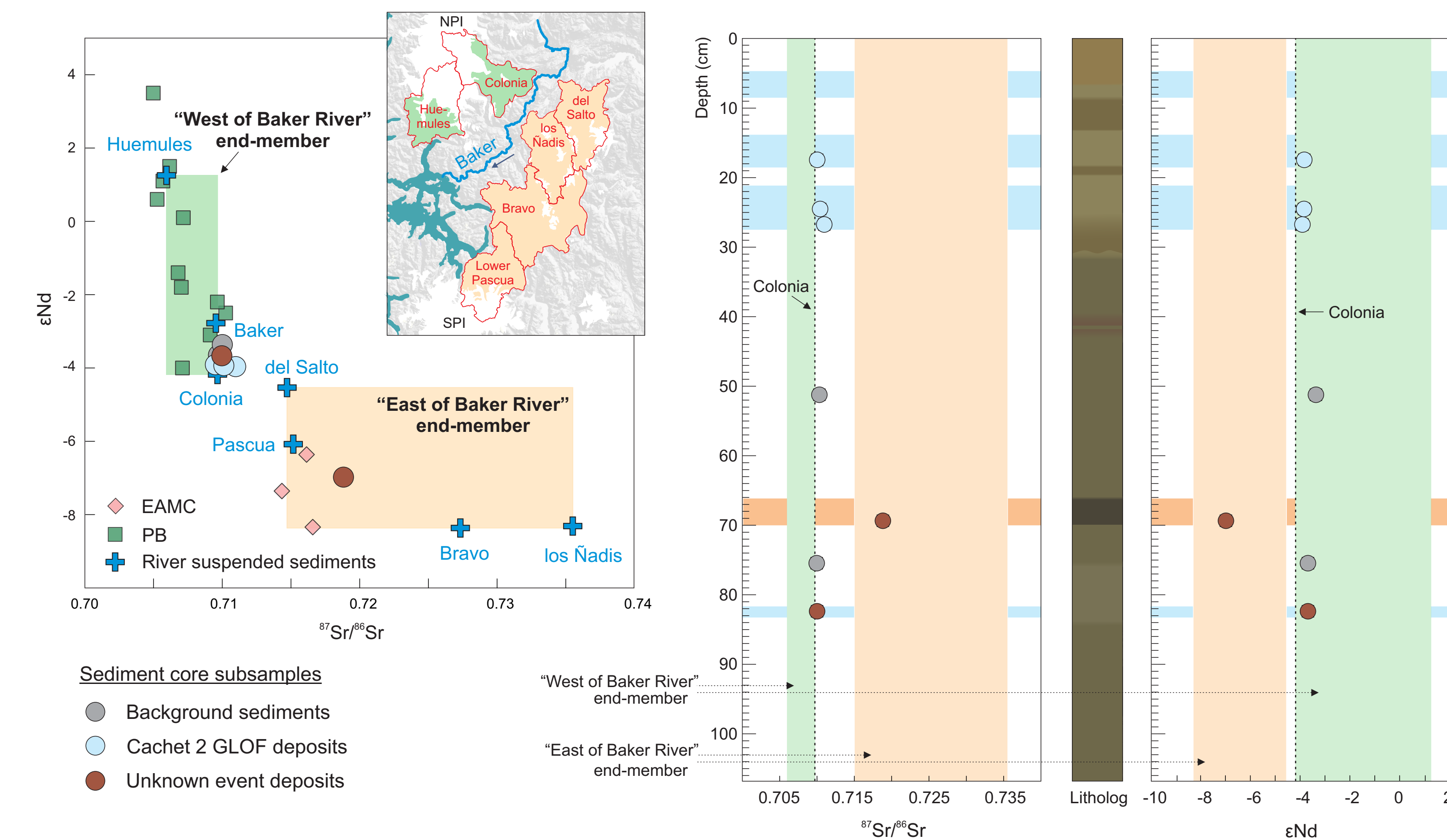
In Patagonia, GLOFs are particularly pronounced in the Baker River watershed (48°S), where 23 events occurred between 2008 and 2020. Since 1976, this region also experienced three intense rain-on-snow events.



Sediment provenance

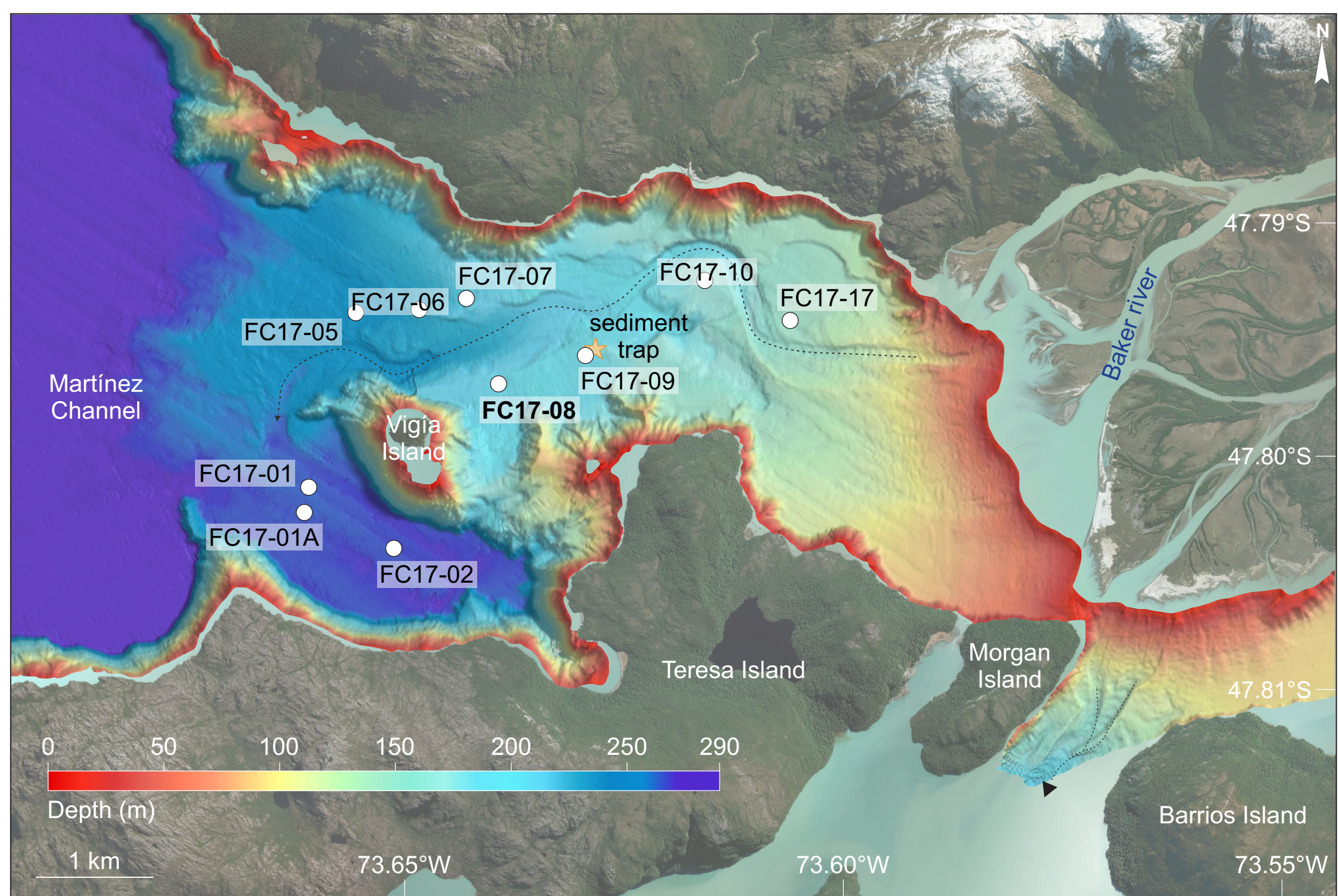
To identify the provenance of the unknown Baker River flood deposits, we used $^{87}\text{Sr}/^{86}\text{Sr}$ and ϵNd , taking advantage of the clear lithological differences that exist between both sides of the watershed.

- The provenance results confirm that the 21st century fine-grained and organic-poor deposits represent Cachet 2 GLOFs (Colonia River)
- The coarser and organic-rich turbidite (66–70 cm) originates from the eastern part of the watershed and represents the largest winter meteorological flood on record (August 1992)
- The fine-grained organic-poor deposit at 82–83 cm represents a rain-on-snow event that occurred in summer (December 1989), and primarily affected the western glacierized part of the watershed.



Baker River and downstream fjord

To identify the sedimentary signature of these flood events, ten sediment cores collected in the fjord immediately downstream of the Baker River (Martínez Channel) were investigated and compared to the recent flood history of the river.



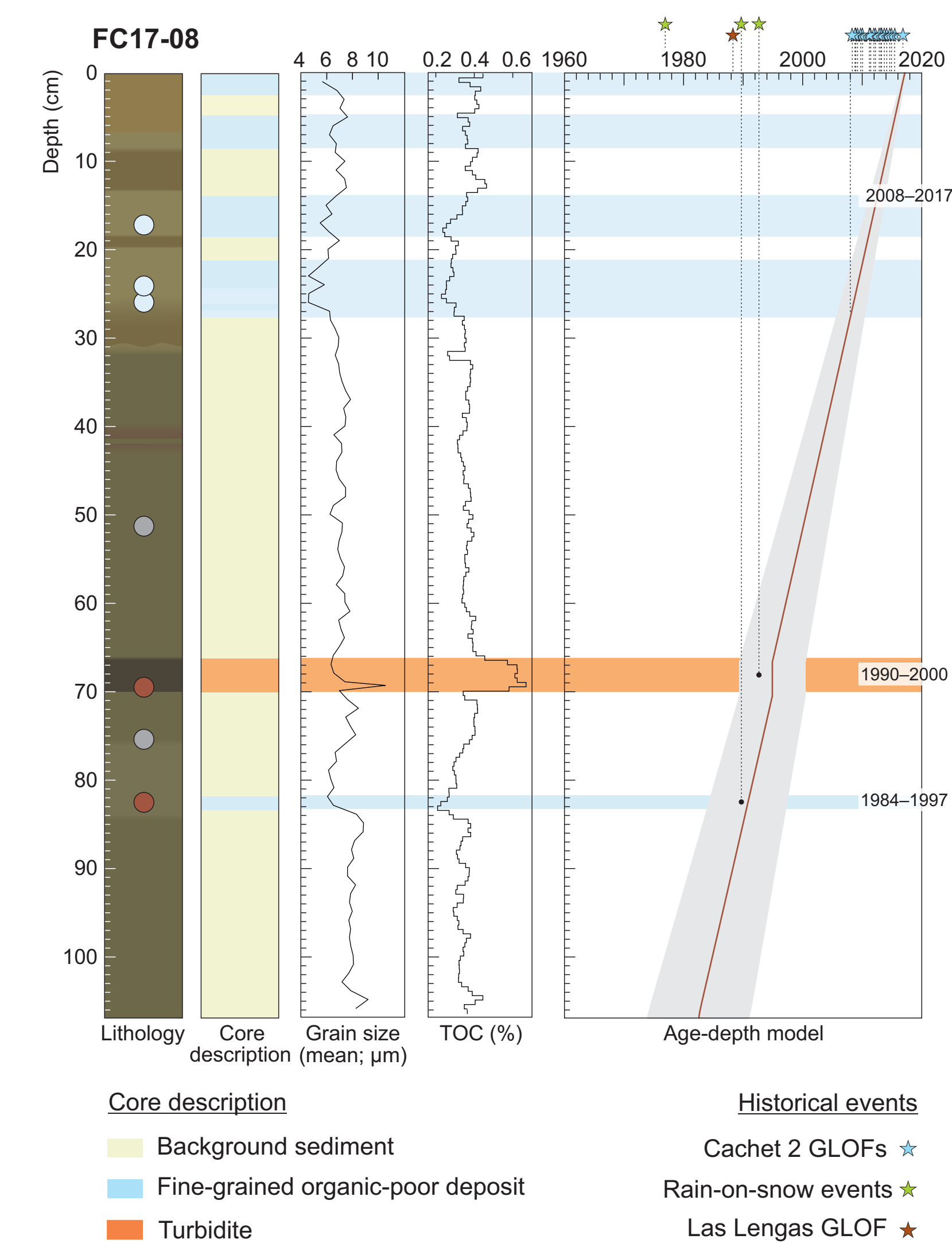
Sediment composition and chronology

On the fjord head delta, sediments accumulate at 2.0 to 3.4 cm yr⁻¹.

The 2008–2017 GLOF deposits can be distinguished from background sediments by their finer grain size ($5.98 \pm 0.82 \mu\text{m}$) and lower organic carbon content ($0.31 \pm 0.06\%$), reflecting the release and transport in suspension of high amounts of glacial rock flour.

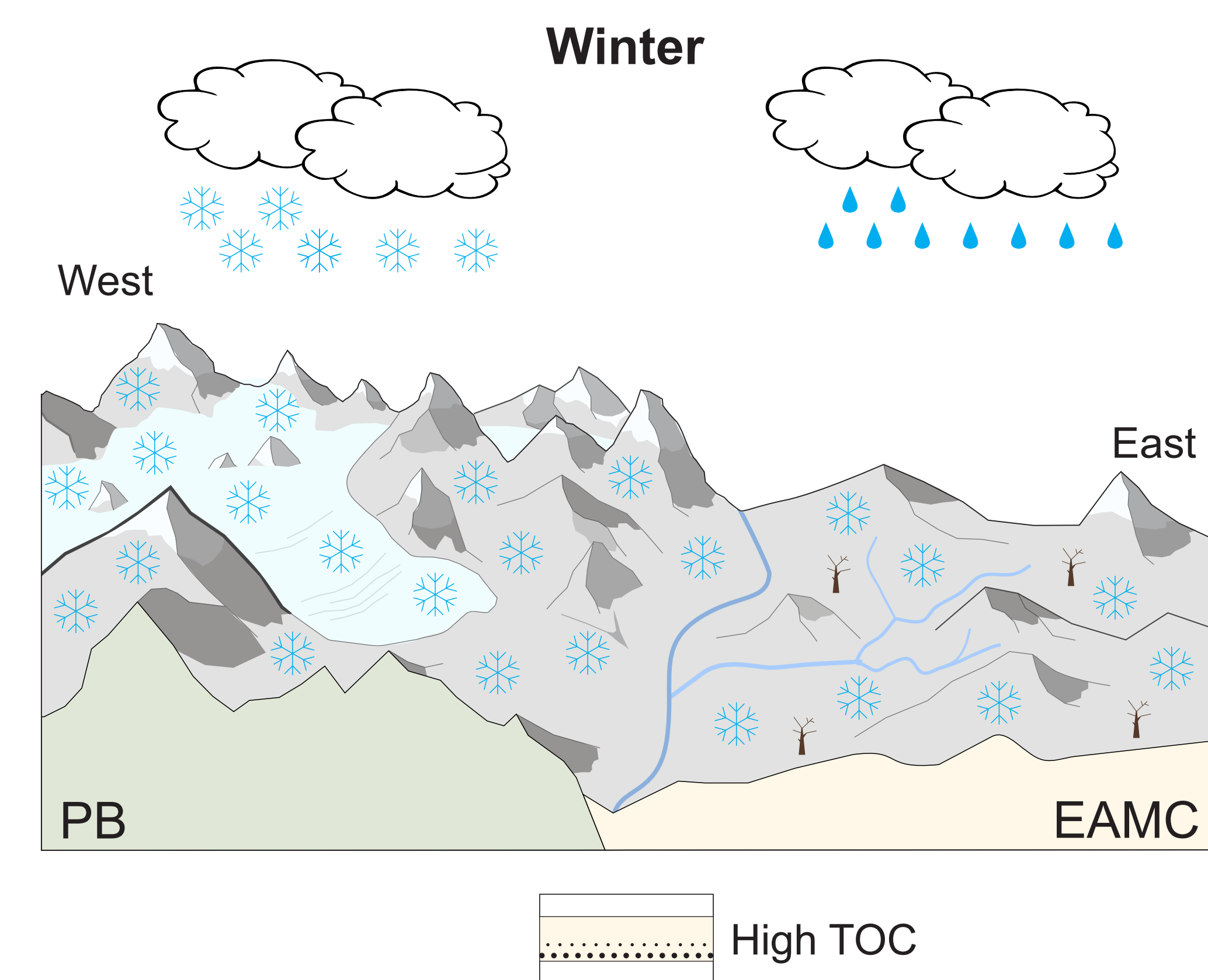
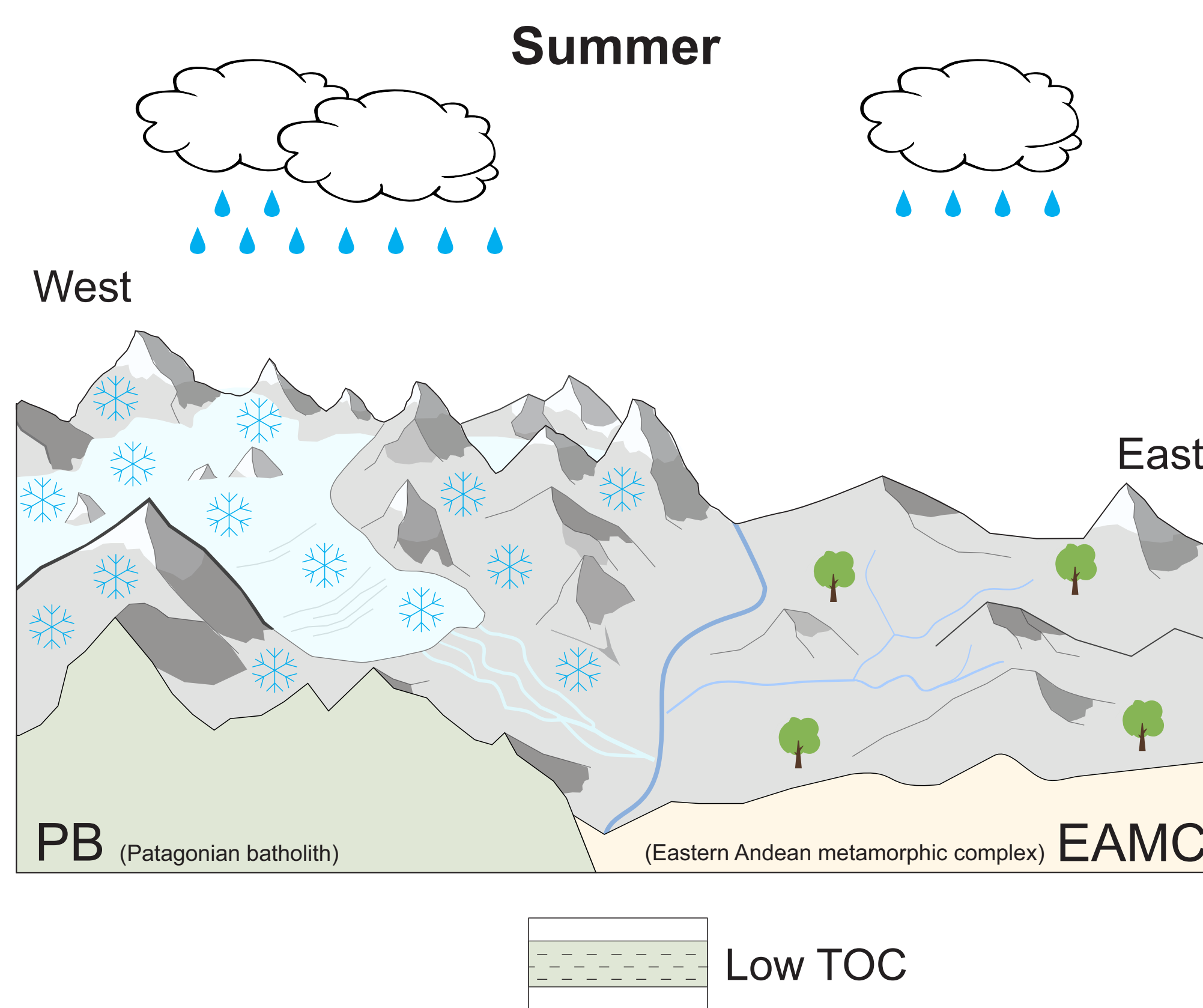
A similar deposit occurs at 82–83 cm but doesn't correspond to any known GLOF.

An organic-rich turbidite of unknown origin occurs at 66–70 cm.



Sedimentary signature of rain-on-snow floods

Rain-on-snow floods that occur in summer, and therefore primarily affect the glacierized (western) part of the watershed, have the same sedimentary signature as GLOFs. In contrast, rain-on-snow events occurring in winter have a distinct coarse and organic-rich signature, reflecting sediment input from the non-glacierized part of the watershed.



Summary

- GLOF deposits in fjord sediments are distinct from typical flood turbidites and are best identified by their low grain size and total organic carbon content.
- The sedimentary signature of rain-on-snow floods in partially glacierized watersheds depends on the season during which they occur.

Interested?

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Vandekerkhove, E., Bertrand, S., Torrejón, F., Kylander, M., Reid, B., Saunders, K. (2021). Signature of modern glacial lake outburst floods in fjord sediments (Baker River, Chile). *Sedimentology* 68 (6), 2798-2819.

Liu, D., Bertrand, S., Vandekerkhove, E., Renson, V. (2022). Provenance of Baker River sediments (Chile, 48°S): Implications for the identification of flood deposits in fjord sediments. *Earth Surface Processes and Landforms*. DOI: 10.1002/esp.5287

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