Last millenium environmental changes in Lake Bertrand sediments, Chilean Patagonia

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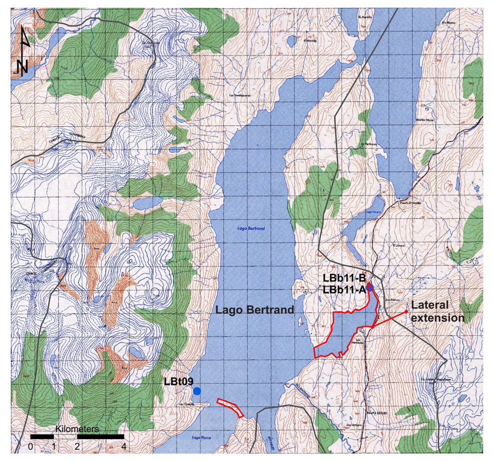
Aim of this study

Our aim is to document the climatic variability during the last millennium in Northern Patagonia and its impact on the environment. This study focuses on the sedimentary records from Lago Bertrand.

Location

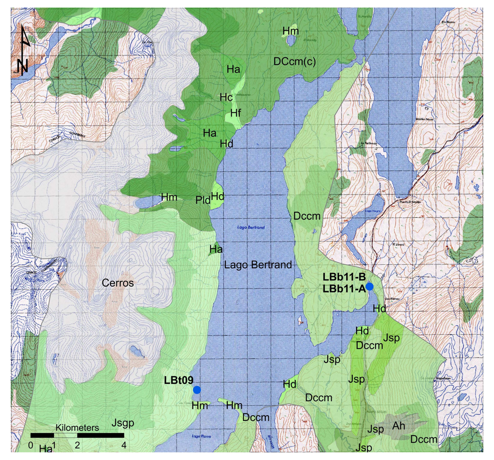
Lago Bertrand is located near the Northern Patagonian Ice Field, on the eastern edge of the Andean Cordillera at 227 m.a.s.l. (46°55'S 72°50'W). Lake aera extents to 50 km^2; its watershed to 380 km^2. This lake flows north to south from Lago General Carrera to Rio Baker. Lago Bertrand is characterized by a lateral extension on its eastern part. The main lake is separated from a pro-glacial lake (Lago Plomo) by a morainic barrier in the southwest.

ENE view of Lago Bertrand (blue) and Lago Plomo (brown)



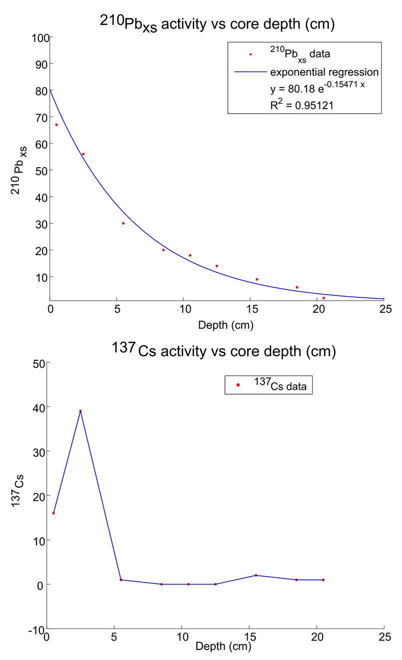
Geological context

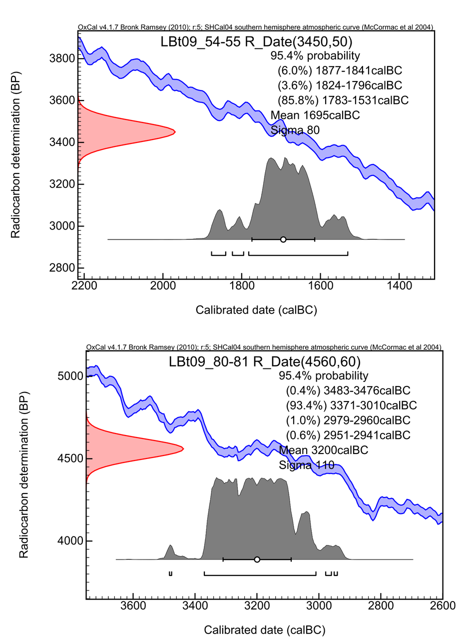
- North and East of the watershed
  - Eastern Andean Metamorphic Complex, Paleozoic (DCcm) : Metamorphosed schists
- Southwest
  - Lago Plomo Plutonic Complex, Jurassic (Jsgp)
- Southeast of the lateral extension
  - Rhyolitic silicified Porphyries, Jurassic (Jsp)
- Holocene deposits
  - Alluvial, deltaic and fluvial deposits (Ha, Hd, Hf)
  - Moraines (Hm)

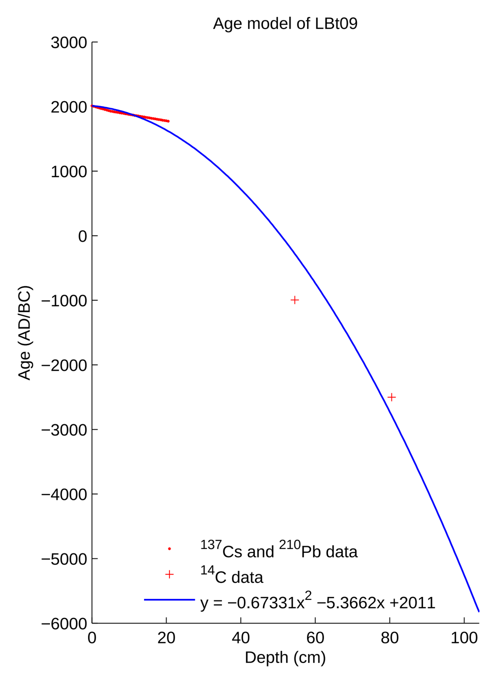


Material

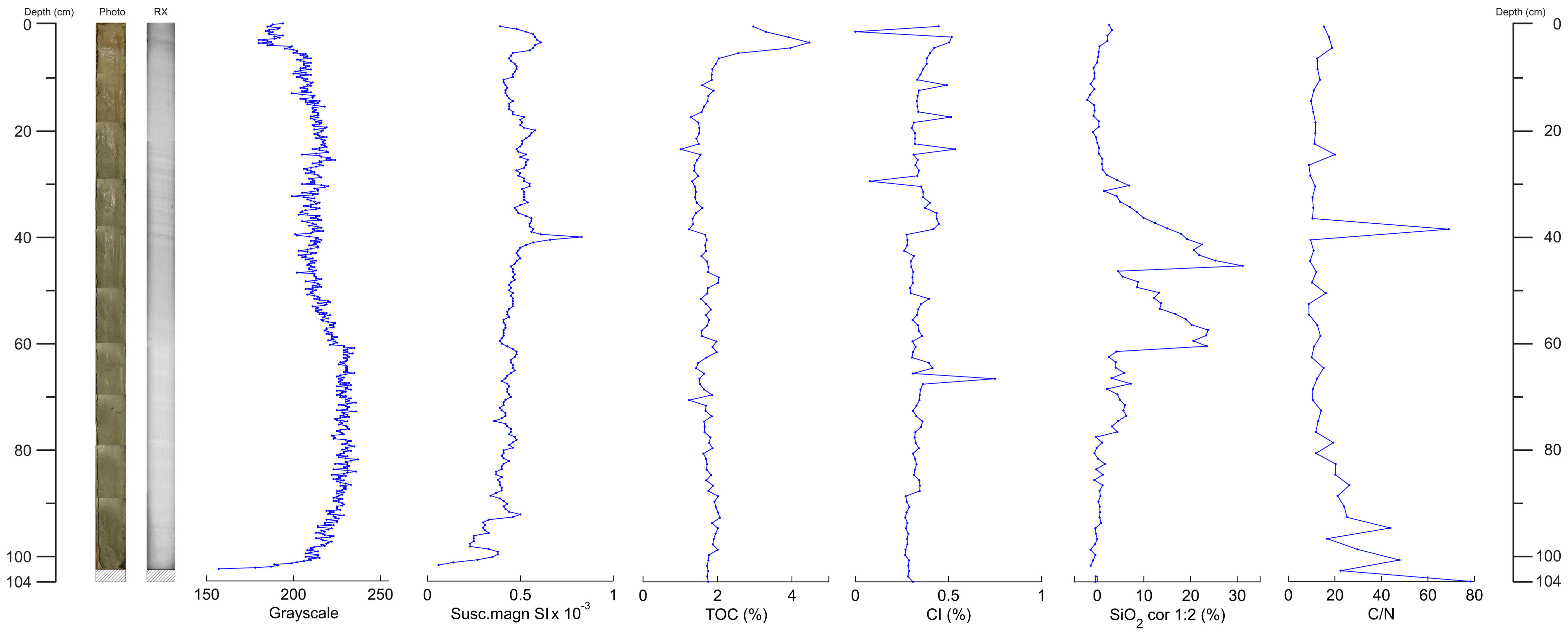
Cores were retrieved during fieldtrips in 2009 and 2011 with an Uwitec gravity corer. One core was collected in the main lake (LBt09, 104 cm) and two others in the lateral extension (LBb11-A, 162 cm and LBb11-B, 156 cm). ^{210}Pb data give average sedimentation rates of 2 mm/yr (CFCS model) for the upper core section from the main lake, allowing a decennial resolution. The ^{137}Cs peak suggests a lower sedimentation rate in the upper 5 cm (0.6 mm/yr). Two radiocarbon dates were measured on sediment organic carbon. They give calibrated ages around 1695 BC at 54-55 cm and around 3200 BC at 80-81 cm. Those ages suggest that the sedimentation rate changes drastically after the first 20 cm to 0.15-0.2 mm/yr. We applied a reservoir offset of 700 years in accordance with N/C data. Radiocarbon dates of the lake extension are in progress.



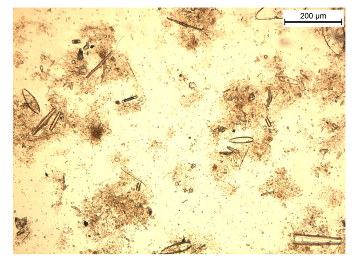


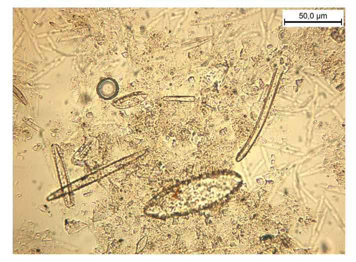


Main lake (LBt09)

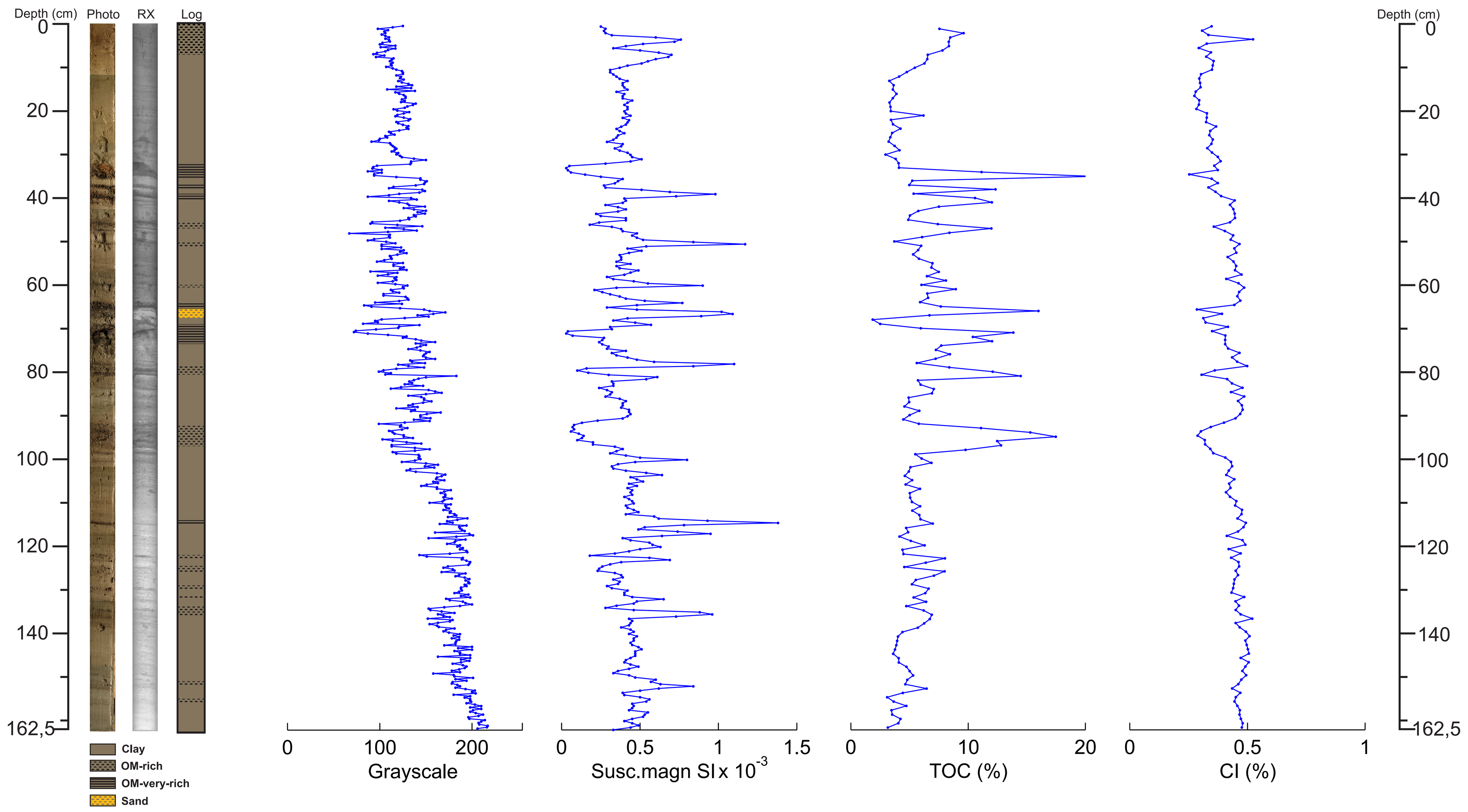


- The sediments of the main lake are composed of clayed silts and very few sandy silts. We don't observe remarkable layers as organic-rich layers or tephras.
- X-ray radiographies show diffuse centimetric laminations in the upper core and pluri-millimetric laminations in the lower core. Those laminations are highlighted by the grayscale profile.
- Magnetic susceptibility profile evidences one magnetic layer around 40 cm depth. X-ray radiographies confirm it.
- Derived from 550°C Loss Of Ignition, the Total Organic Carbon content is close to 2-5%. The first 5 centimeters are richer than the rest of the core.
- The whole core does not contain a lot of inorganic carbon (less than 1 %) after 950°C Loss Of Ignition.
- Two important peaks in the biological silica profile characterize the central part of the core.
- The C/N ratio is relatively stable with an average value of 12. The final 10 centimeters show higher values.
- Microscopic slides reveal diatoms (5-200 μm). We distinguish a lot of pennate species and few centric species.

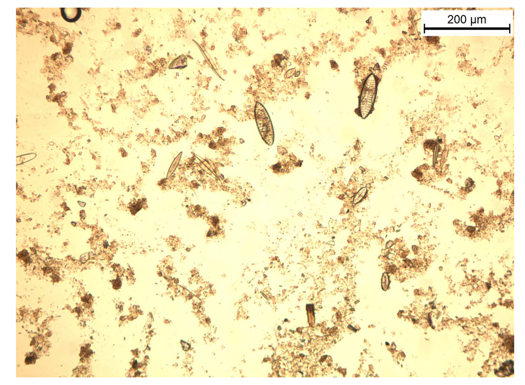


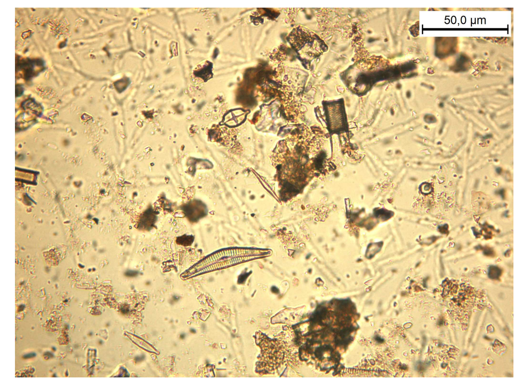


Lake extension (LBb11-A)



- We can observe well-defined pluri-millimetric laminations with organic-rich layers, especially in the central core section.
- X-ray radiographies evidence well-defined pluri-millimetric to centrimetric laminations with organic-rich layers. Grayscale profile confirm it.
- Magnetic susceptibility profile shows several peaks, especially in the central core section. Organic-rich layers are confirmed by troughs in the magnectic susceptibility profile.
- The extension is richer in organic carbon than the main lake (average of 5-10 %). Several peaks (up to 15-20%) are present in the central core section.
- 950°C Loss Of Ignition does not reveal a lot of inorganic carbon (average value of 0.4%).
- We also observe in the extension of the lake several diatoms species, especially pennate species. Specimens exhibit the same dimension than in the main lake (5-200 μm).





LBT09 Discussion

The main sedimentological change observed in Lago Bertrand is related to the two biogenic silica-rich layers. Our temporary age model for Lago Bertrand defines a time period between -700 BC and 1200 AD that includes the two peaks. Similar layers were also recorded in another relatively distant lake (Lago Thompson at 45°30'S, 72°47'W). There, the two peaks occure between 1400 and 1900 AD, an interval equivalent to the Little Ice Age.
The low C/N ratio (12) of Lago Bertrand supports an important aquatic productivity.

LBb11-A Discussion

The more recent sediments (first 30 centimeters), essencially clayed silts, do not record many sedimentological changes.
On the other hand, sediments of the central core section are less clayed and present centrimetric laminations. This variability is well defined in the magnetic susceptibility and in the Total Organic Carbon profile. This section of the core is thus characterized by more organic matter supplies.
Sedimentological parameters of the last 50 centimeters of the core are less variable.

Future prospects

The identification of diatom assemblages and their temporal variability in both lake sediments will help to identify the origin of the two silica-rich layers.
In addition, further sedimentological analyses of the Lago Bertrand extension are in progress to confirm the sedimentological changes observed in the main lake (C/N, XRD, SiBio). If similar peaks or changes appear, it would allow us to correlate the cores of the two lake parts.

Acknowledgement

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