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Potrok Aike Maar Lake Sediment Archive Drilling Project

4th International PASADO Workshop

Bremen (Germany)

August 27-29, 2012

Program and Abstracts

Universität Bremen

icdp

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4th International PASADO Workshop

Program and Abstracts

Bernd Zolitschka
(Editor)

Bremen (Germany)
August 27-29, 2012

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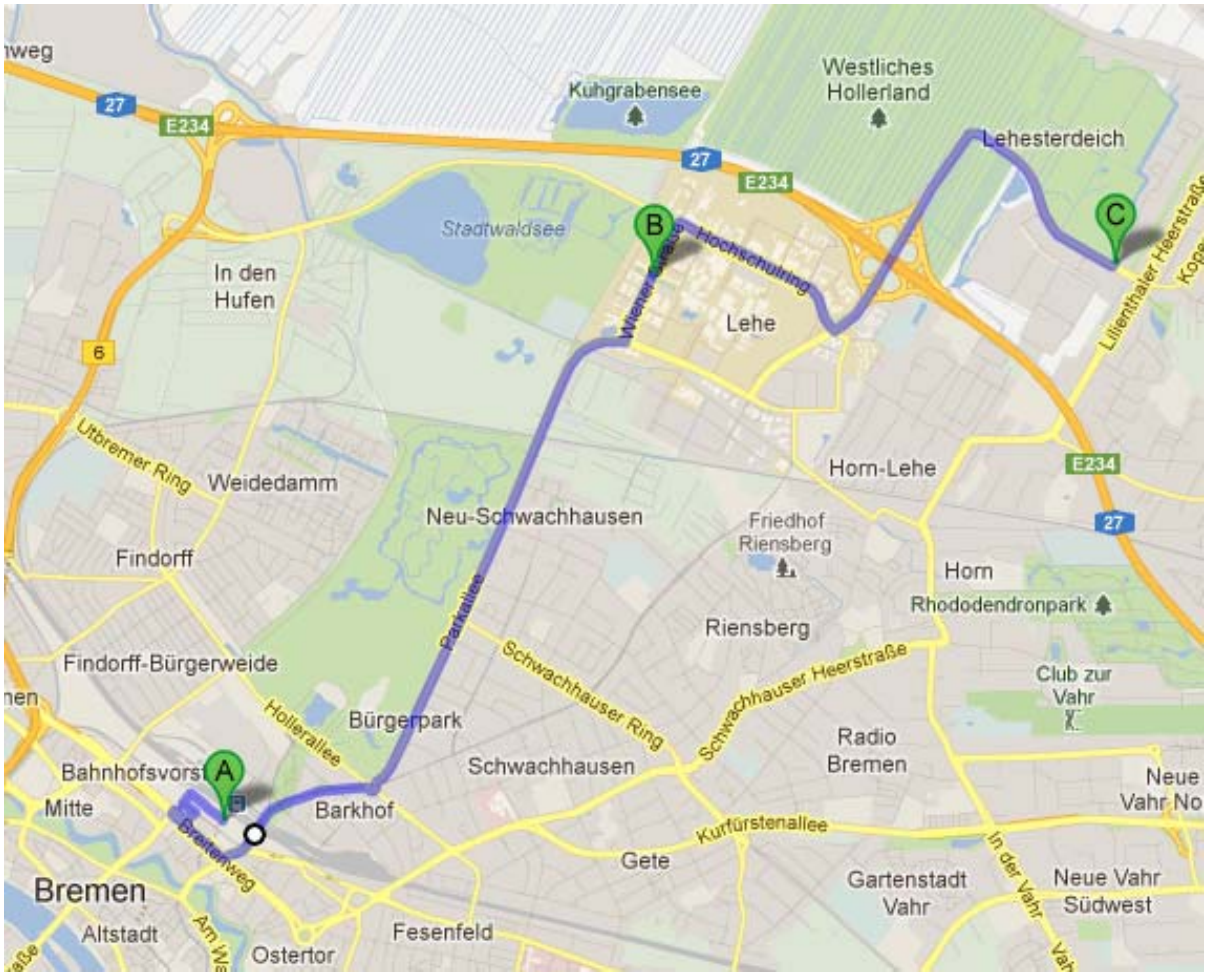
Location and map

Getting from Bremen Airport or Bremen Main Station to the University
Address: Celsiusstrasse, Building FVG-M, D-28359 Bremen
Public transportation: Use the tram line number 6 (direction: Universität) from Bremen Airport via Bremen Main Station to the University and get off at “Universität/ Zentralbereich” from where it is a 5 minutes walk. The tram runs daily every 6 minutes. The one-way fare is 2.35 € and a day ticket is 6.50 €.

Getting from Bremen Airport or Bremen Main Station to Hotel Horner Eiche
Address: Hotel Horner Eiche • Im Hollergrund 1 • D-28357 Bremen
Phone: +49(0)421-27 82 0 • email: info@hotel-horner-eiche.de
Public transportation: Use the tram line number 6 from Bremen Airport to Bremen Main Station; here you change to tram line number 4 (direction: Borgfeld) and get off at “Kopernikusstrasse” from where it is just a 2 minutes walk.

Getting from Hotel Horner Eiche to the University
Public transportation: Use bus number 21 from “Kopernikusstrasse” (direction: “Bremen, Sebaldsbrück”) and get off at “Universität/Zentralbereich” followed by a 2 minutes walk; another option is bus 630 or 670 from “Kopernikusstrasse” (direction: “Bremen Hauptbahnhof” – Central Station) and get off at “Universität/NW1” from where it is just a 3 minutes walk.



Location of Bremen Main Station (A), the FVG-Building at the University of Bremen (B) and the Hotel Horner Eiche (C). Walking distance between A and B is 5 km and between B and C it is 4 km (map source: http://maps.google.de).

Introduction

This 4th International PASADO Workshop is related to the research initiative “Potrok Aike Lake Sediment Archive Drilling Project” (PASADO) within the framework of the “International Continental Scientific Drilling Programme” (ICDP). PASADO addresses challenging issues of geoscientific and socioeconomic relevance related to Earth history and climate like qualitative and quantitative climatic and environmental reconstruction as well as reconstruction of the palaeosecular variation of the Earth's magnetic field but also natural hazards like fire history, frequency of volcanic activity including tephra fallout and dust deposition. The history of volcanic activities for the last ca. 50,000 years is another interesting topic. Moreover, dust and tephra records provide links of this unique southern hemispheric terrestrial record to marine sediment archives and to ice cores from Antarctica. Finally, obtained reconstructions of climate variability will be compared statistically with the output of Global Circulation Model (GCM) simulations to improve our understanding of forcing mechanisms of the global climate.

After the 1st International PASADO Workshop in Rio Gallegos, Argentina (March 15-19, 2006) the international and highly interdisciplinary PASADO research team has successfully obtained funding to carry out the ICDP deep lake drilling in 2008. Since coring and subsampling was completed in 2009, first scientific results have been discussed during the 2nd (in Vienna, Austria) and the 3rd (in Montreal, Canada) International PASADO workshops in subsequent years. Their focus was directed towards chronological issues, fine-tuning of results as well as on joint interpretations. Now, that many results have already been or are about to be published, we will focus during this 4th International PASADO Workshop in Bremen (Germany) on discussing findings of still ongoing research projects, of data sharing and storage, publication strategies and funding of potential future projects. Establishing closer links of collaboration between involved science teams is also a major goal of this workshop.

Acknowledgements

The research project “Potrok Aike Maar Lake Sediment Archive Drilling Project” (PASADO) would not have been possible without the support of the International Continental Scientific Drilling Program (ICDP). Funding for drilling was provided by the ICDP, the German Science Foundation (DFG), the Swiss National Funds (SNF), the Natural Sciences and Engineering Research Council of Canada (NSERC), the Swedish Vetenskapsradet (VR) and the University of Bremen. For their invaluable help in field logistics and drilling we thank the staff of INTA Santa Cruz and Río Dulce Catering as well as the Moreteau family and the DOSECC crew.

Project outline of the Potrok Aike Maar Lake Sediment Archive Drilling Project (PASADO)

Principal Investigators: B. Zolitschka, University of Bremen, Germany; F.S. Anselmetti, EAWAG Dübendorf, Switzerland; D. Ariztegui, University of Geneva, Switzerland; H. Corbella, Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina; P. Francus, INRS Quebec, Canada; A. Lücke, Research Centre Jülich, Germany; N.I. Maidana, University of Buenos Aires, Argentina; C. Ohlendorf, University of Bremen, Germany; F. Schäbitz, University of Cologne, Germany; and S. Wastegard, University of Stockholm, Sweden

History: PASADO developed from the German project "South Argentinean Lake Sediment Archives and modelling" (SALSA) funded by the German Ministry of Science and Education (BMBF) and started after six years of pre-site surveys. These included detailed limnogeological studies (gravity and piston coring), on-site monitoring of modern processes, climatic and hydrologic modelling as well as four seismic surveys at the maar lake of Laguna Potrok Aike. Geophysical studies demonstrated that ~400 m of pelagic sediments were deposited and underlain by an unknown thickness of volcaniclastic breccias. This provides an excellent background for deep drilling in the framework of the ICDP.

Questions to answer: What kind of variability can be detected for climate-related catchment parameters like vegetation change, fire history or dust storms as well as volcanic activity? How did the lacustrine ecosystem respond to this forcing since oxygen isotope stage 4? What is the temporal and regional variability of the Southern Hemispheric Westerlies? Water availability is the main factor influencing this dry steppe region in southern South America: can quantitative reconstructions of temperature, precipitation, wind intensity and wind direction provide keys to the timing and intensity of regional aridity? How is this terrestrial record linked to other natural archives from the southern hemisphere like marine sediments of the Southern Oceans and Antarctic ice cores? What can we learn by comparing our results with the output of climate modelling?

Samples collected and analyses applied: 533 m of lacustrine sediments from 2 sites and 7 holes to a maximum sediment depth of 102 m have been recovered. We carried out high-resolution non-destructive scanning techniques (XRF, physical properties, digital photography, X-ray images, spectrometry), deep biosphere analyses, rock- and paleomagnetic studies, paleobiological investigations (pollen, diatoms, chironomids) for quantitative reconstructions applying training sets and transfer functions, mineralogical, physical, geochemical, stable isotope (^{2}H, ^{10}Be, ^{13}C, ^{15}N, ^{18}O) and biomarker analyses, all backed-up by dating (AMS ^{14}C, U/Th, OSL) and stratigraphic correlation methods.

Results: We recovered a high-resolution continental archive spanning the last 51 ka with a sedimentation rate of 1 m per 1000 years (corrected for mass movement deposits). This is an environmental and climatic record unprecedented for South America south of the tropics. Amongst others, it provides quantitative data of regional water availability improving our understanding of past climate variability, important to improve predictions based on climate modelling. Thus the impact of the ongoing global climate change can be assessed as well as the understanding of the global climate system can be improved.

PASADO-related publications

Publications since 2009:

Anselmetti, F., Ariztegui, D., De Batist, M., Gebhardt, C., Haberzettl, T., Niessen, F., Ohlendorf, C., Zolitschka, B. (2009). Environmental history of southern Patagonia unraveled by the seismic stratigraphy of Laguna Potrok Aike. Sedimentology, 56, 873–892. http://dx.doi.org/10.1111/j.1365-3091.2008.01002.x

Gebhardt, A.C., M. De Batist, F. Niessen, F.S. Anselmetti, D. Ariztegui, C. Kopsch, C. Ohlendorf, B. Zolitschka (2011). Origin and evolution of the Laguna Potrok Aike maar, Southern Patagonia. Journal of Volcanology and Geothermal Research 201: 357-363. http://dx.doi.org/10.1016/j.jvolgeores.2010.12.019

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Gogorza, C.S.G., A.M. Sinito, C. Ohlendorf, S. Kastner, B. Zolitschka, 2011. Paleosecular variation and paleointensity records for the last millennium from southern South America (Laguna Potrok Aike, Santa Cruz, Argentina). Physics of the Earth and Planetary Interiors 184: 41-50. http://dx.doi.org/10.1016/j.pepi.2010.10.011

Gogorza, C.S.G., M.A. Irurzun, A.M. Sinito, A. Lisé-Pronovost, G. St-Onge, T. Haberzettl, C. Ohlendorf, S. Kastner, B. Zolitschka (2012). High-resolution paleomagnetic records from Laguna Potrok Aike (Patagonia, Argentina) for the last 16,000 years. Geochemistry, Geophysics, Geosystems. 13, Q12Z37. http://dx.doi.org/10.1029/2011GC003900

Haberzettl, T., F.S. Anselmetti, S.W. Bowen, M. Fey, C. Mayr, B. Zolitschka, D, Ariztegui, B. Mauz, C. Ohlendorf, S. Kastner, A. Lücke, F. Schäbitz, M. Wille (2009). Late Pleistocene dust deposition in the Patagonian steppe - extending and refining the paleoenvironmental and tephrochronological record from Laguna Potrok Aike back to 55 ka. Quaternary Science Reviews, 28: 2927-2939. http://dx.doi.org/10.1016/j.quascirev.2009.07.021

Hahn, A., P. Rosen, P. Kliem, C. Ohlendorf, P. Persson, B. Zolitschka, and the PASADO science team (2011). Comparative study of infrared techniques for fast biogeochemical sediment analyses. Geochemistry, Geophysics, Geosystems, 12: Q10003. http://dx.doi.org/10.1029/2011GC003686

Kastner, S., Ohlendorf , C., Haberzettl, T., Lücke, A., Mayr, C., Maidana, N.I., Schäbitz, F., Zolitschka, B. (2010). Southern Hemispheric Westerlies control the spatial distribution of modern sediments in Laguna Potrok Aike, Argentina. Journal of Paleolimnology 44: 887-902. http://dx.DOI.org/10.1007/s10933-010-9462-0

Kim, K.J., Zolitschka, B., Jull, A.J.T., Ohlendorf, C., Haberzettl, T., Matsuzaki, H. (2012). Tracing environmental change in southern Patagonia using Beryllium isotopes, (Laguna Potrok Aike, Argentina). Quaternary Geochronology, 9: 27-33. http://dx.doi.org/10.1016/j.quageo.2012.02.006

Mayr, C., A. Lücke, N.I. Maidana, M. Wille, T. Haberzettl, H. Corbella, C. Ohlendorf, F., Schäbitz, M. Fey, S. Janssen and B. Zolitschka (2009). Isotopic and geochemical fingerprints on lacustrine organic matter from Laguna Potrok Aike (southern Patagonia, Argentina) reflect environmental changes during the last 16,000 years. Journal of Paleolimnology 42: 81-102. http://dx.doi.org/10.1007/s10933-008-9249-8

Meyer, I., Wagner, S. (2009). The Little Ice Age in Southern South America: Proxy and Model Based Evidence. in: Vimeux, F., Sylvestre F., Khodri, M. (eds.), Past Climate Variability in South America and Surrounding Regions, Developments in Paleoenvironmental Research 14: 395-412, Springer. http://dx.doi.org/DOI 10.1007/978-90-481-2672-9_16

Ohlendorf, C., C. Gebhardt, A. Hahn, P. Kliem, B. Zolitschka and the PASADO science team, 2011. The PASADO core processing strategy - Sediment core treatment in an interdisciplinary deep lake drilling project. Sedimentary Geology, 239: 104-115. http://dx.doi.org/10.1016/j.sedgeo.2011.06.007

Recasens, C., Ariztegui, D., Gebhardt, A. C., Gogorza, C., Haberzettl, T., Hahn, A., Kliem, P., Lisé-Pronovost, A., Lücke, A., Maidana, N., Mayr, C., Ohlendorf, C., Schäbitz, F., St-Onge, G., Wille, M., Zolitschka, B., the PASADO Science Team, 2012. New insights into paleoenvironmental changes in Laguna Potrok Aike, Southern Patagonia, since the Late Pleistocene: the PASADO multiproxy record. The Holocene, published online December 14, 2011. http://dx.doi.org/10.1177/0959683611429833

Rosén, P., H. Vogel, L. Cunningham, A. Hahn, S. Hausmann, R. Pienitz, B. Zolitschka, B. Wagner, P. Persson (2011). Universally applicable model for the quantitative determination of lake sediment composition using Fourier transform infrared spectroscopy. Environmental Science & Technology, 45 : 8858-8865. http://dx.doi.org/10.1021/es200203z

Ross, P.-S., Delpit, S., aller, M.J., Németh, K., Corbella, H., 2011. Influence of the substrate on maar–diatreme volcanoes — An example of a mixed setting from the Pali Aike volcanic field, Argentina. Journal of Volcanology and Geothermal Research, 201: 253–271. http://dx.doi.org/10.1016/j.jvolgeores.2010.07.018

Vuillemin, A., Ariztegui, D., Vasconcelos, C. and the PASADO science team, 2010. Establishing sampling procedures in lake cores for subsurface biosphere studies: Assessing in situ microbial activity. Scientific Drilling 10: 35-39. http://dx.doi.org/10.2204/iodp.sd.10.04.2010

Zolitschka, B., F. Anselmetti, D. Ariztegui, H. Corbella, P. Francus, C. Ohlendorf, F. Schäbitz and the PASADO Scientific Drilling Team (2009). The Laguna Potrok Aike Scientific Drilling Project PASADO (ICDP Expedition 5022). Scientific Drilling, 8: 29-33. http://dx.doi.org/10.2204/iodp.sd.8.04.2009

Submitted publications:

Hahn, A., P. Kliem, M. Oehlerich, C. Ohlendorf, B. Zolitschka and the PASADO Science Team. Elemental composition of the Laguna Potrok Aike sediment sequence reveals paleoclimatic changes over the past 51 ka in southern Patagonia, Argentina. Journal of Paleolimnology, submitted.

Recasens, C. & N.I. Maidana. Cymbella gravida sp. nov. (Bacillariophyceae), a new lacustrine taxon from Santa Cruz Argentina. Diatom Research, submitted.

Vuillemin A., D. Ariztegui, A.S. De Coninck, A. Lücke, C. Mayr, C.J. Schubert and the PASADO Scientific Team. Microbial biosignatures in diagenetic concretions of Laguna Potrok Aike sediments. Journal of Paleolimnology, submitted.

Vuillemin A., D. Ariztegui, A. Lücke, C. Mayr and the PASADO Scientific Team. Food for thought: Nutrients in lake sediments and their implications for microbial communities. Geochimica et Cosmochimica Acta (submitted).

Publications to the PASADO-related special issue of *Quaternary Science Reviews*:

Zolitschka, B., F. Anselmetti, D. Ariztegui, H. Corbella, P. Francus, A. Lücke, N. Maidana, C. Ohlendorf, F. Schäbitz, S. Wastegard: Environment and climate of the last 50,000 years – new insights from the Potrok Aike maar lake sediment archive drilling project (PASADO) (in prep.)

Coronato, A., Ercolano, B., Corbella, H., Tiberi, P.: Glacial, fluvial and volcanic landscape evolution in the Laguna Potrok Aike maar area, southernmost Patagonia, Argentina. http://dx.doi.org/10.1016/j.quascirev.2012.06.019

Ohlendorf, O., M. Fey, C. Gebhardt, T. Haberzettl, A. Lücke, C. Mayr, F. Schäbitz, M. Wille and B. Zolitschka: Mechanisms of lake-level change at Laguna Potrok Aike (Argentina) - Insights from hydrological balance calculations (in revision)

Oehlerich, M., C. Mayr, E. Griesshaber, A. Lücke, O.M. Oeckler, C. Ohlendorf, W.W. Schmahl, B. Zolitschka: Ikaite precipitation in a lacustrine environment – implications for paleoclimatic studies using carbonates from Laguna Potrok Aike (Patagonia, Argentina). http://dx.doi.org/10.1016/j.quascirev.2012.05.024

Kliem, P., D. Enters, A. Hahn, C. Ohlendorf, A. Lisé-Pronovost, G. St-Onge, S. Wastegård, B. Zolitschka and the PASADO science team: Lithology, radiocarbon chronology and sedimentological interpretation of the lacustrine record from Laguna Potrok Aike, southern Patagonia (in revision)

Nuttin, L., Francus, P., Preda, M., Ghaleb, B. & Hillaire-Marcel, C.: Authigenic, detrital and diagenetic minerals in the Laguna Potrok Aike sedimentary sequence (in revision)

Buylaert, J.P., Murray, A.S., Gebhardt C., Sohbati, R., Ohlendorf, C., Thiel, C., Zolitschka, B.: Luminescence dating of the PASADO core 5022-1D from Laguna Potrok Aike (Argentina) using IRSL signals from feldspar (in revision)

Wastegård, S. Veres, D., Kliem, P., Ohlendorf, C., Zolitschka, B. and the PASADO science team: Towards a late Quaternary tephrochronological framework for the southernmost part of South America – the Laguna Potrok Aike tephra record (in revision)

Lisé-Pronovost, A., St-Onge, G., Gogorza, C., Haberzettl, T., Preda, M., Francus, P., Zolitschka, B. and the PASADO science team: High-resolution paleomagnetic secular

variation and relative paleointensity since the Late Pleistocene in Southern South America. http://dx.doi.org/10.1016/j.quascirev.2012.05.012

Kliem, P., Buylaert, J.P., Hahn, A., Mayr, C., Murray, A., Ohlendorf, C., Veres, D., Wastegård, S., Zolitschka, B. and the PASADO science team: Magnitude, geomorphologic response and climate links of lake level oscillations at Laguna Potrok Aike, Patagonian steppe (Argentina) (in revision)

Vuillemin, A., Ariztegui, D. & the PASADO Scientific Team: Geomicrobiological investigations in subsaline maar lake sediments over the last 1500 years. http://dx.doi.org/10.1016/j.quascirev.2012.04.011

Fortin, D., Francus, P., Gebhardt, A.C., Hahn, A., Kliem, P., Lisé-Pronovost, A., Royshowdury, R., Labrie, G., St-Onge, G. and the PASADO Science Team: Destructive and non-destructive density determination: method comparison and evaluation from the Laguna Potrok Aike sedimentary record (in revision)

Hahn, A., P. Kliem, C. Ohlendorf, B. Zolitschka, P. Rosén and the PASADO science team: Climate induced changes in the content of carbonaceous and organic matter of sediments from Laguna Potrok Aike (Argentina) during the past 50 ka inferred from infrared spectroscopy (in revision)

Schäbitz, F., Wille, M., Haberzettl, T., Quintana, F., Mayr, C., Lücke, A., Ohlendorf, C., Mancini, V., Paez, M., Zolitschka, B.: Reconstruction of paleoprecipitation based on pollen transfer functions – the record of the last 16 ka from Laguna Potrok Aike, southern Patagonia (in revision)

Massaferro, J., Recasens, C., Larocque-Tobler, I., Maidana, N.I., Zolitschka, B.: Major lake level fluctuations and climate changes for the past 16,000 years as reflected by diatoms and chironomids preserved in the sediment of Laguna Potrok Aike, southern Patagonia (in revision)

Jouve, G., Francus, P., Lamoureux, S., Provencher-Nolet, L., Hahn, A., Haberzettl, T., Fortin, D., Nuttin, L., and the PASADO Science Team: Microsedimentological characterization using image analysis and XRF as indicators of sedimentary processes and climatic changes during the Late Glacial at Laguna Potrok Aike, Santa Cruz, Argentina. http://dx.doi.org/10.1016/j.quascirev.2012.06.003.

Zhu, J., A. Lücke, H. Wissel, D. Müller, C. Mayr, C. Ohlendorf, B. Zolitschka and the PASADO science team: The last Glacial – Interglacial transition in Patagonia, Argentina: the stable isotope record of bulk sedimentary organic matter from Laguna Potrok Aike. http://dx.doi.org/10.1016/j.quascirev.2012.05.025.

Pollock, E.W. & Bush, A.B.G.: Atmospheric simulations of the present and past climate of southern South America (in revision)

Scientific Program

Monday, August 27:

Arrival of participants

12:00h Lunch at the University cafeteria for those arriving early

13:00h Get together in the seminar room (FVG-Building West, Room 0060)

13:15h Bernd Zolitschka: Opening of the 4th ICDP-Workshop PASADO and organizational details

Chair: Bernd Zolitschka

13:30h Aurèle Vuillemin et al.: Uncovering present and past microbial activity in lacustrine sediments: Is there an unequivocal sediment-species relationship?

14:00h Katja Hockun et al.: PASADO Lipids project: Calibration of lipid biomarker proxies and their compound-specific isotopes

14:30h Hamed Sanei et al.: Preliminary results of mercury and organic matter sedimentary records from Laguna Potrok Aike

15:00h **Coffee break**

Chair: Enno Schefuß

15:30h Kyeung Kim et al.: High-resolution paleoclimatic records of Beryllium isotopes from Laguna Potrok Aike (Patagonia, Argentina) for the last 18,000 years

16:00h M. Oehlerich, C. Mayr, Andreas Lücke et al.: Stable isotopes of carbonates from Laguna Potrok Aike: methodology, results and paleoclimatic implications

16:30h Jiayun Zhu et al.: Stable oxygen and carbon isotope record of aquatic moss from Laguna Potrok Aike at the last Glacial – Interglacial transition

17:00h Wrap-up session and discussion

19:00h Finish of the day and dinner at the restaurant “Haus am Walde” or “Platzhirsch” (on your own), both within walking distance

Tuesday, August 28:

Chair: Andreas Lücke

08:30h Cristina Recasens et al.: Diatoms from Laguna Potrok Aike: diversity, ecology and paleoenvironmental changes revealed from the PASADO sediment record

09:00h Michael Wille et al.: Comparison of pollen profiles from Laguna Potrok Aike with the dust proxy from the Antarctic ice core EPICA Dome C

09:30h Annette Hahn et al.: Laguna Potrok Aike: elemental composition

10:00h **Coffee break**

Chair: David Fortin

10:30h Guillaume Jouve et al.: Microsedimentological evidences for hydrological changes during Antarctic Isotope Maximum 12, 8 and 4 at Laguna Potrok Aike, Santa Cruz, Argentina

11:00h: Andreas Lücke et al.: Glacial Antarctic warm events in organic isotope records of Laguna Potrok Aike: patterns and lessons

11:30h A. Lisé-Pronovost, Guillaume St-Onge et al.: Rock-magnetic proxies of environmental changes since 51.2 ka cal BP from Laguna Potrok Aike, southern Patagonia

12:00h **Lunch break** at the University cafeteria

Chair: Pierre Francus

13:00h Wrap-up of the morning session and discussion

14:00h Christian Ohlendorf et al.: Attempts to identify eolian input in the sediment record of Laguna Potrok Aike (southeastern Patagonia)

14:30h Discussion* about dust in the southern hemisphere; Summary of present knowledge – what is new? Where is the challenge?

15:30h **Coffee break**

Chair: Daniel Ariztegui

16:00h Bernd Zolitschka et al.: Hydrological variations at Laguna Potrok Aike and its regional perspective for southern Patagonia

16:30h Discussion* about regional hydrological variability; Summary of present knowledge – where is the challenge?

17:30h Wrap-up of the afternoon session and discussion

19:00h **Workshop dinner** on board of the 19th century frigate “Admiral Nelson”

* This discussion should be closely linked to the issues laid out under „The future of PASADO“ on Wednesday morning.

Wednesday, August 29:

Chair: Guillaume St-Onge

08:30h Catalina Gebhardt et al.: Inter- and intrasite comparison between Sites 1 and 2, PASADO deep drilling project – lake evolution, local paleoclimate history, OSL age information

09:00h Towards an integration of radiocarbon and OSL chronologies – do we have to reinterpret the glacial record from Laguna Potrok Aike? Discussion* about the potential and how to deal with future age model(s)

10:00h **Coffee break**

10:30h The future of PASADO

- Data base management: where are we going to store the published data and related metadata?
- Current state of ongoing and potential future projects
- How to deal with future sample requests?
- Status of the PASADO special issue of *Quaternary Science Reviews*
- Quest for a high profile paper (Science, Nature) and what would be the best strategy to achieve this goal?
- Other business

11:30h Final discussion and closing remarks

12:30h Lunch at the University cafeteria for those leaving after lunch

Departure of participants

* This discussion should be closely linked to the issues laid out under „The future of PASADO“ on Wednesday morning.

Abstracts

(Abstracts are sorted alphabetically according to the first author)

Inter- and intrasite comparison between Sites 1 and 2, PASADO deep drilling project – lake evolution, local paleoclimate history, OSL age information

C. GEBHARDT[1], C. OHLENDORF[2], J.-P. BUYLAERT[3], THE PASADO SCIENCE TEAM[4]

[1] Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

[2] Geopolar, Institute of Geography, University of Bremen, Germany

[3] Nordic Laboratory for Luminescence Dating, Department of Geosciences, Aarhus University, Risø DTU, DK-4000 Roskilde, Denmark

[4] PASADO Science Team as cited at: http://www.icdp-online.org/front_content.php?idcat=1494

During the deep drilling campaign at Laguna Potrok Aike in austral spring 2008, two sites were drilled in quadruplicate and triplicate, respectively, and the latter (Site 2) was finally chosen as the key site for a multiproxy study aiming at paleoclimate reconstructions. Site 2 was mainly chosen because its sediments in general were finer grained than those at Site 1. This was also confirmed by a much higher penetration in the seismic sections at Site 2 than in most other places of the lake.

During the process of core opening and description it became obvious that the records at both sites are dominated by a large number of mass transport deposits. In order to perform paleoclimate studies, these parts were cut out from the composite profile, and only the remaining pelagic sediments were considered.

Nevertheless, a comparison between the two sites – Site 1 in the center of the lake in front of the present mouth of the ephemeral inlet, Site 2 sheltered at the southern end of the lake – reveals interesting information on the local paleoclimate history and on lake evolution and dynamics. Many marker beds allow a clear correlation between the two sites, and both small and large mass transport deposits are observed, the former only locally at one site, the latter reaching both sites. Furthermore, a comparison between the single holes at each site shows that mass transport deposits are highly variable also between positions that are only some ten meters apart. This gives an insight into the highly dynamic processes that took place (and still take place) during sediment accumulation in Laguna Potrok Aike.

While most of the multiproxy parameters were only measured on the Site 2 composite profile, all scanning and logging data, i.e. elemental counts (XRF scanning data) and physical properties (magnetic susceptibility, density) were measured on all cores. For this current study, we plan to use these data together with the core images for comparison between the sites (intersite comparison) and between the holes of a site (intrasite comparison). This comparison is complemented with additional information such as grain size or TOC measurements carried out at Site 2. Seismic profiles will be used to track reflectors between the sites and to give more information on the spatial occurrence of specific layers.

A reliable correlation between the two sites will also allow to compare the radiocarbon age model of Kliem et al. (submitted to the special issue) with the new OSL ages from Buylaert et al. (submitted to the special issue). While ^{14}C ages were measured on samples of Site 2, OSL samples were taken from Site 1. OSL samples were taken only from the pelagic part of Site 1 and can relatively easily be correlated to the Site 2 composite profile. A comparison between the age models that result from the two methods shows that mainly the lower part of the record might be older than previously thought and gives some evidence for a potential hiatus. This would be in agreement with seismic data that point at a desiccation phase in the lowermost part of the record (Gebhardt et al., 2012).

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Laguna Potrok Aike: elemental composition

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During the lake deep drilling campaign PASADO in 2008 more than 500 m of lacustrine sediment was recovered from the maar lake Laguna Potrok Aike, Argentina. The major element composition was assessed at high resolution with an ITRAX XRF core scanner. The sharp boundary between the carbonate-bearing and the carbonate-free depositional systems at 15.6 cal. ka BP dominates the principal component analysis of the dataset, marking the transition from the glacial to the Late Glacial. Holocene and Late Glacial sediments can be distinguished by elements that are indicative of organic-rich sediments (Br, Cl) or of calcite (Ca). Glacial sediments are characterized by elements that represent terrigenous sediment fluxes (Fe, Ti, K, Si,). Trace elements (Mn, Rb, V, Ni) accumulate with the bulk of lithogenic elements indicating frequent oxic conditions and uncommon diagentic remobilization. We propose the scores of the first principle component as a summarizing indicator for climate-related variations in depositional conditions.

During the Holocene the first principal component mirrors the total inorganic carbon profile used as a primary proxy for climate reconstructions of the past 16 ka in previous studies. Low scores in the first principle component are assumed to reflect increases of chemical over mechanical weathering and developing soils and vegetation cover limiting sediment availability. These intervals often also show increases in total organic carbon values and total organic carbon/total nitrogen ratios, which are associated to periods of Antarctic warming. Geochemical variations of the clastic glacial sediments are explored by excluding carbonate-bearing sediments from the principal component analysis. Although in carbonate-free sediments Ca is a purely clastic signal, it does not correlate with the bulk of indicators for

terrigenous input. Instead it dominates a second principal component together with Sr. This component mainly distinguishes coarse grained layers from the remaining sediment. The main provenance of this material is suggested to be a basalt outcrop at the western shore. During extremely cold, arid and windy conditions, low lake levels, high waves and flash flood events may have increased the availability of black basaltic sand. High wind speeds and lacking vegetation may have facilitated the increased transport of coarse grained material into the centre of Laguna Potrok Aike. Increases in the second principal component can be observed during OIS 2 during which increased dust input has been found in cores from Laguna Potrok Aike, the Southern Ocean and Antarctica.

PASADO Lipids project: Calibration of lipid biomarker proxies and their compound-specific isotopes

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The PASADO ("Potrok Aike Maar Lake Sediment Archive Drilling Project") Lipids project aims at providing new insights into the climate history of southern South America by using new organic-geochemical approaches based on lipid biomarkers. We study abundance and compound-specific hydrogen isotope compositions (δD) of biomarkers derived from terrestrial and aquatic plants including *n*-alkanes and *n*-fatty acids as well as temperature- and pH-sensitive abundance ratios of membrane lipids of archaea and bacteria (glycerol dialkyl glycerol tetraethers, GDGTs). Based on the GDGTs it is aimed to infer lake temperature changes using TEX_{86} (TetraEther index of GDGTs with 86 carbon atoms) as well as soil temperature and pH changes using the MBT/CBT indices (methylation ratio/ cyclization ratio of branched tetraethers). Differences between compound-specific δD values of biomarkers from aquatic and terrestrial sources are expected to reflect changes in the lake water balance. The overarching goal is to establish quantitative reconstructions of temperature and hydrology in southern Patagonia over the last 51,000 years. Together with published data, we aim at developing an improved mechanistic understanding of the coupling of terrestrial climatic conditions and oceanic climate changes in the Southern Hemisphere.

First, a regional calibration for the TEX_{86}- and MBT/CBT-proxies based on modern conditions is needed to improve later reconstructions of past climate variability. For this purpose, GDGT distributions in soil samples from a W-E transect as well as in a series of lake surface sediments have been analyzed to determine their dependence on soil temperature and pH in southern Patagonia. Furthermore, the lipid biomarker signatures of lake surface sediments and various organic source materials (aquatic and terrestrial plants) from the study site, Laguna Potrok Aike, will be analyzed to identify major organic matter contributors to the sediments and to find suitable tracers for paleo-hydrologic reconstructions. For the 16 top-soil samples from a W-E transect, *n*-alkane, *n*-fatty acid and GDGT concentrations were measured as well as δD compositions of selected long-chain *n*-alkanes (n-C_{29}&n-C_{31}). Preliminary results document a relationship between GDGT index parameters and soil temperature and pH in the study area. The predicted temperatures based on the published global calibration are lower than measured temperatures. For this reason a new calibration is essential for reliable reconstruction. The long-chain *n*-alkanes of the top-soil samples show similar δD values to previously investigated sediment samples from Laguna Potrok Aike. In particular, δD values of n-C_{31} indicate a significant increase

(about 30‰) from W to E likely indicating rainout of Atlantic moisture over southern South America.

In order to reconstruct regional climate changes from Laguna PotrokAike and its vicinity, samples from the PASADO core will be analysed applying the above mentioned proxies extending the investigations to the past 55.000 year.

Microsedimentological evidences for hydrological changes during Antarctic Isotope Maximum 12, 8 and 4 at Laguna Potrok Aike, Santa Cruz, Argentina.

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Ice cores from Vostok and the EPICA Dome C in Antarctica provided several paleoclimatic proxies such as the hydrogen (δD) and oxygen ($\delta^{18}O$) isotope variations as indicators of changes in temperature and ice volume for multiple interglacial-glacial cycles. Since the last glacial, several Antarctic Isotope Maxima (AIM) have occurred. They corresponded to Antarctic Warm Events (AWE) and were contemporaneous with Heinrich events in Greenland (Johnsen et al., 1992; Bond et al., 1993; McManus et al., 1999). During Heinrich events, changes in atmospheric and oceanic circulations in the Northern Hemisphere are well characterized and contrary to those in the Southern Hemisphere during AWE. However, understanding global evolution of environmental systems during sudden climate changes is inseparable from an equivalent knowledge of both hemispheres. Here, microsedimentological characterization using µ-XRF and SEM-EDS analyses were conducted along AIM 12, 8 and 4 at Laguna Potrok Aike (LPA), located in the province of Santa Cruz in Argentina.

Currently, intense Westerlies at LPA enforce polymictic conditions and prevent ice cover during winter (Endlicher, 1993; Zolitschka et al., 2006). In this presented study, we report evidences of high lake level stands during AIM 12, 8 and 4. A general pattern is observed during these events. First, several clay layers and fine laminations (Fig. 1A) together with K/Ti, Fe/Ti, and Mn/Ti peaks, attest of more distal conditions of sedimentation, water stratification and ice cover during winter. Second, clay balls were detected (Fig. 1B) and reveal remobilization of permafrost during these periods. The latter demonstrate intensification of cold conditions and more surface runoff which, in the same way, result in a higher elevation of the lake level. In agreement with other proxies developed by scientists involved in the PASADO project, we propose strong diminution of the Westerlies during AIM12, 8, and 4 at LPA, with substantially more easterlies, bringing more precipitation from the Atlantic Ocean (Schneider et al., 2003; Mayr et al., 2007).

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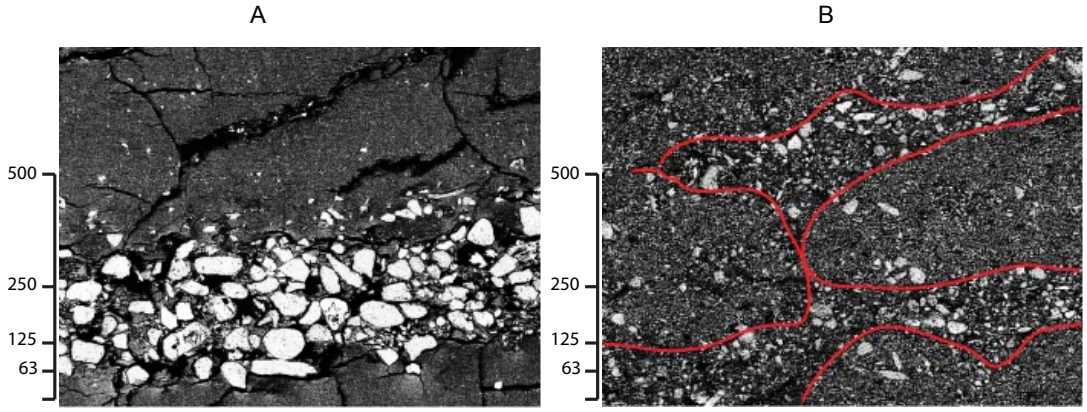

Figure 1: (A) fine laminations (clay/sand) and (B) clay balls

High-resolution paleoclimatic records of Beryllium isotopes from Laguna Potrok Aike (Patagonia, Argentina) for the last 18,000 years

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High-resolution Beryllium-10 records were obtained from the sediment record of Laguna Potrok Aike, Patagonia, Argentina (51°58'S, 70°23'W) for the last 18,000 years. The ^{10}Be records provide an insight into the hydrological balance of the lake (Kim et al., 2012). The preliminary both ^{10}Be and ^{9}Be data may be related to paleoclimatic signals with respect to the sedimentation rate or dry/wet cycles. The Be isotope records show that there were several distinctive dry/cold periods during the last 18,000 years. However, a time associated with a distinctively low ^{10}Be record but high ^{9}Be suggests that this period is related to a time period when paleomagnetic intensity was very high (e.g. ~4 kyr BP) (Gebhardt et al. 2012). Therefore, understanding the ^{10}Be and ^{9}Be records in conjunction with either climatic change or paleomagnetic intensity is feasible through the approach of this study.

There is a debate as to whether the Younger Dryas (YD) could be associated with a cosmic ray flux increase or a cosmic impact. The most recent publication proposed the YD event as a result of a cosmic impact (Firestone et al. 2007; Israde-Alcantara et al. 2012) but

this is not supported by other authors (Boslough et al. 2011; Daulton et al., 2010). In this study, both ^{10}Be and ^{14}C records show an increase of these concentrations just before the cooling period of the YD similar to the ^{10}Be record of the GRIP ice core. We have also examined the sediment for magnetic properties and isotopic studies. We will discuss if this data can be used to confirm the increase of the flux of cosmogenic nuclides and might possibly be due to a cosmic event (e.g. cosmic ray effects). This possible senario can be investigated using our ^{10}Be record. The presentation will cover Be isotope stratigrapy for the last 18,000 years along with other proxies such as dust flux, $\delta^{18}O$, $\delta^{13}C$, relative paleomagnetic intensity, physical examination of the sediment, and other authigenic elemental records of the lake Laguna Potrok Aike.

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Rock-magnetic proxies of environmental changes since 51.2 ka cal BP from Laguna Potrok Aike, southern Patagonia

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Laguna Potrok Aike in southern Patagonia is a key site for paleoenvironmental reconstruction because it is located on one of the only landmasses in the pathway of the Southern Hemisphere Westerly winds (SHW) and within the main dust source area for the

Southern Ocean and Antarctica during the last glacial period. Here we present a high-resolution rock-magnetic study of the long sedimentary sequence recovered as part of the PASADO-ICDP project in order to interpret the magnetic susceptibility record and to develop a proxy of wind intensity and environmental changes since 51.2 ka cal BP.

The rock-magnetic data were acquired at the Institut des sciences de la mer de Rimouski (ISMER) using 1) a Bartington magnetic susceptibility point sensor mounted on a multi-sensor core logger (on u-channels), 2) Bartington systems for high temperature and frequency-dependant magnetic susceptibility measurements (on discrete samples), 3) a 2G Enterprises u-channel cryogenic magnetometer and 4) a Princeton Measurement Corp. alternating gradient force magnetometer for discrete samples. The high-resolution rock-magnetic results clearly indicate that magnetite is the dominant magnetic mineral deposited and preserved in the sediments of Laguna Potrok Aike since 51.2 ka cal BP. In addition to an overall homogeneous magnetic mineral assemblage optimal for paleomagnetic reconstructions (Gogorza et al., 2011; Lisé-Pronovost et al., in press), the variable amount of coarser magnetite grains and the preservation of smaller magnetite grains in specific intervals are useful paleoenvironmental indicators. In particular, the median destructive field of the isothermal remanent magnetisation (MDF_{IRM}) is a measure of the coercivity of the coarse (>10 µm) magnetite grains and is interpreted as a wind intensity proxy over Southern Patagonia, with coarser grains deposited during times of stronger winds. In addition, sharp changes in the magnetic grain size indicators sensitive to the smallest grain sizes (Mr/Ms and MDF_{ARM}) reveal the preservation of distinctively finer magnetic grains at the end of each warm millennial-scale event since 51.2 ka cal BP. This result suggests rapid climate change at the end of the Late Glacial warming, the Antarctic warm events 1 and 2, and at 50 ka cal BP. In addition, the high-resolution rock-magnetic results indicate that the magnetic susceptibility record at Laguna Potrok Aike is controlled by two factors: the flux of ferrimagnetic grains to the lake floor and changes in the input of coarse (>10 µm) magnetite grains. We demonstrate that the input of coarse magnetite grains is controlled by the wind intensity, while the flux is most likely related to the availability of exposed erodible land in Southern Patagonia. This double control on the magnetic susceptibility signal from within the dust source area of Southern Patagonia results in both similarities and differences when compared to distal dust records such as marine sediment cores from the Southern Ocean and ice cores in Antarctica.

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Glacial Antarctic warm events in organic isotope records of Laguna Potrok Aike: patterns and lessons

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The last Glacial was punctuated in Antarctica by several warm events (A1- A7) occurring between 90 and 35 ka BP (Blunier and Brook, 2001). These millennial scale events have been connected to the Southern Hemisphere Westerlies (SHW), respectively to changes in their intensity, based on the ice core evidences. Similarities between the aeolian activity in Patagonia and dust deposition in Antarctic ice cores have been described earlier (Haberzettl et al., 2009). It has been suggested that some of the Glacial Antarctic warm events, namely A1 and A2, have their expression in the sediment record of Laguna Potrok Aike as well (Hahn et al., accepted).

We present the organic isotope records of the time period containing the early warm events (A1 and A2) and describe their patterns. Based on the similarity to the respective Late Glacial development of organic isotope proxies in Laguna Potrok Aike and its interpretation (Zhu et al., accepted) we propose that the counterparts of the Antarctic warm events in Patagonia are characterized by a drop in intensity of the SHW with millennial scale calmer conditions. This fits to the reduction of non-sea-salt calcium flux (nss-Ca^{2+}) in Antarctic ice cores during the warm events that are interpreted as strong changes in aeolian dust deposition (Röthlisberger et al., 2004). Calmer conditions in Patagonia led to reduced heat loss with warmer and probably more stable anticyclonic pressure systems during summer months with a contemporaneous increase in lacustrine primary production. This fundamental pattern seems to have been modulated by sea-level changes with accompanying changes in the South American land mass and the availability of nutrients for lacustrine production. These factors would explain differences between single warm events. We propose the combination of total nitrogen concentration (TN) and stable nitrogen isotopes as qualitative indicator for changes in west wind strength at Laguna Potrok Aike during the Last Glacial. Based on this evidence we mark several older episodes that could be interpreted as periods of calmer conditions at Laguna Potrok Aike. We suggest that these episodes can be connected to the older warm events in Antarctica unequivocally, if a better constrained chronological framework for the Laguna Potrok Aike record could be developed. This indicates that SHW strength is the dominant determinant for climatic conditions in Patagonia independent of the general state of the climate system (glacial – interglacial).

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Stable isotopes of carbonates from Laguna Potrok Aike: methodology, results and paleoclimatic implications

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The ICDP site Laguna Potrok Aike (51°57´S, 70°23´W), is a polymictic lake in the Patagonian steppe of Argentina. The 106 m long composite profile 5022-2CP, recovered in 2008, corresponds to an environmental archive of ~51 kyrs. This record is the closest continuous terrestrial environmental archive of this age to Antarctica and thus bears the opportunity to link climate records of southern South America with high-resolution Antarctic ice cores.

The use of stable isotope geochemistry of inorganically precipitated carbonates as a paleoenvironmental and paleoclimate proxy has been established and constantly improved since the 1950ies. Subsequent studies showed that the carbon and oxygen isotopic composition of bulk carbonates ($\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$) is often influenced by the release of CO_2 derived from organic matter. Thus, pre-treatment methods (vacuum roasting, NaOCl and H_2O_2) have been used for removing organic matter. With artificial mixtures Wierzbowski (2007) demonstrated that a pre-treatment for such analyses is not necessary if the total-inorganic-carbon-to-organic-carbon ratio (TIC/TOC) is larger than 1. However, in the case of Laguna Potrok Aike the low carbonate content of its sediments is often combined with relatively high organic matter content. Moreover, the carbonate content of Laguna Potrok Aike sediments is high in the Holocene (up to 20 wt. %) but low or even absent during the last glacial period. More than fifty powder-XRD analyses of bulk sediment down core indicate that calcite is the main carbonate mineral and only very rarely monohydrocalcite and dolomite occur.

Thus we adapted the experiments of Wierzbowski (2007) to TIC/TOC-ratios as low as possible. Furthermore, we used a wider variety of organic components for the artificial mixtures. It turned out, that the threshold for providing a reliable isotope value depends extremely on the kind of organic matter. Applying a TIC/TOC threshold of 0.1 on the sediment record of Laguna Potrok Aike, all apparent outliers in the isotope record in the period of 9.4 to 14.8 cal. kyrs BP are omitted. In the core sections <9.4 cal. kyrs BP and in the Glacial period a TIC/TOC-ratio of 0.25 is necessary to omit such apparent outliers.

If the $\delta^{18}O_{carb}$ record is revised in this manner, it shows a Holocene maximum centred around 8 cal. kyrs BP that matches highest $\delta^{15}N$ values interpreted as increased soil erosion during that time (Mayr et al., 2009). Maximum TIC and long-distance transported Andean forest pollen (Mayr et al., 2007) indicate a drought period with extreme low lake levels (Anselmetti et al., 2009). Relative $\delta^{18}O_{carb}$ increases around 12.4 and 8.0 cal. kyr BP represent drought periods while periods with low $\delta^{18}O_{carb}$ and TIC, such as around 0.4 cal. kyrs BP, reflect more humid periods. Thus, the $\delta^{18}O_{carb}$ record can be interpreted as proxy for hydrological rather than temperature variations. Sr-isotopes possibly show different sources and thus may improve our understanding of catchment–related processes in the future.

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Attempts to identify eolian input in the sediment record of Laguna Potrok Aike (southeastern Patagonia)

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During the past decade, there was ongoing discussion about the impact of dust in the southern hemisphere. Fingerprint analyses of the dust components detected in Antarctic ice cores revealed Southern South America (SSA) with its extended dry areas as the major source for dust in the higher latitudes of the southern hemisphere. Dust is mostly related to strength and direction of the wind systems and thus to paleoclimatic changes. SSA is mainly influenced by the Southern Hemisphere Westerlies (SHW) that shift in latitudinal position between glacial and interglacial times, thus influencing the amount of dust that is mobilized. Our study site Laguna Potrok Aike is a lake situated in the middle of the source area of dust and thus offers the unique opportunity to investigate a dust record that allows a better understanding of the migration of the SHW and the associated paleoclimatic changes. In this lake, a lacustrine deep drilling campaign (PASADO) was carried out in 2008. The cores recovered during the PASADO deep drilling hold a paleoclimatic record of the past ~51 ka. Magnetic susceptibility was used in marine cores to trace eolian input (Hofmann 1999, Pugh et al. 2009, Weber et al. 2012) and the same approach was proposed for Laguna Potrok Aike (Haberzettl et al. 2009). However, this lake is situated in a large volcanic field, and grains carrying magnetic susceptibility presumeably are not exclusively of eolian origin. It is thus questionable whether magnetic susceptibility can be used without any constraint as a measure for eolian input in this terrestrial record. We are therefore attempting to characterize the specific fingerprint of eolian material in order to distinguish it from e.g. riverine material.

In a first step, 76 samples representative of all different lithologies encountered in the sediment sequence were taken from the 106 m long PASADO Site 2 composite profile. On fresh samples, magnetic susceptibility was measured and the element composition was determined by XRF-scanning. After freeze-drying, physical, chemical and mineralogical sediment properties were determined. Each sample was then separated into six grainsize classes by sieve and sedimentation techniques, and the same parameters were then determined for each fraction separately. SEM techniques were used to verify the eolian origin of grains. The aim of this approach is to isolate the fingerprint of the eolian sediment fraction in terms of their grain size, physical and chemical composition. A first evaluation of the dataset indicates that the magnetic susceptibility signal of the original, wet samples is not

solely representing the grain size of the sediments as is often the case. For instance, samples with high sand percentages show average susceptibility values and low total Fe counts. However, considering only the silt fraction of these samples, high values of magnetic susceptibility and high Fe counts are observed. Element counts have been determined for the different grain size fractions by XRF-scanning of powdered samples. First results indicate that the content of some elements is characteristically enriched in the clay, silt and medium sand fractions which might allow a geochemical fingerprinting of each fraction. The magnetic susceptibility is mainly determined by the fine sand and the silt fraction. For instance, an identification of higher amounts of clay in a sample may be possible based on it's enrichment in heavy metals (Zn, Cu, Pb) and/or Fe. Higher amounts of silt may be recognized by Zr and/or Y enrichment. Apart from a slightly increased Rb content, fine sand probably is difficult to trace based on it's geochemical fingerprint. Medium sand shows an enrichment of Si, Ni, and Sr. Hence, unmixing of the signal stored in the sedimentary record of Laguna Potrok Aike with tools of multivariate statistics is a necessary step to characterize the eolian fraction. The 51 ka BP sediment record of Laguna Potrok Aike can then be used to arrive at a reconstruction of dust availability in the high latitude source areas of the southern hemisphere.

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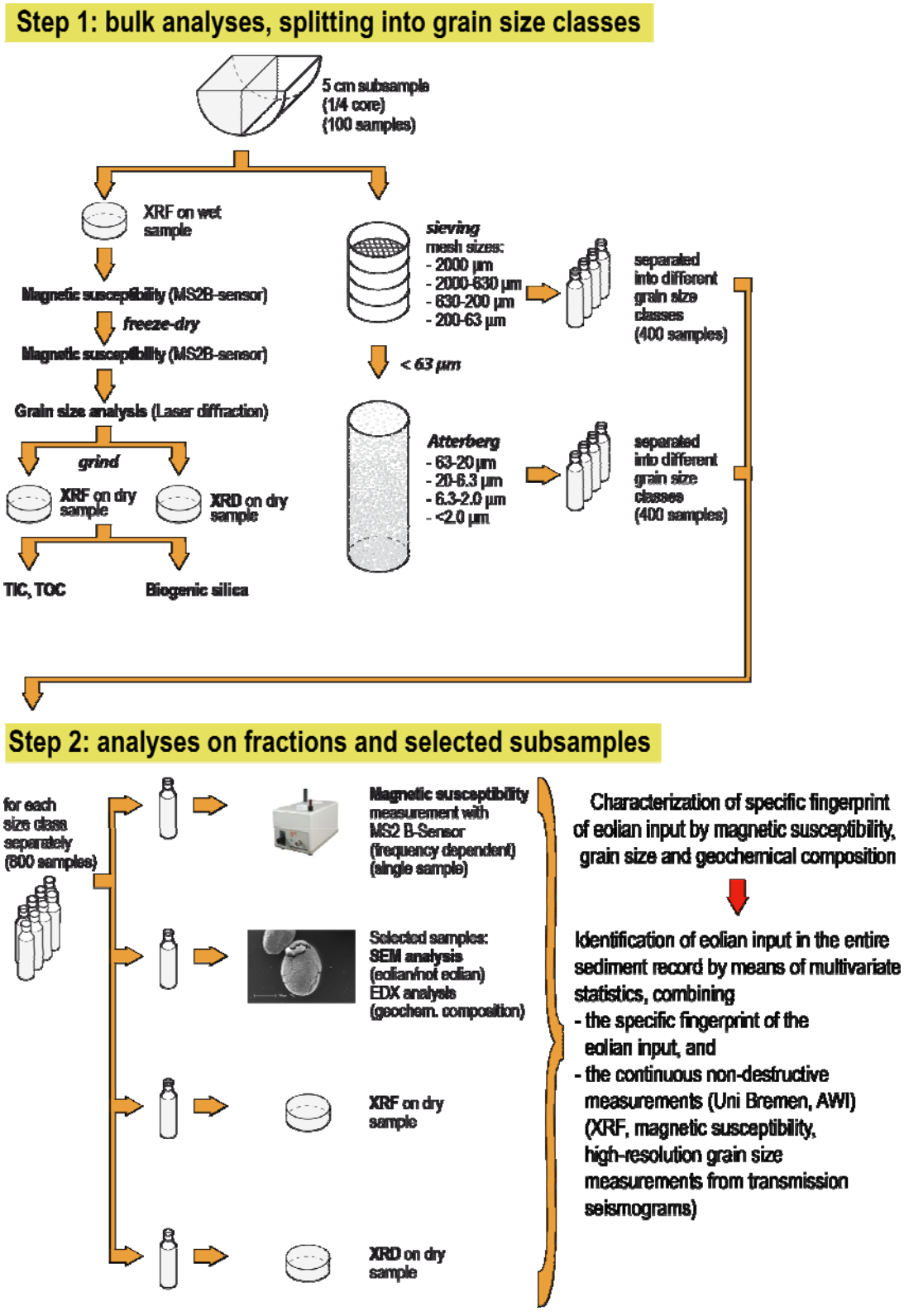

Fig. 1: Workflow of different methods used for this study. All samples are analysed both as a bulk sample as well as after splitting them into different grain size classes.

Diatoms from Laguna Potrok Aike: diversity, ecology and paleoenvironmental changes revealed from the PASADO sediment record

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Laguna Potrok Aike is a maar lake located in southernmost Argentinean Patagonia, in the province of Santa Cruz. As one of the few permanent lakes in the area, it provides an exceptional and continuous sedimentary record. The sediment cores from Laguna Potrok Aike obtained in the framework of the ICDP-sponsored project PASADO (Potrok Aike Maar Lake Sediment Archive Drilling Program), were sampled for diatom analysis in order to reconstruct a continuous history of hydrological and climatic changes since the Late Pleistocene. Diatoms are widely used to characterize and often quantify the impact of past environmental changes in aquatic systems. We use variations in diatom concentration and in their taxonomical assemblages, combined with other proxies, to track these changes.

Diatom assemblages were analyzed on the composite core 5022-2CP, located ca. 700 m south of the center of the lake (Figure 1). The total composite profile length of 106.09 mcd (meters composite depth) was reduced to 45.80 m cd-ec (event-corrected composite profile) of pelagic deposits once gaps, reworked sections and tephra deposits were removed and this continuous deposit spans the last 51.2 cal. ka BP (Kliem et al., in review). The sampling protocol for sediment subsampling for multiproxy analyses was especially developed for the PASADO project (Ohlendorf et al., 2011).

We here present the results from the diatom analysis of the composite core 5022-2CP with a resolution ranging from 16 to 32 cm, corresponding to a multi-centennial time resolution. Previous diatomological analysis from the core catcher samples of core 5022-1D (Recasens et al., 2012), allowed us to determine the dominant diatom assemblage and select the sections where higher temporal resolution was needed. Over 200 species, varieties and forms have been identified in the sediment record, including several endemic species and several species which are new to science. For example, *Thalassiosira patagonica* (Maidana, 1999) and *Corbellia contorta* (Maidana and Round, 1999) were found and described for this lake. In the framework of PASADO, a new species of the genus *Cymbella* has been observed for the first time in the sediments of Laguna Potrok Aike and has been described as *Cymbella gravida sp. nov.* Recasens and Maidana (Recasens & Maidana, in prep.) which is shown in Figure 2. The combination of our study with the modern training set developped for Patagonia within the framework of the Argentinean project PIPA (Proyecto Interdisciplinario Patagonia Austral) will provide unique information on diatom diversity and (paleo)ecology for the Southern Hemisphere.

The quantitative analysis of the sediment record reveals diatom abundances ranging from nearly none to 460 million valves per gram of dry sediment, with substantial fluctuations through time. The new results on diatom diversity and distribution in the glacial to late glacial part of the record give new information on the previously poorly known paleolimnology of this lake for that time. The bottom 5 m of the record, corresponding approximately to the last 51 to 49 cal. ka BP are dominated by *Discostella stelligera* morph 1 (Recasens et al. 2012) and several benthic and epiphytic species such as *Cocconeis placentula* and species of *Pinnularia, Amphora* and *Nitzschia*. At ca. 49 cal. ka BP, this dominating assemblage rapidly decreases and a peak of *Cyclostephanos patagonicus*, a big planktonic diatom, is observed. The former assemblage could be indicative of a lower lake level, or increased in-wash from

the littoral area (explaining the increase in benthic diatoms, living prefereably in the shallower areas). The occurrence of *C. patagonicus* would indicate a freshwater input in the system and increase of the lake level, favouring the hypothesis of a previous lower level. Nevertheless, *C. patagonicus* abruptly disappears at ca. 48 cal. ka BP, only reappearing in the sediment record at 16.5 cal. ka BP. The gap in *C. patagonicus* could be explained by remarkable changes in the lake level, although no other proxies point to that fact in this time period. It is most likely that there was a change in the nutrient balance in the water column, causing the diatom flora to switch dramatically. Indeed, variations in diatom abundance and species distribution could either point toward lake level variations, changes in nutrient input or even periods of ice-cover on the lake. The diatom assemblages between 48 and 16.5 cal. ka BP reveal a stable and quite cosmopolitan flora, making it difficult to establish a fine paleoecological interpretation based only on this proxy. A correlation with other proxies is thus necessary to further develop these hypotheses. The diatom analysis of the top few meters on both profiles (5022-1D and 5022-2CP) are consistent with previous results from a shorter core retrieved during the former SALSA project, covering the last ca. 16 cal. ka BP (Massaferro et al., accepted; Wille et al. 2007). This part of the record is characterized by the presence of *C. patagonicus* which is slowly replaced by more brackish species, *Cyclotella agassizensis* and *Thalassiosira patagonica* at ca. 9.4 cal. ka BP which dominate up to the present. This shift in the phytoplakton composition corresponds to the previously documented salinization of the water and the lake level drop giving a signal of warming temperatures and lower moisture availability during the early and middle Holocene.

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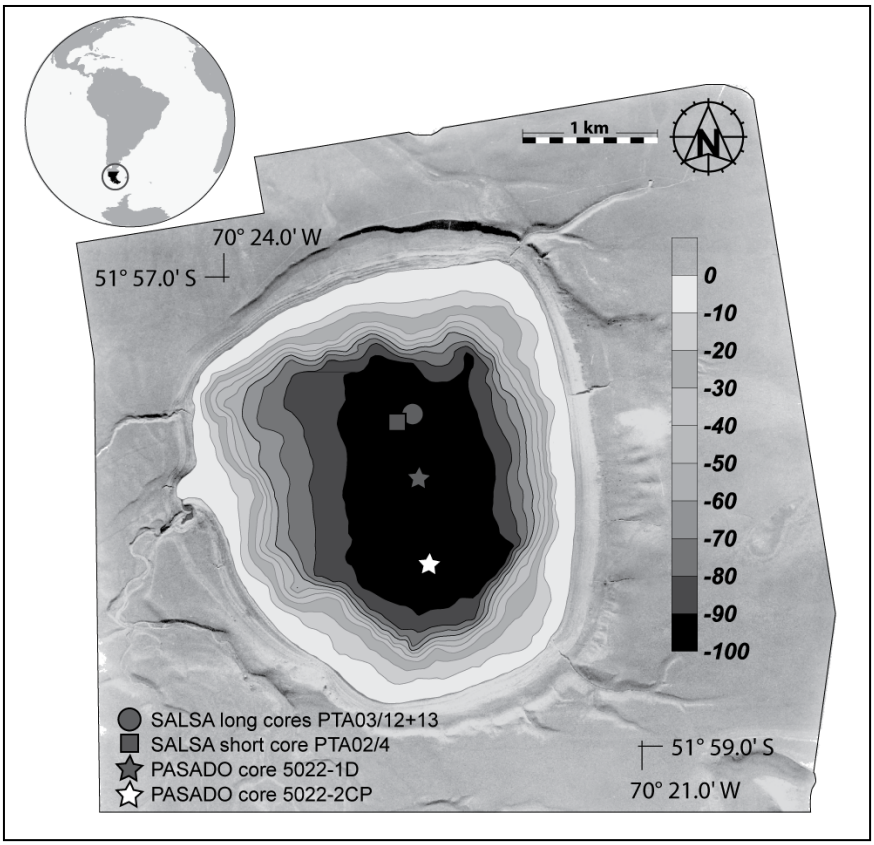

Fig. 1: Bathymetric map of Laguna Potrok Aike showing the location of analyzed sediment cores.

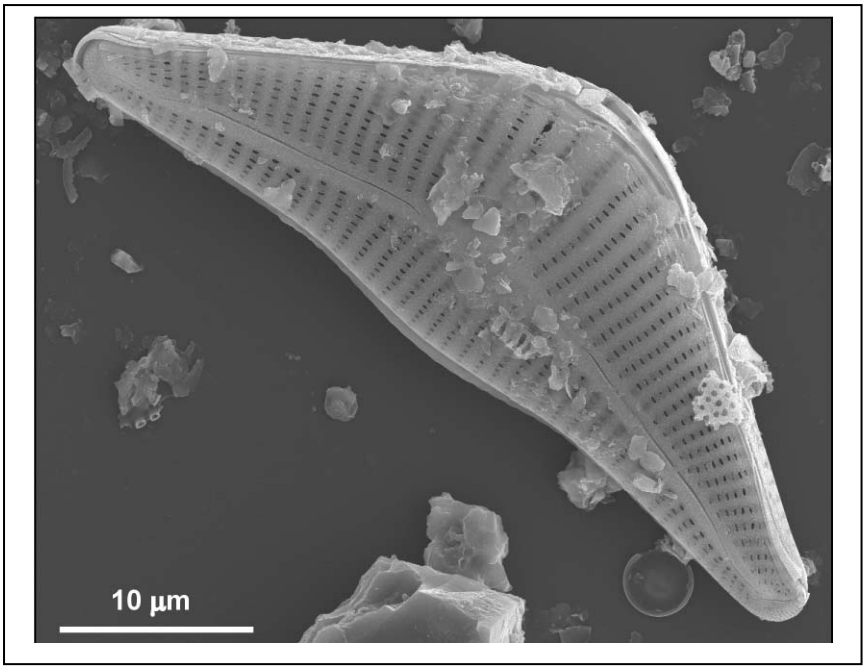

Fig. 2: SEM micrograph of a full frustule of *Cymbella gravida sp. nov.* Recasens & Maidana.

Preliminary results of mercury and organic matter sedimentary records from Laguna Potrok Aike

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We report the preliminary results of total mercury (Hg) analysis and organic matter (OM) characterizations for the long sedimentary records representing the entire Holocene and upper Pleistocene obtained from the Laguna Potrok Aike, Southern Patagonia. The total concentration of Hg (ppb) was measured using milestone Hg analyzer; as well, the type and quantity of OM in the sediments were analysed by Rock-Eval 6 analysis. The total organic carbon (TOC) values for the entire sediment profile fluctuate fairly consistently under 2%. The sedimentary OM for the most part is characterized as Type III, represented by low quantity of autochthonous OM, and possibly a fairly high degree of OM degradation. The late Pleistocene (since ~17,000 cal. BP) is marked by a significant increase in OM production. Quantity of labile, autochthonous OM increased up to 5 folds. This period of high OM production ended approximately at the beginning of the Holocene (~11,000 cal. BP). The sediment OM in this section falls under type II kerogen, which is characterized by a high degree of autochthonous, mainly algal derived OM.

Most interestingly, the Hg record (Figure 1) shows a consistent increase of 4 folds in concentration during the Holocene from a background level of ~10 ppb to ~40 ppb in the uppermost part of the sedimentary profile. The temporal trend of Hg suggests that the increase in Hg level is continuous and the increasing process goes back to preindustrial times, ruling out the effect of global anthropogenic emissions. While recent studies have suggested the effect of climate change on the global cycle of Hg, these results do not appear to show any direct correlations between climate indicator proxies (OM parameters) and temporal variations of Hg. Complete analysis of the entire sedimentary record and integration of all other climate and geochemical data may reveal more information.

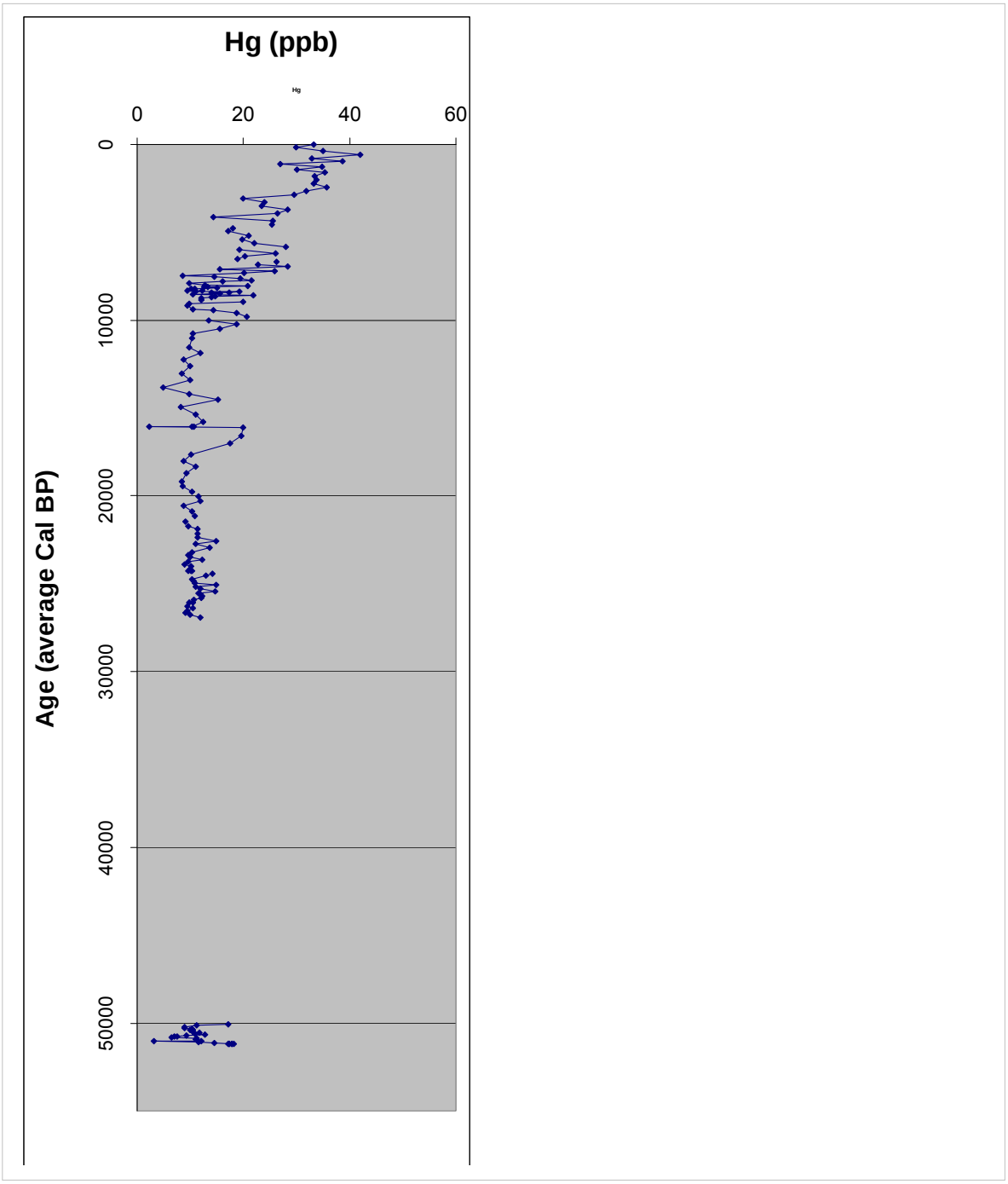

Figure 1: Temporal variations of Hg (dry basis total concetrations in ppb) for the recent lake sediments representing the entire Holocene and upper Pleistocene obtained from the Laguna Potrok Aike, Southern Patagonia.

Uncovering present and past microbial activity in lacustrine sediments: Is there an unequivocal sediment-species relationship?

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Lacustrine sediments are excellent archives of past environments while sheltering actual and active microbial populations. However, up to now, microbiological studies have been confined to surficial sediments without or with a poor characterization of the evolution and survival capacities of the hosted microbial populations (Jiang et al., 2008). Nutrient recycling and consumption of fermentation by-products are microbial adaptive strategies that can induce specific diagenetic changes on the primary environmental signals (Vuillemin et al., in review). Determining microbial interactions in these lacustrine sediments is fundamental to clarify which species remain active. This is crucial to further estimate their diagenetic impact in both the sedimentary organic matter and/or the mineral fraction. The first geomicrobiological investigations carried out during the deep drilling of Laguna Potrok Aike sedimentary infilling (Vuillemin et al., in review) have clearly identified sustained microbial activities within two horizons of distinctive lithologies, salinities and organic sources. DNA extractions and PCR amplifications in selected samples allowed establishing clone libraries to define the evolution of microbial phylogenetic diversity with respect to both sediment depth and dominant lithology (Inagaki et al., 2003). A first horizon at 5 m sediment depth consisting of methane bearing clays and subsaline pore waters displayed the maximum microbial population density and activity of the entire record (Vuillemin et al., in prep.). The microbial consortium from these anoxic organic-rich clays reflects initial geochemical conditions with a microbial population adapted to high salinity and different ability of OM degradation (Wüst et al., 2009; Pachiadaki et al., 2011). It also demonstrates substantial ongoing nutrient recycling processes (Freitag et al., 2003) and complementarities in the OM degradation chain confirming the importance of salinity gradients ruling microbial distribution. A second horizon at 30 m sediment depth consists of organic poor fine basaltic sands with high pore water sulfate content (Fig. 1) and both low microbial population density and activity. Basaltic tephra from the catchment provided iron and sulfur enabling microbial metabolisms using these oxidants (Nakagawa et al., 2006). Authigenic iron sulfides at similar depths (Fig. 2) suggest anaerobic oxidation of methane coupled to sulfate reduction (Inagaki et al., 2006; Schubert et al., 2011) as inferred by an important increase in $\delta^{13}C_{CH4}$ values (Fig. 1).

Signals of microbial activity fade below 40 m sediment depth while authigenic concretions including vivianite were found in glacial sediments (Nuttin et al., in press). Authigenic minerals have been considered reflecting trophic state (Fagel et al., 2005), early diagenetic conditions (Manning et al., 1991, 1999) and even biosignatures of past and perhaps ongoing microbial activity within the sediments (Glasauer et al., 2003; MacLean et al., 2008). Thus, reconstructing the processes leading to the formation of such concretions can help defining past trophic states of the lake system and/or diagenetic processes undergone by the sediments during former microbial activity. This combined evidence points towards the

volcanics from the catchment as the main iron, sulfur and phosphorus supplier influencing primary productivity as well as triggering specific microbial metabolisms that are involved during sediment early diagenesis. Authigenic processes leading to the formation of framboidal pyrite reveal sulfate reduction, while anaerobic oxidation of methane and shifts in iron and sulfate pore water concentrations indicate a substantial microbial influence throughout depth (Vuillemin et al., in prep.). Concurrent multiproxy signals show the substantial role of microbes in the formation of Laguna Potrok Aike concretions and its relationship to changing environmental conditions.

Ongoing work is exploring the role of active methanogenic microbial populations on the $\delta^{13}C$ signals of both the bulk sediment and the methanic fraction along the uppermost 10 m of the sediment record.

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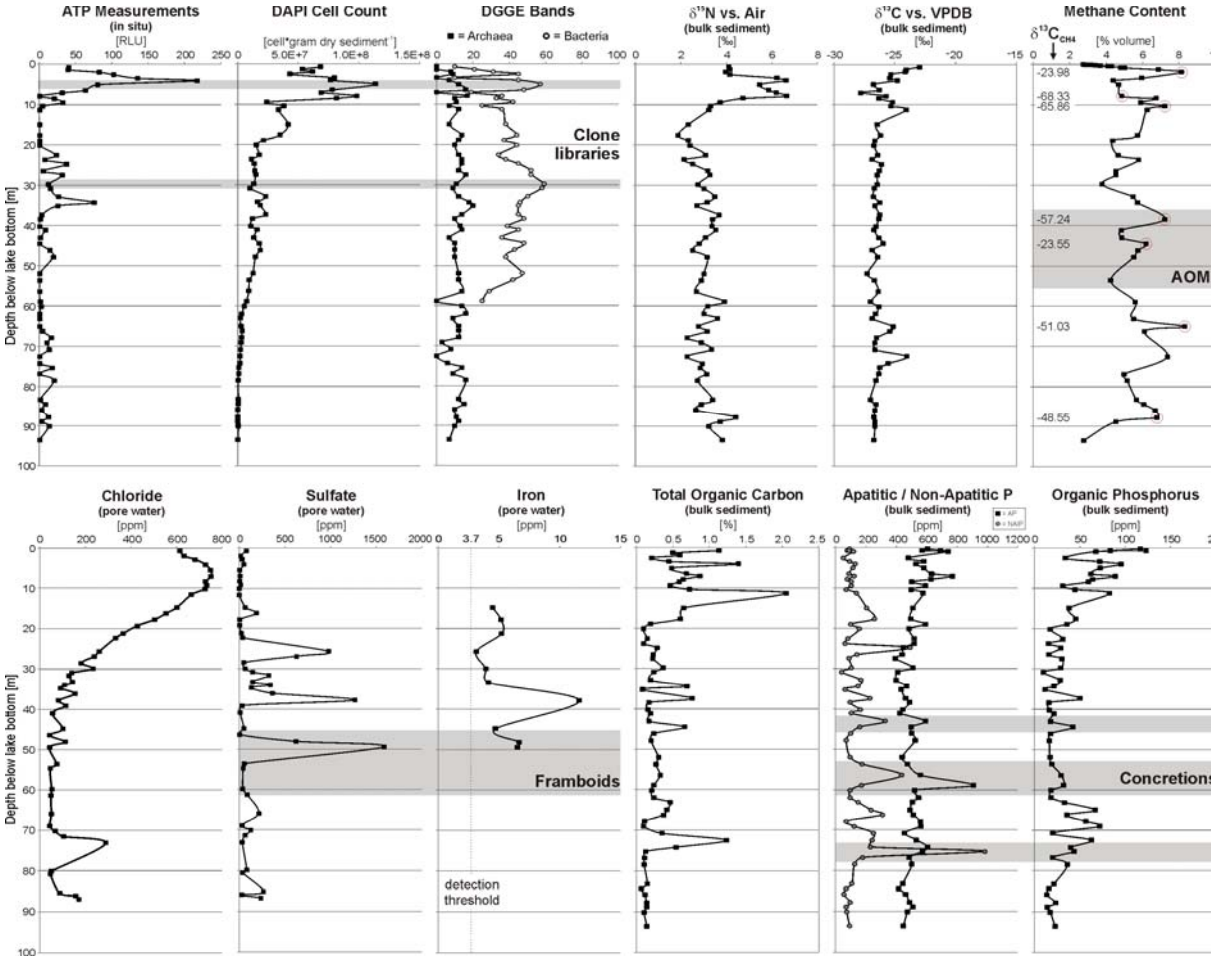

Fig. 1: Multiproxy record of microbial activity, density and diversity (top left); stable isotopes for carbon and nitrogen as well as methane content and its carbon isotopic values (top right); pore water chemistry reflecting salinity changes and mafic inputs (bottom left); TOC and various phosphorus forms reflecting different nutrient behaviours (bottom right).

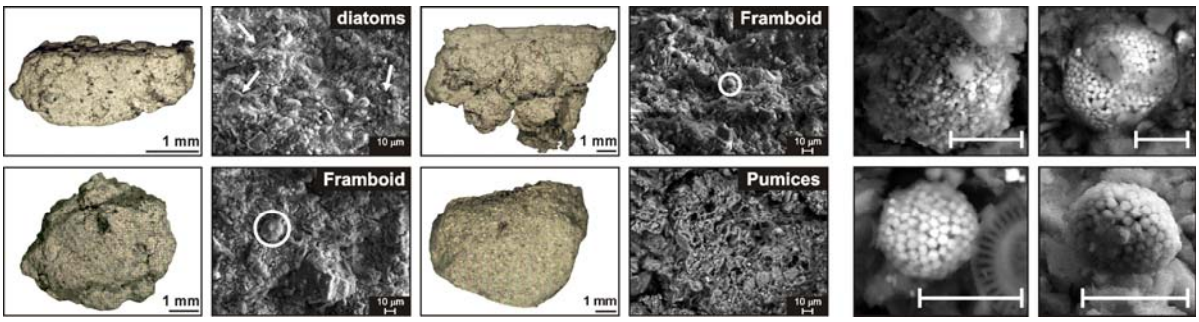

Fig. 2: Photographs of concretions under binocular and SEM (left) highlighting various incorporated allochems. SEM images of framboidal iron sulfides (right).

Comparison of pollen profiles from Laguna Potrok Aike with the dust proxy from the Antarctic ice core EPICA Dome C

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The pollen analytical section of the ICDP-PASADO Core-Catcher-Project (DFG SCHA 472/12) is in its final stage. Two core catcher profiles (sample resolution: 3 m) have been analyzed to help identifying the most promising sediment record to provide a composite core of the ICDP-PASADO deep drilling at Laguna Potrok Aike. This maar lake, located at 52°S and 70°W in the Province of Santa Cruz, Argentina, is one of the few permanent lakes in the area, providing a unique continuous lacustrine record of the climatic and ecological history. The two analyzed pollen records from holes 1D and 2C show considerable differences in quality. The record of hole 1D has several gaps because of low pollen content probably associated with the generally coarser-grained sediments. Although the almost continuous record of hole 2C is better suited for interpretation, major changes are recognized in both pollen records. In total, 65 pollen, 11 spores, 5 algal and 15 other non-pollen-palynomorph types were identified in the core catcher pollen records (Recasens et al., 2011).

Both core catcher pollen records witness climatic changes since the Late Pleistocene and indicate that the study area was covered with Patagonian Steppe vegetation during the last 51.1 ka cal BP (dating: Kliem et al., submitted). The oldest part of both pollen records, corresponding to glacial times, shows a pollen assemblage of dry steppe in the catchment area of Laguna Potrok Aike. In contrast, *Nothofagus* pollen originates in the Andes ca. 60 km to the west. Fire activity seemed to be comparable with Holocene times. We interpret this pollen signal as glacial, because of a higher contribution of dwarf shrubs, indicating conditions drier than today. However in the Andean area *Nothofagus* was present probably as shrubs as it occurs today close to its lower temperature limits. Around 80 m conditions changed to considerably lower temperatures and probably lower humidity than before. The uppermost parts of the pollen records confirm the already well-known and well-dated spread of *Nothofagus* forest in the Andes (Wille et al., 2007). We interpret this pollen signal as related to warming with a contemporaneous increase in humidity during the Lateglacial and earliest Holocene times.

As the PASADO composite profile from site 2 (5022-CP2) became available in the course of the project, our focus changed to this record to provide a more detailed picture of vegetation and climate history of the last 51.1 ka cal BP. At the end of this project a pollen record with 32 cm spatial resolution will be available. In total, 85 pollen, 18 spores, 5 algal and 12 other non-pollen-palynomorph types were identified in this composite pollen record so far.

The pollen analyses of the composite profile (Fig. 1) support the core catcher results that document a dominating grass steppe during the last 51.1 ka cal BP for southern Patagonia. However, the much higher resolution already shows some considerable dynamics in the paleo-vegetation. For the first time a comparison with dust records from Antarctica is worthwhile, as it is well known that the dust in Antarctic ice cores originates from Patagonia (e.g. Delmonte et al., 2002). A detailed interpretation and integration into the results from other proxies will be a future task. However, a preliminary interpretation based on pollen can be given already here:

The lowermost section of the pollen record shows steppe vegetation with a considerable amount of shrubby taxa and reduced dominance of grasses. The contribution of the Andean taxa reaches Late Glacial values. The dust concentration in this section is low. In summary the vegetation in Patagonia was relatively dense probably due to sufficient available moisture and/or low wind speed. The following section (50-32 ka cal BP) shows a glacial pollen signal

with low contribution of Andean taxa. Dust supply is increased but still relatively low. It is remarkable that the increase of dust transport to Antarctica is synchronous to a period with higher amounts of charcoal in Laguna Potrok Aike. This might be the start of cooler and significantly drier conditions. It was shown that fires become more frequent in times when a transition to drier conditions occurs (e.g. Huber et al., 2004). The following period (30-20 cal ka BP) shows the lowest amounts of grasses and the highest values of the drought indicator *Nassauvia*. It is likely that this period is the coldest and driest section of the record. The Late Glacial and Holocene pollen spectra since 18 ka cal BP show the published vegetation dynamics caused by an increase of temperature and humidity (Wille et al., 2007).

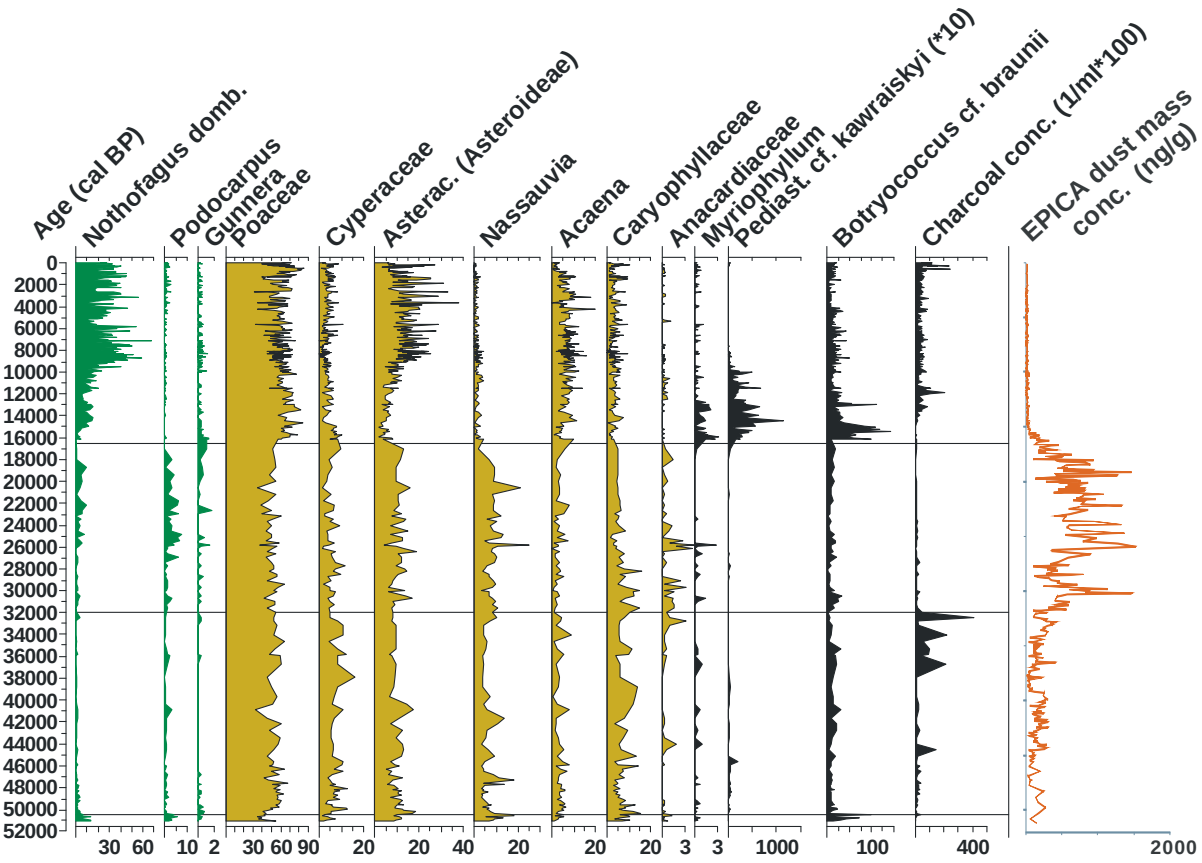

Fig. 1: Pollen percentage diagram of selected taxa of the PASADO composite core at Laguna Potrok Aike, southern Argentina in comparison to the EPICA dust mass concentration profile (Lambert et al. 2008). Core section 16-0 ka is taken from the synchronized SALSA pollen record (Wille et al. 2007) due to its better resolution. Steppe taxa: yellow; Andean taxa: green.

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Stable oxygen and carbon isotope record of aquatic moss from Laguna Potrok Aike at the last Glacial – Interglacial transition

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High-resolution carbon and nitrogen isotope analyses of bulk sedimentary organic matter has shown the changes and development in lacustrine primary productivity at the last Glacial – Interglacial transition in Laguna Potrok Aike (Zhu et al., in review). In this study we report the stable oxygen and carbon isotope record derived from aquatic moss within the same time period.

Carbon and oxygen isotope analyses of lake sediment cellulose have shown the potential for obtaining paleohydrologic and paleoclimatic information (e.g. Edwards & McAndrews, 1989, MacDonald et al., 1993, Wolfe et al., 2001, Wolfe et al., 2007). An important assumption in the corresponding interpretation is the aquatic origin of the cellulose fraction analyzed which records directly the lake water oxygen isotope composition at the time of cellulose syntheses (DeNiro & Epstein, 1981). Under both culture and field conditions, strong correlations between aquatic moss cellulose $\delta^{18}O$ and source water $\delta^{18}O$ haven been reported (Sauer et al., 2001). The reconstruction of lake water $\delta^{18}O$ can allow us to understand the past change in lake water balance and paleoclimatic significance, and furthermore to give a more reliable interpretation of diatom silica $\delta^{18}O$ from the same sediment cores in terms of the change in past water temperature.

We analyzed around 400 samples consisting of available macro aquatic moss remains for the oxygen and carbon isotope composition of aquatic moss bulk organic matter and extracted cellulose. The analyzed samples derived from the core sections with undisturbed and mass movement sediments (defined by Kliem et al., in review) within the composite depth (cd) from 30.03 to 10.03 m covering the period between ca. 26,100 – 8,400 cal. years BP including the Last Glacial Maximum and the last glacial-interglacial transition.

Preliminary results of $\delta^{18}O$ of aquatic moss bulk organic matter have shown a narrow range of variation of about 3‰ for the samples from both undisturbed and mass movement sediments (Fig. 1). Generally, the samples above 16 m (cd) have higher oxygen isotope values than the samples downwards. About 220 samples from undisturbed sediments were plotted on time scale (Fig. 2). Before 17,000 cal. years BP, the resolution of the record is low with several gaps, especially for the time period from 19,500 to 17,000 cal. years BP. Such gaps resulted simply from the absence of available moss material. At 17,000 cal. years BP, the oxygen isotope values began to increase which were from about 22.5‰ to 23.7‰ over a time period of about 1,000 years. After several hundred years, a second rise started und the oxygen isotope values reached about 25‰ at about 14,300 cal. years BP which is similar to the values of modern moss samples. Thereafter, the oxygen isotope values remained at this high level and a slight increase occurred after 9,000 years. A clear negative relation between oxygen and carbon isotope composition can be observed in both glacial and late glacial sediments (Fig. 3).

The pattern of $\delta^{18}O$ record of aquatic moss bulk organic matter resembles the $\delta^{13}C$ and $\delta^{15}N$ record of bulk organic matter from the same sediment cores (Zhu et al., in review). All shifts in the records occurred at about 17,000 cal. years BP. ^{18}O enriched precipitation (due to deglacial warming and/or more rainfall from easterly air masses) and increased evaporation could explain the shift in $\delta^{18}O$ of aquatic moss bulk organic matter. Combined with the analyses of $\delta^{13}C$ and $\delta^{18}O$ of aquatic moss cellulose which are still ongoing, a more reliable interpretation can be given.

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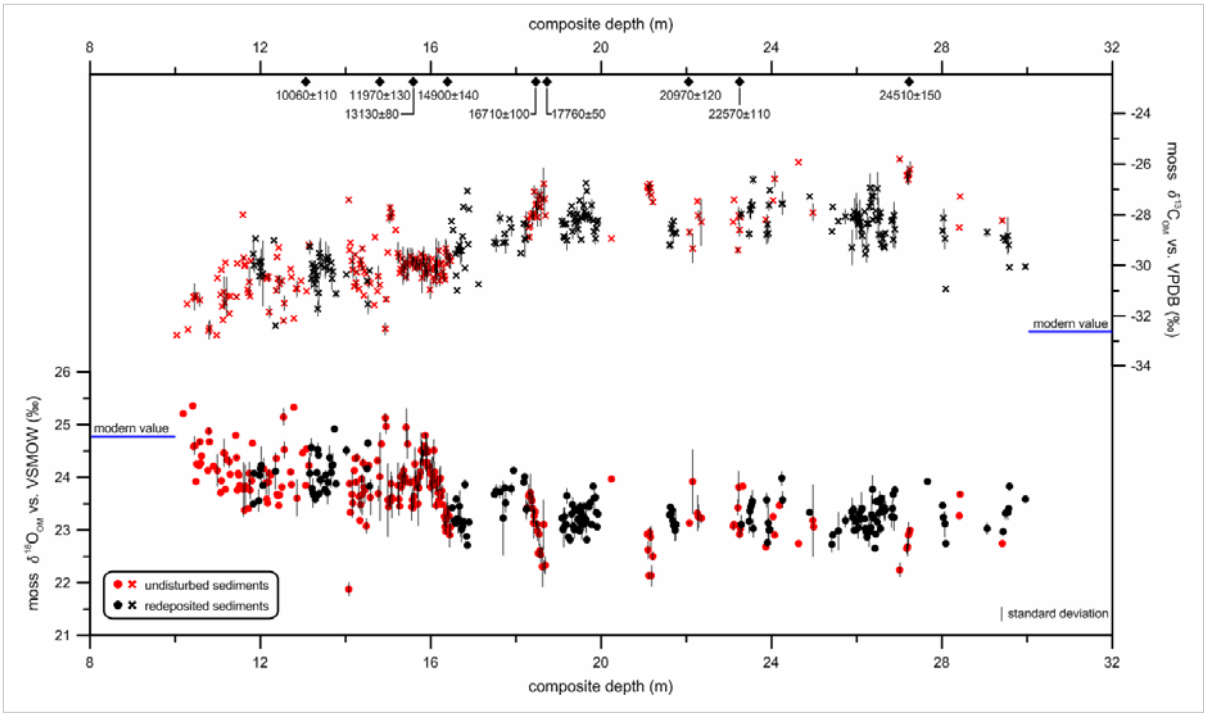

Fig. 1: Oxygen (dot) and carbon (cross) isotope record of aquatic moss bulk organic matter from the samples of undisturbed (red) and mass movement (black) sediments within the investigated composite depths for core 5022-2CP from Laguna Potrok Aike.

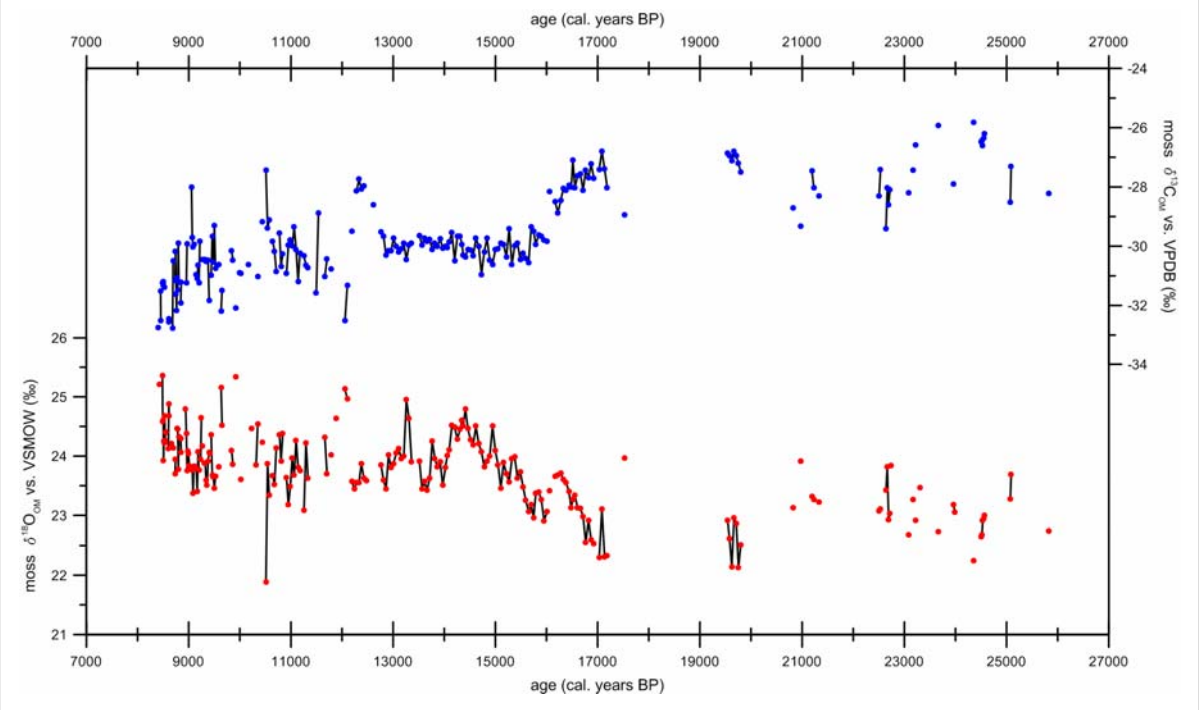

Fig. 2: Oxygen and carbon isotope record of aquatic moss bulk organic matter from the samples of undisturbed sediments within the last Glacial-Interglacial transition for core 5022-2CP from Laguna Potrok Aike. The applied age model (version 3) is given by Kliem et al. (in review).

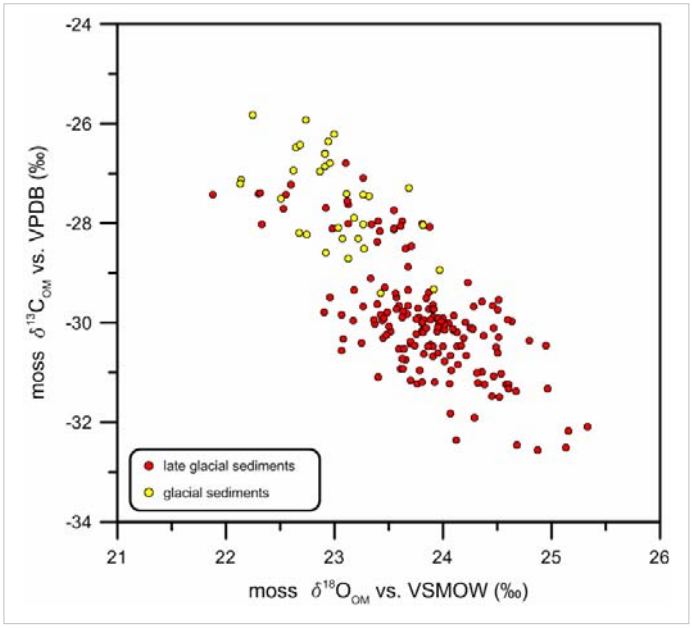

Fig. 3: Relation between oxygen and carbon isotope composition of aquatic moss bulk organic matter from the samples of undisturbed sediments within the last Glacial- Interglacial transition for core 5022-2CP from Laguna Potrok Aike.

Hydrological variations at Laguna Potrok Aike and its regional perspective for southern Patagonia

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The lake level of Laguna Potrok Aike (south-eastern Patagonia, Argentina) mirrors its water balance until overflow conditions are reached. Evidences for lake level fluctuations are outstanding at this site and documented by a sequence of subaerial as well as submerged lake level terraces (Anselmetti et al., 2009, Gebhardt et al., 2012; Kliem et al., subm.). Additionally, the observed range (~60 m) of lake level fluctuations for the last 51 ka caused drastic changes in the lake's water body from a freshwater lake with an outflow in which solutes were diluted to a subsaline lake where dissolved loads built up over time, increased salinity as well as pH and caused the formation of chemical precipitates (calcite). Such distinct changes are necessarily reflected in the chemical composition of its sediments. Geomorphological evidence corroborates sedimentological and geochemical data of the composite stratigraphic record from the lake centre with dated lake level terraces: a high lake level during the LIA, a low lake level during the mid Holocene and highest lake levels with overflow conditions prior to 17 ka cal BP are the general conditions (Kliem et al., subm.). This data forms the backbone of the lake level history developed for Laguna Potrok Aike and illustrated in Fig. 1.

All geochemical changes and related hydrological variability, i.e., water balance and lake level changes, are connected and/or caused by (1) changes in intensity and position of the Southern Hemispheric Westerlies (SHW) linked to variations in precipitation and wind-induced evaporation, (2) temperature control on evaporation, especially from the glacial period to the Holocene temperature increase, (3) changes in runoff due to permafrost sealing of the frozen ground in the catchment area during stadials of the last glacial and (4) seepage of groundwater. The latter is currently an entirely unknown factor, although influential, because groundwater recharge was completely different during glacial periods with permafrost-sealed soils compared to the postglacial with dominating infiltration. Moreover, also the sea level drop during the last glacial and its deglacial rise should modify groundwater dynamics. For the current state of knowledge, however, we have to assume equilibrium between groundwater yield and loss.

When comparing the hydrological record from Laguna Potrok Aike (Fig. 1) with two other sites with lake level records from more northern latitudes of south-eastern Patagonia, i.e. Lago Cardiel, 49°S (Ariztegui et al., 2010) and Laguna Cari-Laufén Grande, 41°S (Cartwright et al., 2011), a more regional synthesis becomes available. Highest lake levels occurred during the LGM for Lagunas Cari-Laufquén and Potrok Aike followed by a more negative water balance until the end of the Late Glacial as evidenced for Lago Cardiel and Laguna Potrok Aike. For these two sites the first two millennia of the Holocene are marked by a higher lake level followed by a distinct change towards negative water balance for another two millennia. Since 7 ka cal BP the lake level at Laguna Potrok Aike is rising until the Little Ice Age (LIA) maximum.

A general mechanistic link between the observed hydrological variations with the SHW as the major driving factor is suggested by Garreaud (2007) who determined a covariability of precipitation and westerly circulation. For modern climatic conditions both seem to be highly correlated for the windward western Andes and anti-correlated for the rain shadow east of the Andes. This results in less precipitation for our study area in south-eastern Patagonia during periods with intense westerly winds causing a strong rain shadow effect and vice versa. Thus the positive water balance during the last glacial period can be explained by an equator-ward shift of the SHW in response to the global ice sheet growth (cf. Cartwright et al., 2011; Fletcher & Moreno, 2012; Toggweiler, 2009).

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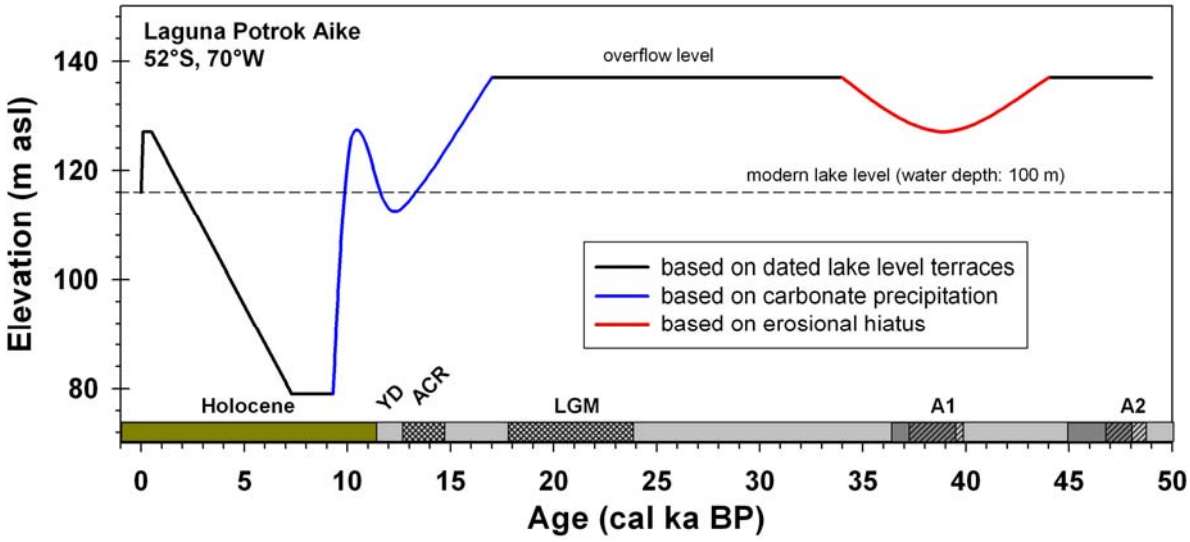

Fig. 1: Lake level history for Laguna Potrok Aike based on geomorphological (black line), geochemical (blue line) and sedimentological (red line) observations. The Younger Dryas (YD), the Antarctic Cold Reversal (ACR), the Last Glacial Maximum (LGM) as well as Antarctic warm events A1 and A2 are marked. Productivity increases as determined by Hahn et al. (subm.) are linked to A1 and A2 events and coloured in dark grey.

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2004/1 **TSK X. 10. Symposium Tektonik, Struktur- und Kristallingeologie.** Kurzfassungen der Vorträge und Poster. 31.03.-02.04.2004, Aachen. – 108 S. – *Verkaufspreis: € 11,50*

2004/2 **18th International Senckenberg Conference. VI International Palaeontological Colloquium in Weimar.** Late Neogene and Quaternary Biodiversity and Evolution: Regional Developments and Interregional Correlations. Conference Volume. April 25-30, 2004, Weimar, Germany. – 289 S. – *Verkaufspreis: € 21,-*

2004/3 **A.M.S.El. Workshop 2004. "Analytik als Werkzeug für die Klima- und Geoforschung".** Programme und Zusammenfassungen der Tagungsbeiträge. 7.-8. Juni 2004, Alfred-Wegener-Institut, Bremerhaven. – 42 S. – *Verkaufspreis: € 7,-*

2004/4 **XXVIII SCAR & COMNAP XVI.** SCAR Open Science Conference. "Antarctica and the Southern Ocean in the Global System". XI SCARLOP Symposium. "Towards the International Polar Year and Beyond". Abstract Volume. July 25-31, 2004, Bremen, Germany. – 480 S. – *Verkaufspreis: € 26,-*

2004/5 **Proceedings of the XI SCALOP Symposium. "Towards the International Polar Year and Beyond".** 28 July, 2004, Bremen, Germany. – 242 S.– *Verkaufspreis: € 21,-*

2005/1 **19th Colloquium on Latin American Geosciences.** April 18-20, 2005, Potsdam. – 147 S. – *Verkaufspreis: € 14,-*

2005/2 **2nd European Conference on Permafrost.** Programme and Abstracts. June 12-16, 2005, Potsdam, Germany. – 224 S. – *Verkaufspreis: € 20,-*

2005/3 **22. Internationale Polartagung der Deutschen Gesellschaft für Polarforschung.** Programm und Zusammenfassung der Tagungsbeiträge. 18.-24. September 2005, Jena. – 151 S. – *Verkaufspreis: € 14,50*

2005/4 **2nd International Alfred Wegener Symposium.** Programme and Abstract. October 30 - November 02, 2005, Bremerhaven, Germany. – 115 S. – *Verkaufspreis : € 13,-*

2005/5 **DFG-SPP 1135. Dynamics of the Central European Basin System.** 4th Rundgespräch. November 30 - December 02, 2005, Eringerfeld, Germany. 136 S. – *Verkaufspreis : € 14,-* **vergriffen**

2006/1 **ICDP-Workshop PASADO. Potrok Aike Lake Sediment Archive Drilling Project.** Scientific Programme – Abstract Volume – Excursion Guide – Participants. March 15-19, 2006, Rio Gallegos, Santa Cruz, Argentina. – 90 S. – *Verkaufspreis: € 11,50*

2006/2 **150 Years of Neanderthal Discoveries. Early Europeans – Continuity & Discontinuity.** Congress, July 21st-26th, 2006 in Bonn, Germany. – 170 S. – *Verkaufspreis : € 17,-*

2006/3 **Shaping the Earth's Surface: Dynamics and Changing Environments.** GV International Conference 2006 and 96th Annual Meeting of the Geologische Vereinigung e.V. September 25-29, 2006, Potsdam, Germany. – 118 S. – *Verkaufspreis : € 14,-*

2006/3a **Geomagnetic Field Variations: Space-Time Structure, Processes, and Effects on System Earth. International Final Colloquium of the German**

Science Foundation Priority Programme 1097. Jointly organized by the Deutsche Forschungsgemeinschaft and the Deutsche Akademie der Naturforscher Leopoldina. October 4-5, 2006. – 120 S. – *Verkaufspreis: € 14,-*

2007/1-2 The Oceans in the Earth System. International Conference 2007 and 97th Annual Meeting of the Geologische Vereinigung e.V. (GV), Bremen, Germany, October 1-5, 2007. – 267 S. – *Verkaufspreis: € 21,-*

2008/1 23. Internationale Polartagung der Deutschen Gesellschaft für Polarforschung. Münster, 10.-14. März 2008. Programm und Zusammenfassung der Tagungsbeiträge. – 107 S. – *Verkaufspreis: € 14,-*

2008/2 12th International Palynological Congress (IPC-XII), 8th International Organisation of Palaeobotany Conference (IOPC-VIII). Abstract Volume. August 30 – September 5, 2008 in Bonn, Germany. – 337 S. – *Verkaufspreis: € 25,-*

2009/1 KALMAR – First Bilateral Workshop on Russian-German Cooperation on Kurile-Kamchatka and the Aleutean Marginal Sea-Island Arc Systems. Program and Abstracts. *Petropavlovsk-Kamchatka, Russia, April 27 - May 1, 2009.* – 73 S. – *Verkaufspreis: € 10,-*

2009/2 System Erde – Mensch. Handlungsoptionen und Managementstrategien. Dokumentation der Strategiekonferenz am 12. und 13. Juni 2008 in Berlin. Herausgegeben von Rolf Emmermann, Gerold Wefer und Volker Mosbrugger. – 118 S. – *Verkaufspreis: € 5,-*

2009/3 Paläontologie. Schlüssel zur Evolution. 79. Jahrestagung der Paläontologischen Gesellschaft, Bonn, 5.-7. Oktober 2009. Kurzfassung der Tagungsbeiträge. – 126 S. – *Verkaufspreis: € 14,-*

2009/4 Annual Meeting of the German Association of Stable Isotope Research (GASIR). Abstract Volume. **– Jahrestagung der Arbeitsgemeinschaft Stabile Isotope e.V. (ASI)**. Tagungsband. – AWI Potsdam, 5.-7. Oktober 2009. – 86 S. – *Verkaufspreis: € 10,-*

2009/5 Klima im System Erde. Klimawandel – Antworten und Fragen aus den Geowissenschaften. Zusammenfassung der Konferenzbeiträge, dbb-forum Berlin, 2. und 3. November 2009. – 89 + 36 S. – *Verkaufspreis: € 5,-*

2010/1 Potrok Aike Maar Lake Sediment Archive Drilling Project. Program and Abstract Volume of the 2nd International ICDP Workshop PASADO, Vienna, 1-2 May, 2010. Edited by Bernd Zolitschka. – 94 S. – *Verkaufspreis: € 12,-*

2010/2 15th Conference of the International Work Group for Palaeoethnobotany, Wilhelmshaven, Germany, May 31 – June 5, 2010. Programme and Abstracts. Edited by Felix Bittmann. – 207 S. – *Verkaufspreis: € 19,-*

2010/3 2nd International Sclerochronology Conference, 24-18th July, 2010, Mainz, Germany. Program and Abstracts. Edited by Bernd R. Schöne and Elizabeth V. Nunn. – 169 S. – *Verkaufspreis: € 17,-*

2010/4 15th International Conference: International Bryozoology Association, Kiel, Germany, August 2-6, 2010. Program and Abstracts. – 75 S. – *Verkaufspreis: € 10,-*

2010/5 24. Internationale Polartagung der Deutschen Gesellschaft für Polarforschung. Obergurgl, 6. bis 10. September 2010. Programm und Zusammenfassung der Tagungsbeiträge. – 101 S. – *Verkaufspreis: € 12,-*

2011/1 Socio-Environmental Dynamics over the last 12,000 Years. The Creation of Landscapes II. Open Workshop, 14th-18th March, 2011, Kiel, Germany. Programme and Abstract Volume. – 114 S. – *Verkaufspreis: € 14,-*

2012/1 3rd PAGES Varves Working Group Workshop, Manderscheid (Germany), March 20-24, 2012. Program and Abstracts. Edited by Bernd Zolitschka. – 114 S. – *Verkaufspreis: € 14,-*

Notes


PASADO