ICDP workshop

Quaternary Tertiary Tropics – Colônia Sediment Archive Drilling Project

(QUE COISA)

Sept 26 - 29, 2014

Abstracts

ICDP-core based paleoreconstructions over several glacial-interglacial cycles (600'000 yrs, Lake Van), their challenges (dating, core analysis, proxies) and their implications

Flavio Anselmetti and PALEOVAN scientific community
Institute of Geological Sciences and Oeschger Centre for Climate Change Research, University of Bern, Switzerland flavio.anselmetti@geo.unibe.ch

A complete succession of a lacustrine sediment sequence deposited during the last ~600,000 years was recovered in Lake Van, Eastern Anatolia (Turkey) in 2010 supported by the International Continental Scientific Drilling Program (ICDP). Based on a detailed seismic site survey, two sites at a water depth of up to 360 m were drilled, and cores were retrieved from sub-lake-floor depths of 140 and 220 m, respectively. To obtain a complete sedimentary section, the two sites were multiple cored in order to investigate the paleoclimate history of a sensitive semi-arid region between the Black, Caspian, and Mediterranean seas.

The sedimentary sequence was dated using climatostratigraphic alignment, varve chronology, tephrostratigraphy, argon-argon single-crystal dating, radiocarbon dating, magnetostratigraphy , and cosmogenic nuclides. Based on the lithostratigraphic framework, the different age constraints are compiled and a robust and precise chronology of the 600,000 year-old Lake Van record is constructed. Paleoenvironmental interpretations comprise reconstructions of paleoclimatic, tectonic and volcanic history and related events. Special emphasis is given to paleoclimate changes on covering multiple glacial-interglacial cycles. The Lake Van cores provide a unprecedented record of millennial to orbital cycle changes in the Middle East that complements and refines other records from ice, land and the oceans. The combination of these various regional dataset reflects teleconnections between the different climate forcing mechanisms on various temporal and spatial scales.

Several technological, logistical, methodological and analytical aspects of PALEOVAN project may serve as a guide to the QUE COISA project, so that the presentation will focus on those aspects.

Investigating the subsurface biosphere in the peat bog and lacustrine sediments in the Colônia scientific drilling

Daniel Ariztegui, Department of Earth Sciences, University of Geneva, Switzerland (daniel.ariztegui@unige.ch)

During many years the microbial impact on marine and lacustrine sediments have been neglected. Only recently the discovery of active microbial life in deep-sea sediments has triggered a rapid development of the field known as deep biosphere. Analogously, geomicrobiological investigations in lacustrine basins have shown a substantial microbial impact on lake sediments as described for their marine counterparts. Microbial activity in the water column of modern lakes is quite known, but significantly less attention has been paid to the study of microbial related processes in the sediments of lacustrine basins. Their study is often logistically easier than in the ocean providing analogues to certain marine environments and, thus, to investigate a wide range of processes involving microbes.
Until now only 30% of ICDP studied lake sites included microbial investigations, they are covering a relatively wide range of salinities and environmental conditions. It was only very recently that subsurface biosphere studies have been implemented in ICDP projects. Several diagenetic processes directly associated with microbes have been identified, in particular the formation of authigenic minerals that can be used as biosignatures of past microbial activity in the geological record. The study of these minerals coupled with modern phylogenetic techniques is critical to better determine the exact role of microbial metabolism in the complex reactions leading to their development. With the emergence of high throughput gene sequencing technology, microbes can be grouped in microbiomes that in the sedimentary realm are best defined as microbial facies. As with lithological types, these microbial facies are representative of a given depositional environment. When referring to lacustrine sediments the existing datasets are still quite limited to fully establish a relationship between climate and microbial facies.
The significance and validity of the results of this kind of studies are largely dependent on the quality, rapidity and prevailing conditions during the initial sampling to allow reducing the impact of contamination issues; determine the best method to accomplish onsite cell counting; choose the appropriated sampling protocol for further molecular characterization; and design a proper strategy for sample archiving. Due to the particular

nature of the Colônia project, it is important to design an appropriated sampling strategy for subsurface studies from the initial phase of the project.
Paleoclimatological reconstructions largely depend on the use of proxies that need to be fully understood since this is crucial in any attempt to reconstruct paleoenvironmental settings and paleoclimate change. Many of these proxies are based on organic compounds (biomarkers) and inorganic constituents including stable isotope compositions. Thus, a clear understanding of the impact of different microbial communities on them is vital.

References

Ariztegui D, Thomas C, Vuillemin A (in review). Present and future of subsurface biosphere studies in lacustrine sediments through scientific drilling. *International Journal of Earth Sciences.*

Thomas C, Ionescu D, Ariztegui D, DSDDP Scientific Team (accepted). Archaeal populations in two distinct sedimentary facies of the subsurface of the Dead Sea. *Marine Genomics*.

Vuillemin A, Ariztegui D, Nobbe G, Schubert C, PASADO Scientific Team (2014a). Influence of methanogenic populations in Holocene lacustrine sediments revealed by clone libraries and fatty acid biogeochemistry. *Geomicrobiology Journal* 31/4: 285-298.

Vuillemin A, Ariztegui D, Lücke A, Mayr C, PASADO Scientific Team (2014b). Paleoenvironmental conditions define current sustainability of microbial populations in Laguna Potrok Aike sediments, Argentina. *Aquatic Sciences* 76: 101-114.

Vuillemin A, Ariztegui D, De Coninck A, Lücke A, Mayr C, Schubert C, PASADO Scientific Team (2013a). Origin and significance of diagenetic concretions in sediments of Laguna Potrok Aike, southern Argentina. *Journal of Paleolimnology* 50:275-291.

Vuillemin A, Ariztegui D, PASADO Scientific Team (2013b) Geomicrobiological investigations in subsaline maar lake sediments over the last 1500 years. *Quaternary Science Reviews* 71: 119-130.

Vuillemin A (2013a) Characterizing the Subsurface Biosphere in Laguna Potrok Aike Sediments (Argentina): A Case Study. *Terre & Environnement* 119, 153p. ISBN978-2-940472-20-8.

Vuillemin A, Ariztegui D, Vasconcelos C, PASADO Scientific Drilling Party (2010) Establishing sampling procedures in lake cores for subsurface biosphere studies: Assessing in situ microbial activity. *Scientific Drilling* 10: 35-39.

Elemental and organic geochemistry of Colônia sediments

Edouard Bard, Kazuyo Tachikawa, Guillemette Ménot, CEREGE, Aix-Marseille Univ, CNRS, IRD, Collège de France, Aix-en-Provence, France

The geochemical composition of lacustrine sediments and peat bogs provides key information enabling to reconstruct paleoclimate conditions. We will apply complementary methods based on chemical measurement of various elements, molecules and isotopes. Our approach will be based on modern geochemistry facilities recently installed at CEREGE in Aix-en-Provence: https://www.cerege.fr/spip.php?article209

We will perform non-destructive analysis at high spatial resolution (200 microns to a few mm) using an **X-ray fluorescence scanner** (ITRAX, Cox Analytical Systems). In addition to chemical composition, our facility provides X-radiographs and optical images.

To test the feasibility and usefulness of XRF scanning, we have already used the ITRAX to measure a short core CO-2011 (200 cm) retrieved in 2011 from Colônia. These preliminary XRF results show the potential of this method to characterize sedimentological changes that can be further related to the prevailing paleoenvironmental conditions at the time of deposition. Indeed, relative changes versus depth of elements such as Fe, Ti, Ca, Mn, K and Si clearly illustrate changes in mineralogical sources that might be related to concomitant changes in the precipitation/evaporation ratio.

Our previous work allowed showing that the semi-quantitative analysis by XRF scanner can be calibrated with measurements by ICP-MS (Böning et al. 2007, Tachikawa et al. 2011, Cartapanis et al. 2011). For Colonia sediments, we will thus quantify elemental concentrations in **discrete samples using our ICP-MS facility** (Agilent 7500ce).

In parallel to these elemental analyses, we will measure several organic compounds as indicators of environmental parameters. The methodology is based on the extraction of organic molecules with an automated facility (Dionex ASE), followed by purification and quantification by various chromatographic techniques:

We will analyze **tetraethers with an HPLC (Agilent 1100) coupled to a QMS** with an APCI source. To allow a high throughput of samples, we recently developed an automated procedure with a Gilson GX-271 to purify tetraethers (Sanchi et al. 2013). Our protocols and results have been validated in the framework of international intercomparisons (Schouten et al. 2009, 2013). Our approach will be applied to Colônia sediments to calculate paleoclimate indices such as TEX86 and MBT/CBT that can ultimately be related to lake temperature and pH of surrounding soils (e.g. Ménot & Bard 2012, Sanchi et al. 2014).

In addition to tetraethers, we plan to analyze mid to long chain **n-alkanes by GC and GCMS** in order to study the relative inputs of terrestrial higher plants, mosses and lake macrophytes (e.g. Rostek & Bard 2013). To reconstruct inputs of charcoals from biomass burning we will analyze **refractory carbon** with techniques we have developed by means of an elemental analyzer (Thevenon et al. 2004). In complement, we will measure the molecular compound **levoglucosan by GC and GCMS** (see for example Elias et al. 2001 who used it to study lacustrine sediments from Amazonia).

In parallel to these paleo-proxies, we will contribute in building the chronology of the Colônia sediments by measuring radiocarbon in various phases present in the cored material. For this purpose, we will use our new **accelerator mass spectrometer AixMICADAS dedicated to the ^{14}C analysis of micro-samples**, which has been installed at CEREGE in 2014. In addition to a conventional graphite source, AixMICADAS is also equipped with a CO_2 gas source coupled directly with an elemental analyzer for organic material and an acidification module for carbonates.

References :

Böning P, Bard E, Rose E. Towards direct micron-scale XRF elemental maps and quantitative profiles of wet marine sediments. *Geochemistry Geophysics Geosystems (G-cubed)* 8 (5), 1-14, DOI: 10.1029/2006GC001480, (2007).

Cartapanis O, Tachikawa K, Bard E. North-Eastern Pacific oxygen minimum zone variability over the past 70 kyr: Impact of primary production and oceanic circulation. *Paleoceanography* 26, PA4208, 1-17, DOI:10.1029/2011PA002126, (2011).

Elias VO, Simoneit BRT, Cordeiro RC, Turcq B. Evaluating levoglucosan as an indicator of biomass burning in Carajas, Amazonia: A comparison to the charcoal record. *Geochimica et Cosmochimica Acta* 65, 267-272 (2001).

Ménot G, Bard E. A precise search for drastic temperature shifts of the past 40,000 years in southeastern Europe. *Paleoceanography* 27, PA2210, 1-13, DOI:10.1029/2012PA002291, (2012).

Rostek F, Bard E. Hydrological changes in eastern Europe during the last 40,000 years inferred from biomarkers in Black Sea sediments. *Quaternary Research* 80, 502-509 DOI: 10.1016/j.yqres.2013.07.003, (2013).

Sanchi L, Ménot G, Bard E. An automated purification method for archaeal and bacterial tetraethers in soils and sediments. *Organic Geochemistry* 54, 83-90, DOI: 10.1016/j.orggeochem.2012.10.005, (2013).

Sanchi L, Ménot G, Bard E. Insights into continental temperatures in the northwestern Black Sea area during the last glacial period using branched tetraether lipids. *Quaternary Science Reviews* 84, 98-108, DOI: 10.1016/j.quascirev.2013.11.013, (2014).

Schouten S et al. (incl. Bard & Ménot). An interlaboratory study of TEX86 and BIT analysis using high performance liquid chromatography/mass spectrometry. *Geochemistry Geophysics Geosystems (G-cubed) 10,* 1-13, DOI:10.1029/2008GC002221, (2009).

Schouten S et al. (incl. Bard & Ménot). An interlaboratory study of TEX86 and BIT analysis of sediments, extracts and standard mixtures. *Geochemistry Geophysics Geosystems (G-cubed*) 14 (12), 5263-5285, DOI: 10.1002/2013GC004904, (2013).

Tachikawa K, Cartapanis O, Vidal L, Beaufort L, Barlyaeva T, Bard E. The precession phase of hydrological variability in the Western Pacific Warm Pool during the past 400 ka. *Quaternary Science Reviews* 30, 3716-3727, DOI:10.1016/j.quascirev.2011.09.016, (2011).

Thevenon F, Bard E, Williamson D, Beaufort L. Biomass burning records from the West Equatorial Pacific over the last 360 kyr: Methodological, climatic and anthropic implications. *Palaeogeography, Palaeoclimatology and Palaeoecology* 213, 83-99, (2004).

Measuring Atlantic forest diversity turnover in space and time

Ana Carnaval*, Jason Brown, Felipe Saiter, Ary Oliveira Filho, Ivan Prates

* Ana Carolina O. Q. Carnaval. City University of New York, The City College of New York. NY, USA.

The fields of biogeography and conservation are experiencing a tremendously exciting phase fueled by the advancement of new integrative approaches to the study of biodiversity. These new methods combine information from current and paleo environments with species-, genetic-, and trait-level data. In this talk, we focus on one such approach, which maps changes in the composition of assemblages or genetic lineages in geographic space, as a function of the environment (both of the present and past). Using generalized dissimilarity modelling and inventory data from vertebrates and plants, we provide examples of how these tools are improving the visualization and understanding of biodiversity patterns in the Atlantic Forest. We close our presentation with a new idea that reaches out to the paleoecology community: that of adapting this approach to model diversity turnover in time.

Recognizing impact-triggered soft sediment deformation: problems and possible guidelines.

Marlei Antonio Carrari Chamani, Instituto de Geociências – Universidade de São Paulo , Brazil
marlei.chamani@usp.br

Soft-sediment deformation can be induced by triggers associated to the sedimentation processes or by external acting agents. The latter are particularly useful in the study of the history of sedimentary basins. However, identifying the trigger mechanism of soft-sediment deformation can be troublesome, and distinction between earthquake and impact triggered deformation may be particularly difficult. We present here a brief review of soft-sediment deformation attributed to impacts in the literature, and a case-study of the Permian-Triassic of the Paraná basin, Brazil.

The use of stable oxygen isotopes in the western South Atlantic paleoceanography: Recent achievements and future research directions in the framework of the Colônia drilling project

Cristiano M. Chiessi[1], Stefan Mulitza[2], Jeroen Groeneveld[2], Adriana R. Perretti[1], Ana Luiza S. Albuquerque[3], Igor M.V. Oliveira[3]

[1] School of Arts, Sciences and Humanities, University of São Paulo, São Paulo, Brazil
[2] MARUM-Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany
[3] Department of Geochemistry, Fluminense Federal University, Niteroi, Brazil

The stable oxygen isotopic composition ($d^{18}O$) of foraminifera provides one of the most widely used tools for reconstructing past changes in oceanic physical properties. In our presentation, we will show the most relevant recent achievements in the use of $d^{18}O$ in western South Atlantic paleoceanography, and highlight future research directions in the framework of the Colônia drilling project.

Colônia basin structure – origin by impact cratering?

Alvaro P. Crósta, Instituto de Geociências, Universidade Estadual de Campinas, Cx. P. 6152, 13083-970 Campinas SP, Brazil (alvaro@ige.unicamp.br)
Wolf Uwe Reimold, Museum für Naturkunde Berlin, Invalidenstrasse 43, 10115 Berlin (uwe.reimold@mfn-berlin.de) and Humboldt University Berlin, Unter den Linden 6, Berlin 10099, Germany.
Claudio Riccomini, Instituto de Geociências & Instituto de Energia e Ambiente, Universidade de São Paulo, Rua do Lago 562, 05508-080, São Paulo, SP, Brazil (riccomin@usp.br)
Christian Koeberl, Department of Lithospheric Research, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria and Natural History Museum, Burgring 7, A-1010 Vienna, Austria

Impact cratering has been a fundamental process on Earth throughout its evolution. The terrestrial impact record is – in comparison to other planetary bodies of the Solar System – meagre, due to the Earth's active geological processes that have lead to constant renewal of the Earth's surface. The total terrestrial impact record now stands at some 184 confirmed impact structures, with only 9 confirmed structures in South America.
It is now established that impact events have affected the biological and geological evolution on Earth. The Chicxulub impact offshore from the Yucatán peninsula (Mexico) is most likely responsible for the Cretaceous/Paleogene mass extinction 66 million years ago that marked the demise of the dinosaurs and well over 50 % of the Earth's fauna and flora. The Chicxulub structure, which is covered with post-impact rock formations, has repeatedly been drilled, including in 2001-2002 within the framework of an ICDP project, which lead to the recovery of impact-melt breccia and target lithologies that documented the cratering process. Even impact structures well exposed at the surface commonly require drill cores to recover deeply buried samples, provide ground-truth for geophysical studies and, possibly, for dating of the impact event, and gain a three-dimensional view of the interior of the structure. Previous ICDP impact crater drillings were carried out as part of multidisciplinary projects, involving – besides impact cratering studies - aspects of paleoclimatology, deep

biosphere, hydrology, coastal development and tectonics, and resources (such as the Bosumtwi, Chesapeake Bay, and El´gygytgyn projects). Considering that some impact events have demonstrably affected the geological and biological evolution on Earth, and that even small impacts can disrupt the biosphere and lead to local and regional devastation, the understanding of impact structures, the processes by which they form, and their environmental consequences should be of interest not only to Earth scientists, but also to society in general.

The Colônia circular structure has been known since the early 1960s, when it was first investigated by geophysical methods. Since then the sedimentary record of the upper layers of the infill have been investigated and a range of geophysical methods have been used to probe the structure.

The structure was formed in Proterozoic crystalline rocks (mostly gneiss, schist, and quartzite). It has a near-circular outline, with a rim-like border formed by a prominent annular ring of hills rising up to 125 m above the inner depression.

The structure is filled with organic-rich sediments of Quaternary age. Geophysical data have shown that the thickness of the sedimentary infill is approximately 300-400 m. Much of what is currently known about the Colônia infill comes from studies of sedimentary and palynological records from shallow cores extracted from the upper 8 m of the sequence (Riccomini et al. 1991; Ledru et al. 2005, 2009). These authors estimated that the complete infill of the basin represents a depositional record of at least 1.5-2.5 Ma. More recent geophysical (seismic) data presented by Riccomini et al. (2011) suggest the thickness of the sedimentary infill - at approximately 275 m thickness - to be less than previously estimated. The origin of the Colônia basin structure by various processes was discussed by Riccomini et al. (2011). They concluded that impact cratering remained the preferred agent but that no unambiguous evidence had been forthcoming. Arguments in support of the impact hypothesis included the overall geometry of the structure and the fact that the local geology does not provide any other plausible explanation for the formation of a relatively deep, circular basin, by endogenous processes.

These authors also noted that the current depth-diameter ratio was different from values for other similarly-sized impact structures and interpreted this as indicating that the crater had likely been substantially eroded since its formation. No datable impact-related material has been found at Colônia so far.

Velazquez et al. (2013) alleged shock petrographic evidence in support of an impact origin of Colônia, based on the analysis of rock chips from two boreholes drilled inside the structure for groundwater. However, their findings were judged insufficient/controversial by Reimold et al. (2014). Consequently, comprehensive drilling of the structure is required to provide the only possible means of better constraining the origin of Colônia Basin and to obtain datable material that could shed light on the age of crater formation. This also entails the requirement to drill through the entire structure into the crater floor, to be able to recover both possible impact-formed basin fill below the sedimentary strata as well as possible impactite injections in the crater floor itself. The central crater floor is the most likely location from which in situ, possibly impact (shock) deformed material can be obtained as a prerequisite for proving a possible impact origin.

References:

Earth Impact Database (July 2014): http://www.passc.net/EarthImpactDatabase/index.html

Ledru M.-P., Rousseau D.-D., Cruz F. W. J., Karmann I., Riccomini C., and Martin L. 2005. Paleoclimate changes during the last 100 ka from a record in the Brazilian Atlantic rainforest region and interhemispheric comparison. Quaternary Research 64:444–450.

Ledru M.-P., Mourguiart P., and Riccomini C. 2009. Related changes in biodiversity, insolation and climate in the Atlantic rainforest since the last interglacial. Palaeogeography, Palaeoclimatology, Palaeoecology 271:140–152.

Reimold, W.U., Ferrière, L., Deutsch, A. and Koeberl, C., 2014. Impact controversies: Impact recognition criteria and related issues. Meteoritics & Planetary Science, 49: 723-731.

Riccomini, C., Crosta, A.P., Prado, R.L., Ledru, M.-P., Turcq, B.J., Sant'Anna, L.G., Ferrari, J.A., and Reimold, W.U., 2011. The Colônia Structure, São Paulo, Brazil. Meteoritics & Planetary Science, 46:1630-1639.

Riccomini C., Turcq B., Martin L., Moreira M. Z., and Lorscheitter M. L. 1991. The Colonia Astrobleme, Brasil. Revista do Instituto Geológico 12:87–94.

Velazquez, V.F., Riccomini, C., Azevedo Sobrinho, J.M., Pletsch, M.A.J.S., Sallun, A.E.M., Sallun Filho, W., Hachico, J. 2013. Evidence of shock metamorphism effects in allochtonous breccia deposits from the Colonia crater, São Paulo, Brazil. International Journal of Geosciences, 4:274-282.

Vegetation and Climate of the Atlantic Rainforest of the State of São Paulo during the Late Pleistocene and Holocene

Paulo E. De Oliveira[1], Vanda Brito de Medeiros[1], Luiz Carlos R. Pessenda[2] & Maria Judite Garcia[3]
[1]DGSA/IGc/USP [2] CENA/USP[3] Bolsista CNPq

Pollen and carbon isotopes analyses carried out within the Atlantic Rainforest State Park and in the Middle Paraíba do Sul River Valley in the State of São Paulo, Brazil, indicate phases of Araucaria forest expansions during cooler and moister climates which are possibly correlated with prolonged phases of enhanced polar air mass incursions during the Last Glacial Maximum and in the Middle Holocene. These humid phases might also explain the occurrence of extensive peatbog fields during the Late Quaternary. This climatic scenario might be useful in future interpretations of the pollen record to be obtained in the Colonia crater.

Spectral analysis of sedimentary records

José Antonio Ferrari, Instituto Geológico - SMA São Paulo Brazil

The deep drilling at the Colonia Crater can finds continuous sedimentary records. The spectral analysis of these stratigraphic series can identify cyclic behavior in the deposits. In this case, it will be possible to correlate the sedimentary pattern with known astronomical and climatic cycles. The periodical patterns are identified by analyzing compositional or thickness time series of the stratigraphic sequences. The poster will discuss different statistical tools for spectral analysis that can be used in the project. Some examples using Fourier, correlation and wavelet analysis will be presented.

Dating the Colonia impact crater (and its sediments?)

Fred Jourdan Western Australian Argon Isotope Facility, JdL Centre & Dept of Applied Geology
Curtin University, Perth, Australia

If Colonia can be demonstrated to be an impact crater, then dating the formation age of this crater is important in order to, (1) determine when exactly this event happened, and (2) as a mean of age calibration for the sediment infill, which in turn can be used to time calibrate climatic variations recorded for the south hemisphere. In addition, Brazil's neighboring countries host a suite of active explosive volcanoes and, although remote, there is a possibility that thin volcanic tuff layers could be found in sedimentary sequence and thus be directly dated, thus offering precise time tie-point(s) in the colonia ~2-3 Ma sedimentary sequence.

Deutsch and Schärer (1994) and Jourdan et al. (2012) presented summaries of best target material and practices for dating impact material. Reliable age data (absolute ages) for the impact events are best obtained using radioisotopic techniques applied to rocks formed during a bolide's hypervelocity impact on a target rock. The heat wave generated by the impact tends to melt part of the target rock and produces melt rocks, and glass ejecta (e.g. spherules, bombs). During the molten state, the melt tends to be purged of any pre-existing radioactive daughter products, and as such, its radioactive clock is reset allowing the impact event to be dated. For that, the best method is arguably $^{40}Ar/^{39}Ar$ dating as the K/Ar system from which it is derived, is relatively easily reset during impact. $^{40}Ar/^{39}Ar$ analyses can be carried out on simple melt rock and glass fragments. The system is however sensitive to alteration, but altered products can be fortunately recognized during step-heating analyses, preventing one to attribute a wrong age for an impact event. Alternative means of radioisotopic dating deal with shocked minerals. Geochronologists can carry U-Pb and/or (U-Th)/He dating analyses on shocked minerals such as zircon and monazite, and zircon and apatite respectively. It should be noted however, that even for relatively large craters, the transient heat generated is usually not enough to fully reset the U-Pb system and the few reset grains tend to be highly perturbed by metamictisation (Tohver et al., 2012; Schmieder et al., subm.) and thus not datable. Large impacts generate neo-crystallized zircon or monazite that are much more suitable for dating. Regarding dating by (U-Th)/He, tentative use apatite repeatedly failed, and only slim success have been met by dating zircon. When applied to crater with a known age, zircon (U-Th)/He dating tends so far to give the "right" age in the minority of the cases preventing complete confidence in the technique yet.

Regarding the Colonia structure, the crater is sufficiently large (3.6 km) for the impact to have produced melt rocks and melt ejecta in sufficient quantity that it would have been preserved below the sedimentary infill and, at least as melt particles contained in the suevite breccia. Similarly, pseudotachylitic veins within the crater floor could be present as well. Melt products recovered from the drilling in the crater breccia and floor will be the primary target for dating the Colonia crater. We will carry high precision and accuracy $^{40}Ar/^{39}Ar$ dating at the

argon laboratory of Curtin University. We will use the new generation of noble gas instrument (ARGUS VI) which provides an improvement in precision of 5-10 times for quaternary samples compared to the previous generation of machine (Matchan & Phillips, 2014). In the eventual absence of melt products, we will concentrate on shocked crystals. We will measure the EBSD patterns of shock crystals to identify the most deformed crystals and attempt U-Pb and/or (U-Th)/He dating on them, keeping in mind the limitation of these systems.

The sediment sequence emplaced in the crater is a great record for the southern hemisphere climatic changes, and has been proposed to span the last few Ma. Available dating of the sequence consists of ^{14}C analyses carried out on the first few m of the sequence. Since South America is a volcanically active region thanks to the Andes volcanic chain, there is always the possibility that ash fall deposits are present in the sequence. If true, then only a few volcanic crystals would be required to date each eruption and would provide absolute age constraints on the sedimentary sequence. No such ash layers have been reported so far in the 270 m depth water borehole (Riccomini et al., 2011), but should constitute a primary target for the new ICDP core log observations.

Deutsch & Schärer. *Meterorit. Planet. Sci.* 1994; Jourdan et al., *Elements* 2012; Tohver et al., *Geochim. Cosmochim. Acta* 2012 ; Schmieder et al., in rev. *Geochim. Cosmochim. Acta* ; Matchan & Phillips, *Quat. Geochro.* 2014; Riccomini et al., *Meterorit. Planet. Sci.* 2011.

Vertical and horizontal drilling simulations in South America, Arctic and Antarctica for future robotic and human mars exploration

Antonio de Morais M. Teles, Brazilian Center of Physics Research, Rio de Janeiro, Brasil
antonioamore@yahoo.com

I propose vertical and horizontal drilling at some very specific places at South America, the Arctic and Antarctica to simulate such operation for the future robotic and manned exploration of planet Mars. Much probably Mars might have had abundance of liquid H2O at 3.5 Gyrs since robotic spacecraft presently there have discovered geo-morphological features on Martian surface resembling ancient fluvial and lake patterns, and spectral signatures of the soil revealed the presence of minerals which are usually formed via H2O chemistry. Since physical laws here on Earth are thought to be the same elsewhere in space, including Mars, then possible biogeochemical pathways might have used water on Mars as life uses it here on Earth. Where is the water now ? Due to gravity, stable liquid water might be localized deep underground within Mars, possibly in the form of ponds or small lakes of salty water (brines) within fractured solid formation buried under many several meters of sand, because of big floods and storms carrying great quantity of sediments in the past. A key for reaching such elusive ponds or lakes is investigating places on Mars (orbital observation using an analogous to the SIR-C/X-SAR radar equipment used aboard the space shuttle, which imaged deep rivers below the Sahara desert) where there were fluvial encounters with lakes, with possible caves formed below the surface and close to big stratigraphic formations – layered walls exposed from below the surface. By using drilling mechanisms we will be able to reach vertically deeper into these subsurface caves, and at the same time, to reach horizontally deeper into the interior of the strata in the walls. I think the chances of finding some possible biological activity on Mars are better in those above mentioned places. The author has performed some simple drilling, using non-electric manual tools, of rocks and sedimentary stratigraphic formation at some points of the Southern Brazilian seacoast. No peer-reviewed scientific results are available yet. Thus, we can at South America, the Arctic and Antarctica to perform the simulation of such above research duties of finding such places and to (vertically and horizontally) drill deep there (from 1 m to 1 km), and to collect samples from inside. And later, to biochemically analyze them for biological signatures – RNA and DNA molecules and others. New and promising lightweight drilling equipment are known as “Ultrasonic Drill Tool” (UDT) or “Ultrasonic/Sonic Driller/Corer” (USDC), the first being developed by the European Space Agency (ESA) and the latter was developed (but the project was suspended) by the American National Aeronautics and Space Administration (NASA). These drillers are under development and studies for ultrasonically/sonically–assisted drilling and sampling of planetary rocks and regolith. The equipment transform low displacement, high frequency oscillations in a transducer into higher displacement vibration at the tip, which effectively cuts into material. The tools were tested in a variety of materials, and the results of these tests are being used to make improvements to the design. Typical UDT/UDSC performances in a relatively hard material such as granite are: a) required thrust force 8-10N; b) 23-mm diameter core; c) 12-mm deep core cut in ~140 min; d) uses less than 40 W power; e) cut is clean and does not fracture core. These new equipment will be aimed for future characterization of subsurface ice and brine and for life detection inside planetary sub-surfaces, as Mars’ and moons’ in the Solar System, in the advancement of Astrobiology. These drilling operations above can give a better solid preparation for future robotic exploration of and human expedition to Mars.

Phylogeography of Atlantic Forest organisms: why paleoenvironment reconstruction is so important?

Cristina Y. Miyaki, Departamento de Genética e Biologia Evolutiva, Instituto de Biociências, Universidade de São Paulo. Brazil.
Ana Carolina O. Q. Carnaval. City University of New York, The City College of New York. 160 Convent Avenue, New York, NY, USA, 10031.

The Atlantic Forest is currently reduced to less than 11% of its original distribution due to deforestation and degradation. Yet, it harbors one of the highest percentages of endemic species in the world. Phylogeographic studies of organisms (especially animals) from the Atlantic Forest have been revealing a complex history for this biome. Some taxa do not present any population genetic structure while others do. Those with genetic structure show latitudinal differentiation and the geographic locations of phylogeographic breaks observed in different organisms sometimes coincide. These results are being used to test paleoenvironmental and paleoclimate models that are already available and those that are under construction by our group. Funds: FAPESP (Biota 2013/50297-0), NSF (DEB 1343578), NASA, CAPES, CNPq.

ICDP at Lake Bosumtwi, Ghana, West Africa

Jonathan T. Overpeck[a], Timothy M. Shanahan[b], Nicholas P. McKay[c], Clifford W. Heil[d], John King[d], John Peck[e], Christopher A. Scholz[f]

a. Departments of Geosciences, University of Arizona, Tucson, AZ 85721 USA
jto@email.arizona.edu
b. Jackson School of Geosciences, The University of Texas at Austin, Austin, TX 78713 USA
c. School of Earth Sciences and Environmental Sustainability, Northern Arizona University, Flagstaff, AZ 86011 USA
d. Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882 USA
e. Department of Geology and Environmental Science, University of Akron, Akron, OH 44325 USA
f. Department of Earth Sciences, Syracuse University, Syracuse, NY 13244 USA

The continuous ca. 1.1 Ma sediment record from impact crater Lake Bosumtwi, Ghana represents one of the longest, continuous lacustrine sequences obtained from an extant lake, and contains an unprecedented record of late Quaternary climate change in sub-Saharan West Africa. After multiple site survey and preliminary coring expeditions, the complete ca. 300m sedimentary sequence in Lake Bosumtwi was recovered by a ICDP and US NSF sponsored drilling program Global Lake Drilling (GLAD) 800 system in the summer of 2004. 14 holes were drilled and 1833 m of sediment was recovered, including the entire sediment record down to the impact itself. Extensive varve, radiocarbon, optically stimulated luminescence and U-series dating, along with paleomagnetic excursion, paleomagnetic reversal and ^{40}Ar-^{39}Ar dates acquired from the impact tektites themselves provide a chronology for the Bosumtwi record. The record has been used to reveal a number key environmental insights that are key to societies in sub-Saharan Africa and beyond, including: (1) substantial future risk of megadroughts far more severe than the 20th century Sahel drought, and more substantial than simulated by state-of-the-art models (e.g., CMIP5) exists for the region; (2) both hydroclimatic variability (i.e., drought variability) and temperature variability increase with time scale following a power-law relationship all the way out to orbital time scales; (3) the Atlantic Multidecadal Oscillation changes in strength and dominant frequency with altered radiative forcing, and continues to operate in warmer climates than at present; and (4) the response of the northern African rainbelt (and West African Monsoon) to changing radiative forcing is likely to yield *locally* abrupt changes in moisture balance and vegetation in the future. Many additional insights remain to be unraveled using the million-year Bosumtwi record in the future.

Searching the prior paleofloras of the atlantic forest

Fresia Ricardi-Branco, Department of Geology and Natural Resources, Institute of Geosciences, University of Campinas Brazil, fresia@ige.unicamp.br

The Brazilian paleogene and neogene floristic records are not many, but they are very rich and diverse in angiosperm species. The records are divided in macrofloras (leaves, seeds, etc) and pollen assemblages (pollens, spores, etc). Some paleofloras are related with formations deposited in continental basins (i.e. Gandarela, Fonseca, Taubate formations), derived from river and lacustrine environments associated with grabens. Others are related with coastal regions (i.e. Maria Farinha Formation) and at last with the evolution of Amazon Basin (i.e. Solimões Formation). It is proposed a research based on these records and other occurrences in South America, if necessary, the clues for the origin of the Atlantic Forest and establish the correlations among them and the Colônia Cratere paleofloristic records.

Sediment Mineralogy and Geochemistry - a perspective from CoDa analysis, based on the example of Lake Iznik

Patricia Angelika Roeser, University of Bonn, Steinmann Institute for Geology, Mineralogy and Paleontology Bonn, Germany

Minerals and geochemical elements – as essential building blocks of sediments and its components – are indispensable for understanding sedimentation processes. Compositional Data analysis (CoDa) allows a statistical evaluation of geochemical and mineralogical information, dealing with the closed nature intrinsic to such data-sets. The example of Lake Iznik shows how millennial scale climate forcing acts on a lake and the catchment. Fluctuations in the depth of the water column, the lake mixing, and weathering intensity, are expressed by the bulk mineral assemblage, geochemistry and grain size.

A molecular geochemical perspective on long-term tropical climate variability

Timothy M. Shanahan, Jackson School of Geosciences, The University of Texas at Austin, Austin, TX 78713 USA

Over the past decade, the development of new paleoclimate techniques based on molecular organic geochemistry have greatly expanded the potential opportunities for generating quantitative paleoclimatic records from terrestrial sediment archives. For example, carbon and hydrogen isotope analysis of sedimentary leaf waxes provide unambiguous proxies for vegetation cover and precipitation that complement more traditional approaches such as pollen, diatoms and bulk geochemistry. Other molecular techniques, such as the MBT/CBT and the TEX_{86} indicies, can provide quantitative temperature estimates in lacustrine systems. In combination with long terrestrial sediment records acquired through deep lake drilling, these techniques can yield unique insights into long-term changes in the terrestrial environment and a valuable complement to existing long marine records. Here we present new results on the applications of these approaches to two of the ICDP led deep lake drilling projects: Lake Bosumtwi and Lake Titicaca. Together, they provide insights into the dominant controls on past changes in temperature, precipitation and vegetation in the deep tropics over the last glacial cycle.

Paleohydrology stratigraphy and the interactions with aquifers from Colônia crater

Sueli Yoshinaga Pereira , Department of Geology and Natural Resources, Institute of Geosciences, University of Campinas, SP, Brazil, sueliyos@ige.unicamp.br

The groundwaters are consequence of infiltration processes that slowly accumulate in sediments and rock pores, at different geologic times. Infiltration waters can be dated and related with different climatic signatures associated with rainfall records. The current groundwater research aims to design the infiltration stratigraphy pattern through dating samples collected at different depths, defining climatic water signature by isotopic studies and hydrogeochemistry. This study will be based on conceptual model elaborated under hydrodynamic conditions, cratere features and the drilling information.

Seismic Reflection Investigation at Colonia Structure

Renato L. Prado, Instituto Astronômico e Geofísico, Universidade de São Paulo, Brazil renato.prado@iag.usp.br
Alvaro P. Crósta, Instituto de Geociências, Universidade Estadual de Campinas, SP, Brazil alvaro@ige.unicamp.br
Claudio Riccomini, Instituto de Geociências, Universidade de São Paulo, Brazil claudio.riccomini@gmail.com

The Colonia Structure has been investigated by geophysical methods since the 1960s. Previous knowledge of its geophysical characteristics was obtained by electric, gravity, magnetic telluric and seismic refraction studies.

The first gravity study (1960) estimated the maximum depth of the basement between 285 and 400 m. Later, gravimetric measurements (1991) estimated in the range of 300-350 m. Audiomagnetotelluric data inversion (distribution of apparent resistivity as function of frequency) yielded an estimation in range 200-400 m. Seismic refraction data produced some information regarding velocities, but with dubious results regarding the depth of the sediment-basement interface.
More recently, in 2010, seismic reflection survey has been carried out on the southeastern portion of the structure aiming to provide complementary information regarding its morphology, thickness of the sedimentary filling and depth of the crystalline basement. Seismic data were acquired through a continuous CDP profile, 1 km in length, employing the "mini-sosie" method, with two mechanical soil compactors as the source energy. The data were processed using standard routines to improve the signal quality. The stack section and the interval velocity functions suggest the presence of three zones with distinct seismic signatures. From top to bottom, the first zone has a maximum thickness of 270-280 m and is represented by the organic-rich clayey sediments and clastic material. The second zone with a maximum thickness of 65 m represents a transition between the sedimentary filling and the third, the lowermost part, might compromise brecciated/fragmented basement rocks. Finally, we'd like to mention that although the swampy conditions and high level of cultural noise (due to the proximity to the city of Sao Paulo) at the Colonia area affect and restrict, in different ways, the acquisition of geophysical data in general, in relation to the seismic methods they stimulate the employment of the Horizontal-to-Vertical Spectral Ratio - HVSR method (employing passive sources and surface waves) mainly as an exploratory approach for the area near the center of the structure.

Sedimentology and mineralogy of Colônia Crater deposits: what we know and implications

Lucy Gomes Sant'Anna, University of São Paulo School of Arts, Sciences and Humanities /Institute of Energy and Environment Brazil, lsantann@usp.br

The sedimentary infill of Colônia Crater, estimated in 270-280 m, was recovered in a groundwater borehole, drilled about 800 m from the center of the crater (Riccomini et al. 2011). The sedimentary column was described as comprised by a pebbly mud at the base (257-258 to 270 m), probably representing deposition of alluvial fans or breccia due to the presence of Precambrian rock fragments, followed by lacustrine organic-rich silty clay with three intervals (242-174, 147-94, and 46-40 m) of sandy mud debris-flows intercalations.
The consistent interlayering of sandy mud and organic clayey layers in the geologic section described by Riccomini et al. (2011) also allows observing that there is:
1) *A general finning upward* distribution of the sediments, with sandy mud layers more frequent at the lower part (174 – 270 m) and organic clayey layers dominating to the top of the section.
2) *A concurrent distribution of the thicknesses* of sandy mud and organic clayey layers, which are thicker towards the base and the top, respectively.
3) *An abrupt thickening of the organic clayey layer* at 174 m, the same depth from which the frequency of sandy mud layers decreases.
Altogether, these sedimentological properties suggest that the debris flows were more common at the beginning of the sedimentary fill of the crater, when the lacustrine environment was incipient. The perennial lacustrine environment installed abruptly in a time recorded at the depth of 174 m and that remains to be dated. The reason

for this sudden environmental change, which obviously needs to be confirmed by a new drilling, is not explained by the mineralogical composition of the sandy mud and organic sediments.
Sandy mud and organic clayey samples from different depths in the groundwater borehole were qualitatively analyzed by X-ray diffraction (XRD) as whole-rock and clay fraction (< 2μm). Preliminary SEM/EDS analyses were performed for five sandy samples and two organic samples. Quartz, mica and kaolinite occur in the XRD diffractograms of all analyzed samples. Under SEM, quartz grains are sub-rounded and occur surrounded by matrix. Detrital mica plates are very common, sand to silt-sized, and exhibit few signs of alteration. Kaolinite was perfectly characterized as authigenic vermicular aggregates. Detrital silt-sized kaolinite plates seem also to be present. Feldspar was identified by XRD only in four samples (two sandy and two organic samples), and under SEM the grains are silt-sized, have no surficial signs of alteration, and exhibit clear two cleavage surfaces. Heavy minerals were identified only by SEM/EDS and correspond to barite, cerium-phosphate, zircon, and titanomagnetite, being the first the most commonly found in the sediments. Microfossils were also found under SEM.
The obtained mineralogical and textural data indicate that:
1) The mineralogical assemblage is the same in the sandy mud and organic clayey layers, suggesting, as expected, that the source area remained constant during the whole depositional time.
2) The whole mineral assemblage found in the sandy and organic layers may be directly correlated to the Neoproterozoic metamorphic rocks in the basement, namely, the gneiss and migmatite at the S-SE border and the mica-schist and quartzite at the S-SW border.
3) Regionally, this composition is very similar to the Pliocene sedimentary deposits of the Pindamonhangaba Formation, Taubaté Basin (Mancini , 1995; Riccomini et al. 2004).

Having in mind the possibility of a new drilling in the Colônia crater and for the continuation of this study we will perform detailed qualitative and quantitative mineralogical analysis by XRD of whole-rock and clay-size fractions, as well as SEM/EDS analysis to the characterization of mineral genesis (detrital *vs* authigenic).
References:
Mancini, F. 1995. Estratigrafia e aspectos da tectônica deformadora da Formação Pindamonhangaba, Bacia de Taubaté, SP. São Paulo, 107p. (Master Dissertation, Institute of Geosciences, University of São Paulo).
Riccomini, C.; Sant'Anna, L.G.; Ferrari, A.L. 2004. Evolução geológica do Rift Continental do Sudeste do Brasil. In: Mantesso, V.; Bartorelli, A.; Carneiro, C.R.; Brito Neves, B.B. (Eds.) Geologia do Continente Sul-Americano: evolução da obra de Fernando Flávio Marques de Almeida. São Paulo, Beca Produções Culturais Ltda., pp.383-405.
Riccomini, C.; Crósta, A.P.; Prado, R.L.; Ledru, M.P.; Turq, B.J.; Sant'Anna, L.G.; Ferrari, J.A.; Reimold, W.U. 2011. The Colônia structure, São Paulo, Brazil. Meteoritics and Planetary Science, 46(11):1630–1639.

Optically Stimulated Luminescence dating: feasabilities to obtain reliable age models for deposition of Quaternary sediments

André Oliveira Sawakuchi (andreos@usp.br)
Luminescence and Gamma Spectrometry Laboratory – Institute of Geosciences – University of São Paulo

The presentation will consider the use of well established and under-development approaches for luminescence dating of sediments from the Colônia site. The methods presented will include Single-Aliquot Regenerative-dose (SAR) protocols using Optically Stimulated Luminescence (OSL-blue), Violet Stimulated Luminescence (VSL), Thermal Transfer (TT)-OSL signals of quartz and Infrared Stimulated Luminescence (IRSL) and post-IR IRSL signals of feldspar. Age range and uncertanities for these methods will be discussed. Practical aspects presented will include sediment type and grain size, sample size and collection, sample preparation and measurements for age calculation.

Application of paleomagnetism and rock magnetism to lacustrine successions: potentials and concerns

Giancarlo Scardia, Instituto de Geociências e Ciências Exatas, UNESP, Rio Claro, SP, Brazil scardia@usp.br

The magnetic analysis of sediment has become a powerful tool to characterize and date continental sediments since the beginnings of the '80s. Its application reaches the maximum result in continuous and expanded stratigraphic successions, from cores as well as land exposures, where the record of magnetic stratigraphic events leads to the development of magnetic polarity stratigraphy and cyclostratigraphic curves. At this regard, lacustrine environment are proving to be uncompetitive archive of paleomagnetic and rock magnetic information

(among many others) in the continental realm. Dating continental deposits is traditionally a difficult task when suitable material of radiometric dating is lacking. In this case, the application of the magnetic polarity stratigraphy (or magnetostratigraphy) often provides a reliable solution. This method refers to the application of the well-known principles of stratigraphy to the pattern of polarity reversals registered in a rock succession by means of natural magnetic acquisition processes. This requires that the rock faithfully recorded the ancient magnetic field at the time of its formation, a pre-requisite that is verified in the laboratory by means of paleomagnetic and rock magnetic techniques. The application of magnetostratigraphy in Plio-Pleistocene successions relies on the detection of a number of magnetic polarity reversals, such as the Brunhes-Matuyama boundary (0.78 Ma), the Jaramillo top (0.99 Ma) and base (1.07 Ma), and the Olduvai top (1.78 Ma) and base (1.95 Ma). If the sedimentary succession is long enough and the sedimentation rates are not too much high, detection of magnetic polarity reversals in sediments is a common expected result. Rock magnetic methods allow for having an insight into paleoenvironmental and paleoclimatic dynamics by detecting the variations of a wide spectrum of minerals. As magnetic minerals are produced by different processes (erosion, weathering, biologic activity) changes in magnetic mineralogy composition of a rock have been demonstrated to reflect changes in sediment source (both detrital and biogenic), which in turn can bear a climatic forcing. Finally, the measure of the anisotropy of magnetic susceptibility (AMS) provides information about the magnetic fabric of the sediment by measuring the crystallographic orientation of phyllosilicates and ferromagnetic grains. AMS fabrics are interpreted to reflect the sedimentary fabric because in phyllosilicates the short shape axis corresponds to the minimum-susceptibility direction and, therefore, in non-deformed sediments AMS usually reflects depositional processes and geometries. This is particularly helpful in the sedimentologic characterization of sediments in cores, where the reduced observation window may lead to ambiguities in facies analysis. Major concerns in the application of magnetic methods rely on the occurrence of authigenic minerals, which can provide a secondary overprint on the original (i.e. syn-sedimentary) magnetic signal. In particular, lacustrine environment often brings anoxic conditions at the bottom or in the pore water leading to the post-depositional formation of iron sulfides, among which the greigite has magnetic properties. This problem is very well known and addressed by analytic techniques that in most of the cases allow a complete recovery of the primary magnetic signal.
In summary, magnetic analyses can strongly support core analysis by contributing to the investigation of many geologic aspects, from the chronology, to facies analysis and the paleoenvironmetal/paleoclimatic assessment.

Colônia basin structure – changes of paleo-environment and climatic conditions investigated at high resolution

Ulrich Struck, Museum für Naturkunde Berlin, Germany(ulrich.struck@mfn-berlin.de)
Alvaro P. Crósta, Instituto de Geociências, Universidade Estadual de Campinas,
SP, Brazil (alvaro@ige.unicamp.br)
Wolf Uwe Reimold, Museum für Naturkunde Berlin, (uwe.reimold@mfn-berlin.de) and Humboldt University Berlin, Germany.

Stable isotopes of bio-reactive elements in sedimentary records such as nitrogen, carbon and oxygen, are known to be very sensitive to long-term and also abrupt changes in the environment driven by, e.g., climate, moisture supply, or weathering rates. With the Colônia basin structure a site has been found which, in turn, has the potential to allow to perform a detailed study of the impact of quaternary climate change in a tropical rain forest environment, which can be compared with modern ecological states with respect to biota and nutrient cycling. In comparison with existing high resolution records of paleoclimate change and the environmental response from marine sedimentary sequences or ice cores, the causal linkages between ocean and continent can be analyzed in detail for the tropics. For the sedimentary sequence of the Colônia basin structure of approximately 230-270 m of soft sediments, covering possibly 2.5-5.0 Ma, an average sedimentation rate of 5-10cm/1000years can be expected, which is comparable to oceanic sedimentary highresolution records. It is, therefore, likely that the proxy data records, which could be relatively easily retrieved from the Colônia basin structure sediments, mirror Milankovitch type cycling or may record even climatic anomalies beyond cycle resolution. A detailed stable isotope and micropaleontological study in high resolution from a Colônia basin structure drilled sequence would be of great potential to gain more specific information of Land – Sea interactions and compare that with man-made changes occurring today (i.e., “the Anthropocene”).

Paleomagnetism of impact craters and their sediment fill

Ricardo I.F. Trindade and Elder Yokoyama, Instituto de Geociências, Universidade de São Paulo, Brazil

The magnetic record of impact structures and sediments that eventually fill in their central depression gives information about the age of the impact, the paleolatitude of the target at the time of impact, and block rotations during and after impact, as well as the post-impact chronology and paleoenvironmental fluctuations from the sediments filling-in the final impact cavity. Basically two magnetic elements are investigated in impact crater studies: the direction of the remanence vector and the scalar parameters of environmental magnetism. A high-resolution chronology of the impact and post-impact sediments is provided by changes in remanence direction, defining reversals and excursions of the Earth's magnetic field that are well-dated chronological markers. The remanence vector also indicates the paleolatitude (relates directly to its inclination) and block rotations in the target. The scalar magnetic parameters provide information about the sediment sources, transport, deposition and postdepositional alterations of magnetic minerals under the influence of a wide range of environmental processes. More specifically in the case of impact crater lake sediments, the magnetic parameters may provide a continuous continental record of past climatic fluctuations related to changes in sources and weathering regimes. Several sedimentary successions of lakes in impact craters have been studied for their magnetostratigraphy and environmental magnetism, among others: Bosumtwi (Gana), El'gygytgyn (Russia), Chicxulub (Mexico), and Manicouagan (Canada). For that, continuous sampling along the sedimentary column is necessary and it is usually achieved through drilling. In the talk we will describe these previous experiences and discuss the use of a similar approach to the study of the sedimentary succession in Colonia impact crater (Brazil).

What are the physical properties data expected for drill holes in impact craters?

Marcos Vasconcelos Instituto de Geociências, Universidade Estadual de Campinas, SP, Brazil

The number of target rocks drilled has increased and provided geophysical information essential for comprehension of deformed strata in the main impact structures of the World. We address the geophysical characteristics found for well-known impact craters in order to drive the next exploration of Colônia.