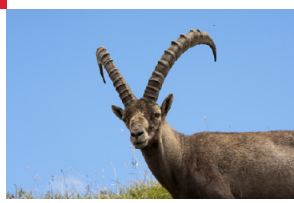

Abstract Volume
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6. Quaternary Research

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6. Quaternary Research

Florian Kober, Susan Ivy-Ochs, Naki Akçar, Irka Hajdas

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6.1

Filling gaps on the shrinking/swelling tale of the Dead Sea through continental drilling

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Intensive investigations on outcrops and short core sediments in the Dead Sea Basin (DSB) have shown a Late Quaternary history containing a succession of expanding and shrinking lakes during glacial and interglacials intervals, respectively. Sedimentation on this basin located in the lowest continental exposed elevation on Earth has been continuously modulated by regional and global climate and rift tectonics. Hence, its sedimentary infill is comprehensively recording limnological, hydrological and seismic events. Moreover, the sections contain datable material such as primary aragonite that can be used to construct a chronology of the environmental history of lakes and their watershed and compare them to late Quaternary global climate archives. Yet, most of the studies carried out on the Dead Sea lakes during the past decades focused on the marginal terraces that are abandoned when the lake declines. Thus, we moved to drill within the framework of an ICDP (International Continental Scientific Drilling Program) two sets of nearly continuous sedimentary cores at water depth of ~300 m close to the deepest area of today's Dead Sea and at ~2.5m depth next the shore near Ein Gedi (Israel). These sedimentary cores fill in known (and estimated) gaps in the outcrop sediments and provide a nearly continuous and undisturbed record covering at least the past two glacial-interglacial cycles judging from changes in dominant lithology. The sedimentary record can be divided into two dominant lithologies: salt layers interbedded with laminated muds; and massive and laminated marl interbedded with thin salt layers. Silt and sand (and gravel) levels indicate intervals of extremely low lake level. The results of this study will provide crucial information to better understand the environmental conditions prevailing during human development and migration through the Dead Sea corridor.

† Complete list of DSDDP scientists @ www.icdp-online.org

6.2

Stalagmite evidence for a highly dynamic Pleistocene hydrological history of the Black Sea

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The hydrological balance of the Black Sea is strongly governed by riverine input and exchange with the Mediterranean Sea through the shallow Bosporus Strait1 (34 m below present sea level (mbsl)), both of which have distinctly different oxygen isotope signatures. Therefore, the oxygen isotope composition of Black Sea water is directly related to the presence of a Mediterranean connection and to climatically-driven hydrological changes in the vast watersheds of the Black Sea (2,410,840 km^3) and the Caspian Sea (3,249,154km^3) further afield.

To date, very little is known about the Pleistocene hydrological history of the Black Sea because oxygen isotope records from its sediments only span the last 30 ka before present (BP). We present a stacked speleothem oxygen isotope record from Sofular Cave (Fleitmann et al., 2009; Badertscher et al., 2011) in Northern Turkey that tracks the isotopic signature of Black Sea surface water, allowing us to reconstruct the hydrological history of the Black Sea in unprecedented detail.

Our record, which extends discontinuously over the last 670,000 years, suggests that a connection between the Black and Mediterranean Seas persisted at least 12 times since 670 ka BP, more often than previously suggested. Each connection phase coincided with sea levels higher than the current Bosporus sill depth, which was remarkably constant over the last 670 ka BP. Distinct minima in the Sofular oxygen isotope record indicate at least 7 intervals when isotopically depleted freshwater from the Caspian Sea overflowed into the Black Sea through the Manych-Kerch spillway. Our data provide the first detailed evidence for a highly dynamic hydrological history of the Black Sea.

REFERENCES

Badertscher, S., Fleitmann, D., Cheng, H., Edwards, L., Göktürk, O.M., Zumbühl, A., Leuenberger, M. & Tüysüz, O. 2011. Pleistocene water intrusions from the Mediterranean and Caspian Seas into the Black Sea. Nature Geoscience, 4: 236-239.

Fleitmann, D., Cheng, H. Badertscher, S, Göktürk, O.M., Mudelsee, M., Fankhauser, A., Pickering, R., Edwards, R.L., Matter, A., Kramers, J. & Tüsyüz, O. 2009. Timing and climatic imprint of Dansgaard-Oeschger events in stalagmites from Northern Turkey, Geophysical Research Letters, doi: 10.1029/2009GL040050.

6.3

The chronology of Lake Soppensee (Switzerland) using a biomarker and a compound-specific isotope approach

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Chronologies of natural archives such as lake sediments are often based on radiocarbon ages of recognizable terrestrial macrofossils that are deposited soon after their biosynthesis. However, in many instances reliable dating is not possible due to a lack of macrofossils or other carbonaceous material that can be dated using radiocarbon (^{14}C). Therefore dating of specific substances that contain a ^{14}C signature of the time of sediment deposition can be a powerful tool to circumvent many chronological problems.

Here, we evaluate the potential of compound-specific radiocarbon analysis (CSRA) as a dating tool for lake sediments. We present the results of a biogeochemical study of the sedimentary record of the Swiss Lake Soppensee covering the last 14,000 years BP in combination with ^{14}C ages given by certain organic compounds. The small, eutrophic, hard-water lake is situated on the central Swiss Plateau (596 m a.s.l.). This is a very well dated (Hajdas and Michczynski 2010) and studied (e.g. Lotter 2001, Fischer 1993) lake with undisturbed organic carbon-rich and partially laminated sediments. The master chronology of the record was established by the use of a varve chronology and ^{14}C dating of terrestrial macrofossils (Hajdas and Michczynski 2010). It allows an evaluation of the potential of CSRA for dating approaches.

We show the radiocarbon ages of long-chain n-alkanes and fatty acids and of the total organic carbon (TOC) and compare them to the existing chronology. Additional information from biomarker profiles and compound-specific isotope analysis ($\delta^{13}C$) allows more insight into: a) The potential of using specific compounds for radiocarbon dating of the sediment core; b) The limnological and environmental history of the lake and of the soils in its watershed; c) Early diagenetic processes taking place in the lake environment.

In the sediment of lake Soppensee the main lipid signature derives from higher terrestrial plants. We isolated individual long-chain n-alkanes and fatty acids by the use of preparative gas and liquid chromatography for subsequent radiocarbon analysis. In the oldest parts of the record the age of these biomarker match well with the chronology, but with decreasing sediment age they show an increasing age difference. This phenomenon has already been described for other systems (Smittenberg et al., 2006) and gives a measure for residence time of these plant-derived compounds in soils before entering the lake.

REFERENCES

Fischer, A. 1993: Isotopengeochemische Untersuchungen ($\delta^{18}O$ und $\delta^{13}C$) im Wasser und in den Sedimenten des Soppensees (Kt. Luzern, Schweiz), Diss. ETH Zürich No. 11924

Hajdas, I. & Michczynski, A. 2010: Age-depth model of Lake Soppensee (Switzerland) based on high-resolution 14C chronology compared with varve chronology. Radiocarbon, 52, 1027-1040

Lotter, A.F. 2001: The palaeolimnology of Soppensee (Central Switzerland), as evidenced by diatom, pollen, and fossil-pigment analyses. J. Paleolimn., 25, 65-79.

Smittenberg, R.H., Eglinton, T.I., Schouten, S. & Sinninghe Damsté, J.S.: Ongoing buildup of refractory organic carbon in Boreal soils during the Holocene. Science, 314, 1283-1286

6.4

Nature and Timing of Terminations I and II recorded in stalagmites from Switzerland

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One of the main objectives of a recently funded SINERGIA program called "STALCLIM- Multi-proxy climatic and environmental reconstructions from stalagmites from Switzerland, Turkey, Arabia and India" is to construct highly resolved and precisely dated paleoclimate records from stalagmites from caves in Switzerland by using a broad array of different analytical techniques. Since the beginning of "STALCLIM" in January 2011 we collected stalagmites from several caves (Figure 1). Based on preliminary results, two stalagmites from Milandre Cave (Jura Mountains; 400 m above sea level) and Cave R5/007 (Alpstein, Apenzell; 1890 m above sea level) cover the glacial-interglacial transitions corresponding to Termination I (Milandre Cave) and II (Cave R5/007) in close detail.

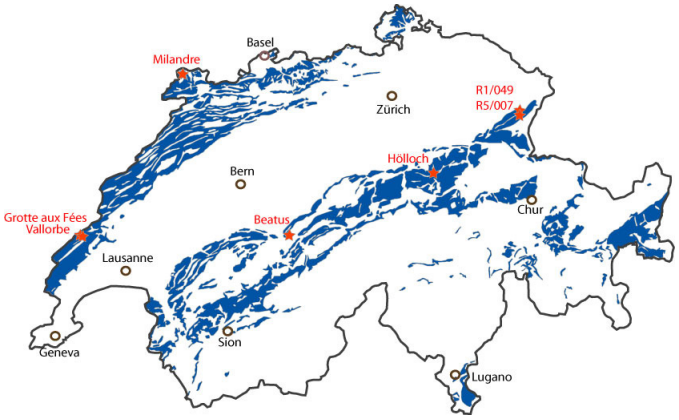

Figure 1. Map of Switzerland showing the location of studied caves (red stars) and spatial distribution of karst areas (blue shaded areas).

High resolution oxygen isotope profiles (Figure 2) indicate that Termination I and II are characterized by distinct positive shift of around 4.5 permil due to temperature dependent positive shifts in the oxygen isotopic composition of precipitation. While the timing and nature of Termination I is fairly well documented in numerous paleoclimate records from Switzerland, no detailed information exists for Termination II. The penultimate glacial termination is covered by stalagmite MF-3 from cave R5/007. Based on very precise Uranium-series ages with age uncertainties of only 500 to 900 years, we provide evidence for an early onset of the Eemian at around 133.000 ± 800 years before present. This timing is in good agreement with other absolutely-dated stalagmite records from Austria (Spötl et al., 2001) and Italy (Drysdale et al., 2009), providing additional support that glacial terminations are rather driven by changes in Earth's obliquity and not Northern Hemisphere summer insolation.

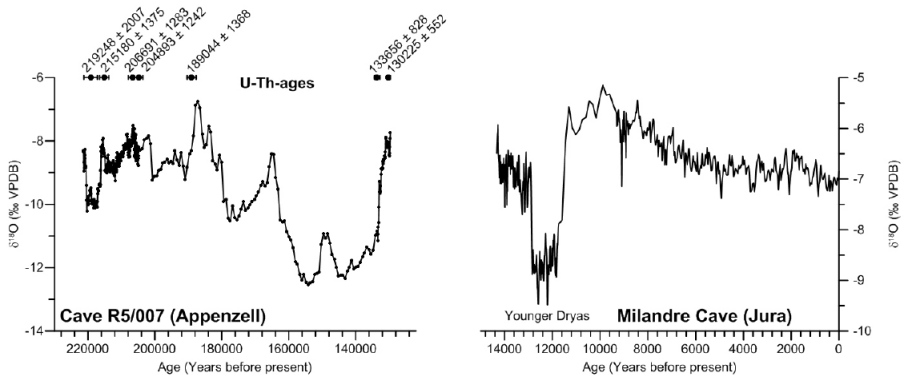

Figure 2. Oxygen isotope profiles of stalagmites from Milandre Cave and Cave R5/007 plotted versus age. Dots with error bars denote Uranium-series ages with age uncertainties.

REFERENCES
Drysdale, R.N., Hellstrom, G.C., Zanchetta, G., Fallick, A. E., Sánchez Goñi, M. F., Couchoud, I., McDonald, J., Maas, R., Lohmann, R. & Isola, I. 2009: Evidence for Obliquity Forcing of Glacial Termination II. Science 323 (5947), 1527-1531
Spötl, Ch., Mangini, A., Frenk, N., Eichstàdter, R. Burns, S. 2002: Start of the last interglacial period at 135 ka: Evidence from high Alpine speleothem. Geology 30/9, 815-818

6.5

New findings concerning quartz properties important for luminescence dating of sediments in the Swiss NW Alpine foreland.

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Application of the Optically Stimulated Luminescence (OSL) and radiocarbon dating, with the aim of establishing the chronology of postglacial lake shore deposits from Grosses Moos (Swiss NW Alpine foreland), showed that the dimness of the sedimentary quartz and resultant poor counting statistics, required the use of large multi-grain aliquots for determining the equivalent doses. This is contrary to the common practice of using small aliquots or single grain luminescence measurements for sediments with complex depositional histories. L_x/T_x tests conducted at the single quartz grain (SG) level revealed that an extremely low proportion (0.5%) of bright grains were dominating the luminescence signal with the remainder being very dim and contributing little to the total signal. Thus large aliquots are equivalent to small aliquots of samples containing a larger proportion of bright grains.

The presence of lots of dim quartz also has implications for the statistical analysis applied to equivalent doses (D_e) replicates when trying to determine an age. Low overdispersion (OD) calculated for D_e replicates and a large number of SAR OSL measurements were required in order to also gain a representative number of bright grains and so reproducible results. The number of aliquots measured, but not their size was decisive for the resulting OD. The OD values obtained from the dose recovery experiments (formerly used as the arbitral σ_b when modelling age estimates) in fact reflected the OD of the photomultiplier tube (PMT) related to the average luminescence intensity (σ_{PMT}). Thus these OD values should not be further used for modelling purposes. For dim quartz data the additional OD (σ_b) value loses its physical importance of being an expression of microdosimetry, beta source inhomogeneity, crystallographic variability or complexity of environmental processes, because large standard errors obscure this information.

In the littoral sediments of Grosses Moos major D_e distributions dominated by a well bleached component with minor contributions from bioturbated and incompletely bleached sediment were anticipated. Because weighted models (e.g. Central Age Model: CAM, Minimum Age Model: MAM and Finite Mixture Model: FMM) favour D_e values resulting from sensitive grains, the final results are at least based on a small number of bright grains, thereby approaching results of modelling SG measurements. Model comparison showed that the FMM results surpass these of the MAM3 and CAM by yielding most consistent D_e values supported by radiocarbon dates.

6.6

Fluid inclusions in stalagmites used as a quantitative thermometer in paleoclimate research

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The fact that cave air temperatures reflect mean annual surface temperatures make speleothems potentially useful for determining absolute paleotemperatures. We have developed a new method to determine stalagmite formation temperatures from liquid-vapour homogenisation temperatures (T_h) of fluid inclusions in stalagmites (Figure 1). Fluid inclusions in stalagmites contain remnants of the drip water from which the calcite precipitated under atmospheric pressure. It is assumed that once they have formed, they do not undergo any changes in volume or composition. Therefore their T_h is expected to equal the stalagmite formation temperature i.e. the cave air temperature. Our approach is to determine the density of fluid inclusions by measuring the liquid-vapour homogenisation temperature after inducing vapour bubble nucleation in initially monophase inclusions. This is achieved by ultra short laser pulses to overcome the metastable state of water (Krüger et al, 2007).

To test our paleothermometer T_h measurements were carried out using thick sections of an actively growing stalagmite from Milandre Cave (Swiss Jura). The observed homogenisation temperatures ($T_{h\,obs}$) display a large variability with a maximum around the actual cave temperature of 9.5°C (Figure 2), because $T_{h\,obs}$ values are influenced by various parameters. $T_{h\,obs}$ values above 9.5°C result from density changes in the fluid inclusions induced during sample preparation. Therefore, these inclusions do not represent the original fluid density and are not considered for the determination of the stalagmite formation temperature (T_f). $T_{h\,obs}$ values lower than 9.5°C can be explained by the effect of surface tension, which leads to a collapse of the vapour bubble below the nominal homogenisation temperature. In fluid inclusions formed at low temperatures this effect can amount to a temperature difference of several degrees. We have developed a theoretical model to calculate T_f based on $T_{h\,obs}$ and the vapour bubble radius measured at different temperatures (Marti et al. in press). This results in a stalagmite formation temperature T_f = 9.42°C (median value), which is close to the present day cave temperature. The results show that our method allows us to determine paleotemperatures with an accuracy of ±0.5°C.

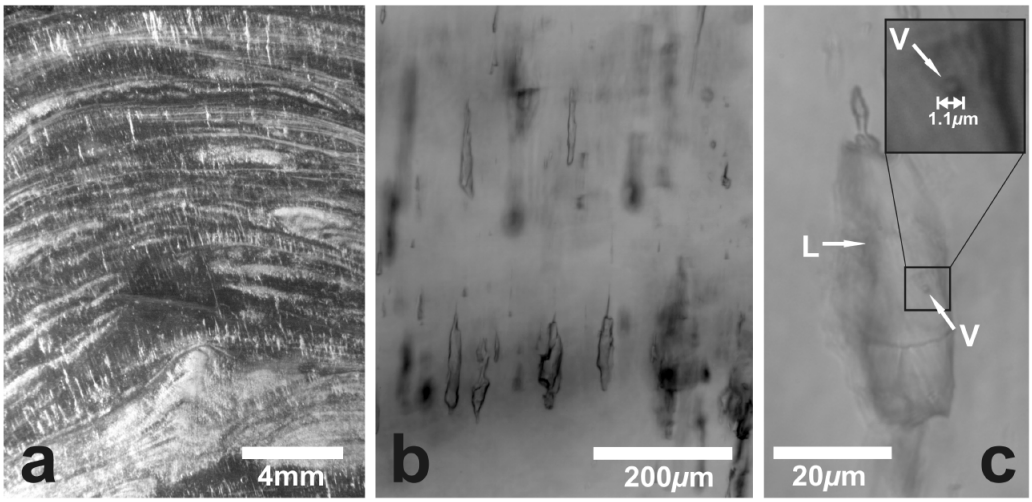

Fig. 1. a) Stalagmite section displaying numerous growth bands with fluid inclusions. b) Enlarged detail displaying typical monophase fluid inclusions. c) Fluid inclusion after bubble nucleation with the vapour bubble (V) indicated.

REFERENCES

Krüger, Y., Stoller, P., Ricka J. and Frenz M. 2007: Femtosecond lasers in fluid-inclusion analysis: overcoming metastable phase states. Eur. J. Mineral., 19, 693–706.

Krüger Y., Marti D., Hidalgo Staub R.; Fleitmann D., Frenz M. in press: Liquid-vapour homogenisation of fluid inclusions in stalagmites: Evaluation of a new thermometer for paleoclimate research. Chemical Geology.

Marti D., Krüger Y., Fleitmann D., Ricka J., Frenz M. in press: The Effect of Surface Tension on liquid-vapour Homogenisation in low-temperature fluid inclusions. Fluid Phase Equilibria.

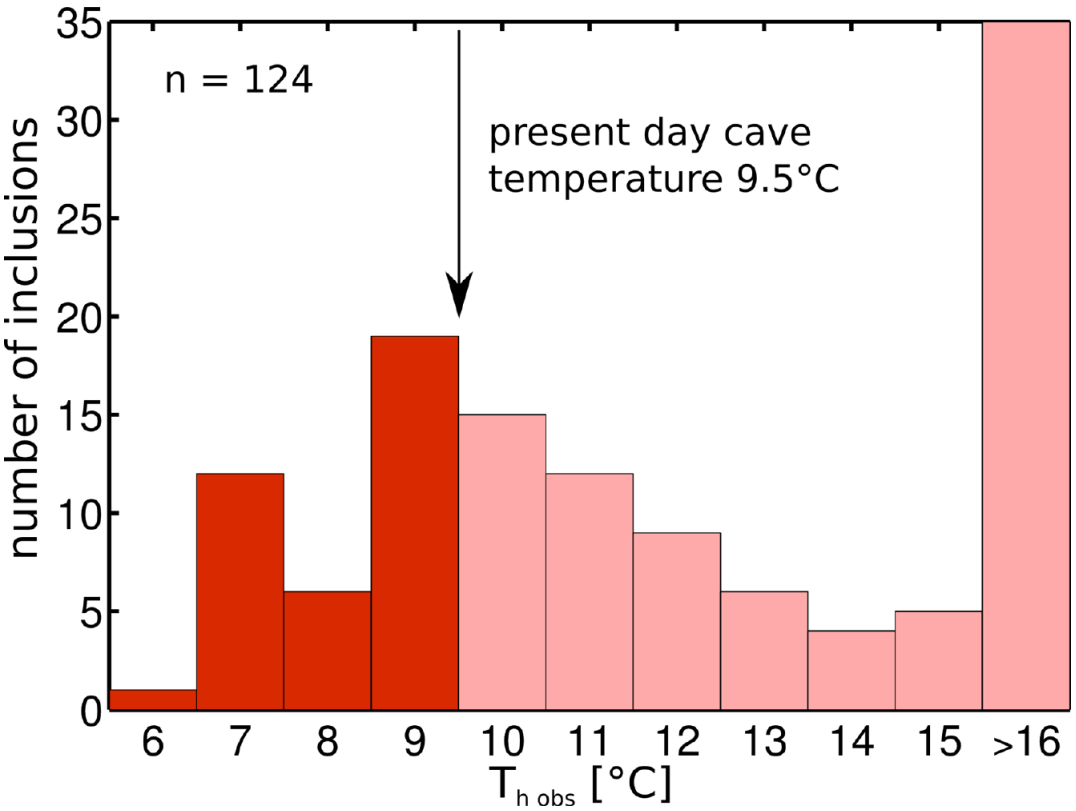

Fig. 2. Distribution of $T_{h\ obs}$ values. Temperatures in light red (higher than the cave temperature) result from preparation induced density alterations. Temperatures in dark red are from fluid inclusions that have potentially preserved their density.

6.7

Evolution of the magnetic inventory in a lacustrine system since the late Pleistocene

Jessica Kind, Ann M. Hirt, Andreas U. Gehring

The magnetic inventory of a sedimentary record covering the last 18 kyr BP is taken to decipher the development of the Soppensee (Central Switzerland). A three-stage development of the lake is constraint from the analysis of the concentration, composition, grain size and configuration of magnetic iron oxides in the magnetic inventory. Stage 1 (18-14 kyr BP): The formation of the proto-lake is triggered by the retreat of the glacier and is characterized by detrital hematite which indicates prevailing oxic depositional conditions. Stage 2 (14-11 kyr BP): The setting of the lake is marked by a shift from an open to a close lake with low detrital input and reducing conditions denoted by the formation of magnetite and the precipitation of ferrous carbonates. This change is assigned to the Bølling/Allerød and the Younger Dryas period. Stage 3 (last 11 kyr): At the beginning of the Holocene a closed lake was established, documented by varves (approximately 11-6 kyr BP) with low magnetite content followed by considerable increase in magnetite production due to the bloom of magnetotactic bacteria (MTB) at approximately 6-2 kyr BP (Gehring et al., 2011, Kind et al. 2011). Intensified forest clearance to provide open areas for pastoral and arable farming at about 2.5 kyr BP affected the chemical conditions in the lakes unfavorable for MTB growth which in turn drop of the magnetite content in the magnetic inventory. With the continuing anthropogenic input the magnetite content in the magnetic inventory remains low and no clear environmental response to the magnetic record is evident. The detailed magnetic analysis of the Soppensee provides clear evidence that the magnetic inventory can be a puzzle piece in a big jigsaw puzzle to understand the paleolimnological development of lake systems.

REFERENCE:

Gehring, A.U., Kind, J., Charilaou, M., Garca-Rubio, I., 2011. The detection of magnetotactic bacteria and magnetofossils by means of magnetic anisotropy. Earth and Planetary Science Letters 309, 113 – 117, doi:10.1016/j.epsl.2011.06.024.

Kind, J., Gehring, A.U., Winklhofer, M., Hirt, A.M., 2011. Combined use of magnetometry and spectroscopy for identifying magnetofossils in sediments. Geochem. Geophys. Geosyst. 12, Q08008, 13 PP, doi:10.1029/2011GC003633.

6.8

Paleoenvironmental changes in eastern Anatolia over the last 500 ka – first insights from the Swiss side of the ICDP Lake Van Drilling Project.

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The PALEOVAN Project, aiming to reconstruct the climatic, tectonic and volcanic history of the eastern Mediterranean and the Near East is the first official Swiss contribution to the ICDP drilling enterprise. During the drilling campaign in summer 2010, our international team recovered a total of 800 m of sediment cores from two sites with multiple holes and reached the bedrock basement of Lake Van. This is a promise of a continuous and complete sedimentary succession covering the entire paleoenvironmental history of Lake Van and its surrounding region over the last ca. 500 ka. Here we present first results acquired within 5 research modules encompassing: (1) sedimentology and stratigraphy, (2) geochemical analyses of solid and fluid phase, (3) organic geochemistry and compound-specific radiocarbon dating, (4) ^{10}Be as a tracer of solar and geomagnetic variability and erosion rate, and (5) noble-gas geochemistry in the pore water.

Lithological description and facies analysis establish the necessary correlative base for other modules. The 218m-long composite profile exhibits great variability and sharp lithological boundaries indicating rapid climate- and/or tectonic-driven changes in depositional conditions. Several annually laminated intervals enable paleo-reconstructions at seasonal resolution. Additionally, the TOC content, clearly showing glacial/interglacial variability, is a useful tool to construct a tuned age model. Pore water pH and elemental profiles (Mg, Ca, K, Na) reveal the geochemical evolution of Lake Van from a Ca-carbonate dominated freshwater basin to a Na-carbonate dominated saline water mass, while the isotopic composition of pore water (δ^{18}O, dD) relates to the regional precipitation/evaporation balance. Lipid biomarker analysis suggests a significant amount of alkenones prospecting possibility of paleotemperature reconstruction. ^{10}Be is used to test to what extent the solar variability and geomagnetic variability can be reconstructed from the production signal of cosmogenic radionuclides. In the first step the analysis focuses at a timeslice of 35-45ka BP (the Laschamp event), where the geomagnetic field was sufficiently reduced. Finally, noble-gas concentrations measured in the pore water allow (in particular He isotope concentration) for understanding of the fluid transport in the sediment column. Moreover the salinity calculated from the concentrations of heavier noble-gas species (i.e., Ar, Kr, Xe) seems to mimic the measured pore water salinity profile, suggesting that noble-gases in the sediments of Lake Van are promising proxies to reconstruct the past physical conditions of the overlying water body.

6.9

Preliminary observations of small scale experiments for the characterization of large rock avalanches

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Rock avalanches are catastrophic events in which granular masses of rock debris flow at high speeds, commonly with unusual long runout. A great volume of material (>10^6 m^3) is involved and the flowing mass can reach velocities up to ten meters per second. It can travel over long distances, in order of kilometers and easily cover an area over 0.1 km^2. These are extremely destructive and uncontrollable events. They present a particular scientific interest because the fundamental processes controlling the behavior of such masses are not well understood. In addition, they are often really costly in term of human lives and infrastructures. The laboratory experiments can play an important role in the understanding of the behavior of such extreme and destructive events.

Small scale experiments were performed on a slope with calibrated material in order to understand the behavior of a sliding mass. The installation is formed by a simple tilting plane where different substratum can be added as well as for the surface of deposition. A volume is released from a starting box, slides along the slope and stops on the horizontal surface. The mass is recorded during its motion by a high speed camera.

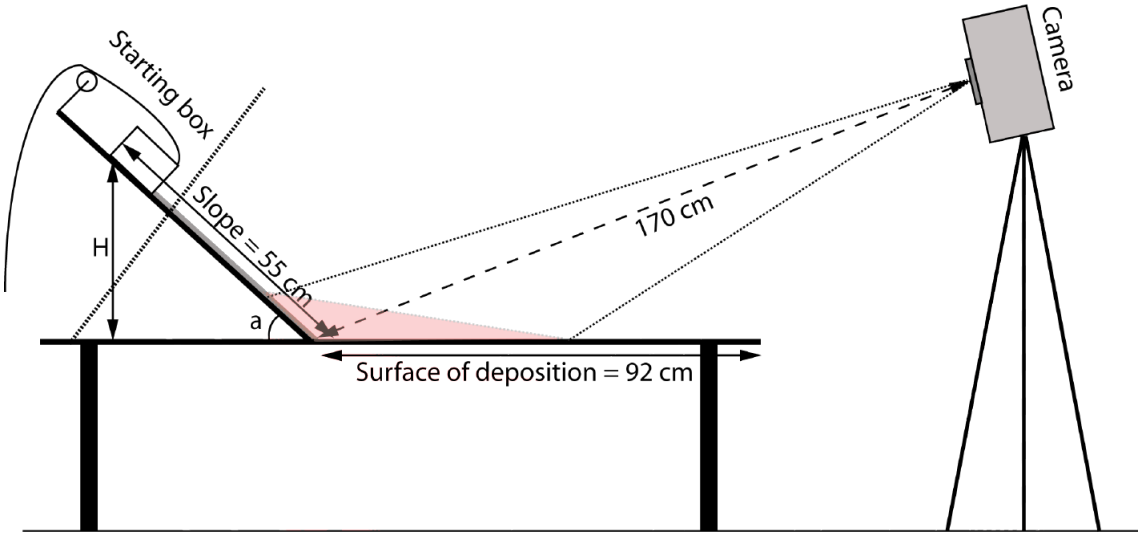

Figure 1. Scheme of the installation with H = height of fall and □ = slope angle. The area filmed by the camera is represented in transparent.

We observe that some features and parameters are similar than these observed in some real cases. Deposits present features perpendicular and parallel to the flow direction similar to features identified in the Frank Slide deposit (Charrière, 2011). When a volume with different grainsize is used, the coarser grains tend to form the top of the deposit whereas the finer material forms the margins of the deposits. Different theories were proposed by several authors to explain this inverse grading of deposits (i.e. Middleton (1970), Bagnold (1954) or Takahashi (1980)). Cruden and Hungr (1986) observed this inverse grading in the Frank Slide deposit. An important parameter used to describe rock avalanche is the Fahrböschung or apparent coefficient of friction. This parameter, defined by Heim (1932), is the angle of a straight line that expresses the rate of frictional dissipation energy (Hsü, 1978). During our experiments, we observed Fahrböschung similar to past events such as: the Lecco rock avalanche, described by Scheideger (1973), Airolo and Schächental events described by Hsü (1975).

The most important impacts of this study are a better understanding of the effects of grain size and spreading of rock avalanches, the relationship between grainsize and the substratum roughness. If the behaviour of those debris avalanches is better understood, the prediction and the risk assessment for such events will be better constrained.

REFERENCES

Bagnold, R.A. 1954: Experiments on a gravity free dispersion of large solid spheres in Newtonian fluid under shear. PRSL, 225: 49-63.

Charrière, M. 2011: Granulometrical, geological and morphological description of the Frank Slide deposit (Alberta, Canada). Master Thesis, University of Lausanne.

Cruden, D.M. & Hungr, O. 1986: The debris of the Frank Slide and theories of rockSlide-avalanche mobility. Canadian Journal of earth Sciences, 23:425-432.

Heim, A. 1932. Der Bergsturz und Menschenleben. Fretz und Wasmuth Verlag, Zürich, 218 p.

Hsü, K.J. 1978: Albert Heim: observations on landslides and relevance to modern interpretations. B. Voight., Elsevier Science Publishers B.V., Amsterdam: 71-73.

Hsü, K.J. 1975: Catastrophic debris streams (strurzstroms) generated by rockfall, Geological Society of America Bulletin, 86: 129-140.

Middleton, G.V. 1970: Experimental studies related to the problems of flysch sedimentation. Geological Association of Canada, Special Paper (7): 253-269.

Scheidegger, A.E. 1973: On the prediction of the reach and velocity of catastrophic landslides. Rock Mechanics and Rock Engineering, 5 (4): 231-236.

Takahashi, T. 1980: Debris flow on prismatic open channel. ASCE Journal of the Hydraulic Division, 106 : 381-396.

6.10

The recurrence pattern of megathrust earthquakes in South-Central Chile: semi-quantitative paleoseismology using lake sediments

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Megathrust earthquakes at the South-Central Chilean subduction zone (e.g. M_w9.5 in 1960; M_w8.8 in 2010) pose a major threat to society. A reliable seismic hazard assessment requires establishing if such mega-events occurred in the past, and determining their recurrence pattern. The Lake District (39-42°S) in South-Central Chile, located in the northern half of the 1960 rupture zone, contains several large glacigenic lakes, the sedimentary deposits in which are highly susceptible to earthquake-triggered slope instability.

To establish the recurrence interval of earthquakes during the Late Holocene, we mapped the spatial distribution of seismically-induced 'event' deposits and sedimentary structures in each lake using very-high resolution seismic data, and collected a series of short gravity cores and long piston cores. Multi-proxy sedimentary analyses (color, magnetic susceptibility, density, geochemistry, grain size), radiocarbon dating and varve-counting were used to identify 'event' deposits in each core and correlate paleoseismic horizons across basins. The sediment sequences investigated contain four main types of earthquake fingerprints: 1) multiple mass-wasting deposits and turbidites on a single stratigraphic level, which are relicts of basin-wide subaqueous slope failure; 2) homogenites indicative of lake seiches and tsunamis; 3) fluid-escape structures (e.g. sediment volcanoes), which reflect sudden liquefaction in buried mass-wasting deposits and subsequent vertical fluidization flow; 4) in-situ deformed units in nearly-flat layers, which reflect strong horizontal ground accelerations.

It appears that the distribution of (liquefiable) volcanic deposits and local sedimentation rates strongly controls the extent and timing of large subaqueous slope failures. However, comparison with historical earthquakes suggests that spatial extent and nature of turbidites can provide key quantitative information about local shaking intensity. For this, we estimated Intensity values using historical reports, instrumental data and empirically-derived attenuation formulae for the largest historical intra-plate and inter-plate ruptures in the region. Here, the well-documented 2010 megathrust event proved to be an ideal calibration point for our lacustrine paleoseismic method.

In three lake basins, we identified and correlated 12 paleoseismic 'events' during the last 3600 yrs with a sedimentary signature comparable to that of the giant 1960 earthquake. This paleoseismic reconstruction points out that strong 1960-like earthquake shaking occurred quasi-periodically with an average recurrence rate of 320 yrs along the northern part of the 1960 rupture zone. Sites characterized by a very-high earthquake recording capacity also recorded significantly smaller events and megathrust events at the adjacent subduction zone segment. New paleoseismic records (tsunami deposits, lake records) in the southern half of the 1960 zone are needed to constrain if the revealed events ruptured the entire 1960 zone, or whether partial ruptures might have taken place.

6.11

Late Pleistocene to early Holocene fluvial dynamics in the southeastern Llanos de Moxos, Bolivian Amazon

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The Llanos de Moxos, which are located in the lowlands of north eastern Bolivia (Beni), are one of the largest seasonally inundated savannahs in the world (150.000 km^2). The region is characterized by a complex fluvial drainage pattern belonging to the Amazon system. Large-scale river migrations in the Beni basin have been reported for the Río Grande, Río Beni and Río Maniqui (Allenby 1988; Dumont 1996; Hanagarth & Sarmiento 1990; Hanagarth 1993; Plafker 1964). Nevertheless, no systematic analysis of the complex patchwork of palaeorivers has been attempted yet, and none of the river shifts can be placed into a temporal frame, complicating their interpretation with regard to their palaeoenvironmental significance and controlling mechanisms over late Quaternary timescales.

Here, we present first results from the southeastern Llanos de Moxos. The region is characterized by a dense pattern of different palaeoriver relicts and currently active rivers. Several large oxbows and numerous smaller palaeorivers have been identified on satellite imagery. A temporal succession of palaeorivers can be distinguished as younger (palaeo-) rivers are crossing older ones, and older fluvial features such as the large oxbows, appear less pronounced and have probably undergone some degradation. Given the clear difference in size, these large oxbows can not have been formed by the currently active fluvial regime.

Two infilled oxbows of these palaeochannel generations have been investigated in 2009 und 2010 and sediment cores have been taken. OSL dating and heavy mineral analysis has been conducted on the fluvial sands. The heavy mineral assemblage of the oxbow sands is similar to that of the today's Río Grande sands, giving clear evidence of the provenance of the fluvial traces. OSL dates indicate that the meanders were abandoned after 9.6 ka and 13.7 ka respectively. Three to four m of fine sediments, which have been deposited after meander cut-off, are overlaying the fluvial sands, and indicate limited but continued sediment supply. Soil formation in the infilled oxbows started between 8.2 and 4.8 cal ka BP, showing stable - non-sedimentary - conditions. This may be explained by i) intensified upstream avulsion dynamics during the mid-Holocene resulting in complete channel abandonment, and/or ii) a mid- to late Holocene reduction in flooding magnitudes and overall sedimentation rates. Both scenarios are indicative of significant changes in discharge and sediment supply of rivers with Andean headwaters, such as the Río Grande, which may be related to larger-scale environmental changes in South America.

In conclusion, our results represent the first available ages for late Pleistocene to mid-Holocene fluvial activity in the Llanos de Moxos. Thus, these data provide valuable information with regard to assessing timescales and styles of longer-term fluvial dynamics in southwestern Amazonia and interpreting their potential controls.

REFERENCES

Allenby, R.J. 1988: Origin of rectangular and aligned lakes in the Beni Basin of Bolivia. Tectonophysics 145 (1-2), 1-20.

Dumont, J.F. 1996: Neotectonics of the Subandes-Brazilian craton boundary using geomorphological data: the Marañon and Beni basins. Tectonophysics 259 (1-3), 137-151.

Hanagarth, W. & Sarmiento, J. 1990: Reporte preliminar sobre la geoecología de la sabana de Espíritu y sus alrededores (Llanos de Moxos, departamento del Beni, Bolivia). Ecología en Bolivia 16, 47-75.

Hanagarth, W. 1993: Acerca de la geoecología de las sabanas del Beni en el noreste de Bolivia. La Paz, Instituto de Ecología.

Plafker, G. 1964: Oriented lakes and lineaments of northeastern Bolivia. Geological Society of America Bulletin 75, 503-522.

6.12

Exposure ages from erratic boulders on the northwestern flank of Rigi (Switzerland)

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As errratic boulders mark different stadial-positions of paleoglaciers, chronology of advance or retreat phases of paleoglaciers can be established with surface exposure dating with cosmogenic nuclides such as ^{10}Be and ^{36}Cl. Nine erratic boulders on the Rigi of different lithologies (four Granitic, four Nagelfluh and one Carbonate) were exposure dated. Three of them are located on a lateral moraine of the Reuss-Piedmont Lobe. Exposure ages between ca. 19 ka to 24 ka reveal a moraine formation at around LGM (Last Glacial Maximum). The other six boulders are located on the northwestern flank of Rigi beyond this lateral moraine. Whether these are deposited by local or older glaciations was unknown. The exposure time of these boulders scatter between around 8 ka and 19 ka, among which five yielded younger exposure ages than LGM because of exhumation and human impact. Only one boulder may reveal local LGM glaciations of the Rigi, however more evidence is needed. Our results are synchronous with global LGM (21 ± 2 ka) (Mix et al. 2001) and in accordance with the existing exposure ages from the northern Alpine foreland.

REFERENCES

Mix, A.C., Bard, E., Schneider, R. (2001): Environmental processes of the ice age: land, oceans, glaciers (EPILOG). – Quaternary Science Reviews 20, 627–657

6.13

Water concentrations in stalagmites as a potential new paleoclimate proxy – first results from two Holocene stalagmites from Socotra Island (Yemen)

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Stalagmites represent excellent and increasingly studied paleoclimate archives as they not only preserve high resolution stable isotope records over long time scales but can also be dated with high precision (e.g., Henderson, 2006). As shown, e.g., by Kluge et al. (2008) and Scheidegger et al. (2010), the absolute temperature in which a stalagmite grew can be deduced from the amounts of atmospheric noble gases dissolved in fluid inclusion water entrapped by the growing stalagmite. As a "by-product" of these noble gas measurements, the water content of the samples (crushed calcite separates) is determined. We will argue below that this water content of stalagmite samples might be a valuable new paleoclimate proxy reflecting changes in drip water availability and thus precipitation outside the cave.

We have analyzed noble gases and water contents in 43 samples from two Holocene stalagmites from Socotra Island (Yemen). Stalagmite D1 (Dimarshim Cave; see Fleitmann et al. (2007) for absolute dating and the $\delta^{18}O_{calcite}$ record of D1) covers the last ~4.5 ka BP, while stalagmite P3 (Pit Cave) covers the time interval between ~10.4 and ~1.3 ka BP. We found that the water content of the samples traces shifts in the $\delta^{18}O_{calcite}$ records of the same stalagmites in a way that a progressively negative trend in the $\delta^{18}O_{calcite}$ record of stalagmite D1 coincides with a decrease of its water content, while a subtle positive trend of the $\delta^{18}O_{calcite}$ record of stalagmite P3 coincides with an increase of its water content (Fig. 1). Note that for the time being the age model for stalagmite P3 is anchored to two absolute age determinations only and consequently is rather uncertain.

Unlike many other speleothem's $\delta^{18}O_{calcite}$ records influenced by the Indian or Asian monsoon systems (see, e.g., Dong et al. (2010) for a recent compilation of own and published $\delta^{18}O_{calcite}$ records from these monsoon regions), stalagmites D1 and P3 show rather uniform or even slightly decreasing $\delta^{18}O_{calcite}$ records, which might imply that Socotra Island was less affected than the continental regions by the weakening of the summer monsoon precipitation caused by an orbitally induced decrease in northern hemisphere summer insolation (e.g., Dong et al., 2010; Fleitmann et al., 2007). Superimposed on this regional trend we find for P3 a positive $\delta^{18}O_{calcite}$ excursion which might hint to temporary dry conditions in Pit Cave causing evaporation effects, followed by the termination of growth of P3 at ~1.25 ka BP. Approximately coeval, D1 shows a major negative excursion with $\delta^{18}O_{calcite}$ values down to –5.3 ‰, which might be interpreted as reflecting a time with unusually intense precipitation. We therefore speculate that during this period the pathways for seepage water feeding stalagmite P3 were blocked, leading to its termination of growth. If the above interpretation is correct, increased precipitation and thus a higher drip rate correlates with lower water content (less water-filled inclusions due to undisturbed calcite growth) of the samples (D1), while a reduced drip rate would lead to the formation of more fluid inclusions and thus an increase of the water content of the stalagmite (P3). Based on these results we propose that the water content of stalagmite samples might be a valuable new paleoclimate proxy reflecting changes in drip water availability and thus might also hint to changes in the regional precipitation pattern. We anticipate to present at the conference an additional data set for stalagmite water content from a Swiss stalagmite ideally covering times of lower and higher drip water availability

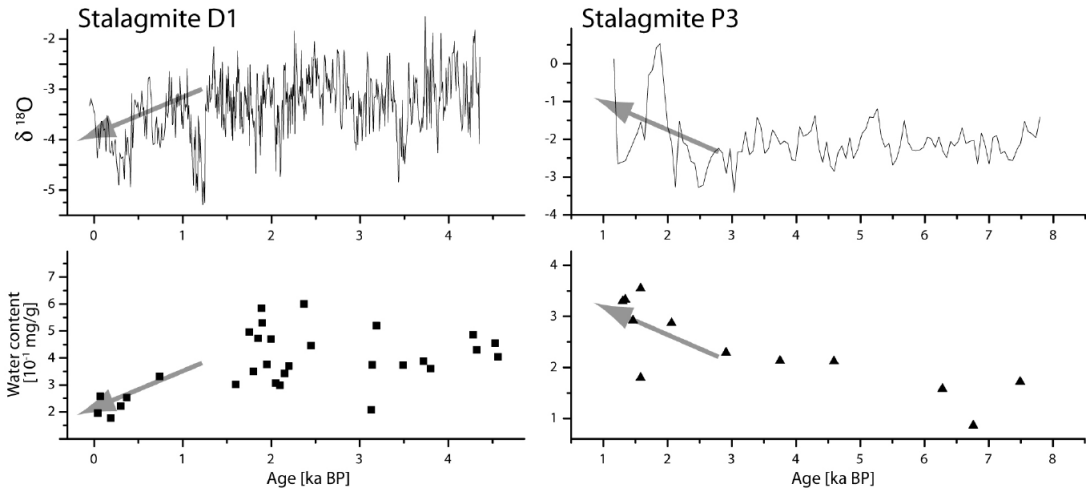

Figure 1: $\delta^{18}O_{calcite}$ records and water contents of stalagmites D1 and P3. Note that the water content released from the crushed samples is systematically lower than the total water content of the samples. Absolute dating and the $\delta^{18}O_{calcite}$ record of D1 were published by (Fleitmann et al., 2007)

REFERENCES

Dong J., Wang Y., Cheng H., Hardt B., Edwards R. L., Kong X., Wu J., Chen S., Liu D., Jiang X. & Zhao K. 2010: A high-resolution stalagmite record of the Holocene East Asian monsoon from Mt Shennongjia, central China. The Holocene, 20, 257-264.

Fleitmann D., Burns S. J., Mangini A., Mudelsee M., Kramers J., Villa I., Neff U., Al-Subbary A. A., Buettner A., Hippler D. & Matter A. 2007: Holocene ITCZ and Indian monsoon dynamics recorded in stalagmites from Oman and Yemen (Socotra). Quarternary Science Reviews; 26, 170-188.

Henderson G. M. 2006: Caving In to New Chronologies. Science, 313, 620-622.

Kluge T., Marx T., Scholz D., Niggemann S., Mangini A. & Aeschbach-Hertig W. 2008: A new tool for paleoclimate reconstruction: Noble gas temperatures from fluid inclusions in speleothems. Earth and Planetary Science Letters; 269, 408-415.

Scheidegger Y. M., Baur H., Brennwald M. S., Fleitmann D., Wieler R. & Kipfer R. 2010: Accurate analysis of noble gas concentrations in small water samples and its application to fluid inclusions in stalagmites. Chemical Geology, 272, 31-39.

6.14

Phylogeographic and morphological study of North East Atlantic benthic foraminifers

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The marine fossil record of benthic foraminifers is an important tool for quantitative faunal and geochemical reconstructions of past environments. Numerical data from assemblage counts can be used to infer bathymetry, ecosystem temperature/salinity conditions, productivity and deep water formation and shell calcitic signatures record the palaeo-environmental conditions of the benthos. The integrity of this approach is based upon the assumption that living communities are similar to their fossil counterparts. It is therefore vitally important to fully understand the relationship between present day environmental conditions and the living foraminiferal assemblages in conjunction with their shell geochemistry. All such numerical and geochemical proxies rely on strict recognition of taxonomic units, yet the morphological taxonomy of benthic foraminifera remains poorly constrained. This is partly due to the application of regional taxonomic systems by different workers, but a newly recognised problem has come to light. Recent genetic characterisation of major benthic foraminiferal groups indicates high levels of cryptic species diversity, compounding these taxonomic issues. Many individual morphospecies have been shown to represent several different genetic types with potentially distinct ecologies.

Here we present the first results of a study combining phylogeography and morphology of common neritic and bathyal benthic foraminifers from the North East Atlantic. The aims are to unify the taxonomy of benthic foraminifers from that region and to detect cryptic species.

6.15

Reconstruction of seismic events using cosmogenic ^{36}Cl: An example from the western Anatolian Province of Turkey

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Western Anatolia is one of the most seismically active and rapidly extending regions in the world. Therefore, it has been experiencing large earthquakes in the deaths of thousands of people and economic devastation for a long time. Seismological studies show that these destructive earthquakes occurred in relation to the western branches of the North Anatolian Fault System, which is located to the north of this extensional province.

In such tectonically active settings, long-term earthquake models are essential as for science as for society. Verification of these models with field observations requires records that contain well-dated earthquakes. However, such paleoseismic records are rare because landforms and sediments that record faulting are difficult to identify and easily buried or weathered; commonly the evidence of earlier earthquakes is obscured by later ones. Naturally exposed bedrock fault planes are the best evidence of paleoearthquakes and these can only be dated directly with cosmogenic nuclides.

In order to recover past seismic activity, we applied the new method of paleoearthquakes reconstruction to Mugirtepe scarp of the Manisa active fault system in western Anatolia. In this method, ^{36}Cl concentration curve along the foot wall surface of normal fault scarp is analysed to determine offsets caused by past earthquake events and their timing. We took 44 limestone samples in two slightly overlapping strips, which in total recovered 2.65 m of the fault scarp. First results from the Mugirtepe normal fault indicate at least two periods of high seismic activity around 8 ka and 14 ka, which resulted in sequences of earthquakes. Novelty of the method hampers to derive detailed results and provoke both methodological and computational improvements.

P 6.1

Oncoids, charales, and homogeneous silt: reconstruction of lake level and environment in the city of Zurich (Switzerland) between the Iron Age and Late Antiquity

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Several trenches and profiles around the Cathedral «Fraumünster» (Zurich, Switzerland) were documented and analysed in recent years. The sites are situated near the shore of Lake Zurich, on an ancient delta of the Sihl River which temporarily flowed through the area of study. Thus, the region around the «Fraumünster» has been influenced by both the Sihl and Lake Zurich. A characteristic stratigraphic sequence including a thin oncoid level, a layer with charales, and a thick deposit of homogenous silt was observed in most trenches. On the basis of micromorphology, granulometry, and chemical analysis the different sediments were attached to specific sedimentary milieu. In combination with radiocarbon data and archaeological features a reconstruction of the environment and water level of Lake Zurich can be postulated.

REFERENCES

Hägele, D., Leinfelder, R., Grau, J., Burmeister, E.-G., & Struck, U. 2006: Oncoids from the River Alz (southern Germany): Tiny ecosystems in a phosphorus-limited environment. Palaeogeography, Palaeoclimatology. Palaeoecology, 237, 378-395.

Magny, M. 2004: Holocene climate variability as reflected by mid-European lake-level fluctuations and its probable impact on prehistoric human settlements. Quaternary International, 113, 65-79.

P 6.2

Sedimentology and geomorphology of the Rhone delta canyons (Lake Geneva, Switzerland-France)

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The 'Elemo' scientific program (http://www.elemo.ch), coordinated at the Swiss Federal Institute of Technology in Lausanne (EPFL), aims to achieve a better understanding of subaquatic processes in Lake Geneva. The 'Elemo' workpackage 'The canyons of the Rhone delta' focuses on the geological and physical properties of the proximal Rhone delta area.

The Rhone delta is characterized by a complex underwater morphology with a slope deeply incised by canyons. The sediments of this delta system consist of channel and levee deposits punctuated by turbidite sequences and mass-movement deposits. A recent multibeam bathymetric survey of the sub-lacustrine Rhone delta (Fig. 1) greatly improved our knowledge of the underwater structures (Sastre et al., 2010) and raised new scientific questions and research goals in relation to the geomorphological and sedimentological processes in these environments.

From June to August 2011 two MIR submersibles have been exploring the submarine canyons of the Rhone delta, including *in-situ* observations of sediment structures, video-recording, and sediment sampling in the levees deposits and canyon beds and walls. These sedimentological and geomorphological data, complemented by regular core sampling from research vessels, will enable us: i) to understand the sedimentary processes and sedimentation rate affecting the channel/levee complex in proximal and distal areas of the active canyon (Fig. 1), ii) to compare the sedimentary sequences of active vs. old canyons; iii) to evaluate the lateral migration rate and the sedimentological processes and evolution of the old, non-active canyons and iv) to investigate the spatial distribution and triggering mechanisms of mass movements and turbiditic deposits in order to assess the contribution of delta failures to the meandering evolution of the deltaic complexes.

We thank the ELEMO Scientific Program for their financial support.

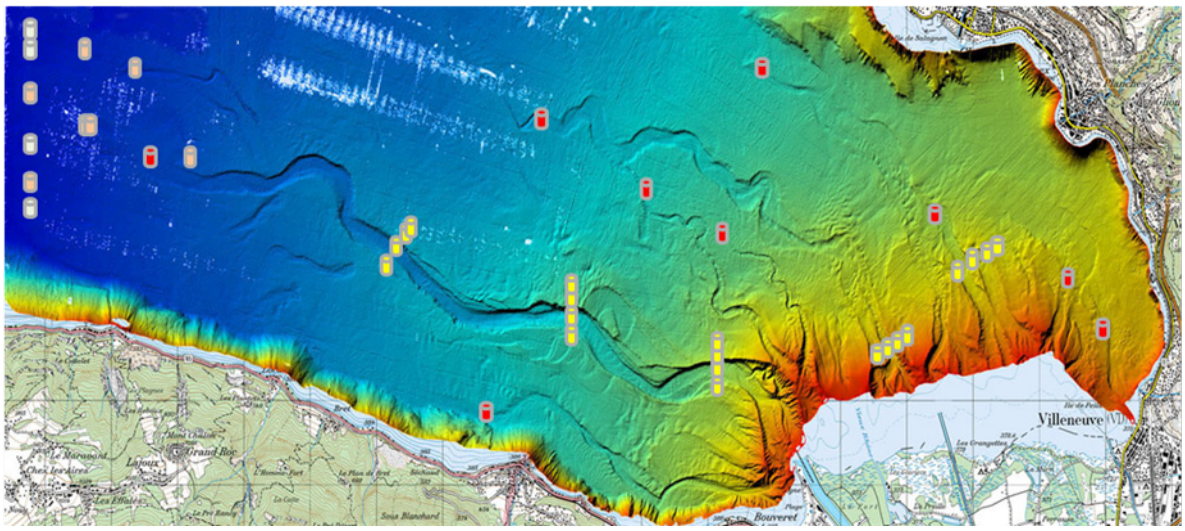

Figure 1. Rhone delta multibeam bathymetric map (Sastre et al., 2010) and location of the retrieved sediment cores

REFERENCE:

Sastre, V. et al., 2010. Morphology and recent history of the Rhone River Delta in Lake Geneva (Switzerland). Swiss Journal of Geosciences, 103: 33-42.

P 6.3

Calcium pools and sinks: the oxalate-carbonate pathway in tropical FERRALSOLS

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In the African intertropical belt, recent research has identified an unexpected soil carbon sink related to the iroko tree (*Milicia excelsa*). Through photosynthesis, part of atmospheric CO_2 is transformed into oxalic acid, which accumulates in plant tissues as an insoluble calcium salt. Ca-oxalate crystals are released during tree decay, incorporated into the soil, and are then oxidised by soil oxalotrophic bacteria. This process, called the oxalate-carbonate pathway, increases the local pH and yields carbonate ions, which can precipitate as Ca-carbonate under certain conditions (Cailleau et al., 2011).
Calcium is present in both end-members of the oxalate-carbonate pathway (Ca-oxalate and Ca-carbonate). Consequently, calcium, as much as carbon, is a key element in the process. In acidic ferralsols, calcium pools are limited due to intense leaching, especially in these old studied soils (Leneuf, 1959). Moreover, in such environments, a carbon sequestration process is considered as a sink if calcium originates from a Ca-carbonate-free source (Elbersen et al, 2000). Therefore, the aim of this study was to quantify calcium pools and fluxes in a particular ecosystem in order to determine calcium behavior in the different ecosystem compartments.

The study site is located in the area of Bertoua (Cameroon), near a stump of a recently felled *M. excelsa*. Three soil profiles were sampled, one below the hollow trunk, one at 40cm from the tree, and a reference profile at 15m. All the identified calcium sources and outputs were collected (i.e. granitic bedrock, airborne particles,...). XRF and ICP-MS analyses were performed in order to quantify the total calcium content in samples. The calcium amounts present in the different soil compartments, i.e. exchangeable ions, carbonate substrates, and organic matter were quantified using a sequential extraction procedure and back titration.

The impact of an oxalogenic-oxalotrophic system on the local calcium cycle is discussed by comparing both *M. excelsa* and reference ecosystems (figure 1). The soil calcium content is 25 times higher near the tree than in the reference profile. Three main soil calcium compartments were identified: pedogenic calcium carbonate, soil available calcium, and calcium trapped in the organic matter.

Calcium is either sequestrated, as $CaCO_3$, or remains exchangeable, with 90% of it in the carbonate form below the hollow trunk. This figure tends to be inverted towards the reference profile, the other compartments becoming more important.

Finally, the 130kg of carbon sequestered as calcium carbonate into the soil during the tree's lifetime constitute a carbon sink as the input providing Ca is not related to calcium carbonate.

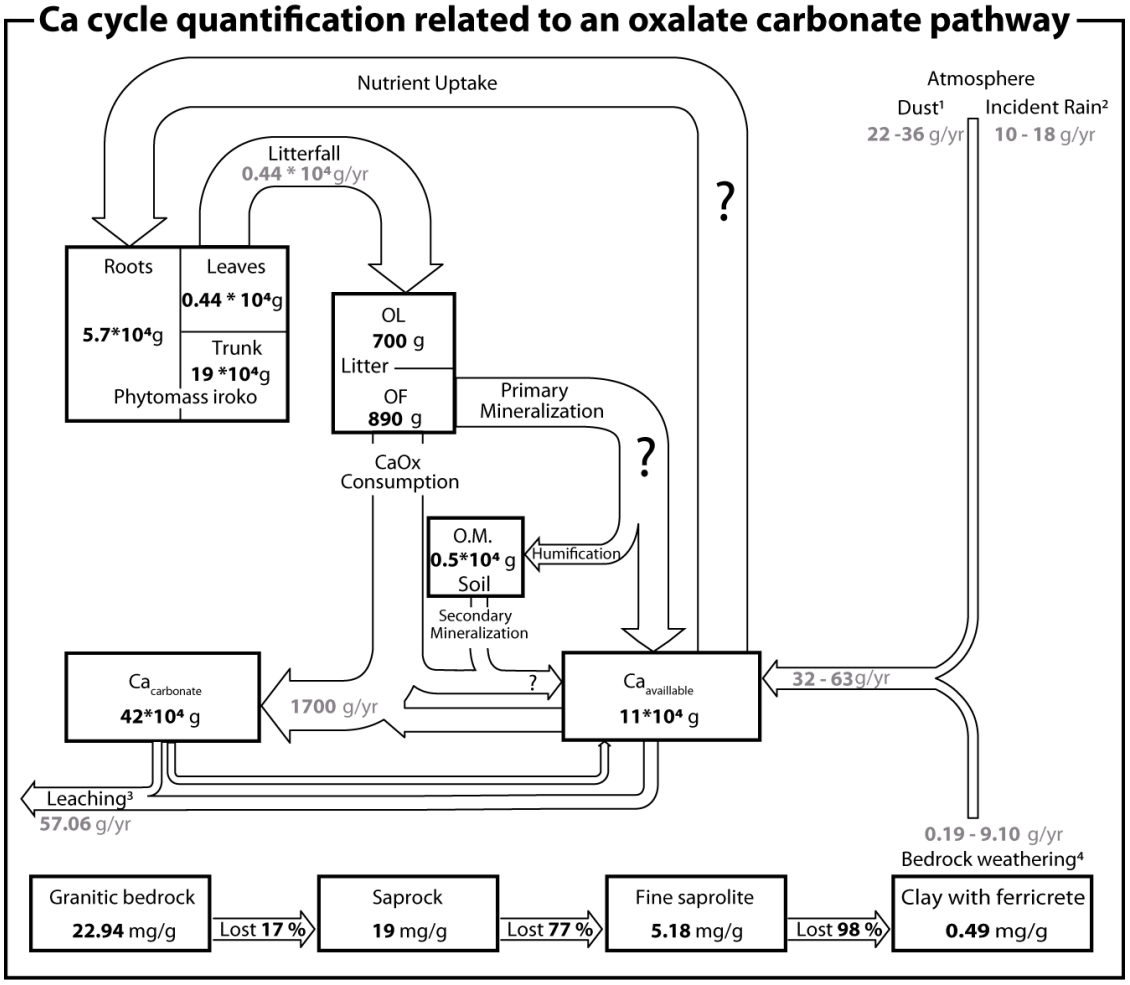

Figure 1. Ca cycle quantification related to an oxalate-carbonate pathway system (Bertoua, Cameroon). OL : recent litter, OF : fragmented litter, OM : organic matter, CaOx : calcium oxalate

1 Combined data from Stroorvogel et al (Biochemistry, 1997) and Dia et al (Chem. Geology, 2006)

2 Data from Braun et al (Geochem. Cosmochem. Acta, 2005) and Seyler et al (Hydrology of Warm Humid Regions,1993)

3 Data from Bierman and Caffee (Am. Jour. Science, 2001) and Boeglin and Probst (Chem. Geology, 1998)

4 Data completed with the data of the University of Yaoundé

Acknowledgements: this research has been founded by the Fonds Matthey-Dupraz, The Swiss Academy of Sciences, and the FP7 EU "Co2SolStock" project (Agr. 226306).

REFERENCES

Cailleau, G., Braissant, O. & Verrecchia, E.P. 2011: Turning sunlight into stone : the oxalate-carbonate pathway in a tropical tree ecosystem, Biogeoscience, 8, 1755-1767.

Elbersen, GWW., Davie, G., Van Reeuwijk, LP. & Janssen RPT. (1999) : The carbon sink function of calcic horizons quantified by means of stable isotopes of strontium. In : 6th International Meeting on Soils with Mediterranean Type of Climate, Section II, Soil Chemistry,150-107.

Leneuf, N. 1959 : L'altération des granites calco-alcalins en Côte d'Ivoire forestière et les sols qui en sont dérivés. O.R.S.T.O.M, Paris, 210p.

P 6.4

Preliminary archeomagnetic results from Korsimoro, Burkina Faso.

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Reconstructions of the past geomagnetic field play an important role in understanding the evolution of the Earth's interior where it is generated. Prior the start of systematic measurements around 1600AD, geomagnetic field components can be indirectly measured from well baked archeological artifacts. Unfortunately archeomagnetic data from the equatorial regions and from the southern hemisphere are very scarce, yielding a global picture that is far from complete.

During the past three millenia the iron industry in West Africa flourished continuously, as witnessed by the large amount of kilns and slags found in that area. In January 2010 an excavation started at Korsimoro (Burkina Faso), aiming at studying the evolution of a complex metallurgical site in time.

In this occasion four kilns were sampled for archeomagnetic investigations. Four to eight samples were collected using the sun-compass technique, and were then cut in cubic specimens after consolidation in water-glass.

kiln 1 and 2 are rather small structures (about 30 cm in diameter) that were used to refine the smelted iron, whereas kiln 3 is a medium sized structure of about 80cm diameter, and finally kiln 4 was a large structure of 150cm diameter. It appears that kiln 4 is older than 1400 AD, because before that age rocks were smelted only once in large kilns. Kilns 1, 2, and 3 were instead used after 1400 AD, when the technique was improved. In these kilns the metal was first smelted in a medium sized oven, and then refined in a smaller one.

A viscous test measuring the changes in magnetization after three weeks storage in zero field shows that minimal changes (less than 6%) occur, indicating a very stable magnetic signal. This behavior is typical of well baked structures. High temperature susceptibility curves were measured to diagnose the various magnetic minerals based on their Curie temperature. In general the black part of the kilns, originated in reducing conditions, show a Curie temperature around 580˚C indicating that magnetite is present. In contrast, samples showing a red color have Curie temperatures around 240˚C and around 620˚C, the latter most likely related to maghemite. A three-axial isothermal remanent magnetization experiment (Lowrie, 1990) was also carried out on selected specimens, and again proves the presence of magnetite and maghemite. Also hysteresis loops confirm the presence of two magnetic minerals when wasp-waisted loops are observed.

Alternating field demagnetization technique was applied to isolate the characteristic remanent component of the kilns. We selected directions that had a maximum angular deviation smaller than 1.5˚ and which consisted of at least 4 points. The first results yield a average declination of 9.7˚ and an inclination of 27.1˚ (number of specimens n = 10, confidence oval α_{95} = 4.7˚, precision parameter k = 107) for kiln 1, 3.2˚ and 25.0˚ (n = 14, α_{95} = 3.8˚, k = 112) for kiln 2, 11.5˚ and 23.2˚ (n = 25, α_{95} = 2.2˚, k = 172) for kiln 3, and 15.9˚ and 9.2˚ (n = 35, α_{95} = 1.8˚, k = 184) for kiln 4.
Preliminary intensity results from 26 specimens suggest that the field strength varied between 20 and 40 µT, and encompass the present field value at Korsimoro of 33µT . Failure rate of this experiment was however high due to the fact that magnetomineralogical changes happened.

Radiocarbon ages are being determined and will serve to present the time variation of the field based on these four kilns. This work represents a preliminary step towards the construction of a reference curve of the geomagnetic field at Burkina Faso, and more sampling will be possible due to the abundance of sampling material at Korsimoro.

REFERENCES

Lowrie, W., 1990. Identification of ferromagnetic minerals in a rock by coercivity and unblocking temperature properties. Geophysical Research Letters, 2, 159-162.

P 6.5

From Soppensee to Altai and New Zealand: Calendar times scales based on ^{14}C chronologies and OxCal Models.

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Radiocarbon chronologies are often applied in studies of past climate as well as archeology. Because of the nearly global nature of the ^{14}C, measurements of ^{14}C concentration and radiocarbon ages in various archives can be applied as a correlation and synchronization tool. However, correlation to other prominent climatic records such as ice cores or stalagmites can only be done using absolute time scales. Therefore, high-resolution calendar time scales of records dated by ^{14}C are needed. Using the Soppensee ^{14}C and Varve chronologies we have shown that such calendar chronology for events can be obtained when high-resolution ^{14}C chronology and Bayesian model available in OxCal4 (Ramsey 2009) are applied (Hajdas and Michczynski 2010).

As the next step of the study we apply this approach to other records. Moreover we will discuss application of other models that are available in OxCal4 (Ramsey 2009) and can be chosen dependent on the type of archive and the type of prior information (additional information about the ^{14}C chronology such as: sequence order, years in between samples, groups of ages).

REFERENCES

Ramsey, CB. 2009. Bayesian Analysis of Radiocarbon Dates. Radiocarbon, 51, 337-360.
Hajdas, I. & Michczynski, A. 2010: Age-depth model of Lake Soppensee (Switzerland) based on high-resolution ^{14}C chronology compared with varve chronology. Radiocarbon, 52, 1027-1040

P 6.6

Rock- and archeomagnetic study on central European artifacts for characterizing the geomagnetic field evolution during mid-Holocene

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One of the major problems in deciphering geomagnetic field evolution prior to 1000 B.C. is the scarcity of archeomagnetic measurements. Nevertheless, recent studies have shown that a variety of burnt sediments from human activities are suitable for archeomagnetic investigations (e.g Carrancho et al. 2009). The Arconciel (ARC) shelter near Fribourg (CH), and the Riparo Gaban (RGB) shelter near Trento (IT) offered us the chance to collect a stratigraphic sequence (8000 to 7200 years BP, and 7000 to 6500 years BP) of burned sediments. In both cases these structures appear to be ancient hearths used for domestic purposes. Additionally, we received a collection of burned cherts and fragments of terracotta from Lugo, which is near Trento, and about 7000 years old. This particularly well burned materials should hold a magnetization stable enough to determine the ancient field strength.

We have performed several rock magnetic analyses to assess the suitability of various burnt, oriented sediments, and unoriented cherts and fragments of terracotta. Both thermomagnetic curves and hysteresis loops indicate magnetite as the main carrier of magnetization. In some cases maghemite and hematite are also detected. In general, the thermomagnetic curves show that new magnetic phases are formed during heating to high temperatures. To quantify the viscous part of the magnetization we measured the change in natural remanent magnetization (NRM) of representative samples from each unit before and after storage for three weeks in a shielded environment. After three weeks the magnetization changes about 20 % maximum.

Anisotropy of magnetic susceptibility (AMS) was measured for RGB and ARC to assess the preferred alignment of the magnetic grains. The directions of the maximum (k1) and intermediate (k2) AMS are evenly distributed in the compaction plane, and the direction of the minimum AMS (k3) is perpendicular to it. For samples from ARC the anisotropy ellipsoid is tilted by around 45˚, and appears to agree with the tilt of these layers. The anisotropy degree P = k1/k3, does not exceed 6%, in general. For most of the specimens the anisotropy ellipsoid is oblate.
The characteristic remanent magnetization (ChRM) was isolated using alternating field (AF) demagnetization. In general, burned, reddish layers tend to yield directions that are more clustered compared to the intercalated ashy and organic layers. The characteristic direction has been defined for 17 of the sampled units from RGB, and 10 of the sampled units from ARC.

Analyses of the burned cherts and fragments of terracotta from Lugo show a single magnetic component carried by magnetite and low to moderate alteration with heating. This characteristic behavior suggests that the samples are suitable for paleointensity experiments. A set of 26 specimens was subjected to paleointensity determination, using the IZZI protocol (Tauxe and Staudigel 2004). Six specimens from Lugo yielded reliable paleointensity estimates. In contrast, all RGB and ARC samples from the burned sediments failed to yield a robust result. A comparison of our preliminary results is made with the recent CALS10K.1 global model (Constable et al. 2010), for which the mid-Holocene period mainly relies on lake sediment records (Figure 1). Our directional results show an easterly trend in declination from 6000 to 5500 B.C. and from 5000 B.C. to 4000 B.C., but a rapid shift to the west around 5500 to 5000 B.C. Inclinations appear to become progressively shallower during the entire time interval. Intensity results agree very well with the model value for that period.

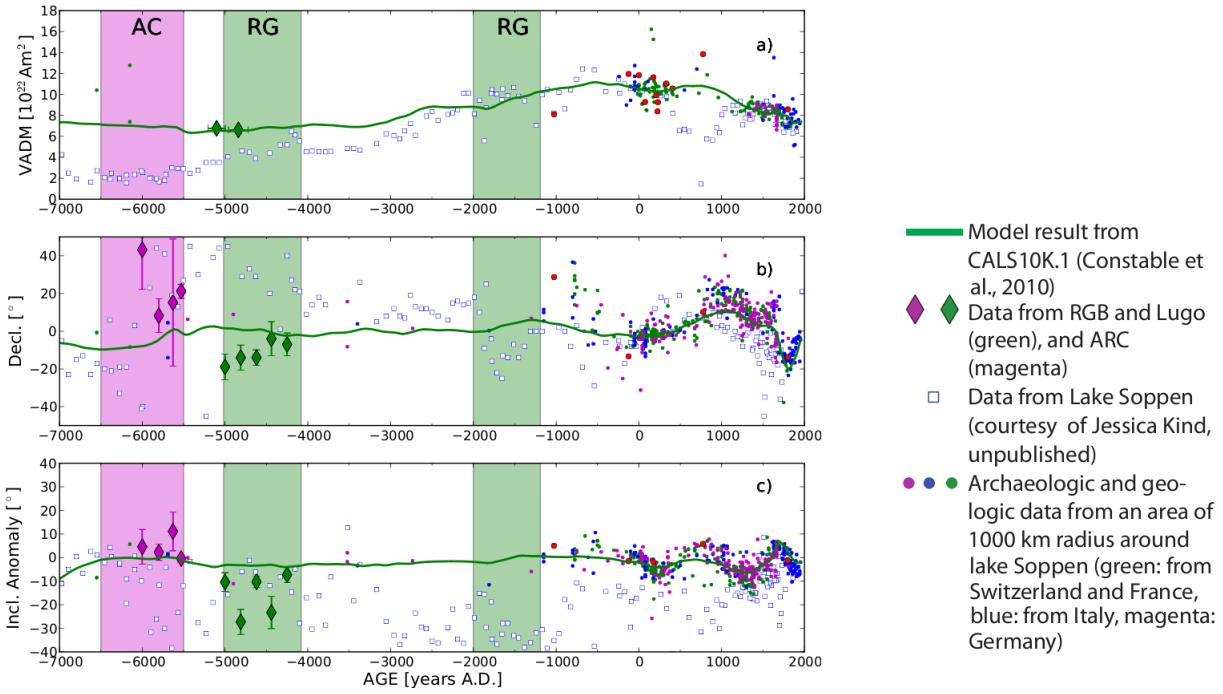

Figure 1. Preliminary results of RGB and ARC plotted together with measurements and model results. a) Virtual Axial Dipole Moment (VADM), b) declination, c) inclination anomaly, spanning a period from 7000 B.C. to 2000 A.D.

REFERENCES

Carrancho, J. J., Villalan, D. E., Angelucci, M. J. Dekkers, J. Vallverdu, & J. M. Verges 2009: Rock-magnetic analyses as a tool to investigate archaeological fired sediments: a case study of Mirador cave (Sierra de Atapuerca, Spain). Geophysical Journal International, 179, 79–96. doi: 10.1111/j.1365-246X.2009.04276.x.

Constable, C., Korte, M. C. & F. Donadini 2010: CALSK10k.1: A geomagnetic field model spanning 10~kyr. American Geophysical Union, Fall Meeting 2010, abstract #DI23B-1987.

Tauxe, L. & H. Staudigel 2004: Strength of the geomagnetic field in the Cretaceous Normal Superchron: New data from submarine basaltic glass of the Troodos Ophiolite. Geochemistry, Geophysics, Geosystems, 5:Q02H06.

P 6.7

Correlation between Quaternary stratigraphy units in different Geological zones of Iran

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In geology of Iran, generally, rocks and deposits related to post Pleistocene conglomeratic formations (Hezardarreh and Bakhtiari) have been attributed to Quaternary period, which have been covered older rocks as unconfirmed which alluvial – alluvial fan, eolian and desert – wilderness deposits have more portion among them. That is why there is this belief that after late Alpine tectonic event, Iranian plate has been emersed from water and it has formed its current morphology that one of its results is beginning of erosional cycles which have been imposed on Iran since that time to recent. Also, in some structural – sedimentary zones of Iran, such as Kopet Dagh mountains, mountains in east of Iran and even vast zones in Alborz and Central Iran, beginning of erosion phenomena is very older than Quaternary when Pyrenean event has more fundamental role in accomplishment of that. In addition to clastic accumulated strata in continental, lake and marine environments, magmatic activities in Quaternary period have created igneous rocks in this period. Regarded to factors just like sedimentary environment, origin, type of weathering processes and erosion, quaternary rocks of Iran can be as follow types. Unfortunately, our information's and data about Quaternary deposits of Iran are not sufficient because the principal geological study in Iran was begun to know more about minerals and hydrocarbourants materials. Therefore you may not find enough researches about the other geological periods. Another reason for lack of data of Quaternary may be the narrow thickness of these deposits. The scale of the most published geological maps in Iran is 1/250000 and 1/100000; therefore to separate horizons and narrow thickness of the sediments in these maps is difficult.
A series of marine, heavily eroded mountain ranges surrounding Iran high interior basin. In sharp contrasts are the coastal regions outside the mountain rings. The Quaternary deposits comprising semiconsolidated to unconsolidated gravel, sand, silt and clay, occupy the greatest part of Iranian platform. These deposits have been used for example in construction aggregates for the residual, industrial and transportation segments of the population, ceramic clays, and laterites. Much of the groundwater essential to agriculture and human existence eminences from aquifers in quaternary sedimentary environments. The Quaternary deposits have been covered half past of Iranian territory and in order to important consist of alluvial, evaporate, eolian, beach sand, effusive activities, landslide-debris and glacial drift deposits. The late walachian minor events and pasadenian main pulsation vigorous were caused uplifting of mountains and subsidence of valleys. The Quaternary alluvial deposits have been composed of thick stratigraphic sediments, which formed by conglomerate, coarse gravels, boulders, pebbles, sand, silt and marls. Intervals of different stages have been distinct by changing in sedimentation. In the four distinguished areas of Iranian platform typically different, Quaternary deposits had similar characters, which indicated mentioned factors influence contemporaneous all part of Iran. In the central part of Iran, the Quaternary and recent Formations are mainly presented by extensive gravel sheets, deposited salt-water, brackish-water and fresh water lakes (Lake deposits, Lut and Kavir deposits, Recent salts), and by Aeolian sand, loess occurs in the western foothills of the Alborz and in the western spurs of the Kopet-Dagh. In the north part of Alborz mountains, Mazandran-Gorgan plain has been formed by marine deposits.

REFERENCES

Haghighi, S. and Khaksar K. 2010 - The Quaternary sediments of Iran. Quaternary stratigraphy and paleontology of the southern Rrussia: connections between Eeurope, Aafrica and Aasia, (2010 annual meeting INQUA-SEQS).

Khaksar, K. 1998 - The Quaternary sediments of the Tehran region, 4th international Conference on the Geology of the Middle East, Beirut Lebanon.

Khaksar, K. 2001 - Quaternary stratigraphy of Maharlu basin, Zagros mountains (South Iran), 4th International Symposium on Eastern Mediterranean Geology, Suleyman Demirel University, 21-25 May, 2001 Isparta, Turkey.

Nabavi M.H. 1976. An introduction to geology of Iran. (in Persian), Geological Survey of Iran, Tehran.

Stoklin J. 1977. Structural correlation of the Alpine ranges between Iran and central Asia. Mem. Hors-serie Soc. Geol. Fr., 8:333-353.

Table 1- Quaternary Chronostratigraphy of Iran

Chronostratigraphy		LITHOSTRATIGRAPHY				Tectono-stratigraphy
		Caspian Region	Piedmont areas			
QUATERNARY	Holocene	Recent Caspian deposits	Holocene alluvium	Holocene stage	Minab alluvium	Pasadenian main Pulsation Vigorous
	Upper Pleistocene	Baku Formation	Tehran alluvial F.	Young alluvial deposits	Sadich alluvium	
			Kahrizak Formation	Old alluvial deposits		
	Lower Pleistocene	Apsheron Formation	Hezardareh Formation	Bakhtyari Conglomerate (Upper half)	Minab Conglomerate (Upper half)	Late Walachian minor events

P 6.8

Cosmogenic dating of unconsolidated sediments on Piz Starlex (at >3000m, Swiss-Italian border area)

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In the Swiss Alps, few examples of unconsolidated, polymict, coarse sandy- gravelly deposits are known at high elevation. Their origin, age, and paleogeography are – with few exceptions – unknown. One of these sites is the top of Piz Starlex, a 3017m a.s.l. solitary mountain in the Swiss-Italian border area of the Val Mustair, SE-Switzerland. At the top of this exquisite mountain, crystalline-rich bouldery sandy gravel covers the almost flat mountaintop of approximately 8000m^2. Piz Starlex is composed of "eastern alpine dolomites" of the tectonic Scarl-Unit, which has been overthrusted by the crystalline Ötztal complex. The aim of this study is to determine the origin, paleogeography and chronology of the Piz Starlex gravel. For that, first literature and rock collections were examined and then thin-sections of the crystalline components were analyzed. First results show that the unconsolidated crystalline components are from at least two major tectonic units: the Sesvenna-Scarl complex and the Ötztal complex. It is certain that the Piz Starlex gravel is not transported to its today's high position (>3000m a.s.l.) by glacial processes, because the maximum vertical expansion of the Ice never exceeded 2700m a.s.l. in this area. It is, therefore, likely that the Piz Starlex gravels are a relict of an old (Paleogene to Neogene) river system in the Eastern Alps or/and has been tectonically uplifted over the past millions of years. To reconstruct the chronology of this deposit, crystalline components were sampled for cosmogenic nuclides analysis with ^{10}Be and ^{26}Al.

P 6.9

History of mass movements deposits in deep Lake Geneva during the last 3000 years

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Lake sediments are excellent archives of past environmental changes, not only due to human activity and climate variations, but also to geological events such as earthquakes and slope collapses. Subaqueous mass movements recorded in lake sediments are often linked to historical earthquakes. However, numerous studies have shown that mass movements can also be triggered by aseismic processes such as delta and slope collapses due to sediment overloading, rockfalls, etc. Thus, the study of mass-movement deposits in lake sediments provides insights into past natural hazards at historic and prehistoric timescales.

In Lake Geneva, a previous seismic reflexion study showed that two large mass movements started on the lake slope off the city of Lausanne (Yrro 2010). In 2010, 100 km of high-resolution seismic reflection data (3.5 kHz Pinger source) were acquired on a dense grid to improve the imaging of the lake deep basin. The seismic data reveal six major mass movement units characterized by lense-shaped, transparent to chaotic seismic facies with irregular boundaries. These units alternate with sequences of parallel, continuous and high-amplitude reflections intercalated with transparent horizons. These sequences are interpreted as the "background" lake sediments composed of hemipelagic sediments interbedded with turbiditic deposits due to floods. The seismic facies interpretation is confirmed by correlation with lithological units of four 8 to 12 m-long sediment cores.

^{14}C dating and the sediment core data reveal that the six major mass movements were deposited during the past 3000 years. These deposits vary in size, seismic and sedimentary facies revealing different deposition and trigger processes. The largest event deposit in this sequence is a 6 m-thick, thinning upwards bed with an erosive base that covers the entire deep basin with a minimum volume of 0.25 km^3. This layer can be associated with the Tauredunum event of 563 AD that is historically known because of large human and material loss in the Rhone valley and in the old city of Geneva. Three older mass movement deposits are situated at the same sismo-stratigraphic level, meaning they were most probably deposited at the same time. As they originate from different locations and settings on the lake slope, they were most likely caused by an earthquake.

This project is funded by the Swiss National Fund nr. 200021-121666/1

REFERENCE

Yrro, B. J.-F. 2010: Etude sismique d'un glissement de terrain sous-lacustre au large de Lausanne. Master thesis, University of Lausanne, 123 pp.

P 6.10

A multidisciplinary approach to the reconstruction of a Lateglacial stadial in Canton Valais, Switzerland

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Remnant moraine deposits preserved on the walls of inner Alpine valleys provide valuable constraint on the timing and extent of Alpine glaciers during Lateglacial stadials. The Matter and Saas Valleys (Canton Valais, Switzerland) were major tributaries to the Rhone Glacier during the Last Glacial Maximum. They are oriented approximately north-south, and sub-parallel, approximately 10 km apart. The total catchment area of the Matter Valley is 450 km^2, while the Saas Valley has a catchment area of 250 km^2, valley floor elevations vary between 700 m and 2200 m. Detailed mapping of a prominent moraine sequence within the region has allowed us to delineate an extensive Lateglacial re-advance in each valley that coincides with a clear, and consistent change in the geomorphology of both. Moraine deposits interpreted to reflect the terminus of the principal valley glaciers are located at 1300 m elevation in the Matter Valley, and 1650 m in the Saas Valley, with lateral moraine deposits located between 300 m and 500 m above the present-day valley floor.

Although the geography of the two valleys is similar, the mapped extents reflect complicated dendritic glacier systems, and calculations of equilibrium line altitude, or correlation of the stadials are difficult. We use the numerical landscape evolution model ICE-CASCADE (Braun et al., 2008) to model glacial ice extents, and find a close correlation between modelled and mapped glaciers for a given equivalent ocean surface temperature. While the principal valley glaciers are particularly sensitive to this variation, it is likely that the mapped re-advance is contemporaneous. Cosmogenic ^{10}Be exposure age dating is used to constrain the timing of moraine emplacement, and will allow us to both correlate this prominent stadial with Lateglacial advances recorded elsewhere in the Alps, and calibrate the ICE-CASCADE model for inferred climatic conditions during this stadial. Alongside results from our field mapping, we present a correlation of mapped extents with model results, as well as first results from ongoing surface exposure dating.

REFERENCES

J. Braun, D. Zwartz, and J. Tomkin. A new surface-processes model combining glacial and fluvial erosion. Annals of Glaciology, 28:282-290, 1998.

P 6.11

Sedimentology and sediment geochemistry of the Oman Gulf and Hormoz Strait coastal plain, SE Iran

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Due to low topography, strong wind systems and availability of fine and loose grains, coastal plains are important sources for aeolian sediments. The Makran coast of Iran and Pakistan with few dry playas produces 12 percent of dust storm of the world.

The main objective of this study is to find out the main controlling processes for sediment deposition and element distribution in the Makran coast.

The coastal plain of the Hormoz Strait and Oman Sea in southeastern Iran have huge watershed, dry climate and annual precipitation of less than 98mm. To study sedimentology and sediment geochemistry of the Oman Sea, 46 samples of surficial sediments were collected from Minab, near the Hormoz Strait, to the Guater Gulf near the Pakistan border.

Granulometry, calcimetry, elemental analysis (ICP), mineralogy and clay determination by XRD were carried out at the Geological Survey of Iran.

The analyses show that sediments are mostly very poorly to moderately sorted sandy mud, mud, muddy sand and sand. They statistically classify as coarse-skewed, fine-skewed, and near symmetrical with very leptokurtic to leptokurtic, platykurtic to very platykurtic and mesokurtic distributions.

Calcite, quartz and feldspar are the three dominant minerals in variable proportions. Halite is the fourth important constituent. Chlorite, illite, kaolinite and poligorskite are frequent clay minerals. Montmorillonite is found in the eastern part of the Oman coastal plain, from Chabahar to the Pakistan border. Conversely, poligorskite is found only in the coastal plain of the Hormoz Strait.

Cluster and factor analyses of elements reveal lead and cadmium of likely anthropogenic origin, yet at concentrations lower than authorized levels in sediments. Accordingly, they present no risk to the local population. Geochemical and mineralogical evidence shows that parts of sodium, calcium, strontium, barium, and phosphorus are chemically and biochemically produced in the region, as supported by their inverse relationship to the earth elements. Shell fragments and corals contribute Ca and Sr. Other elements (Al, Fe, Cr, Co, Zn, Zr, Mn, Ti, Mg, U, Ti, Th …) have also a clastic origin, denoting erosion of ophiolite, mélange zones and turbidites of Makran. They entered the basin as clastic carbonates and aeolian sediments. Poligorskite, in particular, reached the Makran coast through the winds coming from the western part of the Persian Gulf.

This work shows that the clastic, chemical-biochemical and anthropogenic processes influence the elements distribution of Makran coastal sediments. The local rivers and winds are the important processes controlling present-day sedimentation there.

P 6.12

Mudflats of Gulf of Kachchh Coast: Archives of Sea Level Fluctuations and Palaeo-environmental Change since Mid Holocene

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Gulf of Kachchh, situated in western most part of India is a macrotidal regime with a tidal range of 4m at its mouth and 11m in intrinsic creeks (Ramaswamy *et al* 2007). It hosts sand and mud dominating coastal segments along its 450km long coastline. The mouth of gulf consists of sandy landforms like beaches, dunes, beach ridges etc. whereas, the inner gulf coastline is characterised by monotonous microenvironment as mudflats (Prizomwala *et al* 2010). The mineralogical and textural analyses of coastal sediments show that the sand fraction (>63µ) is largely derived from the Kachchh mainland fluvial systems in the north and Saurashtra fluvial systems in the south. Whereas, the finer fraction (<63µ) has dominantly been contributed by the River Indus. The presence of mica minerals (i.e. Muscovite and Biotite) has special significance in the region as they serve as a proxy for predominant River Indus load and is useful in understanding the offshore dynamics (Prizomwala *et al* 2011). We have studied the present day erosional engine and tried to document the sediment dispersal system along the Gulf of Kachchh coast (Fig 1).

A shallow sediment record (~2m) from the mudflats was recovered by trenching and shallow pipe coring. Seven major lithounits were identified on the basis of its sedimentological character and the entire sequence was then sub-sampled at 1cm interval for further studies. The lower most unit consists of loose unconsolidated coarse sand with clasts as larger as 3cm, which could be suggestive of either a beach microenvironment or a fluvial channel. It is overlain by a sandy silt unit with organic debris that marks a transition between underlying high energy regime to the above lying massive mud unit indicative of low energy regime. The massive mud unit is rich in foraminifera tests and is bluish green in colour. It is overlain by a trough cross bedded sandy unit, again suggestive of an increased energy condition (beach microenvironment). There is a conspicuous sand layer sandwiched between mud layers above it. The sharp contact of this sand layer, assorted texture and the abraded foraminifera tests point out towards their deposition on account of a high energy event

like tsunami. Further detailed studies pertaining to the mineralogical and textural character of this sequence is warranted as it could throw light on much sparsely documented sea level change and palaeo-environmental changes in the region. The generated multiproxy dataset on the present day active processes along the Gulf of Kachchh coastline would be immensely useful in studying temporal variations in the sediment sources.

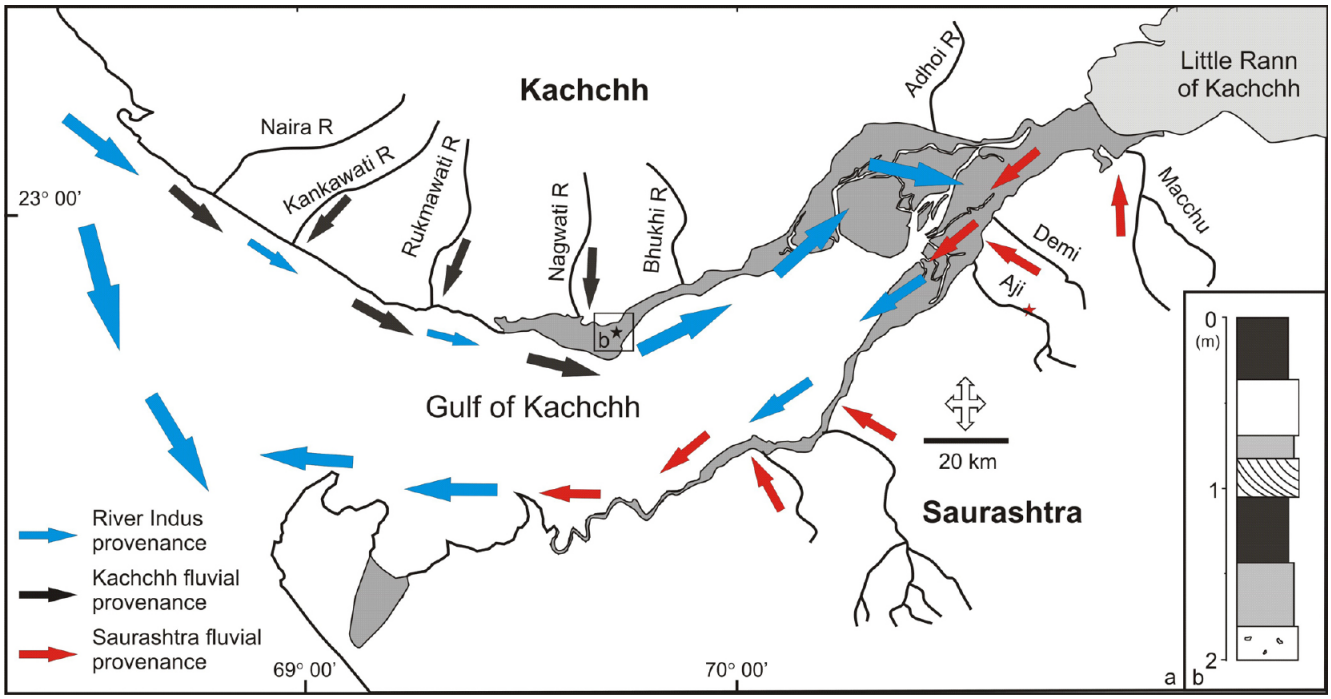

Figure 1. (a) Sediment dispersal system along the Gulf of Kachchh coast, (b) Litholog of shallow sediment sequence ~ 2m (black – laminated mud, gray – sandy mud and white - sand)

REFERENCES

Prizomwala, S.P. Shukla, S.B., Bhatt Nilesh. 2010: Geomorphic assemblage of the Gulf of Kachchh coast, Western India: Implication in understanding the pathways of coastal sediments. Zeitschrift fur Geomorphologie 54 (1), 31-46.

Prizomwala S.P., Shukla S.B. and Bhatt Nilesh. (in press 2011). Distribution of Indus born mica along Gulf of Kachchh coast: Implications in understanding offshore dynamics. Journal of Geological Society of India.

Ramaswamy, V., Nagender, N.B., Vethamony, P., Illangovan, D., 2007. Source and dispersal of suspended sediment in macro-tidal Gulf of Kachchh. Marine Pollution Bulletin 54, 708-719.

P 6.13

Maximal position and retreat phase of the Reuss-Piedmont Lobe during the LGM

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For understanding the timing of glacier retreat during Last Glacial Maximum (LGM) in the northern Alpine foreland Findlinge are sampled with regard to get surface exposure ages. With the exposure age of the Findling a minimum age for the presence of a paleoglacier at that locality can be determined. Three boulders in the lower Reuss-valley were exposure dated with cosmogenic ^{10}Be. The study site is chronostratigraphically situated near to the terminal position of the LGM Reuss-Piedmont Lobe. ^{10}Be exposure ages vary between 20 and 17 ka and are in good agreement with the field observations. The LGM advance is evidenced by the age of the "*Kleiner Römerstein*" (Reuss-22) and the "Grosser *Römerstein*" (Reuss-21). According the surface exposure ages of this boulders this advance was not later than around 20 ka ago. Moreover, a minimal age of a retreating stadial position is given by the exposure age of an erratic boulder located near by the "*Erdmannlistein*" (Reuss-20) at around 17 ka. The effect of human impact seems to be unlikely on these samples, thanks to careful choosing of sample position and general observations in field. These three boulders are comparable with boulders from the Rhone-Piedmont Lobe (Ivy-Ochs 2006) and are in good agreement with global LGM. Finally, more boulders need to be dated in order to verify the comparability of the data and to establish a clearer picture of the glaciation and deglaciation history in the northern Alpine foreland.

REFERENCES

Ivy-Ochs, S., Kerschner, H., Reuther, A., Maisch, M., Sailer, R., Schaefer, J., Kubik, P.W., Synal, H.-A., Schlüchter, C. (2006): The timing of glacier advances in the northern European Alps based on surface exposure dating with cosmogenic ^{10}Be, ^{26}Al, ^{36}Cl, and ^{21}Ne. In: Siame, L.L., Bourles, D.L., Brown, E.T. (Editors): In situ cosmogenic nuclides and their applications in earth sciences. – Geological Society of America Special Paper 415, 43–60.

P 6.14

Understanding site manipulation and destruction in prehistoric lake-dwellings

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Lake-dwellings are well known for their remarkable preservation conditions. This applies to wooden artefacts, plant macro remains, and other organic materials. Contrastingly, features are often difficult to interpret, and cultural layers were affected by various syn- and post-sedimentary disturbances. In this study samples from Swiss Neolithic to Late Bronze Age lake-dwelling sites will be subjected to thin section analysis, in order to identify manipulating and destructive processes.

The poster gives first results from the study of the Neolithic lake-settlement of Zug-Riedmatt (Switzerland). This site has a remarkably thick (1.2 meters) highly organic stratigraphic sequence relating to the occupation(s) of the settlement, preserved by a covering of sediment several meters deep and below groundwater level. Identifiable within the organic sequence are several layers, homogenous in appearance across the site, which possibly indicate breaks in the occupation sequence. Geoarchaeological analysis suggests that these layers were deposited during low-energy inundations. This sediment type has not been identified in previous micromorphological lake-dwelling research, but a similar layer is possibly recognised at a recent lakeside excavation in Zurich.

Subsequently, such stratigraphic anomalies within the sites shall be linked to either cultural or natural phenomena. The aim of this study is to increase understanding of site formation and abandonment in lake-dwellings, in addition to assisting palaeoenvironmental reconstruction. Furthermore, it is hoped that micromorphology can be established as a site monitoring tool for the management of the lake-dwelling heritage in the future.