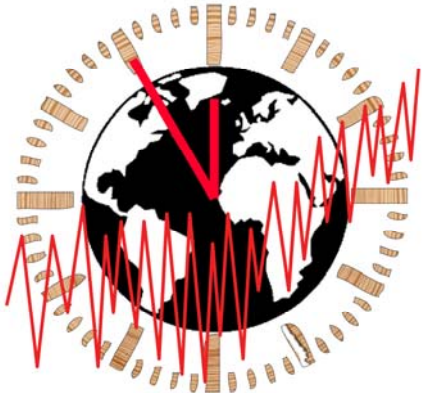
Geochronology



Summer School

International Geochronology Summer School

Dating techniques in environmental research

Morteratsch

1 - 6 September 2019

International Geochronology Summer School
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Program

Time	Sunday, September 1st
16:00-18:30	Arrival
18:30-19:30	**Icebreaker**
19:30-20:30	Dinner

Time	Monday, September 2nd	Lecturer
07:30-08:30	Breakfast	
08:30-10:00	**Basics in dendrochronology**	Holger Gärtner (WSL) / Paolo Cherubini (WSL)
10:00-10:30	Coffee break	
10:30-11:30	**Dendrochronology applications: Dendrogeomorphology**	Holger Gärtner (WSL) / Paolo Cherubini (WSL)
11:30-12:30	**Dendrochronology applications: Anthracology**	Paolo Cherubini (WSL) / Holger Gärtner (WSL)
12:30-13:30	Lunch	
13:30-18:00	**Field and "lab" work: "Wood anatomical applications"** (depends on weather conditions)	Holger Gärtner (WSL) / Paolo Cherubini (WSL)
18:00-19:00	**Participant presentations**	See program of participant presentations
19:00-20:15	Dinner	
20:15-21:00	**Publish or perish**	Paolo Cherubini (WSL)

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Time	Tuesday, September 3rd	Lecturer
07:30-08:30	Breakfast	
08:30-09:00	**Introduction to dating methods and their ranges**	Susan Ivy-Ochs (ETH Zurich)
09:00-09:30	**Cosmic rays and production of cosmogenic nuclides**	Dmitry Tikhomirov (UZH, ETHZ)
09:30-10:30	**Introduction to radiocarbon**	Irka Hajdas (ETH Zurich)
10:30-11:00	Coffee break	
11:00-11:45	**^{14}C calibration, wiggle matching and calibration tools**	Irka Hajdas (ETH Zurich)
11:45-12:45	**Noble gases and groundwater recharge in glaciated regions**	Matthias Brennwald (EAWAG)
12:45-13:45	Lunch	
13:45-14:45	**Luminescence dating**	Natacha Gribenski (University of Bern)
14:45-15:45	**Introduction to exposure dating**	Susan Ivy-Ochs (ETH Zurich)
15:45-16:15	Coffee break	
16:15-17:00	**Late glacial pine forest of the Netherlands, dendrochronology and problems with 14C-dating**	Jos Bazelmans (Cultural Heritage Agency of the Netherlands)
17:00-19:00	**Participant presentations**	See presentation program
19:00-20:30	Dinner	
20:30- …	Open time for discussions	

Time	Wednesday, September 4th	Lecturer
07:30-08:30	Breakfast	
08:30-09:30	**Geoarchaeology and environmental history**	Eileen Eckmeier (University of Munich)
09:30-10:00	**Short briefing of field exercises**	Markus Egli (UZH)
10:00-10:45	Coffee break and preparation of picnic-lunch	
11:00-18:00	**Field exercises and talks** (Lunch in the field)	Markus Egli, Dennis Dahms, Susan Ivy-Ochs, Dmitry Tikhomirov, Eileen Eckmeier
18:30-19:30	Dinner	
19:30-21:00	**Participant presentations**	See presentation program

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Time	Thursday, September 5th	Lecturer
07:30-08:30	Breakfast	
08:30-09:30	**Soils and Time**	Jérôme Poulenard (University Savoie Mont Blanc)
09:30-10:30	**An introduction to archaeomagnetic dating: Theory and applications**	Evdokia Tema (University of Torino)
10:30-11:00	Coffee break	
11:00-12:00	**Dating using ^{210}Pb and ^{137}Cs**	Nathalie Dubois (EAWAG)
12:15-13:30	Lunch	
13:30-14:30	**Cosmogenic chlorine-36 as a dating tool: an example of application to limestone fault scarps**	Dmitry Tikhomirov (UZH, ETHZ)
14:30-15:30	**Pleistocene-Holocene Glacial Soil Stratigraphy in the Rocky Mountains, WY, USA**	Dennis Dahms (University of Northern Iowa, USA)
15:30-16:00	Coffee break	
16:00-18:30	**Participant presentations**	See program of participant presentations
19:00-20:30	Dinner	
20:30- …	Open time for discussions/presentations	

Time:	**Friday, September 6th, without excursion**	
07:30-08:30	Breakfast	
ca. 09:30	Departure	

Time:	**Friday, September 6th, with excursion**	
06:30-07:00	Breakfast	
07:38-18:18	**Excursion: "On the move: Soil and landscape dynamics of the Val Bever and Albula alpine region"** (Lunch in the field)	Markus Egli, Dennis Dahms
	In case of heavy rain	
07:30-08:30	Breakfast	
08:30-18:00	**Excursion: "Fairy tail forests and crude reality in the Upper Engadine"** (Lunch in the field ... or wherever possible)	Paolo Cherubini, Markus Egli, Dennis Dahms
18:30-19:30	Dinner	

Time:	**Saturday, September 7th**
07:30-08:30	Breakfast
ca. 09:00	Departure

Program of participant presentations

18:00 – 19:00	**Monday, September 2nd**
Katja John	Wide span roof constructions of early modern hall and wall-pillar churches in German-speaking Switzerland
Paula Coroiu	Assessing past atmospheric particulate matter composition in Xi'an and Shaanxi Province (Northern China) using novel tree-ring analyses
17:00 – 19:00	**Tuesday, September 3rd**
Cyrielle Messager	Radiocarbon dating of lead white paintings
Laurent Christen	Organic carbon sedimentation in a Greenlandic lake, and its implications on medieval Norse land use
Sarah Kamleitner	The Last Glacial Maximum of the Ticino/Toce glacier system, Italian Alps
Valentine Piroton	Geochronology of ancient deep-seated mass movements in seismically active mountain regions
19:30 – 21:00	**Wednesday, September 4th**
Diana Lozano	Dating of alluvial deposits originated by torrential events. Integration of Schmidt hammer, Radiocarbon and lichenometry technics. Mocoa, Colombia, Southamerica.
Erik Ballo	High-resolution lacustrine records of environmental changes in Scandinavia with a focus on the Migration period and the Viking age
Ethan Silvester	Palaeolimnological analysis of sulphate deposition events following large volcanic eruptions in the past millennium
16:00 – 18:30	**Thursday, September 5th**
Ekaterina Stolpnikova	Paleoenvironmental reconstruction for Early Pleistocene Paleolithic site Mukhkai II using the methods of stable isotope composition and n-alkans
Anuschka Neira	Biodiversity of soil bacteria in greenhouses
Monica Rasmussen	Quantifying climate-dependent mechanical weathering and subcritical cracking over geologic time
Sara Negri	Loess legacies on particle shape and particle size distribution in polygenetic soils of North-Western Italy
Olga Druzhinina and Kasper van den Berghe	Application of phytolith analysis in palaeolimnological and geoarchaeological studies

Participant abstracts

Wide span roof constructions of early modern hall and wall-pillar churches in German-speaking Switzerland

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In German-speaking Switzerland the sacral baroque architecture finds its strongest decorative expression in hall and wall-pillar churches. For the later ones, the «Vorarlberger Münsterschema» is characteristic. It was developed in the 17th century by master builders and carpenters of the «Auer guild». These are mainly found in southern Germany, Austria and Switzerland. The roof structures of both types often span more than 10 meters and had to be individually adapted to the different types of vaulting in the churches. Next to roof structures with continuous tie-beams, which are mostly supported by intermediate beams, open roof structures with interrupted tie-beams are also common, depending on the height of the barrel vault. Mixed forms are mainly caused by the domes that often protrude into the roof space, mainly found in hall churches. Domes can be found in combination with barrel vaults as well. Roof structures with interrupted tie-beams in particular show static problems, caused by the lack of a tie at the base of the rafter roof triangle. These often needed supporting elements and reparations.

Although the archival research of the early modern period usually provides information concerning the construction period, dendrochronological analysis is indispensable for determining the various construction phases. This not only allows statements to be made about the time intervals between repairs and additions, but also allows the differentiation of reused components from the other construction elements.

Problems of the dendrochronological analysis of early modern roof structures can be seen on the one hand in wood processing and on the other hand in the availability of reference data for the evaluation of samples. Wood processing in the 17th to the 19th centuries often involved motorized saws in saw mills, although parallel to this there are also always hewn woods to be found. The edges of the sawn timber are almost always completely lost, making absolute dating impossible. Therefore, it can be difficult to classify the reparation phases in the baroque time. The corpus of available reference data is small, especially for rural regions. Therefore, further possibilities for scientifically confirmed dating would permit better understanding of the construction history baroque churches.

Acknowledgments

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Assessing past atmospheric particulate matter composition in Xi'an and Shaanxi Province (Northern China) using novel tree-ring analyses

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Increased industrial activities and an expansion in the human population have resulted in the release of particulate matter that is deposited into aquatic and terrestrial ecosystems. In the past few decades, fine particles have become of major concern for human health and for entire ecosystems. The use of dendrochemistry to monitor air pollution is essential to provide past levels of contamination and to trace pollutants on a spatial and temporal scale in relation to their sources. A number of studies has shown the ability of trees to accumulate contaminants into their annual growth rings, acting as natural bioconcentrators [1], but the effect of fine particles at nano-scale is still largely unknown and their presence in tree rings unexplored.

In China, particulate pollution is a serious environmental problem that is influencing air quality and human health. The severe haze pollution events at several Chinese urban locations are driven to a large extent by secondary aerosol formation and particles originating from sandstorms [2]. The aim of this research is to assess the presence of fine particles in trees and to relate them, through dating, with specific air pollution and sandstorm episodes. For this purpose, tree cores were collected from Chinese pines (Pinus tabuliformins Carrière) growing at sites affected by heavy pollution, in Xi'an, by sandstorms, in northern Shaanxi Province, and in a control site. Standard dendrochronological, tree-ring stable isotopic and chemical elemental composition analyses will be run.

Very little is known about the penetration of trace metals into plants leaves. We hypothesize that trees uptake nanoparticles through the leaves and transport them into the stem faster than through roots. An experiment in greenhouse using Scots pine and beech and gold nanoparticles is currently carried out to confirm results obtained by Cocozza et al. [3].

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Acknowledgments

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Radiocarbon dating of lead white paintings

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Lead white is an inorganic synthesized pigment widely used in paintings from the Antiquity until his ban in the 20th century due to its toxicity. Cerussite and hydrocerussite are the two main lead carbonates that compose this pigment. The first evidence of its manufacture dates back to 400 BC, reported by Theophrastus in On Stone. [1] The traditional recipe for lead white requires three ingredients: metallic lead, vinegar, and a fermenting environment like horse manure, wine lees, tannin, that provides the CO2 necessary for the pigment synthesis [2]. This organic CO2 is the key for radiocarbon dating of lead white [3, 4]. We developed a protocol in order to extract thermally carbon from lead carbonates. [5] We tested the selectivity of our protocol by thermogravimetry on paints containing a mixture of lead white, chalk and linseed oil to make sure that natural carbonate pigment, often found in old paintings, will not decompose along with lead carbonates. After optimization, we tested the new protocol on historical samples. We obtained results measured with the AMS ARTEMIS in agreement with the expected dates on ancient pigments, lead white paintings, and lead white cosmetics. This innovative project highlights the possibility of applying radiocarbon dating to inorganic pigments and offers a new alternative for the authentication of artefacts.

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Organic carbon sedimentation in a Greenlandic lake, and its implications on medieval Norse land use

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In this thesis, a sediment core from Lake Zucerip Tasia, Greenland, was analysed using various proxies. The goal was to look for anomalies in this sediment core which could be linked to the medieval Norse colonisation of the area. The proxies included radiocarbon dating of bulk sediment and macrofossils, elemental analysis of carbon and nitrogen concentrations, coulometric measurement of inorganic carbon concentrations, and measurement of biogenic silica concentrations. Using them, a qualitative history of lacustrine primary productivity in Lake Zucerip Tasia and soil erosion in the adjacent catchment could be developed for the last 4900 years. The results indicate a phase of increased soil erosion and primary productivity around 4000 years AD, which most likely had natural causes. After a long phase of declining lacustrine primary production, Norse farmers arrived in Greenland at the end of the 10th century. It can be hypothesised that this arrival and subsequent Norse pastoral farming activities is reflected in the sediment by variations in the C/N ratio as indicators of deforestation and increased primary productivity: The increased primary productivity would furthermore indicate increased soil erosion. However, due to the lack of a trustworthy macrofossil age model, this hypothesis cannot be confirmed by the available data. For the second introduction of pastoral agriculture to the area, by the Danish around 1920, clear impacts can be seen in the lake sediment: A sharp increase in primary productivity is reflected by peaks in total organic carbon (TOC) and total nitrogen (TN) concentrations, and strong soil erosion finds its response in pre-aged carbon being washed into the lake.

The Last Glacial Maximum of the Ticino/Toce glacier system, Italian Alps

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Latest insights from paleo-climatic research [1] and glacier modelling [2] suggest that ice build-up during the Last Glacial Maximum may not have been uniform across the European Alps. Favoured by predominant precipitation patterns and a steep topographic gradient, paleo-glaciers on the southern side of the Alps are believed to have reached their maximum extent earlier than glaciers that drained north. While reliable glacial chronologies based on radiocarbon and exposure dates are available for several of the major Italian amphitheatres, the LGM glaciation of the central part of the southern European Alps is a clear lack of knowledge. The latter's connection to the major Alpine ice domes makes understanding the Ticino/Toce glaciers behaviour especially critical. The present study aims on filling this gap of understanding. Detailed mapping of the Toce/Ticino glacier combined with cosmogenic nuclide dating will yield insights into timing and extent of the Last Glacial Maximum and possible (re)advances of the former piedmont glacier.

A total of thirty rock samples for surface exposure dating has been collected from erratic boulders deposited on the western shore of Lago Maggiore by the Ticino/Toce glacier. Preliminary Beryllium-10 results support an LGM extent larger than recently proposed [3]. Next to LGM ages, the present data set together with field evidence also suggests a glacier re-advance following the LGM that ended with rapid down wasting of the glacier.

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Acknowledgments

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Geochronology of ancient deep-seated mass movements in seismically active mountain regions

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The determination of age represents a major step towards the understanding of the causes and the triggers of ancient mass movements, in order to perform an appropriate hazard assessment. It is important to date the geological deposit in order to be able to reconstruct the genesis of the mass movement and, as in our case, to prove their seismic origin. Together with the recent development of new dating techniques, the number of dated landslides is globally increasing, and the precision of age determination is improving as well (Pánek T., 2015).

My PhD research project is focused on dating multiple ancient giant mass movements located in different seismic areas: (1) along the Hockai Fault Zone in Belgium, (2) in the region of Vrancea in Romania and (3) possibly also in the Alps and in the Kyrgyz Tien Shan. In all those regions, mass movements highly contribute to the total seismic hazard. First, in the Eastern part of Belgium, the Bévercé landslide (volume ~ 20 Mio. m3), characterized by a moderate seismic activity, has developed near a major 40 km long fault, in a Permian conglomerate (Mreyen et al., 2018). Second, in the south-eastern Carpathians in Romania, the deep-seated Balta rockslide (volume ~ 3–6 Mio. m3), occurred in a region marked by a higher seismic activity (Mreyen et al., 2017). So far, the main objective was to understand how the seismic energy contributed to massive slope failure. In the frame of my new PhD research, different dating techniques, such as radiocarbon (14C), dendrochronology or cosmic ray exposure (CRE), will be used to date those two mass movements (and possibly others in the Alps and in the Tien Shan), considering the specificity of each landslide as well as method limitations. This will contribute to the reconstruction of the longer earthquake and general geohazard history of each studied region.

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Dating of alluvial deposits originated by torrential events. Integration of Schmidt hammer, Radiocarbon and lichenometry technics. Mocoa, Colombia, Southamerica.

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On April 2017 a disaster related to a debris flow happened in Mocoa. In order to establish the frecuency of the events and therefore to support risk assessment and land planning, there were identified, characterized and dated all alluvial deposits generated by torrential events located in Tilinguara and Taruca creeks and Sangoyaco, Rumiyaco, Mulato, Pepino and Mocoa rivers.

Deposits age was inferred from geological and geomorphological fieldwork, being 1: recent, 2: sub-recent, 3: old and 4: ancient.

By applying X-Ray Diffraction and X-Ray fluorescence on clay fraction, it was identified that recent deposits were richer on quartz, chlorite, hornblende, kaolinite, illita-muscovite, vermiculite, alkali feldspar and plagioclase.

On the other hand, old deposits were richer on Haloisite, gibbsite and minerals produced by weathering of volcanic ashes while ancient deposits were composed 100% by minerals produced by weathering of volcanic ashes.

Schmidt hammer data showed that older deposits have a lowest value compared to recent ones. However, the behaviour was lineal and it was not possible to identify temporary differentiated deposits.

Absolute dating methods of lichenometry and C14 were chosen on the possibility of decadal and centurial dating [1] of old, sub-recent and recent deposits. C14 indicated that old deposits were 1000 to 3000 years old. Lichenometry indicated that recent deposits are 50 - 100 years old.

By aerial photographs interpretation it was discovered that a similar event occurred on 1962, inferring an approximated frequency of 50 to 55 years to recent deposits.

By relating all dating methods, it was established that recent deposits were less than 100 years old, sub-recent deposits were 100 to 1000 years old, old deposits were 1000 to 12000 years old and ancient deposits were more than 12000 years old.

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High-resolution lacustrine records of environmental changes in Scandinavia with a focus on the Migration period and the Viking age

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The middle of the 6th century marked the beginning of a decadal-scale cooling period in Northern Europe due to the 536/540 CE volcanic eruptions. This period has been linked to crop failures, famines and to a number of other major societal crises in the Northern Hemisphere, such as the European outbreak of the plague of Justinian (541 CE). A comparable volcanic event, Eldgjá 939 CE, was so powerful that it must have had a severe effect on climate, environment and society during the Norse expansion of the Vikings in Scandinavia. Although published sediment records from Scandinavia give information about the general climatic evolution of the past 2000 years, they do not have the needed resolution to provide yearly or decadal information which is necessary to obtain a sufficient chronology for the studied period. In this study, we target varved lake sediments in order to construct a high-resolution timeline of geochemical information, vital to discuss and understand the environmental and climatic response to these volcanic eruptions.

We have cored two lakes in southeastern Norway in order to obtain high-resolution records from the time period of interest: Lake Sagtjernet and Lake Nordbytjern. Lake Sagtjernet (c. 12 m depth) provided a sediment sequence of 5 m. A previous study from this nonglacial lake highlighted varved sediments throughout the Holocene. Lake Nordbytjern has a depth of 24 m and is categorized as an endogenic meromictic lake of glacial origin with hydraulic influx about evenly divided between groundwater seepage and two small streams. It is located roughly 1.5 km northeast of the largest burial mound in Norway (mid-6th century). The first short gravity core retrieved from this lake is 1.80 m and displays finely laminated sediments. Based on high resolution geochemical and radiographical analyses including short lived radionuclides, AMS 14C and CT scanning, we will discuss the varved potential of this lake sediment sequence. Mineral and organic geochemical methods are used to reconstruct climate variations.

By comparing our sedimentary records with other natural archives in Scandinavia this study will allow us to discuss the dynamics between climate and environmental changes and their role in facilitating societal changes of the Viking society in Scandinavia.

Acknowledgments

The PhD project is part of the VIKINGS project, funded by The Research Council of Norway through the FRIPRO Toppforsk funding scheme

PhD Project Overview: Palaeolimnological analysis of sulphate deposition events following large volcanic eruptions in the past millennium

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Present-day volcanic ashfall events have multiple human and environmental impacts, as demonstrated by the recent eruption of Eyjafjallajökull in 2010. Although the environmental impacts of volcanic aerosol deposition have been studied, our understanding of ecosystem response across large spatial scales remains limited, particularly for major volcanic events occurring every 100-200 years. Targeting ≥VEI6 events over the past c1000 years, this project will investigate catchment-scale response at sites across Northern Europe. Diatom assemblage characteristics will be used as a proxy for ecological health, supported by geochemical data at annual resolution in varved lake sediments. Primary focus will be given to temporal S and Hg concentration changes in samples.

As part of efforts to establish instrumentation for synchrotron-based analysis of chemically unaltered, frozen sediment records at the MAX IV facility at Lund University, we will also perform high-resolution S, Fe and Hg speciation analyses of the varve records using the Balder beamline.

Acknowledgments

This PhD project is part of the wider project 'VolcVarve: Varved lake sediments as archives of environmental impacts following large volcanic eruptions' funded by the Swedish Research Council.

Paleoenvironmental reconstruction for Early Pleistocene Paleolithic site Mukhkai II using the methods of stable isotope composition and n-alkans

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The question about climatic, landscape conditions of first Early Pleistocene settlements on Eurasian continent remains open now. Were these conditions similar to ancestral homeland Africa? One of the main problems in the study of Early Pleistocene sites is the low content of organic matter in its sediments which is one of the main markers of soil forming processes and paleovegetation. In this case, the carbon isotopic composition and distribution of long-chain n-alkanes are the main methods allowing research of small amounts of organic matter.

The object of study is the Early Paleolithic multi-layered site Mukhkai II located in the eastern part of the North Caucasus (Dagestan, Russia) at an altitude of 1629 m above sea level. The age of this site is estimated by paleomagnetic dating method and paleofauna at 2.1-1.7 Ma [1].

During our study, the Corg, N, S content, isotopic composition of organic carbon, content of n-alkanes with chain length C17-33, and magnetic susceptibility were measured. The studied deposits represented by interlaying pebbled sediments and carbonate loam layers with signs of hydromorphic soil formation such as Fe-Mn spots and gray shades in color (10YR 7/4, 8/3). Hydromorphic conditions are confirmed by low magnetic susceptibility values (11-27*10-6 cm3/g CGS). The isotopic composition of organic matter corresponds to the C3 vegetation and ranges from -26.1-27.2‰. The samples have enriched with biomarkers of woody vegetation (n-alkanes C27 and C29). At the same time, the dominance of medium chain alkanes and the high even to odd ratio are recorded. This suggests that formation of sediments possibly occurred in flooded conditions with contribution of algae and bacteria.

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Biodiversity of soil bacteria in greenhouses

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The existing sectoral plan for crop rotation areas in Switzerland is currently being revised. It is being discussed, whether special areas, such as greenhouses, should also be eligible if the soil meets the qualitative requirements of crop rotation areas. This thesis is part of this research project and analyses the microbial diversity of bacteria in greenhouses with hors-sol, soil-bound and combined production using a molecular genetic fingerprinting method such as terminal restriction fragment length polymorphism (T-RFLP). Shannon indices were extremely significantly higher in the greenhouses than in the references (Welch Two Sample t-test; $t = 4.717$, $df = 108.6$, $p < 0.001$). Shannon indices ranged between values from 3.3 and 3.9, which indicated high biodiversity of both cultivation methods. Evenness indices ranged between values from 0.2 to 0.5, indicating dominant species. This thesis shows that the microbial diversity and the community structure of bacteria between arable land and greenhouse soils are very similar and show little differentiation, caused mainly by environmental parameters and farming practices. Types of production have an influence on the environmental parameters and thus on the bacterial community structure and vice versa. Finally, it can be said that based on the initial results of this study, greenhouses could be suitable as crop rotation areas. In order to be able to conduct a final assessment, further investigations are necessary.

Quantifying climate-dependent mechanical weathering and subcritical cracking over geologic time

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Mechanical weathering of rocks at or near (within ~100m) Earth's surface is a critical component of landscape evolution. Classic geomechanics analyzes critical stress fracturing, understanding the point at which the stresses acting on a rock exceed its critical strength and lead to sudden catastrophic fracturing, including the influence of factors like the rock's elastic properties, confining and differential stresses, and pore fluid pressure and composition. Subcritical cracking, which often propagates slowly and is initiated at stresses far below the rock's critical stress threshold, is less understood, and the mechanisms by which this cracking occurs are not well quantified. However, we propose that subcritical cracking is a dominant mechanism driving surface and near-surface rock weathering, and therefore requires more understanding.

Subcritical cracking rates vary based on rock composition, fabric, thermal and elastic properties; pre-existing weaknesses; and environmental conditions such as humidity and temperature. Our work builds upon numerical modelling analysis by Eppes and Keanini [1] which indicates that increasing temperature and/or humidity will increase subcritical cracking rates.

These concepts have been studied previously, but most existing data are only available over a human timescale (up to tens of years). We will collect data from granites and carbonates that have been experiencing surface erosion for hundreds to tens of thousands of years, from two regions with known temperature ranges and annual precipitation in California, USA, and the Negev desert of southern Israel. The samples will be analyzed through visual characterization of boulder properties and cracks, thin-section analysis, Schmidt hammer measurements, and LiDAR surface roughness measurements. In lab experiments, the data will be subjected to stresses under varying temperature and moisture regimes, during which time subcritical cracking rates and crack density will be measured. Finally, the data will be used to update numerical models to understand the influence of temperature and humidity on subcritical cracking rates in surface and near-surface rocks.

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Loess legacies on particle shape and particle size distribution in polygenetic soils of North-Western Italy

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Loess is a silty aeolian sediment which originates beds with multiple pedo-stratigraphic units. Loess is mainly deposited during rhexistasy periods, while weathering and soil formation characterize biostasy phases. Discontinuous loess covers were reported in Northern and Central Italy, with active sedimentation in the Po Plain since 45 ka BP, at the onset of glacial conditions in MIS4 [1]. Reconstructing the history of polycyclic loess-derived soils is difficult, therefore this work combined field characterization with laboratory analyses and image processing techniques.

The study area is the right riverside of the Stura di Lanzo alluvial fan (Piedmont, NW Italy) where loess lies on top of fluvial and fluvioglacial sediments. Glaciers did not cover the area during LGM, as the closest ice lobe stopped right behind the Lanzo ultramafic Massif, some km north of the fan. Five pedo-stratigraphic units were observed in 6 profiles, and 31 horizons were analyzed. Particle size distribution (PSD) was determined by laser diffraction and peak fitting. Particles in the range 200-10 µm were observed under optical microscope and characterized in shape and color.

PSD cumulative functions showed the typical shape of loess curves, although highlighting the abundance of fine particles in comparison to other loess-derived soils in Italy. All PSD curves showed a tri/bimodal distribution. The dominant peak (at 8-14 µm), was significantly wider in young depositions, suggesting that weathering operated a selection of the material. The second mode, at 0.5-4 µm, had a higher intensity and was shifted towards the upper size range in older depositions. The coarse and fine silt contents showed a clear geographical trend, suggesting a dominant wind direction. During 4 out of 5 depositional cycles, loess likely came from the Po Plain, in agreement with other studies [2], thus explaining the extremely fine nature of the material [3]. On the contrary, in the remaining cycle, loess deposition followed a NW to SE direction. This hypothesis was confirmed by image analysis, which evidenced a significantly darker particle color in this deposition, in agreement with the ultramafic nature of the Lanzo Massif.

In conclusion, the techniques used in this work contributed to the identification of loess sources and the determination of weathering patterns.

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Application of phytolith analysis in palaeolimnological and geoarchaeological studies

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Phytolith study is a part of microbiomorphic analysis - a microscopic investigation of organic (pollen, plant detritus, etc) and mineral (phytoliths, silicified cuticle casts, diatoms, etc) remains of biota in the context of the conditions of their origin [1]. Phytoliths are grains of opal that are formed in plants by intracellular precipitation of silica. Almost all phytolith features can be used for diagnostic purposes regarding plant development, soil and landscape evolution, as well as usage of plants and various human activities; therefore phytolith analysis is gaining more and more appreciation in palaeoenvironmental and geoarchaeological studies as a valuable tool. However, still there is a need of testing informative abilities of phytoliths in different environmental and anthropogenic context. Here two research projects are presented aimed to this issue.

Phytolith analysis is complementing a wide range of methods, which are applied to study the Kamyshovoe lake sediments (Kaliningrad region, Russia) comprising late Pleistocene and Holocene deposits. The target of this study is to use phytoliths as indicators of possible crucial vegetation changes during Pleistocene – Holocene transition, as well as indicators of the earliest human-induces changes of the landscapes in Prehistoric time.

Study involving phytoliths took place at the Voorthuizen archaeological site, dated to Roman time (the Netherlands). Samples of the cultural layer including pits, remains of constructions, ditches will be analysed to trace various functional zones of the settlement, and to describe the range of plants used on the site.

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