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9. Quaternary environments: landscapes, climate, ecosystems, human activity during the past 2.6 million years

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9. Quaternary environments: landscapes, climate, ecosystems, human activity during the past 2.6 million years

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Swiss Society for Quaternary Research (CH-QUAT)

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9.1

Swiss aquatic ecosystems in medieval times: A combined archaeozoological and biomolecular approach

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This interdisciplinary investigation focusses on the evaluation of archaeological fish remains to receive information about the anthropogenic influence on aquatic ecosystems. Fish bone material from 22 sites in Switzerland, covering a time span from the 9th to 16th centuries, has been analysed. Besides the use of classical archaeozoological methods which evaluate osteomorphological criteria, certain fish remains were selected for ZooMS (Zooarchaeology by Mass spectrometry) and stable isotope analysis. The combination of those three methods can inform us about the composition of the fish stocks and the ecological conditions in their habitats.

In particular, this interdisciplinary approach enables new perspectives for the identification of species of the carp family (*Cyprinidae*). Cyprinids are well suited as bioindicators, but are hard to differentiate osteomorphologically. In this case we use ZooMS for species identification. The analysis of peptide masses in fish bone collagen creates a molecular fingerprint (Richter et al. 2011). Until now 286 cyprinid bones have been analysed (Hounslow 2011). The comparison of the medieval fish species spectrum constructed by classical archaeozoological analysis with the preliminary results of the ZooMS analysis revealed a refinement in species composition. The numbers of cyprinids living in eutrophic water bodies, such as tench (*Tinca tinca*) and bream (*Abramis brama*), has increased.

In addition to species identification, we try to find out whether effects of anthropogenic activities on water quality can be assessed through carbon, nitrate and sulphur stable isotope analysis. While sulphur isotope analysis seems to represent the tool best suited to detect the onset of “industrial” activities in water, nitrogen has potential for documenting eutrophication as a result of organic waste disposal (Van Neer et al. 2009). In a next stage of the research project, stable isotope analysis will be conducted on fish bone samples to assess for possible influences and impacts on medieval aquatic ecosystems.

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9.2

Chronology of complex LGM and postglacial sediments in Wauwilermoos (Swiss Plateau) substantiated by new methodological approach in optically stimulated luminescence (OSL) dating.

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Wauwilermoos, located at the north-western rim of the former Reuss-Glacial, provides a range of complex postglacial and colluvial sediments. The profile Mattenhof in a lacustrine terrace of the former Lake Wauwil, which periodically flooded the space between the two ridges of the terminal LGM moraines, consists of sediments spanning the period since the LGM until current times. From bottom to top this profile consists of 5 major sedimentary units: a) two layers of grey, middle-grained sand with frost wedges on tops, identified as proglacial sandur, b) reddish-brownish layers of medium- to coarse-grained sand and gravels laminated with sand and silt, identified as a lacustrine terrace sequence; it is cut by an erosional discordance, c) lower colluvium containing mixed sand, silt, clay and gravels, intermittent laminated, also cut by an erosional discordance brought out by a stone line, d) upper colluvium made of very compact mixed layers of sand, silt, riddled with clay nodules and gravels, e) black mixture of sand and peat, with irregular bottom and downward eversions penetrating into the underlying layers, which might have developed due to tree roots or diggings, in the recent past.

While attempting dating of this sedimentary sequence, discrepancies of the resulting burial ages were observed depending whether small aliquots (SA), large aliquots (LA) or single grains (SG) were used to measure the output of the optically stimulated luminescence (OSL). While SG measurements yielded age estimates supporting the palaeo-environmental and archaeological expectations, revealed e.g. by Nielsen (2009), the aliquot measurements failed, with SA yielding the worst results. In addition, the wide spread of the OSL results made the application of age modelling problematic and age components that could not be supported by the geological records, appeared in the statistical calculation. Application of the new OSL approach, first described by Wang et al. (2012), significantly improved the final results of the OSL dating, indicating that sandur with the frost wedges may represent the intra-LGM oscillation and ice recession. The overlying sands and gravels were deposited during the subsequent lake phase coinciding with the second LGM ice advance (Starnberger et al. 2012) and the build-up of the West-Mauensee moraine. The overlying colluvial beds are related to human occupation during the Younger Dryas and Mid-Holocene. The age of the upper part of the profile is well constrained by estimates obtained from archaeological artefacts and radiocarbon dating of a neighbouring profile Wauwil Obermoos (Nielsen 2009).

This contribution presents the results of the application of both approaches of evaluation of the OSL data – the traditional one and that of Wang et al. (2012) - and discusses the consequences for understanding of the LGM palaeo-environmental changes.

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9.3

Chronology of deglaciation and Lateglacial ice flow reorganization in the Gotthard Pass area, Central Swiss Alps, based on cosmogenic ^{10}Be and *in situ* ^{14}C

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The onset of the Alpine Lateglacial is marked by massive downwasting of the large piedmont glaciers in the Alpine foreland due to the beginning of gradual climate warming after the Last Glacial Maximum (LGM). While the chronology of ice decay and glacier readvance is relatively well known for the foreland and the inner Alpine valleys, the timing of the breakdown of the large high Alpine ice cap(s) is less well constrained. To improve the understanding of the effect of climate change on the high Alpine mountain glaciers, we have performed surface exposure dating using cosmogenic ^{10}Be and *in situ* ^{14}C analysis of bedrock surfaces on the Central Alpine Gotthard Pass, Switzerland.

Dating was combined with detailed mapping of glacial erosional features (e.g. crescentic gouges, glacial striae). These show a progressive downwasting of ice from the maximum LGM ice volume and a gradual reorganization of the ice flow pattern with a southward migration of the ice divide. Although the decay of the LGM ice can be identified from field evidence, it was not recorded by the bedrock exposure ages. The oldest exposure ages obtained by ^{10}Be (~16-15 ky; snow corrected) are interpreted to reflect the decay of the large Gschnitz glacier system, which post-dates deglaciation of the foreland by a few thousand years. In agreement with published ages from other Alpine passes, these data support the concept of large transection glaciers that persisted in the high Alps after the breakdown of the LGM ice masses and possibly decayed as late as the onset of the Bølling warming. Our results indicate that the timing of glacier recession and climate change in the high Alpine regions cannot easily be correlated with the chronology obtained for the Alpine lowlands.

A younger phase of local glacier readvance is evident from the erosional features and is consistent with another group of ^{10}Be exposure ages of ~12-13 ky. These are correlated with the decay of glaciers associated with the Younger Dryas Egesen stadial. Erosional markers and the distribution of exposure ages consistently imply that Egesen glaciers were of comparatively small volume and were following a topographically controlled paleoflow pattern. Dating of a boulder close to pass elevation that was probably deposited during the late stage of glacier readvance gives a minimum age of ~11 ky for final deglaciation by the beginning of the Holocene. *In situ* ^{14}C data are overall in good agreement with the ^{10}Be ages. This consistency excludes the presence of significant glacial ice (including non-erosive ice patches) for any time on Gotthard Pass during the Holocene and points to a continuous exposure of the pass area since the end of the Younger Dryas. From the combination of both nuclides, we were able to evaluate the necessity of a snow shielding correction and gained detailed constraints on the amount of Holocene snow cover for each sampling site.

9.4

The application of optically stimulated luminescence to overdeepened valleys in northern Switzerland

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Overdeepened valleys and basins are commonly found below the present landscape surface in the North of the Alps, and the major control for their development is ascribed to glacial processes during the Quaternary. The extent of these troughs and their sedimentary fillings is an important aspect of applied geology with regard to the geotechnics of deep foundations and tunnelling, and groundwater resource management. Moreover, the sites under investigation for the installation of deep geological repositories for radioactive waste are located in the vicinity of some of these troughs. With the need for them to remain stable for up to 1 Ma, both the timing and nature of the overdeepening processes are being investigated.

One aspect of this investigation is the application of optically stimulated luminescence (OSL) dating to the filling of the valleys to at least identify a minimum age for their formation. This presents a considerable challenge as the valleys are the result of more than one glacial cycle and so a dating method is required that extends beyond 200 ka. OSL dating offers this potential and can be applied to sedimentary deposits to identify the last time they saw light and so, effectively, the age they were buried.

A variety of OSL protocols can be applied to both quartz and feldspar grains, which act as luminescence dosimeters. The methods are constantly developed in order to improve their reliability and extend the age range. Several of these methods have been applied to deposits in Switzerland in order to identify the best approach to dating the infilling sediment of the overdeepened valleys. Some have been more successful than others, and the results of these are being used to determine how future sampling campaigns can be optimised. Work is also being done on the properties of the different mineral and grain-size fractions in the sediments available, in order to identify where the potential lays to extend the age range and reliability of the method. An overview of the work so far will be given, as well as an outlook on future investigations.

9.5

Paleoglacier chronology of the southwestern Black Sea Region

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Information of moisture transport during the cold periods and thus atmospheric circulation patterns during extreme climate conditions can be gathered by detecting glacier oscillations. As mid-latitude mountains often act as a weather divide, the comparison of timing and magnitude of the glacier oscillations in both sides of the divide can directly be correlated to the changes in circulation system. The orography of the Eastern Black Sea Mountains, located in the southwestern Black Sea region, forms a barrier to atmospheric circulation. In order to glean information on the change in circulation patterns during the Last Glacial cycle in this region, we studied the glacial oscillations in two valleys located to the north and the south of the weather divide.

The magnitude and chronology of these oscillations were determined by mapping different glacier advances and surface exposure dating of erratic boulders. Our first results show that there may be a difference between north and south of the weather divide, based on the volume and timing of maximum extent of the glaciers in these two valleys. The glacial chronology reveals an earlier stage before MIS-2 during which the moisture seems to dominantly be transported from south to north causing more extensive glaciations in the south. In contrast during the MIS-2, the direction of moisture transport should have changed and as a result, the glaciers should have advanced to lower altitudes in the north.

9.6

An 'Older Little Ice Age' ~3 kyr ago? Evidence from the Steingletscher, central Swiss Alps

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The 'Little Ice Age' (LIA, 1300-1860 AD) has been identified in many climate records in the Northern Hemisphere and is widely seen as the culmination of a multi-millennia cooling trend throughout the middle and late Holocene. This cooling trend is commonly related to the astronomical forcing represented by decreasing northern summer insolation. Less is known about the extent and duration of LIA-type cold-excursions earlier in the Holocene, mostly due to missing historical evidence and low-resolution climate records.

Based on precise cosmogenic ¹⁰Be surface exposure dating, we here present surveys of Holocene fluctuations of Steingletscher, central Swiss Alps (46°N), which is highly sensitive to regional climate changes and in particular, to summer temperature variations. Our results show that the most extensive Holocene glacier culminations in the Alps occurred during the earliest Holocene. No moraines are preserved from the mid-Holocene, consistent with the scenario of small glaciers during this time. However, we dated moraine fragments close to the LIA moraines to the period between ~3.2 to 2.8 kyr ago, indicating LIA-type climate conditions as early as 3 kyr ago. This finding from the Steingletscher is in agreement with our record from Tsijiore Nuove in the Western Alps, and also with unpublished moraine records from the Western US as well as with existing glacier studies in Alaska, British Columbia and Greenland. Beyond, north Atlantic bottom water temperature records indicate an abrupt, 'LIA' level cold excursion around this time. Taken together, we discuss this 'older LIA' phenomenon in a hemispheric climate context, challenging the view that Holocene climate was quasi-continuously cooling over several millennia prior to the LIA cold peak.

9.7

A model-data comparison of Holocene mountain vegetation dynamics in the Bernese Alps, Switzerland

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Treeline ecosystems are highly sensitive to environmental change, because trees grow at their lower limit of thermal tolerance (Körner 1999). Climatic shifts or disturbance and land use can alter the elevation and species composition of the vegetation at treeline. With an expected temperature rise of 2.7 – 4.8 °C by the end of this century (CH2011 2011) and increasing land abandonment in the Swiss Alps, the treeline will shift upwards. Rates and extent as well as reaction of individual tree species to the different triggers are still largely unknown. To disentangle the effects of climate and human land use on mountain forests, we combine vegetation and climate records from sedimentary archives with a climate and disturbance driven dynamic vegetation model.

We present new pollen and macrofossil-inferred reconstructions of Holocene vegetation from a series of lakes at, above and below the present treeline in the Northwestern Swiss Alps, which span the entire Holocene.

Analyses of pollen and plant macrofossils show that during the rapid warming at the onset of the Holocene treeline reached the first site at 1381 m a.s.l. within 100 years (ca. 11,400 cal BP). The second site at 2065 m a.s.l. however, was un-forested until 1700 years later (ca. 9,700 cal BP), even though reconstructed summer temperatures were sufficient for forest growth (Heiri et al. 2003). We use LandClim, a dynamic vegetation model to explore the effects of different climatic scenarios (e.g. increased seasonality or severe frosts) on the subalpine forest.

The model-data comparison shows that the vegetation at the treeline was in equilibrium with climate until humans started to use the alpine meadows as pasture around 6500 cal. yr BP. The highest position of treeline in the Northwestern Swiss Alps was around 2300 m a.s.l. in the Holocene, ca. 300 m higher than during the 20th century (Berthel et al. 2012). Paleovegetational and modeling results agree well with archaeological remains from Schnidejoch, a pass in the study region (Grosjean et al. 2007, Hafner 2009). During the Bronze Age, mountain forests were repeatedly cleared to expand pastures and finally treeline reached its present position in the Middle Ages. Cross-correlation analysis shows that the expansion of *Picea abies* and the demise of *Abies alba* was strongly supported by human fires and animal grazing since the Neolithic. We hypothesize that future climate change and land abandonment may lead to forest compositions and positions similar to those in the mid-Holocene. Warmer conditions, less moisture availability and/or the decline of land use may disrupt the current monospecific *Picea abies* stands and promote *Abies alba*, *Pinus cembra* and *Larix decidua* up to at least 2300 m a.s.l.

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9.8

Die Fundstelle „Abri Unterkobel“. Ein wichtiges siedlungs- und landschaftsgeschichtliches Archiv im St. Galler Rheintal.

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Die archäologische Fundstelle "Abri Unterkobel" liegt am der Westseite des Alpenrheintales, auf dem Gebiet der Gemeinde Oberriet. Die archäologischen Schichten befinden sich unterhalb einer am Fuss leicht überhängenden, etwa 120 m hohen Felswand, die einen witterungsgeschützten Abri bildet. Dieser prähistorische Siedlungsplatz liegt ca. 30 m über der heutigen Talsohle, auf einer Höhe von 445 m.ü.M.

Die Fundstelle wurde im Winter 2011 wurden bei Baggararbeiten, im Gelände der Bauschuttdeponie Unterkobel angeschnitten und im Frühjahr der Kantonsarchäologie St. Gallen gemeldet. Vom Juli 2011bis Juni 2012 konnte im zentralen Bereich der Abrifundstellen eine Ausgrabung durchgeführt werden, anschliessend wurde die Fundstelle mit Bauschutt überdeckt und ist nicht mehr zugänglich.

Insgesamt wurde auf einer Höhe von etwa 4.5 m eine Abfolge von archäologischen Schichten ausgegraben und dokumentiert. Die Besiedlung der Fundstelle beginnt im Frühmesolithikum und dauert bis in römische Zeit. Eine erste Serie von Radiokarbondatierungen ergaben Alter zwischen 9230 ± 45 C14 BP und 2145 ± 35 C14BP. Diese Datierungen entsprechen den in den Fundschichten gefundenen Artefakten. Im Fundmaterial ist das Mesolithikum, das Neolithikum und die Bronzezeit besonders gut vertreten, Spuren einer eisenzeitlichen und römischen Begehung des Abri sind ebenfalls vorhanden.

Über die ganze Höhe der Fundschichten sind eine Vielzahl von gut erhaltenen Feuerstellen sowie dazu gehörende Asche- und Holzkohlepakete vorhanden. Der Grossteil der Feuerstellen sind einfache, muldenförmige Strukturen, die eine stark brandgerötete Basis aufweisen. Vereinzelt sind auch stärker eingetiefte oder mit Steinen befestigte Feuerstellen zu erkennen. Mehrere Pfostenlöcher sowie verbrannter Hüttenlehm weisen auf bauliche Strukturen zumindest im jüngeren Abschnitt der Stratigraphie hin. Diese anthropogenen Strukturen liegen in wechselnden, natürlich abgelagerten Sedimenten, die erste Rückschlüsse auf lokale Umweltverhältnisse erlauben.

Eine enge archäobiologische und geoarchäologische Begleitung der Ausgrabung erlaubt es nun verschiedene Aspekte der Umweltentwicklung im Alpenrheintal auch in Bezug auf das Verhalten der damaligen Menschen während des ganzen Holozäns vertieft zu untersuchen. Zusätzlich konnten in der näheren Umgebung der Fundstelle verschiedene Proben aus Bohrungen entnommen werden, die weitere Informationen zur Entwicklung der Landschaft und des Klimas während dieser Zeitspanne liefern können.

P 9.1

Past vegetation and land-use of the páramo in southern Ecuador

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Ecuador is a country of very high biodiversity, long cultural history and very different landscapes. However, not much research has been devoted to it so far. Being a developing country, the use of the land is increasing at a high rate, as well as its population and their economic needs. It is, therefore, very important and urgent to understand the ecosystems present in Ecuador, their natural variability and the impact humans could have, as a support for decision makers in developing suitable management techniques that preserve biodiversity, ecosystem services and the life quality of the people.

For this purpose, we use palaeoecological techniques to better understand the vegetation that would be present under natural conditions and to see what impact humans have had since the beginning of the Holocene. We studied a new high-altitude site, the infilled lake Laguna Vendada at 3640 m asl, lying in the southern part of Ecuador, where only few studies have been done so far. We especially focussed on treeline fluctuations and forest dynamics, so we selected this site lying above the actual treeline but within the potential reach of forest. We studied pollen, microscopic charcoal and macrofossils. Much effort was put in finding terrestrial macrofossils for radiocarbon dating, because until now only few well-dated pollen sequences in Ecuador were published in which the radiocarbon dating was not based on the less reliable bulk sediment. As a result, it has so far been difficult to temporarily constrain potential climatic signals and to compare the reconstructions of vegetation amongst each other (Hansen 1995). In addition, plant macrofossils are essential for reconstructing local treeline fluctuations (Tinner and Theurillat 2003).

We found several vegetational shifts during the last ca. 18'200 years (calibrated). Pollen and macrofossils show that especially around the mid-Holocene (7000 to 3000 years ago), forests of mainly *Polylepis*, *Weinmannia* and Asteraceae trees were reaching the study site and were generally more widely distributed than today. Indications for human transformation of the landscape are apparent since about 8000 years ago, when there was a marked increase in charcoal and dung-inhabiting spores. A major decline of forests and treeline lowering below the study site is apparent around 1000 years ago, coinciding with unambiguous signs of intensified land-use in the region in the form of the first occurrence of *Zea mays* pollen and peaks in charcoal and dung-inhabiting spores.

In conclusion, forests would today be much more wide spread if it wasn't for the influence of man. We have clear evidence that grasslands are not the climax vegetation up to ca. 3800 m asl, where they dominate today and only small, isolated patches of forests are found. In contrary to the European Alps, where it is well known that treeline was significantly lowered by man, this is still subject of debate in South America.

As the Andean highlands are very important in their function of gathering and redistributing water to the lowlands, as well as being globally important as a hotspot of biodiversity, we recommend that much care be taken in preserving this ecosystem, especially regarding trampling pressure by cattle and fire utilization as a means to create palatable grass for husbandry animals. Marginal areas should be taken aside to allow the recovery of natural vegetation, while still allowing people to use great parts of the land.

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P 9.2

Water isotope signature of fluid inclusions in speleothems

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Fluid inclusions are common in speleothems and they are natural repositories of cave drip waters (Scheidegger et al., 2010). Therefore, the hydrogen (δD) and oxygen ($\delta^{18}O$) isotopic composition of fluid inclusions can yield direct information on the isotopic composition of paleoprecipitation which can then be combined with isotopic analyses of speleothem calcite to either directly calculate paleotemperatures (McGarry et al., 2004) or to reveal changes in the source of moisture (Fleitmann et al., 2003). To liberate speleothem fluid inclusion water and to measure its isotopic composition, a new method was developed. It consists of a simple hydraulic crushing device similar to that one used to extract noble gases from fluid inclusions. Prior to crushing, the sample tube is conditioned by heating and flushing with nitrogen in order to release adsorbed water. Thereafter, the speleothem sample (approximately 1g of calcite) is crushed and the released water from fluid inclusions is transferred by a nitrogen gas stream to a Picarro L1102-i isotopic liquid water and water vapor analyzer. The measuring principle is based on wavelength-scanned cavity ring-down spectroscopy (WS-CRDS) technology that allows us to simultaneously monitor hydrogen and oxygen isotopes (Gehre et al., 2004). Manual water injections of small amounts of water ranging between 0.3 μl and 0.9 μl showed that the reproducibility of measurements is the key parameter for routine measurements and depends on the amount injected, i.e. on the water amount released by the speleothem. The main task we would like to address with this method is a comparison between the isotope signals of the fluid inclusion and calcite to reduce uncertainties associated with the interpretation of calcite $\delta^{18}O$ values in speleothems in Switzerland and Turkey.

Currently, we are mainly focusing on a stalagmite (M6) from Milandre cave, Jura, Switzerland. We decided to monitor the drip water rate at the sampling site and to collect drip water, which was originally dripping and precipitating on the M6 stalagmite. In parallel, we collected rainfall water at the MeteoSwiss station "Le Mormont" located close to the cave. In this way we are able to compare δD and $\delta^{18}O$ isotopic composition of drip and rainfall water. At the same time, we installed a high precision drip logger ("Stalagmate", Driptych instruments), which continuously counts the number of water drops per time unit using an acoustic technique. This will help us to characterize the water transfer through the soil zone and bedrock into the cave and to understand the fractionation process that can precede the calcite production and the formation of fluid inclusions.

This study is part of STALCLIM – Multi-proxy climatic and environmental reconstruction from stalagmites from Switzerland, Turkey, Arabia and India – a Sinergia project financed through the Swiss National Science Foundation.

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P 9.3

Geomorphology and landscape evolution of the Chironico landslide (Leventina valley, southern Swiss Alps)

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A pulse in landslide activity seemed to have occurred during the Lateglacial and Holocene in the European Alps, as the valley flanks became unstable due to postglacial landscape modification and slope adjustment. This work investigated the Chironico landslide located in the Leventina valley in the southern Swiss Alps. It comprises about 530 million m³ of crystalline granitic gneiss belonging to the Lower Pennic nappes that detached from the eastern valley wall, slid along valleyward dipping exfoliation joints and fractures of 25-30 degrees and was deposited into the Ticinetto stream mouth. The slide mass consists of a northern and a southern lobe separated by the canyon of the Ticinetto stream.

Already existing radiocarbon ages from three pieces of wood found in a borehole drilled in deposits of an upstream-dammed lake, north of the landslide, yielded an age of about 13500 cal yr BP (Antognini & Volpers 2002). Since these ¹⁴C dates represent only a minimum age and originate from a secondary deposit, a direct age determination of the landslide was performed using surface exposure dating on fourteen boulders with the cosmogenic nuclides ¹⁰Be and ³⁶Cl. A mean age of 13.38 ± 1.4 ka resulted, thus revealing the failure of the landslide in one event during the Bølling-Allerød interstadial.

The runout distance and lateral expansion of the Chironico landslide could be reproduced by runout modeling. The potential failure scenario could thus be identified. The geologic and geomorphologic investigation of the study area enabled to understand the landscape evolution history of the Leventina valley around Chironico. From this, it could be concluded that the landslide was triggered around 3000 years after deglaciation. This time gap between deglaciation of the valley and failure of the landslide suggests that the landslide was not directly triggered by the glacial unloading. It however prepared the failure by undercutting and oversteepening the steep SSW-dipping eastern valley slope, creating a dip-slope on this flank.

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P 9.4

Erosion control and steep slope on the Quaternary soils of Chandab area-Iran

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Soil conservation can be very important regarding to production factors. Soils in deep slopes are very sensitive to degradation. Erosion has always been one of the major sources of damage to both the natural environment and the man-made structures and is caused by different factors and can be avoided only if protection measures are properly selected according to its cause. Erosion on slopes may be caused by rainfall, runoff or wind. These days geosynthetic reinforced soil structures belong to the most economically attractive construction methods due to their flexibility and versatility. Also under the ecological point of view, as e.g. CO₂ reduction, further positive impulses for this type of application can be expected in future Khaksar et al. (2011).

This paper is derived from a research on slope stabilization using geogrid in the Quaternary alluvial sediments of Chandab region in southeast of Tehran. The objective was to study the efficiency of geogrid materials in technical and economical aspects for high slope stabilization and decrease of soil erosion. It shows that they can present soil degradation and soil erosion plots of 12x2 meters were chosen in the research. At the end of plots, runoff is caught and measured and sediment amount in the runoff was measured. Different treatments along with replications were chosen. Nine events were measured. The data were analyzed with the Spss program. The results showed in both slope types: a) in the 110% slope the erosion was much more than the 85% slope b) the treatment plots which were stabilized with geogrids. Conclusions and analysis proved that it is very economic compared to other treatments. The Chandab basin is situated in the southern slopes of the Alborz range, 60 km south eastern of Tehran province in the northern part of Iran, in the latitude 35° 24' 31" N and Longitude 51° 55' E situation (Figure 1). The project has been effectuated on quaternary alluvial fan. Quaternary Alluvial fan is composed of coarse material, including coarse gravel, boulders, and pebbles with ~ 1000 meter of thickness in the study area. In this study the geogrid with bellowed characteristics to soil conservation and soil stability (Table. 2) has been used.

The collected data were analyzed. Different treatments along with replications were chosen. Conclusions and analysis proved that it is very economic compared to other usual used methods. Two slopes rate and there replication were among the treatments 6 sampling in the 6 season were recorded (18 months). These data during the operation of project is shows variations in the vegetation covering in the different plots. Also the together influence of slope and soil covering type with %95 of probability is not significant. For evaluation of amount soil losses for Hectare, produced sediments has been extended to hectare. Importance of this subject for this reason is important that erosion and soil losses evaluation in the each area explain erosion situation and sensitivity to erosion of the area. In the table 6, the quantity of sediments that each treatment can produce in each Hectare has been presented. The most of sediments produced related to plots without geogrid with seeding aboriginal grassland species have been most of soil losses. In the two another treatments: A and B the quantity of soil losses are very fewer than the others. So geosynthetics can be used with great success in the arid and semiarid regions. Regarding to obtain results, soil conservation in the steep slope soils with geogrid in comparison with other protective methods like to gabion, retaining wall, pitching and terracing decreased expenses respectively 450, 490 and 219 percent to hectare. The results could be applied for stabilization of slopes next to dam reservoirs or trenches resulted by road construction.

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Figure 1. Location of the study area

Table 1. Different chosen treatments

A	Geogrid with natural grassland covering
B	Geogrid with seeding aboriginal grassland species
C	Without geogrid and with natural grassland covering
D	Without geogrid with seeding aboriginal grassland species

Table 2. Characteristics of used geogrid

Aspect	nets or grids in rolls or boxes
Solubility in water	insoluble
Polymer	Polypropylene-HDPE
Ecotoxicity	Non toxic.
Measure	690 g/m ²
Measure of gates	27×27 mm.
Tensile strength	8.5 Kn/m
Applications	Stabilization and reinforcement of weakly soils



Fig. 2: Sediments produced related to plots with and without geogrid

P 9.5

GEMAS: A harmonised geochemical dataset for soils in Europe and in Switzerland (Peter Hayoz, swisstopo)

Introduction

Geological Surveys have been documenting the natural geochemical background of chemical elements in a variety of sample materials for more than 50 years. However, the existing exposure data at the national and regional scale are often not comparable at the European scale (different sampling strategies, different materials and equipment used for sampling and sample preparation, different sample preparation protocols, different analytical protocols, *etc.*) and are thus not able to provide a harmonised pan-European geochemical "background" variation. A reference network is therefore established, where local data can be tied to continental (European) and finally to global scale data (Darnley *et al.*, 1995).

Thus, the EuroGeoSurveys Geochemical Atlas of Europe (FOREGS dataset, Salminen *et al.*, 2005) has demonstrated that low-sample density geochemical mapping can provide the required information about the geochemical background in natural soil, stream water and sediments of streams and floodplains.

The most recent GEMAS-Data are the result of a harmonised sampling project executed in more than 30 European countries, under the lead of the Geological Surveys from Norway, Germany and Greece and of Eurometaux. Soil samples are taken from Agricultural and Grazing Lands on a 50 km grid. A well-defined sampling procedure and harmonised sample preparation as well as analysis guarantee comparable data all over Europe.

Similar to the IUGS/IAGC Global Geochemical Baselines Programmes, the main objectives of this European survey are: 1) to apply standardised methods of sampling, chemical analysis and data management to prepare a geochemical baseline across Europe and 2) to use this reference network to level national baseline datasets.

Procedure and Analysis

A regular grid of 50 km was established across the European continent (Fig. 1). Within every cell of the grid a composite sample was taken on Agricultural (Ap, depth 0-20 cm) and on Grazing Land (Gr, no farming since >10 yrs; depth 0-10 cm). Samples were taken from subsites at the centre and at each corner of a 10 m square and numbered with a unique code. Duplicate samples were taken every 20 sites or according to the requirements. All in all more than 4300 samples were prepared in just one laboratory (air dried and sieved to <2mm).

Following an international tender, parameters and sets of elements were determined in one laboratory:

- pH, TOC, Loss on Ignition (LOI), Cation Exchange.
- Aqua regia extraction (ICP-MS): Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Pd, Pt, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, and Zr.
- Total element concentrations (XRF) : SiO₂, TiO₂, Al₂O₃, Fe₂O₃, MnO, MgO, CaO, Na₂O, K₂O, P₂O₅, SO₃, Cl, F, As, Ba, Bi, Ce, Co, Cr, Cs, Cu, Ga, Hf, La, Mo, Nb, Ni, Pb, Rb, Sb, Sc, Sn, Sr, Ta, Th, U, V, W, Y, Zn, and Zr.
- Total extraction and REE on Agricultural Soils: Al, Ba, Be, Ca, Cr, Cu, Fe, K, Li, Mg, Mn, Ni, P, Sc, Sr, Ti, V, Zn, Ag, As, Bi, Cd, Ce, Co, Cs, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, In, La, Lu, Mo, Nb, Nd, Pb, Pr, Rb, Sb, Sm, Sn, Ta, Tb, Th, Tl, Tm, U, W, Y, Yb, Zr.
- Pb-isotopes (Agricultural Soils) and Sr-isotopes (Grazing Land Soils).

The most important differences between the FOREGS and the GEMAS datasets are the higher density of sampling, the standardised methodologies, analysis in one laboratory and

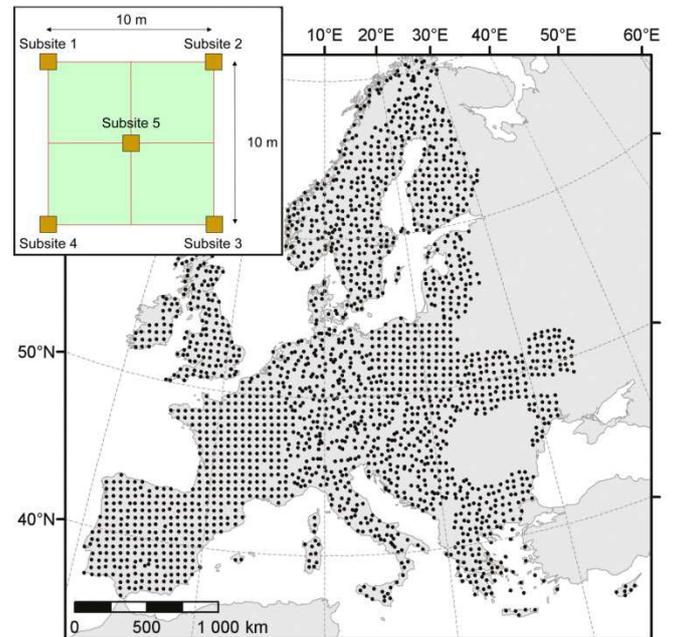


Fig. 1: Distribution of the sampling sites (Agricultural Soils) and sampling configuration. Setting for the Grazing Land Soils is identical.

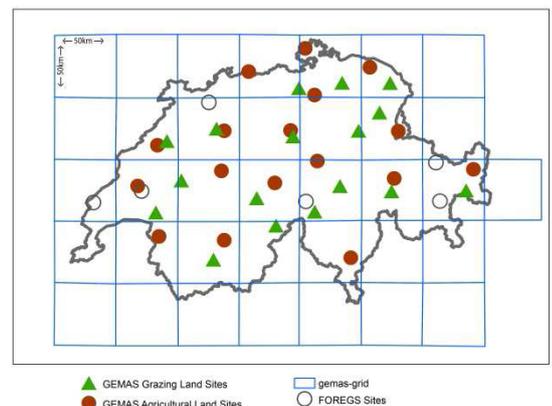


Fig. 2: Distribution of the sampling sites in Switzerland from the FOREGS and the GEMAS projects.

the higher detection limits. It has to be stressed, that the FOREGS data keep their entire importance as a baseline dataset. In Switzerland 17 samples (+ 1 duplicate) were taken from Ap- and 17 (+1) from Gr-Soils by Agroscope (Reckenholz) in autumn 2008.

Results (Aqua Regia)

The main aim of the dataset is to provide a geochemical baseline. This paper briefly demonstrates the content of the Swiss data. Results from the Aqua Regia extractions are presented as an example. Even with the relatively weak density of available data, some interpretations are possible.

The data are generally well comparable between Ap and Gr soils. Some elements such as Cu, P, S, etc. however tend to show a dependency from the agricultural use of the soil. On the other hand it was difficult to sample Ap soils (farmed land) at higher altitudes. The relationship with the geological lithology is thus very important. A comparison between the sampling sites as a whole seems to be much more interesting at the Swiss scale e.g. with synoptic maps (Fig. 3).

Dataset

The entire European dataset will be available as of January 1, 2013, Au and PGE will follow in 2015. If interested please contact the author: peter.hayoz@swisstopo.ch.

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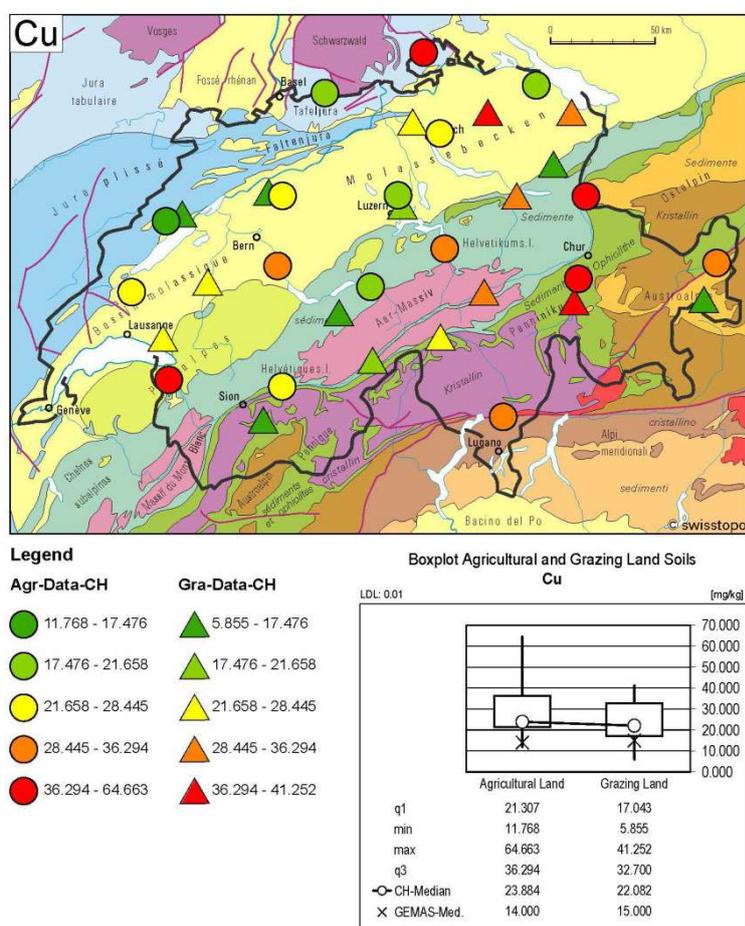


Fig. 3: Statistical overview. The quintiles on the map are calculated for the entire dataset (34 samples), concentrations in mg/kg. GEMAS-Median from the European dataset.

P 9.6

A new pollen-based gridded Holocene climate reconstruction for Europe: multi-proxy evaluation, data-model comparisons and the role of climate modes.

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We present an updated and improved (from Davis et al. 2003) pollen-based seasonal gridded climate reconstruction for Europe for the entire Holocene (0-12 ka). Fossil pollen site density has been increased by more than 50% (to 879 sites) representing almost 60,000 individual pollen samples, while the modern pollen calibration training set has been increased by 81% (to 4287 sites). Further improvements include a series of quality control checks and full-error accounting of transfer function and interpolation errors, as well as the reconstruction of seasonal (winter/summer) temperature and precipitation, and the inclusion of changes in past elevation due to post-glacial isostatic re-adjustment. As well as the internal evaluation of errors, the gridded reconstruction has also been evaluated against other published reconstructions of Holocene climate at individual site locations that have used the same pollen-proxy but different methodology, as well as reconstructions based on different proxies such as chironomids, diatoms, isotopes, and glacier mass balance.

Our new reconstruction shows much greater spatial resolution and a clearer spatial pattern of anomalies, as well as reduced errors at the grid-box scale. Comparison with mid-Holocene climate model simulations demonstrate the same data-model discrepancies as identified in previous studies, but we are able to more clearly demonstrate the role of atmospheric circulation modes and teleconnections in explaining these discrepancies.

In particular the reconstruction shows that the pattern of temperature and precipitation anomalies is consistent with a strong zonal circulation associated with a positive NAO or AO in the mid-Holocene in winter, and weak zonal circulation associated with blocking (e.g. SCAND or EU1) in summer. Neither of these patterns is shown in mid-Holocene climate model simulations, while comparison with transient model simulations shows that this problem extends throughout the Holocene.

These results may help reduce current uncertainties about the role of climate modes in modeled scenarios of future climate change, as well as help understand what drives these modes since climate forcing during the Holocene was relatively simple at low frequency time-scales.

P 9.7

Sediments size characteristic of Jazmurian playa as an important source of dust production in the world and harmful effects of dust on human health

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Jazmourian playa (Hamun Jazmourian) is an ephemeral lake located in the South East of Iran. During the last 10 years this playa was dried because of drought condition and build of dam on the Hirmand River (the major water source of playa). Jazmourian playa sediments are formed mainly of fine grain particles that are in the silt and clay size in the center of basin, sand and slightly granule in the around of playa, unconsolidated sediments due to high muddy cracks networks in the surface sediment.

This study executed because the dust particles smaller than 2 microns are formed of clay minerals that are very harmful for human health. In this investigation 26 surface sediment samples were taken from surface sediment of playa. Sedimentology investigation and grain size analysis, calcimetry and mineralogy (XRD) have been done in Geological Survey of Iran. The results show that mean of sediments sizes are between 0.42 to 4.3 millimeters. Clay sizes particles are between 1.03 to 78.78 percent. Value of silt is between 0.88 to 64.17 percent, sand is 0.77 to 96.5 percent and a few gravels exist in the sediments. The most important minerals are clay minerals, quartz, feldspar, calcite and halite. Also hematite in the East and gypsum in the south of playa have been observed. Montmorillonite, chlorite and Illite are major and Kaolinite is minor clay minerals. Carbonate minerals are 17.3 percent contain 15.6% calcite and 1.7% dolomite.

Major source of sediment in playa are fluvial, eolian and chemical (due to high evaporate and precipitation of Gypsum and halite).

Due to dry climate condition, strong wind system, no flora cover on the playa, fine grain and unconsolidated sediments this area has huge potential for create huge and catastrophic dust storm.

Dust especially smaller than 2microns (clay minerals), pose a risk on our health and adverse effects on respiratory function, cardiovascular system, nervous system and increases the risk of cancer. Respiratory tract are cough, nose, throat and eye irritation, shortness of breath, exacerbation of allergic symptoms.

Key words: Jazmourian playa, Dust storm, Sedimentology, Health

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P 9.8

Solid-rock surface model of the Rhine and Seez valley

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The elevation and morphology of the solid-rock surface and the associated thickness and distribution of Quaternary deposits are of practical and scientific interest. They provide opportunities for studying subglacial erosion and other glacial processes at the glacier bed and provide boundary conditions for geo-engineering tasks, groundwater resource management and the siting of deep geological repositories for radioactive waste.

Digital elevation models of the solid-rock surface are e.g. available for northern Switzerland (Jordan 2010), for the region around Bern (Dürst Stucki et al. 2010) and for western Switzerland (Fiore 2007). Here we present a bedrock model constructed for the Rhine and the Seez valley in eastern Switzerland. This region is of special interest because little is known about the glaciological and geomorphological processes operating at glacier diffluences, like the one of the ice-age Rhine Glacier at Sargans. However, such diffluences likely have a strong influence on the dynamics and hydrology of ice masses and, hence, might play an important role in the formation of valleys and landscape evolution.

Following the methodology of Jordan (2010) and Dürst Stucki et al. (2010) we constructed the digital elevation model (DEM) of the bedrock surface at a 25 m grid cell spacing based on existing topographic maps and elevation models, extensive borehole data, seismic profiles and gravimetric information. With the help of the “topo to raster” function in ArcGIS, elevation contour lines were interpolated to obtain the bedrock topography. The model (Fig. 1) reveals that the Rhine and the Seez valley are deeply incised into the bedrock. Furthermore, two pronounced overdeepenings reaching below sea level exist south of Lake Constance and close to Sargans.

The overdeepened feature at Sargans is located in a region of ice diffluence during LGM and earlier glaciations. While ice confluences have been suggested to favour the formation of overdeepenings (Fischer 2009), such a causal link is not known for ice diffluences. In fact, the formation of an overdeepening at Sargans can be explained by the local geology, i.e. the locations of nappe boundaries, major faults and weak lithologies.

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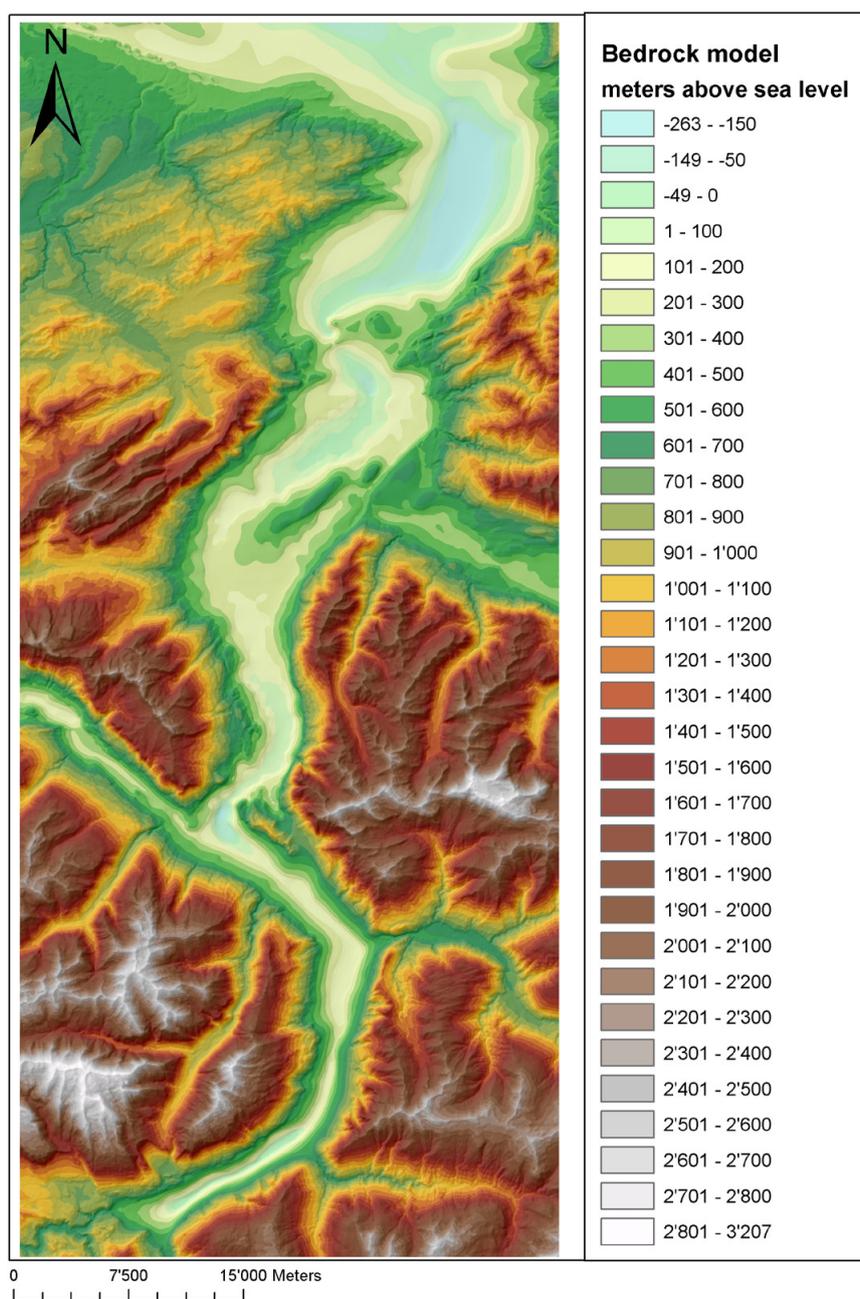


Figure 1: Digital elevation model (DEM) of the bedrock surface of the Rhine and Seez valley.

P 9.9

Calculation of shielding factors for production of cosmogenic nuclides in fault scarps

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For the last 30 years, Terrestrial Cosmogenic Nuclides (TCN) have successfully been used for geochronology. TCN dating relies on independently calibrated production rates, on semi-empirical scaling factors and on geometrical shielding factors. The computation of scaling factors includes the neutron monitor measurements and requires therefore the use of tabulated data. The geometrical complexity of surrounding environment also forces the use of numerical methods. Special programs were developed to ease the calculation of TCN scaling, shielding and production rates.

One of the most challenging TCN applications is the reconstruction of past earthquake histories. In this method, limestone normal fault scarps are used to reconstruct past seismic events that have exposed the foot wall of the scarp. In the simplest case, there is a footwall of infinite height and accumulated colluvium that covers the lower part of the footwall. During an earthquake footwall is moving upwards and exposing a new segment. The complexity of the exposure geometry limits the computation of the geometrical scaling factors analytically. Only one discussion dedicated to this computation was recently published. Unfortunately, the average TCN users would need to spend significant time applying the published material to particular case. Therefore, we aim with our contribution to provide the reader with a clear protocol and an easy-to-use tool for fault scarp geometrical scaling factors computation.

This study consists of a theoretical basis with a reference to previous works and a MATLAB computation code which can be used as stand alone software or as a MATLAB M-file. Geometrical scaling factors are calculated by the program for fast neutron spallation and include all general shielding geometries: topographical shielding, sloped surface, fault scarp surface, colluvium cover, snow cover, self-shielding and erosion.

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