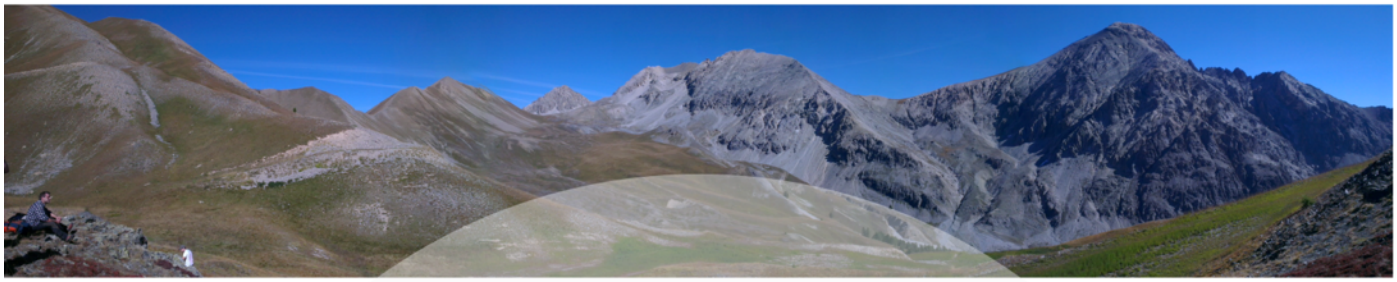
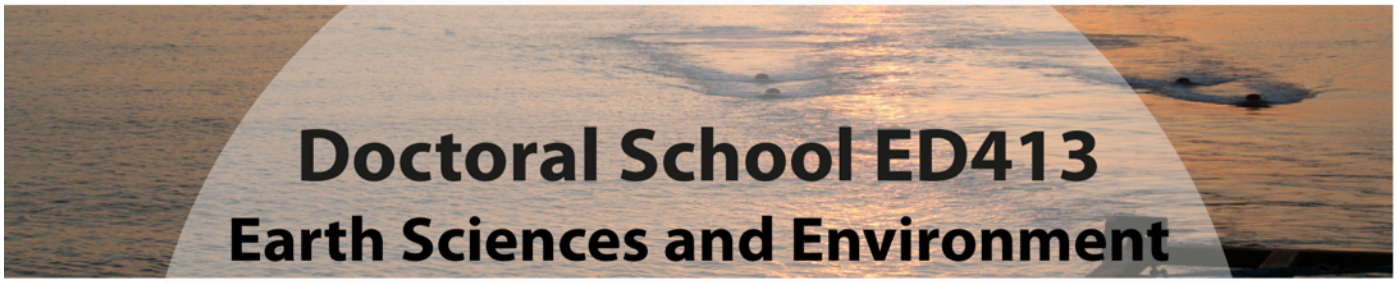
UNIVERSITÉ DE STRASBOURG

ED 413 Sciences de la Terre et de l'Environnement

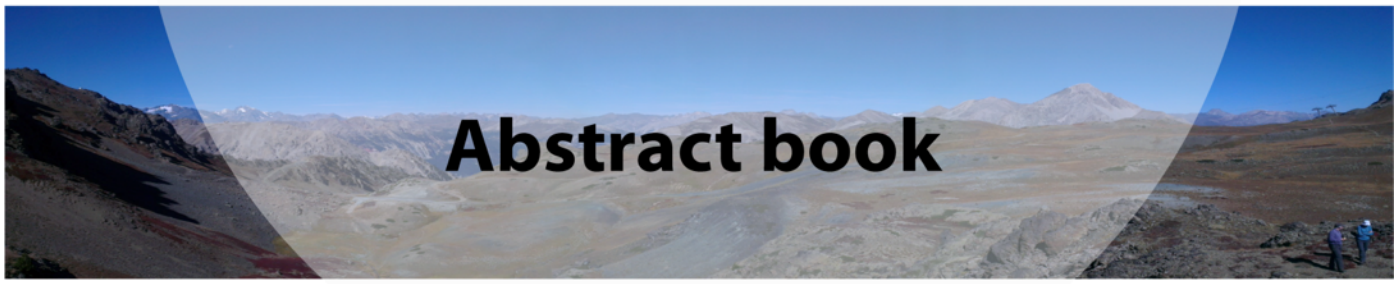
EOST Ecole et Observatoire des Sciences de la Terre





Doctoral School ED413
Earth Sciences and Environment

PhD Congress 2014



Abstract book

Vendredi 21 Novembre 2014 **Collège doctoral européen Strasbourg**

IPGS Strasbourg

LHyGeS

Image Ville Environnement

Word of the Head of the doctoral school ED 413, Earth Sciences and Environment

CDD 2014 PROGRAM

8:30-8:40 **Welcome speech by Dr Philippe Ackerer**

8:40-9:00 **Ivan Toloni (LHyGeS)**

Transport and Retention of Manufactured Nanoparticles in Saturated and Unsaturated Porous Media Under Different Conditions: Measurements and Modeling.

9:00-9:20 **Pierre Dietrich (IPGS)**

The drainage area as the main control on glacial sedimentation, the example of the North Shore of the St-Lawrence Estuary, Québec, Canada.

9:20-9:40 **Juliane Wiederkehr (LIVE)**

Experimental study of uncertainties on the Macrophyte index (IBMR) based on species identification and cover

9:40-10:00 **Poster advertisement**

10:00-10:20 **Coffee break Poster session 1**

10:20-10:40 **Véronique Adam (LHyGeS)**
Impact and Risk Assessments of Nano-TiO2 on Freshwater by Risk Assessment and Life Cycle Assessment (RA-LCA) Modeling.

10:40-11:00 **Morgane Gillard (IPGS)**
Evolution of a magma-poor margin, from the continental crust termination to the oceanic spreading.

11:00-11:20 **Yann Ziegler(IPGS)**
Modeling of the rotation of the Earth and joint analysis of polar motion and gravimetric data.

11:20-11:40 **Abeer AL Ashkar (IPGS)**
Active Tectonic of Ulaanbaatar region, Mongolia.

11:40-12:00 **Poster advertisement**

12:00-13:30 **Lunch Break and Poster session 2**

13:30-13:50 **Clio Bosia (LHyGeS)**

Geochemical implications of new U-Th-Ra disequilibria data from Gandak River sediments.

13:50 -14:10 **Benoit Petri (IPGS)**
Exhumation, cooling and deformation history in the Adriatic rifted margin necking zone: The Campo/Grosina section (SE-Switzerland, N-Italy).

14:10 – 14:30 **Simon Rougier (LIVE)**
Multi-Class Spatial Active Learning for the detection of urban vegetation.

14:30-14:50 **Yi Pan (LHyGeS)**

Numerical simulation of flow and mass transfer in the continuum surface - vadose zone – aquifer.

14:50-15:10 **Christine Heimlich (IPGS)**

Geodetic monitoring of deep geothermal sites in the Upper Rhine Graben.

15:10-15:50 **Coffee Break and poster session 3**

16:00-16:10 **Clossing of the CDD**

Poster Presentations

Fredrik K. Eriksen (IPGS): Aerofractures in Confined Granular Media**.**

Marion Pollet-Villard (LHyGeS): Revisiting classical silicate dissolution rate laws under hydrothermal conditions.

Franck Hess (LIVE): Understanding the relations between daily-life environment and physical activity.

Joanne Chauveau (IPGS): Modeling Niger and Ob River water changes from radar altimetry and space gravity missions.

Fadji Hassane Maina (LHyGeS): Characterization of Complex Aquifers: Modeling and Sensitivity Analysis.

David Eschbach (LIVE): Functional hydromorphological restoration of a Rhine anastomosing channel (Upper Rhine, France): implications of the temporal trajectory and interdisciplinary monitoring for evaluating pre-restoration state.

Jamie Farquharson (IPGS): Failure mode and permeability evolution of volcanic rocks.

Jana Minářová (LIVE): Seasonal course of mean and heavy precipitation in mid-elevation mountain systems in Central Europe: a case study of the Vosges (France).

Michael Nirrengarten (IPGS): 3D partitioning of deformation in hyper-extended rift systems: The example from the southern North Atlantic.

Julien Ackerer (LHyGeS): Investigating the weathering processes and geomorphological dynamic of the Strengbach catchment by a coupled approach of Uranium series isotopes and cosmogenic Beryllium (Vosges massif, France).

Sarah Koenig (LIVE): The experimental area of Colmar: for a better understanding of the nutrients transfer in Vegetated Buffer Zone.

Aktarul Ahsan (IPGS): Seismotectonics of the Bengal-Assam region, active faults, large earthquakes (Shillong plateau and Indo-Burmese fold and thrust belt).

Eugénie Schwoertzig (LIVE): Plant communities are mainly determined by anthropogenic land cover along urban riparian corridors

Semih Turkaya (IPGS): Aero-fracture evolution inside Hele-Shaw cell: Acoustic emissions and Simulations

Bastien Wild (LHyGeS): Chemical Weathering Rates of Feldspars: A Stepwise Approach from Laboratory to Field Estimates

Lucie Froehlicher (LIVE): Hedges, an alternative to the open field in the loess areas of Alsace? Historical perspectives, future agricultural systems, erosion, impact on colluvial and carbon storage.

Eve-Agnès Fiorentino (IPGS): Dual Lattice Boltzmann method for electrokinetic coupling : behavior at high and low salinities.

H. Larnier (IPGS): Magnetotelluric bias reduced by the application of continuous wavelet transform.

Abstracts
of
Oral presentations

Transport and Retention of Manufactured Nanoparticles in Saturated and Unsaturated Porous Media Under Different Conditions: Measurements and Modeling.

Ivan Toloni (LHyGeS)

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Transport and kinetics retention of titanium dioxide (TiO_2, rutile) nanoparticles were investigated in water saturated and unsaturated porous media. Experiments were carried out under a range of ionic strength, water velocity and moisture content, in laboratory columns packed with quartz sand. Columns were packed as uniformly as possible in order to get the same hydrodynamic parameters for each experiment (porosity, dispersivity) and all column experiments were conducted at least in duplicate. The hydrodynamic parameters of the water flow were studied during drainage and imbibition processes, obtaining the hysteresis curve. The sand-pack moisture content was regulated imposing a constant pressure head at the bottom of the column. Conductivity, pH and UV-absorption (280 nm) were measured automatically all along the experiments for both inlet and outlet flows by means of on-line sensors. The break through curves (BTC) had typical blocking controlled shapes with concentration increasing in time. Mass retention decreased with an augmentation of water velocity and moisture content and increased with an augmentation of the ionic strength of the solution. The BTC were modeled coupling the Convective-Dispersive Equation with a kinetic deposition term.

A Langmuirian dynamics was proposed for kinetic deposition, coherently with the blocking mechanism that controls the BTC shape. A two sites model was adopted to describe the deposition role of the interfaces between sand and water and between air and water. The deposition terms depend on two parameters: the deposition coefficient (kd [1/s]) and the maximum solid phase concentration (Smax, [mg/g]). Pressure head and moisture content profiles of each experiment were obtained through the simulations of the water flow using, as for the parameter optimization, the software HYDRUS 1D.

The drainage area as the main control on glacial sedimentation, the example of the North Shore of the St-Lawrence Estuary, Québec, Canada.

Pierre Dietrich (IPGS), Ghienne J.-F., Schuster M., Normandeau A., Lajeunesse P.

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The Atlantic Canada experienced during the upper Pleistocene a major glaciation that reached its maximum extent during the LGM (Last Glacial Maximum) at 23 ky Cal BP. At this time, the ice sheet margin was grounded as far as the eastern continental margin and the Grand Banks of Newfoundland. The subsequent rapid retreat by calving and melting allowed ice-free conditions of the North Shore of the St-Lawrence Estuary around 11-12 ky Cal BP. Proglacial deltas fed by meltwater supply and glaciogenic sediments were established at this time within the context of a rapid Relative Sea Level fall (possibly reaching 10 cm per year) driven by the glacio-isostatic rebound.

The aforementioned deltas, located at the mouth of the major rivers, display a large range of architecture and sedimentary facies despite locations in adjacent areas. While some deltas are characterized by extensive ice-contact glaciomarine fan, others are totally starved of glaciogenic sediments and are only constituted by paraglacial nearshore sand wedges. In between the two end-members, proglacial fluvio-deltaic successions can occur in variable importance. Marine survey including seismic profiles and bathymetric recovery upon these deltas shows that the duration of the subaqueous deltaic progradation is clearly related to proglacial setting. Most of subaqueous deltas are today totally inactive with preserved morphologies since more than 7 ky.

We here suggest that the disappearance of the ice-margin out of drainage basin of each

of these rivers is the primary control on proglacial deltaic progradation. Then, size and shape of drainage basins and their position relative to ice retreat curves are preponderant in present-day deltaic morphologies. Elongated and large basins have experienced perennial connection with retreating ice-margins that allowed important and sustained fluvio-deltaic progradation. Inversely, small drainage areas were early disconnected of the ice-margins and then have restricted proglacial sedimentary suite. At the time of melting out of drainage area, paraglacial reworking of ancient proglacial sediment allows the development of nearshore sand wedge and incision of river meanders. Subaqueous deltas, only active during proglacial setting, were totally abandoned at the time of paraglacial onset.

Such a model also fit with observed deltaic succession on the eastern Hudson Bay coast that experienced a late disconnection with the residual ice dome. It can even be extended to most of actual and former glaciated area (where the ice-marginal configuration is similar to the former St-Lawrence North Shore) such as Greenland, Canadian Arctic Archipelago, Scandinavia and Alaska in order to predict occurrence of proglacial sedimentary successions knowing ice retreat timing. Inversely, by studying in details proglacial sediments, successive ice margins positions can be inferred.

Experimental study of uncertainties on the Macrophyte index (IBMR) based on species identification and cover

Juliane Wiederkehr (LIVE)

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The European Water Framework Directive has required chemical and biological assessments in waterbodies. While studies of water chemistry uncertainties have existed for a long time, few studies have been carried out in hydrobiology. Our aim was to study the role of uncertainties defined as any action that may cause a data error on the French index "Indice Biologique des Macrophytes de Rivières" IBMR based on the macrophyte compartment. IBMR gives the trophic status of the river. The selected uncertainties were based on the surveyor effect both in-situ and in laboratory, such as taxa omission, species identification error and cover class error. We proposed an innovative approach close to sensitivity analysis using controlled virtual changes in taxa identification and cover classes based on two confusion matrices. The creation of new experimental floristic lists and the calculation of metrics according to random specified errors allowed us to measure the effect of these errors on the IBMR and the trophic status. The taxa identification errors and combined errors (taxa identification and cover class) always had a stronger impact than cover class errors. To limit their impact, surveyor training, confrontation between surveyors and a quality control approach could be applied.

Impact and Risk Assessments of Nano-TiO_2 on Freshwater by Risk Assessment and Life Cycle Assessment (RA-LCA) Modeling

Véronique Adam (LHyGeS), Quaranta G., Lawniczak S.

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Anatase-phase TiO_2 nanoparticles (with a diameter between 1 and 100 nm) have been commercialized for several years in the cosmetics industry but also for their photocatalytic properties. TiO_2 nanoparticles offer a big potential to improve the performance of final products but there are unanswered questions about their impacts on human health and the environment. To appreciate the uncertainties regarding the nano-TiO_2 potential impacts and risks on the environment, Life Cycle Assessment (LCA) and Risk Assessment (RA) approaches are combined. LCA is a chain-oriented tool used to evaluate environmental impacts of a product during its entire life cycle, from extraction of raw materials, via manufacturing and use, to waste product final disposal. Data concerning the consumption of raw materials and the nature of pollutants released to various environmental compartments are identified and quantified in the life cycle

inventory analysis step. These data are converted into environmental impacts in the Life Cycle Impact Assessment (LCIA) step. The purpose of LCIA is to express the impact in terms of a category indicator which is calculated by multiplying the emitted mass with the fate factor and the effect factor of the nanoparticle. Risk is expressed as a product of an exposure probability and the probability of a resulting hazard such as the reduction in survival of a group of organisms or impaired ecosystem function "Kaplan S., Garrick B.J., 1981". LCA and RA both rely on the same type of data, that are on the one hand emissions into the environment and transfer to the different environmental compartments (fate/exposure), and on the other hand ecotoxicological data (effect/hazard). However, high uncertainties remain concerning the fate and the effect of nanoparticles, so a probabilistic approach such as Bayesian networks is used in this nano-TiO_2 study. Bayesian networks give satisfying results even under high data uncertainties, and allow direct visualization of the uncertainties. This model is built at a site-specific scale, and is currently being filled with experimental data: samples are collected at and around an industrial site at Thann, France (68), and experimentations are conducted in the laboratory to understand the fate of industrial TiO_2 NPs in freshwater. The analytical and the modeling approaches, will be presented as well as the links between these approaches.

Evolution of a magma-poor margin, from the continental crust termination to the oceanic spreading

Morgane Gillard (IPGS), Autin J., Manatschal G.

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Rifted continental margins represent a complex transition between the continental domain and the oceanic domain. This area develops in presenting a variety of tectonic and magmatic processes that makes it a largely studied geological feature but which is still not well understood. In this context, this study focuses on the distal part of magma-poor rifted margins. The crustal architecture and evolution of the deepest part of these types of margins are indeed still debated, and the precise localisation of the different main boundaries (continental crust termination, first steady state magmatic oceanic crust) are not yet well defined, particularly at rifted margins which do not display geological data sets. With the Australia-Antarctica magma-poor margins as main area, this study shows that the record of the deformation in sedimentary units allows highlighting a polyphase evolution of these distal margins, and particularly of the exhumed domains. This polyphase evolution implies the development of multiple detachment systems displaying an out-of-sequence organization leading to a final symmetric architecture for the exhumed domains. The spatial and temporal organization of fault systems are linked to cycles of delocalisation/re-localisation of the deformation, which appear influenced by the magmatic supply, the presence of a decoupling layer associated to the serpentinization front, and by the asthenospheric uplift. The fault/magma interaction appears particularly important in the evolution of distal margins. This study allowed a better characterization of the lithospheric breakup, which can be defined as a progressive tectono-magmatic event during which the old continental lithosphere delaminated by the multiple detachment systems is progressively intruded by magmatic material from the asthenosphere. It appears that the localisation of the spreading centre can be done with the development of "flip-flop" detachment faults.

Modeling of the rotation of the Earth and joint analysis of polar motion and gravimetric data

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The movement of the Earth rotation axis induces a perturbation of the surface gravity field through (1) the variation of the centrifugal force along with (2) surface deformation and mass

redistribution. These effects of the polar motion can be recovered from the gravimetric data and we usually estimate the amplitude and the phase of the observed perturbation relatively to theoretical estimates based on astronomically-determined time series of the pole position. The *gravimetric factor*, which is composed of these relative amplitude and phase, is a commonly used parameter that may provide some insights about the Earth's mantle rheology, assuming that the discrepancy between observations and theory is due to anelasticity. In this work, we focus on the Chandler wobble, an eigenmode of rotation, with a periodic polar motion of approximately 14 months and a few meters of amplitude.

Using superconducting gravimeter (SG) data and Earth orientation parameters, we first discuss the computation of the gravimetric factor at the Chandler period. The influence of the processing and the various corrections are carefully considered because of their strong impact on the resulting amplitude and, especially, phase. After the validation of the method with the Strasbourg SG time series, the next step is to jointly process the gravity data from a set of SG stations and estimate a global gravimetric factor. In this global analysis, we have stacked the signals with an appropriate weighting, the aim being to improve the signal-to-noise ratio and get rid of local effects. The convergence with time of the computed values is used as a realistic way of estimating the real uncertainty of our results.

In addition to this data analysis, we will briefly introduce the equations describing the small deformations of an ellipsoidal, rotating, anelastic, Earth model, focusing in particular on the correspondence principle. Numerical models based on this formulation enable us to study the influence of viscosity on the Chandler wobble as well as on a broader band of frequencies. This more theoretical approach provides a new perspective on the gravimetric factor interpretation in terms of rheology and dissipation.

Regarding Avdar trench, the trench wall provides insight into late Quaternary activities of the fault, were the fault zone affects a deposit dated at 3800-3630 BC (C14 dating). This trench is characterized by cryo-deformation figures due to freeze/thaw process. Cryoturbation figures hide partially the coseismic deformation. The trench show also offsets associated with thermal contraction cracks that extend downwards from the surface which could exploit pre-existing seismic fractures in the sediments. The relation between these features and the main fault zone are under final investigations as well as the paleoearthquakes (previous events) chronology, recurrence time and slip rates.

Active Tectonic of Ulaanbaatar region, Mongolia.

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Field surveys and images satellites in the recent years led to discover new actives faults around the capital of Mongolia, Ulaanbaatar. Sharkhyn and Avdar faults, the focus of this thesis, are two of newly discovered faults since 2010. The main goal of this study is to map the surface rupture, document evidences of recent activity and to define the seismic behavior (recurrence time, slip rate and co-seismic slip) for the faults thus giving new insights on the seismic hazards of the region. Therefore, multidisciplinary approach (Geomorphology, Paleoseismology) are used. Multispectral and Panchromatic Pleiades images with high resolution (2m and 0.5m, respectively) were analyzed to identify the surface ruptures.

Sharkhyn fault extends about 42 km, striking NNE-SSW, its Northeast end is at about 32 km from Ulaanbaatar and at about 10 km from the new airport project area. 11 stream channels exhibiting left-lateral accumulated displacements of 20 ±1m, 36.4 ± 0.5m, 32 ±1, 2.2m, 31±2m, 7± 1m, 11.5±1m, 58.5±3m, 30.5±3m, 50±6m and 32±1m from Northeast end to southwest end of the fault. In addition to minor extensive component referred by water traps, drainages shape changes when they cross the fault.

Avdar fault can be traced about 45 km long to the NE up to 30 km from Ulaanbaatar and at about 27 kilometer from a new airport project area. Pleiades satellite images show

modifications of the drainage system by lift-lateral motion with extensive component.

In the field, for the both faults, the surface expression of the last coseismic event is relatively weak and mostly expressed by smooth features. This indicates that the last event may be rather old and is consistent with the low deformation rate (≤1 mm/y) observed in the region.

We excavated trenches across Avdar and Sharkhyn faults for paleoseismological analysis and dating (C14, OSL and Pollen analyses). Sharkhyn trench exhibits complex deformation history, it exposes evidence for recent activity (previous paleoearthquakes). The main fault zone is composed of two faults that reach the surface affecting deposits dated from 775-942 AD to 1605-1421 BC by C14. Complex deformations in the main fault zone expose evidence to at least one event and less obvious may be several events. Detailed study to identify seismic events and to reconstruct the events chronology is under final investigations.

Geochemical implications of new U-Th-Ra disequilibria data from Gandak River sediments.

Clio Bosia (LHyGeS), Chabaux F., France-Lanord C., Pelt E., Deloule E., Stille P.

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Sediments transfer and alteration are two main processes playing a key role in landscape evolution and regulation of atmospheric CO2 content.

To constrain sediments dynamics and transfer time in alluvial plain, an approach involving the study of the U-series disequilibria in river sediments along the stream was developed for the Ganga-Brahmaputra basin, allowed defining sediment transfer times varying from a few ky for fine-grained sediments to 100 ky for bank sediments [1&2]. Despite the innovative approach and the encouraging initial findings those estimations can be questioned by recent 10Be and Sr-Nd isotopes studies [3&4], suggesting shorter transfer times for banks sediments in Himalayan streams. In order to better understand the discrepancies between the different studies, we propose to re-evaluate the variations of the U-Th-Ra disequilibria in the bank sediments of the Gandak River, one of the main Ganga's tributaries, by analyzing a series of new samples regularly collected along the stream.

The preliminary U-Th-Ra data outlined that the conventional digestion technique used in U-series studies for soils and sediments - i.e. a HNO_3-HCl-HF protocol in PFE vessels - is not adapted for samples enriched in refractory minor mineral phases. Complete sample dissolution requires an acid digestion procedure at high pressure (HP), allowing for the determination of accurate and precise U-Th-Ra concentrations and isotope ratios. Even if fragments of resistant minerals, particularly zircons, are still present in the sample digestion residues by the HP vessels protocol, the consistency between U-concentrations obtained by isotopic dilution and by alkaline fusion confirms that the dissolution is almost complete. Besides, the reproducible results obtained on different samples taken at the same location by the HP digestion technique confirm that the sampling protocol is suited to collect representative samples of the study site.

Data obtained on coarse and fine-grained sediments along the Gandak river by using the new digestion protocol show that U-Th-Ra fractionation is highly dependent on the sample mineralogical

Exhumation, cooling and deformation history in the Adriatic rifted margin necking zone: The Campo/Grosina section (SE-Switzerland, N-Italy)

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The cooling and exhumation of the Campo unit and the overlying Grosina unit, separated by the Eita shear zone, are explored by the acquisition of $^{40}Ar/^{39}Ar$ ages on hornblende, muscovite and

biotite. New geochronological data on the Grosina unit present $^{40}Ar/^{39}Ar$ ages between 273 and 261 Ma for muscovite, and between 248 and 246 Ma for biotite. The Campo unit shows clearly younger ages between 210 and 177 Ma on hornblende (poorly constrained), between 186 and 176 Ma on muscovite and between 174 and 171 Ma on biotite. Numerous data were discarded due to frequent excess ^{40}Ar on amphiboles, probably associated to the emplacement of the gabbro with a high $^{40}Ar/^{36}Ar$ ratio in Permian times. These new ages, together with a compilation of existing ages obtained with different chronometers (U–Pb, Sm–Nd, Rb–Sr, K–Ar and $^{40}Ar/^{39}Ar$) and performed on different lithologies from both the Campo and the Grosina units allow to estimate cooling rates for these units. The new results shows that both Campo and Grosina units underwent a cooling rate around 10°C/Ma in Permian time. The Grosina unit, being in a shallower crustal level, did not record the Jurassic cooling, reaching up to 50°C/Ma in the Campo unit. The notable difference in cooling rates between the Permian and Jurassic events attests of a cooling without being associated to an exhumation from Permian to Triassic times, whereas the Campo unit cooled rapidly in Jurassic times, associated to an exhumation and an emplacement in shallow crustal levels. The latter tectonic event was probably achieved through shearing along the Eita shear zone separating the Campo unit from the overlying Grosina unit. These results bring new constrains on the strain evolution and the thermal budget of mid crustal levels during late orogenic extension and subsequent rifting.

Multi-Class Spatial Active Learning for the detection of urban vegetation

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Vegetation in urban areas delivers crucial ecological services as a support to human well-being and to the urban population in general, its monitoring is a major issue for urban planners. Existing vegetation database at the local level (1:5,000 to 1:10,000), traditionally produced from field surveys, provide only local coverage and are constrained to public domain. Moreover, few databases integrate vegetation categories. The creation of exhaustive (private and public) and up-to-date databases on trees and grass surfaces necessitates to acquire sub-meter aerial or very high spatial resolution (VHR) satellite imagery that enable a detailed mapping of the urban vegetation by delineating the areas occupied by tree crowns and grass surfaces.

Machine learning algorithms are often use to extract information from satellite images but necessitate training data which are typically obtained through cost- and labour-intensive field work or time consuming visual image interpretation. Active learning was proposed to reduce annotation costs by selecting only the most informative samples with an iterative process. In this research we proposed to extend a region based active learning method developed for bi-classes problem to multi-classes classification. Two study sites are used for the experimental evaluation of the methods, Rennes and Strasbourg, with the objective to extract tree and grass surface based on Pléiades images.

Numerical simulation of flow and mass transfer in the continuum surface - vadose zone - aquifer

Yi Pan (LHyGeS)

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Understanding the response of a water catchment to atmospheric forcing is of critical importance to hydrologists and remains a challenging task for various practical issues such as the sustainable use of water resources, water quality preservation and other protection against natural hazard. Catchment hydrodynamics is difficult to simulate because of the complex interactions between surface and subsurface, the nonlinearity and the variability of characteristic times associated with elementary processes, and the correct depiction of heterogeneity. A physically-based distributed hydrological model describing water catchment dynamics is proposed. The diffusive wave equation and the mixed form of the Richards equation are used to describe respectively river flow in complex drainage networks and subsurface flow in the non-saturated – saturated

zone. The effect of topography is accounted for as well as the exchange between the river bed and the subsurface handled by a first order-approximation of fluxes. The results show that the proposed approach reproduces fairly well the various flow mechanisms and the interactions between compartments of the catchment area. A comparison between proposed approach and classic method has been made. The further developments should focus on the introduction of a 2D surface runoff layer to describe overland flow.

Geodetic monitoring of deep geothermal sites in the Upper Rhine Graben

Christine Heimlich (IPGS), Masson F., Gourmelen N., Schmittbuhl J., Azzoli J., Kim S.W.

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The European Cenozoic rift system, and in particular the Upper Rhine Graben offers a high potential of deep geothermal energy due to the well known geothermal anomaly and to the number of subsurface temperature data from oil exploration in the Upper Rhine Graben. One example is the Soultz-sous-Forêts Enhance Geothermal System (EGS) located in the French part of the Upper Rhine Graben. The Soultz-sous-Forêts EGS started in 1987 as a deep geothermal research site. The research site has provided considerable knowledge on deep geothermal energy and its production. One development of lessons learned from Soultz-sous-Forêts is the geothermal power plant of Landau (Germany), which is located south of the city of Landau and 35 km northeast of Soultz-sous-Forêts. Presently, a new EGS site, ECOGI, is in development near the village of Rittershoffen (France) located at 7 km from Soultz-sous-Forêts. All these EGS sites benefit of the natural circulation of deep geothermal water.

We establish a long-term geodetic monitoring system of the two French geothermal sites using GNSS and Synthetic Aperture Radar images. This study presents our monitoring strategy and our results over the French geothermal sites of the Upper Rhine Graben. We present also an example of surface deformation induced by a deep geothermal power plant by the analysis of the case of Landau. Using Synthetic Aperture Radar images, we analyze the spatial and the temporal evolution of the deformation over the city. Our results from modeling suggest that a significant injection of fluid occurred around 400 meters depth below the geothermal plant during the first phase of deformation.

Abstracts
of
Poster presentations

Aerofractures in Confined Granular Media

Fredrik K. Eriksen (IPGS), Toussaint R., Måløy K.J., Turkaya S., Flekkøy E.G.
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The characterization and comprehension of rock deformation due to fluid flow is a challenging problem with numerous applications in many fields. Applications include natural hazard understanding, mitigation and forecast (e.g. earthquakes, landslides with hydrological control, volcanic eruptions), or in the industry, CO2 sequestration, hydrocarbon production, reservoir exploitation, and borehole stability problems.

We approach the problem by performing experiments with aerofracturing in a rock analog. During the experiments, pressurized air flows through and deforms a packing of fine-grained particles, 80 microns in diameter, confined in a thin rectangular cell. The experiments are recorded with a high speed camera taking 1000 images/s, enabling us to study the deformation and flow processes with a high temporal resolution. We will also compare results to earlier work with circular and open cells as well as numerical models of the problem.

Revisiting classical silicate dissolution rate laws under hydrothermal conditions

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In the context of the Soultz-sous-Forêts enhanced geothermal system (Alsace, France) the circulation of fluid may provoke a partial re-equilibration of the aqueous fluid composition and may favor the dissolution of the main rock-forming minerals of the reservoir and promoting the precipitation of secondary phases (Fritz et al., 2010). These reactions can affect the reservoir porosity and permeability, thereby influencing the efficiency of the geothermal site. Prediction of reactions kinetics of fluid/rock interactions represents a critical issue in this context. But, nowadays, the experimental determination of the kinetic rate laws governing the dissolution of silicate minerals overestimates the real weathering rates (White and Brantley, 2003).

To unravel this point, in the context of the geothermal site of Soultz-sous-Forêts our strategy consists in **(1)** investigating the dissolution of the main cleavages of K-spar, one of the prevalent primary minerals in the reservoir, in order to decipher the impact of crystallographic orientation on the dissolution kinetics and **(2)** proposing a relation between K-spar dissolution rate and the Gibbs free energy of reaction (ΔG) over a wide range of ΔG conditions.

Our experimental work evidences that the dissolution is an anisotropic process and that the relation between K-spar dissolution rate and ΔG differs from the transition state theory currently implemented into geochemical codes. These new findings show promise as a means for modifying reactive transport codes and improving the predictive ability of geochemical simulations.

Understanding the relations between daily-life environment and physical activity

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Lack of physical activity is now recognized as one of the main risk factors for some cancers, cardiovascular and respiratory diseases and diabetes. It is commonly accepted that achieving 30 minutes of daily moderate to vigorous physical activity reduces the risk of occurrence of these non-communicable diseases. However, a part of the general population does not reach the recommended threshold, so public health agencies try to steer people toward a more active lifestyle.

To change individuals' behaviour, it is possible to influence directly their motivations through information and awareness campaigns, and indirectly by modifying their environments. This study intends to contribute to this second approach by analysing the relationship between living environments and physical activity levels generated by daily activities.

Two questionnaires (QEVIC and RPAQm) have been realized in the ACTI-Cités project and proposed on-line on the Nutrinet-Santé website. This survey collects information on daily practices and representations that individuals associate with their environments. Coupled with objective data, such information paves the way for understanding the relationships between space properties and individuals' specifications.

Modeling Niger and Ob River water changes from radar altimetry and space gravity missions

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About 97% of the total surface Earth water is stored in the oceans and the 3% remaining is stored over land water storage. The land water is divided in several components: ice sheets, soil humidity, groundwater, snow and surface waters (lakes and river). Except over the permanently ice covered regions, the main contributor is the soil wetness within the first meters of soil. A lot of global hydrological models have been elaborated over the past years in order to estimate the distribution of the terrestrial water. Most of hydrological models such as GLDAS (Global Land Data Assimilation System) or MERRA-land (Modern-Era Retrospective Analysis), do not include the river contributions to the total water storage (TWS). Although soil humidity is generally the largest component, the river storage can't be neglected for the large river basins.

Here we choose to model the river contribution to the TWS changes for two of the biggest basins in the world: the Niger and the Ob basins. They are characterized by different climate: the first one is a sahelian basin while the other is an arctic basin. Only a few river gauge measurements (flow, height, etc.) are available.

We construct our river model using a simple routing scheme and continuity equation, forced by runoff data from GLDAS and MERRA models. The water quantity estimated for each cell of the basin is expressed in equivalent water heights (e.w.h.). We constrain our model comparing the e.w.h. outputs with altimetry data converted to e.w.h.. For this conversion, we need to know the surface of the cell effectively covered by water. Maps of MODIS vegetation indices allow us to detect water surfaces. Water surfaces are characterized by a low NDVI index (<0.1). Once the model is constrained, we add the contribution of the river to the soil humidity and snow contributions and compare our results with GRACE global mascon solutions and spherical harmonic solutions and also with other hydrology models like WGHM which include the surface water component. The agreement between estimated and measurement TWS is clearly improved went the contribution of the river is taken into account. However there are still some discrepancies mainly caused by errors of the runoff models (especially from GLDAS) used as input of the river model.

Characterization of Complex Aquifers: Modeling and Sensitivity Analysis

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Complex hydrogeological systems are characterized by quite variable dynamic over time and space. Generally, groundwater models are used to simulate flow of water in aquifers without a good estimate of recharge and its spatio-temporal distribution. As groundwater recharge rates show spatial-temporal variability due to climatic conditions, land use, and hydrogeological heterogeneity, these methods have limitations in dealing with these characteristics. To overcome these limitations, an integrated model was developed; The model simulates flow in saturated zone by solving the equation of diffusivity and in unsaturated zone by using a conceptual model or by solving Richards equation. This model takes into account

interactions between atmosphere and unsaturated zone and between unsaturated zone and saturated zone.

Efficient numerical methods were used to solve these equations: we apply non-conforming finite element to diffusivity equation and we developed a new non iterative and efficient method for solving the Richards equation.

Very often, in the natural environment, parameters that control various mechanisms discussed above are unknowns. Therefore modeling doesn't stop at the development of models, it's imperative to estimate these parameters. The number of parameters is usually high because hydrogeological systems are very heterogeneous. Unfortunately, modeling of groundwater systems is often constrained by the available data and modelers have to face the lack of data required for calibration. Identifying keys parameters becomes complicated. To simplify identification of parameters a strategy to reduce unknowns can be used. One method used is the global sensitivity analysis by polynomial chaos expansion. This analysis quantifies the effects of changes in various model parameters on the results and establishes the hierarchy of the model parameters.

Functional hydromorphological restoration of a Rhine anastomosing channel

(Upper Rhine, France): implications of the temporal trajectory and interdisciplinary monitoring for evaluating pre-restoration state

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The Upper Rhine hydrosystem exhibits a high biodiversity. Since mid-19th century, several engineering projects developed for flood control, agriculture, navigation and hydropower, have drastically impacted aquatic and riparian habitats. In this context, the specific alluvial species of the Rohrschollen natural reserve is declining. Its main watercourse, the Bauerngrundwasser, an anastomosing channel of the Rhine, has now a constant and low discharge (under 0.1m3/s), inducing a high rate of fine sediment deposition. During periods of high flow, the site is flooded but water has no energy due to a dam's backwater effect.

The LIFE+ project "Restoring dynamics of Rhine alluvial habitats on the Rohrschollen Island", managed by the City of Strasbourg, plans to restore the hydromorphological and ecological functionalities of the hydrosystem: bedload dynamics, channel mobility, surface water-groundwater exchanges, renewal of pioneer ecosystems…Thus, the Bauerngrundwasser will be reconnected to the Rhine by building a new upstream connection channel. Water input will attain 80m3/s, leading to dynamic floods and making of this project one of the most ambitious for the French side.

To assess the efficiency of this restoration project, an inter-disciplinary monitoring is carried out and is based on the comparison of pre- and post-restoration dynamics. It includes geomorphic and ecological studies. Especially, the geomorphic focuses on topographic, cartographic, sediment transport, hydrological and hydrogeological data, as well as the implications of the temporal trajectory of the hydrosystem (historical study based on old maps, aerial photos and sedimentological investigations). The ecological monitoring focuses on macrophytes, riparian vegetation and macrobenthos. Hydraulic modeling (with sediment transport) and evolution of fluvial forms by 3D modeling will simulate scenarios to guide future management operational decisions. Results of pre-restoration state will be used to optimize post-restoration monitoring and to give some prospective guidelines concerning the efficiency and sustainability of the restoration.

Failure mode and permeability evolution of volcanic rocks

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Volcanic eruptions are intrinsically linked to the efficiency by which a volcanic system can outgas volatiles from magma; in turn controlled by the state and evolution of permeability of the edifice. In order to assess the response of volcanic materials with regards to their physical properties, compressive and permeability experiments have been carried out on edifice-forming andesitic rocks collected from Volcán de Colima, Mexico.

The porosity of cylindrical samples [Ø = 20mm; l = 40mm] was determined using water imbibition and helium pycnometry methods. The first suite of samples were deformed triaxially at a range of confining pressures and encompassing a range of porosities. During these tests, pore pressure within the sample was maintained at 10 MPa, and confining pressure [corresponding to depth in the edifice] was maintained at 15, 20, 40, 60, or 80 MPa, depending on the desired effective pressure for each test. Samples were deformed at a strain rate of $10^{-5}s^{-1}$, until failure. Gas permeability was determined using the steady-state flow method.

We discern two main modes of failure during these experiments: *brittle* deformation is controlled by the propagation and coalescence of microcracks, culminating in axial splitting [in uniaxially deformed samples], or shear faulting. A corresponding increase in porosity is observed during these experiments, meaning that brittle failure is dilatant in these andesites, as in most other rock types. *Ductile* deformation is observed at higher effective pressures. The dominant microstructural process in this case is the cataclastic pore-collapse throughout the sample; this deformation mechanism is thus compactive. The switch from dilatant to compactive behaviour is linked to initial porosity: the lower the porosity, the higher the effective pressure necessary to cause ductile deformation. In our experiments, the switch was observed between 10 and 30 MPa of effective pressure for rocks of 18% porosity and greater, whereas for a porosity of 22%, the switch occurred between 50 and 70 MPa. No switch was observed within the experimental conditions when the initial porosity was 8%.

The assumption that dilatancy or compaction in volcanic rock is associated with an increase or decrease in permeability is borne out by pilot experiments wherein the sample underwent pre- and post-deformation permeability measurements. Results show that in samples fractured parallel to flow permeability approximately doubled [from $0.6x10^{-12}$ and $1.6x10^{-12}$ m^2 to $1.0x10^{-12}$ and $2.8x10^{-12}$ m^2]. Samples deformed in the compactive regime, to 1.5 and 4.5% axial strain, showed a decrease in permeability from $6.2x10^{-12}$ and $3.3x10^{-12}$ m^2 to $2.6x10^{-12}$ and $0.3x10^{-12}$ m^2, respectively - up to an order of magnitude difference.

As the mechanical response of andesite to induced differential stress has been shown to change with porosity and effective pressure, we can infer that the depth range in which rocks will exhibit dilatant explosion-limiting behaviour depends on the initial porosity of the rock. This will be promoted in shallow, low-porosity rocks, whereas the opposite is true for deep or highly-porosity edifice-forming rocks. Further research aims to explore the permeability-porosity relationship of Colima andesites following an extensive field campaign in June/July of 2014, as well as a systematic examination of permeability evolution across the brittle-ductile transition.

Seasonal course of mean and heavy precipitation in mid-elevation mountain systems in Central Europe: a case study of the Vosges (France)

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The goal of this study is to examine the seasonal distribution of heavy precipitation in the area of the Vosges mountain range that is situated in north-eastern France. This area is selected as an example of mid-elevation mountain systems of Central Europe. These systems are frequently densely populated in their lee (i.e. the Upper Rhine Plain). Thus they concentrate many stakes and natural hazards that are related to heavy precipitation (e.g., flood, landslides).

The analysis is based on daily precipitation totals from 84 rain gauge stations covering the period

1960-2013. Computing mean monthly totals, the mean seasonal course of precipitation is showed. One can observe that the Vosges influences the spatial and temporal distribution of precipitation in its surroundings. Most of precipitation is concentrated on the windward side in autumn and on the crest in winter whereas on the leeward side in summer. This is due to the position of Vosges almost perpendicular to the prevailing western airflow that modifies the climatic type from more oceanic on the windward side and crest to rather continental in lee. In addition, this may be supported by a decreasing mean annual precipitation total from West to East and by an increasing uneven temporal distribution of precipitation also in this direction. The phenomena of rain shadow and orographic enhancement of precipitation may be stronger in winter when the zonal western circulation is more pronounced and stratiform precipitation much more frequent than convective precipitation that occur rather randomly and mostly in summer.

However, the seasonality of heavy precipitation does not correspond to the mean one. For the analysis, the heavy precipitation event is defined using two methods: (i) method of block maxima (BM) and (ii) method of peak over threshold (POT). In the case of BM, the annual one- to ten-day (1-10D) precipitation maxima is used as heavy precipitation whereas in the case of POT, an exceedance of 1-10D totals over 99^{th} and 99.9^{th} percentile characterise a heavy precipitation event. One can state that the seasonal pattern of these events is much more pronounced, the prevailing season dominates more in comparison to the mean seasonality. Nevertheless, one can also see that more extreme events do not necessarily occur within the month with the highest mean precipitation concentration and are more randomly scattered.

Comparing BM and POT, both methods slightly differ in results. The seasonal course of heavy precipitation may be considered method depending. Moreover, increasing the threshold to 99.9^{th} percentile, summer events appear more. Thus, the seasonal course is also threshold depending.

Furthermore, the evolution of seasonality of heavy precipitation is outlined averaging the prevailing season across stations for each of 54 years. Results might indicate a connection to the values of North Atlantic Oscillation Index (NAOI) and of Central European Zonal Index (CEZI).

Lastly, the Vosges changes the seasonal course of mean and heavy precipitation in its surroundings and represents a natural barrier between an oceanic climate and a climate in transition or more continental.

3D partitioning of deformation in hyper-extended rift systems: The example from the southern North Atlantic

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Hyper-extended rifted margins are recording large deformation prior to seafloor spreading. The analysis and quantification of this extensive deformation is crucial to determine the pre-breakup kinematic evolution of rifted margins. The aim of this study is to investigate, using the example of the southern North Atlantic, the 3D partitioning of deformation in a hyper-extended rift system.

The rifting associated with hyper-extension of southern North Atlantic is developing during Late Jurassic-Early Cretaceous with several rift systems developing simultaneously. The interrelationship between these concomitant rift systems lead to the present-day complex rift architecture observed in the southern North Atlantic with hyper-extended, magma-poor rifted margins and basins distributed along both sides of the ocean showing various sizes, structures and orientations. To reconcile global plate kinematic, tectonic processes, rheological evolution, and physical properties of the deforming material, it is necessary to develop a method to describe and quantify the deformation history.

Hyper-extended rifted margins are commonly formed by 3 major rift domains: 1) the pre-existing, little or non deformed continental crust, 2) the thinned continental crust, and 3) the new created basement, which is either exhumed mantle and/or magmatically accreted

crust (e.g. oceanic crust). 2D seismic interpretation, potential field analysis, borehole data and 3D gravity modelling are used to map those domains on the southern North Atlantic.

In my PhD, I first focused on the thinned continental crust domain, which is made of highly extended, pre-existing/inherited continental crust. Assuming that there is no material addition (i.e magma poor) or loses (i.e. erosion) and knowing the continental crustal thickness by 3D gravity inversion, an area balancing can be performed to determine the pre-deformation continental boundary. Preliminary results highlight the initiation of a transform margin south of the Galicia Bank-Flemish cap conjugate margin concomitant with the opening of the Galicia Interior Basin and the East Orphan Basin. This configuration implies a different rheological evolution most likely controlled by inheritance, between the south and the north of Iberia-Newfoundland. This observation leads to the question of the propagation of the deformation in a rift system and how the deformation is partitioned between orthogonal and transfer movements. The next step, to answer to those questions, is to implement the pre-deformation continental polygons in a kinematic software to test published rotation poles.

In parallel I'm looking at the deformation mechanisms and the rheology of hyper-thinned continental crust with the aim to test if this domain can be explained by the Coulomb wedge theory. Testing this hypothesis will enable to add new information on the evolution of physical properties (e.g. basal and internal friction, basal shear, fluid pressure) in a hyper-extended rift system.

Investigating the weathering processes and geomorphological dynamic of the Strengbach catchment by a coupled approach of Uranium series isotopes and cosmogenic Beryllium (Vosges massif, France).

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The determination of soils sustainability is a major issue for societies. It is crucial to estimate the soil formation and denudation rates to evaluate the landscapes stability and their response to natural or anthropological forcing. In this work, we propose a method to determine the mass balance of soils at millennial timescales. We combined the Uranium-Thorium-Radium isotopes with the cosmogenic Beryllium to estimate both production rate of regolith and denudation rate of soils located in the Strengbach catchment in the Vosges massif. The field campaigns include the realization of a weathering profile located on the summit of the watershed and extending from the top soil to the granitic bedrock at 2 m depth. Bulk analyses reveal weak variations of major concentrations but smooth and distinctive trends of Uranium series disequilibria into the bedrock and the regolith. A particle swarm optimization dedicated to isotopic ratios fitting has been used to evaluate the production rate of regolith from the Uranium-Thorium-Radium data. The simulations show that the regolith production rate at the summit of the watershed is about 35 $T/km^2/an$. A numerical optimization for nonlinear inverse problem has been developed to estimate the age of the soil and the mean denudation rate at the summit from the Beryllium data. The results show that the age of the soil is about 14 000 years and the mean denudation rate is about 32 $T/km^2/an$. The soil mass balance seems to be at steady state as the production of regolith and denudation of soil are in the same order of magnitude.

The experimental area of Colmar: for a better understanding of the nutrients transfer in Vegetated Buffer Zone

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Surface water is still increasingly polluted by nutrients (N, P), responsible for eutrophication. This increase can be due to effluents from sewage treatment plants (STP). Constructed

wetlands such as Vegetated Buffer Zones (VBZs) have been created in order to improve the effluent water quality. A VBZ is an artificial area planted of woody species and / or helophytes in which water and solute infiltrate and percolate. Benefits expected in this area are efficient nutrient retention by soil and plants and as a consequence a high biomass production. Whereas this treatment is expanding rapidly, the role of both compartments (soil and plant) in nutrient retention is not well defined. The aim of the study was to investigate the reduction of nutrients (N, P) transfer, and the main factors which can control this transfer. An experimental area was created. It is composed of four gutter leads, willows planted, in which was settled at four soil depths ceramic porous cups. Each month, gutter leads are fertirrigated with phosphate and nitrate solute except in one gutter lead (witness), irrigated only with water. The monthly sampling of soil solution, quarterly sampling of plants and biannual sampling of soil in each gutter lead, should bring out the impact of different irrigation methods (irrigation vs. fertirrigation), willows density and exploitation model (coppicing). In addition, a study of the biomass produced will determine the amount of nitrogen and phosphorus exported by each gutter lead. The poster presents this experimental area and the methodology used.

Seismotectonics of the Bengal-Assam region, active faults, large earthquakes (Shillong plateau and Indo-Burmese fold and thrust belt).

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The Indo-Asia collision in the Bengal-Assam region results in a complex plate boundary implying parts of north-east India, Bangladesh, Burma and China. From the Himalayan Frontal Thrust in the north, to the Indo-Burmese fold and thrust belt in the south and to the Sagaing strike-slip fault to the east, the plate converge is accommodated through various mode of deformation. This region is known for some of the largest intra-continental seismic events of the last century, the 1897 Shillong earthquakes of magnitude Ms 8.7 and the 1950 Assam earthquake of magnitude Mw 8.6. Despite many studies of the Himalayan tectonics the source faults of these events and whether these large earthquakes occurred on faults that reached the surface or reminded blind remain controversial. The eastern Himalayan or Bengal-Assam Syntaxis still needs to be better understood in term of active faulting and seismicity. The interactions between the various plates, the Indian plate, the Burma micro-plate and the Tibetan blocks, together with the activity on the Dauki fault of southern Shillong, the Naga fault, still need to be elucidated.

For instance, the major faults, rivers and Quaternary surfaces of the southern part of the Shillong Plateau have been mapped. Uplifted terraces and noticeable knickpoints along the longitudinal profiles or rivers will help constrain thrust fault activity. Hence, as a step towards a better understanding of fault activity, we began a detailed seismotectonic study of the eastern Himalayan syntaxis. One of the objectives is to enhance our knowledge of earthquake hazard on known active faults. Our results may improve seismic risk assessments and building codes for building houses, dams and bridges and thus can save human life in a future big earthquake.

In this PhD, we concentrate on the faults of the Shillong Plateau, Indo-Burma Ranges and Bangladesh. We use satellite image analysis (GIS), quantitative geomorphology, active fault mapping, field and DEM topographic surveys, paleoseismology techniques. After a reconnaissance survey of the entire area was done, we selected areas for detailed work using the satellite image interpretations and fieldwork. In 2014, we carried out a detailed fieldwork in Raghunandan Hill, Shajibazar, in the eastern part of Bangladesh. In its northwestern part, the Raghunandan hill is characterized by a 22 km-long and 55 m-high, steep west-facing front. Topographic leveling using Total Station and Kinematic GPS helped to identify the different levels of terraces abandoned by the Shahapur river. A set of 5 terraces from 1.5 m to 25 m above stream bed are identified, T1 and T2 being 1.5 m and 5 m above stream bed. A trench (30 m X 5-8 m X 2-3m) was excavated across the steep front of the hill. Charcoal, quartz rich sands and silts samples were collected for C^{14},

Be^{10} and OSL dating. Sampled in the various terraces and from the trench walls these samples will constrain the age of the terrace formation and geomorphic surfaces. Analysis of the topographic profiles together with further trenching will help better constrain the strain rate associated to the growth of the Raghunandan anticline.

Plant communities are mainly determined by anthropogenic land cover along urban riparian corridors

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Riparian corridors become a widespread and popular tool to mitigate landscape fragmentation and preserve biodiversity. But at the same time riparian corridors are increasingly threatened by urban expansion and land use change worldwide. However they are the only physical link with the surrounding countryside and potentially appear as a species source for urban biodiversity. This study aims to understand the effect of urbanization on plant assemblages along two riparian corridors crossing the metropolitan area of Strasbourg (North-East France). We sampled 15 sites along an urban-rural gradient along each corridor. Data of spontaneous species abundance were collected from 180 quadrats. Riparian plant composition was related to land cover (within a 500m buffer around each site) and soils characteristics. Hierarchical clustering analysis reveals that riparian corridors present similar compositional pattern with that of land cover. This result is in accordance with between-site co-inertia. Anthropogenic land cover is the most significant predictor of urban-rural gradient whereas soil characteristics discriminate hydrological regimes. Urban sites are characterized by cosmopolitan herbaceous species, e.g *Poa annua*, *Lolium perenne* but conserve some specific features of riparian area with the presence of several native trees, mainly *Alnus glutinosa* and *Fraxinus excelsior*. While agricultural and prairial sites include some exotics, forested sites are composed of a large layer of shrubs indicative of reduced disturbance. This study shows that although riparian corridors are determined by land cover, they also support regional biodiversity until near urban center.

Aero-fracture evolution inside Hele-Shaw cell: Acoustic emissions and Simulations

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The characterization and comprehension of rock deformation processes due to fluid flow is a challenging problem with numerous applications in many fields. This phenomenon has received an ever-increasing attention in Earth Science, Physics, with many applications in natural hazard understanding, mitigation or forecast (e.g. earthquakes, landslides with hydrological control, volcanic eruptions), or in the industry, as CO2 sequestration.

Even though the fluids and rocks are relatively easier to understand individually, the coupled behaviour of porous media with a dynamic fluid flow makes the system difficult to comprehend. The dynamic interaction between flow and the porous media, rapid changes in the local porosity due to the compaction and migration of the porous material, fracturing due to the momentum exchange in fast flow, make understanding of such a complex system a challenge.

In this study, analogue models are developed to predict and control the mechanical stability of rock and soil formations during the injection or extraction of fluids. The models are constructed and calibrated based on the experimental data acquired. The experimental setup consist of a rectangular Hele-Shaw cell with three closed boundaries and one semi-permeable boundary which enables the flow of the fluid but not the solid particles, an air pump, a high speed camera (1000 fps) and acoustic sensors (1MHz sampling frq.). During the experiments, the fluid is injected into the system from the point opposite to the semi-permeable boundary so that the fluid penetrates into the solid and

makes a way via creating channels, fractures or directly using the pore network to the semi-permeable boundary. Experiments are repeated in different orientations of Hele-Shaw cell (i.e. horizontal, vertical, and tilted) to compare the effect of gravity into the system. During the experiments acoustic signals are recorded using different sensors then, those signals are compared and investigated further in both time and frequency domains.

It has been observed that the spectrum of the signal, is affected by the size and shape of deforming channels, fundamental frequency of the plate, noise created by injection itself and aero-granular interactions during the injection. Characteristic frequency ranges of those different phenomena are investigated experimentally.

Furthermore, during the experiments photos of the Hele-Shaw cell are taken using a high speed camera. Thus, it is possible to visualize the solid-fluid interaction and to process images to gather information about the mechanical properties of the solid partition. The link between the visual and the mechanical wave signals is investigated.

Additionally to the experimental approach to the acoustic emissions a numerical simulation study is also conducted. In the numerical study a direct model of acoustic emissions is built. This model is constructed by using Green's Function for Lamb Waves in finite plates and using the source forms derived from the mechanics of deforming granular/fluid medium which is recorded optically.

Chemical Weathering Rates of Feldspars: A Stepwise Approach from Laboratory to Field Estimates

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Chemical weathering of silicate minerals directly impacts geochemical cycles and fundamental processes, such as pedogenesis or global atmospheric CO2 drawdown. A long-standing problem in water-rock kinetics is to relate laboratory-defined mineral dissolution rates with those observed in the field, since they differ by several orders of magnitude. This field/lab discrepancy may arise from both intrinsic (i.e., related to the microstructural evolution of mineral surfaces) and extrinsic (i.e., related to the composition of the reacting fluids) factors. To date, the exact nature and the relative contributions of intrinsic and extrinsic factors remain poorly understood.

Here we present a stepwise approach to elucidate the respective impact of both intrinsic and extrinsic factors on feldspar weathering rates. The dissolution anisotropy was measured using vertical scanning interferometry (VSI) coupled with atomic force microscopy (AFM) to follow-up modifications of surface microstructures in order to evaluate how intrinsic factors influence long-term labradorite reactivity. In a first step, polished labradorite single-crystals are reacted using acidic synthetic solutions at 80°C and 30°C. In a second step, a similar protocol is followed using filtered-sterile environmental fluids collected from the XX soil horizon of a spruce plot from the Strengbach catchment (Aubure, France) to better understand the role of dissolved solutes (e.g. colloids and dissolved organic matter) on labradorite reactivity. In a third step, environmental fluids and associated microbial communities are reacted to investigate the effect of both biotic and abiotic extrinsic factors on mineral reactivity.

Our preliminary results on labradorite show that abiotic experiments conducted at 80°C under acidic conditions (pH = 1.5 and 3) lead to the formation of Amorphous Si-rich Surface Layers (ASSLs). While the stability of these layers seems to be accurately controlled by dissolved silica concentration in the reactive fluid, their passivating properties are pH-controlled. Experiments at pH = 1.5 exhibit linear global retreat of the surface and a linear cation release in solution with time, despite the formation of a thick ASSL. On contrary, dissolution experiments conducted under higher pH conditions (pH = 3) show parabolic cation release in solution, accounting for their higher passivating

properties, while a non-linear surface retreat with time was interpreted as a potential evolution of the structural properties of the surface layer through time and the first direct evidence for the aeging of the surface layers. These preliminary results illustrate the potential of an integrated approach to unravel the contribution of intrinsic and extrinsic factors in controlling mineral reactivity.

Hedges, an alternative to the open field in the loess areas of Alsace ? Historical perspectives, future agricultural systems, erosion, impact on colluvial and carbon storage.

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In erosion-prone areas in Alsace, Sundgau and Kochersberg appear to be particularly vulnerable areas. As a consequence of the association of both (i) soils developed on loess materials characterized by low structural stability, (ii) monoculture farming systems (corn), and (iii) unfavorable topography and climate (relatively steep slopes, stormy spring precipitation), these spaces are topics at times spectacular lava sludge.

To overcome these problems, the introduction of fascines and hedges (GERIHCO program 2 & 3) was tested as alternative agronomical technics in these areas of openfields vulnerable to erosion. The consequences of implementing these structures are multiple:

- Landscape (visual changes in farming systems).

- Soil (changing dynamic colluvial with a "split" and

reduced flows).

- Ecological (hedges serve as green belt).

- Economical (value of products hedges, new agrarian system).
- Social (adaptation and acceptance of a "new landscape" capacity).

However, it is not possible to measure the effectiveness of the hedges in the long term without a long experiment. In order to measure the impact of these systems it is necessary to quantify stocks of soil and organic matter accumulated behind the hedges.

In this perspective, we conducted a temporal approach of old systems with hedges (Medieval?), Evidenced by colluvial bank. The aim is to quantify the flows of colluvium and carbon trapped behind the hedges. The selection of study sites takes in account several criteria: location in loess area, sloping, abundance of colluvial bank reflecting a former agricultural past.

Habsheim area was selected as the main study site after analysis of the LIDAR and many surveys of land in all the loess areas. A transect intersecting two curtain cultures was described and sampled in order to study the hedge colluvial system face to the dynamic of agricultural origine and to quantify the colluviation deposits and organic carbon accumulated stocks. For each sampling site, a pit is made and used to determine the depth of occurrence of loess and the different soil horizons. Thus, it is possible to determine the origin of colluviated materials. This material will be dated (OSL, 14C) to measure the flow of soil and carbon. Carbon stocks between upstream and downstream portions between two curtains will be measured to assess the role of these devices in the carbon and improve understanding of the role of the agrarian system in the theme of "global change and sustainable agriculture".

The expected results of this study on the farming systems of the past, should allow to have a better understanding (age, distribution ...), and thus establish recommendations and advice for future environmental management.

Dual Lattice Boltzmann method for electrokinetic coupling : behavior at high and low salinities

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The Lattice Boltzmann method is a computational fluid dynamics technique that is used for advection and diffusion modeling. We implement a coupled Lattice Boltzmann algorithm that solves both the mass transport and the electric field arising from charge displacements in a porous medium.

The streaming potential and electroosmosis phenomena occur in a variety of situations and derive from this coupling. We focus on the streaming potential which is described using the ratio between the created potential difference and the applied pressure gradient. This ratio is assumed to be inversely proportionnal to the fluid conductivity, but experimental results highlight anomalous behaviors at high and low salinities. We try to account for them by setting extreme conditions that are likely to generate non-linearities.

Several pore radii are tested so as to determine what is the effect of a radius that is comparable to the Debye length, the screening length of the electric potential. The volumetric integral of the electrical current is calculated for comparison with the 2D simulations. High values of zeta potential are tested to verify if the discrepancy regarding the theoretical result is concentration-dependent. Some tests including a rugosity on the channel walls are performed.

Magnetotelluric bias reduced by the application of continuous wavelet transform

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In magnetotellurics (MT), time series processing are mainly based on Fourier transform to characterize the transfer function between horizontal electric and magnetic time series. In order to reduce the noise in electromagnetic (EM) measurements we often correlate the EM fields with another MT station located far away to cancel the noise induced in both stations. However, the set-up of such a station is time and data consuming and the position has to be cautiously selected (with an electromagnetic environment as quiet as possible). Moreover, the distance between the two stations has to be long enough to remove as much noise as possible. To reduce the influence of the EM noise, we have applied the continuous wavelet transform (CWT) to select the MT transient signal (sferics or geomagnetic pulsations) and computed the impedance transfer function using only the coefficients of these geomagnetic events. We have shown that using this processing instead of the classic Fourier transform we are able to reduce the bias induced by noise in MT time series. We have seen that even by doing the processing using a single station, we are able to recover the unbiased transfer function computed with the use of a remote station. Moreover, with the application of wavelet transform, we are now able to study each geomagnetic event.