UNIVERSITÉ DE STRASBOURG

ED 413 Sciences de la Terre et de l'Environnement

EOST Ecole et Observatoire des Sciences de la Terre

Congrès des Doctorants 2015

Sciences de la Terre et de l' Environnement

Actes de conférence

Lundi 30 Novembre 2015

Collège Doctoral Européen

46 boulevard de la Victoire 67000 Strasbourg

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Congrès des Doctorants 2015

Lundi 30 Novembre 2015

Le Congrès des Doctorants (CDD) 2015 est l'occasion pour l'ensemble des doctorants de se réunir et de présenter leurs travaux dans un moment convivial. Cette journée permet également aux enseignants-chercheurs de rencontrer les doctorants de leurs laboratoires.

Le CDD est organisé par l'École Doctorale des Sciences de la Terre et de l'Environnement de l'Université de Strasbourg (STE). Cette école doctorale réunit l'Institut de Physique du Globe de Strasbourg (UMR 7516), le Laboratoire d'Hydrologie et de Géochimie de Strasbourg (UMR 7517) et le Laboratoire Image, Ville, Environnement (ERL 7230).

Session Orale

Les étudiants en thèse en 3ème année présenteront leurs travaux de recherche en cours durant une présentation de 15 minutes (questions comprises). Un résumé de 250 mots doit être soumis.

Session Poster

Les étudiants en thèse en 2ème année pourront discuter de leurs travaux de recherche avec les participants autour d'un poster durant les pauses cafés ainsi que le buffet de midi. Le poster aura de préférence le format portrait A0. Un résumé de 250 mots doit être soumis.

Information

Le site du congrès : http://eost.u-strasbg.fr/stue/

Inscription gratuite sur le sondage : http://studs.unistra.fr/studs.php?sondage=jkjrlbvjof7ce4z7

Merci de préciser si vous avez un régime alimentaire particulier lors de l'inscription ainsi que de vous inscrire au repas du soir (aux frais des participants)

Date limite des inscriptions et des soumissions : 30 octobre 2015

Les résumés sont à envoyer à Julien Ackerer (julien.ackerer2@etu.unistra.fr)

Programme préliminaire

09:00	Enregistrement
09:15	Message de bienvenue de M. Ackerer
09:30	Session orale
10:30	Pause café et session poster
11:00	Session orale
12:00	Buffet au Jardin intérieur du CDE et session poster
13:30	Session orale
15:00	Pause café et session poster
15:30	Session orale
16:30	Clôture du Congrès des Doctorants
19:00	Repas des doctorants à la brasserie Le Public House

Le Public House
14 rue Paul Janet
67000 Strasbourg France

Collège Doctoral Européen
46 Boulevard de la Victoire
67000 Strasbourg France

Congrès des Doctorants 2015

Collège Doctoral Européen de Strasbourg - Lundi 30 Novembre 2015

PROGRAMME DU CONGRES

09 :00 Enregistrement

09 :15 Mot d'accueil de la direction de l'Ecole doctorale

09 :30 Session orale 1 : **Géographie** *{Into the Wild}*

Carbon storage in hedge landscape in loess areas of Alsace (France) – **Lucie Froehlicher**, Dominique Schwartz, Damien Ertlen

Etude et comparaison du transfert des nutriments (azote, phosphore) dans deux Zones tampon Végétalisées – **Sarah Koenig**, Michèle Trémolières

Heavy precipitation in mid-elevation mountain systems in Central Europe : case of study of the Vosges Mountains (France) and the Ore Mountains (Czech Republic, Germany) – **Jana Minarova**, Alain Clappier, Miloslav Müller, Goerges Najjar

Impacts of an urbanization gradient on plant communities: a case study along riparian corridors in Strasbourg, France – **Eugénie Schwoertzig**, Suzanne Brolly, Damien Ertlen, Michèle Trémolières

10 :30 Pause café

11 :00 Session orale 2 : **Géochimie et Hydrologie** *{The Day after Tomorrow}*

Combined analysis of Uranium series nuclides and in situ Beryllium in a weathering profile located in the Strengbach catchment (Vosges massif, France) – **Julien Ackerer**, François Chabaux, Jérôme Van der Woerd, Elise Kali, Eric Pelt, Marie-Claire Pierret, Daniel Viville, Robert Wyns, Philippe Negrel

Estimation of the groundwater recharge by inverse modeling – **Fadji Hassane Maina**, Philippe Ackerer, Olivier Bildstein

Chemical weathering rates of feldspars: a stepwise approach from laboratory to field estimates – **Bastien Wild**, Damien Daval, François Guyot, Diane Rebiscoul, Alejandro Fernandez-Martinez, Marion Pollet-Villard, Martiane Cabié, Kevin Knauss, Gwanaël Imfeld

Crystallographic anisotropy prevents conventional isotropic treatment of aqueous mineral reactivity – **Marion Pollet-Villard**, Damien Daval, Philippe Ackerer, Giuseppe Saldi, Bastien Wild, Kevin Gnauss, Bertrand Fritz

12 :00 Buffet au Jardin intérieur du CDE et session des posters *{The Truman Show}*

14 :00 Session orale 3 : **Géophysique** *{Armageddon}*

Invasion patterns during two-phase flow in deformable porous media – **Frederik Eriksen**, Knut Maloy, Eirik Flekkoy

Pore fluid-driven fracturing in volcanic rock – **Jamie Farquharson**, Michael Heap, Patrick Baud, Thierry Reuschlé, Nick Varley

Lattice Boltzmann modeling of streaming potentials – **Eve-Agnès Fiorentino**, Laurence Jouniaux, Renaud Toussaint

Detecting and using properties of electromagnetic natural sources in magnetotelluric data processing – **Hugo Larnier**, Pascal Sailhac, Aude Chambodut

Secrets of aero-fractures: a dual (optical/microseismic) study – **Semih Turkaya**, Renaud Toussaint, Fredrik Eriksen, Megan Zecevic, Guillaume Daniel, Eirik Flekkoy, Knut Maloy

15 :15 Pause café

15 :45 Session orale 4 : **Géologie** *{Pacific Rim}*

Seismotectonics of the Bengal-Assam region, active faults, large earthquakes (Shillong plateau and Indo-Burmese fold and thrust belt) – **Aktarul Ahsan**, Jérôme Van der Woerd, Elise Kali, Paul Taponnier, AKM Khorshed Alam, Catherine Dorbath

Assessing the impact of orogenic inheritance on the architecture, timing and magmatic budget of the North Atlantic rift system: a mapping approach – **Pauline Chenin**, Gianreto Manatschal, Luc Lavier

Evidence of hydrothermal fluid flow in distal rifted margins: the case study of Err nappe (Switzerland) – **Nicolo Incerpi**, Martire Luca, Gianreto Manatschal, Stefano Bernasconi

How do physical properties influence the shape of hyper-extended rifted margins? – **Michael Nirrengarten**, Gianreto Manatschal, Xiaoping Yuan, Nick Kusznir, Bertrand Maillot

17 :00 Clôture du Congrès des Doctorants

19 :00 Repas des doctorants à la brasserie Le Public House

PROGRAMME DE LA SESSION DES POSTERS

1 *Melt infiltration in heterogeneous mantle domains during oceanization. Evidences from present-day and fossile magma-poor rifted margins* – **Méderic Amann**, Marc Ulrich, Julia Autin, Daniel Sauter, Gianreto Manatschal, Othmar Muntener

2 *Interpretation aeromagnetique régionale du bassin d'Illizi et locale de la région des Tassili N'Ajjer* – **Sonia Brahimi**, Marc Munschy, Jean-François Ghienne, Amar Bourmatte

3 *Rôle des phases oragno-minérales des sols en tant que réservoirs de nutriments : approche expérimentale (biotique et abiotique) et multi-isotopique (isotopes stables Ca-Sr-Li)* – **Jean-Michel Brazier**, Anne-Désirée Schmitt

4 *Evaluation d'un schéma stratégique des Energies Renouvelables (EnR) appliquée à l'Eurométropole de Strasbourg* – **Sophie Buessler**, Christine Weber, Dominique Badariotti

5 *Characterization of basement highs in hyper-extended rifts systems: examples from the Err nappe, Switzerland* – **Marie-Eva Epin**, Gianreto Manatschal, Isabelle Haupert, Alessandro Decarlis

6 *Une base de données pour l'évaluation et le suivi de la qualité hydrobiologique des cours d'eau* – **Corinne Grac**, Lilia Berrahou, Sandro Bimonte, Kamal Boulil, Agnès Braud, Sandra Bringay, Flavie Cernesson, Xavier Dolques, Michaël Fabrègue, Bruno Fontan, Nathalie Lalande, Florence Le Ber, Danielle Levet, Guilhem Molla, Jacques Niel, Maguelonne Teisseire

7 *A new setup for studying thermal microcracking through acoustic emission monitoring* – **Luke Griffiths**, Patrick Baud, Michaël Heap, Jean Schmittbuhl

8 *Sensitivity analysis of the air quality model INCA-Indoor to few input parameters using automatic differentiation* – **Fangfang Guo**, Nadège Blond, Isabelle Charpentier, Maxence Mendez, Didier Hauglustaine, Jean-Luc Ponche

9 *Apport du magnétisme multi-échelle dans la compréhension de la proche surface : application à la base Ba 112 (Reims)* – **Pauline Le Maire**, Marc Munschy

10 *Intergration of isotopes into coupled hydrogeochemical modeling* – **Marianna Marinoni**, Philippe Ackerer

11 *Transport of pesticides in small agricultural head-catchments: coupling hydrological and stable isotope approaches* – **Fatima Meite**, Gwenaël Imfeld

12 *Etude de l'apport d'un modèle de vitesse 3D pour la localisation de la micro-sismicité des glissements de terrain argilo-marneux* – **Floriane Provost**, Jean-Philippe Malet, Cécile Doubre, Agnès Helmstetter

13 *Water-rock interaction and watermixing processes from regolith to catchment scale: evidence from trace elements, Sr-Nd-Pb-U-Th + O-H isotopes* – **Cristina Moragues Quiroga**, Peter Stille, Arnaud Legout, Christophe Hissler

14 *Evaluation des bénéfices écologiques apportés par des modifications géomorphologiques à deux communautés biologiques spécifiques* – **Staentzel Cybill**, Jean-Nicolas Beisel, Isabelle Combroux, Laurent Schmitt, Michèle Trémolières, Agnès Barillier

15 *Ground Penetrating Radar investigation for the characterization of Songino active fault, Ulaanbaatar, Mongolia* – **Nyambayar Tsend-Ayush**, Maksim Bano, Antoine Schlupp, Ulziibat Munkhuu, Battogtokh Davaasambuu, Bayarsaikhan Enkhee, Byambakhorol Battsetseg

16 *Evidence of permeability in fractured rocks from deep geothermal boreholes in the Upper Rhine Graben from well-logging data* – **Jeanne Vidal**, Hubert Whitechurch, Jean Schmittbuhl, Albert Genter

INFORMATIONS PRATIQUES

Le site du congrès : **http://eost.u-strasbg.fr/stue/**

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Session orale : Géographie

Into the wild

Carbon storage in hedge landscape in loess areas of Alsace (France)

LUCIE FROEHLICHER* [1, 2], DOMINIQUE SCHWARTZ[1], DAMIEN ERTLEN[1]

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1. Introduction

The issue of carbon storage in soils is a major challenge. Indeed, with the agronomic and environmental changes (soil fertility, chemical and physical characteristics of the soil, carbon sinks, etc.) it is essential today to understand the carbon fluxes in soils at different scales. To understand this phenomenon, we must be able to quantify a stock, but also simulate the evolution of this stock of carbon at different time scales.

Within the different existing agricultural practices, fragmented systems with hedges (bocage systems in a watershed) combined with cropping activity are very good field of study to measure changes in carbon stocks at the slope scale. Indeed, with such a configuration, it is possible to measure all inputs / outputs of different agricultural erosion phases (colluvial), and quantified products of this erosion (colluvium). Coupled with a historical study of the hedge landscape, the rhythm of C accumulation in the system can also be estimated.

2. Objectives

The objective of this study is to measure / quantify the storage capacity of soil organic carbon in both:

Colluvium deposited behind and under the hedges (when the hedge is uplift)

The entire watershed following a representative transect perpendicular to the slope, intersecting one or more "hedge system" (hedge plus colluvium) from the top to the bottom of the watershed

From these measures we estimate the carbon stock changes in the watershed.

3. Material & methods

To carry out the measurements of organic carbon stocks, the prevailing formula is as follows:

$Q_{(Organic\ Carbon)}$ = Thickness $_{(m)}$ X Organic Carbon $_{(\%)}$ X Apparent density surface $_{(m^2)}$

The measures of these stocks are made on regular sampling of soil samples every 10 cm of each pits.

The figure 1 shows the location of the different pits (HABS01 to HABS10) performed at the watershed scale for one of study site : Habsheim, 68, France).

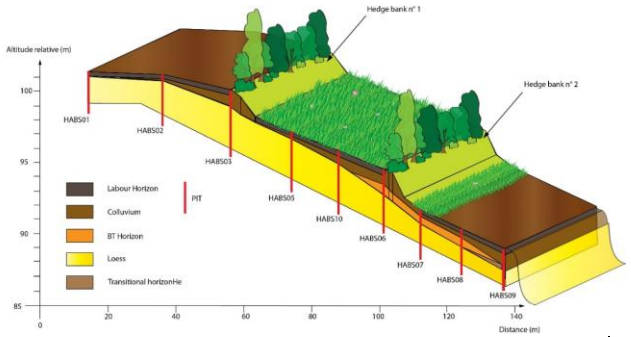

Fig 1: Localisation of the 10 sampled pits and the hedges for the site of HABSHEIM (FRANCE/Alsace/68) ; Source : Lucie Froehlicher, 2015

4. Results

The measurements of organic carbon stocks in these agricultural soils associated with agrarian structures like hedges, clearly show a trend of organic carbon storage behind the hedges (HABS03, HABS06). The figure 2 shows the evolution with depth of this organic carbon stock every 10 cm for each pit across the transect.

5. Conclusion

Although loess soils are not likely to store carbon due to their particle size characteristics, the evolution of organic carbon stock can be significant. Indeed, for HABS06 behind the hedge the stock is four times higher than in the upper part of the field (HABS05). A couple of other

studied sites show the same tendency. Thus, hedges appear as a possible solution to carbon sequestration

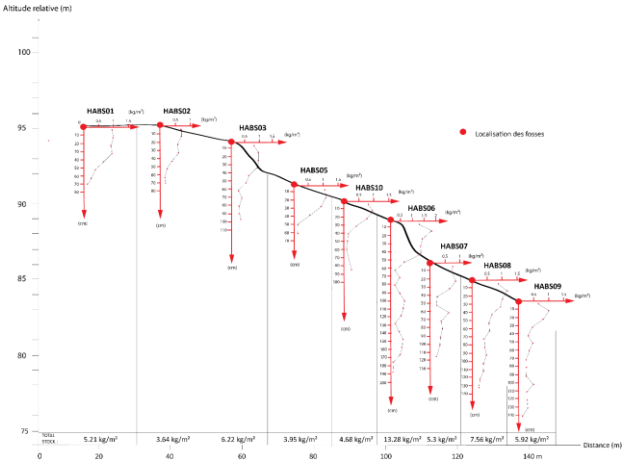

Fig 2: Evolution of the organic carbon stock for the site of HABSHEIM (FRANCE/Alsace/68) ; Source : Lucie Froehlicher.

Etude et comparaison du transfert de nutriments (azote, phosphore) dans deux Zones tampon Végétalisées

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Les eaux de surface sont de plus en plus polluées par les nutriments (N, P), responsable du phénomène d'eutrophisation. Cette augmentation peut être due aux effluents de sortie de station d'épuration. Les zones humides artificielles telles que les Zones Tampon Végétalisées (ZTVs) ont été crées afin d'améliorer la qualité de l'eau avant son rejet dans le milieu naturel par infiltration dans le sol ou encore par rétention des nutriments par les plantes et le substrat. L'objectif de cette présentation est de comparer l'efficacité de ces deux ZTBs de caractéristiques différentes (taille, perméabilité du sol, végétation) dans l'abattement du phosphore et de l'azote en comprenant les mécanismes de transferts. L'azote et le phosphore ont été mesurés dans l'eau en entrée, milieu et sortie de système ainsi que dans les végétaux et le sol.

Les premiers résultats sur l'eau montrent que dans le cas d'une infiltration non totale de l'effluent, l'abattement des différentes formes de l'azote et du phosphore n'est le plus souvent pas significatif. L'infiltration à travers le substrat serait donc le facteur le plus important pour la protection du milieu récepteur. Les résultats sur les végétaux, en cours de traitement, devraient permettre de conseiller les développeurs de ces zones tertiaires sur le choix des espèces à planter en priorité.

Ces résultats préliminaires couplés à l'étude de la biomasse et des mécanismes microbiologiques dans deux ZTVs différentes devraient permettre de mieux comprendre leur fonctionnement et d'aiguiller les constructeurs vers un développement plus adapté et donc plus efficace de ces zones.

Heavy precipitation in mid-elevation mountain systems in Central Europe: case study of the Vosges Mountains (France) and the Ore Mountains (Czech Republic, Germany)

JANA MINÁŘOVÁ* [1,2], ALAIN CLAPPIER[1,3], MILOSLAV MÜLLER[2,4], GEORGES NAJJAR[1]

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The goal of this study is to investigate the heavy precipitation in the area of the Vosges Mountains in the north-eastern France and in the area of the Ore Mountains at the Germany–Czech Republic border, two examples of mid-elevation mountain systems of Central Europe. These systems are characterized by a relatively high density of population, mainly in their lee (i.e. the Upper Rhine Plain and basins in the Czech Republic), therefore with a lot of stakes. The most natural hazards in such areas are often associated with heavy precipitation (e.g., flooding, landslides).

Proceeding from daily precipitation totals from 335 rain gauge stations within the period 1960–2013, the 1–10day precipitation events with non-zero precipitation are computed. The reference

heavy precipitation events are selected according to the Weather Extremity Index (WEI) that is calculated from the return period values computed from the fitted Generalized Extreme Value distribution. The events exceeding 30 WEI value are defined as heavy precipitation reference events. For these events the weather types are also examined.

The analysis has shown that the extreme events occur the most in autumn and summer in the Vosges Mountains area whereas mainly in summer in the Ore Mountains. Heavier rainfall events are more concentrated in fewer months over a year in both areas. As for the synoptic conditions, even if some of them may lead to a heavy precipitation in both areas under study, e.g., the Cyclonic Westerly weather type, the events are not related one to another. Fifteen the heaviest rainfall events have occurred mostly within the South-Shifted Westerly synoptic field in the Vosges Mountains and within the Cyclone over Central Europe in the Ore Mountains. The 1-2day heavy precipitation events are observed predominantly in the Vosges Mountains while the duration of events in the Ore Mountains ranges between 1-10day events with the maximum occurrence of 2-day or 10-day events. This may be related to a different genesis of precipitation, i.e. of the convective and stratiform precipitation. The mean affected area across events evinces the same order of square kilometres in both areas under consideration.

Impacts of an urbanization gradient on plant communities: a case study along riparian corridors in Strasbourg, France

EUGENIE SCHWOERTZIG* [1], SUZANNE BROLLY[2], DAMIEN ERTLEN[1], MICHELE TREMOLIERES[1]

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In an urban context, riparian corridor is a widespread and popular tool to mitigate landscape transformation and fragmentation and to maintain connections between riparian ecosystems. Nevertheless, riparian corridors are also increasingly threatened by urban expansion. It is then difficult to estimate how many urban riparian corridors issues, like connection to functional communities, conservation of habitat or movement of plants, are still guaranteed. This study focused on two rural-to-urban riparian corridors in Strasbourg, France. Three levels of urbanization based on landscape composition were detected and used to assess the ecological impacts of urbanization on riparian communities' distribution. The environmental effects such as the distance to the nearest natural area and/or the modification of soil characteristics created a novel anthropogenic habitat that determines species presence and plant functional type. However plant species distribution also depended on the surrounding pressures and land cover. By analyzing the landscape composition and configuration within 500 meters of the study sites, we showed that matrix transformation and fragmentation resulted in a net loss of specific species of riparian area and a gain of cosmopolitan species. Impacts of urbanization on riparian communities were therefore simultaneously the consequences of both landscape.

Session orale : Géochimie et Hydrologie

The Day after Tomorrow

Combined analysis of Uranium series nuclides and in situ Beryllium in a weathering profile located in the Strengbach catchment (Vosges massif, France)

JULIEN ACKERER* [1], FRANÇOIS CHABAUX[1], JEROME VAN DER WOERD[2], ELISE KALI[2], ERIC PELT[1], MARIE CLAIRE PIERRET[1], DANIEL VIVILLE[1], ROBERT WYNS[3], PHILIPPE NEGREL[3].

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Recent studies underline the potential of U series nuclides to quantify the regolith production rate in weathering profiles (Chabaux et al, 2013; Dosseto et al, 2011; Dequincey et al, 2002). However, the quantification of regolith production rate in climatic temperate context encountered a certain number of limitations when analyzing only superficial samples in the first meter of soil (Rihs et al, 2011). In this work, we propose to combine the analysis of Uranium-Thorium-Radium isotopes with the cosmogenic in situ Beryllium in a weathering profile extending from the top soil to the granitic fractured bedrock at 2 m of depth to better estimate both production and denudation rate of regolith. The weathering profile is located on the summit of the watershed and has been sampled with a high spatial resolution (15 samples). Whole rock data show different trends of variation of major and trace element concentrations and also of U-Th-Ra disequilibria in the upper part of the regolith (0-80 cm) and the deeper part of the fractured saprolith and/or bedrock (100cm-200cm). The data confirm that the Uranium series isotopes in the surface of the profile are difficult to interpret in term of weathering rate, while the disequilibria in the deeper weathered bedrock show a smooth trend. The modeling of the U-Th-Ra data in this deeper part of the profile is performed with a common approach of gain/leaching radionuclide coefficient determination and leads to a regolith production rate of 30 ± 10 T/km²/year. In addition, a numerical optimization for nonlinear inverse problem has been performed to estimate the exposure age and the mean denudation rate at the summit from the Beryllium data. The results show that the exposure age of the profile is about 20 000 years and the mean denudation rate is 37 ± 15 T/km²/year. The consistency between the regolith production rate and the soil denudation rate suggests therefore that in such a temperate context, the long-term mass balance of soil developed on granitic bedrock would be close to a steady state.

Estimation of groundwater recharge by inverse modeling

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Complex hydrogeological systems are characterized by a variable dynamic over time and space. Generally, groundwater models are used to simulate aquifers flow without a good estimation 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 which simulates flow in the unsaturated zone and recharge as well as groundwater flow was developed: flow in the unsaturated zone is solved either with resolution of Richards equation or with empirical models while the diffusivity equation governs flow in the saturated zone. Robust numerical methods were used to solve these equations: we apply non-conforming finite element to solve the diffusivity equation and we developed an accurate and efficient non

iterative method for solving the Richards equation.
In the natural environments, parameters that control these hydrological mechanisms aren't accurately known or even unknowns, only variations of piezometric heads are commonly available. Hence, all parameters related to unsaturated and saturated flows will be identified by using only these piezometric data. To ensure that this manner of parameters identification could be made, we performed global sensitivity analysis by polynomial chaos expansion. This analysis allows us to quantify the influence of each input parameter on the output, and provides us relevant information for the better understanding of the model. The acquired knowledge of the input-output relationships suggests that all parameters can be calibrated from the variations of piezometric heads. Therefore, we developed an inverse method to determine these parameters, this approach involves minimizing a quadratic objective function by using the quasi-Newton algorithm.

Crystallographic anisotropy prevents conventional isotropic treatment of aqueous mineral reactivity

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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 [1]. 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 [2].
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. The overall crystal dissolution rate and its evolution over time depend on the initial crystal morphology. These results call into question the conventional method used to determine minerals dissolution rates.

1. Fritz, B., Jacquot, E., Jacquemont, B., Baldeyrou-Bailly, A., Rosener, M., and Vidal, O., 2010. Geochemical modelling of fluid-rock interactions in the context of the Soultz-sous-Forets geothermal system. *Cr Geosci* **342**, 653-667.
2. White, A. F. and Brantley, S. L., 2003. The effect of time on the weathering of silicate minerals: why do weathering rates differ in the laboratory and field? *Chem Geol* **202**, 479-506.

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

BASTIEN WILD* [1], DAMIEN DAVAL[1], FRANÇOIS GUYOT[2], DIANE REBISCOUL[3], ALEJANDRO FERNANDEZ-MARTINEZ[4], MARION POLLET-VILLARD[1], MARTIANE CABIE, KEVIN G. KNAUSS[6], GWENAËL IMFELD[1]

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Chemical weathering of silicate minerals directly impacts biogeochemical 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 versus extrinsic factors remain poorly understood.

Here we present a stepwise approach to evaluate the contribution of intrinsic and extrinsic factors on feldspar weathering rates.

In a first step, polished labradorite single-crystals were reacted using synthetic solutions with a pH ranging from 1.5 to 3 at 80°C to evaluate the impact of the formation of amorphous surface Si-rich layers (ASSLs) on reaction kinetics. Progressive loss of the mineral reactivity was evidenced and related to the modifications of surface microstructures using vertical scanning interferometry (VSI) coupled with inductively coupled plasma atomic emission spectroscopy (ICP-AES) and transmission electron microscopy (TEM). In situ methods such as synchrotron-based X-ray reflectivity (XRR) were also applied to address the mechanisms underlying this passivation phenomenon and characterize how intrinsic factors influence the labradorite reactivity over time. The results show that the stability of ASSLs is controlled by the dissolved silica concentration in the reactive fluid, while their passivating properties are pH-controlled. Experiments at pH=1.5 exhibit linear 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 ageing of the surface layers.

In a second experiment, the same labradorite minerals were reacted in environmental fluids collected from an organic soil horizon of a spruce plot from the Strengbach catchment (OHGE observatory, Aubure, France). The experimental setup was designed to evaluate the effect of microbial communities as well as dissolved organic matter (e.g. colloids and dissolved organic matter) on the kinetics of mineral dissolution. In the same time, this setup should enable the exploration of the feedback impact of mineralogy and surface microstructure on the so-called mineralosphere.

Finally, we developed microbial-based bioassays for evaluating microbial communities associated with silicate weathering. In-situ microcosms containing the same plagioglase feldspar minerals were incubated under sterile conditions for 9 and 18 months respectively in different locations of the critical zone at the Strengbach catchment, including a soil profile and a river bed. Sufficient microbial DNA material (>0.5 ng.µL-1) was successfully extracted from buried mineral powders for 16S rDNA sequencing (Illumina Seq) and further analysis the microbial communities are still under completion.

Overall, this thesis will enable to investigate independently key intrinsic and extrinsic parameters which may contribute to the well-known gap existing between field- and laboratory-derived weathering rates.

Session orale : Géophysique

Armageddon

Invasion patterns during two-phase flow In deformable porous media

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We will present our experimental study of the viscous fingering and fracturing patterns that occur when air at constant overpressure invades a circular Hele-Shaw cell containing a liquid-saturated deformable porous medium [1] -- i.e. during the flow of two non-miscible fluids in a confined granular medium at high enough rate to deform it. The resulting patterns are characterized in terms of growth rate, average finger thickness as function of radius and time, and fractal properties. Based on experiments with various injection pressures, we identify and compare typical pattern characteristics when there is no deformation, compaction, and/or decompaction of the porous medium. This is achieved by preparing monolayers of glass beads in cells with various boundary conditions, ranging from a rigid disordered porous medium to a deformable granular medium with either a semi-permeable or a free outer boundary. We show that the patterns formed have characteristic features depending on the boundary conditions. For example, the average finger thickness is found to be constant with radius in the non-deformable system, while in the deformable ones there is a larger initial thickness decreasing to the non-deformable value. Then, depending on whether the outer boundary is semi-permeable or free there is a further decrease or increase in the average finger thickness. When estimated from the flow patterns, the box-counting fractal dimensions are not found to change significantly with boundary conditions, but by using a method to locally estimate fractal dimensions, we see a transition in behavior with radius for patterns in deformable systems; In the deformable system with a free boundary, it seems to be a transition in universality class as the local fractal dimensions decrease towards the outer rim, where fingers are opening up like fractures in a paste.

Pore fluid-driven fracturing in volcanic rock

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Inside a volcano, the propensity for a brittle failure mode within porous edifice-forming rocks is largely governed by the overlying lithostatic pressure and the pressure of pore fluids within the rock, both of which are subject to change in space and time. While lithostatic pressure will tend to increase monotonously with the progressive accumulation of erupted products, pore pressures are prone to fluctuations (during periods of volcanic unrest, for example). An increase in pore fluid pressure can result in rock fracture, even at depths where the lithostatic pressure would otherwise preclude such dilatant behaviour—a process termed pore fluid-induced embrittlement. We explore this phenomenon through a series of targeted triaxial experiments on typical edifice-forming andesites (from Volcán de Colima, Mexico). We first show that increasing pore pressure over a range of timescales (on the order of one minute to one day) can culminate in brittle failure of otherwise intact rock. Irrespective of the pore pressure increase rate, we record comparable accelerations in acoustic emission and strain prior to macroscopic failure. We further show that oscillating pore fluid pressures can cause iterative and cumulative damage in porous andesite, ultimately resulting in brittle failure under relatively low stress conditions. We find that macroscopic failure occurs once a critical threshold of damage is surpassed, suggesting that only small increases in pore pressure may

be necessary to trigger failure in previously-damaged rocks. Finally, we observe that inelastic compaction of volcanic rock (as we may expect in much of the deep edifice) can be overprinted by shear fractures due to this mechanism of embrittlement. Pore fluid-induced embrittlement of edifice rock during volcanic unrest is anticipated to be highest closer to the conduit and, as a result, may assist in the development of a fractured halo zone surrounding the conduit, potentially explaining commonly observed near-conduit outgassing at many active volcanoes. Further, rock embrittlement at depth may create transient outgassing pathways by linking fracture networks near the edifice to larger-scale regional fault systems. Increasing the fracture network within a volcanic edifice can have further implications, including flank destabilisation, the generation of seismicity, and change in the volatile budget (in turn affecting the likelihood of catastrophic explosive eruptions). Our experimental results affirm that pore pressure fluctuations associated with volcanic unrest may play a crucial role in dictating the evolution of a volcanic system.

Lattice Boltzmann modelling of streaming potentials

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The streaming potential phenomenon is produced by the flow of an electrolyte in a porous medium, and is used for geophysical prospecting. It is quantified through an electrokinetic (EK) coefficient. The dependence of the EK coefficient on the conductivity of the electrolyte is described by the Helmholtz-Smoluchowski (HS) equation. This equation provides successful forecasts of the EK coefficient in the standard range of concentration. However, experimental measurements show non-linear behaviours at extreme low and extreme high salinities. The aim of this work is to model the EK coefficient using Lattice Boltzmann simulations, with a view to understanding these non-linearities. The constitutive parameters of the HS equation such as the permittivity and the viscosity are discussed. The impact of the Debye-Hückel approximation is assessed with the use of strong ζ potentials. A model of bulk fluid conductivity is derived. This model allows to take into account the change of local ionic distribution in the vicinity of the mineral. It appears to have a significant impact on the derivation of ζ potentials at low salinities and in the presence of polyvalent counterions. This model can be further developed for the comprehension of streaming potentials in unsaturated conditions.

Detecting and using properties of electromagnetic natural sources in magnetotelluric data processing

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Magnetotellurics (MT) is an electromagnetic (EM) technique using natural time-varying magnetic fields as source of induction of electric currents in the ground. Data processing consists in recovering the transfer function linking induced electric fields to inducing magnetic fields. This transfer function is then interpreted or inverted to infer geoelectric properties of the subsurface. Most processing techniques use Fourier transform and robust statistics on EM signals without really taking into account the nature of the inducting MT source.
These sources have frequencies varying from than 10 kHz down to less than 1 mHz. Some sources can be classified as transient such as electromagnetic waves emitted by lightning activity across the globe, others as quasi-periodic such as continuous geomagnetic pulsations. All these sources have different behaviors (frequency content, diurnal amplitude variations). Due to their complexity, we prefer to use the continuous wavelet transform (CWT) rather than the Fourier transform. The CWT is used to compose EM signals on a time-frequency plane and is therefore well suited to study MT sources.

In this presentation, we will show how the CWT can be used to detect MT sources and derive their characteristics (frequency content, polarizations). We will also discuss about how this can be integrated in the framework of MT processing and what are the main improvements using this methodology.

Secrets of aero-fractures: a dual (optical/microseismic) study

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In this work, analogue models are developed (similar to the previous work of Johnsen [1]) in a linear geometry, with confinement and at lower porosity to study the instabilities developing during fast motion of fluid in dense porous materials: fracturing, fingering, channeling (Fig 1). We study these complex fluid/solid mechanical systems using two imaging techniques: optical imaging using a high speed camera (1000 fps) and high frequency resolution accelerometers and piezoelectrical sensors. Additionally, we develop physical models rendering for the fluid mechanics (similar to the work of Niebling [2,3]) in the channels and the propagation of microseismic waves [4] around the fracture (Fig 2). We then confront a numerical resolution of this physical system with the observed experimental system.

The experimental setup [5] consists in 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. During the experiments, the fluid is injected into the system with a constant injection pressure from the point opposite to the semi-permeable boundary. At the large enough injection pressures, the fluid also displaces grains and creates channels, fractures towards the semi-permeable boundary.

In the analysis phase, power spectrum of different timewindows (5 ms) obtained from the recorded signal are calculated. Then, the evolution of the power spectrum is compared with the optical recordings. The power spectrum initially follows a power law trend and when the channel network is developed, stick-slip events generating peaks with a characteristic frequency can be seen. These peaks are strongly influenced by the size and branching of the channels, compaction of the medium, vibration of air in the pores and the fundamental frequency of the plate. Furthermore, the number of these stick-slip events, similar to the data obtained in hydraulic fracturing operations, follows a Modified Omori Law decay with an exponent p value around 0.5. Using direct simulations of acoustic emissions due to the air vibration in developing fractal cavities the evolution in the power spectrum is investigated.

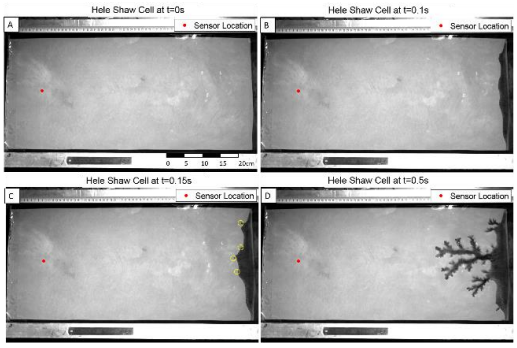

Fig. 1 Aerofractures in a Hele-Shaw cell during air injection

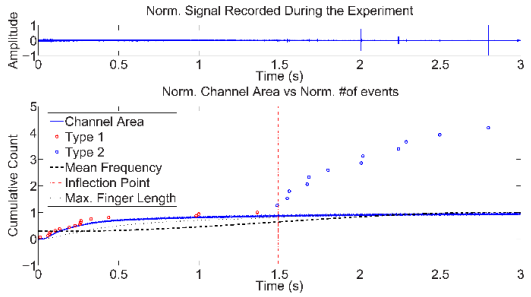

Fig. 2 Top: Signal during air injection inside the cell. Bottom: Number of acoustic events compared with carved area, maximum finger length and mean frequency.

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Session orale : Géologie

Pacific Rim

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

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The Eastern part of Indian Plate is situated in a complex tectonic zone where the Indian-Eurasian Plates and Indian-Burmese Plates are colliding. This region is known for some of the largest intra-continental seismic events of the last 500 years, the 1548 Bengal earthquake of magnitude M>8?, the 1762 Arakan earthquake of magnitude M>8?, the 1897 Shillong earthquakes of magnitude Ms 8.7, the 1918 Srimangal earthquake of magnitude Ms 7.6 and the 1950 Assam earthquake of magnitude Mw 8.6. The source faults of these events and whether these large earthquakes occurred on faults that reached the surface or reminded blind remain controversial. The Bengal basin still needs to be better understood in terms of active faulting and seismicity.

The Eastern boundary of Bengal basin is marked by numerous NS trending folds of Indo-Burma Ranges. We focused on the Raghunandan Anticline, NE Bengal basin, a broad, asymmetric, growing ramp anticline, steep west-facing front and bounded westwards by a steep tectonic scarp truncating gently east dipping Quaternary sandstone beds. The scarp morphology is suggestive of a still preserved co-seismic free face above a colluvial wedge. We carried out more than 20 topographic profiles to document the precise height and shape of this 12-15 m high scarp (above alluvial surface) and to survey a set of uplifted alluvial terraces located along the Shahapur River behind the scarp. The analysis of the topographic profiles around the Shajibazar area reveals the presence of 5 alluvial terraces hanging 3 m to 19 m above Shahapur River bed. T1 and T2 terraces are the best-preserved terraces on both sides of the Shahapur River. C^{14} and Be ^{10} ages allow to date the lowest abandonned terrace and to estimate the uplift rate of this area.

We also mapped the major faults, rivers and Quaternary surfaces of the southern part of the Shillong Plateau. 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

Assessing the impact of orogenic inheritance on the architecture, timing and magmatic budget of the North Atlantic rift system: a mapping approach

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To investigate the impact of orogenic inheritance on the characteristics of the North Atlantic rift system we develop new mapping methods that highlight the first-order architecture and timing of rifts, as well as the distribution of heterogeneities inherited from the Palaeozoic Caledonian and Variscan orogenies. These maps demonstrate major differences in the behaviour of the North Atlantic rift system relative to both orogens, with the Variscan front appearing to be an important boundary. Indeed, the rift cuts

through the Caledonian orogen and parallels its structural grain to the north, while it circumvents the core of the Variscides to the south. In addition, rifting is protracted and polyphase with breakup being magma-rich north of the Variscan front, as opposed to the south where a single, apparently continuous extensional event led to magma-poor breakup in less than 50 Myr. Besides, the North Atlantic rift system reactivates sutures corresponding to large (> 2,000 km) former oceans, while sutures of small (< 500–1,000 km) oceanic basins are little affected in both the northern and southern North Atlantic. These observations point to a major influence of orogenic inheritance on the characteristics of rift systems.

Evidence of hydrothermal fluid flow in distal rifted margins: the case study of Err nappe (Switzerland)

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The increasing availability of high resolution seismic and deep drill hole data allowed to understand the architecture of present-day passive rifted margins and to propose new models about their tectono-stratigraphic evolution. Nonetheless, the thermal evolution of distal margins is poorly constrained, although hydrothermal systems seem to play a key role in determining the short termheat fluxes. This study aims to characterize ancient hydrothermal systems including mass fluxes and fluid types and their relations to the stratigraphic and main tectonic structures observed in the Adriatic paleo-margin. In the studied area (SE Switzerland) a detailed sampling was carried out on carbonate rocks from the most proximal to the most distal parts of the ancient margin. We are focusing on the interaction between fluids and pre- and syn-rift sediments that are, respectively, preserved as extensional allochthons and basin-filling sedimentary breccias that reworked both the footwall and hanging wall of the detachment fault. Field evidence, petrography and cathodoluminescence reveal a strong heterogeneity in the composition of the fluid. Crosscutting relationships provide evidence of how the hydrothermal products refer to different steps of the evolution of the margin, from very early stages during the onset of extension until the Alpine orogeny. O, C and Sr isotopic analysis, fluid inclusions microthermometry and geochemistry have been performed. The results point to a hydrothermal origin of the fluids flowing through the sediments coupled with a strong interaction with the underlying granitic basement. These data can also be compared with those coming from present-day Iberia continental margin (ODP Leg 103).

How do physical properties influence the shape of hyper-extended rifted margins?

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The increasing availability of high resolution seismic and deep drill hole data allowed to understand the architecture of present-day passive rifted margins and to propose new models about their tectono-stratigraphic evolution. Nonetheless, the thermal evolution of distal margins is poorly constrained, although hydrothermal systems seem to play a key role in determining the short termheat fluxes. This study aims to characterize ancient hydrothermal systems including mass fluxes and fluid types and their relations to the stratigraphic and main tectonic structures observed in the Adriatic paleo-margin. In the studied area (SE Switzerland) a detailed sampling was carried out on carbonate rocks from the most proximal to the most distal parts of the ancient margin. We

are focusing on the interaction between fluids and pre- and syn-rift sediments that are, respectively, preserved as extensional allochthons and basin-filling sedimentary breccias that reworked both the footwall and hanging wall of the detachment fault. Field evidence, petrography and cathodoluminescence reveal a strong heterogeneity in the composition of the fluid. Crosscutting relationships provide evidence of how the hydrothermal products refer to different steps of the evolution of the margin, from very early stages during the onset of extension until the Alpine orogeny. O, C and Sr isotopic analysis, fluid inclusions microthermometry and geochemistry have been performed. The results point to a hydrothermal origin of the fluids flowing through the sediments coupled with a strong interaction with the underlying granitic basement. These data can also be compared with those coming from present-day Iberia continental margin (ODP Leg 103).

Session des Posters

The Truman Show

Melt infiltrations in heterogeneous mantle domains during oceanization. Evidences from present-day and fossile magma-poor rifted margins

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Magmatism processes occurring before and during the lithospheric and continental break-up in magma-poor margins leading to a steady-state ocean seafloor are still in debate. Despite the obvious effect of the tectonic activity caused by the upwelling of the asthenosphere, magmatic processes also play a key role in the kick-start of the oceanization. To decipher the impact of such processes in the opening of a new ocean, Ocean-Continent-Transitions (OCTs) are of a particularly great interest. OCTs are complex areas where hyperextended continental crust, exhumed mantle and proto-oceanic crust occur. All these domains have been identified and sampled in both present-day and fossile margins. In this study, we focus on the mantle section of OCTs and associated melts.

Exhumed mantle encounters two types of mantle: (i) a « sub-continental domain » free of syn-rift melt imprint and where the ancient history remains preserved, and (ii) a « refertilized domain » characterizes by melt infiltrations and mantle-melt interactions. This study aims to discriminate these mantle domains on the basis of their chemical compositions. We therefore summarize whole-rock, *in-situ* and isotopic analyzes available in the literature and complete the existing database with new additional data (mainly from *in situ* approaches). In addition, we show that the magmatism related to an oceanic inception is transitional from alkaline to N-MORB-type melts.

Interprétation aéromagnétique régionale du bassin d'Illizi et locale de la région des Tassili N'Ajjer.

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Le bassin d'Illizi (Sud-Est algérien) est une dépression intracratonique du paléozoïque et mésozoïque inférieur situé dans la plateforme saharienne, entre le massif du Hoggar et l'Atlas saharien. Il a évolué au cours du Paléozoïque comme un dépocentre intracratonique où l'épaisse série sédimentaire repose sur un socle granitique et cristallométamorphique d'âge Précambrien, qui serait de même nature que celui du Hoggar.

Le bassin d'Illizi est parmi les bassins sahariens qui ont mieux préservé l'enregistrement sédimentaire de la glaciation ordovicienne supérieur (445,6-443,7 Ma). Des paléovallées (structures glaciogéniques de l'ordovicien supérieur) ont été identifiées par de nombreux sédimentologues, soit en affleurement dans les Tassili ou en sub-surface à Tinguentourine et In Aménas.

Pour la reconnaissance des grands traits structuraux du bassin, de la topographie du socle, ainsi que de l'architecture des paléovallées glaciaires en surface ou en sub-surface, des méthodes géophysiques (gravimétrie, magnétisme et sismique) ont été utilisées.

L'analyse qualitative basée sur les cartes de méthodes potentielles ont permis de mettre en évidence de nombreuses structures et failles d'orientations multiples (N-S, NE-SW, NW-SE). Ainsi nous avons pu établir une carte structurale régionale. La comparaison de l'allongement et l'orientation des paléovallées nous permet de les mettre en relation avec l'orientation des failles panafricaines.

Comme première étude, on a opté pour les Tassili, qui constituent la preuve terrain car les structures glaciaires sont à l'affleurement et bien identifiées par les géologues. On applique une

série d'opérateurs de transformations de cartes magnétiques, avec pour objet de mieux imager les paléovallées. Ainsi on calcule un modèle pour une paléovallée bien apparente sur les données magnétiques, qui servira par la suite comme analogue pour calculer celles de sub-surface ou plus profondes, sachant que les paléovallées d'In Aménas sont de bons réservoirs pétroliers en cours d'exploration et exploitation.

Rôle des phases organo-minérales des sols en tant que réservoirs de nutriments : Approche expérimentale (biotique et abiotique) et multi-isotopiques (isotopes stables Ca-Sr-Li)

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Le calcium étant un macronutriment essentiel à la croissance végétale, la question de sa réserve et de sa biodisponibilité dans les sols se pose. Il apparaît que les phases organo-minérales des sols (minéraux argileux, complexe argilo-humique, hydroxydes de Fer…) jouent un rôle important dans le stockage/relargage de nutriments de par leur capacité de rétention des cations lié à des phénomènes d'adsorption/désorption. L'étude des mécanismes de fractionnement isotopique (amplitude, nature) associés à ces phénomènes et permettant la contrainte des cycles biogéochimiques des nutriments reste très mal comprise.

Cette thèse se propose donc d'améliorer la connaissance du cycle biogéochimique global du Ca à l'interface eau-sol-plante en couplant trois systèmes isotopiques qui ont des domaines d'application complémentaires (isotopes stables Ca-Li-Sr) ainsi qu'en identifiant et quantifiant l'origine et l'intensité des fractionnements isotopiques associés.

Pour cela des expériences abiotiques d'adsorption/désorption de ces éléments sont actuellement réalisés en laboratoire sur des matériaux « modèles » (phyllosilicates, acide humique, hydroxyde de fer). Dans un deuxième temps la compétition entre ces différents éléments et l'effet potentiel de communautés bactériennes du sol sur l'intensité du fractionnement isotopique observé est à tester, avant de passer à une étude en milieu naturel sur des échantillons du bassin versant du Strengbach.

Les premiers résultats en milieu abiotique ne montrent aucun fractionnement isotopique significatif du calcium au cours de l'adsorption sur la Kaolinite (KGa-2) ainsi que sur la Muscovite de Tuftane, quels que soient les paramètres utilisés (durée d'adsorption, pH, concentrations élémentaires de la solution mère).

Évaluation d'un schéma stratégique des énergies renouvelables (EnR) appliquée à l'eurométropole de Strasbourg

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Pour parvenir à atteindre les objectifs du Schéma Régional Climat-Air-Energie alsacien :

- l'augmentation de 20 % de la production d'énergies renouvelables d'ici 2020
- la réduction de 20 % de la consommation énergétique finale entre 2003 et 2020
- la diminution de 75 % des émissions de gaz à effet de serre à l'horizon 2050

Les territoires urbains sont les mieux placés, mais ils doivent faire face à plusieurs difficultés :

- gérer l'évolution des énergies décentralisées (production d'énergies renouvelables, proche du consommateur final)
- coordonner différents groupes d'acteurs (fournisseurs d'énergies, associations, bailleurs sociaux, aménageurs, résidents, etc...)
- mieux comprendre les interactions dynamiques entre les composants du système énergétique.
- rassembler des données (production, consommation), avoir des outils et moyens de communication pour fédérer tous les acteurs.

Le projet PLAN-ER un outil d'aide à la décision

Le projet franco-allemand (2012-2015) PLAN-ER INTERREG IV Rhin Supérieur (soutenu par l'ADEME) a pour objectif de créer un outil de planification pour l'aménagement des énergies renouvelables. Ma thèse propose de poursuivre la création de cet outil (collecter des données) et étudier et évaluer un schéma stratégique des

énergies qui prend en compte la réhabilitation du bâti et le développement des EnR.
L'objectif de la thèse consiste à tester l'hypothèse d'une optimisation d'un mix énergétique à l'échelle du territoire en tenant compte des potentiels énergétiques (techniques, financiers, environnementaux, si possible) et humains. Cette recherche rend compte des problèmes liés à l'échange de données, leurs uniformisations et/ou leurs absences.

Characterization of basement highs in hyper-extended rift systems: examples from the Err nappe, Switzerland

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Despite of the fact that many studies investigated magma-poor rifted margins, there are still open questions that are related to the nature of basement highs and the timing and processes related to their formation. While these questions are difficult to answer at present-day margins due to the lack of drillhole data, field analogues provide important insights and enable to find some answers to these questions. This is particularly true for the Err nappe in southeastern Switzerland, which is one of the world's few exposed and preserved rift-related hyper-extended domains. This nappe preserves a rift related extensional detachment system that is exposed over more than 200km^2.
The aim of our study was to investigate the 3D architecture of the detachment system based on detailed mapping of its structure north and south of the Julier valley between Bivio and San Moritz in Central Grisons, SE Switzerland. Our results show strong lateral variations of the morphology of the major detachment fault and of its relation to extensional allochthons and the pre-, syn- and post-tectonic sediments. The main observation presented in this poster is that the architecture of the detachment system changes over very short distance from a situation where the detachment is overlain by an allochthonous block and syn-tectonic sediments to a state where the detachment fault is exhumed at the seafloor and directly overlain by post-rift sediments. The mapping of thickness variations and facies changes in the syn-tectonic sediments and the occurrence of prominent hiatus in the sedimentary sequence suggest a complex morpho-tectonic evolution of the detachment system.

Sensitivity analysis of the air quality model INCA-Indoor to few input parameters using automatic differentiation

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INCA-Indoor, a new indoor air quality (IAQ) model is developed to simulate the concentrations of the indoor major chemical species which may impact the health. This model takes into account all the processes existing in confined environments such as: ventilation, emission, deposition, gas phase chemical processes. A sensitivity analysis of the INCA-Indoor model is performed to identify the most sensitive parameters and processes. The goal of this research is to (i) identify the major uncertainty sources in order to improve the simulations, (ii) to set a guideline for improvement of the indoor air quality, and (iii) to estimate uncertainties on the simulations. In this communication, a first sensitivity analysis is carried out using a differentiation algorithm, called hereafter TAPENADE. TAPENADE allows the computation of the tangent linear derivatives of the INCA-Indoor model. It is applied here to calculate the local fist order sensitivities defined as partial derivatives of indoor species concentrations with respect to the model parameters. The results allows for the identification of the main chemical reactions pathways and the physical parameters that can affect key indoor air pollutant concentrations.

Une base de données pour l'évaluation et le suivi de la qualité hydrobiologique des cours d'eau

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FresQueau, soutenu par l'ANR (ANR 11 MONU 14), est un projet interdisciplinaire porté par un collectif d'informaticiens, d'hydrologues et d'hydroécologues issus de quatre laboratoires de recherche et de deux bureaux d'études. Son objectif est de développer des méthodes de fouilles de données pour l'évaluation de la qualité écologique des cours d'eau.

Ce poster en présente la première étape: la collecte et la structuration des données à fouiller. Les données sont issues de 21 bases de données sources et de 16 fournisseurs différents. Elles concernent deux districts : Rhin-Meuse et Rhône-Méditerranée-Corse et sont déclinées en cinq thèmes : (1) la qualité physico-chimiques et biologiques de l'eau, (2) les réseaux hydrographiques, (3) les stations de mesures, (4) les variables de contexte et de forçage telles que le climat ou l'hydrologie, (5) les activités humaines. Nous avons réalisé un important travail de modélisation et d'intégration pour aboutir à la base de données FRESQUEAU de 20 giga-octets, comprenant 80 tables et implantée en PostgreSQL/PostGIS. Un système d'exploration des données par « forages » successifs selon plusieurs dimensions est proposé pour le thème qualité de l'eau. Ayant été un des principaux acteurs de la collecte de cette étape du projet, ces données, leur structuration et les outils d'exploration développés constituent une partie des matériel et méthodes de mon sujet de thèse intitulé : « Comment combiner des indicateurs chimiques et biologiques pour l'évaluation de l'état, des pressions et de la capacité de résilience des rivières ».

A new setup for studying thermal microcracking through acoustic emission monitoring

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Thermal stressing is common in nature and has been shown in the laboratory to induce changes in the physical and mechanical properties of rocks. These changes are generally considered to be a consequence of the generation of thermal microcracks and debilitating chemical reactions. Thermal microcracks form as a result of the build-up of internal stresses due to: (1) the thermal expansion mismatch between the different phases present in the material, (2) thermal expansion anisotropy within individual minerals, and (3) thermal gradients. The generation of cracks during thermal stressing has been monitored in previous studies using the output of acoustic emissions (AE), commonly used as a proxy for microcrack damage, and from microstructural observations. Here we present a new experimental setup which optimised to record AE from a rock sample at high temperatures and under a servo-controlled uniaxial stress. The design is such that the AE transducer is embedded in the top of the piston, which is acting as a continuous wave guide to the sample. In this way, we minimise the number of interfaces between the microcrack and the transducer, maximising the quality of the signal. This allows for an in-depth study of waveform attributes such as energy, amplitude and duration. Furthermore, this device has the advantage of being able to apply a servo-controlled load on the sample, whilst measuring strain in real time, leading to a spectrum of possible tests combining mechanical and thermal stress. We plan a systematic experimental study of the AE of thermally stressed rock during heating and cooling cycles. The first series of pilot tests were performed on Darley Dale

sandstone. Understanding the effects of thermal microcracking in rock is of particular interest at a geothermal site, where circulating fluids are at a different temperature to the surrounding rock mass. This is a source of thermal stressing which can, for example, provoke thermal borehole breakouts due to cooling-induced tensile microcracking or can be actively used to enhance the injectivity of geothermal wells.

Apport du magnétisme multi-échelle dans la compréhension de la proche surface : application à la base Ba 112 (Reims)

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Cette étude est basée sur un partenariat entre l'EOST, le CEA et l'entreprise Cardem. L'objectif est d'aller plus loin dans la compréhension de la répartition des aimantions dans le sous-sol. Le lieu choisi est l'ancienne base aérienne 112 de Reims. En effet, des vestiges archéologiques, des traces de combats des deux guerres mondiales et des structures anthropiques actuelles (réseaux et bâtiments) y sont présents. La problématique est de mieux quantifier l'apport d'acquisition de mesures magnétiques à différentes échelles et altitude pour la compréhension et la modélisation des aimantations dans le sous-sol en trois dimensions. L'éventail des acquisitions s'étend de la mesure aéroportée à cent mètres d'altitude à une cartographie magnétique centimétrique ciblée sur certaines zones d'intérêt. Pour une des zones étudiées, quatre acquisitions magnétiques distinctes ont été effectuées, deux en aérien, deux au sol. La première utilisait un Ulm, deux capteurs étant placés aux extrémités des ailes. L'Ulm volait à cent mètres du sol avec un espacement des profils de cent mètre. Par la suite, les acquisitions se sont rapprochées du sol avec l'utilisation d'un drone. Grâce à cet outil, des mesures ont pu être effectuées à cinq, quinze et trente-cinq mètre du sol. Puis, les mesures se sont faites au sol, les capteurs étant placés à un mètre du sol. Enfin, pour obtenir une plus grande résolution des données, des profils de mesure ont été enregistrés tous les vingt centimètres et à une vingtaine de centimètre du sol.

Integration of isotopes into coupled Hydrogeochemical Modeling

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Reactive transport modeling is applied widely; fields vary from the study of rock weathering to pollutant migration within the soil. Space and time scales vary from field to field but the main concept remains untouched: water moves within the porous medium, bringing different substances in and out of it. During this journey, substances change as a consequence of their reciprocal interaction and their interaction with the porous medium. The aim of reactive transport modeling is describing the journey of water and the changes that brings. How can reactive transport modeling describe such a complex phenomenon? The answer is: through equations. There are equations describing transport and there are other equations describing chemical reactions, and those laws are strictly coupled. The analytical solution of such equations is possible only for extremely simple situations that have nothing to do with reality. The only alternative to analytical solutions are numerical solutions, i.e. approximated solutions obtained through spatial and chronological discretization of the problem and carried out by a computer. Human beings and computers communicate through different languages (FORTRAN, C, C++ etc.) and a code written in a given language is nothing but a sequence of requests understandable by a computer. A code for reactive transport modeling is then a list of orders to be executed by the computer in order to provide an approximated solution for our group of equations. The spatial domain is divided in a huge number of cells (10000, as order of magnitude) and the duration of the process is also divided in subsequent time steps. At each time step approximated equations are solved within each cell. In some codes the solution of

transport and chemistry are called together at each time step (global approach), in other codes they're called separately (sequential approach). In this context it's clear that the numerical solution has to be as reliable and fast as possible. In reactive transport codes working with a sequential approach, equations coming from chemistry are usually solved through Newton Raphson Method, a technique known for being fast when successful, but rather prone to failure. For this reason, modifications to Newton Raphson algorithm are necessary, and some of them were tested: from the application of preconditioners to coupling Newton Raphson algorithm with complementary techniques such as Positive Continued Fractions. Once the basic features of the code prove to be robust then additional capabilities (such as that of treating isotopes) can be safely implemented.

Transport of pesticides in small agricultural head-catchments: coupling hydrological and stable isotope approaches

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Synthetic and inorganic pesticides are increasingly used since the last decades to control diseases and pests in cultures. However, only a fraction of pesticides efficiently reaches their target. The remaining fraction enters into the atmosphere and the soil, where it can accumulate and become toxic to organisms. In the soil, pesticides interact with the porewater and the particle-size fractions, including carbonates, oxides, phyllosilicates or organic matter, and microorganisms. Synthetic pesticides can undergo processes such as sorption/desorption, chemical and microbial degradation, while inorganic pesticides can diffuse into the soil micro pores, enter the solid phase by precipitation at the surface of soil compounds or co-precipitation with metallic oxides and carbonates. These processes decrease the availability and the mobility of the pesticides. Depending on the hydrological settings and agricultural practices, pesticides can be exported towards aquatic ecosystems due to soil erosion, including dissolution of soil sorbed pesticide, or following rainfall events. So far, most of the studies focusing on pesticides look at the bulk soil without taking into account the particle-size fractions of the soil and the kinetic of pesticides partitioning among these fractions. In addition, the impact of the soil water content and temperature on the fate of pesticides needs to be evaluated in order to better assess seasonal variations of pesticides pools and to a greater extent the possible effect of global warming. Studies on the co-effects of both synthetic and inorganic pesticides on their respective partitioning and degradation are scarce. This PhD thesis aims to focus on the processes that lead to the evolution of the association of pesticides with soil components and the transfer of pesticides from the soil to runoff or leaching waters in small agricultural head-catchments, from their application to their export toward aquatic ecosystems, with respects to hydrological conditions and agricultural practices. Field campaigns and lab experiments will be coupled to evaluate the degradation kinetics of pesticides and the temporal evolution of pesticides partitioning in soil particle-size fractions using stable isotope analysis. From March to November 2015, soil, runoff, leaching and precipitation waters were collected at the experimental vineyard catchment of Rouffach (Alsace, France). These samples currently undergo quantification and isotope analyses, of the two metals Cu and Zn introduced as Cu-based fungicides and by-products of different formulations, respectively, as well as of nineteen pesticides, previously or currently used by agricultural holders. Preliminary results emphasize that (i) Cu and Zn differ in terms of mobility and response to rainfall events in the catchment (e.g. 1.23 fold more dissolved Zn exported than Cu), and (ii) the catchment outlet and precipitation waters contain four pesticides (e.g. pyrimethanil, tetraconazole, kresoxim-methyl and pyraflufen-ethyl) that can be evaluated by compound-specific isotope analysis (CSIA), thereby opening the door to the *in situ* evaluation of pesticide degradation rates and pathways. In order to better understand the degradation of pesticides in the field, two laboratory experiments are currently set up, using two Calcareous soils, e.g. the Rouffach soil

and a crop soil from another field site in Alteckendorf (Alsace, France). The first experiment focuses on the degradation kinetics of synthetic pesticides and the evolution of their carbon and nitrogen isotope composition. The two soils are spiked with a mix of 19 synthetic pesticides at environmental concentration and incubated up to 200 days. The effect of two water contents and two incubation temperature (e.g. 20 or 30 °C) on the degradation is investigated. The second experiment evaluates how pesticides interact over time with the soil components and partition in the particle-size fractions. The soils are spiked with synthetic pesticides at environmental concentration and/or inorganic ones at concentration toxic for microorganisms, at 20 % soil water content, and incubated up to 200 days at 20 °C. Overall, this study couples field and lab experiments to evaluate key-factors controlling the reactivity of pesticides in soil in the context of changing hydrological conditions. In particular, this will enable to improve predictive models for pesticide transport accounting for the transformation reactions in the soil with respects to hydrological and agricultural conditions.

Water-rock interaction and water mixing processes from regolith to catchment scale: evidence from trace elements, Sr-Nd-Pb-U-Th + O-H isotopes

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Hydrological studies need better tools for understanding mixing of water sources and flow paths within their geological system context. It is essential to well describe geological and hydrological behaviour from soil to catchment scale. At the same time, the soil water content is of primary importance since the soil solution is the vector of the matter exchange between soil and vegetation or soil and groundwater. It is the phase, which is best suited to characterize the current dynamics in the soil and to provide information on mid- to long-term soil processes. Here, we propose a multi tracer approach using Sr-Nd-Pb-U-Th radiogenic isotopes and trace elements concentrations parallel combined with stable isotopes of water (2H, 18O). Radiogenic isotopes and trace elements are powerful geochemical tracers since they provide stable signatures due to the lack of isotopic fractionation. Thus, they can be useful indicators of the spatial origin and evolution of regolith materials and waters, whereas stable isotopes, are used to trace water sources and water transit times. Our objectives are: i) incorporating geochemical signatures derived from radiogenic isotopes and trace elements to the description of flow paths and sources of water contributions in the stream; ii) assessing the most suitable tracers for water collection, mixing, storage and release processes.

Etude de l'apport d'un modèle de vitesse 3D pour la localisation de la micro-sismicité des glissements de terrain argilo-marneux

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La micro-sismicité permet de mieux comprendre les mécanismes liés à la déformation observée sur les glissements de terrain. Cependant, l'interprétation et l'étude de ces signaux reste difficile à cause (a) de la géométrie du réseau sismique, (b) de la difficulté d'identifier et de différencier l'arrivée des différents types d'ondes, (c) de l'hétérogénéité des vitesses sismiques dans le milieu étudié. L'intégration d'un modèle sismique 3D (onde P) dans deux algorithmes de localisation a été testé afin de mieux prendre en compte l'hétérogénéité du milieu et d'améliorer les localisations en dehors du réseau sismique.
Le glissement argilo-marneux de Super-Sauze (Alpes) a été étudié. La majorité des signaux sismiques détectés proviennent de l'amont du glissement. Deux antennes nano-sismiques composées de 3 sismomètres verticaux et d'un

sismomètre trois composantes centrales y sont installées de façon permanente à l'est et à l'ouest de la zone active. Une campagne de tomographie sismique a permis de réaliser le modèle de vitesse 3D en ondes P. Douze profiles ont été obtenus par inversion Quasi-Newtonienne puis interpolés afin d'obtenir un modèle final. Des grilles de temps de trajet sont ensuite calculées par FMM (Fast Marching Method) pour chaque capteur. Deux algorithmes de localisation sont testés : l'un basé sur une inversion probabiliste de l'hypocentre et du temps d'origine à partir du pointé des ondes P, l'autre basé sur l'optimisation de la corrélation inter-traces à partir des grilles de temps de trajets. Des tirs de calibration ont aussi été réalisés afin d'estimer les corrections de station nécessaires. Ces algorithmes ont été testés tout d'abord sur des signaux synthétiques. L'utilisation du modèle de vitesse 3D permet de réduire significativement les erreurs de localisation (majoritairement inférieures à 20m tant à l'horizontal qu'en vertical). Les signaux sismiques ont ensuite étaient classés et localisés par les deux méthodes en tenant compte des corrections de station.

Evaluation des bénéfices écologiques apportés par des modifications géomorphologiques à deux communautés biologiques spécifiques. Etude de la faune benthique, de la végétation rivulaire et aquatique

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Au cours des deux derniers siècles, la plaine inondable du Rhin supérieur a été soumise à des travaux hydrauliques importants (redressage, canalisation) qui ont entraîné des pertes de fonctionnalité écologique. Le Vieux Rhin (partie résiduelle naturelle du Rhin après canalisation) a été particulièrement touché par les aménagements. Au vu des déficits fonctionnels du Vieux Rhin, des actions de restauration ont été effectuées visant à diversifier ses habitats aquatiques et riverains. Deux types principaux de restauration sont mis en œuvre : la recharge sédimentaire et l'érosion maîtrisée. Le travail doctoral consiste à évaluer les bénéfices écologiques de ces actions de restauration basées sur des modifications d'ordre physique en étudiant deux compartiments étroitement liés à la qualité du milieu: les invertébrés et la végétation (rivulaire et aquatique). Une étude diachronique de la dynamique de ces deux communautés biologiques est en cours pour identifier les changements liés aux modifications géomorphologiques. L'objectif de la recherche est de mettre en évidence le lien entre les compartiments biologiques et leur habitat-substrat, mesurer la sensibilité de ces écosystèmes fluviaux restaurés aux espèces envahissantes végétales (*Fallopia japonica* et *Elodea nuttallii*) et animales (*Dikerogammarus villosus* et *Neogobius* sp.) ainsi qu'identifier les adaptations et interactions entre espèces dans la structuration d'une biodiversité nouvellement créée.

Ground Penetrating Radar investigation for the characterization of Songino active fault, Ulaanbaatar, Mongolia.

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The seismic activity observed in the vicinity of Ulaanbaatar (UB) city not only has been increased since 2005, but it is also organized, at least, on two perpendicular directions which determine two active faults: Emeelt fault (40 km long, situated 15 km NW of UB) and Hustai fault (80 km long, less than 30 km West of UB). The Songino fault (20 km long, situated 25 km West of UB) is located between Emeelt and Hustai fault. Their length and morphology indicate they can produce earthquakes of magnitude 6.5 to 7.5. Most of the Mongolian population (1.5 million over 3 million) is concentrated around UB

city which is the main political and economic centre of the country. Hence, the study of seismic hazard is of first importance for the country. Since the last large earthquake, the fault geomorphology has been smoothed due to erosion processes and a low slip rate. The exact location of the fault is thus hidden in a several meter strip.

In such a context, the Ground Penetrating Radar (GPR) method gives good and useful results and can help to characterize faults by identifying offsets of radar reflections and buried fluvial channel deposits. In order to image and characterize these faults, we have conducted many GPR campaigns in 2010, 2011 and 2013 over active areas around UB. In our study we present only some preliminary results of GPR measurements performed along the Songino fault (in 2013). The objective is to understand its geometry (dip, length, orientation) and the type of displacements and amplitude. In this survey we used 250 MHz, 500 MHz shielded antenna and RTA 50 MHz unshielded antenna and also used a differential GPS in order to measure the topography. One trenche has been dug in Songino area. The interpretation of trenches results combined with GPR images will be shown here.

Evidence of permeability in fractured rocks from deep geothermal boreholes in the Upper Rhine Graben from well-logging data

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The thermal regime of the Upper Rhine Graben (URG) is characterized by a series of geothermal anomalies on its French part near Soultz-sous-Forêts, Rittershoffen and in the surrounding area of Strasbourg. Sedimentary formations of these areas host oil field widely exploited in the past which exhibit exceptionally high temperature gradients. Thus, geothermal anomalies are superimposed to the oil fields which are interpreted as natural brine advection occurring inside a nearly vertical multi-scale fracture system cross-cutting both deep-seated Triassic sediments and Paleozoic crystalline basement. The sediments-basement interface is therefore very challenging for geothermal industry because most of the geothermal resource is trapped there within natural fractures. Several deep geothermal projects exploit local geothermal energy to use the heat or produce electricity and thus target permeable fractured rocks at this interface. Permeability of fractured rocks after drilling operations or stimulation operations