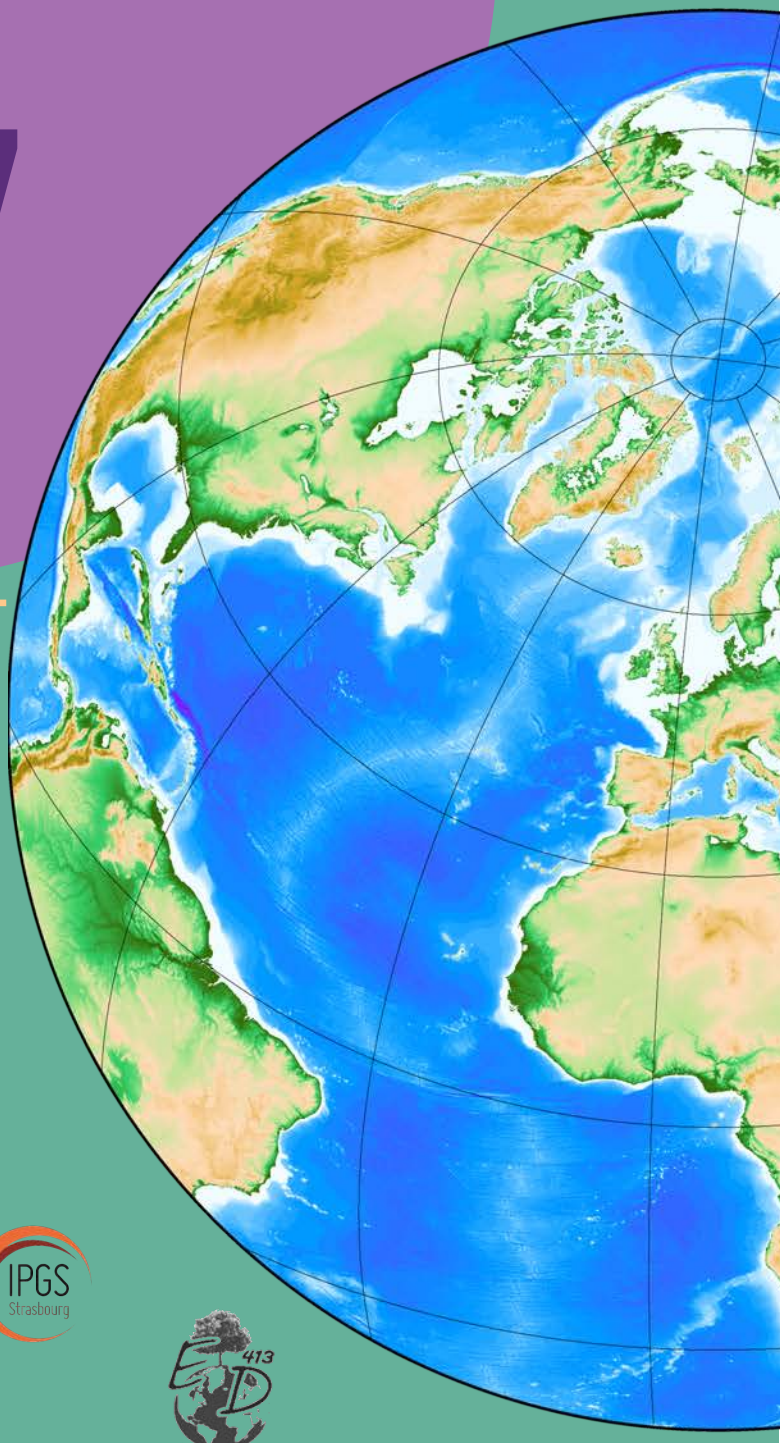
29 // Novembre // 2017 //

CONGRÈS DES DOCTORANTS 2017



SCIENCES DE LA TERRE ET DE L'ENVIRONNEMENT

COLLÈGE DOCTORAL EUROPÉEN
46 BOULEVARD DE LA VICTOIRE,
STRASBOURG

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UNIVERSITÉ DE STRASBOURG

Laboratoire d'Hydrologie et de Géochimie de Strasbourg

IPGS Strasbourg

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Image Ville Environnement

ED 413 Sciences de la Terre et de l'Environnement

Congrès des doctorants 2017

Collège Doctoral Européen – Mercredi 29 novembre

9 :00		**Registration**
9 :15		**Welcome**
9 :30	**Monem Ayaz**	**Fluid transport by capillary-bridges during slow drainage**
9 :45	**Paul Calou**	**Airborne magnetic ranging for magnetization computation**
10 :00	**Shahin Ghahramani**	**Petrography and mineralogy of Iron oxide-Apatite deposits in the Tarom Zone, SE Zanjan, NW Iran**
10 :15	**Camille Jestin**	**An experimental investigation of the role of seismic asperity interactions on radiation efficiency**
10 :30		**Coffee Break**
11 :00	**Rodolphe Lescoutre**	**Control of rift asymmetry on the thermal architecture of hyperextended rift systems**
11 :15	**Josipa Majstorovic**	**Gravimetric observations of gravitational effects: determination of low-frequency normal modes and structure coefficients**
11 :30	**Jeanne Mercier de Lépinay**	**Acquisition and interpretation of magnetic data over Guadeloupe volcanic Island**
11 :45	**Bérénice Vallier**	**THM modeling of large scale hydro-thermal circulation in the deep geothermal reservoir of Soultz-sous-Forts (France).**
12 :00		**Presentation “Les doctoriales d’Alsace”**
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13 :30	**Pierrick Bornemann**	**Detection and quantification of surface changes through dense time series of 3D point clouds**
13 :45	**Valentin Chardon**	**Feedbacks of gravel augmentation in a by-passed reach: The Old Rhine River (France, Germany)**
14 :00	**Wassim Hached**	**The ergonomics of access to everyday facilities by urban public transportation (bus and tramway) and soft mobility: Creating a measuring method applied to the Eurométropole of Strasbourg**
14 :15	**Pablo Alvarez**	**Pesticide degradation and export losses at the catchment scale: insights from compound-specific isotope analysis (CSIA)**
14 :30	**Hamid Badri**	**Inverse problem, a comparison of discrete versus continuous adjoint states to estimate parameters of groundwater flow in heterogeneous dual porosity systems**

14 :45	**Manel Boughanmi**	**A modeling approach to quantify the impact of floodwaters on vertical water fluxes in the plain of sidi Bouzid (Tunisia)**
15:00		**Coffee Break**
15 :30	**Mylène Mombru**	**Lithium and boron isotopes for a new coupled geothermometer.**
15 :45	**Eric Lascar**	**Behaviour of Radium and radioactive ascendants in soil and its transfer to terrestrial plants**
16 :00	**Benjamin Jeannot**	**Dimensionally reduced model for solving surface and subsurface flow at the scale of a watershed system – Model principles and application to a real test case: the Rohrschollen Island**
16 :15	**Justine Négrel**	**Compared behavior of boron, lithium and uranium series isotopes fractionement during the weathering of granite (Strengbach catchment, France)**
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19:00		**Dinner**

Contents

Fluid transport by capillary-bridges during slow drainage

Monem Ayaz[1,2], Renaud Toussaint[1,2], Knut Jørgen Måløy[2], and Gerhard Schäfer[1]

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Abstract

We experimentally study the residual saturation left behind as a fully saturated porous media is drained on a quasi two-dimensional porous model. The model is transparent, allowing the displacement process and structure to be monitored in space and time. Observations show the residual saturation to be interconnected by means of capillary bridges, allowing for seemingly entrapped fluid to be transported back to the bulk. This process shows dependence with the Bond number and a statistical decay with increasing distance from the invasion front. Furthermore we have analyzed the spatial connectivity of the networks spanned by capillary bridges, and examined the occurrence of rupturing of individual bridges.

Tectonic geomorphology and earthquake geology in the central Tell Atlas (northern Algeria)

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Abstract

The topic of my research deals with the tectonic movements of past earthquakes along the coastal region and active zones of the central Tell Atlas in northern Algeria. The study area belongs to convergent plate boundary zone between Africa and Eurasia. This region experienced large and moderate shallow earthquakes(Mw 7.1 in 1980 at El Asnamand Mw 6.8 in 2003 at Zemmouri)associated with E-W to ENE-WSW trending fold-related faults, confirmed by thrust and reverse focal mechanisms. Our aim is to establish a correlation between visible coseismic tectonic structures with cumulative surface deformation and earthquake generation at depth (see Figures 1 and 2). Tectonic geomorphology and cumulative slip are recorded in geological units, alluvial and marine terraces, and drainage network. The active tectonic structures are identified and characterized also using satellite images (Pléiades) and high-resolution (1 m) DEM. Successive uplift and folding affect the most recent deposits and reveal the occurrence of successive seismic events during the late Quaternary. Several active folds in the Tell Atlas have dimension, geometry and structures analogue to the El Asnam fault-related fold. Among them, the Sahel anticline structure near Algiers that experienced historical earthquakes attests to the existence of a seismogenic structure and a potential for marge earthquakes. Surface and subsurface tectonics including blind faults provide evidence for an active deformation in late Quaternary sediments. Mechanical and elastic modelling shows the existence of reverse fault with a high dip.

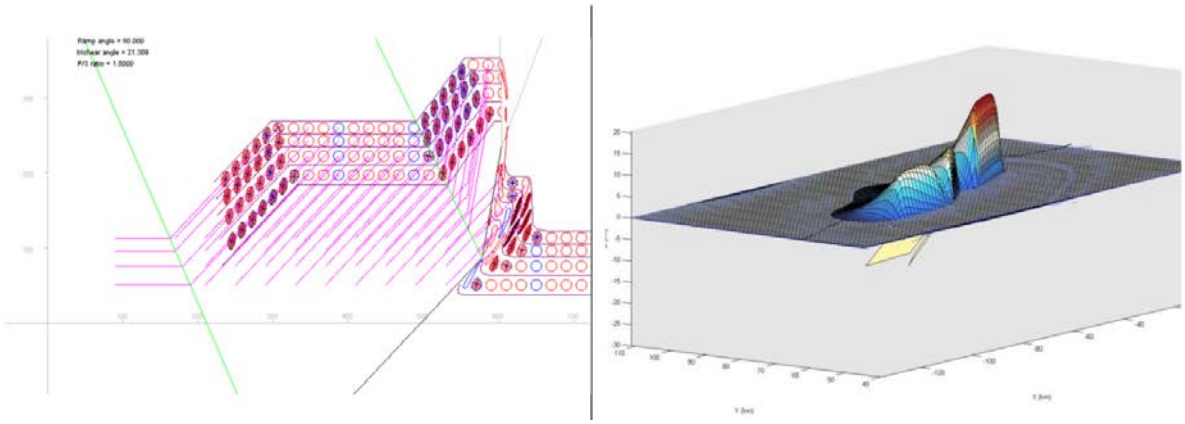

Figure 1: (Left) Mechanical modelling of the Sahel anticline using FaultFold (v4.5). (Right) Elastic modelling of the Sahel anticline using Coulomb (v3.3).

Airborne magnetic ranging for magnetization computation

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Abstract

Magnetic signature is crucial information for warships, as most marine mines are designed with magnetic sensors. Usually, measurements are done over an underwater fixed range of magnetic sensors, and the ship magnetization is derived. This allows the calibration of the degaussing system (coils installed in the ship hull and in the three directions), leading to the reduction of the magnetic signature of the ship. Then, the ship sails to its theater of operations and an Earth's magnetic field model is used to update the degaussing system.

We propose a new measurement system, using an UAV equipped with a magnetometer. With this system, we can reproduce the measurements of the underwater sensors and proceed to the computation of the magnetization at any place in the world. These measurements contain the variations of the hull's magnetization due to sailing and provide information in terms of magnetic signature and efficiency of the degaussing system, in the operation area.

We show why fluxgate sensors can be used for such applications and how we can compensate the effects of the UAV. Finally, inversion results for synthetic data and scaled model experiments are discussed with their key parameters.

Petrography and mineralogy of Iron oxide-Apatite deposits in the Tarom Zone, SE Zanjan, NW Iran

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Abstract

The Tarom volcano-plutonic zone in northwestern Iran is part of the Cenozoic Western Alborz–Azarbaijan magmatic belt elongated in NW-SE and include the minable Magnetite-Apatite ore bodies with W-E trending as en echelon mineralized faults. The area is covered by Eocene marine volcanic rocks (Amand Member of Karaj Formation) including pyroclastic and lava flows with high-K calc-alkaline to alkaline affinity. The volcanic rocks are intruded by quartz monzonite to quartz monzodiorite plutons of Post Eocene-Early Oligocene.

The iron oxide-apatite deposits including Sorkhe-Dizaj, Morvarid, Aliabad, Zaker, Eskandar, Golestan Abad and Zarnan, are hosted by quartz monzonite and subordinately by andesitic tuff. The volcanic rocks and the quartz monzonite are extensively alterated, including argillic alteration, silicification, chloritization (with epidote and actinolite), and carbonatization. The iron ore occurred as few millimeters thick veinlets to few meters thick dyke like crosscutting the quartz-monzonite. It is composed of magnetite with apatite, pyroxene, and actinolite. Many veins include prismatic up to 20 cm long apatites. The main types of mineralization are: (1) dissemination of magnetite and apatite in the host rock, (2) massive vein-type apatite-magnetite ore, (3) irregular vein-veinlets stockwork, (4) banded magnetite–apatite and (5) minor brecciated ores.

Field observations and petrography and mineralogy of polished slabs and thin sections provides support for the hypothesis that I-type granitoids of calc-alkaline magmatic affinity in Kiruna-types iron ores, that occurred in magmatic tectonic setting and the mineralization are in relationship with the metasomatic reactions, hydrothermal fluids, alterations, mineralizations and geochemical characteristics of host rocks.

An experimental investigation of the role of seismic asperity interactions on radiation efficiency

Camille Jestin[1], Olivier Lengliné[1], and Jean Schmittbuhl[1]

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Abstract

The dissipation of the available potential strain energy during ruptures involves multiple physical processes: wave radiation, frictional heating, creation of new surface, etc. The energy repartition among these different processes is still poorly understood in particular for complex material like rocks. In this study, we assess the radiation efficiency η_N (ratio of the radiated energy to the available energy for driving the fracture) of a slow rupture propagation through a heterogeneous interface with numerous asperities for different rupture velocities. We use it as a generic model for monitoring the role of the small scale asperities on the energy dissipation during large scale slow ruptures. We based our approach on an analog experiment of a stable mode I interfacial crack propagation through asperities of variable toughness. Both acoustic and optical advances of the crack front could be measured simultaneously, providing precise estimates of the different dissipated energies. A non-linear increase of the radiation efficiency η_N with the average fracture propagation velocity v is observed over two orders of magnitude independently of the quenched disorder. The observed increase is supported by a model based on the fluctuation of the local rupture velocity induced by the crack front pinning on local asperities and leads to an unexpected behavior: $\eta_N \propto v^{0.55}$ close to the square root of the velocity. We discuss implications for slow ruptures within the Earth accompanied by seismic signals.

Control of rift asymmetry on the thermal architecture of hyperextended rift systems

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Abstract

The evolution of hyperextended rift systems has been widely studied these last decades. Yet, few of them considered the implications of rift asymmetry on the thermal evolution and final thermal architecture of rift basins. In this study, we combine field observations and numerical modelling to assess the first order thermal architecture of asymmetric rift basins. The Pyrenean rift basins have been slightly reactivated during the Pyrenean orogeny and the rift architecture as well as complete stratigraphic sequences are well preserved and exposed in the Pyrenees. As such, substantial thermal data have been collected and new vitrinite reflectance data are provided, highlighting a strong asymmetry in the distribution of Tmax (maximum T^{o}C recorded by a rock) associated with the rift asymmetry (upper vs lower plate). In parallel, we use a numerical model of asymmetric rifting to extract the evolution of top basement heat flow during hyperextension. These results show a strong asymmetry in the distribution of heat flow due to rift migration and exhumation of deep lithospheric rocks at the upper-lower plate transition. Both field observations and numerical modelling suggest a complex and asymmetric thermal architecture in asymmetric rift systems. This study argues for a strong tectonic control on the thermal evolution of hyperextended basins and suggests a complex thermal evolution in space and time that cannot be described with the classical McKenzie model.

Gravimetric observations of gravitational effects: determination of low-frequency normal modes and structure coefficients

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Abstract

Although there are numerous studies about 3D density Earth model, building an accurate one is still an engaging challenge. One procedure to refine global 3D Earth density models is based on unambiguous measurements of Earth's normal mode eigenfrequencies. To have unbiased eigenfrequency measurements one needs to deal with a variety of time records quality and especially different noise sources, while standard approaches usually include signal processing methods such as Fourier transform. Our analysis was performed in three steps. The first step includes the use of stacking methods to enhance specific modes of interest above the observed noise level. Out of three trials the optimal sequence estimation turned out to be the foremost compared to the spherical harmonic stacking method and receiver strip method. In the second step we apply an autoregressive method in the frequency domain to estimate complex eigenfrequencies of target modes. In the third step we apply the phasor walkout method to test and confirm our eigenfrequencies. Before conducting an analysis of time records, we evaluate how the station distribution and noise levels impact the estimate of eigenfrequencies and structure coefficients by using synthetic seismograms calculated for a 3D realistic Earth model, which includes Earth's ellipticity and lateral heterogeneity. Synthetic seismograms are computed by means of normal mode summation and the perturbation theory. Eventually, the methods tested on synthetic data are applied to long-period seismometer and superconducting gravimeter data recorded after six mega-earthquakes of magnitude greater than 8.3. Hence, we propose new estimates of structure coefficients dependent on the density variations.

Acquisition and interpretation of magnetic data over Guadeloupe volcanic Island

J. Mercier de Lépinay[1] and M. Munschy[1]

[1]IPGS, Université de Strasbourg

Abstract

This work is part of the GEOTREF project which benefits from the support of both the ADEME and the French public funds "Investments for the future". The program focuses on the exploration for geothermal resources in Guadeloupe, Lesser Antilles, where a geothermal power plant is in production since 1986 (Bouillante, Basse Terre). For this purpose, the structural geology of the south of Bouillante (Vieux Habitants area) must be known precisely. Considering the dense vegetal cover of the island, aeromagnetic surveying is a well-adapted method to achieve a full recovery of the underlying geology. A precise magnetic dataset was acquired throughout the investigated area using a fluxgate magnetometer mounted on a quadcopter UAV. This measurement system is also well adapted to steep topography environments. The quality of the acquired data can be compared with an already existing aeromagnetic survey (SkyTEM heliborne survey). However, the interpretation of magnetic data can be challenging in volcanic context: not only the magnetization is most likely remanent but the topography can also contribute to the magnetic signal. We compute the effect of the topography and remove it from the data to carry on the interpretation. After having performed synthetic forward modeling and inversion, we invert the magnetic data to obtain a magnetization intensity map. To supplement the interpretation, the use of potential field transforms allows a large variety of structures to be highlighted. The latter provides insights on the nature and distribution of the magnetic sources. An automatic picking method was also performed

THM modeling of large scale hydro-thermal circulation in the deep geothermal reservoir of Soultz-sous-Forts (France).

Bérénice Vallier[1], Vincent Magnenet[2], Christophe Fond[2], and Jean Schmittbuhl[1]

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[2]ICUBE, Université de Strasbourg / CNRS, 72 Route du Rhin, Illkirch, FRANCE

Abstract

Many numerical models have been developed in deep geothermal reservoir engineering to interpret field measurements of the natural hydro-thermal circulations or to predict exploitation scenarios. They typically aim at analyzing the Thermo-Hydro-Mechanical and Chemical (THMC) coupling and the influence of large geological structure. However, few approaches address in details the role of the fluid rheology and more specifically the non-linear sensitivity of the brine rheology with temperature. Here we use the finite element *Code_Aster* to solve the balance equations of a 2D THM model of the Soultz-sous-Forts reservoir in order to invert both the temperature and stress profiles with depth. The brine properties are assumed to depend on the fluid pressure and the temperature. A sensitive parameter is the viscosity of the brine that is assumed to depend exponentially with temperature. The rock matrix is homogenized at large scale with a little influence of the details of the local fault network. We introduced four main geological units to adjust the rock physic parameters at large scale: thermal conductivity, permeability and elastic parameters. We obtain a new family of solutions with a large hydro-thermal convection for which the cover-basement transition has a weak influence leading to a significant hydro-thermal flow close to the surface. Our study provides new insights on the origin of the heat anomaly in Soultz-sous-Forts with a strong geothermal gradient close to the surface.

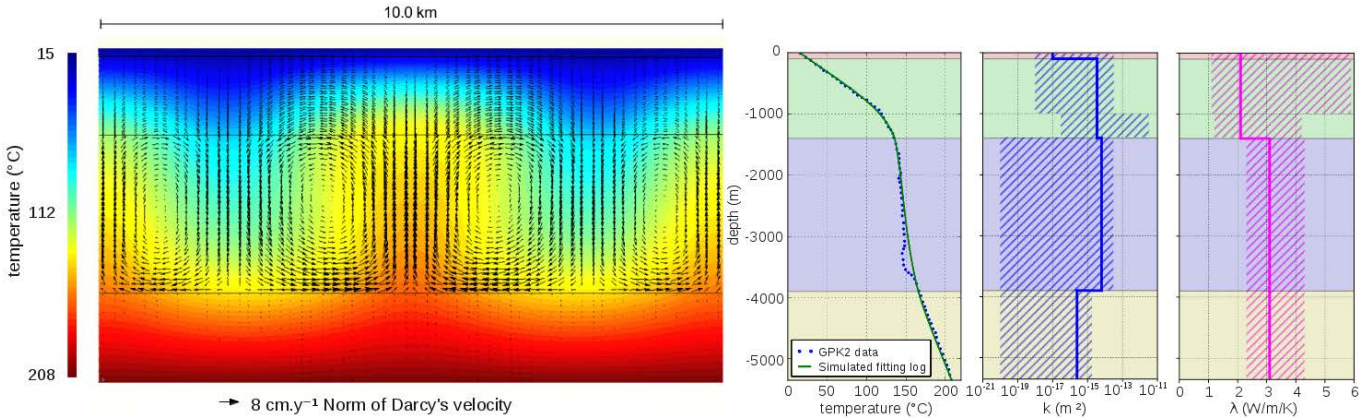

Figure 1: Results of the inversion with experimental temperature-depth profile by adjusting thermal conductivity and permeability. From left to right: maps of calculated temperatures (background colors) and Darcy velocities (arrows) ; vertical fitting temperature profile obtained at the ascending side of the convection cell ; inverted permeability (blue) and thermal conductivity (red) vertical profiles. The shadow zones represent the ranges of values for the two properties from laboratory measurements. The depth of the top of the geothermal reservoir is at 100 meters deep.

Detection and quantification of surface changes through dense time series of 3D point clouds

Pierrick Bornemann[1]

[1]University of Strasbourg

Abstract

Terrestrial Laser Scanning remote sensing is an interesting and innovative method for the quantitative monitoring of environmental systems. The data that it produces are well suited to such studies, mostly because of their high spatial resolution, high accuracy and the density of associated positioning information.

More specifically, dense topographical models in the form of three dimensional point clouds offer valuable insight for the monitoring of features whose evolution results in spatial and temporal changes of surface geometry and topography.

The aggregation of the 3D models in time series and the development of adequate processing methods, have various applications, and come with several transversal methodological challenges (i.e. the development of processing methods that are adapted to multi-scale change detection and to large volumes of multi-dimensional data, use the redundancy of dense 3D data).

In this thesis, we use spatially and temporally dense time series of 3D point clouds for the multi-scale detection and monitoring of surface displacements that affect landslides, and for the extraction of geomorphic surface features such as roughness. In doing so, we also aim at investigating and assessing the overall levels of accuracy and uncertainty associated with 3D datasets.

Feedbacks of gravel augmentation in a by-passed reach: The Old Rhine River (France, Germany)

Chardon .V[1,2], Schmitt, L.[1], Piégay, H.[2], Arnaud, F.[2], Serouillon, J.[1], Houssier, J.[1], and Clutier, A.[3]

[1] Université de Strasbourg, LIVE - UMR 7362 CNRS/ENGEES - LTER - "Zone Atelier Environnementale Urbaine", Strasbourg, France
[2]Université de Lyon, EVS – UMR 5600-CNRS, Lyon, France
[3]Electricité de France, Centre d'Ingénierie Hydraulique (CIH) – Savoie Technolac, Le Bourget du Lac, France

Abstract

The Old Rhine is a 50 km by-passed reach downstream from the Kembs diversion dam in the Alsacian plain (France/Germany). It has been impacted by engineering works since the 19^{th} century. This reach exhibits poor ecological functionalities due to severe geomorphological alterations (e.g., channel bed stabilization, narrowing, degradation and armoring, sediment deficit). In the frame of the Kembs power plant relicensing (2010), Électricité de France has undertaken two gravel augmentations (18 000 and 32 000 m^3) to promote bedload transport. A first pilot gravel augmentation was also implemented in 2010 (23 000 m^3). A geomorphological monitoring based on bedload tracking, grain size analyses and topo-bathymetric surveys has been performed on the three gravel augmentation reaches to assess the efficiency and sustainability of these actions (2010-2017). Results show that augmented gravels are entrained for a Q_2 flood. Gravels moved several hundred meters for moderate floods and up to one kilometer for intense floods (Q_{15}), while sediment deposition mainly diffused within the channel. The mobilization of augmented gravels depends to the deposit placement and configuration. Bed armoring reestablished once the sediment wave moved further downstream, after only four to six years, due to the stability and the narrowness of the channel and the absence of upstream bedload supply. The virtual velocity decreased over time due to progressive tracer burial in the subsurface layer and trapping in the armor layer. Morphological and grain size diversification, including sediment refinement, were relatively limited spatially. Furthermore, the risk of rapid sediment transfer towards channel navigation was discarded. Monitoring results demonstrate that gravel augmentations are not sufficient to diversify geomorphological conditions of the Old Rhine.

The ergonomics of access to everyday facilities by urban public transportation (bus and tramway) and soft mobility: Creating a measuring method applied to the Eurométropole of Strasbourg

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Abstract

The research forms part of the sustainable development. The political commitment is partially reflected by local urban policies. In this case transport is a recursive question. Cities aim is to lessen the negative impact caused by the transport of goods and people. They try to reduce the domination of the city by cars; decreases traveled distances by polluting means of transportation and propose alternative solutions. These policies affect the infrastructure, the practices of sustainable mobility and the morphology of urban space. The RED project (Risques Emergents de la mobilité Durable) analyzes in detail and on different levels the different impacts of these new modes of mobility. I decided to get interested on the impact of the sustainable mobility system on the ergonomics of access of citizens to daily lives facilities. This needs to focus on urban public transport means and soft mobility infrastructure. My goal is to create a GIS measurement and cartography method of *ergonomics of access* to everyday resources. Its aim is to take into account many factors which can encourage or discourage people to adopt sustainable mobility such as: accessibility, space ergonomics like defined by T.SAINT-GERAND, the social factor and the quality of urban space. This method will be, first of all, applied to selected areas, but it is applicable to the whole Eurométropole of Strasbourg. This statistical and mapping method could be used as a support to take decision which help for the detection of socio-spatial disparity, the optimization of the supply of sustainable mobility infrastructure at the best ergonomic of access, lower cost / effort and the simulation of the impact of changes in infrastructure on the lives of everyday citizens.

Pesticide degradation and export losses at the catchment scale: insights from compound-specific isotope analysis (CSIA)

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Abstract

Although pesticides undergo degradation tests prior to use, determining their fate under field conditions remains a challenge precluding adequate water resource management. Compound specific isotope analysis (CSIA) can provide evidence of contaminant degradation extent, as it is generally independent of non-destructive processes regulating environmental concentrations. While this approach has been successfully implemented in subsurface environments, its application to pesticides in near-surface hydrological contexts at catchment scale is lacking. This study demonstrates the applicability of CSIA to track pesticide degradation and export at catchment scale and identify pesticide pool sources in stream discharge under dynamic hydrological monitoring contexts. Based on a change in carbon stable isotope signature $\Delta\delta 13C = 3.1$ ‰S-metolachlor, a widely-used herbicide, we estimate overall catchment degradation to have reached 88% two months after first application. In combination with mass balance (MB) approaches, non-destructive dissipation was determined to have reached 8% of the applied product. Our results show that CSIA can be applied to evaluate natural attenuation of pesticides in top soils at catchment scale. By providing a more detailed account of pesticide dissipation under field conditions we anticipate the contribution of pesticide CSIA to the improvement of regulatory and monitoring strategies.

Inverse problem, a comparison of discrete versus continuous adjoint states to estimate parameters of groundwater flow in heterogeneous dual porosity systems

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Abstract

Dual porosity models become increasingly used for simulating groundwater flow at the large scale in fractured porous media. In this context, model inversions with the aim of retrieving the system heterogeneity are frequently faced with huge parameterizations for which descent methods of inversion with the assistance of adjoint state calculations are well suited. We compare the performance of discrete and continuous forms of adjoint states associated with the flow equations in a dual porosity system. We rely upon an adaptive multiscale parameterization technique manipulating model parameters located at the nodes of a grid independent of the calculation grid. The parameter grid can eventually be refined at some locations. The continuous adjoint state is non-intrusive with the meaning that it does not need modifying the code of the forward problem to be calculated. Both discrete and continuous adjoint states are tested and compared over different test cases encompassing various degrees of heterogeneity of the system. It is shown that the continuous adjoint state can be employed with success under the condition that its calculation is performed over a grid refined enough to catch the spatial distribution of model parameters.

A modeling approach to quantify the impact of floodwaters on vertical water fluxes in the plain of sidi Bouzid (Tunisia)

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Abstract

The sustainability and the depletion of groundwater resources in semi-arid regions are subject to the combined effect of intensive water extraction and scarcity of water recharge. To cope with, the artificial recharge of the groundwater has been favored in the plain of Sidi Bouzid by the development of gabions structures on the Wadi El Fekka designed for spreading of floodwaters. This study aims to quantify the vertical water flux, to establish water balance and to estimate the infiltrated water during successive flooding events. It highlights the variation of water content in response to environmental factors such as evaporation and water root uptake. One-dimensional flow simulations in the deep vadose zone were conducted at three sites. The hydraulic boundary condition of time-dependent water blade applied to soil surface were determined from measured hydrographs of flood. The wetting front behavior was analyzed for four locations of each site. The successive flooding events contributed to a significant artificial recharge of the natural groundwater. The mean annual recharge calculated for the Hachim, Fekka and Guedera sites are approximately 4727, 3224 and 3067 mm, respectively. Although the hydraulic soil parameters did not vary strongly in space, flow simulations conducted for all twelve soil profiles show significant differences in the water balance of about 9 to 16% for the various sites. This can be attributed to the variation of saturated hydraulic conductivities of soil horizons in the studied vadose zone from 1.42 up to $2.58 * 10^{-6}$ m/s. Beneath the root zone, the water content was moderately reduced by the root water uptake and evaporation.

Dimensionally reduced model for solving surface and subsurface flow at the scale of a watershed system - Model principles and application to a real test case: the Rohrschollen Island

Jeannot Benjamin[1]

[1]Strasbourg University, Strasbourg, France

Abstract

Modeling via a mechanistic approach to the dynamics of hydrological systems has revealed an efficient tool for various applications, including decision making regarding water resource management. A pre-existing hydrological model coupling surface and subsurface flow, has been revisited and deeply amended with the aim of building an efficient tool for various simulations of complex systems. The model reduces the three dimensionality of flow to a two-dimensional problem. It is assumed that flow in the subsurface is mainly parallel to the substratum of the aquifer, with the subsequent feature that hydraulic heads are uniform along a direction normal to the substratum. These settings allow for a rigorous integration of the flow equations, then yielding a two-dimensional problem manipulating averaged parameters as integrals along the direction normal to the substratum. The main benefit of this operation is to drastically reduce the number of elements necessary to implement the discrete calculation, resulting in a substantial gain in simulation time, as accurate calculations of water fluxes and hydraulic heads are preserved. The model is applied to the hydrodynamics of an actual restored hydrosystem, namely, Rohrschollen Island of the Upper Rhine River, for the purpose of addressing highly transient hydrological conditions. The calibration and validation steps associated with this modeling exercise show that the coupled model describes fairly well the water dynamics induced by artificial injections of surface water in a channel dug for reconnecting and revitalizing the whole system.

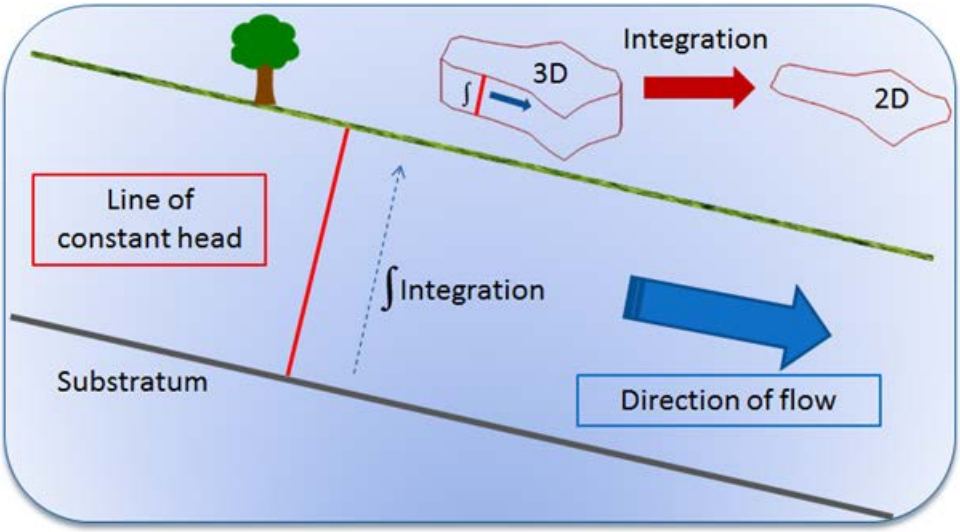

Figure 1: Principle of the dimensionally-reduced groundwater model.

Behaviour of Radium and radioactive ascendants in soil and its transfer to terrestrial plants

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Abstract

Radium (Ra) is a long-lived alpha emitting radionuclide and is of major concern in risk assessment, especially in the nuclear fuel cycle. To date, several studies have shown variable Ra affinities and bioavailabilities among different soil compartments, but the relative role of each compartment has not yet been clearly defined. Little data is available about Ra vegetation cycling. The objective of this study is to constrain the distribution and mobility of Ra in a forest ecosystem using $U-Th-^{226}Ra$-series disequilibria and the $^{226}Ra/^{228}Ra$ ratios. Soil samples, litterfall, roots, leaves, atmospheric dusts and soil solutions were taken at the experimental beech forest site of Montiers (France), belonging to the environmental monitoring OPE network, to constrain the mobility and the biodisponibility of Ra on soil, to establish the Ra input and output on Montiers ecosystem and to identify the Ra residence time within beeches. Also, a litterbags experiment was carried out to understand Ra mobility during beech litter degradation. First results show an apparent lack of ^{226}Ra mobility on soil and the data indicates a preferential mobility of ^{228}Ra relative to ^{226}Ra, which can be explained by a preferential location of the parent long-lived nuclides, ^{238}U and ^{232}Th, in clay minerals and Fe-Mn oxides, respectively. ^{226}Ra appears to be less mobile than Th on some soil solutions, enlightened by a high mobilization of Th by organic matter (OM). Moreover, no release of ^{226}Ra was observed after one year of decomposition of beech litter, which suggest that Ra has formed strong complexes with OM.

Lithium and boron isotopes for a new coupled geothermometer

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[1]LHyGeS

Abstract

The estimation of the temperature in deep hydrothermal fields is essential to evaluate the potential geothermal resources. The analysis of surface hydrothermal springs, supposed linked to the geothermal reservoir, can help for the determination of the deep temperature. Several methods based on major/trace chemical ratio, such as, Na/Li ratio were previously used as a proxy for the temperature acting in the reservoir. Here, a new approach is proposed coupling lithium and boron isotopes to minimize the influence of the mineralogy and deep water chemistry and therefore provide a more reliable geothermometer. The isotopic imprint of water/rock interaction on deep fluids is related to the temperature at which reactions occur. Because the fractionation of lithium and boron is different for a given temperature, coupling these isotopes allows to reduce the number of parameters and test whether equilibrium conditions are reached in the reservoir. This fractionation was investigated through fluid/rock interaction experiments conducted at different pH (3-8) and temperatures ($50 - 200°C$) in diluted seawater. Three minerals – albite, K-feldspar and biotite – and two rock samples – andesite and granite – were used in these experiments to represent several hydrothermal context. Experimental results show that concentrations and isotopic ratios of both elements are clearly dependent on temperature. A decrease of fractionation with temperature is systematically observed. Boron and lithium isotopes primarily result from a mixing between the diluted seawater and the elements released from solids. The temperature dependence of the isotopic fractionation during secondary minerals precipitation appears of second order. These results show that coupling lithium and boron isotopes in hydrothermal fluids allows to remove parameters such as weathering intensity leading to a relationship only dependent on temperature.

Compared behavior of boron, lithium and uranium series isotopes fractionement during the weathering of granite (Strengbach catchment, France)

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Abstract

Boron, lithium and uranium-thorium-radium isotopes have been most often used independently of each other for the purpose of deciphering reactions and rates of water-rock interactions in weathering profiles. Here, we evaluate whether a comprehensive study of their respective isotopic fractionation provides consistent information about the processes that control the development of one weathering profile developed on granitic bedrock and the spatial variability of this different isotopes between six weathering profiles and sediments in the outlet in the Strengbach watershed (Vosges Mountain, France). B and Li isotopic ratios and U-series nuclides have been determined in parallel in the same samples from six weathering profiles, sediments and suspended matters. For each sample both bulk-sample and clay size fractions were analyzed. Measured Li, B and U-series concentrations in the different weathering profiles show enrichment in clay-size samples relative to their respective bulk regolith horizons. We also observe a clear relationship between B isotopic ratios and the mineralogy of the clay size fraction suggesting the presence of two generations of clay minerals mixed in different proportions with depth: hydrothermal clays with $\delta^{11}B$ lower than -30% and pedogenic clays with $\delta^{11}B$ around -20%. The preliminary $\delta^{11}B$, $\delta^{7}Li$ and $(^{234}U/^{238}U)$ ratios measured in the different samples (soil, sediments and suspended matters) suggests a difference of isotopic ratios between soils in this catchment and a difference between sediments and suspended matters. Clays of soils would not be changed by the sediment transport.

Global sensitivity analysis and Bayesian estimation of the parameters: application to transfers in unsaturated porous media

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Abstract

Various contaminants generated by human activities and deposited at the surface of the soil are transported by water run off during rainy events and eventually seep to the water table. In general, early soil horizons condition most of the migration of these contaminants to groundwater. As a result, the study of water and contaminant transfers in the unsaturated porous media is of major importance in order to preserve water and soil quality. For this purpose, modeling appears as an interesting tool for understanding and reproducing the transfer processes in the soil. These processes are described by non-linear differential equations including a large number of parameters that depend on the nature of the soil and the fluid passing through it.

The main objective of this thesis is the use of GLOBAL sensitivity analysis methods and Bayesian parameter estimation for transfers in unsaturated porous media. During these transfers, several quantities can be measured (with more or less precision) and can help characterize the properties of the soil. In this thesis, we are interested in two outputs that are (i) the spontaneous potential induced by the flow of water in the unsaturated zone and (ii) the concentration of a non-reactive contaminant (tracer of water) induced by transport in soil. The global sensitivity analysis and the Bayesian estimation of the parameters will be applied for each of its outputs in order to study the effect of the different parameters on the output in question as well as the identification of the parameters from the output considered.

How to establish a very precise chrono-lithostratigraphic log based on cuttings, core samples, gamma ray logs and analogues: application on the Soultz-sous-Forêts and the Rittershoffen geothermal wells (Rhine Graben, France)

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Abstract

The Upper Rhine Graben (URG) is characterized by abnormal high geothermal gradient especially in Northern Alsace (France) and by the presence of natural brines circulating in the deep fault system. These high temperatures (50^oC at 400 meters deep) and brines (on the order of 100g/L) triggered different geothermal projects in Alsace region (Housse 1984; Schellschmidt and Schultz 1991; Carlier et al. 1992; Vernoux et al. 1995; Sanjuan et al. 2010. The URG is therefore one of the most studied region in Europe, mainly for petroleum exploitation and recently for geothermal applications like on the French side with the Soultz-sous-Forêts geothermal site and the Rittershoffen industrial geothermal one. Between 2012 and 2014, at Rittershoffen, two new geothermal boreholes GRT-1 and GRT-2 were successfully drilled up to the granitic basement, final depth at 2562 m and 2707 m vertical depth respectively. The achievement of the Rittershoffen's geothermal doublet which was the subject of a particular attention in the acquisition of a very precise stratigraphic profile, enabled the establishment of a 3 km-thick complete geological section from the Quaternary formations, through the Cenozoic and Mesozoic sediments down into the granitic Paleozoic basement (Aichholzer et al. 2015). It is the first complete well documented geological log of the entire sedimentary cover of the URG combining the succession of the formations including thickness with precise limits of top and base, age and sedimentary facies. It is the result of a close combination between cuttings and gamma ray log (GR), field campaign and the study of core samples. One of the first steps was to establish the lithostratigraphic log of the borehole with the cuttings and well data.

Mechanical strain measurement from coda wave interferometry

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Abstract

Coda Wave Interferometry (CWI) aims at tracking small changes in solid materials like rocks where elastic waves are diffusing. They are intensively sampling the medium, making the technique much more sensitive than those relying on direct wave arrivals. Application of CWI to ambient seismic noise has found a large range of applications over the past years like for multiscale imaging but also for monitoring complex structures such as regional faults or reservoirs. Physically, observed changes are typically interpreted as small variations of seismic velocities. However, this interpretation remains questionable. Here, a specific focus is put on the influence of the elastic deformation of the medium on CWI measurements. The goal of the present work is to show from a direct numerical and experimental modeling that deformation signal also exists in CWI measurements which might provide new outcomes for the technique. For this purpose, we model seismic wave propagation within a diffusive medium using a spectral element approach (SPECFEM2D) during an elastic deformation of the medium. The mechanical behavior is obtained from a finite element approach (Code ASTER) keeping the mesh grid of the sample constant during the whole procedure to limit numerical artifacts. The CWI of the late wave arrivals in the synthetic seismograms is performed using both a stretching technique in the time domain and a frequency cross-correlation method. Both show that the elastic deformation of the scatters is fully correlated with time shifts of the CWI differently from an acoustoelastic effect. This result could support the interpretation of coda wave interferometry and have implications for ambient seismic noise monitoring.

Measuring finite-frequency S+ScS delay-times: Implications for global seismic tomography

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Abstract

Over the past, seismic tomography has been a major tool for investigating the Earth's interior. This technique was used to detect the main discontinuities of the Earth such as the CMB (core mantle boundary) located at 2900km depth separating the solid silicate mantle from the liquid iron-rich core. However most seismological models exhibit a very poor resolution at this depth due to their poor data coverage. To overcome that problem we need to measure seismic waves that sample the lowermost part of the mantle. ScS-waves are suitable candidates since these waves are reflected at the CMB before going up to the station, and thus have a very good sensitivity to the lower mantle (see Figure 1). Although this latter is a good candidate to enhance our data coverage, ScS wave may interfere with other seismic phases like the direct S-wave making measurements more complex.

In order to increase the number of measured seismic phases at this depth, we will measure the whole interfering wave packet including ScS waves at different frequencies. By measuring those exotic wave packets we will be able to produce new tomographic models with a higher resolution and potentially infer new structural features in the lowermost part of the mantle.

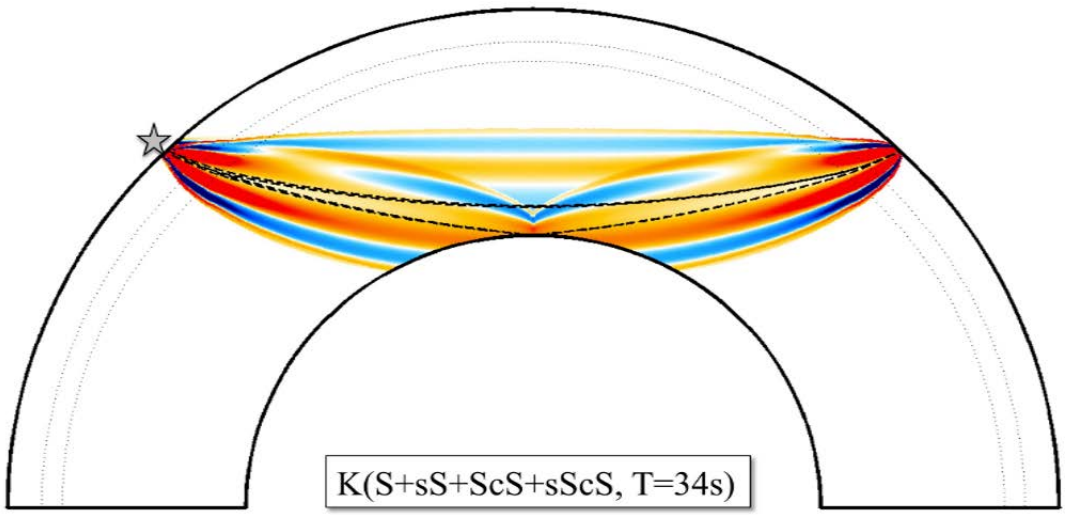

Figure 1: "Moustache kernel": Traveltime kernel for 4 interfering phases: S+sS+ScS+sScS for a measurement at a period of 34s (sS and sScS are the depth phases associated to S and ScS wave respectively). Dash lines represent ray paths of indicated waves and the two circular dot lines indicate mantle discontinuities at 440 and 660km.

Towards an automatic detection of geothermal accidents with InSAR monitoring: case of the geothermal site of Landau (Germany)

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Abstract

The geothermal exploitation of Landau in Germany, located at about 30 kilometres of the French frontier underwent an accident. It was probably caused by a water leak in an injection well. A recent study used the archive of TerraSAR-X acquisitions (2012-2015) and showed that this accident is associated with an uplift of 25 mm spread on the entire city of Landau. From the whole archive of 114 images (2012-2016), we study the evolution of soil surface displacements meanwhile and after the accident to constraint the superficial levels behaviour. We used the StaMPS software (Stanford Method of Persistent Scatterers) because the area mainly corresponds to open fields and the coherence is low. Our results confirm the deformation associated to the accident and its spatial distribution which is concentrated along a North-South axis with asymmetric gradients on both sides of this direction. They also highlight the soil displacement evolution following an exponential decrease towards an uncertain return to the initial state. From this archive and this case, we aim to set up an adapted automatic processing to allow the detection in near real-time of an accident of the same amplitude in the future.

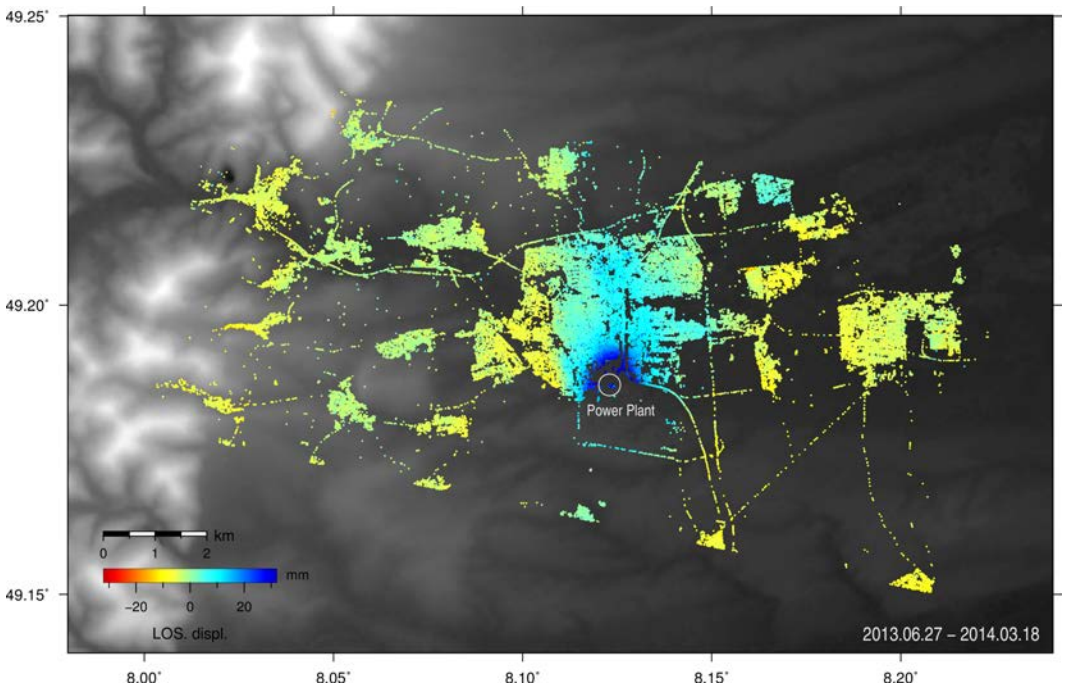

Figure 1: Cumulated LOS displacements field (mm) during the uplift period from June 2013 to March 2014.

Detailed experimental study of the continuous to intermittent flow transition in granular piles

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Abstract

Using a specially designed experimental set up, we have studied the so-called continuous to intermittent flow transition in sand piles confined in a Hele-Shaw cell where the deposition height of the sand can be controlled in addition to the input flow. Through systematic measurements varying the height and the input flow, we have established how the size of the pile at which the transition takes place depends on the two parameters studied. The results obtained allows to explain, at least semi-quantitatively, the observations commonly reported in the literature, carried out in experiments where the deposition height is not controlled.

Stress change and fault interaction from a two century-long earthquake sequence in the central Tell Atlas (Algeria)

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Abstract

We study the role and distribution of stress transfer that may trigger destructive earthquakes in the Central Tell Atlas (Algeria). A sequence of historical events reaching Ms 7.3 and related stress tensor with thrust faulting mechanism illustrates the Coulomb Failure Function (ΔCFF) modeling. We explore here the physical pattern for a stress transfer along the Tell thrust-and-fold belt taking into account an eastward trending earthquake migration from 1891 to 2003. The Computation integrated the seismicity rate in the ΔCFF computation, which is in good agreement with the migration seismicity. The stress transfer progression and increase of 0.1 to 0.8 bar are obtained on fault planes at 7-km-depth with a friction coefficient μ' 0.4 showing stress loading lobes on targeted coseismic fault zone and location of stress shadow across other thrust-and-fold regions. The Coulomb modeling suggests a distinction in earthquake triggering between zones with moderate-sized and large earthquake ruptures. Recent InSAR and levelling studies and aftershocks that document postseismic deformation of major earthquakes are integrated into the static stress change calculations. The presence of fluid and related poroelastic deformation can be considered as open questions on the occurrence of majors earthquakes in the north-central Algeria.

Evolution of the surface displacement field associated with the operational Mine De Potasse d'Alsace (MDPA) over the 1990's from InSAR-ERS observations

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Abstract

The Mine De Potasse d'Alsace (MDPA), located in the south of the Rhine graben near Mulhouse (France), was operational between 1904 and 2002. Two distinct layers were exploited at a depth of 635m and 655m and a thickness of 1-2m and 2-5.5m.

We used ERS SAR data acquired along two ascending and two descending tracks, to estimate the surface deformation during the exploitation phase. Because of the low interferometric coherence due to fields and forests, we used the Stanford Method for Persistent Scatterers (StaMPS) (Hooper & al, 2012) to track the displacements at permanent scatterers and follow the surface evolution using the time series analyses. Doing, we are able to cover around one third of the total surface above the full gallery network. The resulting surface LOS displacement fields are consistent with localised and fast vertical displacement. The maximum mean velocity is 36.5 mm/year but the velocity reached about 85 mm/year. The exponential behavior of the subsidence, observed through time series, explains the differences. At a specific place, an unexplained uplift is detected. We then compared our results to leveling data, provided by the MDPA. The displacement curves are nearly the same for both data set, except at some locations where the subsidence rate is above 100 mm/year.

After these first encouraging results, our future work will consist in the treatment of ENVISAT and Sentinel data to follow the displacement field during the post-exploitation phase. By adding to our InSAR data some in-situ measurements of the convergence speed, we aim to build a geomechanical model.

Effects of different Earth's structures on W-phase CMT parameters

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Abstract

The source inversion of the W-phase has demonstrated a great potential to provide fast and reliable estimates of the centroid moment tensor (CMT) for moderate to large earthquakes. It has since been implemented in different operational environments (NEIC-USGS, PTWC, etc.) with the aim of providing rapid CMT solutions. These solutions are in particular useful for tsunami warning purposes. Computationally, W-phase waveforms are usually synthetized by summation of normal modes at long period (100 – 1000 s) for a spherical Earth model (e.g., PREM). Although the energy of these modes mainly stays in the mantle where lateral structural variations are relatively small, the impact of 3D heterogeneities on W-phase solutions have not yet been quantified. In this study, we investigate possible bias in W-phase source parameters due to un-modeled lateral heterogeneities in the Earth structure. We generate a simulated dataset consisting of synthetic seismograms of large past earthquakes that accounts for Earth's 3D structure (3D velocity anomalies, topography and ellipticity). The W-phase algorithm is then used to invert this synthetic dataset for earthquake CMT parameters. The idea here is to investigate the effect of 3D structure on inverted source parameters. This is essential both to assess the accuracy of W-phase CMT solutions and to investigate how the effect of 3D lateral heterogeneities could be corrected in the future.

New results on the gravity monitoring of Soultz-sous-Forêts and Rittershoffen (Alsace, France) geothermal reservoirs

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Abstract

The exploitation of Rittershoffen and Soultz-sous-Forêts geothermal energy in the northern Alsace (France) began in May and June 2016. Soultz-sous-Forêts site is the first enhanced geothermal system demonstration site producing electricity in France (4 wells, ≈ 5km deep, 1.5MW, 165°C), while Rittershoffen site is dedicated to an industrial use for heat application (2 wells, 2.5km deep, 24 MWth, 160° C). In order to study underground mass redistributions and hence to follow a geothermal reservoir both in its natural state or undergoing man-made stimulations, time-lapse gravity measurements have been made since 2014. Each summer, weekly repetitions with a Scintrex CG5 gravimeter of a network of 13 stations at the two sites allow us to calculate the gravity double differences. These differences show the gravity variation at each measuring point compared to a reference time and station. The stability of the reference station is investigated both by using repeated measurements of absolute gravity and by doing regular links with the Strasbourg gravimetric observatory J9, where several superconducting gravimeters operate continuously. Thus, we approach the concept of hybrid gravimetry. Furthermore, to perform a rigorous vertical control which can impact our measurements, all gravimetric sites are leveled: the height changes are less than 1 cm. So, we can consider that our gravity variations are only due to Newtonian attraction. We notice that the gravity values are lower next to the production area than next to the injection area after the beginning in summer 2016 of the exploitation in Soultz-sous-Forêts site. Rittershoffen site emphasizes another trend that we don't yet explain. We hope to improve our geothermal site understanding thanks to the future measurements on the sites in Alsace but also to our new time-lapse gravity project in Iceland (Krafla and Theistareykir geothermal sites) that begins this summer.

Long-term monitoring of temperature using FO-DTS for indirect soil moisture observation in subsoil

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Abstract

The soil moisture monitoring is a great importance for various hydrological, agronomical and environmental studies, but it is more difficult to assess because it can be highly non-linear. As a function of thermal properties, the soil moisture can be estimated by temperature measurement and it is relevant in hydro-geophysics. By using soil temperature measurements with Fiber-Optic Distributed Temperature Sensing (FO-DTS), we indirectly estimate the soil water changes at high spatial and temporal frequency. In this research, we installed an observatory of soil temperature on a representative black marl slope of the long-term Draix-Bléone hydrological observatory (South French Alps, Réseau de Basins-Versants / RBV). A 350 m long reinforced fiber optic cable was buried at 0.05, 0.10 and 0.15 m of depths and installed at the soil surface. The total length of the monitored profile is 60 m, and it three different soil units consisting of argillaceous weathered black marls, silty colluvium under grass and silty colluvium under forest. Soil temperature is measured every 6 minutes at a spatial resolution of 0.50 m using a double-ended configuration. These changes indicate different processes of water infiltration at different velocities in relation to the presence of roots and the soil permeability. We further test several inversion strategies to estimate soil water content from the thermal diffusivity of the soils using simple and more complex thermal models. The soil moisture calculation was compared to direct soil moisture measurement and meteorology datasets. The work is supported by the research project HYDROSLIDE and the large infrastructure project CRITEX funded by the French Research Agency (ANR).

Interaction between deformation, magnetism and inheritance in a rifted margin around the Mozambique Channel

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Abstract

The magmatic processes related to rifting and the role of inheritance controlling the inception of extension and subsequent evolution remain poorly understood. This study aims to better constrain the occurrence of magma formed during and after the formation of a rift system and how the structural, compositional and thermal inheritance control the evolution of a rift system. In this context, the margins along the Mozambique Channel represents a perfect example where the influence of inheritance and magmatic evolution of a margin can be investigated. Interpretations of 2D-Seismic lines and mapping of genetic rift domains show structures orientation similar to the Karoo rift trends and/or Permian suture zone. Preliminary results also show a propagator between the Mozambique margin and the Beira High surprisingly aborted despite an important magmatic event. Thus, this margin presents a complex rift evolution preceding the lithospheric breakup which includes polyphase tectonic and magmatic events. Answering to the question of how far these events are related to inherited structures from Karoo age is one of the aims of the PhD. The first part of the study consisting in the compilation of existing data and interpretation of new data prepares the next studies that will characterize magmatic processes and the role of inheritance in channelling and localizing the tectono-magmatic evolution related to this margin. The key question addressed then is how the observed kinematic evolution of the margin and the final structure are the result of external events or controlled by internal processes.

The potential of the railway network to support the new territorial organization of the regions: modeling of prospective scenarios and accessibility measures on the French Greater East

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Abstract

The recent modification of the perimeter of the regions by the "NOTRe" law tends to give back to the regional space a coherent area regarding the evolution of the territorial practices and the spatial representations. However, the French Greater East region remains marked by the juxtaposition of three entities (Alsace, Lorraine, Champagne-Ardenne) of which each of them is operated with a specific dynamic.

The networking of these entities represents a means of ensuring a transversal functioning which could be a vector for a greater use of the regional railway network. This networking can be achieved through the rail network itself: the main instrument of territorial coherence through its dual capacity to support mobility and to condition its emergence.

A decision support tool will be developed in order to highlight the evolution of the network and the rail services which are needed to address these challenges. An approach by the schedule accessibility, which takes into account the train timetables, will enable the modeling of scenarios previously defined within the prospective part of the thesis.

The results will enable the exploration of strategies for the evolution of regional railway policy. By analyzing the contributions and consequences of some adjustments, a modeling of a new railway system that answer the initial problematic must be proposed.

Integrating urban and regional metabolism into territorial governance: data issues and restitution

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Abstract

The development of our societies is facing sustainability issues. Resources extraction and waste emissions have reached unsustainable levels, resulting in worrisome loss of ecosystem services and rarefaction of resources. Thus, assessment of human activity impacts has become a requirement in order to reduce theses impacts, without compromising a sufficient quality of life to which people aspire.

Territorial metabolism is one of the approaches for assessing theses impacts: we focus our attention on the inputs needs (goods, material or energy) of a territory (which can be a city, a region, a country), their transformation, and the ensuing outputs (waste or exported goods). This tackles environmental issues which are resulting of too high and more or less toxic material flows from our anthropic ecosystems to the natural one, and vice versa.

However, the approach has limits due to the complexity of data retrieval and analysis. Thus, the thesis aims to analyze the methods for evaluating territorial metabolism, through the different steps of data gathering, processing and restitution. This will highlight the difficulties, but it is also intended to enlarge the possible applications. We will explore methods to overcome the difficulties and to facilitate the actors over a territory to integrate this accounting into governance of the territories.

This work should allow for reducing efforts mobilized during the quantitative analysis of territorial metabolism, and for bringing more information with a better quality to the actors to help them in defining sustainable strategies. The methodological results will be applied regarding the case of the Grand-Est region.

Upper Pleistocene and Holocene chronostratigraphy and paleoenvironments in the south-western part of the Upper Rhine Graben: state of art, new methods and first results

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Abstract

Distribution and thickness of Quaternary formations in the Upper Rhine Graben, a Cenozoic intra-plate graben, depend of the graben structure and of associated tectonic movements. The sedimentary architecture is characterized by a superposition of alluvial formations in the subsiding central area and by alluvial terraces covered by loess deposits on the flanks of the bordering horsts. A lot of work has been devoted to these formations since the beginning of the twentieth century. However, it is still difficult to provide a conclusive regional overview of the last climatic cycle. This temporal scale is however fundamental to understand if archaeological sites locations is due to taphonomy or to human strategies. It is also fundamental for the characterization of northern Europe environmental variability to better understand the dynamics of both fauna and human occupations during middle and late Palaeolithic, Mesolithic and Protohistory.

A critical revision of literature and geological maps of the south-western part of the Upper Rhine Graben, in the Alsace plain and the Vosges foothills, combined with the study of available digital terrain models allow to define and to map about twenty entities characterized by their morphology and sedimentary sequence. In parallel, new studies in loess quarries permit to assess the main pedosedimentary trends in the region since the Eemian, whereas rescue archaeology test pits allow to assess their spatial variability, in terms of sedimentary budget and pedogenesis. First results constitute the sketch of a geomorphological and paleoenvironnemental evolution model in Alsace during the last climatic cycle.

1D and 2D reactive-transport simulations: the example of calcite dissolution.

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Abstract

Numerous studies about mineral dissolution have revealed huge discrepancies (several orders of magnitude) between the rates measured in laboratory and those observed in the field (“ the laboratory field discrepancy ”). However, dissolution rate laws determined from laboratory experiments are usually used to implement reaction terms in geochemical models. Hence, it is crucial to improve the understanding of this discrepancy in order to make realistic extrapolations to the field. Among the potential explanations for these differences, the role of intrinsic or extrinsic factors can be investigated. This study was dedicated to understand the effect of the chemical homogeneity of the aqueous fluid surrounding the mineral. Several experiments were run in flow-through reactors continuously stirred to obtain a dissolution rate law for (104) calcite face dissolution as a function of solution saturation. In our conditions, the results are not consistent with the transition state theory. A second experiment consisted in studying the dissolution of single crystals of calcite exposing their (104) face to the fluid in a column filled with zirconia beads to mimic a non-reactive porous medium (first step to understand the role of fluid chemical heterogeneity on the dissolution rate). The results highlighted a decrease of the dissolution rate compared to experiments carried out in continuously stirred reactors, and a dramatic difference between the reactivity of faces with identical orientations but either positioned face or back to the flow. This final experiment will be compared to 1D and 2D reactive-transport simulations highlighting the importance of flow characteristics in natural dissolution process.

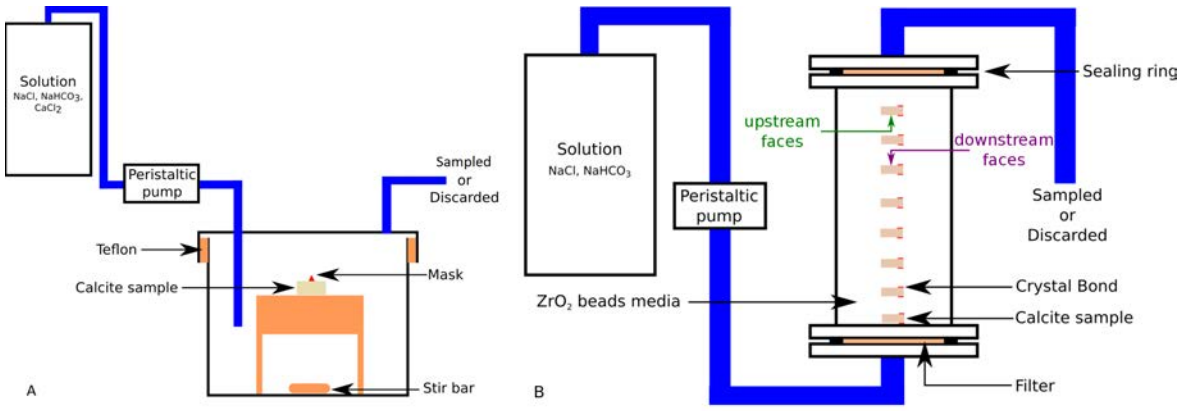

Figure 1: 1D and 2D reactive-transport simulations: the example of calcite dissolution.

A finite volume method applied to simulate water flow inside a fractures network

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Abstract

In the context of modeling the hydrodynamics of a regional karstic aquifer, it appears interesting to account for both diffuse regional flow in a fractured matrix and preferential flow associated with drain or fracture corridors.

An efficient way to simulate flow in a fractured system is dual porosity model overlapping two continua, one describing water and solute conveyed in fractures, as the other mimics storage in the matrix housing the fractures. That said, this approach is only applicable dense fracture networks and does no account for preferential flow paths irregularly spread over the modeled domain. In a first step of our investigations, we develop a pipe network simulating preferential flow that will be further coupled with a dual porosity system.

A finite volume method to compute flow within the pipe network is employed. This method is easy to use even on irregular and distorted mesh, as can be pipe networks superimposed onto a continuous domain. A full implicit time discretization ensures numerical stability of the discrete flow equations set up as a symmetric system matrix solved via the MA57 solver pack.

To evaluate the performance of the code, we designed calculation exercises checking on mass conservation at various scales, from nodes of the pipe network to the whole assemblage. In any configuration, the model revealed mass conservative, and guaranties a good base to pursue the work toward of the coupling between localized preferential flow and general flow of a dual porosity system. In this task, various physical and numerical forms of exchange terms (fluxes) between the compartments of the whole model will be tested.

From Phenomenological Studies to Well Layout Optimization: Illustration of a geothermal reservoir performance assessment methodological approach on a real case stud

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Abstract

High temperature geothermal systems are complex dynamic systems, which never are in initial hydrostatic conditions unlike petroleum reservoirs. Convective cells are naturally present, hot fluids tending to go up and colder fluids to go down. The geometry of the convective cells is governed by structural and geological heterogeneities and by the hydrogeological and geothermal boundary conditions. It follows that geothermal resource assessment cannot simply be summarized to estimate a stock of heat but it is strongly initial (current) condition dependent. It is also well-layout dependent, requiring first to optimize the well-layout based on production objectives. A methodological approach has been devised in the framework of the GEOTREF research project to address these issues. It takes into account reservoir uncertainties and well-layout optimization to numerically assess geothermal reservoir performances. The approach will be presented and illustrated on a real case study.

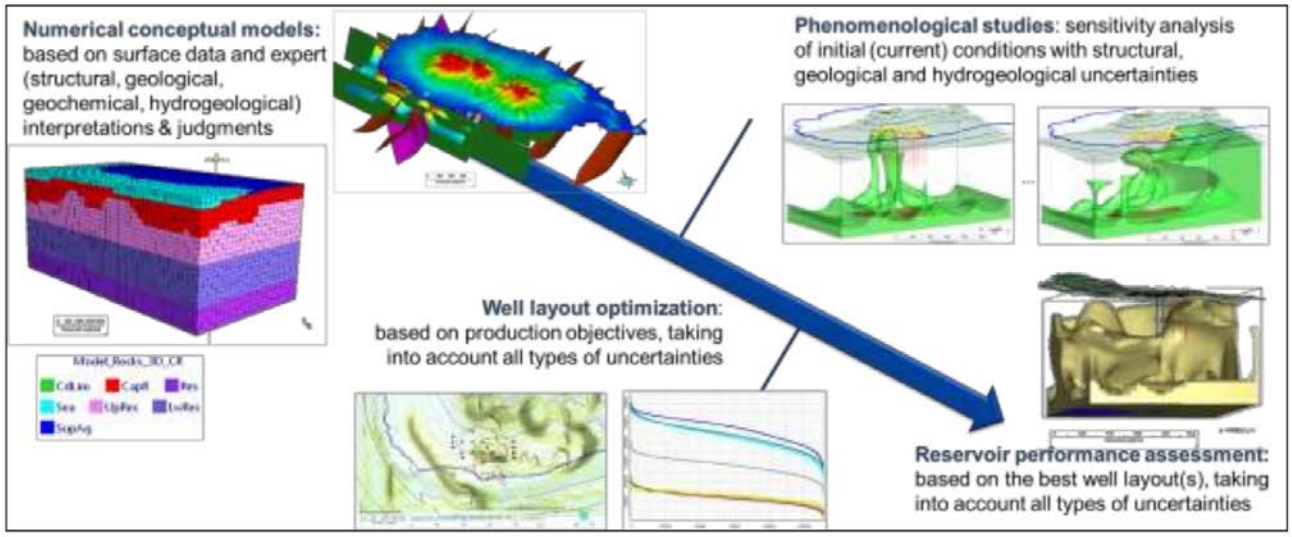

Figure 1: A four-step approach to assess geothermal resource at prefeasibility study stage (before drilling).

Development of an experimental way to better understand the evolution of fertility in low mountains ranges forest

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Abstract

Forests are subject to several natural and/or anthropogenic perturbations, over short and/or long terms. A better understanding of how a complex system can response to perturbations over time is key for a better management of natural and renewable resources.

Since 1970, major symptoms of sick forests had been observed worldwide. They started to appear in 1980 in the Vosges forest (France) and Black forest (Germany). These latter forests are mainly made of resinous trees, such as Picea, which trap the atmospheric pollution. An unexpected input of acidity from atmospheric pollution can totally modify the availability of nutrients in top soil and equilibrium between the different nutrient pools.

The site of studies is the Strengbach catchment, a forest ecosystem of 80 ha, located in the Vosges mountain. The main parameters of this site (climate, geochemistry, hydrology...) are monitored since 1986 by the Observatoire Hydro-Géochimique de l'Environnment (OHGE).

Various soil horizons from two different forest types were used in different experiments aimed at characterizing the chemical kinetics of nutriment availability. In particular, the importance of different parameters (such as temperature and pH), were tested to assess the evolution of fertility over time.

U and Sr isotopic ratios in surface and deep waters of the Strengbach catchment (Vosges Massif, France)

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Abstract

The localization and the characterization of the different hydrological compartments controlling the weathering of the critical zone is an important issue to evaluate and model properly the evolution of Earth surface in response to natural and anthropogenic forcing. In this study, we propose to better constrain the water rock interactions involved in the deeper part of the critical zone. Major and trace element concentrations, as well as $^{87}Sr/^{86}Sr$ isotope and $(^{234}U/^{238}U)$ activity ratios have been analyzed in water samples collected from boreholes drilled in the Strengbach watershed down to a depth of 50 to 100m on the both slopes of the watershed. The preliminary results obtained on these samples confirm the existence of contrasted geochemical and isotopic compositions between the deep borehole waters and the spring waters collected on the watershed. They also indicate for the borehole waters a clear geochemical distinction between "surface waters" (until 15m deep) circulating in hypodermic area, which have geochemical characteristics very close to those analyzed in spring waters, and deep waters flowing along fractures in the deeper part of the bedrock. Such a distinction is also well apparent when looking at Sr and U isotope ratios: surface waters are systematically marked by higher Sr isotope ratios and much smaller $(^{234}U - ^{238}U)$ disequilibrium, than deep borehole waters which have $(^{234}U/^{238}U)$ activity ratios between 1.3 and 2 depending on the considered borehole. Such contrasted U data suggest contrasted residence times of waters within the watershed and hence different circulation histories between surface and deep waters.

The challenges and the limitations in Life Cycle Impact Assessment for metal oxide nanoparticles: a case study on TiO2 NPs on terrestrial ecosystems and sediments

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Abstract

Nanoparticles are nano-objects between 1 and 100 nanometers in size. TiO_2 nanoparticles are used in several fields like construction, cosmetic and food which leads to an important production and inevitably to emissions generating environmental impacts. To quantify them, the Life Cycle Assessment is a powerful method that characterizes TiO_2 NPs according to their fate in environmental media and their effects on ecosystems and human health. The general aim of this thesis is to create a new calculation method in order to characterize TiO_2 NPs in terrestrial ecosystems and sediments. For this purpose, it requires to detect and quantify TiO_2 NPs in water, soil and sediment near a production site in Vieux-Thann (68) to determine parameters which act on TiO_2 NPs fate in soils. Then, it is necessary to determine parameters which act on TiO_2 NPs effects on terrestrial ecosystems by using a mesocosm experiment. It consists on reproducing physical and biological properties of the soil compartment though experimentations and expose species to TiO_2 NPs. Parameters determined in the previous steps will serve to analyze the relevance of the evaluation method of environmental impacts of pollutants (USEtox) and its adaptability to TiO_2 NPs. This calculation model established characterization factors of many organic and inorganic substances on a global scale regarding two impacts: aquatic ecotoxicology and human health. A reflection will be conducted to determine if this model is applicable for nanoscale substances such as TiO_2 NPs present in the terrestrial ecosystem at a local scale to develop a characterization factor.